

**IN THE HIGH COURT OF SOUTH AFRICA
(WESTERN CAPE DIVISION, CAPE TOWN)**

Case: 370, 23

In the matter between:

THE GREEN CONNECTION NPC

SOUTH AFRICAN FAITH COMMUNITIES

ENVIRONMENT INSTITUTE NPC

and

PRESIDENT OF THE REPUBLIC OF SOUTH AFRICA

MINISTER OF MINERAL RESOURCES & ENERGY

First Applicant

Second Applicant

First Respondent

Second Respondent

NOTICE OF MOTION

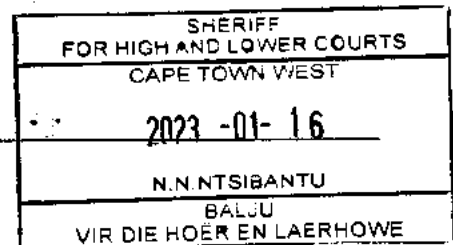
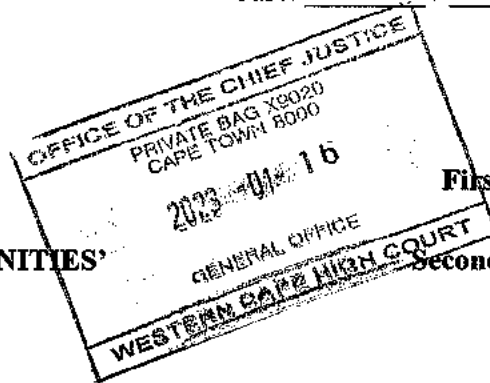
PLEASE TAKE NOTICE THAT:

1. The applicants apply to this court for the following orders:

- 1.1. The first respondent's ongoing failure to bring section 6 of the National Energy Act 34 of 2008 (section 6) into operation is reviewed and declared unlawful.
- 1.2. The second respondent's ongoing failure to advise the first respondent to bring section 6 into operation is reviewed and declared unlawful.
- 1.3. The respondents are ordered to do whatever is necessary to bring section 6 into operation within three months from the date of this order.

Chennells Albertyn Attorneys
18 Greenwich Grove, Station Rd, Rondebosch, 7700
021-6858354
andrew@chennellsalbertyn.co.za

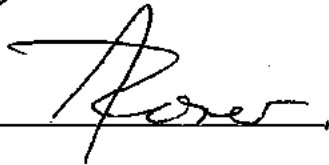
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- 1.4. The respondents are ordered jointly and severally to pay the applicants' costs.
- 1.5. The applicants are afforded alternative relief.
2. The applicants will rely on the accompanying affidavits of Kholwani Simelane and Francesca De Gasparis
3. The applicants will accept notice and service of all documents in these proceedings at the address of their attorneys of record mentioned below.
4. The first respondent is hereby called upon,
 - 4.1. to show cause why his ongoing failure to put section 6 into operation should not be reviewed and declared unlawful; and
 - 4.2. within fifteen days after receipt of this application, to despatch to the Registrar the record of his ongoing failure to put section 6 into operation together with such reasons as he is by law required or desires to give and to notify the applicants that he has done so.
5. The second respondent is hereby called upon,
 - 5.1. to show cause why his ongoing failure to advise the first respondent to put section 6 into operation should not be reviewed and declared invalid; and
 - 5.2. within fifteen days of receipt of this application, to despatch to the Registrar the record of his ongoing failure to advise the first respondent to put section 6 into operation together with such reasons as he is by law required or desires to give and to notify the applicants that he has done so.
6. The applicants may, within ten days after the Registrar has made both records available to them, amend their notice of motion and supplement the founding and confirmatory affidavits.
7. If you wish to oppose this application, you must,

- 7.1. within fifteen days after receiving this application or any amendment or supplement of it, give the applicants notice of your intention to oppose and appoint an address within fifteen kilometers of the office of the Registrar at which you will accept notice and service of all documents in these proceedings; and,
- 7.2. within 30 days after expiry of the time referred to in rule 53(4), file your answering affidavits, if any.
8. If you do not oppose this application, it will be heard on a date determined by the Registrar.

DATED at RONDEBOSCH this 13TH day of January 2023.



Per : A J Dorer

CHENNELLS ALBERTYN ATTORNEYS

Attorneys for the Applicants

18A Greenwich Grove

Station Road

Rondebosch

Cape Town

7700

Tel: (021) 685 8354

Email: andrew@chennellsalbertyn.co.za

Ref: 11017AD

TO:

Chennells Albertyn Attorneys
18 Greenwich Grove, Station Rd, Rondebosch, 7700
021-6858354
andrew@chennellsalbertyn.co.za

THE REGISTRAR OF THE ABOVE HONOURABLE COURT

Western Cape Division, Cape Town

AND TO:

PRESIDENT OF THE REPUBLIC OF SOUTH AFRICA

FIRST RESPONDENT

Care of The State Attorney (Cape Town)

Floor 4, Liberty Life Ctr

22 Long St

Central

Cape Town

8001

AND TO:

MINISTER OF MINERAL RESOURCES AND ENERGY

SECOND RESPONDENT

Care of The State Attorney (Cape Town)

Floor 4, Liberty Life Ctr

22 Long St

Central

Cape Town

8001

Chennells Albertyn Attorneys
18 Greenwich Grove, Station Rd, Rondebosch, 7700
021-6858354
andrew@chennellsalbertyn.co.za

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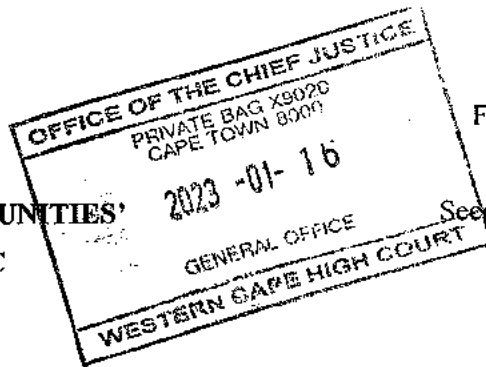
MINISTER OF MINERAL RESOURCES AND ENERGY

First Applicant

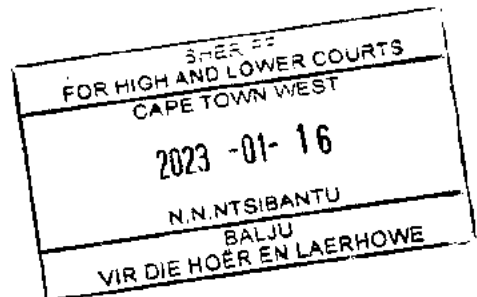
Second Applicant

First Respondent

Second Respondent



FOUNDING AFFIDAVIT



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I, the undersigned,

KHOLWANI SIMELANE

do hereby make oath and state:

1. I am an adult environmentalist and the Advocacy Officer of the First Applicant (**Green Connection**).
2. The facts in this affidavit are true and correct. They are within my personal knowledge and belief, unless otherwise stated or apparent from the context. Where I refer to information conveyed to me by others, I state the source and believe that information to be correct. Where I make legal submissions, I do so on the advice of Green Connection's legal representatives, whose advice I believe to be correct.
3. I am duly authorised to bring this application on behalf of Green Connection. I attach a resolution to that effect as "KSI 1".
4. This application is supported by South African Faith Communities Environment Institute (**SAFCEI**), which is the Second Applicant. The affidavit of **FRANCESCA DE GASPARIS**, the Executive Director of SAFCEI, will accompany my affidavit.

INTRODUCTION AND ISSUES

5. The National Energy Act 34 of 2008 (**Act**) became law when the President assented to it on 17 November 2008. Rather than coming into operation upon publication, the Act delegated to the President the power to bring its provisions into effect by proclamation

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in the *Gazette*. The President has brought all provisions of the Act—except section 6—into operation.

6. Green Connection and SAFCEI apply to this Honourable Court to have the President's ongoing failure or refusal to bring section 6 into operation judicially reviewed. And seek an order compelling the President to take the necessary steps to bring section 6 into effect.
7. Section 6, if brought into operation, would oblige the Second Respondent (**Minister**) to develop an Integrated Energy Plan (**IEP**), to consult the public on a draft IEP, and to review and update an adopted IEP annually. An IEP is meant to provide a roadmap of the future energy landscape for South Africa and to guide future energy infrastructure investments and policy development.
8. The Minister and Department of Energy (**Department**) researched the formulation of the IEP, published a draft for public comment in 2016, and have reportedly worked on the draft IEP since. Yet the Minister has still not advised the President to bring section 6 into operation. And the President, in turn, has unlawfully deferred to the Minister.
9. The Minister's justification is based on a misinterpretation of section 6. Green Connection thus also seeks judicial review of the Minister's failure or refusal to advise the President to bring it into operation. The reasons for the Minister's resistance to bringing section 6 into effect accordingly taint the President's conduct with unlawfulness.

10. Section 6 has been ready to commence since the Department began researching and preparing the draft IEP. There is thus no rational basis for the President to withhold his exercising delegated power to bring section 6 into operation. Doing so would merely found a statutory duty on the Minister to do what the Department has been, and is already doing—developing the IEP.
11. That section 6 is not yet operative impedes parliamentary oversight. The Department's engagements with the National Assembly's Portfolio Committee on Mineral Resources and Energy (**Portfolio Committee**) reveal that Parliament assumes that section 6 is operative, as much as it has sought to hold the Minister and his predecessors accountable for the delay in finalising an IEP. But delay does not arise absent a duty.
12. Withholding the operation of section 6 also impacts on South Africa's response to its energy crisis. Government has been exploring alternative energy sources, with many controversial options being considered. But none of these options has been guided by an IEP, as the Act envisions. And public input on how those energy choices should be informed has effectively been precluded, frustrating a key purpose of the Act.

PARTIES

Applicants

13. Green Connection is a non-profit company, incorporated under section 14 of the Companies Act 71 of 2008 and registered under the Non-Profit Organisations Act 71 of 1997. Green Connection has its registered office at Unit B1 Clareview Business Park, 236 Imam Haron Road, Claremont, Cape Town.

14. Green Connection's objective, in terms of its memorandum of incorporation (MOI), is socio-economic wellbeing. The preamble to its constitution records that Green Connection believes that economic growth and development, improvement of socio-economic status and conservation of natural resources can occur only in a commonly understood framework of sustainable development.
15. I have attached copies of Green Connection's MOI, certificate of registration as a non-profit organisation and constitution as "KSI 2", "KSI 3" and "KSI 4" respectively.
16. Green Connection seeks to provide practical support to governmental and non-governmental sectors in pursuit of sustainable development. It undertakes research at grassroots level to critique energy and climate change project implementation, to compile technical reviews, to campaign for renewable energy, and to produce educational materials on energy and climate change issues.
17. Green Connection focusses on the interface among energy governance, planning and sustainable development. It participates in local initiatives to promote transition to a just energy future.
18. Green Connection is a South African partner of Electricity Governance Initiative International (EGI). EGI is a global initiative of civil society, policy-makers, regulators and other electricity sector actors. The members collaborate to promote open, transparent and accountable decision-making processes required for a socially and environmentally sustainable energy future.

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19. Green Connection is also part of Energy Governance – South Africa, a civil society network that meets to discuss current energy challenges and how organisations can collaborate to address them.
20. Green Connection therefore has standing to bring these proceedings. It does so as an environmental organisation acting in its own interest and in the public interest, in terms of section 38(a) and (d) of the Constitution.
21. SAFCEI is a multi-faith organisation, committed to supporting faith leaders and their communities in Southern Africa. Its registered address is The Green Building, 9B Bell Crescent Close, Westlake Bus, Tokai, Western Cape, 7945. I attach a copies of SAFCEI's Memorandum of Incorporation, Certificate of Registration as a Non-Profit Organisation, and Certificate of Confirmation by the Companies and Intellectual Properties Commission, as annexures "KSI 5", "KSI 6" and "KSI 7".
22. SAFCEI emphasises the spiritual and moral imperative to care for the Earth and the community of all life. It aims to increase awareness, understanding and action on eco-justice, sustainable living and climate change.
23. One of SAFCEI's focus areas is energy justice. Its vision is for South Africans to have accessible, affordable and sustainable energy, and for faith leaders and communities from other countries to learn from South Africa's experience. SAFCEI is committed to ensuring that people of faith are informed about energy choices and the right to participat in energy decisions that affect them. It endeavours to hold the state accountable to its citizens for energy policies and processes.

24. SAFCEI has standing to bring these proceedings. It does so as an environmental organisation acting in its own interest and in the public interest, in terms of section 38(a) and (d) of the Constitution.

Respondents

25. The President is the head of the national executive and Head of State. The President's official residence is at Tuynhuys, Plein Street, Cape Town. The President is cited as the bearer of the power to bring section 6 of the Act into operation.
26. The Minister's official seat is at the Department of Mineral Resources and Energy, 192 Visagie Street (Corner Paul Kruger & Visagie Street), Pretoria. The Minister is cited as the member of Cabinet who administers the Act and who advises the President on whether to bring section 6 into operation.
27. Service of this application will be effected on the President and Minister at the offices of the State Attorney (Cape Town), Floor 4, Liberty Life Center, 22 Long St, Central, Cape Town.
28. The Honourable Court has jurisdiction to determine this matter.

LEGISLATIVE HISTORY AND RELEVANT PROVISIONS

29. The National Assembly (NA) passed the National Energy Bill (B52-2008) on 21 August 2008. The National Council of Provinces passed the Bill on 25 September 2008. The Bill was then sent to the President for assent, in terms of section 79 of the Constitution.

30. The President assented to and signed the Bill on 17 November 2008. On that date, the Bill became the Act, in terms of section 81 of the Constitution. The Act was published in the *Government Gazette* on 24 November 2008.

31. By enacting section 21, Parliament conferred the power on the President to bring the Act, or particular provisions, into operation on dates that the President determines by proclamation. Section 21 provides:

'21 Short title and commencement

- (1) This Act is called the National Energy Act, 2008 and comes into operation on a date determined by the President by proclamation in the *Gazette*.
- (2) Different dates may be so fixed in respect of different provisions of this Act.'

32. The President has brought all the provisions of the Act into operation, except one: section 6. The President brought—

32.1. sections 17 to 19 into operation on 1 April 2009;

32.2. sections 7 to 16 into operation on 1 April 2011; and

32.3. sections 1 to 5, 20 and 21 into operation on 1 March 2012.

33. Section 6 is the key component for integrated energy planning. Despite that, it does not yet have the force of law. It provides:

'6 Integrated energy planning

- (1) The Minister must develop and, on an annual basis, review and publish the Integrated Energy Plan in the *Gazette*.
- (2) The Integrated Energy Plan must deal with issues relating to the supply, transformation, transport, storage of and demand for energy in a way that accounts for—
 - (a) security of supply;

- (b) economically available energy resources;
 - (c) affordability;
 - (d) universal accessibility and free basic electricity;
 - (e) social equity;
 - (f) employment;
 - (g) the environment;
 - (h) international commitments;
 - (i) consumer protection; and
 - (j) contribution of energy supply to socio-economic development.
- (3) The Integrated Energy Plan must—
- (a) take account of plans relating to transport, electricity, petroleum, water, trade, macro-economy energy infrastructure development, housing, air quality management, greenhouse gas mitigation within the energy sector and integrated development plans of local and provincial authorities;
 - (b) inform and be informed by plans from all supply, production and demand sectors whose plans impact on or are impacted by the Integrated Energy Plan; and
 - (c) be based on the results of the energy analysis envisaged in sections 3 (4) (a) and 3 (5).
- (4) The development of the Integrated Energy Plan must take into account—
- (a) sustainable development;
 - (b) optimal use of indigenous and regional energy resources;
 - (c) balance between supply and demand;
 - (d) economic viability;
 - (e) environmental, health, safety and socio-economic impacts; and
 - (f) developmental requirements of the Southern African region.
- (5) The Integrated Energy Plan must have a planning horizon of no less than 20 years.
- (6) The Integrated Energy Plan must—
- (a) serve as a guide for energy infrastructure investments;
 - (b) take into account all viable energy supply options; and
 - (c) guide the selection of the appropriate technology to meet energy demand.
- (7) Before finalising the Integrated Energy Plan, the Minister must—
- (a) invite public comments; and

(b) duly consider such comments.'

34. If section 6 were in effect, the following duties would arise:

34.1. First, the Minister would be obliged to develop an IEP. Without that statutory duty, Parliament cannot hold the Minister accountable for not producing an IEP in terms of section 6. Any development of a policy instrument which simulates an IEP would not stem from the legislative will embodied in section 6.

34.2. Secondly, before finalising an IEP the Minister would have to invite and consider public comments on a draft IEP. The IEP, after all, is meant to ensure delivery of energy services to the public and the attainment of policy objectives, which balance varied political interests and where market activity alone might not yield optimal solutions to energy sector challenges.

34.3. The purpose of consultation is to give the public a chance to influence the content of the IEP. Because the IEP is meant to guide decisions on investments in publicly and privately owned structures used for the production, transformation, conversion, transportation and distribution of energy carriers, it will ultimately affect the public and draw from the public purse.

34.4. The selection of supply options and appropriate technologies should be geared towards meeting energy demand, which the public partly drives.

34.5. The public will be affected by the IEP's impact on the affordability of other energy sources and services, the protection of consumers, the equitable

distribution of energy, the environment and intergenerational environmental equity, and employment and socio-economic development, among other things.

34.6. The IEP's influence on access to free basic electricity will affect poor households in particular.

34.7. Thirdly, the Minister would have to make sure that an IEP addresses the subject matter listed in section 6(2), (3) and (4).

34.8. Developing an IEP would entail a coordinated and integrated approach, linked to other planning tools. Cross-sectoral impacts will be relevant to designing long-term energy strategies (of at least 20 years). Factoring in the inter-relationships among sectors is likely to promote the IEP's long-run sustainability and efficacy.

34.9. The IEP would need to respect South Africa's international commitments, including global environmental commitments in responding to climate change. Sustainable development is a key consideration for the IEP under section 6.

34.10. Given that South Africa's current energy supply depends heavily on coal and oil which are both fossil fuels (the consumption of which for energy-generation contributes significantly to CO₂ emissions), sustainable development in the energy sector must conform to international and domestic climate change responsibilities and strategies.

34.11. Parliament, therefore, had in mind section 24(b) of the Constitution when passing the Act. The Act is a legislative measure for preventing pollution and

promoting sustainable development; and an IEP under section 6 would be another measure geared towards those objectives.

34.12. Fourthly, the IEP is meant to be adaptive and evolving. Section 6 would therefore require the Minister to review and update it annually, to maintain its relevance.

34.13. The IEP should also be based on pertinent energy data, analyses and statistics. The analyses must review past energy demand and supply, forecast energy demand and supply for the next 20 years, and anticipate plausible energy scenarios. Since the assumptions about future demand and supply are likely to change due to technological advancements and the climate change crisis, the Act caters for ongoing updates to, and refinement of, the IEP.

34.14. Fifthly, the IEP should guide all energy infrastructure development, both private and public. It should inform how technology is selected to meet energy demand. And it must do so having regard to all viable energy supply options. These obligations would apply not only to the Minister, but also to all actors in the energy sector.

35. But because the President has not brought section 6 into operation, none of those duties relating to the IEP can arise.

36. The President's reasons for not yet bringing section 6 into effect, and the Minister's reasons on which the President has depended, now bear scrutiny.

REASONS FOR THE PRESIDENT'S FAILURE

Correspondence with the President and Minister

37. Green Connection, through its legal representative Adrian Pole, wrote to the President on 24 November 2020. I attach as “**KSI 8**”, the letter to the President.
38. It noted that the Minister of Minerals and Energy, Mr Gwede Mantashe MP, committed the Department to publishing the IEP before the end of the parliamentary year ending in 2020. But Green Connection was concerned that the Minister's commitment would be meaningless, as the President had not yet brought section 6 into operation. Indeed, almost two years on, there is still no IEP.
39. Green Connection stressed the importance of the Act and the envisioned IEP in shaping the country's energy future, economic growth and poverty alleviation, and energy planning. And it expressed concern over several energy-related plans and programmes that were being conceived and implemented without an IEP to guide them.
40. The plans and projects included the Integrated Resource Plan, 2019, renewable energy programmes, energy from gas programmes and related infrastructure, oil and gas exploration, and possible nuclear build programme. Green Connection emphasised the significance of having these plans and programmes guided by an IEP, developed in terms of the Act, having regard to the country's energy future and climate change.
41. Green Connection asked the President to bring section 6 into effect or to give reasons for not doing so.

42. The Presidency acknowledged receipt of Green Connection's letter, "KSI 8", but directed Green Connection *'to liaise with the Ministry of Mineral Resources and Energy as the best place office to engage with'*. I attach as "KSI 9" the Presidency's email of 27 November 2020.
43. Green Connection responded to the President's email through its legal representative. I attach as "KSI 10", that letter to the President, dated 7 December 2020.
44. The letter explained that Green Connection would engage with the Department, if it published an IEP. But the real issue was that section 6 had not been brought into effect—something which only the President could do under section 21. Green Connection repeated its request for the President to bring section 6 into operation urgently or to explain fully his reasons for not doing so.
45. The Presidency responded on 14 December 2020. I attach as "KSI 11" the letter from the Acting Head: Legal and Executive Services Unit. It explained:

'Your letter has been referred to the Legal and Executive Services Unit for further processing and response.

In terms of the government administrative processes relating to the proclaiming of the commencement date of the Act or particular section(s) of the Act, the relevant Minister / relevant national government department which administer (sic) the Act will advise the President of its readiness to implement such Act or particular section(s) of the Act.

The Minister of Mineral Resources and Energy has not yet recommended to the President to bring section 6 of the National Energy Act, 2008 into operation.

Your letter was referred to the Department of Mineral Resources and Energy for further advice. We will revert to you as soon as we receive the response (sic) Mineral Resources and Energy.'

46. Green Connection's legal representative acknowledged receipt of the Presidency's letter "KSI 11". By February 2021, Green Connection had received no response to its

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request, so it requested an update from the Acting Head: Legal and Executive Services Unit in the Presidency on 12 February 2021. I attach as “KSI 12” both emails to the Presidency.

47. Having had no response for over a month, Green Connection’s legal representative wrote to the Presidency again on 24 March 2021. He requested an update on the Department’s response to Green Connection’s request to the President. I attached as “KSI 13” the email to the Presidency.

48. The Principal State Law Advisor in the Presidency responded on 26 March 2021. He advised that, at his request, the Department would follow up and revert. He would then convey the response to Green Connection. I attach as “KSI 14” the email from the Presidency.

49. By June 2021 no response from the Presidency or Department had been forthcoming. Green Connection addressed another letter to the President through its legal representative on 17 June 2021. I attach as “KSI 15” a copy of that letter.

50. Green Connection conveyed its concern over controversial energy- and electricity-generation plans and programmes, including procurement programmes, that the Department was pursuing without the benefit of an IEP.

51. It welcomed the President’s announcement that government would increase the threshold for companies to produce their own electricity without a licence and the Presidential Climate Change Coordinating Commission’s efforts to facilitate transition to a low carbon economy. But these developments still pointed to the need for an IEP.

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52. Green Connection cautioned that the President could not refuse to exercise the power in section 21 effectively to veto section 6 and block its implementation. The Act was passed in 2008 and section 6 *'could [have been] brought into effect by the President within a shorter period of time.'*

53. Once again, Green Connection repeated its request to the President to bring section 6 into effect or to give full reasons for not doing so.

54. The Department at last responded on 21 July 2021. I attach as "KSI 16" its correspondence to Green Connection's legal representative. The Department stated:

54.1. An understanding of sector-specific constraints, through undertaking detailed sector studies and analysis, is important for developing the IEP. The Department, together with relevant State Entities, *'has undertaken . . . sector plans'* for that purpose.

54.2. Six sector plans were relevant:

- '1. Electricity Distribution Industry Asset Assessment;
2. Electricity Transmission Plan;
3. Electricity Generation Plan (Integrated Resource Plan (version 2010 and 2019));
4. Draft liquid fuels master plan (a 20-year liquid fuel infrastructure roadmap) which deals with logistical issues relating to pipelines and storage facilities for petroleum products;
5. Draft Gas Utilization Masterplan (GUMP 2015); and
6. Gas Master Plan (GMP 2022) (currently under development).'

54.3. Once Cabinet approves all six sector plans, they will be fed back into the IEP process. This *'will enable overall enhancement and an integrated approach to*

South Africa's energy planning process. The draft IEP was published in 2015 and the idea is to improve this draft with inputs from the above sector plans in order for the IEP to be technically sound and based on credible, factual data.'

54.4. Once Cabinet approves the IEP, based on the six sector plans, the IEP will then inform future iterations of the sector plans. The IEP will therefore function as an *'overarching country energy policy.'*

54.5. The President should consider bringing section 6 into force only after the six sector plans have been completed (or are near completion) and approved by Cabinet.

54.6. The anticipated development of the sector plans and approval by Cabinet would take about six months; internal government consultations would take about three months; and public consultations would take about two months. Internal technical modelling, report drafting and editing would then follow.

54.7. *'Bringing section 6 into effect prior to completing the relevant sector plans could result in the Department failing to comply with the prescribed timelines for the development and review of the IEP, for reasons outlined above.'*
(Emphasis added.)

55. Following the Department's letter, Green Connection sought legal advice from counsel (which is legally privileged) and, with the assistance of its legal representatives, conducted research into the six sector plans, which informed the correspondence

discussed below. It engaged Chennells Albertyn Attorneys to assist with possible litigation.

56. Green Connection replied to the Department's letter of 21 July 2021 through its legal representative on 27 October 2021. I attach as "KSI 17" a copy of the letter. Green Connection could not establish the status of five of the six listed sector plans. The only sector plan available was the Integrated Resource Plan (IRP) (version 2010 and 2019). Online research into the status of the other sector plans was inconclusive.
57. The letter sought confirmation that the six sector plans were the only sectors plans, in the Department's view, that needed to be completed and approved by Cabinet before the President would consider bringing section 6 into operation; an indication of whether other sector plans were also considered pre-requisites; and the way to access all relevant sector plans. It asked whether the Minister had published an analysis of energy data, in terms of sections 3(4)(a) and 3(5) of the Act.
58. On the same day, Green Connection had its legal representative write to the President. I attach as "EMJ 18" a copy of the letter. It apprised the President of Green Connection's exchanges with the Department.
59. Green Connection sought clarity on whether the Department had informed the President of its readiness to implement section 6 or whether its reasons for recommending that section 6 not yet be brought into effect had been communicated to, and considered by, the President.

60. While the President may receive and act on advice from the Minister on government's readiness to implement a provision of an act, Green Connection explained, the President remains the functionary in whom Parliament vested the discretion to bring provisions of the Act into force. The President must personally and independently exercise his discretion for the purpose for which Parliament conferred the power on him.

61. Green Connection highlighted that the letter from the Presidency dated 14 December 2020, "KSI 11" shed no light on '*the detailed considerations taken into account by the President*' in deciding not to bring section 6 into effect or on whether the President would bring section 6 into effect without the Minister's or Department's recommendation to do so.

62. The letter then set out why Green Connection believed the Department's reasons for considering it inappropriate to bring section 6 into operation sooner were flawed.

62.1. Nothing in the Act makes the finalisation of sector plans a pre-requisite for developing an IEP. It would be irrational for the President to depend on the Minister to finalise '*[the] policy*' (i.e., the IEP) before bringing section 6 into operation.

62.2. Section 6 envisions an IEP accounting for plans in various sectors, informing and being informed by them, and being updated annually based ongoing energy analysis. This was no reason to hold back on triggering the duty to start that process.

- 62.3. The Department's understanding of the relationship between the sector plans and an IEP was illogical. Making each depend on the other would not be rational.
- 62.4. None of the sector plans that the Department referred to has any legislated deadline. The risk was that the development of the IEP, on the Department's own version, could be delayed endlessly.
- 62.5. Not bringing section 6 into effect frustrates the purpose of the Act. It hampers ensuring the availability and affordability of diverse energy resources, environmentally sustainable economic development and poverty alleviation, and energy planning that promotes renewable energies and investment and upkeep of energy infrastructure.
63. Green Connection considered the inoperative status of section 6 to be the cause of poor energy planning for over a decade. It identified the following unguided projects as concerns, based on the Department's advice:
- '[A] request for proposals to procure up to 2000 MW of electricity generation capacity in an effort to address the current energy shortfall, and expediting of policy implementation of the capacity under the IRP2019 to procure generation capacity from various sources (renewable energy, hydro, gas to power, storage and coal). Additional examples include the [Department's] planned commencement of a new 2500MW nuclear new build programme, as well as its liquid natural gas (LNG) infrastructure programme. This risks locking South Africa in to long-term energy infrastructure developments and electricity generation programmes, without being guided by an IEP developed in accordance with section 6 of the NEA.'
64. The letter concluded by asking whether the President still intended to take no steps until the Department recommended that he bring section 6 into operation. And it queried

whether the President was aware of the Department's justification that bringing section 6 into operation before the six sector plans had been finalised and approved by Cabinet would supposedly breach '*the prescribed timelines for the development and review of the IEP.*'

65. The Presidency acknowledged receipt of Green Connection's letter later on 27 October 2021. I attach as "KSI 19" the email from the Principal State Law Advisor in the Presidency.
66. On 9 November 2021 the Green Connection's legal representative wrote to both the Department and President requesting responses to its letters of the 27th October 2021, in respect of the responses and clarifications required in those letters. Both the letters of 9 November 2021 are attached as "KSI 20".
67. The Presidency acknowledged receipt of Green Connection's letter later that day. I attach as "KSI 21" the email from the Principal State Law Advisor in the Presidency, who advised that the matter was receiving attention and that he would revert. But the Presidency never did.

PAIA request and appeal

68. Green Connection therefore made a request for access to information under the Promotion of Access to Information Act 2 of 2000 (PAIA). I attach as "KSI 22" a list of the documents requested. By this stage, Green Connection had instructed an additional attorney, Mr Andrew Dorer of Chennells Albertyn Attorneys.

69. The Acting Chief Operations Officer and Deputy Information Officer in the Presidency advised Green Connection on 2 March 2022 that the Presidency would be transferring the PAIA request to the Department. I attach as “KSI 23” the Presidency’s letter dated 1 March 2022 and covering email.
70. I also attach as “KSI 24” the Presidency’s letter to the Director-General of the Department, which transferred Green Connection’s PAIA request.
71. But the Department ignored the PAIA request. Green Connection therefore lodged an internal appeal under Part 4 of PAIA on the 31st May 2022, on the basis of a deemed refusal. But the Department similarly ignored it.
72. Green Connection has now been compelled to rely on Rule 53 in these proceedings to access the record of the President’s and Minister’s conduct.

Invitation to the President to avoid litigation

73. In a final attempt to spur the President into bringing section 6 into force, Green Connection wrote to him on 2 November 2022. I attach as “KSI 25” my letter to the President. I set out the history of fruitless engagements with his office and the Department, spanning almost two years, summarised the legal basis for seeking the review of his inaction, and extended an invitation to him to avoid litigation by exercising his power under section 21 in respect of section 6.
74. I received no response from the Presidency. This litigation therefore became necessary.

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GROUNDS OF REVIEW

75. A decision by the President under section 21 to bring other provisions of the Act into operation amounts to an exercise of public power. Conversely, failure or refusal to take that decision is also an exercise of a public power. Whatever the President does with the power in section 21 must accord with the principle of legality.
76. The principle of legality requires that all exercises of public power must be performed lawfully and rationally. It is an incident of the rule of law—section 1(c) of the Constitution.
77. As to lawfulness, the basis on which the President's failure or refusal to bring section 6 into effect must be supportable in terms of the Act. As to rationality, the President's failure to bring section 6 into effect must bear a rational relationship to the purpose for which Parliament delegated that power to him and to the reasons for the decision.
78. Parliament delegated the power under section 21 to the President alone. He must personally exercise the power, after satisfying himself that the circumstances which warrant discharging it exist. Although the President may rely on the advice of the Minister, he may not pass the buck.
79. If the President acts on the Minister's advice on whether to bring section 6 into effect, the President's conduct must be assessed against the Minister's reasons and any other factors that the President considered. To the extent the President considered and relied upon the Minister's advice, his decision must stand or fall by the Minister's reasons.

80. In this section Green Connection sets out the grounds for contending that the Minister's advice and the President's ongoing failure or refusal to bring section 6 into operation based on the Minister's advice are reviewable and invalid. There are five grounds of review:

80.1. First, the President is in breach of a duty inherent in section 21 by abdicating his responsibility to the Minister to determine whether to bring section 6 into force. Accordingly, his conduct is invalid and reviewable.

80.2. Secondly, the Department and Minister's reasons for not advising the President to bring section 6 into effect were materially influenced by an error of law—they misinterpreted section 6(1). In turn, the President's conduct is invalid and reviewable.

80.3. Thirdly, the Department and Minister rely on non-existent pre-conditions for developing an IEP, which has no basis in the Act. In turn, the President's inaction based on their material legal error is invalid and reviewable.

80.4. Fourthly, the Department and Minister's view that section 6 is not ripe for implementation is not rationally related to the information before them or to their conduct. Had the President exercised his discretion under section 21, he could not rationally have supported their conclusion. His conduct is thus invalid and reviewable.

80.5. Fifthly, the President's ongoing failure or refusal to bring section 6 into effect undermines an object of the Act and Parliament's oversight functions. It is therefore irrational, invalid and reviewable.

First ground: President's breach of duty entailed by section 21

81. Section 21 confers on the President the power to bring provisions of the Act into operation. This is a delegated power which imports a duty. The duty is two-fold:

81.1. First, the President must determine whether circumstances permit the legislation to function effectively if brought into operation.

81.2. Secondly, once the President is satisfied that those circumstances exist, he must bring the relevant provisions into operation.

82. The President's discretion to exercise this power is narrower than his power to assent to Bills under section 79 of the Constitution. The power under section 21 of the Act must be exercised for the purpose for which Parliament conferred it: to ensure that the Act can be implemented upon commencement.

83. Parliament could have stipulated a commencement date itself, in terms of section 81 of the Constitution, but it delegated that function to the President instead. It did so because it regarded the President as appropriately suited to gauge the practicability of implementing the Act after assent. If it were practically impossible to implement the Act (or sections of it) because of prevailing circumstances, then it could not rationally be brought into operation.

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84. The President is free to select the factors he considers relevant in deciding whether it would be appropriate to bring provision of the Act into effect. And he may rely on advice from the Minister, who is in charge of administering the Act. But ultimately he must exercise the discretion that Parliament conferred on him personally.
85. Here, the President has failed to discharge the first duty, to satisfy himself that the circumstances are appropriate—or, in this case, inappropriate—for bringing section 6 into effect. Rather, he has left it to the Minister to make that call.
86. In deferring to the Minister on whether to bring section 6 into effect, the President has unlawfully abdicated the responsibility that Parliament conferred on him under section 21.
87. The unlawful abdication consequently invalidates the President's ongoing failure or refusal to bring section 6 into operation, in that he has failed to exercise his discretion. The President's conduct therefore falls to be reviewed and declared invalid, in terms of section 172(1)(a) of the Constitution.

Second ground: Department and Minister's reasons materially influenced by misinterpretation of section 6(1)

88. The Minister claims that unless the six sector plans, listed in paragraph 54.2 above, have been completed (or are near completion) and approved by Cabinet before bringing section 6 into effect, the Minister risks breaching the '*prescribed timelines for the development and review of the IEP*'. Accordingly, the Minister believes that the President should await the six sectors plans before bringing section 6 into effect.

89. However, section 6 prescribes no timeframe for the initial development of an IEP. The Minister is therefore mistaken in law.
90. Once section 6 is brought into operation, and the obligation to develop an IEP arises, the Minister must discharge that obligation within a reasonable time. What is reasonable will depend on the prevailing circumstances.
91. The duty to review and update the IEP every year arises only after the IEP is first published. As much as the Department and the Minister suggest that the only period mentioned in section 6(1)—i.e., annual review—applies to the initial development of the IEP, they are also mistaken.
92. The Department and Minister's apprehension of breaching a statutory timeframe is legally unsupportable. The error is material in that, had they appreciated that section 6 would set no hard deadline for developing an IEP, the Department and Minister would not have recommended holding back on bringing section 6 into force. Indeed, they give no other reasons to show that they would still have concluded that section 6 was not ready to be brought into effect.
93. The President has adopted the Department and Minister's flawed reasons. Green Connection has no reason to believe that the President considered other factors in deciding not to bring section 6 into effect. The error of law that materially influenced the Department and Minister's reasons, therefore, materially influenced the President's inaction and continue to do so.

94. The President's ongoing failure or refusal to bring section 6 into effect is therefore falls to be reviewed and declared invalid, in terms of section 172(1)(a) of the Constitution.

Third ground: six sector plans not pre-requisites for an IEP

95. As Green Connection pointed out to the Presidency, section 6 does not make the development of an IEP contingent on the finalisation and adoption of the six sector plans listed in paragraph 54.2 above.
96. Section 6(3)(a) provides that the IEP must account for plans relating to certain matters relevant to the energy sector and integrated development. And section 6(3)(b) provides that the IEP '*must inform and be informed by*' plans from supply, production and demand sectors.
97. As much as the Department and Minister suggest that the six sector plans are legal pre-requisites for the IEP's development, they have read into section 6 a condition that Parliament did not legislate.
98. Their view strays from the express wording and purpose of section 6. The envisaged IEP process is dynamic. That policy instruments should be aligned with one other for coherence does not necessarily entail a sequential approach to their development, as the Department and Minister would have it.
99. The Department and Minister's approach is rigid—it precludes the prospect of the IEP, an overarching energy sector policy, influencing those sector plans. It thus departs from the intended function of an IEP and the purpose of section 6. Accordingly, it misconstrues the Act.

100. The Department and Minister's misunderstanding of section 6, read with the objects of the Act, materially influenced their reasons for not advising the President to bring section 6 into operation.

101. The President's ongoing failure or refusal to bring section 6 into effect therefore falls to be reviewed and declared invalid, in terms of section 172(1)(a) of the Constitution.

Fourth ground: President's withholding operation of section 6 not rationally related to available information

102. Had the President exercised his discretion to determine the appropriateness of bringing section 6 into effect, he would have had heeded these factors.

First, section 6 does not demand an IEP upon its commencement

102.1. Section 6 envisions a process for developing, reviewing and updating an IEP, having regard to relevant science, interrelated policies and the public's views. The process is meant to be ongoing—the aim being to maintain the IEP's relevance through regular updates.

102.2. Section 6 would not require an IEP to be in place before section 6 comes into force.

102.3. The Department and Minister in effect seek time to update the existing draft IEP before becoming obliged to do so. That is irrational.

Secondly, the Department has accepted that it must develop an IEP and has been doing so

102.4. Section 6(1) would oblige the Minister to start developing an IEP when it is brought into effect. The Minister's predecessors and the Department started that process years ago, as the Department has consistently advised the Portfolio Committee.

102.5. As early as 2010, the Department signalled its readiness to start developing an IEP. I attach as "KSI 26" the Department's presentation to the Portfolio Committee on 1 November 2010. Green Connection's attorney downloaded this presentation, as well as the Department's other presentations mentioned below, from the Parliamentary Monitoring Group's website in preparation of my affidavit.

102.6. In the presentation, the Chief Director: Energy Planning gave some background to the IEP process, an update on progress already made and an indication of further steps to be taken.

102.7. Slide 6 noted that the IEP Steering Committee intended to publish the draft IEP for public comment by 31 March 2011. The presentation gave the impression that the Department was working to meet the obligation under section 6(7). No mention was made of the fact that section 6 was not yet operative.

102.8. On 13 October 2011, the Department's Director-General briefed the Portfolio Committee on the Department's 2010/2011 Annual Report. Slide 19 summarised key focus areas. Corresponding to item 1 '*Ensuring energy*

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security', the presentation said: '2. *The Department has also started the process of developing the Integrated Energy Plan (IEP).*'

102.9. Slide 34 advised the Portfolio Committee that the Department intended to 'Ensure sustainable energy supply by developing the Integrated Energy Planning Strategy by September 2010.'

102.10. And slide 38 explained that the IEP development process had been 'Partially Achieved':

'The Integrated Energy Plan was expected to be published for comments by 31 March 2011. Further revisions had been made to the *Plausible Futures* as well as to the IEP methodology within the IEPS. Significant work has been done in developing the IEP, with the IEP methodology, the *Plausible Futures*, and the Integrated Energy Planning Strategy documents having been finalized. However, the Integrated Energy Planning Strategy was not approved by Cabinet for publication as was originally envisaged.'

102.11. I attach slides 1, 19, 34 and 38 of the Director-General's presentation as "KSI 27".

102.12. On 20 November 2012 the Department gave a presentation to the Portfolio Committee on the IEP. I attach as "KSI 28" the entire presentation. Slide 17 explained that in preparation of the draft IEP, global oil price projections up to 2035 and from 2036 to 2050 had been computed.

102.13. Slide 28 summarised the steps already completed: key planning assumptions had been identified; demand projections based on modelling and been made; key policy questions and alternatives were considered; and key criteria and the approach for evaluating the model output had been selected.

102.14.Slide 29 listed the steps yet to be completed. They ended in stakeholder consultations on the draft IEP.

102.15.On 16 April 2013, the Department's Acting Chief Operating Officer presented the Strategic Plan and Budget Vote to the Portfolio Committee. Slide 44 stated that the Department had '*finalised the data collections and energy modelling*' for developing the IEP. I attach as "**KSI 29**" slides 1 and 44.

102.16.The Department has never indicated to the Portfolio Committee that it is practically impossible to develop the IEP. That is the critical issue which should determine whether section 6 should be brought into operation. The Department, on the contrary, has shown the Portfolio Committee that it has been doing what section 6 would oblige it to do.

102.17.These facts show up the Department and Minister's desire to hold off triggering an obligation under section 6 to develop the IEP as irrational.

Thirdly, Department's simulated compliance with section 6(7)

102.18.The Department published a draft IEP for public comment on 24 July 2013. I attach as "**KSI 30**" the version published under GN 512 in GG 36690. Had section 6(7) been in effect at the time, the publication of the draft IEP in 2013 would have discharged the public consultation requirement.

Fourthly, further work on the IEP following stakeholder engagement undertaken

102.19.The Department's Acting Director-General told the Portfolio Committee on 14 October 2014 that '*the stakeholder engagement on the Integrated Energy*

Plan (IEP) [had been] completed. I attach as “KSI 31” slides 1 and 20 of that presentation.

102.20. The Department’s Acting Director-General reported to the Portfolio Committee on 14 April 2015 that, by the third quarter of the 2014/2015 financial year, it had partially achieved its target of finalising the IEP and submitting it to Cabinet.

102.21. Slide 38 stated: *‘All the technical information that is used as an input to (sic) the process has already been submitted from DoE to National Treasury. The National Treasury will be conducting the Macro-economic Impact Assessment for the IEP.’* I attach as “KSI 32” slides 1 and 38 of that presentation.

102.22. On 4 August 2015, in the fourth quarter of the 2014/2015 financial year, the Department reported to the Portfolio Committee:

‘Since the approval and publication of the first draft during the 2013/2014 financial year, [it had] addressed the public comments and produced a draft report which include[d] the technical outputs. The final IEP report [would] be submitted to Cabinet during the third quarter of the 2015/2016 financial year.’

102.23. I attach as “KSI 33” slides 1, 2 and 25 of the Department’s presentation to that effect.

102.24. On 20 September 2016, the Department briefed the Portfolio Committee on developments concerning the IEP. I attach as “KSI 34” the Department’s full presentation.

Fifthly, Cabinet approval of draft IEP for public consultation and publication of draft IEP

102.25. On 3 November 2016, Cabinet released a media statement on its meeting of 1 and 2 November 2016. I attach that statement as “**KSI 35**”. Item 2 listed the key Cabinet decisions. Item 2.2 provided:

‘Cabinet approved that the Integrated Energy Plan (IEP) be published for public discussion to afford stakeholders and interested parties to engage (sic) with it. The IEP is anchored in the National Energy Act, 2008 (Act No. 34 of 2008). It seeks to guide future energy infrastructure investments and policy development which will shape the future energy landscape of South Africa.’

102.26. The President’s predecessor would have approved the publication of the draft IEP at this Cabinet meeting. Doing so would have been required under section 6(7). And so the former President’s approval of the draft IEP for publication cannot rationally be reconciled with not bringing section 6(7)—and indeed all of section 6—into operation.

102.27. That the incumbent President stands by the decision not to bring section 6 into effect is also not rationally reconcilable with this Cabinet decision of 2016.

Sixthly, publication of the draft IEP 2016

102.28. On 25 November 2016, the Department published a document styled the ‘*Integrated Energy Plan*’ under GN 1430 in GG 40445. Although the document was not referred to as a draft for public comment, that was the intention. I attach as “**KSI 36**” the draft IEP of 2016.

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102.29.I attach as “KSI 37” the Department’s media release of 9 December 2016, which makes it clear that the document published on 25 November 2016 was indeed a draft IEP for public comment.

103. There can be no rational explanation for effectively complying with the process envisioned in section 6, while not giving effect to the legislature’s will to breathe the force of law into it. The Department’s and Cabinet’s conduct prove that section 6 is capable of implementation.

Fifth ground: frustration of parliamentary power

104. There are two points that must be addressed under this sub-heading: the President’s frustration of the scheme of the Act, and the resultant disempowerment of Parliament in its oversight functions.

105. First, the absence of a rational relationship between the purpose for which Parliament conferred the discretion on the President to determine when to bring section 6 into operation and the President’s failure or refusal to do so frustrates the statutory scheme. For instance—

105.1. Section 3 requires the Minister to establish mechanisms for energy sector-related data collection and analysis and to publish the analysis, models, assumptions, among other things, ‘*for energy planning*’.

105.2. But section 3 serves little purpose if the primary tool for energy planning, the IEP, is not required. Not bringing section 6 into operation renders one of the goals of section 3 nugatory.

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105.3. Section 6 is the main operational provision of the Act. The Act envisages its objects being given effect through integrated energy planning. The structures established under Chapter 4 perform functions that ultimately feed into the refinement of an IEP.

105.4. With the main operational provision lacking the force of law, therefore, the objects of the Act in section 2 cannot readily be achieved.

106. The upshot is to stymie the legislative will in circumstances where it can and should find expression. This is at odds with the delegated authority vested in the President under section 21. Accordingly, the President's conduct is unlawful, invalid and reviewable.

107. Secondly, it appears that the Portfolio Committee has been led to believe that section 6 is in force, and that it has been exercising oversight in respect of its implementation by the executive. But this is not so.

108. The President's withholding the force of law from section 6, therefore, undermines Parliament's attempt—

108.1. to make law and to require the development of policy pursuant to section 24(b) of the Constitution, as much as it relates to the energy sector; and

108.2. to oversee the implementation of its legislative and policy choices in pursuit of the environmental aspects of energy regulation.

109. The President's failure or refusal to bring section 6 into effect has therefore undermined the National Assembly's power, in terms of section 55(2) of the Constitution, to oversee the implementation of the Act and the exercise of executive authority. Accordingly, the President's conduct is unlawful, invalid and reviewable.

RECENT DEVELOPMENTS AFFECTED BY THE IEP GAP

110. Earlier in this affidavit I referred to controversial energy and electricity projects being pursued without the benefit of a guiding IEP. Green Connection referenced these projects referred to in its correspondence to the President (Karpowership in the gas sector, the 2500MW new procurement in the nuclear power sector, and liquified natural gas).
111. More recently, Green Connection learnt of the following developments in the energy sector, which underline the need for an IEP and reveal mistaken assumptions about the legal status of section 6.
112. On 5 September 2022, the Petroleum Agency SA (PASA) received a production right application in terms of section 83 of the Mineral and Petroleum Resources Development Act, 2002, from, among others, TotalEnergies EP South Africa B.V (Total) to produce and process gas and condensate, mined off the coast of the Eastern and Western Cape provinces, at the project location referred to as Block 11B/12B. The proposed duration is 30 years.
113. Attached as "KSI 38" and "KSI 39" are PASA's notice of the application and an executive summary of the application.

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114. According to the presentation of its annual business performance results to the NA's Portfolio Committee on Mineral Resources & Energy, the Central Energy Fund SOC Ltd (CEF), PASA's parent company, indicated that the Department of Minerals & Energy requested that Block 11B/12B be designated as a Strategic Integrated Project. Cabinet supported that request. I attach as "KSI 40" pages 1 and 47 of the CEF's presentation, dated 13 October 2022.
115. A Strategic Integrated Project, once designated as such, falls under the purview of the Infrastructure Development Act, 2014, which the Minister of Public Works administers. The designation is aimed at expediting its establishment.
116. The Minister of Public Works published the National Infrastructure Plan 2050 (NIP) on 1 March 2022. The NIP, amongst other things, *'is 25-year plan for critical network infrastructure, with a focus on energy'*. The NIP, amongst other things, envisions investment in green hydrogen, green chemicals and sustainable aviation fuels. It has been published without the guidance of an IEP in terms of section 6.
117. However, the NIP appears to incorrectly assume that Section 6 has been brought into operation, and accordingly, the Minister is obliged to develop the IEP and to review and update it annually (NIP, p 19, fourth unnumbered paragraph). The IEP is meant to set the substantive framework for considering the suitability of long-term energy infrastructure development. The NIP recognises that.
118. A copy of the NIP is attached as "KSI 41".

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119. Without the IEP, green energy diversification risks being haphazard. Yet, according to the Council for Geoscience's presentation to the Portfolio Committee on Mineral Resources and Energy in October 2022, pages 1 and 30 of which are attached as "KSI 42", government has already allocated more than R800m to onshore activities (including fracking) and offshore activities (including seismic surveys and oil and gas exploration).
120. The automobile value chain is also undergoing an overhaul in pursuit of net-zero emissions. Transport demands in the global North and regional markets are shifting towards electric-power and away from fossil fuels. South African producers need to match the global transition or risk exclusion.
121. The Presidential Climate Change Commission highlights the impending shift to e-vehicle industrialisation. Just as with the examples in the gas sector, the shift to e-vehicles risks going ahead without a coherent energy policy setting the necessary energy-related parameters. Attached as "KSI 43" are pages 1 and 11-14 of the PICC's *Framework for a Just Transition in South Africa*.
122. Not having an IEP, and the legislative bedrock to back it up, poses serious practical risks for South Africa's transition to a just and sustainable energy future. When a bird's eye view is taken of recent developments in the energy space in the absence of a statutorily developed IEP, it is clear that the result is a combination of policy incoherence and contradiction, as the State simultaneously pursues policies that seek to lock in fossil fuel infrastructure, while at the same time pursuing a shift to electrically powered vehicles. It is precisely this kind of mischief that a statutorily developed IEP should prevent.

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REMEDY

123. Green Connection seeks declaratory orders under section 172(1)(a) of the Constitution in respect of the President's inaction and the Minister's failure to advise the President to bring section 6 into operation, as detailed above.

124. Green Connection also seeks just and equitable relief under section 172(1)(b) of the Constitution, attendant upon those declarations of invalidity. An order directing the President to take all necessary steps to bring section 6 into operation would effectively and appropriately vindicate the unlawful conduct.

125. Directing the President to do so amounts to a substitutive order. In this regard, Green Connection points out the following:

125.1. The reasons that the Department and Minister have given for not advising the President to bring section 6 into operation are based on a misconception of the law.

125.2. This Court is best placed to decide that section 6 does not prescribe a timeframe for developing an IEP, failure to adhere to which would place the Minister in breach of the Act.

125.3. This Court is also best placed to decide that section 6 does not require the six sector plans mentioned in paragraph 54.2 above as pre-requisites for the development of an IEP, and therefore as pre-requisites for bringing section 6 into effect.

125.4. Since the Department and Minister have proffered no other reasons for not advising the President to bring section 6 into operation, this Court may make a substitutive decision on that basis alone.

125.5. But in any event, there is also no rational basis to regard section 6 as incapable of implementation, having regard to the conduct of the Department and Cabinet in developing the draft IEP. Government has shown through its conduct that section 6 can be implemented.

125.6. There is therefore no prospect that the President could come to a different conclusion as to whether section 6 is capable of implementation and thus whether it would be appropriate to bring it into operation. The facts make it a foregone conclusion.

125.7. There are no other factors that might justify remitting the matter to the President to consider whether he should bring section 6 into effect.

125.8. The 14-year delay making section 6 operative warrants prompt and final intervention. No purpose would be served by affording the President more time to do so.

126. Since Green Connection applies for an order declaring conduct of the President unlawful, any such order must be referred to the Constitutional Court for confirmation under section 172(2)(a) of the Constitution. Green Connection would therefore ask that the just and equitable relief, referred to in paragraph 124 above, be granted expressly subject to confirmation by the Constitutional Court.

CONCLUSION

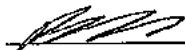
127. Green Connection asks for an order in terms of the notice of motion. It reserves the right to amend its notice of motion and to supplement its founding papers, in terms of Rule 53(4), following disclosure of the records of decision by the President and Minister.

128. If Green Connection succeeds, it will ask for costs against the President, Minister and any other respondent opposing the proceedings. If the application is unsuccessful, Green Connection will seek an order that each party bear its own costs.



KHOLWANI SIMELANE

I certify that the above signature is the true signature of the deponent who has acknowledged that he knows and understands the contents of this affidavit, which affidavit was signed and sworn to at Rondebosch on this 11 day of January 2023 in accordance with the provisions of R128 dated 21 July 1972, as amended by Regulation R1648 dated 19 August 1977, R1428 dated 11 July 1980 and GNR774 of 23 April 1982.



COMMISSIONER OF OATHS

COMMISSIONER OF OATHS

Beeth Kuster, Gaylard
18 Greenwich Grove, Station Rd, Rondebosch, 7700
021 686 7890
15 Greenwich Grove
Station Road,
Rondebosch, 7700
(T) +27 21 686 7890

EXTRACT FROM A MEETING OF THE BOARD OF DIRECTORS OF GREEN CONNECTION NPC

HELD IN Zoom ON THE 3rd DAY OF
November 2022.

It is resolved that the Company, alongside such other co-applicants as may participate, bring an Application against PRESIDENT OF THE REPUBLIC OF SOUTH AFRICA and THE MINISTER OF MINERAL RESOURCES AND ENERGY, and such other Respondents as Counsel may advise, for the purposes of obtaining an order in the following approximate terms and for the following purposes: that the ongoing failure of the President to bring section 6 of the National Energy Act 34 of 2008 into operation is reviewed and declared unlawful, that the Minister's ongoing failure to advise the first respondent to bring section 6 into operation is reviewed and declared unlawful, that the respondents are ordered to do whatever is necessary to bring section 6 into operation within three months from the date of the order, and for costs.

1. That Chennells Albertyn Attorneys be instructed to attend to the above litigation, and all prior attendances by them pursuant to that litigation be ratified.
2. That Elizabeth Jane McDaid, additionally and alternatively, Kholwani Simelane be authorised to bring the Application and to: execute all documents, depose all affidavits, give all instructions and grant all authorisations in respect of the litigation and preceding demands and notices, deliver all notices and appoint all agents, agree to the joining of other parties, and otherwise take all action required for the pursuance and finalization of that litigation, including varying the basis of the Application and settling same at any stage of, or prior to, the proceedings, and that any such action taken by either or both of them prior to this meeting in respect of same be ratified.
3. Prior notice of this meeting is waived.

Certified a true extract:

Sign:

Directors name:.....

Sign:

Directors name:.....ELIZABETH MCDAID.....

Sign:

Directors name:....NOMAPHELO HLAKULA.....

Sign: 

Directors name: Jaclyn Smith

Sign: 

Directors name: Anton Pickard

Sign:

Directors name:.....

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Certificate issued by the Commissioner of Companies & Intellectual
Property Commission on Thursday, January 13, 2022 at 16:41

**Memorandum of Incorporation - Short Standard Form for Non Profit
Companies Without Members**



COR 15.1C

Registration Number: K2021773480
Enterprise Name: THE GREEN CONNECTION



Tracking Number: 9349978322



Customer Code: IMRAHD

**MEMORANDUM OF INCORPORATION
OF
THE GREEN CONNECTION NPC**

which is referred to in the rest of this Memorandum of Incorporation as "the Company".

The Company is a Non Profit company without members, with the following objective:

COMMUNITY SOCIAL WELFARE

The Company has 7 directors(s), 7 incorporator(s) and 0 alternate director(s), to be appointed in the following manner:

DURING ANNUAL GENERAL MEETING HELD WITHIN 6 MONTHS AFTER FINANCIAL YEAR END

Adoption of Memorandum of Incorporation

This Memorandum of Incorporation was adopted by the incorporators of the Company, in accordance with section 13 (1), as evidenced by the following signatures made by each of them, or on their behalf.

Signature of Incorporator	Identification Number	Cellphone Number	Email Address	Address
SMITH, JACLYN LIESL	8512130224088	0839283411	JACLYN790@GMAIL.COM	Postal: 97 RANGER ROAD, FISH HOEK, FISH HOEK, WESTERN CAPE, 7975 Residential: 97 RANGER ROAD, FISH HOEK, FISH HOEK, WESTERN CAPE, 7975
		Signature	Date	
REDDY, YACHIKA	7309040036082	0833028435	YACHIKA@SUSTAINABLE.ORG.ZA	Postal: 24 LOW STREET, OBSERVATORY, CAPE TOWN, WESTERN CAPE, 7925 Residential: 24 LOW STREET, OBSERVATORY, CAPE TOWN, WESTERN CAPE, 7925
		Signature	Date	
DRAMAT, ABDUL-BASIER	7307135095083	0824680843	BASIER@MWEB.CO.ZA	Postal: 18 LYNDON CRESCENT, PINATI ESTATE, CAPE TOWN, WESTERN CAPE, 7780 Residential: 18 LYNDON CRESCENT, PINATI ESTATE, CAPE TOWN, WESTERN CAPE, 7780
		Signature	Date	

Page 1 of 4

This form is prescribed by the Minister of Trade and Industry in terms of section 223 of the Companies Act, 2008 (Act No. 71 of 2008).



KS

Certificate issued by the Commissioner of Companies & Intellectual
Property Commission on Thursday, January 13, 2022 at 16:41

**Memorandum of Incorporation - Short Standard Form for Non Profit
Companies Without Members**



Companies and Intellectual
Property Commission
a member of the dsig group

COR 15.1C

Registration Number: K2021773480
Enterprise Name: THE GREEN CONNECTION



Tracking Number: 9349978322



Customer Code: IMRAHD

PICKARD, ANTON

7307235079086

0764507870

GUS.PICKARD@GMAIL.COM

Postal: 13 LAING STREET,
PIKETBERG, PIKETBERG, WESTERN
CAPE, 7320

Residential: 13 LAING STREET,
PIKETBERG, PIKETBERG, WESTERN
CAPE, 7320

Signature

Date

MCDALD, ELIZABETH JANE

6206090038087

0827315643

LIZWE@MWEB.CO.ZA

Postal: 21 ST LUKES STREET,
CLAREMONT, CLAREMONT,
WESTERN CAPE, 7700

Residential: 21 ST LUKES STREET,
CLAREMONT, CLAREMONT,
WESTERN CAPE, 7700

Signature

Date

WILLIAMS, GLYN ERIC

5410125125084

0846658855

G.WILLIAMS@CHENNELLSALBERTYN

Postal: 18 GREENWICH GROVE,
STATION ROAD, RONDEBOSCH,
WESTERN CAPE, 7700

Residential: 18 GREENWICH GROVE,
STATION ROAD, RONDEBOSCH,
WESTERN CAPE, 7700

Signature

Date

HLAKULA, NOMAPHELO

8502110302087

0722840303

PENNYHLAKULA@GMAIL.COM

Postal: 13 MATI WLEFUMA STREET,
NY 140, GUGULETHU, WESTERN
CAPE, 7750

Residential: 13 MATI WLEFUMA
STREET, NY 140, GUGULETHU,
WESTERN CAPE, 7750

Signature

Date

Page 2 of 4

This form is prescribed by the Minister of Trade and Industry in terms of section 223 of the Companies Act,
2008 (Act No. 71 of 2008).



KS

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**Memorandum of Incorporation - Short Standard Form for Non Profit
Companies Without Members**



COR 15.1C

Registration Number: K2021773490
Enterprise Name: THE GREEN CONNECTION



Tracking Number: 9349978322



Customer Code: IMRAHD

In this Memorandum of Incorporation -

- (a) a reference to a section by number refers to the corresponding section of the Companies Act, 2008;
- (b) words that are defined in the Companies Act, 2008, bear the same meaning in this Memorandum as in that Act.

Article 1 - Incorporation and Nature of the Company

1.1 Incorporation

- (1) The Company is incorporated as a Non Profit company, as defined in the Companies Act, 2008
- (2) The Company is incorporated in accordance with, and governed by -
 - (a) the provisions of the Companies Act, 2008 without any limitations, extension, variation or substitution; and
 - (b) the provisions of this Memorandum of Incorporation.

1.2 Objects and Powers of the Company

- (1) The Objects of the Company are as set out on the cover sheet and, except to the extent necessarily implied by the stated objects, the purposes and powers of the Company are not subject to any restriction, limitation or qualification, as contemplated in section 19 (1)(b)(ii).
- (2) The Company is not subject to any provision contemplated in section 15 (2)(b) or (c).
- (3) upon dissolution of the Company, its net assets must be distributed in the manner determined in accordance with item 1(4)(b) of Schedule 1 of the Companies Act, 2008.

1.3 Memorandum of Incorporation and Company Rules

- (1) This Memorandum of Incorporation of the Company may be altered or amended only in the manner set out in section 16, 17 or 152 (6) (b).
- (2) The authority of the Company's Board of Directors to make rules for the Company, as contemplated in section 15 (3) to (5), is not limited or restricted in any manner by this Memorandum of Incorporation.
- (3) The Board must publish any rules made in terms of section 15 (3) to (5) by delivering a copy of those rules to each director by ordinary mail.
- (4) The Company must publish a notice of any alteration of the Memorandum of Incorporation or the Rules, made in terms of section 17 (1), by delivering a copy of the notice to each director by ordinary mail.

1.4 Optional provisions of Companies Act, 2008 do not apply

The Company does not elect, in terms of section 34 (2), to comply voluntarily with the provisions of Chapter 3 of the Companies Act, 2008.

1.5 Company not to have members

As contemplated in Item 4 (1) of Schedule 1 of the Act, the Company has no members.

Page 3 of 4



KS

Certificate issued by the Commissioner of Companies & Intellectual
Property Commission on Thursday, January 13, 2022 at 16:41

**Memorandum of Incorporation - Short Standard Form for Non Profit
Companies Without Members**



Companies and Intellectual
Property Commission
a member of the dti group

COR 15.1C

Registration Number: K2021773490
Enterprise Name: THE GREEN CONNECTION



Tracking Number: 9349978322



Customer Code: IMRAHD

Article 2 - Directors and Officers

2.1 Composition of the Board of Directors

The Board of Directors of the Company comprises at least the number of directors, and alternate directors shown on the cover sheet, each of whom -

- (a) is to be appointed in the manner set out on the cover sheet; and
- (b) serves for an indefinite term until substituted by the person or entity that appointed the director.

2.2 Authority of the Board of Directors

- (1) This memorandum of Incorporation does not limit or restrict the authority of the Company's Board of Directors to -
 - (a) manage and direct the business and affairs of the Company, as set out in section 66 (1);
 - (b) consider a matter other than at a meeting, as set out in section 74;
 - (c) conduct a meeting entirely by electronic communication, or to provide for participation in a meeting by electronic communication, as set out in section 73 (3);
 - (d) determine the manner and form of providing notice of its meetings, as set out in section 73 (4);
 - (e) proceed with a meeting despite a failure or defect in giving notice of the meeting, as set out in section 73 (5);
 - (f) appoint committees of directors, and to delegate to any such committee any of the authority of the Board as set out in section 72 (1), or to include in any such committee persons who are not directors, as set out in section 73 (2)(a).
- (2) The right of the Company's directors to requisition a meeting of the Board, as set out in section 73 (1), may be exercised by at least 25% of the directors, if the board has 12 or more members, or by 2 (two) directors, in any other case, as provided in that section.
- (3) The quorum requirement for a directors meeting to begin, the voting rights at such a meeting, and the requirements for approval of a resolution at such a meeting, are as set out in section 73 (5).
- (4) This Memorandum of Incorporation does not limit or restrict the authority of any committee appointed by the Company's Board of Directors, as set out in section 72 (2).

2.3 Indemnification of Directors

This Memorandum of Incorporation does not limit, restrict or extend the authority of the Company's Board of Directors to-

- (a) advance expenses to a director, or indemnify a director, in respect of the defense of legal proceedings, as set out in section 78 (4);
- (b) indemnify a director in respect of liability, as set out in section 78 (5); or
- (c) purchase insurance to protect the Company, or a director, as set out in section 78 (7).

2.4 Officers

The Board of Directors may appoint any officers it considers necessary to better achieve the objects of the Company.

Page 4 of 4



KS 14

G.T.-S. 012-0123



CERTIFICATE OF REGISTRATION OF NONPROFIT ORGANIZATION

In terms of the Nonprofit Organisation Act, 1997, I am satisfied that

The Green Connection

.....
(name of the nonprofit organization)

meets the requirements for registration.

25 June 2010

The organisation's name was entered into the register on
(date)

Registration number

080-620-NPO

Director's signature

25 June 2010

Date

Department of Social



Development

KS

THE GREEN CONNECTION

CONSTITUTION

1. PREAMBLE

The Green Connection believes that empowering people to participate in their environment is the only way that truly sustainable development can take place. Our environmental resources are limited and not ours to squander but to protect for future generations.

The Green Connection believes that economic growth and development, improvement of socio-economic status and conservation of natural resources can only take place within a commonly understood framework of sustainable development.

2. NAME

The name of the organisation is the Green Connection.

3. DEFINITIONS AND ABBREVIATIONS

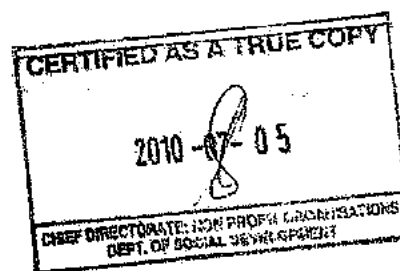
In this Constitution unless inconsistent with the text:

- "EXCO" means the Executive Committee
- "ORG" means The Green Connection.
- "NGO" means a Non-Government Organisation
- "CBO" means a Community Based Organisation.
- "NPO" means a Non-Profit Organisation

4. THE ORGANISATION

The Organisation must:

- 4.1. exist with its own identity as a body corporate in its own right, separately from its office-bearer or members;
- 4.2. continue to exist even when its membership changes and when office-bearers change;
- 4.3. be able to own property, assets and other possessions; and
- 4.4. be able to sue, and similarly be sued as a separate entity.



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5. OBJECTIVES

The objective of the organisation is to provide practical support to both the government and non-government sector as an as an integral part of sustainable development

6. THE FUNCTIONS OF THE ORGANISATION

The Organisation will strive to promote and implement sustainable development projects particularly focused on the following:

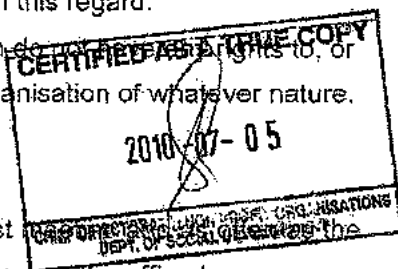
- 6.1. Materials development
- 6.2. Facilitation in Afrikaans, English and Xhosa
- 6.3. Community development
- 6.4. Capacity building in environmental sustainability
- 6.5. Legislative and policy analysis
- 6.6. Public Awareness
- 6.7. Communication and conflict management

7. INCOME AND PROPERTY

- 7.1. The Organisation must keep a record of everything it owns, keeping and maintaining proper accounting records.
- 7.2. The Organisation may not give any of its money, assets, or property to its members or office-bearers. The only time it may deviate from this is when it pays for work that a member or office-bearer has done for the Organisation.
- 7.3. Any member of the Organisation may only be reimbursed by it upon proof to the satisfaction of the Executive Committee, or Chairperson, or any person duly authorized by the Executive Committee in this regard.
- 7.4. Members or office-bearers of the Organisation do not have rights to, or over any assets or property owned by the Organisation of whatever nature.

8. STRUCTURE AND OPERATION

- 8.1. The EXCO must elect office-bearers at the first meeting after the positions of office-bearers become vacant. If any of the office-bearers are not present at any meeting, the members of the EXCO present must elect one of their members to act as the relevant office-bearer for that meeting.



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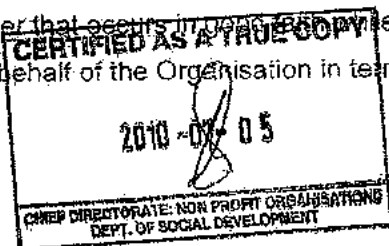
- 8.2. The office-bearers may not hold office for longer than three years at a time in a particular position, and may not hold office for longer than two consecutive terms.
- 8.3. The EXCO may hold meetings as it deems fit and may adjourn a meeting from time to time. However, meetings must take every three months place at least, or when the committee has to review developments.
- 8.4. The EXCO may regulate and control its meetings in such a way as it may deem fit.
- 8.5. All questions before a meeting of the EXCO will be decided by the majority vote of the members present.
- 8.6. The EXCO must decide the date, place, and hour of the next meeting, failing which the chairperson must take that decision.
- 8.7. The secretary must provide an agenda and notify all members of the place, date and hour of such a meeting at least seven (7) days before a meeting of the EXCO.
- 8.8. Fifty percent of the members of the EXCO form a quorum and no business may be transacted unless the quorum is present.
- 8.9. A special general meeting may be held at the request of two-thirds of the members of the Organisation.

9. DISQUALIFICATION OF MEMBERS OF EXCO

- 9.1. Any member of EXCO who is absent-without-leave for three consecutive meetings ceases to be a member unless EXCO at its next meeting condones such absence whereupon that person will resume their appointment as a member.
- 9.2. Any member of EXCO who wishes to resign from the committee must register their formal resignation in writing to the secretary of EXCO.

10. INDEMNIFICATION

An office-bearer will not be held personally liable for any loss suffered by any person because of any act or omission by that office-bearer that occurs in good faith while the office-bearer is performing functions for or on behalf of the Organisation in terms of the Constitution.



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11. DUTIES OF OFFICE-BEARERS

11.1. Chairperson

The Chairperson, as elected chair of the Organisation, chairs all the Organisation's meetings.

11.2. Deputy Chairperson

The Deputy Chairperson takes over the Chairperson's tasks and duties when the Chairperson is not there.

11.3. Treasurer

11.3.1. The Treasurer must keep a record of all the money that comes into the Organisation, as well as money spent by the Organisation. The Treasurer must also keep an inventory of the assets.

11.3.2. The Treasurer must ensure that all monies of the Organisation are deposited within forty-eight (48) hours into a designated Bank Account.

11.4. Secretary

The Secretary is responsible for making sure that the Organisation's administration runs smoothly. The secretary must keep proper records and minutes of all meetings as well as prepare and give notice of all meetings of the Organisation. Such records and minutes shall be open for inspection by all members. However, this will only be allowed by written application to the Secretary.

12. POWERS OF THE ORGANISATION

12.1. EXCO may take on such lawful power and authority as it believes it needs to be able to achieve the objectives that are stated in Section 5 of this Constitution. EXCO must abide by the provisions of this Constitution and of all other relevant legislation at all times.

12.2. EXCO has the power and authority to raise funds and to invite and receive contributions for the Organisation.

12.3. EXCO has the power to buy, hire or exchange any property or assets that it needs to achieve the Organisation's objectives.

12.4. EXCO has the right to draw up rules for asset management, including procedures for application, approval, and termination of its membership and for any other matter that may be necessary to achieve the objectives of the

CERTIFIED AS A TRUE COPY

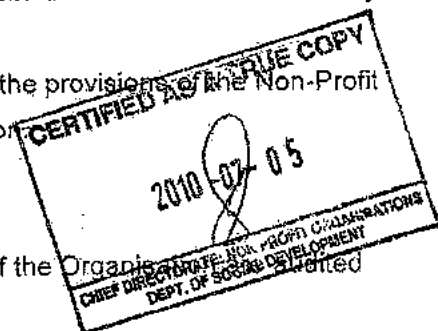
KS

13. FINANCES

- 13.1. The Treasurer shall be responsible for controlling the finances of the Organisation together with two members of the Organisation. They must ensure that all funds are deposited into a bank account in the name of the Organisation.
- 13.2. Whenever funds are withdrawn from the Organisation's bank account, the Chairperson, (or his/her deputy) and the Treasurer must authorize the withdrawal.
- 13.3. The financial year of the Organisation commences annually on 1 July each year and terminates 30 June of the following year.
- 13.4. The Organisation must ensure that all funds are deposited into a bank account in the name of the Trust within forty-eight (48) hours of receipt thereof.
- 13.5. If the Organisation has funds to be invested, such funds may only be invested with registered financial institutions. These institutions are listed in Section 1 of the Financial Institutions (Investment of Funds) Act, 1984.
- 13.6. The Organisation shall within six (6) months after financial year end, draw up financial statements which must include the following:
 - an income and expenditure statement;
 - a balance sheet showing its assets, liabilities; and
 - the financial position as at the end of that financial year.
- 13.7. Within two (2) months after drawing up its financial statements, the Organisation must arrange for an accounting officer to compile a written report stating that:
 - the financial statements are consistent with its accounting records;
 - the accounting policies are appropriate and have been consistently applied; and
 - the Organisation has complied with the provisions of the Non-Profit Organisations Act and its Constitution.

14. AUDITORS

EXCO must ensure that the books of account of the Organisation are audited annually by independent auditors.



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15. CODE OF CONDUCT

15.1. The Code of Conduct is binding on all members and office-bearers of the Organisation.

15.2. The following Rules of Conduct must be observed:

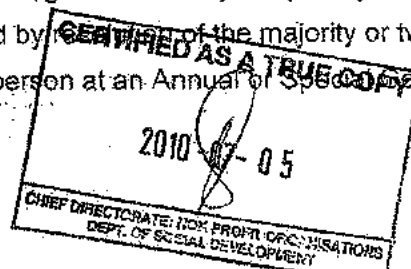
- Members and/or office-bearers conduct themselves at meetings in a dignified and orderly manner at all times. Any member and/or office-bearer persisting in conducting himself/herself inappropriately must leave the meeting immediately when so ordered to do so by the Chairperson.
- All members and/or office-bearers must comply with the aims and objectives of the Constitution of the Organisation
- No member and/or office-bearer of the Organisation may conduct himself/herself in such a way as to bring the Organisation into disrepute.
- No member and/or office-bearer may influence or attempt to influence the Organisation when considering a decision on any matter brought before it so as to gain some direct or indirect benefit, whether in the form of money or otherwise for himself or herself or any other person or body with whom or with which he or she is associated.
- No member and/or office-bearer of the Organisation may directly or indirectly accept any gift, reward or favour, whether in the form of money or otherwise as a consideration for voting in a particular manner on any matter before the Organisation.
- No member and/or office-bearer of the Organisation may carry or display firearms or weapons at any meeting.

15.3. EXCO may refuse membership to a member not adhering to the Code of Conduct. The member however shall have right of appeal to EXCO against this decision.

16. ALTERATIONS OF CODE OF CONDUCT

The Code of Conduct or any other rule that the Organisation may adopt may be added to, varied, altered, amended or modified by a majority or two-thirds of the votes of the members present in person at an Annual or Special Meeting.

17. AMALGAMATION AND DISSOLUTION

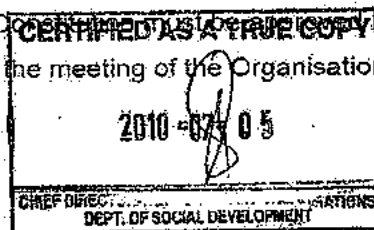


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- 17.1. The Trust may enter into partnership or amalgamation with any entity or Organisation with the same or similar objectives. Any moveable property and assets of the Trust may be sold and the Organisation wound up - or reconstructed - by the resolution of the majority of not less than two-thirds of the votes of the members present in person at a Special General Meeting. Provided, however, that there is no less than thirty (30) days special notice of such meeting to consider such question, of partnership, amalgamation, winding up or reconstruction shall be given. Such notice must clearly set forth the objectives of the meeting and provides further than no less that 20% of members eligible to vote shall be present at any such meeting.
- 17.2 If at any meeting properly called, as set out in 17.1 above, the requisite number of members and office-bearers fail to attend, then the meeting shall stand adjourned to the same time and place in the following week. Special notice of the adjourned meeting must be given by the Secretary and at such adjourned meeting any member or members present is deemed a quorum and has full power to act.
- 17.3 If, upon dissolution of the Organisation, any assets whatsoever remain after the satisfaction of all its debts, liabilities and obligations, such assets shall not be paid to or distributed amongst its members. This shall be given to a similar non-profit organisation operating in the area or to such body/bodies as may be decided by the EXCO in the event of the members of the Association being unable to agree upon an appropriate organisation.

18 AMENDMENTS TO THE CONSTITUTION

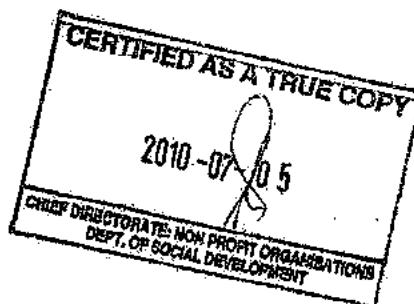
- 18.2 All members of the Organisation must be notified of any proposed changes to this Constitution at least thirty (30) days before a meeting to consider such proposed amendment(s).
- 18.3 An amendment to the Constitution shall be approved by two-thirds majority of registered members at the meeting of the Organisation following notification of such proposal.



KS

This Constitution was adopted at CLAREMONT on this day 28/08 2009.

[Signature]



KS *[initials]*

Memorandum of Incorporation

of

Southern African Faith Communities' Environment Institute NPC

with

2006/014388/08

- It is a Non Profit company with members.
- It has the following objects:
 - To collaborate and network with various faith communities to promote environmental awareness, greening, or sustainable development projects;
 - To conduct education and training programmes relating to environmental awareness, greening, clean-up, or sustainable development projects;
 - To engage in the conservation, rehabilitation or protection of natural flora, fauna or biosphere;
 - To engage in community development for poor and needy persons and anti-poverty initiatives, including the promotion of community-based projects relating to self-help empowerment, capacity building, skills development, or anti-poverty;
 - To provide training, support or assistance to community-based projects contemplated above; and
 - To raise funds and obtain donations to carry out the above objectives.
- It is referred to in the rest of this Memorandum as "the Company".
- A reference to a section by number refers to the corresponding section of the Companies Act, 2008.
- Words that are defined in the Companies Act, 2008 bear the same meaning in this Memorandum as in that Act.
- This Memorandum is substantially similar to the CIPC prescribed form CoR 15.1E, but it is different.

Reference number	SAFCEI001
Customer code	
Template version number	

KS 11

Adoption of Memorandum of Incorporation

This Memorandum of Incorporation was adopted by the members of the Company, in accordance with section 13(1), as evidenced by the following signatures made by each of them, or on their behalf.

Name of Member	Identity or Registration Number of Incorporator	Signature	Date

Article 1 - Incorporation and Nature of the Company

1.1 Incorporation

- (1) The Company is incorporated as a Non Profit company, as defined in the Companies Act, 2008.
- (2) The Company is incorporated in accordance with, and governed by -
 - (a) the unalterable provisions of the Companies Act, 2008 that are applicable to Non Profit companies;
 - (b) the alterable provisions of the Companies Act, 2008 that are applicable to Non Profit companies, subject to any limitation, extension, variation or substitution set out in this Memorandum; and
 - (c) the provisions of this Memorandum of Incorporation.

1.2 Objects and Powers of the Company

The Objects of the Company are as set out on the cover sheet and, except to the extent necessarily implied by the stated objects, the purposes and powers of the Company-

[X] are not subject to any restriction, limitation or qualification, as contemplated in section 19(1)(b)(ii).

[] are subject to any restriction, limitation or qualification, contemplated in section 19(1)(b)(ii), as set out in Part A of Schedule 1.

- (1) The Company-

[X] is not subject to any provision contemplated in section 15(2)(b) or (c) .

[] is subject to the provision contemplated in section 15(2)(b) or (c), as set out in Part B of Schedule 1.
- (2) Upon dissolution of the Company, its net assets must be distributed in the manner determined in accordance with-
 - (a) Item 1(4)(b) of Schedule 1 of the Companies Act, 2008; and
 - (b) the provisions, if any, set out in Part C of Schedule 1 of this Memorandum.

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1.3 Memorandum of Incorporation and Company rules

- (1) This Memorandum of Incorporation of the Company-
☒ may be altered or amended only in the manner set out in section 16, 17 or 152(6)(b).
☐ may be altered or amended in the manner set out in section 16, 17 or 152(6)(b), subject to the provisions contemplated in section 16(1)(c), and set out in Part D of Schedule 1.
- (2) The authority of the Company's Board of Directors to make rules for the Company, as contemplated in section 15(3) to (5):
☒ is not limited or restricted in any manner by this Memorandum of Incorporation.
☐ is limited or restricted to the extent set out in Part D of Schedule 1.
- (3) The Board must publish any rules made in terms of section 15(3) to (5)-
☐ by delivering a copy of those rules to each Director by ordinary mail.
☒ in accordance with the requirements set out in Part D of Schedule 1 (includes email).
- (4) The Company must publish a notice of any alteration of the Memorandum of Incorporation or the Rules, made in terms of section 17(1) -
☐ by delivering a copy of those rules to each Director by ordinary mail.
☒ in accordance with the requirements set out in Part D of Schedule 1 (includes email).

1.4 Optional provisions of Companies Act, 2008 do not apply

The Company-

- ☒ does not elect, in terms of section 34(2), to comply voluntarily with the provisions of Chapter 3 of the Companies Act, 2008.
☐ elects, in terms of section 34(2), to comply voluntarily with the provisions of Chapter 3 of the Companies Act, 2008.

1.5 Members of the Company

As contemplated in Item 4(1) of Schedule 1 of the Act, the Company has members, who -

- ☐ are all in a single class, being voting members, each of whom has an equal vote in any matter to be decided by the members of the Company.
☒ are in either of two classes, being voting and non-voting members, respectively. The terms and conditions of membership in the Company are as set out in Part E of Schedule 1 to this Memorandum.

Article 2 - Rights of Members

2.1 Members' authority to act

- If, at anytime, every member of the Company is also a Director of the Company, as contemplated in section 57(4), the authority of the members to act without notice or compliance with any other internal formalities, as set out in that section-
☒ is not limited or restricted by this Memorandum of Incorporation.
☐ is limited or restricted to the extent set out in Part A of Schedule 2.

2.2 Members' right to Information

In addition to the rights to access information set out in section 26(1), a member of the Company has the further rights to information, if any, set out in Part B of Schedule 2 of this Memorandum of Incorporation.

2.3 Representation by concurrent proxies

- The right of a member of the Company to appoint persons concurrently as proxies, as set out in section 58(3)(a) -
☐ is not limited, restricted or varied by this Memorandum of Incorporation.
☒ is limited, restricted or varied to the extent set out in Part C of Schedule 2.

2.4 Authority of proxy to delegate

The authority of a member's proxy to delegate the proxy's powers to another person, as set out in section 58(3)(b)

☐ is not limited or restricted by this Memorandum of Incorporation.

☒ is limited or restricted to the extent set out in Part C of Schedule 2.

2.5 Requirement to deliver proxy instrument to the Company

The requirement that a member must deliver to the Company a copy of the instrument appointing a proxy before that proxy may exercise the member's rights at a members meeting, as set out in section 58(3)(c) -

☒ is not varied by this Memorandum of Incorporation.

☐ is varied to the extent set out in Part C of Schedule 2.

2.6 Deliberative authority of proxy

The authority of a member's proxy to decide without direction from the member whether to exercise, or abstain from exercising any voting right of the member, as set out in section 58(7)-

☒ is not limited or restricted by this Memorandum of Incorporation.

☐ is limited or restricted to the extent set out in Part C of Schedule 2.

2.7 Record date for exercise of member rights

If, at any time, the Company's Board of Directors fails to determine a record date, as contemplated in section 59, the record date for the relevant matter is-

☒ as determined in accordance with section 59(3).

☐ as determined in the manner set out in Part D of Schedule 2.

Article 3 - Members Meetings

3.1 Requirement to hold meetings

The Company-

☒ is not required to hold any members meetings other than those specifically required by the Companies Act, 2008.

☐ is required to hold members meetings, in addition to those specifically required by the Companies Act, 2008, as set out in Part A of Schedule 3.

3.2 Members' right to requisition a meeting

The right of members to requisition a meeting, as set out in section 61(3), may be exercised-

☒ by at least 25% of the voting members, as provided for in that section.

☐ by at least not applicable% of the voting members.

3.3 Location of members meetings

The authority of the Company's Board of Directors to determine the location of any members meeting, and the authority of the Company to hold any such meeting in the Republic or in any foreign country, as set out in section 61(9)-

☒ is not limited or restricted by this Memorandum of Incorporation.

☐ is limited or restricted to the extent set out in Part B of Schedule 3.

3.4 Notice of members meetings

The minimum number of days for the Company to deliver a notice of a members meeting to the members, as required by section 62 -

☒ is as provided for in section 62 (1) (15 business days);

☐ is not applicable business days before the meeting is to begin.

KS

3.5 Electronic participation in members meetings

The authority of the Company to conduct a meeting entirely by electronic communication, or to provide for participation in a meeting by electronic communication, as set out in section 63 -

☒ is not limited or restricted by this Memorandum of Incorporation.

☐ is limited or restricted to the extent set out in Part C of Schedule 3.

3.6 Quorum for members meetings

- (1) The quorum requirement for a members meeting to begin, or for a matter to be considered are-

☒ as set out in section 64(1) without variation (~~25% of voting members~~).

☐ as set out in section 64(1) subject to a minimum of not applicable % in substitution for the 25% required by that section.

- (2) The time periods allowed in section 64(4) and (5)-

☒ apply to the Company without variation

☐ apply to the Company, subject to the variations set out in Part D of Schedule 3.

- (3) The authority of a meeting to continue to consider a matter, as set out in section 64(9) -

☒ is not limited or restricted by this Memorandum of Incorporation.

☐ is limited or restricted to the extent set out in Part D of Schedule 3.

3.7 Adjournment of members meetings

The maximum period allowable for an adjournment of a members meeting is-

☒ as set out in section 64(13), without variation.

☐ as set out in section 64(13), subject to the variations set out in Part E of Schedule 3.

3.8 Members resolutions

- (1) For an ordinary resolution to be adopted at a members meeting, it must be supported by at least -

☒ 50% of the members who voted on the resolution, as provided in section 65(7).

☐ not applicable % of the members who voted on the resolution, despite section 65(7).

☐ the minimum percentage of members voting on the resolution, as set out in Part F of Schedule 3.

- (2) For a special resolution to be adopted at a members meeting, it must be supported by at least -

☒ 75 % of the members who voted on the resolution, as provided in section 65(7).

☐ not applicable % of the members who voted on the resolution, despite section 65(7).

☐ the minimum percentage of the members who voted on the resolution, as set out in Part F of Schedule 3.

- (3) A special resolution adopted at a members meeting is -

☒ not required for a matter to be determined by the Company, except those matters set out in section 65(11).

☐ required, in addition to the matters set out in section 65(11), for the matters set out in Part F of Schedule 3.

Article 4 - Directors and Officers

4.1 Composition of the Board of Directors

- (1) The Board of Directors of the Company comprises of at least five (5), but no more than ten (10) Directors, and no alternate Directors each of whom is to be elected-

(a) is to be appointed in the manner set out in Part A of Schedule 4; and

(b) serves for a term of three years.

- (2) In addition to the appointed Directors -

☐ there are no appointed or ex officio Directors of the company, as contemplated in section 66(4).

☒ there are appointed, and ex officio, Directors of the company, as contemplated in section 66(4), to be designated in the manner specified in Part B of Schedule 4.

KS

- (3) In addition to satisfying the qualification and eligibility requirements set out in section 69, to become or remain a Director of the Company, a person-
- ☐ need not satisfy any further eligibility requirements or qualifications.
 - ☒ must satisfy the additional eligibility requirements and qualifications set out in Part C of Schedule 4.
- (4) ~~At each AGM~~, each Board Director who has served 3 years will step down, and at least one third of the Directors will step down.

4.2 Authority of the Board of Directors

The authority of the Company's Board of Directors to manage and direct the business and affairs of the Company, as set out in section 66(1) -

☒ is not limited or restricted by this Memorandum of Incorporation.

☐ is limited or restricted to the extent set out in Part C of Schedule 2.

4.3 Board of Directors meetings

- (1) The authority of the Company's Board of Directors to consider a matter other than at a meeting, as set out in section 74-
- ☒ is not limited or restricted by this Memorandum of Incorporation.
 - ☐ is limited or restricted to the extent set out in Part E of Schedule 4.
- (2) The right of the Company's Directors to requisition a meeting of the Board, as set out in section 73(1), may be exercised by-
- ☒ at least 25% of the Directors, as provided in that section.
 - ☐ at least not applicable% of the Directors, despite the provisions of that section.
- (3) The authority of the Company's Board of Directors to conduct a meeting entirely by electronic communication, or to provide for participation in a meeting by electronic communication, as set out in section 73(3):-
- ☒ is not limited or restricted by this Memorandum of Incorporation.
 - ☐ is limited or restricted to the extent set out in Part F of Schedule 4.
- (4) The authority of the Company's Board of Directors to determine the manner and form of providing notice of its meetings, as set out in section 73(4)-
- ☒ is not limited or restricted by this Memorandum of Incorporation.
 - ☐ is limited or restricted to the extent set out in Part F of Schedule 4.
- (5) The authority of the Company's Board of Directors to proceed with a meeting despite a failure or defect in giving notice of the meeting, as set out in section 73(5) -
- ☒ is not limited or restricted by this Memorandum of Incorporation.
 - ☐ is limited or restricted to the extent set out in Part F of Schedule 4.
- (6) The quorum requirement for a Directors meeting to begin, the voting rights at such a meeting, and the requirements for approval of a resolution at such a meeting, are-
- ☒ as set out in section 73(5) (~~a majority of directors~~).
 - ☐ as set out in section 73(5), subject to the variations set out in Part F of Schedule 4.

4.4 Indemnification of Directors

- (1) The authority of the Company's Board of Directors to advance expenses to a Director, or indemnify a Director, in respect of the defence of legal proceedings, as set out in section 78(3) -
- ☒ is not limited or restricted by this Memorandum of Incorporation.
 - ☐ is limited, restricted or extended to the extent set out in Part G of Schedule 4.
- (2) The authority of the Company's Board of Directors to indemnify a Director in respect of liability, as set out in section 78(5)-
- ☒ is not limited or restricted by this Memorandum of Incorporation.
 - ☐ is limited, restricted or extended to the extent set out in Part G of Schedule 4.

- (3) The authority of the Company's Board of Directors to purchase insurance to protect the Company, or a Director, as set out in section 78(6)-
[X] is not limited or restricted by this Memorandum of Incorporation.
[] is limited, restricted or extended to the extent set out in Part G of Schedule 4.

Article 5 - General Provisions

None

Schedule 1 - Incorporation and nature of the Company

Part A

None

Part B

None

Part C

None

Part D

The Board must publish any rules it makes by delivering a copy to each Director by email.

The company must publish a notice of any alteration of the MOI (memorandum of incorporation) or the rules, by delivering a copy to each Director by email.

Part E

There will be two classes of membership in terms of Item 4(2)(d) of schedule 1 of the Companies Act:

- Class one are full members, with voting rights; and
- Class two are associate members, without the right to vote.

The qualification for membership in terms of item 4(2)(e)(i) of schedule 1 of the Companies Act is that:

- For class one, an entity must be a faith community.
- For class two, the member will be an individual.

The process for obtaining membership in terms of item 4(2)(e)(ii) of schedule 1 of the Companies Act is for class one to pay a renewable annual subscription of at least R100. Both classes will sign a commitment to SAFCEI's mission and vision.

The Directors may resolve to terminate or suspend a member's membership in terms of item 4(2)(e)(v) of schedule 1 of the Companies Act if in their opinion the member has ceased to be committed to SAFCEI's mission and vision.

KS *AK*

Schedule 2 - Rights of Members

Part A

None

Part B

Members do not have a right to more information than that given to them in the Companies Act.

Part C

A member can only appoint a member in class one as a proxy.

A proxy can only delegate to another member in class one.

Part D

None

Schedule 3 - Members Meetings

Part A

None

Part B

None

Part C

None

Part D

None

Part E

None

Part F

None

Schedule 4 - Directors of the Company

Part A

Any member in class one may nominate a Board Director for consideration of appointment by the Board, at any time (including the AGM). The Board appoints Directors and at the AGM presents them to members for approval.

KS H

Each class one member has a single vote in any election to approve a Director.

Part B

The Executive Director (ED) is an *ex officio* director of the Company.

Part C

The person must be a member of a class one member to become (or remain) a Director.

Part D

None

Part E

None

Part F

None

Part G

None

Part H

None



CERTIFICATE OF REGISTRATION OF NONPROFIT ORGANIZATION

In terms of the Nonprofit Organisation Act, 1997, I am satisfied that

Southern African Faith Communities Environment Institute

(name of the nonprofit organization)

meets the requirements for registration.

01 March 2007

The organisation's name was entered into the register on
(date)

Registration number

053-498-NPO

Director's signature

01 March 2007

Date

Department of Social



Development

KS 14



Companies and Intellectual
Property Commission
a division of the dtg group

Date: 30/04/2021

Our Reference: 9345452234

PORTIA ASTRID BIGGAR
E-mail: PORTIA@SAFCEI.ORG.ZA
PO BOX 106
KALK BAY
CAPE TOWN
7990

RE: Amendment to Company Information

Company Number: 2006/014388/08

**Company Name: SOUTHERN AFRICAN FAITH COMMUNITIES' ENVIRONMENT
INSTITUTE NPC**

We have received a COR39 (Notice of change of company directors) from you dated 30/04/2021.

The COR39 was accepted and placed on file.

The following change was effected to Director/Secretary/Officer:
Director DAVID MUNENE was added

The following change was effected to Director/Secretary/Officer:
Director USHA JEVAN - Change was made.

The following change was effected to Director/Secretary/Officer:
Director CHRISTINE LEONE JARDINE - Change was made.
- Director / member status changed from Active to Resigned.

The following change was effected to Director/Secretary/Officer:
Director FRANCESCA RINIA MARGHERITA DE GASPARIS - Change was made.

The following change was effected to Director/Secretary/Officer:
Director MOHAMMED SHU-AIB APPLEBY - Change was made.

The following change was effected to Director/Secretary/Officer:
Director STEPHEN JACOBS - Change was made.

The following change was effected to Director/Secretary/Officer:
Director KIRTANYA LUTCHMINARAYAN - Change was made.

The following change was effected to Director/Secretary/Officer:
Director SHAUN COZETT - Change was made.

The following change was effected to Director/Secretary/Officer:
Director ABRAHAM HANEKOM - Change was made.

The following change was effected to Director/Secretary/Officer:
Director CLARE HENDRY - Change was made.
- Director / member status changed from Active to Resigned.



The Companies and Intellectual Property Commission
of South Africa

P.O. BOX 429, PRETORIA, 0001, Republic of South Africa. Docex 256, PRETORIA

Call Centre Tel 086 100 2472, Website www.cipc.co.za



KS 16

COR39

Yours truly

Commissioner: CIPC



Companies and Intellectual
Property Commission
an independent regulatory authority
a member of the sars group

Please Note:

The attached certificate can be validated on the CIPC web site at www.cipc.co.za.
The contents of the attached certificate was electronically transmitted to the South African Revenue Services.



The Companies and Intellectual Property Commission
of South Africa
P.O. BOX 429, PRETORIA, 0001, Republic of South Africa. Docex 256, PRETORIA
Call Centre Tel 086 100 2472, Website www.cipc.co.za



KS *KS*

**Certificate issued by the Companies and Intellectual Property
Commission on Monday, May 10, 2021 08:33
Certificate of Confirmation**



Companies and Intellectual
Property Commission
a member of the SAG

Registration number	2006 / 014388 / 08
Enterprise Name	SOUTHERN AFRICAN FAITH COMMUNITIES' ENVIRONMENT INSTITUTE NPC
Enterprise Shortened Name	SAFCEI
Enterprise Translated Name	None provided.
Registration Date	26/04/2006
Business Start Date	26/04/2006
Enterprise Type	Non Profit Company
Enterprise Status	In Business
Financial year end	February
Main Business/Main Object	COLLABORATE AND NETWORK, CONDUCT EDUCATION AND TRAINING PROGRAMMES AND OTHER RELATED ACTIVITIES
Postal address	P O BOX 106 KALK BAY KALK BAY WESTERN CAPE 7990
Address of registered office	THE GREEN BUILDING 9B BELL CRESCENT CLOSE WESTLAKE BUS TOKAI WESTERN CAPE 7945



The Companies and Intellectual Property Commission
of South Africa

P.O. BOX 429, PRETORIA, 0001, Republic of South Africa. Docex 256, PRETORIA.

Call Centre Tel 086 100 2472, Website www.cipc.co.za



KS *KS*

**Certificate issued by the Companies and Intellectual Property
Commission on Monday, May 10, 2021 08:33
Certificate of Confirmation**



Registration number 2006/014388/08
Enterprise Name SOUTHERN AFRICAN FAITH COMMUNITIES' ENVIRONMENT
INSTITUTE NPC
Auditor Name SOLACE & ASSOCIATES INC
Postal Address P O BOX 24094
CLAREMONT
7735
Designated Auditor Name CRONJE GREGORY
Postal Address

Active Directors / Officers

Suriname and first names	ID number or date of birth	Director type	Appoint-ment date	Addresses
MUNENE, DAVID	BK105740	Director	15/08/2020	Postal: PO BOX 37434, 00100 NAIROBI, KENYA, KENYA, 00100 Residential: PO BOX 37434, 00100 NAIROBI, KENYA, KENYA, 00100
HANEKOM, ABRAHAM	6004215107083	Director	15/08/2019	Postal: 38 STEPPING STONES, DURBANVILLE, CAPE TOWN, WESTERN CAPE, 7550 Residential: 38 STEPPING STONES, DURBANVILLE, CAPE TOWN, WESTERN CAPE, 7550
COZETT, SHAUN	7612015086086	Director	15/08/2019	Postal: 7 SIR GEORGE GREY STREET, ORANJEZICHT, CAPE TOWN, WESTERN CAPE, 8001 Residential: 7 SIR GEORGE GREY STREET, ORANJEZICHT, CAPE TOWN, WESTERN CAPE, 8001
LUTCHMINARAYAN, KIRTANYA	9111170113084	Director	03/09/2018	Postal: FLAT 301 LYLE SUITES, LYLE ROAD, RONDEBOSCH, WESTERN CAPE, 7700 Residential: FLAT 301 LYLE SUITES, LYLE ROAD, RONDEBOSCH, WESTERN CAPE, 7700
JACOBS, STEPHEN	6005315016082	Director	03/09/2018	Postal: 87 NEWTON DRIVE, MEADOWRIDGE, 7806, WESTERN CAPE, 7806 Residential: 87 NEWTON DRIVE, MEADOWRIDGE, 7806, WESTERN CAPE, 7806



The Companies and Intellectual Property Commission
of South Africa

P.O. BOX 429, PRETORIA, 0001, Republic of South Africa. Docex 256, PRETORIA.

Call Centre Tel 086 100 2472, Website www.cipc.co.za



**Certificate issued by the Companies and Intellectual Property
Commission on Monday, May 10, 2021 08:33**
Certificate of Confirmation



Companies and Intellectual
Property Commission
Johannesburg, South Africa

Active Directors / Officers

Surname and first names	ID number or date of birth	Director type	Appoint- ment date	Addresses
APPLEBY, MOHAMMED SHU-AIB	7402175043083	Director	25/10/2017	Postal: 60 ALBERT ROAD LANDSDOWNE, CAPE TOWN, CAPE TOWN, WESTERN CAPE, 7780 Residential: 60 ALBERT ROAD LANDSDOWNE, CAPE TOWN, CAPE TOWN, WESTERN CAPE, 7780
DE GASPARIS, FRANCESCA RINIA MARGHERITA	7009210406082	Director	01/02/2017	Postal: 6 GREENWOOD WALK, TOKAI, CAPE TOWN, WESTERN CAPE, 7966 Residential: 6 GREENWOOD WALK, TOKAI, CAPE TOWN, WESTERN CAPE, 7966
JEVAN, USHA	6707030141083	Director	03/06/2015	Postal: 143 BELMONT ROAD, EFFINGHAM, DURBAN, KWA-ZULU NATAL, 4051 Residential: 143 BELMONT ROAD, EFFINGHAM, DURBAN, KWA-ZULU NATAL, 4051



The Companies and Intellectual Property Commission
of South Africa
P.O. BOX 429, PRETORIA, 0001, Republic of South Africa. Docex 256, PRETORIA
Call Centre Tel 086 100 1472, Website www.cipc.co.za



KS



13 Quarry Road • Assagay • KwaZulu Natal • SA
 P O Box 671 • Hillcrest • 3650
 Mobile: 082 340 8534
 Email: adrian@adrianpole.co.za
 Web: www.adrianpole.co.za

Your ref: The President of South Africa

Our ref: Green Connection/ap

Mr. Cyril Ramaphosa
President of the Republic of South Africa
 Private Bag X1000
 Pretoria
 0001

By Email c/o: presidentrsa@presidency.gov.za
malebo@presidency.gov.za
khuseia@presidency.gov.za

24 November 2020

Dear Mr President

Re: Proclamation of section 6 of the National Energy Act, 2008

We write to you on behalf of the Green Connection, a registered non-governmental organisation focussing (among other things) on environmental justice and a just energy transition within the context of the global Climate Emergency.

The Green Connection has noted that the Honourable Minister of Mineral Resources & Energy (the Minister) recently in Parliament committed the Department of Mineral Resources and Energy (DMRE) to publishing an Integrated Energy Plan (IEP) before the end of the current parliamentary year.¹

The Green Connection cautiously welcomes this development, and looks forward to participating meaningfully in the process of developing the IEP together with many other interested and affected parties.

However, the Green Connection is deeply concerned that the development of the IEP will be meaningless given that section 6 of the National Energy Act, 2008² (NEA) - the statutory provision empowering the Minister to develop, review and publish the IEP - has not yet been brought into effect by the President.

Section 21 of the NEA provides that the Act comes into operation on a date determined by the President by Proclamation in the *Gazette*, and provides further that different dates may

¹ <https://parlyreportsa.co.za/tag/minister-gwede-mantashe/>

² Act 34 of 2008.

KS

be so fixed in respect of different provisions of the Act.³ According to our research, three Proclamations have been gazetted, bringing into operation sections 17 to 19 on 1 April 2009, sections 7 to 16 on 1 April 2011, and sections 1 to 5 and 20 to 21 on 1 March 2012.⁴

However, no Proclamation has been published by the President bringing section 6 into operation, notwithstanding that the NEA was published in the Gazette as far back as 24 November 2008.⁵

The Green Connection believes that the NEA and the IEP have critical roles to play in shaping South Africa's energy future. The preamble to the NEA indicates that it was enacted (among other things) to ensure that diverse energy resources are available, in sustainable quantities and at affordable prices, to the South African economy in support of economic growth and poverty alleviation; and to provide for energy planning, including increased generation and consumption of renewable energies.

The importance of section 6 of the NEA is that it sets out various mandatory requirements for the IEP, including (among other things) that:

- The Minister must develop and, on an annual basis, review and publish the IEP in the *Gazette*;⁶
- The IEP must deal with issues relating to supply, transformation, transport, storage of and demand for energy in a way that accounts for (among other things) affordability, universal accessibility and free basic electricity, social equity and the environment;⁷
- The IEP must take into account plans relating to electricity, macro-economy infrastructure developments and the environment;⁸
- The IEP must have a planning horizon of no less than 20 years;⁹
- The IEP must serve as a guide for future energy infrastructure investments, and must guide the selection of appropriate technology to meet energy demand;¹⁰ and
- Before finalising the IEP, the Minister must invite public comment and duly consider such comments.¹¹

South Africa is at a crossroads regarding its energy future, with various plans and programmes being conceived and implemented in the absence of a lawful IEP, including but not limited to:

³ The Constitutional Court has held that such power conferred on the President 'is a public power and has to be exercised lawfully for the purpose for which it was given in the enactment. It could not lawfully be used to veto or otherwise block its implementation... The new section... remains in abeyance for reasons that Parliament did not contemplate when the power to implement was given to the President... Suffice is to say that the new section bears the stamp of approval of the legislature and could be put into operation within a matter of days.' See *Ex Parte Minister of Safety and Security and Others: In Re: S v Walters and Another 2002 (7) BCLR 663 (CC)*, at paragraph 73.

⁴ Proclamation No R. 19 of 1 April 2009 (GG 32802); Proclamation No. 28 of 1 April 2011 (GG 34175); and Proclamation No. 10 of 24 February 2012 (GG 35053).

⁵ GG 31638 of 24 November 2008.

⁶ Section 6(1).

⁷ Section 6(2).

⁸ Section 6(3).

⁹ Section 6(5).

¹⁰ Section 6(6)(a) and (c).

¹¹ Section 6(7).

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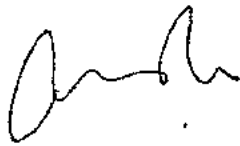
the Integrated Resources Plan, 2019; renewable energy programmes; energy from gas programmes and associated infrastructure; accelerated onshore and offshore oil and gas exploration; and the development of a roadmap towards a possible future 2500MW new nuclear build programme (in respect of which the Minister recently submitted a determination in terms of s34 of the Electricity Regulation Act¹² to the National Energy Regulator of South Africa (NERSA) for their concurrence). Having regard to South Africa's energy future and its response to the global Climate Emergency, including the just energy transition, Green Connection strongly believes that these plans and programmes should be guided by a lawful IEP that is developed subject to the mandatory requirements contained in s6 of the NEA as envisaged by Parliament.

In the circumstances, the Green Connection respectfully calls upon the President to urgently issue a Proclamation bringing s6 of the NEA into operation.

Should the President not be inclined to urgently issue a Proclamation bringing s6 of the NEA into operation, the Green Connection respectfully requests that the President to provide a full explanation for not doing so.

We look forward to receiving your urgent response.

Yours sincerely



Adrian Leonard Pole

¹² 4 of 2006.

KS 

Andrew Dorer

From: Robert Ngobeni-Hlongwane <Robert@presidency.gov.za>
Sent: Friday, 27 November 2020 18:57
To: adrian@adrianpole.co.za
Cc: Nomusa Zondi; Makhosini Makhubele; Mike Louw
Subject: FW: Green Connection Letter to the President re. s6 of the National Energy Act / IEP
Attachments: Green Connection - Letter to President re s6 National Energy Act (24 November 2020).pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Mr Pole

Receipt of the correspondence addressed to the President of the Republic of South Africa, HE President Cyril Ramaphosa, is acknowledged with appreciation.

You are nevertheless directed to liaise with the Ministry of Mineral Resources and Energy as the best placed office to engage with. Please contact Mr George Lekorotsoana, Chief of Staff to the Minister, on 012 444 3856/ George.Lekorotsoana@dmre.gov.za

Kind regards

Robert Hlongwane
 Private Office of the President
 West Wing, Room 65, Union Buildings
 The Presidency
 Tel: 012 300 5219
 Website: www.thepresidency.gov.za
 E-Mail: Robert@presidency.gov.za



DISABILITY
 RIGHTS
 AWARENESS
 MONTH 2020

From: adrian@adrianpole.co.za [mailto:adrian@adrianpole.co.za]
Sent: Tuesday, 24 November 2020 08:20
To: President RSA <PresidentRSA@presidency.gov.za>; Malebo Sibiya <malebo@presidency.gov.za>; Khusela Sangoni <khusela@presidency.gov.za>
Subject: Green Connection Letter to the President re. s6 of the National Energy Act / IEP

To whom it may concern

Please find attached letter for the attention of President Ramaphosa.

We would be grateful if you could acknowledge receipt hereof by return of email.

KS

Yours faithfully

Adrian Leonard Pole
BA.LLB.MEnvDev.LLM

Adrian Pole Attorneys
13 Quarry Road · Assagay
P O Box 671 · Hillcrest · 3650
KwaZulu-Natal · SA
Mobile: 082 340 8534
Email: adrian@adrianpole.co.za
Website: www.adrianpole.co.za

<http://www.thepresidency.gov.za/content/legal-disclaimers>
<http://www.thepresidency.gov.za/content/legal-disclaimers>
<http://www.thepresidency.gov.za/content/legal-disclaimers>
<http://www.thepresidency.gov.za/content/legal-disclaimers>

KS¹¹



13 Quarry Road • Assagay • KwaZulu Natal • SA
 P O Box 671 • Hillcrest • 3650
 Mobile: 082 340 8534
 Email: adrian@adrianpole.co.za
 Web: www.adrianpole.co.za

Your ref: The President of South Africa

Our ref: Green Connection/ap

Mr. Cyril Ramaphosa
President of the Republic of South Africa
 Private Bag X1000
 Pretoria
 0001

By Email c/o: presidentrsa@presidency.gov.za
malebo@presidency.gov.za
khusela@presidency.gov.za

7 December 2020

Dear Mr President

Re: Proclamation of section 6 of the National Energy Act, 2008

We refer to our letter dated 24 November 2020, and to the emailed response received from the Private Office of the President on 27 November 2020.

The Green Connection will engage directly with the Department of Mineral Resources and Energy (DMRE) should the DMRE proceed with the publishing an Integrated Energy Plan (IEP).

However, as indicated in our letter of 24 November 2020, section 21 of the National Energy Act, 2008 (NEA) provides that the NEA comes into operation on a date determined by the President by Proclamation in the *Gazette*. While such Proclamations have been gazetted bringing into operation sections 17 to 19 on 1 April 2009, sections 7 to 16 on 1 April 2011, and sections 1 to 5 and 20 to 21 on 1 March 2012,¹ no Proclamation has been published by the President bringing section 6 into operation (notwithstanding that the NEA was published in the *Gazette* as far back as 24 November 2008).²

Given that it the President determines the date when section 6 of the NEA comes into operation, our correspondence was appropriately addressed to the President.

In the circumstances, and for the reasons set out in our letter dated 24 November 2020, the Green Connection respectfully reiterates it call upon the President to urgently issue a Proclamation bringing section 6 of the NEA into operation.

¹ Proclamation No R. 19 of 1 April 2009 (GG 32802); Proclamation No. 28 of 1 April 2011 (GG 34175); and Proclamation No. 10 of 24 February 2012 (GG 35053).

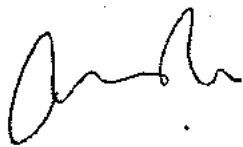
² GG 31638 pf 24 November 2008.

KS AL

Should the President not be inclined to urgently issue a Proclamation bringing section 6 of the NEA into operation, the Green Connection reiterates its request that the President provide a full explanation for not doing so.

We look forward to receiving the President's urgent response.

Yours sincerely



Adrian Leonard Pole

KS¹⁶



THE PRESIDENCY: REPUBLIC OF SOUTH AFRICA
Private Bag X 1000, Pretoria, 0001

Mr Adrian Leonard Pole
Adrain Pole Environmental Law
P O Box 671
Hillcrest
3650

Per email: adrian@adrianpole.co.za

Dear Mr. Pole,

Proclamation of section 6 of the National Energy Act, 2008

Reference is made to your letter dated 07 December 2020 on the above matter.

Your letter has been referred to the Legal and Executive Services Unit for further processing and response.

In terms of the government administrative processes relating to the proclaiming of the commencement date of the Act or particular section(s) of the Act, the relevant Minister / relevant national government department which administer the Act will advise the President of its readiness to implement such Act or particular section(s) of the Act.

The Minister of Mineral Resources and Energy has not yet recommended to the President to bring section 6 of the National Energy Act, 2008 into operation.

Your letter was referred to the Department of Mineral Resources and Energy for further advice. We will revert to you as soon as we receive the response Mineral Resources and Energy.

We trust you will find the above in order.

Yours faithfully

Geoffrey Mphaphuli
Acting Head: Legal and Executive Services unit

Date: 14/12/2020

KS 11

Andrew Dorer

From: adrian@adrianpole.co.za
Sent: Friday, 12 February 2021 09:38
To: 'Geofrey Mphaphuli'
Cc: 'Robert Ngobeni-Hlongwane'; 'Nomusa Zondi'; 'Makhosini Makhubele'; 'Mike Louw'; 'Angeline Coetzee'; 'Mkile Zweni'
Subject: RE: Green Connection Letter to the President re. s6 of the National Energy Act / IEP

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We would be most grateful if you could let us have an update regarding whether a response has been received from the Department of Mineral Resources & Energy?

Yours sincerely

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 BA.LLB.MEnvDev.LLM

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 KwaZulu-Natal · SA
 Mobile: 082 340 8534
 Email: adrian@adrianpole.co.za
 Website: www.adrianpole.co.za

From: adrian@adrianpole.co.za <adrian@adrianpole.co.za>
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Dear Mr Pole

Please find the attached letter as discussed.

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From: Robert Ngobeni-Hlongwane <Robert@presidency.gov.za>
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To: adrian@adrianpole.co.za
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Andrew Dorer

From: adrian@adrianpole.co.za
Sent: Wednesday, 24 March 2021 13:08
To: 'Geofrey Mphaphuli'
Cc: 'Robert Ngobeni-Hlongwane'; 'Nomusa Zondi'; 'Makhosini Makhubele'; 'Mike Louw'; 'Angeline Coetzee'; 'Mkile Zweni'
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Cc: Nomusa Zondi <Nomusa@presidency.gov.za>; Makhosini Makhubele <Makhosini@presidency.gov.za>; Mike Louw <mike@presidency.gov.za>

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AWARENESS
MONTH 2020

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KS *Rec*

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From: Geoffrey Mphaphuli <Geofrey@presidency.gov.za>
Sent: Friday, 26 March 2021 11:29
To: adrian@adrianpole.co.za
Cc: Robert Ngobeni-Hlongwane; Nomusa Zondi; Makhosini Makhubele; Mike Louw; Angeline Coetzee; Mkile Zweni; Pieter Alberts
Subject: RE: Green Connection Letter to the President re. s6 of the National Energy Act / IEP

Morning

Thank you for the reminder. Kindly be advised we have not yet received the respond from Mineral Resources and Energy. I spoke to Mr Peter Alberts from the Mineral Resources he is making follow up with the relevant branch in his office, I have also copied him in this email.

We will revert you as soon as Mr Alberts revert to us.

Regards

Mr Geoffrey Mphaphuli
 Principal State Law Advisor
 The Presidency
 Tel: +27 12 300 5403
 Cell: +27 82 578 6484
 Fax: +27 12 300 5780
 E-mail: Geofrey@presidency.gov.za
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Your ref: The President of South Africa

Our ref: Green Connection/ap

Mr. Cyril Ramaphosa
President of the Republic of South Africa
 Private Bag X1000
 Pretoria
 0001

By Email c/o: geofrey@presidency.gov.za

Cc'd to: robert@presidency.gov.za
nomusa@presidency.gov.za
makhosini@presidency.gov.za
mike@presidency.gov.za
angeline@presidency.gov.za
mikile@presidency.gov.za
pieter.alberts@dmre.gov.za

17 June 2021

Dear Mr President

Re: Proclamation of section 6 of the National Energy Act, 2008

We refer to our letters written on behalf of the Green Connection dated 24 November 2020 and 7 December 2020, to our emails dated 12 February 2021 and 24 March 2021, and to the emailed responses received from the Private Office of the President on 27 November 2020, 14 December 2020 and 26 March 2021.

We understand from your 14 December 2020 letter that the Minister of Mineral Resources and Energy has not yet recommended to the President to bring section 6 of the National Energy Act, 2008 (NEA) into effect, that our letter of 7 December 2020 had been referred to the Department of Mineral Resources and Energy (DMRE) for further advice, and that your office would revert to us as soon as a response was received from the DMRE. We understand further from your office's last emailed communication of 26 March 2021 that the Presidency had still not received a response from the DMRE, that your Mr Mphaphuli had spoken with the DMRE's Mr Pieter Alberts, and that Mr Alberts would be making follow-up with the relevant branch in his office.

To date we have not received any further communication from the Presidency or the DMRE.

As indicated in previous correspondence, section 21 of the NEA provides that the NEA comes into operation on a date determined by the President by Proclamation in the *Gazette*, and

Attorney: Adrian Leonard Pole
 BA LLB MEnvDev LLM(environmental law)
 VAT Registration Number: 4030234308

KSI

that despite having been approved by the legislature in 2008 (over twelve years ago), no Proclamation has been gazetted bringing section 6 into effect.

Having regard to the current energy crisis, the climate emergency and the various (and often controversial) energy and electricity-generation plans and programmes (including procurement programmes) that are being actively promoted and pursued by the DMRE, the Green Connection is of the view that it is of critical importance to sound energy planning that section 6 of the NEA be brought into effect without any further delay, and that a lawful IEP is developed in accordance with its provisions.

The Green Connection welcomes the President's recent announcement that government will increase the threshold for companies to produce their own electricity without a license to 100MW, and believes that this emphasises the need for lawful integrated energy planning. The Green Connection also notes that the Presidential Climate Change Coordinating Commission is coordinating the just energy transition to a low carbon economy. The Green Connection believes that an orderly transition from reliance on unsustainable fossil fuels and nuclear energy to a sustainable renewable energy future requires integrated energy planning as a core part of this transition, and that it is difficult to see how such a just energy transition can take place without a lawful IEP.

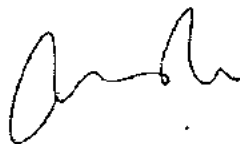
The power conferred on the President to bring section 6 of the NEA into effect is a public power that must be exercised lawfully for the purpose for which it was given, and should not be used to veto or otherwise block its implementation. Section 6 of the NEA was approved by the legislature in 2008, and we respectfully submit that it could be brought into effect by the President within a short period of time.

In the circumstances, the Green Connection repeats its call upon the President to urgently issue a Proclamation bringing s6 of the NEA into operation. It has been over 7 months since the Green Connection's request was first communicated to the President.

We also repeat the Green Connection's request that, should the President not be inclined to urgently issue a Proclamation bringing s6 of the NEA into operation, the President urgently provides a full explanation for not doing so.

The Green Connection reserves its rights, including its right to approach the Courts for appropriate relief.

Yours sincerely



Adrian Leonard Pole

KS 18



**mineral resources
& energy**

Department:
Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

Enquiries: Thabang Audat; Mobile: 082 839 9567; Email: Thabang.Audat@dmre.gov.za

Physical Address: Matimba House; 192 Visagie, Pretoria, 0001

Mr. Adrian Leonard Pole

Adrian Pole Attorneys

13 Quarry Road

Assagay

KwaZulu-Natal

By email: adrian@adrianpole.co.za

cc: nokukhanya@presidency.gov.za

cc: geofrey@presidency.gov.za

**RE: PROCLAMATION OF SECTION 6 OF THE NATIONAL ENERGY ACT, 2008 (ACT
34 OF 2008)**

I refer to your letter dated 17 June 2021 on behalf of the Green Connection addressed to his Excellency, President Ramaphosa relating to the above matter (**copy attached**).

The Department was requested by the Presidency to respond to this letter as it is specific to energy planning issues. I thus provide the following response.

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The development of Integrated Energy Plan (IEP) is informed by the output of analyses founded on a solid fact base. The IEP is a multi-faceted, long-term energy framework which has multiple objectives, some of which include:

- To guide the development of energy policies and, where relevant, set the framework for regulations in the energy sector;
- To guide the selection of appropriate technologies to meet energy demand at an affordable cost (i.e. the types and sizes of new power plants, gas infrastructure and petroleum refineries to be built);
- To guide investment in and the development of energy infrastructure in South Africa; and
- To propose alternative energy strategies which are informed by testing the potential impacts of various factors such as proposed policies, introduction of new technologies, environmental considerations and effects of exogenous macro-economic factors.

The IEP considers the national energy supply and demand balance and proposes alternative capacity expansion plans based on varying sets of assumptions and constraints across energy sectors (electricity sector, petroleum sector and gas sector). It, however, does not explicitly consider supply and demand at specific geographical locations within the country nor does it take into account sector specific infrastructure constraints at specific locations. It is thus important to develop an understanding of sector specific constraints, through undertaking detailed sector studies and analysis. This is a crucial exercise that must be diligently undertaken in order to develop an IEP which is credible and technically sound for South Africa.

The Department, together with relevant State Entities, has thus undertaken the following sector plans to understand specific sector constraints to date:

1. Electricity Distribution Industry Asset Assessment,
2. Electricity Transmission Plan,
3. Electricity Generation Plan (Integrated Resource Plan (version 2010 and 2019),

KS 14

4. Draft liquid fuels master plan (a 20-Year liquid fuel infrastructure roadmap) which deals with logistical issues relating to pipelines and storage facilities for petroleum products,
5. Draft Gas Utilization Masterplan (GUMP 2015) and
6. Gas Master Plan (GMP 2022) (currently under development).

All of the above sector plans will, once approved by Cabinet, feedback into the Integrated Energy Planning process and will enable overall enhancement and an integrated approach to South Africa's energy planning process. The draft IEP was published in 2015 and the idea is to improve this draft with inputs from the above sector plans in order for the IEP to be technically sound and based on credible, factual data.

As stated before, once fully developed, the IEP will provide a basis/platform to evaluate the impact and effect of different government policies simultaneously such as testing the impact of emission reduction limit with energy efficiency interventions as well as the effect of the Carbon Tax policy together with improvement in vehicle efficiency and implementation of the solar water heating programme, amongst other interventions that Government is implementing.

The future iterations of the sector plans review will, from the point the IEP is approved by Cabinet forward, therefore be informed by the IEP as the overarching country energy policy. However, in order to develop the first credible IEP, the above approach (i.e. sector study/ analysis) is technically sound and addresses the unique technical nature of South Africa's energy planning.

Given the period it would ordinarily take for the sector specific policies to be developed and approved by Cabinet, taking into account NEDLAC consultations (approximately 6 months), internal government consultations (approximately 3 months) and general public consultations (approximately 2 months) and the required internal technical modelling exercise, report drafting and editing, the Department is of the view that bringing section 6 of the National Energy Act, 2008 into force should be considered once the all sector plans have been completed (or near completion) and approved by Cabinet. Bringing section 6

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into effect prior to completing the relevant sector plans could result in the Department failing to comply with the prescribed timelines for the development and review of the IEP, for reasons outlined above.

Recognizing the impact that the lack of energy security supply poses to the economy, the Department is revising Schedule 2 of the Electricity Regulation Act, 2006 (Act 4 of 2006) to enable electricity generation from embedded generators of up to 100 MW per site. The process to finalize the schedule is currently with the Regulator. The Department has also issued a request for proposal to procure up to 2000 MW of electricity generation capacity, this process is at an advanced stage. All this is done in an effort by the Department to address the current energy shortfall.

It should be noted further that the policy implementation of the capacity under the IRP2019 is being expedited to procure generation capacity from renewable energy (up to 20 400 MW), hydro scheme (up to 2500 MW), gas to power (up to 3000 MW), storage (up to 2100 MW) and coal (up to 1500 MW).

The officials responsible for energy planning are available for further technical discussions on this very important topic.

I hope you find the above in order.



Adv. Thabo Mokoena

Director-General

Department of Mineral Resources & Energy

Date: 21/07/2021

KS 11



13 Quarry Road • Assagay • KwaZulu Natal • SA
 P O Box 671 • Hillcrest • 3650
 Mobile: 082 340 8534
 Email: adrian@adrianpole.co.za
 Web: www.adrianpole.co.za

Your ref: The President of South Africa

Our ref: Green Connection/ap

To: Advocate Thabo Mokoena
 Director-General
 Department of Mineral Resources & Energy

By Email c/o: nonhlanhla.ndebele@dmre.gov.za

Cc'd to: thabang.audat@dmre.gov.za
mamabefu.modipa@dmre.gov.za
geofrey@presidency.gov.za
nokukhanya@presidency.gov.za

27 October 2021

Dear Adv. Mokoena

Re: Proclamation of section 6 of the National Energy Act, 2008

We refer to your letter dated 21 July 2021, responding to our letter dated 17 June 2021 on behalf of the Green Connection addressed to the President.

In essence, the Department of Mineral Resources & Energy's (DMRE) response (to our client's request to the President to issue a Proclamation bringing section 6 of the National Energy Act, 2008 (NEA) into effect) is that the DMRE is of the view that a credible and technically sound IEP is dependent upon various sector plans being completed (or being near completion), and that:

"The Department is of the view that bringing section 6 of the National Energy Act, 2008 into force should be considered once the all (sic) sector plans have been completed (or near completion) and approved by Cabinet. Bringing section 6 into effect prior to completing the relevant sector plans could result in the Department failing to comply with the prescribed timelines for the development and review of the IEP."

We note that the DMRE has listed that following 'sector plans' that have been undertaken 'to understand specific sector constraints to date', namely:

- Electricity Distribution Industry Asset Assessment;
- Electricity Transmission Plan;
- Electricity Generation Plan (Integrated Resource Plan (version 2010 and 2019);
- Draft liquid fuels master plan;

Attorney: Adrian Leonard Pole
 BA, LLB MEnvDev LLM (environmental law)
 VAT Registration Number: 4030234308

KS 11

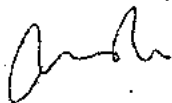
- Draft Gas Utilisation Masterplan (GUMP 2015); and
- Gas Master Plan (GMP 2022) (indicated as currently under development).

We have attempted to ascertain the status of these 'sector plans', but - save for the *IRP2010* and *IRP2019* - the current status of these 'sector plans' could not readily be established. The *Electricity distribution Industry Asset Assessment* and *Electricity Transmission Plan* could not be found through our online search, while an *Energy Security Master Plan - Liquid Fuels* was gazetted back in 2007.¹ Regarding the development of the GUMP, information on the DMRE Independent Power Producer (IPP) website indicates that 'the Department is, at present, finalising a GUMP for South Africa',² while the requirement for the Minister to compile a *Gas Master Plan* is included in proposed amendments to the Gas Act.³

In light of the above, we would be grateful if you could clarify the following:

1. Are the six sector plans referred to the only sector plans that in the DMRE's view should be completed (or near completion) and approved by Cabinet before consideration should be given to bringing section 6 into operation?
2. If not, could you please indicate what other sector plans also need be completed (or near completion) and approved by Cabinet before consideration should be given to bringing section 6 into operation?
3. Can you please indicate the current status of each of the sector plans that need to be completed?
4. Can you please advise where such sector plans (or draft plans) may be accessed (other than the IRP2010 and IRP2019)?
5. Can you please clarify whether the Minister has published an analysis of energy data in accordance with section 3(4)(a) and section 3(5) of the NEA, and if so where such analysis can be accessed?

Yours sincerely



Adrian Leonard Pole

¹ GN859 of 12 September 2007. The notice indicates that this Energy Security Master Plan - Liquid Fuels 'elucidates South Africa's energy security strategy and includes the integrated energy modelling and planning approach, approved by Cabinet at its ordinary meeting held in Pretoria on 8 August 2007'.

² <https://www.ipp-gas.co.za/>

³ Gas Amendment Bill, 2021. The Bill proposes to insert the following definition of 'gas master plan': '...an indicative, forward-looking plan for gas supply and demand, compiled in accordance with the provisions of section 28A in order to reflect national policy on gas infrastructure planning, which considers the sources from which gas is, and may be, supplied, and also considers the development, strengthening, upgrading and refurbishment of the gas transmission network and the linkages between this system and any relevant facilities for the import or export of gas necessary to supply the anticipated demand'. See also proposed new section 28A.

KS *me*



13 Quarry Road • Assagay • KwaZulu Natal • SA
P O Box 671 • Hillcrest • 3650
Mobile: 082 340 8534
Email: adrian@adrianpole.co.za
Web: www.adrianpole.co.za

Your ref: The President of South Africa

Our ref: Green Connection/ap

Mr. Cyril Ramaphosa
President of the Republic of South Africa
Private Bag X1000
Pretoria
0001

By Email c/o: geofrey@presidency.gov.za

Cc'd to: robert@presidency.gov.za
nomusa@presidency.gov.za
makhosini@presidency.gov.za
mike@presidency.gov.za
angeline@presidency.gov.za
mkile@presidency.gov.za
pieter.alberts@dmre.gov.za

27 October 2021

Dear Mr President

Re: Proclamation of section 6 of the National Energy Act, 2008

We refer to our letters written on behalf of our client, the Green Connection, dated 24 November 2020 and 7 December 2020, to our emails dated 12 February 2021 and 24 March 2021, and to the emailed responses received from the Private Office of the President on 27 November 2020, 14 December 2020 and 26 March 2021, to the letter from the Presidency dated 14 December 2020, and to the subsequent letter from the Department of Mineral Resources & Energy (DMRE) dated 21 July 2021.

As you will be aware from the correspondence set out above, our client has made several requests to the President to exercise the power given to him in section 21 of the National Energy Act, 2008 (NEA) by issuing a Proclamation bringing section 6 of the NEA into operation.

Having regard to the current energy crisis, the climate emergency and the various (and often controversial) energy and electricity-generation plans and programmes (including procurement programmes) that are being actively promoted and pursued by the DMRE, our client remains of the view that it is of critical importance to sound energy planning that section 6 of the NEA be brought into effect without any further delay, and that a lawful IEP is developed in accordance with its provisions.

Attorney: Adrian Leonard Pole
BA,LLB MEnvDev LLM(environmental law)
VAT Registration Number: 4030234306

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In its letter dated 14 December 2020, the Presidency advised that in terms of government administrative processes relating to the proclaiming of the commencement date of an Act or a particular section(s) thereof, the relevant Minister / relevant national government department which administer the Act will advise the President of its readiness to implement such Act or particular section(s).

The Presidency advised further that the Minister responsible for Mineral Resources and Energy ('the Minister') has not yet recommended to the President to bring section 6 of the NEA into operation, and that our client's letter of 7 December 2020 had been referred to the DMRE for further advice.

On 21 July 2021, the DMRE responded to our follow-up letter to the Presidency dated 17 June 2021. In essence, the DMRE's response is that it is of the view that a credible and technically sound IEP is dependent upon various sector plans being completed (or being near completion), and that:

"The Department is of the view that bringing section 6 of the National Energy Act, 2008 into force should be considered once the all (sic) sector plans have been completed (or near completion) and approved by Cabinet. Bringing section 6 into effect prior to completing the relevant sector plans could result in the Department failing to comply with the prescribed timelines for the development and review of the IEP."

The letter from the Presidency dated 14 December 2020 reveals that the Minister has not yet made a recommendation to the President to bring section 6 of the NEA into operation.

The letter from your office does not indicate whether the DMRE has reported to the President on its readiness to implement section 6 of the NEA, or whether the DMRE's reasons for not recommending that section 6 be brought into operation have been communicated to and duly considered by the President (having regard also to other relevant factors, such as the obligation to perform all constitutional obligations diligently and without delay¹).

While it may be so that in terms of government administrative processes, the details of which are not specified in your letter, the relevant Minister or Department which administers an Act will advise the President of its readiness to implement a particular section, this administrative process cannot override the President's constitutional obligation to determine, in the exercise of his independent discretion, when the section should be brought into operation. As we have pointed out previously, the power conferred on the President to bring section 6 of the NEA into effect is a public power that must be exercised lawfully for the purpose for which it was given. The letter from your office dated 14 December 2020 furthermore does not provide clarity regarding the detailed considerations taken into account by the President in deciding not to exercise his power to bring section 6 of the NEA into operation nor does it indicate whether, irrespective of any other considerations, no decision by the President will be made to bring section 6 of the NEA into operation in the absence of a recommendation by the Minister or the DMRE to do so.

¹ SA Constitution, section 237.

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Our client's view is that the stated approach of the DMRE - that bringing section 6 of the NEA into force should be considered once all sector plans have been completed (or are near completion) and approved by Cabinet – is fundamentally flawed for a number of reasons.

Firstly, there is no statutory basis for the DMRE's position that the development of an IEP in terms of section 6 of the NEA is dependent upon sector plans being finalised, and it would be irrational for the President to depend on the Minister to finalise policy before bringing section 6 into operation. The NEA was approved by the National Assembly in 2008 and - save for section 6 - the rest of the NEA has been brought into operation by Presidential proclamations.² The NEA does not give any indication that section 6 should be brought into effect only when the sector plans referred to in the DMRE's letter have been completed (or are near completion), nor does it make the development of an IEP dependent upon the completion of such sector plans.

Secondly, it is clear from the wording of section 6 of the NEA that the legislature intended that the IEP would take account of plans in various sectors, would inform and be informed by these plans, and would be based on the results of energy analysis (which the Minister is required to publish annually). This is evident from section 6(3), which provides that the development of the IEP must:

- (a) take account of plans relating to transport, electricity, petroleum, water, trade, macro-economy energy infrastructure development, housing, air quality management, greenhouse gas mitigation within the energy sector and integrated development plans of local and provincial authorities;
- (b) inform and be informed by plans from all supply, production and demand sectors whose plans impact on or are impacted by the Integrated Energy Plan; and
- (c) be based on the results of the energy analysis envisaged in sections 3 (4) (a) and 3 (5).³

Thirdly, in its letter, the DMRE recognises that *'future iterations of the sector plans review will, from the point the IEP is approved by Cabinet forward, therefore be informed by the IEP as the overarching country energy policy'*, but illogically goes on to state that *'in order to develop the first credible IEP, the above approach (i.e. sector study / analysis) is technically sound and addresses the unique technical nature of South Africa's energy planning.'*

² Sections 17, 18 and 19 were brought into operation on 1 April 2009 (Proclamation 19 of 1 April 2009). These sections deal with security of supply (Chapter 5), and in particular the acquisition and maintenance of national strategic energy feedstocks and carriers, and investment in and maintenance of the energy infrastructure. Chapter 4 (dealing with the establishment of the South African National Energy Development Institute) was brought into operation on 1 April 2011 (Proclamation 28 of 1 April 2011). Sections 1, 2, 3, 4, 5, 20 and 21 were brought into operation on 1 March 2012 (Proclamation 10, GG 35053, 24 February 2012).

³ Section 6(3). Section 3(4)(a) requires the Minister to collect, collate and analyse energy data and information, while section 3(5) requires the Minister to annually publish an analysis:

- (a) reviewing energy demand and supply for the previous year;
- (b) forecasting energy supply and demand for no less than 20 years; and
- (c) of plausible energy scenarios of how the future energy demand and supply landscape could look like under different demand and supply assumptions.

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There is simply no statutory basis for the DMRE's contention that a credible IEP is dependent upon a sector study / analysis approach.

Fourthly, in our client's view, it would be irrational to make the development of the IEP dependent upon sector plans that - as far as we can determine - have no legislative basis or prescribed time-lines, as the development of these sector plans as policy could be endless. The DMRE lists the following 'sector plans' that have been undertaken 'to understand specific sector constraints to date', namely:

- Electricity Distribution Industry Asset Assessment;
- Electricity Transmission Plan;
- Electricity Generation Plan (Integrated Resource Plan (version 2010 and 2019));
- Draft liquid fuels master plan;
- Draft Gas Utilisation Masterplan (GUMP 2015); and
- Gas Master Plan (GMP 2022) (indicated as currently under development).

We have attempted to ascertain the status of these 'sector plans', but - save for the *IRP2010* and *IRP2019* - the current status of these 'sector plans' could not readily be established. The *Electricity distribution Industry Asset Assessment* and *Electricity Transmission Plan* could not be found through our online search, while an *Energy Security Master Plan - Liquid Fuels* was gazetted back in 2007.⁴ Regarding the development of the GUMP, information on the DMRE Independent Power Producer (IPP) website indicates that 'the Department is, at present, finalising a GUMP for South Africa',⁵ while the requirement for the Minister to compile a *Gas Master Plan* is included in proposed amendments to the Gas Act.⁶

The DMRE's view that section 6 of the NEA should not be brought into operation until these (and potentially other unspecified) sector plans are finalised at some future unspecified date is therefore likely to result in an indefinite delay.

Finally, the failure to bring section 6 of the NEA into effect frustrates the purpose and objects of the NEA. The NEA was enacted to (among other things) ensure diverse energy resources are available, in sustainable quantities and at affordable prices, to the South African economy in support of economic growth and poverty alleviation, taking into account environmental management requirements and interactions amongst other economic sectors; and to provide for energy planning, increased generation and consumption of renewable energies, and adequate investment in, appropriate upkeep of and access to energy infrastructure.⁷ Its objects include (among other things) to ensure uninterrupted supply of energy to the

⁴ GN859 of 12 September 2007. The notice indicates that this Energy Security Master Plan - Liquid Fuels 'elucidates South Africa's energy security strategy and includes the integrated energy modelling and planning approach, approved by Cabinet at its ordinary meeting held in Pretoria on 8 August 2007'.

⁵ <https://www.ipp-gas.co.za/>

⁶ Gas Amendment Bill, 2021. The Bill proposes to insert the following definition of 'gas master plan': '...an indicative, forward-looking plan for gas supply and demand, compiled in accordance with the provisions of section 28A in order to reflect national policy on gas infrastructure planning, which considers the sources from which gas is, and may be, supplied, and also considers the development, strengthening, upgrading and refurbishment of the gas transmission network and the linkages between this system and any relevant facilities for the import or export of gas necessary to supply the anticipated demand'. See also proposed new section 28A.

⁷ Preamble.

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Republic, and to ensure effective planning for energy supply, transportation and consumption.

Our client records that in its view, the failure to bring section 6 of the NEA into effect, and the subsequent failure of the DMRE to develop and update an IEP in accordance with the mandatory provisions of the IEP, has resulted in poor energy planning for over a decade. Instead of energy infrastructure developments and the selection of appropriate technology to meet energy demand being guided by an IEP developed, annually reviewed and published in accordance with section 6 of the NEA, a number of contentious energy infrastructure developments and electricity generation programmes are being pursued without the guidance of an IEP that takes into account sustainable development, economic viability, and environmental, health and socio-economic impacts (amongst others).⁸ The DMRE itself indicates in its letter that various projects are being rolled-out to address electricity shortages, including a request for proposals to procure up to 2000 MW of electricity generation capacity in an effort to address the current energy shortfall, and expediting of policy implementation of the capacity under the IRP2019 to procure generation capacity from various sources (renewable energy, hydro, gas to power, storage and coal). Additional examples include the DMRE's planned commencement of a new 2500MW nuclear new build programme, as well as its liquid natural gas (LNG) infrastructure programme. This risks locking South Africa in to long-term energy infrastructure developments and electricity generation programmes, without being guided by an IEP developed in accordance with section 6 of the NEA.

In contrast, bringing section 6 into operation would give effect to the purpose and objects of the NEA by providing for effective energy planning, and would result in an IEP (following the required public comment process) that would in turn serve as a guide for energy infrastructure investments, and which would also guide the selection of appropriate technologies.⁹

In the circumstances, we are instructed to address the following queries to the President:

- (1) Given the considerations and factors set out above, whether the President remains of the view that he will not take steps to bring section 6 of the NEA into operation until such time as the DMRE makes a recommendation to him to do so?
- (2) Whether the President is aware of the DMRE's position, namely that bringing section 6 of the NEA into force should be considered once all sector plans have been completed (or near completion) and approved by Cabinet, and that bringing section 6 into operation prior to the completion of these sector plans could result in the

⁸ Section 6(4) stipulates that the development of the IEP **must take into account:**

- (a) **sustainable development;**
- (b) **optimal use of indigenous and regional energy resources;**
- (c) **balance between supply and demand;**
- (d) **economic viability;**
- (e) **environmental, health, safety and socio-economic impacts; and**
- (f) **developmental requirements of the Southern African region.**

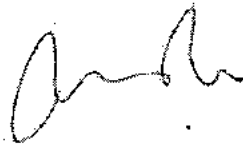
⁹ Section 6(6)(a) and (c).

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DMRE failing to comply with the prescribed timelines for the development and review of the IEP?

We look forward to your urgent response to these queries and reserve all of our client's rights in relation to further appropriate steps it may institute in the light of this correspondence.

Yours sincerely



Adrian Leonard Pole

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Andrew Dorer

From: Geoffrey Mphaphuli <Geofrey@presidency.gov.za>
Sent: Wednesday, 27 October 2021 19:41
To: adrian@adrianpole.co.za
Cc: Robert Ngobeni-Hlongwane; Nomusa Zondi; Makhosini Makhubele; Mike Louw; Angeline Coetzee; Mkile Zweni; 'Pieter Alberts'
Subject: RE: Green Connection Letter to the President re. s6 of the National Energy Act / IEP

Evening, the letter has been received, Thanks. We will consider and revert.

Regards

Mr Geoffrey Mphaphuli
 Principal State Law Advisor
 The Presidency
 Tel: +27 12 300 5403
 Cell: +27 82 578 6484
 Fax: +27 12 300 5780
 E-mail: Geofrey@presidency.gov.za
 Website: www.thepresidency.gov.za

E-mail Disclaimer: <http://www.thepresidency.gov.za/pebble.asp?relid=97>

From: adrian@adrianpole.co.za <adrian@adrianpole.co.za>
Sent: Wednesday, October 27, 2021 2:57 PM
To: Geoffrey Mphaphuli <Geofrey@presidency.gov.za>
Cc: Robert Ngobeni-Hlongwane <Robert@presidency.gov.za>; Nomusa Zondi <Nomusa@presidency.gov.za>; Makhosini Makhubele <Makhosini@presidency.gov.za>; Mike Louw <mike@presidency.gov.za>; Angeline Coetzee <Angeline@presidency.gov.za>; Mkile Zweni <Mkile@presidency.gov.za>; 'Pieter Alberts' <Pieter.Alberts@dmre.gov.za>
Subject: Green Connection Letter to the President re. s6 of the National Energy Act / IEP

Dear Mr Mphaphuli

We refer to the above matter, to our previous correspondence and to a letter received from the Department of Mineral Resources & Energy dated 21 July 2021.

Please find attached our further letter to the President written on behalf of our client the Green Connection.

We look forward to receiving the President's response.

We would be most grateful if you could confirm receipt of this email and attached letter.

Yours sincerely

Adrian Leonard Pole
 BA.LLB.MEnvDev.LLM

Adrian Pole Attorneys
 13 Quarry Road · Assagay
 P O Box 671 · Hillcrest · 3650

KS 14

KwaZulu-Natal · SA
Mobile: 082 340 8534
Email: adrian@adrianpole.co.za
Website: www.adrianpole.co.za



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<http://www.thepresidency.gov.za/content/legal-disclaimers>



13 Quarry Road • Assagay • KwaZulu Natal • SA
P.O. Box 571 • Hillcrest • 3611
Mobile: 083 341 6434
Email: adrian@adrianpole.co.za
Web: www.adrianpole.co.za

Your ref: The President of South Africa

Our ref: Green Connection/ap

Mr. Cyril Ramaphosa
President of the Republic of South Africa
Private Bag X1000
Pretoria
0001

By Email c/o: geofrey@presidency.gov.za

Cc'd to: robert@presidency.gov.za
nomusa@presidency.gov.za
makhosini@presidency.gov.za
mike@presidency.gov.za
angeline@presidency.gov.za
mikile@presidency.gov.za
pieter.alberts@dmre.gov.za

9 November 2021

Dear Mr President

Re: Proclamation of section 6 of the National Energy Act, 2008

We refer to previous correspondence, and to our letter written on behalf of our client the Green Connection dated 27 October 2021.

While we received an email (of the same date) in response confirming that our client's letter has been received, and that the letter would be considered and responded to, to date we have not received the President's substantive response to our client's queries.

In the circumstances, please may we have the President's response to the queries contained in our client's 27 October 2021 letter by close of business on 16 November 2021.

We reserve all of our client's rights in relation to further appropriate steps it may institute in the light of this correspondence.

Yours sincerely

Adrian Leonard Pole

Attorney: Adrian Leonard Pole
BA, LLB (Member ULM Environmental Law)
VAT Registration Number: 4050234308

KSI

Your ref: The President of South Africa

Our ref: Green Connection/ap

To: Advocate Thabo Mokoena
Director-General
Department of Mineral Resources & Energy

By Email c/o: nonhlanhla.ndebele@dmre.gov.za

Cc'd to: thabang.audat@dmre.gov.za
mamabefu.modipa@dmre.gov.za
geofrey@presidency.gov.za
nokukhanya@presidency.gov.za

9 November 2021

Dear Adv. Mokoena

Re: Proclamation of section 6 of the National Energy Act, 2008

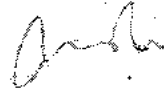
We refer to previous correspondence and to our letter on behalf of the Green Connection dated 27 October 2021.

To date we have not received the DMRE's response to our client's request for clarification on the issues set out in the aforementioned letter.

In the circumstances, please may we have the DMRE's response to the requests for clarification contained in our client's 27 October 2021 letter by close of business on 16 November 2021.

We reserve all of our client's rights in relation to further appropriate steps it may institute in the light of this correspondence.

Yours sincerely



Adrian Leonard Pole

KS

Andrew Dorer

From: Geoffrey Mphaphuli <Geofrey@presidency.gov.za>
Sent: Tuesday, 09 November 2021 18:21
To: adrian@adrianpole.co.za
Cc: Robert Ngobeni-Hlongwane; Nomusa Zondi; Makhosini Makhubele; Mike Louw; Angeline Coetzee; Mkile Zweni; 'Pieter Alberts'
Subject: RE: Green Connection Letter to the President re. s6 of the National Energy Act / IEP

Follow Up Flag: Follow up
Flag Status: Flagged

Afternoon

Kindly be advise the matter is still receiving attention. We will revert to you.

Regards

Mr Geoffrey Mphaphuli
 Principal State Law Advisor
 The Presidency
 Tel: +27 12 300 5403
 Cell: +27 82 578 6484
 Fax: +27 12 300 5780
 E-mail: Geofrey@presidency.gov.za
 Website: www.thepresidency.gov.za

E-mail Disclaimer: <http://www.thepresidency.gov.za/pebble.asp?relid=97>

From: adrian@adrianpole.co.za <adrian@adrianpole.co.za>
Sent: Tuesday, November 9, 2021 5:44 PM
To: Geoffrey Mphaphuli <Geofrey@presidency.gov.za>
Cc: Robert Ngobeni-Hlongwane <Robert@presidency.gov.za>; Nomusa Zondi <Nomusa@presidency.gov.za>; Makhosini Makhubele <Makhosini@presidency.gov.za>; Mike Louw <mike@presidency.gov.za>; Angeline Coetzee <Angeline@presidency.gov.za>; Mkile Zweni <Mkile@presidency.gov.za>; 'Pieter Alberts' <Pieter.Alberts@dmre.gov.za>
Subject: RE: Green Connection Letter to the President re. s6 of the National Energy Act / IEP

Dear Mr Mphaphuli

We refer to the above matter.

Please find attached our letter to the President written on behalf of our client the Green Connection.

We would be most grateful if you could confirm receipt of this email and attached letter.

Yours sincerely

Adrian Leonard Pole
 BA,LLB,MEnvDev,LLM

Adrian Pole Attorneys

KS 11

13 Quarry Road · Assagay
P O Box 671 · Hillcrest · 3650
KwaZulu-Natal · SA
Mobile: 082 340 8534
Email: adrian@adrianpole.co.za
Website: www.adrianpole.co.za

From: Geoffrey Mphaphuli <Geoffrey@presidency.gov.za>
Sent: Wednesday, 27 October 2021 19:41
To: adrian@adrianpole.co.za
Cc: Robert Ngobeni-Hlongwane <Robert@presidency.gov.za>; Nomusa Zondi <Nomusa@presidency.gov.za>; Makhosini Makhubele <Makhosini@presidency.gov.za>; Mike Louw <mike@presidency.gov.za>; Angeline Coetzee <Angeline@presidency.gov.za>; Mkile Zweni <Mkile@presidency.gov.za>; 'Pieter Alberts' <Pieter.Alberts@dmre.gov.za>
Subject: RE: Green Connection Letter to the President re. s6 of the National Energy Act / IEP

Evening, the letter has been received, Thanks. We will consider and revert.

Regards

Mr Geoffrey Mphaphuli
Principal State Law Advisor
The Presidency
Tel: +27 12 300 5403
Cell: +27 82 578 6484
Fax: +27 12 300 5780
E-mail: Geoffrey@presidency.gov.za
Website: www.thepresidency.gov.za

E-mail Disclaimer: <http://www.thepresidency.gov.za/pebble.asp?relid=97>

From: adrian@adrianpole.co.za <adrian@adrianpole.co.za>
Sent: Wednesday, October 27, 2021 2:57 PM
To: Geoffrey Mphaphuli <Geoffrey@presidency.gov.za>
Cc: Robert Ngobeni-Hlongwane <Robert@presidency.gov.za>; Nomusa Zondi <Nomusa@presidency.gov.za>; Makhosini Makhubele <Makhosini@presidency.gov.za>; Mike Louw <mike@presidency.gov.za>; Angeline Coetzee <Angeline@presidency.gov.za>; Mkile Zweni <Mkile@presidency.gov.za>; 'Pieter Alberts' <Pieter.Alberts@dmre.gov.za>
Subject: Green Connection Letter to the President re. s6 of the National Energy Act / IEP

Dear Mr Mphaphuli

We refer to the above matter, to our previous correspondence and to a letter received from the Department of Mineral Resources & Energy dated 21 July 2021.

Please find attached our further letter to the President written on behalf of our client the Green Connection.

We look forward to receiving the President's response.

We would be most grateful if you could confirm receipt of this email and attached letter.

Yours sincerely

Adrian Leonard Pole
BA.LLB.MEnvDev.LLM

Adrian Pole Attorneys
13 Quarry Road · Assagay
P O Box 671 · Hillcrest · 3650
KwaZulu-Natal · SA
Mobile: 082 340 8534
Email: adrian@adrianpole.co.za
Website: www.adrianpole.co.za



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<http://www.thepresidency.gov.za/content/legal-disclaimers>

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ANNEXURE X

1. Copies of all records, reports, documents, presentations, recommendations and/or memoranda submitted to the President of the Republic of South Africa and/or the Cabinet or its committees by the Minister of Mineral Resources and Energy ("the Minister") and/or the Director-General: Department of Mineral Resources and Energy ("the Department") and/or any functionaries of the Department, and which relate to the bringing into effect of section 6 of the National Energy Act 34 of 2008.
2. Copies of all records recording a draft and/or final Socio-Economic Impact Assessment System ("SEAS") report in respect of and/or which accompanied any documents, presentations, recommendations and/or memoranda submitted to the President of the Republic of South Africa and/or the Cabinet or its committees by the Minister, the Director-General or functionaries of the Department, and which relate to the bringing into effect of section 6 of the National Energy Act 34 of 2008.
3. The Electricity Distribution Industry Asset Assessment referred to at page 2 of the letter from the Director-General to Adrian Pole Attorneys dated 21 July 2021 (a copy of which is annexed marked "X1" and hereinafter referred to as "Annexure X1").
4. The Electricity Transmission Plan referred to at page referred to page 2 of Annexure X1.
5. Copies of any reports, documents, presentations, recommendations and/or memoranda prepared by the Department relating to the implementation status as at 21 July 2021 of the Electricity Distribution Industry Asset Assessment, Electricity Transmission Plan, Electricity Generation Plan (Integrated Resource Plan (version 2010 and 2019), Draft Liquid Fuels Master plan, Draft Gas Utilization Masterplan (GUMP 2015) and/or the Gas Master Plan (GMP 2022) referred to at pages 2 and 3 of Annexure X1.
6. Copies of any other sector plans not specifically referred to in Annexure X1, but in respect of which the Department is of the view require completion or near completion and approval by Cabinet, as indicated in Annexure X1, prior to the bringing into effect of section 6 of the National Energy Act 34 of 2008.
7. Copies of any records which record "*future iterations of the sector plans review*" and/or the "*sector study /analysis*" referred to at page 3 of Annexure X1.
8. The analysis of energy data required to be published by the Minister in terms of section 3(4)(a) and section 3(5) of the National Energy Act 34 of 2008.

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**mineral resources
& energy**

Department:
Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

Enquiries: Thabang Auda; Mobile: 082 839 9567; Email: Thabang.Auda@dmre.gov.za

Physical Address: Matimba House; 182 Visagie, Pretoria, 0001

Mr. Adrian Leonard Pole

Adrian Pole Attorneys

13 Quarry Road

Assagay

KwaZulu-Natal

By email: adrian@adrianpole.co.za

cc: nokukhanya@presidency.gov.za

cc: geofrey@presidency.gov.za

**RE: PROCLAMATION OF SECTION 6 OF THE NATIONAL ENERGY ACT, 2008 (ACT
34 OF 2008)**

I refer to your letter dated 17 June 2021 on behalf of the Green Connection addressed to his Excellency, President Ramaphosa relating to the above matter (copy attached).

The Department was requested by the Presidency to respond to this letter as it is specific to energy planning issues. I thus provide the following response.

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The development of Integrated Energy Plan (IEP) is informed by the output of analyses founded on a solid fact base. The IEP is a multi-faceted, long-term energy framework which has multiple objectives, some of which include:

- To guide the development of energy policies and, where relevant, set the framework for regulations in the energy sector;
- To guide the selection of appropriate technologies to meet energy demand at an affordable cost (i.e. the types and sizes of new power plants, gas infrastructure and petroleum refineries to be built);
- To guide investment in and the development of energy infrastructure in South Africa; and
- To propose alternative energy strategies which are informed by testing the potential impacts of various factors such as proposed policies, introduction of new technologies, environmental considerations and effects of exogenous macro-economic factors.

The IEP considers the national energy supply and demand balance and proposes alternative capacity expansion plans based on varying sets of assumptions and constraints across energy sectors (electricity sector, petroleum sector and gas sector). It, however, does not explicitly consider supply and demand at specific geographical locations within the country nor does it take into account sector specific infrastructure constraints at specific locations. It is thus important to develop an understanding of sector specific constraints, through undertaking detailed sector studies and analysis. This is a crucial exercise that must be diligently undertaken in order to develop an IEP which is credible and technically sound for South Africa.

The Department, together with relevant State Entities, has thus undertaken the following sector plans to understand specific sector constraints to date:

1. Electricity Distribution Industry Asset Assessment,
2. Electricity Transmission Plan,
3. Electricity Generation Plan (Integrated Resource Plan (version 2010 and 2019),

KS 11

4. Draft liquid fuels master plan (a 20-Year liquid fuel infrastructure roadmap) which deals with logistical issues relating to pipelines and storage facilities for petroleum products,
5. Draft Gas Utilization Masterplan (GUMP 2015) and
6. Gas Master Plan (GMP 2022) (currently under development).

All of the above sector plans will, once approved by Cabinet, feedback into the Integrated Energy Planning process and will enable overall enhancement and an integrated approach to South Africa's energy planning process. The draft IEP was published in 2015 and the idea is to improve this draft with inputs from the above sector plans in order for the IEP to be technically sound and based on credible, factual data.

As stated before, once fully developed, the IEP will provide a basis/platform to evaluate the impact and effect of different government policies simultaneously such as testing the impact of emission reduction limit with energy efficiency interventions as well as the effect of the Carbon Tax policy together with improvement in vehicle efficiency and implementation of the solar water heating programme, amongst other interventions that Government is implementing.

The future iterations of the sector plans review will, from the point the IEP is approved by Cabinet forward, therefore be informed by the IEP as the overarching country energy policy. However, in order to develop the first credible IEP, the above approach (i.e. sector study/ analysis) is technically sound and addresses the unique technical nature of South Africa's energy planning.

Given the period it would ordinarily take for the sector specific policies to be developed and approved by Cabinet, taking into account NEDLAC consultations (approximately 6 months), internal government consultations (approximately 3 months) and general public consultations (approximately 2 months) and the required internal technical modelling exercise, report drafting and editing, the Department is of the view that bringing section 6 of the National Energy Act, 2008 into force should be considered once the all sector plans have been completed (or near completion) and approved by Cabinet. Bringing section 6

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Into effect prior to completing the relevant sector plans could result in the Department failing to comply with the prescribed timelines for the development and review of the IEP, for reasons outlined above.

Recognizing the impact that the lack of energy security supply poses to the economy, the Department is revising Schedule 2 of the Electricity Regulation Act, 2006 (Act 4 of 2006) to enable electricity generation from embedded generators of up to 100 MW per site. The process to finalize the schedule is currently with the Regulator. The Department has also issued a request for proposal to procure up to 2000 MW of electricity generation capacity, this process is at an advanced stage. All this is done in an effort by the Department to address the current energy shortfall.

It should be noted further that the policy implementation of the capacity under the IRP2019 is being expedited to procure generation capacity from renewable energy (up to 20 400 MW), hydro scheme (up to 2500 MW), gas to power (up to 3000 MW), storage (up to 2100 MW) and coal (up to 1500 MW).

The officials responsible for energy planning are available for further technical discussions on this very important topic.

I hope you find the above in order.



Adv. Thabo Mokoena

Director-General

Department of Mineral Resources & Energy

Date: 21/07/2021

KS



THE PRESIDENCY
REPUBLIC OF SOUTH AFRICA

Private Bag X1000, PRETORIA, 0001

Enq: Ms Karabo Kolobe
Tel: 082 907 2967
Email: Karabo@presidency.gov.za

Our Ref: PAIA/19/2021/22
Mr Andrew John Dorer
CHENNELLS ALBERTYN ATTORNEYS
P.O. Box 78
Newlands
7725

E-mail: andrew@chennellsalbertyn.co.za

Dear Mr Dorer

Re: Your request for access to information in terms of the Promotion of Access to Information Act, 2 of 2000 (the Act)

1. I refer to your client's request for access to information dated 8 February 2022 wherein you requested access to the copies of the record listed in Annexure "X" read with Annexure "X1" of your request.
2. I wish to bring to your attention the provision of section 92(1) of the Constitution of the Republic of South Africa, 1996, which states that the Ministers are responsible for the powers and functions of the executive assigned to them by the President.
3. As you may be aware, the Minister of Mineral Resources and Energy is assigned to deal with all energy related matters on behalf of the government of the Republic of South Africa.
4. According to section 20(1)(b) of the PAIA, if the request for access is made to the information officer of a public body in respect of which the record's subject matter is more closely connected with the functions of another public body than those of the public body of the information officer to whom the request is made, the information officer to whom the request is made must as soon as reasonable possible, but in any event within 14 days after the request is received transfer the request to the information officer of the relevant public body.

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5. In light of the above, I have made a decision to transfer your request to the Department of Mineral Resources and Energy in terms of section 20(1)(b) of the PAIA.
6. I attached hereto a copy of the transfer letter.
7. Kindly be advised that in terms of section 25 (1) of PAIA, the Information Officer of the Information Officer in the Department of Mineral Resources is required to make a decision on your request within 30 days of the receipt of your request.

Yours sincerely



Ms. Lusanda Mxenge
Acting Chief Operations Officer and Deputy Information Officer
Date: 01/03/2022

KS 11

Andrew Dorer

From: Information Officer <InformationOfficer@presidency.gov.za>
Sent: Wednesday, 02 March 2022 09:22
To: Andrew Dorer; Information Officer
Cc: Karabo Kolobe; Buhle Vilane; Nombongo Zwelibanzi; Angeline Coetzee; Geoffrey Mphaphuli; Sello Mabelane; Ezekias Mkhabela; Nthabiseng Mollo; Bongani Kok
Subject: RE: THE GREEN CONNECTION / PRESIDENT OF THE RSA - REQUEST IN TERMS OF SECTION 11 OF THE PROMOTION OF ACCESS TO INFORMATION ACT 2 OF 2000.
Attachments: PAIA Response Letters_PAIA_19_2021_22_Green Connection.pdf; PAIA Transfer Letters_PAIA_19_2021_22_Green Connection.pdf; GREENCONNECTION PAIA APP - 08-02-2022.pdf

Good day;

Kindly find attached the response to your PAIA request and the transfer thereof to the Department of Mineral Resources and Energy in terms of Section 20(1)(b) of the Act..

Regards;

Ms Karabo Kolobe
Office of the Chief Operations Officer
The Presidency
Tel: +27 12 300 5374
Cell: +27 82 907 2967
E-mail: Karabo@presidency.gov.za
Website: www.thepresidency.gov.za



From: Andrew Dorer <andrew@chennelisaibertyn.co.za>
Sent: Tuesday, 08 February 2022 09:48
To: Information Officer <InformationOfficer@presidency.gov.za>
Subject: RE: THE GREEN CONNECTION / PRESIDENT OF THE RSA - REQUEST IN TERMS OF SECTION 11 OF THE PROMOTION OF ACCESS TO INFORMATION ACT 2 OF 2000.

ATTENTION: THE INFORMATION OFFICER OF THE PRESIDENCY
The Acting Director-General and Secretary of the Cabinet

Dear Ms Mxenge

RE: THE GREEN CONNECTION / PRESIDENT OF THE RSA – REQUEST IN TERMS OF SECTION 11 OF THE PROMOTION OF ACCESS TO INFORMATION ACT 2 OF 2000.

LSH



THE PRESIDENCY
REPUBLIC OF SOUTH AFRICA

Private Bag X1000, PRETORIA, 0001

Enq: Ms Karabo Kolobe
Tel: 082 907 2967
Email: Karabo@presidency.gov.za

Our Ref: PAIA/19/2021/22

Adv Thabo Mokoena
Director-General
The Department of Mineral Resources and Energy
Private Bag X59
Arcadia
0007

By e-mail: Mamabefu.Modipa@dmre.gov.za

Dear Adv Mokoena

**RE: TRANSFER OF A REQUEST FOR ACCESS TO INFORMATION IN TERMS OF THE
PROMOTION OF ACCESS TO INFORMATION ACT, ACT 2 OF 2000(PAIA).**

1. The Presidency received a request for access to the record from Chennells Albertyn Attorneys on behalf of The Green Connection NPC. The record requested is listed in Annexure "X" read with Annexure "X1" attached to the prescribed form. The copy of the prescribed form with the above-mentioned Annexures is attached hereto.
2. According to section 20(1)(b) of the PAIA, if the request for access is made to the Information Officer of a public body in respect of which the record's subject matter is more closely connected with the functions of another public body than those of the public body of the Information Officer to whom the request is made, the Information Officer to whom the request is made must as soon as reasonably possible, but in any event within 14 days after the request is received transfer the request to the Information Officer of the relevant public body.
3. Having considered the request, I am of the view that the record requested is more closely connected with the functions of the Department of Mineral Resources and Energy.
4. In light of the above, I have taken a decision of transferring the request to your Department in terms of section 20(1)(b) of the PAIA.

PAIA/19/2021/22 – Request for information –Green Connection

KS

{2}

5. Kindly note that in terms of section 25(1) of PAIA you are required to make a decision on this request within 30 days of the receipt of the transfer.
6. I hope you will find the above in order

Yours sincerely



Ms. Lusanda Mxenge

Acting Chief Operations Officer and Deputy Information Officer

Date: 01/03/2022

KS¹⁰

2/3/22

Andrew Dorer

From: Information Officer <InformationOfficer@presidency.gov.za>
Sent: Wednesday, 02 March 2022 09:23
To: Mamabefu.Modipa@dmre.gov.za
Cc: Thabo.Mokoena@dmre.gov.za; Khayaletu.Matrose@dmre.gov.za; Kwazi.Mhlongo@dmre.gov.za; Buhle Vilane; Nombongo Zwelibanzi; Karabo Kolobe; Geoffrey Mphaphuli; Sello Mabelane; Angeline Coetzee; Ezekias Mkhabela; Nthabiseng Mollo; Bongani Kok; Andrew Dorer
Subject: FW: THE GREEN CONNECTION / PRESIDENT OF THE RSA - REQUEST IN TERMS OF SECTION 11 OF THE PROMOTION OF ACCESS TO INFORMATION ACT 2 OF 2000.
Attachments: GREENCONNECTION PAIA APP - 08-02-2022.pdf; PAIA Response Letters_PAIA_19_2021_22_Green Connection.pdf; PAIA Transfer Letters_PAIA_19_2021_22_Green Connection.pdf

Good day Ms Modipa;

Kindly find attached the Transfer of a PAIA request in terms of Section 20(1)(b) of the PAIA (Act).

Regards;

Ms Karabo Kolobe
Office of the Chief Operations Officer
The Presidency
Tel: +27 12 300 5374
Cell: +27 82 907 2967
E-mail: Karabo@presidency.gov.za
Website: www.thepresidency.gov.za

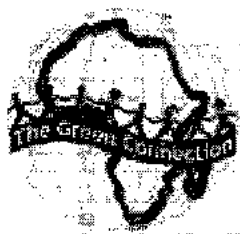


From: Andrew Dorer <andrew@chennellsalbertyn.co.za>
Sent: Tuesday, 08 February 2022 09:48
To: Information Officer <InformationOfficer@presidency.gov.za>
Subject: RE: THE GREEN CONNECTION / PRESIDENT OF THE RSA - REQUEST IN TERMS OF SECTION 11 OF THE PROMOTION OF ACCESS TO INFORMATION ACT 2 OF 2000.

ATTENTION: THE INFORMATION OFFICER OF THE PRESIDENCY
The Acting Director-General and Secretary of the Cabinet

Dear Ms Mxenge

KS



P O Box 24308

Lansdowne

7779

Our ref: GC-IEP-2-11-22

Mr. Cyril M. Ramaphosa

President of the Republic of South Africa

Private Bag X1000

Pretoria

0001

By Email c/o: presidentrsa@presidency.gov.za ; malebo@presidency.gov.za ;
khusela@presidency.gov.za ; geofrey@presidency.gov.za

Cc'd to: robert@presidency.gov.za ; nomusa@presidency.gov.za ; makhosini@presidency.gov.za ;
mike@presidency.gov.za ; angeline@presidency.gov.za ; mkile@presidency.gov.za ;
pieter.alberts@dmre.gov.za ; nonhlanhla.ndebele@dmre.gov.za

2nd November 2022

Dear President Cyril Matamela Ramaphosa,

Re: Proclamation of Section 6 of the National Energy Act, 2008

1. As you know, section 6 of the National Energy Act, 2008 (NEA) remains on the statute books, but is not yet in operation. Section 21 invests you with the power to bring it into force when the circumstances are appropriate.
2. Green Connection is deeply concerned that the inoperative status of section 6 is retarding our nation's ability to respond to its energy crisis and to undertake long-term energy planning in a coordinated, democratic and environmentally sustainable manner. Section 6 of the NEA is meant to help us do just that. It requires the Minister responsible for energy to develop and maintain an Integrated Energy Plan (IEP), based on current science, long-term policy perspectives, global and domestic climate change strategies and public input.
3. Our Attorney, Adrian Pole, has tried to engage with your office and the Department of Mineral Resources & Energy (Department) by correspondence for almost two years. The exchanges stretch back to November 2020. The letters canvas substantive issues in detail (there were at least six requests on behalf of Green Connection). The goal was to help move the legislative process along, to breathe life into section 6.

Making Sustainable Development A Reality

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080-620-NPO

NPC 2021/773490/08

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4. Sadly, nothing of substance has come of those engagements. Green Connection has been blocked at every turn from doing what it—and Parliament—knows to be right and lawful. When our requests for assistance from the Department got us nowhere, we invoked the statutory right to access information under PAIA. But our formal request was ignored. So was our appeal against the deemed refusal to give us information.
5. Green Connection's work in the energy space is beneficial, credible and—we believe—valuable. We have demonstrated the value of our efforts through fruitful engagements with officials and public representatives in the sector. And when cooperative endeavours have not succeeded, we have demonstrated the merit of our ideas in the courts.
6. We have already set out in earlier correspondence compelling legal and policy reasons for you to bring section 6 into operation. That you are unwilling to do so brings us to the point where Green Connection has to resort to the courts to bring the law into effect.
7. Green Connection has therefore instructed lawyers to draw a court application to review your failure or refusal to bring section 6 into force. This decision was based on the advice of independent senior and junior advocates who specialise in public law. We claim privilege over the advice, but want to convey the essence of the case against you.
 - a. Section 21 of the NEA requires you personally to determine that the circumstances are appropriate for bringing section 6 into operation. It requires constant vigilance on your part. But you have abdicated that responsibility to the Minister of Minerals and Energy.
 - b. Based on what we could learn from the Department, the Minister's reasons for not advising you to bring section 6 into effect are based on an untenable interpretation of section 6. Bringing it into operation would not, without more, expose the Minister to breach of a statutory obligation.
 - c. As it happens, the former Minister already started the process of developing the IEP. That is what section 6 would require. Cabinet—including your predecessor—approved the draft IEP, which was put out for public comment. Section 6 would also have required that. So why hold back on making the statutory duty effective?
 - d. The fact that the IEP has not been completed is no reason not to bring section 6 into operation. Section 6 would require a development process and ongoing refinement; it would not require a finished product the moment it is brought into operation. An IEP by its very nature is meant to evolve and not be static.
 - e. So any advice by the Minister that section 6 is not ripe for implementation would be unsupportable and not rationally related to the actual state of play, both past and present. It also does not fit with what the Minister intends to do—i.e. to continue to refine the draft IEP in anticipation of its publication.
 - f. The Minister is also mistaken in thinking that other sector plans need to be established before bringing section 6 into operation. The IEP under section 6 is meant to inform those sector plans, after all. The Minister is creating a catch-22 situation, irrationally.

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NPC 2021/773490/08

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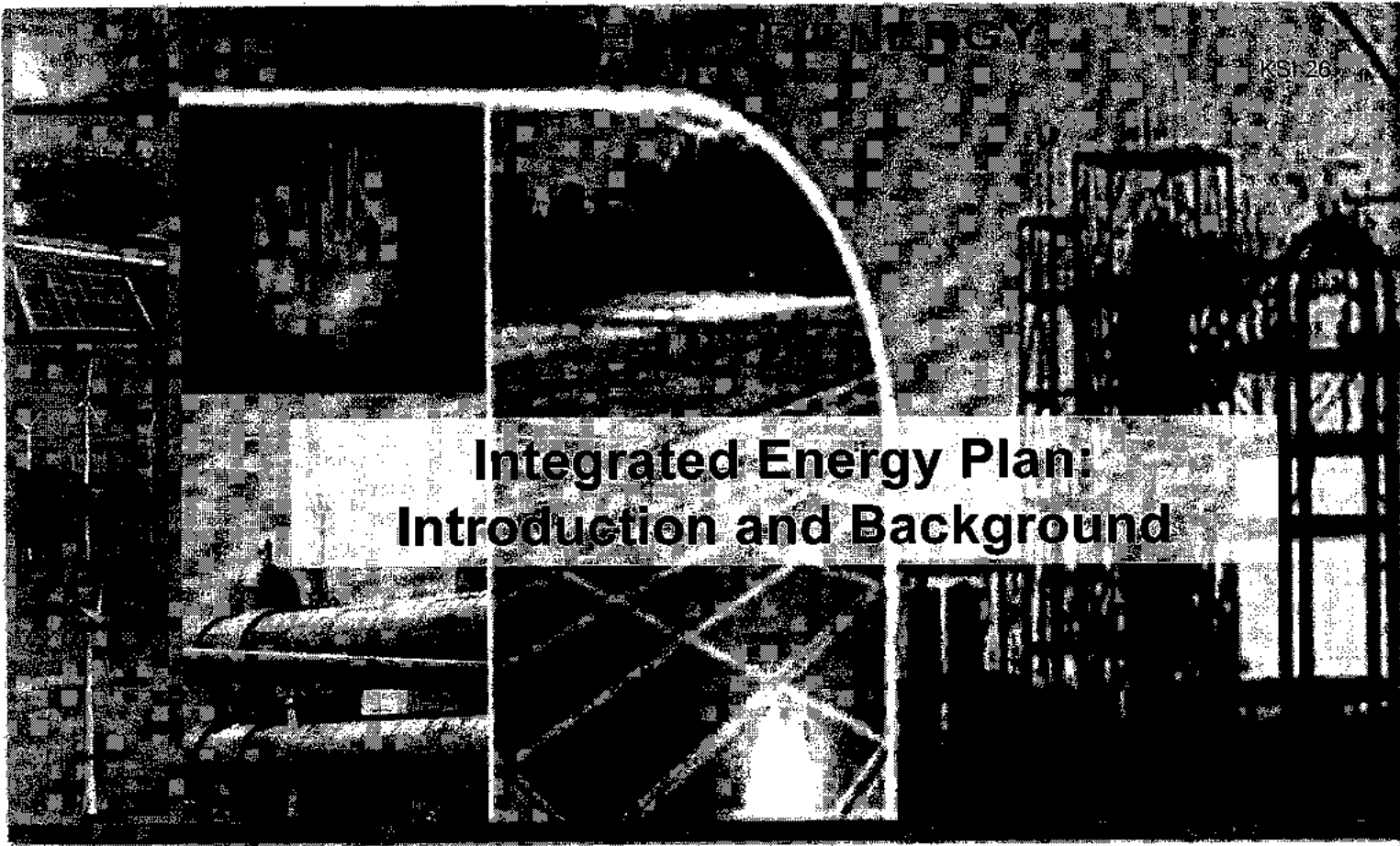
- g. As far as you have relied on the Minister's unsupportable views, your own failure or refusal to bring section 6 into effect is legally tainted. And your inaction frustrates the objects of the NEA.
8. Disparate decisions about South Africa's energy future is something section 6 would curb, if brought into effect. Yet there are a host of energy projects being considered and undertaken without a comprehensive and long-term plan. The IEP would be that plan. It is meant to balance competing economic, environmental, political and social interest and set the context in which energy-related decisions should be made. It is unnecessary to list these projects to appreciate the point.
9. There is a burning need for an IEP. But the work done so far is meaningless without section 6 having legal effect.
10. These grounds are not meant to be exhaustive. What we want to convey is the nub of the problem as it will play out in a court and in the public arena. This could be averted by doing what section 21, the NEA's objects and Parliament demand—by bringing section 6 into force.
11. Green Connection intends to launch its court application imminently. We remain, however, open to meaningful engagement on this issue. Green Connection believes in dialogue and finding constructive solutions for the greater good. We therefore encourage you to reconsider your position and to approach this matter in the spirit of cooperation, and we will gladly avail ourselves to discuss and decide on steps to resolve this dispute.

Sincere regards,



L. McDaid

Strategic Lead, the Green Connection



Integrated Energy Plan: Introduction and Background



energy

Department:
Energy
REPUBLIC OF SOUTH AFRICA

Ms. Tshilidzi Ramuedzisi
Chief Director: Energy Planning



CONTENTS

- Scope and context of IEP
- IEP Governance Structure
- IEP Process and Methodology
- Progress to Date and Way Forward

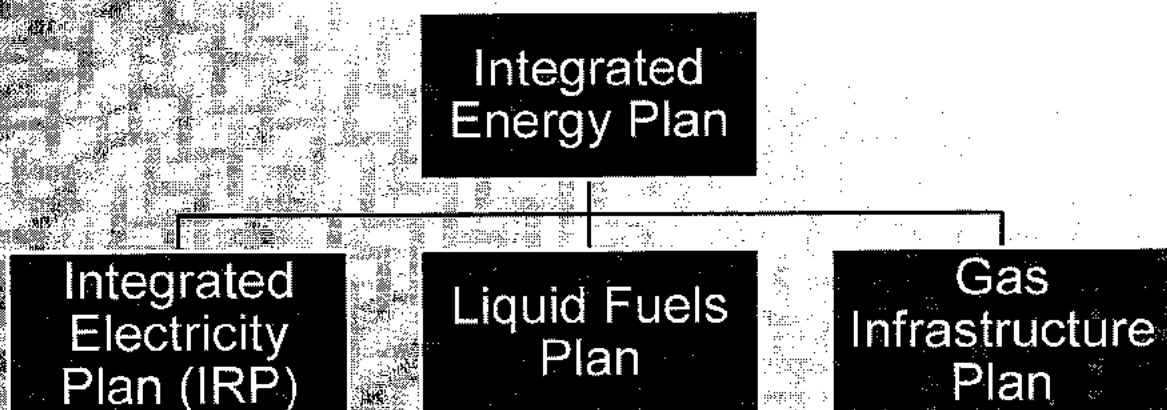


energy

Department:
Energy
REPUBLIC OF SOUTH AFRICA

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Integrated Energy Plan

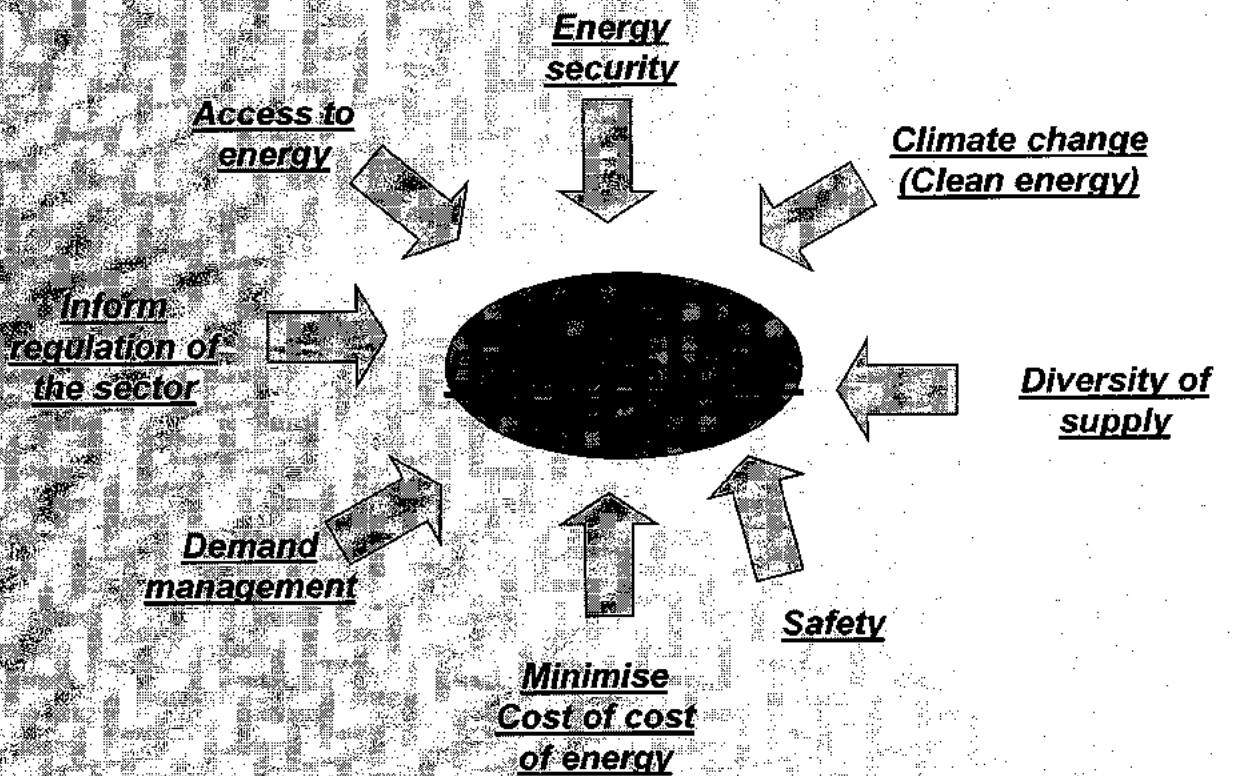


energy

Department:
Energy
REPUBLIC OF SOUTH AFRICA

KS P

What does IEP seek to achieve?

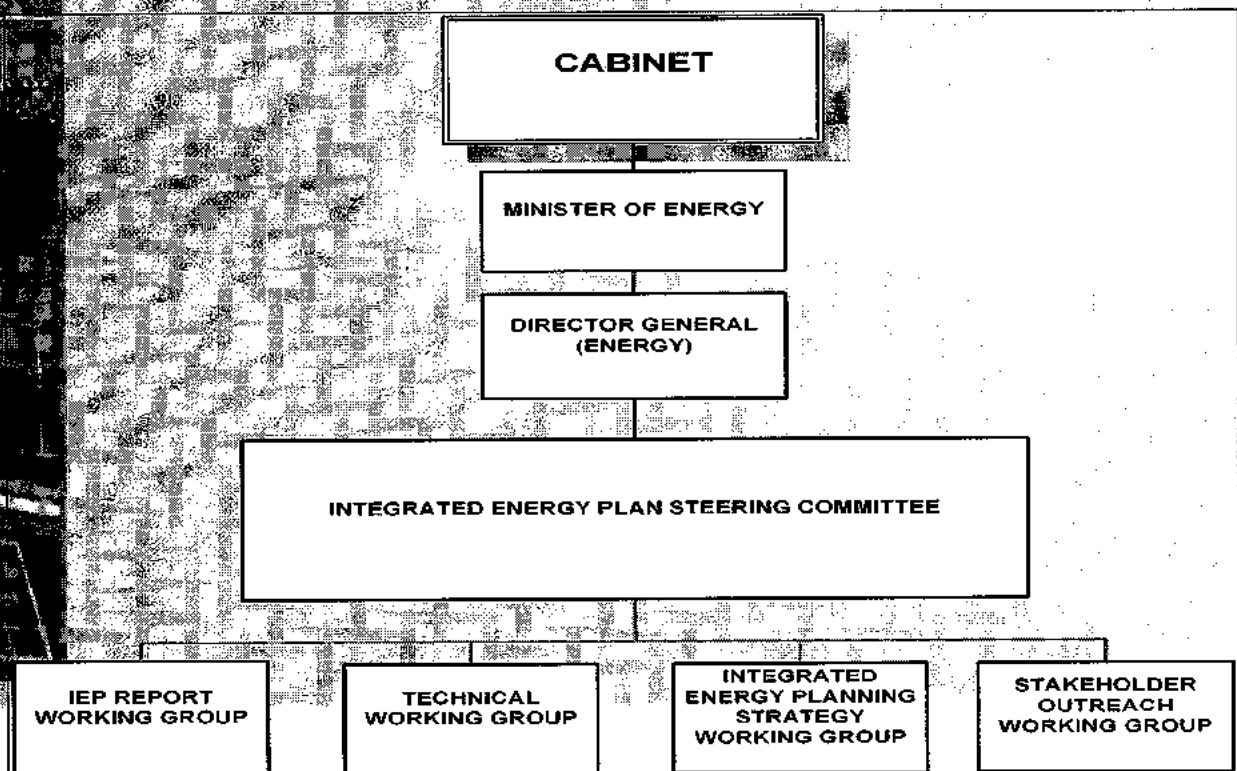


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IEP Governance Structure



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IEP Governance Structure

WG/SWG	Key Purpose	Key Deliverables
IEP Steering Committee	•Oversee the IEP development process •Approve ToR for SWGs •Recommend approval of key deliverables to DG and Minister	•IEP published for public comments by 31 March 2011
IEP Report WG	•Define modeling approach and methodology •Selection of adequate energy modeling tool/system •Define policy questions •Define scenarios •Define key modeling parameters and values	IEP Report
IEP Strategy SWG	•Draft IEPS with a clearly defined framework for the IEP development process	IEP Strategy



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Department:
Energy
REPUBLIC OF SOUTH AFRICA

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EP Governance Structure

WG/SWG	Key Purpose	Key Deliverables
Stakeholder Engagement WG	• Define stakeholder engagement framework • Ensure stakeholder representation and stakeholder engagement processes implemented • Define communication strategy and ensure implementation thereof	• Stakeholder Engagement Framework • Stakeholder Engagement Implementation Plan
Technical WG	• Determine data requirements and develop Energy Data Inventory for modeling exercise • Collect data required for modeling exercise • Conduct modeling exercise • Conduct analyses of model outputs	• Energy Data Inventory • Centralized Energy Database • Technical Report



energy

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IEP Methodology

- Defines process that will be followed in development of IEP
- Ensures transparency of process to improve repeatability and enhancement
- Clarifies distinction between conceptual and technical processes
- Scenario-Based Methodology
 - Enables systematic and structured approach to consideration of complex and competing objectives
 - Forces one to consider only those key variables which have the most significant impact



energy Structured approach to testing various policy options, often
Department: with competing objectives
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National Objectives

DoE Mandate

PROBLEM FORMULATION

Key Policy Question

Define Plausible Futures

Evaluate Outcomes

Recommendations

TECHNICAL PROCESS

Develop Reference Energy System and Energy Demand Model

Model Base Case

Model Test Cases

Within each Plausible Future:
• Project Demand
• Test 'Base Case'
• Test 'Test Cases'

Model Output/Results

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Defining of Plausible Futures

- Premised on the principle that the future is unknown and an indeterminate set of futures can unfold
- Allows focus on those factors that affect the economy which can have most significant impact on the realisation of objectives
- The demand trajectory will be shaped by the assumptions which describe particular future
- Objective is to develop plan which is robust or flexible enough for different pictures of the future



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Plausible Futures

Factors influenced by Global Environment

Plausible Future 1
 • Unconstrained Global Environment
 • Unfavourable Socio-Economic Development

Plausible Future 2
 • Constrained Global Environment
 • Favourable Socio-Economic Development

Plausible Future 4
 • Constrained Global Environment
 • Unfavourable Socio-Economic Development

Plausible Future 3
 • Relaxed Global Environment
 • Favourable Socio-Economic Development

Socio-Economic Factors



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Key Driving Forces Socio-Economic Factors

ILLUSTRATION

Key Driving Force	Key Indicator	Government Goal	Average over between 1998 and 2008	Current	Unfavourable Local Socio-Economic Development	Favourable Local Socio-Economic Development
Local Economic Growth	GDP	6% per annum	3.50%	3.10%	Less than 4%	Greater than 4%
	CPIX	3-6%	6.81 (Between 1998 and 2008)	11.30%	Less than 6% or greater than 6%	Between 3-6%
	CPI	3-6%	6.65%	11.50%	Less than 6% or greater than 6%	Between 3-6%
Poverty Levels	Inequality measure (Gini Coefficient)	Reduction in income inequality	0.68	0.66	Greater than 0.5	Less than or equal to 0.5
	Poverty Headcount Index	Meeting basic needs of all South Africans	48%	39%	Some South Africans still living below poverty line	No South Africans living below poverty line

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Key Driving Forces Global Environment

ILLUSTRATION

Key Driving Forces	Key Indicators	Unfavourable Global Environment	Favourable Global Environment
International Stability	International Commodity Prices	High prices of commodities in international markets (i.e. Price of crude oil > \$150/bbl)	High prices of commodities in international markets (i.e. Price of crude oil < \$150/bbl)
Regional Stability	Regional Commodity Prices	High prices of commodities in regional markets Lack of cooperation amongst regional players	Competitive prices of commodities in regional markets Cooperation amongst regional players
Level of global competition for technology	International technology prices Lead time for delivery of equipment needed to build new energy infrastructure	High levels of global competition for technology driving technology prices up Long lead times	Healthy levels of global competition for technology driving technology prices up Acceptable lead times
Availability and cost of funding from international markets	Sovereign credit rating Large enterprises credit rating	Unfavourable sovereign credit rating Unfavourable credit rating of large enterprises	Good sovereign credit rating Good credit rating of large enterprises

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Defining Policy Options to be tested

- Energy planning is about making choices, often between imperatives with competing objectives
- Classification of policies
 - Existing and implemented
 - Approved but not yet implemented or effected
 - New and future policies to be considered
- Choosing the most appropriate set of policy options to achieve objectives



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NEXT STEPS

Activity

- Presentation of IEP Methodology to Cabinet
- Approval and publishing of Plausible Futures
- Public Participation Workshops
- Finalise Scenarios and Test Cases to be considered in IEP
- Conduct technical work
- Analysis of Results
- Draft recommendations for IEP



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DEPARTMENT OF ENERGY

PPC PRESENTATION ON THE

DEPARTMENT'S 2010/11 ANNUAL REPORT

Ms N Magubane
Director General



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SUMMARY OF PERFORMANCE AGAINST PREDETERMINED OBJECTIVES KEY FOCUS AREAS

Objective	Key Focus Area(s)
1. Ensure energy security	1. Integrated Resource Plan (IRP2010-2030) 2. The Department also started the process of developing the Integrated Energy Plan (IEP). 3. New Multi-Product Pipeline (NMPP) from Durban to Johannesburg
2. Achieve universal access and transform the energy sector	1. Integrated National Electrification Programme (INEP) 2. The Inclining Block Tariffs (IBTs) for domestic /residential customers implemented this year. 3. Solar Water Heaters programme 4. Compliance Audit on the Liquid Fuels Charter 5. We launched the 7th Integrated Energy Centre (IEC) in Qunu



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PROGRAMME 2: Hydrocarbons and Energy Planning (Continued)

Objectives and measures

- Ensure sustainable energy supply by developing the Integrated Energy Planning Strategy by September 2010.
- Developing the national strategic fuel stocks policy by March 2011.
- Provide oversight over the construction of the National Multipurpose Petroleum Pipeline.
- Encourage research and development for energy related technologies with a key focus on energy efficiency and mitigating greenhouse gases by establishing the South African National Energy Development Institute (SANEDI) by March 2011. (R & D –focus on energy efficiency and mitigating greenhouse gasses)



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PROGRAMME 2: Hydrocarbons and Energy Planning (Continued)

Progress Partially Achieved

- The Integrated Energy Plan was expected to be published for comments by 31 March 2011. Further revisions had been made to the *Plausible Futures* as well as to the IEP methodology within the IEPS. Significant work has been done in developing the IEP, with the IEP methodology, the *Plausible Futures*, and the Integrated Energy Planning Strategy documents having being finalized. However, the Integrated Energy Planning Strategy was not approved by Cabinet for publication as was originally envisaged.
- Against the annual target of establishing two Integrated Energy Centres (IECs), one had been established in Qunu within the financial year, while another at Mbizana scheduled for completion by May 2011.
- A comprehensive review of the Liquid Fuels Charter also meant the postponement of the Petroleum Products Amendment Act into the next financial year since the Charter is currently appended to the Act.



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INTEGRATED ENERGY PLAN PRESENTATION
PORTFOLIO COMMITTEE ON ENERGY

20 NOVEMBER 2012



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HIGH-LEVEL APPROACH

Identify key objectives for IEP

- Guided by National Objectives
- Informed by Energy White Paper and other energy policies
- Described in National Energy Act
- Influenced by various government policies

Define Status Quo and implications for future trends

- Local and global challenges
- Informed by implemented policies with high impact on energy sector
- Macroeconomic factors, existing and implemented policies
- Informs assumptions about future energy demand
- Informs assumptions about technology trends

Define Problem Statement

- Key Policy Questions that IEP should deal with
- Define key criteria and relative importance (weightings)



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HIGH-LEVEL APPROACH

Identify policy alternatives

- Test Cases/Scenarios: Impact of existing high-impact policies
- Test Cases/Scenarios: New and proposed high-impact policies and policy options
- Desktop studies: New policy considerations

Analyse and Evaluate Policy Alternatives

- Supply optimisation based on projected future demand (for Base Case and Test Cases)
- Evaluation of output from Supply Optimisation using Multi-Criteria Decision-Making Approach (MCDA)

Make recommendations

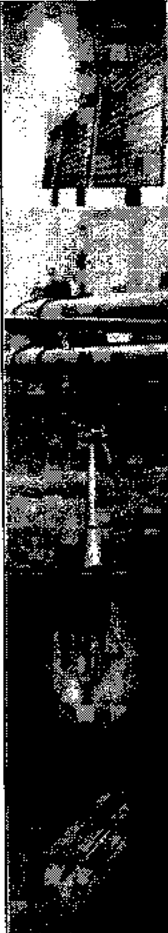
- Will be informed by outcomes from previous step (MCDA)



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KEY PLANNING PARAMETERS AND ASSUMPTIONS



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BASE CASE

The Base Case (also referred to as Baseline or Reference Case) encapsulates the state of energy demand and supply over the planning horizon, which is most closely informed by current energy market trends; the national macroeconomic outlook; assumed energy prices; existing energy infrastructure and the existing suite of policies and government programmes

The Base Case is not a representation of the most likely future or most likely scenario, but is rather a simplistic representation of a future outcome that could materialise in light of current policies and macroeconomic trends. It represents a Business-As-Usual or Status Quo scenario where current trends continue into the future.



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TEST CASE

A deviation from the status quo where current trends do not continue into the future and deviations are as a result of specific policy interventions. A Test Case therefore defines a set of circumstances and resultant outcomes or impacts which is informed by the possible impacts of policies and policy interventions. A Test Case does not indicate what will happen but rather tests what could happen if a particular course of action takes place.

While Test Cases are sometimes also referred to as scenarios, for the purposes of common interpretation, a Test Case is specifically differentiated from a scenario in that a scenario is largely influenced by exogenous forces which the policy maker has no control over.



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KEY GLOBAL PLANNING PARAMETERS

HIGH-IMPACT POLICIES

- Energy White Paper
- Integrated Resource Plan (IRP 2010)
- National Development Plan
- New Growth Path
- National Climate Change Response White Paper
- National Transport Master Plan
- Beneficiation Strategy
- Proposed Carbon Tax Policy

POLICY-DRIVEN PLANNING PARAMETERS

- Minimum Renewable Energy Production Target
- Reserve Margin
- Annual Emissions Limits
- Emission Penalties

MACROECONOMIC PARAMETERS

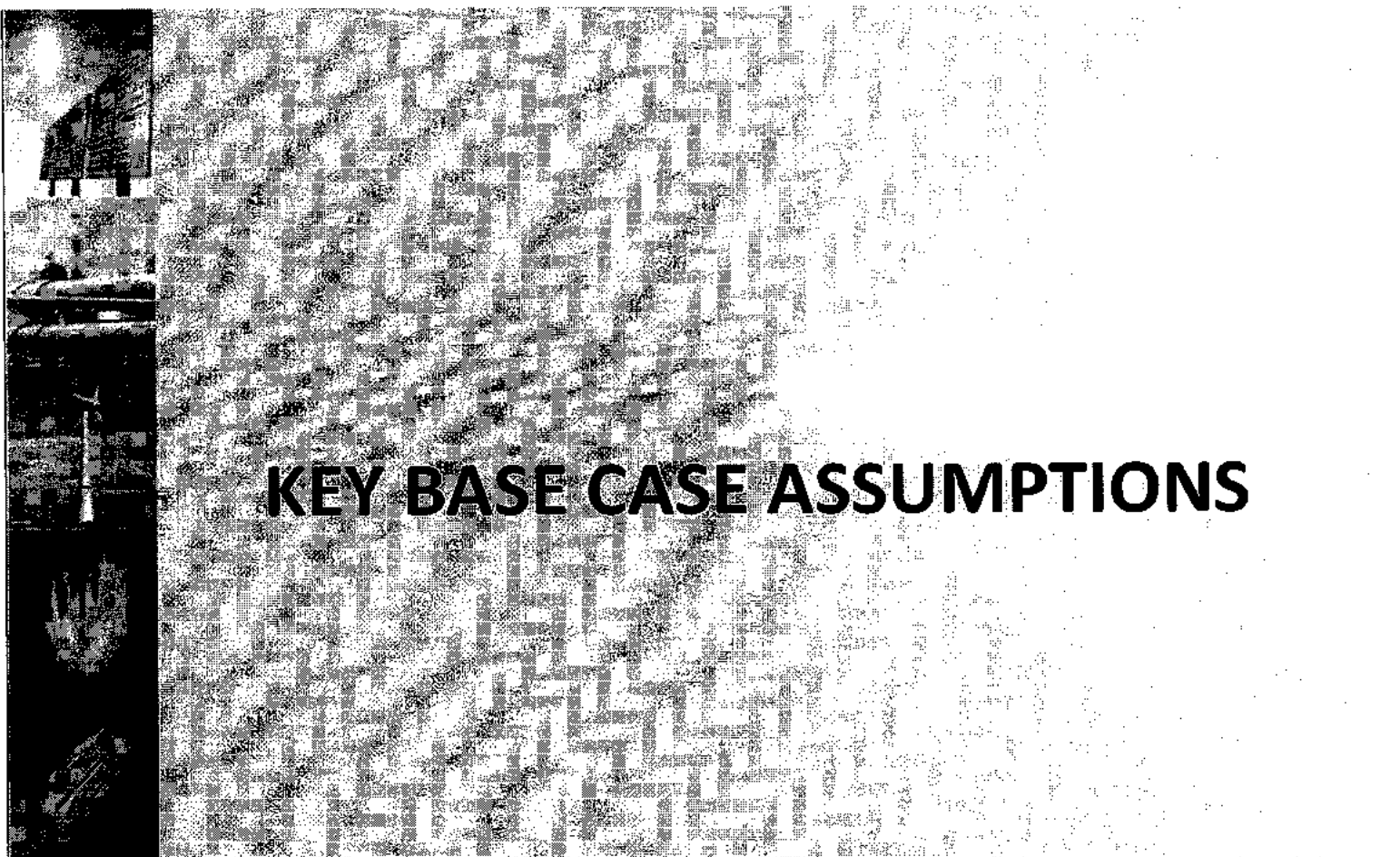
- Discount Rate
- Economic Growth
- Global Oil Prices



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KEY BASE CASE ASSUMPTIONS



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The IRP committed build plan is included in the Base Case

	New build options								Committed					Non-IRP generation	TOTAL
	Coal imports	Nuclear	Import hydro	Gas - CCGT	Peak - OCGT	Wind	CSP	Solar PV	Coal	Other	DoE Peaker	Wind	Other Renew.		
2017															640
2018															809
2019								300				400	100		1,103
2020								300			1,020	400	25		2,901
2021								300					100		3,021
2022								400					100		2,944
2023								400	100	300					1,722
2024															3,168
2025															1,723
2026															2,733
2027															2,010
2028															487
2029															2,198
2030															2,238
2031															533
2032															605
2033															-
2034															-
2035															-
2036															-
2037															-
2038															-
2039															-
2040															-
2041															-
2042															-
2043															-
2044															-
2045															-
2046															-
2047															-
2048															-
2049															-
2050															-
TOTAL	2,500	-	2,509	711	2,415	2,800	500	2,700	10,133	1,722	1,020	800	325	800	29,035



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Eskom Commitments (Pre IRP)
2011 determinations 9
2012 determinations

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POLICY-DRIVEN PARAMETERS

- Annual Emissions Limits
- Emissions Penalties
- Minimum Renewable Energy Production
- Reserve Margin



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POLICY-DRIVEN PARAMETERS: MINIMUM RENEWABLE ENERGY PRODUCTION

- Electricity: Will be based on total renewable energy in IRP2010
- Liquid Fuels/Petroleum: Regulations on Blending of Biofuels not yet promulgated

New build options			Committed		TOTAL
Wind	CSP	Solar PV	Wind ²	Other Renew.	
		300	400	100	800
		300	400	25	725
400		300		100	800
400		300		100	800
400	100	300			800
					800
					800
					800
					800
400	100	300			800
400	100	300			800
400	100	300			800
600	100	300			1,200
1,600	100	1,000			2,700
400		600			900
1,600		500			2,100
		500			500
		1,000			1,000
		1,000			1,000
8,400	1,000	8,400	800	325	18,925



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RE IPP Window 1
RE IPP Window 2
Future Windows

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RESERVE MARGIN

- The Energy Security Master Plan for Electricity, ESMP-Electricity, of 2007 recommended a reserve margin of 19% for electricity generation capacity in South Africa
- A reserve margin of 19% indicates the point where the trade-off between costs and reliability is minimum. (Based on costs as calculated during the drafting of the ESMP 2007)



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MACROECONOMIC INDICATORS

- **Discount Rate:**
 - 11.3% as provided by National Treasury
- **Economic Growth:**
 - Based on National Treasury 2012 Budget Forecast (Provided prior to the 2012 Medium-Term Budget Policy Statements - MTBPS)
- **Global Oil Price:**
 - Based on the Energy Information Administration (EIA) Annual Energy Outlook 2012 (AEO2010) Projections



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GDP GROWTH RATE

GDP growth scenarios are based on National Treasury 2012 Budget Forecast

Base Case: GDP growth forecasts will be based on "Moderate Growth Scenario"

Low growth scenario				
Short Term			Medium Term	Long Term
2012	2013	2014	2015-2020	2021-2031
2.7%	3.0%	3.3%	3.2%	3.0%
Moderate growth scenario				
Short Term			Medium Term	Long Term
2012	2013	2014	2015-2020	2021-2031
2.7%	3.6%	4.2%	4.0%	4.0%
High growth scenario				
Short Term			Medium Term	Long Term
2012	2013	2014	2015-2020	2021-2031
2.7%	3.6%	4.2%	4.6%	5.0%



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GDP GROWTH RATE

Low growth assumption:

National Treasury 2012 Forecast then growth of 2.9% over the forecast period

Assumptions

Continued skills constraints
Infrastructure bottlenecks
Low global growth

Upside Risks

Strong commodity price growth
Reduced skills constraints
Reduced infrastructure bottlenecks
Improved global growth outlook

Moderate growth assumption:

National Treasury 2012 Forecast, followed by

Assumptions

Continued skills constraints
Infrastructure bottlenecks

Risks

Risks to the moderate forecast can be either up- or downside risks
Upside risks to growth forecasts are the same as the risks faced in the low growth assumption
Downside risks to growth forecasts are the same as the risks faced in the high growth assumption

High growth assumption:

National Treasury 2012 Forecast,

Assumptions

Strong commodity price growth
Reduced infrastructure bottlenecks
Improved global growth outlook
Skills shortage alleviates

Downside Risks

Continued skills constraints
Infrastructure bottlenecks
Low global growth



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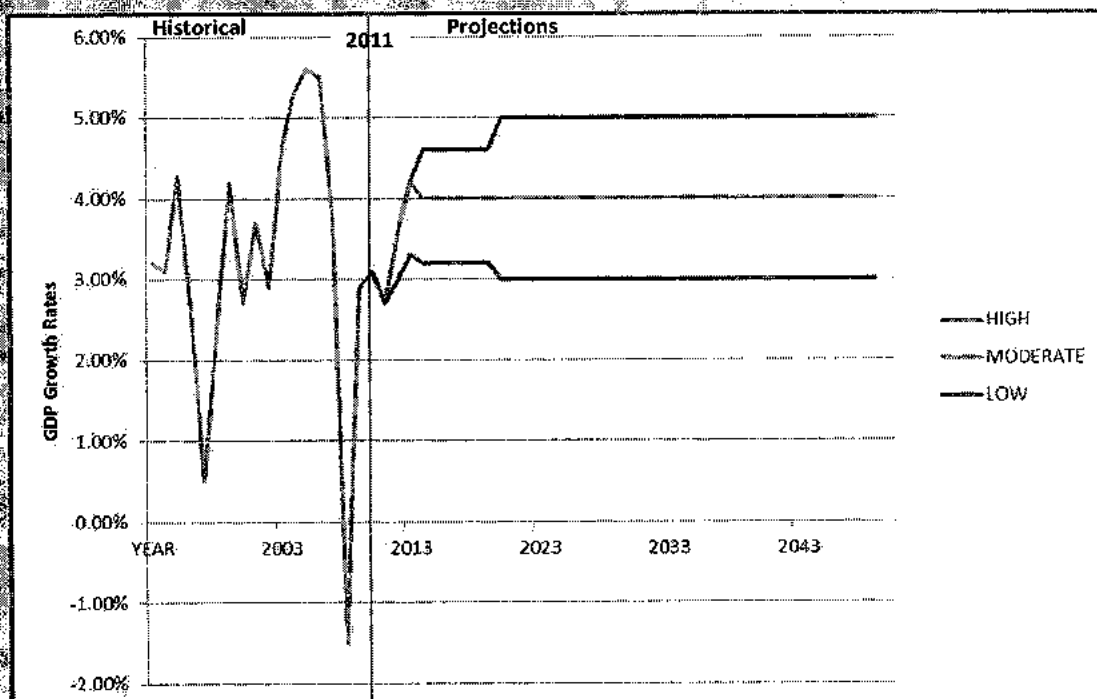
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GDP GROWTH RATE



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GLOBAL OIL PRICE PROJECTIONS

The Global Oil Price projections made by the Energy Information Administration (EIA) on an annual basis within the Annual Energy Outlook, 2012 (AEO2012) have been used as a basis for the projection of future global oil prices for the purposes of the IEP

The AEO2012 makes projections for High, Moderate and Low price scenarios which are informed by various assumptions about the global geopolitical and macroeconomic environment.

The AEO2012 global oil price projections are defined as the average price of crude oil similar to the price for West Texas Intermediate (WTI) crude oil, which is traded on the New York Mercantile Exchange

Although daily spot prices of crude oil from different sources vary, trends for annual averages are similar and therefore the AEO2012 projections deemed independent and reliable source of future projected prices

Projections up to 2035: The key assumptions which inform the global oil price projections and the actual projections have been taken directly from the Annual Energy Outlook 2012, which has projections up to 2035.

Projections from 2036 to 2050: The oil prices from 2036 and 2050 have been extrapolated using a straight line based on the average price increases of each of the three scenarios from 2012 to 2035.

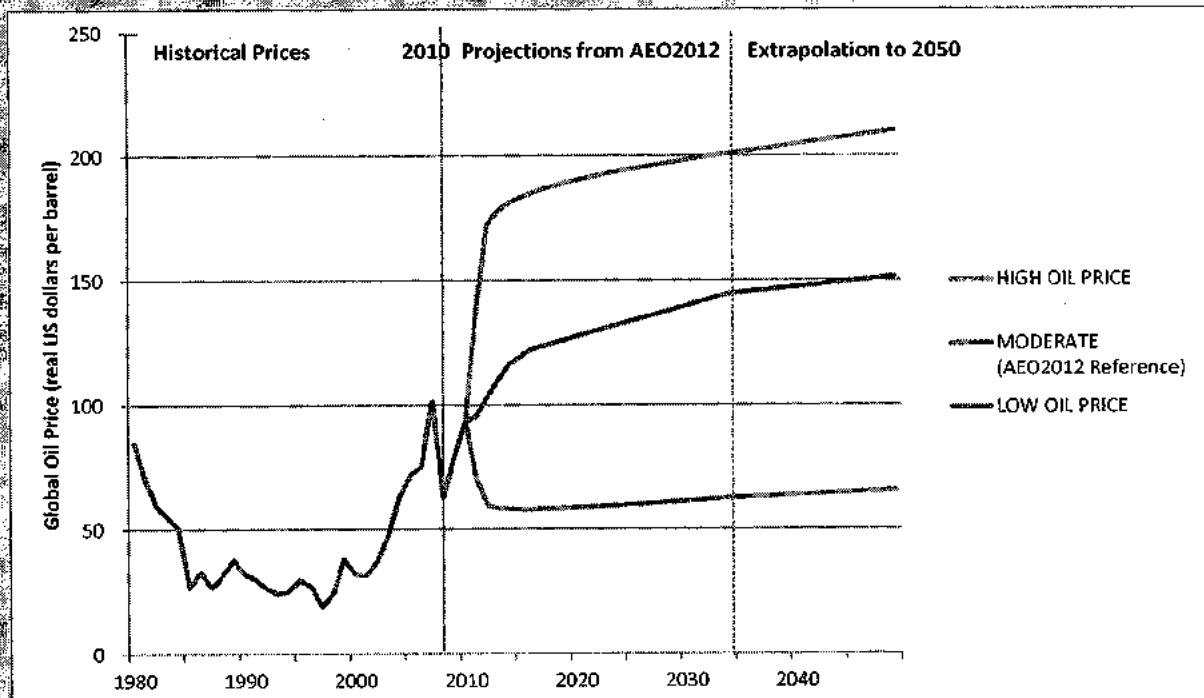
(More information available in the Annual Energy Outlook 2012 which is available at www.eia.doe.gov)



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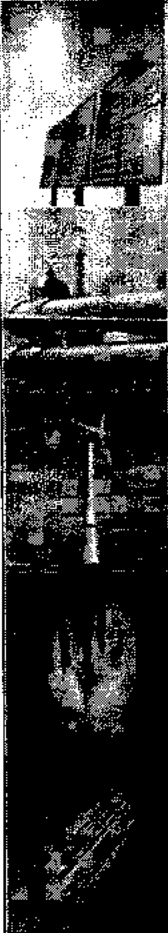
GLOBAL OIL PRICE PROJECTIONS



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ASSUMPTIONS FOR VARIOUS TEST CASES



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TEST CASES

BACKGROUND

The IRP 2010 determined that nuclear power should form a large part, about 20 percent by 2030, of the country's energy mix from 5 percent in 2010. The Fukushima nuclear crisis of 2011 has made some governments around the world to rethink the role of nuclear energy.

One of the recommendations from the National Development Plan was for other alternatives, such as liquefied natural gas for electricity generation, to be compared against the construction of a new nuclear fleet.

The burning of coal is responsible for a significant amount of GHGs emissions. While new technologies such as CCS are being developed to curb the GHG emissions, the use of natural gas in power generation has gained steam.

POLICY QUESTION

What will be the impact of removing nuclear as an option on our targets to significantly reduce emissions by 42 percent by 2025 as outlined in the National Climate Change Response Policy (NCCRP)?

What is the impact of removing nuclear and introducing more natural gas as an option on the total cost of energy and emissions target?

TEST CASE

Test Case 1: In this case, the new nuclear build in the Policy-Adjusted IRP 2010 is excluded as a supply option. This implies that all the committed capacity from Policy-Adjusted IRP are included with the exception of new nuclear. Nuclear is replaced by the next best supply options as chosen by the model.

Test Case 2: The new nuclear build in the Policy-Adjusted IRP 2010 is excluded as a supply option. This implies that all the committed capacity from Policy-Adjusted IRP are included with the exception of new nuclear. The nuclear is replaced by natural gas supply options.



TEST CASES

BACKGROUND

As a net importer of crude oil, South Africa is a price taker in the oil market and its market is highly sensitive to fluctuating global oil prices.

The Department of Energy is in the process of introducing new fuel specifications (CE2) which will ensure refined product with reduced sulphur content and thereby reducing the quantity of pollutants and green-house gas emissions from the liquid fuel and transportation sectors.

South Africa is currently also considering the construction of new refining capacity which would be aligned with these specifications.

While mobility is a key contributor to energy demand, developments in technology could see the move away from traditional modes of transport to more efficient and less costly means of transportation. However for South Africa, it is assumed that traditional modes of transport (i.e. fuel-powered vehicles with minimal penetration of electric and hybrid vehicles) will continue into the foreseeable future (NAEMSA presentation "Energy Planning Colloquium, March 2012").

The National Development Plan has presented five different options that South Africa should consider:

- (1) Build new oil-to-liquid refinery
- (2) Build new coal-to-liquid refinery
- (3) Upgrade existing refineries or allow significant expansions of one or more of the existing refineries or both
- (4) Import refined product
- (5) Build a new refinery in Angola or Nigeria (and buy a share of the product of that refinery)



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TEST CASES

POLICY QUESTION

Assuming more people will continue to drive fuel-powered vehicles as their primary means of transport well into the future, what is the best way of ensuring security of fuel supply in the country? (Note: Fuels pertain to final product and includes synfuels from CTL and GTL production processes)

TEST CASE

The National Development Plan provides a high-level analysis of the advantages and disadvantages associated with each of the options presented therein. As South Africa is a price taker when all other investment costs have been taken into consideration (capital costs, upgrade costs), the main differentiating factor is the input costs (in this case the price of crude oil). Equally important is the price of coal and shale gas. Therefore sensitivity analyses (of different crude oil price ranges) will also be conducted on all the alternatives considered.

For given sets of crude oil price ranges and for each price range:

Test Case 3: The cost of increasing refining capacity (green field refinery which could be crude oil, CTL or GTL as optimized by model) is determined together with total emissions.

Test Case 4: The cost of upgrading/expanding existing refineries. In this option any production shortfall would be met by imports. (This test case takes into account possible upgrade of port infrastructure that may be necessary as well as the associated costs).



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ANNUAL EMISSIONS LIMITS

- The South African Government has made a commitment to reduce emissions by 34% by 2020 and 42% by 2025 which was informed by the outcomes from a study on the Long-Term Mitigation Scenarios (LTMS)
- Two scenarios:
 - "Business As Usual" which led to a range of trajectories - BAU lower and upper bounds
 - "Required by Science" which led to the "Peak Plateau Decline" emissions trajectory
- The findings of the LTMS study also determined that South Africa's energy use emissions constituted just under 80% of total emissions, of which the majority arose from electricity generation (40% of total emissions) in 2000.
- Emissions from oil refining and production of synthetic fuels (CTL and GTL) were estimated to contribute 9% towards total emissions. Therefore, total emissions from the energy transformation and conversion processes contributes approximately 49% towards total emissions.
- The "Peak Plateau Decline" trajectory will inform the emissions constraints for electricity generation and petroleum refining in one of the IEP Test Cases



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TEST CASES

BACKGROUND	POLICY QUESTION	TEST CASE
According to the National Climate Change Response Policy (NCCRP), the energy sector contributes about 80 percent towards total carbon emissions for the country. South Africa has also committed to reducing emissions by 34 percent by 2020 and 42 percent by 2025 below a business as usual baseline. These targeted reductions in total emissions have been defined by the Department of Environmental Affairs (DEA) as the "Peak, Plateau, Decline" emissions trajectory and have further been translated into absolute reductions required for the entire country and by each sector based on contribution to the total.	What are the impacts of meeting the emission reduction targets as set by the Department of Environmental Affairs for the energy sector?	Test Case 5: Refurbish the existing fleet of plants so as to meet the targets set by DEA. Retrofit on the existing infrastructure. (Note: It is acknowledged a retrofit programme would still leave demand outstripping the supply of electricity). Test Case 6: The energy sector should meet the 34 percent and 42 percent emissions reduction target no matter what. This includes mothballing the power plants that are responsible for emissions and investing in new technologies.



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EMISSIONS PENALTIES

- In 2010, the National Treasury published a discussion document on a proposed carbon tax policy
- The policy document is near finalisation and could potentially be promulgated in the short-to-medium term
- The introduction of a Carbon Tax has significant implications for the energy sector and will be considered as a Test Case in the IEP



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TEST CASES

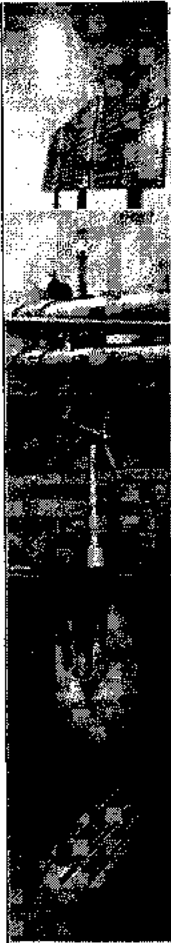
BACKGROUND	POLICY QUESTION	TEST CASE
In efforts to support the country's commitments of reducing emissions, the National Treasury has published 2 Discussion Documents which seek to introduce a Carbon Tax across all sectors.	What are the possible impacts of the proposed Carbon Tax by National Treasury on the energy sector?	Test Case 7: Impact of the Carbon Tax on the choice of energy technologies throughout the entire value chain. The current proposal is a tax of R75 per ton of CO ₂ and with an increase to around R200 per ton CO ₂ (at 2005 prices) introduced as from 2015.



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PROGRESS TO DATE



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HIGH-LEVEL WORKPLAN

COMPLETED TO DATE

Key Planning Assumptions

- Global Planning Parameters and Policy Assumptions informed by High-Impact Policies
- Key Macroeconomic Parameters/Indicators
- Assumptions underpinning Demand Projections
- Base Case versus Test Cases

Demand Projections

- Approach to modelling demand for energy services within all demand sectors
- Demand Projections

Key Policy Questions and Alternative Options for each

- Test Cases to be considered in the model
- Other Policy Options to be considered

Key Criteria and approach for evaluating model output (Outcome of Base Case and Test Cases)



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HIGH-LEVEL WORKPLAN

STILL TO BE COMPLETED

- Quality-checking and finalisation of technology data collected
- Address any data gaps that may arise
- Configuring of Model for Base Case and model runs
- Configuring of Test Cases in model and Model runs
- Analysis and Evaluation of model output
- Report Writing
- Table Draft IEP Report in Cabinet
- Stakeholder Consultations on Draft IEP Report



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PPC PRESENTATION ON THE DOE STRATEGIC PLAN AND BUDGET VOTE

Mr L Mulaudzi

Acting Chief Operating Officer

16 April 2013



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2013/14 BUDGET VOTE THEME

- In line with DoE's previous years commitments (APP) we have finalised the data collections and energy modelling which are essentials elements of developing the Integrated Energy Plan (IEP)
- The Department will table the draft IEP Report in Cabinet at the end of 1st quarter of 2013/14 FY.



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GOVERNMENT NOTICES**DEPARTMENT OF ENERGY**

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DEPARTMENT OF ENERGY

DRAFT 2012 INTEGRATED ENERGY PLANNING REPORT

EXECUTIVE SUMMARY**(For Public Consultation)**

June 2013

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EXECUTIVE SUMMARY

1 Background

The purpose and objectives of the Integrated Energy Plan (IEP) are anchored in the National Energy Act, 2008 (Act No. 34 of 2008). Integrated energy planning is undertaken to determine the best way to meet current and future energy service needs in the most efficient and socially beneficial manner, while:

- Maintaining control over economic costs;
- Serving national imperatives such as job creation and poverty alleviation; and
- Minimising the adverse impacts of the energy sector on the environment.

Government strives to improve the lives of the people of South Africa through various programmes. This improvement is effected through policy development and the implementation of appropriate policy choices.

The IEP takes into consideration the crucial role that energy plays in the entire economy and is informed by the output of analyses founded on a solid fact base. It is a multi-faceted, long-term energy framework which has multiple objectives, some of which include:

- To guide the development of energy policies and, where relevant, set the framework for regulations in the energy sector;
- To guide the selection of appropriate technologies to meet energy demand (i.e. the types and sizes of new power plants and refineries to be built and the prices that should be charged for fuels);
- To guide investment in and the development of energy infrastructure in South Africa; and
- To propose alternative energy strategies which are informed by testing the potential impacts of various factors such as proposed policies, introduction of new technologies, and effects of exogenous macro-economic factors.

Energy is an integral part of the economy and the energy sector is a key enabler for the attainment of national policy imperatives such as those expressed in the National Development Plan and its supporting pillars which include the New Growth Path and the Industrial Policy Action Plan, amongst others. It is therefore important that a mechanism is developed to enable energy policymakers to quantify and provide feedback on the extent to which the energy sector can contribute to the attainment of these and other national policy imperatives. It is equally important to quantify and provide feedback on the extent to which policy objectives outside the energy sector may impact on the attainment of energy sector imperatives. Examples of these include objectives, targets and/or constraints set in the following policy documents:

- The Beneficiation Strategy;
- The National Climate Change Response Policy;

- The National Transport Master Plan (NATMAP 2050); and
- The proposed Carbon Tax policy

While sectoral plans look at how to ensure that energy needs are met, the IEP endeavours to provide a long-term vision of how energy can be optimally used as a mechanism for South Africa to remain competitive. Optimal use of energy may at times require a shift in the use of a particular energy resource. For example, with the challenge of carbon emissions related to the use of coal in the generation of electricity, alternative supply options such as renewable and nuclear energy should be considered, as they provide a cleaner source of energy. That said, the cost associated with these alternatives needs to be considered and investment needs to be made to promote the development of new technologies to improve the use of coal.

Today's choices about how energy is produced and used will determine the sustainability of the future energy system and consequently of socio-economic progress. Integrated energy planning involves thorough analysis of the benefits and shortcomings of integrated relationships and seeks to optimise the energy system as a whole. The benefits and advantages associated with the pursuit of a particular strategic pathway are thoroughly explored and assessed against the trade-offs of not considering other alternative pathways. Integrated energy planning is therefore not only about ensuring that South Africa's energy needs are met, but also about finding alignment and ensuring that cross-sectoral impacts are analysed in a systematic way.

As a fast emerging economy, South Africa needs to balance the competing need for continued economic growth with its social needs and the protection of the natural environment. South Africa needs to grow its energy supply to support economic expansion and in so doing, alleviate supply bottlenecks and supply-demand deficits. In addition, it is essential that all citizens are provided with clean and modern forms of energy at an affordable price. The IEP will take these and other constraints into consideration. From the myriad of factors which need to be considered and addressed during the Integrated Energy Planning process, eight key objectives were identified.

- Objective 1: Ensure the security of supply;
- Objective 2: Minimise the cost of energy;
- Objective 3: Increase access to energy;
- Objective 4: Diversify supply sources and primary sources of energy;
- Objective 5: Minimise emissions from the energy sector;
- Objective 6: Promote energy efficiency in the economy;
- Objective 7: Promote localisation and technology transfer and the creation of jobs; and
- Objective 8: Promote the conservation of water.

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2 Energy Demand

Energy is a basic human need and is also a key enabler for the attainment of economic growth and other broader national imperatives. The desired structure of the economy as well as the level of activity within each of the sectors of the economy provide the starting point on which future energy requirements to support the desired economic growth can be determined. Access to modern forms of energy improves the livelihood of individuals and the growth of the population is therefore a key factor in determining future energy requirements for domestic use.

The energy planning process therefore starts with an understanding of the drivers for energy demand (with economic growth, population growth and energy prices being the three key drivers).

2.1 Macroeconomic Drivers

The National Treasury provided 20-year projections of domestic average potential economic growth for three scenarios (low growth, moderate growth and high growth) which were based on various sets of assumptions. The moderate growth assumptions assume the steady growth of the economy, with continued skills constraints and infrastructure bottlenecks in the short- to medium-term. These projections have been used in the Integrated Energy Planning process and are taken as the baseline. The GDP growth assumptions based on the National Development Plan (NDP) have been used for the high-growth scenario, but the relevant outputs have not yet been analysed.

The population growth combined with the average household size provides a good basis for determining the number of households in the future. Energy demand in the residential sector is determined by estimating the average energy consumption by different household types.

In the transport sector, GDP per capita is used to estimate future demand for passenger transportation.

Using the above-mentioned key drivers as a basis, demand projections were conducted for each of the energy demand sectors (agriculture, commerce, industry, mining, residential and transport).

- For the agricultural, commercial, industrial, mining and residential sectors, energy demand was estimated and projected for individual energy carriers (i.e. electricity, natural gas, LPG, coal, diesel, etc.); and
- For the transport sector, energy demand was projected for energy end-use (i.e. mobility measured by passenger kilometres or freight tonne kilometers) as opposed to individual fuels (i.e. petrol, diesel, jet fuel, etc.). This second approach makes it possible to quantify the extent to which different fuels can be used to meet the same energy end-use/need.

The demand projections and inferred energy intensity are provided in the sections that follow.

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2.2 Total Energy Demand

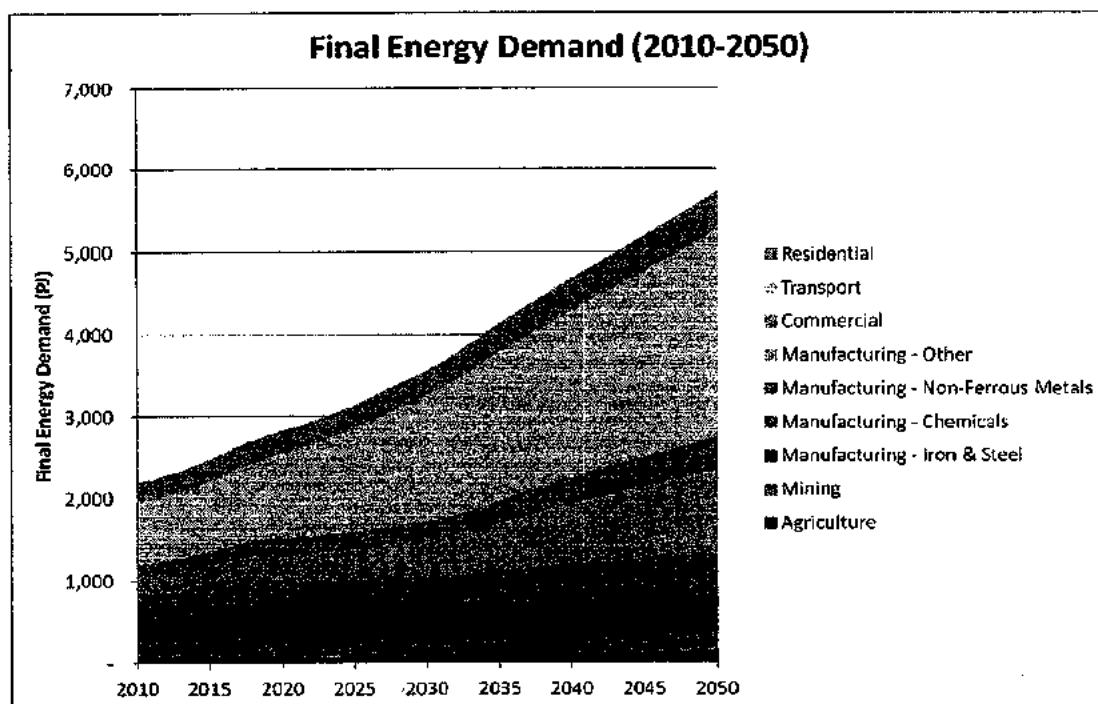


Figure 2-1: Projected energy demand for the entire economy by sector

The demand projections indicate a substantial increase in total energy demand by 2050, increasing at an average annual rate of 2% to more than double the 2010 levels.

The transport sector, comprising 34% of total energy demand in 2010, will continue to impose the most significant demand on total energy.

In line with global growth patterns, the key driver for continued passenger transport demand is linked to increased mobility which results from economic development. Disposable income levels influence the preferred mode of passenger transport with the tendency for individuals to use private passenger vehicles rather than mass public transport as income levels increase. However other factors which influence this preference include quality of roads as well as safety, efficiency and reliability of public transport systems. More recent factors that could possibly slow down the trend for people to move from public transport to private passenger vehicles include government policy interventions, which aim to accelerate the improvement of public transport by establishing integrated rapid public transport networks. These will introduce priority rail corridors and Bus Rapid Transit (BRT) systems in cities. Taxes on passenger vehicles to discourage their use, particularly in city centres, have also been introduced in efforts to reduce Greenhouse Gas (GHG) emissions. Transportation demand is largely met through liquid fuel, however the penetration of electric and hybrid vehicles could see demand shift from petroleum products to electricity for small private passenger vehicles in the future. This will see

significant reduction in energy demanded relative to economic growth and an overall reduction in energy intensity for passenger transportation in the long-term.

Freight haulage, predominantly by road, has contributed the most substantially to increases in transport demand and related fuel consumption. In recent years the rail freight market lost its market share to road haulage, and presently it is estimated that 85% of total freight is hauled by road, with the remainder being transported by rail. Road freight transport, which is more reliable, flexible, accessible, and secure and provides shorter transit times by comparison with rail freight transport, is preferred by the industrial sector. However this carries with it negative externalities such as increased and rapid damage to roads, road congestion, air pollution and higher fuel/energy requirements.

Demand for freight haulage is strongly linked to the value-add of the transport sector and overall economic growth. However government has now reviewed its rail investment programme to accelerate the shift from road to rail. This will see an investment of about R63billion by Transnet in the freight rail system over the next five years. The move should result in a reduction in projected road freight haulage and resultant energy demanded and will therefore require further analysis.

Outside of the transport sector, the most significant energy demand increase is expected to be in industry (the manufacturing sector), followed by the commercial sector. The energy demand in the 'Manufacturing - Other' is largely associated with projected economic growth, while the increase in energy demand within the commercial sector is associated with the continued expansion of the tertiary sector as South Africa moves to become more of a knowledge-based economy.

Demand in the residential sector is largely driven by population growth coupled with increased urbanisation. As living standards improve, people tend to consume more energy; however, energy efficiency interventions could see this trend start to slow down in the future.

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The graph below shows projected energy demand for individual energy carriers.

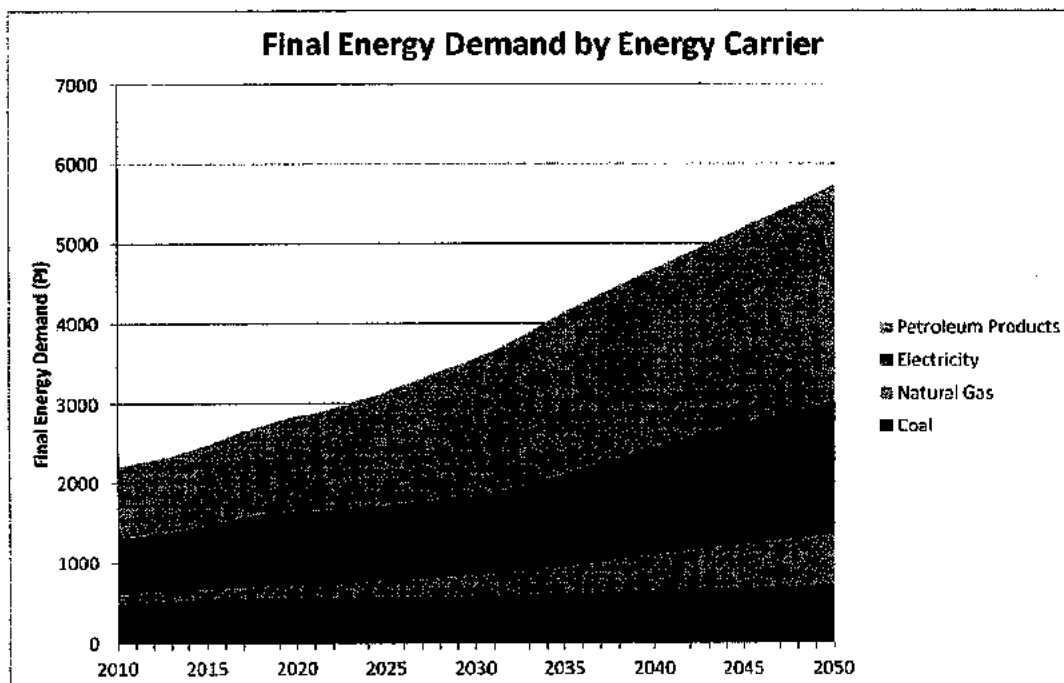


Figure 2-2: Total energy demand for different energy carriers

Demand for petroleum products increases the most significantly between 2010 and 2050 in comparison to that for other energy carriers. This is mostly attributed to the continued use of petrol and diesel vehicles to meet transportation needs into the foreseeable future with electric vehicles only beginning to make a significant contribution for passenger transport after 2030. Demand for LPG is expected to increase steadily in the residential sector and although fairly minor, ranks as the third largest increase between 2010 and 2050. Diesel consumption continues to increase in the mining sub-sector but only marginally when compared to electricity and natural gas. The use of illuminating paraffin is expected to decrease in future.

Demand for natural gas shows the next most significant increase after that of petroleum products. Natural gas is primarily used in the industrial sector and the projected growth of the sector is a factor in this increase.

Demand for electricity continues to rise as more houses become electrified and as the tertiary sector, largely comprised of commercial and public buildings continues to expand. In the industrial sector, the increase in electricity demand is largely attributed to the manufacturing sector with the exception of the iron & steel sub-sector. The iron & steel and mining sub-sectors show very little energy demand increase from current levels.

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Demand for coal will continue to grow in the industrial sector, while in the residential sector it is expected to start declining due to ongoing electrification of previously non-electrified households and improvement in household incomes.

2.3 Proportion of Final Energy Demand within Different Sectors

The share of total energy demanded across different sectors in 2010, 2030 and 2050 is provided in the table below.

Table 2-1: Proportion of current and projected final energy demand within different sectors

SECTOR	2010	2030	2050	Change
Industry (Excluding Mining)	37%	33%	34%	↓
Mining	8%	7%	4%	↓
Agriculture	3%	2%	3%	■
Commerce	7%	7%	7%	■
Residential	11%	9%	8%	↓
Transport	34%	43%	44%	↑
TOTAL	100%	100%	100%	

2.4 Energy Intensity

Figure 2-3 and Figure 2-4 below reflect the changes in energy intensity for the different energy demand sectors relative to 2010 levels. Using 2010 as the base year (with an energy intensity index = 1), an energy intensity index below 1 indicates an improvement or reduction in energy intensity relative to that of 2010, while an energy intensity index above 1 indicates an increase in energy intensity relative to that of 2010.

Figure 2-3 indicates an improvement in the energy intensity of the industrial, mining, commercial and transport sectors. Although energy demand increases in the tertiary sector (commerce and transport) the rate of increase is slower than projected economic growth and continues to decline throughout the planning period. The energy intensity in the mining sector increases initially (between 2010 and 2017) and starts to decline thereafter.

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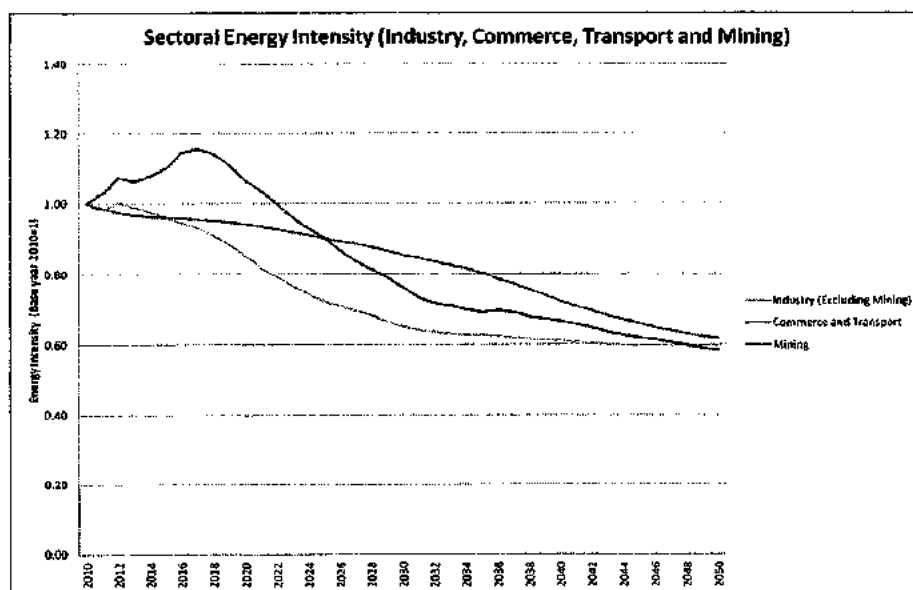


Figure 2-3: Energy Intensity Indices for the Industrial, Mining, Commercial and Transport Sectors

Unlike the sectors discussed above, energy intensity in the agricultural and residential sectors is likely to increase (See Figure 2-4). In the agricultural sector, the significant increase in energy consumption has historically been driven by the adoption of large-scale, intensive farming practices, which are assumed to continue into the foreseeable future. In the residential sector this increase will be driven by an assumed increase in the population.

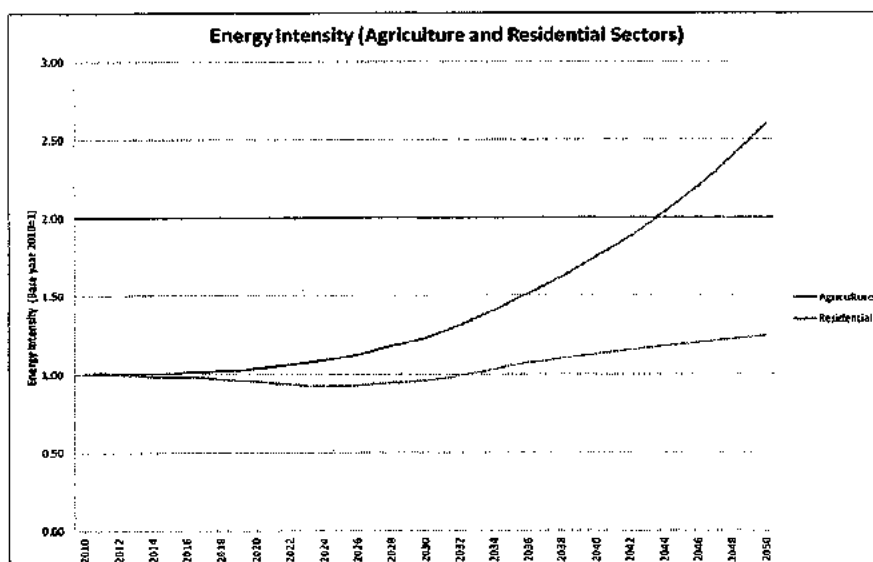


Figure 2-4: Energy intensity indices for the agriculture and residential sectors

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Figure 2-5 indicates an overall reduction in the intensity of the economy. Structural changes; significant changes in the level of activity; and technological and process improvements which have taken place within each of the sectors inform the projected demand and hence the reduction in energy intensity. Further analysis is required to quantify and separate the historical impact of structural changes, activity level changes and technological changes on energy intensity. Improvements in technologies, industrial processes and practices alone can play a significant role in future efficiency improvements and government policies, such as the recently published Draft National Energy Efficiency Strategy and interventions such the financial and tax incentives for energy efficiency could materialise in further reductions of energy intensity within these sectors.

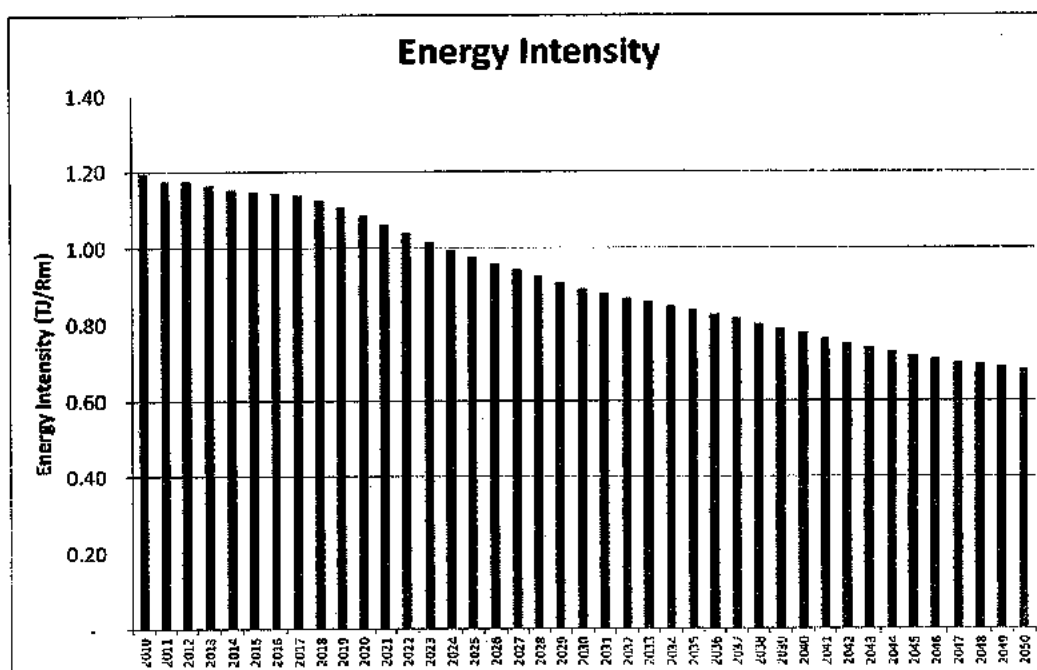


Figure 2-5: Energy intensity of the economy

3 The Base Case and Alternative Cases

The demand projections are a key input into the energy model and have a significant influence on the outcome of the Base Case and the various Test Cases. The underpinning objective is to ensure that future energy supply options meet future energy demand.

To ensure that the most appropriate supply-side options are selected, it is important to define a starting point or base against which all options are compared and analysed. This base has been defined as the 'Base Case' whilst alternative options that can be considered have been defined as 'Test Cases'.

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BASE CASE

- The Base Case encapsulates the state of energy demand and supply over the planning horizon, which is most closely informed by current energy market trends; the national macroeconomic outlook; assumed energy prices; existing energy infrastructure and the existing suite of policies and government programmes. Thus, while the IEP seeks to recommend an energy roadmap or policy pathway for the energy sector, this process is not conducted in isolation and should build on energy policies, strategies and plans which have already been adopted.
- The Base Case, is therefore not a representation of the most likely future or most likely scenario, but is rather a simplistic representation of a future outcome that could materialise in light of current policies and macroeconomic trends. It represents a Business-As-Usual or Status Quo scenario where current trends continue into the future.

Alternative policy options or 'policy alternatives' look at different pathways that can be pursued by policymakers to achieve energy sustainability and in some instances this requires testing the impacts of competing factors. These policy alternatives are defined as 'Test Cases'.

TEST CASE

- A Test Case has been defined as a deviation from the status quo where current trends do not continue into the future and deviations are as a result of specific policy interventions. A Test Case therefore defines a set of circumstances and resultant outcomes or impacts which is informed by the possible impacts of policies and policy interventions. A Test Case does not indicate what will happen but rather tests what could happen if a particular course of action is pursued.
- While Test Cases are sometimes also referred to as scenarios, within the context of the IEP and for the purposes of common interpretation, a Test Case is specifically differentiated from a Scenario in that a Scenario is largely influenced by exogenous forces which the policy maker has no control over, while a Test Case seeks to test the possible implications of active policy interventions.

The Base Case assumes that only prevailing policies are pursued to shape the future energy pathway. The Test Cases which were also considered and modelled are described briefly below. Each Test Case has been informed by the policy imperatives of high-impact policies within the energy sector which include the Integrated Resource Plan, the National Development Plan and the National Climate Change Response White Paper.

1. **"Peak-Plateau-Decline" Emission Limit Test Case:** This Test Case assumes that the country's target (i.e. a reduction on the 'business as usual' emission level of 34% by 2020 and

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of 42% by 2025) for electricity generation and liquid fuel production is met at all costs. This is achieved by setting emission limits *on electricity generation and liquid fuel supply only* in line with the upper bound of the "Peak-Plateau-Decline" emission trajectory, as defined in the National Climate Change Response Policy. No carbon tax is assumed. This Test Case seeks to analyse the effect of the emission limit constraints on energy supply options and costs.

2. **Emission Limit - No Nuclear Build Programme Case:** This Test Case assumes that the emission limit of the "Peak Plateau Decline" must be met as described above but that the 9,600MW Nuclear Build Programme is explicitly excluded as a supply option. This Test Case seeks to analyse the effect of embarking upon, or not embarking upon, the Nuclear Build Programme in terms of future energy security, as well as meeting the emission limit targets defined in the National Climate Change Response Policy.
3. **Renewable Energy Target Case:** No emission limit constraints are set but renewable energy options are gradually introduced into the energy mix from 2010 to 2030 such that by 2030, 10% of total energy output (electricity generation and liquid fuel production) is from renewable energy sources. From 2031 onwards, the target of 10% is maintained as a minimum. (It should be noted that given the low load factors for most renewable energy technologies, the installed capacity would effectively be much higher than 10%). This Test Case analyses the efficacy of setting renewable energy targets for reducing emissions within the energy sector.
4. **Emission Limit - Natural Gas Case:** This assumes that the emission limit of the "Peak Plateau Decline" trajectory must be met and that the Nuclear Build Programme is excluded as a supply option, as in the Test Case above. However the nuclear option is replaced by natural gas options as a policy intervention. This Test Case seeks to analyse the efficacy of including natural gas in the energy supply mix as a transitional fuel towards a low carbon economy and the implications of choosing this as a supply option over nuclear. In this context natural gas includes conventional gas, coal bed methane and shale gas.
5. **Carbon Tax Cases:** In these two Test Cases no emission limit constraints are set but the carbon tax is implemented as a test case with an upper bound of R120 per ton of CO₂-eq and a second case is implemented with a R48 per ton to simulate the 60% tax-free threshold. These test cases analyse the cost implications of a possible carbon tax on the energy sector as defined in the impending Carbon Tax Policy.

In addition, the following sensitivity analyses were conducted for the Base Case in order to test the impact of different crude oil price growth assumptions on decisions for new refining capacity:

1. **Low Crude Oil Price Case:** Assumes a low growth in the future crude oil price.
2. **High Crude Oil Price Case:** Assumes a high growth in the future crude oil price.

The model output from the Base Case and "Peak-Plateau-Decline" Emission Limit Test Case are described briefly in the two sections that follow.

4 Summary of Model Output

Based on the key macroeconomic, policy and technology assumptions made for the Base Case, the following section provides a summary of the total capacity for electricity generation, liquid fuel production and primary energy mix as well as estimated annual emissions and water use throughout the planning horizon.

4.1 Electricity Generation

The technology options for electricity generation for the High Oil Price and the Low Oil Price Test Cases remains the same as the Base Case as changes in crude oil price have little impact on electricity generation options.

- Coal technologies continue to play a role in the Base Case and all Test Cases however this is reduced significantly by 2030 as the existing fleet of coal technologies starts to be retired. The role of coal technologies continues to decline in the three Test Cases within emissions limits as no new coal power plants (besides Medupi and Kusile) are brought onstream. However in the Base Case and the Renewable Energy Target Cases new coal technologies continue to contribute to electricity supply (approximately an additional 50GW by 2050 in the Base Case and 30GW in the Renewable Energy Target Case).
- Solar plays a significant role in the Base Case and all Test Cases as the cost of solar technologies is projected to continue declining in the foreseeable future. Solar shows the biggest increase in contribution to the total energy mix in the Base Case and all Test Cases.
- The contribution of wind technologies is reduced in the Base Case as other options are more cost effective than wind technologies in the absence of emissions limits or renewable energy targets. However wind does play a significant role in the Emissions Limit and Renewable Energy Target Test Cases. Wind shows the second biggest increase in contribution in all Test Cases with emissions limits.
- A new nuclear plant is selected by the model in the Emissions Limit Case with no explicit exclusion of nuclear. Nuclear, together with Renewable Energy technologies are therefore viable options in reducing emissions in the Emissions Limit Test Cases. Nuclear does not feature in the Renewable Energy Target Case as preference is given to renewable energy technologies in this Test Case.
- Biomass only features in the Renewable Energy Target Test Case in order to ensure that the renewable energy targets are met.
- Besides the natural gas options included as part of the ministerial determinations, new natural gas options do not feature prominently in the Base Case or any of the Test Cases. New natural gas only features in the Test Case where Natural Gas options are explicitly enforced.

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- While coal-fired power plants with Carbon Capture and Storage (CCS) technologies were considered as an option, due to their relatively high cost the model does not select any CCS technologies in the Test Cases with emissions limits as other cheaper alternatives (i.e. Wind and Solar technologies) are available.

Figure 4-1 presents the electricity generation capacity for different technologies by 2050.

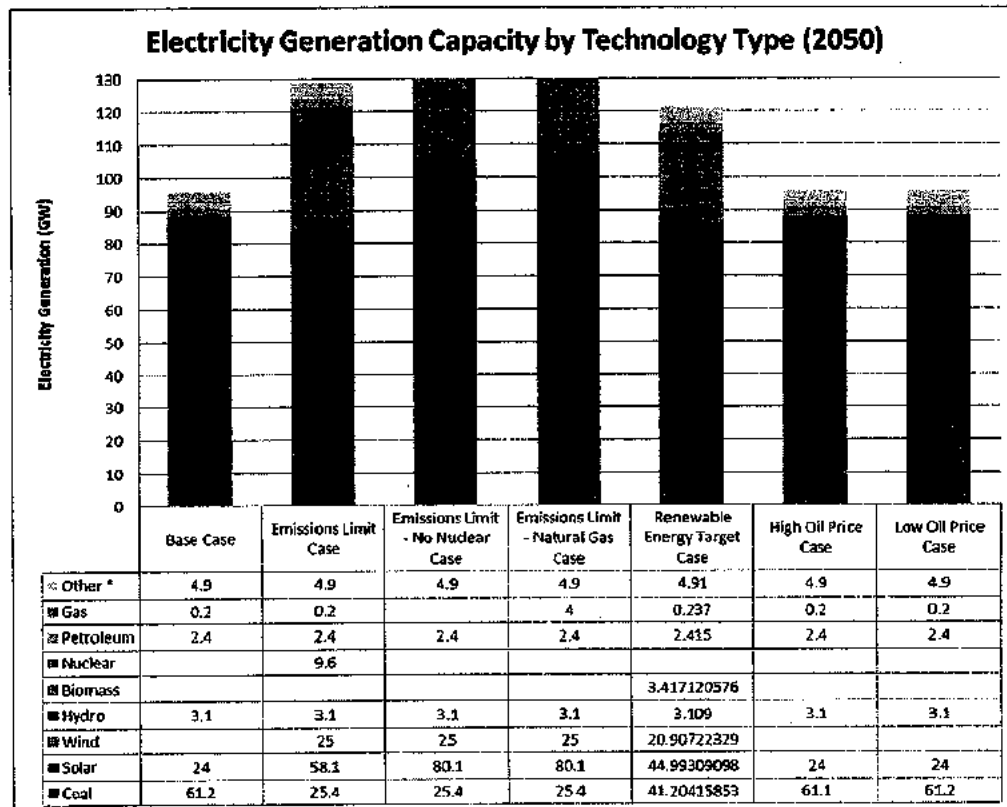


Figure 4-1: Electricity generation capacity by technology type (2050)

4.2 Liquid Fuel Production

The exclusion of nuclear energy (i.e. Emissions Limit – No Nuclear Case) has no significant impact on the liquid fuels sector in comparison to the Emissions limit case. Likewise the enforcement of natural gas as a supply option (i.e. Emissions Limit – Natural Gas Case) also has no significant impact on the liquid fuel sector. The output from these two test cases therefore requires no further analysis in this section as the output is the same as that for the Emissions Limit Test Case.

- In the Base Case and all Test Cases, the model selects new refining capacity to meet future liquid fuel demand from as early as 2020. Total liquid fuel production slows down by 2034 and

plateaus to 2040 after which it declines as a result of electric vehicle penetration in all Test Cases.

- New conventional crude oil refineries are a viable option in the Base Case and all Test Cases however additional capacity in the outer years is reduced for the Emission Limit Test Cases. It is assumed that existing conventional refineries are not retired within the modelling period and that their operational life is extended through continued maintenance, occasional upgrades (usually related to fuel specifications) and the low cost of maintaining the existing refineries relative to the cost of crude oil processed.
- In the Base Case and test cases without emissions limits, the cost of producing liquid fuels from coal is lower than that for both conventional refineries and gas to liquid plants as presented in the assumptions. In these test cases a coal-to-liquid plant is built to the maximum constraint set in the input parameters of 80 000 barrels per day, after which conventional refineries are selected to provide for the increasing liquid fuels demand. In the Emissions Limit Test Case, the selection of a new coal-to-liquid plant is restricted as a consequence of the high associated carbon emissions. A new plant does however feature only after 2040 when the existing coal to liquids plant is decommissioned and the use of electric vehicles reduces overall emissions below the emissions limits therefore providing scope for the more cost-effective coal to liquid plant. In the absence of a carbon tax, the total discounted cost of producing liquid fuels from coal-to-liquid plants is lower than that for both conventional refineries and gas to liquids.
- No new Gas-to-Liquid (GTL) plants are selected by the model. This is partially informed by the relative costs of new GTL plants as compared to conventional crude oil refineries as well as projected natural gas prices.
- In the absence of emissions limit constraints, the model output shows sensitivity to new capacity for different crude oil price assumptions. The capacity of new conventional refineries is highest in the Low Oil Price Case as compared to the Base Case and all the other Test Cases. On the contrary, the capacity of new conventional refineries in the High Oil Price Case is lower than that of the Base Case but is comparable to that of new capacity in the Emissions Limit Case.
- All supply shortfalls are met via imports in all Test Cases. Imports are especially high in the High Oil Price Case and the test cases which set limits on carbon emissions.

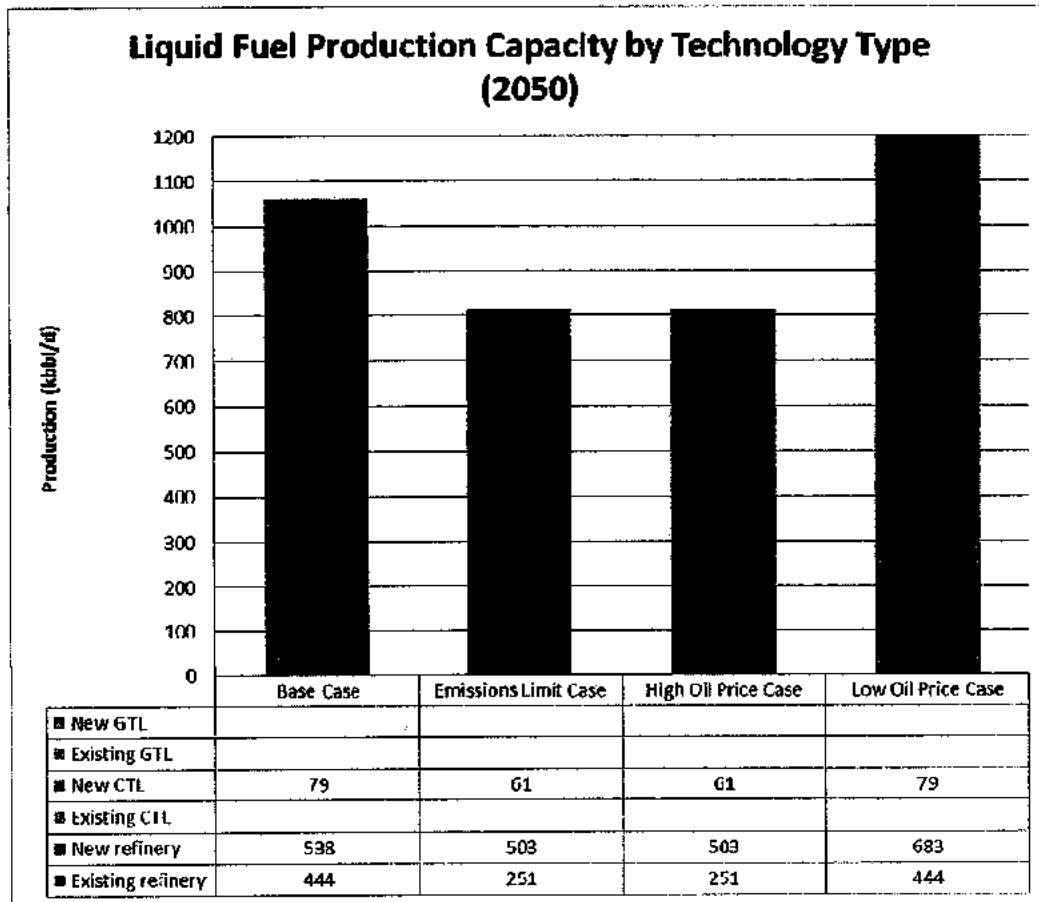


Figure 4-2: Liquid fuel production by technology type (2050)

4.3 Primary Energy Supply

- Coal loses its share in the primary energy mix in the Base Case and all three Test Cases however this is pronounced in the Emissions Limit Cases.
- New nuclear only features in the Emission Limit Test Case without technology constraints.
- Solar technologies are viable and play a prominent role in all Test Cases however the share contribution is reduced in the Renewable Energy Target Case as Wind – which is included earlier in this Test Case reduces the requirements for new renewable energy technologies in the outer years.
- New biomass only features when a renewable energy target is set.
- Transport demand continues to increase which results in an increase in the demand for liquid fuel. In the Base Case and the Test Cases without emissions limits, this demand is met

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through local production (primarily crude oil refining and limited production of synfuels from coal and gas). The share of crude oil in the primary energy mix therefore increases in these Test Cases.

- In the Emissions Limit Test Cases, local production of liquid fuel is displaced with imports and this sees an increase in the share of petroleum products in the primary energy mix. In the High Crude Oil Price Case, the import of final product surpasses crude oil imports and the inverse is the case in the Low Crude Oil Price Case.
- Imported natural gas plays an increasing role in all Test Cases throughout the planning period; however this is not prominent in comparison to other primary energy sources.

4.4 Discounted Cost

The total discounted cost represents all the costs of the energy system discounted to a single number for comparison purposes. It is the main variable used to compare the policy interventions which inform the various test cases which have been defined.

A large dependence on imported energy (crude oil and liquid fuels) in all test cases can be observed from an analysis of costs related to the energy system as presented in Figure 4-3. Imports increase from about 70% to 80% of the total energy supply costs for the Base Case between 2010 and 2050; from 80% to 90% in the Emissions Limit Case and the No Nuclear Case; from 70% to 80% in the Renewable Energy Target Case.

The total discounted costs for the Emissions Limit Case and the No Nuclear Case are both 4.8% more than that for the Base Case; and that for the Renewable Energy Target Case is 1% more than that for the Base Case. The higher costs are due to an increase in the share of imported energy and the use of technologies which are less carbon intensive in the test cases with emissions limits.

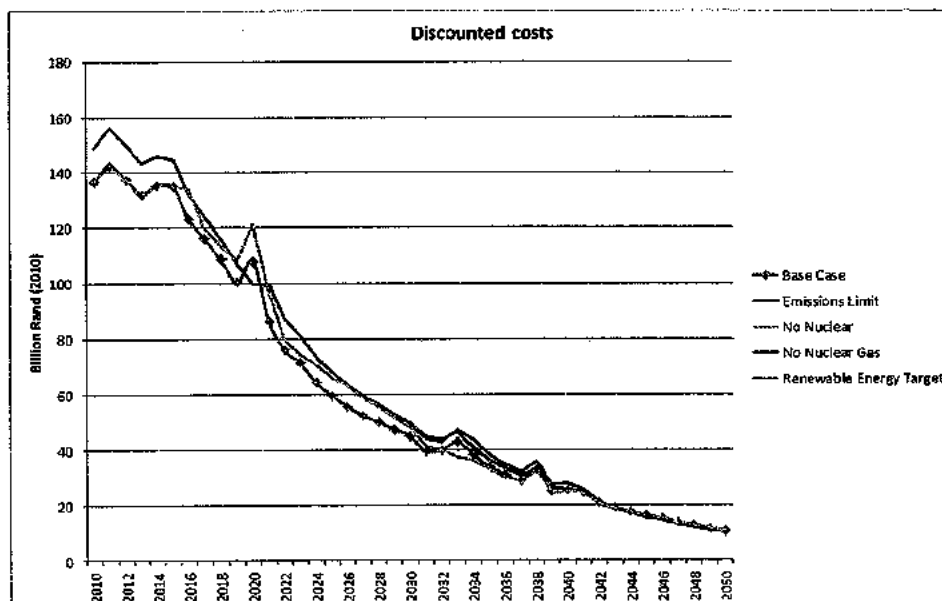


Figure 4-3: Discounted costs for all Test Cases

4.5 Emissions

Carbon dioxide emissions for the Base Case and test cases are presented in Figure 4-4. These emissions are primarily driven by the use of coal for electricity generation and liquid fuel production; however a considerable amount of coal is also used in other parts of the economy and is not included here. The abatement cost for meeting the emissions limit for the Emissions Limit Test Case and the No Nuclear Test Case is calculated at R41/t (in 2010 Rand). Setting emissions limits on energy production (i.e. refineries and electricity generation) without setting emissions constraints or emissions penalties on energy end-use (i.e. demand-side emissions controls) results in greater use of imported energy. Emissions resulting from energy end-use therefore continue growing unconstrained. Therefore national emissions limits cannot be met without addressing final demand for energy carriers.

Fuel switching between final energy carriers was only modelled for the transport sector and this allows for the switching from fuel-powered vehicles to hybrid and electric vehicles which results in reduced emissions in the transport sector when constraints are set.

In summary:

- Emissions in the Base Case continue to increase.
- Emissions are reduced for the Renewable Energy Target Test Case however the reduction is not significant enough for them to be below the levels required by the "Peak Plateau Decline" Emissions Trajectory.

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- The carbon emissions associated with energy supply (electricity generation and liquid fuel production) for all the test cases with emissions limits are within the "Peak Plateau Decline" Emissions Trajectory as this is set as a constraint. The reduction in the use of coal has the most significant impact on this reduction and the emissions constraints resulted in a 7.5 billion tonnes (or 31%) reduction in carbon dioxide emissions over the 40 year period as compared to the Base Case.

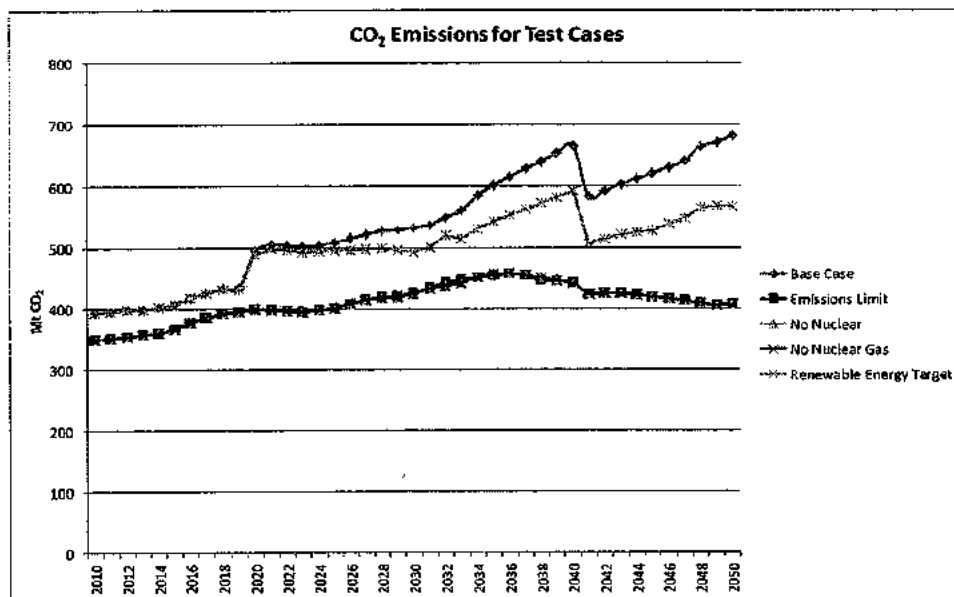


Figure 4-4: CO₂ emissions for all Test Cases

4.6 Water Use

Water use in the various test cases is shown in Figure 4-5. Coal-to-liquid plants use large quantities of water - this is evident by comparing the water consumption of the Base Case (which includes a new coal-to-liquid plant) with that of the Emissions Limit case (all of which exclude a new coal-to-liquid plant). There is very little difference in water consumption for the Emissions Limit case and the No Nuclear case. The small difference is because nuclear (which is selected by the model in the Emissions Limit Test Case) is assumed to use sea water whereas the CSP technologies (which are selected by the model partially in place of nuclear in the Emissions Limit – No Nuclear Test Case) use fresh water. In general the test cases which have limited or no production from coal-to-liquid plants have a reduced demand for water in comparison to those that have significant production. In the latter years, water demand is also reduced as dry-cooled plants replace wet-cooled plants for electricity generation and renewable energy technologies which use less water start to play a more prominent role in the energy mix.

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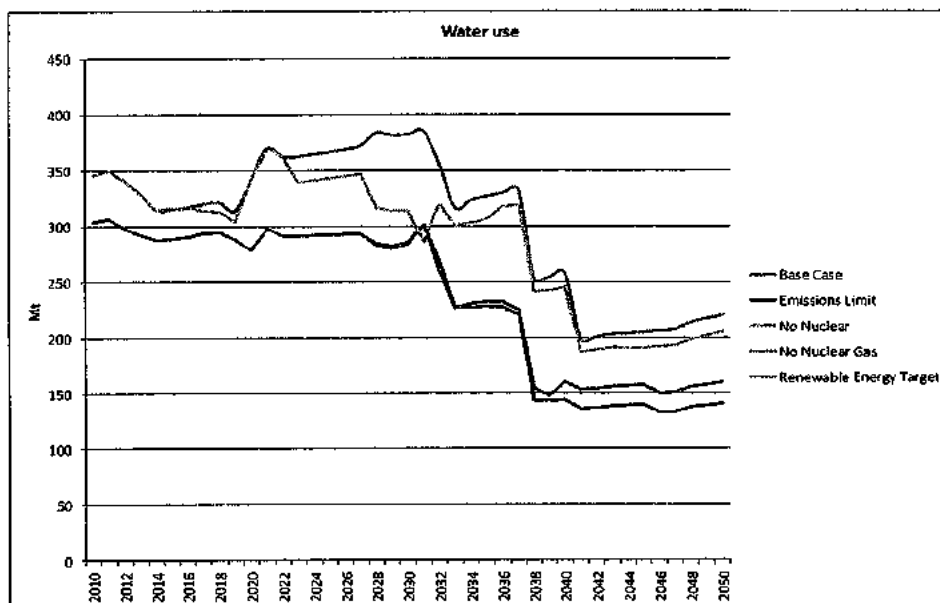


Figure 4-5: Water use for the test case

5 Way Forward

The energy planning process entails quantitative analysis as well as qualitative analysis or value judgement. The key inputs into the energy models and the underpinning assumptions which inform that input are therefore critical and need to be well communicated. The demand projections are largely informed by the macroeconomic and demographic assumptions which have been made, and in the case of the transport sector assumptions about energy end-use technologies (or vehicles). The final output from the energy models is greatly influenced by the projected demand, together with assumptions made about the impact of policies, energy supply technologies as well technological developments.

The Draft Integrated Energy Planning Report presents the energy planning approach followed, including the methodologies used to estimate energy demand projections in light of the data scarcity issues encountered. It also presents the model output and analysis for the Base Case and the test cases which were modelled.

This document therefore does not seek to make recommendations but provides the preliminary model output and a basis from which stakeholder input can be obtained. Once published various stakeholder consultations will take place over a period of approximately four (4) months. During the stakeholder consultation process, it is anticipated that various inputs will be received which will provide information to guide further analysis. Some of the assumptions, (for example GDP growth rates) may need to be revised based on the latest national forecasts. Areas which require further analysis include the following:

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- Assess the impact of Transnet Freight Rail's expansion plan on displacement of freight haulage from road to rail and the impact that this may have on projected demand;
- Conduct further analysis of the constraints that natural gas infrastructure may have in meeting projected demand for natural gas, particularly in the industrial and commercial sectors;
- Explore options for natural gas imports and analyse the potential impact on projected natural gas import prices including imports from Mozambique and other countries within the region;
- Obtain more data and information to explore regional options such as the Northern Mozambique Power Development Programme and the Grand Inga Hydropower Scheme;
- Gain a better understanding of the land limitations which may constrain growth in the agricultural sector and in particular the projected demand for diesel, which is primarily used by tractors for ploughing; and
- Assess in more detail and better quantify the impact of technological advancements and process improvements which could result in further energy efficiency gains in the industrial and commercial sectors.

The input obtained from the stakeholder engagement process may result in the revision of some of the key planning assumptions. Such revisions may also result in changes to the demand projections and subsequently outputs from the Base Case and test cases.

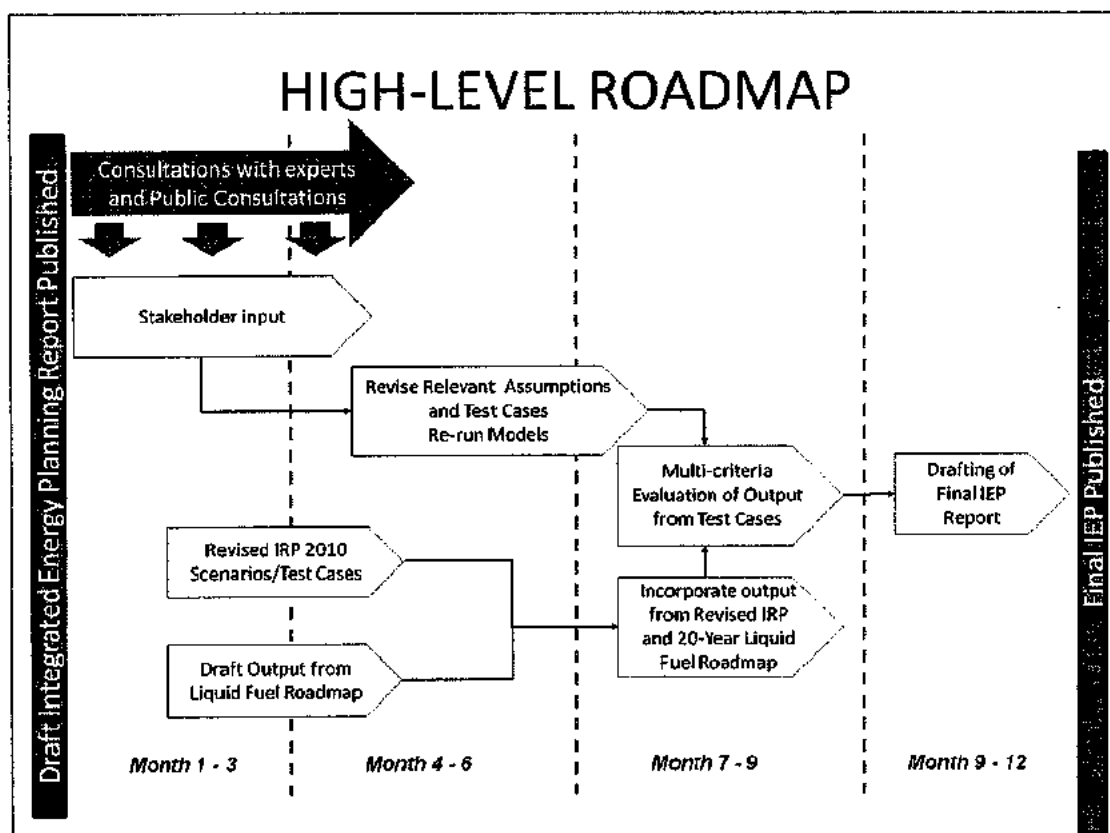


Figure 5-1: High-level roadmap

After the stakeholder engagement process, the final set of outputs will be evaluated using a Multi-Criteria Decision Analysis (MCDA) technique. The outcome from this process will inform the final IEP.

6 Document Structure

- Section 1 presents the main introduction of the report and defines the scope of the IEP. It also covers the high-level integrated energy planning approach and sets the scene for the remainder of the document.
- Section 2 provides a discussion on the key policies which have informed the Integrated Energy Planning process, including those policies outside of the energy sector which are considered to have a high impact on the energy sector. The eight (8) competing objectives that the Integrated Energy Planning process seeks to balance are discussed.
- Section 3 provides an overview of the South African energy sector, including an overview of primary energy sources and their potential future role in the energy mix.
- Section 4 provides the key macroeconomic assumptions including the detailed write-up and values with supporting calculations and tables where relevant.

- Section 5 provides an analysis of the projected energy demand by sectors. In each instance the key assumed drivers for demand are discussed.
- Section 6 provides the detailed write-up of the Base Case policy assumptions and Test Cases which were modelled.
- Section 7 provides analyses of the model output for the Base Case and all the Test Cases.
- Lastly, Section 8 presents the way forward, including the stakeholder consultation process and timelines and how input will be incorporated into the final IEP Report. This section also outlines how the Multi-Criteria-Decision-Making (MCDA) technique will be used to evaluate all model outputs and make final recommendations based on the key objectives of the IEP. The MCDA technique is also described in detail in Appendix 1.

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24 July 2013

DEPARTMENT OF ENERGY

DRAFT 2012 INTEGRATED ENERGY PLANNING REPORT

(For Public Consultation)

June 2013

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ABBREVIATIONS AND ACRONYMS

bpsd	Barrels per Stream Day
CBM	Coal Bed Methane
CCGT	Combined-Cycle Gas Turbine
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CFC	Chlorofluorocarbon
CH ₄	Methane
CMM	Coal Mine Methane
CNG	Compressed Natural Gas
CO ₂	Carbon Dioxide
CO ₂ e	Carbon Dioxide Equivalent
CSP	Concentrated Solar Power
CTL	Coal to Liquids
CUE	Cost of Unserved Energy
DC	Direct Current
DME	Department of Minerals and Energy
DoE	Department of Energy
DRC	Democratic Republic of the Congo
EIA	Energy Information Administration
ESMP	Energy Security Master Plan
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GTL	Gas-to-Liquid
GW	Gigawatt
GWh	Giga Watt Hours
IEA	International Energy Agency
IEP	Integrated Energy Plan
IPP	Independent Power Producer
IRP	Integrated Resource Plan
km	Kilometre
kt	Kiloton
kWh	kilowatt hour
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas

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mb/d	Million Barrels per Day
MCDA	Multi-Criteria Decision Analysis
MJ	Megajoule
MMbbl	Million Barrels
MMBtu	Million British Thermal Units
m/s	meters per second
Mt	Million Tons
Mtoe	Million Tons of Oil Equivalent
MTSF	Medium Term Strategic Framework
MW	Megawatt
MWe	Megawatt Electric
NATMAP	National Transport Master Plan
NCCRP	National Climate Change Response Policy
NDP	National Development Plan
Necsa	South African Nuclear Energy Corporation
NO _x	Nitrogen Oxide
NPT	Non-Proliferation Treaty
OCGT	Open-Cycle Gas Turbine
OECD	Organisation of Economic Cooperation and Development
OPEC	Organisation of Petroleum Exporting Countries
PASA	Petroleum Agency of South Africa
PGM	Platinum Group Metals
PJ	Petajoule
PPP	Purchasing Power Parity
PV	Photovoltaic
PWR	Pressurised Water Reactor
R&D	Research and Development
SANEDI	South African National Energy Development Institute
SAWEP	South African Wind Energy Programme
Tcf	Trillion Cubic Feet
TJ	Terajoule
V	Volt
W/m ²	Watt per square meter
UCG	Underground Coal Gasification
USA	United States of America

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SECTION 1: INTRODUCTION

Energy is essential to many human activities and is critical to the social and economic development of an economy. One of the key objectives of the Department of Energy (DoE) is to ensure energy security, which in essence is about ensuring the availability of energy resources, and access to energy services in an affordable and sustainable manner, while minimising the associated adverse environmental impacts. Many factors pose potential threats to energy security including scarce and depleting energy resources, geopolitical instability, inadequate energy infrastructure, and more recently natural disasters. To ensure continued security of energy supply, it is essential that a co-ordinated and integrated approach to energy planning, which takes into account these complex issues, is undertaken.

The development of a National Integrated Energy Plan (IEP) was envisaged in the White Paper on the Energy Policy of the Republic of South Africa of 1998 and, in terms of the National Energy Act, 2008 (Act No. 34 of 2008), the Minister of Energy is mandated to develop and, on an annual basis, review and publish the IEP in the *Government Gazette*. The purpose of the IEP is to provide a roadmap of the future energy landscape for South Africa which guides future energy infrastructure investments and policy development. The National Energy Act requires the IEP to have a planning horizon of no less than 20 years. The development of the IEP is therefore a continuous process as it needs to be reviewed periodically to take into account changes in the macro-economic environment, developments in new technologies and changes in national priorities and imperatives, amongst other factors. While change is on-going, the plan must remain relevant.

Integrated Energy Planning entails understanding the current and future energy requirements of different types of consumers (e.g. industry, commerce, mining, agriculture, households, etc.) and then determining the most optimal mix of energy sources and technologies to meet those energy needs in the most cost-effective, efficient, socially beneficial and environmentally responsible manner. Delivering energy to end users requires multiple processes (production, conversion, transmission and distribution) and involves many participants, from both the public and private sectors. Today's choices about how energy is extracted, harnessed and used will determine the sustainability of the energy system in the future and thereby influence the extent of socio-economic development.

Integrated energy planning at a national level is therefore focused on the entire energy value chain and requires a comprehensive representation and understanding of the entire energy system. The energy planning process starts with an understanding of the different forms of energy which are consumed by different end users and the applications in which those forms of energy are used. The alternative technologies for producing and distributing those different forms of energy are evaluated according to a number of factors such as cost, efficiency, lifecycle and associated emissions. The different primary energy sources which are available are considered, since these inform the types of production and the distribution technologies that will be required and contribute to the final energy end use cost as well as emissions.

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These multiple aspects must be considered in a balanced manner to ensure that the objective of achieving sustainable socio-economic development is realised. *"Integrated energy planning is the systematic analysis of all the factors that influence the evolution of energy systems. It facilitates problem solving and makes it possible to explore linkages, evaluate trade-offs and compare consequences, thereby helping countries to develop an effective energy strategy that supports national sustainable development goals."*¹

The integrated energy planning process analyses the benefits and shortcomings of relationships between components of the energy sector and seeks to optimise the energy system as a whole. For example, the increase in car ownership, coupled with tight oil refining capacity and inadequate logistics infrastructure continues to threaten the security of liquid fuel supplies in South Africa. Similarly, the upsurge in property development, especially in the residential and commercial sectors, coupled with the successful rollout of the electrification programme, has resulted in increased demand for electricity. Against this background, environmental pressures, increases in the global crude oil prices, potential increases in coal prices together with new potential discoveries of shale gas in the Karoo and natural gas in Mozambique are all potential game-changers which require a sharpened focus on the use of alternative energy sources as well as the efficient use of traditional energy sources. Thus, in energy planning, it is essential to take the broader aspirations and goals of the country into consideration as well as external factors which characterise the sector.

Key government and political commitments such as the Millennium Development Goals, the National Development Plan, the Climate Change Response Policy, and the shift to the Green Economy need to be considered as part of energy planning. Integrated energy planning is therefore not only about ensuring that South Africa's energy needs are met, but rather takes a broader approach in ensuring alignment between cross-sectoral impacts and the National Objectives - where applicable, Regional developments are also considered. While sectoral plans look at how to ensure that energy needs are met, the IEP seeks to provide a long-term vision of how South Africa can remain competitive and how it can use energy as a mechanism to remain competitive.

1.1 Scope of the IEP

The IEP considers the national supply and demand balance and proposes alternative capacity expansion plans based on varying sets of assumptions and constraints. While infrastructural issues are briefly discussed, the IEP does not explicitly consider supply and demand at specific geographical locations within the country nor does it take into account infrastructure bottlenecks at specific locations.

¹ International Atomic Energy Agency, Integrated Energy Planning for Sustainable Development

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- With regard to electricity infrastructure issues (transmission and distribution) these are dealt with in other plans and going forward the Integrated Resource Plan (IRP) should assess these in detail, taking into consideration grid planning currently conducted by Eskom.
- With regard to liquid fuels, the 20-Year Liquid Fuel Infrastructure Roadmap will deal with logistical issues relating to pipelines and storage facilities for petroleum products.
- The gas infrastructure framework which is currently in the early stages of development will take into consideration bottleneck and capacity constraints of the current natural gas infrastructure.
- All the above will provide feedback into the integrated energy planning process and will enable overall enhancement through ongoing periodic iterations.

1.2 High-Level Integrated Energy Planning Approach

The high-level energy planning approach, depicted in Figure 1-1, is used to ensure that the process of developing the IEP is continuous and takes into account stakeholder engagement. The scope of this process is encompassed in Steps I, II and III.

Steps IV, V, and VI are within the broader scope of the IEP process, but fall outside the sphere of its development. Once the IEP recommendations have been made and promulgated, implementation, monitoring and review of those recommendations need to take place. The outcomes from these steps must inform future iterations of the IEP.

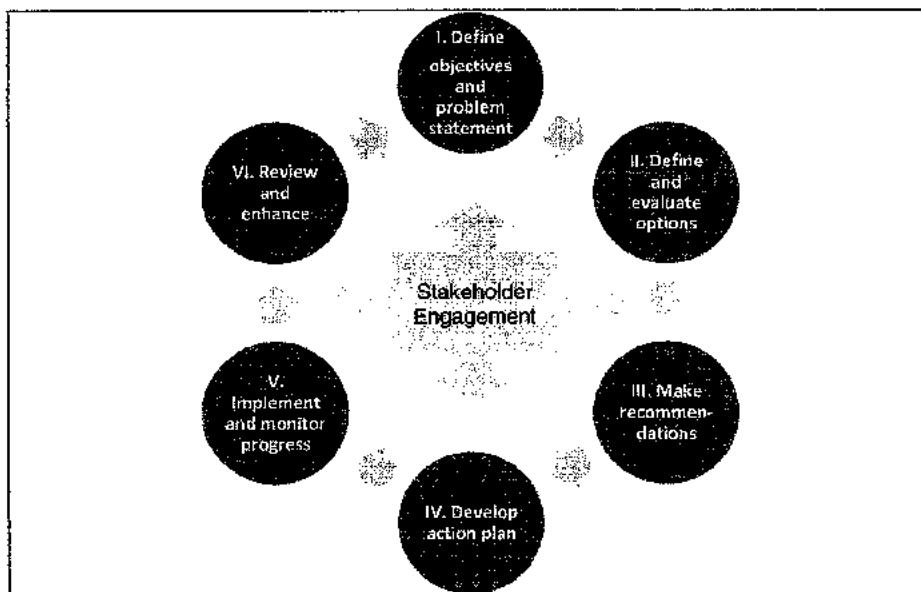


Figure 1-1: High-Level Planning Approach

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The high-level approach is described in the following six key steps:

I. Define objectives and problem statement: The National Objectives of the South African Government are set to ensure that government departments work in a co-ordinated way to fulfil their respective public mandates. The National Objectives set the priorities of the country and are articulated on an annual basis as part of the President's State of the Nation Address as well as government's Programme of Action. The first step is to understand those key objectives so that, through the IEP, the DoE can achieve those objectives that are within its mandate. The objectives of the IEP must be placed first and foremost in the planning process.

II. Define and evaluate policy options or pathways: This step requires an understanding of the policy objectives that should be considered in the planning process. Once these are identified and understood, their impact is assessed. This process involves defining the main questions to be tackled by the IEP, examining the different policy pathways or options that can be pursued and testing the relative impacts of these possible pathways/options. To ensure that different alternatives are considered in a congruent manner, a policy analysis framework has been developed. The framework describes how different high-impact policies – or those with a potential impact – should be considered within government. During the planning process it is acknowledged that, while data provides a fact base which enables analytical tools and models to inform the final plan, the most significant outcomes of this process are based on human input and judgment. The policy analysis framework provides transparency on how various policies were included, and how the key criteria for evaluating the alternative policy pathways were chosen and eventually applied in reaching the final recommendations. In this step it is therefore important that a detailed methodology, which shows the linkages and feedback loops between the technical and the non-technical elements, is developed. Although the planning process is non-linear, the methodology provides a high-level overview of the key steps and decision points in a linear fashion. The technical elements include activities such as identifying the data requirements and collection of data, developing energy models, conducting demand forecasts and running various Test Cases through the energy optimisation models. The non-technical elements include defining the key objectives and the problem statement of the IEP, defining the key policy questions to be addressed and alternative policy options or pathways to be considered, and based on the objectives defining the key criteria for assessing alternative policy options or pathways. Other critical elements of the non-technical aspects of energy planning include defining the macro-economic and policy assumptions which inform the input into the energy models.

III. Make recommendations: Once the future energy demand path has been projected and various policy options have been analysed and evaluated, recommendations on how best to meet the country's energy needs are made. As described in the previous steps, recommendations are informed by a combination of output from the analytical tools and human judgment and therefore the assumptions which inform the analytical tools are critical.

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IV. Develop action plan: Once the recommendations have been made and approved, they must be supported by a clear action plan for implementation. Anticipated challenges and shortcomings must be highlighted and mechanisms to address those challenges should be proposed.

V. Implementation and monitoring: Implementation of the recommendations lies in different areas, and could entail policy interventions that need to be put in place by various policy units within the Department of Energy. Action could be required from regulators, State-Owned Entities or the private sector and civil society. In all cases, mechanisms to raise awareness to ensure action by the relevant stakeholders should be introduced. An integral part of any policymaking and implementation process entails monitoring the progress and effectiveness of policy recommendations which have been implemented, as well as assessing key constraints to those which have not been implemented. The monitoring process should also include assessing the effectiveness of the integrated energy planning methodology and approach as well as the governance structures to ensure ongoing enhancement.

VI. Review and enhance: The energy planning process must be dynamic as the energy system must meet consumer needs that are constantly changing. Prices of commodities and materials continually fluctuate, new technologies are continually being developed and improved, and geo-political issues and uprisings may sporadically occur. The IEP must be reviewed periodically in order it to be up to date and remain relevant in line with the realities of the day.

The outcomes of the monitoring process need to be factored in to subsequent IEP development in a process of continual learning. Once the effectiveness of the process followed has been assessed, and the progress of the implementation programme together with challenges and successes has been measured, recommendations for possible enhancement should be made.

1.2.1 Stakeholder Engagement

Stakeholder engagement underpins the entire IEP development process and is critical in ensuring that the IEP is understood, its development process is transparent, and that ultimately the necessary stakeholder buy-in is obtained. Stakeholder engagement at inter-governmental level is anchored by the IEP Steering Committee, which is an inter-departmental government committee led by the Department of Energy and consisting of the departments of Science and Technology; Environmental Affairs; Water Affairs; National Treasury; Economic Development; Trade and Industry; Human Settlements; Transport; Rural Development and Land Reform; Mineral Resources and National Planning Commission. The IEP Steering Committee oversees the IEP development process and ensures that legislation, strategies and policies that have an impact upon the energy sector are taken into account. The IEP Steering Committee is supported by various working groups whose focus is on more specific policy issues and, where relevant, the provision of technical input. Industry and community stakeholders are consulted at different stages and through various forums throughout the planning process including public stakeholder workshops, bilateral engagements, and presentations at parliamentary and other energy forums. The

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high-level energy planning approach and stakeholder engagement framework were presented to Cabinet for noting in February 2011.

1.3 Energy Planning Methodology

Integrated energy planning is about taking into account multiple factors and assessing 'what-if' scenarios for their impact on the energy sector so as to inform choices amongst the many alternative courses of action that could possibly be taken. While the previous section outlined the high-level planning approach, this section deals with the detailed methodology involved in Steps I, II and III in Figure 1-1.

There is no single, prescribed or best suited method or process for developing long-term plans. In the OECD countries, energy planning has often considered the '3E' elements – **'Energy access and security; Economic growth and development; and Environmental sustainability'** – to ensure that the effects of achieving one objective are weighed up against the other two. South Africa is faced with additional challenges such as high levels of unemployment and poverty and lack of access to modern and clean forms of energy. The IEP Methodology seeks to ensure that the process of designing the future energy roadmap keeps a balanced view of the '3E' imperatives.

While the National Energy Act provides details as to which elements should be considered in the development of the national IEP, it does not provide details on the mechanisms or processes which must be followed in order to achieve this. The purpose of defining a methodology is therefore to provide a framework which will ensure that a systematic and transparent approach is followed, thereby making the overall process consistent and repeatable and strengthening the Department's ability to improve the integrated energy planning process in future.

Figure 1-2 below depicts in more detail the phases entailed in Steps I, II and III as represented in Figure 1-1. Although the methodology is depicted and described in sequential steps or phases, the energy planning process is an iterative one where several phases take place in parallel and output from some of the phases is informed through feedback loops from subsequent phases. The process also entails a series of discussions and debates which feed into or inform the technical process. The individual steps in the methodology also provide a logical breakdown of the sets of activities or process steps within which interaction and input from stakeholders is required. These are described briefly below and also inform subsequent sections in this document.

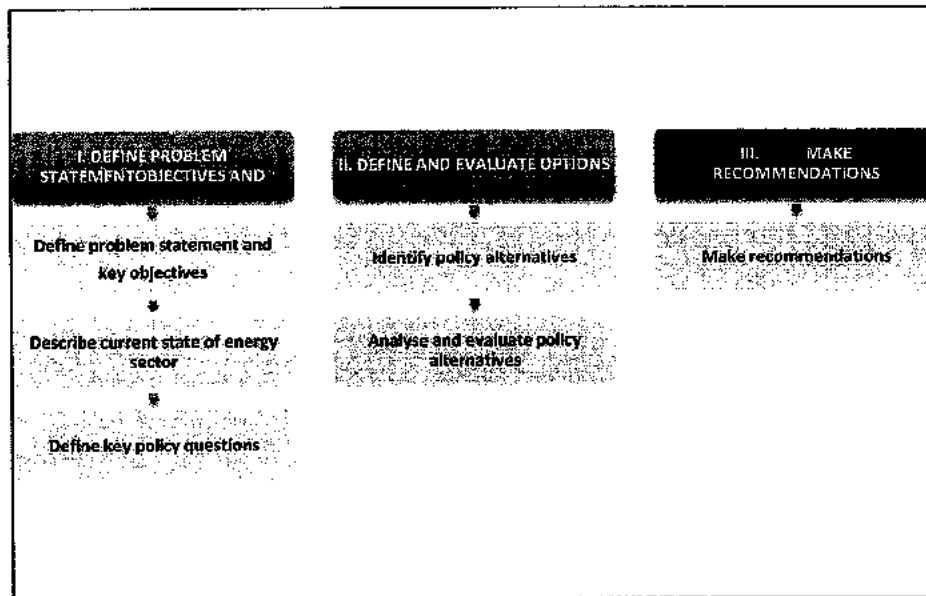


Figure 1-2: Schematic diagram of the IEP methodology



Figure 1-3: Outline of the key steps of the IEP methodology

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1.4 Purpose of this Report

The Draft Integrated Energy Planning Report ***does not provide recommendations but presents model output from the Base Case and various Test Cases. This output gives insight on the possible implications of pursuing alternative energy policy options.*** Once the implications of all the alternative options have been explored and evaluated against each of the eight (8) key objectives, final recommendations will be made in the form of the Final IEP Report.

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SECTION 2: KEY OBJECTIVES OF THE INTEGRATED ENERGY PLAN

The IEP takes into consideration the central role that energy plays in the entire economy and is guided by a sound fact base in determining viable options. The IEP development process should provide for a co-ordinated view of the energy sector which considers the impacts of different plans within the energy sector, as well as those from other government departments – the focus being their impact on the energy sector and vice versa.

The decisions made in energy planning are highly integrated and their effects on one another should always be considered. If for example, a choice is made to implement wind technology for electricity generation, the optimal area and location of land required for these wind farms may be valuable agricultural land which provides food to the population. While South Africa is endowed with abundant coal resources which provide an affordable supply of energy, continued use of coal for power generation and synfuel production results in high levels of GHG emissions which are harmful to the environment.

The increase in car ownership, coupled with tight oil refining capacity and an inadequate logistics infrastructural base continue to threaten the security of liquid fuel supplies. Similarly, the production and operation of electric and hybrid cars may require more electricity and result in significant changes to the current electricity demand profile. Moreover the upsurge in property development, especially in the residential and commercial sectors, has resulted in increased demand for electricity supplies. Amidst all this, increases in the global oil and local electricity prices, as well as environmental pressures, have sharpened the focus on the increased generation and use of alternative energy sources as well as the efficient use of traditional energy sources.

Choices made in respect of energy, impact not only on the demand for energy, but also on the supply of feedstock and other resources such as water. Therefore not only do these choices have an impact on the economy but on the environment as well. The above-mentioned choices have to be made within the context of overall planning of the energy sector and how this will impact on other sectors.

At government level, the introduction and execution of policies requires proper contextualisation and detailed analysis. As cabinet considers other energy-related policies brought to it, such as climate change mitigation strategies, questions should be raised on the likely impact of such strategies on the overall economy of the country.

The IEP seeks to provide a future energy roadmap premised on a balanced view of the '3E' imperatives – Energy access and security; Economic growth and development; and Environmental sustainability, while taking into account key challenges facing South Africa such as poverty, inequality and unemployment, and the boundaries and constraints posed by overarching government policies and high-impact policies from other sectors.

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The White Paper on the Energy Policy of the Republic of South Africa (Energy White Paper), which was adopted and published in 1998, is the premier policy document which guides all subsequent policies, strategies and legislation within the energy sector. The Energy White Paper provides specific policy statements on what government intends for the energy system as a whole and sets out five (5) key objectives (see Table 2-1). These objectives have subsequently formed the foundation and informed the development of energy policy in South Africa and still remain relevant. Various other energy policies have been developed and are in different stages of implementation. Some of the key policies include:

- The White Paper on Renewable Energy, 2003 (Renewable Energy White Paper);
- The National Energy Efficiency Strategy of the Republic of South Africa, 2008 (Energy Efficiency Strategy);
- The Nuclear Energy Policy for the Republic of South Africa, 2008 (Nuclear Energy Policy);
- The Biofuels Industrial Strategy of the Republic of South Africa, 2007 (Biofuels Strategy); and
- The Electricity Basic Services Support Tariff (Free Basic Electricity) Policy, 2003 (Free Basic Electricity Policy).

Table 2-1: The Five Energy Policy Objectives Defined in the Energy White Paper

OBJECTIVE	DESCRIPTION
Increasing access to affordable energy services	• Government will promote access to affordable energy services for disadvantaged households, small businesses, small farms and community services.
Improving energy governance	• Governance of the energy sector will be improved. The relative roles and functions of the various energy governance institutions will be clarified, the operation of these institutions will become more accountable and transparent, and their membership will become more representative, particularly in terms of participation by blacks and women. • Stakeholders will be consulted in the formulation and implementation of new energy policies, in order to ensure that policies are sympathetic to the needs of a wider range of stakeholder communities. • Co-ordination between government departments, government policies, and the various spheres of government will be improved in order to achieve greater integration in energy policy formulation and implementation. • Government capacity will be strengthened in order to better formulate and implement energy policies.
Stimulating	• Government will encourage competition within energy markets.

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economic development	- Where market failures are identified government will intervene through transparent, regulatory and other carefully defined and time delineated mechanisms to ensure effective delivery of energy services to consumers. - Government policy is to remove distortions and encourage energy prices to be as cost-reflective as possible. To this end prices will increasingly include quantifiable externalities. - If subsidies are required, these should be implemented transparently based on agreed criteria. - Energy taxation will continue to remain an option within government's fiscal policy, but will be exercised with more consideration for the economic and behavioural impacts of such policies. - Government will work towards an investor-friendly climate in the energy sector through good governance, stable, transparent, regulatory regimes and other appropriate policy instruments.
Managing energy-related environmental impacts	- Government will promote access to basic energy services for poor households, in order to ameliorate the negative health impacts arising from the use of certain fuels. - Government will work towards the establishment and acceptance of broad national targets for the reduction of energy-related emissions that are harmful to the environment and to human health. - Government will ensure a balance between exploiting fossil fuels and maintenance of acceptable environmental requirements.
Securing supply through diversity	Given increased opportunities for energy trade, particularly within the Southern African region, government will pursue energy security by encouraging a diversity of both supply sources and primary energy carriers.

The National Energy Act, 2008 (Act No. 34 of 2008) was developed to introduce measures to ensure energy security as well as to address those objectives of the Energy White Paper which had not been effected due to legislative and regulatory shortfalls. The National Energy Act thus encapsulates the key objectives espoused in the Energy White Paper and more specifically translates them into concrete objectives that must be addressed by the Integrated Energy Plan (IEP). Chapter 3 of the National Energy Act specifies that the IEP must assist government in its efforts to:

- Ensure security of energy supply;
- Ensure optimal usage of economically available energy resources;

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- Ensure affordability of energy services;
- Promote universal accessibility of modern forms of energy;
- Promote social equity through the energy sector;
- Contribute towards employment creation;
- Protect the environment;
- Fulfil its international commitments;
- Ensure consumer protection from dangers of energy; and
- Ensure the contribution of energy supply to socio-economic development.

2.1 High-Impact Policies

While many government policies have an impact on the energy sector in one way or another, several policies have a more significant impact and therefore have a substantial influence on energy policies that should be developed. The nature of the impact can be broadly categorised as follows:

- **Overarching national policies:** These policies set high-level aspirations or goals for the country and influence energy policy in such a way that the energy sector needs to respond to or contribute to some of these aspirations and goals.
- **Policies with a unidirectional impact:** These policies, by their nature and definition, have a unidirectional impact on energy policy in that they set certain constraints or boundaries within which the energy sector must comply. Energy policy must therefore be developed in such a manner that the policy constraints or targets set by these policies are adhered to as closely as possible (taking into consideration other conflicting factors). The manner in which the energy sector responds to these constraints does not have a reciprocal impact on the relevant policies.
- **Policies with a bi-directional impact:** These are policies which are reliant on the response of the energy sector for their targets and constraints to be met.

One of the key elements during the energy planning process is to ensure alignment and identify synergies amongst various government policies.

Table 2-2 lists the high-impact policies which have been identified within the different categories as described above.

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Table 2-2: High Impact Policies Considered in the IEP

OVERARCHING NATIONAL POLICIES	POLICIES WITH UNIDIRECTIONAL IMPACT	POLICIES WITH BIDIRECTIONAL IMPACT
• National Development Plan (NDP) • New Growth Path	• Proposed Carbon Tax Policy	• National Climate Change Response Policy (NCCRP) • Beneficiation Strategy • National Transport Master Plan (NATMAP)

2.1.1 National Development Plan, 2012

The NDP outlines the 2030 vision for South Africa's energy sector. It states that the energy sector will promote:

- Economic growth and development through adequate investment in energy infrastructure and the provision of quality energy services that are competitively priced, reliable and efficient. Local production of energy technology will support job creation;
- Social equity through expanded access to energy services, with affordable tariffs and well targeted and sustainable subsidies for needy households; and
- Environmental sustainability through efforts to reduce pollution and mitigate the effects of climate change.

Furthermore, the NDP envisages a South Africa which by 2030 will have adequate supplies of electricity and liquid fuels to avoid disruptions to economic activity, transport and welfare. It acknowledges that energy prices are likely to be higher in future, but will still be competitive when compared with South Africa's major trading partners. In addition, the NDP affirms that more than 90 percent of the population should enjoy access to electricity by 2030.

The NDP proposes diversity and alternative energy resources and energy supply options, both in terms of power generation and the supply of liquid fuels. The purpose of the IEP is to test the various options presented in the NDP and make firm recommendations in the form of an energy sector roadmap.

2.1.2 New Growth Path, 2011

The New Growth Path (NGP) reflects Government's commitment to prioritising employment creation in all economic policies. The NGP outlines five key physical and social infrastructure areas – energy, transport, communication, water and housing – as being critical in growing the economy of South Africa. It lays out

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the strategies to collectively achieve a more developed, democratic, cohesive and equitable economy and society over the medium term, in the context of sustained growth.

The New Growth Path targets 300 000 additional direct jobs by 2020 to green the economy, with 80 000 in manufacturing and the rest in construction, operations and maintenance of new environmentally friendly infrastructure. The potential for job creation envisaged rises to well over 400 000 by 2030.

2.1.3 Proposed Carbon Tax Policy (Discussion Paper, 2010)

In December 2010, the National Treasury published a carbon tax discussion paper. The discussion paper outlines the primary objective of the proposed carbon tax, which is to reduce GHG emissions and facilitate the transition to a Green Economy. In the discussion paper, **carbon taxation and emission trading schemes** were identified as the two main economic policy instruments available for putting a price on carbon and curbing GHG emissions.

The discussion paper acknowledges that although carbon tax does not set a fixed quantitative limit to GHG emissions over the short term, such a tax at an appropriate level and phased in over time to the 'correct' level will provide a strong price signal to both producers and consumers to change their behaviour over the medium to long term. The introduction of a carbon price is expected to change the relative prices of goods and services, over time making emission-intensive goods more expensive relative to those that are less emission intensive. Assuming that South Africa's trading partners follow suit, this will provide a powerful incentive for consumers and businesses to adjust their behaviour, resulting in a reduction of emissions.

The discussion paper deems a carbon tax to be the most appropriate mechanism on which to base the pricing of carbon and begin to internalise the externalities associated with GHG emissions within the South African context. Some of the key reasons presented in this regard include:

- The design of a carbon tax can be relatively easy;
- Measuring and monitoring of direct GHG emissions might be a challenge;
- A proxy tax base can be considered, i.e. a fuel input tax;
- The level of the tax can be phased in over time. Such a price trajectory will provide certainty; and
- Distribution and competitiveness concerns can be dealt with in a transparent manner.

The development of carbon taxation policies for South Africa should be informed by the following key considerations:

- The tax rate should, over time, be equivalent to the marginal external damage costs of GHGs to affect appropriate incentives;
- Comprehensive coverage should be targeted, and the tax should, as far as possible, cover all sectors;

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- Should a proxy tax base be used, the tax should be levied according to the carbon content of fossil fuels;
- Relief measures, if any, should be minimal and temporary; and
- The design of the tax needs to minimise the potential regressive impacts on low-income households and protect the competitiveness of key industries.

The discussion paper therefore proposes the phasing in of the carbon tax, which approach is envisaged to send the necessary policy signals to investors and consumers of the need to ensure investment in low-carbon options, which in turn will minimise the need for retrofit and the risk of redundant, large-scale, major capital projects and related investments in the future.

As an initial proposition, the discussion paper highlights the preference of a carbon tax based on measured and verified emissions, although a proxy tax base, based on the carbon content of fuel inputs, could be considered in future. An initial tax of R75 per ton of CO₂, with an increase to about R200 per ton CO₂ (at 2005 prices) was identified as both feasible and appropriate to achieve the desired behavioural changes and emission-reduction targets.

The IEP needs to consider the implications of the possible introduction of the proposed carbon tax on future energy options and the associated costs.

2.1.4 National Climate Change Response White Paper, 2011

The National Climate Change Response White Paper was published by the Department of Environmental Affairs in 2011. This White Paper presents the South African Government's vision for an effective climate change response and the long-term transition to a climate-resilient and lower-carbon economy and society.

South Africa's response to climate change, as defined within the policy document, has two objectives:

- Effectively manage inevitable climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity; and
- Make a fair contribution to the global effort to stabilise greenhouse gas (GHG) concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner.

The policy document identifies several key elements in the overall approach to mitigation, which include:

- Using a National GHG Emission Trajectory Range, against which the collective outcome of all mitigation actions will be measured;

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- Defining desired emission reduction outcomes for each significant sector and sub-sector of the economy based on an in-depth assessment of the mitigation potential, best available mitigation options, science, evidence and a full assessment of the costs and benefits;
- The deployment of a range of economic instruments to support the system of desired emission reduction outcomes, including the appropriate pricing of carbon and economic incentives, as well as the possible use of emission offsets or emission reduction trading mechanisms for those relevant sectors, sub-sectors, companies or entities where a carbon budget approach has been selected.

According to the policy document, in 2000, emissions as a result of average energy use for developing countries constituted 49 percent of total emissions, whereas South Africa's energy use emissions constituted just less than 80 percent of total emissions. In terms of South Africa's latest Greenhouse Gas Inventory (base year 2000), the majority of South Africa's energy emissions arose from electricity generation, which constituted around half of South Africa's energy emissions and just under 40 percent of total emissions in 2000. Transportation and energy used in industry contributed just less than 10 percent each of total emissions and industrial process emissions constituted around 14 percent of total emissions. Clearly the bulk of South Africa's emissions arises from energy supply (electricity and liquid fuels) and use (mining, industry and transport), and mitigation actions with the largest emission reduction potential focus on these areas.

While the policy document acknowledges that opportunities for mitigation of emissions from non-energy sources do exist, it highlights that the most substantial mitigation contributions will have to come from reduced emissions from energy generation and use. The main opportunities for mitigation consist of energy efficiency, demand management and moving to a less emission-intensive energy mix, with consequent economic benefits of improved efficiency and competitiveness as well as incentivising economic growth in sectors with lower energy intensities. In this regard the policy document also identifies several 'near-term' flagship programmes, some of which apply to the energy sector and were already under way at the time that the Climate Change White Paper was published. These include:

- The Renewable Energy Flagship Programme;
- The Energy Efficiency and Energy Demand Management Flagship Programme; and
- The Carbon Capture and Sequestration Flagship Programme.

In response to a less emission-intensive energy mix, the IEP considers the emission limits which have been set for the energy sector up to 2050 and identifies the most appropriate energy mix as well as the associated costs. The output from the analysis in turn enables feedback on the extent to which such emission limits can be met, taking into consideration other socio-economic factors, including job creation, cost to the economy and the effect that the cost of energy will have on final energy prices.

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2.1.5 Beneficiation Strategy, 2011

The Beneficiation Strategy provides a framework within which to translate the country's comparative advantage, inherited from its mineral resources endowment, into a national competitive advantage and presents opportunities for South Africa to continue sustainable growth of its economy beyond mining.

The strategy identifies several instruments that constitute an enabling environment for beneficiation and highlights prevailing constraints to the effective implementation of beneficiation that require an integrated mitigation approach. Amongst the key enablers, it recognises that infrastructure, including amongst other factors the adequate supply of energy, has a material impact on sustaining current beneficiation and that the bulk of early-stage beneficiation programmes require large and uninterrupted energy supply. The lack of adequate and reliable energy supply therefore poses a major threat to future prospects of growth in mineral value addition. The country's limited exposure to breakthrough research and development is also identified as a significant barrier to prospects of innovation in creating new products for beneficiation.

While the concept of beneficiation is not new to South Africa or to the energy sector (since the bulk of the country's electricity is generated from coal power stations, where more than 50 percent of the country's annual production of coal is beneficiated), new beneficiation opportunities are sought to complement conventional electricity generation in the country, which will underpin the much needed economic growth. Other critical infrastructure such as rail, water and ports have a material impact on sustaining current beneficiation initiatives and pose a major threat to future prospects of growth in mineral value addition. Therefore successful implementation of the strategy depends on intensive co-ordination across a range of departments, including the Department of Energy.

The strategy outlines five value chains, of which energy is one, which were identified as a result of the advancement of selected mineral commodities through various stages of beneficiation. The beneficiation of energy commodities is seen as critical, especially in light of the projected increase in future energy demand world-wide and in South Africa. Three commodities (or classes of commodities) were identified for potential beneficiation in order to meet future energy needs:

Platinum Group Metals (PGM): PGM fuel cell technology presents an opportunity for new energy generation sources, since the extent and scope for further growth in traditional sources of energy generation are limited. Ongoing research by the Department of Science and Technology with respect to fuel cell technology needs to continue.

Synergies with and the role of energy-focused research institutes, such as the South African National Energy Development Institute (SANEDI), need to be pursued once this technology becomes more proven and enters into the demonstration phase.

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Coal: Given that coal is currently the most abundant and affordable of all fossil fuels, the strategy sees this as continuing to play a vital role in meeting energy demand world-wide and also in South Africa. The strategy also recommends coal conversion technologies to produce synthetic gas and liquid transportation fuels derived from coal. However, given the high levels of harmful emissions associated with coal-generated electricity and other fuels produced from coal, it has become increasingly important for cleaner alternatives to be considered. In addition to diversifying to renewable and other clean sources of energy, South Africa is to actively pursue alternative options for reducing carbon emitted from coal, which include:

- The capturing of harmful gases at source, processing them and then storing them in underground geological formations to mitigate their contribution to global warming.
- The implementation of carbon emission reduction measures (either carbon tax or market mechanisms) to curb the use of such technologies. These options may, however, contribute to an increase in the cost of energy produced from coal such as electricity and synthetic fuel from coal; and
- Research and development (R&D) to be directed at finding an alternative approach, such as the potential for recycling captured gases in the process of energy generation for re-generation of electricity as well as other uses.

The strategy document also identifies several interventions for the optimal value creation (beneficiation) of coal, including:

- Policy support for clean and efficient use of coal in power generation to encourage the take-up of existing advances in technologies for low emission coal-fired electricity production – providing secure and clean energy;
- Policy support for technology transfer, through mechanisms such as the Clean Development Mechanism (CDM). Bilateral and multilateral funds such as the Global Environment Facility and the Prototype Carbon Fund must be explored;
- Investment in research, development and the demonstration of new technologies such as clean coal technologies and carbon capture and storage (CCS). These could provide a very significant opportunity for the major reduction in emissions;
- Investment in R&D to find innovative means for the beneficiation (recycling) of gases emitted in the generation of electricity;
- Investment in technology to optimise the use of coal bed methane (CBM);
- Investment in metallurgical research to disentangle uranium and coal in the Springbok flats coalfield, which will increase the country's reserve base of coal and uranium; and
- Exploration of options for further final-stage beneficiation of coal through production of chemicals as feedstock for plastics and fertilisers.

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Uranium and Thorium: Uranium is used to fuel commercial nuclear power plants. South Africa is currently exporting uranium in its oxide form – the first stage of beneficiation – and importing the enriched uranium from the northern hemisphere for its own power generation purposes. This is due to the closure of South Africa's uranium beneficiation operations due to its obligations under the Nuclear Non-Proliferation Treaty (NPT), which was signed by South Africa in 1991. South Africa has gained expertise over many years in the beneficiation of uranium, from the mining of the ore through to producing uranium for power generation and beyond.

Researchers have subsequently been exploring the possibility of using thorium as an alternative fuel for nuclear reactors and preliminary research indicates that the prospect is positive. Thorium is estimated to be three times more abundant than uranium. However, present knowledge of the distribution of thorium resources is poor due to low key exploration efforts as a result of insignificant demand. With the commitment of government to build nuclear power stations to complement fossil fuel based electricity, preparatory work for the beneficiation of uranium/thorium and other minerals, such as fluorspar, is critical. The following interventions for the successful implementation of nuclear power generation have been identified:

- Quantify the uranium and/or thorium reserves and resources in the country;
- Ascertain the economic feasibility of re-establishing uranium enrichment;
- Plan for comprehensive waste treatment and mine rehabilitation; and
- Finalise the uranium policy with all relevant stakeholders.

The strategy document highlights critical areas of intervention to ensure the co-ordinated, seamless and effective implementation of the beneficiation of South Africa's mineral commodities. These include, amongst others, ***ensuring security of energy supply through investment in new generation capacity, implementing energy efficiency measures and pursuing co-generation potential, where possible.***

2.1.6 National Transport Master Plan

The National Transport Master Plan (NATMAP 2050), which was published by the Department of Transport (DoT) in 2010, is a long-term strategy for the transportation sector which in part addresses the impact of the transport sector on various issues. The goal thereof is to develop a dynamic, long-term, sustainable land use/multi-modal transportation systems framework for the development of network infrastructure facilities, interchange terminus facilities and service delivery.

South Africa faces many challenges in instituting a practical National Transportation Plan in an environment of increasing energy demand, sustained high oil prices, regular disruptions in the energy value chain, increasing requirements for diminished GHG emissions and other environmental and social considerations. Transportation requires access to energy sources and it is therefore imperative that

synergies be established between transportation planning and national energy planning. Transportation objectives must be aligned with the country's energy supply-demand conditions and *vice versa*. At the same time transportation has an environmental footprint that stretches from the global level (via international travel – trains, ships, planes), through to the national, regional and local levels (the effects of construction and operation).

Transportation in South Africa is almost totally dependent on petroleum liquids, with less than 5 percent of the energy used in transport is in the form of electricity. This makes the transport sector extremely vulnerable to the availability of oil, as well as the cost of oil and therefore the cost of fuel. Almost 69 percent of the energy that is used in transportation is derived from oil that is imported. The balance is from fuel derived from coal (the SASOL coal to liquid process), and natural gas (the Mossesgas project).

Some of the goals of NATMAP 2050 that require a corresponding response from the energy sector are as follows:

- To minimise the impact on the environment and reduce the carbon footprint of transport (through less carbon-intensive transport fuels);
- To provide energy-efficient transport, using energy sources that are sustainable in the long term;
- To provide affordable transport to end users, operators and government; and
- To develop transport infrastructure that meets international standards and is technologically sustainable.

The IEP takes into consideration the implications of some of the goals of the NATMAP and the resultant actions or responses that are required from the energy sector. In particular, the effects that such objectives will have on the future demand for energy were assessed. Some key considerations are outlined below:

- In the short term, measures to improve fuel efficiency need to be continually explored and enhanced;
- The effect that various interventions will have on liquid fuel consumption needs to be evaluated and monitored so as to improve the understanding of their implications on future demand. These include interventions by the DoT to emphasise modes of transport where mechanical energy is used most efficiently and to advocate non-motorised transport within urban areas (short distances); and
- The effects that various interventions may have on shifting demand from liquid fuels to electricity need to be analysed. These include long-term strategies to encourage modal shifts from private passenger transportation to mass transit (most probably to rail and buses) as well as those that encourage the shift of long-distance freight off roads and on to rail.

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The effects of these policy imperatives should be factored into long-term IEP policy assumptions. The processes of monitoring, reviewing and evaluating some of these interventions will require ongoing alignment between the two respective departments.

2.2 The Objectives of the IEP

The IEP takes a balanced view of the objectives of various policies. Those policies which are overarching set aspirational targets and provide the context within which the IEP was developed. The impact of policies which will influence energy markets cannot be ignored, and their possible implications were taken into consideration in order to develop long-term energy sector response strategies which are sustainable.

Keeping the '3E's imperatives in mind, and taking the Energy White Paper, the National Energy Act and the above-mentioned high-impact policies, amongst others into consideration, eight key (competing and, at times seemingly, conflicting) objectives were identified for the IEP and are represented in Figure 2-1 below.

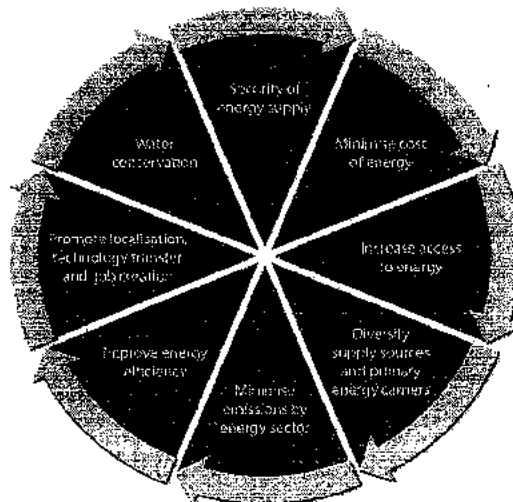


Figure 2-1: Key IEP Objectives

Each of the objectives depicted in Figure 2-1 is described in Table 2-3 below and also form the basis of the key criteria against which different policy alternatives and proposals made in the IEP were evaluated.

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Table 2-3: Key Objectives of the IEP

OBJECTIVE	DESCRIPTION
Security of energy supply	A fundamental objective of the IEP is to ensure that all projected future energy demand is met. In determining the point at which the cost of guaranteeing the supply of energy (i.e. reliability cost) is at a minimum and does not exceed the benefit of providing that energy, the Cost of Unserved Energy (CUE) is calculated. The Energy Security Master Plan (ESMP) – Electricity of 2007 recommended a reserve margin of 19% for electricity generation capacity in South Africa. The reserve margin of 19% therefore indicates the point where the trade-off between cost and reliability is at a minimum (based on costs as calculated during the drafting of the ESMP). Ensuring adequate and reliable forms of energy for end-consumers is the underpinning objective of the IEP. An adequate reserve margin of 19% for electricity generation has been determined for South Africa.
Minimise cost of energy	Other than labour, energy is a major input into the production of goods and services. The lower the cost of energy, the lower the production cost of tangible and non-tangible items. Lower energy costs are directly related to higher profit margins. The objective of the IEP is to identify and highlight the mix of technology options and energy resources and sources that minimise the total cost of energy, while meeting the projected energy demand.
Increase access to energy	Access to sustainable, modern, affordable, and reliable energy services is central to addressing many of today's global development challenges, including poverty, gender inequality, climate change, food security, health and education. Energy access is now widely recognised as a prerequisite for human development. Energy is needed for survival (for example to power hospital emergency equipment). It is important for the provision of social services such as education, and it is critical to all economic sectors from households and farming, to business and industry. The wealth and development status of a nation and its inhabitants closely correlates with the type and extent of its access to energy. The more that usable energy is available, the better are the conditions for development of individuals,

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households, communities, the society and its economy. Thus, improving access to energy is a continuous challenge for governments and development organisations. Access to energy is a function of availability and affordability and implies access to clean and reliable energy. According to the White Paper on the Energy Policy of the Republic of South Africa of 1998, the South African Government will promote access to affordable energy services for disadvantaged households, small businesses, small farms and community services.

While several policies and programmes aimed at increasing access to modern forms of energy have already been developed and are currently being implemented, the IEP seeks to explore further options that can be pursued in order to address some of the challenges identified.

Diversify supply sources and primary energy carriers

If South Africa is to make the transition to a low carbon economy, it will become increasingly important to reduce dependence on fossil fuels and diversify energy resources to include other energy forms such as natural gas, nuclear and renewable energies. These are necessary to improve security of supply while at the same time minimising environmental impact and facilitating regional development. The dominance of a single energy system, which is highly reliant on fossil fuels, inevitably places an excessive burden on a particular aspect of the environment. This eventually weakens it through environmental fatigue, failure (permanent damage) or even catastrophe if the situation continues for too long. This inevitably poses a health and environmental risk.

The IEP takes into consideration all energy resources and weighs up the costs and benefits associated with each against the ultimate objective of proposing a balanced energy mix, comprising traditional and alternative energy resources and sources.

Minimise emissions from the energy sector

Energy planning needs to be done in such a manner that it does not impair government's goals of reducing CO₂ emissions. Because of South Africa's extensive use of coal and petroleum fuels, the adverse impact on both the local and global environment is significant. In 2004, the world produced about 49,000 million metric tonnes carbon dioxide equivalent (Mt CO₂e), mainly from energy generation and deforestation. In comparison, South Africa produced about 440 Mt CO₂e, or about 1 percent of the global figure.

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	South Africa's emissions are large relative to its population and economy. The IEP identifies and highlights those technology options with emissions that are within the constraints identified in the National Climate Change Response White Paper. It is important that the associated economic and socio-economic implications of such options are also identified.
<i>Improve energy efficiency (reduce energy intensity of the economy)</i>	Energy efficiency relates to the economical and efficient production and utilisation of an energy carrier or resource. It results in achieving the same quality and level of service and use of energy (heating, cooling, lighting, etc.) with a lower level of energy input. Increased energy efficiency reduces overall energy demand, with a substantial decrease in cost to the energy system. The benefits of energy efficiency to the environment are self-evident. These benefits are of particular relevance to South Africa, which remains one of the highest emitters of the greenhouse gas CO₂ per capita in the world. This can largely be attributed to South Africa's coal-based energy economy which has enabled it to enjoy relatively low energy prices historically and in turn also favoured energy-intensive industries. At a local level the problems of CO₂ and smoke emissions have been the focus of concern for many communities living adjacent to heavily industrialised areas. Energy efficiency can address both the macroscopic and microscopic aspects of atmospheric pollution while contributing overall benefits and cost containment to the economy. While the Draft Second National Energy Efficiency Strategy Review of 2012 sets targets for energy efficiency improvements within the economy, the IEP explores further technology options that can be pursued. Of particular importance is the proposed mix of those options (supply- and demand-side) making them more efficient and therefore contributing overall efficiency improvements.
<i>Promote localisation, technology transfer, and job creation</i>	Localisation will ensure knowledge transfer of both technical know-how and management processes from international suppliers to local industries. The objective is to build, initial or enhanced innovative capacity in South Africa's energy sector. The New Growth Path targets 300,000 additional direct jobs by 2020 to green the economy, with 80,000 in manufacturing and the rest in construction, operations and maintenance of new environmentally friendly

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infrastructure. The potential for job creation rises to well over 400 000 by 2030.

As part of the development of the IEP it is acknowledged that an indirect consequence of the implementation process is the creation of jobs. These can be partly achieved by encouraging energy technologies that are labour intensive.

Water conservation

One of government's vision statements is "A South Africa where environmental assets and natural resources are valued, protected and continually enhanced". South Africa is a water scarce country and minimising the consumption of water is critical to contributing to this vision. The energy sector is highly reliant on water, and in particular in the generation of electricity and the production of syntuels through the coal liquefaction process. According to the second National Water Resources Strategy, the energy sector contributes about 2% of total national water consumption, however that being said, it is still important that the energy sector look at ways in which to minimise water consumption especially in the generation of electricity and refining of liquid fuels. Overall conservation of water in turn also reduces the demand for energy as energy is required to move water. The Department of Water Affairs advocates the introduction of dry-cooled power plants in the inland region which will ensure the reduction of the burden on power plants.

The IEP highlights the estimated water usage associated with the various technology options.

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SECTION 3: OVERVIEW OF THE ENERGY SECTOR

According to the 2012 Energy Sustainability Index developed by the World Energy Council, out of 94 countries, South Africa ranked 57th on the Energy Sustainability Index, this was partly informed by a ranking of 78th on energy security and 53rd on environment impact mitigation, the latter being an improvement from previous years ratings. According to the report, the drop by two places to 57th place was mostly driven by a drop in energy security due to a decrease in the wholesale margin on gasoline, and a particular weak performance in diversification of electricity production. The report does however also acknowledge that positive developments such as the introduction of Independent Power Producers (IPPs) and renewable energy technologies into the electricity sector are not reflected in the rating. The report further highlights the provision of energy to rural communities and ensuring affordability of energy as some of the critical challenges that South Africa should focus on.

3.1 Primary Energy Supply

Primary Energy supply in South Africa is dominated by coal (~67%), followed by crude oil (~20%). Nuclear, natural gas and renewable energy (including hydro and biomass) have historically played a less significant role in the total energy mix, collectively contributing the remaining ~13%.

A closer examination of the electricity generation industry (Department of Energy, 2010) reveals that 90 percent of electricity was generated from coal, followed by nuclear and hydro at 5 percent and 4.5 percent respectively. Petroleum products (diesel), natural gas and other renewable energy sources (i.e. solar, wind, biomass, bagasse, and landfill gas) collectively contributed less than 0.5 percent towards the total installed capacity for electricity generation. Imported crude oil dominated the primary supply of liquid fuels at approximately 70 percent, followed by coal at approximately 20 percent and natural gas at an estimated 10 percent. Production of fuel from renewable energy sources and waste remained in its infancy and had not really taken off.

Over the last few years, various policies have been developed by the Department of Energy (DoE) in an effort to increase diversification of primary energy sources as well as to reduce over-reliance on fossil fuels for the supply of energy. The threat of climate change and global developments in renewable energy technologies could see South Africa's future energy mix being quite different from that of the past.

3.1.1 Coal

South Africa ranks amongst the top 10 countries in terms of coal reserves (SA Coal Roadmap, 2010) and is currently the sixth largest coal producer in the world with total production being equivalent to approximately 4 percent of world production (SA Coal Roadmap, 2010). While South Africa dominates Africa's coal industry, this picture could change in the medium term as other Southern African nations, including Mozambique, Zimbabwe, Botswana, Tanzania, Zambia, Swaziland and Malawi, are also endowed with significant coal reserves (IEA, 2012).

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While approximately 26.2 percent of South African produced coal is exported, the remainder contributes to approximately 80 percent of the country's total primary energy requirements. 92.8 percent of South Africa's electricity is generated by Eskom, with only the remaining 7.2% being generated by IPPs. Approximately 30 percent of South Africa's total liquid fuel requirements are produced from coal through Sasol (SA Coal Roadmap, 2010).

As a result, South Africa emits more than its share of carbon dioxide and contributes disproportionately to climate change. According to the 2012 Energy Sustainability Index, developed by the World Energy Council, the emission intensity of the South African economy (measured in kg of CO₂ per USD) is 3.97.

The advantages of coal-generated power for South Africa are that the country has abundant coal reserves, the infrastructure to generate electricity from coal is well established, and coal-fired power stations reliable. However, coal is the most polluting source of energy for electricity generation and produces the greatest amount of waste, which is a significant cause of air pollution, and greenhouse gas (GHG) emissions. In addition to these threats, a major challenge in continuing to use coal is the threat of penalties imposed for emitting GHGs, and hence the environmental aspects of coal-fired stations will become pressing.

Another disadvantage of coal is that the building of new coal-fired power stations is a long and expensive process. Furthermore, South Africa's coal fields are concentrated in Mpumalanga, which limits the location options for power stations and therefore increases transmission costs. However coal deposits in the Waterberg present a possible alternative for new coal-fired power plants, but the scarcity of water in the area presents a new challenge.

Globally, coal is the second most important primary energy source after oil with power generation being responsible for the largest absolute use of coal. The use of coal in the production of energy has however come under the global spotlight in view of the associated high levels of greenhouse gas (GHG) emissions. The IEA's World Energy Outlook 2012 scenarios for the coal market suggest that coal demand will continue to grow at an estimated average rate of 1.9 percent per year if there are no further changes to current government policies on climate change globally. However, this trend in demand is projected to be on the lower end should government's world-wide embark on aggressive policies to curb climate change. Unless new technologies, aimed at reducing the carbon intensity of coal are discovered and put into use, the international competitiveness of South African exports could potentially be negatively affected. In the medium term, however, coal will continue to play an important role in the country's energy mix.

Research and development in clean coal technologies has been slowly taking off in South Africa. In 2007 Eskom began a pilot project on Underground Coal Gasification (UCG) at the Majuba plant. UCG is a method of converting unworked coal (coal still in the ground) into a combustible gas which can be used for industrial heating and power generation, or the manufacture of hydrogen, synthetic natural gas or

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diesel fuel. UCG technology allows countries that are endowed with coal to continue to utilise their resource in an economically viable and environmentally safer way by converting coal into high value products such as electricity, liquid fuels, syngas, fertilisers and chemical feedstocks. While the process had previously been criticised for generating large quantities of hydrogen as a useless by-product, hydrogen is now in demand as a feedstock for the chemical industry and shows potential as an alternative fuel for vehicles.

Other advantages of the use of this technology include low plant costs (as no surface gasifiers are required) and the absence of coal transport costs. UCG presents the opportunity to reduce emissions as there are fewer surface emissions and could also have synergies with Carbon Capture and Storage (CCS) because the CO₂ could be stored in the coal cavity after gasification (World Coal Association).

According to Eskom, in terms of coal extraction, UCG is the most efficient underground mining technology known. In the Majuba coalfield, the pilot plant has achieved up to 83% extraction, whereas conventional mining could not achieve more than 25% extraction due to geological disruptions.

In 2010 Eskom's UCG demonstration plant commenced delivery of gas to one of the units at Majuba Power Station. The gas is co-fired with coal, and contributes 3 MW to the unit's current electricity production of approximately 650 MW. This demonstration plant is the first production of commercial electricity from UCG gas outside of the former Soviet Union.

3.1.2 Crude Oil

South Africa's crude oil requirements are met by imports, mainly from the Middle East and Africa. Almost all crude oil is used toward the production of liquid fuels, with a small percentage used towards lubricants, bitumen, solvents and other petrochemicals. Like elsewhere in the world, liquid fuels are primarily used to meet the country's mobility needs. As a net importer of crude oil South Africa is not sufficiently influential to affect the price of crude oil and the economy is therefore highly susceptible to the volatility of the global oil market. The South African liquid fuels industry and its economy at large are therefore highly impacted by global developments and fluctuations in the crude oil price.

Projections for global oil demand show a continued increase in the medium to long term if current policies, politics and levels of access continue (EIA, 2012). The continued growth in demand is spurred by robust economic growth in the non-OECD nations, including China and India, which will offset the slower growth projected for many OECD nations. Lower growth in crude oil demand is expected only if economic growth in non-OECD countries is slower than projected. It is envisaged that passenger transportation will continue to create the highest demand for crude oil, followed by freight, power-generation and non-energy uses.

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While government policy is an important factor influencing long-term trends in global oil demand, other factors such as economic activity, population, prices and technology play a key role. Developments in vehicle technologies have the greatest potential to impact future global oil demand and improvements in efficiency can help to decouple the increasing demand for mobility from fuel consumption.

3.1.3 Nuclear

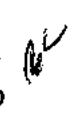
Nuclear power accounts for roughly 5 percent of South Africa's primary energy supply (Department of Energy, 2010). South Africa has one nuclear power station, Koeberg, situated about 30 km north-west of Cape Town. Koeberg has a capacity of 1 800 MW and consists of two 900 MW Pressurised Water Reactors (PWRs). Built in the early 1980s, with the first unit commissioned in 1984, the two units at the plant were designed with a 40-year lifespan; with retrofitting this could be increased to 50 or even 60 years. Koeberg's electricity costs are now comparable with those of the coal-fired power stations, although the capital outlay of building the power plant was higher, as is expected for nuclear power plants.

South Africa has significant uranium resources and nuclear power generation has the potential to play a very significant role in efforts to reduce South Africa's carbon footprint from power generation because nuclear reactors generate very large amounts of electricity from very small amounts of fuel and release no greenhouse gases in their operation. While nuclear plants require larger capital outlays than other technologies, such as wind power or coal-fired plants incorporating carbon capture and storage (CCS), the lifecycle cost of nuclear power per megawatt of electricity remains competitive. Unlike CCS, nuclear power has the additional advantage that it is fully proven and provides base-load electricity generation capacity, which has yet to become a reality for either wind or solar power generation. Controlling the capital costs of nuclear projects is the critical factor if nuclear is to remain a competitive and viable supply option.

Despite the advantages of no emissions and the low lifecycle costs associated with nuclear plants, opinion is fragmented internationally as to whether nuclear power should form part of future plans for low-emission power. Concerns were raised after the 2011 crisis at the nuclear facility in Fukushima, Japan, and the safe storage of nuclear fuel waste continues to be of concern because the radioactive waste produced by nuclear power stations degrades very slowly and there are currently no long-term storage solutions for this waste anywhere in the world. While some countries, such as Germany are reducing the role of nuclear in their energy mix by decommissioning all nuclear plants, others, such as China, Russia, India, South Korea, the USA and Canada have commenced with the construction of new nuclear plants.

3.1.4 Natural Gas

Natural gas plays a relatively small part (roughly 3 percent) in South Africa's total energy mix. South Africa has substantial local expertise in field development work as well as drilling and exploration

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activities in pursuit of energy security. Production has historically taken place in the offshore Bredasdorp Basin to supply PetroSA's Mossel Bay Gas-to-Liquid (GTL) facility, however the available resources at this Basin are near depletion and have affected operations of PetroSA's GTL facility.

At a national level, natural gas consumption currently exceeds production, with the majority of demand being met through imports from Mozambique. The gas infrastructure between Mozambique and South Africa consists of a high-pressure pipeline from Mozambique's Temane Pande gas fields to Sasol's Secunda site, where it links to the Sasol Gas network. This network provides gas to industrial and commercial customers, primarily within the Gauteng region. Recent exploration suggests that Mozambique's Rovuma basin may yield further recoverable natural gas in excess of 100 trillion cubic feet (Tcf). The Government of Mozambique has thus developed a Natural Gas Masterplan for Mozambique to ensure exploitation of the natural gas discoveries in a manner that will bring about the greatest socio-economic benefit for its citizens (IFC International, 2012). Due to South Africa's limited LNG import infrastructure; there are no other sources of gas imports. However South Africa has the opportunity to explore options for exploiting the Mozambican new gas discoveries.

Furthermore, despite extensive drilling along South Africa's coastline, only marginal conventional gas discoveries have been made, with limited historical prospects. This, together with the vastness of the country, has made it difficult to justify expansion of the gas transmission pipeline or gas grid infrastructure to link pockets of gas to each other and to the markets in the regions where there have been discoveries.

Despite the limited proven reserves of conventional natural gas, a recent report by the Energy Information Administration (EIA) has estimated unconventional gas resources (shale gas and coal bed methane) in the Southern Karoo basin of 485 Tcf. Further exploration is however still required in order to determine the extent of the recoverable resource. The perceived environmental risks of extracting 'tight' gas such as shale gas are considered to be significant, since the process (called hydraulic fracturing) requires substantial amounts of water, which presents a challenge in water-scarce areas. There are also environmental concerns over the possible contamination of ground water, which may result as a consequence of improper disposal of fluids during the hydraulic fracturing process.

Due to these concerns, the Department of Mineral Resources (DMR) placed a moratorium on the granting of licensing for the exploration of shale gas and commissioned a study to evaluate the potential environmental risks posed by the process of hydraulic fracturing in South Africa, as well as the positive and negative social and economic impacts of shale gas exploration (DMR, 2012).

The study concluded that, due to the limited amount of data currently available, was not possible to quantify the extent of the shale gas resource accurately, however acknowledged that the existence of a significant shale gas resource in the Karoo would have positive implications for South Africa's energy security by reducing national dependence on other fossil fuels. This concession is based on the fact that the construction of the PetroSA Mossel Bay plant was based on 1Tcf of natural gas, therefore if even a

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fraction of the estimated 485 Tcf is found to be proven, this could have a significant impact on the South African economy. The DMR is currently in the process of reviewing the regulatory framework with the objective of ensuring that any resultant negative impacts associated with hydraulic fracturing for shale gas exploration and exploitation are adequately mitigated.

One of the challenges of introducing gas into new markets is that large, capital-intensive investment in infrastructure along the supply chain is required. Transporting gas by pipeline is relatively expensive, more so than oil, because of the additional capital-intensive equipment needed to overcome the lower energy density of gas.

Natural gas also has a significant potential both for power generation as well as direct thermal uses. Power generation remains the main driver behind gas demand growth globally and remains a key potential for South Africa. South Africa has a limited gas network but with a well-developed electricity transmission grid, the construction of an LNG facility would need to be underpinned by a gas-fired power plant as a key off-taker as the most feasible solution in the short- to medium-term. This option could enable South Africa to move towards a low carbon future as natural gas has lower carbon content than coal.

In the longer term, thermal applications of natural gas, requiring a well-developed gas network could find application. Developments in Natural Gas Vehicles (which use CNG and LNG) could see natural gas providing a cleaner alternative to petroleum products in the longer term.

3.1.5 Renewable Energy

South Africa is well endowed with renewable energy resources, which have in the past remained largely untapped. South Africa generally receives sufficient sunlight to support a sustainable solar power industry. The Northern Cape has some of the world's best conditions for solar power, and much of South Africa's coastal region is suitable for wind power. While a wind power generation industry could thrive, it is acknowledged that erratic wind flow, resulting in inconsistent supply of electricity, could dilute the potential of this energy source, causing intermittency.

The South African government is currently developing the renewable energy industry in order to meet the long-term goal of a sustainable energy sector. In 2003, a 10-year target of 10 000 Gigawatt hour (GWh) (the equivalent of 0.8 Megaton oil equivalent (Mtoe)) was set for renewable energy, which was the envisaged industry contribution to final energy consumption by 2013. By 2008, the nascent renewable energy industry contributed less than 8 percent of South Africa's primary energy supply. The IRP2010 envisaged electricity generated from hydropower maintaining its share of 5% and from other renewable energy technologies forms to 9% (from almost negligible) by 2030. Total installed capacity of renewable energy technologies would be in the magnitude of 26.3% of total installed capacity by 2030.

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The DoE embarked on an aggressive programme which will see an increase in the share of renewable energy technologies in the energy mix. The table below shows the total allocation for each type of technology from the bids awarded in rounds 1 and 2 of the Renewable Energy Independent Power Producers (RE IPPs) procurement process. During 2012, government signed contracts to the value of R47 billion for 28 projects, which include wind, solar and small hydro technologies to be developed in the Eastern Cape, Western Cape, Northern Cape and Free State provinces. The third round of the RE IPP procurement process is due to close in August 2013.

Table 3-1: Total allocation for renewable energy technologies through the RE IPP Programme

	Allocation to preferred bidders: Window 1		Allocation to preferred bidders: Window 2		Allocation per determination still available		MW allocation per determination
	MW	%	MW	%	MW	%	
Solar PV	632	44%	417	29%	401	28%	1,450
Solar CSP	150	75%	50	25%	-	-	200
Wind	634	34%	562	30%	654	35%	1,850
Biomass	-	-	-	-	13	100%	13
Biogas	-	-	-	-	13	100%	13
Landfill Gas	-	-	-	-	26	100%	25
Small Hydro	-	-	14	19%	60.7	81%	75
Total MW	1,416	39%	1,044	28%	2,210	32%	3,625

(Source: <http://www.ipprenewables.co.za>)

3.1.5.1 Solar Energy

South Africa experiences some of the highest levels of solar radiation in the world and this renewable resource holds great potential for the country.

The daily solar radiation in South Africa varies between 4.5 and 6.5 kWh/m² (16 and 23 MJ/m²) (Stassen, 1996), compared to about 3.6 kWh/m² in parts of the United States and about 2.5 kWh/m² in Europe and the United Kingdom. The total area of high radiation in South Africa amounts to approximately 194 000 km², including the Northern Cape, which is one of the best solar resource areas in the world. With electricity production per square kilometre of mirror surface in a solar thermal power station being 30.2 MW, and just 1 percent of the high radiation area in the country being made available for solar power generation, the generation potential is approximately 64 GW. Solar energy has the potential to contribute quite substantial to South Africa's future energy needs. This would, however, require large investments in transmission lines from the areas of high radiation to the main electricity consumer centres.

There are two main technologies for producing electricity from solar radiation: concentrated solar power (CSP), also known as solar thermal energy, and solar photovoltaic (PV). CSP technology uses mirrors to concentrate the thermal energy of the sun and heat a transfer fluid. The heat energy is then used to produce steam, with which electricity is generated in conventional turbines. PV technology on the other hand uses silicon-based PV to convert the solar radiation directly into electricity. PV technologies which have become commercialised are PV thinfilm and PV crystalline.

A 2011 report from the US puts the levelised electricity generation cost for new CSP plants at approximately 19.5 to 22.6 US cents per kWh (Pew Center on Global Climate Change, 2011). This comparatively high cost is due to the high initial investment in solar thermal power stations. CSP is suitable for large-scale plants and provides base load, as the heat produced can be stored more easily and cheaply than, for example, electricity from solar photovoltaic systems. However, CSP technology is still at an early stage of commercialisation. The cost reduction potential has not yet been fully explored. The German Aerospace Centre estimates that a cost reduction down to €0.05 per kWh at a global total installed capacity of 40 GW could be achieved between 2020 and 2025.

The best applications of solar power have primarily been the heating of water for households and the provision of photovoltaic electricity for remote rural communities in houses, schools and clinics. However, solar energy technologies are also starting to see growth in large-scale commercial applications.

Government is considering the best way to mobilise industrial development around an ambitious solar park concept, which is planned for deployment in the Northern Cape Province over the coming years, primarily because of the intense solar radiation in this province. The pre-feasibility study indicates that the project could theoretically generate 5 000 MW from solar energy. Once completed, the solar park is expected to provide as much power as one large coal-fired power station.

In 2009, the Minister of Energy also embarked on an aggressive solar water heating programme with the target being to install 1 million solar water heater geysers in households and commercial buildings by 2014. As at January 2013, 315 000 solar water geysers had been rolled out, mostly to poor households.

3.1.5.2 Wind

An estimate of wind power potential for South Africa was undertaken by Prof. Roseanne Diab (Diab, 1995) wherein it was observed that wind power potential is generally good along the entire coast with localised areas, such as the coastal promontories, showing very good potential, i.e. mean annual speeds above 6 m/s and power exceeding 200 Watt per square metre (W/m^2). Moderate wind power potential areas include the Eastern Highveld Plateau and the Drakensberg foothills in the Eastern Cape and KwaZulu-Natal. The remainder of the country has low wind power potential.

About 500 wind turbines have been installed on a number of wind farms and are used to generate Direct Current (DC) electricity, usually at 36 V.

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The Klipheuvel Wind Farm near Cape Town is an Eskom demonstration plant which is being used to explore the use of wind energy for bulk electricity generation. The wind farm consists of three units, the first of which was commissioned in 2002 and the last in 2003. Total capacity is 3.2 MW and, at a load factor of between 20 and 30 percent, average annual production is just over 4 GWh.

The Darling Wind Farm, 70 km north of Cape Town, consists of four wind turbines with a capacity of 1.3 MW each, bringing the total installed capacity to 5.2 MW. At an average load factor of 28%, the facility has an annual average output of 13.2 GWh. As the first Independent Power Producer, the Darling Wind Farm Company uses the national grid (through a Power Wheeling Agreement with Eskom) and supplies electricity to the city of Cape Town through a 20-year Power Purchase Agreement (PPA). The site is used as an example for future public-private partnerships in the establishment of electricity generation and was declared a National Demonstration Project by the Minister of Minerals and Energy in June 2000.

The Department of Energy has established the South African Wind Energy Programme (SAWEP). Funded by the Global Environment Facility, this programme aims to provide dedicated support for wind energy development in the country and to update South Africa's wind atlas, which is publicly available to prospective wind energy developers. A strong focus on capacity building is targeted at research and development institutions.

3.1.5.3 Hydro

South Africa is a water-scarce country and is a net importer of hydro-electricity. The country has a mix of small hydro-electricity stations (688 MW) and pumped water storage schemes (1 580 MW) (Banks and Schäffler, 2006) and imports 1 300 MW of hydropower from Mozambique's Cahora Bassa Dam. However, due to a major reactor failure in 2012, combined with various other failures on power lines and recent disruptions due to floods in Mozambique, the capacity has been reduced to 650 MW.

In 2002, the then Department of Minerals and Energy (DME) conducted a Baseline Study on Hydropower in South Africa (Barta, 2002) which found that in specific areas of the country significant potential exists for the development of all categories of hydropower in the short and medium term. The Eastern Cape and KwaZulu-Natal provinces are endowed with the best potential for the development of small (i.e. less than 10 MW) plants. The advantages and attractiveness of these plants are that they can either be standalone or in a hybrid combination with other renewable energy sources. Further advantage can be derived from association with other water uses (for example water supply, irrigation, flood control, etc.), which are critical to the future economic and socio-economic development of South Africa.

Despite the advantages of hydropower, global pressures regarding the environmental impact and displacement of settlements by huge storage dams will likely limit the exploitation of hydropower on a large scale. In addition, as a water-stressed country, South Africa would not be able to rely on smaller-scale hydropower resources during dry periods. Irrespective of the size of any prospective installation,

local hydropower development will require authorisation in terms of the National Water Act, 1998 (Act No. 36 of 1998).

The Southern African Power Pool (SAPP) allows the free trade of electricity between Southern African Development Community (SADC) member countries. Therefore, despite the recent disruptions in hydropower supply from Cahora Bassa, government remains committed to its vision of importing clean hydropower that is developed in the region. South Africa and the Democratic Republic of Congo signed a memorandum of understanding in 2011 and a draft treaty in 2012 for the development of the Grand Inga Hydro-electric project (Grand Inga 4). With an estimated capacity of 39 000 MW comprised of 52 turbines of 750 MW capacity each, Grand Inga is the world's largest proposed hydropower scheme and is the centrepiece of a continent-wide power system which is being developed in multiple phases.

Although South Africa is not particularly well endowed with hydropower potential, there is therefore some potential to develop micro-hydro locally and significant potential to co-develop and import hydropower from the region.

Biomass

The main sources of biomass are wood waste (generated in the commercial forestry industry) and bagasse (generated in the cane sugar industry). Biomass is used commercially in the pulp and paper mills, and in sugar refineries where bulk from logs, black liquor and bagasse are burned to produce process heat and generate electricity (a process commonly referred to as own-generation or co-generation). Some of this energy could be sold into the national grid (depending on electricity prices and environmental regulations).

In the forestry sector, the volume of waste remaining in the forests is substantial. This waste is about three times the total waste used or discarded in all the mills and, as such, is a potentially large renewable energy resource that might have use for charcoal, gasification or direct generation of power.

Wood

Wood, as a source of energy in South Africa, has two quite different uses, namely industrial and domestic. Industrial use of wood is primarily by South Africa's modern pulp and paper industry, which produces about approximately 2.4 million tons of pulp and 2.7 million tons of paper per year. In the chemical pulp mills, the fibre is separated out in chemical digesters and the residue, known as 'black liquor' and containing useful energy, is burned in recovery boilers to raise steam for process heat and electricity generation. Bark and sawdust from the wood are also burned in boilers.

The domestic use of wood is primarily by poor households, mainly in the remote rural areas, making wood a very important residential fuel in South Africa, as is the case throughout the continent. The exact quantity of residential fuel-wood used in South Africa is unknown, but is estimated at about 86 Petajoules

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(PJ), which is equivalent to 7 million tons of wood per year. These estimates suggest that present wood consumption is unsustainable because it is being consumed faster than it is replenished.

Bagasse

Bagasse from sugarcane production and waste from the pulp and paper industry are used to provide energy within these industries but can be used to a greater extent to provide energy for nearby consumers. Bagasse (waste fibre from sugar cane) is the most important energy source for South Africa's sugar refining industry. The total sugar cane crop is over 20 million tons per year, which yields about 7 million tons of bagasse with a heating value of 6.7 MJ/kg, most of which is used as energy in raising steam for process heat and electricity generation. The installed generation capacity of the industry is about 245 MWe. Some bagasse is used for making paper.

Biofuels

There is high potential for the production of biofuels from energy crops such as sugarcane, sugar beet, sunflowers and canola. However, the low energy density of these makes it uneconomical to transport them over long distances and hence they need to be used either close to where they are produced, or they need to be condensed for more economical transport. The production of biofuels from food crops is a contentious issue which presents itself globally. In December 2007, cabinet approved the Biofuels Industrial Strategy which outlines government's approach to the development of policy, regulations and incentives to develop and stimulate the biofuels industry in South Africa. The strategy seeks to achieve a 2% penetration rate of biofuels in the national liquid fuel supply and specifically excludes food crops, such as maize, based on food security concerns. Since the publishing of the strategy, an initial study was conducted on the feasibility of a biofuel manufacturing plant using grain sorghum and soya beans as feedstock. Based on 2010 data, the study found that ethanol production from sugar cane would be much more expensive than that from grain sorghum in South Africa. The Department of Energy has also published regulations which require a minimum of 5% biodiesel blending with Diesel and between 2% and 10% bioethanol blending with Petrol. Consultations are currently taking place regarding the development of a biofuels industry as well as the implications of the infrastructure requirements and costs associated with the manufacturing and blending of biofuels with petrol and diesel.

Municipal Waste

South Africa disposes of almost all of its refuse in landfill sites. It has been estimated that the total domestic and industrial refuse has an energy content of about 11 000 GWh per annum. This could be directly incinerated or converted into biogas and methane to produce electricity. There have been proposals for such schemes, and some landfill sites already produce electricity, such as the Durban Landfill-Gas-to-Electricity Project, Mariannhill and La Mercy Landfills, Ekurhuleni Landfill Gas Recovery

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Project, New England Landfill Gas to Energy Project, Alton Landfill Gas to Electricity Project, Nelson Mandela Bay Metropolitan's Landfill, and the EnviroServ Chloorkop Landfill Gas Recovery Project.

3.1.5.4 Barriers to Renewable Energy Development and Global Trends

There are some natural barriers to the use of renewables such as the inherent limitations of biomass and the need for waterless cooling systems because of the scarcity of water. However, the main barriers are to be found in the South African energy innovation system and in the economics of renewable energy technologies. In addition to the higher risk they entail, the cost of renewable energy technologies is a very significant barrier in South Africa. While rising electricity prices will improve the competitive position of renewable energy technologies in the future, these technologies will still need considerable support if they are to be deployed on a commercial, large-scale basis. The Department of Energy's renewable energies procurement process has seen significant competition in the renewable energy market, as well as significant drops in average prices of renewable energy technologies, with the most notable differences being between PV and CSP technologies.

Storage remains one of the most important challenges to the widespread use (small- and large-scale) of renewable energy. Due to the intermittent nature of renewable energy systems and the variability in electricity load requirements, storage of the electricity generated when demand is low is especially critical.

The demand for biofuels internationally is being driven by higher oil prices and government targets and incentives. The leading ethanol producers are Brazil and the USA, both of which receive large government subsidies and use non-staple food crops as feedstock. To put South African ethanol producers on the same footing would require an oil price which is US\$20/bbl higher than that of Brazil, or about US\$65/bbl.

Comparative analysis of international experience shows that the biofuels industry, particularly in its infant stages, is at the mercy of volatile oil prices, crop prices and exchange rates. It therefore needs government support in the initial stages.

The market expansion of renewable energy technologies globally has been accompanied by cost reductions in critical technologies such as wind and solar PV, and such trends are set to continue. The portfolio of renewable technologies, which includes established hydropower, geothermal and bio-energy technologies is now, therefore, cost-competitive in an increasingly broad range of circumstances, providing investment opportunities without the need for specific economic support.

At a global level, each of the renewable sectors has grown strongly, as reflected below:

- The renewable electricity sector grew by 17.8 percent between 2005 and 2009, providing 19.3 percent of total power generation in the world;

- Hydropower is still the major source of renewable electricity (83.8 percent of renewable generation, corresponding to about 16 percent of total generation in 2009), and the absolute growth in hydropower generation over the previous five years was equivalent to that of all the other renewable electricity technologies, mainly because of developments in China. Hydropower will continue to be an important technology for years to come;
- Renewable heat grew by 5.9 percent between 2005 and 2009. Although the use of biomass is still the dominant technology (and includes the use of 'traditional' biomass with low efficiency for heating and cooking), growth in solar heating and, to a lesser extent, geothermal heating technologies was strong, with an overall growth rate of nearly 12 percent between 2005 and 2009. Growth here was particularly driven by rapid increases in solar heating in China;
- The production and use of biofuels grew by 26 percent between 2005 and 2009, and in 2009 biofuels provided 53.7 Mt, equivalent to some 3 percent of road transport fuels (or 2 percent of all transport fuels). Biofuel production and consumption are concentrated in Brazil, the USA and in the European Union. The main centres for ethanol production and consumption are the USA and Brazil, while Europe produces and consumes mainly biodiesel. The remaining markets in other regions and the rest of the world account for only 6 percent of total production and for 3.3 percent of consumption. Trade in biofuels plays a limited, yet increasingly important role.

Overall, at a global level, renewable energy deployment has expanded rapidly, providing evidence that this group of low-carbon energy technologies can deliver the intended policy benefits of improved energy security, GHG reductions and other environmental benefits, as well as economic development opportunities.

3.1.6 Alternative Energy Sources

The hydrogen economy is undergoing serious consideration in South Africa, in an effort to develop safe, clean and reliable alternative energy sources to fossil fuels. Hydrogen, as an energy carrier, is used to store and distribute energy and can be combined with the use of fuel cell technologies to produce electricity. Another driving force behind this technology is the prevalence of platinum reserves found in South Africa. Platinum group metals (PGMs) are the key catalytic materials used in most fuel cells, and more than 75% of the world's known platinum reserves are found within the South African borders. Hence there is great potential for socio-economic benefits to be obtained from these natural resources. Fuel cells directly convert chemical energy into electrical energy in a clean, environmentally friendly way with no harmful CO₂ emissions at the point of use. Converting hydrogen gas into electricity does not destroy the hydrogen, but rather transforms it into water. Hydrogen can be produced from carbon compounds, including fossil fuels, but the emphasis in South Africa is upon developing hydrogen from renewable energy sources in the long-term. In combination with renewable energy sources, hydrogen has the potential to become a crucial energy carrier in a future sustainable energy system.

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3.2 Transformation and related infrastructure

3.2.1 Electricity

South Africa has a total installed capacity of 43 895 MW of which more than 90% is owned by Eskom (IRP 2010). Eskom generates, transmits and distributes electricity to industrial, mining, commercial, agricultural and residential customers and redistributors. Table 3-2 shows existing Eskom-owned and operated power plants together with the capacities.

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Table 3-2: Existing Eskom Power Plants

Eskom Existing	Capacity (GW)	Plant Type	Remaining Life	Year of Decommissioning
Arnot	2.28	Coal	13	2023
Camden	1.52	Coal	15	2025
Duvha	3.45	Coal	22	2032
Grootvlei	0.752	Coal	19	2029
Hendrina	1.87	Coal	12	2022
Kendal	3.84	Coal	30	2040
Komati	0.202	Coal	14	2024
Kriel	2.85	Coal	18	2028
Lethabo	3.558	Coal	27	2037
Majuba	3.843	Coal	41	2051
Matimba	3.69	Coal	29	2039
Matla	3.45	Coal	21	2031
Tutuka	3.51	Coal	27	2037
Gariep	0.36	Hydro	15	2025
Van der Kloof	0.24	Hydro	17	2027
Acacia	0.342	Diesel	21	2031
Ankertig	1.323	Diesel	22	2032
Gourikwa	0.735	Diesel	22	2032
Koeberg	1.8	Nuclear	37	2047
Drakensberg	1	Pumped Storage	21	2031
Palmiet	0.4	Pumped Storage	28	2038
Total	41.015			

Source: Eskom

Eskom is currently embarking on a build programme to expand electricity supply capacity. Three major projects are underway and are indicated in the table below.

Table 3-3: Eskom Greenfields Projects

Eskom Committed Plant (GW)	Type	Projected Life	Year of Decommissioning
Medupi (4.332)	Coal	40	2052
Kusile (4.338)	Coal	40	2054
Ingula (1.332)	Pumped Storage	60	2073
Sere (0.1)	Wind	20	2032

Source: Eskom

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Table 3-4: Non-Eskom Plants

non-Eskom Existing Plant	Capacity (GW)	Plant Type	Remaining Life	Year of Decommissioning
Coal	1.08	Coal	30	2040
Cahora Bassa	1.5	Hydro (Imported)	23	2033
Other	0.5	Co-generation	30	2040
Steenbras	0.18	Pumped Storage	-	-
Total	3.26			

3.2.2 Distributed Generation and Off-Grid Solutions

While South Africa is striving to increase the rate of electrification, and more specifically connectivity to the grid, it is acknowledged that 100 percent electrification is a target that will be difficult, if not impossible, to meet. The statement in the National Development Plan that *"more than 90 percent of the population should enjoy access to grid-connected and off-grid electricity within 20 years"* firstly acknowledges that challenges exist which may not allow for full electrification to be realised, and secondly that both off-grid and on-grid solutions need to be considered. Whereas electricity is currently generated and distributed (on-grid) from centralised power plants, government recognises the potential for renewable energy and distributed generation technologies to improve connectivity.

Distributed generation is essentially an off-grid solution that includes the use of small generators, typically ranging in capacity from 5 kW to 10 MW, at or near to the end-user to provide the electric power needed. Many of the renewable energy technologies lend themselves particularly well to distributed generation applications. Government has already implemented small-scale generation options in various provinces and to date photovoltaic (PV) solar systems have been used for the electrification of over 2 000 clinics and 16 800 schools. PV or solar home systems are eventually expected to electrify an estimated 200 000 homes and 100 000 small businesses in a comprehensive off-grid electrification programme.

One of the main advantages of distributed generation is that it reduces reliance on large-scale transmission lines and, if properly applied, can reduce substation loading and the need for substation/transmission line upgrades. Smaller scale generation options typically require shorter lead times for construction, and construction programmes can be adapted more easily to changes in total demand. Large-scale centralised plant construction programmes, on the other hand, carry significant economic risk, in that a slower than anticipated growth in electricity demand can result in expensive excess capacity (as happened in the period from the late 1970s to the early 1980s in South Africa) (Banks and Schaffler, 2006).

At the next level, distributed generation can include generation, energy storage, on-site management (i.e., dispatch, control, communications), and all ancillary devices and services (Petrie *et al.*, 2009). This means that distributed generation technologies could be operated at a localised level, with excess capacity being fed back into the local or national power grid.

However distributed generation faces numerous technological challenges in this regard, mainly because such systems are essentially designed to operate independently. Most wind turbine operation systems, for example, are automated to immediately stop power production when the frequency or voltage of the grid is below or above certain thresholds, so that no excess is available.

The nature of an efficient distributed generation management system will depend largely on whether the generators are dispatchable or non-dispatchable. While dispatchable units can be controlled by a central system and relied upon to generate according to the needs of the power system, non-dispatchable technologies generate power according to the intermittent availability of their energy source. Most renewable energy systems (e.g., wind and solar) are non-dispatchable and the fact that these technologies cannot be controlled or dispatched by central control has made them historically less popular and less understood than other technologies. However, with the advent of hybrid systems which consist of multiple technologies and whose design exploits the strong points of the technologies to optimise performance and cost, dispatchable generation can be used at times when renewable power generation is unavailable. This seems to offer the most promise when considering the multiple needs of environment, system performance, and overall cost.

Distributed generation tends to have greater economic advantage where customer locations are very remote or expensive to reach; the number of customers is quite small and they are far apart; or the per capita usage is low (Petrie *et al.*, 2009). However while distributed generation represents an opportunity to increase the quality of life for individuals in remote rural areas, several other barriers exist that could make even technologically viable solutions unsuccessful. Such barriers include the sociological dimension of introducing new technologies to communities that are not aware of the benefits that such technology can provide (Szewczuk, 2009). This sociological dimension is understood to be an extremely complex issue. Some recommendations which have been made with regard to how this can be addressed include linking economic development with energy by integrating renewable energy into local planning activities and integrating renewable energy programmes with training and development programmes.

As the electricity supply sector evolves, there is likely to be greater use of distributed generation.

3.2.3 Liquid Fuels

South Africa has a total of six refineries with a combined nameplate capacity of 692 000 barrels per stream day (bpsd). Four of the refineries are located on the coast and the remaining two inland. Available

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capacity is lower than design capacity, with some of the contributing factors being planned and unplanned shutdowns, ageing of refineries and, in the case of PetroSA, the depletion of natural gas feedstock.

The supply of liquid fuels to the coastal market is either directly from a local refinery by road and rail, or by coastal transfer using ships. Generally the local refineries in a coastal region can provide sufficient supply to the particular region. The largest demand for liquid fuels in South Africa is, however, the inland market which is supplied by the coastal refineries via pipeline, rail or road.

The inland market is linked to the coastal region by the 12-inch Durban-to-Johannesburg Pipeline (DJP) which currently operates at full capacity and has reached the end of its design life. In January 2012, the first phase (construction of the main trunkline) of the New Multi-Product Pipeline (NMPP) was commissioned, which has alleviated some of the capacity constraints of the DJP. The NMPP will be completed in further construction phases and comprises a 24-inch main trunkline (currently completed and operational) and 16-inch pipelines (which are still under construction), with a design lifespan of 70 years.

The major players in the South African oil industry are BP Southern Africa, Chevron South Africa, Engen Petroleum, PetroSA, Sasol Oil, Shell South Africa and Total South Africa. These players own refineries as well some of the storage terminals and distribution facilities throughout the country (www.sapia.co.za).

Table 3-5: Existing Refinery Capacity

Refinery	Refinery Type	Nameplate Capacity (bpsd ²)	Ownership	Location
Chevref	Conventional (Crude Oil)	100 000	Chevron South Africa	Cape Town
Enref	Conventional	125 000	Engen Petroleum	Durban
Natref	Conventional	92 000	Sasol/Total South Africa (64/36%)	Gauteng
Sapref	Conventional	180 000	Shell South Africa/BP Southern Africa (50/50%)	Durban
Sasol (Secunda)	Coal-to-Liquid	150 000 (crude equivalent @ average yield)	Sasol	Gauteng
PetroSA	Gas-to-Liquid	45 000 (crude equivalent @ average yield)	PetroSA	Western Cape

Source: www.sapia.co.za

3.3 Technology, Research and Development

South Africa is a very small player in energy-related research and development (R&D) when compared to the bigger economies. China, the USA and the European Union (EU), with their larger financial and human capital are currently leaders in developing new technologies in the energy sector, with Brazil and India not far behind. Generally, R&D requires partnerships between government, the private sector and academia and in most cases (particularly in the initial stage of an innovation process that is set to benefit the entire economy) governments take the lead by injecting financial capital. Compared to the countries

² bpsd – barrels per stream day

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mentioned above, and as mentioned previously, South Africa's resource capability – both financial and human – is insignificant in comparison with the rest of the world. This is a major constraint to the country's ability to develop the new technologies required to pioneer innovation in the sector. To mitigate this risk co-operation at all levels – public, private and academic – is required if South Africa is not to fall far behind the innovation curve.

In 2010, government established the South African National Energy Development Institute (SANEDI) to undertake nationally focused energy research, development and innovation as well as undertake energy efficiency measures with a strong relevance for South Africa. While SANEDI was established as an organ of state, various other government and academic institutions undertake energy-related research in specialised areas. SANEDI needs to leverage the strengths, knowledge and expertise of existing institutions involved in energy research by establishing synergies which will enable it to lead the transformation of the energy sector through technology. This should be supported by a strong focus on Human Capital Development.

3.3.1 Technology Learning Rates

Technology learning refers to the reduction in the cost to construct and operate new technologies. Costs of commercialised technologies have generally shown the propensity to decline with cumulative manufacturing and project construction experience. Cost reduction and performance improvements can occur for a wide variety of reasons, including research and development, economies of scale, technology spill-over, economy-wide advances in science and technology, and process improvement resulting from manufacturing learning. Most of these factors are virtually impossible to separate from each other because of high correlations among many of the factors and the lack of sufficient data.

As future costs of technologies are uncertain, technological learning is incorporated into models to cater for the potential reduction in the capital costs of various technologies. For mature technologies, learning rates are assumed to be slower or negligible, while for newer technologies these may increase initially and plateau as the technologies become more mature and mainstream. Figure 3-1 illustrates the assumed learning rates for different types of electricity-generation technologies.

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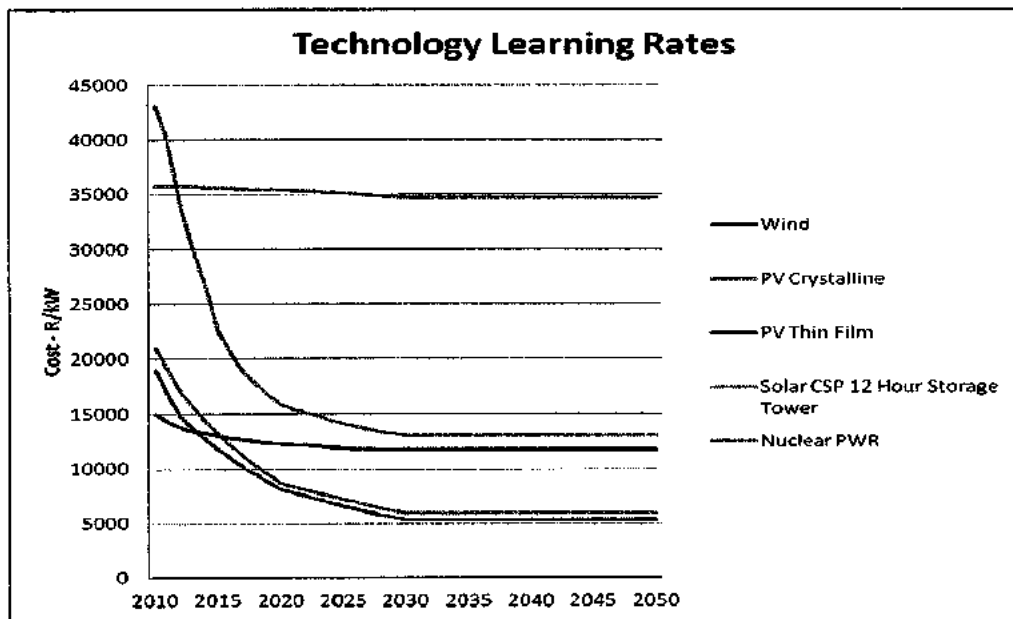


Figure 3-1: Assumed technology learning rates for electricity generation

SECTION 4: KEY MACROECONOMIC ASSUMPTIONS

This section presents the key macroeconomic parameters and assumptions for the IEP, namely: Inflation Rate, Exchange Rates, Discount Rate, Economic Growth (GDP), Global Oil Prices and Natural Gas Import Prices.

Table 4-1: Summary of Key IEP Macroeconomic Parameters for Base Case

PARAMETER	DESCRIPTION	SOURCE OF INFORMATION	UNIT	ASSUMPTION
Discount Rate	The rate at which future benefits and costs decline in importance because they occur in the future. Used to express a time preference for money – money right now is preferred to money in the future.	National Treasury	Percentage per year	11.3%
Average Potential Economic Growth over planning period (GDP)	An increase in the capacity of goods and services produced by an economy from one period of time to another.	2012-2031: National Treasury (July 2012) 2032-2050: Projected assuming slowing down of growth as economy reaches maturity	Percentage per year	Base case assumes on Moderate GDP growth scenario 2012: 2.7% 2013: 3.6% 2014: 4.2% 2015-2020: 4% 2021-2042: 4% 2043-2045: 3.5% 2045-2050: 3%
Global Oil Prices (Assumed to inform the variable cost of oil imports)	The annual average global spot price of crude oil	- Projections for 2012 to 2035: U.S. Energy Information Administration, Annual Energy Outlook 2012 (AEO2012) - Projections for 2036 until 2050: Assumed continued trends from AEO2012	Real 2010 US dollars per barrel (US\$/bbl)	2012-2035: Base Case assumes AEO2012 Reference Case crude oil price projections has been assumed for the IEP Base Case 2036-2050: Assumed continued trends from AEO2012 Reference Case Scenario

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PARAMETER	DESCRIPTION	SOURCE OF INFORMATION	UNIT	ASSUMPTION
Global Natural Gas Prices	The annual average Natural Gas import price	- International Energy Agency, 2011 World Energy Outlook - European Natural Gas Import Prices	Original Units: Real 2010 US dollars per Mbtu IEP Units: R/GJ	2012-2035: Base Case assumes European Natural Gas Import Prices under the 'New Policies' Scenario 2036-2050: Assumed continued trends of 'New Policies' Scenario continue into the future

4.1 Discount Rate

The discount rate is an interest rate used to convert a future income stream to its present value. In the context of the IEP the use of the discount rate across time enables computation of social discount factors, which are to be used to convert the spot prices of various goods and services in the future into their present-value prices. The National Treasury evaluated two approaches on the determination of the appropriate social discount rate to use for long-term national planning, namely:

- The ethical considerations approach (based on the Stern report)
- The Economic Opportunity Cost of Capital (EOCK)

The National Treasury has recommended the use of the EOCK approach, which in summary is a weighted average of (i) forgone return on private investment; (ii) rate of time preference for forgone consumption; and (iii) Marginal economic cost of foreign borrowing. The EOCK in essence gives the social opportunity cost of capital (i.e., the next best use of an economy's resources). According to the National Treasury, this approach provides the right discount rate for determining the choice of various projects (i.e. generation technologies) and gives the correct measure of the opportunity cost of resources used in any given project.

While the formula is highly sensitive to certain parameters such as i) the savers' shares; (ii) the supply elasticity of household saving; (iii) the supply elasticity of the stock of foreign funds to SA; and (iv) the elasticity of demand for private sector investment, certain assumptions were made about the values of these parameters from existing studies.

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Table 4-2 below provides the details of the EOCK equations and the values of the input parameters.

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Table 4-2: EOCK Calculation for Social Discount Rate for the IEP

Simple function: Weighted Average = $\alpha SDC + (1-\alpha)SRTIP$

therefore $EOCK = f_1 r + f_2 r^*$

$$EOCK = \frac{\sum_i e_i (S_i / S_p) r_i - \sum_i \eta_i (I_i / S_p) r_i}{\sum_i e_i (S_i / S_p) - \sum_i \eta_i (I_i / S_p)}$$

Economic Opportunity Cost of Capital (EOCK)

Ref	Description	Variables	Households	Business	Government	Foreign
1	Servers: Share	S_i/S_p	0.1429	0.5055	0.0000	0.3516
2	Normal interest rate	i	0.1300		0.1156	0.0325
3	Tax rate	t	0.3100		0.0000	0.0000
4	Proportion of total borrowing responsive to foreign interest rate	k				0.4000
5	Return on savings/normal MC of foreign borrowing	$rs = r(1-t)$	0.0897	0.0000	0.1156	0.0325
6	Inflation rate	p	0.0570	0.0570	0.0570	0.0280
7	Real return/real MC of foreign borrowing	$rs = (rs-p)/(1+p)$	0.0309	-0.0539	0.0555	0.0069
8	Basicities	e	0.5000	0.0000	0.0000	1.5000
	Group weight	$e_i (S_i/S_p)$	0.0714	0.0000	0.0000	0.5274
	Group weight * real return	$e_i (S_i/S_p) * rs$	0.0022			0.0047
	Sum of Group weights	A				0.5989
	Sum of Group weights * real return	B				0.0094
	Investors: Share	I_i/S_p		0.6108	0.1369	
	Normal interest/borrowing rate	r		0.2120	0.1563	
	Real return on investment	$rr = (r-p)/(1+p)$		0.0000	0.0000	
	Basicity	η		0.6108		
	Group weight	$\eta_i (I_i/S_p)$		-0.1295		
	Group weight * real return	$\eta_i (I_i/S_p) * rr$				
	Sum of Group weights	C				-0.6106
	Sum of Group weights * real return	D				-0.1295
	EOCK	$EOCK = (B-D)/(A-C)$				

Note: need to determine whether foreign investment and government investment crowds-out private investment

The calculations yielded a discount rate of 11.3% which will be assumed for all technologies throughout the planning horizon.

4.2 GDP Growth Rate

GDP is widely used as an indicator of total demand in the economy. GDP is a good proxy of the amount of energy demanded in the economy hence projections of GDP provide a sense as to the direction of energy demand going forward. The National Treasury provided a 20-year projection of domestic economic growth. The forecasts provided follow the same trajectory as the projections done by the National Treasury in respect of the Integrated Resource Plan (IRP 2010) - a high, moderate and low growth scenario, each of which is based on a high probability of realisation given certain assumptions.

The official forecast released by the National Treasury for the 2012 Budget, provides a 3 year base for each of the scenarios i.e. 2012 – 2014. Following the 2012 Budget forecast, the low-growth scenario assumes real GDP growth of 3.2 per cent per annum over the medium-term and 3.0 per cent per annum over the long-term. The main drivers of the low growth over the period are the assumptions of continued skills constraints and infrastructure bottlenecks. All risks to the low growth forecast are on the upside. The moderate growth scenario forecasts real GDP growth of 4.0 per cent per annum over the medium and long-term. The high growth scenario assumes an improved domestic outlook and recovery from the

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financial crisis with stronger commodity prices, reduced bottlenecks and higher global growth equilibrium. Over the long term, for this scenario, real growth is expected to be 4.6 per cent per annum over the medium-term and 5.0 per cent per annum over the long-term.

Table 4-3 shows the GDP growth forecasts for from the National Treasury 2012 Budget, while Table 4-4 shows the Low, Moderate and High GDP growth scenarios for the short, medium and long terms.

Table 4-3: National Treasury 2012 Budget Forecast

	2012	2013	2014
real GDP	2.7%	3.6%	4.2%

Table 4-4: GDP Forecasts for the IEP model

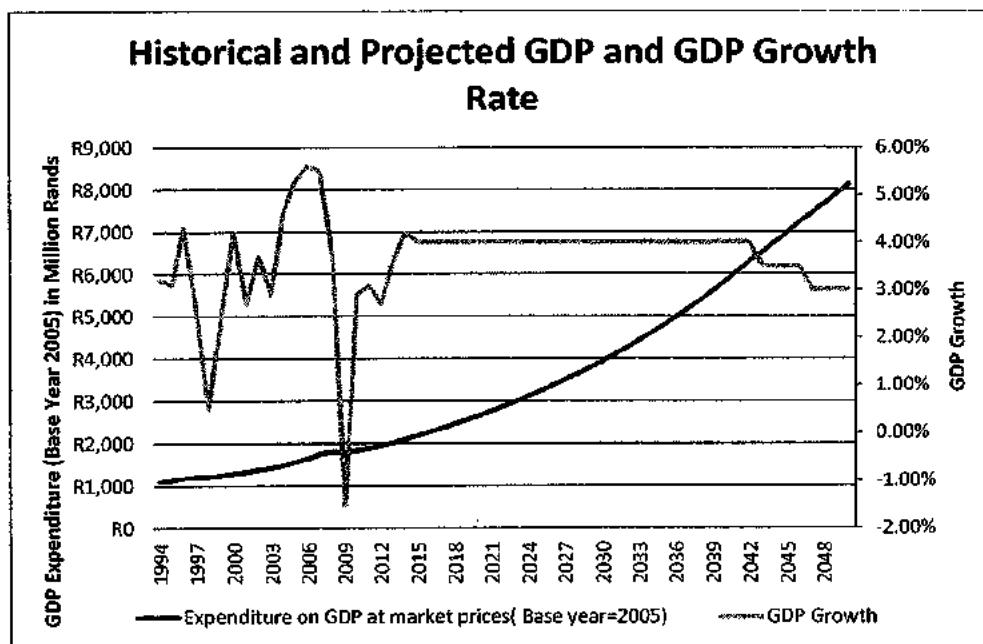
Low growth scenario				
<i>Short Term</i>			<i>Medium Term</i>	<i>Long Term</i>
2012	2013	2014	2015-2020	2021-2031
2.7%	3.0%	3.3%	3.2%	3.0%
Moderate growth scenario				
<i>Short Term</i>			<i>Medium Term</i>	<i>Long Term</i>
2012	2013	2014	2015-2020	2021-2031
2.7%	3.6%	4.2%	4.0%	4.0%
High growth scenario				
<i>Short Term</i>			<i>Medium Term</i>	<i>Long Term</i>
2012	2013	2014	2015-2020	2021-2031
2.7%	3.6%	4.2%	4.6%	5.0%

Table 4-8: Assumptions and Risks to the MTBPS forecast

Low growth assumption:	
<i>National Treasury 2012 Forecast, then growth of 2.0% over the forecast period</i>	
Assumptions	Upside Risks
Continued skills constraints	Strong commodity price growth
Infrastructure bottlenecks	Reduced skills constraints
Low global growth	Reduced infrastructure bottlenecks
	Improved global growth outlook
Moderate growth assumption:	
<i>National Treasury 2012 Forecast, followed by</i>	
Assumptions	Risks
Continued skills constraints	Risks to the moderate forecast can be either up- or downside risks
Infrastructure bottlenecks	Upside risks to growth forecasts are the same as the risks faced in the low growth assumption
	Downside risks to growth forecasts are the same as the risks faced in the high growth assumption
High growth assumption:	
<i>National Treasury 2012 Forecast,</i>	
Assumptions	Downside Risks
Strong commodity price growth	Continued skills constraints
Reduced infrastructure bottlenecks	Infrastructure bottlenecks
Improved global growth outlook	Low global growth
Skills shortage alleviates	

The official GDP forecast released by the National Treasury for the 2012 Budget, have therefore been used for the IEP. The Moderate GDP Growth Rate Scenario will inform the Base Case demand projections over the planning horizon.

The graph below charts the GDP growth forecasts for the High, Moderate and Low growth scenarios.



Source: Historical Statistics South Africa (1994-2012), Projected Values National Treasury (2013-2050)

Figure 4-1: Projected National GDP Growth Rates

4.3 Global Oil Price Projections

As mentioned previously, South Africa's crude oil requirements are met through imports and as a net importer, the country is not sufficiently influential to affect the price of crude oil. More importantly, the country is also highly susceptible to the volatility of the global oil market. The Energy Information Administration (EIA) publishes the Annual Energy Outlook on an annual basis which includes, amongst other aspects, projections of global crude oil prices. Projections are made for high, moderate and low global oil price scenarios which are informed by various assumptions about the global geopolitical and macroeconomic environment.

The global oil price projections for the IEP have been taken directly from the Annual Energy Outlook 2012, which has projections up to 2035. The oil prices from 2036 and 2050 have been extrapolated using a straight line based on the average price increases of each of the three scenarios from 2012 to 2035. A summary of the key assumptions underpinning each of the three oil price scenarios is provided in the annexures and the details is also available in the EIA's Annual Energy Outlook for 2012. The global oil price projections for the IEP Base Case have been based on the Reference Case of the Annual Energy Outlook 2012.

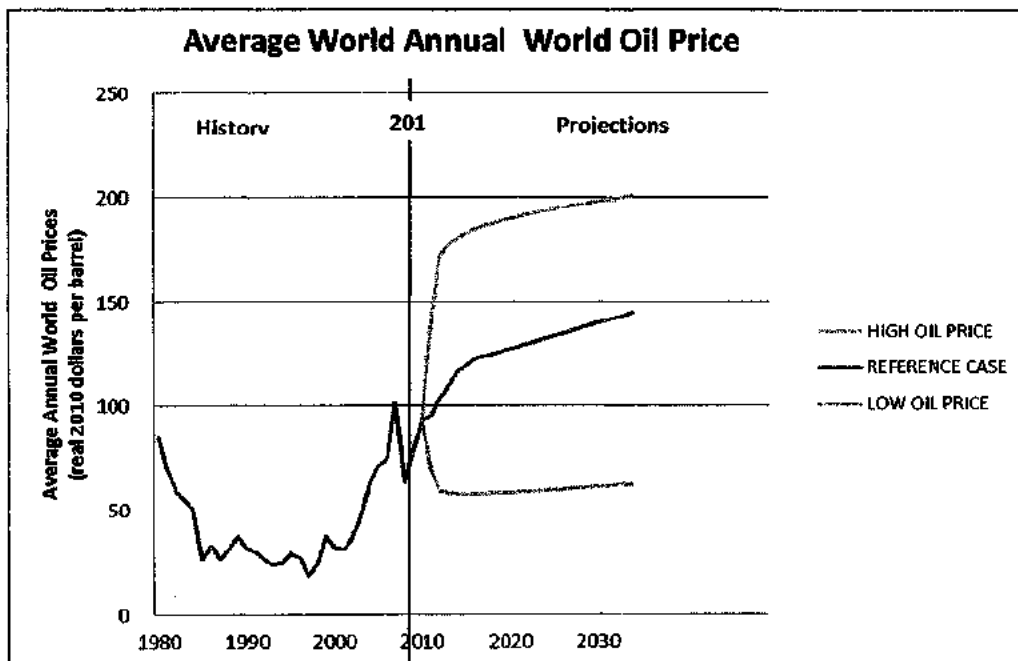


Figure 4-2: Average Annual World Oil Price Scenarios, Annual Energy Outlook 2012, US EIA

4.4 Natural Gas Price

The International Energy Agency (IEA) develops and publishes the World Energy Outlook on an Annual basis. The natural gas price projections are based on the projections for average gas import prices in Europe in the 2011 World Energy Outlook.

According to the World Energy Outlook, historically natural gas prices in the OECD have been closely correlated to oil prices through indexation clauses in long-term supply contract and also as a result of competition between gas and oil products in power generation and end-use markets. However different pricing mechanisms in different parts of the world lead to differences in the actual level of prices. When oil prices are high, oil-indexed gas prices also tend to be high (with a certain lag period). However gas prices which are driven by competition and supply/demand dynamics tend to be lower than oil-indexed prices as has been seen in Europe and the US.

The 2011 World Energy Outlook provides gas price projections for three scenarios: the Current Policies Scenario; the New Policies Scenario; and the 450 Scenario within three regions, namely United States, Europe and Japan. The price projections in the 2011 World Energy Outlook have been revised down from the 2010 release, primarily because of improved prospects for the commercial production of unconventional gas.

Given that South Africa currently imports most of its natural gas, it is assumed that in the foreseeable future, natural gas prices will be informed by the international supply and demand market.

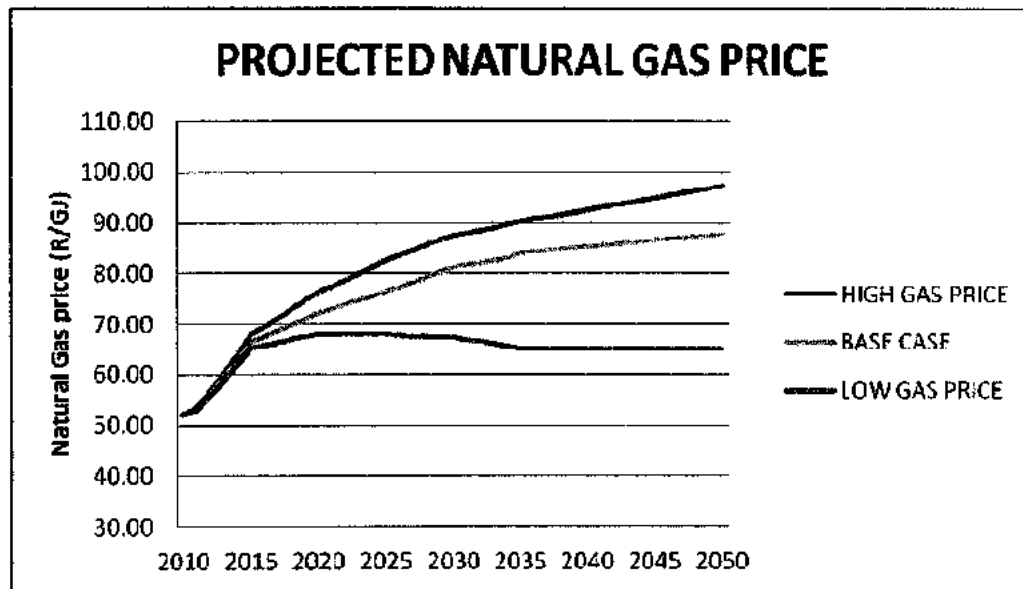


Figure 4-3: Natural Gas Price, IEA: World Energy Outlook 2011 (Average European Natural Gas Import Price)

SECTION 5: ENERGY DEMAND

5.1 Demand Modelling Approach

The economy of a country can be described broadly through three main categories, namely: primary, secondary and tertiary sectors. The primary sector is the sector of the economy making direct use of natural resources. This is contrasted by the secondary sector, which is characterised by the production of manufactured and other processed goods, and the tertiary sector which is characterised by the production of services. The economic grouping is based on the economic activities of the various sectors, and is therefore effective in quantifying and analysing the economic value-add of each of the sectors. However in order to effectively quantify energy consumption within each of the economic sectors, a grouping aligned to energy end-use becomes more constructive. While energy demand can be closely linked to economic activity, this approach also becomes effective in quantifying energy demand in those sectors whose economic activity may not always have a high level of correlation with energy demand (for example energy consumed in offices and public buildings).

Six demand sectors were considered, namely: agriculture; commerce; industry, mining; residential; and transport.

- The agricultural sector includes animal husbandry, crop farming, forestry and fishing.
- The commerce sector includes wholesale and retail, public services, financial and business services, hospitality, education, entertainment, information and communication. It does however exclude commercial transport.
- The transport sector includes passenger transportation (private and public) and freight transportation. While economically freight transport forms a part of commercial services, this has been separated and quantified separately for better clarity.
- The industrial sector includes all manufacturing (manufacturing and production of all goods and products including fast moving consumer goods) and also includes construction.
- The mining sector includes mining of all commodities through different mining techniques. (In the analysis mining is included within industry).
- The residential sector includes all personal dwellings (i.e. formal and informal households in rural and urban areas).

The table below provides a mapping of economic sectors to energy demand sectors with the key activity variable indicated in the last column.

Table 5-1: Mapping of economic sectors to energy demand sectors

Economic Sectors	Regional Sectors	Energy Demand Sectors	Sub-Sectors	Sub-Sectors Included	Energy Carriers Considered	Key Variables
PRIMARY	Agriculture, forestry and fishing	Agricultural Sector	N/A	N/A	Electricity, Coal, Diesel	Value-Added in the Agriculture Sector
	Mining and Quarrying	Mining Sector	N/A	N/A	Electricity, Coal, Diesel	GDP
SECONDARY	Manufacturing	Industrial Sector (Excluding Mining) or Manufacturing Sector	Chemicals	N/A	Electricity, Coal, Natural Gas	Value-Added in the Secondary Sector
			Iron and Steel	N/A	Electricity, Coal, Natural Gas	Production Activity (Iron Ore Mined)
			Non-Ferrous Metals	N/A	Electricity, Natural Gas	Value-Added in the Secondary Sector
			Other Manufacturing	Non-Metallic Minerals, Food and Tobacco, Paper and Pulp, Construction, Machinery, Textile, Wood and Wood Products, Transport Equipment	Electricity, Coal, Natural Gas	Value-Added in the Secondary Sector
	Construction Electricity, gas and water					
TERTIARY	Wholesale and retail trade; hotels and restaurants	Commercial Sector	N/A	N/A	Electricity, Coal, LPG, Residual Fuel Oil	Value-Added Tertiary Sector
	Finance, real estate and business services					
	General government services					
	Personal services					
	Storage and communication	Transport Sector	Private passenger transport	N/A	Diesel, petrol, electricity, aviation fuel	GDP/Capita
			Public passenger transport		Diesel, petrol, electricity, aviation fuel	GDP/Capita
			Freight transport		Diesel, petrol, electricity (rail)	GDP
HOUSEHOLDS	N/A	Residential Sector	N/A	N/A	Electricity, Coal, LPG, Paraffin	Population growth, Number of households and electrification rate

Gross Domestic Product (GDP) is widely used as an indicator of total demand in the economy and is therefore a good proxy to determine energy consumption. The National Treasury provided 20-year projections of domestic average potential economic growth for three scenarios (low growth, moderate growth and high growth) based on a set of assumptions. The moderate growth assumptions assume the steady growth of the economy, with continued skills constraints and infrastructure bottlenecks in the short- to medium-term. These projections have been used in the Integrated Energy Planning process and are taken as the baseline. The GDP growth assumptions based on the National Development Plan (NDP) have been used for the high-growth scenario, but the relevant outputs have not yet been analysed.

The population growth combined with the average household size provides a good basis for determining the number of households in the future. Energy demand in the residential sector is determined by estimating the average energy consumption by different household types.

In the transport sector, GDP per capita is used to estimate future demand for passenger transportation.

While the ultimate objective is to conduct demand projections for all energy services (cooking, lighting, industrial processes, transportation, etc.) within each major energy demand sector (residential,

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commercial, industrial and agricultural), due to paucity of energy consumption data at an energy end-use level, using the above-mentioned key drives as a basis, demand projections were conducted for each energy demand sectors (agriculture, commerce, industry, mining, residential and transport).

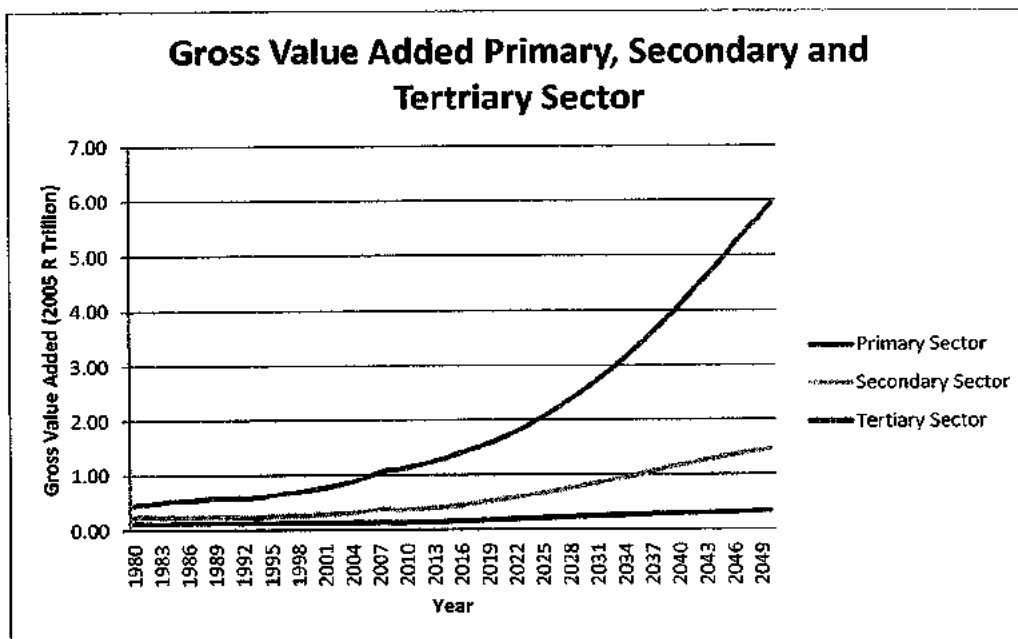
- For the agricultural, commercial, industrial, mining and residential sectors, energy demand was estimated and projected for individual energy carriers (i.e. electricity, natural gas, LPG, coal, diesel, etc.); and
- For the transport sector, energy demand was projected for energy end-use (i.e. mobility measured by passenger kilometres or freight tonne kilometers) as opposed to individual fuels (i.e. petrol, diesel, jet fuel, etc.). This second approach makes it possible to quantify the extent to which different fuels can be used to meet the same end-use/need.

5.2 Analysis of Demand by Sector

As mentioned previously, GDP growth remains closely dependent on the supply of energy and is therefore a key indicator of potential future demand. In the short-term, the GDP growth rate for South Africa is projected to grow from 2.7% in 2012 to 3.6% 2013 and 4.2 % in 2013. In the medium-to-long-term this is projected to grow at an average rate of 4%. The assumed GDP growth projections used to inform the demand projection are illustrated in the graph below. However understanding the projected value-add or production of individual sub-sectors is important in deriving final demand for individual sectors and sub-sectors.

The average potential growth assumptions for the economy as well as the primary, secondary and tertiary sectors are represented in the graph in Figure 5-1. The demand for fossil fuels within the industrial sector (with the exception of mining) is assumed to be closely aligned with the growth of gross value added for the secondary sector. The growth in energy demand in the commercial sector was determined based on projected expansion of the tertiary sector.

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Source: Historical values (1980-2010): StatsSA; 2011-2050 – Model Projections

Figure 5-1: Historical and Projected Gross Value Added Primary, Secondary and Tertiary Sector

5.2.1 Agricultural Sector

South Africa has a dual agricultural economy which comprises a well-developed commercial sector and a predominately subsistence-oriented sector in the rural areas. Primary commercial agriculture contributes about 3% to South Africa's gross domestic product (GDP) and about 7% to total formal employment. However, there are strong backward and forward linkages into the economy, so that the agro industrial sector is estimated to contribute about 12% to GDP (SA Yearbook 2011/12).

Since South Africa's re-admission into world-trade, the agriculture has undergone significant structural changes over the past 15 years some of which has seen the sector shift to large-scale intensive farming, as well as a shift from low-value, high-volume products intended for domestic consumption, such as wheat and milk, to high-value products intended for export, such as deciduous fruit, citrus and game. Intensive farming practices are highly dependent on water and fuel with the latter making up the second biggest expenditure item after farm feeds. On the other hand, land-reform could see the emergence of a large number of small-scale farmers, most likely to use traditional farming methods. Fuel usage (predominantly diesel) in the agricultural sector is primarily used for traction and other farm machinery as well as the transportation of agricultural produce and is the predominant energy source in the sector.

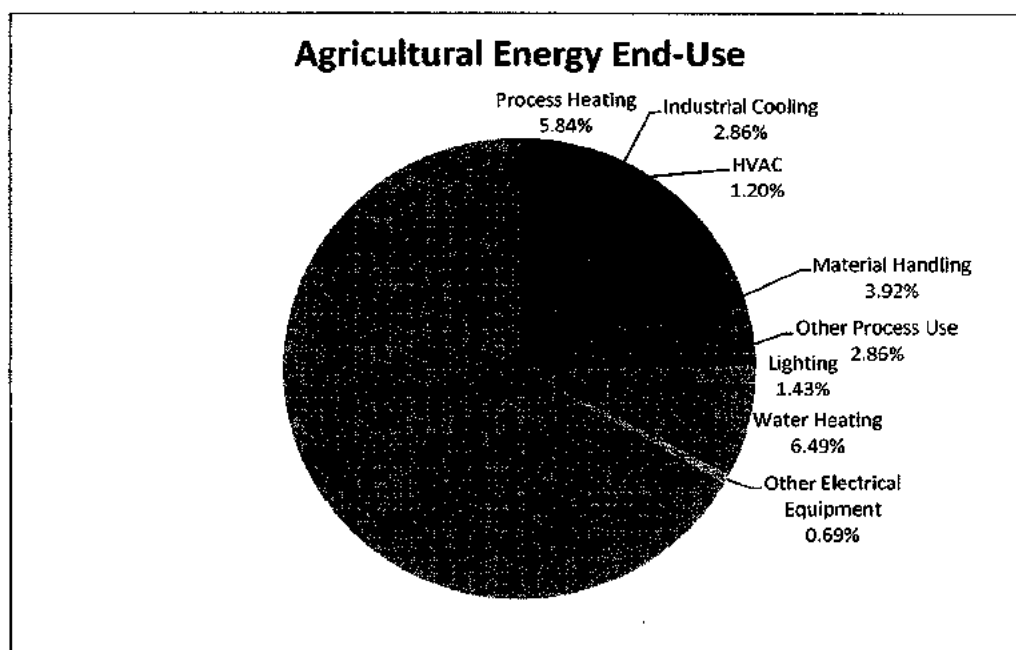


Figure 5-2: Energy End-Use within the agricultural sector

While small-scale farmers have emerged over the last few years, this growth has been slow and has had minimal impact of total energy demanded within the sector. A bulk of the demand has been from large-scale intensive farming wherein use of electricity and diesel has remained high.

Key drivers for energy demand in this sector include shifts to large-scale intensive farming practices and changes in the types of food crops farmed, the latter being highly influenced by changing diets of the population as income increases. It is likely that in future the share of electricity in this sector will grow, however the extent of the growth will be influenced by energy prices, while diesel is projected to continue playing a significant role. Energy demand in the agricultural sector will continue to be linked to growth and value-add of the sector.

With large-scale highly mechanised intensive farming, most efficiency gains resulting from improved machinery, equipment and production practices have been realised and the rate of further efficiency improvements will start to decline. The value-added in the agricultural sector is therefore assumed to continue to see growth into the future, however with the rate of increase slowing down.

Farming is assumed to remain vitally important to the economy and the development of the southern African region. The projected energy demand for the agricultural sector is depicted in Figure 5-3.

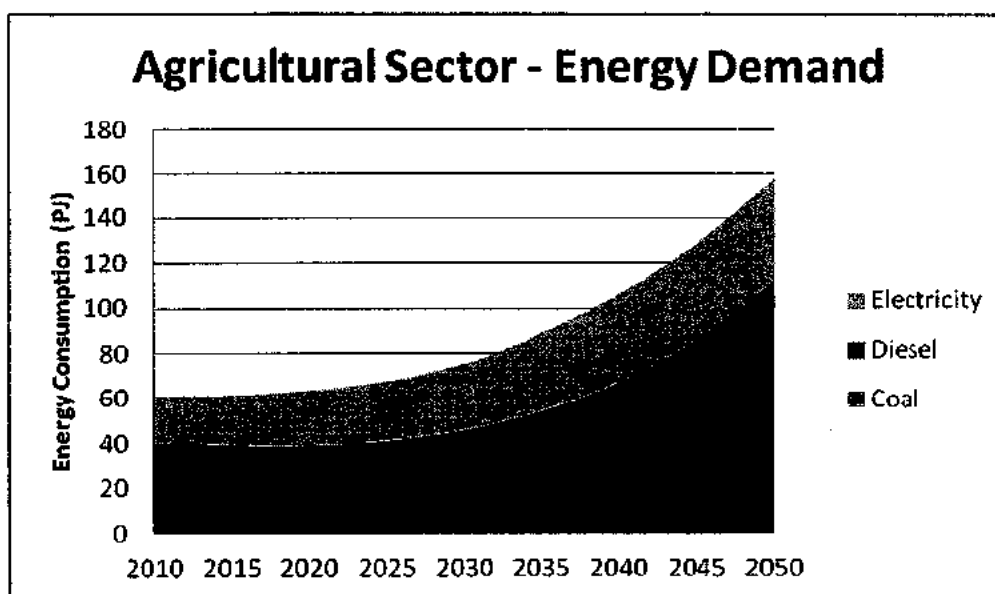


Figure 5-3: Projected Demand in the Agricultural Sector

The average energy demand growth rate is between 1% and 2% in the short-to medium term increasing to between 3% and 4% in the long-term. The intensity of energy end-use the sector declines in the short-to medium-term, but starts to increase in the longer terms as the rate of energy efficiency improvement in the sector start to decline.

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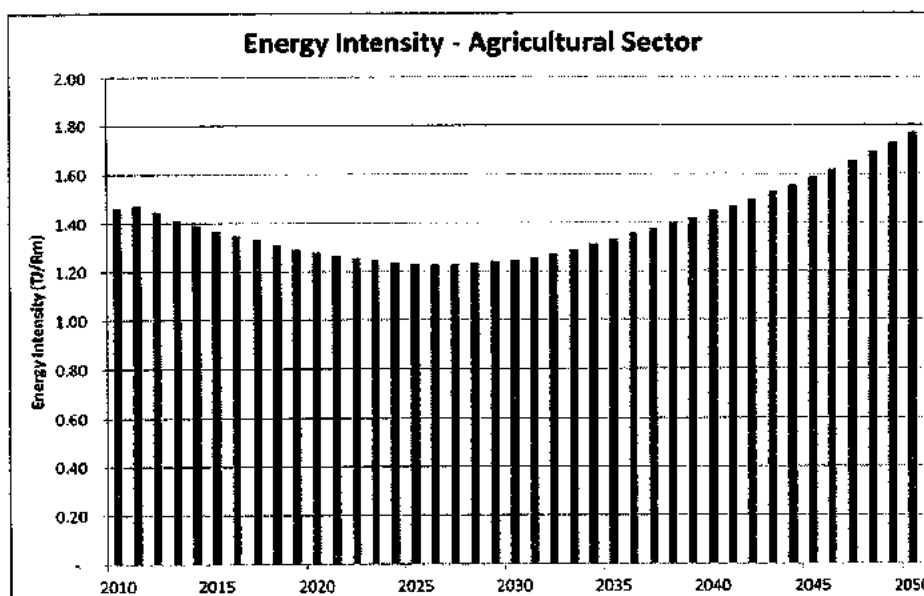


Figure 5-4: Energy intensity in the agricultural sector

5.2.2 Industrial Sector

South Africa is a highly energy intensive economy. According to the 2012 Energy Sustainability Index developed by the World Energy Council, the energy intensity of South Africa is 0.05 million British Thermal Units (BTU) per USD. The industrial sector which comprises of mining, iron and steel, chemicals, non-ferrous metals, non-metallic minerals, pulp and paper, food and tobacco, and other manufacturing consumes ~40% of the final energy demand in the country. The largest of these is iron and steel which consumes ~27% of the total energy used by the sector, followed by mining which consumes ~26%.

The majority of energy within the industrial sector is used for process heating. In energy intensive industrial sub-sectors such as iron and steel and chemicals process heating comprises 90% and 88% respectively. The use of energy for motor driven systems which are accounted for under pumps, compressors and material handling contribute the second largest share of total energy use at 14.73%. 'Other process use' encapsulates other processes whose exact end-use is not well defined and cannot be attributed to a specific purpose. Industrial cooling which is designated as deep mine cooling within the mining sub-sector is the third largest share.

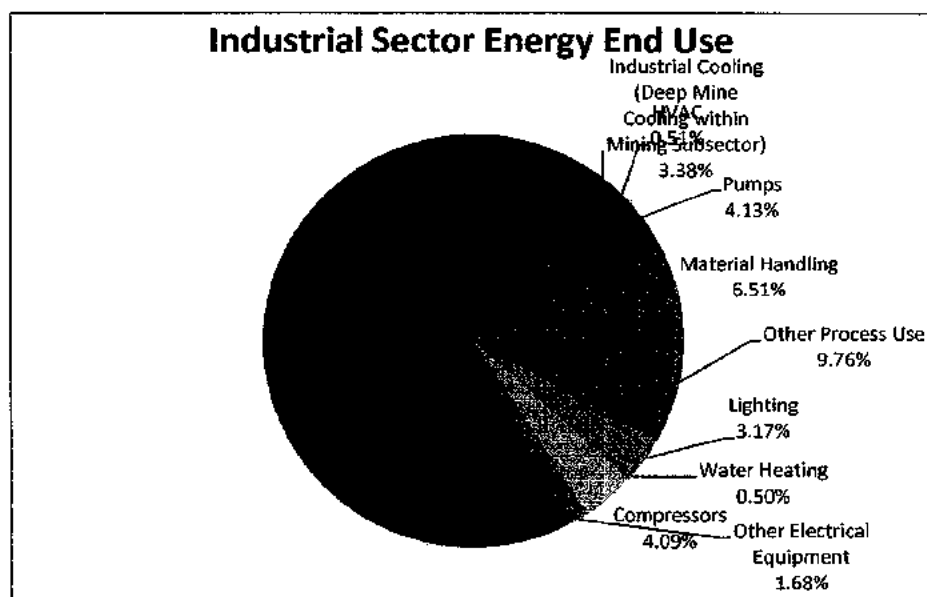


Figure 5-5: Break-Down of Energy End-Use in the Industrial Sector

While the use of fossil fuels within the industrial sector is used primarily towards process heating, the end-use of electricity is very diverse as indicated in the table below.

Table 5-2: Detailed electricity end-use in the industrial sector

End Use	Chemicals	Iron and Steel	Non-ferrous Metals	Other Manufacturing	Gold Mining	Coal Mining	Platinum Mining	Other Mining
Process Heating	4%	60%	23%	38%	2%	3%	2%	3%
Industrial Cooling/Deep Mine Cooling	8%	5%	9%	6%	15%	9%	15%	9%
HVAC	1%	1%	1%	2%	0%	1%	0%	1%
Pumps	26%	3%	9%	13%	17%	5%	17%	5%
Material Handling	15%	4%	5%	4%	27%	6%	27%	6%
Other Process Use	21%	21%	19%	14%	11%	58%	11%	58%
Lighting	4%	4%	11%	10%	4%	6%	4%	6%
Water Heating	0%	0%	0%	0%	4%	3%	4%	3%
Compressors	20%	4%	7%	11%	20%	5%	20%	5%
Other Electrical Equipment	1%	0%	17%	2%	1%	5%	1%	5%
Total	100%	100%	100%	100%	100%	100%	100%	100%

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Source: Eskom IDM

5.2.2.1 Total Energy Demand within the Industrial Sector

Key drivers for potential changes in energy demand trends in the industrial sector will include economic and non-economic factors. The general loss of competitiveness characterised by relatively high input costs including high wages compared to competing countries such as China and India, has the potential of changing the structure of energy demand. In some instance it has resulted in the mechanisation of production processes. The loss of competitiveness has in some instances resulted in increased importation of finished products, thus reducing the size and demand pattern of the manufacturing sector in terms of its contribution to GDP. Non-economic factors include moves towards a low carbon economy; an increased focus on climate change and emissions associated with energy end-use; increases in energy prices and adoption of less energy-intensive technologies and practices.

The projected energy demand for the industrial sector is depicted in Figure 5-6.

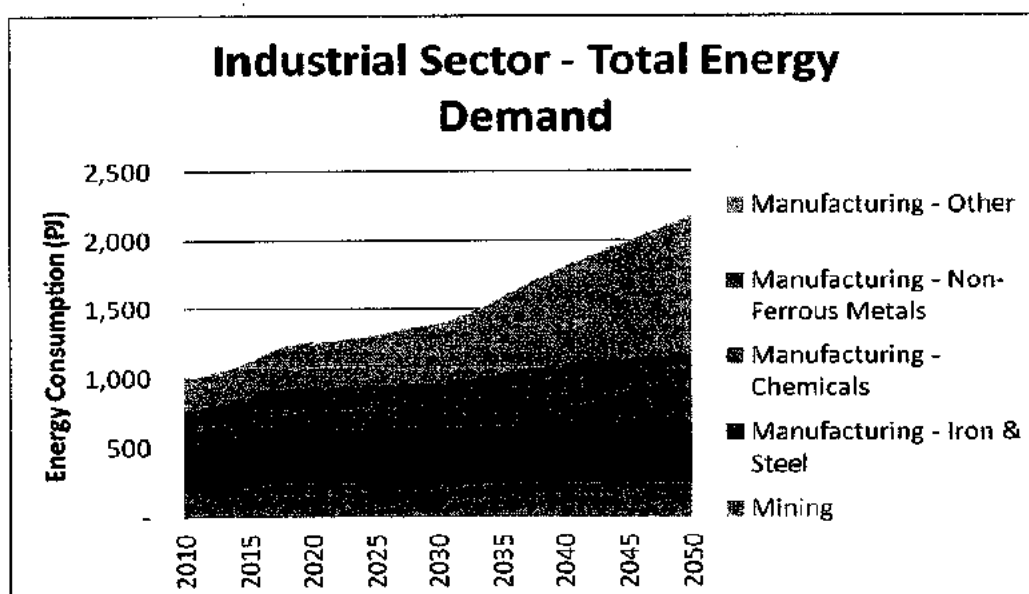


Figure 5-6: Total Energy Demand in the Industrial Sector

With an average annual energy demand growth rate of 2% over the planning period, the growth in energy demand for the industrial sector more than doubles from 2010 through to 2050 with most growth coming from 'Other Manufacturing'. It is estimated that in 2010, the share of total energy demand within the industrial sector was from iron and steel with 30%, chemicals 15%, nonferrous metals 14%, other manufacturing 23% and mining 18%.

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In 2030 the share of individual subsectors to total energy demand reduces slightly in most sub-sectors with iron and steel accounting for 28%, chemicals 12%, nonferrous metals 12% and mining 17%. This share is taken by other manufacturing which takes up 31% of total energy demand within the sector. Further on in 2050 this trend continues with the iron and steel taking up 20%, chemicals 12%, nonferrous metals 10% and mining 11%. Other manufacturing continues to take up the most significant share of 46% by 2050. The reduction in the share of total energy demand from the mining sector is expected due to the fact that while production from mining is increasing overall there are sharp declines seen in the gold sector. For instance in 2007, gold mining accounted for close to 47% of the electricity demand within the mining subsector and from 2007 to 2050 the share of electricity demand for gold mining declines to 28%.

Demand in other manufacturing which includes, among others, sub-sectors such as textiles, paper and paper products, household appliances, beverages, and food processing, grows the most substantially.

5.2.2.2 Industry: Coal Demand

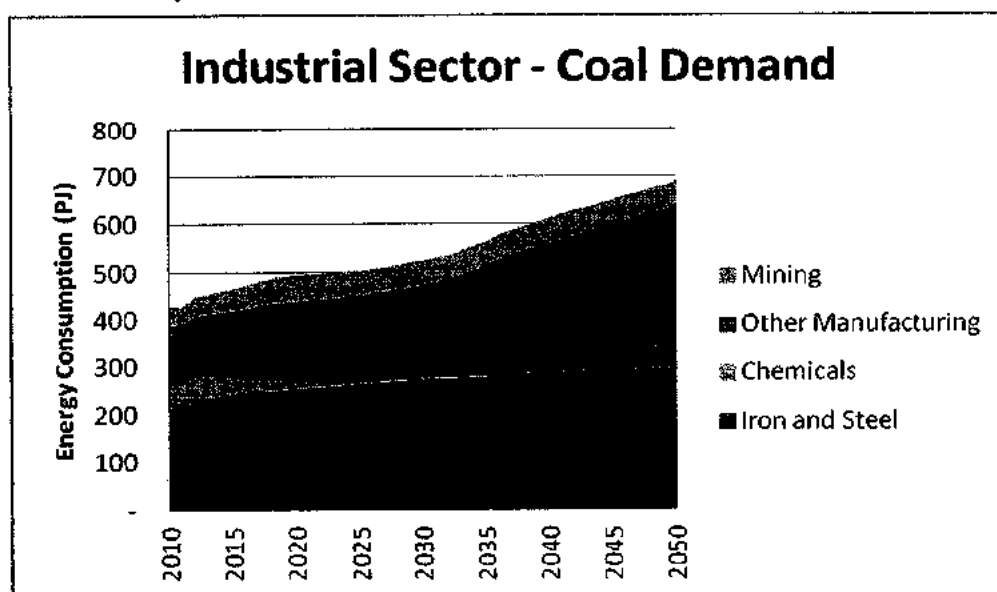


Figure 5-7: Projected Coal Demand in the Industrial Sector

From 1999 to 2010 coal consumption within the Chemical sector has declined by a cumulative 77% (DME, Energy balances 1999-2010) with steep drops occurring most recently in the last five years. Coal projections from 2010 to 2050 show similar trends with the total demand for coal, declining with an average of ~10% from 2010 to 2050 being replaced by natural gas and electricity consumption as depicted in Figure 5-8 and Figure 5-9 below. Despite the drops in coal demand in the chemical sector, coal consumption in the overall industrial sector grows with iron and steel increasing at an annual average rate of ~1% and 'Other Manufacturing' increasing at an annual average of ~3% between 2010 to 2050.

5.2.2.3 Industry: Natural Gas Demand

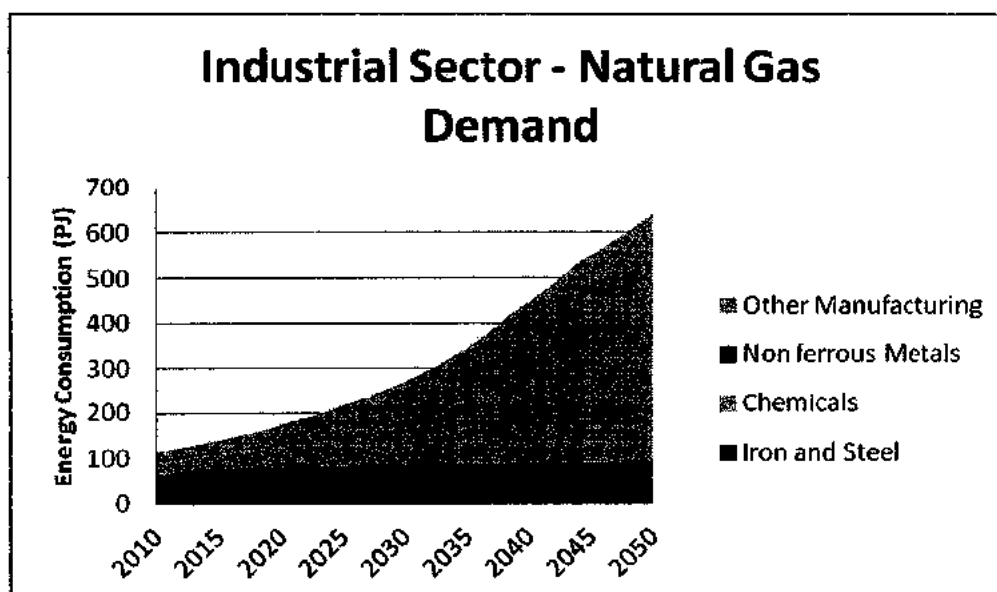


Figure 5-8: Projected Natural Gas Demand in the Industrial Sector

Natural gas usage within the industrial sector is primarily seen in 'Other Manufacturing' and Chemicals sectors. Most of the growth of natural gas within the industrial sector is accounted to Other Manufacturing which grows at an annual rate of ~8% 2010 to 2050 and the Chemicals sectors which grows at an annual average rate of ~2% from 2010 to 2050.

5.2.2.4 Industry: Electricity Demand

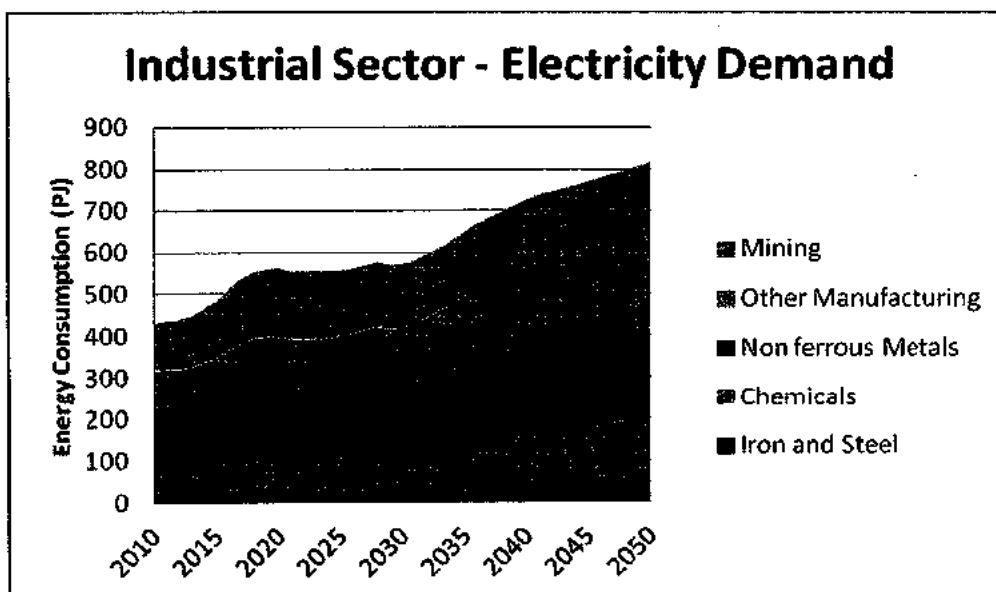


Figure 5-9: Projected Electricity Demand in the Industrial Sector

Total electricity demand doubles over the time period from 2008 to 2050. Over the same period electricity demand within the iron and steel sector shows an average growth rate just under 1%.

The use of electric arc furnaces which account for the bulk of electricity usage within the Iron and Steel sector is limited by the availability of scrap metal. The average annual growth rate of electricity within the nonferrous sector at ~1% from 2010 to 2050 is well below the growth experienced by other manufacturing which shows an average annual growth rate of ~2% and Chemicals at ~3%.

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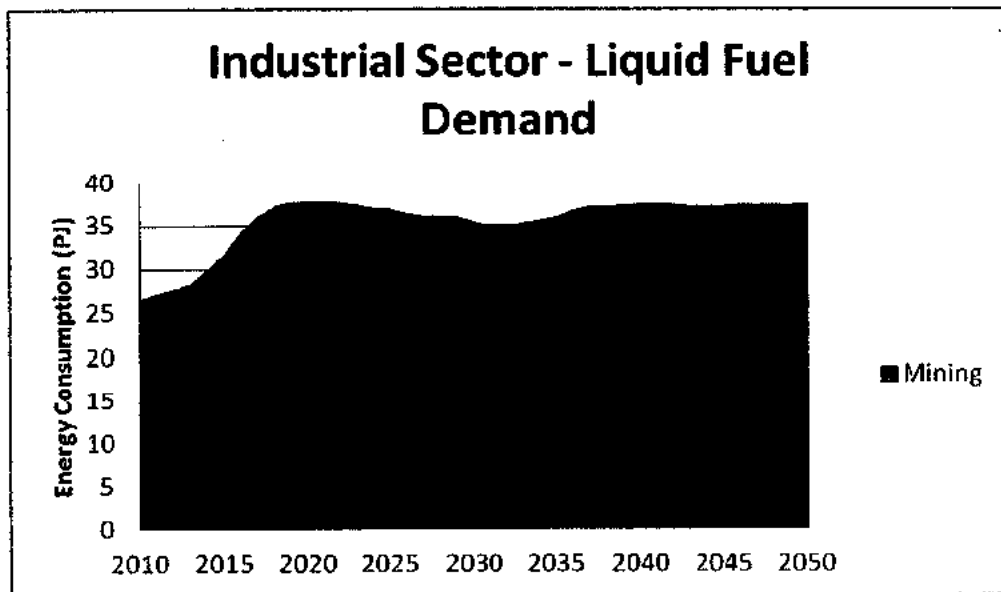
5.2.2.5 Industry: Liquid Fuel Demand

Figure 5-10: Projected Liquid Fuel Demand in the Industrial Sector

The use of petroleum products within the industrial sector is mostly limited to the mining sector. Material handling which accounts for ~26% of total energy end use within the mining subsector encompasses both diesel and electric equipment. In general, diesel fuel is used by rubber tyre or track vehicles that deliver material in batches while electricity powers continuous delivery systems such as conveyor belts or slurry lines.

5.2.3 Commercial Sector

The commercial sector comprises of the following economic sub-sectors: finance, real estate and business services; general government services; personal services; storage and communication; and wholesale, retail, motor trade and accommodation.

The commercial sector therefore largely comprises of the tertiary or services group of industries, but specifically excludes the transport sector. In this analysis the commercial sector therefore describes all industries within the tertiary sector excluding transportation of passengers and freight. The basis for the exclusion is that transportation demand requires a separate and focused analysis for energy consumption. However in describing the characteristics of the tertiary sector, transportation of goods and passengers are implicitly included.

For the last 100 years, there has been a substantial shift from the primary and secondary sectors to the tertiary sector in industrialised countries. The tertiary sector is the fastest-growing sector in developing

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countries including South Africa. As a result of a wealth of mineral resources and favourable agricultural conditions, South Africa's economy has historically been rooted in the primary sectors. However, over the past four decades, the economy has been characterised by a structural shift in output. Since the early 1990s, economic growth has been driven mainly by the tertiary sector and more recently South Africa is moving towards becoming a knowledge-based economy, with a greater focus on technology, e-commerce and financial and other services.

Some of the fastest growing tertiary sectors from the over the last couple of years include transport and financial services, with most value-add having occurred in information and communications technology; communications; retail as well as finance and business services.

As the commercial sector is highly characterised by people providing services, rather than machinery or equipment, energy requirements are predominately to increase levels of comfort and ensure sustenance of individuals. Energy end-use is therefore primarily used for space heating and cooling (~34%), followed by water heating (~21%), cooking (~17%) and lighting (~14%) and the remainder towards cool storage (~5%) and electrical equipment such as computers, printers, faxes, etc. (~9%).

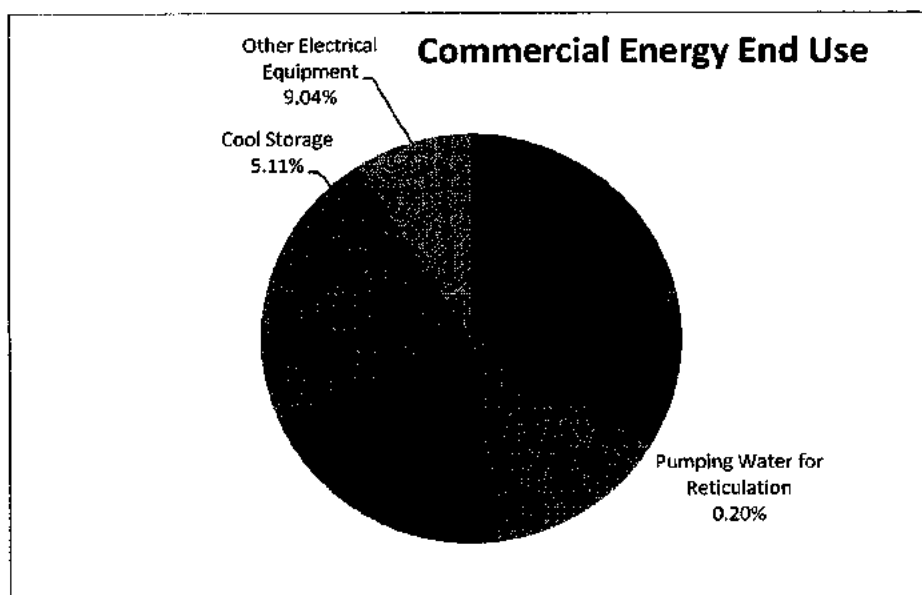


Figure 5-11: Energy End-Use within the Commercial Sector

Given the fact that the tertiary sector is predominant in highly-electrified urban areas, and that it is the most modern and convenient source of energy, electricity dominates total energy usage. It is also no surprise that the historical consumption of electricity has shown a steady increase aligned with the growth of the tertiary sector.

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As economies develop, the commercial and public sector usually grow faster than other sectors – and this has been true for South Africa. Continued expansion of tertiary sector will see continued increases in the demand for energy, and more specifically electricity. Although energy demand in the tertiary sector is relatively low when compared to other industrialised countries, significant opportunities for improvements in energy efficiency exist especially through the heating and cooling of office buildings, office equipment and lighting. Water heating is slowly starting to see a shift to alternative energy sources such as solar and more energy efficient heat pumps. To this effect, the government has also introduced various legal and policy instruments aimed at improving efficiency. These include the National Building Regulations which include specifications and standards for the energy efficiency of new buildings as well as standards for the labelling of the efficiency of appliances. Various incentives schemes have also been introduced which will encourage more energy efficient practices and behaviour from all industries including those that fall within the commercial sector. Therefore while energy demand in the tertiary sector will continue to grow, this will not follow the same trajectory as the economic growth of the sector, but should rather lag behind.

The projected energy demand for the commercial sector is depicted in Figure 5-12.

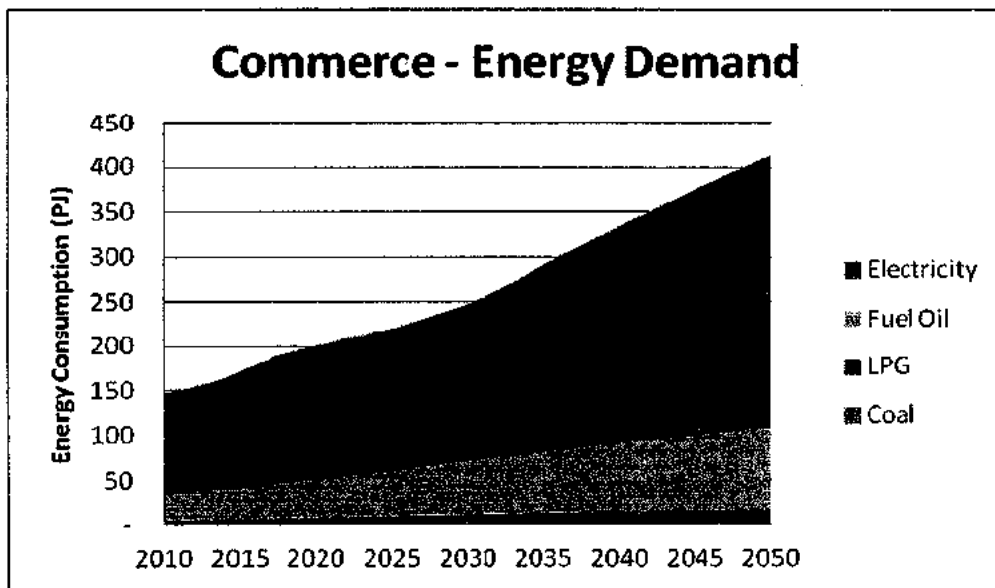


Figure 5-12: Projected Demand in the Commercial Sector

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5.2.4 Transport Sector

Across Africa, roads remain the dominant mode of transportation, accounting for more than 90% of passenger and freight transport in Africa, compared with around 50% of freight in Europe. South Africa is a large country with an extensive network of road, rail and air transport (SA Yearbook, 2011/12). Land passenger transport is the biggest user of energy followed by land freight and then air transport. Transport energy demand consists overwhelmingly of liquid fuels. The dominant fuel for transportation is petrol (>50%), followed by diesel (~35%), jet fuel (~10%), and the lowest is electricity (<2%) primarily used in rail (see Figure 5-13).

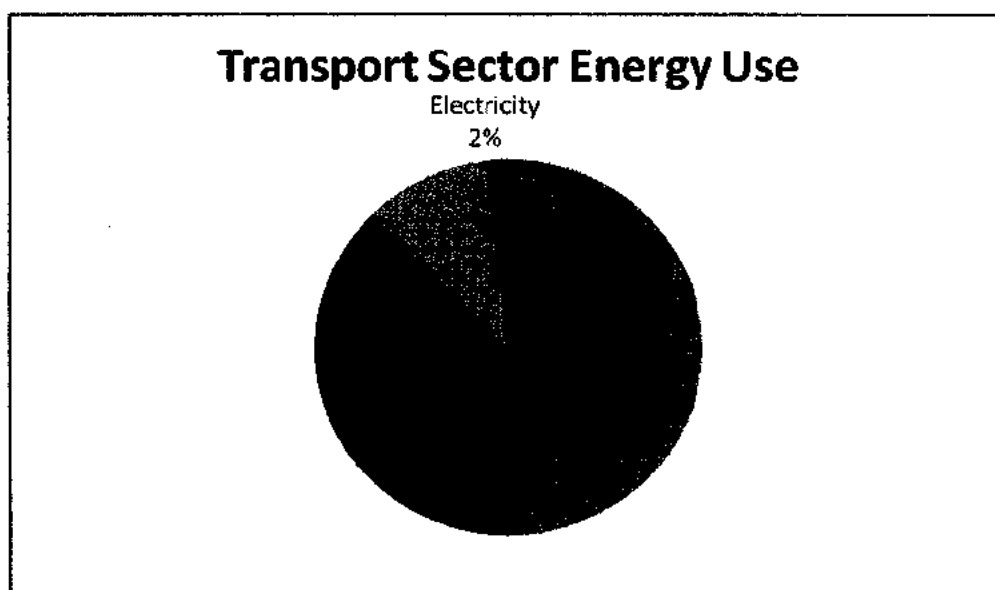


Figure 5-13: Energy End-Use within the Transport Sector

Demand for transport services is assumed driven by economic activity represented by GDP for freight and public transport and GDP per capita for private passenger transport. The graph below shows the projected GDP per capita based on the GDP growth and populations projections discussed previously.

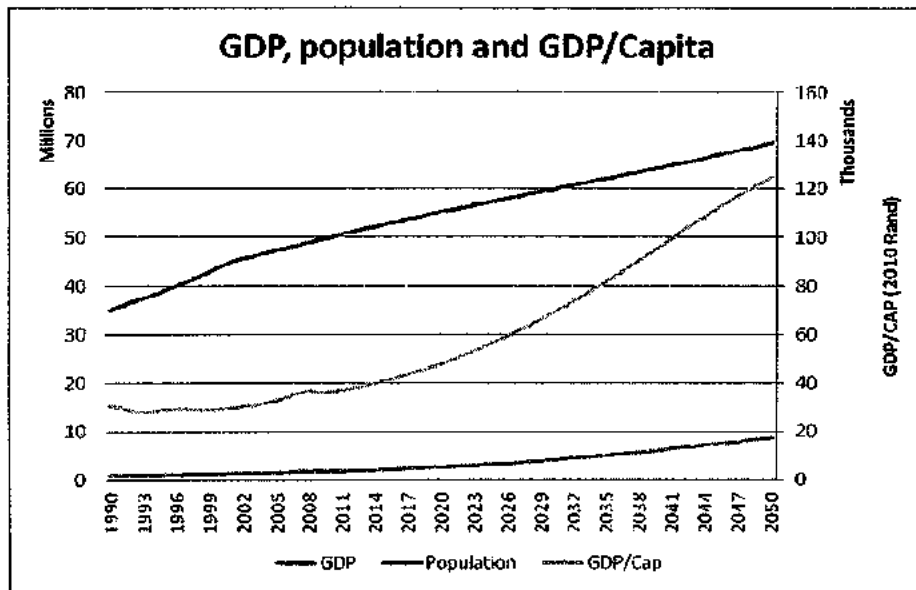


Figure 5-14: GDP, population and GDP/Capita for the IEP Base Case

5.2.5 Passenger Transportation

In line with global growth patterns, the key driver for continued demand is likely to be the desire for increased mobility. For passenger transportation this becomes possible when improvements in GDP per capita allow the move from mass and public modes of transport to small passenger vehicles. Other indirect factors which impact the mode of transport include quality of roads as well as safety, efficiency and reliability of public transport systems. More recent factors that could also change passenger movement patterns include government policy interventions, which aim to accelerate the improvement in public transport by establishing integrated rapid public transport networks. These will introduce priority rail corridors and Bus Rapid Transit (BRT) systems in cities. Transportation demand is largely met through liquid fuels, however the penetration of electric and hybrid vehicles could see demand shift from petroleum products to electricity in the future. Three vehicle categories were modelled for passenger transportation: Small Passenger Cars, Sport Utility Vehicles (SUVs) - which include bakkies and mini vans and Public Passenger Transport (Buses and Minibus Taxis).

5.2.5.1 Small Passenger Cars

Projected energy demand for private passenger cars is presented in Figure 5-15: Electric vehicles are selected by the model as a significant part of new vehicle fleet. The initial uptake of electric vehicles is slow due to the low base at which electric vehicles start. While electric vehicles have the lowest cost over the model period, based on the vehicle costs and the energy value chain there are practical limits to their adoption. The escalation of fuel prices coupled with the costs of investing in additional refining capacity to

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meet future liquid demand contribute to the uptake of electric vehicles in the later years of the modelled period. Petrol use for small passenger vehicles continues to dominate throughout the modelling period with the contribution of diesel diminishing by 2038. Use of electricity for small passenger vehicles is negligible and only starts to take off after 2035.

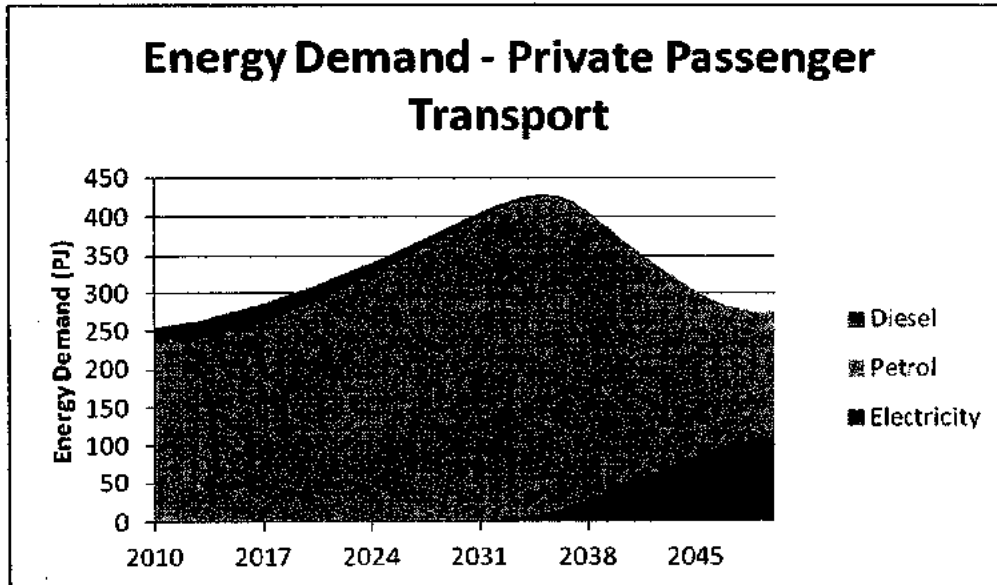


Figure 5-15: Projected energy use for small passenger cars

The results presented meet the electric vehicle targets set by the Department of Transport's National Transport Plan for the year 2050, i.e. 60% electric vehicles, based on the assumed penetration rates. Other aspects not considered which would impact on electric vehicle penetration rates are the required charging infrastructure, market conditions and range limitations of electric vehicles.

Diesel cars are not chosen by the model but new petrol vehicles are selected, mainly at the start of the modelling period but start to decline by 2050 as more electric vehicles enter the market.

From a policy perspective, based on the assumptions provided, the model output suggests that electric vehicles should be considered as they provide a least cost option for providing private passenger transport and result in lower end-use emissions for the transport sector. However further analysis on the possible penetration rate of electric vehicles in South Africa needs to be conducted. Where possible, this should take into consideration economic factors such as the capital cost of vehicles and the cost of fuels, as well as social factors such the value placed on different types of vehicles and associated social status that are difficult to quantify.

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5.2.5.2 Sport Utility Vehicles (SUVs)

The category of vehicles classified as Sport Utility Vehicles (SUVs) includes bakkies and mini vans. The projected energy demand for SUVs is shown in Figure 5-16. The model chose petrol over diesel for these vehicles and by 2050 almost all vehicles in this class are assumed to use petrol. This class of vehicles is comprised primarily of small bakkies which are assumed to continue using petrol and the capital costs of diesel vehicles is less economical given the assumed distances travelled, however the rate at which use of diesel diminishes may be slower in reality. Electric drive trains were not considered as an option for SUV type vehicles.

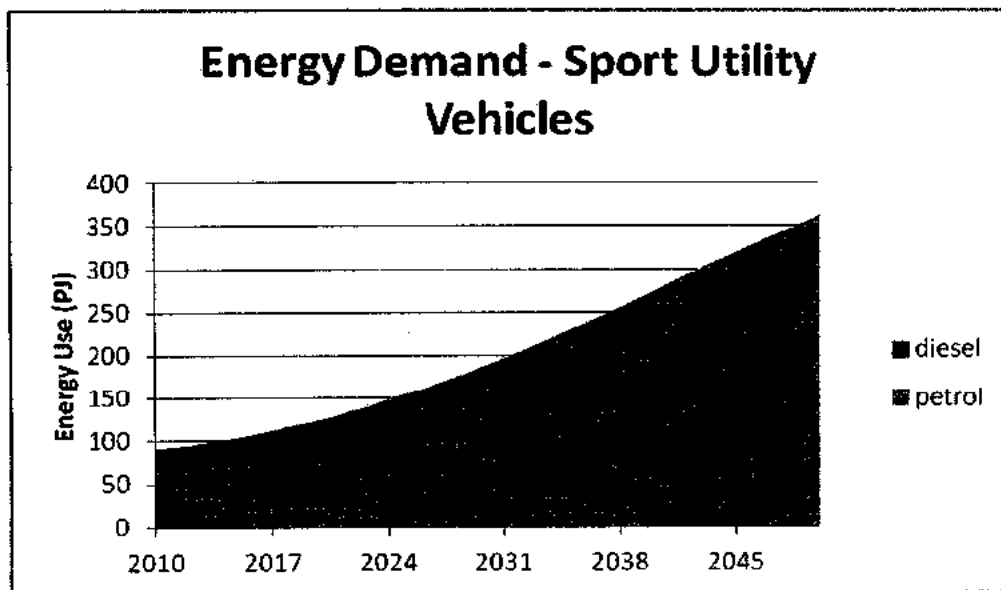


Figure 5-16: Projected energy use for SUVs

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5.2.5.3 Public Passenger Transport

In the public transport sector (Figure 5-17) buses are the cheapest option to providing passenger kilometres. The model output indicates that scrapping most of the existing minibus taxi fleet and replacing them with new buses would be a better option of meeting future passenger mobility requirements. However that said the capital investment required combined with the possible public resistance to replacing minibus taxis with buses limit this as a practical solution and closer consideration of these options is needed. It may also be argued that buses do not provide the same type of service based on trip length, frequency of service and other conveniences to the same extent that minibus taxis are able to. The model reflects that diesel continues to be the most used fuel for buses by 2050.

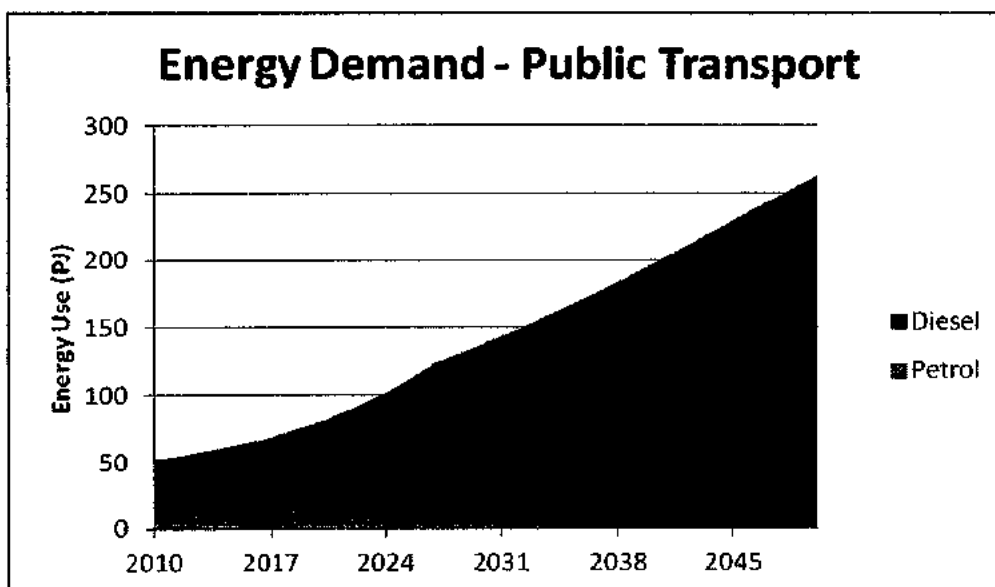


Figure 5-17: Projected energy use for public transport

5.2.6 Freight Transportation

In recent years the rail freight market has been losing its market share to road haulage, and presently it is estimated that 85% of total freight is hauled by road with the remainder being transported by rail. With the exception of coal and iron-ore most freight is hauled by road. Road freight transport with its higher reliability, flexibility, accessibility, security and shorter transit time, in comparison with rail freight transport, is preferred by the industrial sector and this has contributed to the increase in road haulage (Stander and Plenaar). However it also carries with it negative externalities such as increased and rapid damage to roads, road congestion, air pollution and higher fuel/energy requirements.

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Demand for freight haulage is highly linked to the value-add of the sector and overall economic growth and the assumptions about increased road haulage have informed the demand projections.

The projected energy demand for freight transport is depicted in Figure 5-18.

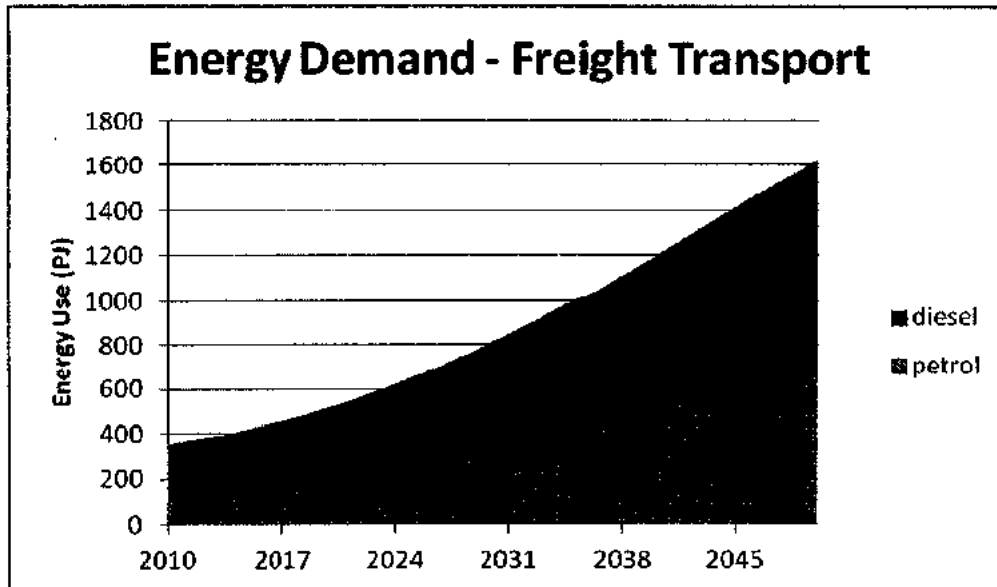


Figure 5-18: Projected energy demand for Freight Transport

Projections of new heavy and medium commercial vehicles correspond with historical trends and are directly related to the demand for these services as there are no alternative technologies considered.

While the shifting of freight from road to rail has significant advantages, including lower costs and fewer externalities, further analysis is required which will take into account the impact of the freight rail investment on shifting freight haulage from road to rail. Energy demand for freight transport will continue to be met through petrol and diesel into the foreseeable future. However it should be noted that government has now reviewed its rail investment programme to accelerate the shift of freight transport from road to rail and this will see an investment of about R63 billion by Transnet in the freight rail system over the next five years (SA Yearbook 2011/12). This could see a potential reduction in projected road freight haulage and a corresponding increase in rail freight transportation.

5.2.7 Residential Sector

Households consume ~20% of South Africa's total energy. This energy is provided from various sources including wood, dung and other vegetable matter, coal, paraffin, LPG, candles, electricity and natural gas. The main form of energy used is governed by availability, accessibility, cost of the energy carrier and

costs of energy devices. In 2006, ~73% of energy consumed by South African households was in the form of electricity, 29% in the form of coal, and 7.4% in the form of petroleum products (mostly illuminating paraffin but also a small amount of LPG).

Use of energy in households is predominantly for cooking (~38%), followed by space heating (~28%), water heating (~20%) and lighting (~5%), with the remainder primarily for other uses - predominantly electrical uses.

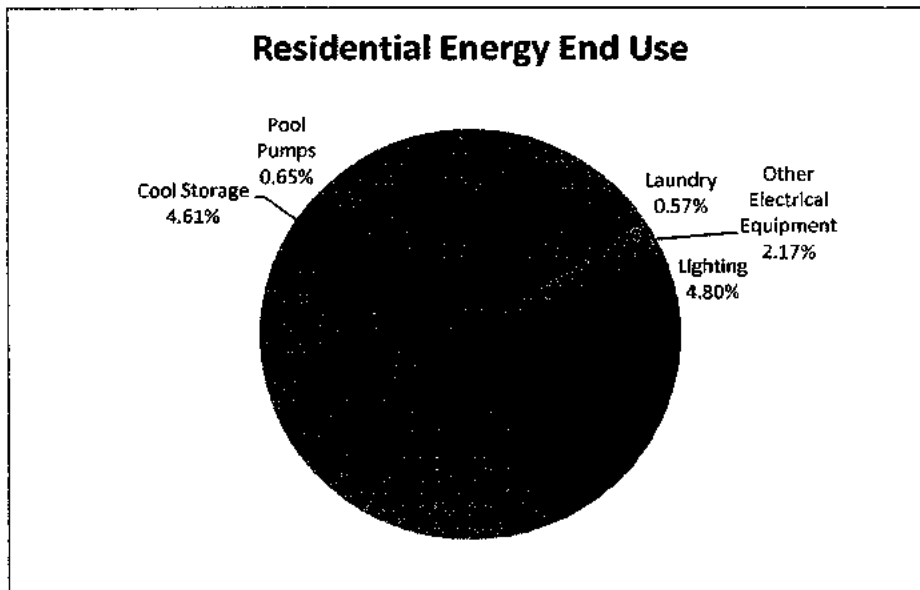


Figure 5-19: Energy End-Use in the Residential Sector

At the end of 2012, more than 75% of households (including informal households) in South Africa were electrified, totalling 9,809,136 households (www.energy.gov.za). The highest percentage (86%) of electrified households is situated in the Western Cape and the lowest percentage (60%) in the Eastern Cape (DoE, 2009). The percentage of households connected to the grid is projected to grow until 2033 to encompass 98% of total households within South Africa. After 2033 households which are not directly connected to the grid due to constraints of expensive electricity infrastructure cost will be able to access electricity through non-grid solar home systems.

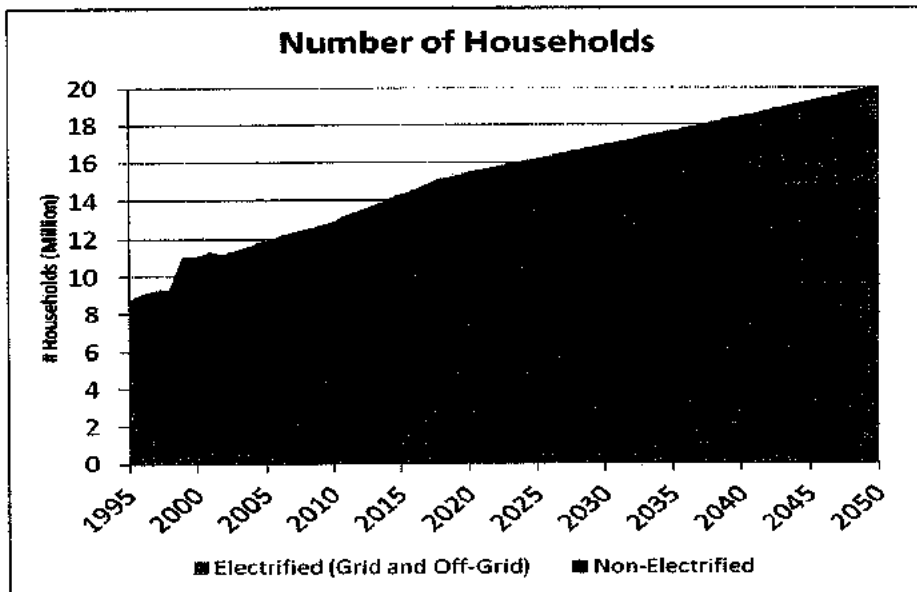


Figure 5-20: Projected number of electrified households

Increased electrification rates combined with continued developments in renewable energy technologies could see an increase in distributed electricity generation and a shift from use of other forms of energy (such as coal for cooking and space heating and illuminating paraffin for lighting) to electricity. However coal may continue to play a significant role in those areas situated close to mines and where coal is easily accessible and still relatively cheap.

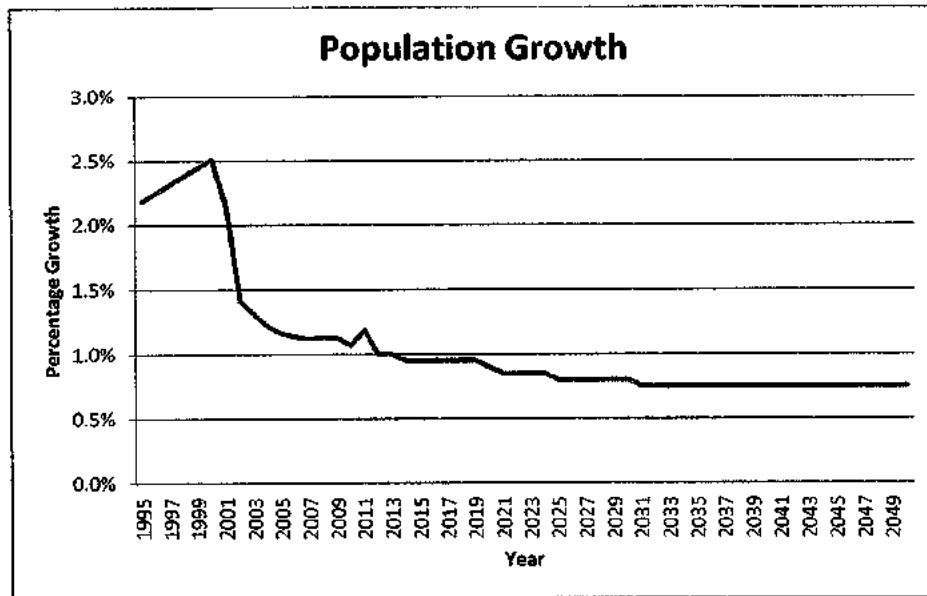


Figure 5-21: Projected population growth rate for South Africa

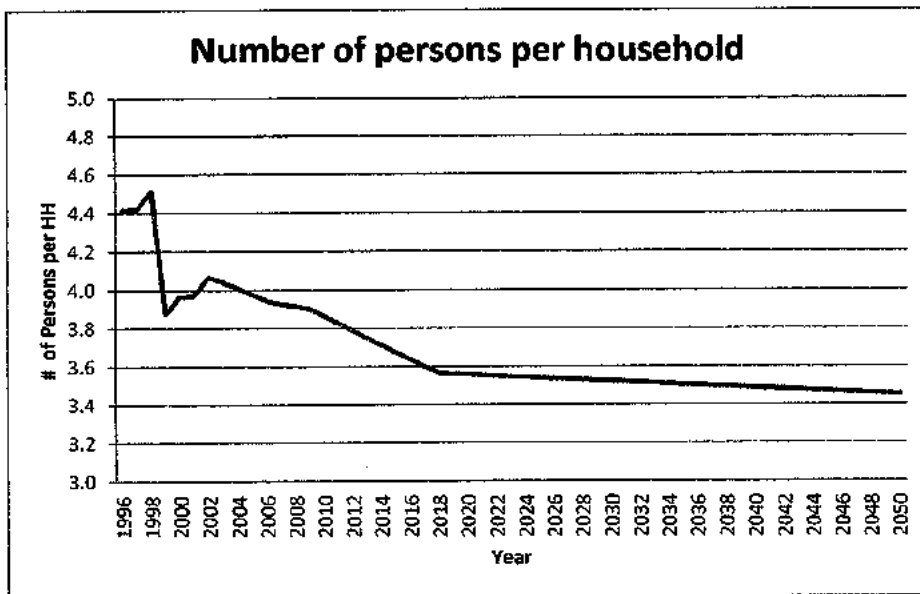


Figure 5-22: Projected number of persons per household

It is expected that, like the rest of the world, population growth will continue to be a key driver for energy demand in the household sector. The population growth rate in South Africa has been declining over the past 12 years and with increased urbanisation and household income, it is expected that it will continue to slow down and that the average number of persons per household will also decrease over time. Therefore while total energy demand is expected to increase as the population increases, the rate of increase is also expected to decline as a consequence. The composition of energy demanded or the forms of energy consumed will also change over time as household income and the number of electrified households increase. Increased urbanisation will also contribute towards the increase in the demand for electricity in the residential sector.

Based on the assumed population growth, projected number of households and the number of electrified households, the projected energy demand for the residential sector is depicted in Figure 5-23.

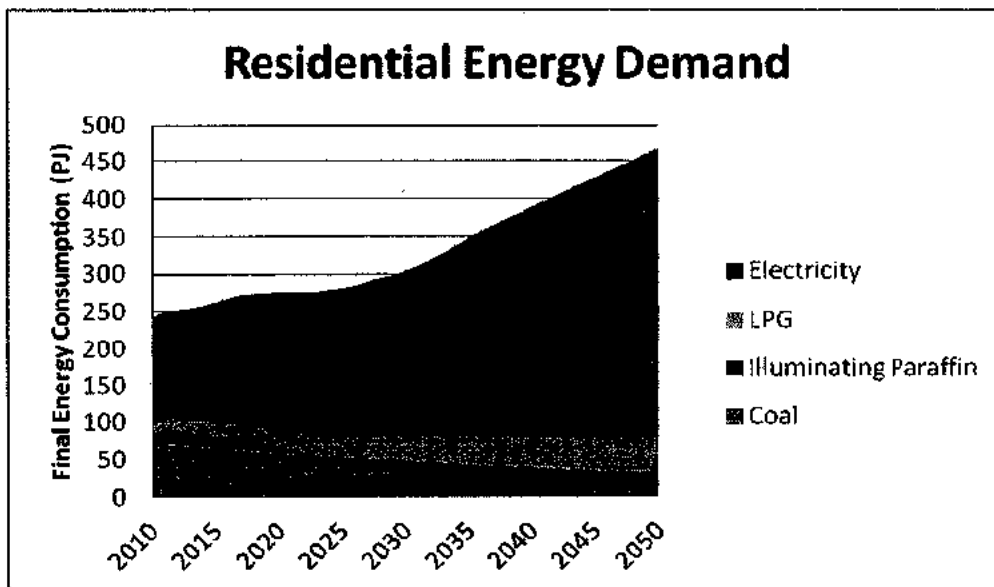


Figure 5-23: Projected Energy Demand for the Residential Sector

The decrease in coal usage continues while the use of cleaner forms of energy such as LPG and electricity increase and illuminating paraffin plays no role after 2022. Electricity continues to be the dominant energy carrier used within the residential sector with its share increasing substantially by 2050. However despite increased electrification, it is expected that coal will remain dominant in certain low-income households for the foreseeable future. Some of the key factors influencing the continued use of coal include the fact that it is relatively affordable fuel source (especially in communities close to mines) and it provides a dual utility (i.e. it provides thermal energy for space heating and cooking simultaneously).

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While the general demand for electricity is expected to rise, ongoing increases in electricity tariffs could dampen this demand. Energy prices affect affordability of energy, especially in low-income households and the potential impact that this may have on future energy demand has not been factored and requires further analysis.

5.2.8 Total Energy Demand in all sectors

The projected energy demand within individual sectors is depicted in Figure 5-24.

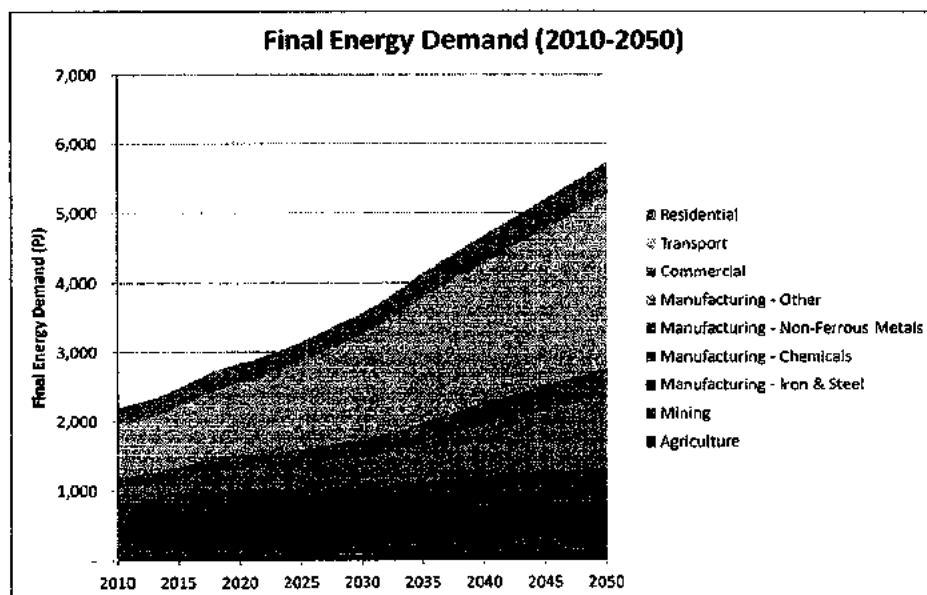


Figure 5-24: Projected demand within different sectors

The transport sector will continue to contribute the most significantly toward total energy demand. Demand for petroleum products therefore increases the most significantly between 2010 and 2050. This can be mostly attributed to the continued use of petrol and diesel vehicles into the foreseeable future with electric vehicles only starting to make a significant contribution for passenger transportation after 2030. Freight haulage, predominantly by road, contributes the most substantially to increases in transport demand and related fuel consumption.

Outside of the transport sector, the most significant energy demand increase is expected to be in industry (the manufacturing sector), followed by the commercial sector. The energy demand in the 'Other Manufacturing' sector is largely associated with projected economic growth, while the increase in energy demand within the commercial sector is associated with the continued expansion of the tertiary sector as South Africa moves to become more of a knowledge-based economy. Demand in the residential sector is largely informed by population growth coupled with increased urbanisation. As living standards improve, people also consume more energy; however energy efficiency interventions could see this trend start to slow down in the future.

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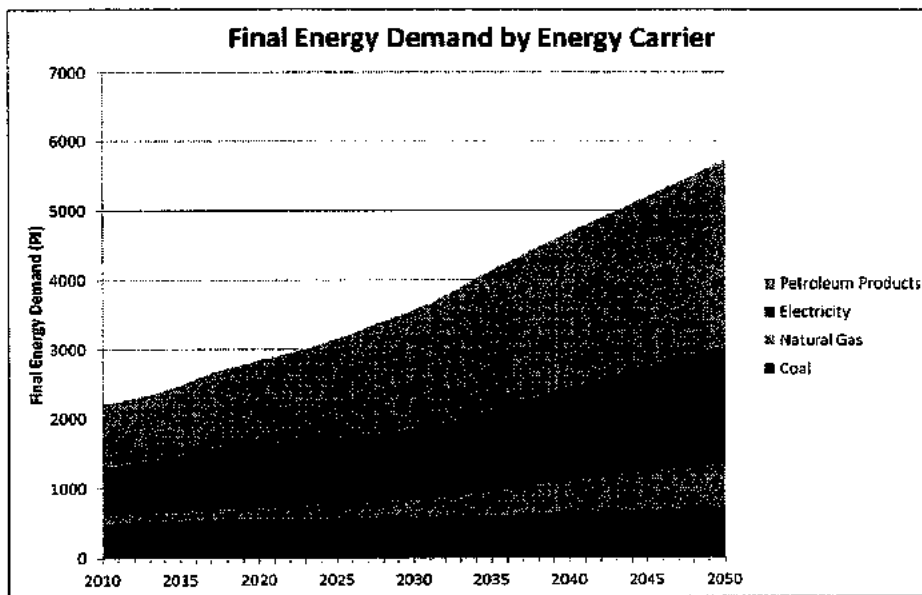


Figure 5-25: Total energy demand for different energy carriers

In line with the demand in different sectors depicted in Figure 5-24, demand for petroleum products increases the most significantly between 2010 and 2050 as this is primarily used within the transport sector. Demand for other petroleum products, is less significant, demand for LPG is expected to have a steady increase in the residential sector and although fairly minor ranks as the third largest increase between 2010 and 2050. Diesel consumption continues to increase in the mining sub-sector but only marginally when compared to electricity and natural gas. The use of illuminating paraffin is expected to decrease in future and to be negligible by 2025.

Demand for natural gas, although the least significant in terms of percentage share, shows the next most significant increase after that for petroleum products. Natural gas is primarily used within the industrial sector and the projected growth of the sector is a factor in this increase. Demand for electricity continues to rise as more houses become electrified and as the tertiary sector, largely comprised of commercial and public buildings continues to expand. In the industrial sector, the increase in electricity demand is largely attributed to the 'Other Manufacturing', non-ferrous and chemicals sub-sectors, with mining and iron & steel showing very little increase from current demand levels. Demand for coal continues to grow in the industrial sector, while in the residential sector it is expected to start declining as a result of ongoing electrification of previously non-electrified households and improvements in household income.

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The share of energy demanded across different sectors in 2010, 2030 and 2050 is provided in the table below.

Table 5-3: Proportion of Current and Projected Final Energy Demand within different Sectors

SECTOR	2010	2030	2050	Change
Industry (Excluding Mining)	37%	33%	34%	↓
Mining	8%	7%	4%	↓
Agriculture	3%	2%	3%	↓
Commerce	7%	7%	7%	↓
Residential	11%	9%	8%	↓
Transport	34%	43%	44%	↑
TOTAL	100%	100%	100%	

5.2.9 Energy Intensity

Figure 5-26 and Figure 5-27 below show the changes in energy intensity for the different energy demand sectors relative to 2010 levels. Using 2010 as the base year (with an energy intensity index = 1), energy intensity index below 1 indicates an improvement or reduction in energy intensity relative to that in 2010, while an energy intensity index above 1 indicates an increase in energy intensity relative to that in 2010.

Figure 5-26 indicates an improvement in the energy intensity of the industrial, mining, commerce and transport sectors. Although energy demand increases in the tertiary sector (commerce and transport) the rate of increase is slower than projected economic growth and continues to decline throughout the planning period. The energy intensity in the mining sector increases initially (between 2010 and 2017) and starts to decline thereafter.

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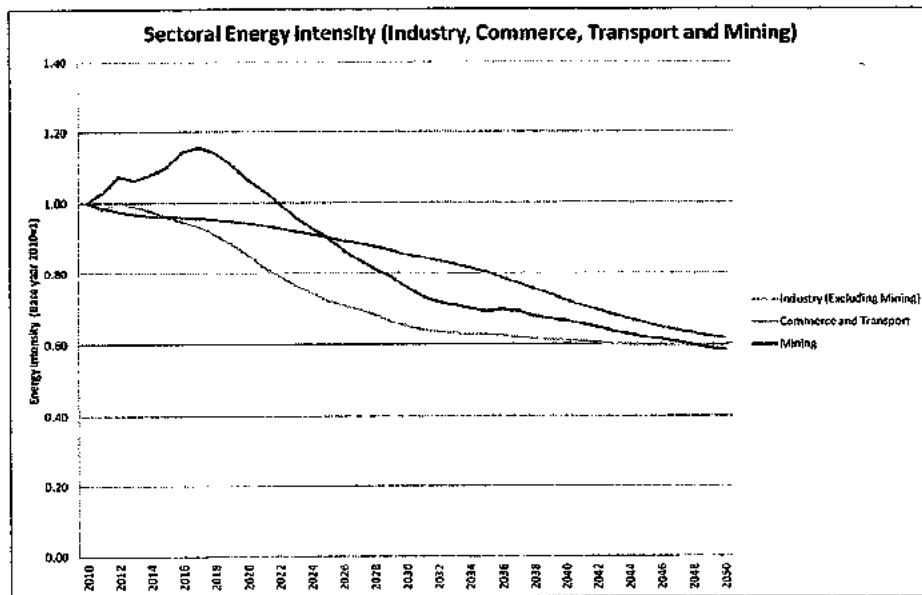


Figure 5-26: Energy Intensity Indices for the Industrial, Mining, Commercial and Transport Sectors

Unlike the sectors discussed above, energy intensity in the agricultural sectors worsens, followed by that in the residential sector (See Figure 5-27). In the agricultural sector, the significant increase in energy consumption is informed by large-scale intensive farming practices which continue to be adopted and the rate of future energy intensity improvements starts to decline. In the residential sector this is assumed to be influenced by the increasing population coupled with increased urbanisation and more energy consumption as household income increases.

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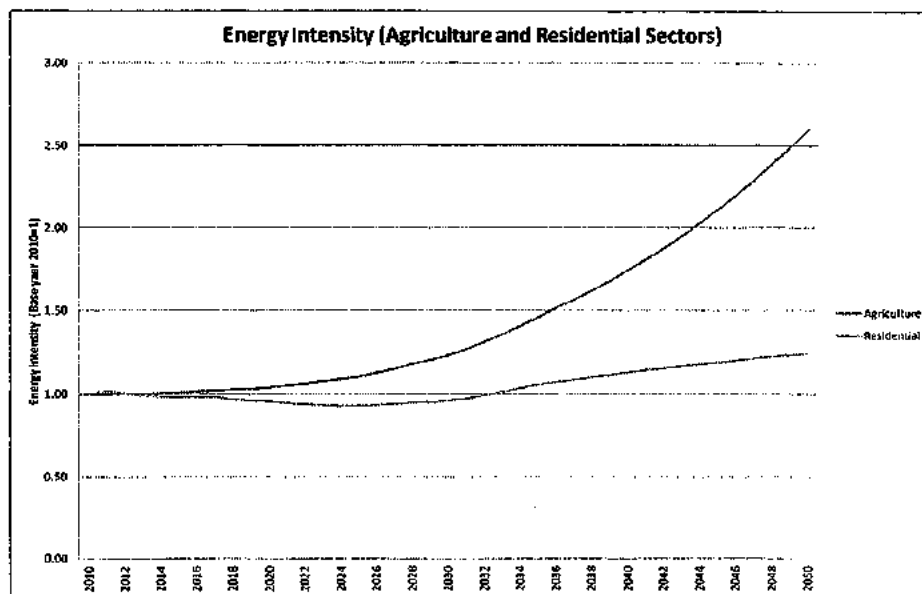


Figure 5-27: Energy Intensity Indices for the Agriculture and Residential Sectors

Figure 5-28 indicates an overall reduction in the intensity of the economy. Structural changes; significant changes in the level of activity; and technological and process improvements which have taken place within each of the sectors inform the projected demand and hence the reduction in energy intensity. Further analysis is required to quantify and separate the historical impact of structural changes, activity level changes and technological changes on energy intensity. Improvements in technologies, industrial processes and practices alone can play a significant role in future efficiency improvements and government policies, such as the recently published Draft National Energy Efficiency Strategy and interventions such as the financial and tax incentives for energy efficiency could materialise in further reductions of energy intensity within these sectors.

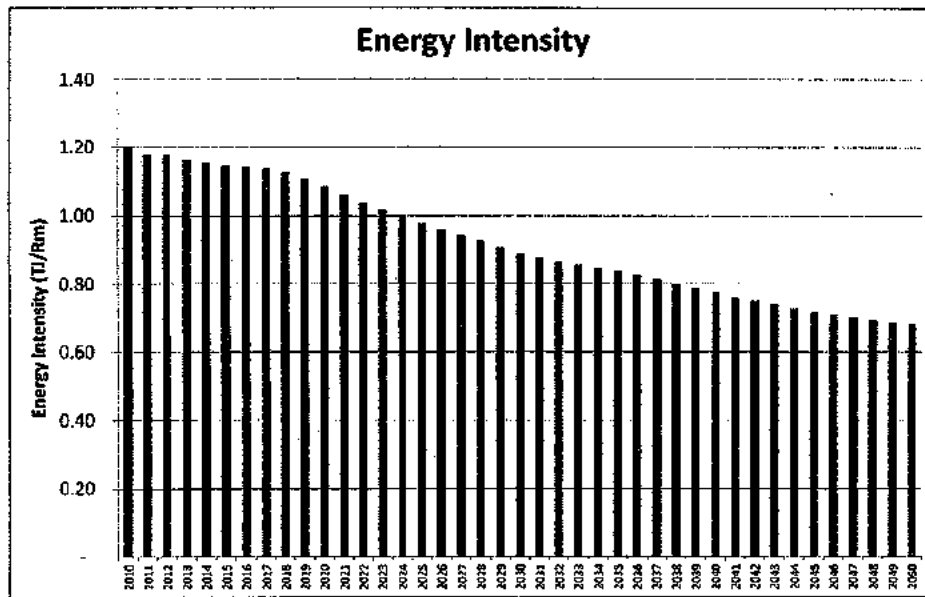


Figure 5-28: Energy intensity of the economy

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SECTION 6: BASE CASE POLICY ASSUMPTIONS AND TEST CASES

This section provides the assumptions about key policies, costs and other factors which have an influence on energy supply options; and which can be represented and simulated by energy models. While many real world phenomena (physical, financial and economic) have an impact on the future optimal supply options, the selected models and modelling approaches simplify reality by considering only a subset of parameters which have a significant impact. Furthermore, only those assumptions (about real world phenomena) which can be translated into model parameters and quantified as parameter values need mention. This section is therefore limited in scope to those assumptions which inform the final values of the model parameters for the Base Case and the various Test Cases which were modelled.

The demand projections are a key input into the energy model and inform the required supply capacity. The underpinning objective of the energy planning process is to ensure that future energy supply options meet future energy demand. However in order to ensure a balanced consideration of all the eight objectives, different supply-side energy options are explored based on different sets of assumptions and constraints. As a starting point, the 'Base Case' is defined and serves as a basis to measure the extent to which current interventions within the energy sector can meet the constraints and targets set by various policies.

From this base, policy options which enable policymakers to consider alternative energy pathways that can be pursued are identified and evaluated. During the integrated energy planning process, various policy options (referred to as Test Cases) were identified and modelled. These Test Cases were informed by national government policies which are considered to be high-impact policies for the energy sector, and include the Integrated Resource Plan, National Development Plan, the National Climate Change Response Policy and the impending Carbon Tax Policy.

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6.1 Base Case Assumptions

BASE CASE

- The Base Case encapsulates the state of energy demand and supply over the planning horizon, which is most closely informed by current energy market trends, the national macroeconomic outlook, assumed energy prices, existing energy infrastructure and the existing suite of policies and government programmes. Thus, while the IEP seeks to recommend an energy roadmap or policy pathway for the energy sector, this process is not conducted in isolation and should build on energy policies, strategies and plans which have already been adopted.
- The Base Case is therefore not a representation of the most likely future or most likely scenario, but is rather a simplistic representation of a future outcome that could materialise in light of current policies and macroeconomic trends. It represents a Business-As-Usual or Status Quo scenario where current trends continue into the future.

Table 6-1: Key IEP Base Case Assumptions

PARAMETER	DESCRIPTION	ASSUMPTION
IEP Planning Horizon	The period over which key assumptions which inform demand projections and supply options are made	2010-2050
Base Year	The starting year on which projections are made. Any values/data prior to and including the base year are based on actuals. While any values/data after the base year are projections.	2010
Annual Emission Limit	This sets annual limits on allowable emissions	No emissions limit constraints are defined in Base Case
Emissions Penalty	This enables emission penalties (such as the carbon tax) to be imposed in the model	No emissions penalties (carbon taxes) are defined in Base Case
Renewable Energy Minimum Production Target (electricity generation) Integrated Resource Plan	This allows for renewable energy targets to be set in the model (i.e. minimum capacity of total energy mix that must come from renewable energy technologies)	No renewable energy targets are set in the Base Case. Only renewable energy technologies as per the 2011 and 2012 determinations are included (See Table 6-2).
		The Policy-Adjusted IRP (IRP2010), which was promulgated in March 2011, sets targets as to the share of electricity-generation capacity by various carriers. Several projects included in the IRP2010 have already been committed, while a window of decision-making still remains open for firm commitments to be made on others. It therefore follows that all projects which are already committed are included in the Base Case of the IEP, while alternative options may still be considered for those technologies or projects for which firm commitments are yet to be made.
		Electricity supply options included in the IEP Base Case are therefore informed by the

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PARAMETER	DESCRIPTION	ASSUMPTION
		current commitments as defined in the IRP2010. These are Eskom's pre-IRP determinations as well as the 2011 and 2012 determinations (See Table 6-2).
Liquid Fuel Production		No constraints are defined for liquid fuel production
Technology Options		All technologies are considered and there are no model constraints on energy supply options

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Market activity alone does not deliver optimal solutions to the challenges faced by the energy sector, such as the guarantee of energy security, the reduction of GHG emissions, the reduction in energy intensity, or increasing energy efficiency within the economy. Thus, in some instances government intervention – through policy and regulation – is necessary to ensure the delivery of certain services to the public and the attainment of certain policy objectives.

Energy is an integral part of the economy and the energy sector is a key enabler for the attainment of national policy imperatives. It is therefore important to quantify and provide feedback on the extent to which the energy sector can contribute to the attainment of various national policy imperatives. It is equally important to quantify and provide feedback on the extent to which policy objectives outside the energy sector may impact on the attainment of energy sector imperatives.

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In section SECTION 2: several policies, identified and described as "high-impact" policies, were discussed. These "high-impact" policies have a significant impact and influence on the development of energy policies as they require some level of intervention or deviation from the status quo from the energy sector. Therefore while the Base Case largely assumes that only prevailing policies are pursued to shape the future energy pathway, the effects of these "high-impact" policies on the future energy landscape is considered and the concept of different Test Cases to explore these possible policy impacts is introduced.

TEST CASE

- A Test Case will be defined as a deviation from the status quo where current trends do not continue into the future and deviations are as a result of specific policy interventions. A Test Case therefore defines a set of circumstances and resultant outcomes or impacts which is informed by the possible impacts of policies and policy interventions. A Test Case does not indicate what will happen but rather tests what could happen if a particular course of action is pursued.
- While Test Cases are sometimes also referred to as scenarios, within the context of the IEP and for the purposes of common interpretation, a Test Case is specifically differentiated from a Scenario in that a Scenario is largely influenced by exogenous forces which the policy maker has no control over, while a Test Case seeks to test the possible implications of active policy interventions.

This section provides a list of the Test Cases that were considered and modelled during the energy planning process. A brief background of the policy issues which led to the choice of these Test Cases is also provided.

6.2.1 Policy Issue: Climate Change and Emissions Reduction

According to the National Climate Change Response Policy (NCCRP), the energy sector contributed about 80 percent towards total carbon emissions for the country in 2000, of which the majority arose from electricity generation (40 percent of total emissions). Emissions from oil refining and production of synthetic fuels (CTL and GTL) were estimated to contribute 9 percent towards total emissions. Therefore, total emissions from the energy transformation and conversion processes contribute approximately 49% towards total emissions.

The President announced that South Africa will implement mitigation actions that will collectively result in a 34% and a 42% deviation below a 'Business As Usual' emissions growth trajectory by 2020 and 2025 respectively. The NCCRP defines these targeted reductions in total emissions as the 'Peak-Plateau-

Decline' emissions trajectory, and the work on further translation of these reductions by each sector is currently underway.

The extent to which this outcome can be achieved depends on the extent to which developed countries meet their commitment to provide financial, capacity-building, technology development and technology transfer support to developing countries. With financial, technology and capacity-building support, this level of effort will enable South Africa's GHG emissions to peak between 2020 and 2025, plateau for approximately a decade and decline in absolute terms thereafter.

The national emissions limits aligned with the "Peak-Plateau-Decline" trajectory are presented in Figure 6-1.

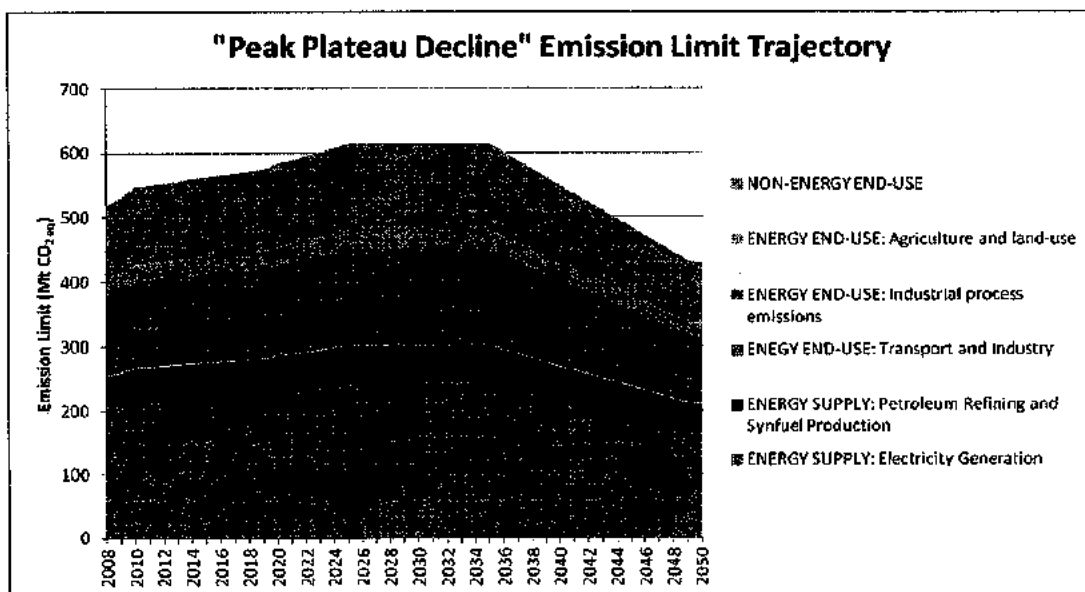


Figure 6-1: National CO₂ emissions limits for Peak-Plateau-Decline

In light of the above and in efforts to support the country's aspirations of reducing emissions, the National Treasury has published a draft Carbon Tax Policy Document which will introduce a carbon tax across all relevant sectors.

6.2.2 Policy Issue: Addressing Climate Change and the Role of Alternative Supply Options such as Nuclear and Natural Gas

Nuclear is seen as a viable electricity supply option in moving the country towards a low emissions trajectory. The IRP 2010 recommends power generation from nuclear power stations as a viable supply option and sees the capacity of nuclear power plants contributing approximately 20% towards the total energy mix by 2030 as compared to 5% in 2010. The nuclear policy sees nuclear technology playing a

significant role in reducing emissions from electricity generation as well as contributing towards diversifying the energy mix.

One of the recommendations from the National Development Plan is that while clean-coal technologies (such as Carbon capture and Storage) are still in the nascent stage of development, natural gas should be considered as an alternative to coal, provided that the overall economic and environmental costs and benefits outweigh those associated with South Africa's dependence on coal, or with the alternative of nuclear power. All conventional and unconventional natural gas options should be considered and these include off-shore natural gas coal-bed methane and shale gas.

6.2.3 Policy Issue: The role of Renewable Energy Technologies in moving towards a low-carbon economy

The Renewable Energy White Paper sets a contribution target of 10 000 GWh of renewable energy towards the final energy consumption by 2013. Furthermore, the policy states that the renewable energy is to be utilised for power generation and non-electric technologies such as solar water heating and biofuels. The 10 000 GWh was estimated at approximately 4 percent (1 667 MW) of the projected electricity demand for 2013, which had been projected as 41 539 MW.

While the actual realisation of this target has lagged behind, government remains committed to increasing the share of renewable energy within the total energy mix of the country.

Given the rapid development of renewable energy technologies and the role that they can play in reducing emissions and providing both on-grid and off-grid supply options, these should be considered as an alternative options provided that the environmental and economic benefits outweigh those of other supply options.

6.2.4 Policy Issue: Liquid Fuels Supply Options under different crude oil price scenarios

While mobility is a key contributor to energy demand, developments in technology could see the move away from traditional modes of transport (e.g. liquid fuel powered passenger vehicles) to more efficient and less costly means of transport (e.g. electric trains and passenger vehicles, CNG buses). However the penetration of these modes of transport and the associated impact on the demand for liquid fuels is projected to only be felt in the long term (i.e. more than 20 years). Therefore for South Africa, it is assumed that traditional modes of transport (i.e. fuel-powered vehicles, with minimal penetration of electric and hybrid vehicles) will continue into the foreseeable future (Kruger, 2012). The continued reliance on liquid fuel and inherently crude oil presents with it various challenges.

As a net importer of crude oil, South Africa is a price taker in the oil market and its market is highly sensitive to fluctuating global oil prices.

The Department of Energy is in the process of introducing new fuel specifications (CF2) which will ensure a refined product with reduced sulphur content, thereby reducing the quantity of pollutants from the liquid fuel and transportation sectors. South Africa is currently also considering the construction of new refining capacity which would be aligned with these specifications.

The National Development Plan presents five different options that South Africa should consider and provides a high-level analysis of the advantages and disadvantages associated with each of the options presented:

- 1) Build a new oil-to-liquid refinery;
- 2) Build a new coal-to-liquid refinery;
- 3) Upgrade existing refineries or allow significant expansions of one or more of the existing refineries or both;
- 4) Import refined product; and/or
- 5) Partner with Angola or Nigeria to build a new refinery.

These options need to be analysed and evaluated such that decisions made in the short-term remain viable in the long-term.

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Table 6-3: List of Test Cases

TEST CASE	DESCRIPTION	POLICY ISSUE
'Peak-Plateau-Decline' Emissions Limit Case	- Annual emissions limits for power generation and liquid fuel supply as derived from the 'Peak-Plateau-Decline' trajectory are set as the upper bound. - No carbon tax is imposed and emission constraints are met through energy supply options. - All supply options are considered (including nuclear and natural gas options).	This Test Case seeks to evaluate alternative energy supply technology options and the associated financial implications of ensuring that the energy sector meets the emission reduction targets defined in the National Climate Change Response Policy.
Emissions Limit - No Nuclear Build Programme Case:	- The emissions limits of the "Peak Plateau Decline" must be met. - The 9,600MW Nuclear Build Programme is explicitly excluded as a supply option.	Given the country's commitments to reduce carbon emissions, coupled with the public outcry from various interest groups regarding the role of nuclear technology in the energy mix, this Test Case seeks to assess the efficacy of ensuring security of supply while simultaneously ensuring that the emissions reduction targets are met without nuclear as a supply option.
Emissions Limit - Natural Gas (No Nuclear) Case	- The emissions limit of the "Peak Plateau Decline" trajectory must be met. - The Nuclear Build Programme is explicitly excluded as a supply option. - Natural gas options for electricity generation are explicitly included as a policy intervention.	This Test Case seeks to analyse the efficacy of including natural gas in the energy supply mix as a transitional fuel towards a low carbon economy and the implications of choosing this as a supply option over nuclear. In this context natural gas includes conventional gas, coal bed methane and shale gas.

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Carbon Tax Case	- No emissions limit constraints are set. - A carbon tax of R120 per ton of CO₂-eq above the 60% tax-free threshold is set for the first five years. The carbon tax rate is increased by 10% per annum for a further five years and is absolute thereafter.³ This test case seeks to provide insight as to the efficacy of a carbon tax on the reduction of emissions to be within the "Peak-Plateau-Dedine" trajectory. It also analyses the cost implications of a possible carbon tax on the energy sector as defined in the impending Carbon Tax Policy.
Renewable Energy Target Case	- No emission limit constraints are set. - Renewable energy options are gradually introduced into the energy mix from 2010 to 2030 such that by 2030, 10% of total energy output (electricity generation and liquid fuel production) is from renewable energy sources. - From 2031 onwards, the target of 10% is maintained as a minimum. (It should be noted that given the low load factors for most renewable energy technologies, the installed capacity would effectively be much higher than 10%). This Test Case analyses the efficacy of setting renewable energy targets for reducing emissions within the energy sector. It also provides insight into the economic implications of renewable technologies as an alternative option in the energy mix.
Low Crude Oil Price Case	In these test cases sensitivity analyses of the low and high crude oil price scenarios are conducted to determine the most optimal liquid fuel supply options under each price scenario. These sensitivity analyses seek to assess the best way of ensuring security of fuel supply in the country for different sets of crude oil price scenarios. (Note: Fuels pertain to final product and therefore includes fuel produced from conventional crude oil refineries as well as syngas from coal to liquids (CTL) and GTL production processes). This therefore seeks to provide responses to the five liquid fuel supply options presented in the National development Plan.
High Crude Oil Price Case	- The prices of other commodities coal and natural gas are assumed to remain the same as for the Base Case. - No emissions limit constraints are set.

³ The actual value of the carbon tax is subject to review once the Carbon Tax Policy has been promulgated

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SECTION 7: ANALYSIS OF MODEL OUTPUT

This section provides a summary of the results from modelling the Base Case and the Test Cases described in the previous section. The detailed analysis of the model output is provided in the Technical Report on Model Output (**Annexure A**). The section is structured as follows:

- **Total Electricity Generation and Liquid Fuel Capacity by Technology Type**
- **Primary Energy Use:** The sources of primary energy are discussed as well as the change in the primary energy mix within the particular Test Case.
- **Discounted cost of plan:** The discounted costs for all technology types for the planning period are provided.
- **Overall Emissions and Water Usage:** The implications for water demand and carbon dioxide emissions are presented for the whole energy supply sector.

7.1 Electricity Generation Capacity

Figures 7-1 through to 7-5 provide total capacity for electricity generation between 2010 to 2050 for the Base Case and several Test Cases for various technology types. The technology options for electricity generation for the High Oil Price and the Low Oil Price Test Cases remains the same as the Base Case as changes in crude oil price have little impact on electricity generation options.

- Coal technologies continue to play a role in the Base Case and all Test Cases however this is reduced significantly by 2030 as the existing fleet of coal technologies starts to be retired. The role of coal technologies continues to decline in the three Test Cases within emissions limits as no new coal power plants (besides Medupi and Kusile) are brought onstream. However in the Base Case and the Renewable Energy Target Cases new coal technologies continue to contribute to electricity supply (approximately an additional 50GW by 2050 in the Base Case and 30GW in the Renewable Energy Target Case).
- Solar plays a significant role in the Base Case and all Test Cases as the cost of solar technologies is projected to continue declining in the foreseeable future. Solar shows the biggest increase in contribution to the total energy mix in the Base Case and all Test Cases.
- The contribution of wind technologies reduces in the Base Case as other options are more cost effective in the absence of emissions limits or renewable energy targets and as wind technologies. However wind does play a significant role in the Emissions Limit and Renewable Energy Target Test Cases. Wind shows the second biggest increase in contribution in all Test Cases.

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- A new nuclear plant is selected by the model in the Emissions Limit Case with no explicit exclusion of nuclear. Nuclear, together with Renewable Energy technologies are therefore viable options in reducing emissions in the Emissions Limit Test Cases.
- Biomass only features in the Renewable Energy Target Test Case in order to ensure that the renewable energy targets are met.
- Besides the natural gas options included as part of the ministerial determinations, new natural gas options do not feature prominently in the Base Case or any of the Test Cases. New natural gas only features in the Test Case where Natural Gas options are explicitly enforced.
- While coal-fired power plants with Carbon Capture and Storage (CCS) technologies were considered as an option, due to their relatively high cost the model does not select any CCS technologies in the Test Cases with emissions limits as other cheaper alternatives are available.

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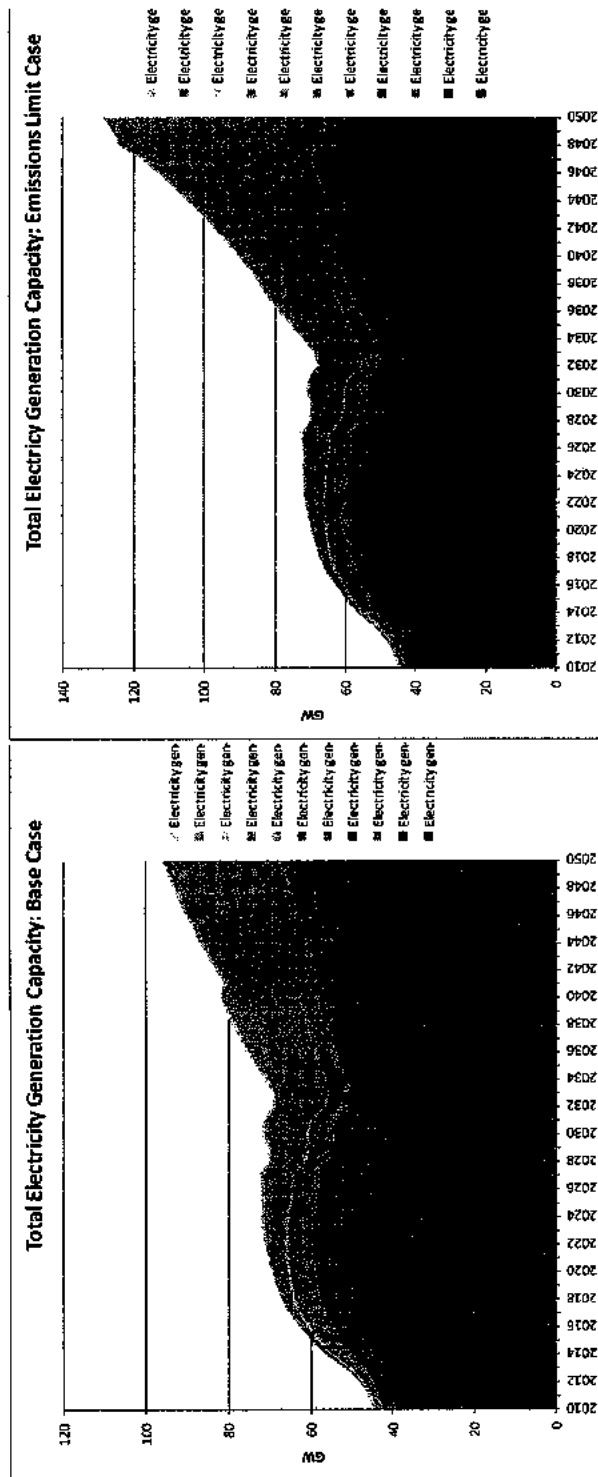


Figure 7-2: Electricity generation capacity: Emissions Limit Case

Figure 7-1: Electricity generation capacity: Base Case

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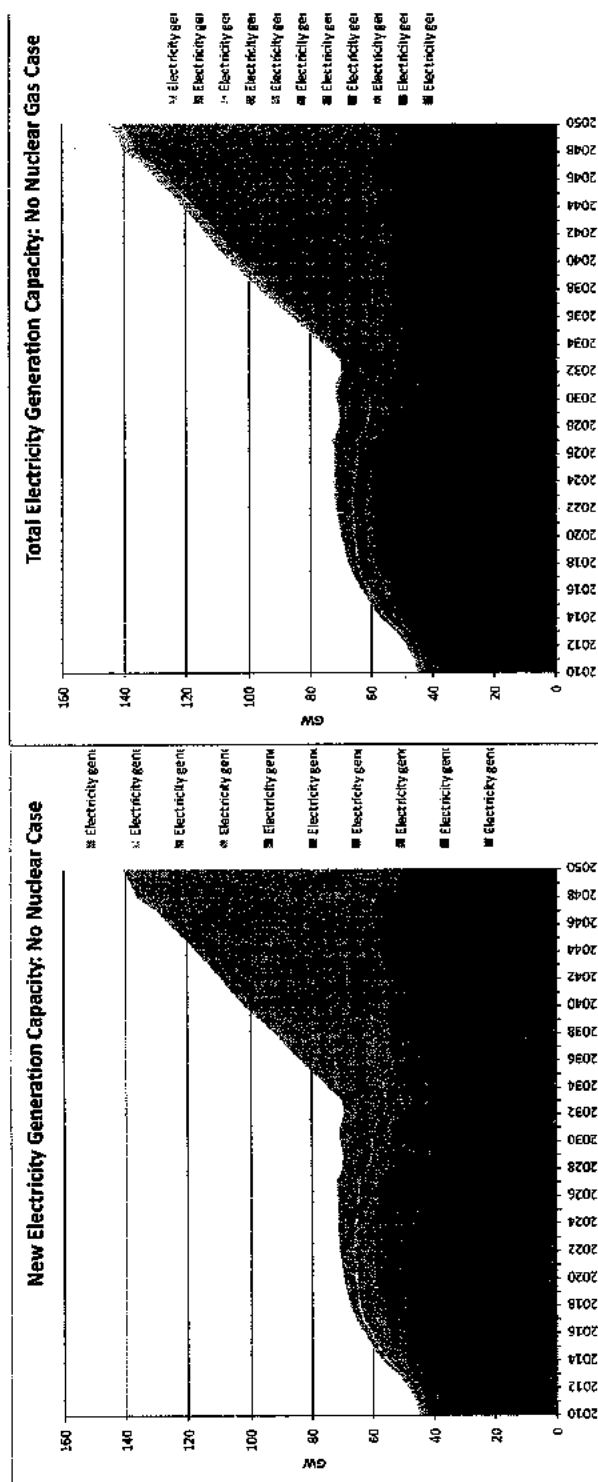


Figure 7-3: Electricity generation capacity: Emissions Limit -- No Nuclear Case

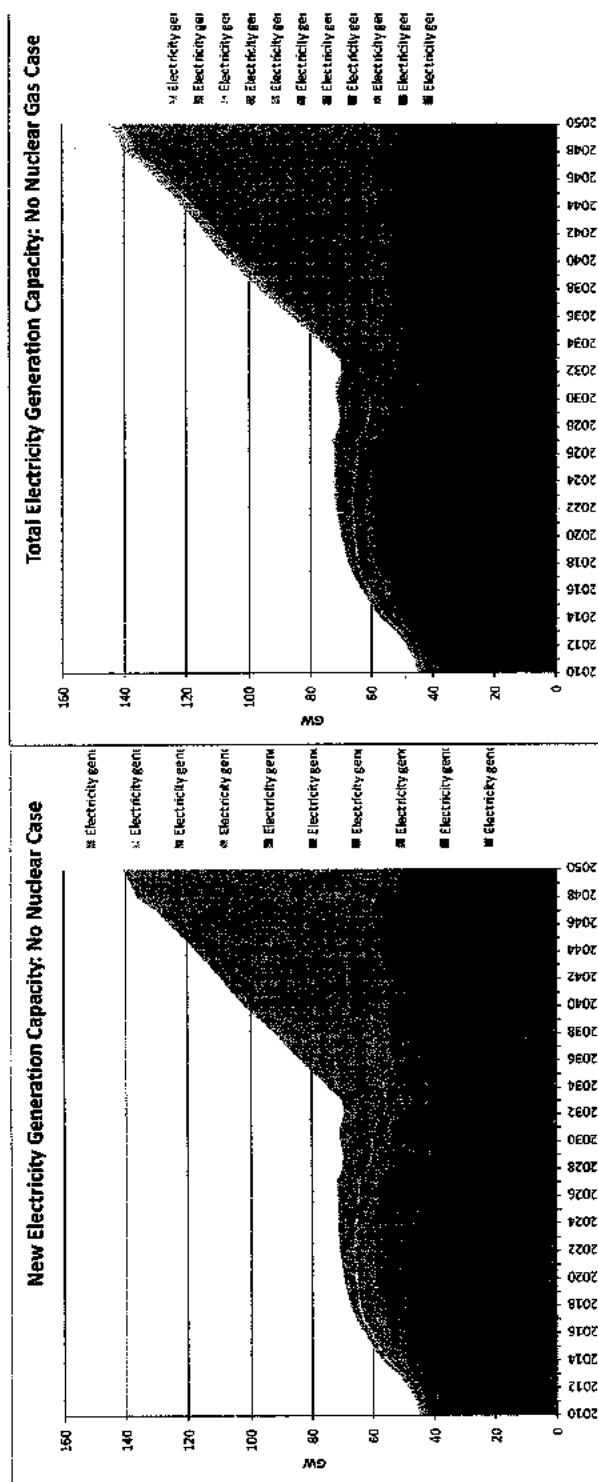


Figure 7-4: Electricity generation capacity: Emissions Limit - Natural Gas Case

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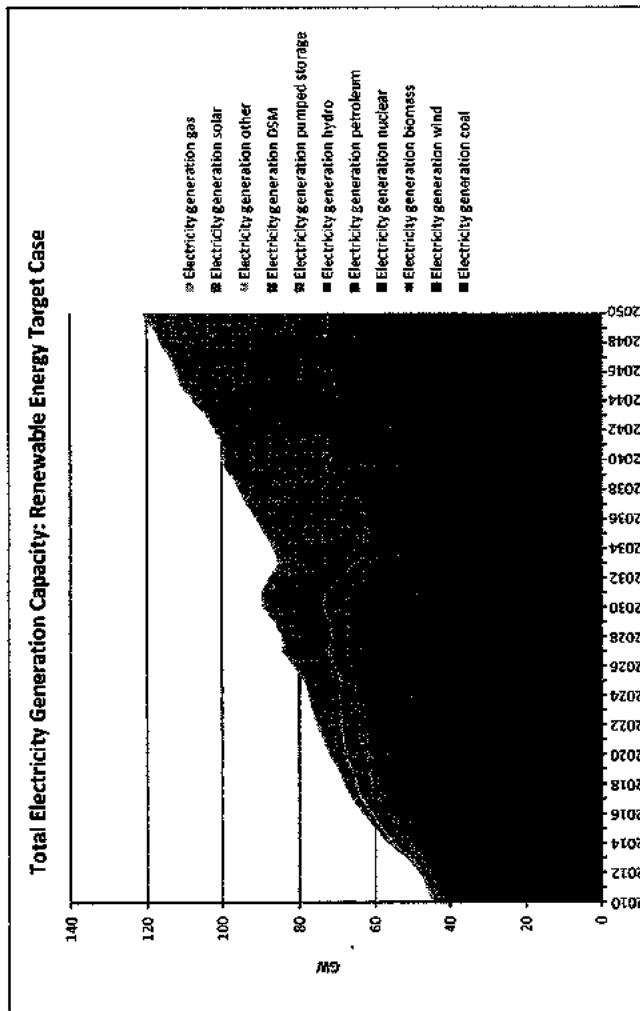


Figure 7-5: Electricity generation capacity: Renewable Energy Target Case

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Figures 7-6 and 7-7 indicate the proportion of electricity generation by the various technology types at 2030 and 2050. While the share of electricity generation capacity by technology type is similar in all test cases in 2030, by 2050 there is a significant reduction in electricity generated from coal and this is replaced largely by solar, followed by wind technologies. The Emissions Limit Case with no technology constraints presents an electricity generation mix with the most diversity in terms of technology and nuclear plays a prominent role. Given the low load factors for most renewable energy technologies, the total installed capacity for the Test Cases with significant renewable energy technologies is higher than for those Test Cases without.

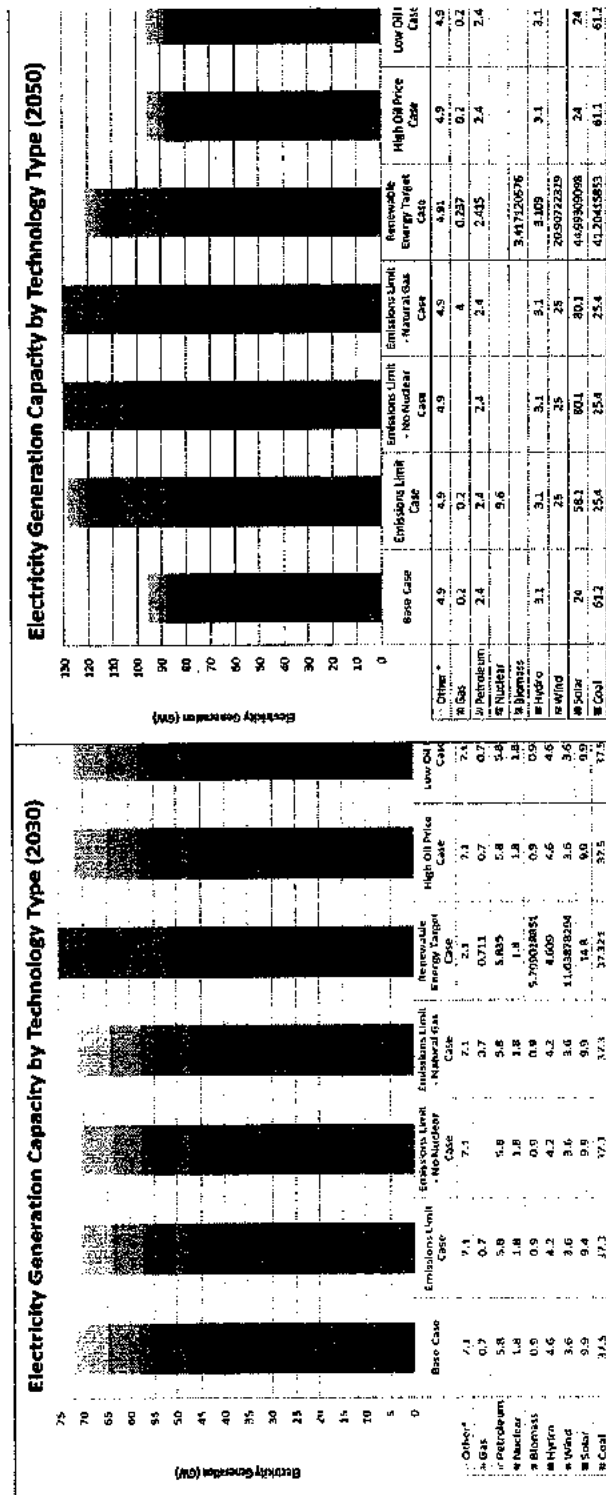


Figure 7-7: Electricity generation capacity by technology type (2050)

Figure 7-8: Electricity generation capacity by technology type (2030)

7.2 Liquid Fuel Production

Figures 7-8 through to 7-12 provide total capacity for liquid fuel production between 2010 to 2050 for the Base Case and several Test Cases for various technology types. The exclusion of nuclear energy (i.e. Emissions Limit – No Nuclear Case) has no significant impact on the liquid fuels sector in comparison to the Emissions limit case. Likewise the enforcement of natural gas as a supply option (i.e. Emissions Limit – Natural Gas Case) also has no significant impact on the liquid fuel sector. The output from these two test cases therefore requires no further analysis in this section as the output is the same as that for the Emissions Limit Test Case.

- In the Base Case and all Test Cases, the model selects new refining capacity to meet future liquid fuel demand from as early as 2020.
- New conventional crude oil refineries are a viable option in the Base Case and all Test Cases, however additional capacity in the outer years is reduced for the Emissions Limit Test Cases. It is assumed that existing conventional refineries are not retired within the modelling period and that their operational life is extended through continued maintenance, occasional upgrades (usually related to fuel specifications) and the low cost of maintaining the existing refineries relative to the cost of crude oil processed.
- In the Base Case and test cases without emissions limits, the cost of producing liquid fuels from coal are lower than both conventional refineries and gas to liquids as presented in the assumptions. In these test cases coal to liquids is built to the maximum constraint set in the input parameters of 80 000 barrels per day, after which conventional refineries are added to provide for the liquid fuels demand. In the Emissions Limit Test Case, new coal to liquid plants are restricted to their high carbon emissions and a new plant only features after 2040 when the existing coal to liquids plant is decommissioned and the use of electric vehicles reduces overall emissions below the emissions limits therefore providing scope for the more cost-effective coal to liquid plant. In the absence of a carbon tax, the total discounted cost of providing liquid fuels from coal to liquids is lower than both conventional refineries and gas to liquids.
- The total liquid fuel production slows down by 2034 and plateaus to 2040 after which it declines as a result of electric vehicle penetration.
- No new Gas-to-Liquid (GTL) plants are selected by the model. This is partially informed by the relative costs of new GTL plants as compared to conventional crude oil refineries

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- In the absence of emissions limit constraints, the model output shows very little sensitivity to different crude oil price assumptions with conventional refining capacity increasing in the outer years.
- All supply shortfalls are met via imports in all Test Cases.
- In 2012 the Department of Energy has published Regulations on the Mandatory Blending of Biofuels with Petrol and Diesel. The regulations require a minimum concentration of 5% biodiesel blending and between 2% and 10% for bio-ethanol blending. The requirement for biofuel blending has not been explicitly included in the model but will have negligible impact on the liquid fuel supply options for the Base Case and the various Test Cases.

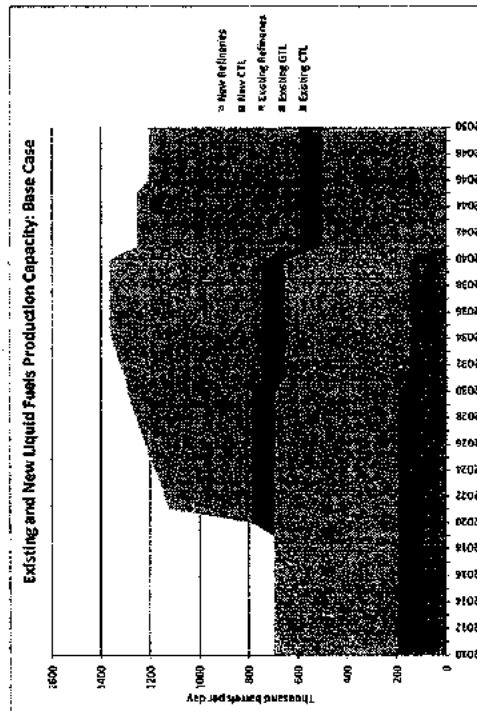


Figure 7-8: Total capacity in liquid fuel production: Base Case

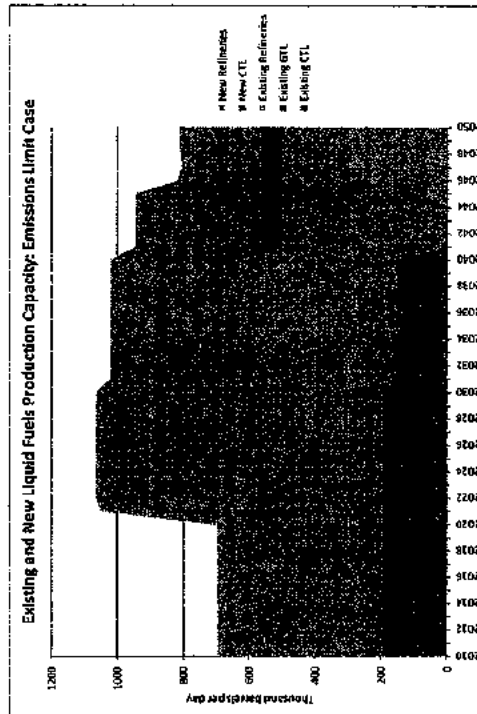


Figure 7-9: Total capacity in liquid fuel production: Emissions Limit Case

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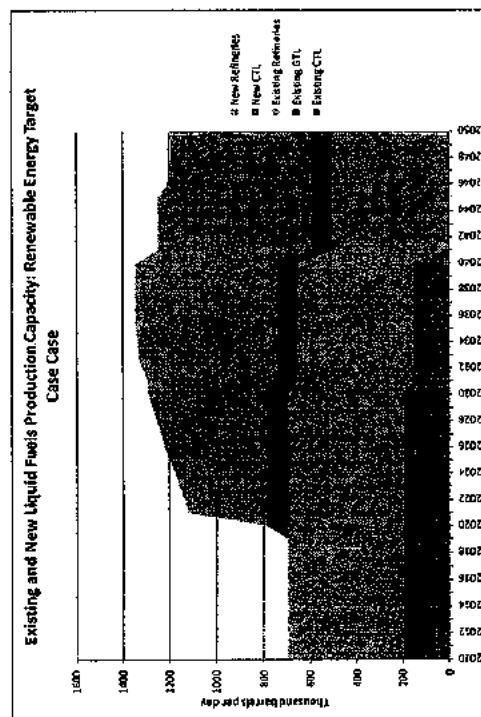
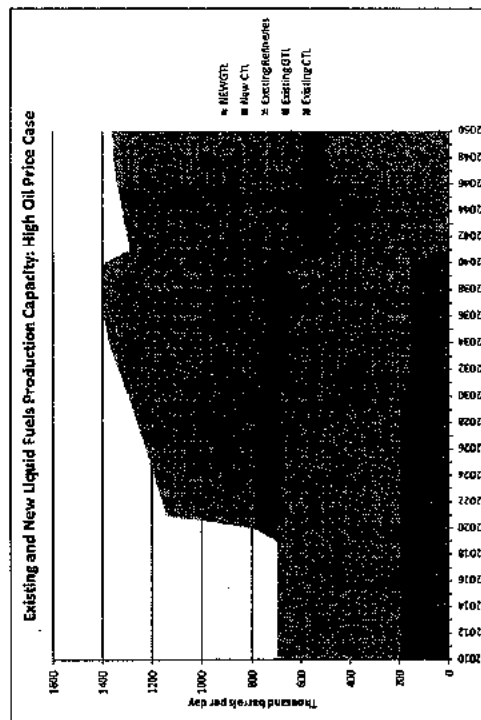


Figure 7-11: Total capacity in liquid fuel production: High Oil Price Case

Figure 7-10: Total capacity in liquid fuel production: Renewable Energy Target Case

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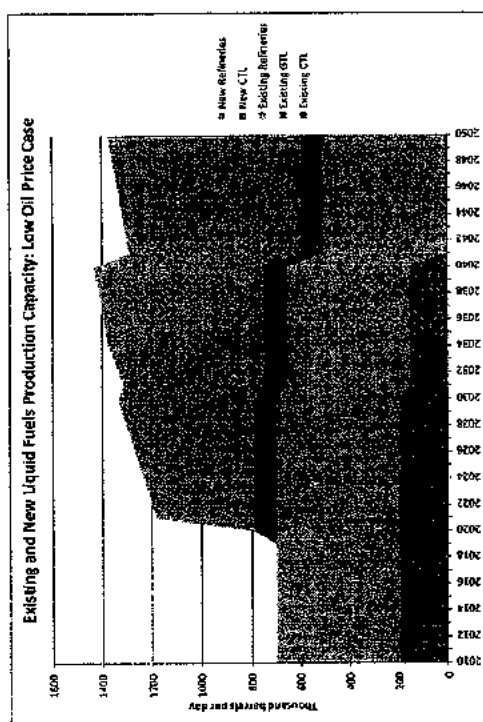


Figure 7-12: Total capacity in liquid fuel production: Low Oil Price Case

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While figures 7-8 to 7-12 present total installed capacity, Figures 7-13 and 7-14 indicate the proportion of liquid fuel production from different refining technologies at 2030 and 2050. In the Base Case and the Low Oil Price Test Cases, existing refineries operate close to their technical capacity, while for the Emissions Limit Test Cases and the High Oil Price Case activity is reduced due to carbon emissions constraints and the cost of production due to high crude oil prices respectively.

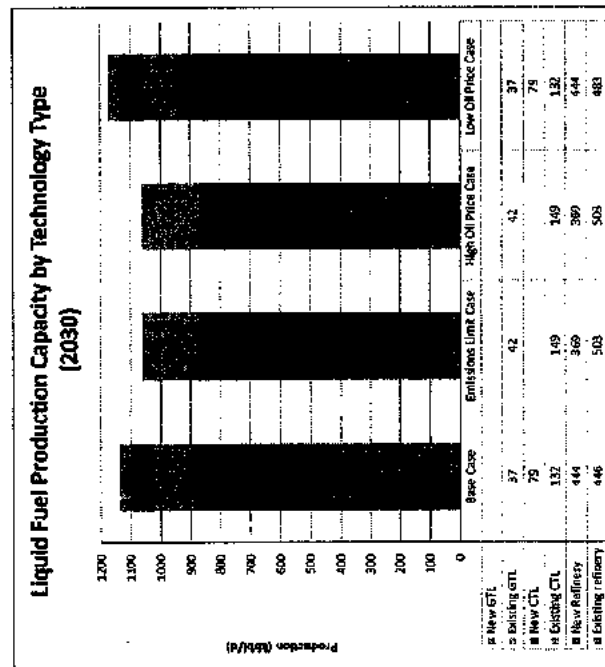


Figure 7-13: Liquid fuel production by technology type (2030)

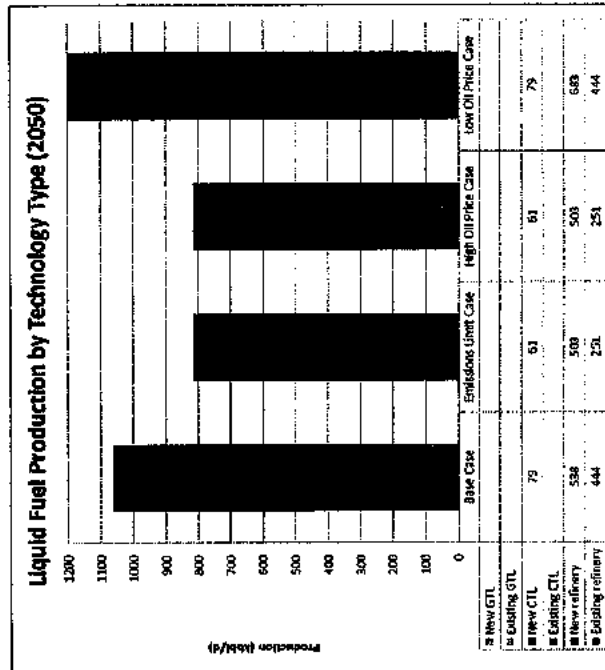


Figure 7-14: Liquid fuel production by technology type (2050)

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7.3 Primary Energy Use

- Coal loses its share in the primary energy mix in the Base Case and all three Test Cases however this is pronounced in the Emissions Limit Cases.
- Transport demand continues to increase which results in an increase in the demand for liquid fuel. In the Base Case and the Test Cases without emissions limits this demand is met through local production (primarily crude oil refining and limited production of synfuels from coal and gas). The share of crude oil in the primary energy mix therefore increases in these Test Cases.
- In the Emissions Limit Test Cases, local production of liquid fuel is displaced with imports and this sees an increase in the share of petroleum products in the primary energy mix. In the High Crude Oil Price Case, the import of final product surpasses crude oil imports and the inverse is the case in the High Crude Oil Price Case.
- Imported natural gas plays an increasing role in all Test Cases throughout the planning; however this is not prominent in comparison to other primary energy sources.
- New nuclear only features in the Emission Limit Test Case without technology constraints
- Solar technologies are viable and play a prominent role in all Test Cases however the share contribution is reduced in the Renewable Energy Target Case as Wind – which is included earlier in this Test Case reduces new renewable energy technologies in the future.
- New biomass only features when a renewable energy target is set.

7.4 Discounted Costs

The total discounted cost represents all the costs of the energy system discounted to a single number for comparison purposes. It is the main variable used to compare the various test cases developed for the Integrated Energy Plan.

A large dependence on imported energy (crude and liquid fuels) in all test cases can be observed from an analysis of costs related to the energy system as presented in **Error! Reference source not found.** Imports increase from about 70% to 80% of the total energy supply costs for the Base Case between 2010 and 2050, 80% to 90% in the Emissions Target Test Case and the No Nuclear Test Case and 70% to 80% in the Renewable Energy Target Test Case.

The total discounted cost for the Emissions Limit Test Case and the No Nuclear Test Case are both 4.8% more than the Base Case. The increase in costs is largely attributed to an increase in the share of imported energy and the use of technologies which are less carbon intensive and as the activity of coal to liquids and coal fired power plants is minimised.

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The Renewable Energy Target Test Case is 1% more than the Base Case over the planning period. The difference is informed by the cost of renewable energy technologies which are enforced into the system in order to meet the minimum renewable energy target of 10% in the Renewable Energy Target Test Case.

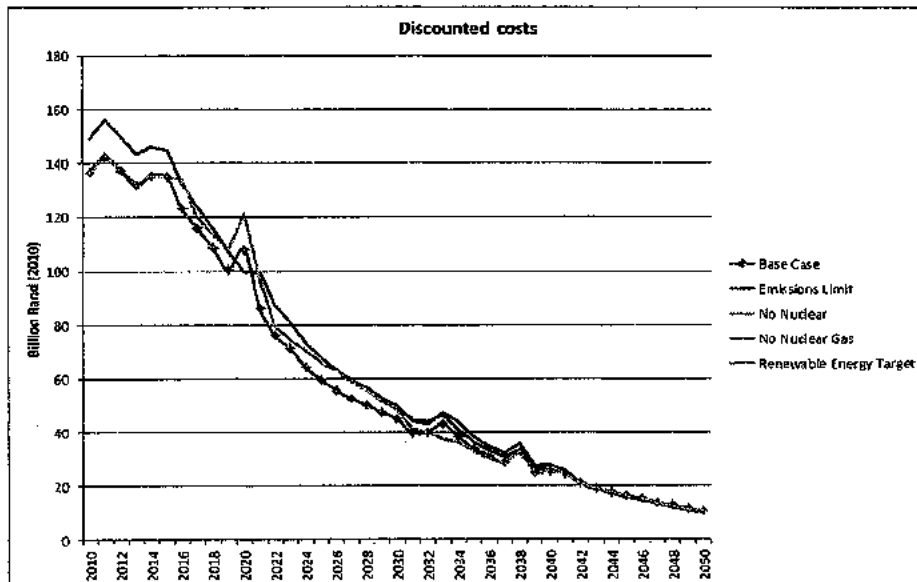


Figure 7-15: Discounted costs for all Test Cases

7.5 Emissions

Carbon dioxide emissions for the test cases are presented in Figure 7-16. These emissions are primarily driven by the use of coal for transformation but considerable amounts of coal are also used in other parts of the economy. The abatement cost for meeting the emissions limit for the Emissions Limit Test Case and the No Nuclear Test Case are both R41/t (in 2010 Rand). Placing emissions limits on energy production (i.e. refineries and electricity generation) results without emissions constraints or emissions penalties on energy end-use (i.e. demand-side emissions controls) results in greater use of imported energy. Emissions resulting from energy end-use therefore continue growing unconstrained. Therefore national emissions limits cannot be met without addressing final demand for energy carriers.

Fuel switching between final energy carriers was only modelled for the transport sector and this allows for the switching from fuel-powered vehicles to hybrid and electric vehicles.

- Emissions for the Base Case continue to increase.

- Emissions are reduced for the Renewable Energy Target Test Case however the reduction is not significant enough for them to be below the levels required by the "Peak Plateau Decline" Emissions Trajectory.
- The carbon emissions associated with energy supply (electricity generation and liquid fuel production) for all the test cases with emissions limits are within the "Peak Plateau Decline" Emissions Trajectory as this is set as a constraint. The reduction in the use of coal has the most significant impact on this reduction and the emissions constraints resulted in a 7.5 billion tonnes (or 31%) reduction in carbon dioxide emissions over the 40 year period as compared to the Base Case.

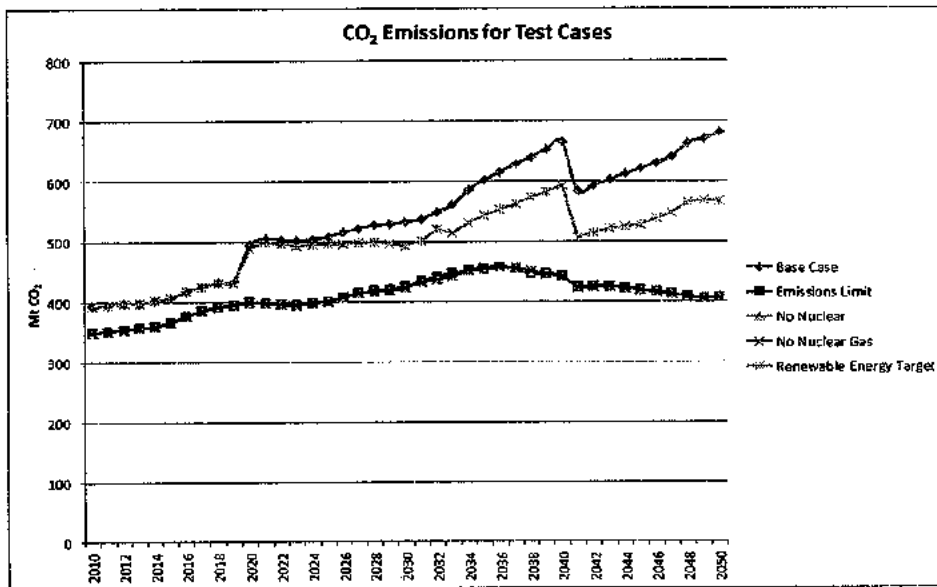


Figure 7-16: CO₂ emissions for all Test Cases

7.6 Water Use

Water used in the various test cases is shown in Figure 7-17. Coal to liquid plants use large quantities of water as can be seen in a comparison of the Base Case and the Emissions Limit Test Cases. There is very little difference in water consumption for the Emissions Limit Test Case and the No Nuclear Test Case. The small difference is because nuclear is assumed to use sea water whereas the CSP technologies require fresh water. In general the test cases which have limited coal to liquid activity have a reduced demand for water. In the long term, water demand is also reduced as a result of dry cooling in electricity generation and the increased penetration of renewable energy technologies which use less water.

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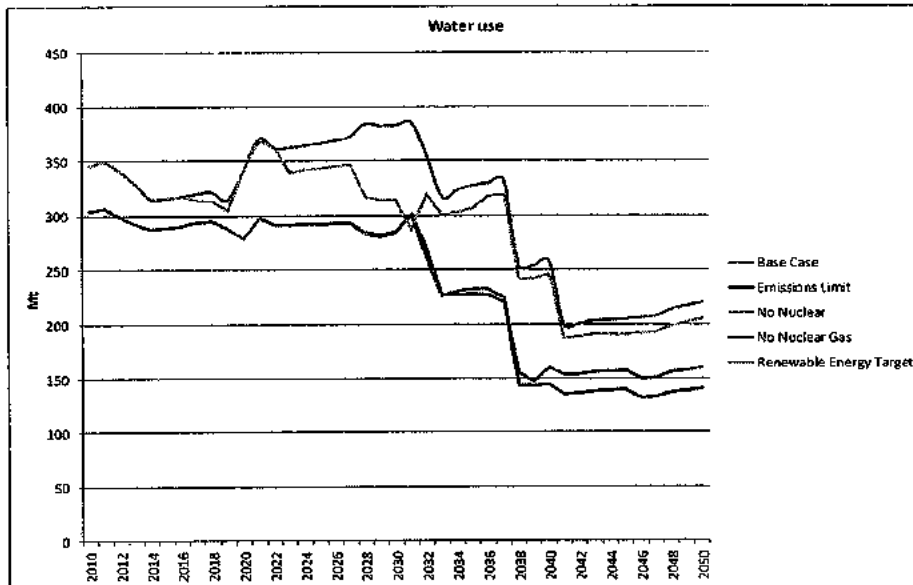


Figure 7-17: Water use for the test case

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SECTION 8: WAY FORWARD

8.1 Quantitative Analyses

Sections 5 and 9 outline the output from the econometric modelling (demand projections) and supply optimisation (energy models) respectively. The primary output from the quantitative analyses is an **optimal energy and technology mix for South Africa** throughout the planning horizon within a given set of constraints (as defined by the assumptions of the base case and each of the test cases). Such output includes the following:

- A combination of supply-side technologies, energy resources and secondary energy carriers/fuels to meet the projected energy demand;
- For the proposed mix of supply-side technologies (energy mix), the following were provided and were used as a basis for comparing the output from the Base Case with those of the various Test Cases:
 - Costs (total and average per unit of output)
 - Primary energy resource usage
 - Total production of secondary energy carriers/fuels
 - Emissions (total and average per unit of output)
 - Water usage (total and average per unit of output); and
- For individual technologies included in the proposed energy mix
 - Capacity
 - Activity of each technology.

The output from the quantitative analyses or energy modelling relies heavily on a sound fact base, data and key input assumptions which have been made. An overview of the energy sector and the macroeconomic environment has been provided in section 4, while the assumptions are summarised in sector 5. Detailed information on model assumptions and modelling approaches are provided in the detailed Demand Modelling Report and the Optimisation Modelling Report.

8.2 Qualitative Analyses

The key objective of the technical analyses is to obtain an energy system which has the least cost to the economy, given emission limits and fresh water constraints. The optimised solutions/outputs were provided for the Base Case and for each of the Test Cases (already discussed in Section 5). While it is highly desirable that the outputs from the quantitative analyses provide an optimal solution (energy mix) with the least cost to the economy, the least amount of emissions, and the minimal requirement for water, it is unlikely that such output will provide a single solution which meets all of these criteria simultaneously. For example, a solution optimised for least cost might not be the solution which results in the least emissions or lowest water usage; and a solution optimised for minimal emissions might not be the most

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economical for South Africa. Therefore, in addition to the technical analyses, choosing a particular strategy or set of policy options requires human judgment.

In addition to the above-mentioned requirements, other objectives (as outlined in Section 3) also had to be met. To ensure that the final recommendations of the IEP take into consideration both the output of the technical analyses and other socio-economic factors, a Multi-Criteria Decision Analysis (MCDA) approach will be adopted. The strength of this approach lies in the fact that it has wide application in policy analysis and evaluation. It ensures that during the screening process, value judgments about the socio-political, environmental and economic attributes of a policy can be included because it allows tradeoffs, co-benefits and compromise solutions to complex policy and planning problems.

There are many MCDA techniques that can be applied and the specific technique chosen for the IEP is the weighting and scaling method (This is described in more detail in appendix 1). This is a 'compensatory' method that allows for the evaluation of tradeoffs between the attributes of each candidate policy alternative. In using this technique, attributes are grouped or 'bundled', with each group receiving a weighting that represents a contribution to the overall score, based on the importance of the group of attributes to the decision-making body. This approach has been used before for the selection of sites for nuclear repositories, integrated resource planning, the selection of power generation facility sites, developing national energy policy, and for water resource planning.

To determine the weighting of each criterion in the list of criteria, a rating scale is applied and the relative importance and resultant weight of each criterion is determined through a consultative process with the relevant stakeholders to ensure that consensus is reached on the weighting given to each criterion.

The list of criteria was based on the list of objectives described in section 3 and is included in Appendix 1. While this approach cannot and does not aim to remove subjectivity in its entirety, it aims to minimise personal sentiment from the analysis process in that once the list of criteria has been decided upon and weighted, the same set of criteria is used consistently to evaluate all alternative options.

8.3 Revisions emanating from stakeholder consultations

The Draft Integrated Energy Planning Report provides preliminary model output and a basis for stakeholder consultation. During the stakeholder consultation process, it is anticipated that various inputs will be received which will provide information for further analysis to be conducted. Some of the assumptions, (for example, GDP growth rates) may need to be revised based on the latest national forecasts. Some of the work which needs to be done includes, but is not limited to the following:

- Assess the impact of Transnet Freight Rail's rail expansion plan on displacement of freight haulage from road to rail and the impact that this may have on projected demand
- Further analysis on the constraints of the natural gas infrastructure on the ability to meet projected demand for natural gas, particularly in the industrial and commercial sectors.

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8.4 Making Final Recommendations

The core purpose of the IEP is to provide a roadmap of the future energy landscape of South Africa. In order to achieve this, the IEP is therefore a multi-faceted, long-term energy framework which has multiple objectives:

- Guide the development of energy policies and, where relevant, set the framework for regulations in the energy sector;
- Guide the selection of appropriate technologies to meet energy demand (i.e. what types and size of new power plants and refineries should be built); and
- Guide the investment in and development of energy technology and infrastructure in South Africa.

The Draft Integrated Energy Planning Report is not intended to provide recommendations but presents model output from the Base Case and various Test Cases. This output gives insight on the possible implications of pursuing alternative energy policy options. Once the implications of all the alternative options have been explored and evaluated against each of the eight (8) key objectives, final recommendations will be made in the form of the Final IEP Report.

The Integrated Energy Planning Policy Working Group will be reconstituted and a workshop will be conducted to determine the relative weights of each of the criteria, before the output from the models are obtained. This same working group will then evaluate the model output which will inform the final recommendations presented to the IEP Steering Committee.

8.5 High-Level Timeline

Once the Draft Integrated Energy Planning Report has been published, various public stakeholder consultations will take place over a period of three months. The input obtained from this process will inform the revision of key planning assumptions which will emanate in the revision of the demand projections, the base case optimisation as well as the optimisation of the different test case. An alternative scenario, based on GDP growth projections aligned with the National Development Plan will also be conducted. Once all input has been obtained and the analysis work has been completed, the final report will be tabled in Cabinet for approval before finally being published in the Government Gazette.

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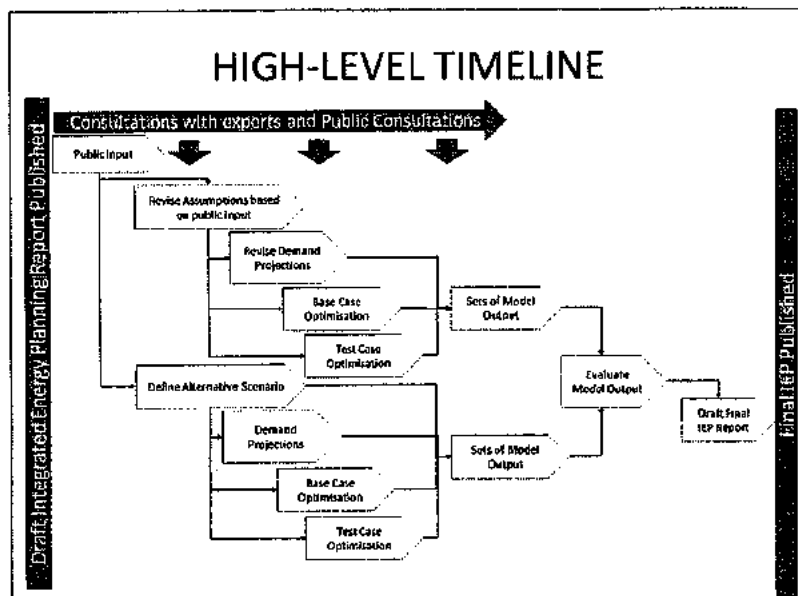


Figure 8-1: High-Level IEP Timeline

8.6 Areas of Further or Ongoing Analysis

As already described in section 2, the IEP process is not a once-off event but is rather a process of ongoing review and enhancement. This therefore requires ongoing and further research, collection of further data to enhance supporting evidence, and analysis. There are a multitude of factors and phenomena that have to be considered in order to ensure that a tangible output can be produced within a reasonable timeframe, and thus it is important to prioritise the focus areas. The prioritisation is largely informed by the timeframe within which key policy decisions need to be made, and/or by the availability of reasonable supporting evidence on which key planning assumptions can be made. The process therefore (by design) will always require further analysis as new questions arise and the dynamic nature of the macroeconomic environment is continually at play.

Some of the areas which should be explored further are as follows:

- The impact of energy prices on demand, taking into consideration other concurrent changes such as household income
- The impact on energy costs, employment and output if South Africa imports electricity from the region
- Possible scenarios on the potential exploitation of shale gas in the Karoo

- The detailed implications of NATMAP and in particular Transport Sector Alternative Policy Shifts
 - Alternative mode use and shifting of goods and people to mass transport (i.e. passengers from vehicles to buses or rail; freight from trucks to rail)
 - Advanced transport technology innovations such as rail powered by renewable energy
 - Non-motorised transport
- In-depth implications of the transport sector collaborative alternative policy shifts, which include land use management, including an increase in urban settlement densities and corridor developments;
- Technological advancement and potential penetration rates of electric vehicles in South Africa, including their broader implications

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APPENDIX 1: POST-MODELLING MULTI-CRITERIA DECISION ANALYSIS (MCDA) TECHNIQUE

1.1 Analysing Policy Options and Choosing the Option which Offers the Best Solution

Multi-Criteria Decision Analysis (MCDA) techniques are useful in helping the policymaker choose the right policy options, sometimes, among competing alternatives. These techniques are used to screen policy options and ideally identify a set of optimal solutions, such that a feasible option exists which is just as good in all objectives and strictly better in at least one. During the screening process, value judgments about socio-political, environmental and economic attributes of a policy can be included. Therefore, MCDA methods can be used to identify tradeoffs, co-benefits and compromise solutions to complex policy and planning problems.

1.2 Determining Evaluation Criteria from the Key Objectives

The key objectives of the Integrated Energy Plan (IEP) are described in the Main 2012 Integrated Energy Planning Report. As discussed in the document, the attainment of these objectives has conflicting implications in certain instances. An objective mechanism to determine their relative importance has therefore been devised and is described herein. In addition, because the output from the Base Case and the various Test Cases may be divergent, a consistent and transparent method of evaluating the model output and making recommendations is necessary. The key objectives inform the criteria which will be used to evaluate the key outputs from the Base Case and the various Test Cases. Table A-1 provides a list of the objectives, the respective criteria against which the attainment of each objective will be quantified and the unit of measure which will be applied.

Table A-1: Key Objectives of the IEP and Evaluation Criteria

#	KEY OBJECTIVE	CRITERION	UNIT
1	Security of supply	All projected energy demand is met. Calculated reserve margin of 19% achieved and maintained	Percentage
2	Minimise cost of energy	Total cost	Million Rands (Rm)
3	Increase access to energy	Based on expert judgement	Rating on scale of 0 to 10
4	Diversify supply sources and primary energy carriers	Diversity of energy mix	Rating on scale of 0 to 10
5	Minimise emissions from energy sector	- Total annual CO₂ emissions from electricity generation and liquid fuel production - Annual CO₂ emissions from electricity generation and	- Megatons of Carbon Dioxide (Mt/CO₂) - Megatons of Carbon Dioxide equivalent per PetaJoule (Mt CO₂/PJ)

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		liquid fuel production per unit of energy output or per unit of GDP	or per Million Rands GDP (Mt CO ₂ /Rm GDP)
6	Improve efficiency/Reduce energy Intensity	Annual energy intensity (Units of energy per unit of GDP)	Petajoules per Million Rands GDP (PJ/ Rm GDP)
7	Promote localisation, technology transfer and job creation	- Total number of direct permanent jobs - Number of indirect and/or contract/temporary jobs	Job years
8	Water conservation	- Total annual fresh water use for electricity generation and liquid fuel production - Annual fresh water use for electricity generation and liquid fuel production per unit of energy output	- Megalitres of water (Mt water) - Water use per unit of energy output (Mt water /PJ)

1.3 Computing Weights of Criteria Using a Comparison Matrix

The technique used for the IEP is the weighting and scaling method, which will be employed after the results from the modelling were completed. The technique chosen is a 'compensatory' method that allows for the evaluation of tradeoffs between the attributes of candidate alternatives. In this technique, attributes are grouped or 'bundled', with each group receiving a weight that represents a contribution to the overall score, based on the importance of the group of attributes to the decision-making body. This approach has been used before to select sites for nuclear repositories, integrated resource planning, selection of power generation facility sites, developing national energy policy, and in undertaking water resource planning.

To determine the weighting of each criterion, a rating scale will be applied as defined in Table A-2 below.

Table A-2: Rating Scale for the Criteria

Scale	Definition	Explanation
0.33	Significantly less important	
0.5	Less important	Experience and judgment slightly favour one activity over another
1	Of equal importance	Two activities contribute equally to the objective
2	More important	Experience and judgment strongly favour one activity over another
3	Significantly more important	The evidence favouring one activity over another is of the highest possible order of affirmation

Once the rating scale had been defined, the criteria will be evaluated against one another to determine the relative importance of each criterion against the others. This exercise will be conducted during a multi-stakeholder forum including representatives from different policy units. For the purposes of the IEP, this process will be conducted by the Intergovernmental Integrated Energy Planning Policy Working Group or IEP Steering Committee. The output from this process will enable the weight of each of the criteria to be determined.

Because input to determine the weight involves multiple stakeholders, the resultant weighting of each criterion should be unbiased. A comparison matrix, similar to the example shown in Table A-3, will be used to assign weights to the criteria, indicating the relative importance of the criterion in the columns compared with the criterion in the rows. To ensure consistency and transparency when assigning weights, the criteria in the rows are assumed to be *constant* whereas the criteria in the columns are *variables*. This is important because values are assigned by comparing criteria in the rows with those in the columns. As such, each individual criterion appearing in each row was compared with all the criteria appearing in each of the columns. The total scores for each of the criteria (reflected in the second last row) are then used to determine the weighted averaged which reflects the relative importance of the criteria.

Table A-3: Example of a Comparison Matrix Depicting the Weighting of Criteria

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	TOTALS
C1		0.5	0.33	0.5	0.5	1	0.5	0.5	4.83
C2	2		0.33	2	0.5	2	0.5	0.33	8.66
C3	3	3		2	2	3	2	0.33	16.33
C4	2	0.5	0.5		0.5	2	0.5	0.5	7.5
C5	2	2	0.5	2		2	0.5	1	11
C6	1	0.5	0.33	0.5	0.5		0.33	0.5	4.66
C7	2	2	0.5	2	2	3		1	13.5
C8	2	3	3	1	0.5	2	2		14.5
TOTAL	15.03	10.03	3.99	11	7.5	15.03		7.33	80.96

Note: This is an example, and NOT the actual scoring

1.4 Scoring the Output against the Criteria

Once the relative weights of the criteria have been determined, the next step is to evaluate the actual model output (i.e. the output from the various Test Cases against the Base Case) against each of the

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criteria. The key idea is to construct preference scales representing the extent to which each set of model outputs meets the criteria described in Table A-1.

A relative preference scale is used and the same method is applied for evaluating all Test Cases. However the rating scale for the criteria whose scores can be calculated and determined directly from the model output will differ from those criteria more reliant on expert judgment.

The relative preference scale method is anchored on either end by the highest and lowest score against a criterion:

- **For the criteria whose scores can be calculated and determined directly from the model output:** Assuming 'n' Test Cases are being evaluated against one another, the Test Case with the highest points meeting a particular criterion is assigned a score of 'n', and the Test Case with the lowest points meeting a particular criterion is assigned a score of 0. Scores are assigned to the remaining Test Cases so that differences in the numbers represent differences in strength of meeting the particular criterion; and
- **For the criteria whose scores may not be easily calculated directly from the model output:** The rating scale will be set from 0 to 10, with 0 representing the output which least meets the criteria and 10 representing the output which most meets the criteria. In these instances, expert judgement will be used by the evaluating panel.

The scoring guide for scoring each Test Case against each criterion is provided in Table A-4.

Table A-4: Scoring Guide Against Each of the Criteria

Criteria	Model Output	Rating Scale
Security of supply	All projected energy demand is met	- All projected energy demand is met - Reserve margin of 19% achieved
Minimise cost of energy	Model output (plan) with highest cost	Model output (plan) with the lowest cost
Increase access to energy	Policy proposals do not promote access to energy (0 to 10 rating scale)	Policy proposals which promotes access to energy (0 to 10 rating scale)
Diversify supply, sources, and primary energy carriers	Model output (plan) with most diversity of: Primary energy sources	Model output (plan) with most diversity of: Primary energy sources

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	• Supply sources (0 to 10 rating scale)	• Supply sources (0 to 10 rating scale)
Minimise emissions from energy sector	• Model output (plan) with the most annual and planning period emissions • Model output with the highest emissions per unit of energy output	• Model output (plan) with the least annual and planning period emissions • Model output with the lowest emissions per unit of energy output
Improve energy efficiency	Policy proposals do not promote energy efficiency (0 to 10 rating scale)	Policy proposals promote energy efficiency (0 to 10 rating scale)
Promote localisation, technology transfer and job creation	Model output (plan) with least potential for job creation measured by: • Number of direct permanent jobs • Number of indirect and/or contract/temporary jobs	Model output (plan) with most potential for job creation measured by: • Number of direct permanent jobs • Number of indirect and/or contract/temporary jobs
Water conservation	Model output (plan) with the most water usage requirements on an annual basis and over the planning period	Model output (plan) with the least water usage requirements on an annual basis and over the planning period

An example of the scoring is presented in Table A-5 below. The Base Case and all Test Cases are listed in the left column and the criteria and their associated weights are reflected in the first and second rows. (In practice it is advisable to remove the weights on the criteria when scoring the Test Cases against the criteria). Therefore a score between 0 and 'n' (or 0 and 10) will be assigned to the Base Case or a Test Case, depending on the observed evidence and where applicable a value judgement of how it achieved a particular criterion, e.g. how Test Case 1 is measured using criterion C1 or C2, etc.

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Table A-5: : Example of Policy Analysis Matrix to Assign Scores and Weights

	6%	11%	20%	9%	14%	6%	17%	18%	WEIGHTED AVERAGES
	7	5	10	9	8	2	7	6	7.25
	5	6	8	7	6	5	5	8	6.57
	8	6	4	7	9	5	7	7	6.50
	8	5	5	7	8	4	5	4	5.54

1.5 Examining the Results, Agreeing on the Way Forward and Making the Final Choice

The options will be ranked according to the weighted average of all the preference scores. These total scores also give an indication of how much better one option is over another against the given criteria. An MCDA can yield surprising results that need to be digested before decisions are taken. It may be necessary to establish a temporary decision system to deal with unexpected results and to consider the implications of new perspectives revealed by the MCDA. This temporary system should consist of a series of working meetings which eventually produce recommendations to the final decision-making body. At the working meetings, participants should be given the task of examining the MCDA results, testing the findings for their validity, working through the possible impacts for the organisation, and formulating proposals for the way forward.

1.6 Conclusion

The Integrated Energy Planning Policy Working Group will be reconstituted and a workshop will be conducted to determine the relative weights of each of the criteria, before the output from the models are obtained. This same working group will then evaluated the model output which will inform the final recommendations presented to the IEP Steering Committee.

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Department of Energy

Presentation to the Parliamentary Committee on Energy – 2013/14 Annual Report

*Dr Wolsey Barnard
Acting Director-General
14 October 2014*



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Key Policy Development and Legislative Changes

During the year under review stakeholder engagement on the Integrated Energy Plan (IEP) was completed. The IEP is a high level planning platform to manage the interrelations between electricity, gas, and liquid fuels up to 2050.

The revised Integrated Resource Plan was drafted for public consultation, with major highlights being:

- Reconfirmation of nuclear and renewables as supply side solutions to meet environmental and macroeconomic development objectives;
- Shale gas and imported piped gas playing a prominent role;
- Coal technology, particularly fluidised bed combustion, to sustain the coal programme; and
- Regional integration through imported hydro projects to improve the SADC economy, while simultaneously providing a renewable energy source.

With regard to the development of South Africa's gas resources, including regional gas opportunities in neighbouring countries and the country's own shale gas resource, the draft Gas Utilisation Master Plan (GUMP) was completed and stakeholder engagement will commence to solicit broader input into the plan.



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2nd and 3rd QUARTER PERFORMANCE REPORTS
2014- 15

Dr. Wolsey Barnard
Acting Director General
14 APRIL 2015



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Programme 2: Policy and Planning Progress, 3rd Qt 2014/15

Annual Target 2014/15 (from Strategic Plan - link to Technical Indicator Description)	Quarterly Target (from APP)	Progress this Quarter ("achieved", or "partially achieved", or "not achieved", and support for the self-assessment)	Comments (constraints, variances, likelihood of annual achievement, corrective actions, etc)	Means of Verification (documents or other sources supporting reported progress)
Finalised IEP submitted to Cabinet	Assess economic Impact of IEP	Partially Achieved	All the technical information that is used as an input to the process has already been submitted from DoE to National Treasury. The National Treasury will be conducting the Macro-economic Impact Assessment for the IEP	E-mails from DoE to the National Treasury with attachments of technical information to input into the process.
Draft 20YRLFMP Submitted to Cabinet for approval	No target set	No Target Set	Although there is no target, progress has been made in that the Report has been analysed and shortcomings identified. Certain aspects of the Report, particularly on the storage and handling infrastructure, need to be refined.	The Document on the analysis of the 20 YRLFMP Report



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PORTFOLIO COMMITTEE ON ENERGY 4th Qt 2014/15 and 1st Qt 2015/16 PERFORMANCE REPORTS

4 August 2015



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Background

This presentation reflects the performance information of the Department of Energy (DoE) for the fourth quarter 2014/15 and first quarter of 2015/16.

At the end of the 4th Quarter performance report an overview is given of the 14/15 financial year.

DoE implements its Annual Performance Plan (APP) through six programmes;

- ✓ Programme 1 – **Administration**,
- ✓ Programme 2 – **Energy Policy and Planning**,
- ✓ Programme 3 – **Petroleum & Petroleum Products Regulation**,
- ✓ Programme 4 – **Electrification & Energy Programme and Projects**,
- ✓ Programme 5 – **Nuclear Energy and**
- ✓ Programme 6 – **Clean Energy**.

The APP and Financial performance of the different Programmes are summarized in this presentation, but the complete APP performance targets are presented in Appendix A (4th Q 14/15) and Appendix C (1st Q 15/16), while the detailed Financial Performance per Programme is presented in Appendix B (4th Q 14/15) and Appendix D (1st Q 15/16) respectively.



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KEY ACHIEVEMENTS FOR 14/15 FINANCIAL YEAR

Policy Development:

- **Integrated Energy Plan (IEP):** Since the approval and publication of the first draft during the 2013/14 financial year, we have addressed the public comments and produced a draft report which includes the technical outputs. The final IEP report will be submitted to Cabinet during the third quarter of the 2015/16 financial year.
- **20 year Liquid Fuels Framework (20YRLFRM)** - The draft 20YRLFRM has been completed but it is currently undergoing consultations process before is submitted to Cabinet for approval.
- **The Draft Gas Utilization Master Plan** was completed and is being considered within the DOE, and
- **The IRP** was implemented according to timeframes set out in IRP 2010.



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PRESENTATION OF THE INTEGRATED ENERGY PLAN (IEP)



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BACKGROUND

- The development of the Integrated Energy Plan (IEP) was envisaged in the White Paper on Energy Policy of the Republic of South Africa of 1998
- The purpose and objectives of the Integrated Energy Plan (IEP) are further anchored in the National Energy Act, 2008 (Act No. 34 of 2008) which also mandates the Minister of Energy to develop, review and publish the IEP.
- To ensure a coherent and coordinated approach to meeting our energy needs, the IEP will ultimately incorporate detailed sector plans for electricity, gas and liquid fuels

INTEGRATED ENERGY PLAN

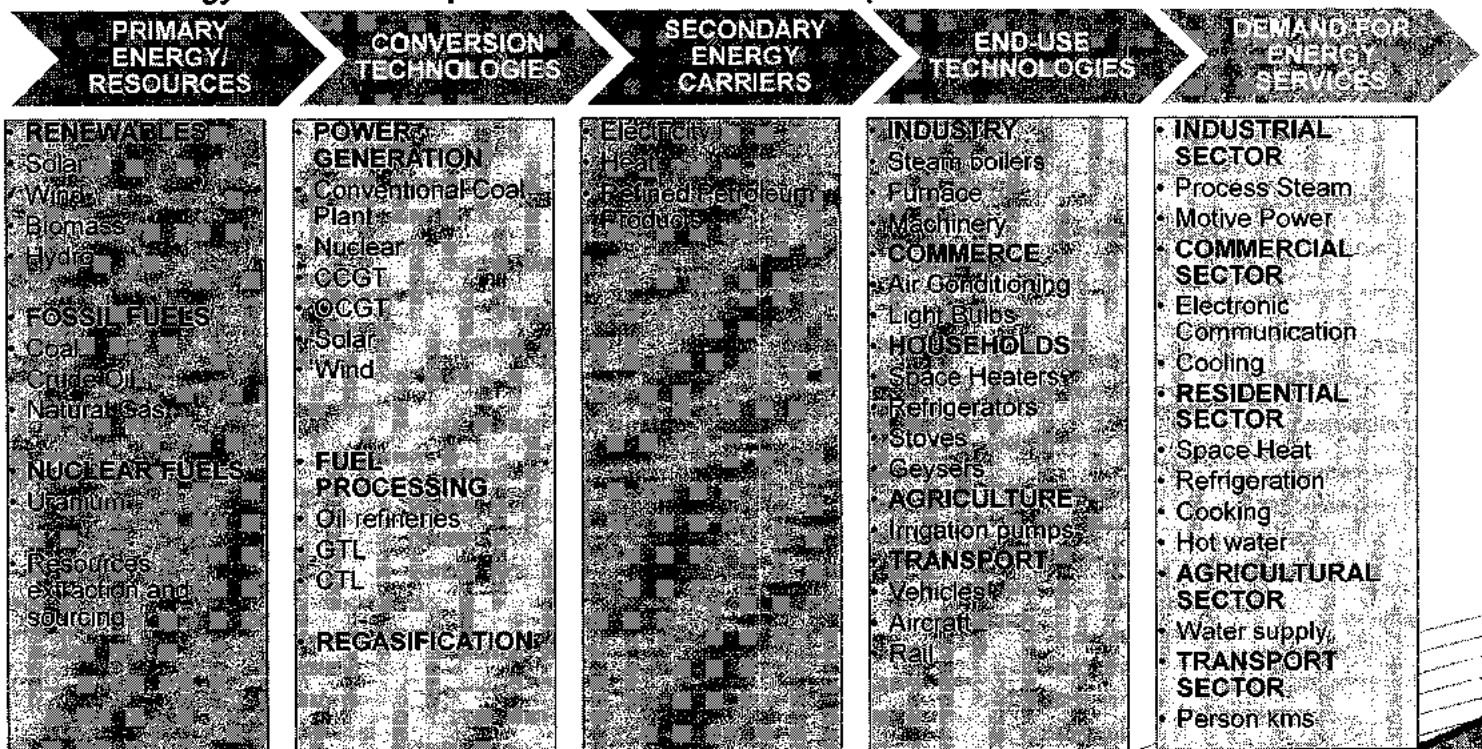
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ENERGY VALUE CHAIN



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The IEP considers all different energy carriers, all technology options and all key national policy imperatives and proposes an energy mix and policy recommendations which ensures that the energy sector can help achieve these in the most optimal manner.



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STAKEHOLDER ENGAGEMENT – WHAT WE TEST

- Agreement of the Purpose of the IEP
- Agreement with stakeholders on the minimum content of the IEP
- Agreement of the requisite quantitative baselines and assumptions
- Assessment of the gaps between expected content and existing content and data
- Agreement on the scenarios/pathways to be tested and the associated timelines
- Integration of various sector plans (for electricity, gas, liquid fuels ...)
- Develop Draft IEP for consultation
- After the Public Participation process, adoption of the IEP



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PROBLEM STATEMENT

- Energy is the life blood of the economy which impacts on all sectors as well as individual livelihoods. Integrated energy planning is required to ensure that future energy service needs can be met in the most cost effective, efficient and socially beneficial manner, also considering environmental impacts.
- A lack of coordinated and integrated national planning for the energy sector has led to underinvestment in much needed energy infrastructure.
 - There is currently inadequate supply in both the electricity and liquid fuel industries due to a lack of timely investments in new capacity.
 - Electricity generation is constrained due to insufficient capacity and inadequate availability of existing infrastructure.
 - There is a high dependence on import of liquid fuels as the current production capacity does not meet national and export demand. No investments have been made in new capacity since the start of the new democracy.
- Planning at individual organisation level is commercially driven and therefore investments which are required in order to ensure that the policy objectives of the country have been left under invested.
- The IEP aims to guide future energy infrastructure investments, identify and recommend policy development to shape the future energy landscape of the country.

INTEGRATED ENERGY PLAN

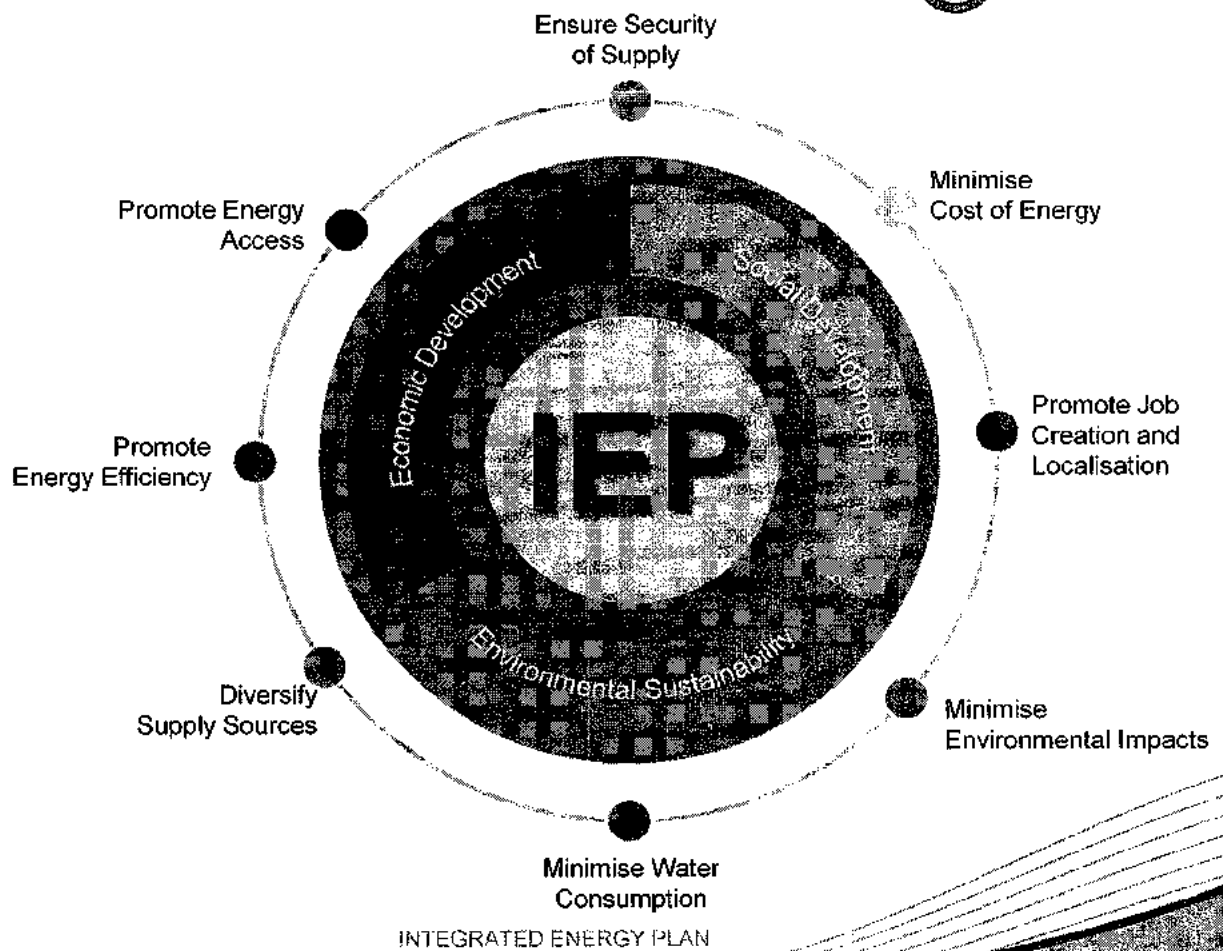
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8 KEY OBJECTIVES



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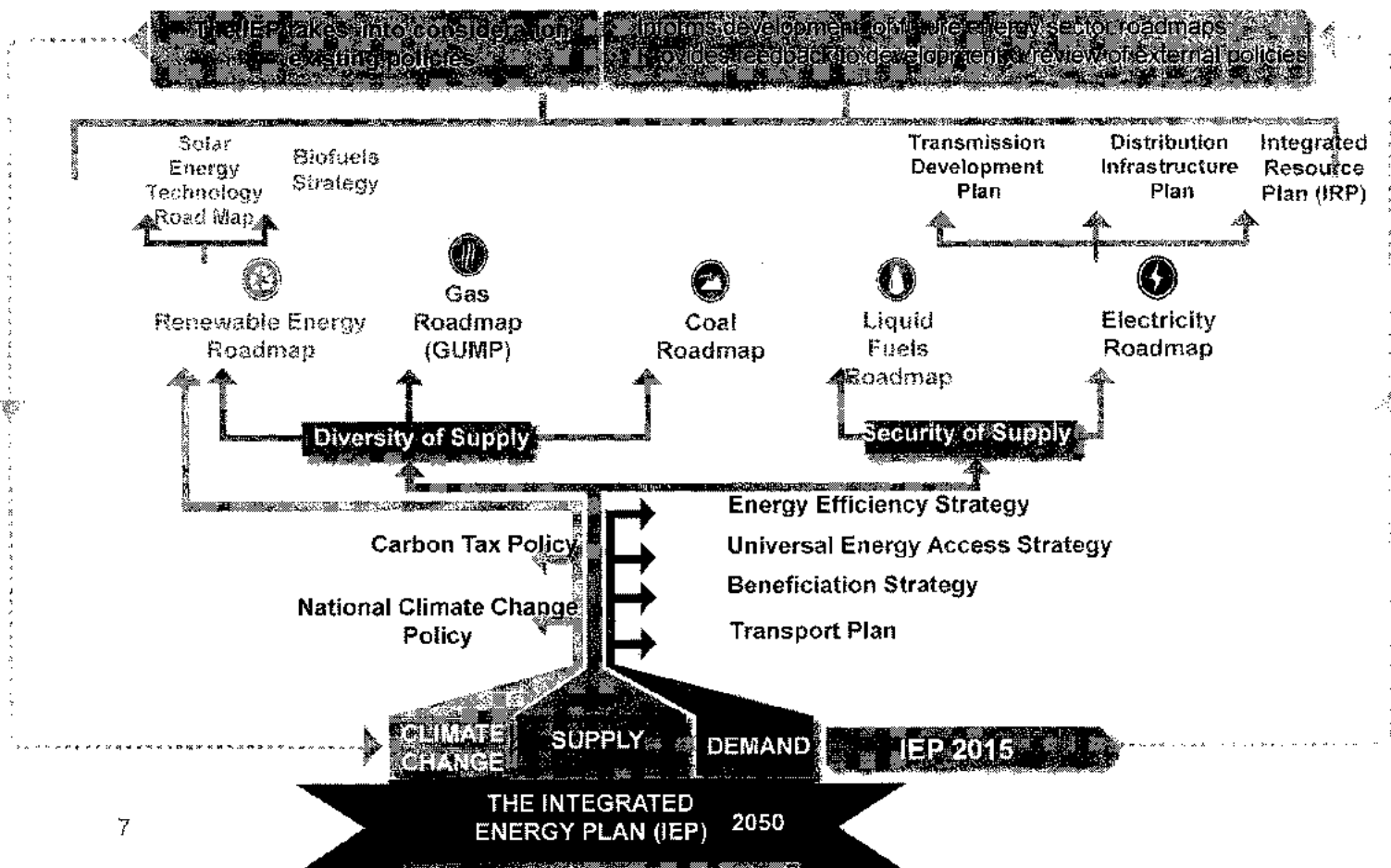


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IEP AND OTHER SECTOR PLANS



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KEY POLICY ISSUES



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ECONOMIC GROWTH AND DEVELOPMENT

- **National Development Plan**
 - Defines alternatives that should be considered for ensuring security of liquid fuel supply is met
 - Alternative sources for electricity generation
- **New Growth Path**
 - Sets aspirational targets for employment, economic growth and green economy
- **National Treasury**
 - Economic Growth Projections

CLIMATE CHANGE AND EMISSIONS REDUCTION

- **Proposed Carbon Tax Policy**
 - Proposes a carbon tax for energy supply and energy end-use amongst other sectors
- **National Climate Change Response White Paper**
 - "Peak, Plateau, Decline" emission reduction targets have significant implications for the energy sector
- **Air Quality Standards**
 - Air emission limits
- **Water Quality**

INDUSTRIALISATION

- **National Industrial Policy Framework**
 - Articulates South Africa's overarching approach to industrial development, which includes amongst others: movement toward knowledge economy, promotion of more labour-absorbing and broad-based industrialisation path
- **Beneficiation Strategy**
 - Implementation of strategy will affect demand profile of industrial sector

ENERGY DEMAND MANAGEMENT

- **Transport Plan**
 - Modal shifts from passenger vehicles to mass transit, from road to rail, amongst others have implications on future energy requirements transport from the sector
- **Energy Efficiency Strategy**
 - Sets targets for energy efficiency improvements for different economic sectors

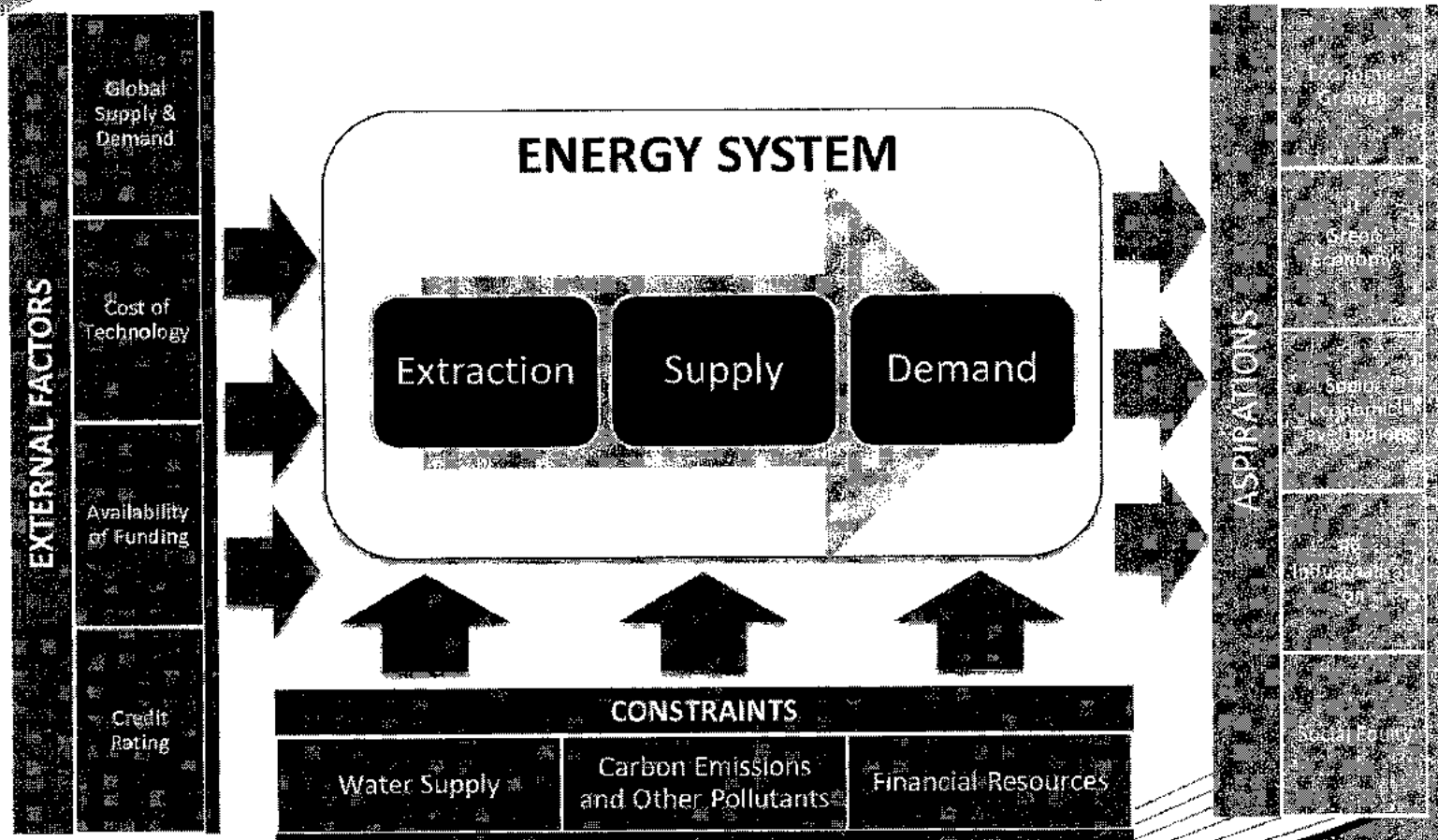
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ENERGY PLANNING PROCESS



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MACROECONOMIC ASSUMPTIONS

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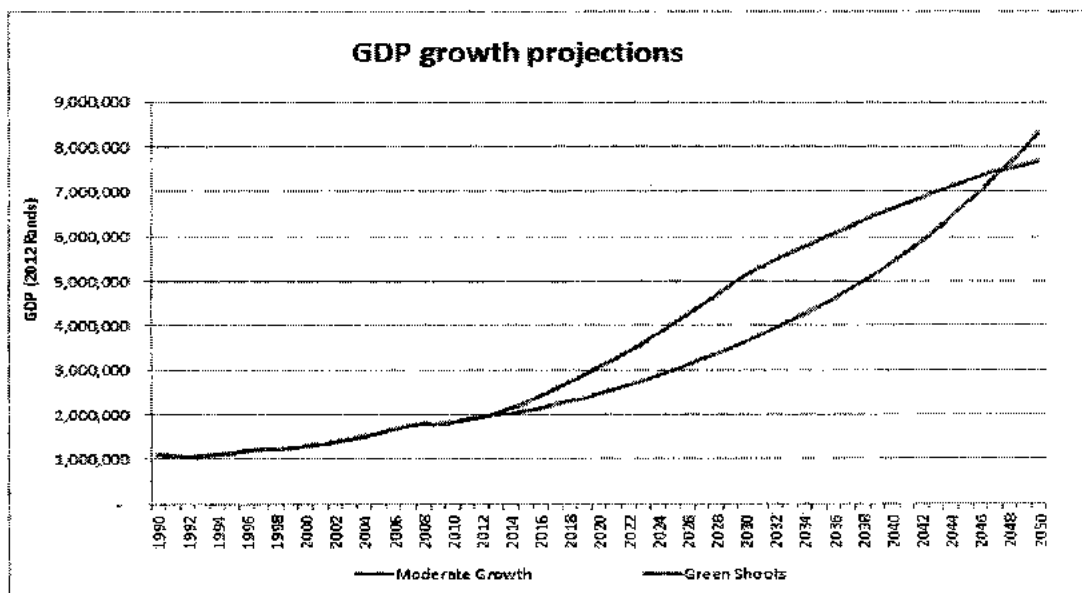
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ECONOMIC GROWTH PROJECTIONS



Source: National
Treasury – 2014
Budget

	Short-Term				Medium-Term	Long-Term
	2014	2015	2016	2017	2018-22	2023-50
Low Growth	1.5	1.8	2.3	2.5	2.8	3.0
Moderate Growth	1.8	2.7	3.2	3.5	3.7	4.2
High Growth	2.0	3.3	3.7	4.0	4.9	5.5

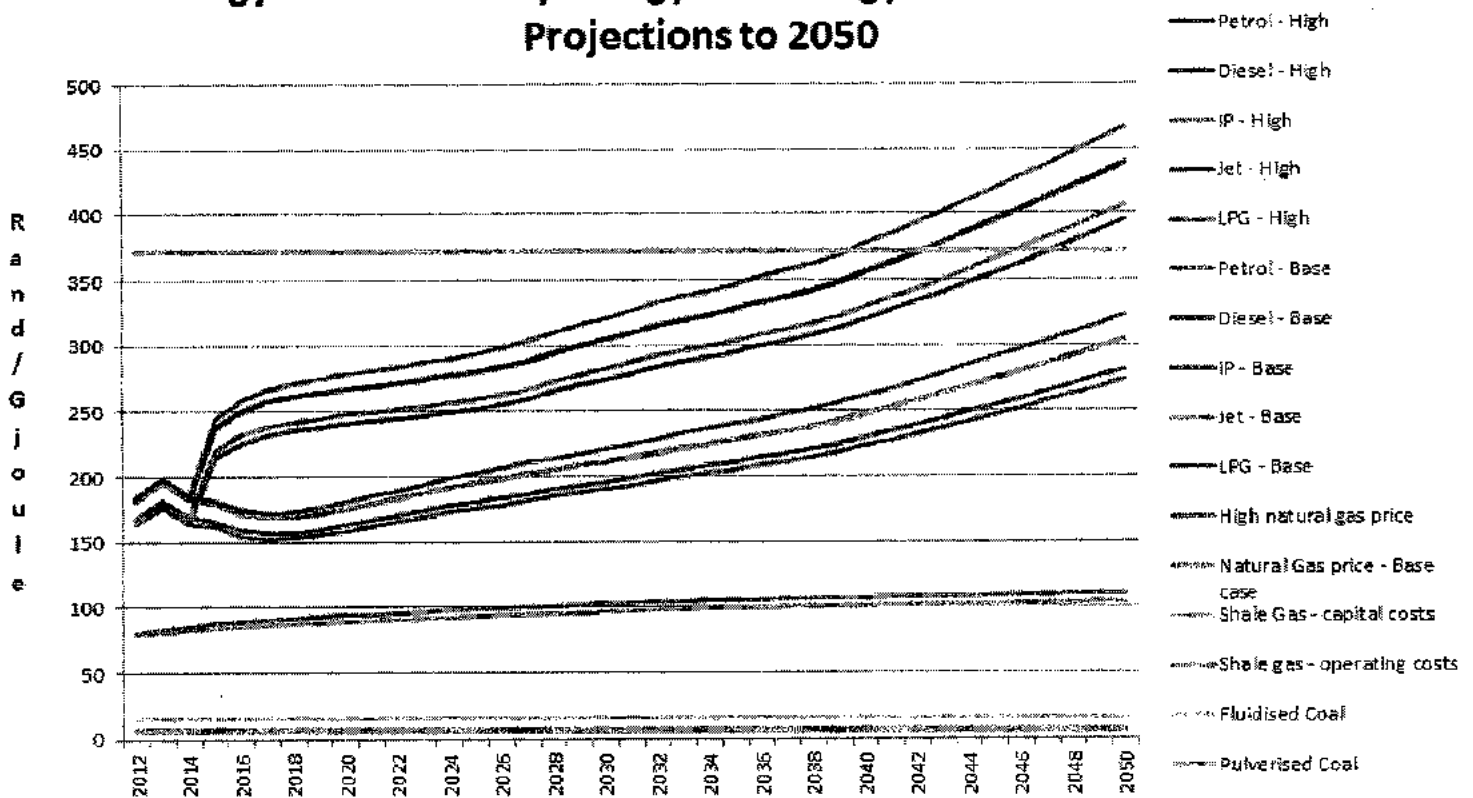
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Energy Prices: Primary Energy and Energy Commodities Price Projections to 2050

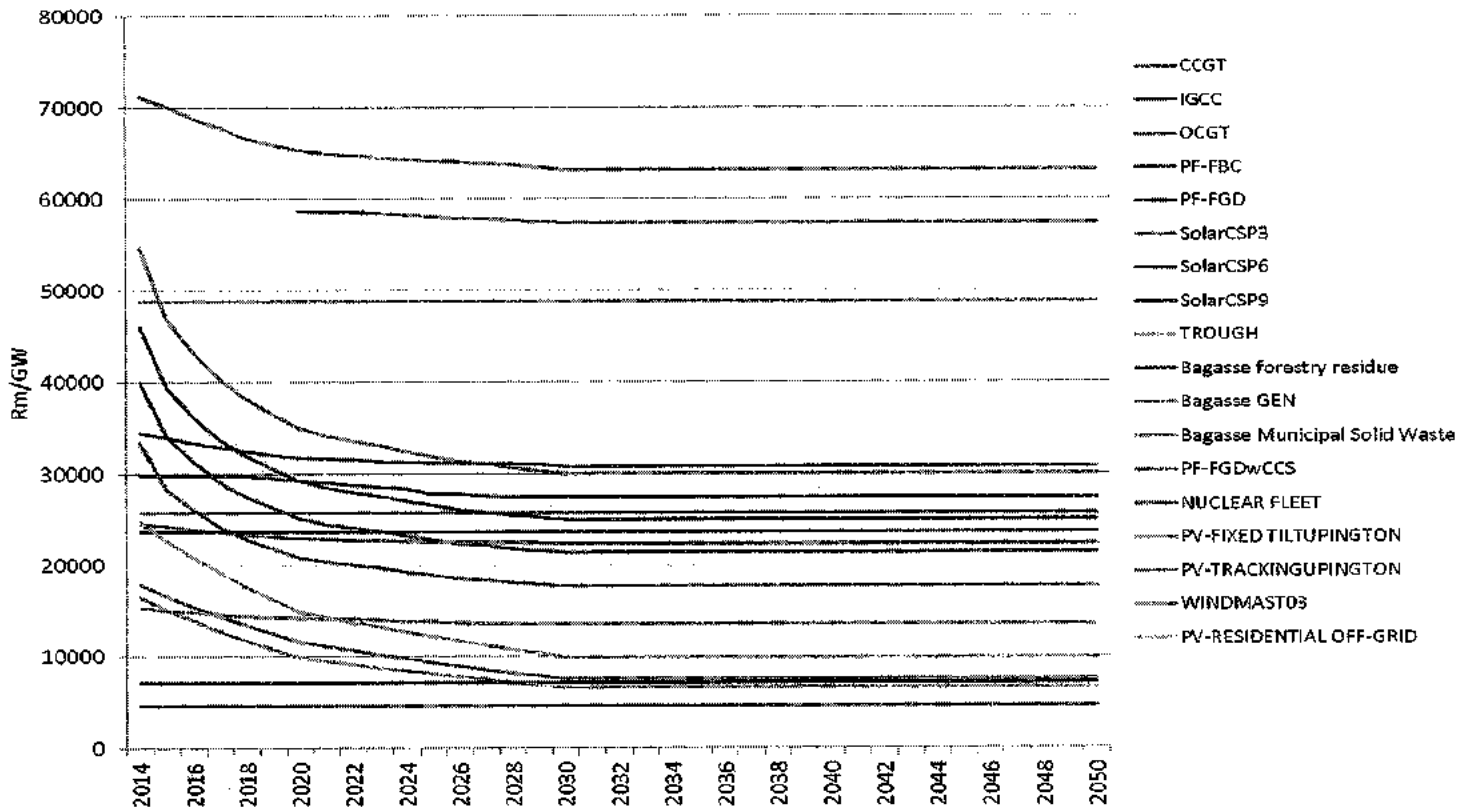


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Electricity Technology Capital Costs

Electricity Generation Capital Costs



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DESCRIPTION OF SCENARIOS

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MODELED SCENARIOS



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INDICATORS	BASE CASE	RESOURCE CONSTRAINED	ENVIRONMENTAL AWARENESS	GREEN SHOOT'S
Technology Constraints	9.6 GW New Nuclear Build			
GDP	Treasury moderate GDP growth			National Development High GDP Growth
DEMAND-SIDE INTERVENTIONS				
DSM	1 million SWH		5 million SWH	10 million SWH
Energy efficiency	Business As Usual	High Energy Efficiency		
VEHICLE EFFICIENCY (new vehicle improvement per annum)				
Cars and SUVs	1.1%		2.50%	
Trucks and buses	0.8%		1.00%	
Electric vehicle penetration	20% annual rate			40% annual rate
Prices of Energy Commodities	Moderate	High	Moderate	Moderate
CLIMATE CHANGE				
CO ₂ emissions limits	Upper bound "Peak-Plateau-Decline" (PPD) emission limit trajectory from the National Climate Change Response White Paper		PPD lower limit	PPD upper limit
CO ₂ externality costs	• R48-R120/t (2015-2019) • R120/t onwards		• R270/t (2015-2050)	• R48-R120/t (2015-2019) • R120/t onwards
Carbon Tax	Embedded in the externality cost of Carbon			

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MODELED SCENARIOS



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INDICATORS	BASE CASE	BIG SWH	NUCLEAR RELAXED	NO SHALE GAS
Technology Constraints	9.6 GW New Nuclear Build enforced		None	9.6 GW New Nuclear Build enforced
GDP	Treasury moderate GDP growth			
DEMAND SIDE INTERVENTIONS				
DSM	1m SWH	10 million SWH		1 million SWH
Energy efficiency	Business As Usual			
VEHICLE EFFICIENCY (new vehicle improvement per annum)				
Cars and SUVs	1.1%			
Trucks and buses	0.8%			
Electric vehicle penetration	20%			
Prices of Energy Commodities	Moderate			Unavailable shale gas
CLIMATE CHANGE				
CO ₂ emissions limits	PPD upper limit			
CO ₂ externality costs	• R48-R120/t between 2015 and 2019 • R120/t onwards			
Carbon Tax	Embedded in the externality cost of carbon			

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CONCLUSION AND RECOMMENDATIONS

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RESEARCH AND DEVELOPMENT



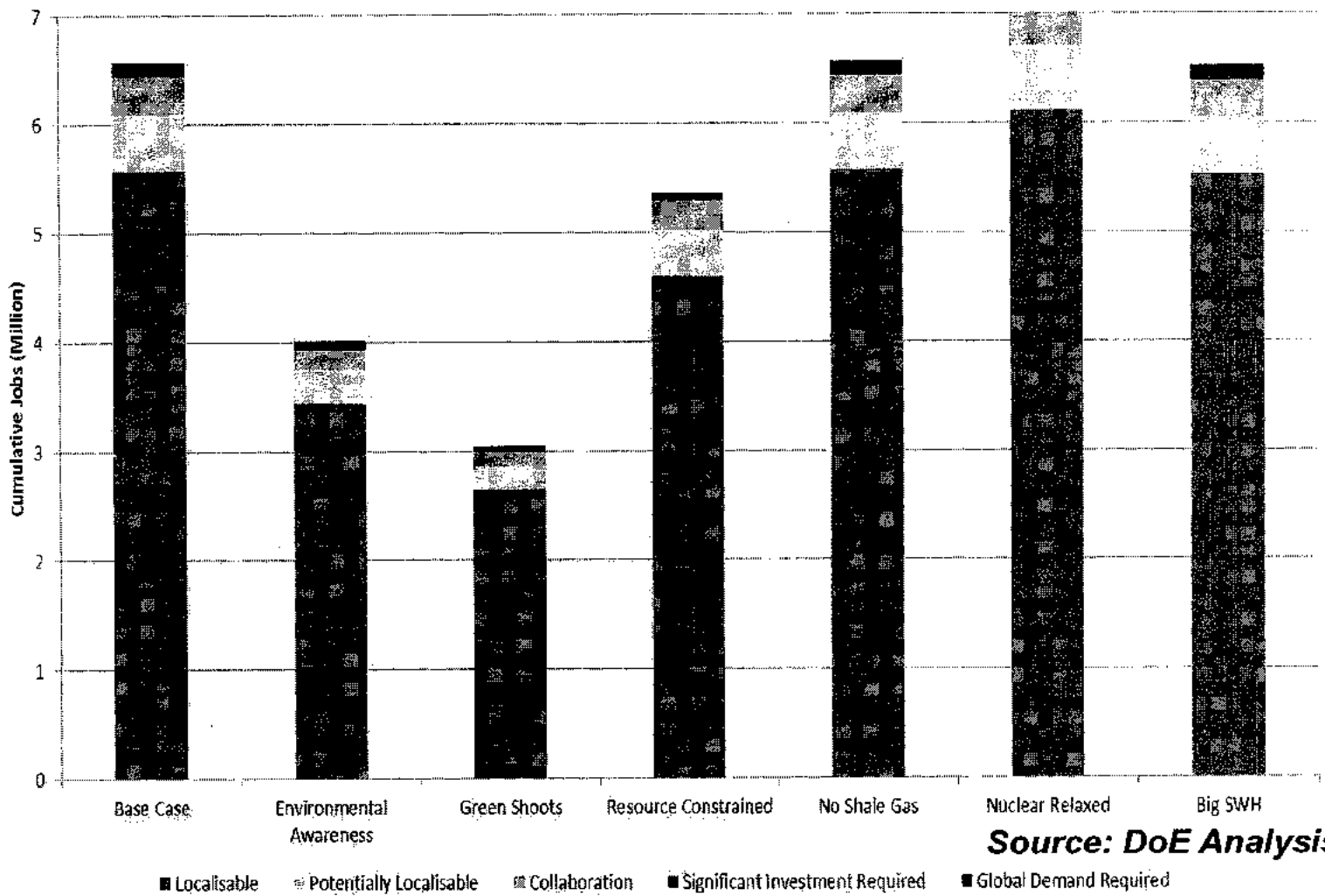
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- Explore solar augmentation for existing coal-fired power plants
- Investigate possibilities for mass production of PV panels locally
- Explore innovations that can aid in the reduction of CSP costs
- Investigate the role of solar in providing heating needs of industry (starting with light industry)
- Explore solar hybridization technologies (solar/gas, solar/diesel)

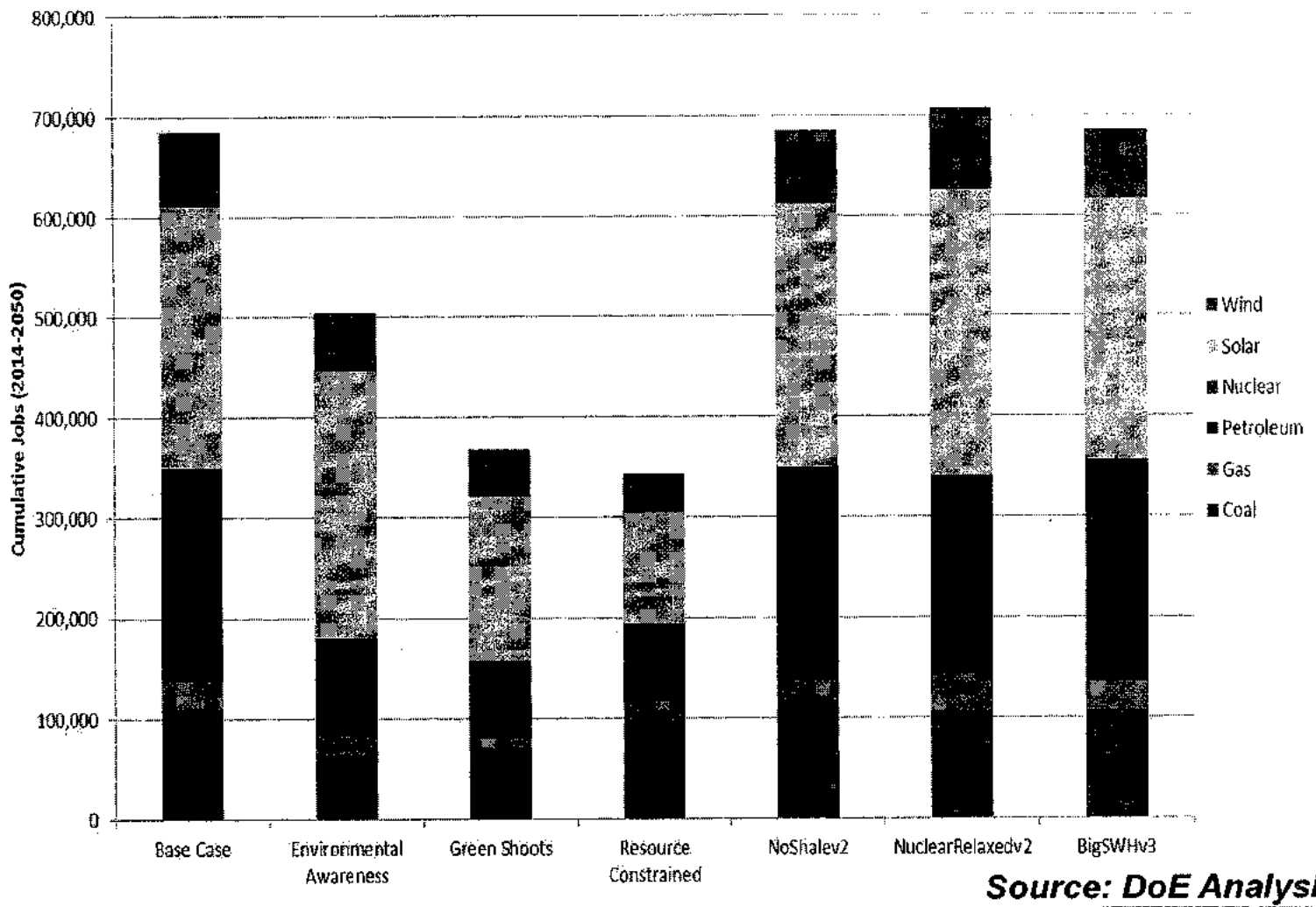
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Localisation Potential



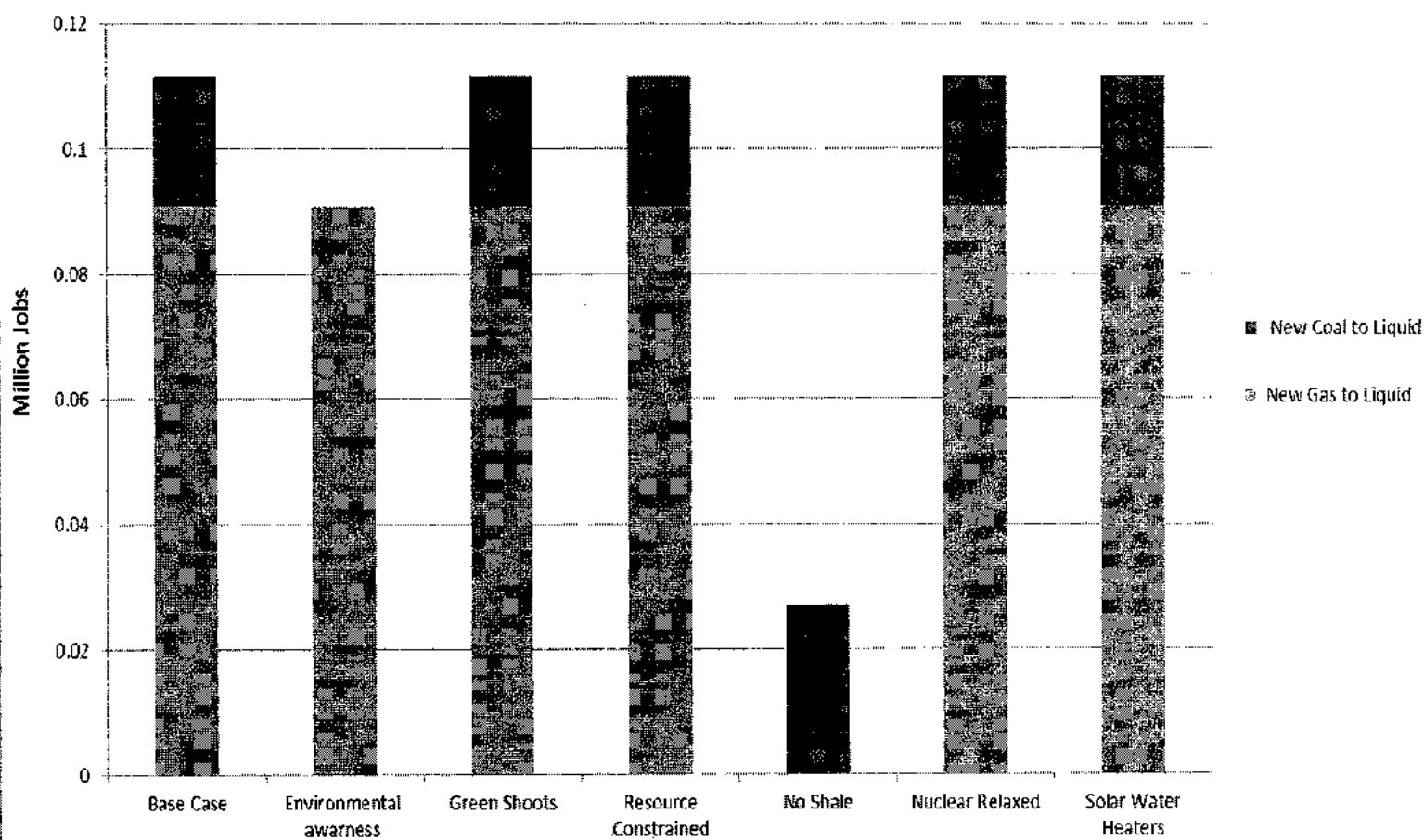
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Job Potential - Electricity Generation



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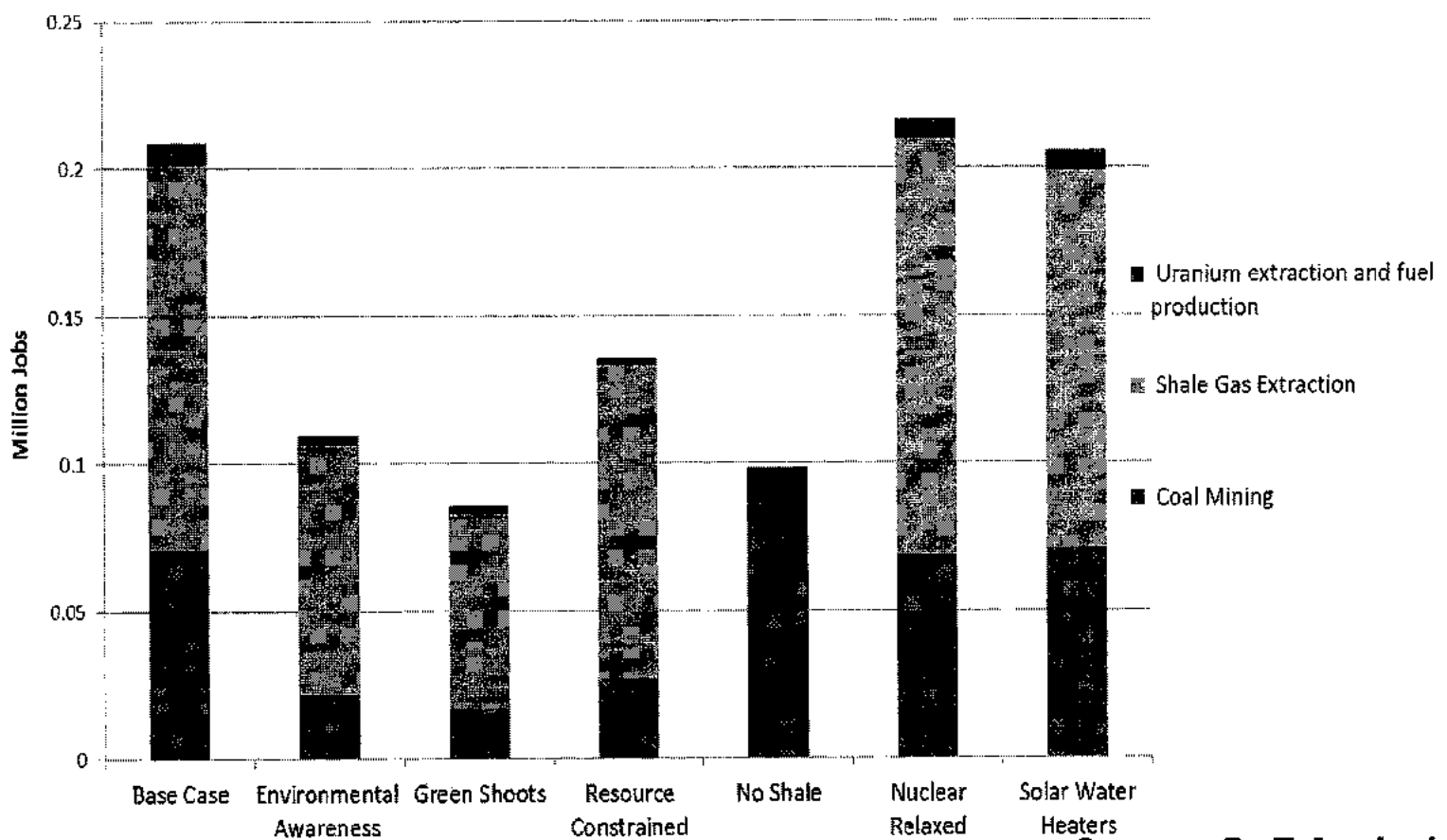
Job Potential in Liquid Fuel Production - 2050



Source: Doe Analysis

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Job Potential in Extraction by Technology Type - 2050



Source: DoE Analysis

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THANK YOU

INTEGRATED ENERGY PLAN

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ANNEXURE – MODEL OUTPUTS

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PROJECTED DEMAND PER SCENARIO

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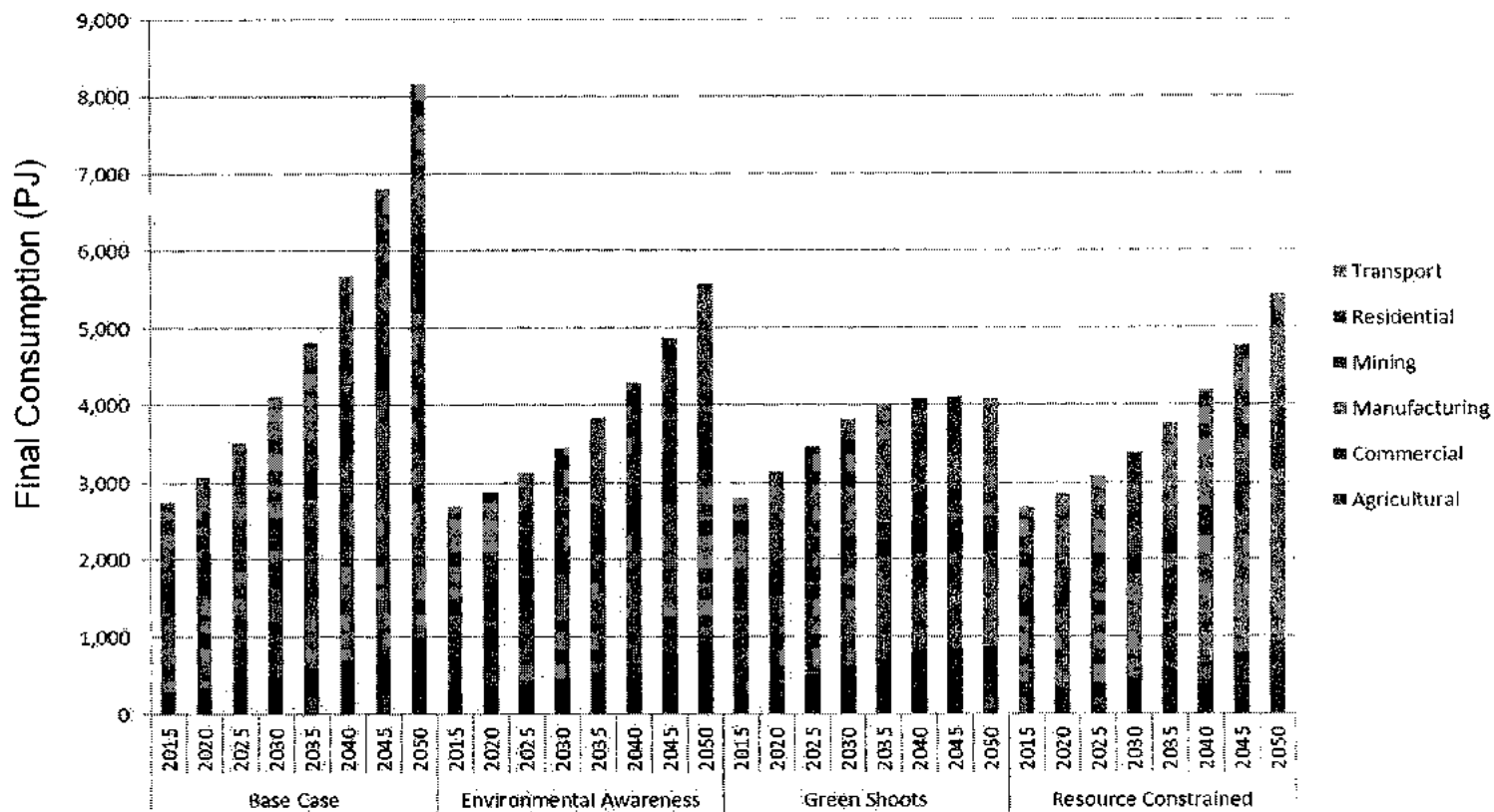
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FINAL CONSUMPTION



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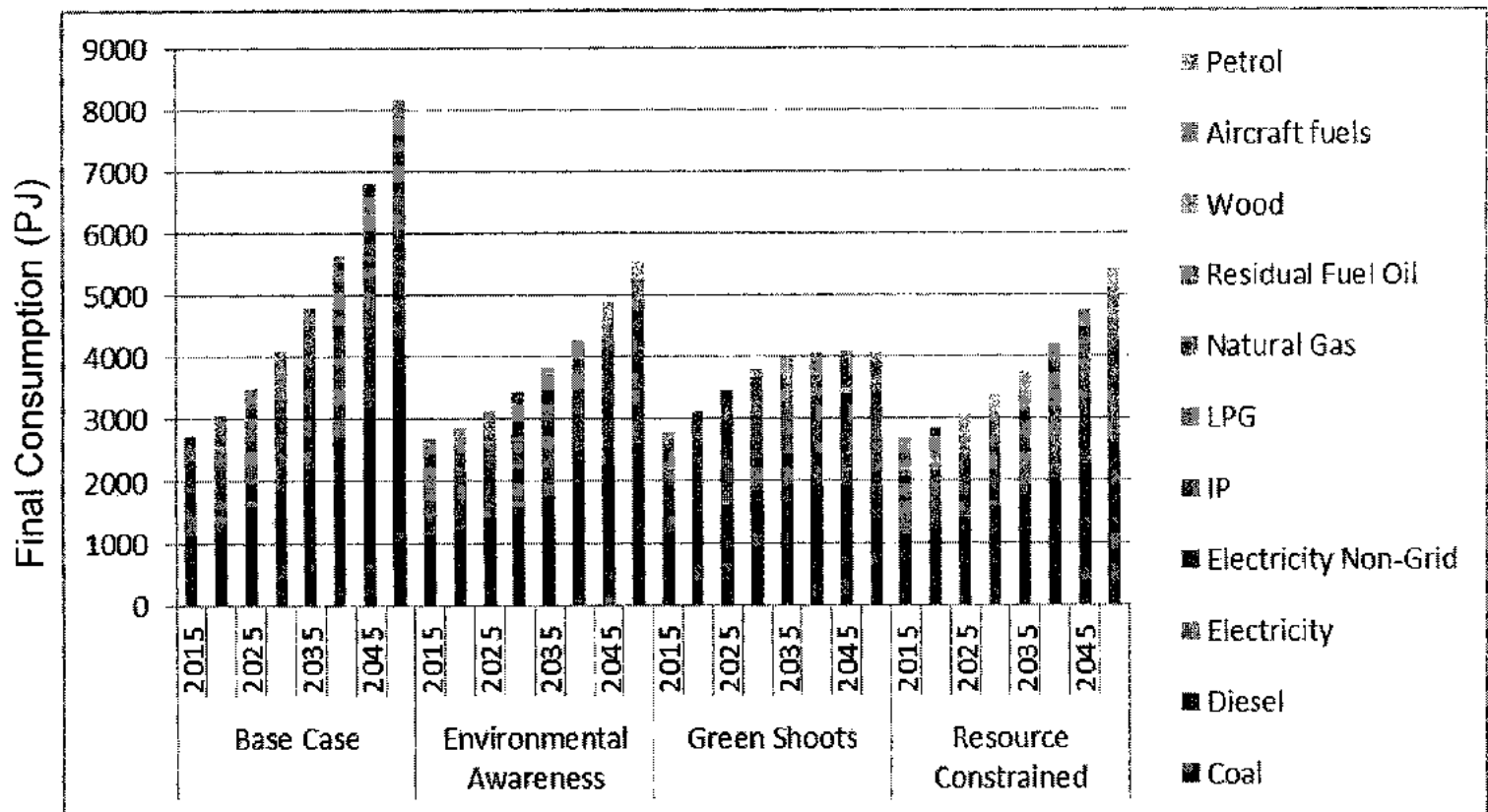
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FINAL CONSUMPTION (PER CARRIER)



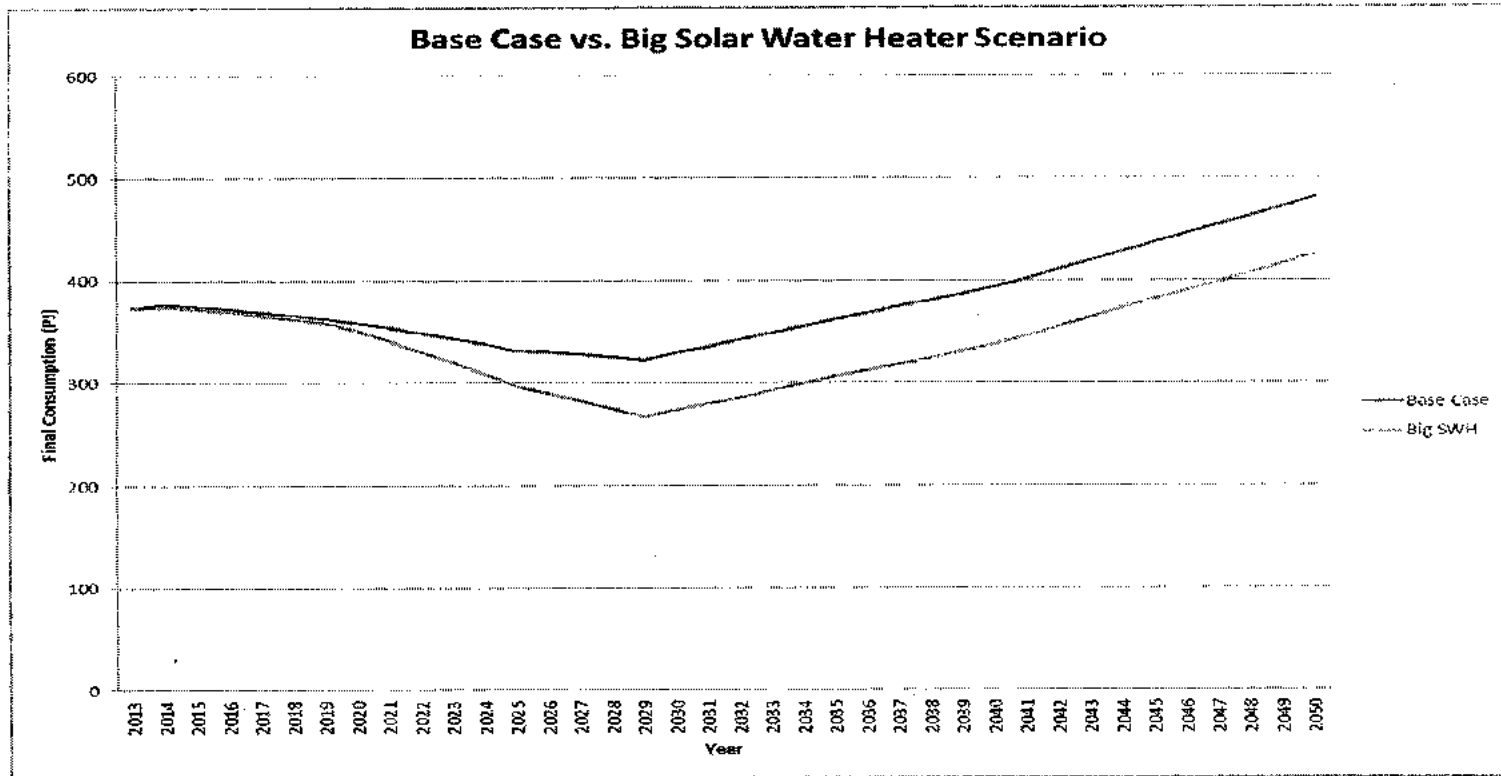
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FINAL CONSUMPTION - BIG SWH VERSUS BASE CASE



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ENERGY MIX (SUPPLY-SIDE OPTIONS) FOR EACH SCENARIO



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ELECTRICITY GENERATION

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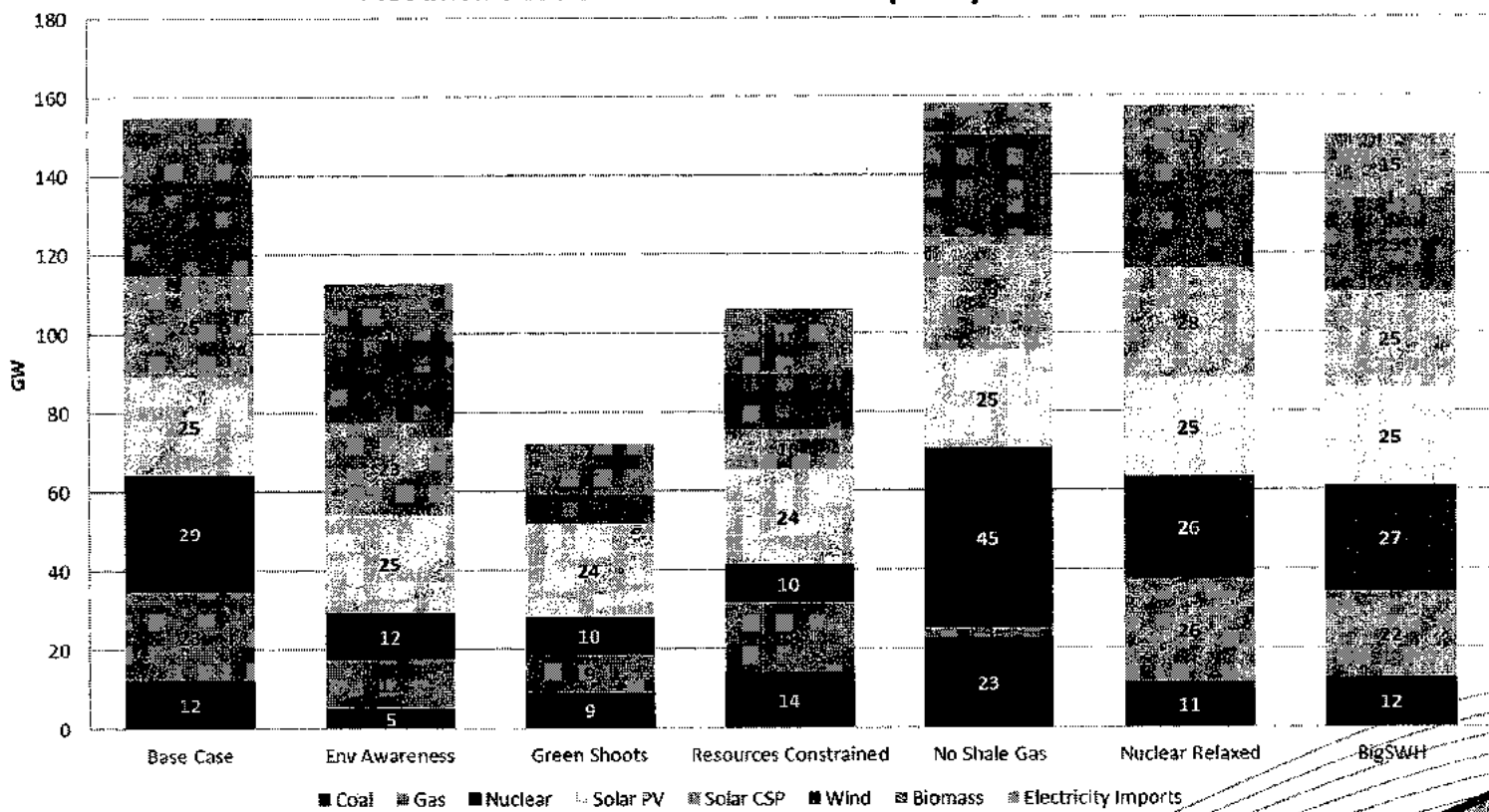
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Accumulated New Generation Capacity - 2050



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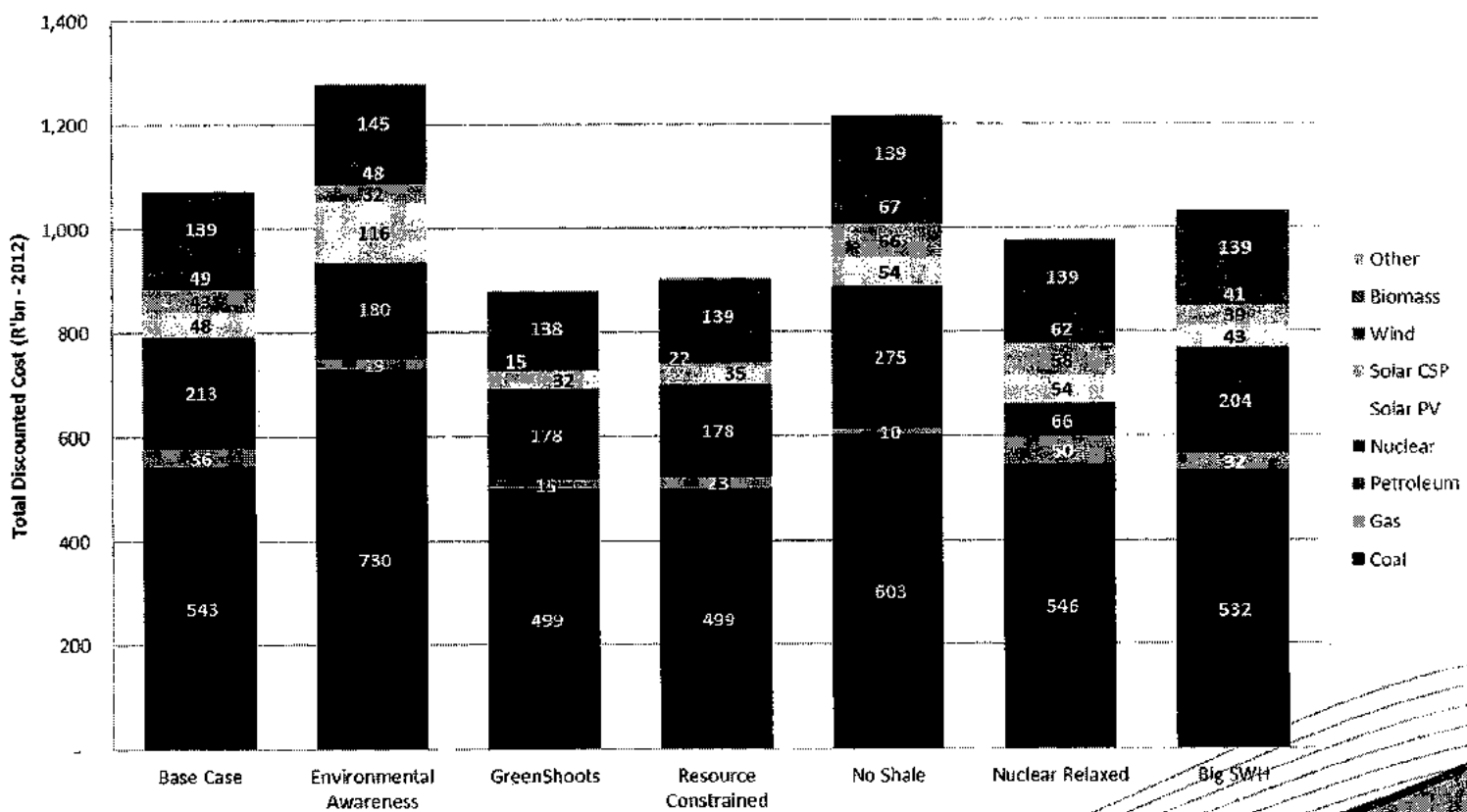


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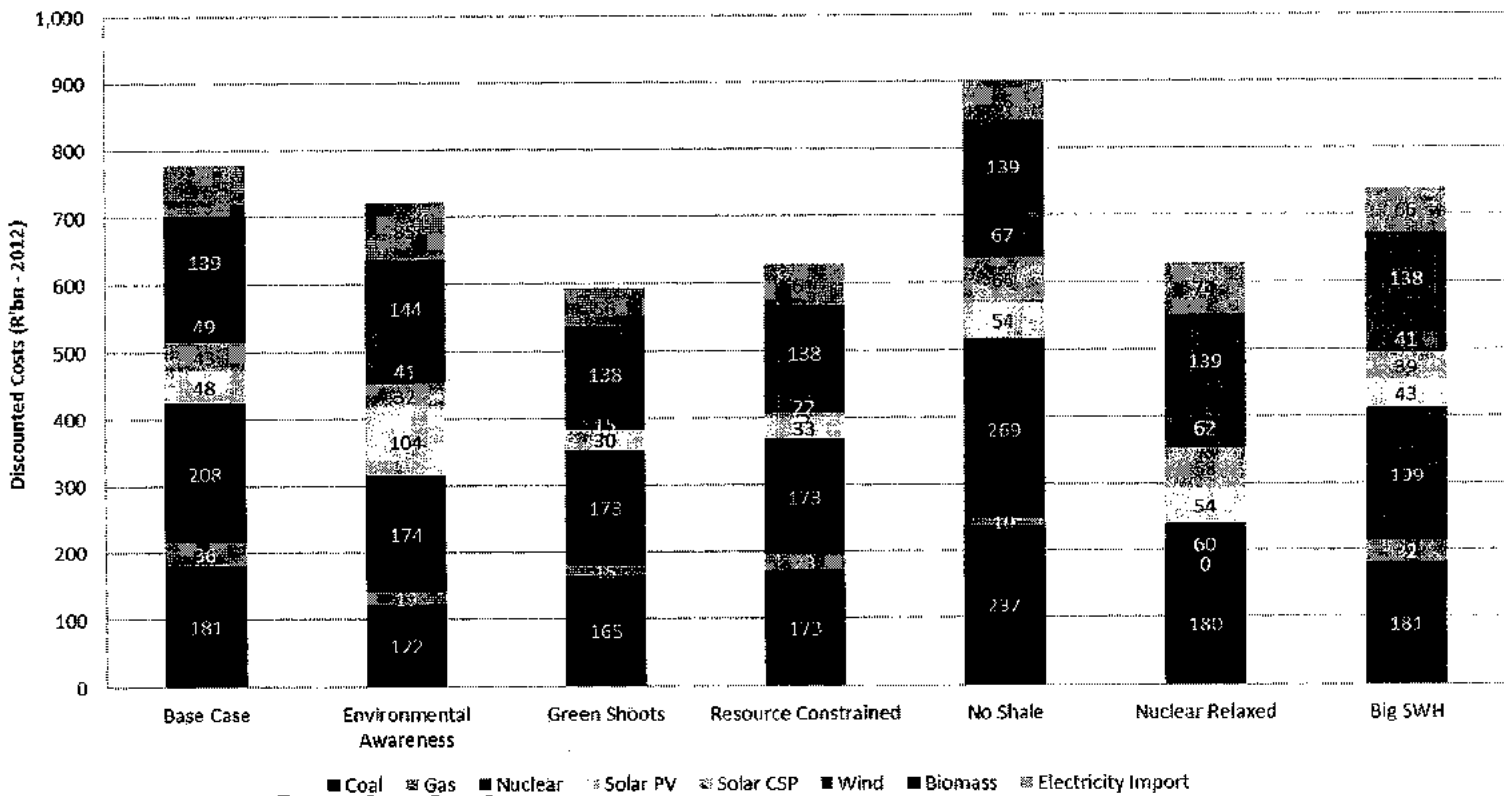
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Total Discounted Costs - Electricity Generation





Discounted Costs - Electricity Generation (New Capacity Only)



Source: Doe Analysis

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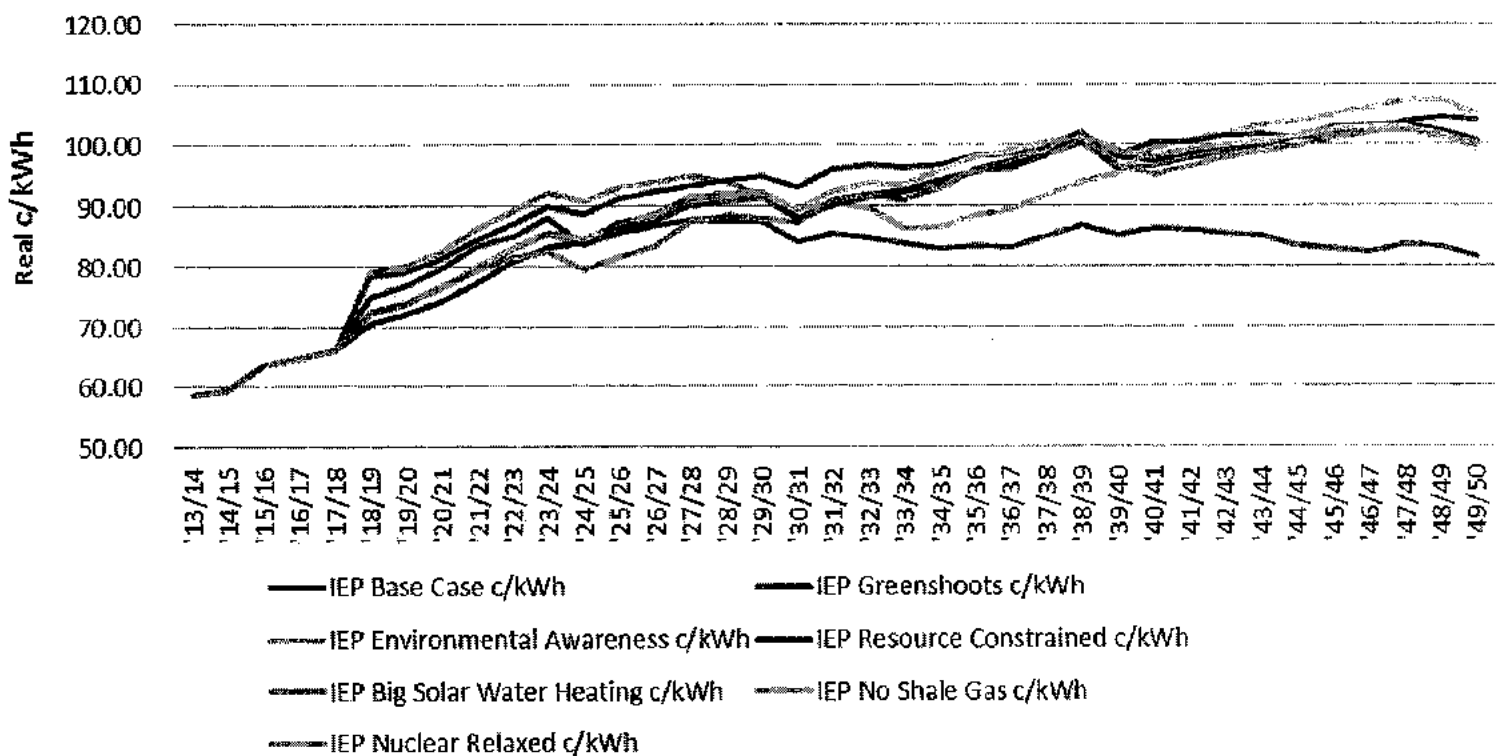
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ELECTRICITY PRICE PATH

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IEP Scenario Price Comparison - Real c/kWh



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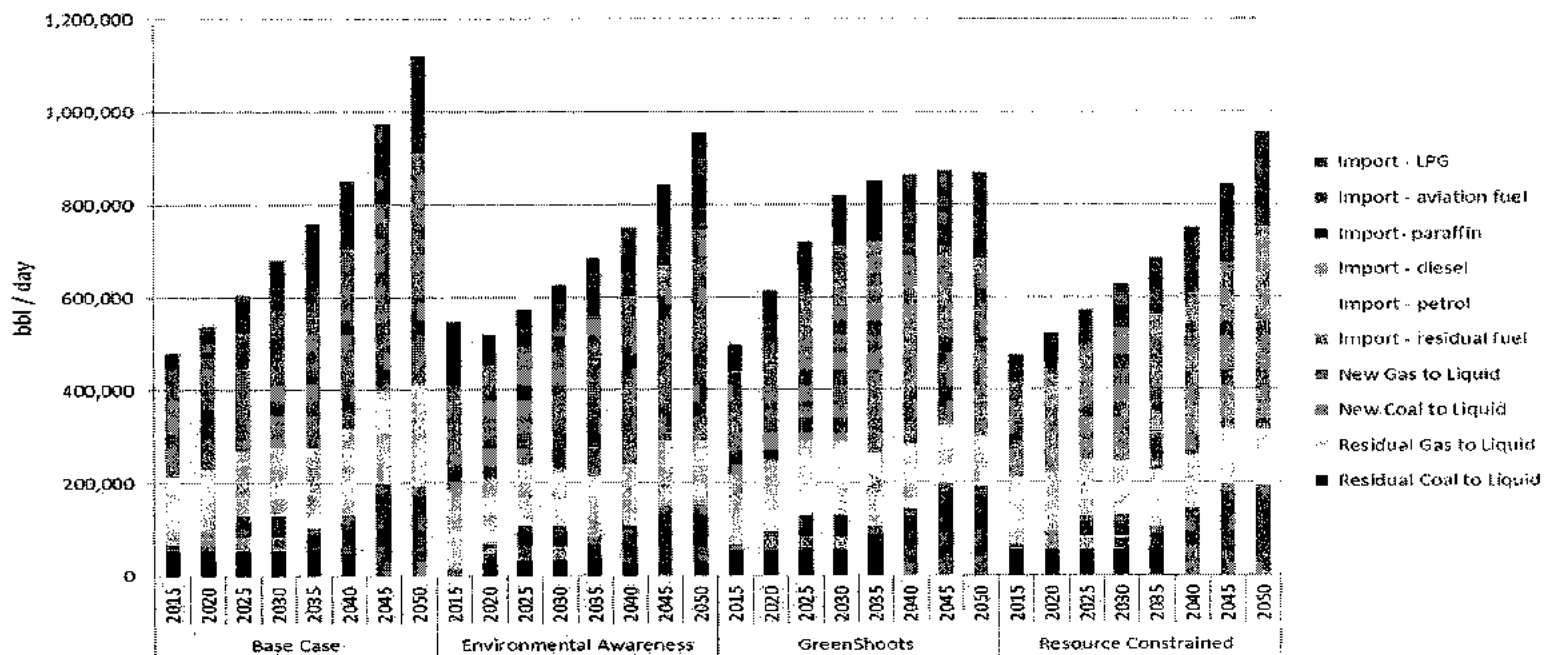
LIQUID FUEL SUPPLY

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Liquid Fuel Production Mix



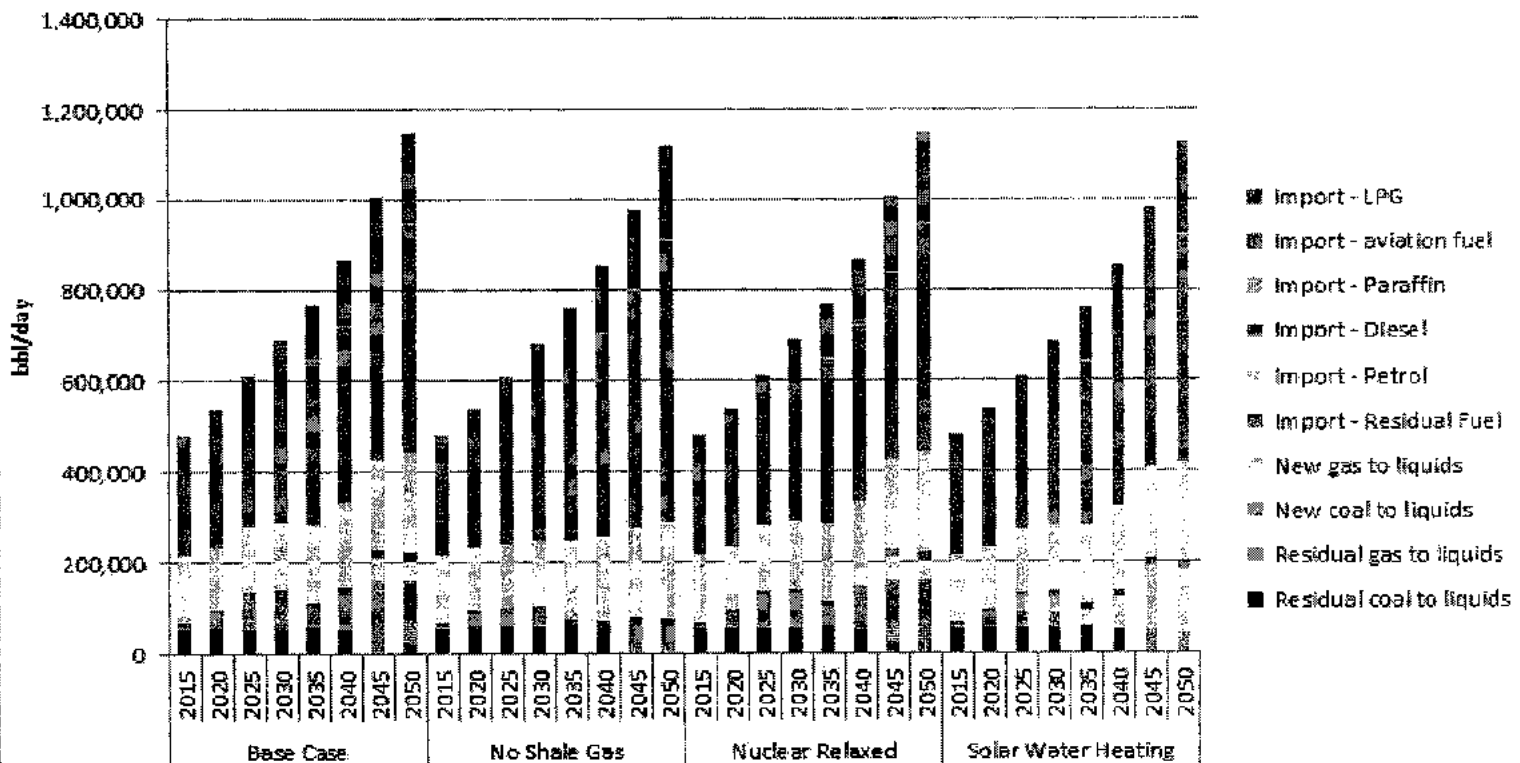
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Liquid Fuel Production Mix sensitivity analysis



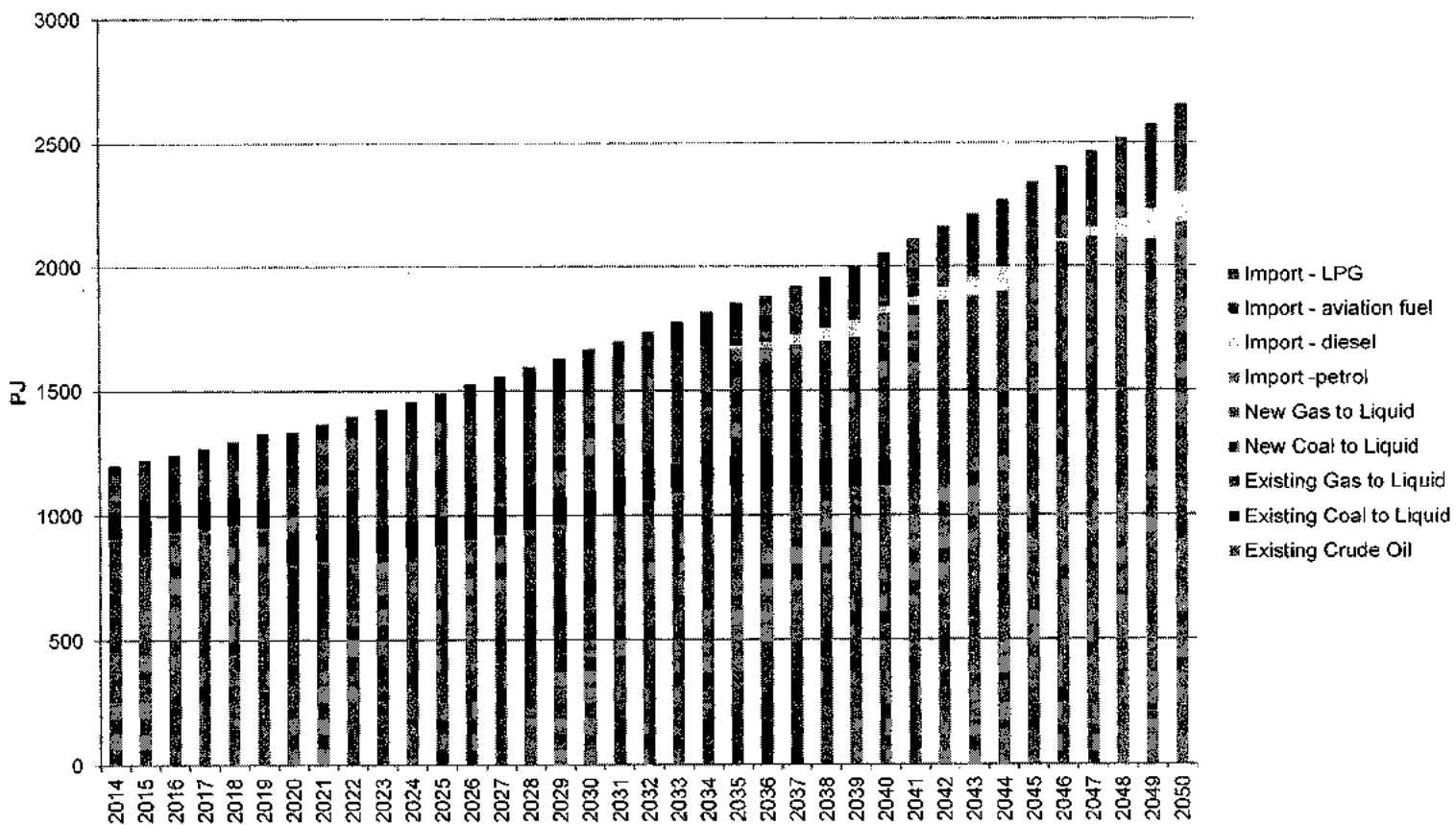
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Liquid Fuel Supply



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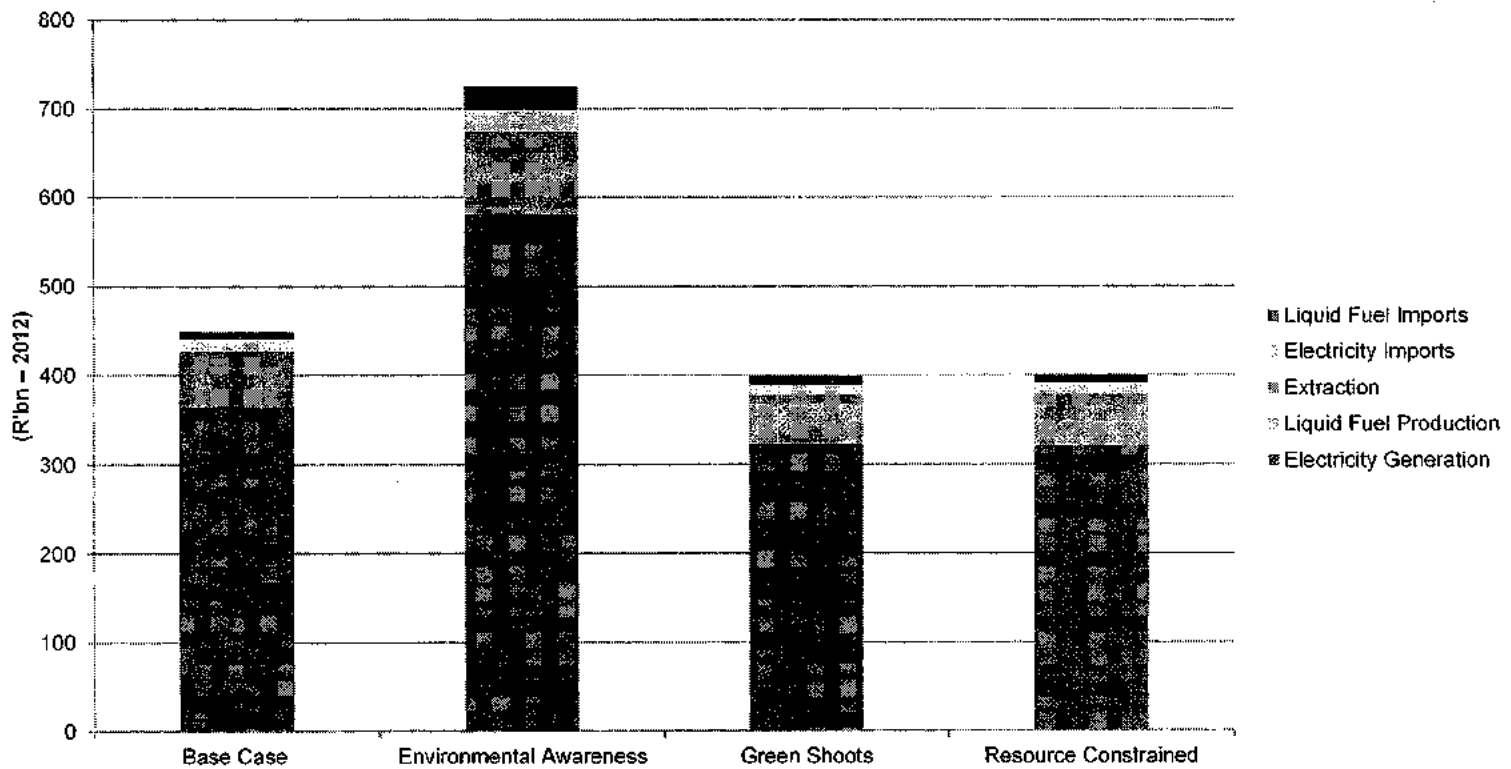
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ENVIRONMENTAL CONSIDERATIONS

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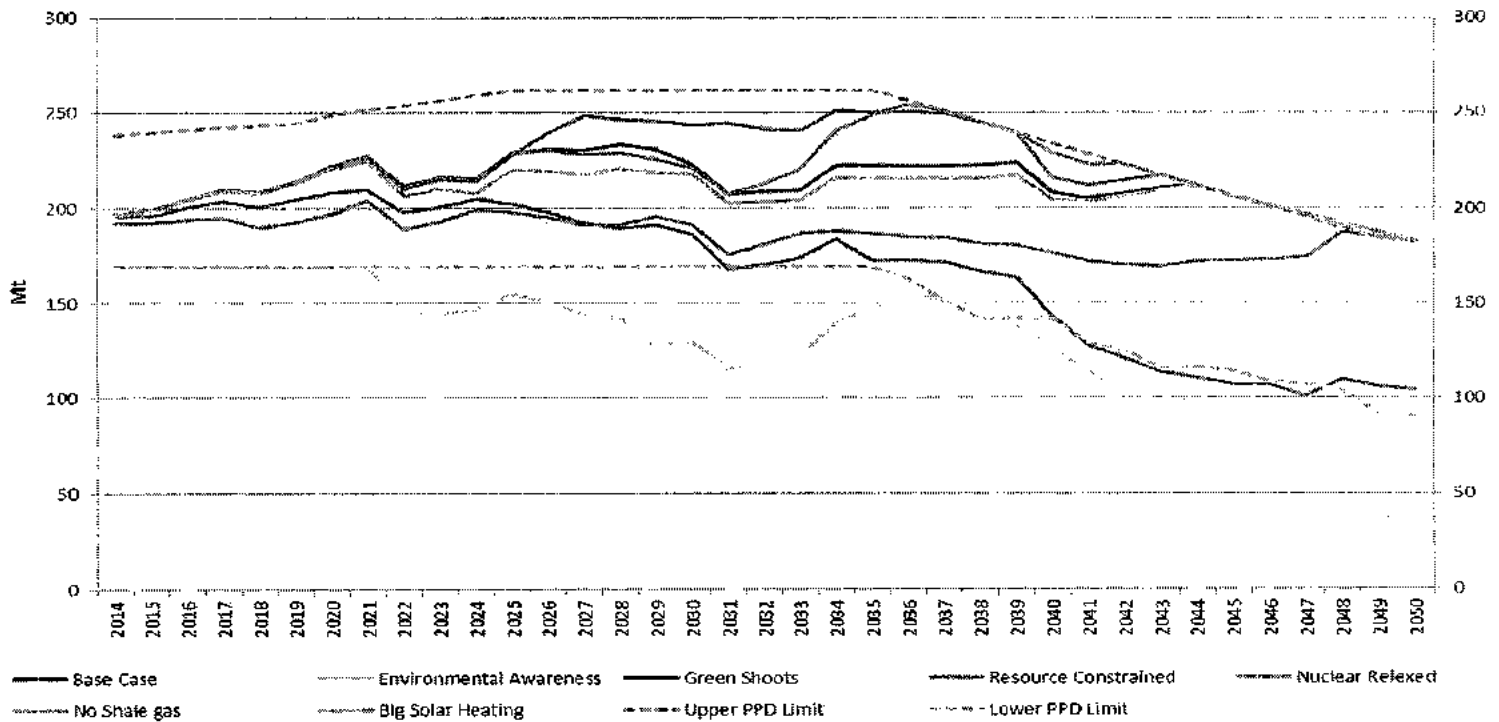


Externality Costs



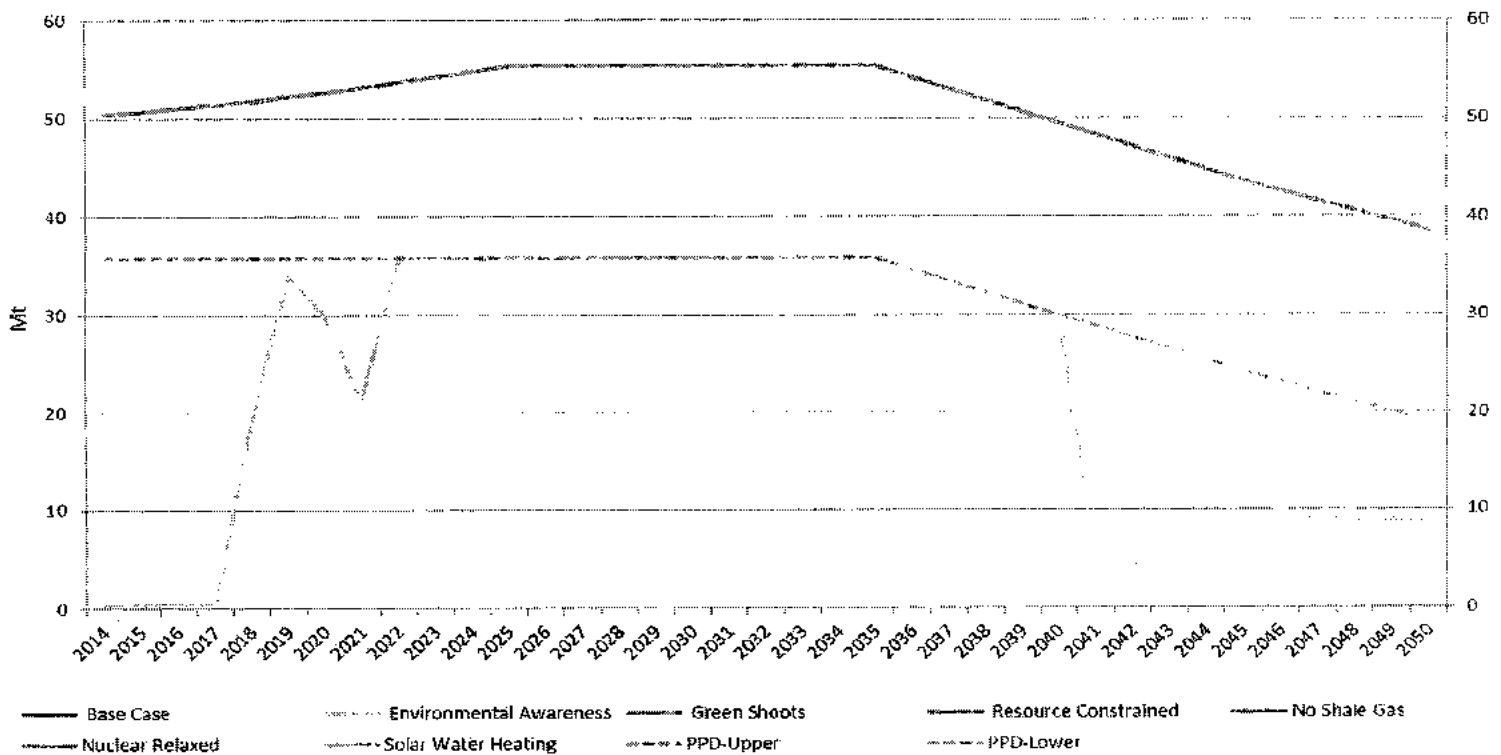


Carbon Dioxide in Electricity Generation





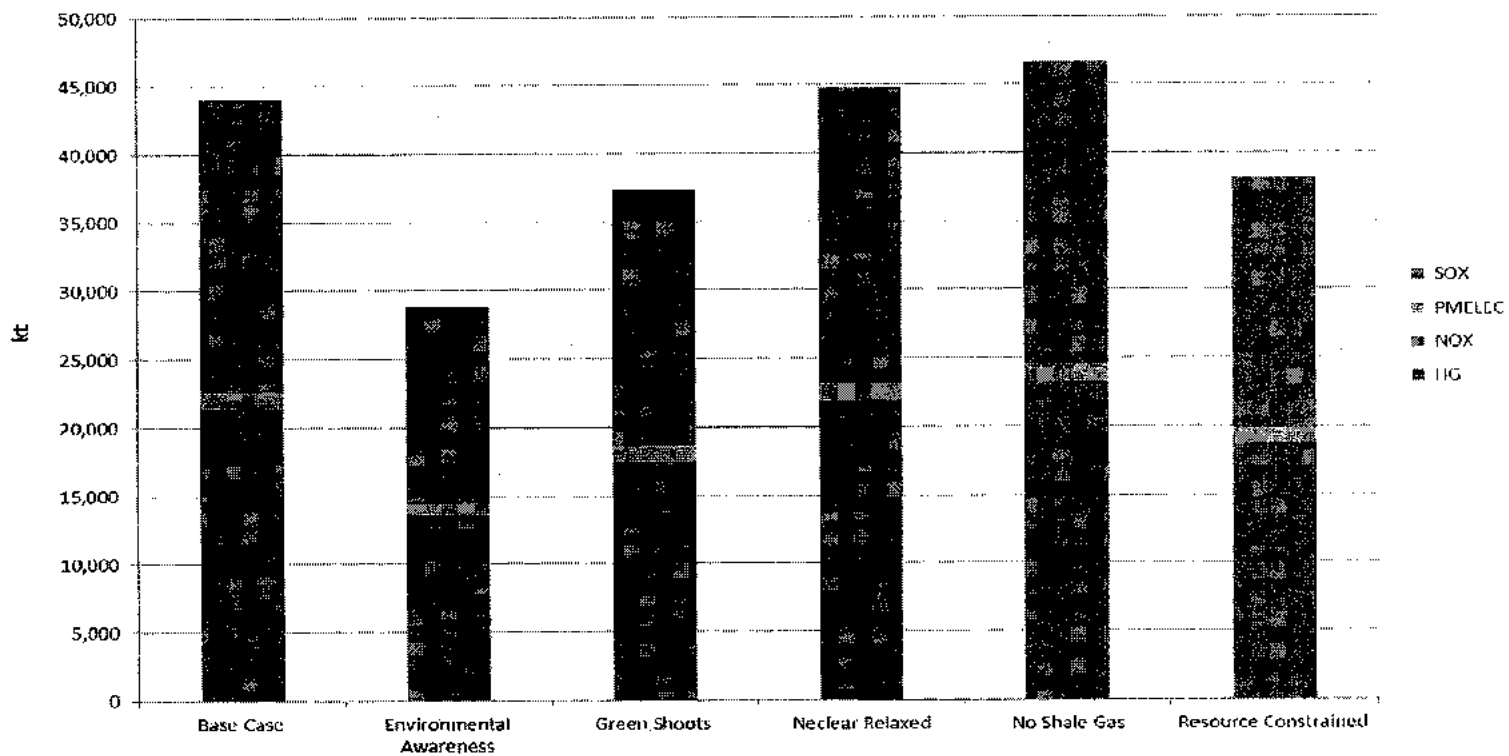
Carbon Dioxide Emissions for Liquid Fuel Sector



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Total Pollutants



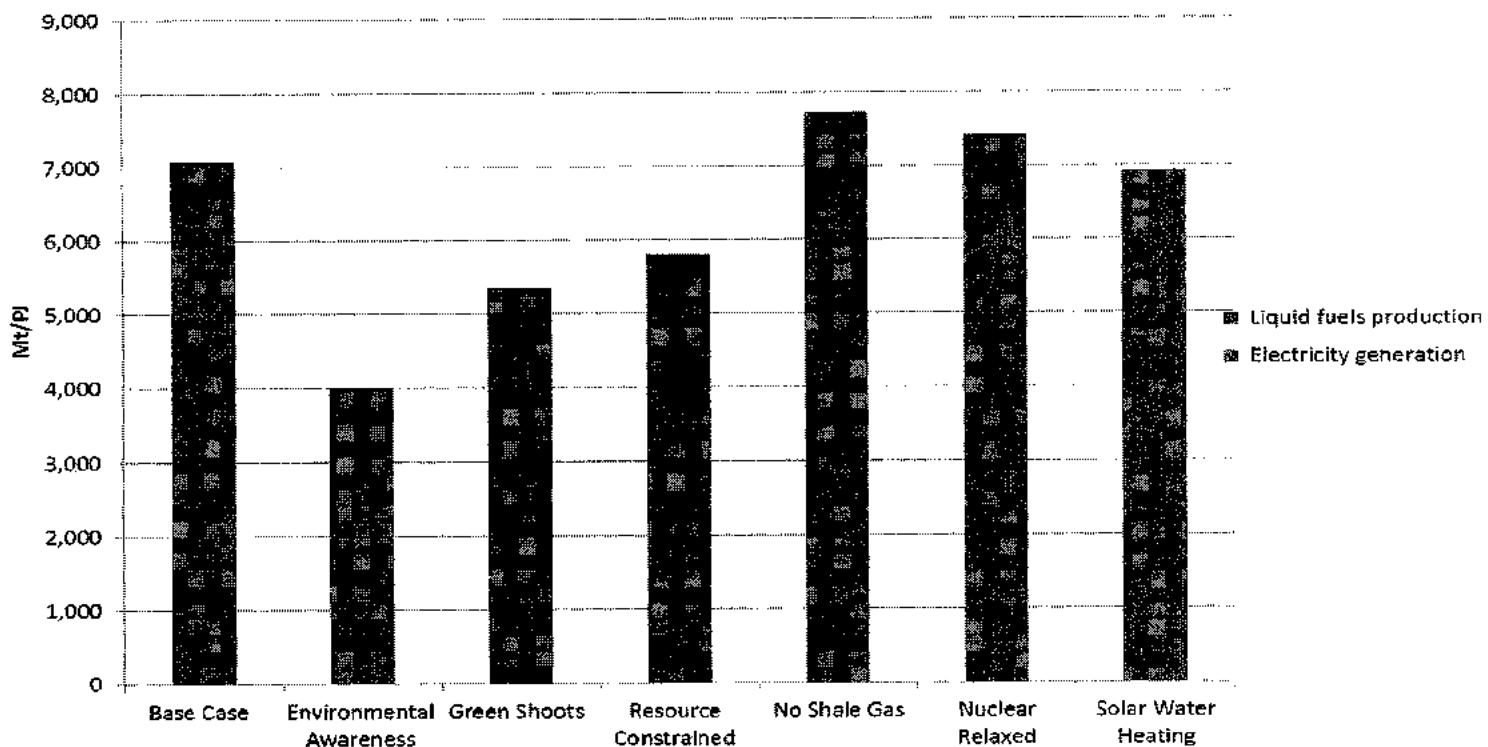
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Total Water Consumption



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Statement on the Cabinet meeting of 1 and 2 November 2016

3 Nov 2016

1. Implementation of Key Government Programmes

1.1. Cabinet congratulates Finance Minister Pravin Gordhan and the team at National Treasury for delivering a balanced and well thought-out budget. The Medium Term Budget Policy Statement (MTBPS) provides an opportunity for civil society, labour and business to work together with government to achieve the economic objectives of our country. Cabinet supports the initiatives announced in the MTBPS to guide the economy through these difficult economic times, achieve inclusive economic growth and efficiently use state resources.

1.2. Cabinet thanks the more than 4, 5 million taxpayers who submitted their tax returns during the 2016 Tax Season and reminds all non-provisional taxpayers who still have to submit a tax return to do so as the deadline for submission on 25 November 2016 is fast approaching.

Patriotic taxpayers are helping to improve the lives of millions of South Africans by partnering with government as it rolls out much needed services and social support across the communities.

Cabinet calls on South Africans to join our efforts in growing the economy by creating new jobs, and adopting a culture of saving. Working together we can ensure that we boost

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economic growth.

Cabinet supports calls for a quick and effective investigation into the alleged hostage situation at the South African Revenue Service. Incidents such as these have a negative impact on public confidence in our law enforcement authorities and need to be quickly addressed.

1.3. Funding higher education remains a priority for government and the additional R17 billion allocated to universities over the next three years will help to further ease the burden on financially needy poor and missing middle students. This funding will also ensure that more students are able to access higher education as R9.2 billion of this funding will be allocated to NSFAS.

This funding is welcomed, however the immediate priority now is to resume learning. Cabinet calls on South Africans to support all efforts to save the 2016 academic programme. Now is the time to end all protests, return to class and complete the academic year without further delays.

Government believes that dialogue to address the demands of students can take place while the academic programme is underway. We reaffirm the right to protest but this must be done within the confines of the law and in a manner that does not infringe on the rights of others.

Government's advances in making higher education accessible are borne out by the Statistics South Africa Financial Statistics of Higher Education Institutions 2015 report. It shows that student enrolment in Higher Education grew by 32.5 per cent from 2006 to 2015. Further, grants by national government to Higher Education increased by 144 per cent over a ten year period from 2006 to 2015.

Government grants and tuition fees account for the bulk of university income, with government spending accounting for 43 per cent of university income and tuition fees accounting for 34 per cent. These findings demonstrate government's commitment to education and reaffirms our call for those who can afford to pay their fair share, and reveals that tuition fees remain an important part of overall funding.

Progress has also been made by the Ministerial Task Team appointment by the Minister of Higher Education and Training, Blade Nzimande, to develop a support and funding model for Poor and "Missing Middle" students. A blueprint entitled the Ikusasa Student Financial Aid Programme (ISFAP), underwent an engagement process, which saw various inputs incorporated, and agreement obtained across all key stakeholders for the future governance structure of ISFAP.

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The Ikusasa Student Financial Aid Programme makes various recommendations which are currently under consideration for implementation. The proposed model and recommendations contained in the report, will go a long way in not only addressing the funding problems faced by poor and "missing middle" students, but also in addressing amongst other challenges which South Africa faces, including:

- Reducing the high dropout rates of poor and working class students in the higher education and training sector,
- Improving the employability of the funded graduates,
- Improving the skills profile of the country,
- Improving the partnership between government, the private sector and higher education institutions in supporting poor and "missing middle" students.

The ISFAP blueprint provides poor and "missing middle" students financial assistance to cover the full cost of study. While recommending a fully subsidized education to the poor in the form of bursaries and grants, it also proposes progressively reducing bursaries and grants to the "missing middle" students as household income increases and sketches scenarios of how this can be achieved by mobilising funds from both the public and private sectors.

1.4. The launch of the Tourism Enterprise Development Incubator, in Pilanesberg in the North West by the Minister of Tourism Derek Hanekom, will create a conduit for economic inclusion through viable tourism businesses. This enhances the tourism sector's contribution to building an inclusive economy.

The pilot incubator will target 50 SMMEs in the Bojanala District and will support them for three years to become sustainable. The Tourism Enterprise Development Incubator provides business support to tourism enterprises.

1.5. The launch of Ngwaabe Integrated Energy Centre on 4 November 2016 by the Department of Energy, in collaboration with strategic partners is part of a programme to establish Integrated Energy Centres in poverty nodal areas. This one-stop energy shop provides access to safe and affordable energy resources for poor households.

In addition, it provides information on safe, efficient and environmentally sustainable use of energy sources. It also promotes the SMME sector and grows job opportunities through energy related businesses.

1.6. The Windaba Conference and Exhibition which is taking place from 2 to 4 November 2016 at the Cape Town International Convention Centre under the theme "Towards 100% renewables" also boosts government's renewable energy initiatives.

It brings together stakeholders involved in the wind energy value chain on the African continent and in South Africa in particular. In addition, the 11th Annual 2016 Southern African Energy Efficiency Convention from 8 to 9 November 2016 at Emperors Palace in Johannesburg will focus on a range of energy-related fields. Areas that will be covered include energy engineering, efficiency improvement, facilities and building management, renewable and alternative energy, co-generation, power generation, energy services and sustainability.

1.7. Today, President Jacob Zuma will co-chair the Inaugural Session of the Zimbabwe-South Africa Bi National Commission with President Robert Mugabe. The main objective is to deepen bilateral relations and cooperation between the two countries and to strengthen and develop the potential that exists for closer ties in the fields of trade, investment, mining, water, energy, infrastructure development, transport, and ICT, among others.

To date, the two countries have signed more than 38 Memoranda of Understanding and Agreements, which cover a broad range of areas, which include among others, trade and investment, immigration and consular matters, defence, agriculture, the environment, energy, health, as well as arts and culture.

1.8. The successful hosting of the Annual Diplomatic Fair by the Department of International Relations and Cooperation and Proudly South Africa at the Union Buildings on 29 October 2016 in Pretoria serves as a key platform to educate the general public about diplomacy and South Africa's foreign policy objectives.

This event brought together embassies, high commissions and international organisations accredited to South Africa to showcase and promote cultural diplomacy through creative expressions such as arts, music and cuisine from around the world. Over 60 diplomatic missions and several private businesses showcased their products and opportunities this year.

2. Key Cabinet decisions

2.1. The Special Cabinet of 1 November 2016, received progress reports on the work of the Inter-Ministerial Committee on State Owned Companies (SOC) Reform, chaired by Deputy President, Cyril Ramaphosa.

This emanates from the implementation of Cabinet endorsed recommendations from the 2010 Presidential Review Commission of SOCs. Cabinet reaffirmed the phased approach to implementation of these recommendations.

Cabinet reiterates that all state owned entities must be efficient, and financially viable.

A suite of decisions was taken to pursue the central policy objective of strengthening SOCs to enable them to meet their developmental objectives.

- Cabinet endorsed a Private Sector Participation framework for infrastructure delivery which will guide collaboration between SOCs and the private sector.
- Cabinet adopted the guideline for the remuneration and incentive standards for directors of SOEs.
- Cabinet endorsed the broad thrust of a guide for the appointment of boards and executive officers, for which, the Department of Public Service and Administration will undertake a consultation process with provinces and municipalities, before Cabinet approval.
- The first draft of a new government shareholder policy was recommended for further consultation. This will culminate in the promulgation of an over-arching SOC legislation.
- National Treasury developed a proposal for determining and costing developmental mandates of state enterprises, the introduction of this approach will help streamline commercial and non-commercial activities of SOCs.

These better position the SOCs to contribute towards the implementation of the National Development Plan: building infrastructure, growing the economy, expanding industry, helping develop high-end skills, creating jobs and advancing other transformation objectives.

2.2. Cabinet approved that the Integrated Energy Plan (IEP) be published for public discussion to afford stakeholders and interested parties to engage with it. The IEP is anchored in the National Energy Act, 2008 (Act No. 34 of 2008). It seeks to guide future energy infrastructure investments and policy development which will shape the future energy landscape of South Africa.

Integrated energy planning is required to ensure that current and future energy service needs can be met in the most efficient and socially beneficial manner, while controlling economic costs, serving national imperatives such as poverty alleviation and job creation and minimising adverse impacts on the environment.

The IEP provides a long-term vision of how South Africa can use energy optimally as a mechanism to remain competitive, which inherently requires a shift in how various energy resources are utilised.

2.3. Cabinet amended its decision of 10 June 2015 to designate the South African Nuclear Energy Corporation as the implementing Agent for the Nuclear New Build Programme. This decision, at the time, allowed Eskom to focus on the Medupi, Kusile and Ingula projects and the energy challenges the country was experiencing.

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Cabinet designated Eskom as the Owner Operator and Procurer for Nuclear Power Plants in accordance with the Nuclear Energy Policy of 2008. Eskom has more than 30 years of safe operation of the Koeberg Nuclear Power Plant, which is also the only Nuclear Power Plant in Africa, and has been developing the Environmental Impact Assessment and nuclear Site Safety Reports for possible nuclear power plants since 2007.

Cabinet also approved designating the South African Nuclear Energy Corporation as the Owner Operator and Procurer for Nuclear Fuel Cycle and Multi-Purpose Reactor.

The Department of Energy will continue to act on its mandate as the policy setting and coordinating department of the Nuclear Build Programme.

2.4. Cabinet was briefed on the progress regarding the update of the Integrated Resource Plan (IRP) and approved that public consultation be undertaken on the base case and assumptions.

Since the IRP 2010-30 there has been a number of developments affecting the energy sector. The IRP update process balances a number of objectives to ensure security of supply so as to minimise cost of electricity, to promote job creation and localisation, to minimise negative environmental impacts, minimise water use and to diversify supply sources.

The first milestone which is the compilation of assumptions to be used in the IRP has been completed, pending public consultation. The second milestone on the development of the base case which is a least cost plan has been completed. The third milestone which is a scenario analysis is underway. And the fourth milestone, is policy adjustment.

2.5. Cabinet received an update on developments in the negotiating position at the World Trade Organisation and agreed on the need for a development focus in the post-Nairobi work programme and in preparation for Eleventh Ministerial Conference of the WTO (MC11) to be held in Argentina in December 2017.

This is in line with the National Development Plan's objectives of developing appropriate policy responses in a dynamic global environment.

2.6. Cabinet was briefed on the resolutions taken by the President's Coordinating Council meeting held on 11 March 2016. This is a statutory body established in terms of the Intergovernmental Relations Framework Act, 2005 (Act No13 of 2005), which brings together the three spheres of government on matters of common interest and national importance with a view to strengthening co-operative governance.

Issues which were discussed included: Implementation of the Back to Basics Programme, progress report on the establishment of newly re-determined municipalities; government's



response to drought and water shortages; and review of South African Immigration Regulations, 2014.

2.7. Cabinet approved publication of the draft White Paper on Fire Services, public comments. It outlines key policy proposals and options that form the basis for a reviewed fire services legislation that will replace the outdated Fire Brigades Services Act, 1987 (Act No. 99 of 1987).

This resonates with the Back to Basic approach, by placing an obligation on fire services to constantly engage with communities they serve to work together to reduce fire risks and ensure adequate response strategies and systems to respond to fires and other related incidents rapidly and effectively.

The White Paper repositions the fire services from response orientated fire services towards a fire risk reduction based approach. This contributes to effective integrated disaster management and fire services, by placing fire safety and prevention, particularly community-based fire risk reduction, at the centre of fire services delivery which will significantly contribute to the creation of safer communities as highlighted in the National Development Plan.

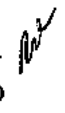
3. Bills

3.1. Cabinet approved the introduction of the Road Accident Fund Amendment Bill, 2016 in Parliament. The Bill amends the Road Accident Fund Act, 1996 (Act No 56 of 1996) which provides for the payment of compensation for loss or damage wrongfully caused by the driving of motor vehicles.

The Bill is aligned with the National Development Plan and with Outcome 13 which provides for an inclusive and responsive social protection system by ensuring efficient service delivery and early medical intervention to assist with recovery and return to work, and no-fault cover to ease the financial burden on those who are disadvantaged.

4. Upcoming events

4.1. Members of the Executive across the three spheres of government will interact with South Africans countrywide during the National Imbizo Focus Week between 7 and 11 November 2016, under the theme "Together we move South Africa forward: "Our future – make it work". Cabinet encourages all South Africans to actively participate in these events and engage with political principals, as an informed and active citizenry is a critical to deliver on Vision 2030, of the National Development Plan (NDP). The Imbizo Focus Week programme will be available on www.gov.za.

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4.2. South Africa marks National Disability Rights Awareness Month under the theme: "Persons with disabilities - equal participants in shaping a sustainable future" from 3 November and concludes with International Day of Persons with Disabilities, on 3 December 2016.

The month long programme will be used to mobilise society and decision-makers to take responsibility for ensuring that persons with disabilities have equitable access. Programmes will also raise awareness on the participation of persons with disabilities in building sustainable and cohesive communities. Information on the rights of persons with disabilities will also be made accessible to support their empowerment.

Cabinet calls on all South Africans to advance the rights and quality of life of people with disabilities in line with our commitment in the National Development Plan to increase access to services, particularly in quality education and employment for people with disabilities.

4.3. Cabinet calls on all South Africans to support the 16 Days of Activism for No Violence Against Women and Children campaign. South Africa adopted the campaign in 1998 as one of the intervention strategies towards creating a society free of violence.

16 Days is an international campaign which takes place every year from 25 November to 10 December. The campaign aims to raise awareness amongst South Africans about the negative impact of violence against women and children. It also calls on every person to take a stand against violence against women and children.

4.4. Cabinet approved South Africa's negotiating mandate to serve as the basis for engagement at the 22nd Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP22), and the 12th Session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (CMP12), to be held from 7 to 18 November 2016 in Bab Ighli, Marrakech, Morocco.

The negotiating position is in line with the National Development Plan which promotes environmental sustainability as well as the Constitution, which states that the environment should be preserved for present and future generations.

5. Cabinet's position on key issues in the environment

5.1. The decision by the National Prosecuting Authority (NPA) to withdraw fraud charges against Finance Minister Pravin Gordhan brings the matter to finality and allows the country to direct all efforts to advance the economy, build investor confidence and avert an international credit rating downgrade.

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5.2. Cabinet was briefed on the impact of the drought on water supplies in South Africa with a particular focus on Gauteng which is supplied with water from the Integrated Vaal River system.

South Africa received the lowest rainfall since 1904 (114 years) with extremely high temperatures experienced in October and November of 2015.

This has severely impacted on our water supplies with national average dam levels decreasing to 48.4% compared with the same time last year when levels were at 66.6%. We are still very much in a neutral situation and it is very likely that we can expect an extended period of recovery.

It could take at least two to three years to see any significant recovery in dam capacity and this could even extend to five years. We are therefore still in for a long road to recovery.

With regard to the Integrated Vaal River System consisting of 14 dams which supplies water to Gauteng, the system is currently at 49.1% compared with 67.9% at the same time last year.

This system also provides water to the bulk of the ESKOM coal fired power stations, SASOL, irrigation users and mines and industries in Eastern Mpumalanga, North West, Free State and Northern Cape, thus supporting approximately 45% of the country's economy and 35% of the population. 80% of the water from the Vaal system is used by domestic consumers.

This is the third week that the system is below 50% during this drought. The Vaal Dam is now at 26.4%, Katse dam is at 38.4%, Sterkfontein Dam at 91.5% and Grootdraai Dam is at 66.3%. Restrictions of 15% for urban use and 20% for irrigation use have been imposed as published in the Government gazette on 12 August. These restrictions are mandatory.

A Technical Task Team has been established to monitor the implementation of the restrictions. Rand Water is the main supplier of potable water into Gauteng and the target is to reduce the supply from Rand Water by 687 million litres per day.

All Municipalities within the supply area have been given specific targets to meet in respect of reducing their water consumption. The initial approach has been an incremental one with a gradual reduction in supplies, starting at 5% and gradually increasing to 15% by throttling the main valves. From 3 October we shifted to a volume based restriction.

It is important that all consumers comply with the restrictions to make sure that we can stretch our available water supplies. The province of Gauteng is setting up a Joint Operations Centre (JOC) to monitor and ensure compliance. All Municipalities have also been directed to establish operation centres with immediate effect and to ensure that communication with consumers is improved.

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The Vaal dam will be kept at 25% and this will be achieved by transferring water from Sterkfontein dam. This is necessary to protect the integrity of intakes for ESKOM, Rand Water and SASOL. Releases will commence on 7 November and continue for a minimum of 54 days to 30 December.

The minimum release planned at this stage is 190 million cubic metres of water which will drop the Sterkfontein dam by approximately 7%. The staggered release is to minimise any danger to communities downstream of Sterkfontein and to minimise damage to river banks which have been dry for a considerable period of time.

Cabinet calls on South Africans to use water efficiently and conserve it. All water users must adhere to water restrictions where they are being implemented, and continue to save water, working with municipalities. Government is doing all it can to mitigate against the current conditions and is working with all stakeholders in drought affected areas.

5.3. The African Union Commission Chairperson, Dr Nkosazana Dlamini-Zuma hosted the engagement between African Editors and Press Officers from all 54 African Union member States, under the theme "Deepening Africa's Narrative and Capacities to Deliver Agenda 2063". Agenda 2063 calls for all segments of the African society and the African Diaspora to work together to build a prosperous and united Africa based on shared values and a common destiny.

Participants reflected on African Union milestones over the past four years, gained a better understanding of Agenda 2063 and how African media can be at the forefront of popularising and driving it. The role of accurate reporting in shaping an African narrative and advocating for media ownership amongst Africans was also discussed.

5.4. Cabinet joins in the commemoration of the life and times of OR Tambo as a demonstration of the respect and appreciation for the role he played in driving the agenda of a non-racial, non-sexist, democratic and prosperous South Africa.

The department of Arts and Culture has already commenced with the planning of the Centenary Celebration of OR Tambo in 2017.

Cabinet congratulated the following:

5.5. Mamelodi Sundowns who are the new African football champions after winning the Confederation of African Football Champions League. Cabinet thanks all the supporters and all South Africans for rallying behind the team, which did South Africa proud. Sundowns joined another South African team, Orlando Pirates who won Africa's top club championship in 1995 to earn the country the first star of this competition.

5.6. The winners of 14th Annual Centre for Public Service Innovation Public Sector Innovation Awards who will go on to compete for the coveted Public Sector Innovator of the Year Award. The awards promote and encourage best practices in public sector innovation and celebrate the successes of individuals and teams at all spheres of government. It serves as a tool for expanding innovation and encouraging others to innovate for improved service delivery.

Cabinet conveyed its condolences to the following:

5.7. To the family and friends of the former Deputy Minister of Social Development, Ms Bongile Maria Ntuli who was a servant of the people and a dedicated gender activist.

5.8. Joins the President in extending condolences to the family and friends of photojournalist, Mr Juda Ngwenya whose iconic images documented our history and compelled us to have conversations about the wellbeing of our country and continent.

5.9. To the family and friends of Abram Thuri Phago who died when two trains collided on the rail split near Tembisa in Johannesburg and wishes those who were injured a speedy recovery. The Department of Transport will be working with Prasa and Railway Safety Regulator to fast track the Board of Inquiry into the full investigation to determine the root cause of the accident to prevent a recurrence of such fatal accidents.

5.10. To the family of Tshwane University of Technology student leader Lesego Benjamin Phehla who died as a result of an accident in Soshanguve.

5.11. To the people of Cameroon following the tragic train accident between Yaoundé and Douala which left 79 people dead. Cabinet also wishes the hundreds who were injured a speedy recovery.

6. Appointments

All appointments are subject to the verification of qualifications and the relevant clearance.

6.1. Extension of the contract of Dr Sam Makhudu Gulube as Secretary of Defence.

6.2. Mr ZU Dangor as Director-General to the Department of Social Development.

6.3. Mr Robert D Nkuna to the position of Director-General to the Department of Telecommunications and Postal Services.

6.4. Dr Thulani Dlamini as the Chief Executive Officer of the Council for Scientific and Industrial Research.

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**6.5. Arts, Culture and National Historical, Natural, Cultural and Architectural Heritage
Distributing Agency of the Board of the National Lotteries Commission:**

- a) Ms Marjorie MM Letoaba (Chairperson);
- b) Mr Thendo Resnic Ramagoma (Deputy Chairperson);
- c) Mr Thanduxolo Lungile; and
- d) Mr Sershan Theeyaagaraj Naidoo.

6.6. Board of Trustees for the Independent Development Trust:

- a) Prof. Somadoda Fikeni (Chairperson);
- b) Ms Nomvula Rakolote (Deputy Chairperson);
- c) Mr Theo Charl Adam;
- d) Mr Siyaduma Biniza;
- e) Ms Phelisa Nkomo;
- f) Ms Andani Amandaline Makhado;
- g) MS Octavia Matshidiso Matloa;
- h) Mr Tlhotse Enoch Motswaledi;
- i) Mr Rashid Amod Sadeck Patel;
- j) Dr Lulama Zitha;
- k) Mr Zakhele Alex Tummy Zitha; and
- l) Dr Gcwalisile Cynthia Zulu-Kabanyane.

Enquiries:

Donald Liphoko

Cell: 082 901 0766

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TRANSLATIONS

English

Afrikaans

isiNdebele

isiXhosa

isiZulu

Sesotho

KS

Sepedi

Setswana

Siswati

Tshivenda

Xitsonga

RELATED INFORMATION

Road Accident Fund Amendment Bill

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GOVERNMENT NOTICES • GOEWERMENTSKENNISGEWINGS

DEPARTMENT OF ENERGY

NO. 1430

25 NOVEMBER 2016

Integrated Energy Plan

INTEGRATED ENERGY PLAN

DEPARTMENT OF ENERGY

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*Integrated Energy Plan***Abbreviations**

BAT	Best Available Technology
bbl	Barrel
CCGT	Combined-Cycle Gas Turbine
CCS	Carbon Capture and Storage
CHP	Combined Heat and Power
CNG	Compressed Natural Gas
CO ₂	Carbon Dioxide
CO ₂ -eq	Carbon Dioxide Equivalent
CSP	Concentrated Solar Power
CTL	Coal-to-Liquid
DMR	Department of Mineral Resources
DoE	Department of Energy
DoT	Department of Transport
DSM	Demand-side Management
EEDSM	Energy Efficiency Demand-side Management
EETMS	Energy Efficiency Target Monitoring System
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GJ	Gigajoule
GTL	Gas-to-Liquid
GW	Gigawatt
GWh	Gigawatt Hours
Hg	Mercury
HVAC	Heating, ventilation, and air conditioning
HySA	Hydrogen South Africa
IEP	Integrated Energy Plan
INEP	Integrated National Electrification Programme
IPAP	Industrial Policy Action Plan
IPP	Independent Power Producer
IRP2010	Integrated Resource Plan - 2010
km	Kilometre
kt	Kiloton
kWh	kilowatt hour
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MBtu	Million British Thermal Units
MJ	Megajoule
Mt	Million Tons

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Integrated Energy Plan

Mtoe	Million Tons of Oil Equivalent
MW	Megawatt
MWe	Megawatt Electric
MYPD	Multi-Year Price Determination
NATMAP	National Transport Master Plan
NCCRWP	National Climate Change Response White Paper
NDP	National Development Plan
NIPF	National Industrial Policy Framework
NO_x	Nitrogen Oxide
NWRS2	National Water Resource Strategy 2
OCGT	Open-Cycle Gas Turbine
PJ	Petajoule
PM	Particulate Matter
PPD	Peak-Plateau-Dcline
PV	Photovoltaic
REIPP	Renewable Energy Independent Power Producer
SANEDI	South African National Energy Development Institute
SO_x	Sulphur Oxide
SWH	Solar Water Heater
UCG	Underground Coal Gasification

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*Integrated Energy Plan***Executive summary**

Energy is essential to many human activities and is critical to the social and economic development of a country. One of the key objectives of the Department of Energy (DoE) is to ensure energy security which, in essence, is about ensuring the availability of energy resources, and access to energy services in an affordable and sustainable manner, while minimising the associated adverse environmental impacts. Many factors pose potential threats to energy security including scarce and depleting energy resources, geopolitical instability, inadequate energy infrastructure and, more recently, natural disasters. To ensure continued security of energy supply, it is essential that a co-ordinated and integrated approach to energy planning, which takes into account these complex issues, is undertaken.

The development of a National Integrated Energy Plan (IEP) was envisaged in the White Paper on the Energy Policy of the Republic of South Africa of 1998 and, in terms of the National Energy Act, 2008 (Act No. 34 of 2008), the Minister of Energy is mandated to develop and, on an annual basis, review and publish the IEP in the Government Gazette. The purpose of the IEP is to provide a roadmap of the future energy landscape for South Africa which guides future energy infrastructure investments and policy development. The National Energy Act requires the IEP to have a planning horizon of no less than 20 years. The development of the IEP is therefore a continuous process as it needs to be reviewed periodically to take into account changes in the macroeconomic environment, developments in new technologies and changes in national priorities and imperatives, amongst other factors. Since change is on-going, the plan must remain relevant.

... South Africa needs to grow its energy supply to support economic expansion ...

As a fast emerging economy, South Africa needs to balance the competing need for continued economic growth with its social needs and the protection of the natural environment. South Africa needs to grow its energy supply to support economic expansion and in so doing, alleviate supply bottlenecks and supply-demand deficits. In addition, it is essential that all citizens are provided with clean and modern forms of energy at an affordable price. From the myriad of factors which had to be considered and addressed during the Integrated Energy Planning process, eight key objectives were identified:

- Objective 1: Ensure security of supply;
- Objective 2: Minimise the cost of energy;

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- Objective 3: Promote the creation of jobs and localisation;
- Objective 4: Minimise negative environmental impacts from the energy sector;
- Objective 5: Promote the conservation of water;
- Objective 6: Diversify supply sources and primary sources of energy;
- Objective 7: Promote energy efficiency in the economy; and
- Objective 8: Increase access to modern energy.

The IEP analyses current energy consumption trends within different sectors of the economy (i.e. agriculture, commerce, industry, residential and transport) and uses this to project future energy requirements, based on different scenarios. The scenarios are informed by different assumptions on economic development and the structure of the economy and also take into account the impact of key policies such as environmental policies, energy efficiency policies, transport policies and industrial policies, amongst others. The IEP then determines the optimal mix of energy sources and technologies to meet those energy needs in the most cost-effective manner for each of the scenarios. The associated environmental impacts, socio-economic benefits and macroeconomic impacts are also analysed. The IEP is therefore focused on determining the long-term energy pathway for South Africa, taking into account a multitude of factors which are embedded in the eight objectives.

Four key scenarios were developed, namely the Base Case, Environmental Awareness, Resource Constrained and Green Shoots scenarios:

- The **Base Case** Scenario assumes that existing policies are implemented and will continue to shape the energy sector landscape going forward. It assumes moderate economic growth in the medium to long term.
- The **Environmental Awareness** Scenario is characterised by more stringent emission limits and a more environmentally aware society, where a higher cost is placed on externalities caused by the supply of energy.
- In the **Resource Constrained** Scenario, global energy commodity prices (i.e. coal, crude oil and natural gas) are high due to limited supply.
- The **Green Shoots** Scenario describes an economy in which the targets for high economic growth and structural changes to the economy, as set out in the National Development Plan (NDP), are met.

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All the above-mentioned core scenarios include the implementation of the 9.6 GW New Nuclear Build Programme, a policy decision that was outlined in the Integrated Resource Plan 2010 (IRP2010) and mentioned by the President in his 2014 State of the National Address.

In addition to the above-mentioned scenarios, three sensitivity analyses were conducted:

- **Big Solar Water Heaters:** This sensitivity analysis tests the impact of pursuing the more aggressive introduction of solar water heaters into households.
- **No Shale Gas:** The four core scenarios assume an optimistic outlook on the role of shale gas in the South African economy. The underpinning assumptions are that economically recoverable volumes of shale gas are extracted and that shale gas is competitively priced and available to the local market. The scenarios also assume that the relevant legislation and regulations have been developed and promulgated to enable safe exploitation of shale gas. The No Shale Gas sensitivity analysis examines the case where shale gas cannot be economically extracted or is not competitively priced.
- **Nuclear Relaxed:** The economic growth projection assumptions made during the development of the IRP2010 have not materialised and the economic growth outlook has been revised downwards. This has had a downward impact on projected electricity demand. Due to the fact that the New Nuclear Build Programme adds substantial capacity (9.6 GW) to the energy mix and there have been indications that the scale and pace of the programme should not have an adverse impact on the economy, a sensitivity analysis was conducted to assess the impact of relaxing the 9.6 GW New Nuclear Build Programme and using the model to optimise the least cost energy system by considering alternative options. This effectively allows for the timing and commissioning of new nuclear plant in the most optimal manner.

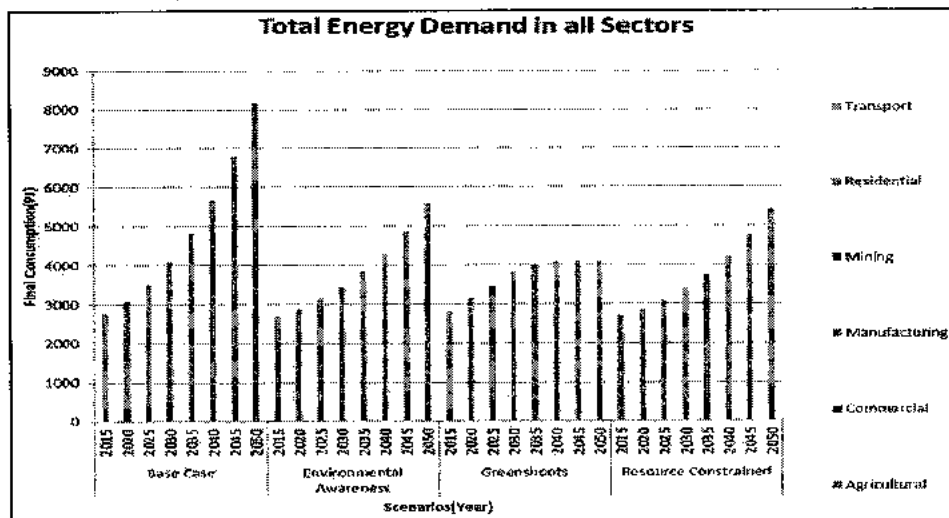
Analysis of energy demand

The transport sector will continue to make the highest demand on energy (Figure 0-1). Freight haulage, predominantly by road, is the greatest contributor to increases in transport demand and related fuel consumption. Petrol and diesel vehicles will continue to be used in the foreseeable future, with electric vehicles only starting to make a significant contribution to passenger transportation after 2030.

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Outside of the transport sector, the most significant energy demand increase is expected to be in the industrial sector (manufacturing), followed by the commercial sector. The increase in energy demand within the commercial sector is associated with continued expansion of the tertiary sector as South Africa moves towards becoming a knowledge-based economy. Demand in the residential sector is largely driven by population growth, coupled with increased urbanisation. As living standards improve, people tend to consume more energy; however energy efficiency interventions could see this trend start to slow down in the future.



Source: DoE Analysis

Figure 0-1: Projected demand within different sectors

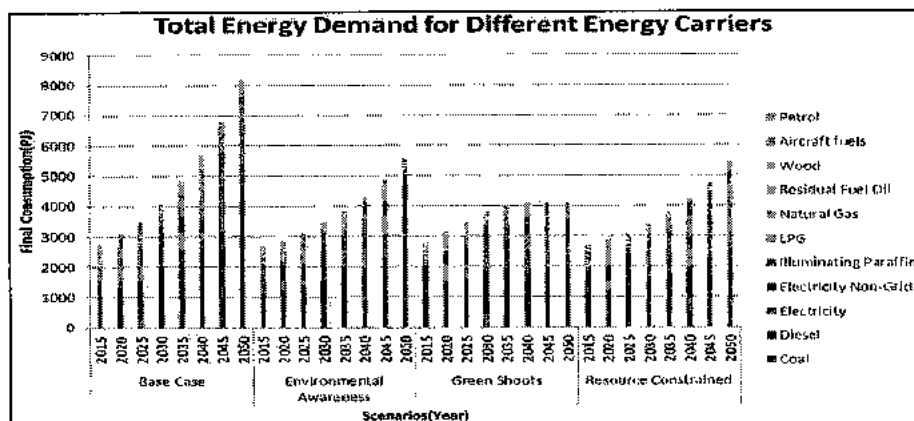
In line with the demand in different sectors depicted in Figure 0-1, demand for petroleum products increases the most significantly between 2015 and 2050 as this is primarily used within the transport sector (Figure 0-2). Demand for other petroleum products is less significant, although the demand for LPG is expected to increase steadily in the residential sector and whilst fairly minor, ranks as the third largest increase between 2010 and 2050. Diesel consumption continues to increase in the mining sector but only marginally when compared to electricity and natural gas. The use of illuminating paraffin is expected to decrease in future and to be negligible by 2025.

Demand for natural gas, although the least significant in terms of percentage share, shows the next most significant increase after that for petroleum products. Natural gas is primarily used within the industrial sector and the projected growth of the sector is a factor in this increase. Demand for electricity continues to rise as more houses become electrified and as the tertiary sector, largely comprised of commercial and public buildings, continues to

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expand. Demand for coal continues to grow in the industrial sector, while in the residential sector it is expected to start declining as a result of the increase in households and improvements in household income.



Source: DoE Analysis

Figure 0-2: Total energy demand for different energy carriers

Analysis of supply-side energy options against objectives

Objective	High-level summary of scenario results
Ensure security of energy supply	The objective of optimisation modelling is to ensure that all demand is met. Within all scenarios, the projected demand is met and therefore the objective of ensuring security of supply (which is the underpinning objective) is assumed to have been met.
Minimise the cost of energy	While all scenarios seek to ensure that costs are minimised within the constraints and parameters of each scenario, when total energy system costs are considered, the Base Case Scenario presents the least cost option, followed by the Environmental Awareness. Resource Constrained and Green Shoots scenarios respectively. Total costs are mostly comprised of imports of final petroleum products. When total electricity system costs are explored in isolation, however, this picture changes. • Electricity sector system costs: The Green Shoots Scenario presents the lowest total cost for electricity generation. This is followed by the Resource Constrained and Base Case scenarios while the Environmental Awareness Scenario is the most costly. • Liquid Fuel Supply (Combined production and imports): When total liquid fuel system costs are considered the profiles are similar to those of the total energy system costs.

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Objective	High-level summary of scenario results
Promote job creation and localisation potential	The potential number of jobs created within each of the scenarios changes year-on-year. Cumulatively, the Base Case Scenario presents the greatest job creation potential, followed by the Resource Constrained, Environmental Awareness and Green Shoots scenarios respectively. In all scenarios, approximately 85% of total jobs are localisable. • In the case of electricity generation, most jobs arise from solar technologies followed by nuclear and wind, with natural gas and coal making a smaller contribution. • In the case of liquid fuel, most jobs arise from new Gas-to-Liquid (GTL) plants and to a smaller extent from Coal-to-Liquid (CTL) plants, with no additional jobs arising from new crude oil refining as no new crude oil refining capacity comes on line.
Minimise negative environmental impact	The Environmental Awareness Scenario, due to its stringent emission constraints, shows the lowest level of total emissions over the planning horizon. This is followed by the Green Shoots, Resource Constrained and Base Case scenarios respectively. This result is similar when emissions are considered in terms of individual pollutants.
Minimise water consumption	The results for water consumption across the four scenarios are similar to those for emissions, with the Environmental Awareness Scenario showing the lowest level of water consumption and the Base Case Scenario showing the highest.
Diversify supply sources and primary energy carriers	All scenarios present a fairly diversified energy mix across the electricity and liquid fuel sectors. It is important to note that none of the scenarios include crude oil going forward because the importation of refined petroleum products is considered the least cost option.
Promote energy efficiency (reduce energy intensity of the economy)	The Green Shoots Scenario, which is characterised by a significant structural shift in the economy, presents the greatest reduction in energy intensity. This is largely the result of the greater contribution made by a less energy intensive commercial sector to the economy in this scenario. It is followed by the Environmental Awareness, Resource Constrained and Base Case scenarios respectively.
Promote energy access	Energy access is informed by the ability to provide energy as well as the availability of that energy when required. The ability to provide electricity to all South African citizens is made possible by connecting new households to the grid where it is cost-effective to do so and by introducing off-grid technologies where it is not. Therefore an energy mix that includes technologies which are suitable for off-grid application presents the greatest potential to increase energy access. Presently solar energy technologies (e.g. rooftop solar Photovoltaic (PV) panels and other solar home systems) show the greatest potential in this regard. The Base Case Scenario comprises the largest share of renewable energy technologies, followed by the Environmental Awareness, Resource Constrained and Green Shoots scenarios respectively. It should be noted that in addition to the supply-side renewable energy technologies, the Base Case and Resource Constrained scenarios assume the introduction of 1 million solar water heaters by 2030, and the Environmental Awareness and Green Shoots scenarios assume the introduction of 5 and 10 million solar water heaters by 2030 respectively.

Recommendations

Cost of energy

Many factors contribute to total energy system costs. Demand-side energy management interventions and improvements in energy efficiency contribute to total energy system cost reductions by reducing the demand for energy. However, the cost of implementing these programmes needs to be accounted for and has not been factored into the total system costs. When considering the supply-side technology options only, the capital costs, operating and maintenance costs as well as fuel costs have been taken into account (Figure 0-3).

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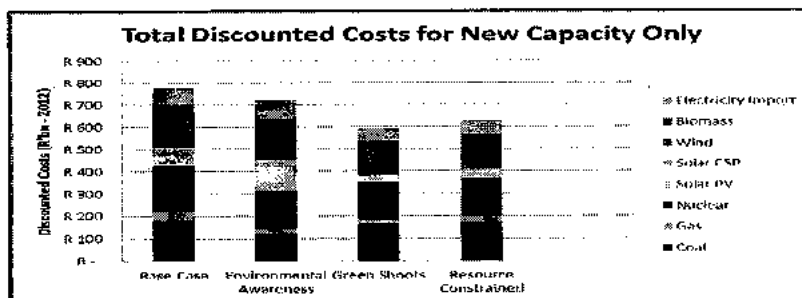


Figure 0-3: Total Discounted Cost of New Generation Capacity

New electricity generators should be brought online through a competitive bidding process, where the ability to generate electricity at low cost is a key criterion.

The implementation of a new nuclear programme should be conducted in a manner that poses the least cost to the energy system. The implementation of the 9.6 GW New Nuclear Build Programme, as espoused in the IRP2010, should be reviewed such that the scale and pace of the programme has a less severe impact on electricity tariffs than an accelerated build programme.

The price of petroleum products is influenced by global crude oil prices. As such, South Africa is a price taker, having little to no influence on the market. Where possible, maximum (i.e. capped) retail prices should continue to be implemented for fuels such as LPG and

... South Africa should continue to pursue a diversified energy mix which reduces reliance on a single or a few primary energy sources ...

natural gas to encourage a switch away from electricity.

Energy mix

South Africa should continue to pursue a diversified energy mix which reduces reliance on a single or a few primary energy sources.

- **Coal:** Coal should continue to play a role in electricity generation; however investments need to be made in new and more efficient technologies (e.g. new supercritical pulverised fuel power plants with flue-gas desulphurisation). Investments should also continue on the testing of underground coal gasification. New coal-to-

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liquid (CTL) plants are not competitive if South Africa is to achieve the objective of moving towards a low carbon economy, and despite the beneficiation targets, no new investments are encouraged in this regard. Long-term investment in research and test injections for Carbon Capture and Storage (CCS) should continue to be pursued. Given the significant investments required for this technology, South Africa should establish strategic partnerships with countries that have made advancements in the development of CCS technologies (e.g. Norway) as well as those that have abundant coal resources and therefore similar objectives in terms of exploiting their coal resources responsibly (e.g. Australia).

- **Nuclear:** Power generation from nuclear needs to play a more significant role in the provision of new baseload generation, depending on the cost of nuclear reactors and the financing thereof. The first unit of the New Nuclear Build Programme should be brought on line by 2030, however additional capacity should be implemented at a scale and pace that will not have a negative impact on the economy and additional capacity can be brought online after 2030 in a well-spaced out manner. However given the long lead-times associated with construction of nuclear plants, planning with regard to the New Nuclear Build Programme should progress and a decision on a vendor/country partnership should be expedited.
- **Natural Gas:** Natural gas presents the most significant potential in the energy mix. The use of natural gas in Combined Cycle Gas Turbines (CCGT) in the electricity sector, GTL plants in the liquid fuel sector and for direct thermal applications in the industrial and residential sectors, positions it as a viable option in the energy mix. Local exploration to assess the magnitude of recoverable shale and coastal gas needs to be pursued in line with the relevant regulations. Co-operation with neighbouring countries also needs to be pursued and partnerships developed for joint exploitation and beneficiation of natural gas within the region. The short-term and long-term infrastructure requirements to enable the uptake of a natural gas market should be analysed in the Gas Utilisation Master Plan (GUMP).
- **Crude Oil and Imports of Final Liquid Fuels:** The low contribution of crude oil in the energy mix for all the scenarios has been informed by the assumption that lower priced gas (mainly comprising natural gas) will be available, and no externality costs will be imposed on imported refined product.
 - Should the levels of economically recoverable shale gas be insignificant, however, such that no investment in shale gas extraction is viable, crude oil will have to be imported.

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- Should externality costs have to be included in the price of imported fuels, the cost of imported fuels will further increase and will in turn have a negative impact on the balance of payment.
- Therefore in order to ensure security of supply and to reduce the negative impact on the balance of payments due to increased imports of refined product, new refinery capacity will be essential in the medium to long term. Such capacity should meet the new fuel specifications.
- **Solar:** Solar PV and CSP with storage present excellent opportunities to diversify the electricity mix, to produce distributed generation and to provide off-grid electricity. Solar technologies also present the greatest potential for job creation and localisation. Incentive programmes and special focused programmes to promote further development in the technology, as well as solar roll-out programmes, should be pursued.
- **Wind:** Wind also presents an alternative source of power, however this is limited to windy areas on the coast.
- **Biomass:** Biomass can play a role as a feedstock for cogeneration and in the provision of electricity close to the source.

Job creation

... The proposed energy mix promotes the creation of jobs.

The proposed energy mix promotes the creation of jobs. Primary energy extraction has the highest potential for job creation and localisation efforts. Local exploration of shale gas needs to be pursued. In the electricity generation sector clean energy technologies like nuclear, solar and wind have great potential for job creation and skills development in the country.

Environmental considerations

Energy policies should support the pursuit of low emission limit targets. Ongoing work by the Department of Environmental Affairs to determine Desired Emissions Reduction Outcomes (DEROs) should proceed. New technologies should be implemented for all coal-fired power plants to ensure that environmental legislation is met. Furthermore, all new coal-fired power plants should be dry-cooled to conserve water in alignment with the National Water Resource Strategy 2.

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*Integrated Energy Plan***Demand**

Various demand-side levers can be considered in order to reduce energy intensity within different sectors of the economy. Improvements in end-use technology and fuel-switching are some of the alternative options.

- **Agricultural Sector:** Government should develop and implement a package of specifically designed policies and energy savings measures to promote energy efficiency, which may include the promotion of high quality and relevant information on proven practices for energy efficiency that is appropriate for emerging farmers.
- **Commercial Sector:** A database should be developed on energy consumption in both public and commercial buildings and efficiency indices for the evaluation of relevant policy measures such as the Energy Efficiency Strategy.
- **Industrial Sector:** Energy intensive users should submit Energy Management Plans to the DoE in line with the relevant draft regulations. All organisations identified in terms of the regulations should submit the required data on energy consumption. The population of the national Energy Efficiency Target Monitoring System (EETMS) with this data will enable ongoing monitoring of energy consumption patterns and efficiency improvements across all sub-sectors.
- **Residential Sector:** To address challenges in all households, policy initiatives should constructively differentiate between low income and high income households.
 - Fuel switching away from electricity to LPG (especially for space heating and cooking) and diversifying the household energy mix should be encouraged in high-income households.
 - The implementation of the Electrification Programme, including both grid connection and off-grid solar systems, should continue. An integrated household energy strategy, which amongst other factors looks into the safe use of fuels in low income households, needs to be developed with civil society and local government representatives.
- **Transport Sector:** The improvement of the fuel economy of vehicles (i.e. vehicle technology efficiency) combined with fuel quality improvement, will make the most significant impact on projected future fuel demand. A GTL plant is a viable option if shale and local gas exploration yields economically recoverable resources. Since demand is projected to grow substantially in this sector, a GTL plant will help reduce reliance on imported liquid fuels (diesel and petrol).

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- For passenger transportation, non-motorised transport and mass transport (buses and trains) should be promoted. Variable pricing schemes such as electronic tolling systems should be used to penalise/incentivise inefficient/efficient vehicles.
- For freight transport, high penalties should be imposed on heavy vehicles to encourage a shift from road to rail. Greater investment should be made in rail infrastructure to improve the rail network and encourage the use of rail for long distance haulage.

The national EETMS should be expanded to include energy consumption data for all sectors, including transport.

Energy access

Solar technologies feature fairly prominently in the energy mix. This should be supported by the implementation of mini-grid, off-grid and distributed generation. Solar PV technologies in urban and rural areas should continue to play a role and regulations pertaining to small-scale distributed power, which can be fed back to the grid, need to be developed. The Solar Water Heating Programme should continue to be implemented aggressively in both rural and urban areas.

... Research and development should focus on innovative solutions ...

Research and development

Research and development should focus on innovative solutions and in particular on solar energy, as this has the greatest potential to address electricity challenges for small-scale energy consumers in a fairly short timeframe. Solar energy also has the potential to address the need for energy access in remote areas; create semi-skilled jobs; and increase localisation. More funding should be targeted at long-term research focus areas in clean coal technologies such as CCS and UCG as these will be essential in ensuring that South Africa continues to exploit its indigenous minerals responsibly and sustainably. Exploration to determine the extent of recoverable shale gas should be pursued and this needs to be supported by an enabling legal and regulatory framework.

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*Integrated Energy Plan***Other considerations**

The mandate of government agencies accountable to the DoE must be clarified and streamlined. Adequate funding should be provided to ensure that their mandates are achieved. The role that the South African National Energy Development Institute (SANEDI) should play in conducting studies on collecting data and providing insight on the impact of technology development for different energy end-use technologies within the different demand sectors needs to be supported. SANEDI also needs to play a more significant role in the identification and building of human capacity, especially in the areas of energy modelling, planning, statistics, and renewable energy technology and energy efficiency.

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*Integrated Energy Plan***Section 1: Background and introduction**

The purpose and objectives of the Integrated Energy Plan (IEP) are anchored in the National Energy Act, 2008 (Act No. 34 of 2008). Integrated energy planning is undertaken to determine the best way to meet current and future energy service needs in the most efficient and socially beneficial manner, while:

- Maintaining control over economic costs;
- Serving national imperatives such as job creation and poverty alleviation; and
- Minimising the adverse impacts of the energy sector on the environment.

Government strives to improve the lives of the people of South Africa through various programmes. This improvement is effected through policy development and the implementation of appropriate policy choices.

The IEP takes into consideration the crucial role that energy plays in the entire economy and is informed by the output of analyses founded on solid facts. It is a multi-faceted, long-term energy framework which has multiple objectives, some of which include:

- To guide the development of energy policies and, where relevant, set the framework for regulations in the energy sector;
- To guide the selection of appropriate technologies to meet energy demand (e.g. the types and sizes of new power plants and refineries to be built and the prices that should be charged for fuels);
- To guide investment in and the development of energy infrastructure in South Africa; and
- To propose alternative energy strategies which are informed by testing the potential impacts of various factors such as proposed policies, the introduction of new technologies, and the effects of macroeconomic factors.

... The IEP takes into consideration the crucial role that energy plays in the entire economy and is informed by the output of analyses founded on solid facts ...

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Energy is an integral part of the economy and the energy sector is a key enabler for the attainment of national policy imperatives such as those expressed in the National Development Plan (NDP) and its supporting pillars which include, *inter alia* the New Growth Path and the Industrial Policy Action Plan. It is therefore important that a mechanism is developed to enable energy policymakers to quantify and provide feedback on the extent to which the energy sector can contribute to the attainment of these and other national policy imperatives. It is equally important to quantify and provide feedback on the extent to which policy objectives outside the energy sector may impact on the attainment of energy sector imperatives. Examples of these include objectives, targets and/or constraints set in the following policy documents:

- The Beneficiation Strategy;
- The National Climate Change Response White Paper;
- The National Transport Master Plan (NATMAP 2050); and
- The proposed Carbon Tax Policy.

Today's choices about how energy is produced and consumed will determine the sustainability of the future energy system and consequently of socio-economic progress. Integrated energy planning involves thorough analysis of the benefits and shortcomings of integrated relationships and seeks to optimise the energy system as a whole. The benefits and advantages associated with the pursuit of a particular strategic pathway are thoroughly explored and assessed against the trade-offs of not considering other alternative pathways. Integrated energy planning is therefore not only about ensuring that South Africa's energy needs are met, but also about finding alignment and ensuring that cross-sectoral impacts are analysed in a systematic way.

For example, the increase in private vehicle ownership, coupled with inadequate oil refining capacity and constrained logistics infrastructure, continues to threaten the security of liquid fuel supplies in South Africa. Similarly, the upsurge in property development, especially in the residential and commercial sectors, coupled with the successful rollout of the electrification programme, has resulted in increased demand for electricity. Against this background, environmental pressures, increased volatility in global crude oil prices and increases in coal prices, together with potential new discoveries of shale gas in the Karoo and natural gas in Mozambique, are all potential game-changers which require a sharpened focus on the use of alternative energy sources as well as sustainable and efficient use of traditional energy sources. Thus, in energy planning, it is essential to take the broader aspirations and goals of the country into consideration as well as external factors which characterise the sector.

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... Today's choices about how energy is produced and consumed will determine the sustainability of the energy system and consequently of socio-economic development ...

1.1. Scope of the IEP

The IEP considers the national supply and demand balance and proposes alternative capacity expansion plans based on varying sets of assumptions and constraints. While infrastructural matters are briefly discussed, the IEP does not explicitly consider supply and demand at specific geographical locations within the country, nor does it take into account infrastructure bottlenecks at specific locations. These are, or will be, covered in detail as follows:

- Electricity infrastructure (transmission and distribution) is dealt with in other plans and the Integrated Resource Plan (IRP) should assess these in detail, taking into consideration the grid planning currently conducted by Eskom;
- Electricity supply is dealt with in the IRP;
- Liquid fuels will be dealt with in the 20-Year Liquid Fuel Infrastructure Roadmap which will cover logistical matters relating to pipelines and storage facilities for petroleum products.
- The Gas Utilisation Master Plan (GUMP) will take into consideration the bottlenecks and capacity constraints of the current natural gas infrastructure.

All the above will inform the integrated energy planning process and will enable overall enhancement through ongoing periodic iterations to ensure alignment.

1.2. Energy policy considerations

At government level, the introduction and execution of policies requires appropriate contextualisation and detailed analysis. As Cabinet considers other energy-related policies, such as climate change mitigation strategies, questions should be raised on the likely impact of such strategies on the overall energy security and economy of the country.

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The 1998 White Paper on the Energy Policy of the Republic of South Africa (Energy White Paper) is the primary policy document which guides all subsequent policies, strategies and legislation within the energy sector. It provides specific policy statements on what government intends for the energy system as a whole and sets out five key objectives (see Table 0-1). These objectives have subsequently formed the foundation and informed the development of energy policy in South Africa and still remain relevant. Various other energy policies have been developed and are in different stages of implementation. Some of the key policies include:

- The White Paper on Renewable Energy, 2003 (Renewable Energy White Paper);
- The National Energy Efficiency Strategy of the Republic of South Africa, 2008 (Energy Efficiency Strategy);
- The Nuclear Energy Policy for the Republic of South Africa, 2008 (Nuclear Energy Policy);
- The Biofuels Industrial Strategy of the Republic of South Africa, 2007 (Biofuels Strategy);
- The Electricity Basic Services Support Tariff (Free Basic Electricity) Policy, 2003 (Free Basic Electricity Policy); and
- The Integrated Resource Plan 2010 (IRP2010).

Table 0-1: The five energy policy objectives defined in the Energy White Paper

Objective	Description
Increasing access to affordable energy services	• Government will promote access to affordable energy services for disadvantaged households, small businesses, small farms and community services.
Improving energy governance	• Governance of the energy sector will be improved. The relative roles and functions of the various energy governance institutions will be clarified, the operation of these institutions will become more accountable and transparent, and their membership will become more representative, particularly in terms of participation by black people and women. • Stakeholders will be consulted in the formulation and implementation of new energy policies, in order to ensure that policies are sympathetic to the needs of a wider range of stakeholder communities. • Co-ordination between government departments, government policies, and the various spheres of government will be improved in order to achieve greater integration in energy policy formulation and implementation. • Government capacity will be strengthened in order to better formulate and implement energy policies.

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Objective	Description
Stimulating economic development	- Government will encourage competition within energy markets. - Where market failures are identified government will intervene through transparent, regulatory and other carefully defined and time delineated mechanisms, to ensure effective delivery of energy services to consumers. - Government policy is to remove distortions and encourage energy prices to be as cost-reflective as possible. To this end prices will increasingly include quantifiable externalities. - If subsidies are required, these should be implemented transparently based on agreed criteria. - Energy taxation will continue to remain an option within government's fiscal policy, but will be exercised with more consideration for the economic and behavioural impacts of such policies. - Government will work towards an investor-friendly climate in the energy sector through good governance, stable, transparent, regulatory regimes and other appropriate policy instruments.
Managing energy-related environmental impacts	- Government will promote access to basic energy services for poor households, in order to ameliorate the negative health impacts arising from the use of certain fuels. - Government will work towards the establishment and acceptance of broad national targets for the reduction of energy-related emissions that are harmful to the environment and to human health. - Government will ensure a balance between exploiting fossil fuels and the maintenance of acceptable environmental requirements.
Securing supply through diversity	Given increased opportunities for energy trade, particularly within the Southern African region, government will pursue energy security by encouraging a diversity of both supply sources and primary energy carriers.

The National Energy Act, 2008 (Act No. 34 of 2008) was developed to introduce measures to ensure energy security as well as to address those objectives of the Energy White Paper which had not been effected due to legislative and regulatory shortfalls. The National Energy Act thus encapsulates the key objectives espoused in the Energy White Paper and more specifically translates them into concrete objectives that must be addressed by the IEP. Chapter 3 of the National Energy Act specifies that the IEP must assist government in its efforts to:

- Ensure security of energy supply;
- Ensure optimal usage of economically available energy resources;
- Ensure affordability of energy services;
- Promote universal accessibility to modern forms of energy;
- Promote social equity through the energy sector;
- Contribute towards employment creation;
- Protect the environment;
- Fulfil its international commitments;
- Ensure consumer protection from dangers of energy; and
- Ensure the contribution of energy supply to socio-economic development.

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1.3. Key policy issues

Market activity alone does not deliver optimal solutions to the challenges faced by the energy sector, such as the guarantee of energy security, the reduction of greenhouse gas (GHG) emissions, the reduction in energy intensity, or increasing energy efficiency within the economy. Thus, in some instances government intervention – through policy and regulation – is necessary to ensure the delivery of certain services to the public as well as the attainment of certain policy objectives.

Energy is an integral part of the economy and the energy sector is a key enabler for the attainment of national policy imperatives. It is therefore important to quantify and provide feedback on the extent to which the energy sector can contribute to the attainment of various national policy imperatives. It is equally important to quantify and provide feedback on the extent to which policy objectives outside the energy sector may impact on the attainment of energy sector imperatives.

While many government policies have an impact on the energy sector in one way or another, several policies have a more significant impact and therefore have a substantial influence on energy policies that should be developed.

One of the key elements during the energy planning process is to ensure alignment and identify synergies between various government policies. This section identifies some of the key policy issues that have been considered during the energy planning process.

1.3.1. Economic growth and development

National Development Plan

The National Development Plan, which was published in November 2012 outlines the 2030 vision for South Africa's energy sector. It states that the energy sector will promote:

- Economic growth and development through adequate investment in energy infrastructure and the provision of quality energy services that are competitively priced, reliable and efficient. Local production of energy technologies will support job creation;
- Social equity through expanded access to energy services, with affordable tariffs and well targeted and sustainable subsidies for needy households; and
- Environmental sustainability through efforts to reduce pollution and mitigate the effects of climate change.

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Furthermore, the NDP envisages a South Africa which, by 2030, will have adequate supply of electricity and liquid fuels to avoid disruptions to economic activity, transport and welfare. It acknowledges that energy prices are likely to be higher in future, but will still be competitive when compared with South Africa's major trading partners. In addition, the NDP affirms that more than 90% of the population should enjoy access to electricity by 2030.

The NDP proposes diversity by way of alternative energy resources and energy supply options, both in terms of power generation and the supply of liquid fuels. The purpose of the IEP is to test the various options presented in the NDP and make firm recommendations in the form of an energy sector roadmap.

New Growth Path

The New Growth Path of 2011 (NGP) is a more specific policy element which reflects government's commitment to prioritising employment creation in all economic policies. The NGP outlines five key physical and social infrastructure areas – energy, transport, communication, water and housing – as being critical in growing the economy of South Africa. It lays out the strategies to collectively achieve a more developed, democratic, cohesive and equitable economy and society over the medium term, in the context of sustained growth.

The NGP targets 300 000 additional direct jobs by 2020 through the greening of the economy, with 80 000 in manufacturing and the rest in construction, operations and maintenance of new, environmentally friendly infrastructure. The potential for job creation envisaged rises to well over 400 000 by 2030.

... According to the National Climate Change Response White Paper (NCCRWPP), the energy sector contributed to about 50% of total carbon emissions for the country in 2005...

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1.3.2. Environmental sustainability

National Climate Change Response Policy

According to the 2010 National Greenhouse Inventory Report, the energy sector contributed more than 80% of total carbon emissions for the country in 2000. The majority of emissions were from energy industries (63.6%), followed by 10.8% from transport and 9.8% from manufacturing industries and construction. The main source of emissions in the energy sector is CO₂ from fossil fuel combustion (GHG Inventory, 2014).

During the 16th United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP 16), the President of South Africa announced that South Africa would implement mitigation actions that would collectively result in a 34% deviation below a 'Business As Usual' emissions growth trajectory by 2020 and a 42% deviation by 2025, subject to relevant support from more developed countries. The NCCRWP defines these targeted reductions in total emissions as the 'Peak-Plateau-Dcline' emissions trajectory, and work on further translation of these reductions by each sector is currently under way.

The extent to which this outcome can be achieved depends on the extent to which developed countries meet their commitment to provide financial, capacity-building, technology development and technology transfer support to developing countries. With such support, South Africa's GHG emissions will peak between 2020 and 2025, plateau for approximately a decade and decline in absolute terms thereafter.

Carbon Tax Policy

In light of the above, and in an effort to support the country's aspiration to reduce emissions, the National Treasury published a Carbon Tax Policy Paper for public comment in May 2013. The policy paper outlines the primary objective of the proposed carbon tax, which is to reduce GHG emissions across all relevant sectors and facilitate the transition to a Green Economy. In the policy paper, carbon taxation and emission trading schemes are identified as the two main economic policy instruments available for putting a price on carbon and curbing GHG emissions.

The policy paper acknowledges that although carbon tax does not set a fixed quantitative limit to GHG emissions over the short term, such a tax, at an appropriate level and phased in over time to the 'correct' level, will provide a strong price signal to both producers and consumers to change their behaviour over the medium to long term. The introduction of a carbon tax is expected to change the relative prices of goods and services over time, making

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emission-intensive goods more expensive relative to those that are less emission intensive. Assuming that South Africa's trading partners follow suit, this will provide a powerful incentive for consumers and businesses to adjust their behaviour, resulting in a reduction in emissions.

The proposed carbon tax design incorporates tax-free thresholds that take into account the competitiveness concerns of locally based and trade-exposed carbon-intensive sectors and businesses, as well as distributional concerns, such as the impact on low-income households. These thresholds are subject to periodic review.

In terms of the energy sector, the Carbon Tax Policy Paper proposes the following:

- The electricity supply industry has been allocated a basic tax-free threshold of 60%; and
- The petroleum industry (including crude oil refining, coal-to-liquid and gas-to-liquid sub-sectors) has been allocated a basic tax-free threshold of 60% with a further maximum additional allowance of 10% for trade exposure.

The policy paper proposes an initial carbon tax of R120 per ton of Carbon Dioxide Equivalent (CO₂-eq) above the tax-free thresholds with effect from January 2015. This tax is increased at a rate of 10% per annum for five years (i.e. up until 31 December 2019). A revised regime, with lower tax-free thresholds and a revised rate which will be announced at a later point, will commence on 1 January 2020.

National Water Resource Strategy 2

The Second National Water Resource Strategy (NWRS2) has been developed as mandated by the National Water Act (Act No. 36 of 1998). The NWRS2 emphasises the strategic value of water and its necessity for growth and development, the environment, health and wellbeing of the people of South Africa. The well-developed water management and infrastructure framework of the country has resulted in a perceived sense of water security (urban and growth areas). As a consequence, despite the fact that South Africa is a naturally water stressed country, the resource has not received the relevant priority status and attention. Wastage is high, with approximately 37% of water lost to the system, and further loss due to pollution and degradation. In addition to this the strategy purports that water is currently inadequately financed.

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While on a national scale, the energy sector only consumes approximately 2% of total water used, the energy sector is highly dependent on reliable supplies of water for the generation of electricity (steam generation and cooling processes), and an elaborate and sophisticated network of water transfer and storage schemes has been developed specifically to support the sector and ensure high levels of reliability. The provision of water for the energy sector is therefore a significant cost driver. The water sector on the other hand, is highly dependent on a constant and reliable supply of electricity to 'move water'. The deployment of more water-efficient technologies (such as dry-cooled, coal-fired power plants) is required. Energy production capacity is expected to increase, with the DoE planning significant investment in new power generation capacity. Current plans include the building of dry-cooled, coal-fired power stations which will be more water efficient. However, these power stations are located in water-scarce areas and, despite their design, are likely to strain available water resources. The return to service of older power stations, which are wet-cooled, has further burdened available water resources.

The IEP has taken into account and considered the associated costs of:

- The emission limit reduction targets set by the NCCRWP and concomitant commitments made by the President;
- The implications of the proposed carbon tax on future energy options and its efficacy in reducing emissions;
- Wet-cooled older power stations, some of which have been returned to service in order to address current electricity constraints; and
- Ensuring that all new coal-fired power plants are dry-cooled to minimise the constraints on water.

... Sufficient, reliable and cost-effective energy supply is therefore a key contributor to the successful implementation of various elements of the industrialisation policy ...

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1.3.3. Industrialisation

National Industrial Policy Framework

The National Industrial Policy Framework (NIPF) articulates South Africa's overarching approach to industrial development, providing a strong basis for the policy certainty that must underpin it. The NIPF vision for South Africa's industrialisation trajectory is, amongst other factors:

- To facilitate diversification beyond our current reliance on traditional commodities and non-tradable services. This requires the promotion of increased value-addition per capita, characterised particularly by movement into non-traditional tradable goods and services that compete in export markets;
- The long-term intensification of the country's industrialisation process and movement towards a knowledge economy;
- The promotion of a more labour-absorbing industrialisation path, with a particular emphasis on tradable labour-absorbing goods and services and economic linkages that catalyse employment creation;
- The promotion of a broader-based industrialisation path, characterised by greater levels of participation of historically disadvantaged people and marginalised regions in the mainstreams of the industrial economy; and
- Contributing to industrial development on the African continent, with a strong emphasis on building its productive capabilities.

In addition to the above, it is indicated that although the NIPF aims to improve growth and employment conditions across much of the economy generally, its primary focus is on the relatively low skill-intensity industries, including non-traditional tradable goods and services in the primary, manufacturing and services sectors of the economy.

Sufficient, reliable and cost-effective energy supply is therefore a key contributor to the successful implementation of various elements of the industrialisation policy.

Industrial Policy Action Plan and Beneficiation Strategy

The Industrial Policy Action Plan (IPAP) is developed to provide a programme of action to ensure implementation of the NIPF objectives. IPAP 2015/16–2017/18 (which is the seventh iteration of IPAP to date) is also informed by the vision set out for South Africa's development, provided by the National Development Plan. The overriding goal of the IPAP in this policy context is to prevent industrial decline and support the growth and diversification of

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South Africa's manufacturing sector. The balance of international evidence is that manufacturing is the engine of growth and employment for all economies that have achieved high gross domestic product (GDP) and employment growth. Manufacturing can generate significant job creation directly, as well as indirectly, in a range of primary and service sector activities.

In alignment with the NIPF, the Beneficiation Strategy (DMR, 2011) provides a framework within which to translate the country's comparative advantage, inherent in its mineral resources endowment, into a national competitive advantage and presents opportunities for South Africa to continue sustainable growth of its economy beyond mining. It identifies several instruments that constitute an enabling environment for beneficiation and highlights prevailing constraints to the effective implementation of beneficiation that require an integrated mitigation approach. Much like the NIPF, it recognises that infrastructure, including amongst other factors the adequate supply of energy, has a material impact on sustaining current beneficiation and that the bulk of early-stage beneficiation programmes require large and uninterrupted energy supply. The lack of adequate and reliable energy supply therefore poses a major threat to future prospects of growth in mineral value addition. The country's limited exposure to breakthrough research and development is also identified as a significant barrier to prospects of innovation in creating new products for beneficiation.

While the concept of beneficiation is not new to South Africa or to the energy sector (since the bulk of the country's electricity is generated from coal fired power stations, where more than 50% of the country's annual production of coal is beneficiated), new beneficiation opportunities are sought to complement conventional electricity generation in the country, which will underpin the much needed economic growth. Other critical infrastructure, such as rail, water and ports, has a material impact on sustaining current beneficiation initiatives and poses a major threat to future prospects of growth in mineral value addition. Therefore successful implementation of the Beneficiation Strategy depends on intensive co-ordination across a range of departments, including the DoE.

The Beneficiation Strategy outlines five value chains, of which energy is one, which have been identified as a result of the advancement of selected mineral commodities through various stages of beneficiation. The beneficiation of energy commodities is seen as critical, especially in light of the projected increase in future energy demand world-wide and in South Africa. Three commodities (or classes of commodities) were identified for potential beneficiation in order to meet future energy needs:

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Platinum Group Metals (PGM): PGM fuel cell technology presents an opportunity for new energy generation sources, since the extent and scope for further growth in traditional sources of energy generation are limited. Ongoing research and development by the Department of Science and Technology with respect to fuel cell technology needs to continue.

The DST has developed the National Hydrogen and Fuel Cell Technologies (HFCT) Research, Development and Innovation Strategy, which was approved by Cabinet in May 2007. The Strategy was formally launched in September 2008 and branded Hydrogen South Africa (HySA). The vision of the HySA Strategy is to create knowledge and human resource capacity and to develop high level commercial activities in HFCT, utilising local resources.

The HySA Strategy is geared towards the development and deployment of HFCT, with the aim of establishing South Africa as an exporter and provider of high-value products into the growing international and local hydrogen and fuel cell markets.

The overall goal of the HySA Strategy is to develop and guide innovation along the value chain of HFCT in South Africa and to capture 25% of the global hydrogen and fuel cell catalyst demand by 2020.

Coal: Given that coal is currently the most abundant and affordable of all fossil fuels, the Beneficiation Strategy sees this as continuing to play a vital role in meeting energy demand world-wide and also in South Africa. The Beneficiation Strategy also recommends coal conversion technologies to produce synthetic gas and liquid transportation fuels derived from coal. However, given the high levels of harmful emissions associated with coal-generated electricity and other fuels produced from coal, it has become increasingly important for cleaner alternatives to be considered. In addition to diversifying to renewable and other clean sources of energy, South Africa is to actively pursue alternative options for reducing carbon emitted from coal, which include:

- The capturing of harmful gases at source, processing them and then storing them in underground geological formations to mitigate their contribution to global warming;
- The implementation of carbon emission reduction measures (either carbon tax or market mechanisms) to curb the use of such technologies. These options may, however, contribute to an increase in the cost of energy produced from coal such as electricity and synthetic fuel from coal; and

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- Research and development (R&D) to be directed at finding an alternative approach, such as the potential for recycling captured gases in the process of energy generation for re-generation of electricity as well as other uses.

The Beneficiation Strategy document also identifies several interventions for the optimal value creation (beneficiation) of coal, including:

- Policy support for clean and efficient use of coal in power generation to encourage the take-up of existing advances in technologies for low emission coal-fired electricity production – providing secure and clean energy;
- Policy support for technology transfer, through mechanisms such as the Clean Development Mechanism (CDM). Bilateral and multilateral funds such as the Global Environment Facility and the Prototype Carbon Fund must be explored;
- Investment in research, development and the demonstration of new technologies such as clean coal technologies and carbon capture and storage (CCS). These could provide a very significant opportunity for major reduction in emissions;
- Investment in R&D to find innovative means for the beneficiation/recycling of gases emitted in the generation of electricity;
- Investment in technology to optimise the use of coal bed methane (CBM);
- Investment in metallurgical research to disentangle uranium and coal in the Springbok flats coalfield, which will increase the country's reserve base of coal and uranium; and
- Exploration of options for further final-stage beneficiation of coal through production of chemicals as feedstock for plastics and fertilisers.

Uranium and Thorium: Uranium is used to fuel commercial nuclear power plants. South Africa is currently exporting uranium in its oxide form – the first stage of beneficiation – and importing the complete nuclear fuel elements containing the enriched uranium from the northern hemisphere for its own power generation purposes. This is due to South Africa being able to access more competitively priced nuclear fuel in the global market. South Africa has gained expertise over many years in the beneficiation of uranium, from the mining of the ore through to producing uranium for power generation and beyond.

Researchers have subsequently been exploring the possibility of using thorium as an alternative fuel for nuclear reactors and preliminary research indicates that the prospect is positive. Thorium is estimated to be three times more abundant than uranium. However, present knowledge of the distribution of thorium resources is poor due to low key exploration

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efforts as a result of insignificant demand. With the commitment of government to build nuclear power stations to complement fossil fuel based electricity, preparatory work for the beneficiation of uranium/thorium and other minerals, such as fluorspar, is critical. The following interventions for the successful implementation of nuclear power generation have been identified:

- Quantify the uranium and/or thorium reserves and resources in the country;
- Ascertain the economic feasibility of re-establishing a uranium enrichment and fuel fabrication facility;
- Plan for comprehensive waste treatment and mine rehabilitation; and
- Finalise the uranium policy with all relevant stakeholders.

Other areas: The Beneficiation Strategy document highlights other critical areas of intervention to ensure the co-ordinated, seamless and effective implementation of the beneficiation of South Africa's mineral commodities. These include, amongst others, ensuring security of energy supply through investment in new generation capacity, implementing energy efficiency measures and pursuing cogeneration potential, where possible.

... Transportation in South Africa is almost totally dependent on petroleum liquids with less than 5% of the energy used in transport being in the form of electricity ...

1.3.4. Energy demand management

National Transport Master Plan

A significant portion of South Africa's transportation needs are met through liquid fuels. Transport-related policies therefore have a significant impact on the growth in transport demand and the inherent demand for liquid fuels. The National Transport Master Plan (NATMAP 2050), which was published by the Department of Transport (DoT) in 2010, is a long-term strategy for the transportation sector which in part addresses the impact of the transport sector on various issues. The goal thereof is to develop a dynamic, long-term, sustainable land use/multi-modal transportation systems framework for the development of network infrastructure facilities, interchange terminus facilities and service delivery.

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South Africa faces many challenges in instituting a practical National Transportation Plan in an environment of increasing energy demand, sustained high oil prices, regular disruptions in the energy value chain, increasing requirements for diminished GHG emissions and other environmental and social considerations. Transportation requires access to energy sources and it is therefore imperative that synergies be established between transportation planning and national energy planning. Transportation objectives must be aligned with the country's energy supply-demand conditions and vice versa. At the same time, transportation has an environmental footprint that stretches from the global level (via international travel – trains, ships, planes), through to the national, regional and local levels (the effects of construction and operation).

Transportation in South Africa is almost totally dependent on petroleum liquids, with less than 5% of the energy used in transport being in the form of electricity. This makes the transport sector extremely vulnerable to the availability of oil and the cost of oil and therefore the cost of fuel. Almost 92% of the energy that is used in transportation is derived from oil that is imported. The balance is from fuel derived from coal (the SASOL coal to liquid process), and natural gas (the PetroSA GTL plant) (DoE, 2012).

Some of the goals of NATMAP 2050 that require a corresponding response from the energy sector are as follows:

- To minimise the impact on the environment and reduce the carbon footprint of transport (through less carbon-intensive transport fuels);
- To provide energy-efficient transport, using energy sources that are sustainable in the long term;
- To provide affordable transport to end users, operators and government; and
- To develop transport infrastructure that meets international standards and is technologically sustainable.

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The IEP takes into consideration the implications of some of the goals of the NATMAP and the resultant actions or responses that are required from the energy sector. In particular, the effects that such objectives will have on the future demand for energy were assessed. Some key considerations are outlined below:

- In the short term, measures to improve fuel efficiency need to be continually explored and enhanced;
- The effect that various interventions will have on liquid fuel consumption needs to be evaluated and monitored so as to improve the understanding of their implications on future demand. These include interventions by the DoT to emphasise modes of transport where mechanical energy is used most efficiently and to advocate non-motorised transport within urban areas (short distances); and
- The effects that various interventions may have on shifting demand from liquid fuels to electricity need to be analysed. These include long-term strategies to encourage modal shifts from private passenger transportation to mass transit (most probably to rail and buses) as well as those that encourage the shift of long-distance freight off roads and onto rail.

National Energy Efficiency Strategy

The National Energy Efficiency Strategy was last published in 2005 and sets targets for energy efficiency improvements in several sectors. The strategy is currently undergoing a third review process and new targets for 2016–2030 will be set for different sectors. In addition to this, the DoE has released draft regulations which will provide the data requirements for legal entities that use more than 400 Terajoules (TJ) to develop Energy Management Plans (EMPs). Progress towards the implementation of the EMP must be submitted to the Department on an annual basis and thereafter updated and submitted every five years. The submission of such plans and the implementation of the Energy Efficiency Target Monitoring System (EETMS) will enable ongoing monitoring of energy efficiency improvement and benchmarking of different sectors.

The effects of these policy imperatives have been factored into the long-term IEP policy assumptions. The processes of monitoring, reviewing and evaluating some of these interventions will require ongoing alignment between the respective departments.

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1.3.5. Energy equity

Household Electrification Strategy

Energy equity refers to the accessibility and affordability of energy supply across the population. The Universal Access to Energy Strategy aims to have 90% of homes electrified by 2030, with the remaining 10% being connected through off-grid solutions (primarily solar home systems).

According to the New Household Electrification Strategy for South Africa, energy is critical in improving the well-being of the poor who need it for cooking and lighting, heating water, transportation and the production of goods and services. Energy access affects quality of life by contributing to better public services, such as health care and education, and improving the possibilities for income generation and employment. The provision of adequate, affordable, and reliable energy services is therefore necessary to enable development and to achieve the Millennium Development Goals (MDGs).

The strategy identifies electricity as the mainstay that gears development activities leading to the improvement in the quality of life and the eradication of energy poverty. In this regard energy is the basis for delivering a host of energy services such as clean illumination in the home and in schools; the ability to operate life-saving equipment in clinics; the running of industries and productive small businesses; and providing modern communications technology.

Although significant progress has been made with regard to electrification (access more than doubled from 36% of the population in 1994 to over 84% all households in 2012), according to the 2011 Census statistics, there were still 2.2 million households without electricity.

... The 'EP needs to consider the impact of grid and off-grid electrification in terms of future energy demand and the opportunities presented by different energy technologies in increasing access to energy...

Several challenges have led to this backlog including costs associated with providing grid connections to areas remote from the main transmission infrastructure. The strategy advocates the implementation of innovative non-grid technologies to ensure access to areas where network infrastructure will take a number of years to reach. However challenges around the sub-optimal use of non-grid electrification in the overall electrification programme

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in the country would need to be identified and addressed. The IEP needs to consider the impact of grid and off-grid electrification in terms of future energy demand as well as the opportunities presented by different energy technologies in increasing access to energy.

1.4. The objectives of the IEP

Based on the key policies identified in the previous section, the IEP takes a balanced view of the objectives of various policies. Policies which are overarching set aspirational targets and provide the context within which the IEP was developed. The impact of policies which will influence energy markets cannot be ignored, and their possible implications have been taken into consideration in order to develop long-term energy sector response strategies which are sustainable.

Taking the Energy White Paper, the National Energy Act and the various high-impact policies, amongst others into consideration, eight key objectives were identified for the IEP and are reflected in Figure 0-1.

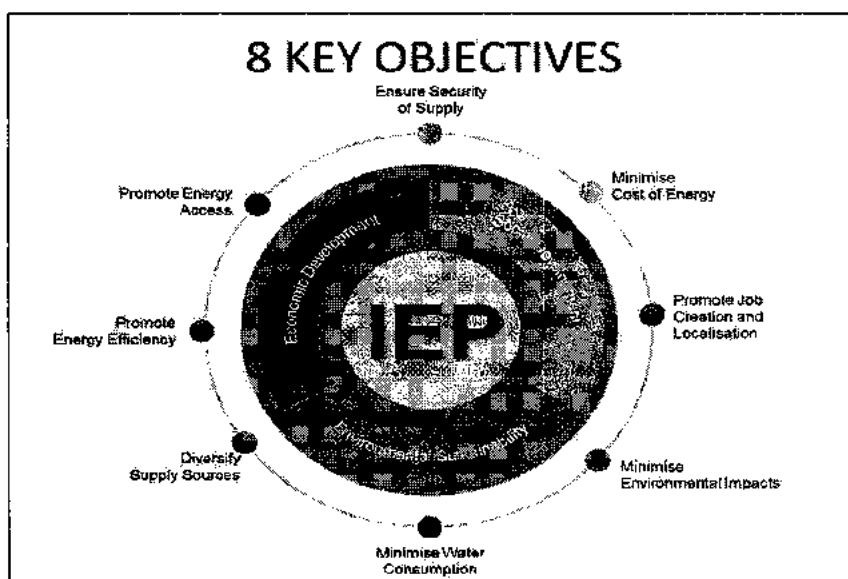


Figure 0-1: Key IEP objectives

These objectives are the key criteria against which the different policy alternatives and proposals made in the IEP are evaluated. Each of the objectives depicted in Figure 0-1 is described in Table 0-2 below.

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Table 0-2: Key objectives of the IEP

Objective	Description
Ensure security of energy supply	A fundamental objective of the IEP is to ensure that all projected future energy demand is met. In determining the point at which the cost of guaranteeing the supply of energy (i.e. reliability cost) is at a minimum and does not exceed the benefit of providing that energy, the Cost of Unserved Energy (CUE) is calculated. The Energy Security Master Plan (ESMP) – Electricity of 2007 recommended a reserve margin of 19% for electricity generation capacity in South Africa. The reserve margin of 19% indicates the point where the trade-off between cost and reliability is at a minimum (based on costs as calculated during the drafting of the ESMP). Ensuring adequate, sustainable and reliable forms of energy for end-consumers is the underpinning objective of the IEP. An adequate reserve margin of 19% for electricity generation has again been adopted for South Africa.
Minimise cost of energy	Other than labour, energy is a major input into the production of goods and services. The lower the cost of energy, the lower the production cost of tangible and non-tangible items. Lower energy costs are directly related to a more competitive economy. The objective of the IEP is to identify and highlight the mix of energy supply and demand technology options and energy resources and sources that minimise the total cost of energy, while meeting the projected energy demand subject to a boundary of conditions.
Promote job creation and localisation	The New Growth Path targets 300 000 additional direct jobs by 2020 to green the economy, with 80 000 in manufacturing and the rest in construction, operations and maintenance of new environmentally friendly infrastructure. The potential for job creation rises to well over 400 000 by 2030. Localisation will ensure knowledge transfer of both technical know-how and management processes from international suppliers to local industries. The objective is to build 'initial' or 'enhanced' innovative capacity in South Africa's energy sector. As part of the development of the IEP, it is acknowledged that an indirect consequence of the implementation process is the creation of jobs. These can be partly achieved by encouraging energy technologies that are labour intensive and which can be mass produced locally.
Minimise negative environmental impact by the energy sector	Energy planning needs to be done in such a manner that it does not impair government's goals of minimising adverse impacts on the environment. Because of South Africa's extensive use of coal and petroleum fuels, the adverse impact on both the local and global environment is significant. In 2004, the world produced about 49 000 million tons of carbon dioxide equivalent (Mt CO₂-eq), mainly from energy generation and deforestation. In comparison, South Africa produced about 440 Mt CO₂-eq, or about 1% of the global figure. South Africa's emissions are large relative to its population and economy. The IEP identifies a mix of technology options whose combined emissions will ensure that South Africa remains within the constraints identified in the National Climate Change Response White Paper. Environmental legislation such as the National Environment Act and the Air Quality Act are also taken into consideration by ensuring that pollution from the energy sector is kept to a minimum.
Minimise water consumption	One of government's vision statements is "A South Africa where environmental assets and natural resources are valued, protected and continually enhanced". South Africa is a water-scarce country and minimising the consumption of water is critical to contributing to this vision. The energy sector is highly reliant on water particularly for the generation of electricity and the production of syngas through the coal liquefaction process. According to the second National Water Resources Strategy, the energy sector is responsible for about 2% of total national water consumption. However, overall conservation of water by the energy sector reduces not only water consumption but also the demand for energy, as energy is required to move water.

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Objective	Description
	The Department of Water Affairs advocates the introduction of dry-cooled power plants in the inland region, which will ensure a reduction in water consumption, and this has been taken into account in the IEP. The IEP further highlights the estimated water usage associated with the various technology options.
Diversify supply sources and primary energy carriers	If South Africa is to make the transition to a low carbon economy, it will become increasingly important to reduce dependence on fossil fuels and diversify energy resources to include other energy forms such as nuclear and renewable energy (including imported hydropower from neighbouring countries). The role that natural gas can play in the transition to a low carbon future should also be considered. Diversifying the energy mix is necessary in order to improve security of supply, while at the same time minimising environmental impact and facilitating regional development. The dominance of a single-energy system, which is highly reliant on fossil fuels, inevitably places an excessive burden on the environment. This eventually weakens it through environmental fatigue, failure (permanent damage) or even catastrophe if the situation continues for too long. This inevitably poses a health and environmental risk. The IEP takes into consideration all energy resources and weighs up the costs and benefits associated with each against the ultimate objective of proposing a balanced energy mix, comprising traditional and alternative energy resources and sources.
Improve energy efficiency (reduce energy intensity of the economy)	Energy efficiency relates to the economical and efficient production and use of an energy carrier or resource. It results in achieving the same quality and level of some 'end uses' of energy (e.g. heating, cooling, lighting, etc.) with a lower level of energy input. Increased energy efficiency reduces overall energy demand, with a substantial decrease in cost to the energy system. While the 2013 National Energy Efficiency Strategy sets targets for energy efficiency improvements within the economy, the IEP explores further technology options that can be pursued. Of particular importance is the proposed mix of these options (supply- and demand-side) making them more efficient and therefore contributing overall efficiency improvements.
Promote energy access	Access to sustainable, modern, affordable, and reliable energy services is central to addressing many of today's global development challenges, including poverty, gender inequality, climate change, food security, health and education. Energy access is now widely recognised as a prerequisite for human development. Energy is needed for survival (for example to power hospital emergency equipment). It is important for the provision of social services such as education, and it is critical to all economic sectors from households and farming, to business and industry. The wealth and development status of a nation and its inhabitants closely correlates with the type and extent of its access to cleaner forms of energy. The more available the usable energy, the better are the conditions for development of individuals, households, communities, the society and its economy. Thus, improving access to energy is a continuous challenge for governments and development organisations. Access to energy is a function of availability and affordability and implies access to clean and reliable energy. According to the White Paper on the Energy Policy of the Republic of South Africa of 1998, the South African Government will promote access to affordable energy services for disadvantaged households, small businesses, small farms and community services. While several policies and programmes aimed at increasing access to modern forms of energy have already been developed and are currently being implemented, the IEP seeks to explore further options that can be pursued in order to address some of the challenges identified.

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Section 2: Overview of the energy sector

According to the 2014 Energy Sustainability Index, developed by the World Energy Council, South Africa ranked 83rd on the Energy Sustainability Index out of 129 countries. This was partly informed by its ranking at 42nd on energy security, which is an improvement over the previous two years; a ranking of 85th on energy equity, which declined over the last two years; and a placing of 129th in terms of environmental impact mitigation, which remains the lowest score for the past three years. According to the report, the drop by two places was mostly driven by the continued poor performance on the environmental sustainability dimension and the drop in energy equity. The low performance in environmental sustainability is due to the electricity sector's heavy reliance on coal and hence its high emission rates; while increasing petroleum prices, coupled with rising electricity tariffs, informed the low score on energy equity (WEC, 2014).

2.1. Primary energy supply

Primary energy supply in South Africa is dominated by coal (~71%), followed by crude oil (~15%). Nuclear, natural gas and renewable energy (including hydro and biomass) have historically played a less significant role in the total energy mix, collectively contributing to the remaining ~11% (DoE, 2014).

A closer examination of the electricity generation industry (DOE, 2010) reveals that 90% of electricity was generated from coal, followed by nuclear and hydro at 5% and 4.5% respectively. Petroleum products (diesel), natural gas and other renewable energy sources (i.e. solar, wind, biomass, bagasse, and landfill gas) collectively contributed less than 0.5% towards the total installed capacity for electricity generation. Imported crude oil dominated the primary supply of liquid fuels, followed by imported natural gas. Production of fuel from renewable energy sources and waste remained in its infancy and had not really taken off.

[... Primary energy supply in South Africa is dominated by coal (~71%), followed by crude oil (~15%) ...]

Over the last few years, various policies have been developed by the DoE in an effort to increase diversification of primary energy sources and reduce over-reliance on fossil fuels for the supply of energy. The threat of climate change, together with global developments in renewable energy technologies and other alternatives to coal, could see South Africa's future energy mix being quite different from that of the past.

2.1.1. Coal

South Africa ranks amongst the top 10 countries in terms of coal reserves (SA Coal Roadmap, 2010) and is currently the sixth largest coal producer in the world, with total production being equivalent to approximately 4% of world production (SA Coal Roadmap, 2010). Globally the five largest users of coal are China, USA, India, Japan, and South Africa and account for about 82% of its use. Coal is the second most important primary energy source after oil globally, with power generation being responsible for the largest absolute use of coal.

While South Africa dominates Africa's coal industry, this picture could change in the medium term as other southern African nations, including Mozambique, Zimbabwe, Botswana, Tanzania, Zambia, Swaziland and Malawi are also endowed with significant coal reserves (IEA, 2012).

According to the coal reserve and resource study conducted by the Council for Geo-Science in 2011, South Africa has in excess of 66 billion tons (Bt) of coal resources and reserves remaining (Eskom, 2015). At the current production rates it is estimated that coal supply is in excess of 200 years. More than 70% of these resources lie in the Waterberg Coalfield in the Limpopo Province, however there is only one operating colliery in that coalfield at present.

... Eskom generates 92.8% of South Africa's electricity with the remaining 7.2% being generated by municipalities and Independent Power Producers (IPPs) ...

While approximately 26.2% of South African produced coal is exported, the remainder contributes to approximately 80% of the country's total primary energy requirements. Eskom generates 92.8% of South Africa's electricity, with the remaining 7.2% being generated by municipalities and Independent Power Producers (IPPs). Within the liquid fuel sector, approximately 30% of South Africa's total liquid fuel requirements were produced from coal by Sasol, but in recent years this has slowly begun to decline, as gas is also being used as feedstock to meet the increasing demand.

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The use of coal going forward will be impacted by price and more so by environmental challenges. The combustion of coal results in the emission of various harmful gases and particulate matter into the atmosphere and also produces a significant amount of waste. The mining activities associated with the extraction of coal also have dire consequences for the environment.

Unless new technologies, aimed at reducing the carbon intensity of coal, are developed and put into use, the international competitiveness of South African exports could potentially be negatively affected. In the short- to medium-term, however, coal will continue to play an important role in the country's energy mix.

Underground Coal Gasification (UCG) is a process whereby coal, which has not yet been mined, is heated *in situ* under controlled conditions to release synthetic gas (syngas). The syngas is then brought to the surface and can be used directly for power generation. This process avoids the need for coal mining, transportation, preparation as well as disposal of ash, all of which have a tremendous impact on cost, labour and the environment. This in turn would help to reduce the cost of electricity.

The process can also be applied to coal that would not normally be mined due to various factors, including depth. Since up to three quarters of South Africa's coal may not be mineable, UCG could help to increase South Africa's 'coal supply' and could function in parallel with conventional mining. Extraction rates for UCG have been proven to be high (at about 83%) compared to less than 25% in conventional mining.

Eskom's UCG project, located near Majuba Power Station, was commissioned in January 2007. Initial co-firing in unit 4 at Majuba Power Station was achieved in October 2010. The design phase for a 100–140 megawatt electric (MWe) open-cycle gas turbine (OCGT) demonstration plant using UCG gas is currently under way (Eskom, 2015).

UCG technology therefore allows countries that are endowed with coal to continue to utilise this resource in an economically viable and environmentally safer way by converting coal into high value products such as electricity, liquid fuels, syngas, fertilisers and chemical feedstock. While the process has previously been criticised for generating large quantities of hydrogen as a useless by-product, hydrogen is now in demand as a feedstock for the chemical industry and shows potential as an alternative fuel for vehicles. The development of this technology and the viability of its implementation are still at a nascent stage and ongoing research needs to be undertaken.

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2.1.2. Crude oil

South Africa's crude oil requirements are met by imports, mainly from the Middle East and Africa. Almost all crude oil is used for the production of liquid fuels, with a small percentage used towards lubricants, bitumen, solvents and other petrochemicals. As is the case elsewhere in the world, liquid fuels are primarily used to meet the country's mobility needs. As a net importer of crude oil, and a developing country, South Africa is not in position to influence the price of crude oil. The South African liquid fuels industry is highly impacted by global developments and fluctuations in the crude oil price and the economy as a whole is therefore extremely vulnerable to the volatility of the global oil market.

Projections for global oil demand show a continued increase in the medium to long term if current policies, politics and levels of access continue (EIA, 2012). The continued growth in demand is spurred by robust economic growth in the non-Organisation for Economic Cooperation and Development (OECD) nations, including China and India, which offsets the slower growth projected for many OECD nations. Lower growth in crude oil demand is expected only if economic growth in non-OECD countries is slower than projected. It is envisaged that passenger transportation will continue to create the highest demand for crude oil, followed by freight, power-generation and non-energy uses.

While government policy is an important factor influencing long-term trends in global oil demand, other factors such as economic activity, population growth, prices and technology play a key role. Developments in vehicle technologies have the greatest potential to impact future global oil demand and improvements in efficiency can help to decouple the increasing demand for mobility from fuel consumption. Globally, Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG) and electricity play a significant role as primary fuels in the transport sector.

2.1.3. Nuclear

Nuclear power accounts for roughly 5 percent of South Africa's primary energy supply (Department of Energy, 2010). South Africa has one nuclear power station, Koeberg, situated about 30 km north-west of Cape Town. Koeberg has a capacity of 1 800 MW and consists of two 900 MW Pressurised Water Reactors (PWRs). Built in the early 1980s, with the first unit commissioned in 1984, the two units at the plant were designed with a 40-year lifespan; with retrofitting this could be increased to 50 or even 60 years. Koeberg's electricity costs are now comparable with those of the coal-fired power stations, although the capital outlay of building the power plant was higher, as is expected for nuclear power plants.

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South Africa has significant uranium resources and nuclear power generation has the potential to play a very significant role in efforts to reduce South Africa's carbon footprint from power generation because nuclear reactors generate very large amounts of electricity from very small amounts of fuel and release no greenhouse gases in their operation. While nuclear plants require larger capital outlays than other technologies, such as wind power or coal-fired plants incorporating carbon capture and storage (CCS), the lifecycle cost of nuclear power per megawatt of electricity remains competitive. Unlike CCS, nuclear power has the additional advantage that it is fully proven and provides base-load electricity generation capacity, which has yet to become a reality for either wind or solar power generation. Controlling the capital costs of nuclear projects is the critical factor if nuclear is to remain a competitive and viable supply option.

Despite the advantages of no emissions and the low lifecycle costs associated with nuclear plants, opinion is fragmented internationally as to whether nuclear power should form part of future plans for low-emission power. Concerns were raised after the 2011 crisis at the nuclear facility in Fukushima, Japan, and the safe storage of nuclear fuel waste continues to be of concern because the radioactive waste produced by nuclear power stations degrades very slowly and there are currently no long-term storage solutions for this waste anywhere in the world. While some countries, such as Germany are reducing the role of nuclear in their energy mix by decommissioning all nuclear plants, others, such as China, Russia, India, South Korea, the USA and Canada have commenced with the construction of new nuclear plants.

2.1.4. Natural gas

Natural gas plays a relatively small part (roughly 3%) in South Africa's total energy mix. South Africa has substantial local expertise in field development work as well as drilling and exploration activities in pursuit of energy security. Production has historically taken place in the offshore Bredasdorp Basin to supply PetroSA's Mossel Bay Gas-to-Liquid (GTL) facility; however the available resources from this basin are near depletion and have affected operations of PetroSA's GTL facility.

At a national level, natural gas consumption currently exceeds production, with the majority of demand being met through imports from Mozambique. The gas infrastructure between Mozambique and South Africa consists of a high-pressure pipeline from Mozambique's Temane and Pande gas fields to Sasol's Secunda site, where it links to the Sasol Gas network. This network provides gas to industrial and commercial customers, primarily within the Gauteng region. Recent exploration suggests that Mozambique's Rovuma Basin may

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yield further recoverable natural gas in excess of 100 trillion cubic feet (Tcf). The location of the Rovuma Basin is further north on the coast of Mozambique and the importation of gas from these fields by pipeline or through LNG infrastructure should be explored. The Government of Mozambique has developed a Natural Gas Masterplan for Mozambique to ensure exploitation of the natural gas discoveries in a manner that will bring about the

... Despite extensive drilling along South Africa's coastline, only marginal conventional gas discoveries have been made, with limited future prospects ...

greatest socio-economic benefit for its citizens (IFC International, 2012).

Due to South Africa's limited LNG infrastructure, there are no other sources for possible gas imports. South Africa does, however, have the opportunity to explore options relating to the new gas discoveries in Mozambique.

Despite extensive drilling along South Africa's coastline, only marginal conventional gas discoveries have been made, with limited future prospects. This, together with the vastness of the country, has made it difficult to justify expansion of the gas transmission pipeline or gas grid infrastructure to link pockets of gas to each other and to the markets in the regions where there have been discoveries.

A recent report by the Energy Information Administration (EIA) however, has estimated unconventional gas resources (shale gas and coal bed methane) in the Southern Karoo Basin of 485 Tcf. Further exploration is required to determine the extent of this recoverable resource. The perceived environmental risks associated with extracting 'tight' gas such as shale gas are considered to be significant, since the process (called hydraulic fracturing) requires substantial amounts of water. This presents a challenge in water-scarce areas. There are also environmental concerns over the possible contamination of ground water, which may result as a consequence of improper disposal of fluids during the hydraulic fracturing process.

Due to these concerns, the Department of Mineral Resources (DMR) placed a moratorium on the granting of licences for the exploration of shale gas and commissioned a study to evaluate the potential environmental risks posed by the process of hydraulic fracturing in South Africa, as well as the positive and negative social and economic impacts of shale gas exploration (DMR, 2012).

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The study concluded that, due to the limited amount of data currently available, it was not possible to quantify the extent of the shale gas resource accurately. It is however acknowledged that the existence of a significant shale gas resource in the Karoo would have positive implications for South Africa's energy security by reducing national dependence on other fossil fuels. Bearing in mind that the construction of the PetroSA Mossel Bay plant was founded on 1 Tcf of natural gas, if even a fraction of the estimated 485 Tcf is proven, it could have a significant impact on the South African economy. The DMR is currently in the process of reviewing the regulatory framework with the objective of ensuring that any resultant negative impacts associated with hydraulic fracturing for shale gas exploration and exploitation are adequately mitigated.

One of the challenges of introducing gas into new markets is that large, capital-intensive investment in infrastructure along the supply chain is required. Compared to oil, transporting gas by pipeline is relatively expensive because of the additional capital-intensive equipment needed to overcome the lower energy density of gas. However, these challenges can be overcome if there is a sizeable off-taker.

Natural gas has significant potential both for power generation as well as direct thermal uses. The power generation and liquid fuel sectors could be the main drivers behind the large-scale introduction of gas in South Africa. Construction of a combined-cycle gas turbine (CCGT) plant which has a relatively short lead time, together with the augmentation of gas supply to the existing PetroSA plant in Mossel Bay could help fast track the introduction of bulk gas at competitive prices in the short to medium term. Co-firing of existing old coal fired power stations with gas is an option that should be explored. A further option for the introduction of gas to the market is the introduction of Floating Storage and Regasification Units. These could be moored at key coastal points to receive LNG from ships for power generation and industrial use. This would help South Africa to reduce GHG emission, as natural gas has lower carbon content than coal.

The direct use of gas in energy intensive industries as an alternative to electricity and other fossil fuels should also be explored as it provides an efficient thermal energy source. Developments in Natural Gas Vehicles (which use CNG and LNG) could see natural gas providing a cleaner alternative to petroleum products in the longer term.

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2.1.5. Renewable energy

South Africa is well endowed with renewable energy (RE) resources in the form of radiation from the sun, and wind in coastal and mountainous areas, which have in the past remained largely untapped. South Africa generally receives abundant sunlight to support a sustainable solar power industry. The Northern Cape is one of the world's highest solar radiation areas; and much of South Africa's coastal region and its mountainous terrain is suitable for wind power.

In 2003, a 10-year target of 10 000 gigawatt hours (GWh) (the equivalent of 0.8 million tons of oil equivalent [Mtoe]) was set for RE, which was the envisaged industry contribution to final energy consumption by 2013. By 2008, the nascent RE industry contributed less than 8% of South Africa's primary energy supply. The IRP2010, which was promulgated in March 2011, envisaged electricity generated from hydropower maintaining its share of 5% and other RE technology forms contributing up to 9% (from an almost negligible amount) by 2030. Total installed capacity of RE technologies would be in the magnitude of 26.3% of total installed capacity by 2030.

Following the promulgation of the IRP2010, the DoE embarked on an aggressive Renewable Energy Independent Power Producer (REIPP) programme which has seen a steady increase in the share of RE technologies in the energy mix. In August 2011, subsequent to the Ministerial Determination of the same month providing for the procurement of 3 725 MW of

... South Africa is well endowed with renewable energy resources in the form of radiation from the sun, and wind in coastal and mountainous areas, which have in the past remained largely untapped ...

RE capacity from IPPs, the DoE initiated the IPP Procurement Programme to procure renewable energy generation from the private sector in a series of rounds (commonly referred to as Bid Windows). In December 2012 further Ministerial Determinations were announced for the procurement of 3 200 MW of RE generation from IPPs. To date the DoE has procured over 4 000 MW of renewable energy across Bid Windows 1 to 3.5 under the REIPP Programme. The DoE has entered into the following agreements with IPPs in the energy sector:

- Bid Window 1: 28 Agreements entered into on 05 November 2012;

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- Bid Window 2: 19 Agreements entered into on 09 May 2013; and
- Bid Window 3: 17 Preferred bidders announced on 4 November 2013 and 15 agreements entered into on 11 December 2014

A further 77 bids were received under Bid Window 4. The total capacity of these bids exceeded 5 000 MW which by far exceeds the 1 105 MW capacity available for allocation. The average bidding prices have declined with each bid window for the various technologies.

Table 0-1 shows the total allocation for each type of technology from the bids awarded in rounds 1 to 4 of the REIPP procurement process.

Table 0-1: Total allocation for renewable energy technologies through the REIPP Programme

Technology	MW capacity allocated in Bid Window 1	MW capacity allocated in Bid Window 2	MW capacity allocated in Bid Window 3	MW capacity allocated in Bid Window 4	MW capacity remaining
Solar Photovoltaic	632 MW	417 MW	435 MW	415 MW	626 MW
Onshore Wind	634 MW	563 MW	787 MW	676 MW	680 MW
Concentrated Solar Power	150 MW	50 MW	200 MW	N/A	..*
Small Hydro (≤ 40 MW)	--	14 MW	--	5 MW	116 MW
Landfill Gas	--	--	18 MW	--	7 MW
Biomass	--	--	18 MW	25 MW	19 MW
Biogas	--	--	--	N/A	60 MW
Total	1 416MW	1 044MW	1 456MW	1 121 MW	1 488 MW

* 200 MW was allocated in the March 2014 CSP Bid Window

Source: Presentation by DoE on REIPP bid Window 4, April 2015

*Integrated Energy Plan***Solar energy**

South Africa experiences some of the highest levels of solar radiation in the world and this renewable resource holds great potential for the country. The daily solar radiation in South Africa varies between 4.5 and 6.5 kilowatt hours per square meter (kWh/m^2) (16 and 23 megajoules per square meter [MJ/m^2]) (Stassen, 1996), compared to about 3.6 kWh/m^2 in parts of the United States and about 2.5 kWh/m^2 in Europe and the United Kingdom. The total area of high radiation in South Africa amounts to approximately $194\,000 \text{ km}^2$, including the Northern Cape, which is one of the best solar resource areas in the world. With electricity production per square kilometre of mirror surface in a solar thermal power station being 30.2 MW, and just 1% of the high radiation area in the country being made available for solar power generation, the generation potential is approximately 64 GW. Solar energy has the potential to contribute quite substantially to South Africa's future energy needs. This would, however, require large investments in transmission lines from the areas of high radiation to the main electricity consumer centres.

There are two main technologies for producing electricity from solar radiation, namely concentrated solar power (CSP), also known as solar thermal energy, and solar photovoltaic (PV) energy. CSP technology uses mirrors to concentrate the thermal energy of the sun and heat a transfer fluid. The heat energy is then used to produce the steam with which electricity is generated in conventional turbines. PV technology on the other hand uses silicon-based PV to convert the solar radiation directly into electricity. The PV technologies which have become commercialised are PV thin-film and PV crystalline.

A 2011 Pew Center report from the US put the levelised cost (the total lifecycle cost of producing electricity using a specific technology) of electricity generation from new CSP plants at approximately 19.5 to 22.6 US cents per kWh (Pew Center on Global Climate Change, 2011). This comparatively high cost is due to the high initial investment in solar thermal power stations. CSP is suitable for large-scale plants and provides baseload, as the heat produced can be stored more easily and cheaply than, for example, electricity from solar photovoltaic systems. However, CSP technology is still at an early stage of commercialisation. The cost reduction potential has not yet been fully explored. The German Aerospace Centre estimates that a cost reduction down to €0.05 per kWh at a global total installed capacity of 40 GW could be achieved between 2020 and 2025.

The best applications for solar power have primarily been the heating of water for households and the provision of PV electricity for houses, schools and clinics in rural communities. Solar energy technologies are also starting to grow in large-scale commercial applications.

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Government is considering the best way to mobilise industrial development around an ambitious solar park concept, which is planned for deployment in the Northern Cape in the coming years, primarily because of the intense solar radiation in this province. The pre-feasibility study indicates that the project could theoretically generate 5 000 MW from solar energy. Once completed, the solar park is expected to provide as much power as one large coal-fired power station.

In 2009, the Minister of Energy embarked on an aggressive solar water heating programme with the target being the installation of 1 million solar water heater geysers in households and commercial buildings by 2014. As at January 2013, 315 000 solar water geysers had been rolled out, mostly to poor households.

Wind

An estimate of wind power potential for South Africa was undertaken by Prof. Roseanne Diab (Diab, 1995) wherein it was observed that wind power potential is generally good along the entire coast, with localised areas, such as the coastal promontories, showing very good potential, i.e. mean annual speeds above 6 meters per second (m/s) and power exceeding 200 Watt per square metre (W/m^2). Moderate inland wind power potential areas include the Eastern Highveld Plateau and the Drakensberg foothills in the Eastern Cape and KwaZulu-Natal. The remainder of the country has low wind power potential.

About 500 wind turbines have been installed on a number of wind farms and are used to generate Direct Current (DC) electricity, usually at 36 volt (V).

The Klipheuwel Wind Farm near Cape Town is an Eskom demonstration plant which is being

... Government is considering the best way to mobilise industrial development around an ambitious solar park concept which is planned for deployment in the Northern Cape in the coming years ...

used to explore the use of wind energy for bulk electricity generation. The wind farm consists of three units, the first of which was commissioned in 2002 and the last in 2003. Total capacity is 3.2 MW and, at a load factor of 14%, average annual production is just over 4 GWh.

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The Darling Wind Farm, 70 km north of Cape Town, consists of four wind turbines with a capacity of 1.3 MW each, bringing the total installed capacity to 5.2 MW. As the first Independent Power Producer, the Darling Wind Farm Company uses the national grid (through a Power Wheeling Agreement with Eskom) and supplies electricity to the city of

... Government remains committed to exploring options for importing clean hydropower that is developed in the region ...

Cape Town through a 20-year Power Purchase Agreement (PPA). The site is used as an example for future public-private partnerships in the establishment of electricity generation and was declared a National Demonstration Project by the Minister of Minerals and Energy in June 2000.

The DoE has established the South African Wind Energy Programme (SAWEP). Funded by the Global Environment Facility, this programme aims to provide dedicated support for wind energy development in the country and to update South Africa's wind atlas, which is publicly available to prospective wind energy developers. A strong focus on capacity building is targeted at research and development institutions.

Hydro

South Africa is a water-scarce country and is a net importer of hydro-electricity. The country has a mix of small hydro-electricity stations (688 MW) and pumped water storage schemes (1 580 MW) (Banks and Schäffler, 2006) and imports 1 300 MW of hydropower from Mozambique's Cahora Bassa Dam. As a water-scarce country, South Africa would not be able to rely on smaller-scale hydropower resources during dry periods. Irrespective of the size of any prospective installation, local hydropower development will require authorisation in terms of the National Water Act, 1998 (Act No. 36 of 1998).

The Southern African Power Pool (SAPP) allows for the free trade of electricity between Southern African Development Community (SADC) member countries. Government remains committed to exploring options for importing clean hydropower that is developed in the region. South Africa and the Democratic Republic of Congo signed a memorandum of understanding in 2011 and a draft treaty in 2012 for the development of the Grand Inga Hydro-electric project (Grand Inga 4). With an estimated capacity of 39 000 MW, comprised of 52 turbines of 750 MW capacity each, Grand Inga will be the world's largest hydropower scheme and is the centrepiece of a continent-wide power system which is being developed in multiple phases.

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*Integrated Energy Plan***Biomass**

The main sources of biomass are wood waste (generated in the commercial forestry industry) and bagasse (generated in the cane sugar industry). Biomass is used commercially in the pulp and paper mills, and in sugar refineries where bulk from logs, black liquor and bagasse are burned to produce process heat and generate electricity (a process commonly referred to as own-generation or cogeneration).

In the forestry sector, the volume of waste remaining in the forests is substantial. This waste is a potentially large renewable energy resource that might have use for charcoal, gasification or direct generation of power.

Wood

Wood, as a source of energy, has two quite different uses, namely industrial and domestic. Industrial use of wood is primarily by South Africa's modern pulp and paper industry, which produces approximately 2.4 million tons (Mt) of pulp and 2.7 Mt of paper per year. In the chemical pulp mills, the fibre is separated out in chemical digesters and the residue, known as 'black liquor' and containing useful energy, is burned in recovery boilers to raise steam for process heat and electricity generation. Bark and sawdust from the wood are also burned in boilers.

The domestic use of wood is primarily by poor households, mainly in the remote rural areas, making wood a very important residential fuel in South Africa, as is the case throughout the continent. The exact quantity of residential fuel-wood used in South Africa is unknown, but is estimated at about 86 Petajoules (PJ), which is equivalent to 7 Mt of wood per year. These estimates suggest that present wood consumption is unsustainable because it is being consumed faster than it is replenished.

Bagasse

.. There is high potential for the production of biofuels from energy crops such as sugarcane, sugar beet, sunflowers and canola ...

Bagasse from sugarcane production and waste from the pulp and paper industry are used to provide energy within these industries but can be used to a greater extent to provide energy

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for nearby consumers. Bagasse (waste fibre from sugar cane) is the most important energy source for South Africa's sugar refining industry. The total sugar cane crop is over 20 Mt per year, which yields about 7 Mt of bagasse with a heating value of 6.7 MJ/kg, most of which is used as energy in raising steam for process heat and electricity generation. The installed generation capacity of the industry is about 245 MWe. Some bagasse is used for making paper.

Biofuels

There is high potential for the production of biofuels from energy crops such as sugarcane, sugar beet, sunflowers and canola. However, the low energy density of these food crops makes it uneconomical to transport over long distances and hence they need to be used either close to where they are produced, or condensed for more economical transport. The production of biofuels from food crops is a contentious issue which presents itself globally. In December 2007, Cabinet approved the Biofuels Industrial Strategy which outlines government's approach to the development of policy, regulations and incentives to develop and stimulate the biofuels industry in South Africa. The strategy seeks to achieve a 2% penetration rate of biofuels in the national liquid fuel supply and specifically excludes food crops, such as maize, based on food security concerns. Since the publishing of the strategy, an initial study has been conducted on the feasibility of a biofuel manufacturing plant using grain sorghum and soya beans as feedstock. Based on 2010 data, the study found that ethanol production from sugar cane would be much more expensive than that from grain sorghum in South Africa. The DoE has published regulations which require a minimum of 5% biodiesel blending with diesel and between 2% and 10% bioethanol blending with petrol. Consultations are currently taking place regarding the development of a biofuels industry as well as the implications of the infrastructure requirements and costs associated with the manufacturing and blending of biofuels with petrol and diesel.

Municipal waste

South Africa disposes of almost all of its refuse in landfill sites. It has been estimated that the total domestic and industrial refuse has an energy content of about 11 000 GWh per annum. This could be directly incinerated or converted into biogas and methane to produce electricity. There have been proposals for such schemes, and some landfill sites already produce electricity, such as the Durban Landfill-Gas-to-Electricity Project, Mariannhill and La Mercy Landfills, Ekurhuleni Landfill Gas Recovery Project, New England Landfill Gas to Energy Project, Alton Landfill Gas to Electricity Project, Nelson Mandela Bay Metropolitan Landfill, and the EnviroServ Chloorkop Landfill Gas Recovery Project.

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*Integrated Energy Plan***2.1.6. Alternative energy sources**

The hydrogen economy is undergoing serious consideration in South Africa, in an effort to develop safe, clean and reliable alternative energy sources to fossil fuels. Hydrogen, as an energy carrier, is used to store and distribute energy and can be combined with the use of fuel cell technologies to produce electricity. A driving force behind this technology is the prevalence of platinum reserves found in South Africa. Platinum group metals (PGMs) are the key catalytic materials used in most fuel cells, and more than 75% of the world's known platinum reserves are found within the South African borders. Hence there is great potential for socio-economic benefits to be obtained from these natural resources. Fuel cells directly convert chemical energy into electrical energy in a clean, environmentally friendly way with no harmful CO₂ emissions at the point of use. Converting hydrogen gas into electricity does not destroy the hydrogen, but rather transforms it into water. Hydrogen can be produced from carbon compounds, including fossil fuels, but the emphasis in South Africa is upon developing hydrogen from renewable energy sources in the long-term. In combination with renewable energy sources, hydrogen has the potential to become a crucial energy carrier in a future sustainable energy system.

Developments to establish a hydrogen economy in South Africa are progressing and through the Department of Science and Technology's HySA various projects are being undertaken to develop technologies for cost effective and safe hydrogen production, delivery, transportation, storage and electricity generation via fuel cells as well as the development of codes and standards. Projects are executed through local and international collaborative research and include the following themes:

- Combined Heat and Power (CHP);
- Stand-alone Power Systems and Uninterruptible Power Supplies (UPS);
- Hydrogen Fuelled Vehicles (HFVs);
- Hydrogen Storage (Compressed, Metal Hydrides, etc.); and
- Renewable Hydrogen Production.

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Section 3: Summary of key assumptions

This section presents a summary of assumptions for the key parameters that inform the IEP analysis, namely:

- Macroeconomic assumptions (GDP, discount rate and energy commodity prices);
- Demographic assumptions (population growth);
- Socio-economic assumptions (job and localisation potential of different technologies);
- Technology costs; and
- Externality costs.

A detailed analysis for each of these assumptions can be obtained in the annexures.

3.1. Macroeconomic assumptions

A detailed analysis of the macroeconomic assumptions can be obtained in ANNEXURE B.

Parameter	Description	Source of information	Unit	Assumption
GDP	• Average potential economic growth over planning period • Average potential economic growth over planning period	• National Treasury • IRP2010	• Percentage per year • Percentage per year	• See Table 0-1 • Green Shoots
Discount Rate	• The rate at which future benefits and costs decline is important because they occur in the future. Used to express a time preference for money – money right now is preferred to money in the future	• National Treasury	• Percentage per year	• 8.4%
Crude Oil Price	• The annual average global spot price of crude oil	• International Energy Agency, 2014 World Energy Outlook	• Original units: Real 2012 US dollars per barrel (US\$/bbl) – update • IEP units: R/gigajoule (GJ)	• Base Case: Assumes the crude oil projections of the 'New Policy Scenario' • The Resource Constrained Scenario: Assumes the crude oil prices of the 'Current Policy Scenario'

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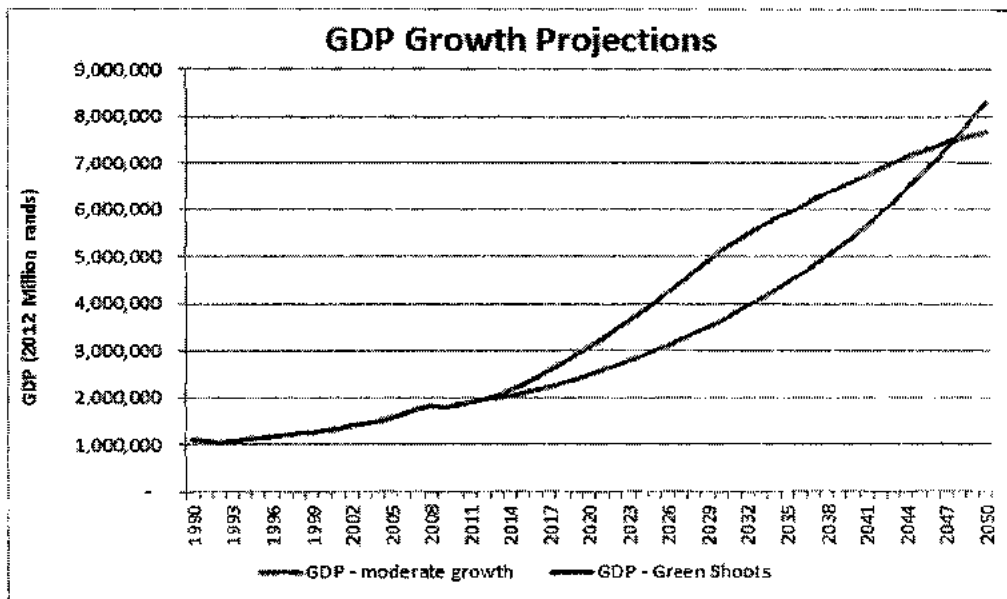
Parameter	Description	Source of information	Unit	Assumption
Petroleum Product Prices	• Price at which petroleum products are sold to the market	• DoE analysis (derived from crude oil price)	• R/GJ	• Petroleum product prices were derived from the crude oil price projections mentioned above
Natural Gas Price	• The annual average natural gas import price	• International Energy Agency, 2014 World Energy Outlook • European Natural Gas Import Prices	• Original Units: Real 2012 US dollars per million British thermal units (MBtu) • IEP Units: R/GJ	• Base Case: Assumes the natural gas projections of the 'New Policy Scenario' • The Resource Constrained Scenario: Assumes the natural gas prices of the 'Current Policy Scenario'
Coal Prices				
Fluidised Coal		• EPRI report	• R/GJ	• Fixed at R15/GJ throughout the planning horizon
Pulverised Coal		• EPRI report	• R/GJ	• Fixed at R7.50/GJ throughout the planning horizon
Shale Gas Extraction	• Capital costs for primary energy production	• PetroSA	• R/GJ/annum	• Fixed R372/GJ per annum throughout the planning horizon
	• Fixed costs for primary energy production	• PetroSA	• R/GJ/annum	• Fixed R8/GJ per annum throughout the planning horizon

Table 0-1: GDP growth projections

	Short term				Medium term	Long term
	2014	2015	2016	2017	2018–22	2023–50
Low Growth	1.5	1.8	2.3	2.5	2.8	3.0
	2.4	2.5	2.9		3.1	3.0
Moderate Growth	1.8	2.7	3.2	3.5	3.7	4.2
	3.0	3.2	3.5		3.7	4.0
High Growth	2.0	3.3	3.7	4.0	4.9	5.5
	3.3	3.6	4.0		4.9	5.4

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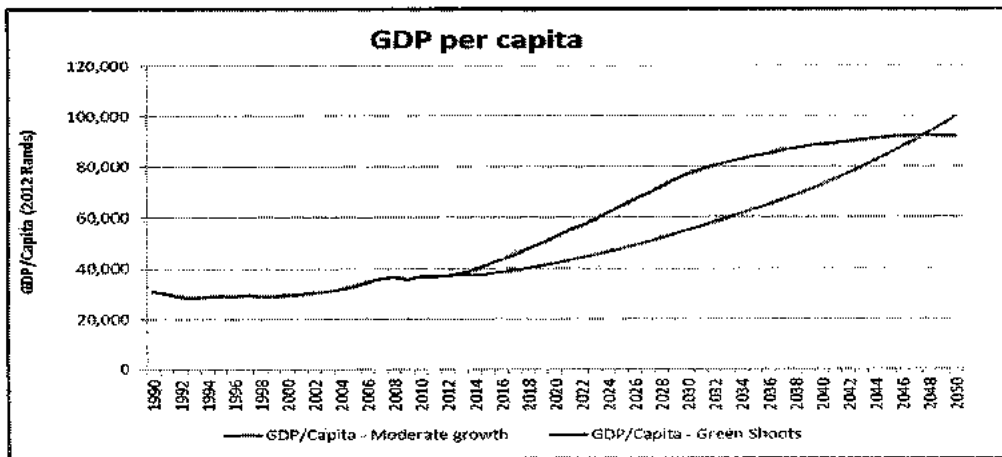
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Source: DoE Analysis

Figure 0-1: GDP growth projections

The graph below shows different scenarios for the projected GDP per capita based on the GDP growth and population projections.



Source: DoE Analysis

Figure 0-2: Moderate growth and Green Shoots GDP/Capita

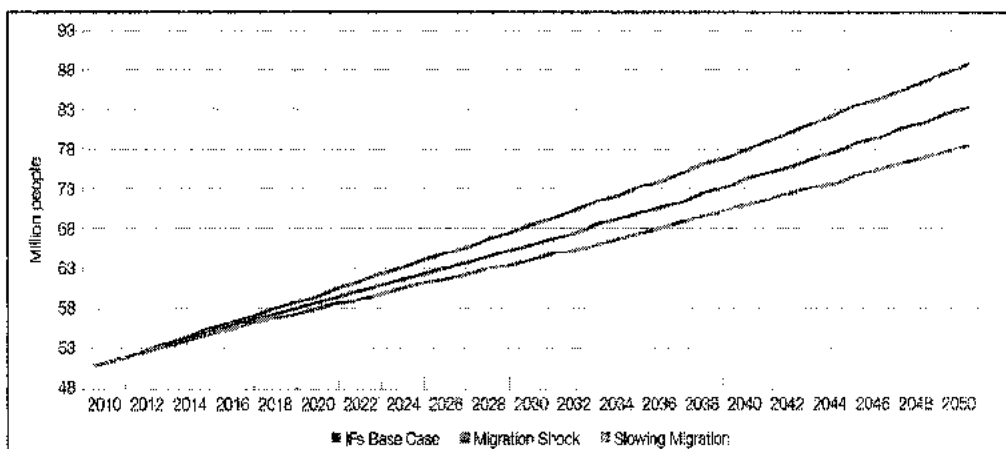
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3.2. Demographic assumptions

A key driver of energy demand is population size and expected growth. A detailed analysis of demographic and macroeconomic assumptions can be obtained in ANNEXURE B.

Parameter	Description	Source of information	Unit	Assumption
Population Growth	Growth of the national population taking into account three key drivers: Fertility Rate, Life Expectancy and Migration	Institute for Security Studies	Million people	See Figure 0-3 below



Source: ISS (2013)

Figure 0-3: RSA population growth projections

3.3. Socioeconomic assumptions

The job creation potential of the energy sector is summarised in this section. A detailed analysis of the socioeconomic assumptions can be obtained in ANNEXURE B. Job creation potential within the electricity sector is based on the output from a study conducted by McKinsey & Company (McKinsey & Company, 2014), while job creation potential for the liquid fuel sector is based on several studies conducted by independent consultants on behalf of PetroSA (PetroSA, 2012). Direct, indirect, supplier jobs and induced jobs were considered in estimating the number of jobs created by the deployment of different technologies.

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Table 0-2: Job categories



	Definition	Examples
Direct jobs	Jobs resulting from construction or operation of the technology	- Construction workers - Bricklayers - Plant operators
Supplier jobs	Jobs resulting from first level suppliers during construction/operation	- Turbine manufacturers - Cement producers - Steel manufacturers
Indirect jobs	Jobs resulting further down the value chain during construction/operation: 'suppliers to suppliers'	- Iron ore miners - Smelters
Induced jobs	Jobs resulting from more money in the economy because of the project (e.g., etc.)	- Restaurants - Transport services - Medical facilities

Source: McKinsey and Company, 2014

For the electricity sector, further analysis was done to determine the localisation potential. This was determined based on two criteria: Sufficiency of demand for required goods or services within the economy; and the ability of the country to supply this particular spend component.

- Sufficiency of demand:** Localisation requires sufficient long-term demand to justify investing in the resources to deliver the goods or services. Demand was assessed based on whether or not sufficient demand existed in a 5 GW installation of any given technology. If the demand did not exist, further assessment was conducted incrementally to determine whether demand could be created through adjacent industries (e.g. mining and oil and gas), and if not whether there was sufficient demand in sub-Saharan Africa to justify building new capacity. If the demand could not be created at the first three levels it was then assumed that to have sufficient economic rationale to build an industry, South Africa would need to participate in the global market and therefore would need to be globally competitive.
- Ability to supply:** In determining the ability to supply a particular spend component (material or service), a qualitative analysis of the time and effort required to build sufficient skills, infrastructure, capital plants and regulatory frameworks to ensure sufficient supply was conducted. The time and effort required was categorised into short, medium and long term. Short term indicates that sufficient skills and the required infrastructure exist or could be developed fairly quickly and that an enabling regulatory framework exists. Long term indicates that more time and effort would be required in order to establish sufficient supply.

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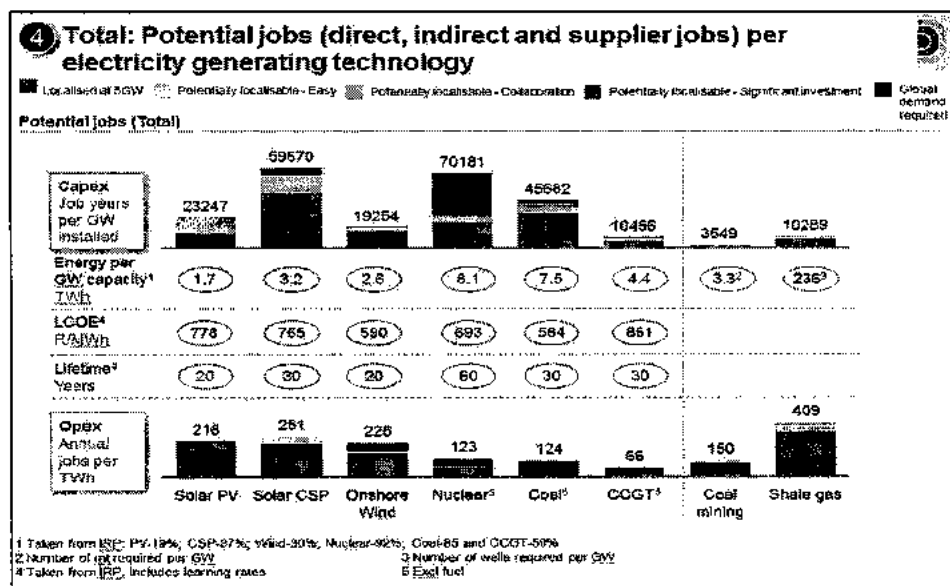
To differentiate between the localisation potential of electricity generating technologies, five different colour indicators (red, black, green, yellow and orange) were used and are described in the table below.

Table 0-3: Levels of localisation potential

Localisation potential	Description
Potentially localisable - Easy	The current policy framework is conducive for localisation; local supply of the required skills set is available; and there is sufficient demand for raw material to justify local production
Potentially localisable - Moderate	The current policy framework exists or could be developed and implemented within a fairly short timeframe (3–5 years)
Potentially localisable - Significant investment	The current policy and regulatory framework could be developed and implemented within five years and some targeted investments would need to be made
Potentially localisable - Global demand required	Regional co-operation and partnerships would need to be developed in order to create demand beyond South Africa's borders
Global demand required	Some of the required technology components can be localised, but South Africa would need to be competitive in exporting the technologies and services to the global market

Source: McKinsey and Company, 2014

3.3.1. Electricity sector jobs



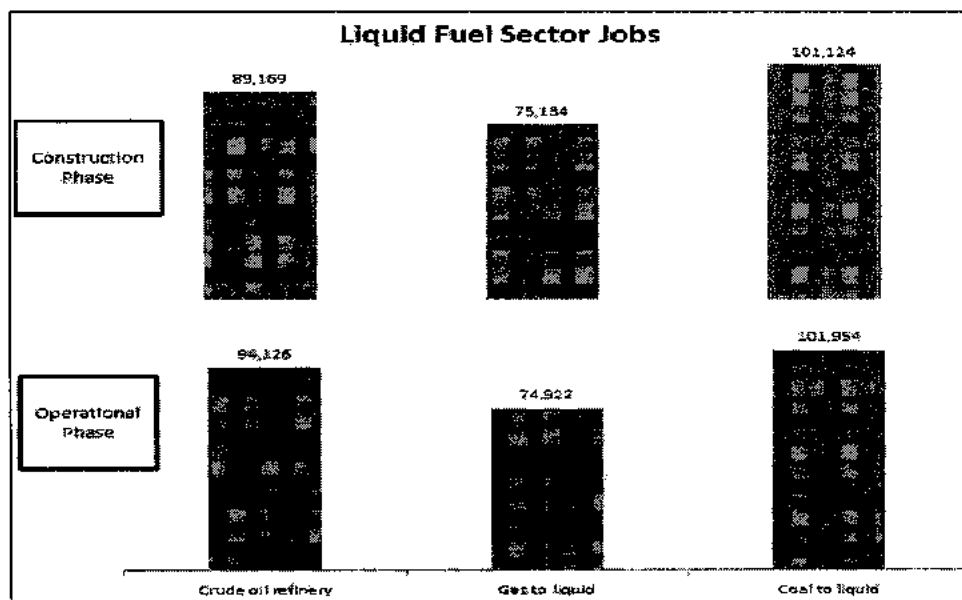
Source: McKinsey and Company, 2014 (The figures for shale gas extraction include reticulation infrastructure which will be required)

Figure 0-4: Job creation potential for electricity generation technologies

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3.3.2. Liquid fuel sector jobs



Source: PetroSA, 2012

Figure 0-5: Job creation potential for liquid fuel technologies

3.4. Technology costs

This section summarises capital costs for electricity generation and liquid fuel production technologies. Learning rates have been assumed for electricity generation technologies. The detailed reports on technology costs and other technology assumptions are included in ANNEXURE A.

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3.4.1. Electricity generation

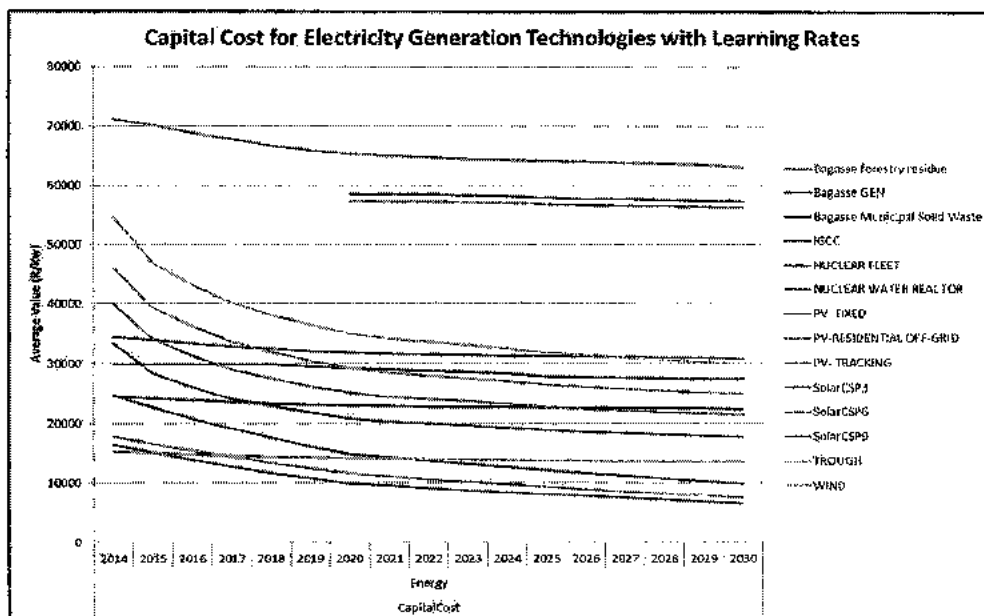


Figure 0-6: Capital costs for electricity generation technologies with learning rates

3.4.2. Liquid fuel production

Table 0-4: Capital and fixed costs for liquid fuel production technologies

Unit: Rm/PJ ou/annum

Sector: Energy

Technology type: Transformation

Technology name	Parameter	
	Capital cost	Fixed operating cost
New coal liquefaction	388.38	25.71
New gas to liquids	230.61	7.91
New conventional crude oil refineries	133.27	7.27
Residual coal liquefaction		25.71
Residual gas to liquids		34.84
Residual conventional crude oil refineries		9.63

3.5. Externality costs

An externality cost is a cost imposed on society due to the activities of a third party, resulting in social, health, environmental, degradation or other costs. These costs may be beneficial (e.g. a mine builds a fire break between its operations and the neighbouring farm from which the farmer then directly benefits in terms of safety and security).

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In this IEP iteration, however, only the negative externalities related to the different energy sources associated with power stations, refineries, vehicles, mining, shale gas and gas have been considered. These relate to air pollution (caused by pollutants such as nitrogen oxide [NO_x], sulphur oxide [SO_x], particulate matter [PM] and mercury [Hg]), climate change (caused by excess CO₂) and water use. With the exception of water (where the true water cost is estimated), the 'cost of damage' approach was used to determine the externality costs.

For the purpose of these statements, overall cost to society is defined as the sum of the imputed monetary value of costs to all parties involved.

Externality costs were calculated for different types of pollutants based on the estimated cost of damage caused by those pollutants. The final values were derived from various studies which were conducted and are indicated in the table below. The detailed reports which informed the cost of externalities are included in ANNEXURE C.

Table 0-5: Externalities costs

Externality	Description	Value	Unit	Source
CO ₂	Carbon dioxide	0.27	2012 Rand/kg	ANNEXURE C1: Vivid Economics (2014)
SO ₂	Sulphur dioxide	7.60	2012 Rand/kg	ANNEXURE C2: FRIDGE Study (2013)
NO _x	Nitrous oxide	4.50	2012 Rand/kg	ANNEXURE C2: FRIDGE Study (2013)
Hg	Mercury	41484.00	2012 Rand/kg	ANNEXURE C3: Cukrowska (2011)
PM	Particulate matter	11.30	2012 Rand/kg	ANNEXURE C2: FRIDGE Study (2013)
PM _{transport}	Particulates in transport sector	280.70	2012 Rand/kg	ANNEXURE C2: FRIDGE Study (2013)

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Section 4: Scenarios

Four core scenarios were considered during the planning process. While the objective was to develop and analyse a set of scenarios that would be as mutually exclusive as possible, there may be some level of interdependency within the key underpinning assumptions which form the basis of the scenarios. Although the scenarios themselves are not intended to test the impact of specific policy interventions, they are characterised by an environment in which certain national policy imperatives are dominant and shape the future economic landscape.

A 'Business as Usual' scenario is encapsulated in the Base Case, while three other scenarios, namely the Resource Constrained, Environmental Awareness and Green Shoots scenarios are also considered.

4.1. Base case

The Base Case can be referred to as the 'Business as Usual' scenario. It is assumed that all existing and appropriate government policies relevant to the energy sector have shaped the energy sector landscape and will continue to do so in the future. Economic growth is perceived to be increasing at moderate rate in line with the moderate National Treasury GDP projections described earlier. As a consequence immigration increases at a moderate rate. In line with prospects within the economy, the unemployment rate continues at the current rate as there are no perceived changes in the structure of the economy.

[... Global crude oil prices continue to increase at the current (moderate) growth rate which then translates to moderate price increases for refined petroleum prices ...]

Global crude oil prices continue to increase at the current (moderate) growth rate which then translates to moderate price increases for refined petroleum prices. Efforts to develop co-operation regionally do not show much improvement and as such the import of primary energy (i.e. natural gas) and power imports continue at the current rates.

Motor vehicles and light delivery truck fuel efficiency improves moderately at an annual average rate of 1.1% whilst trucks and buses improve their fuel efficiency at an annual average of 0.8%. Electric vehicles do enter the market, however as this is not policy-driven they are assumed to have a maximum 20% penetration rate by 2050.

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The mitigation of climate change remains one of the primary policy imperatives and the Peak-Plateau-Decline emission limits are adopted as the norm. The national emission reduction targets are translated across all economic sectors and all externality costs associated with carbon emissions and other pollutants are accounted for. Although no carbon tax is assumed, the externality cost of carbon is calculated based on the carbon tax rate advocated in the proposed Carbon Tax Policy.

The 9.6 GW New Nuclear Build Programme as envisaged in the IRP2010 has been included in the Base Case and all the core scenarios.

4.2. Resource constrained

The main characteristics of this scenario are high commodity prices, in particular those of crude oil and natural gas. High crude oil prices lead to higher than usual increases in petroleum product prices which have an impact on inflation. Domestic economic growth is then severely impacted and remains lower than expected.

The low to moderate economic growth results in reduced immigration into South Africa slowing down population growth. The demand for products and services domestically also remains low and would impact the energy demand growth in all sectors.

There is a marked improvement in the adoption of more energy efficient technologies as a consequence of high energy prices and also due to more aggressive policy interventions. Cars and SUVs have an annual average efficiency improvement of 2.5% while trucks and buses have an average annual improvement of 1%. As electricity price increases are also high in this scenario, electric vehicles enter the market at a maximum penetration rate of 20%.

... There is a marked improvement in the adoption of more energy efficient technologies as a consequence of high energy prices and also due to more aggressive policy interventions ...

4.3. Environmental awareness

In this scenario there is greater awareness and a more concerted effort to reduce greenhouse gases than in other scenarios. More countries at a global level adopt policies that aim to achieve the emission reduction targets that seek to keep the average annual temperature increases below the 2°C threshold. For South Africa this means that there are more aggressive interventions to curb the effects of climate change and the lower Peak-Plateau-Decline emission limits become the order of the day. A higher cost is placed on externalities associated with carbon, with the cost placed at R270/ton.

Individual consumers pursue alternative sources of energy and there is an increased uptake of solar water heaters, primarily in new houses.

4.4. Green shoots

The Green Shoots scenario is characterised by the high economic growth outlook and significant structural changes envisaged in the National Development Plan. The economy is assumed to grow at an annual average rate of 5.7% to 2030, with a slight and steady slowdown from then until 2050. The structure of the economy shifts from a resource-driven to a manufacturing- and a services-driven economy as the country's 're-industrialisation' objectives materialise. This results in higher demand for energy in these two sectors as compared to other scenarios.

... The Green Shoots scenario is characterised by the high economic growth outlook and significant structural changes envisaged in the National Development Plan ...

There is a more aggressive uptake of alternative energy sources such as solar water heaters, rooftop PV panels and electric vehicles by individual consumers, which are made possible by the higher average household income levels envisaged in this scenario. While awareness of climate change is a key policy imperative in this scenario, this is balanced with stimulating the growth of the economy.

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4.5. Summary of scenarios

Table 0-1: Summary of scenarios

Indicators	Scenarios			
	Base case	Resource constrained	Environmental awareness	Green shoots
GDP	Treasury moderate GDP growth	Treasury moderate GDP growth	Treasury moderate GDP growth	National Development high GDP growth
Demand-side levers				
DSM	1 million SWH	1 million SWH	5 million SWH	10 million SWH
Energy efficiency	Business as usual	High energy efficiency	High energy efficiency	High energy efficiency
Vehicle efficiency (new vehicle improvement per annum)				
Cars and SUVs	1.10%	2.50%	2.50%	2.50%
Trucks and buses	0.80%	1.00%	1.00%	1.00%
Electric vehicle penetration rate (% per annum)	20%	20%	20%	40%
Prices of energy commodities	Moderate	High	Moderate	Moderate
Climate change				
CO ₂ emissions limit	PPD* upper limit	PPD upper limit	PPD lower limit	PPD upper limit
CO ₂ externality costs	- R48-120/t 2015-2019 - R120/t onwards	- R48-120/t 2015-2019 - R120/t onwards	R270/t 2015-2019	- R48-120/t 2015-2019 - R120/t onwards
Carbon tax	None	None	None	None

* "Peak-Plateau-Decline" emission trajectory from NCCRWP

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Section 5: Analysis of demand

The economy of a country can be described broadly through three main categories, namely primary, secondary and tertiary sectors. The primary sector is the sector of the economy making direct use of natural resources. This is contrasted by the secondary sector, which is characterised by the production of manufactured and other processed goods, and the tertiary sector which is characterised by the production of services. The economic grouping is based on the economic activities of the various sectors, and is therefore effective in quantifying and analysing the economic value-add of each of the sectors. However in order to effectively quantify energy consumption within each of the economic sectors, a grouping aligned with energy end-use becomes more constructive. While energy demand can be closely linked to economic activity, this approach also becomes effective in quantifying energy demand in those sectors whose economic activity may not always have a high level of correlation with energy demand (for example energy consumed in offices and public buildings).

... In order to effectively quantify energy consumption within each of the economic sectors, a grouping aligned with energy end-use becomes more constructive ...

Five demand projections were conducted according to five sectoral groupings, namely the agricultural, commercial, industrial, residential and transport sectors. These are described briefly below:

- The agricultural sector includes animal husbandry, crop farming, forestry and fishing.
- The commercial sector includes wholesale and retail, public services, financial and business services, hospitality, education, entertainment, information and communication. It does however exclude commercial transport.
- The industrial sector includes all manufacturing (manufacturing and production of all goods and products including fast moving consumer goods) as well as construction and mining.
- The residential sector includes all personal dwellings (i.e. formal and informal households in rural and urban areas).
- The transport sector includes passenger transportation (private and public) and freight transportation. While economically freight transport forms a part of commercial services, this has been separated and quantified separately for better clarity.

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Table 0-1 provides a mapping of economic sectors to energy demand sectors with the key activity variable indicated in the last column.

Table 0-1: Mapping of economic sectors to energy demand sectors

Economic grouping	Economic sector	Energy demand sector	Sub-sectors	Subsectors included	Energy carriers considered	Activity variable
Primary	Agriculture, forestry and fishing	Agricultural Sector	N/A	N/A	Electricity, coal, diesel	GDP
	Mining and quarrying	Mining Sector	N/A	N/A	Electricity, coal, diesel	Value-added in the Mining Sector
Secondary	Manufacturing	Industrial Sector (excl. mining) or Manufacturing Sector	Chemicals	N/A	Electricity, coal, natural gas	Value-added in the Manufacturing Sector
			Iron and steel	N/A	Electricity, coal, natural gas	Value-added in the Manufacturing Sector
			Non-ferrous metals	N/A	Electricity, coal, natural gas	Value-added in the Manufacturing Sector
			Other manufacturing	Non-metallic minerals, food and tobacco, paper and pulp, construction, machinery, textile, wood and wood products, transport equipment	Electricity, coal, natural gas	Value-added in the Manufacturing Sector
	Construction					
Tertiary	Wholesale and retail trade; hotels and restaurants	Commercial Sector	N/A	N/A	Electricity, coal, LPG, residual fuel oil	GDP
	Finance, real estate and business services					
	General government services					
	Personal services					
	Storage and communication					
	Transport	Transport Sector	Private passenger transport	N/A	Diesel, petrol, electricity, aviation fuel	GDP/capita
			Public passenger transport		Diesel, petrol, electricity, aviation fuel	GDP/capita
			Freight transport		Diesel, petrol, electricity (rail)	GDP/capita
Households	N/A	Residential Sector	N/A	N/A	Electricity, coal, LPG, paraffin, wood	Population growth, number of households, electrification, urbanisation and household income

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Gross Domestic Product (GDP) is widely used as an indicator of total demand in the economy and is therefore a good proxy to determine energy consumption. Where data was available, value added by the sector was used to estimate energy demand.

The population growth combined with the average household size provides a good basis for estimating the number of households in the future. Energy demand in the residential sector is determined by estimating the average energy consumption by different end uses.

In the transport sector, GDP per capita is used to estimate future demand for passenger transportation while GDP is used for freight transport.

... GDP is widely used as an indicator of total demand in the economy and is therefore a good proxy to determine energy consumption ...

While the ultimate objective is to conduct demand projections for all energy services (cooking, lighting, industrial processes, transportation, etc.) within each major energy demand sector, due to paucity of energy consumption data at an energy end-use level, the above-mentioned key drivers were used as a basis and demand projections were conducted for each energy demand sector as follows:

- For the agricultural, commercial, industrial and residential sectors, energy demand was estimated and projected for individual energy carriers (e.g. electricity, natural gas, LPG, coal, diesel, etc.).
- For the transport sector, energy demand was projected for energy end-use (i.e. mobility measured by passenger kilometres or freight tonne kilometres) as opposed to individual fuels (e.g. petrol, diesel, jet fuel, etc.). This second approach makes it possible to quantify the extent to which different fuels can be used to meet the same end-use/need.

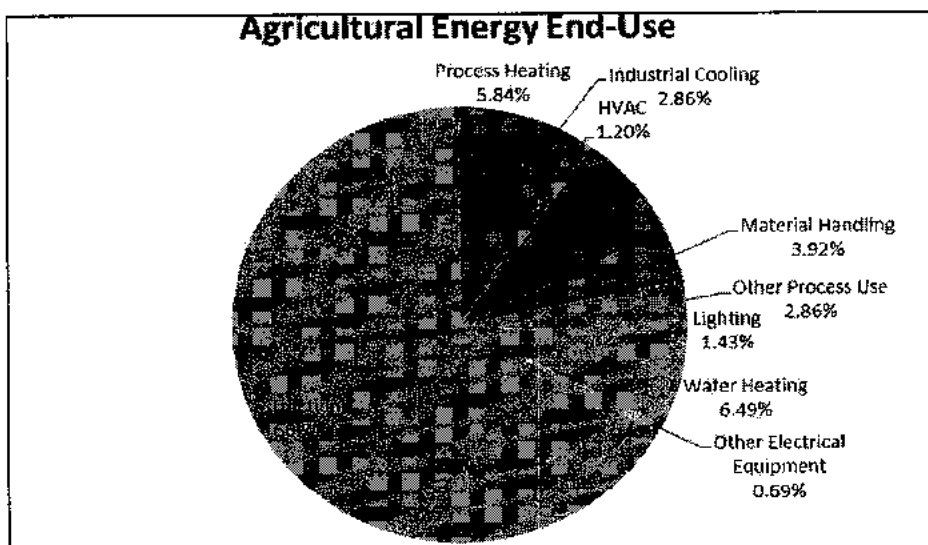
An analysis of demand within each of the scenarios described in 0 is described in this section. It should be noted that where demand projections are substantially similar per scenario, they are grouped together in the representative Figures.

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5.1. Agricultural Sector

South Africa has a dual agricultural economy which comprises a well-developed commercial sector and a predominately subsistence-oriented sector in the rural areas. Primary commercial agriculture contributes about 3% to South Africa's GDP and about 7% to total formal employment. However, there are strong backward and forward linkages into the economy, so that the agro-industrial sector is estimated to contribute about 12% to GDP (SA Yearbook, 2011/12).

Since South Africa's re-admission into world-trade, the agricultural sector has undergone significant structural changes. Over the past 15 years the sector has shifted to large-scale intensive farming, and has shifted from low-value, high-volume products intended for domestic consumption, such as wheat and milk, to high-value products intended for export, such as deciduous fruit, citrus and game. Intensive farming practices are highly dependent on water and fuel with the latter making up the second largest expenditure item after farm feeds. On the other hand, land reform could result in the emergence of a large number of small-scale farmers, who are most likely to use traditional farming methods. Fuel (predominantly diesel) is the prime energy source used in the sector and is primarily used for traction and other farm machinery as well as the transportation of agricultural produce.



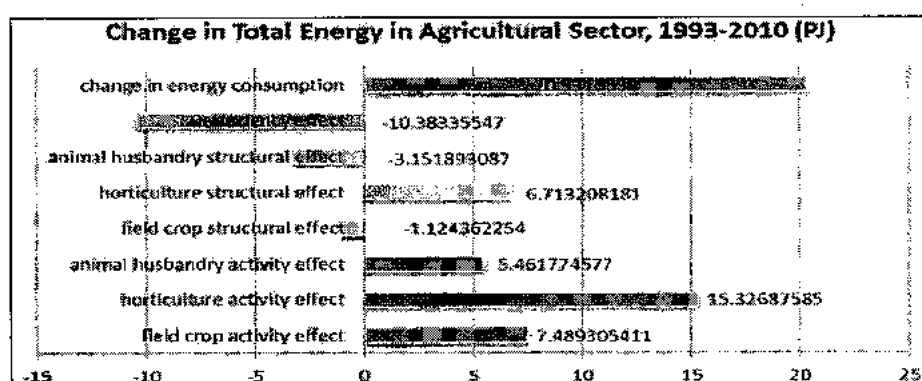
Source: DoE Analysis

Figure 0-1: Energy end-use within the agricultural sector

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While small-scale farmers have emerged over the last few years, this growth has been slow and has had minimal impact on total energy demand within the sector. The bulk of the demand has been from large-scale intensive farming where the use of electricity and diesel has remained high. Key drivers for energy demand in this sector include shifts to large-scale, intensive farming practices and changes in the types of food crops farmed, the latter being highly influenced by changes in diet among the population as incomes increase. It is likely that in future the share of electricity in this sector will grow, with the extent of the growth being influenced by energy prices, while diesel is projected to continue playing a significant role. Energy demand in the agricultural sector will continue to be linked to growth and value-add of the sector.

With large-scale, highly mechanised, intensive farming, most efficiency gains resulting from improved machinery, equipment and production practices have been realised and the rate of further efficiency improvements will start to decline. The value-add of the agricultural sector is therefore assumed to continue to see growth into the future, however with the rate of increase slowing down. Farming is assumed to remain vitally important to the economy and the development of the Southern African region. In order to understand these pathways of energy demand in the sector, it is helpful to understand historical patterns of total energy change which are due primarily to three drivers and are therefore used in assessing energy efficiency using decomposition analysis (Ang, B.W., Zhang, F.Q., Choi, K-H, 1998). The drivers are the level of activity, structural changes and energy intensity in the sector relative to the other sectors. The relationship between these drivers is described by the following effects; activity effect, structural effect and efficiency effect. Figure 0-2 provides a graphical representation of the full decomposition analysis results for 2010 relative to the 1993 baseline.



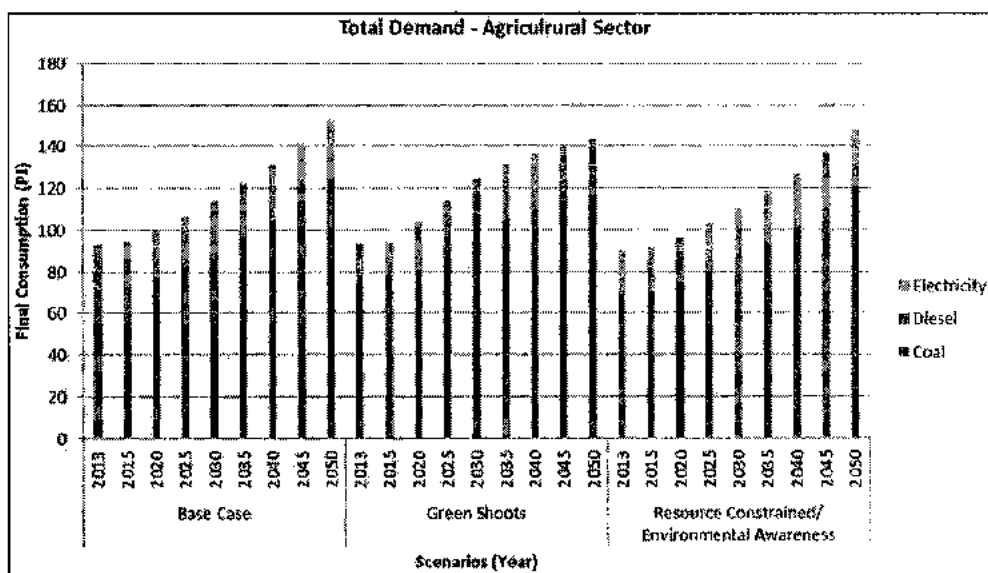
Source: DoE Analysis

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Figure 0-2: Decomposition analysis results for change in energy consumption in the agricultural sector

Total energy consumption in 2010 had increased by 20.33 petajoules (PJ) relative to 1993. This change is composed of the sum of: a 28.28 PJ increase due to greater level of activity, a 2.44 PJ increase due to structural changes and a 10.38 PJ decrease due to energy efficiency improvements. This means that over the 17-year period, if all other factors had remained constant, improvements in efficiency alone would have led to a 10.38 PJ decrease in energy consumption, which is 15.13% of the 1993 baseline figure. This is equivalent to a compound annual decrease of about 0.01% in energy consumption attributable to efficiency improvements. This compounded annual decrease of (0.01%) is then used to estimate energy improvements in the projected energy demand presented. The projected energy demand for the agricultural sector is depicted in Figure 0-3.



Source: DoE Analysis

Figure 0-3: Projected demand in the agricultural sector

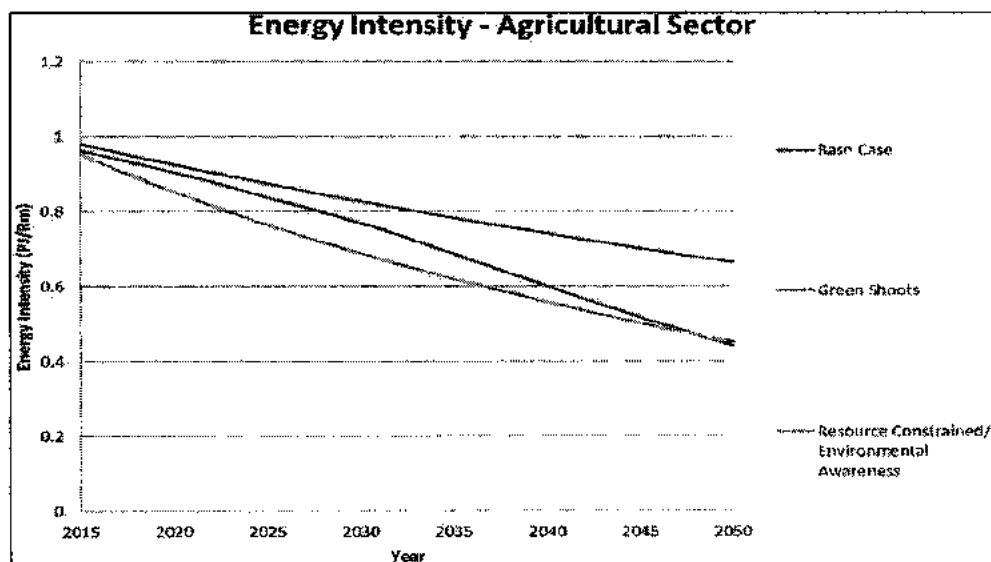
The main driver behind energy demand projections is the gross domestic product and the detailed information behind these assumptions is presented in 0The energy demand projections are based on four scenarios explained in 0The fuel mix in all these scenarios shows that diesel is the most used energy carrier, mainly because the sector is characterised by traction which accounts for 66.71% of energy use. This trend is likely to continue due to the Biofuel Industrial Strategy. The strategy targets new and additional land which is approximately 1.4% of arable land in South Africa (DME, 2007), implying more traction in the sector and therefore an increase in diesel consumption. The demand for diesel is followed by

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demand for electricity to supply energy services for irrigation and heating, ventilation and air conditioning (HVAC). The demand for coal is very small and this is likely to continue throughout the modelling period. An overall observation is that the total energy demand in this sector will continue to increase as there is high potential for economic growth.

In this sector, energy use per rand of gross domestic product is used as a measure of energy intensity. The average energy demand growth rate for both the Base Case and Resource Constrained/Environmental Awareness scenarios is between 1% and 2% in the short to medium term, increasing to between 2% and 3% in the long term, in line with the GDP assumptions described earlier. The average energy demand growth rate for the Green Shoots Scenario is between 2% and 3% in the short to medium term, decreasing to between 2% and 1% in the long term. The growth patterns for all the scenarios are similar to those of the corresponding GDP growth rates as GDP is the main driver behind the energy demand projection.



Source: DoE Analysis

Figure 0-4: Energy intensity in the agricultural sector

In this sector, the energy intensities for the four scenarios (i.e., Base Case, Resource Constrained, Environmental Awareness and Green Shoots) show a declining trend, which is mainly attributable to the introduction of energy efficient technologies in the sector. The respective overall average reductions in energy intensities in the aforementioned scenarios

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are slightly more than 1.1%, 2.2% and 2.1% over the modelling period. A similar pattern of decline is also reflected in both the short- to medium-term periods.

5.2. Commercial Sector

The commercial sector comprises the following economic sub-sectors: finance, real estate and business services; general government services; personal services; storage and communication; and wholesale, retail, motor trade and hospitality.

The commercial sector therefore largely comprises the tertiary services group of industries, but specifically excludes the transport sector (transportation of passengers and freight). The basis for the exclusion is that transportation demand requires a separate and focused analysis for energy consumption.

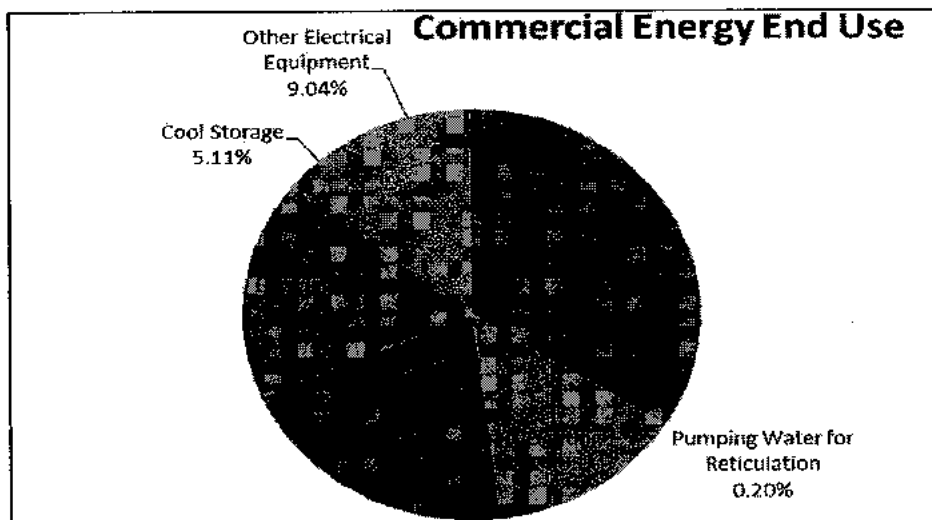
For the last 100 years, there has been a substantial shift from the primary and secondary sectors to the tertiary sector in industrialised countries. The tertiary sector is also the fastest-growing sector in developing countries including South Africa. South Africa's economy was historically rooted in the primary sectors due to the wealth of mineral resources and favourable agricultural conditions. However, over the past four decades, the economy has been characterised by a structural shift in output. Since the early 1990s, economic growth has been driven mainly by the tertiary sector and more recently South Africa is moving towards becoming a knowledge-based economy, with a greater focus on technology, e-commerce and financial and other services.

Some of the fastest growing tertiary sectors over the last few years include transport and financial services, with the most value-add having occurred in information and communications technology; communications; retail as well as finance and business services.

As the commercial sector is highly characterised by the provision of services rather than machinery or equipment, energy is predominately required to increase levels of comfort and ensure the sustenance of individuals. Energy end-use is therefore primarily for heating, ventilation and air conditioning (HVAC) (~34%), followed by water heating (~21%), cooking (~17%) and lighting (~14%), with the remainder being used for cold storage (~5%) and electrical equipment such as computers, printers, faxes, etc. (~9%).

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Source: DoE Analysis

Figure 0-5: Energy end-use within the commercial sector

Given that the tertiary sector is predominantly located in highly-electrified urban areas, and that electricity is the most convenient source of energy for the sector, electricity dominates total energy usage. It is also no surprise that the historical consumption of electricity has shown a steady increase aligned with the growth of the tertiary sector. Figure 0-6 provides a graphical representation of the full decomposition analysis results for 2010 relative to the 1993 baseline.

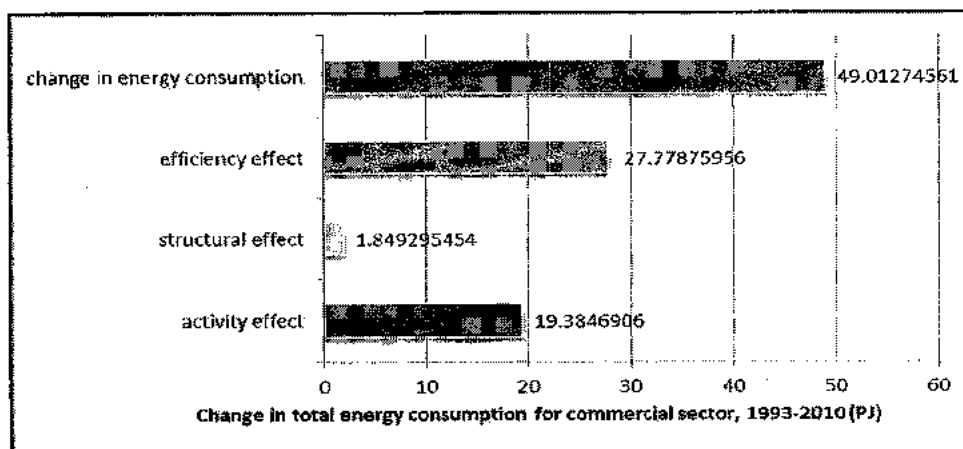
The analysis shows that energy efficiency contributed more than 50% to the change in total energy consumption. Total energy consumption in 2010 had increased by 49.01 PJ relative to 1993. This change is composed of the sum of:

- A 19.38 PJ increase due to greater level of activity; a
- A 1.85 PJ increase due to structural changes; and
- A 27.78 PJ increase due to energy efficiency reduction.

This means that over the 17-year period, if all other factors had remained constant, reduced efficiency within the sector would have resulted in an increase of 27.78 PJ in energy consumption, which is 84.01% of the 1993 baseline figure. This is equivalent to a compound annual increase of about 0.45% in energy consumption attributable to energy efficiency reductions. This compound annual increase indicates that more measures must be taken to improve energy efficiency in the sector.

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Source: DoE Analysis

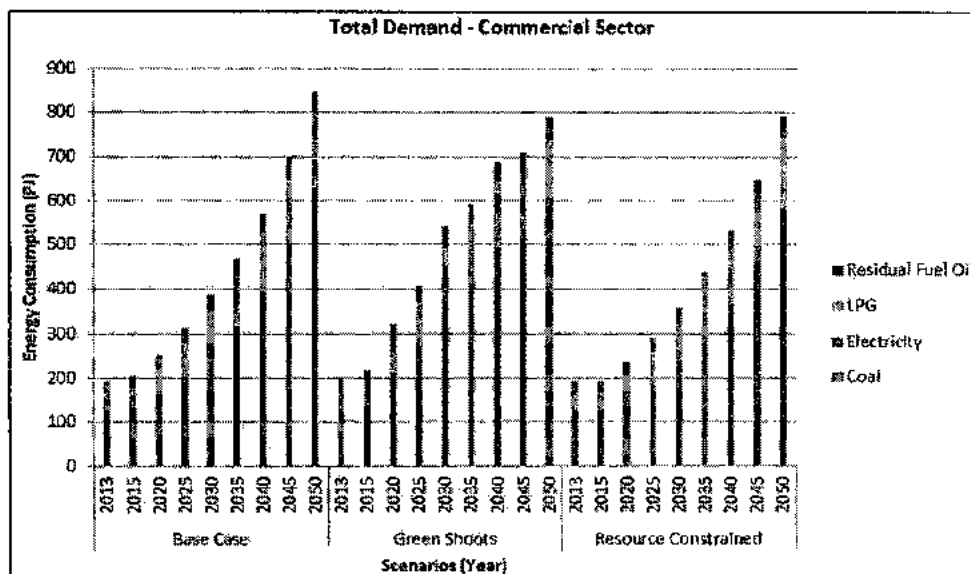
Figure 0-6: Decomposition analysis results for energy consumption in the commercial sector

As economies develop, the commercial and public sectors usually grow faster than other sectors – and this has been true for South Africa. Continued expansion of the tertiary sector will see a continued increase in the demand for energy, and more specifically electricity. Although energy demand in the tertiary sector is relatively low when compared to other industrialised countries, significant opportunities for improvements in energy efficiency exist, especially in terms of the heating and cooling of office buildings, office equipment and lighting. Water heating is slowly shifting to alternative energy sources such as solar and more energy efficient heat pumps. However, government has introduced various legal and policy instruments aimed at further improving efficiency. These include the National Building Regulations which include specifications and standards for the energy efficiency of new buildings as well as standards for the labelling of the efficiency of appliances. Various incentive schemes have also been introduced which will encourage more energy efficient practices by all industries, including those that fall within the commercial sector. If these policy interventions are successfully implemented, even though energy demand in the tertiary sector will continue to grow, it should not follow the same trajectory as the economic growth of the sector, but should rather lag behind.

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The projected energy demand for the commercial sector is depicted below.



Source: DoE Analysis

Figure 0-7: Projected demand in the commercial sector

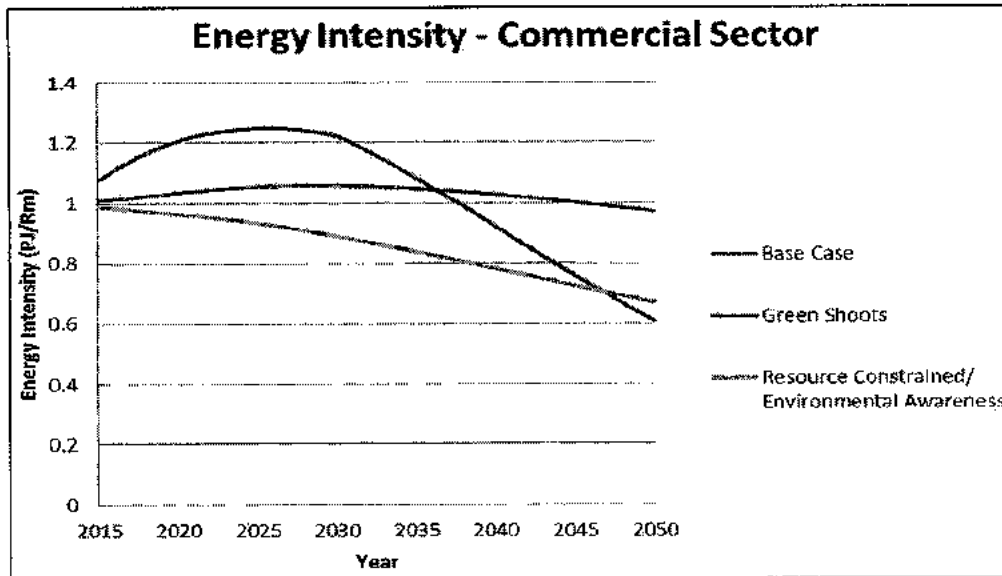
In this sector, the main driver behind energy demand projections is GDP. The projections are based on the four scenarios, but represented in three categories due to corresponding growth rates between the Resource Constrained and Environmental Awareness scenarios. The average energy demand growth rate for both the Base Case and Resource Constrained/Environmental Awareness scenarios is between 1% and 2% in the short to medium term, increasing to between 2% and 3% in the long term. This is in line with the percentage increase of the GDP growth rates outlined earlier. The average energy demand growth rate for the Green Shoots Scenario is between 2% and 3% in the short to medium term, decreasing to between 2% and 1% in the long term. The growth patterns for all the scenarios are similar to those of the corresponding GDP growth rates as GDP growth is the main driver behind the energy demand projections.

The dominant energy carriers in the commercial sector include electricity, liquefied petroleum gas (LPG), residual fuel oil and coal. The fuel mix in all these scenarios shows electricity to be the most used energy carrier, mainly because the sector has begun shifting towards tertiary sector activities, which are characterised by the use of electrical technologies. The demand for electricity is followed by the demand for LPG which is an alternative source of energy to electricity for providing energy services such as HVAC. The demand for coal and

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residual fuel oil is very small and this is likely to continue throughout the modelling period. However, an overall observation is that the total energy demand in this sector will continue to increase, as the potential for economic growth and economic structural changes within the sector is high. Figure 0-8 illustrates the energy intensity in the sector, which is based on the energy use per rand of GDP as a measure.



Source: DoE Analysis

Figure 0-8: Energy intensity in the commercial sector

In the commercial sector, energy intensity for the Resource Constrained/Environmental Awareness scenarios shows a steady decline of about 1.07% over the modelling period, whereas the Base Case and Green Shoots scenarios, in the short to medium term, reflect an average increase of about 0.74%, thereafter decreasing by about 20% in the medium to long term. In this sector, the increase in energy intensity is mainly attributed to economic structural changes and changes in climate. It is important to note that building design has an impact on the future energy needs of the commercial sector. The major portion of building stock in the short to medium term will comprise existing buildings, which are not subject to compulsory energy efficiency regulations. The retrofitting of existing buildings, beyond superficial improvements, is therefore likely to result in only a slight decrease in energy intensity for the commercial sector. Compulsory building regulations are directed at new buildings and thus the effect of more efficient technologies will only be felt in the longer term. In addition, energy efficiency benefits may take some time before they are realised due to the increase in the use of technologies such as laptops, printers, etc. Another contributing factor to energy

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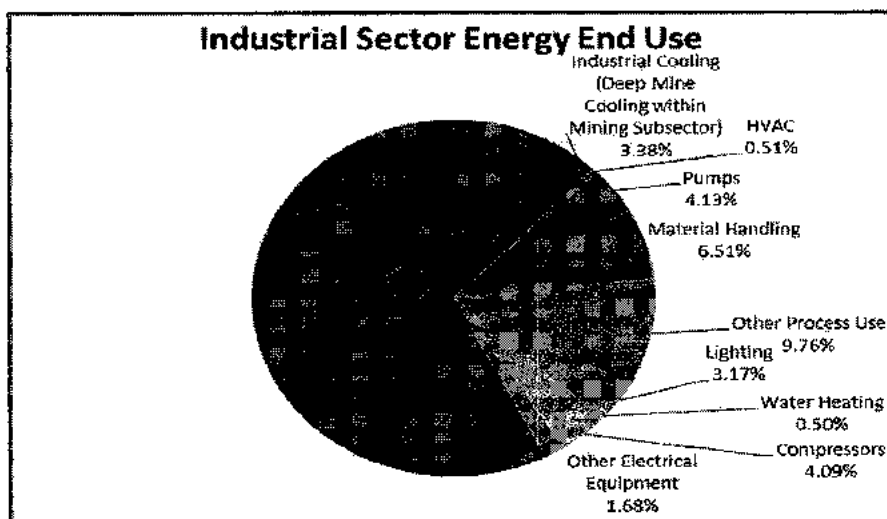
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intensity in the sector is climate, with the number of 'cooling degree days' in winter and 'heating degree days' in summer causing a noticeable increase in energy intensity. This phenomenon is likely to affect energy intensity at least until the midyear of the modelling period.

5.3. Industrial Sector

South Africa is a highly energy intensive economy. The 2012 Energy Sustainability Index quantifies the energy trilemma (security, equity and environmental sustainability) and ranks countries comparatively in terms of their ability to provide a secure affordable and environmentally-sustainable energy system (WEC, 2013). The 2013 Energy Sustainability Index, developed by the World Energy Council, ranks South Africa at 79th position, midway between the other BRICS (Brazil, Russia, India, China and South Africa) countries. In comparison, Brazil ranks 34th, Russia 54th, China 78th and India 115th. The industrial sector, which comprises mining, iron and steel, chemicals, non-ferrous metals, non-metallic minerals, pulp and paper, food and tobacco, and other manufacturing, consumes ~40% of the final energy demand in the country. The largest of these consumers is iron and steel at ~27% of the total energy used by the sector, followed by mining which consumes ~26%.

Within the industrial sector, most energy is used for process heating. In energy intensive industrial sub-sectors such as iron and steel and chemicals, process heating accounts for 90% and 88% respectively of total energy consumed.



Source: DoE Analysis

Figure 0-9: Energy end-use within the industrial sector

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The use of energy for motor-driven systems, which are accounted for under pumps (4.13%), compressors (4.09%) and material handling (6.52%), accounts for the second largest share of total energy use at 14.73%. 'Other process use' encapsulates other processes whose exact end-use is not well defined and cannot therefore be attributed to a specific purpose. Industrial cooling, which is designated as deep mine cooling within the mining sub-sector, accounts for the third largest share. While the use of fossil fuels within the sector is primarily for process heating, the end-use of electricity is very diverse across the sub-sector, as indicated in Table 5-2.

Table 0-2: Electricity end-use within the industrial sector

End use	Chemicals	Iron and steel	Non-ferrous metals	Other manufacturing	Gold mining	Coal mining	Platinum mining	Other mining
Process heating	4%	60%	23%	38%	2%	3%	2%	3%
Industrial cooling/deep mine cooling	8%	5%	9%	6%	15%	9%	15%	9%
HVAC	1%	1%	1%	2%	0%	1%	0%	1%
Pumps	26%	3%	9%	13%	17%	5%	17%	5%
Material handling	15%	4%	5%	4%	27%	6%	27%	6%
Other process use	21%	21%	19%	14%	11%	58%	11%	58%
Lighting	4%	4%	11%	10%	4%	6%	4%	6%
Water heating	0%	0%	0%	0%	4%	3%	4%	3%
Compressors	20%	4%	7%	11%	20%	5%	20%	5%
Other electrical equipment	1%	0%	17%	2%	1%	5%	1%	5%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: Eskom IDM

The National Energy Efficiency Strategy (NEES) includes a 15% target for improvement in energy efficiency within the industrial sector which means a 15% reduction in the amount of energy required to produce the same output. Measuring change in energy efficiency at the industrial sub-sector level, however, is a complex process with no single universally applicable approach. In the case of mining and industry, for example, output may be quantified in either physical units (typically tonnes of output) or in economic units (value-added measured in Rand).

For the period 2000–2010, data was available only at the aggregate level – energy consumption data in the form of Energy Balance Tables from the DoE, and output data in the form of GDP estimates from Statistics South Africa. Output is thus necessarily quantified in economic units, and energy intensity (energy consumption per unit of economic output) must serve as a proxy for energy efficiency. There are several reasons why energy intensity, at an

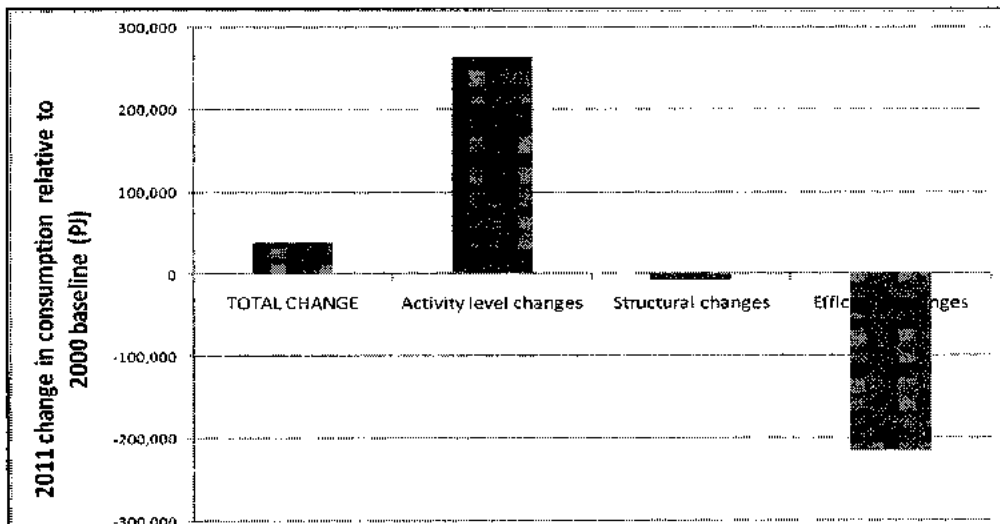
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aggregate level, is an imperfect proxy for energy efficiency. The most important of these is that it includes the effect of structural change. However, structural change can be quantified and separated out using a process known as 'decomposition analysis'.

Figure 0-10 provides a graphical representation of the full decomposition analysis results for 2011 relative to a 2000 baseline. Total energy consumption in the industry and mining industrial sub-sectors in 2011 had increased by 39.5 PJ relative to 2000. This change is composed of the sum of:

- a 263 PJ increase due to greater levels of activity;
- a 7.5 PJ decrease due to structural changes; and
- a 216 PJ decrease due to efficiency improvements.



Source: DoE 2014

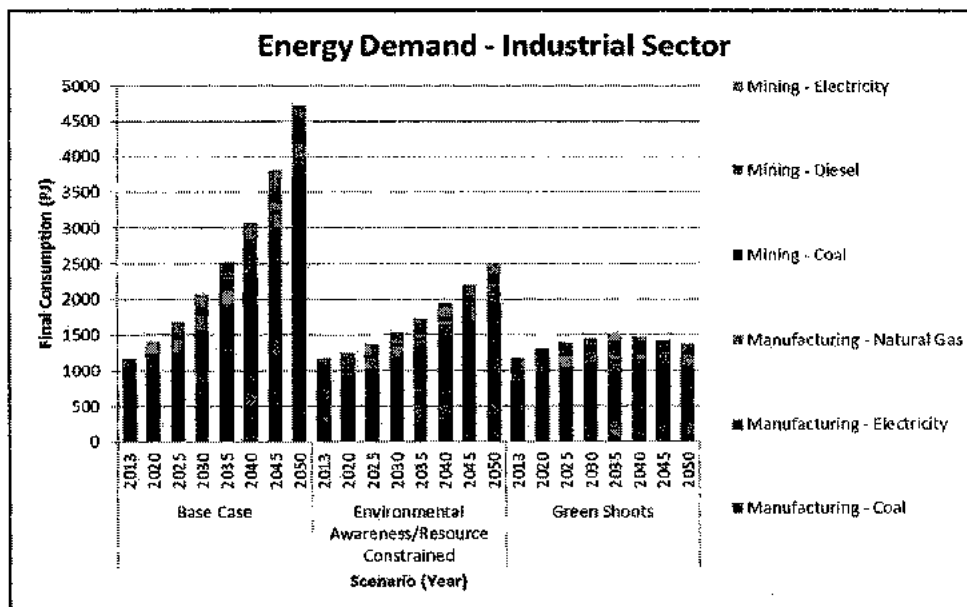
Figure 0-10: Decomposition analysis results for energy consumption in the industrial sector

Over the eleven-year period, if all other factors had remained constant, improvements in efficiency would have led to a 216 PJ fall in energy consumption, which is 20.8% of the 2000 baseline figure. This is equivalent to a compounded annual decrease of about 2.1% in energy consumption, attributable to efficiency improvements.

The main drivers for the projected demand within the manufacturing sub-sector are the gross value added for manufacturing and improvements in energy efficiency over time. With regards to the mining sub-sector the gross value added for mining as well as the rate of

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improvement in energy efficiency were used as drivers. Four scenarios, Base Case, Resource Constrained, Environmental Awareness and Green Shoots, were considered for the industrial sector in which the key drivers were changed.



Source: DoE Analysis

Figure 0-11: Projected energy demand for the industrial sector

The projected energy demand for the industrial sector is depicted in Figure 0-11 for the Base Case, Green Shoots, Resource Constrained, and Environmental Awareness scenarios. In all scenarios coal continues to dominate the fuel mix for the manufacturing sector as process heating is the primary end-use within manufacturing sub-sectors such as iron and steel and chemicals. Electricity is the mainly dominant energy carrier used within the mining sub-sector as electricity is key for ensuring deep mine cooling. The use of petroleum products within the industrial sector is mostly limited to the mining sub-sector. Material handling, which accounts for ~26% of total energy end-use within the mining sub-sector, encompasses both diesel and electrical equipment. In general, diesel fuel is used by rubber tyre or track vehicles that deliver material in batches, while electricity powers continuous delivery systems such as conveyor belts or slurry lines.

The Base Case Scenario is premised on a moderate growth in both the gross value added for the manufacturing and mining sub-sectors. The Base Case is characterised by no new energy efficiency capital investment improvements beyond those funded through the multi-

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year price determination (MYPD) process, as part of the Eskom Demand-side Management Programme. The Base Case scenario for the industrial sector experiences a four-fold increase in energy demand in line with the four-fold increase in gross value added by the manufacturing and mining sub-sectors.

*... The Base Case Scenario is premised on a significant growth
in both the gross value added for the manufacturing
and mining sub-sectors ...*

The Resource Constrained scenario is characterised by moderate economic growth, coupled with high energy prices due to the high oil price. According to the United Nations Industrial Development Organisation (UNIDO), the drivers of energy efficiency can vary from industry to industry and in most sectors high prices can be the key driver for energy efficiency. Implementing Best Available Technology (BAT) offers potential energy savings equivalent to an energy efficiency improvement of 1.7% a year (UNIDO, 2010) and this improvement is expected within the Resource Constrained Scenario. Similar to the Base Case, the Environmental Awareness Scenario is characterised by moderate economic growth. The energy efficiency improvements are similar to those within the Resource Constrained Scenario, such that BAT is implemented despite the fact that energy prices are moderate in comparison with those of the Resource Constrained Scenario. Within the Resource Constrained/Environmental Awareness scenarios the energy demand only doubles over the planning period despite the four-fold increase in gross value added. This is due to the energy efficiency improvements in the industrial sector over the same time period.

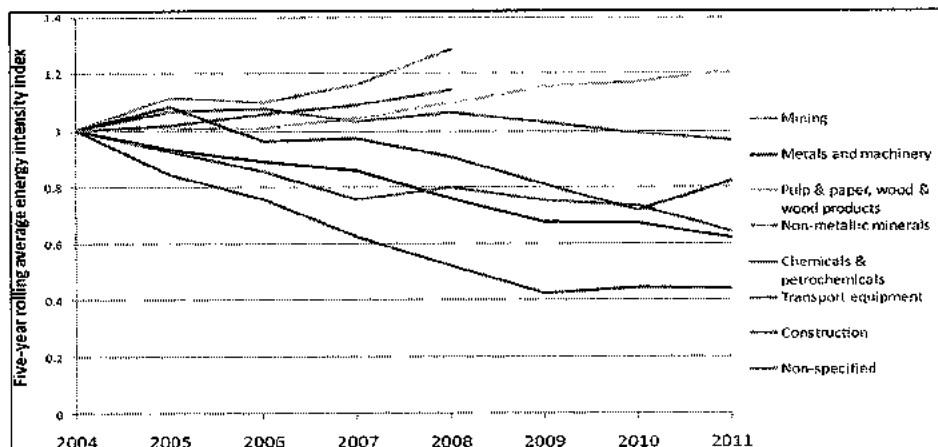
The Green Shoots Scenario is characterised by accelerated economic growth in the short to medium term with a decline in the later years. Energy efficiency improvements within the Green Shoots Scenario are attributed to the penetration of BAT. In the short and medium terms, economic growth leads to a growth in overall energy demand. In the long term the energy requirements decrease due to the reduction in economic growth attributed to both manufacturing and mining.

Energy intensity (the ratio of energy consumption to gross value added) in the industry and mining sub-sectors decreased from 3.08 MJ/R in 2000 to 2.16 MJ/R in 2011 (DoE, 2014). This represents a compounded annual reduction of 3.2% in energy intensity. Trends in energy intensity within the sub-sectors are illustrated in

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Figure 0-12. In order to make these trends easier to observe, the graph shows five-year rolling averages which smooth out the wide fluctuations in energy intensity that are often seen between consecutive years. Note that, because a five-year rolling average has been used, the base year for the trends displayed in this graph is 2004, with energy intensity being expressed as an index relative to this base year.



Source: DoE 2014 (Energy Efficiency Target Monitoring System: First Monitoring System Report)

Figure 0-12: Five year rolling average of energy intensity in the industrial sub-sectors

The main trends are the following:

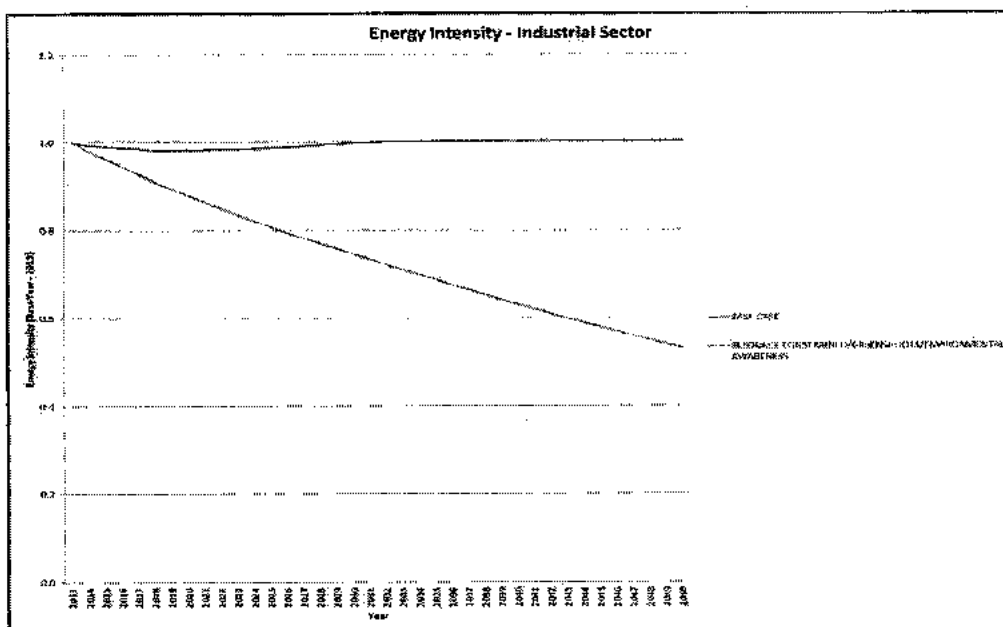
- An increase of nearly 30% in energy intensity in the non-metallic minerals sub-sector until 2008;
- A smaller but still significant increase in energy intensity in pulp and paper and the 'Non-specified' category;
- A fall of almost 60% in energy intensity in the chemicals and petrochemicals sub-sector;
- Significant decreases of 20-40% in energy intensity in metals and machinery; transport equipment; and construction; and
- The energy intensity of mining, when calculated as a five-year rolling average, remains fairly constant.

Figure 0-13 shows the changes in energy intensity for the industrial sector relative to 2013 levels. Using 2013 as the base year (with an energy intensity index = 1), an energy intensity index below 1 indicates a reduction in energy intensity relative to that in 2013, while an

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energy intensity index above 1 indicates an increase in energy intensity relative to that in 2013.

The energy intensity for the Base Case Scenario reduces in the short term due to Demand-side Management (DSM) interventions which are currently funded, but after 2030 benefits from the DSM Programme diminish and cannot be sustained without further funding. The energy intensity for the Resource Constrained, Environmental Awareness and Green Shoots scenarios reduces over time due to the penetration of BAT within the industrial sector. The rate of improvement is based on international benchmarks but may vary according to local circumstances. For instance sub-sectors which are early adopters of more efficient technologies will show a slower rate of improvement over the long term.



Source: DoE Analysis

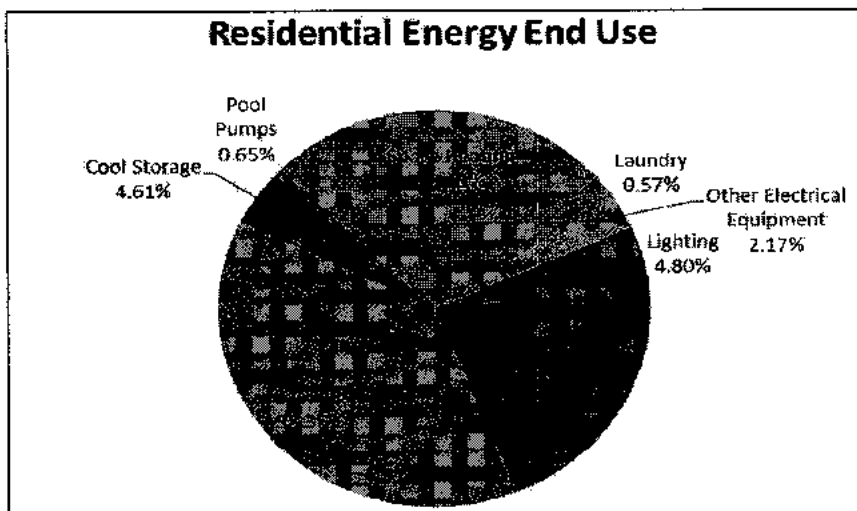
Figure 0-13: Energy intensity in the Industrial sector

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5.4. Residential Sector

Households consume ~20% of South Africa's total energy. This energy is provided from various sources including wood, dung and other vegetable matter, coal, paraffin, LPG, candles, electricity and natural gas. The main form of energy used is governed by availability, accessibility, cost of the energy carrier and the cost of energy devices. In 2006, ~73% of energy consumed by South African households was in the form of electricity, 29% in the form of coal, and 7.4% in the form of petroleum products (mostly illuminating paraffin but also a small amount of LPG).

Use of energy in households is predominantly for cooking (~38%), followed by space heating (~28%), water heating (~20%) and lighting (~5%), with the remainder for other, predominantly electrical, uses.



Source: DoE Analysis

Figure 0-14: Energy end-use in the residential sector

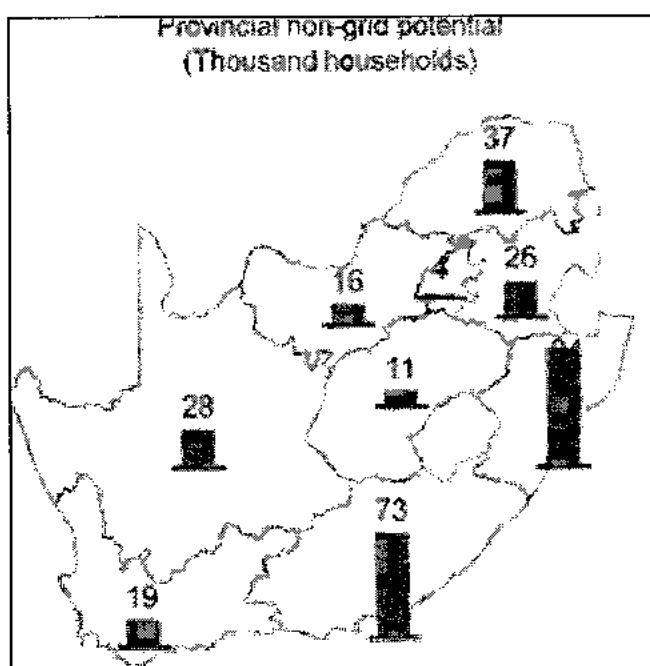
Given that water heating is responsible for over 20% of residential energy within households there have been a number of policies implemented to reduce the use of electricity and wood for water heating in the household sector. Currently government is implementing the One Million Solar Water Heater (SWH) Programme and within the National Development Plan possible targets of an additional 4 million have been mentioned, which when added to the current programme would mean 5 million SWH by 2030. Within the four scenarios different penetration rates for solar water heaters have been tested to gauge the possible efficacy of the programme. The enforcement of the Building Regulations (SANS 10400-XA) is included

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within all scenarios for hot water heating for all new households. The regulation states that 50% of all hot water in new houses needs to be produced by methods other than electrical element heating. This means that conventional geysers may no longer be used, and must be replaced by solar water heating systems (which still partially use electricity), or alternatively by a heat exchange type heat pump.

At the end of 2012, more than 75% of households (including informal households) in South Africa were electrified, totalling 9 809 136 households (www.energy.gov.za). The highest percentage (86%) of electrified households is situated in the Western Cape and the lowest percentage (60%) in the Eastern Cape (DoE, 2009). In June 2013 Cabinet approved the implementation of the New Electrification Strategy which redefined universal access as 97% of households, because full electrification is unlikely to be possible due to the growth and delays in the process of formalising informal settlements. Of the 97% of households, 90% will be connected to the grid, with the remainder using high quality non-grid solar home systems or other possible technologies. As illustrated in Figure 5-15 below, the areas with the highest potential for non-grid solutions are located in Kwazulu-Natal and the Eastern Cape.



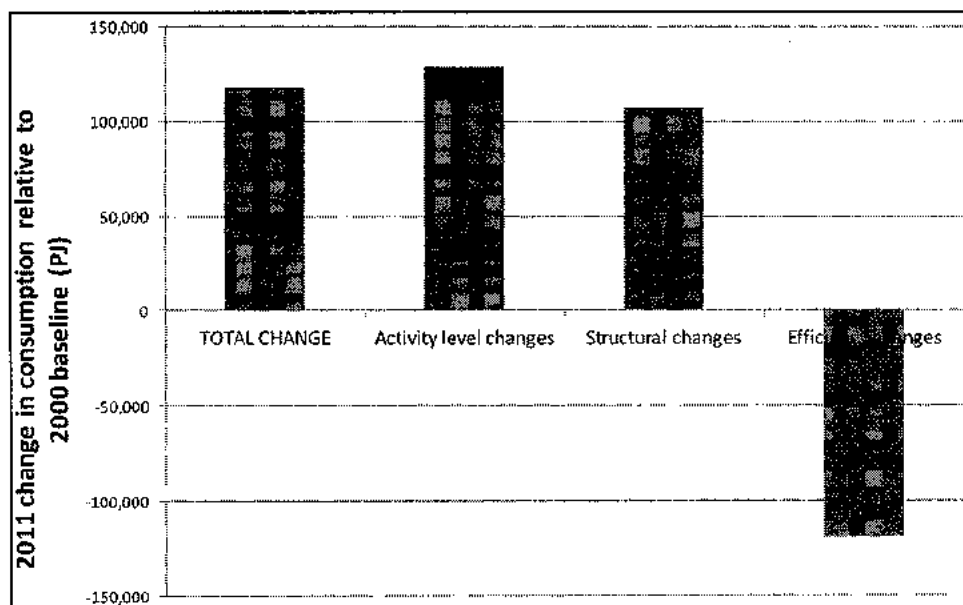
Source: DoE 2012 National Household Electrification Strategy

Figure 0-15: Provincial non-grid potential

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Increased electrification rates, combined with continued developments in renewable energy technologies, are expected to encourage an increase in distributed electricity generation and a shift from use of other forms of energy (such as illuminating paraffin for lighting) to electricity. Figure 0-16 provides a graphical representation of the full decomposition analysis results for 2011 relative to the 2000 baseline. Total energy consumption in the residential sector in 2011 had increased by 117 PJ relative to 2000. This change is composed of the sum of:

- A 129 PJ increase due to greater levels of activity (i.e. increased number of households);
- A 107 PJ increase due to structural changes (i.e. increases in living standards); and
- A 119 PJ decrease due to efficiency improvements (encompassing behavioural and lifestyle changes as well as technological changes).



Source: DoE 2014

Figure 0-16: Decomposition analysis results for energy consumption in the residential sector

The key drivers for future energy demand in the residential sector are policies, urbanisation, electrification rates, household income and population growth/household growth. The future number of households was derived by dividing the population growth by the total number of persons per household. According to Statistics South Africa, in 2011 the number of persons per household was 3.4 persons and this was kept fixed from 2013 to 2050, hence household

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size was not a factor in the change in household energy consumption. Four scenarios, Base Case, Resource Constrained, Environmental Awareness and Green Shoots, were considered for the residential sector, in which the key drivers were changed.

The Base Case is characterised by a moderate growth in gross domestic product which contributes to a similar increase in household income. The One Million Solar Water Heater Programme is implemented as expected. The National Building Regulations were implemented from 2011, so that all new households comply with the standards set for water heating. Over and above the improvements encouraged as part of the MYPD 3 process, energy efficiency improvements are negligible due to the lack of investment in more efficient technologies.

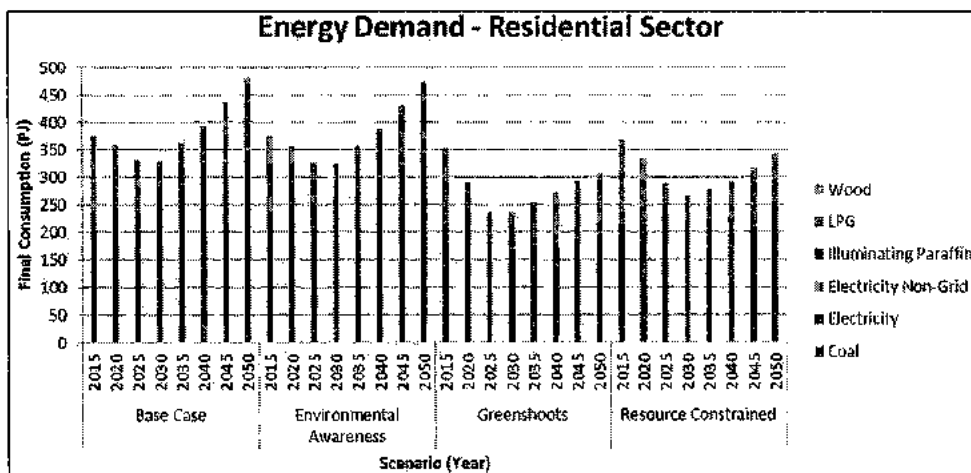
As in the Base Case, the Resource Constrained Scenario is characterised by moderate economic growth which leads to a moderate increase in household income over time. The penetration of more efficient technologies for electric lighting, cooking, space heating, water heating, and electrical appliances also occurs and has an impact on the energy intensity. As in the Base Case, the Environmental Awareness Scenario is characterised by moderate economic growth which leads to a moderate increase in household income. The energy efficiency improvements are similar to those in the Resource Constrained Scenario. Within the residential sub-sector the existing Solar Water Heater Programme is extended to 5 million solar waters by 2030.

The Green Shoots Scenario is characterised by accelerated economic growth in the short to medium term, with a decline in the later years which translates into an overall increase in household income. This is higher than experienced in the Base Case in the short and medium term, but lower in the long term. Energy efficiency improvements for electrical appliances in the Green Shoots scenario are similar to those in the Resource Constrained and Environmental Awareness scenarios. The Solar Water Heater Programme is extended past 2019 with up to 10 million solar water heaters by 2030.

The composition of energy demanded and the forms of energy consumed change over time as household income and the number of electrified households increase. Increased urbanisation also contributes to the increase in demand for electricity and other cleaner forms of energy, such as LPG, in the residential sector. The driver which has the greatest impact on future fuel mix is household income, which is likely to result in increased ownership of electrical appliances, thus contributing to electricity demand.

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The increase in non-grid electrification is primarily due to the targets set in government's New Household Electrification Strategy which defines universal access to electricity at 97% of which 7% of households are served by off-grid solutions.



Source: DoE Analysis

Figure 0-17: Projected demand in the residential sector

Despite increased electrification, it is expected that coal will remain dominant in certain low-income households for the foreseeable future. Some of the key factors influencing the continued use of coal include the fact that it is a relatively affordable fuel source (especially for communities close to mines) and it is a dual utility (i.e. it provides thermal energy for space heating and cooking simultaneously). While the general demand for electricity is expected to rise, the penetration of solar water heaters coupled with building regulations will reduce the rate of increase.

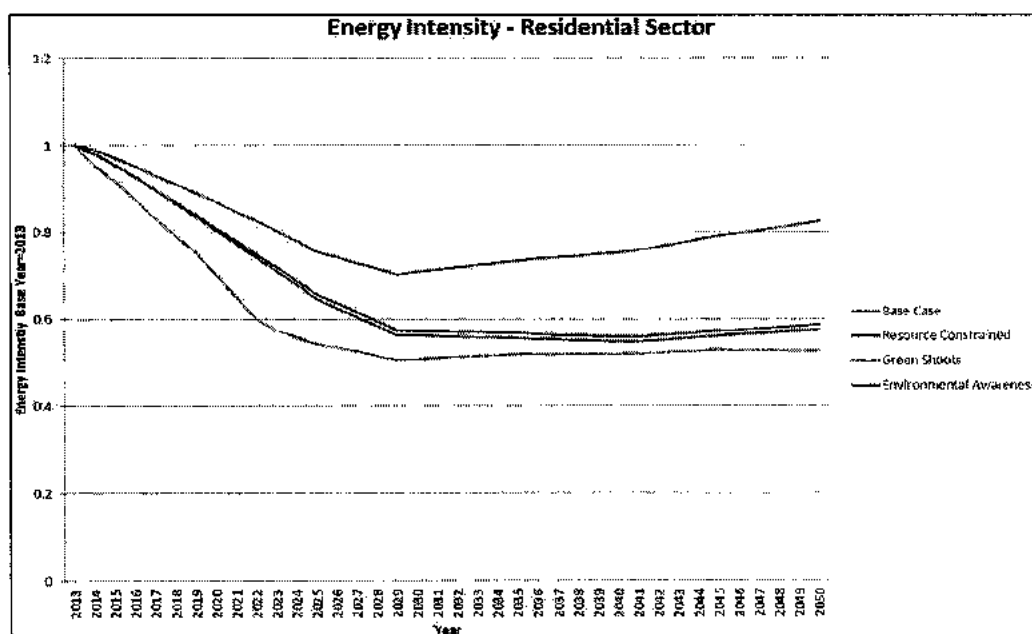
The use of solid fuels (coal and wood) for thermal purposes such as cooking, water heating and space heating declines the fastest in the Green Shoots Scenario due to the faster increase in household income. In addition the Solar Water Heating Programme is extended from 1 million to 10 million in the Green Shoots scenario and hence contributes to the movement of households that could not switch from solid fuels to cleaner forms of energy without government assistance.

The decline in illuminating paraffin shows similar trends, with the Green Shoots Scenario experiencing the sharpest decline. However over the long term there will be a residual number of households which will continue to use illuminating paraffin.

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In the short term, energy intensity also decreases fastest in the Green Shoots Scenario as this scenario has the greatest increase in household income. The increase in household income leads to households moving away from solid fuels such as wood and coal for end uses such as cooking. The energy required for cooking using a cleaner fuel such as LPG or electricity is lower and thus contributes to lower intensity. In addition, energy efficiency improvements in electrical appliances such as refrigerators and washing machines will reduce the impact of the steady rise in ownership. In the long term the increase in household income in the Green Shoots Scenario slows as a result of reduced GDP growth and in line with this the rate of increase in ownership of electrical appliances also slows.



Source: DoE Analysis

Figure 0-18: Energy intensity in the residential sector

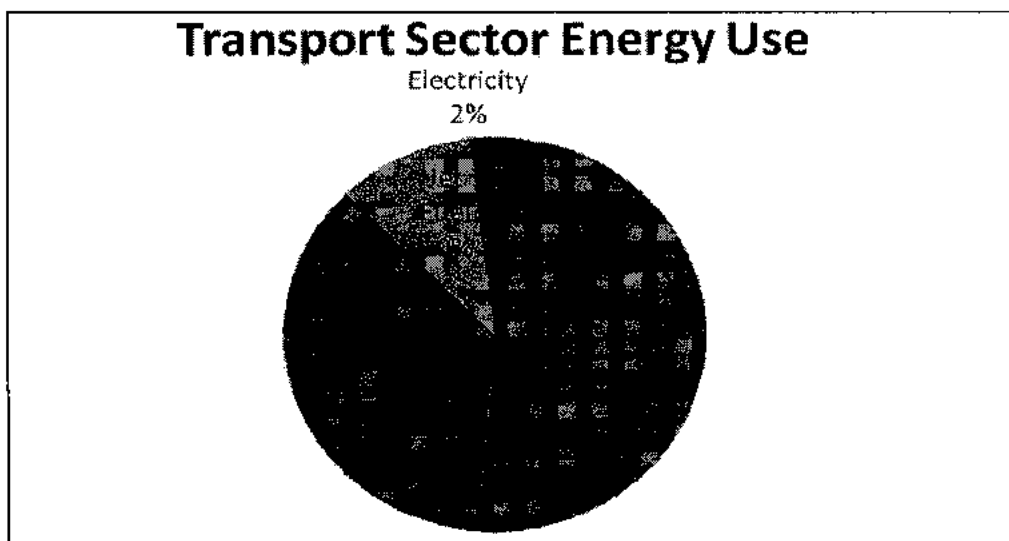
In the Resource Constrained Scenario, energy intensity is lower than in the Base Case Scenario due to higher levels of energy efficiency, but higher than in the Green Shoots Scenario due to the slower increase in household income as well as the difference in the uptake of solar water heaters (one million SWH in the Resource Constrained Scenario by 2030, versus 10 million in the Green Shoots Scenario in the same period). As households switch from using solid fuels and electricity to solar energy to provide water heating, the energy intensity of households will reduce. When comparing the Resource Constrained Scenario with the Environmental Awareness Scenario the impact of energy efficiency is greater than the impact of the Solar Water Heater Programme. Thus despite the penetration

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of 4 million more SWH in the Environmental Awareness scenario the difference in energy demand is marginal. When the number of SWH increases from 5 million to 10 million in the Green Shoots Scenario, the impact of the SWH Programme is felt due to the fact that SWH are available to replace electric geysers. In the 1 million and 5 million SWH Programme, the majority of SWH are used to replace households using wood and illuminating paraffin for water heating.

5.5. Transport Sector

Across Africa, roads remain the dominant mode for transportation, accounting for more than 90% of passenger and freight transport in Africa, compared with around 50% of freight in Europe. South Africa is a large country with an extensive road, rail and air transport network (SA Yearbook, 2011/12). Land passenger transport accounts for the greatest use of energy followed by land freight and then air transport. Transport energy demand consists overwhelmingly of liquid fuels. The dominant fuel for transportation is petrol (>50%), followed by diesel (~35%) and jet fuel (~10%), with the lowest being electricity (<2%) which is primarily used in rail transport (see Figure 0-19).



Source: Energy Digest, 2010

Figure 0-19: Energy end-use within the transport sector

Demand for transport services is assumed to be driven by economic activity represented by GDP for freight and public transport and GDP per capita for private passenger transport.

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Figure 0-20 and Figure 0-22 show the results of the decomposition analysis results for changes in energy consumption in passenger transport and freight transport, respectively. The overall total energy consumption in the sector increased by 466.83 PJ between 1993 and 2010. Passenger and freight transport respectively contributed to increases of 11.96 PJ and 454.87 PJ of energy consumption. The activity effect alone resulted in an increase in energy consumption of 651.8 PJ. This is accounted for by growth in both passenger transport and freight transport.

*... The overall total energy consumption in the sector increased ...
by 466.83 PJ between 1993 and 2010...*

In this sector, energy services are projected based on the concept of a "vintage stock model" which allows for the time-related effect of new technologies entering and old ones leaving the market. The energy services considered are passenger kilometres and tonne-kilometres. The passenger kilometres are calculated based on the stock of vehicles on the road multiplied by annual average kilometres travelled. The stock of vehicles on the road is determined by sales units of vehicles multiplied by remaining vehicles from the previous years. Tonne-kilometres are determined by tonnes multiplied by annual average kilometres travelled.

5.5.1. Passenger transportation

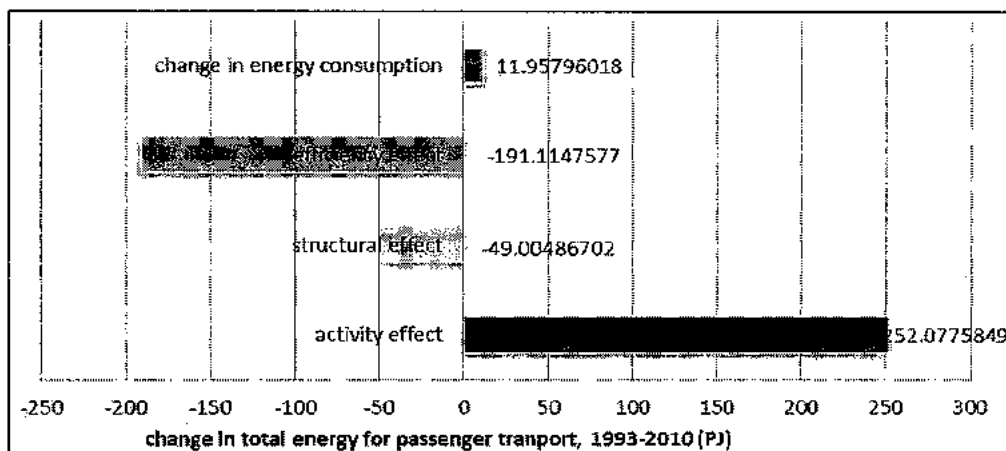
Figure 0-20 shows the changes of energy consumption in passenger transport. The total energy consumption in 2010 had increased by 11.96 PJ relative to 1993. This change is composed of the sum of:

- A 252.08 PJ increase due to greater level of activity;
- A 49 PJ decrease due to structural changes; and
- A 191.11 PJ decrease due to energy efficiency improvements.

This means that over the 17-year period, if all other factors had remained constant, improvements in energy efficiency would have led to a 191.11 PJ fall in energy consumption.

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Source: DoE Analysis

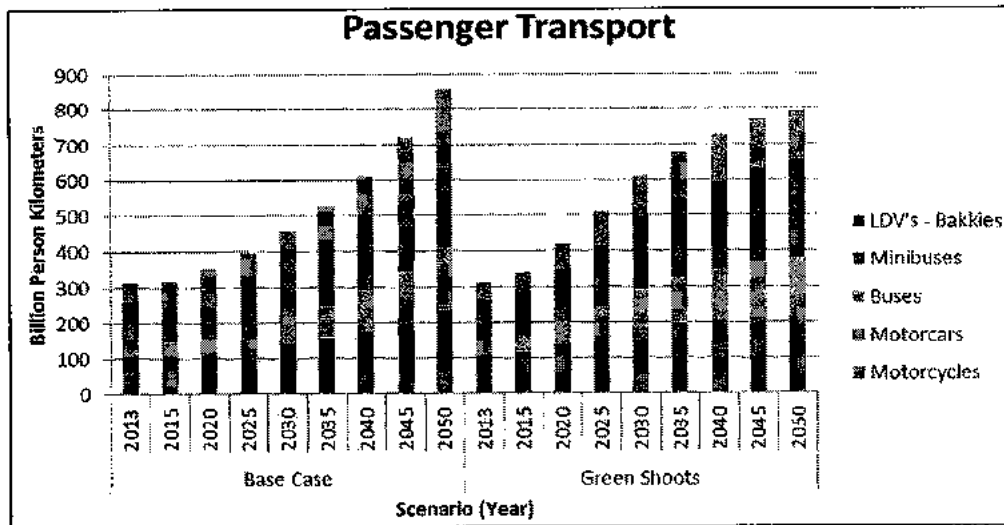
Figure 0-20: Decomposition analysis results for energy consumption in the passenger transport sub-sector

In line with global growth patterns, the key driver for continued demand is likely to be the desire for increased mobility. For passenger transportation this becomes possible when improvements in GDP per capita allow for the move from mass and public modes of transport to small passenger vehicles. Other indirect factors which affect the mode of transport include quality of roads as well as safety, efficiency and reliability of public transport systems. More recent factors that could change passenger movement patterns include government policy interventions, which aim to accelerate the improvement of public transport by establishing integrated rapid public transport networks. These will introduce priority rail corridors and Bus Rapid Transit (BRT) systems in cities.

Figure 0-21 presents the passenger kilometres over the modelling period from 2013 to 2050. The two economic growth rates used to project these services are based on moderate GDP growth rates (the Base Case Scenario) and high GDP growth rates (the Green Shoots Scenario). The passenger-kilometres for the Base Case Scenario grow at an annual rate of 2.8%, from approximately 311 billion passenger-kilometres in 2013 to approximately 855 billion passenger-kilometres in 2050 and the passenger kilometres for the Green Shoots Scenario grow at an annual rate of 2.6%, from approximately 311 to 795 billion passenger-kilometres over the same period. The fuel mix corresponding to these passenger-kilometres is presented in Figure 0-24, Figure 0-25, and Figure 0-26 and presents detailed information about energy consumption in the transport sector across the scenarios.

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Source: DoE Analysis

Figure 0-21: Projected energy services for passenger transport

5.5.2. Freight transportation

In recent years the rail freight market has lost market share to road haulage. Currently, it is estimated that 85% of total freight is hauled by road, with the remainder being transported by rail. In fact, with the exception of coal and iron-ore, most freight is hauled by road. Road freight transport with its higher reliability, flexibility, accessibility, security and shorter transit time in comparison with rail freight transport, is preferred by the industrial sector and this has contributed to the increase in road haulage (Stander and Pienaar, 2002). However, it also carries with it negative externalities such as increased and rapid damage to roads, road congestion, air pollution and higher fuel/energy requirements.

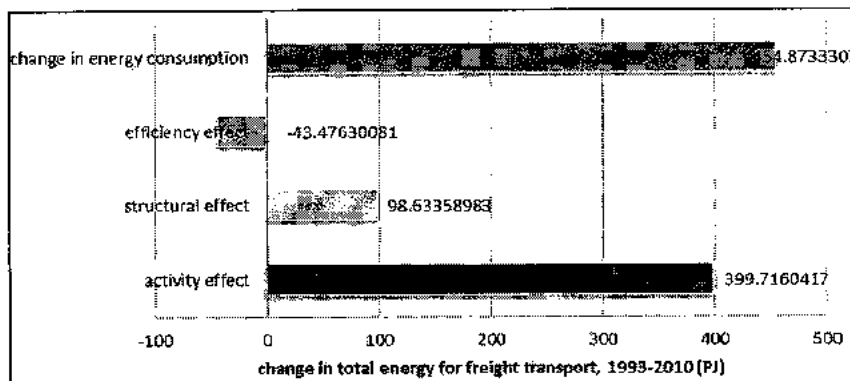
The decomposition analysis results show that energy efficiency declined by almost 50 basis points in terms of total energy consumption. Total energy consumption in 2010 increased by 49.01 PJ relative to 1993. This change is composed of the sum of:

- A 19.38 PJ increase due to greater level of activity;
- A 1.85 PJ increase due to structural changes; and
- A 27.78 PJ increase due to energy efficiency reduction.

This means that over the 17-year period, if all other factors had remained constant, the reduction in energy efficiency would have led to a 49.01 PJ increase in energy consumption.

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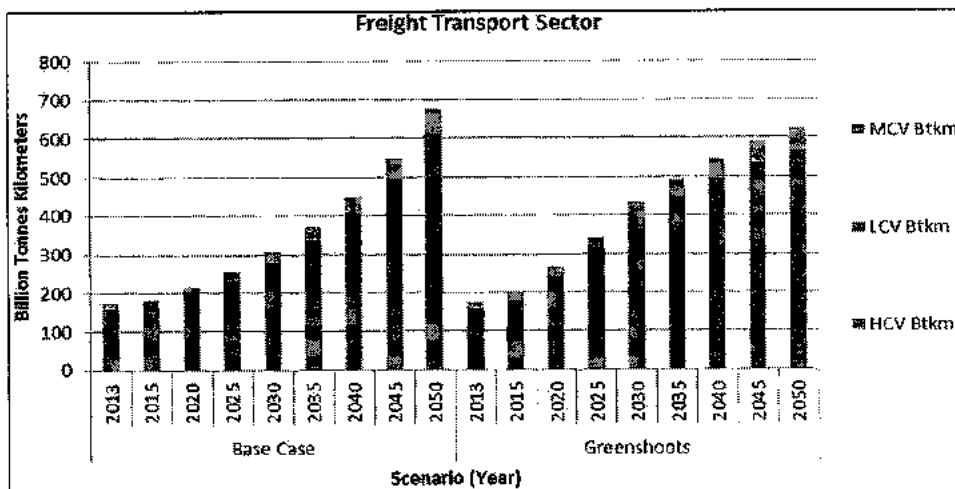
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Source: DoE Analysis

Figure 0-22: Decomposition analysis results for energy consumption in the freight transport sector

Demand for freight haulage is strongly linked to the value-add of the sector and overall economic growth, together with assumptions about increased road haulage, have informed demand projections. The projected energy services for freight transport are depicted in Figure 0-23 and projections for the services (tonne-kilometres) are presented for the Base Case and Green Shoots scenarios of economic growth. The freight tonne-kilometres in the sector grow at an annual rate of 3.7% in the Base Case Scenario, from 175 billion tonne-kilometres in 2013 to 676 billion tonne-kilometres in 2050. In the Green Shoots scenario, the services grow at an annual rate of 2.6%, from 175 billion tonne-kilometres in 2013 to 623 billion tonne-kilometres in 2050.



Source: DoE Analysis Fuel Demand in Transportation

Figure 0-23: Projected energy services growth for freight transport

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Sections 0 and 0 outlined the projections for energy services in the form of passenger-kilometres and tonne-kilometres. The following section presents the corresponding projections for energy carriers for these services.

Liquid fuel demands are predominantly driven by the road transport sector. The demands for petrol, diesel and electricity for road transport in each of the scenarios are shown in Figure 0-24.

In all scenarios, the share of diesel increases from 50% in 2014 to approximately 85% in 2050. In absolute terms, diesel demand triples but petrol demand halves. Electricity used for electric vehicles constitutes a very small share in the last few time intervals. This has a modest impact on petrol requirements but less impact on electricity because of the relative sizes of the two sub-sectors (electricity demand is more than double the demand for liquid fuels in terms of energy) and the higher efficiency of electric vehicles compared to conventionally powered vehicles (85–90% for electric compared with 20–30% for

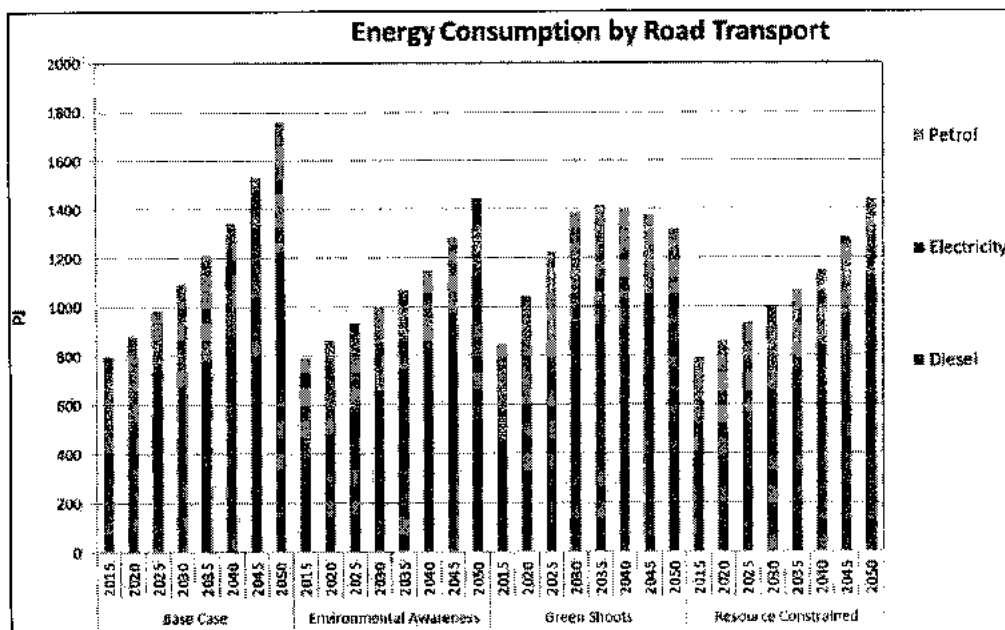
... In all scenarios, the share of Diesel increases from 50% in 2014 to approximately 85% in 2050.

conventionally powered vehicles).

The increase in the demand for diesel is related to the types of vehicles which use diesel. Most road freight, and a significant share of public transport, is fuelled by diesel. For these technologies the rate of energy efficiency improvement, as defined in the assumptions, is lower than for private vehicles. (The Environmental Awareness, Green Shoots and Resource Constrained scenarios assume an average annual fuel economy improvement for new cars and SUVs of 2.5% and 1.1% for freight and public transport. The Base Case Scenario uses 1% and 0.8% respectively.)

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Source: DoE Analysis

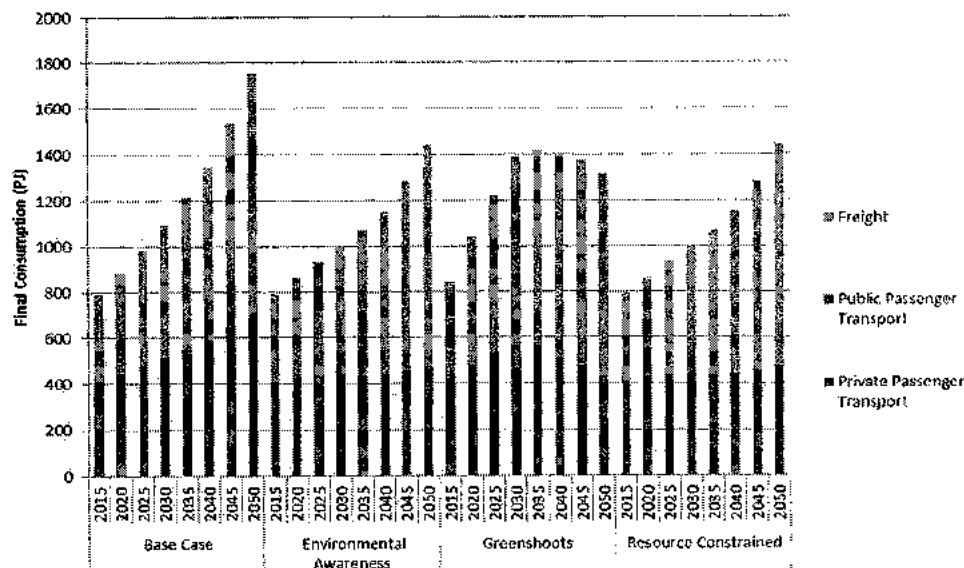
Figure 0-24: Total energy consumption by transport sector by fuel

The shares of energy used in transport by vehicle category (private passenger, public passenger and freight) are provided in Figure 0-25. Freight and public transport vehicles have less room for efficiency improvements because transport companies and public transport operators use efficiency as a criterion to minimise operating costs. Private vehicles, however, are subject to individual preferences and owners are likely to prioritise other features, such as comfort and safety, ahead of fuel economy.

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Energy Consumption by Road Transport



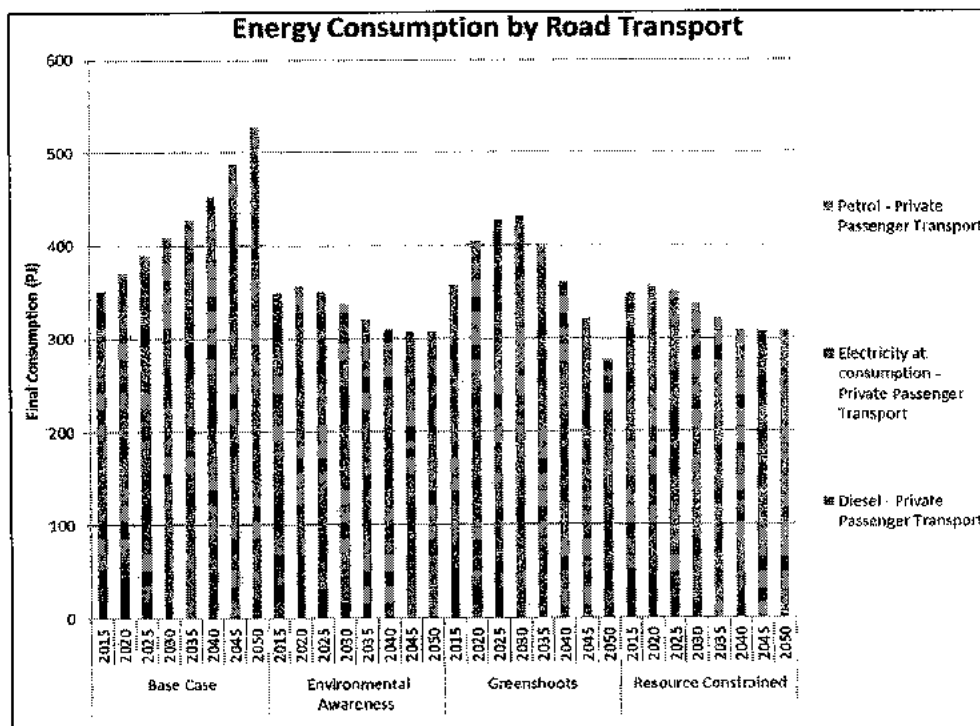
Source: DoE Analysis

Figure 0-25: Total energy consumption by transport sector and category of transport

Further consumption details for private passenger vehicles are provided in Figure 0-26. The factor with the most significant impact on fuel demand is the energy efficiency (or fuel economy) of vehicles as evident when comparing the Base Case Scenario with the other scenarios. This suggests an important role for vehicle energy efficiency within energy policy, as a mechanism to manage liquid fuel demand. Vehicle efficiency improvements are equivalent to providing virtual refineries but fuel quality improvements are needed to enable these more efficient vehicles. Implementation of clean fuels would reduce dependence on imported crude oil, reduce refining capacity requirements and improve the quality of the environment.

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Source: DoE Analysis

Figure 0-26: Energy consumption by private passenger vehicles and fuel type

5.5.3. Transport fleet structure

The private passenger vehicle fleet (defined in terms of the person-kilometres travelled per year) is disaggregated by technology type as presented in Figure 0-27. The fleet structure for freight and public transport is assumed to stay unchanged and alternative technology options were not considered beyond aggregate efficiency improvements. The future transportation demands for the various Integrated Energy Plan (IEP) scenarios were determined using demand modelling, based on correlations between transport demand and economic development assumptions (GDP growth). The Base Case, Environmental Awareness and Resource Constrained scenarios have the same demand trajectory because they are based on the same economic growth projections. The Green Shoots scenario, with a higher initial growth rate, has a higher demand for transport services in the first 25 years but this declines in the last decade.

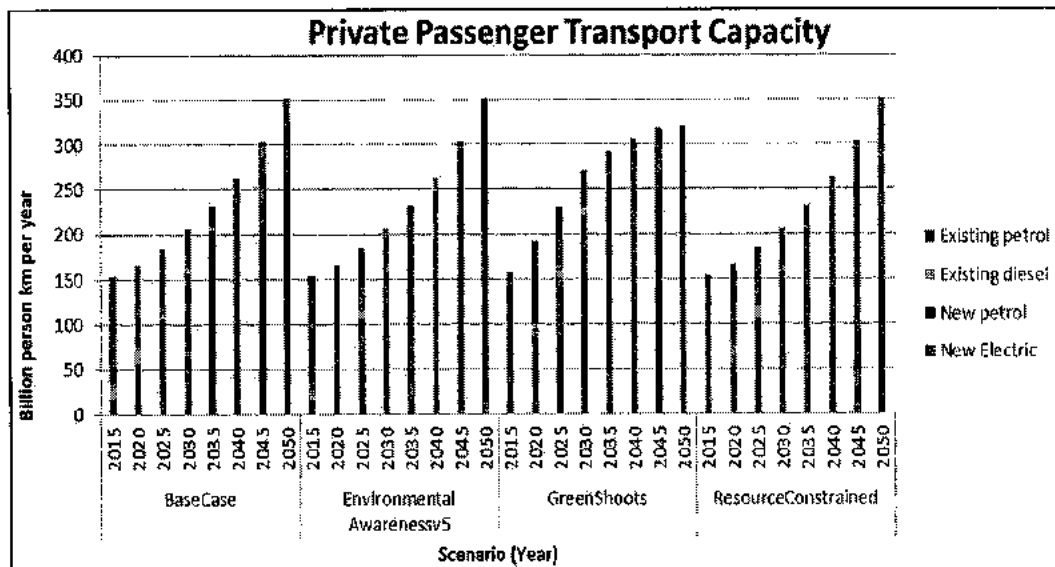
Electric vehicles are present in all the scenarios and in all time intervals, but they only begin to make a significant contribution after 2040 at about 1% of the fleet. This increases to approximately 4% by 2050, but is far from the National Transport Master Plan (NATMAP)

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target of 60%. The lower crude oil prices that are currently experienced, and are expected to continue in the short term, have the effect of delaying the switch from conventional petrol and diesel vehicles to electric vehicles due to their higher capital outlay costs.

While the demand for transportation as a service is the same for the Base Case, Environmental Awareness and Resource Constrained scenarios, the shares of petrol, diesel and hybrid vehicles vary after 2030. This impacts on the demand for liquid fuels as described in the previous section. The Base Case and Resource Constrained scenarios have similar technology shares throughout the modelled period. Petrol vehicles dominate the fleet while other hydrocarbon technologies barely play a role at all in 2040.



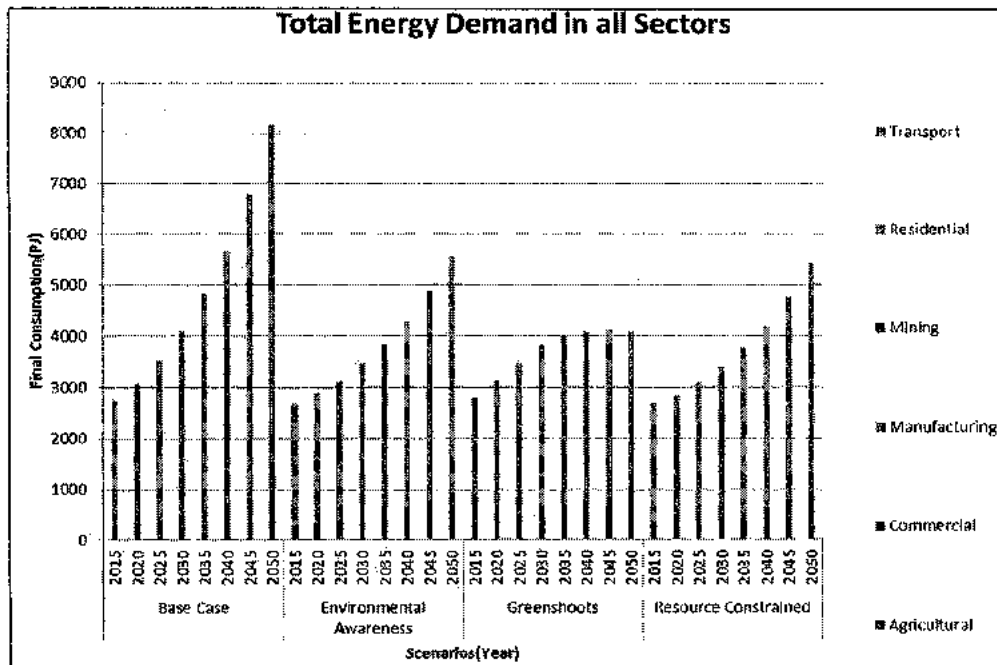
Source: DoE Analysis

Figure 0-27: Private passenger transport capacity by technology type

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5.6. Total energy demand in all sectors



Source: DoE Analysis

Figure D-28: Projected demand within different sectors

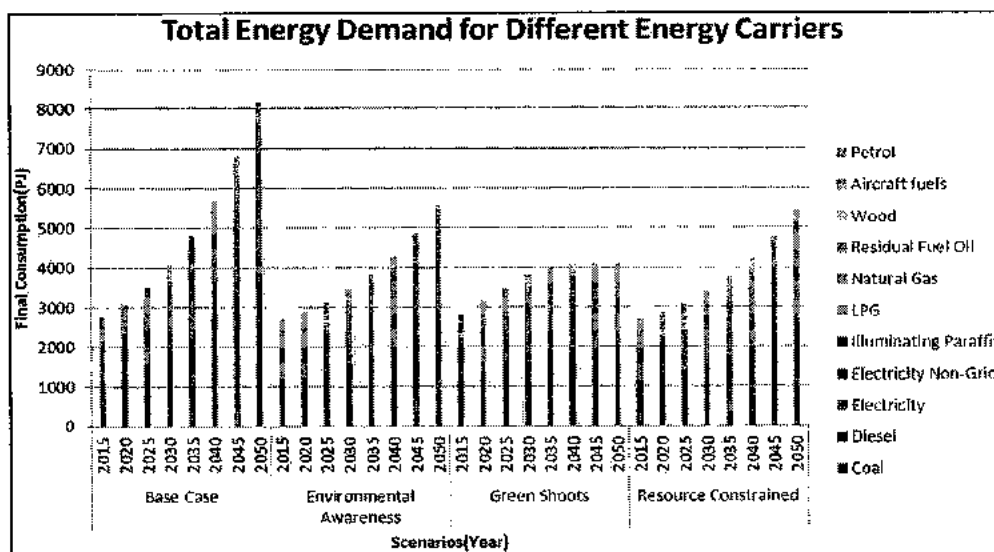
Of all the sectors, the transport sector will continue to make the most significant demand on total energy supply. Consequently, demand for petroleum products increases significantly between 2015 and 2050. This is attributed to the continued use of petrol and diesel vehicles in the foreseeable future, with electric vehicles only starting to make a noticeable contribution to passenger transportation after 2030. Freight haulage, predominantly by road, is the greatest contributor to increases in transport demand and related fuel consumption.

Outside of the transport sector, the most significant energy demand increase is expected to be in the industrial (manufacturing) sector, followed by the commercial sector. The increase in energy demand in the commercial sector is associated with the continued expansion of the tertiary sub-sector, as South Africa moves towards becoming a more knowledge-based economy. Demand in the residential sector is largely informed by population growth, coupled with increased urbanisation. As living standards improve, people consume more energy; however, energy efficiency interventions could see this trend start to slow down in the future.

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While the demand for petrol increases the most significantly between 2015 and 2050, as depicted in Figure 0-29, demand for other petroleum products is less significant. Demand for LPG, however, is expected to show a steady increase in the residential sector and although fairly minor, ranks as the third largest increase between 2015 and 2050. Diesel consumption continues to increase in the mining sub-sector but only marginally when compared to electricity and natural gas. The use of illuminating paraffin is expected to decrease in future and to be negligible by 2025.



Source: DoE Analysis

Figure 0-29: Total energy demand for different energy carriers

Demand for natural gas, although the least significant in terms of percentage share, shows the next most significant increase after that of petroleum products. Natural gas is primarily used in the industrial sector and the projected growth of the sector is a factor in this increase. Demand for electricity continues to rise as more houses become electrified and as the tertiary sector, largely comprised of commercial and public buildings, continues to expand. Demand for coal continues to grow in the industrial sector, while in the residential sector it is expected to start declining as a result of ongoing electrification of previously non-electrified households and improvements in household income.

The share of energy demand across different sectors in 2010, 2030 and 2050 is provided in Table 0-3 to Table 0-6 below.

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Within the manufacturing sub-sector the total share of final consumption grows in all scenarios except in the Green Shoots Scenario, due to a reduction in the sub-sector's share of GDP post 2030. In the Resource Constrained and Environmental Awareness scenarios the percentage share of final consumption (41% and 40% respectively) is similar due to the assumptions regarding energy efficiency improvements. In comparison the manufacturing sub-sector's consumption increases to 51% of final consumption given that energy efficiency improvements are not made over the planning period.

For the mining sub-sector the share of final consumption decreases in all scenarios except in the Base Case Scenario. This is due to the fact that in the Green Shoots, Resource Constrained and Environmental Awareness scenarios energy efficiency improvements are implemented, whereas in the Base Case Scenario they are not. Furthermore, the mining sub-sector's final consumption also decreases due to a reduction in its share of GDP post 2030.

The share of final consumption for the agricultural sector remains relatively constant across the three scenarios with the exception of the Base Case scenario. This is due to the fact that in the Green Shoots, Resource Constrained and Environmental Awareness scenarios energy efficiency improvements are balanced out by rebound effects whereas in the Base Case scenarios energy efficiency improvements are not implemented. The decline in the Base Case is due to lack of production activities in the sector.

The share of final energy consumption increases in all scenarios for the commercial sector, despite energy efficiency improvements. This is mainly due to the structural shifts in the economy and climate change. In recent years, the economy has shown a shift towards the services sub-sector and as the economy grows this trend is likely to continue. As a result, energy efficiency benefits may take some time before they are realised due to the increased use of technologies such as laptops, printers, etc. Another contributing factor to energy consumption in the commercial sector is the current weather conditions, which are likely to continue. As noted previously, the greatest effect on energy consumption in this regard is the number of cooling degree days in winter and heating degree days in summer.

Within the residential sector the share of final consumption decreases across all scenarios albeit at different rates. With regard to the Base Case Scenario, the decrease in the residential sector's share is due largely to growth in the manufacturing sub-sector which increases up to 51% due to the lack of energy efficiency improvements implemented as well as the implementation of Building Regulations post 2011. Within the Green Shoots Scenario the larger decrease in comparison to the Resource Constrained and Environmental

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Awareness scenarios (despite similar assumptions on energy efficiency) is due to a more aggressive penetration of Solar Water Heaters (10 million by 2030).

Within the transport sector the share of final consumption decreases in all scenarios except in the Green Shoots Scenario which is characterised by high GDP growth. Energy efficiency improvements, which range from 1% to 2.5%, contribute to the decline in the share of final consumption.

Table 0-3: Base Case Scenario: Proportion of final energy demand by sector

Sector	2015	2030	2050	Change
Industry (excl. mining)	37%	43%	51%	↑
Mining	7%	7%	7%	→
Agriculture	3%	3%	2%	↓
Commerce	7%	9%	10%	↑
Residential	14%	8%	6%	↓
Transport	32%	29%	24%	↓
Total	100%	100%	100%	

Table 0-4: Environmental Awareness Scenario: Proportion of final energy demand by sector

Sector	2015	2030	2050	Change
Industry (excl. mining)	36%	38%	40%	↑
Mining	7%	6%	5%	↓
Agriculture	3%	3%	3%	→
Commerce	7%	10%	14%	↑
Residential	14%	9%	9%	↓
Transport	32%	32%	29%	↓
Total	100%	100%	100%	

Table 0-5: Green Shoots Scenario: Proportion of energy demand by sector

Sector	2015	2030	2050	Change
Industry (excl. mining)	37%	33%	30%	↓
Mining	7%	5%	4%	↓
Agriculture	3%	3%	3%	→
Commerce	8%	13%	16%	↑
Residential	13%	6%	8%	↓
Transport	33%	39%	37%	↑
Total	100%	100%	100%	

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Table 0-6: Resource Constrained Scenario: Proportion of final energy demand by sector

Sector	2015	2030	2050	Change
Industry (excl. mining)	36%	39%	41%	↑
Mining	7%	6%	5%	↓
Agriculture	3%	3%	3%	↔
Commerce	7%	11%	15%	↑
Residential	14%	8%	6%	↓
Transport	32%	33%	30%	↓
Total	100%	100%	100%	

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Section 6: Analysis of supply-side options

This section analyses the output of the optimisation modelling executed for the Integrated Energy Plan (IEP). The modelling was undertaken using the indicators for the eight IEP objectives (i.e. cost of the energy system; jobs within the energy sector; CO₂ and pollutant emissions; water consumption; diversity of supply and primary sources; energy intensity; and energy access) across the four core scenarios (i.e. Base Case, Resource Constrained, Environmental Awareness and Green Shoots).

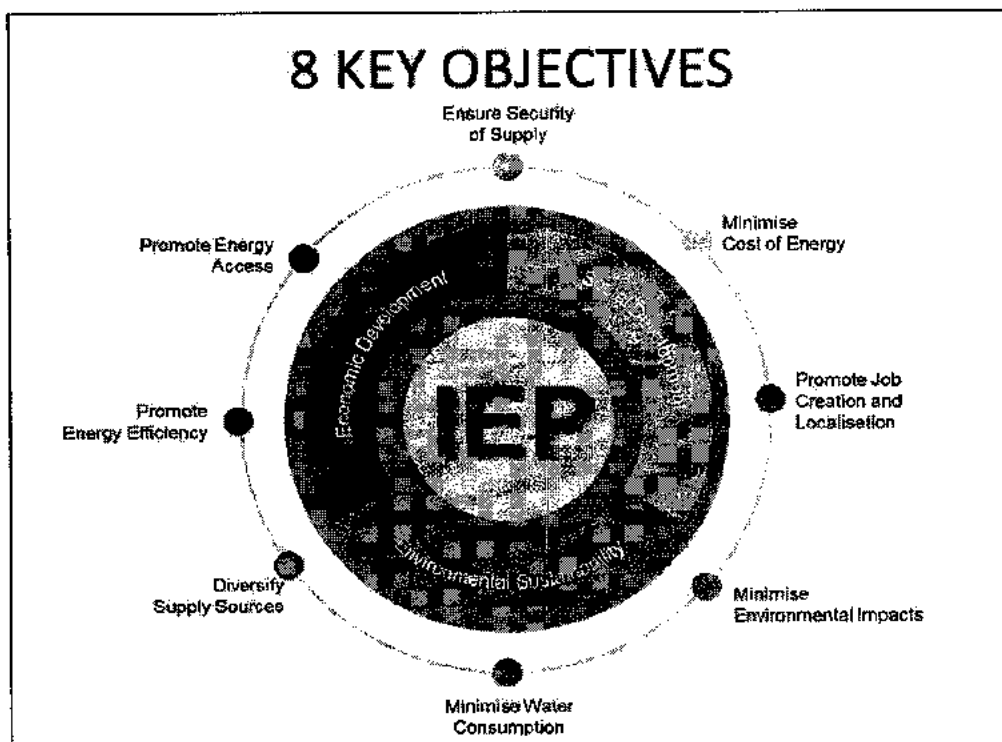


Figure 0-1: Eight key objectives of the IEP

6.1. New capacity requirements

Total capacity requirements for electricity generation and liquid fuel production for the four scenarios are discussed in this section. Total capacity requirements include the residual capacity and the accumulated new capacity for each sector.

CONTINUES ON PAGE 130 - PART 2

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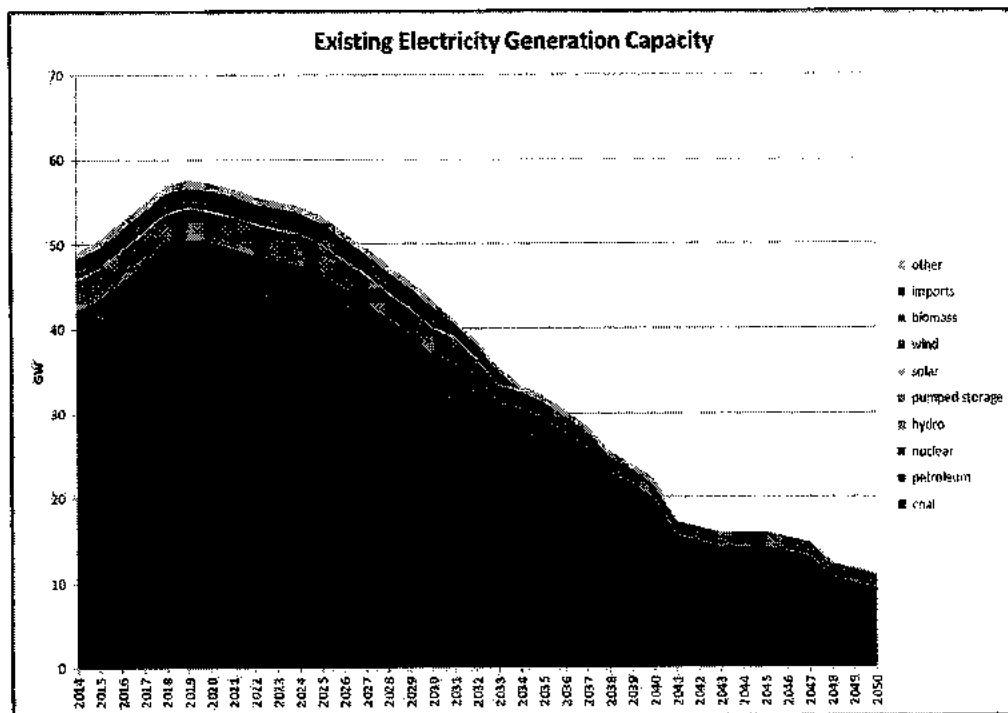
AIDS HELPLINE: 0800-0123-22 Prevention is the cure

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6.1.1. Electricity generation capacity

Existing electricity generation capacity is shown in Figure 0-2. Existing capacity starts to decline notably from 2025, with significant plant retirement occurring in 2031, 2041 and 2048. By 2050 only 20% of the current electricity generation capacity remains. This means that large investments are required in the electricity sector in order to maintain an adequate supply in support of economic growth.



Source: DoE Analysis

Figure 0-2: Total existing electricity generation capacity

Accumulated new electricity generation capacity by scenario is shown in Figure 0-3, accumulated new generation capacity by 2050 is provided in Figure 0-4, while total generation capacity is provided in Figure 0-5. The electricity generation system remains constrained in the short term (i.e. within the next five years) with the only new technologies that can be rapidly deployed to address the constraint being those with short lead times, such as biomass and solar. New capacity added during this time is mostly from the DoE's Renewable Energy Independent Power Producer (REIPP) Programme. By 2020, various import options become available and some new coal capacity is added along with new wind, solar and gas capacity.

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The Base Case assumes that the 9.6 GW New Nuclear Build Programme is embarked upon and the first unit comes on line by 2026, with the last unit commissioned by 2031, in line with the IRP2010. Throughout the period after 2020, dependence on imported capacity gradually increases to between 11 and 16 GW depending on the scenario. These imports comprise mostly hydro generation from neighbouring states but also include up to 8.5 GW of gas and up to 1.5 GW of coal generation capacity.

The small amounts of local coal powered generation capacity introduced into the mix between 2020 and 2050 comprise both new capacity and existing plants where the plant life has been extended (an additional ten years is given as an option). The new capacity is introduced in the medium term and the life extensions occur post 2030 when the relevant plants reach the end of their originally planned operational lifespans. Of the eleven coal powered plants considered as options for life extension, only three were determined to be viable in the Base Case and Resource Constrained scenarios (Kendal, Lethabo and Matimba) and only one in the Green Shoots and Environmental Awareness scenarios (Matimba). Additional life extensions are limited by carbon limits and carbon price within the scenarios. Further analysis and consultation need to be conducted by Eskom with relevant government departments and stakeholders to determine the economic viability and environmental impact associated with life extensions. Nuclear (over and above the 9.6 GW New Nuclear Build Programme) and solar technologies start contributing significant generation capacity by 2030 due to greenhouse gas (GHG) emission limits and the costs associated with externalities which make new coal fired plant uneconomical.

... The mix of generation capacity technologies by 2050 is considerably more diverse than the current energy mix across all scenarios ...

The mix of generation capacity technologies by 2050 is considerably more diverse than the current energy mix, across all scenarios. The main differentiating factors between the scenarios are the level of demand, constraints on emission limits and the carbon dioxide externality costs.

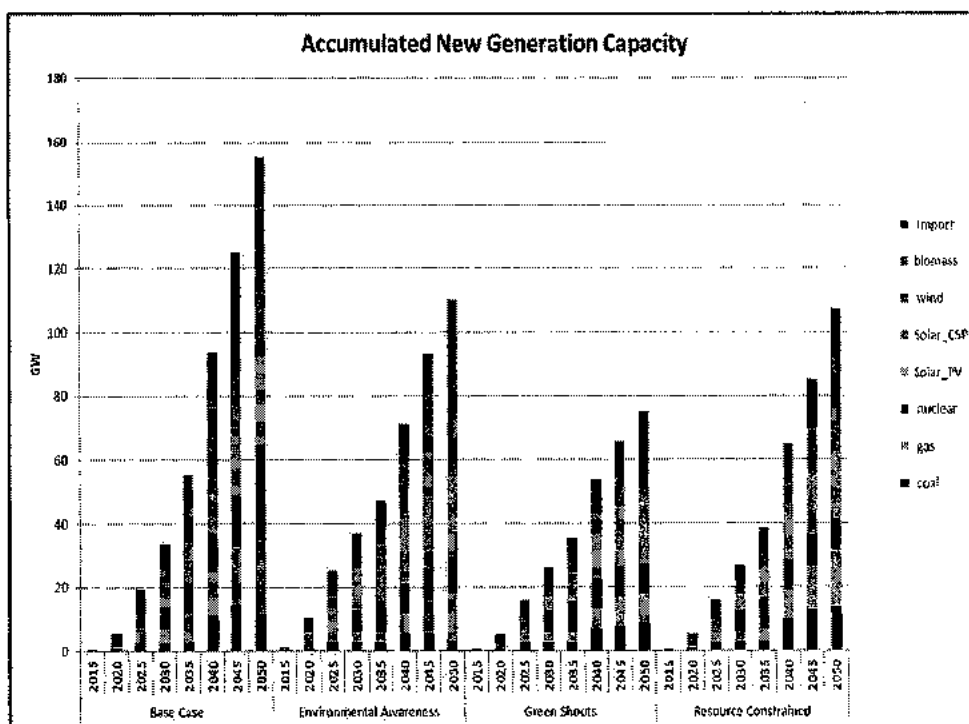
The Base Case and Environmental Awareness scenarios have the highest solar capacity additions – in the Base Case Scenario this is influenced by higher electricity demand and tighter emission constraints after 2035 and in the Environmental Awareness Scenario this is primarily due to the lower emission constraints and the higher penalties for externalities.

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For the same reasons mentioned above, the Base Case Scenario has the highest nuclear capacity additions. While the Base Case, Environmental Awareness and Resource Constrained scenarios have the same economic growth assumptions, the Base Case Scenario has the highest electricity demand and consequently the highest new capacity requirement, but is characterised by the combination of a slower penetration of solar water heaters, slow improvement in energy efficiency (including vehicle efficiency), and moderate increases in energy commodity prices.

While the Green Shoots Scenario has the most optimistic economic growth projections, most economic growth is a consequence of the commercial sector expanding faster than the primary sub-sector. This is coupled with aggressive implementation of the Solar Water Heater Programme (10 million by 2030), high energy efficiency improvements and a high vehicle penetration rate. These combined factors result in a less energy intensive economy and thus a significantly reduced demand for electricity.



Source: DoE Analysis

Figure 0-3: Accumulated new electricity generation capacity by scenario

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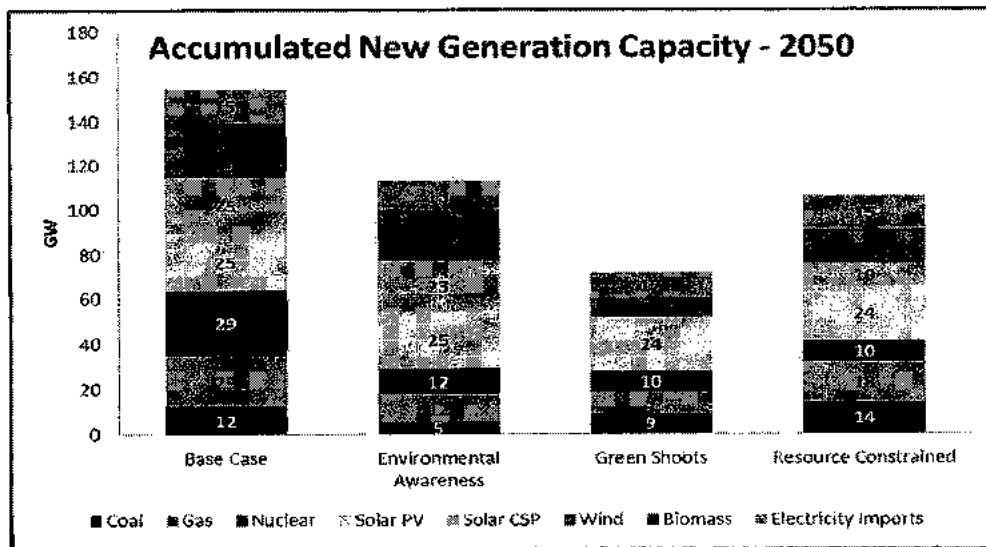
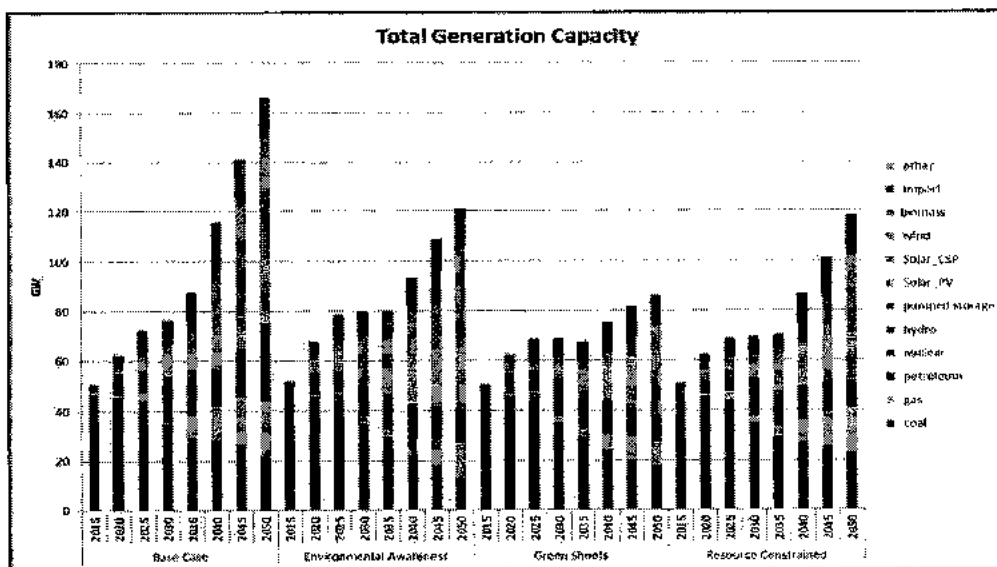


Figure 0-4: Accumulated new generation capacity by 2050



Source: DoE Analysis

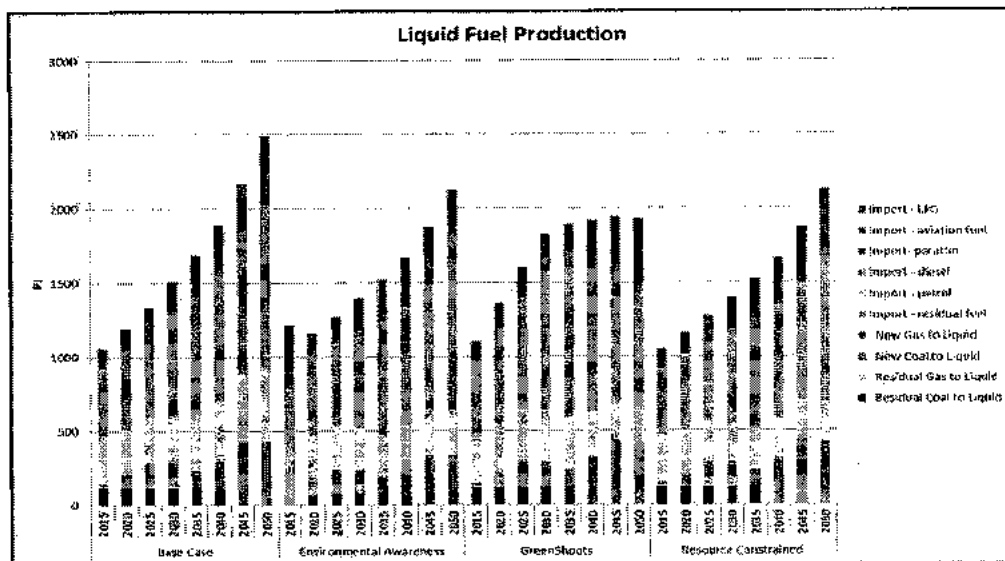
Figure 0-5: Total electricity generation capacity

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6.1.2. Liquid fuel production and supply

Demand for liquid fuels is met through various sources which include local production from crude oil, gas-to-liquid (GTL) and coal-to-liquid (CTL). Supply shortfalls are met through the importation of final refined products. The sources of liquid fuel production for each scenario are shown in Figure 0-6.



Source: DoE Analysis

Figure 0-6: Liquid fuel production

As with new electricity generation capacity requirements, the Base Case Scenario has the most significant requirement for new liquid fuel production capacity. This is followed by the Environmental Awareness and Resource Constrained scenarios. Faster vehicle efficiency improvements together with a higher penetration of electric vehicles in the Green Shoots Scenario result in reduced fuel intensity for the transport sector and consequently decoupling of economic growth from fuel demand. All four scenarios assume the presence of economically recoverable shale gas and that shale gas is moderately priced. These two assumptions combined would make new crude oil refining capacity unlikely to be economically viable in the short to medium term. The model results therefore suggest the importation of refined petroleum products as a more cost effective option.

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When considering the possibility of shale gas, GTL is a viable option based on the assumed costs of local extraction. All scenarios assume that the extraction of shale gas will be approximately R40 per GJ, although considerable externality costs are added to this in the modelling to accommodate emissions in the extraction value chain. Higher international energy prices in the Resource Constrained Scenario favour local energy resource extraction and beneficiation in the longer term. Methane emissions from the shale gas value chain can represent a significant external cost if not properly controlled and will need to be addressed through appropriate regulation to enable this option.

While the existing refineries are not likely to be retired based on operational life (normal maintenance and upgrades generally extend the life of refineries), some older and less efficient refineries may become less economically viable before 2050.

... In the Base Case, Resource Constrained and Green Shoots scenarios, existing CTL is likely to be maintained throughout the period considered but there are unlikely to be any new investments in CTL ...

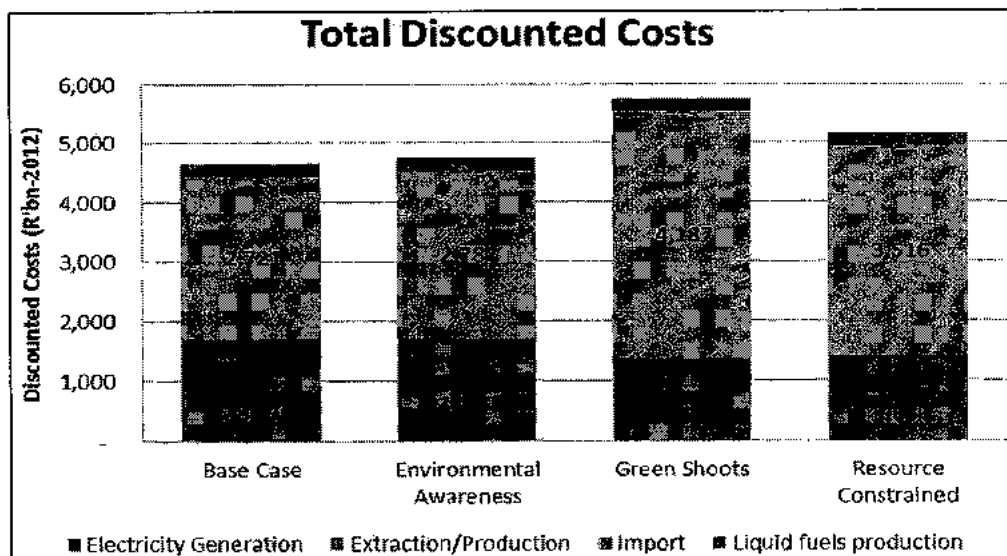
In the Base Case, Resource Constrained and Green Shoots scenarios, existing CTL is likely to be maintained throughout the period considered but there are unlikely to be any new investments in CTL due constraints resulting from carbon emissions and the external costs related to greenhouse gas and pollutant emissions. In the Environmental Awareness Scenario existing CTL is forced out of operation due to the very tight emission limits imposed on liquid fuel production, compounded by a much higher carbon price.

6.2. Costs

Energy system costs are divided into cost components representing different parts of the energy value chain from primary energy supply (imports and extraction) to the production of the end product, energy. The cost components for the IEP scenarios are provided in Figure 0-7. Imports include imported electricity and imports of refined product.

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Source: DoE Analysis

Figure 0-7: Total discounted energy system costs (2014-2050)

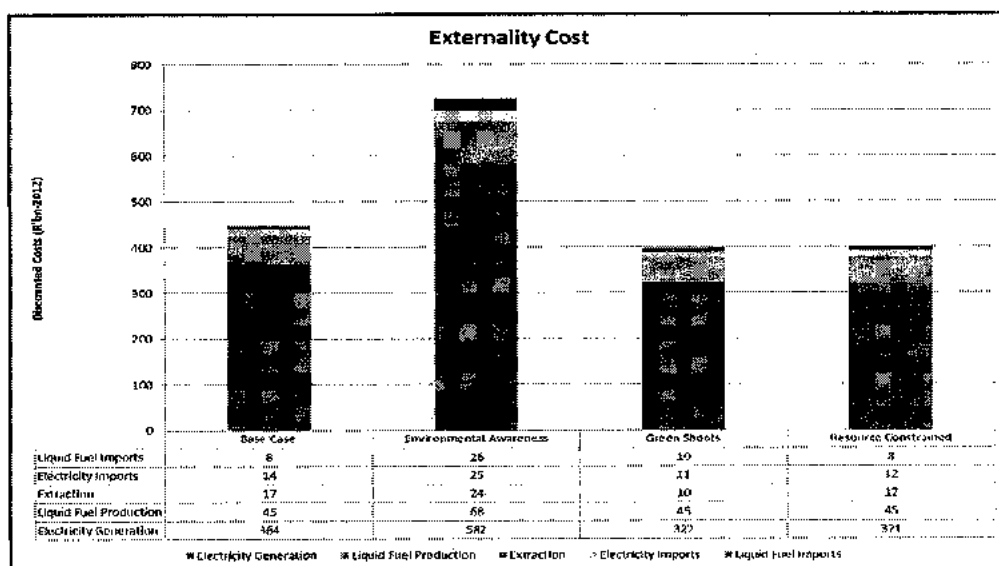
The major energy system costs arise from imports of petroleum products. Imports of electricity from neighbouring countries contribute towards import costs but are comparatively small (less than 2%). Local energy resources are favoured, because imported energy impacts not only on the national balance of trade but also on energy security due to geopolitical risks. It is assumed that shale gas extraction in South Africa will be cheaper than imports of gas within all the scenarios considered (see inputs and assumptions). The resultant import costs over the modelled period shown in Figure 6-7 are slightly lower than those currently experienced, which are in the region of 70-75% of energy costs.

Externality costs were included in the modelling of the energy system and represent the damage costs caused by pollutants, more specifically CO₂, NO_x, SO_x and particulate matter. Such damage costs seek to quantify the negative impacts of various pollutants on society. Examples include the effect of carbon emissions on the climate; deterioration of health and mortality due to fires and inhalation of poisonous fumes from the combustion of harmful fuels; waste handling of spent nuclear fuels; and disaster management in the event of leaks or spills. Externality costs have the effect of making technologies which use fuels that have high levels of pollutants relatively more costly and are shown in Figure 0-8 for the four core scenarios. The Environmental Awareness Scenario has the highest total externality costs of R725 billion over the modelled period, followed by the Base Case Scenario (R448 billion), the Resource Constrained Scenario (R399 billion) and lastly the Green Shoots Scenario (R398 billion). While the Environmental Awareness Scenario indicates high externality costs, it has

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low volumes of emissions but allocates higher value to the environment as reflected in the higher carbon dioxide penalty cost of R270/t which results in the high internalised cost. Electricity generation accounts for approximately 80% of the externality cost in all scenarios. This is followed by liquid fuel production which accounts for approximately 10% of the cost. Extraction and imports make up the remaining 10% of the externality cost with liquid fuel imports contributing 2% towards the cost.



Source: DoE Analysis

Figure 0-8: Externality Cost

A detailed analysis of the key factors that contribute to the cost structure for new electricity generation capacity is described in the following sub-section.

6.2.1. Electricity generation costs

The total discounted cost for new electricity generation is shown in Figure 0-9. While coal and biomass contribute a fairly small share towards total generation capacity, as shown in Figure 0-5, higher externality costs in the case of coal, and technology costs in the case of biomass, mean that these technologies contribute more towards total energy system costs. The Environmental Awareness Scenario, with its higher externality costs (R270/ton throughout the planning period as opposed to a range of R48-R120/ton for other scenarios) has the highest total energy system cost when existing plants are taken into account. However when only new electricity generation capacity is considered (see Figure 0-10) the profile of the comparative costs is similar to the new generation capacity which is added (see Figure 0-3)

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and the Base Case Scenario reflects the highest total new capacity energy system cost. New plants are assumed to be more efficient – hence the total cost of capacity from new coal plants is less than that of existing plants.

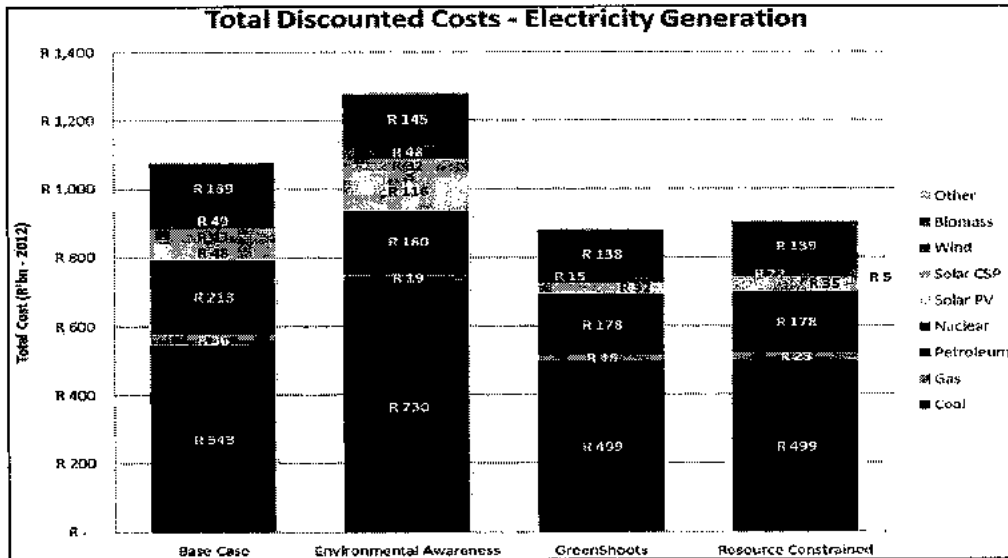


Figure 0-9: Discounted generation costs for electricity

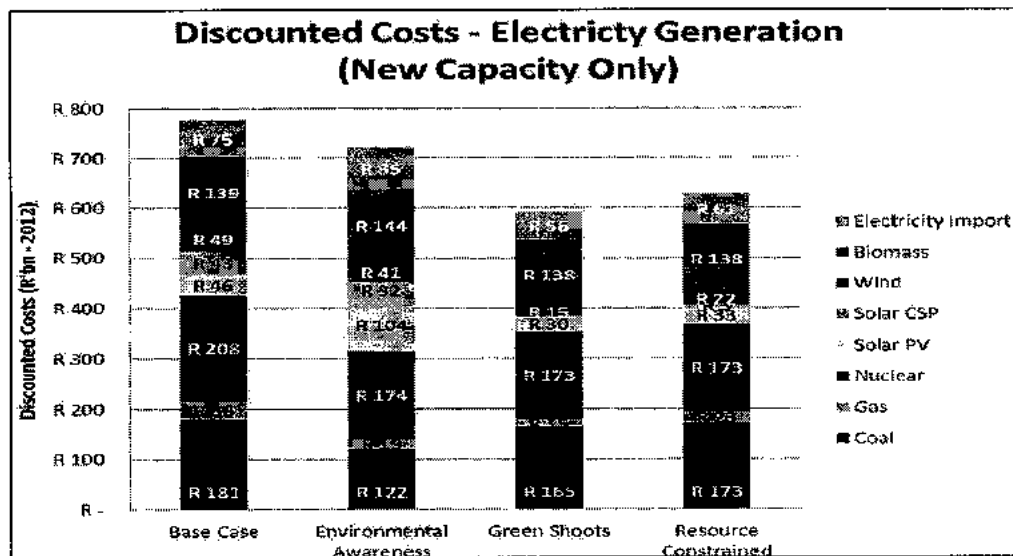


Figure 0-10: Cumulative discount cost for new electricity generation capacity

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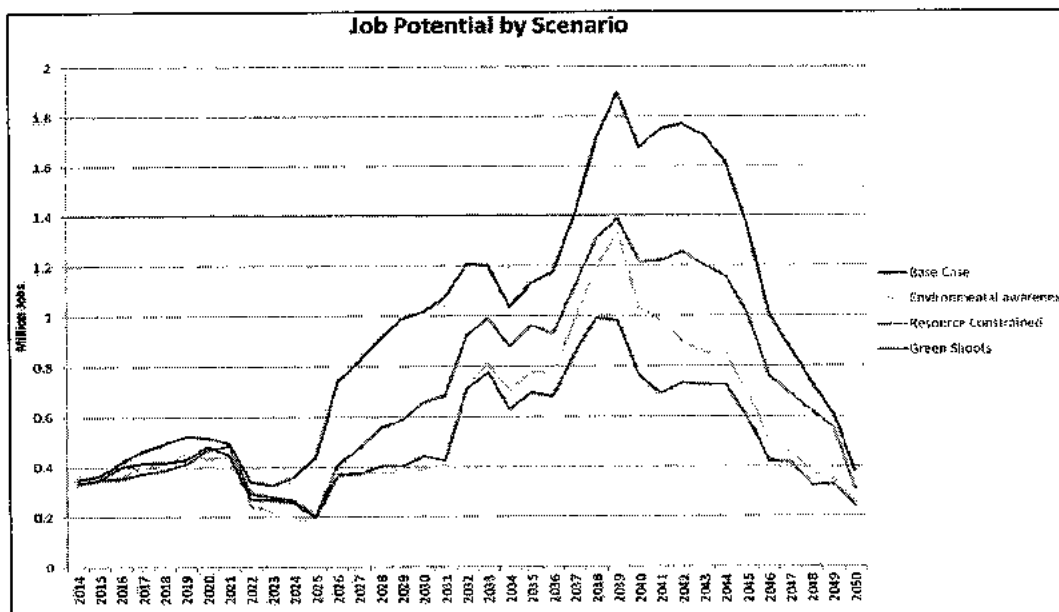
6.3. Jobs

The maximum number of potential jobs within the energy sector by year for each of the scenarios is presented in Figure 0-11. The decline in the number of jobs indicated from 2040 to 2050 is the result of the modelling timeframe and methodology, which only considers infrastructure capacity requirements to 2050 (i.e. there is no construction activity (or jobs created) in the lead up to 2050 for capacity requirements beyond 2050). In addition, all jobs related to construction are evenly distributed over the lead-time of the technology as an approximation within the IEP modelling. There is little difference in the job potentials for the scenarios in the first eight years of the modelling period however in the longer term, the differences become more pronounced.

- In the Green Shoots Scenario, the jobs are a result of GDP growth, which is higher in the short term but slows down in the longer term thus reducing the demand for energy compared to the other scenarios.
- In the Resource Constrained Scenario, higher energy prices reduce the importation of energy while increasing dependence on local energy resources. This has the effect of encouraging improvements in energy efficiency. The combined effect is a lower demand for energy than in the Base Case Scenario and hence a lower requirement for investments and jobs within the energy sector.
- The Environmental Awareness Scenario is constrained by tight emission limits and high externality costs which create an aggressive energy efficiency drive and a switch towards renewable energies. Demand for energy will essentially be lower than the Base Case and Resource Constrained scenarios.

... The number of potential jobs in the energy sector is dependent on the circumstances assumed in the scenarios and the level of investment in the various energy technologies ...

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Source: DoE Analysis

Figure 0-11: Potential number of jobs in the energy sector by scenario

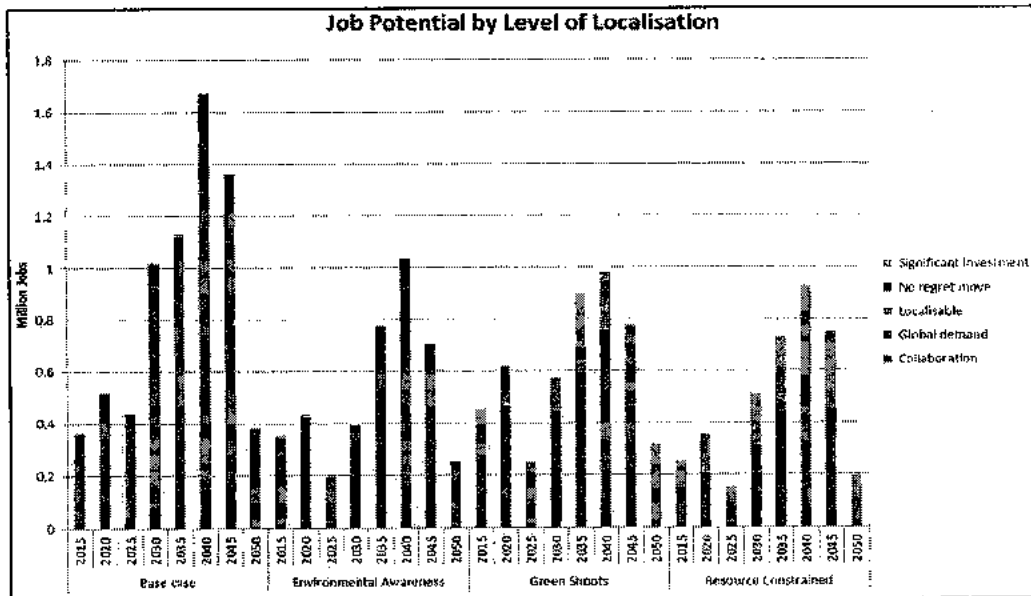
For a more detailed analysis, jobs were classified according to five levels of localisation in line with a McKinsey & Company report on localisation of energy technologies (McKinsey & Company, 2014). Each level within the classification requires greater investment than the previous level. These levels and their associated assumptions are as follows:

- **Localisable** – Assumes that the current policy framework is conducive for localisation, local supply of the required skills set is available and there is sufficient demand for raw material to justify local production
- **No regret move** – The current policy framework exists or could be developed and implemented within a fairly short timeframe
- **Significant investment required** – The current policy and regulatory framework could be developed and implemented within five years and some targeted investments would need to be made
- **Collaboration** – Regional co-operation and partnerships would need to be developed in order to create demand beyond South Africa's borders
- **Global demand required** – South Africa would need to be competitive in exporting the technologies and services to the global market.

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The localisation potential for each of the scenarios is presented in Figure 0-12. The number of potential jobs in the energy sector is dependent on the circumstances assumed in the scenarios and the level of investment in the various energy technologies. In all scenarios and time intervals, 85% of the jobs are localisable without any additional large investments beyond those required for the construction and operation of the various technologies.



Source: DoE Analysis

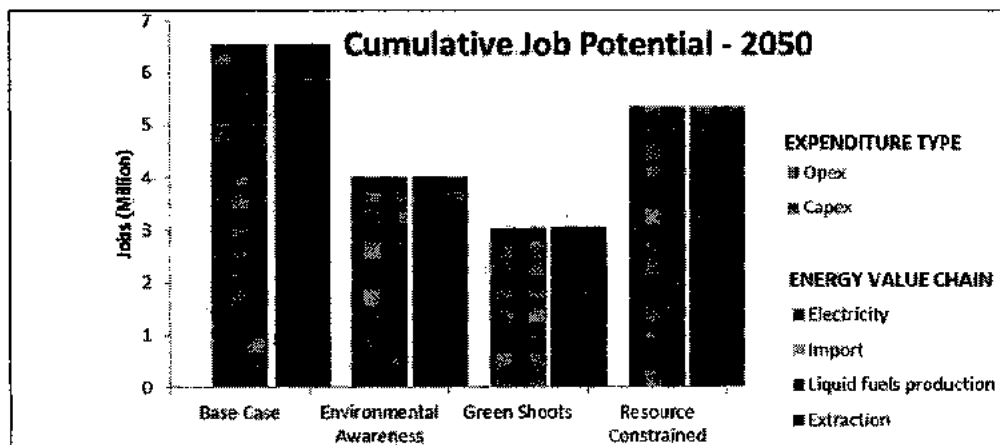
Figure 0-12: Job potential in the energy sector by scenario level of localisation

Job potential by investment type (operational and capital expenditure) as well as segment of the energy value chain (extraction, liquid fuel production, electricity generation and imports) are illustrated in Figure 0-13.

Expenditure Type: For all scenarios, more job potential exists as a result of the construction of energy technologies rather than the operation of these technologies. Although capital expenditure provides more jobs (required for construction of new capacity) than operational jobs, these are of a short-term nature and may therefore not be sustained without continually increasing capacity requirements. As the economy matures, less new capacity is needed, as is evident in the Green Shoots Scenario.

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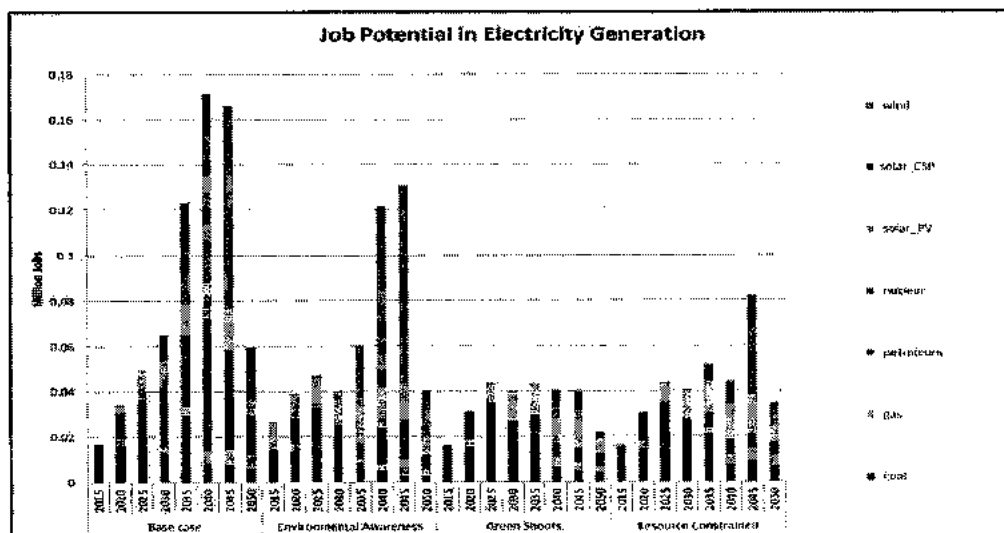
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Source: DoE Analysis

Figure 0-13: Cumulative jobs in the energy sector by scenario

Energy Value Chain: Most of the potential jobs are in the extraction of energy commodities (shale gas and coal) followed by electricity generation. The jobs in electricity generation result mostly from solar technologies followed by nuclear technologies as shown in Figure 0-14. Jobs in imports and retail were not considered, however, retail jobs are directly related to the final consumption of fuels and will correspond with final energy demands in the scenarios.



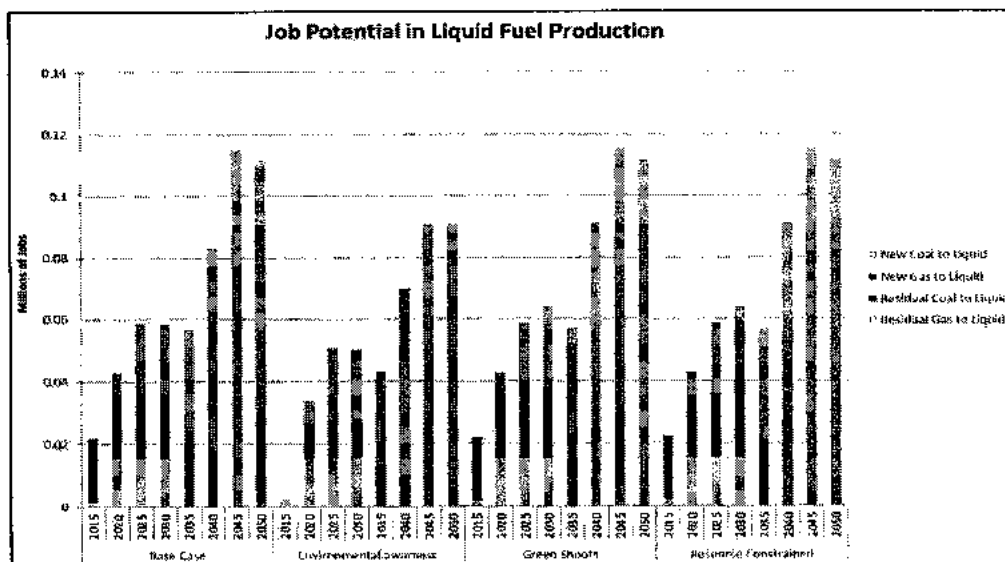
Source: DoE Analysis

Figure 0-14: Job potential in electricity generation by scenario

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Job potential in the liquid fuels sector is shown in Figure 0-15. The creation of jobs as a result of the construction of new GTL plant is prominent in all scenarios. This is due to more GTL plant being constructed in the planning horizon.



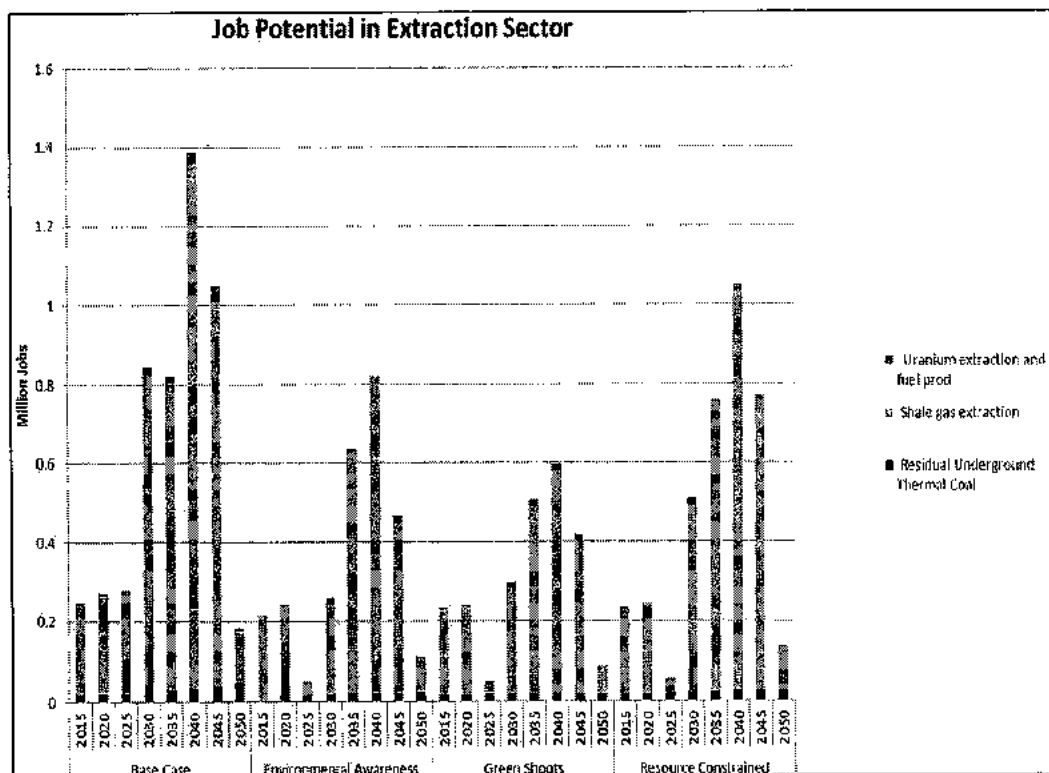
Source: DoE Analysis

Figure 0-15: Job potential in liquid fuels production by scenario

The job potential related to the extraction of coal and shale gas, and the uranium fuel cycle are illustrated in Figure 0-16. Initial supply of natural gas is from imports only. It is assumed that shale gas extraction has a lead time of seven years and job potential from shale gas extraction results from shale gas coming online from 2022. In all scenarios the majority of jobs are related to the extraction of shale gas. In the Resource Constrained and Environmental Awareness scenarios, the assumed emission constraints and improvements in energy efficiency dampen the level of extraction. In the Green Shoots Scenario, coal and gas demand are lower due to the assumed GDP growth.

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Source: DoE Analysis

Figure 0-16: Jobs in the energy extraction sub-sector by scenario¹

6.4. Emissions

Emissions from the energy sector and the final use of energy are presented and compared in this section. Emissions are separated into carbon emissions and pollutant emissions.

6.4.1. Carbon emission

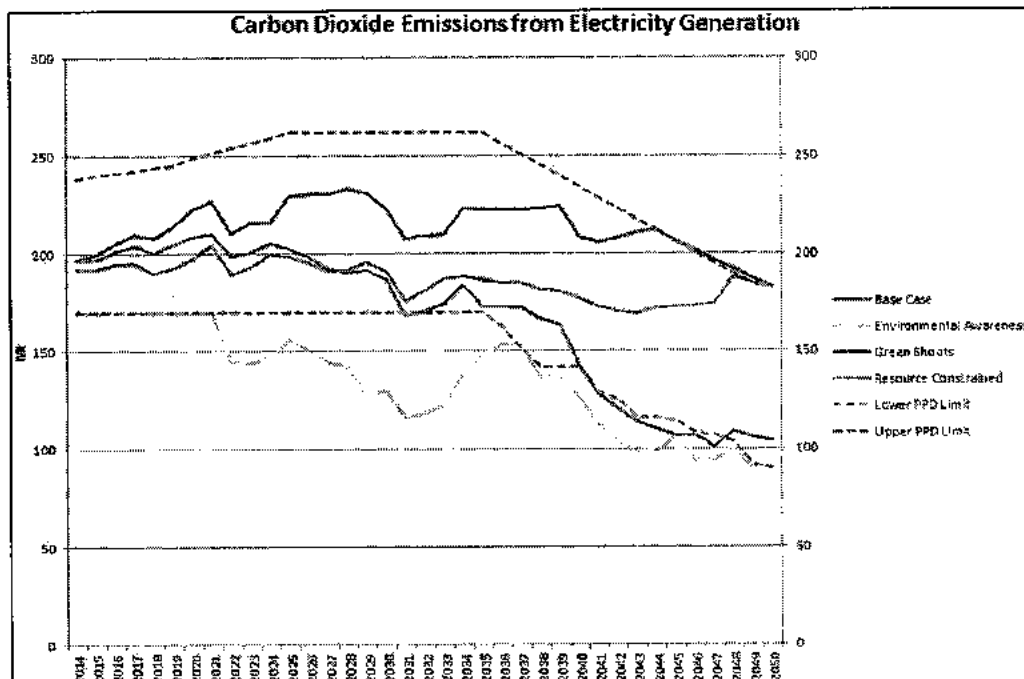
The National Climate Change Response White Paper (NCCRWP) defines targeted reductions in total emissions in terms of a 'Peak-Plateau-Decide' (PPD) emissions limit trajectory. CO₂ emission from electricity generation is presented in Figure 0-17. The PPD upper limit is applied to the Base Case, Green Shoots and Resource Constrained scenarios while the PPD lower limit is applied to the Environmental Awareness Scenario. The CO₂ emission profiles in all scenarios fall well within the specified emission limits and this is attributable to the inclusion of externality costs associated with carbon and other pollutants as part of the technology and fuel costs. It should be noted from Figure 6-14 that the PPD upper

¹ Jobs for shale gas extraction include construction of reticulation infrastructure

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limit is binding on the Base Case only from 2044 onwards. All scenarios (with the exception of the Base Case and Resource Constrained scenarios), show decreases in emissions between 2021 and 2031 and a general decline after 2040. While the increase in CO₂ emissions is caused by either new coal capacity or life extension of older plant, in most cases retired coal plant is replaced by technologies which have lower or no emission factors or externality costs, resulting in a general decline in the emission trajectories.



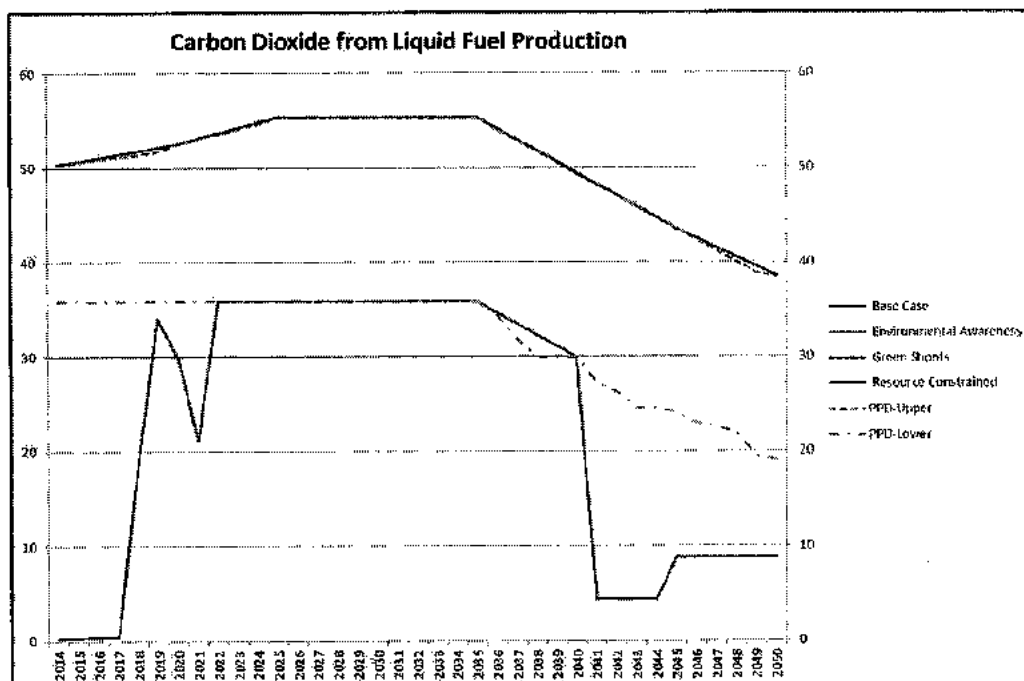
Source: DoE Analysis

Figure 0-17: Carbon dioxide emission from electricity generation

CO₂ emission from liquid fuel production is shown in Figure 0-18. The Base Case, Green Shoots and Resource Constrained scenarios conform to the upper PPD emission limit. Towards the end of the modelling period there is a decrease in CO₂ emission in all scenarios, as a result of the importation of final refined petroleum products. In the Environmental Awareness Scenario CO₂ emission is below the lower PPD limit with a substantial decline from 2040. This is due to the high externality cost imposed on this scenario, resulting in no new CTL capacity being built.

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Source: DoE Analysis

Figure 0-18: Carbon dioxide emissions from liquid fuel production

The total carbon dioxide emission from all sub-sectors, including electricity generation, liquid fuel production, transport and final end-use, is shown in Figure 0-19. The carbon emission limits placed on electricity generation and liquid fuel production are the equivalent to those discussed above. No emission limits were imposed on the extraction of energy commodities or on the final consumption of fuels but the emissions from these activities are included in the total CO₂ emissions presented, and externality costs are applied to them.

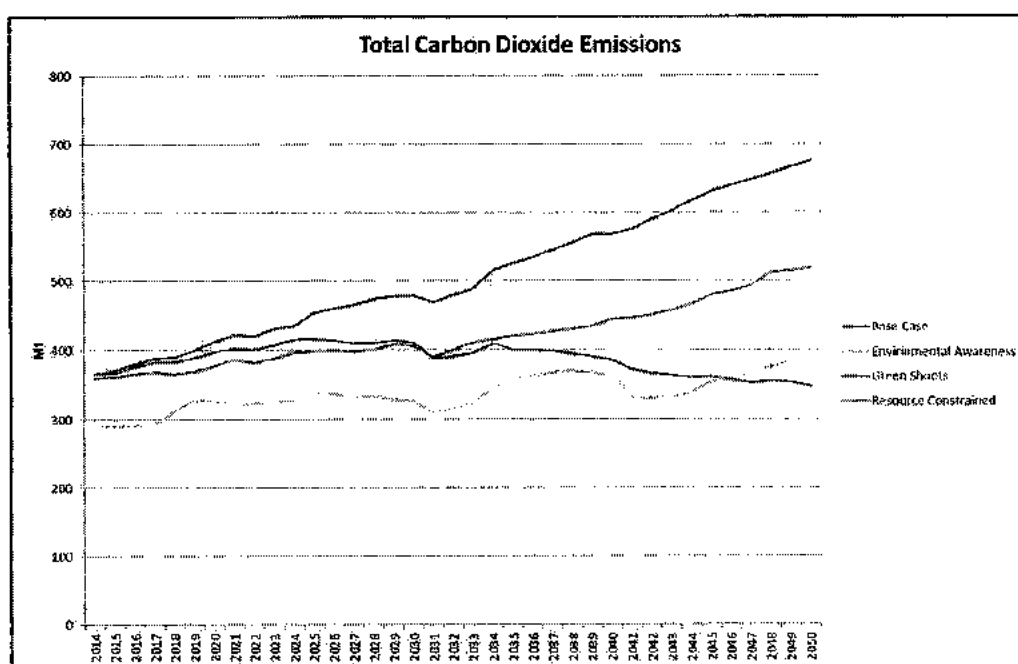
The Environmental Awareness Scenario is subject to a more stringent emission limit which is evident in the lower emission trajectory for this scenario. Lower emission is achieved through fuel switching and efficiency improvements on the demand side, in addition to a larger share of renewable energy technologies on the supply side.

Although the Green Shoots Scenario has a higher economic growth trajectory in the earlier years, its economic growth slows compared to the other scenarios in the longer term and energy efficiency improves, both of which result in a declining emission trajectory.

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The Resource Constrained Scenario has an emission trajectory that lies between that of the Base Case and Environmental Awareness scenarios. This is due to a greater improvement in energy efficiency compared to the Base Case Scenario but lower costs and less stringent constraints compared to the Environmental Awareness Scenario.

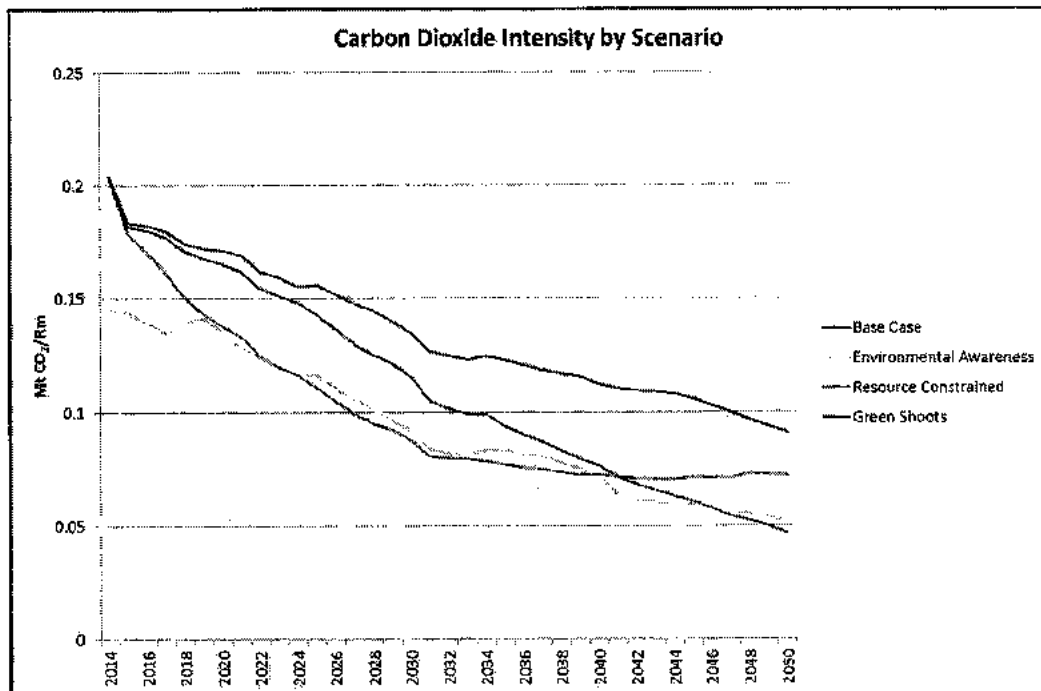


Source: DoE Analysis

Figure 0-19: Total CO₂ emissions (energy supply and energy end-use)

The changing carbon dioxide intensities across the four scenarios are shown in Figure 0-20. These intensities are similar to the total emissions but the growth in GDP in all cases changes the path of the trajectories.

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Source: DoE Analysis

Figure 0-20: CO₂ intensity per scenario

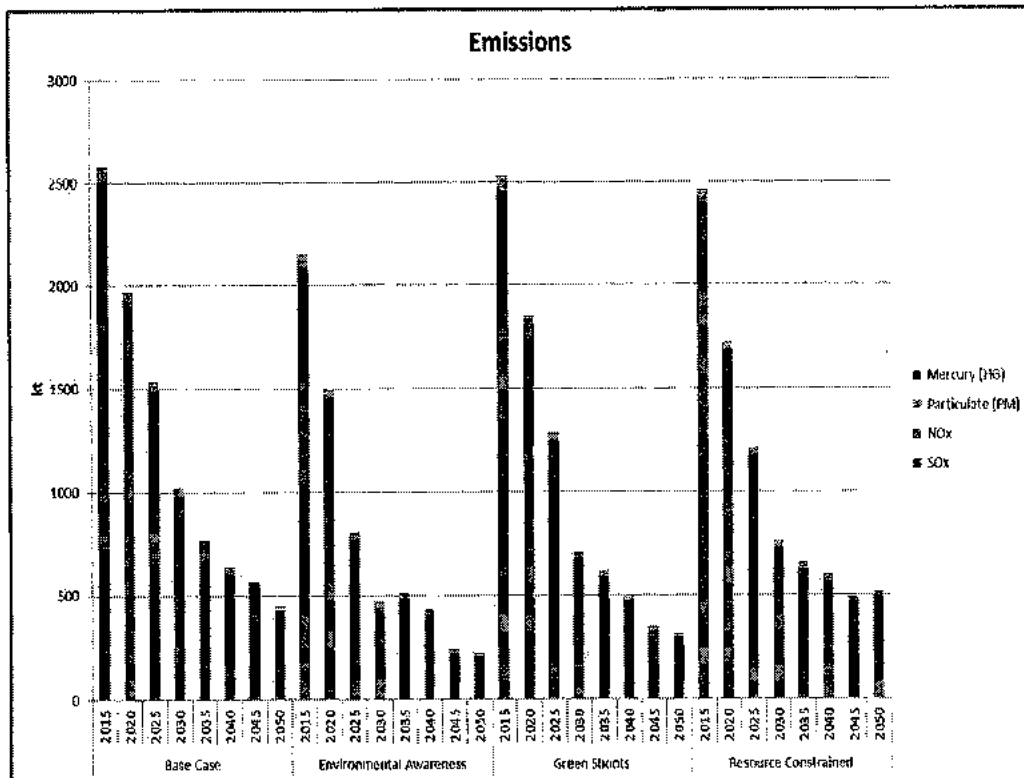
6.4.2. Pollutant emissions

Pollutant emissions of SO_x, NO_x, particulate matter (PM) and mercury (Hg) are presented in Figure 0-21. In all scenarios it is assumed that the necessary retrofits, required to meet environmental regulations, have been implemented. Financial and practical implications (in terms of cost and downtime of units) were not considered as part of the optimisation process within the IEP modelling process. Further detailed studies are required to determine the impact of possible combinations of retrofits, life extensions and early plant retirements.

All the pollutants show a substantial decline in all scenarios over the modelled period. This is mainly due to assumed compliance with the emissions regulations, and the use of flue gas desulphurisation and particulate filters.

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	Base Case				Environmental Awareness				Green Shoots				Resource Constrained			
	SOx (kt)	NOx (kt)	PM (kt)	Hg (kt)	SOx (kt)	NOx (kt)	PM (kt)	Hg (kt)	SOx (kt)	NOx (kt)	PM (kt)	Hg (kt)	SOx (kt)	NOx (kt)	PM (kt)	Hg (kt)
2015	1648	859	66	0.03	1406	688	54	0.03	1618	843	64	0.03	1577	821	61	0.03
2020	1265	662	38	0.03	950	510	30	0.02	1191	620	35	0.03	1111	574	34	0.03
2025	828	667	35	0.03	341	433	26	0.02	662	584	32	0.03	612	563	31	0.03
2030	342	639	34	0.03	95	346	21	0.02	195	481	28	0.02	228	502	28	0.02
2035	174	558	32	0.03	107	374	25	0.02	126	461	28	0.02	132	491	29	0.02
2040	145	463	25	0.02	111	297	19	0.01	125	349	22	0.02	140	476	24	0.02
2045	104	434	22	0.02	49	172	11	0.01	71	256	16	0.01	93	378	20	0.02
2050	79	350	13	0.02	40	166	9	0.01	61	233	14	0.01	92	397	19	0.02

Source: DoE Analysis

Figure 0-21: Total pollutant emissions from the electricity sector only

The emissions of the various pollutants and their sources are shown in Figure 0-22. Sulphur oxides and nitrous oxides from power generation constitute the greatest volume of pollutants, followed by carbon monoxide and nitrous oxides from the transport sector.

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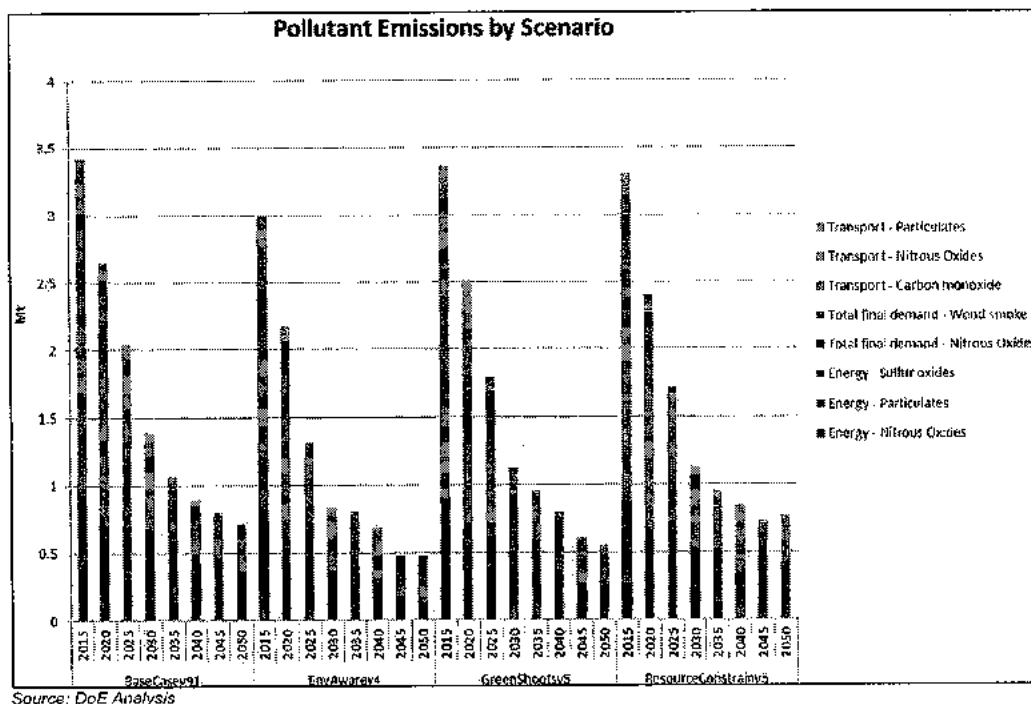
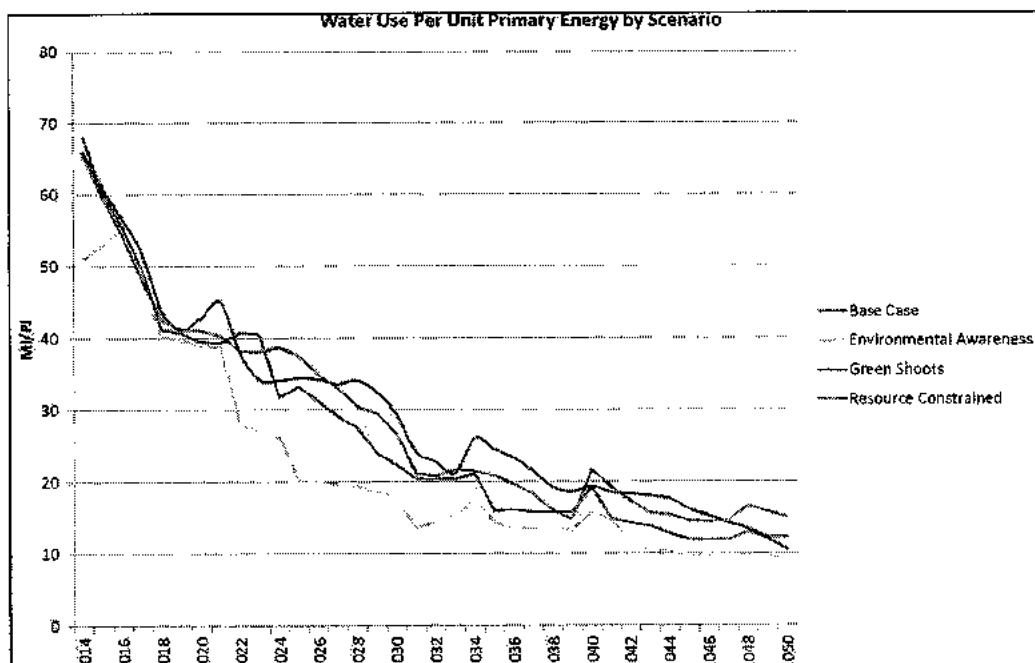


Figure 0-22: Total pollutant emissions (energy supply and energy end-use) by scenario

6.5. Water consumption

Water consumption for the core IEP scenarios is shown in Figure 0-23. There is little variation between the Base Case, Green Shoots and Resource Constrained scenarios; however, they do all gradually decrease over time. The Environmental Awareness Scenario reflects significantly lower water usage as a result of the more stringent CO₂ emission limit which results in greater investment in technologies which are less water intensive. All future coal fired power stations are expected to be air cooled and will contribute to the reduction in water demand by the energy sector.

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Source: DoE Analysis

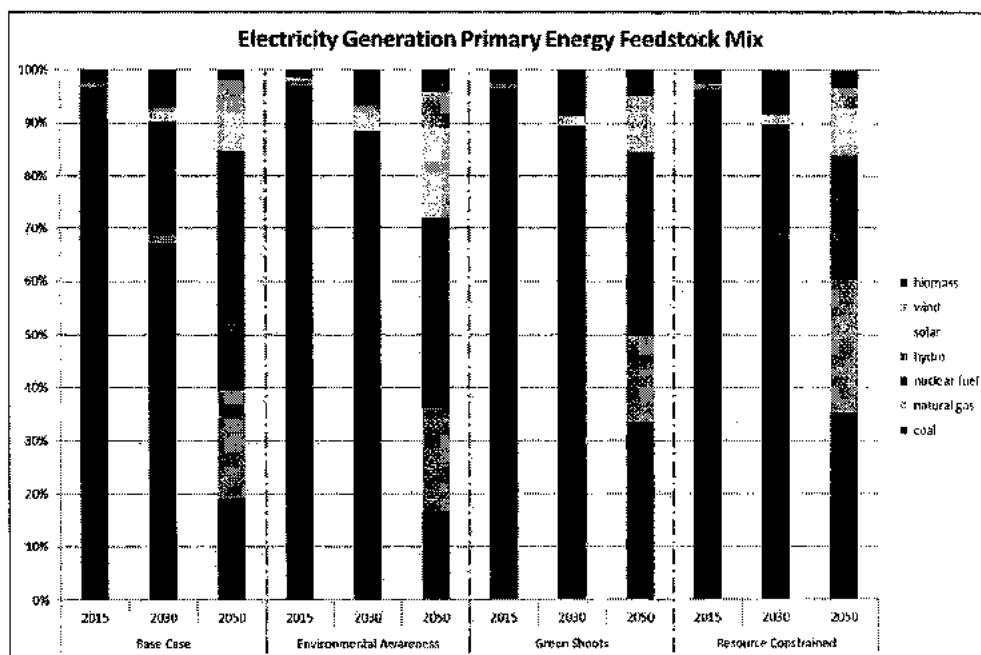
Figure 0-23: Total water use in the primary energy sector

6.6. Primary energy mix (diversity)

Primary energy feedstock for electricity generation, liquid fuel production and final end-use are shown in Figure 0-24, Figure 0-25 and Figure 0-26. Coal and gas feature in all sectors. In the electricity generation sector, coal constitutes close to 90% of the primary energy mix in 2015 in all scenarios. The use of coal declines to below 35% of the primary energy mix by 2050 in the Green Shoots and Resource Constrained scenarios, and to below 20% of the primary energy mix in the Base Case and Environmental Awareness scenarios. Nuclear fuel constitutes over 20% of the primary energy mix from 2030 onwards in all scenarios. In terms of liquid fuels, the primary energy mix is dominated by coal and gas with gas becoming the more prominent energy carrier in the future. The primary energy mix in the final demand sub-sector comprises coal, gas and wood. Coal is most dominant in this sector with wood declining in use beyond 2030.

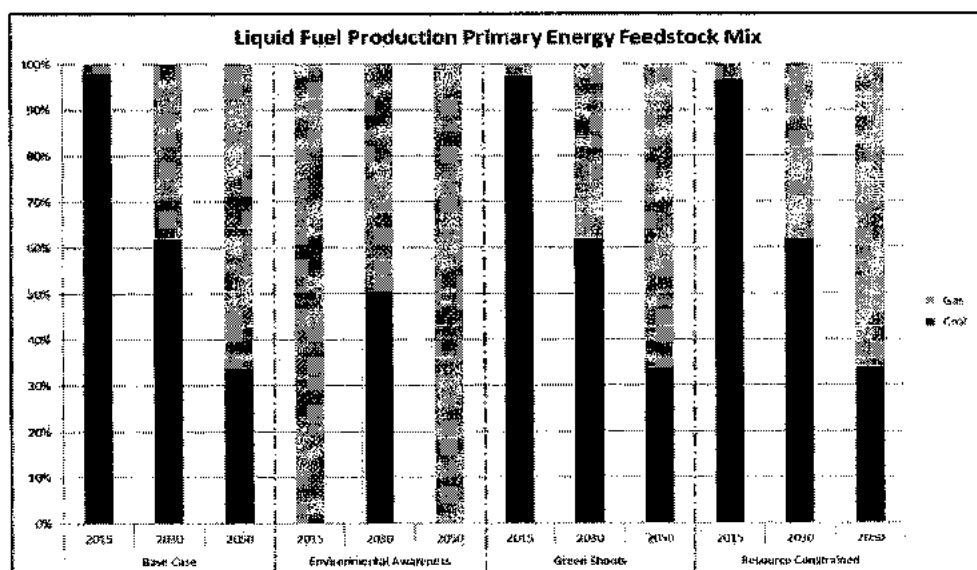
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Source: DoE Analysis

Figure 0-24: Electricity generation primary energy feedstock mix

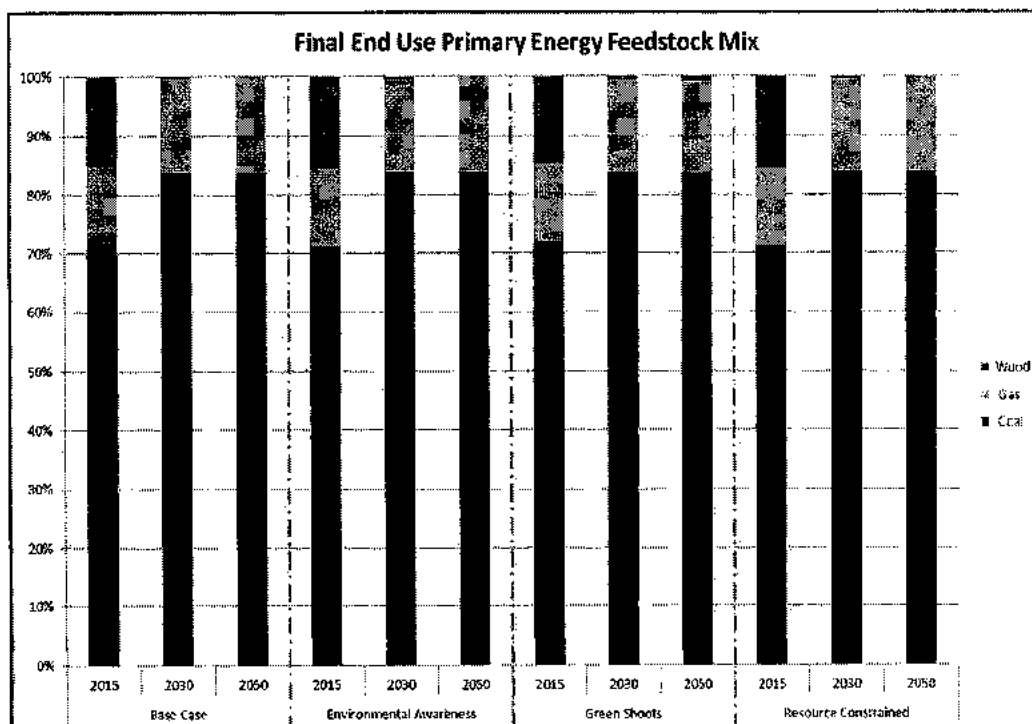


Source: DoE Analysis

Figure 0-25: Liquid fuel production primary energy feedstock mix

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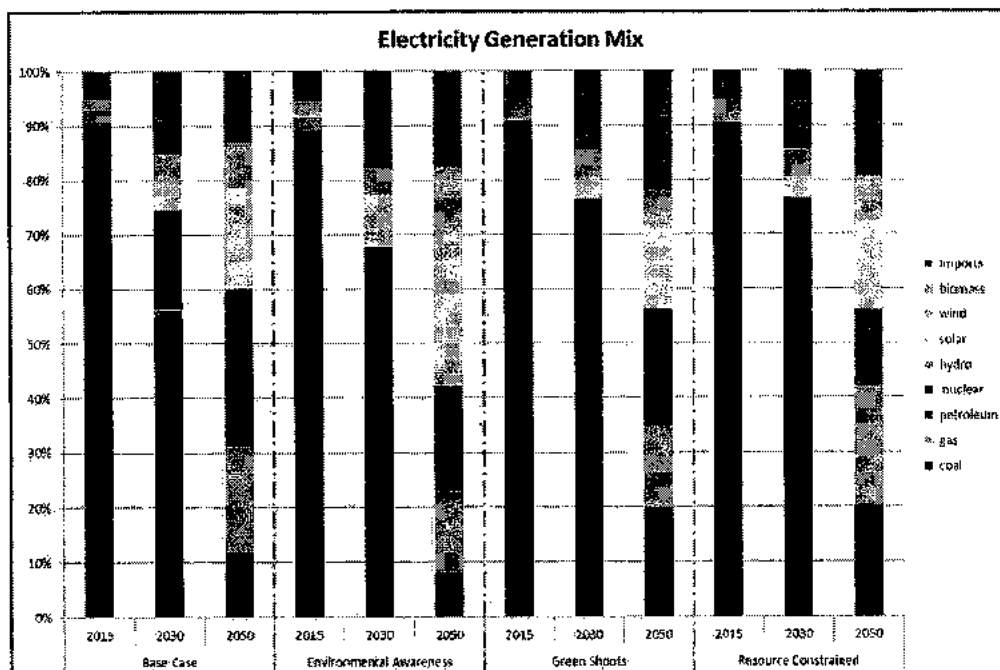
Source: DoE Analysis

Figure 0-26: Final end-use primary energy feedstock mix

The changes in the energy mix for electricity generation and liquid fuel production for the IEP scenarios over the modelled period are shown in **Error! Reference source not found.** and Figure 0-28. Primary energy supply includes locally extracted resources, electricity generated from wind and solar, imports of refined petroleum products and imports of electricity (in this context only). In all scenarios the energy mix for electricity generation becomes more diverse over the period to 2050, with coal reducing its share from about 85% in 2015 to 15–20% in 2050 (depending on the scenario). Solar, wind, nuclear, gas and electricity imports increase their share. The Environmental Awareness and Green Shoots scenarios take on higher levels of renewable energy.

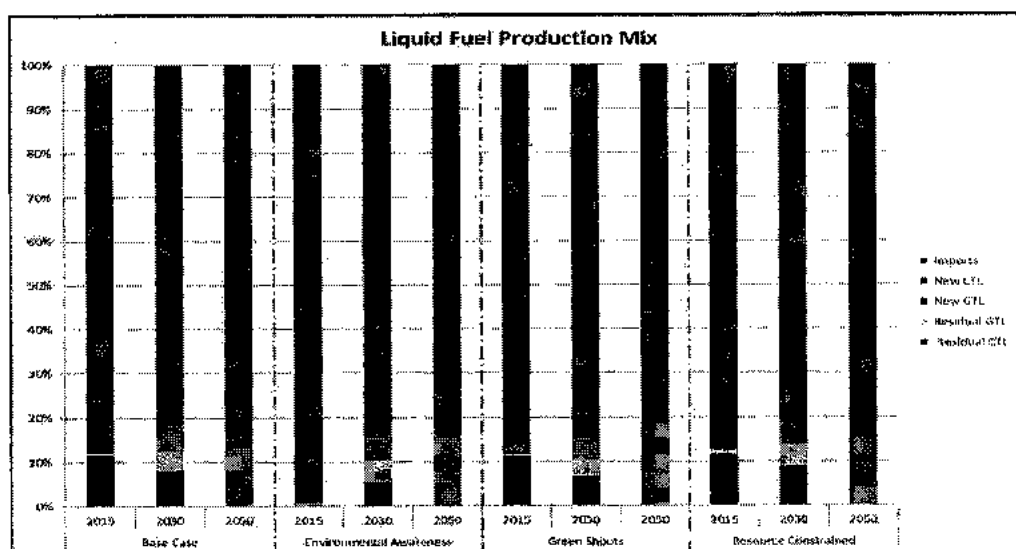
Imports form the bulk of the supply mix for liquid fuels in all scenarios and constitute at least 75% of the mix over the entire planning horizon for all scenarios. All scenarios show a slight decline in the importation of refined petroleum products as shale gas is used in gas to liquid production.

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Source: DoE Analysis

Figure 0-27: Electricity generation mix



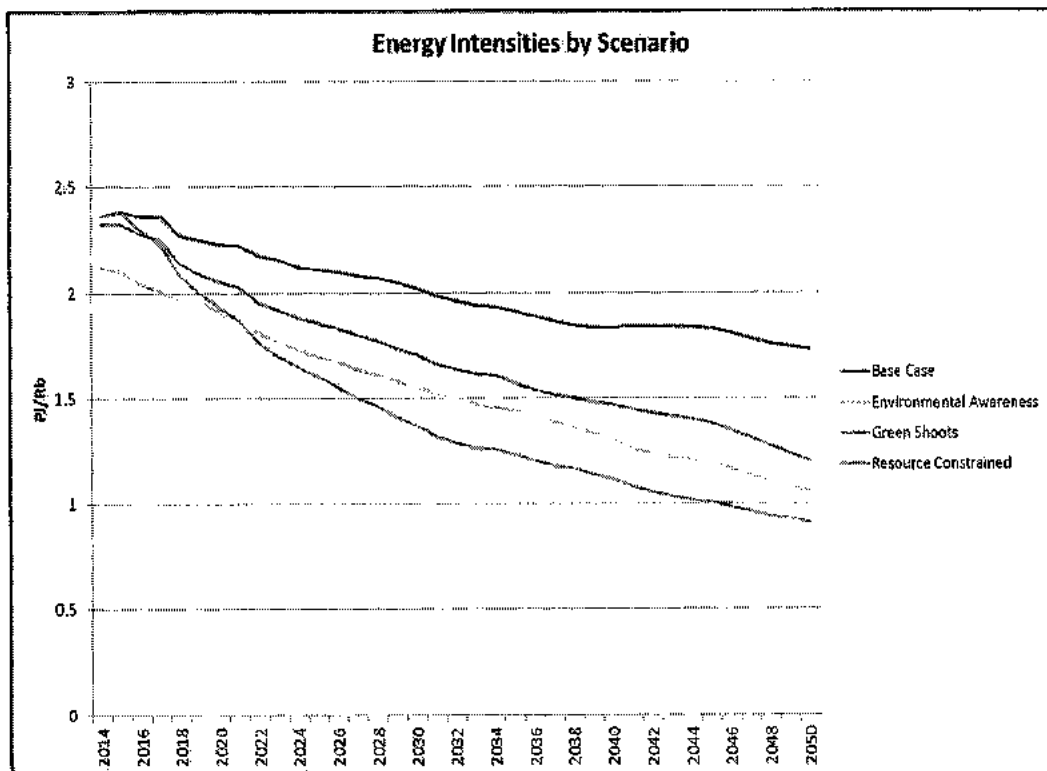
Source: DoE Analysis

Figure 0-28: Liquid fuel production mix

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6.7. Energy intensity

Energy intensities over the modelled period decline for all scenarios as shown in Figure 0-29. This is due to improvements in energy efficiency and GDP growth relative to energy demand. The Green Shoots Scenario has the fastest improvement in energy intensity in the first decade of the modelling period due to the initially high growth in GDP. The remaining scenarios have the same GDP growth rates so the differences in the intensities are due to energy efficiency improvements and fuel switching.



Source: DoE Analysis

Figure 0-29: Energy intensities in the energy sector

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*Integrated Energy Plan***6.8. Summary of scenarios against the eight objectives**

Objective	High-level summary of scenario results
Ensure security of energy supply	The objective of optimisation modelling is to ensure that all demand is met. Within all scenarios, the projected demand is met and therefore the objective of ensuring security of supply (which is the underpinning objective) is assumed to have been met.
Minimise the cost of energy	While all scenarios seek to ensure that costs are minimised within the constraints and parameters of each scenario, the Base Case Scenario presents the least cost followed by the Environmental Awareness, Resource Constrained and Green Shoots scenarios respectively when total energy system costs are considered. The total costs are mostly comprised of imports of final petroleum products but when electricity system costs are explored in isolation this picture changes. • Electricity Sector system costs: The Green Shoots Scenario has the lowest total cost for electricity generation. This is followed by the Resource Constrained and Base Case scenarios while the Environmental Awareness Scenario has the highest cost. • Liquid Fuel Supply (Combined production and imports): When the total supply of liquid fuels is considered the resulting profiles are similar to those of total system costs.
Promote job creation and localisation potential	The potential number of jobs created within each of the scenarios changes year-on-year. Cumulatively, the Base Case Scenario presents the greatest job creation potential, followed by the Resource Constrained, Environmental Awareness and Green Shoots scenarios respectively. In all scenarios, approximately 85% of total jobs are localisable. • For electricity generation, most jobs result from solar technologies followed by nuclear and wind, with natural gas and coal making a smaller contribution. • For liquid fuel, most jobs result from new GTL plants and, to a smaller extent CTL plants, with no additional jobs resulting from new crude oil refining as no new crude oil refining capacity comes on line in the period.
Minimise negative environmental impacts	The Environmental Awareness Scenario, due to its stringent emission constraints, shows the lowest level of total emissions over the planning horizon. This is followed by the Green Shoots, Resource Constrained and Base Case scenarios. These trends are similar when emissions are considered cumulatively and individually by type.
Minimise water consumption	The results for water consumption across the four scenarios are similar to those of emissions with the Environmental Awareness Scenario showing the lowest level of water consumption and the Base Case showing the highest water consumption.
Diversify supply sources and primary energy carriers	All scenarios present a fairly diversified energy mix across the electricity sub-sector and the liquid fuel sub-sector. It is important to note that none of the scenarios include crude oil in the future, implying that the importation of refined petroleum products is the least cost option.

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Objective	High-level summary of scenario results
Promote energy efficiency (reduce energy intensity of the economy)	The Green Shoots Scenario, which is characterised by a significant structural shift in the economy, presents the highest reduction in energy intensity. This is largely informed by the larger contribution by the tertiary sub-sector by comparison with other scenarios. This is followed by the Environmental Awareness, Resource Constrained and Base Case scenarios respectively.
Promote energy access	Energy access encompasses the ability to provide energy as well as the availability of that energy when required. The ability to provide electricity to all South African citizens is made possible by connecting new households to the grid where it is cost-effective to do so and by introducing off-grid technologies where it is not. Therefore an energy mix that includes technologies which are suitable for off-grid application presents the most potential to increase energy access. Presently solar energy technologies (e.g. rooftop solar PV panels and other solar home systems) show the greatest potential in this regard. The Base Case Scenario includes the largest share of renewable energy technologies, followed by the Environmental Awareness, Resource Constrained and Green Shoots scenarios respectively. It should be noted that in addition to the supply-side renewable energy technologies, the Base Case and Resource Constrained scenarios assume the introduction of 1 million solar water heaters by 2030, and the Environmental Awareness and Green Shoots scenarios include the introduction of 5 and 10 million solar water heaters respectively by 2030.

6.9. Sensitivity analysis

While the four main scenarios described in the previous sections have informed core analysis for the IEP, they include three assumptions which, if varied, could particularly affect the Base Case Scenario, namely:

- Shale gas is economically viable and abundant;
- New nuclear capacity in the amount of 9.6 GW is made available as planned; and
- One million solar water heaters are installed.

Three further sensitivity analyses were therefore conducted on the Base Case Scenario to inform model output. These are described below.

No Shale Gas Scenario: This scenario does not consider shale gas as a viable primary energy source. The objective of this scenario is to test the impact of a long-term energy future where the extraction of shale gas turns out to be less economically viable than is currently projected, due to the high uncertainty associated with the levels of recoverable shale gas.

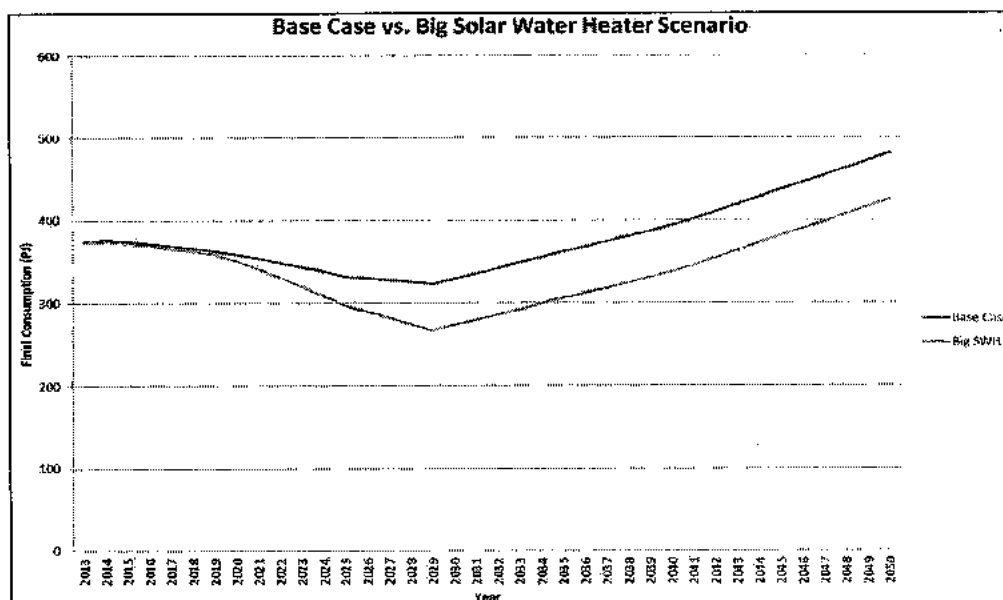
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Nuclear Relaxed Scenario: The Base Case Scenario currently assumes that the New Nuclear Build Programme to introduce 9.6 GW, which was announced by the President in the 2014 State of the Nation Address, will proceed as planned. The nuclear relaxed study allows the IEP process to explore flexibility in the building of new nuclear capacity in detail, by allowing nuclear build options to compete with other technologies to meet future energy needs.

Big Solar Water Heater Scenario: The one million Solar Water Heater (SWH) Programme is currently being implemented by government in an effort to reduce dependence on solid fuels in low income households as well as reduce the peak demand for electricity. The objective of this scenario is to test the impact of pursuing a more aggressive approach to the introduction of SWH in households as part of electricity Demand-side Management.

Total energy demand for the Base Case and the Big SWH scenarios is shown in Figure 0-30: . In the short term the penetration of SWH is slow and the energy demand for both scenarios is the same until 2019. From 2020, a more aggressive approach is adopted to ensure the installation of up to ten million SWH by 2030 to replace electrical water heaters. This has a marked impact, which is reflected in the sharp decline in energy consumption. After 2030, there is an increase in energy consumption due to the SWH programme being terminated in 2030.



Source: DoE Analysis

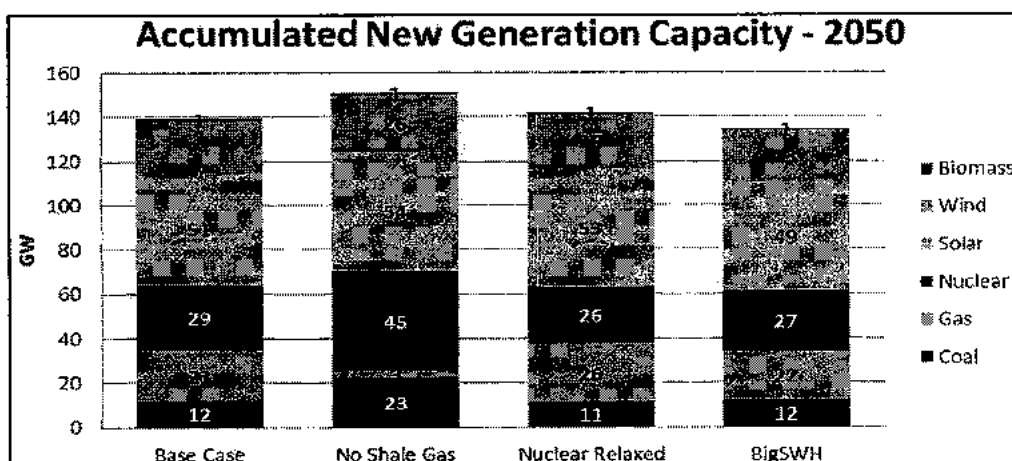
Figure 0-30: Base Case and the Big Solar Water Heater Scenario

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6.9.1. Accumulated new capacity

Accumulated new electricity generation capacity for the four scenarios is shown in Figure 0-31. Environmentally clean technologies are preferred in the selection, in keeping with the climate change mitigation strategy. New capacity using solar constitutes the highest percentage in all scenarios (50.5 GW in the Base Case Scenario, 53.8 GW in the No Shale Gas Scenario, 53 GW in the Nuclear Relaxed Scenario and 49.5 GW in the Solar Water Heater Scenario).

- In the Base Case Scenario, nuclear constitutes (29.5 GW), wind (23 GW), gas (22.7 GW), imports (15.5 GW) and coal (12 GW) of the new generation capacity mix.
- The Nuclear Relaxed Scenario includes gas (26.3 GW), nuclear (25.8 GW), wind (24.6 GW), imports (15.5 GW) and coal (11.1 GW). This scenario has the highest new capacity using gas. New capacity in terms of imports is very similar to that of the Base Case.
- In the No Shale Gas Scenario the elimination of gas as an option results in a large percentage of the new generation mix being nuclear (45.4 GW), followed by wind (25.6 GW), coal (22.5 GW) and imports (7.2 GW). The use of new coal technologies in this scenario is approximately double that of the other scenarios. Imports in this scenario are much lower than in the other scenarios.
- Accumulated new generation capacity in the Solar Water Heaters scenario comprises nuclear (26.9 GW), wind (23.1 GW), gas (21.7 GW), imports (15 GW) and coal (12.4 GW).



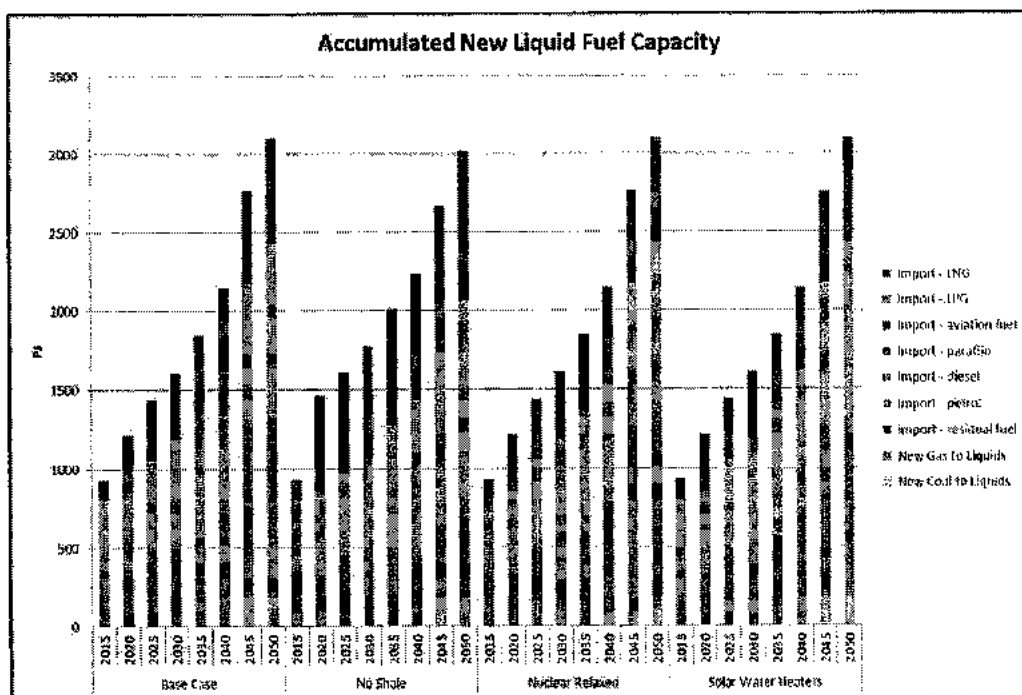
Source: DoE Analysis

Figure 0-31: Accumulated new electricity generation capacity by scenario

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The accumulated new capacity for liquid fuels is shown in Figure 0-32. The bulk of new capacity in all scenarios is from imports (74% in the Base Case Scenario, 94% in the No Shale Gas Scenario, 74% in the Nuclear Relaxed Scenario and 74% in the Solar Water Heater Scenario). Diesel comprises the bulk of imports (36% in all scenarios except the No Shale Scenario where new capacity for liquid fuel imports is 45%). This is followed by petrol (21% in all scenarios). Aviation fuel, liquefied petroleum gas (LPG) and liquefied natural gas (LNG) constitute 21% of the accumulated new capacity from imports in all scenarios except the No Shale Gas Scenario. In the No Shale Gas Scenario, these products constitute 31% of imports due to a higher amount of LNG being imported. Accumulated new capacity for domestic liquid petroleum production is achieved by building new coal to liquid (CTL) and gas to liquid (GLT) plant. In the Base Case, Nuclear Relaxed and Solar Water Heater Scenarios, 792 PJ of accumulated new capacity, comprising 176 PJ of CTL capacity and 616 PJ of GLT capacity, is brought on line. In the No Shale Gas Scenario only 176 PJ of CTL capacity is brought on line due to shale gas not being a viable primary energy option.



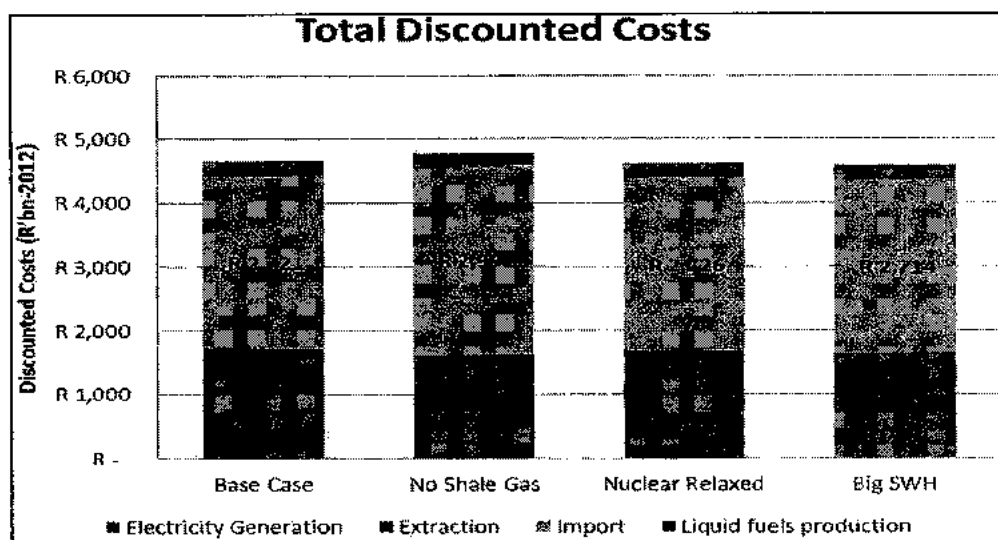
Source: DoE Analysis

Figure 0-32: Accumulated new liquid fuel capacity by scenario

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6.9.2. Costs

The energy system costs are divided into cost components representing different parts of the energy value chain from primary energy supply (imports and extraction) to energy provided for final consumption. The cost components for the three sensitivity analyses are provided in Figure 0-33.



Source: DoE Analysis

Figure 0-33: Cost structure of the energy system for the period 2014-2050

The No Shale Gas Scenario is the most costly of all the scenarios. The elimination of shale gas as a primary energy option leads to higher imports of comparatively more expensive refined petroleum products, and a reduction in domestic fuel production. This is coupled with higher electricity generation costs as other alternatives to combined-cycle gas turbines (CCGTs) are needed to meet electricity demand. Elimination of gas as a primary energy option leads to lower extraction costs as expected. The price of shale gas is assumed to be lower than that of gas imports in the Base Case Scenario.

The Nuclear Relaxed and the Solar Water Heater scenarios are marginally less costly than the Base Case Scenario. In the Nuclear Relaxed Scenario, this is due to the optimisation of investment costs through the scheduling of new nuclear build capacity only when it is economical to do so. In the Solar Water Heater Scenario, the use of solar water heaters as a renewable energy technology results in a decrease in coal extraction costs.

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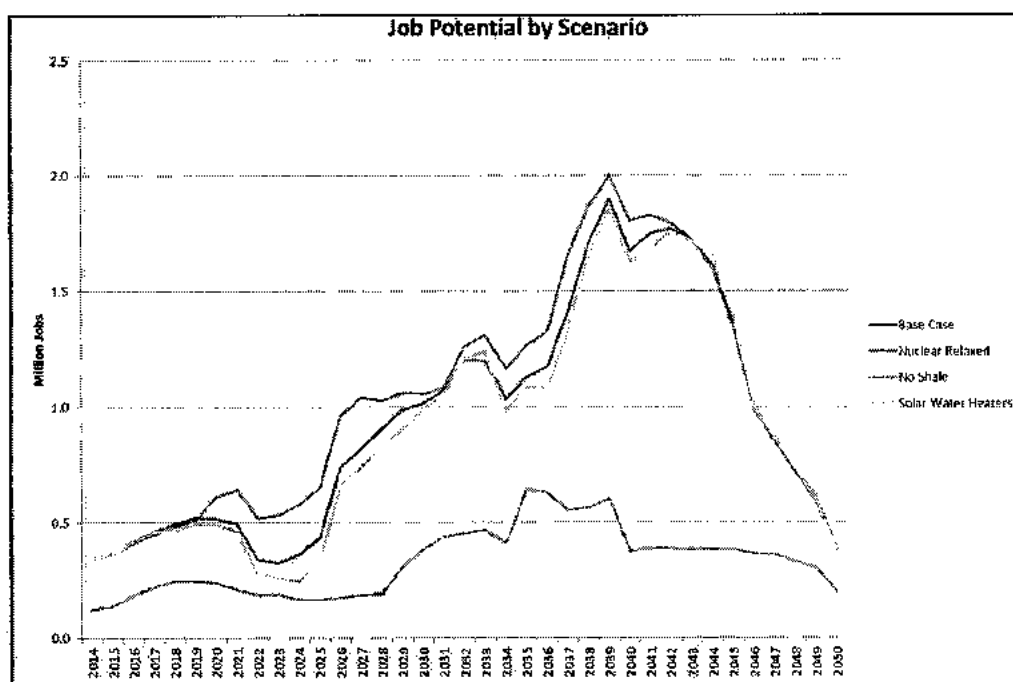
The Nuclear Relaxed Scenario has the highest externality cost due to the use of generation technologies with primary energy that have a high level of pollutants relative to nuclear energy. The No Shale Scenario has the lowest externality cost, due to the externalities associated with imports being lower.

6.9.3. Jobs

The total number of potential jobs annually in each of the sensitivity scenarios and the Base Case Scenario are shown in Figure 0-34.

The Nuclear Relaxed Scenario has the highest annual job potential from 2020 to 2043, due to more construction in this period.

The No Shale Gas Scenario has a significantly lower annual job potential due to the assumption that it is not economically viable to extract shale gas.



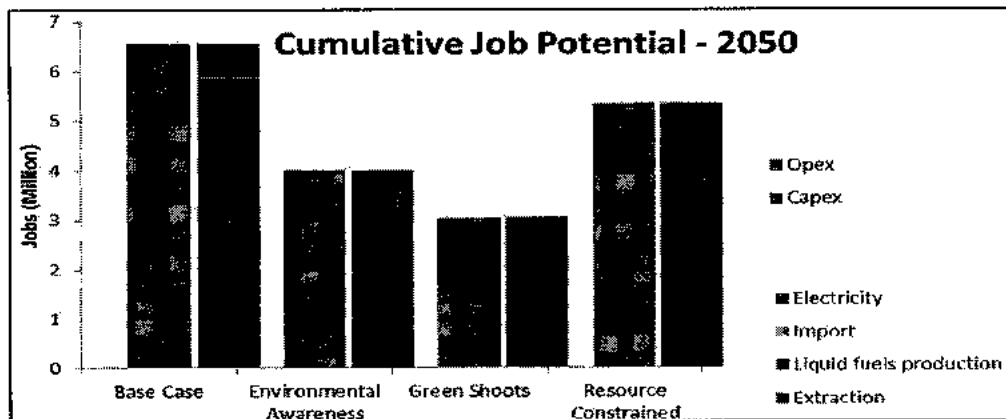
Source: DoE Analysis

Figure 0-34: Potential number of jobs in the energy sector by scenario

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Job potential by investment type (operational and capital expenditure) as well as segment in the energy value chain (extraction, liquid fuel production, electricity generation and imports) are illustrated in Figure 0-35.

As in the four core scenarios, there is a higher potential for jobs in the construction of energy technologies compared to the operation of residual technologies. The reduced potential for jobs in the No Shale Gas Scenario results from no new capital investment in shale gas extraction or in the construction of new GTL refineries. As can be expected, the potential for jobs relating to extraction in the No Shale Gas Scenario is much lower as a result of shale gas not being explored.



Source: DoE Analysis

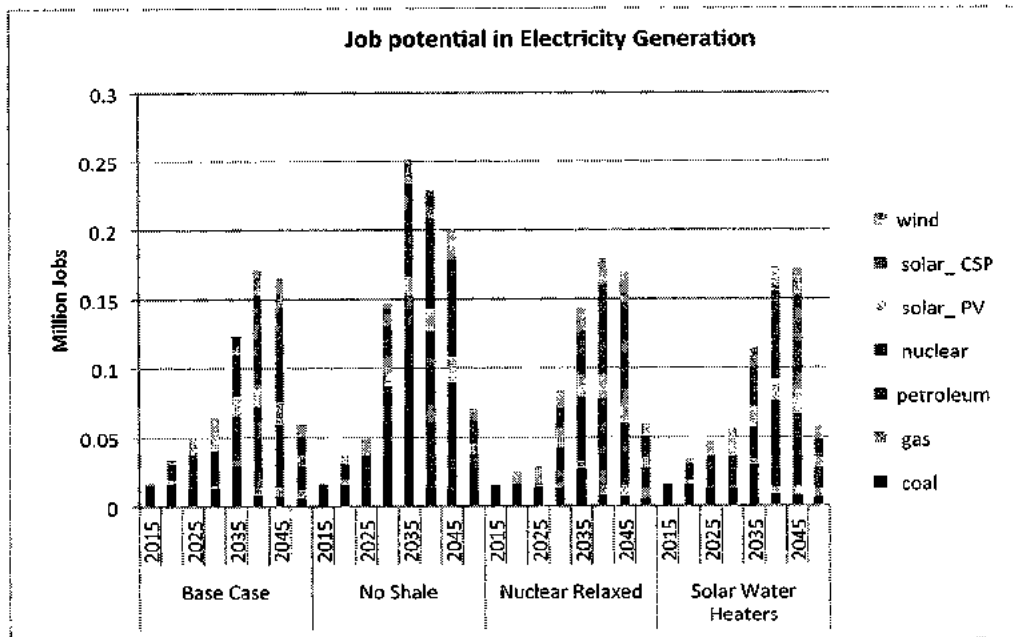
Figure 0-35: Cumulative jobs in the energy sector by scenario

The job potential for the electricity generation sector for the scenarios is shown in Figure 0-36. The No Shale Gas Scenario has the highest job potential over the planning horizon. Most of the potential jobs in this scenario are in the nuclear, solar and coal sectors. In the other scenarios, the nuclear and solar sectors are dominant in creating jobs.

... As in the four core scenarios, there is a higher potential for jobs in the construction of energy technologies compared to the operation of residual technologies ...

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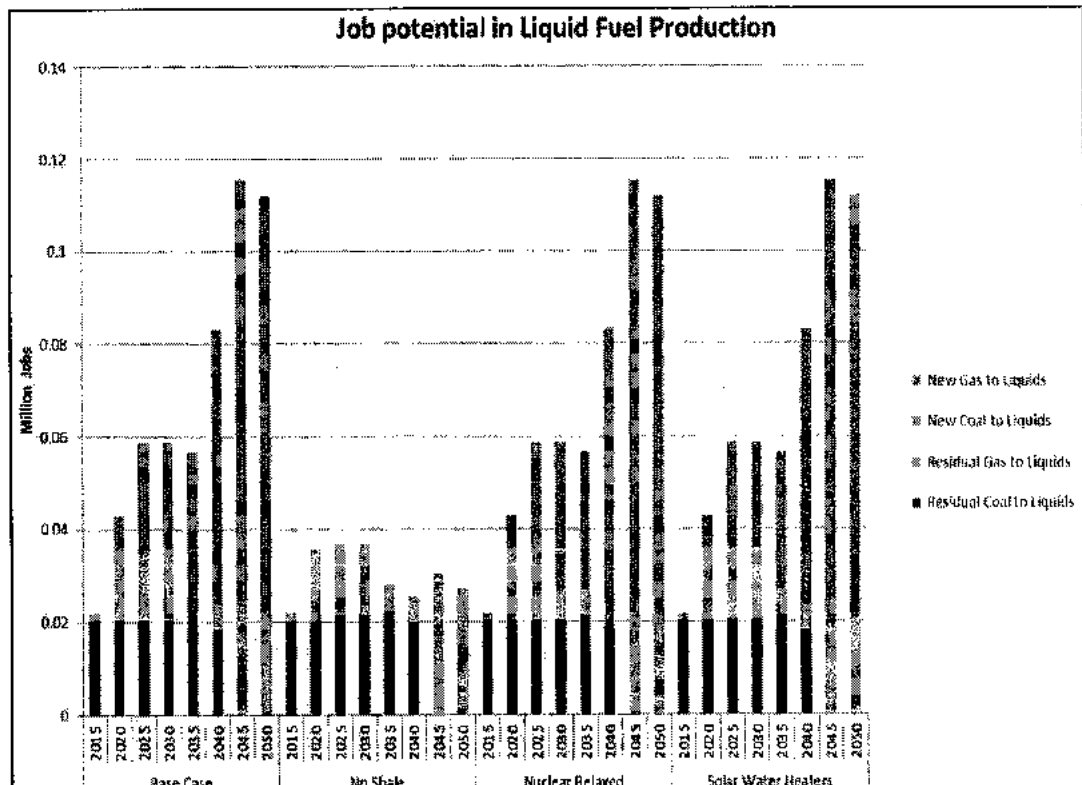
Source: DoE Analysis

Figure 0-36: Jobs for electricity generation by scenario

The job potential in liquid fuel production for the four scenarios is shown in Figure 0-37. The same numbers of jobs are created in the Base Case, Nuclear Relaxed and Solar Water Heater scenarios as flexibility in the New Nuclear Build Programme and electricity demand-side interventions have no impact on liquid fuel production capacity requirements. In these scenarios new CTL and GTL plant is constructed, leading to an increase in job potential for these scenarios. In the No Shale Gas Scenario, no new GTL plant is constructed due to economic constraints, with a resultant negative impact on the job potential for this scenario.

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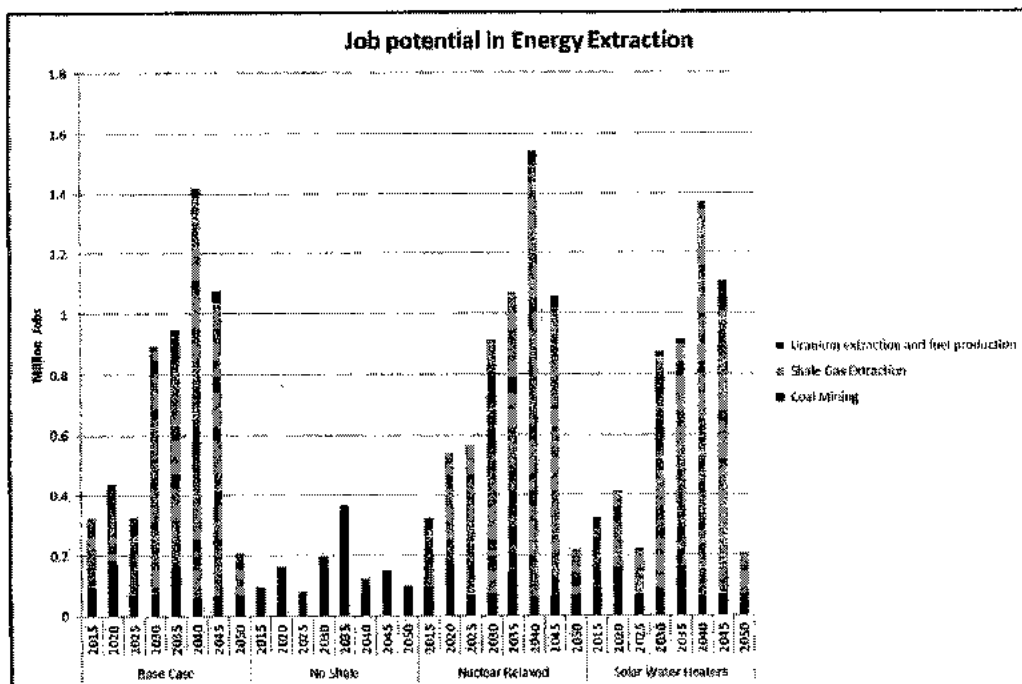
Source: DoE Analysis

Figure 0-37: Jobs for liquid fuel production by scenario

The job potential related to the extraction of coal and shale gas, and the uranium fuel cycle in the four scenarios is shown in Figure 0-38. The Nuclear Relaxed Scenario has the highest job potential. The No Shale Gas Scenario has the lowest job potential due to there being no extraction of shale gas in this scenario.

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Source: DoE Analysis

Figure 0-38: Jobs in the energy extraction sub-sector

6.9.4. Emissions

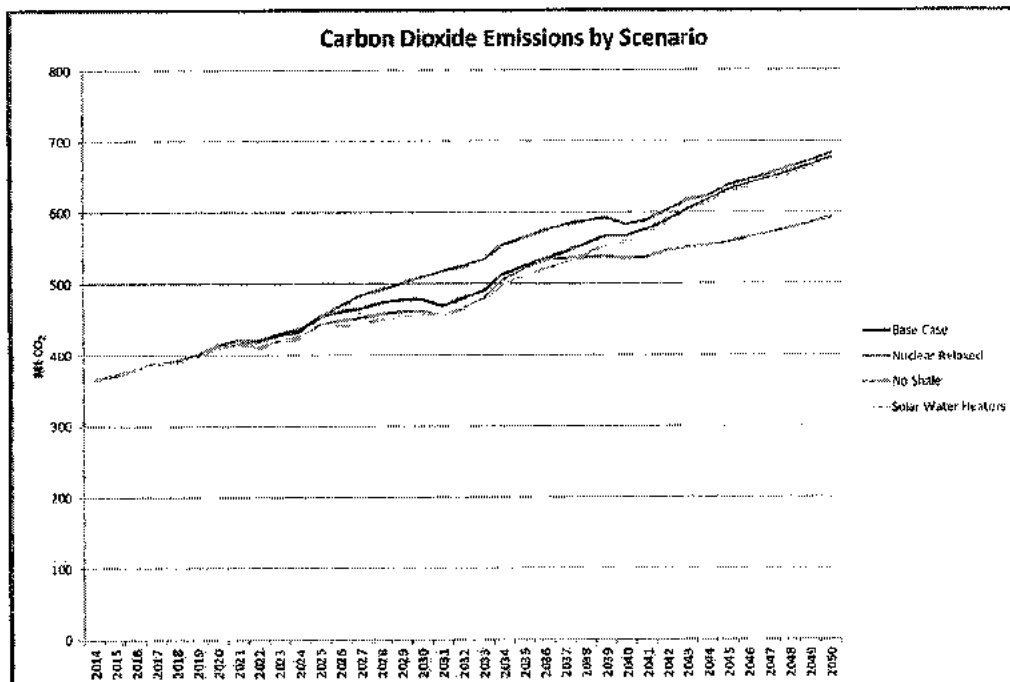
Emissions from the energy sub-sector are compared for the Base Case, Nuclear Relaxed, No Shale Gas and Solar Water Heater scenarios in this section. The emissions are separated into carbon emissions and pollutant emissions.

Carbon emissions

Carbon dioxide (CO₂) emissions for the energy sub-sector, transport sub-sector and final demand sub-sector are shown in Figure 0-39. The total CO₂ emitted until 2019 is approximately the same in all scenarios. Post 2019, the Solar Water Heater Scenario presents the lowest CO₂ emissions until 2030, in keeping with the Solar Water Heater Programme. Post 2021, the Nuclear Relaxed Scenario has the highest CO₂ emissions due to other polluting technologies replacing nuclear technology. The main contributors to the high emissions are the electricity generation sub-sector and the final demand sub-sector. Although the No Shale Gas Scenario presents the lowest CO₂ emissions over the planning horizon, this scenario has the highest emissions from the electricity generation sub-sector due to a higher percentage of coal fired power stations in the generation mix.

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Source: DoE Analysis

Figure 0-39: Total CO₂ emissions (energy supply and energy end-use)**Pollutant emissions**

Emissions of sulphur oxide (SO_x), nitrogen oxide (NO_x), particulate matter (PM) and mercury (Hg) are shown in Figure 0-40. There are significant reductions in SO_x, NO_x and PM in all scenarios as a result of the implementation of emission controls to comply with regulations for new and retrofitted power stations in accordance with Section 21 of the Air Quality Act. As in the core scenarios the reduction of these pollutants can be attributed firstly to PPD emission limits (with the Environmental Awareness Scenario attracting the more stringent PPD lower limit) set across all scenarios; secondly to costing of all externalities associated with NO_x, SO_x, PM, Hg; and finally to Flue-gas Desulphurisation (FGD) being compulsory in all new coal fired plant and life extensions to existing coal fired plant. This results in a preference for non-fossil fuelled electricity-generating technologies.

FGD has a considerable impact on the reduction of SO_x emissions as shown in Figure 0-40. The main driver of SO_x and Hg pollution is the content of these pollutants in the coal used in coal fired power stations and CTL plants.

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PM in the electricity generation sub-sector is reduced by retrofitting fabric filters, as part of the life extension of existing power stations. Emissions of NO_x and PM are also produced in the transport sub-sector thereby contributing to the slower reduction in these emissions when compared to other pollutants. Post 2025 until 2032, NO_x emissions in the Nuclear Relaxed Scenario are higher than in the other scenarios, due to higher emissions from the electricity generation sub-sector. Post 2035, NO_x emissions in the No Shale Gas Scenario dominate due to the use of environmentally unclean electricity generation technologies.

PM and Hg emissions in the No Shale Gas Scenario are marginally higher than in the other scenarios, due to a higher percentage of coal fired power stations in this scenario.

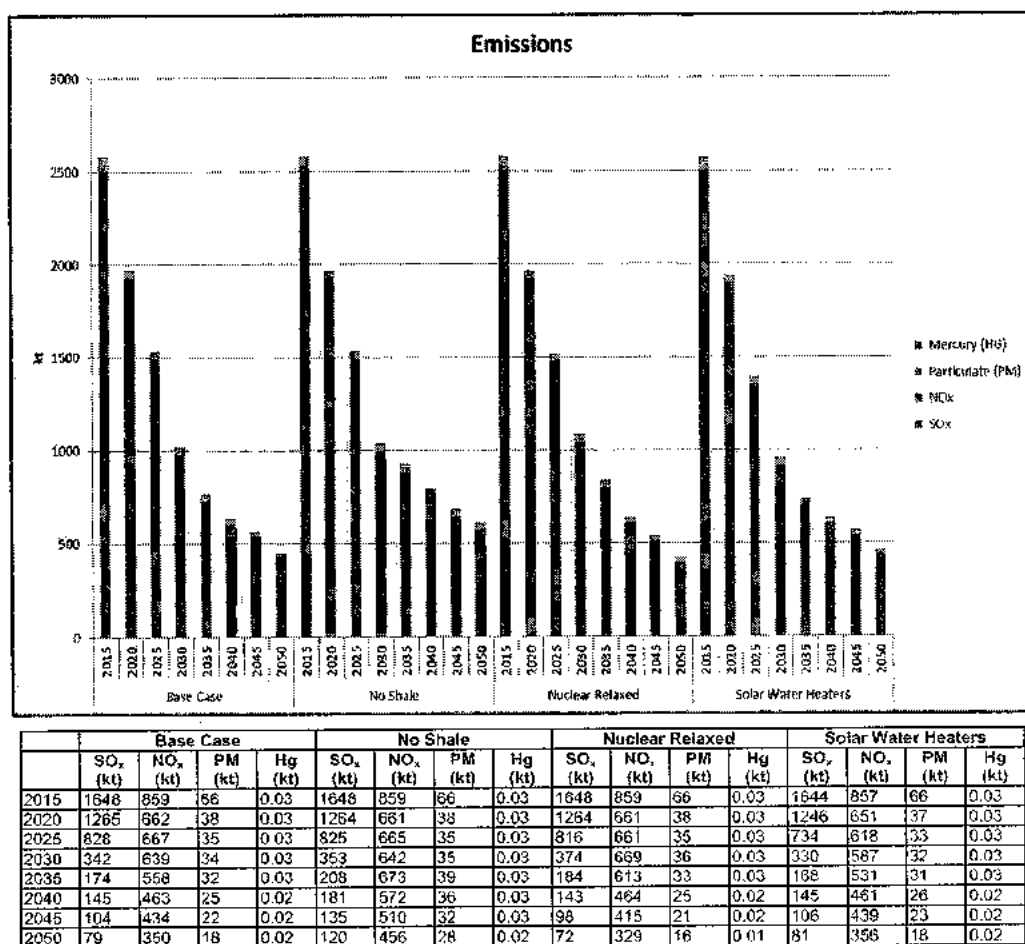


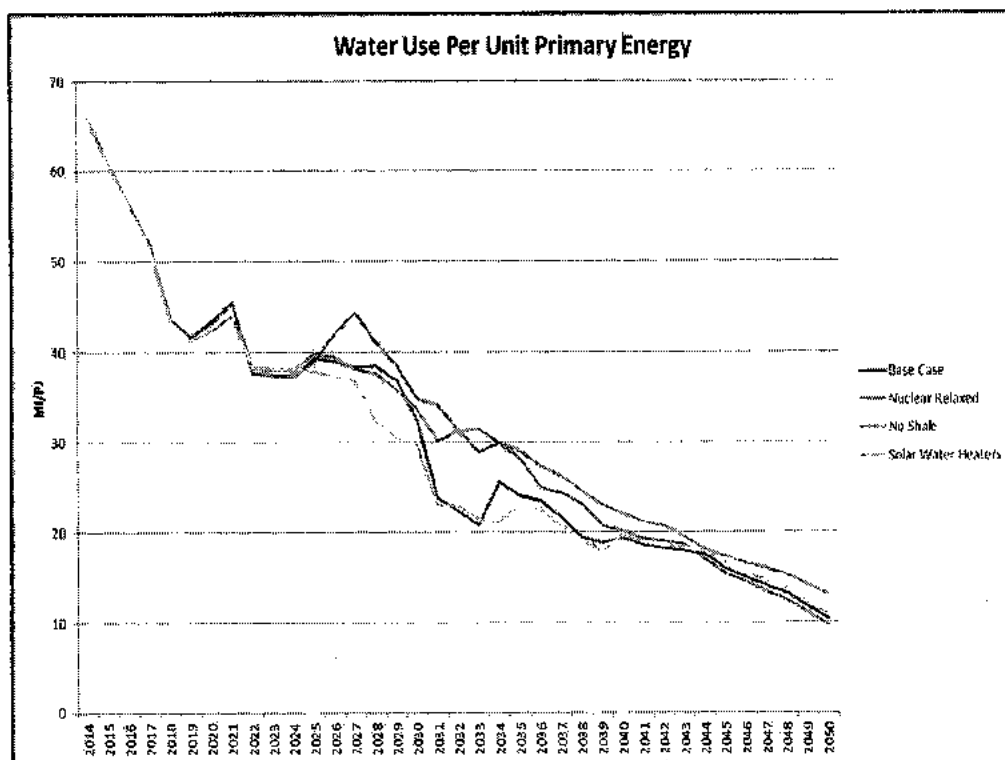
Figure 0-40: Total emissions from the energy sub-sector

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6.9.5. Water consumption

Water consumption across the four alternate scenarios is shown in Figure 0-41. Water consumption per unit of primary energy decreases across all scenarios over the planning horizon, because all future coal fired power stations will be air cooled rather than water cooled. A slight variation in water consumption occurs across all scenarios up to 2023. Post 2023 until 2032, the Nuclear Relaxed Scenario is the most water intensive, followed after 2032 by the No Shale Gas Scenario.



Source: DoE Analysis

Figure 0-41: Total water use in the primary energy sub-sector

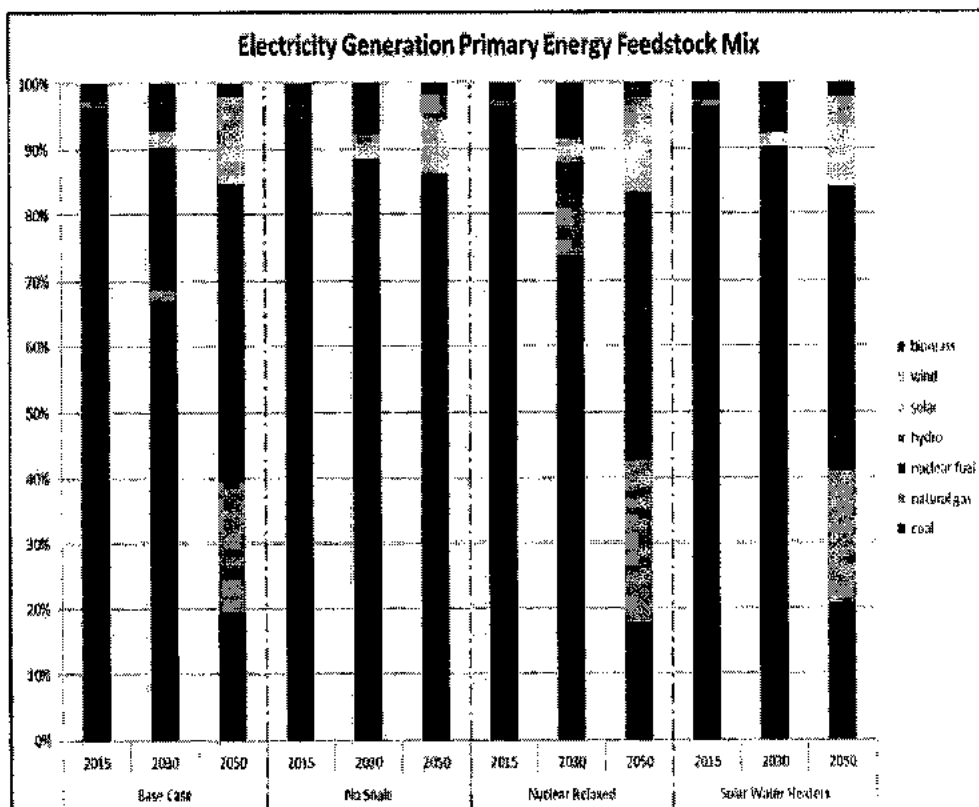
6.9.6. Primary energy mix (diversity)

Changes in the primary energy feedstock mix for electricity generation, liquid fuel production and final end-use are shown in Figure 0-42, Figure 0-43 and Figure 0-44. Coal and gas feature in all sectors except in the No Shale Gas Scenario. Coal constitutes close to 90% of the primary energy mix for electricity generation in 2015 in all scenarios. The use of coal declines to below 30% of the primary energy mix by 2050 in the No Shale Gas Scenario and below 21% in the other scenarios. Nuclear fuel features prominently in electricity generation

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from 2030, contributing over 40% of the generation mix by 2050. In the liquid fuel sub-sector, the primary energy mix is dominated by coal and gas in the Base Case, Nuclear Relaxed and Solar Water Heater scenarios, with gas becoming the more prominent energy carrier in the future. In the No Shale Gas Scenario, liquid fuel production is predominantly from coal with total production from coal by 2050. The primary energy mix in the final demand sub-sector comprises coal, gas and wood as in the core scenarios.

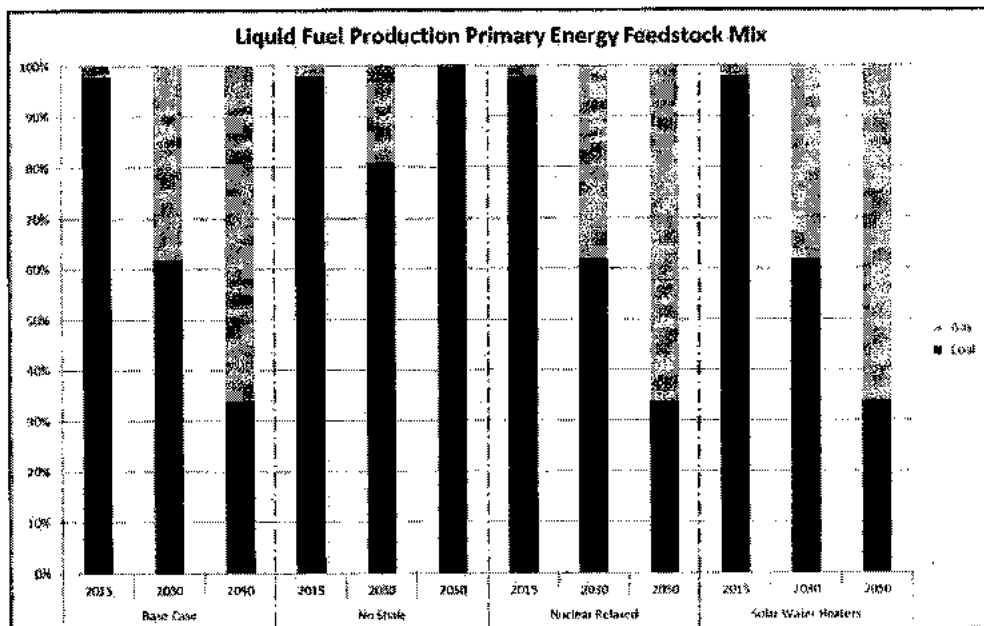


Source: DoE Analysis

Figure 0-42: Primary energy feedstock mix for electricity generation

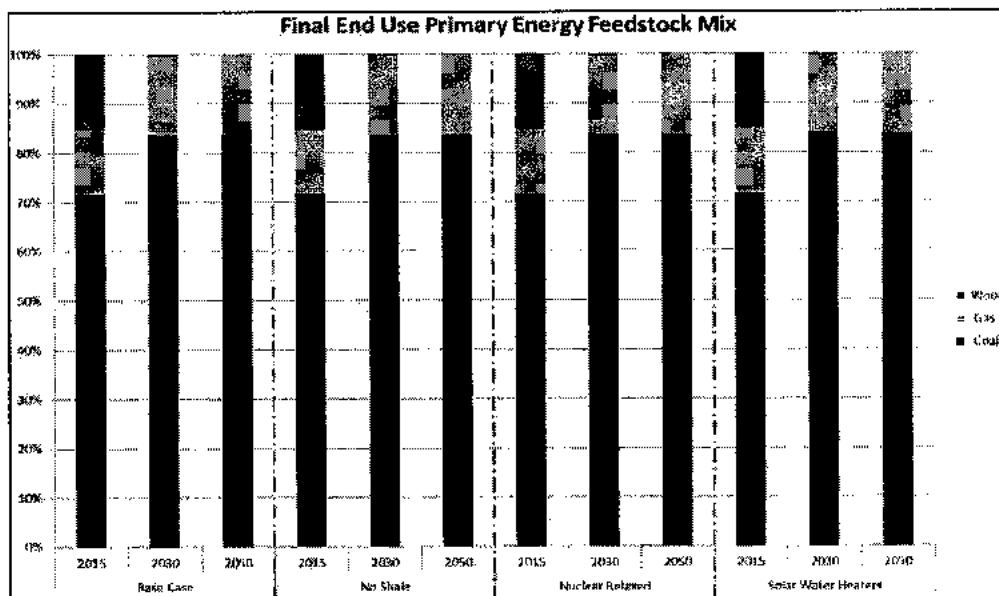
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Source: DoE Analysis

Figure 0-43: Primary energy feedstock mix for liquid fuel production



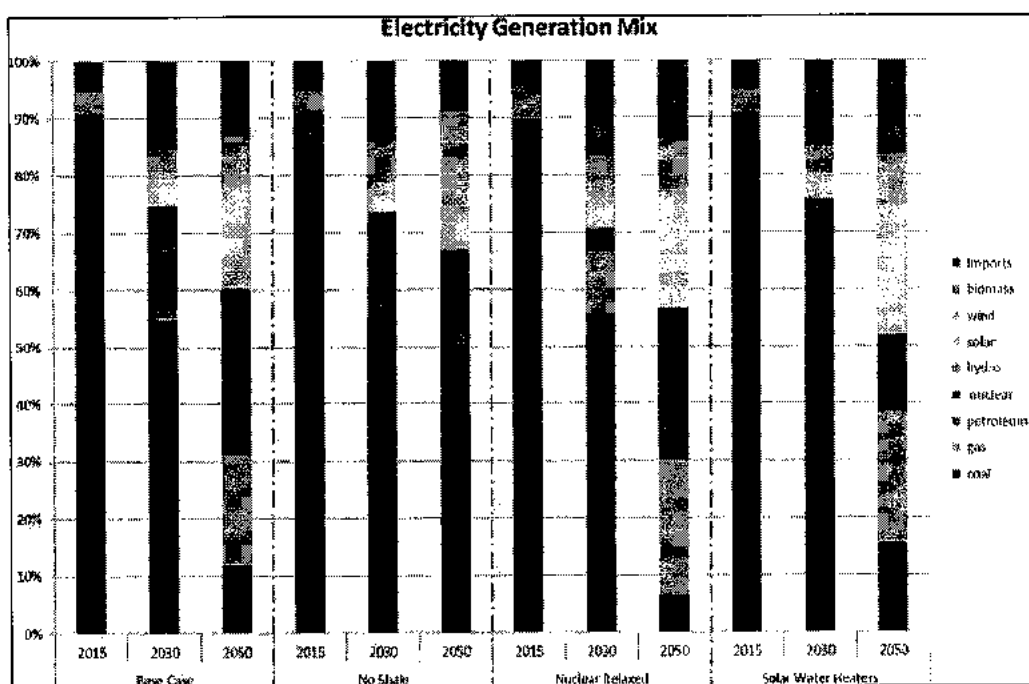
Source: DoE Analysis

Figure 0-44: Primary energy feedstock mix for final end-use

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The change in the primary energy mix for electricity generation across the four scenarios is shown in Figure 0-45. Results for all scenarios are similar to the four core scenarios, with the energy mix becoming more diverse over the period to 2050, and the share of coal reducing from about 85% in 2015 to under 16% in 2050 in the Base Case. Nuclear Relaxed and Solar Water Heater scenarios. In the No Shale Gas Scenario, coal contributes to less than 25% of the energy mix by 2050. Nuclear and solar become more prominent sources of energy in the future in all scenarios.

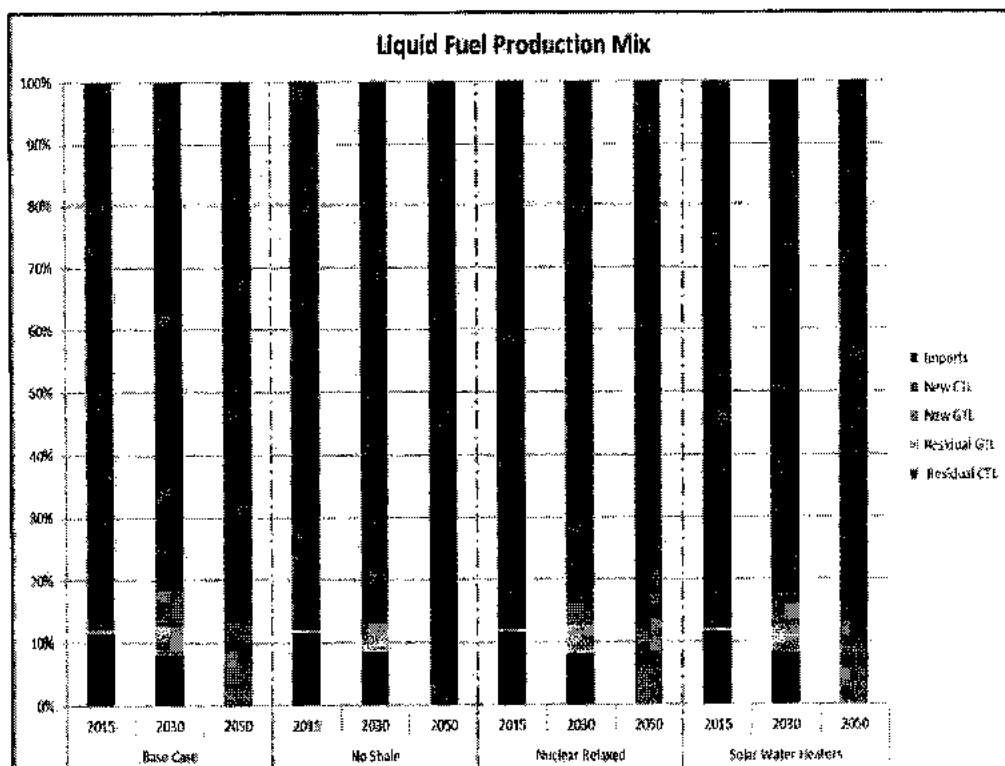


Source: DoE Analysis

Figure 0-45: Electricity generation energy mix

The change in the energy mix for liquid fuel production across the four scenarios is shown in Figure 0-46. Results in all scenarios are similar to the four core scenarios with imports constituting the bulk (75%) of the supply mix over the entire planning horizon. The importation of petroleum products is higher in the No Shale Gas Scenario due to reduced domestic production of petroleum products based on the assumption that shale gas is not economical as a primary fuel option.

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Source: DoE Analysis

Figure 0-46: Liquid fuel production energy mix

6.9.7. Liquid fuel imports

The sensitivity of domestic fuel production to refined petroleum product imports was investigated by constraining annual diesel imports. Figure 0-47 shows the annual liquid fuel production when diesel imports are limited to 864 PJ over the planning horizon. Residual oil refineries are the major producer of petroleum products, contributing to 85% of production in 2015 and decreasing to 42% by 2050. Production from new CTL and GTL make up 8% over the planning horizon, with increased production from 2040 onwards. Importation of refined petroleum products increases from 15% in 2015 to 42% by 2050. The percentage change in energy mix for liquid fuel production for the four scenarios is shown in Figure 0-48.

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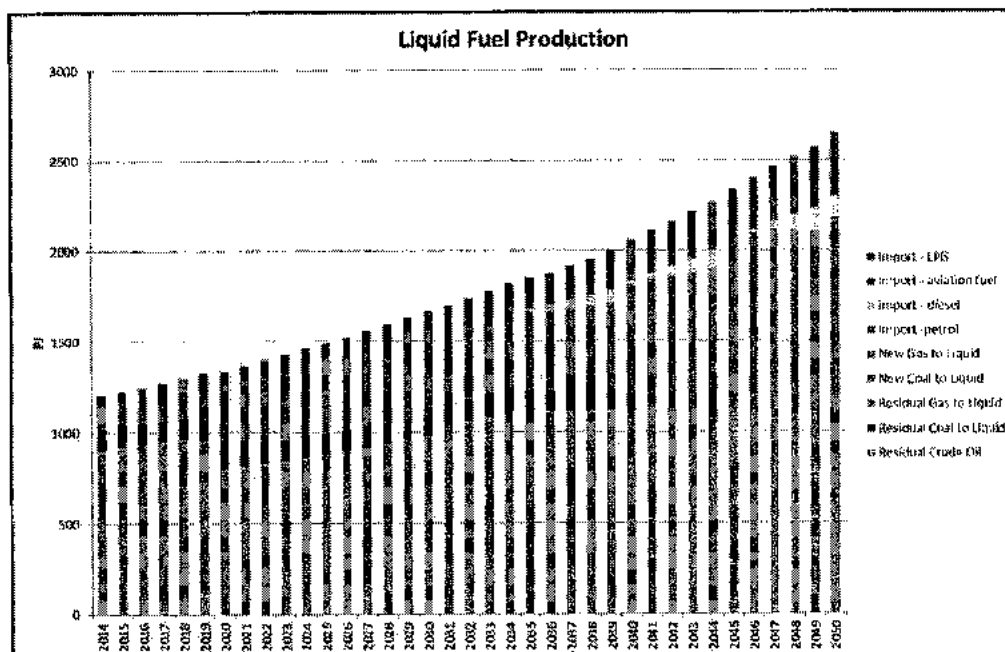


Figure 0-47: Liquid fuel production energy mix – diesel import constrained

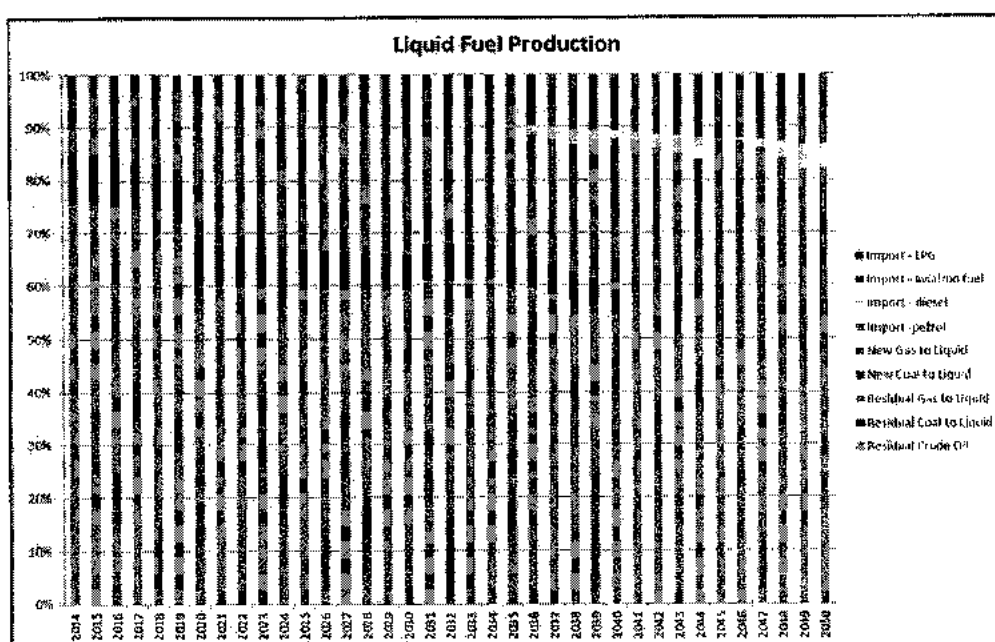


Figure 0-48: Percentage change in liquid fuel production energy mix – diesel import constrained

Section 7: Electricity price path and macroeconomic impact analysis

Electricity price paths were calculated for the four core scenarios and the three sensitivity analyses. Assumptions were made regarding the proportion of new capacity to be built by the state-owned entity (SOE) and Independent Power Producers (IPPs), as indicated in Table 0-1. The percentage split between SOE-built and IPP-built capacity is based on the total required capacity rather than individual unit size.

Table 0-1: Assumed split of build by technology type

Technology type	SOE built	IPP built	Import built
Nuclear	100%		
Coal	70%	30%	
Gas – CCGT and OCGT	70%	30%	
CSP	70%	30%	
Solar PV		100%	
Wind		100%	
Landfill biomass		100%	
Imported hydro, coal and gas			100%

Figure 0-1 shows the assumed proportion of new capacity built by the SOE versus IPPs based on the above split.

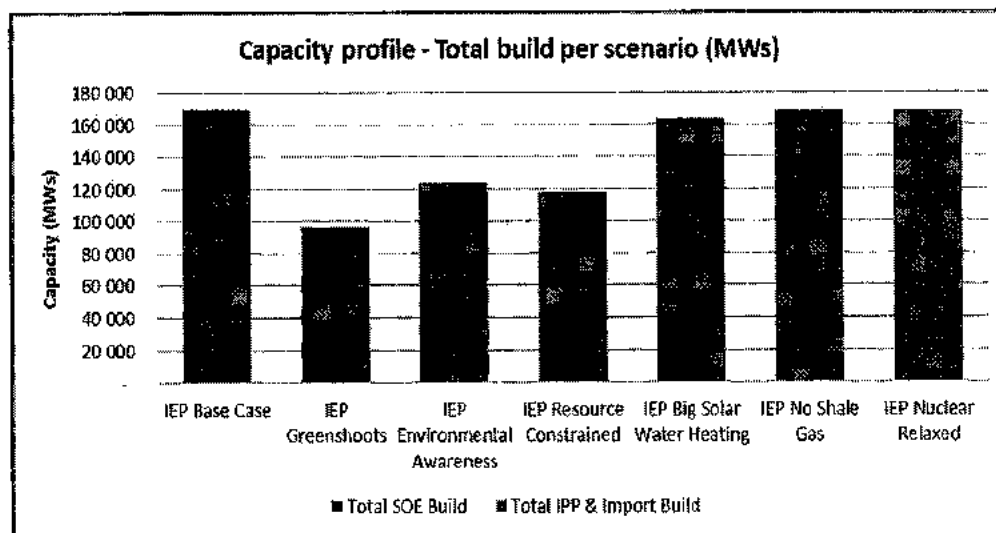


Figure 0-1: Proportion of build for new capacity per scenario

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Figure 0-2 indicates the electricity price paths for all scenarios. The price path for the Environmental Awareness Scenario shows the greatest fluctuations as new investments are more flexible; the scenario shows the highest increase in electricity prices between 2018 and 2028, and again from 2043 onwards. It shows the second lowest prices between 2032 and 2040 following the Green Shoots Scenario. Overall the Environmental Awareness Scenario presents the highest average prices.

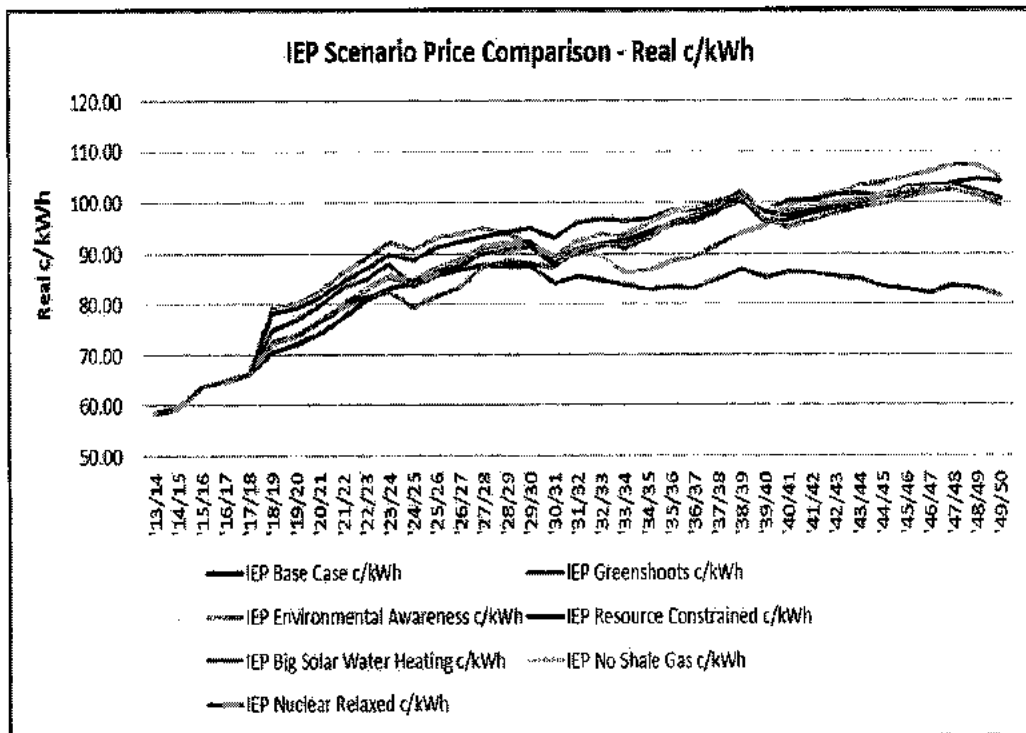


Figure 0-2: Electricity price path across all scenarios

... The Base Case Scenario presents higher average and peak prices as a result of the additional capacity required to meet the energy demand of an economy which is still fairly energy intensive ...

Figure 0-3 reflects the average and peak electricity prices for each scenario. Estimated electricity prices range from 80c/kWh to 105c/kWh, with the Green Shoots Scenario showing the lowest average and peak electricity price due to its reduced new capacity requirements.

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The significant investments in demand-side interventions (i.e. aggressive implementation of the Solar Water Heater Programme and greater improvements in energy efficiency) result in a reduced demand overall for energy and hence lower investments in new electricity generation capacity in this scenario. The Base Case Scenario presents higher average and peak prices as a result of the additional capacity required to meet the energy demand of an economy which is still fairly energy intensive. The higher prices presented in the Environmental Awareness Scenario result from the higher externality costs for fossil fuels.

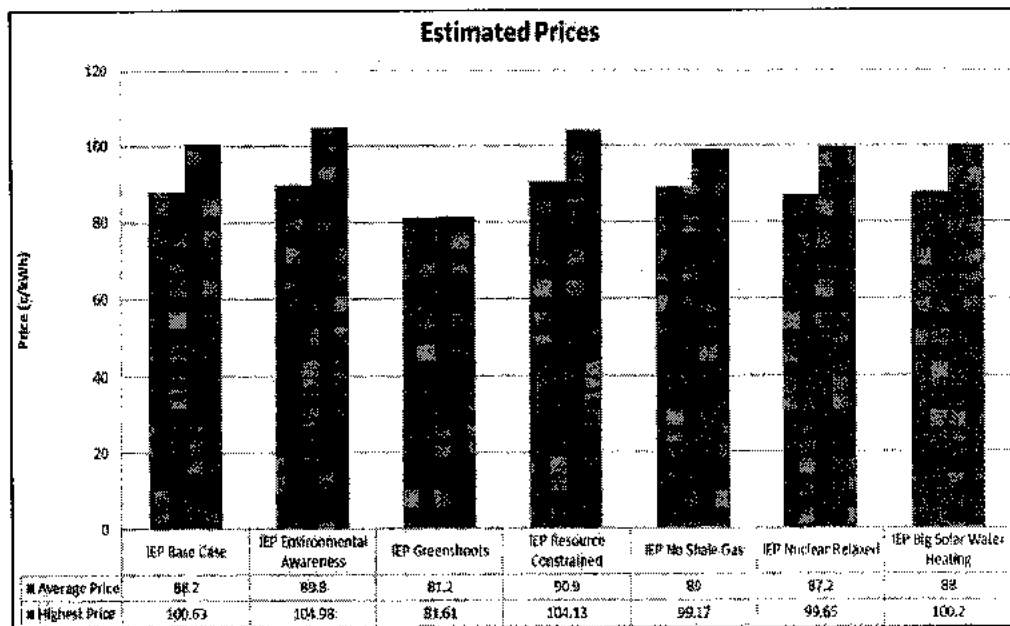


Figure 0-3: Average and highest electricity prices per scenario

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Section 8: Conclusions and recommendations

The future energy landscape is one in which all eight objectives of the IEP are met.

8.1. Security of supply

Security of supply is ensured by timely decisions and investment in new energy infrastructure.

- For the electricity sector, cost reflective tariffs are applied by all generators to ensure that adequate funds are available to:
 - make the necessary investments in new capacity that may be required; and
 - make allocations for required maintenance.
- For the liquid fuel sector, security of supply should be ensured by diversifying, to move away from imported fuel sources. Local production capacity should be considered as a strategy to increase security of supply, however this option must be weighed up against the associated costs.

... The future energy landscape is one in which all eight objectives of the IEP are met ...

8.2. Cost of energy

- New electricity generators should be brought on line through a competitive bidding process, where the ability to generate electricity at low cost is a key criteria.
- The implementation of new nuclear capacity should be conducted in a manner that has the least cost impact on the energy system. The implementation of the 9.6 GW New Nuclear Build Programme, as espoused in the IRP2010, should be reviewed such that the scale and pace of the programme has a less severe impact on electricity tariffs than an expedited programme.
- South Africa is a price taker and the price of petroleum products is influenced by global crude oil prices. Where possible, maximum (i.e. capped) retail prices should continue to be implemented for fuels such as LPG and natural gas to encourage the switch away from electricity.

8.3. Diversified energy mix

A diversified energy mix, wherein reliance on a single or a few primary energy sources is reduced, needs to be pursued. For electricity generation, the technology mix should take into consideration the roles that different technologies play in providing baseload and peaking power.

8.3.1. Coal

- Coal will continue to play a role in providing energy in the future, however this will be limited to electricity generation, because alternative and more economically viable options such as gas and crude oil exist for the production of liquid fuels. Coal is suitable for providing baseload power and will continue to do so in the foreseeable future. It will, however, be displaced substantially over time by a diverse mix of energy carriers including solar, wind, nuclear and gas. These alternatives reduce GHG emissions and other pollutants, help to improve security of supply and in most cases lower the cost of providing energy when externality costs are accounted for.
- Coal will, however, play an increased role should gas prices prove not to be competitive (either in the form of economically recoverable shale gas or imported gas).
- Coal-to-liquid plants are not viable in an environment of stringent emission constraints or when externality costs are taken into consideration. New investments are not envisaged and this is unlikely to change in the future.
- Investments should be made in research targeted at clean-coal technologies, including carbon capture and storage and underground coal gasification. Such research will ensure that South Africa develops mechanisms to exploit this indigenous resource responsibly in the long term.

... For electricity generation, the technology mix should take into consideration the roles that different technologies play in providing baseload and peaking power ...

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8.3.2. Nuclear

- In efforts to mitigate climate change while ensuring a steady source of electricity supply, nuclear will need to play a more prominent role in the provision of baseload power in the energy mix.
- The sensitivity analysis for the Nuclear Relaxed Scenario (which realises 25 GW of new nuclear capacity by 2050) indicates that the ~~timing and pacing for additional generation capacity from nuclear can be revised, such that the first unit starts~~ generating power from 2030, without causing a further negative impact on the adequacy of electricity supply before that period because other options can be deployed faster.
- The No Shale Gas sensitivity analysis (which assumes no economically recoverable shale gas) sees 45 GW of new capacity from nuclear by 2050. The availability of competitively priced gas will determine the magnitude of nuclear required in the energy mix.
- Given the long lead times associated with the development of nuclear projects, it is recommended that preparatory work on the New Nuclear Build Programme continue to take place and that the decision be prioritised as to the vendor/s with whom South Africa will partner.

... In efforts to mitigate climate change while ensuring a steady source of electricity supply, nuclear will need to play a more prominent role in the provision of baseload power in the energy mix ...

8.3.3. Natural gas

- Conventional and unconventional natural gas should play a more prominent role in South Africa's future energy mix both in the electricity sector and in the liquid fuel sector. Natural gas is a cleaner energy source than coal; it can be used as a primary energy source for power generation and for liquid fuel production and directly in end-use applications such as thermal.
- Gas-fired Combined Cycle Gas Turbines (CCGTs) present the most significant potential for developing the gas market in South Africa. The advantages of CCGT power plants include:
 - Relatively short construction and commissioning lead times;
 - Low capital costs per unit of capacity;

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- Increased efficiency using simple and proven technology;
- Operational flexibility as they can be ramped up or down to suit the system demand on an hourly or daily basis. They are therefore suitable to meet unexpected spikes in electricity demand and also for complementing intermittent generation from renewable energy plants.
- When situated at the coast they have several benefits, including:
 - The ability to use sea water as a cooling medium;
 - Providing an additional source of power close to source in high usage areas;
 - If supplied through an LNG terminal, the LNG terminal can be expanded to supply other industries.
- Gas as feedstock to GTL is a viable option should gas prices allow for this or should local exploration activity yield recoverable gas resources.
- Switching from electricity to gas as a fuel source should be prioritised. Direct use of natural gas in industrial processes could be the starting point for the development of a gas market in South Africa in the medium to long term as this presents the most significant potential and could assist in providing energy requirements in support of the re-industrialisation policy.
- Compressed Natural Gas (CNG) is already being used on a small scale in the transport sector by minibuses and buses. The CNG market could be expanded in the long term and could help to reduce the demand for the import of liquid fuels in the sector.
- Regional co-operation with gas-rich countries such as Mozambique, Tanzania and Angola should be strengthened. Agreements with neighbouring countries should be pursued for the purpose of joint development and exploitation in countries that have abundant resources. South Africa, through its state-owned entities and other local players in the sector should co-invest in the development of gas projects in these countries.
- The No Shale Gas Scenario includes more coal, nuclear and renewable technologies in the energy mix and also reflects significantly higher total energy system costs. Recoverable shale gas could thus become a game changer for the South African energy landscape if it is exploited in a responsible and transparent manner. The perceived environmental risks of extracting 'tight' gas such as shale gas are considered to be significant, requiring substantial amounts of water and presenting a challenge in water-scarce areas. There are also concerns regarding the possible contamination of ground water, which may result from improper disposal of fluids during the hydraulic fracturing process. Amendments to the Minerals and Petroleum Resources Development Act (MPRDA) are currently being finalised and will set the

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legislative framework for the extraction of shale gas. Regulations which define the manner in which extraction must be done have been finalised and will become operational once the amendment to the MPRDA has been enacted.

- The availability of indigenous shale gas at affordable prices makes the case for GTL, GTP and the direct application of gas for thermal needs feasible. Exploration to determine the extent of locally recoverable resources therefore needs to be expedited.
- South Africa should consider appropriate alliances and possible joint ventures to further the development of coal bed methane opportunities in other countries such as Botswana and Zimbabwe.

8.3.4. Crude oil and imports of final liquid fuels

- The low contribution of crude oil in the energy mix across all scenarios has been informed by assumptions regarding its availability; lower priced gas (mainly comprising natural gas); and no externality costs imposed on imported refined product.
- However, should the levels of economically recoverable shale gas be insignificant, new crude oil refineries will be needed in the medium to long term.
- If externality costs are imposed in the price of imported fuels, the cost of imported fuels increases which in turn has a negative impact on the balance of payments.
- Therefore in order to ensure security of supply and to reduce the negative impact on the balance of payments due to imports of refined product, new refinery capacity will be essential. New refinery capacity should meet the new fuel specifications.

8.3.5. Solar

- Solar should play a much more significant role in the electricity generation mix than it has done historically, and constitutes the greatest share of primary energy (in terms of total installed capacity) by 2050. The contribution of solar in the energy mix comprises both CSP and solar PV. Solar PV includes large scale installations for power generation which supply to the grid and individual, off-grid solar home systems and rooftop panels.
- Several interventions which could enhance the future solar energy landscape are recommended as follows:
 - Large scale CSP projects with proven thermal storage technologies and hybridisation/industrial steam application projects should be incentivised in the short to medium term. In the long term the existing incentives could be extended

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to promote locally developed CSP technology storage solutions and large scale solar fuel projects.

- A thorough solar resource assessment for South Africa should continue to be undertaken in the Northern Cape Province and extended to other provinces deemed to have high solar radiation levels.
- Investments should be made to upgrade the grid in order to accommodate increasing solar and other renewable energy contributions.

8.3.6. Wind

- In addition to solar, wind energy should continue to play a role in the generation of electricity. Allocations to ensure the development of wind energy projects aligned with the IRP2010 should continue to be pursued.

8.3.7. Renewable Energy Independent Power Producer (REIPP) Procurement Programme

- To ensure the ongoing deployment of renewable energy technologies, the REIPP Procurement Programme should be extended and new capacity should be allocated through additional bidding windows.
- Experience and insights gained from the current procurement process should be used to streamline and simplify the process.
- The implementation of REIPP projects in subsequent cycles of the programme should be aligned with the spatial priorities of provincial and local government structures in the regions that are selected for implementation, in line with the Spatial Development Frameworks. This will ensure that there is long-term, sustainable infrastructure investment in the areas where REIPP projects are located. Such infrastructure includes bulk infrastructure and associated social infrastructure (e.g. education and health systems). This alignment will further assist in supporting the sustainable development objectives of provincial and local government by benefiting local communities.
- The Department of Environmental Affairs has commissioned the CSIR to undertake a Strategic Environmental Assessment aimed at facilitating the efficient and effective rollout of wind and solar PV energy in South Africa. The assessment covers the infrastructure projects identified by the Presidential Infrastructure Coordinating Commission, and aims to identify strategic development areas for renewables with the intention of integrating environmental considerations with social and economic benefits in those areas at implementation level. (CSIR, 2015).

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- To this effect Renewable Energy Development Zones (REDZs) have been identified and describe geographical areas:
 - In which clusters (several projects) of wind and solar PV development will have the lowest negative impact on the environment while yielding the highest possible social and economic benefit to the country;
 - That are widely agreed to have strategic importance for wind and solar PV development;
 - Where the environmental and other authorisation processes have been aligned and streamlined based on scoping level pre-assessments and clear development requirements; and
 - Where proactive and socialised investment can be made to provide time-efficient infrastructure access.
- The Strategic Environmental Assessment been implemented in the Western Cape, Northern Cape, and KwaZulu-Natal. The assessment should be extended to all provinces where there is potential for renewable energy.

*[... the REIPP Procurement Programme should be extended and
 new capacity should be allocated through additional bidding
 windows ...]*

8.3.8. Biomass

- Cogeneration is the simultaneous production of electrical and thermal energy from a single fuel source and is sometimes also termed combined heat and power (CHP). These systems are characterised according to the sequence of energy types generated. Topping cycle systems produce electricity first, and then recover the excess thermal energy for heating or cooling applications. Topping cycle cogeneration is widely used and is the most popular method of cogeneration (Sanedi, 2013). In contrast, bottoming cycle systems utilise a process where waste heat from an existing process is used to produce electricity. Bottoming cycle systems are mainly deployed in industries that require a large amount of process steam (e.g. cement and petrochemical plants) (Sanedi, 2013).
- Biomass (inclusive of bagasse and wood waste) plays an important role in the provision of electricity close to the demand location through cogeneration. Given the current electricity supply challenges, cogeneration options should be pursued in order to address electricity capacity constraints in the short to medium term.

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- The optimal use of waste energy in cogeneration results in an increase in the overall efficiency of the heat and power production processes. The fuel intake for the combined process is less than that required for the individual heat and power production processes. Other advantages of on-site cogeneration include a positive contribution to the reduction of greenhouse gas (GHG) emissions, due to a reduced dependence on grid supply. Reduced dependence on the grid also helps alleviate capacity constraints and transmission losses. In the case of feed-in to the national grid, cogeneration can assist in increasing generation capacity on the network.
- To date only a few cogeneration plants have been constructed in South Africa. These include amongst others, a biomass cogeneration plant at an abattoir in Jan Kempdorp in the Northern Cape, a gas turbine tri-generation plant at MTN in Johannesburg, cogeneration from natural gas at Sasol Synfuels, and cogeneration from calcium carbide furnace waste gas at SA Calcium Carbide. The overall efficiency of the biomass cogeneration plant is 84.6%, with savings of 247 MWh/year in electrical energy and 991 MWh/year in diesel heating energy. The annual reduction in emissions is 2000 t CO₂-equ. The total energy savings of the gas turbine tri-generation plant at MTN is 26 GWh/year and the annual reduction in emissions is 2000 t CO₂-equ. Annual reduction in emissions for the Sasol Synfuels plant is in excess of 1 Mt CO₂-equ (Sanedi, 2013).
- The sugar industry in South Africa has demonstrated commitment to expanding cogeneration capability. Sugar cane is a renewable energy source, and the production of electrical energy from sugar cane fibre is receiving increased attention due to the positive spin offs in terms of security of supply and greenhouse gas (GHG) emission reductions.
- The South African sugar industry produces an average of 2.2 Mt of sugar per annum (South African Sugar Association, 2015). Sugar cane is supplied to 14 mills where it is processed into sugar (South African Sugar Association, 2015). Bagasse and molasses are produced in the process. Bagasse is the fibrous biomass that remains after sugar cane stalks are crushed to extract the juice. According to Tongaat Hulett Sugar, every 100 tons of sugar cane harvested and milled produces 10 tons of sugar and 28 tons of bagasse (Tongaatt Hulett Sugar, 2015). Some of the sugar mills are undertaking cogeneration of electricity from bagasse but mainly for their own consumption and a small amount is exported into the national grid.
- The South African sugar industry generates about 5.9 Mt of bagasse per annum. The power output per ton of sugar cane in the South African industry is approximately 30 kWh (Mbohwa, 2013). The industry produces a total of 742 GWh of electrical energy per year, most of which is consumed by the industry itself. A great deal of potential

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exists to increase the energy output of the industry by adopting more efficient cogeneration technologies and this should be pursued and supported through the cogeneration programme, which is currently being implemented by the DoE.

... New energy infrastructure investments that contribute to the creation of jobs within the energy sector should be favoured ...

8.3.9. Hydrogen and fuel cells

Opportunities related to hydrogen technologies can help to establish South Africa's place in the fuel cell sector both locally and globally. A sizeable pilot demonstration will maximise the opportunities for local adoption as well as incorporation of local technology content in said systems in the foreseeable future.

- **Stand-alone 1-20 kW power systems**

Substantial opportunity exists in the electrification of municipalities and operations that are too far from the nearest grid point to be included in short- and medium-term grid expansion plans.

Fuel cell systems can also be used in residential and commercial buildings, as back-up power or in energy efficiency demand-side management (EEDSM) initiatives to shift load and reduce pressure on the generating capacity.

- **Storage for Renewable Energy (P2G technology)**

Hydrogen is an ideal medium to 'store' excess electricity during off-peak times by producing hydrogen through electrolysis using the excess electricity and then using the stored hydrogen to produce electricity via fuel cells during peak/required times. This is specifically relevant to the new renewable energy being introduced on the national grid, where wind and PV power, which is not dispatchable, poses integration and stability challenges.

- **Combined Heat and Power (CHP) units**

Smaller 1-2 kW fuel cell systems can be used in residential buildings as back-up power or prime power in EEDSM initiatives to shift load and reduce pressure on the generating capacity. This creates substantial opportunity for off-grid applications, and should be considered for inclusion in long-term grid expansion plans.

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- **Back-up Power and Prime Power Units**

Portable/stationary power is a niche market, where proton-exchange membrane (PEM) fuel cells and hydrogen storage technology are likely to compete commercially with alternative solutions in the near-term (next five years). This is particularly true for remote areas, where there is no road infrastructure, making transportation of fuel costly. Uninterrupted Power Supply (UPS) for telecommunication systems is a rapidly growing market, particularly in regions where there is a rapid growth of mobile phone users (Asia and Africa). South Africa seems very well positioned to be part of the telecom infrastructure development in the southern parts of Africa. Hence, there has been a special focus in HySA Systems on 1–5 kW class UPS/prime power for telecom and rural applications and for African conditions.

- **Hydrogen Fuelled Vehicles – Rail transport**

Hydrogen powered rail transport systems have been developed and are being tested at various locations worldwide. An ideal (but not the only) application in South Africa would be on the Sishen-Saldanha iron ore railway line. As a long-term solution, implementing hydrogen-powered locomotives will assist to expand capacity on the line and will reduce reliance on diesel fuel and alleviate pressure on electrical supply on the line as well as potential transmission and distribution line upgrades. This railway line is close to a number of new solar installations and could potentially tap into hydrogen resources produced using renewable energy.

8.4. Job creation and localisation potential

New energy infrastructure investments that optimise the creation of jobs within the energy sector should be favoured. More importantly, these jobs should be sustainable, either due to their relevance throughout the operating life of a plant or as a result of the continuous deployment of a particular technology. In addition, the ability to ensure that local skills exist and are utilised or can be easily developed should be a key criterion.

- To find a combination of technologies that both makes sense for the economy and is cohesive within the energy ecosystem, a systems approach to a solution needs to be considered.

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- **Overall costs:** No matter how many jobs a technology can create, if the cost of creating those jobs is too high (e.g., results in a significant increase in energy prices), then the gains through direct employment in energy generation are counter-productive.
- **Skills and capabilities:** Temporary construction jobs have minimal long-term impact compared to permanent employment, however the build programme can be planned to account for these spikes in temporary employment.
- **Industrialisation potential:** Technologies that have the potential to deliver jobs in other parts of the South African economy could make a bigger contribution to overall development objectives than a technology that creates jobs in just one sector.
- **Maximising localisation potential:** By focusing on a few demand and supply levers, South Africa should be able to increase the localisation potential of certain technologies.
- **Broader macroeconomic impact:** Focusing only on job creation potential in a particular sector or technology may mean that fewer resources are available for other more productive activities, potentially reducing the economy's long-term productivity, and hence growth prospects, therefore broader macroeconomic considerations need to be taken into account.
- The number of jobs that a single technology can potentially generate is therefore only one consideration amongst others that should inform long-term energy policy making.
- **Nuclear:** The McKinsey study shows that while nuclear plant construction generates the highest number of total job years per GW installed, the localisation of these jobs would require significant investment and South Africa would need to be globally competitive in order to create sufficient demand to warrant local manufacturing. This challenge is minimised when the construction of nuclear plants takes the form of an extended fleet programme, implemented over an extended period rather than as a standalone, once-off project.
- Other technologies, notably coal, concentrated solar power (CSP) and onshore wind, have a much higher immediate localisation potential of total jobs at 5 GW. Total jobs generated by the extraction technologies have very high localisation potential (over 80% of the total jobs can be localised at 5 GW).
- **Coal** also has significant job creation potential, both during construction and throughout the operating life of the power plants. In addition, coal-fired power plants require sustained mining activity to keep up the supply of coal, which in turn increases the number of associated supplier jobs. However the impact of carbon

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emissions on the climate and environment is an inhibiting factor and once externality costs are taken into account coal no longer becomes an affordable option.

- **Natural gas** as an energy source has the potential to create jobs in many fields, from extraction (in the case of shale gas) to the generating of power in CCGT plants and the liquefaction process in GTL plants. Besides the fact that affordable, locally produced gas could replace current imports of petroleum, it has the potential to make South Africa more competitive and would boost domestic growth (and hence job creation) in industries that can make direct use of natural gas. These include process heating in the manufacturing sector (e.g. cement, fertiliser, methanol/ethanol, glass, paper and pulp, plastics, steel and aluminium) and as a feedstock (e.g. plastic polymers, glass sheets).
- **CSP** creates the most jobs in terms of capital investment and operating expenditure. The technology is still, however, relatively expensive and without storage does not provide a stable source of baseload power. In addition, depending on where CSP plants are located, there could be a requirement for significant investment in additional transmission lines to densely populated areas. As a result, installing CSP alone, or for that matter any technology with these same constraints, would not be cost effective for South Africa's economy.
- **Solar PV** technologies present the greatest opportunity for localisation. To this effect several developments should be supported:
 - Establish solar component manufacturing policy framework and supplier park infrastructure to support industry in a similar manner to the way in which the automotive component industry has been supported by the Automotive Industry Development Centre.
 - Expand the offerings of the South African Renewable Energy Technology Centre at the Cape Peninsula University of Technology, to include national train-the-trainer skills development programmes for solar sector component manufacture, system maintenance, installation, and system service skills.
 - Promote joint-ventures with global solar component manufacturers to attract existing know-how and value chains to South Africa – beyond that of the local market. Use export potential to the rest of the continent as an attraction.
 - Promulgate and enforce SABS quality standards, and potentially add tariffs to de-incentivise imports of solar technology components that can be manufactured locally.
 - Assess the optimal levels of local content for each solar technology from a macroeconomic perspective – inclusive of potential export demand to sub-Saharan African markets.

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... South Africa has committed to reducing its Green House Gas emissions by 34% below its 'business as usual' growth trajectory by 2020, and by 42% by 2042 ...

- The diffusion of distributed generation in the energy supply sector will promote localisation, technology transfer and job creation. It is therefore imperative that joint ventures with international partners be created to enable skills transfer and value chains to South Africa. It is also important that a manufacturing framework be developed to ensure that norms and standards are adhered to in the manufacturing process of distributed generation components and subsystems.

8.5. Environmental considerations

- South Africa has committed to reducing its Green House Gas emissions by 34% below its "business as usual" growth trajectory by 2020, and by 42% by 2042. The NCCRWP defines these targeted reductions in total emissions as the 'Peak-Plateau-Decline' (PPD) emissions limit trajectory. Although presenting a higher externality cost and the most stringent emission reduction limits, the Environmental Awareness Scenario presents significantly lower total systems costs than the Base Case. This indicates that pursuing lower emission targets is not necessarily more costly when all other factors have been considered. It is therefore proposed that the lower PPD emission limit trajectory be factored into future energy sector targets. The work currently being undertaken by the Department of Environmental Affairs to translate the total targets into sectoral targets should continue to be pursued.
- The deployment of technologies that utilise primary energy carriers with high carbon content and other pollutants should be reduced over time. Regulatory measures such as the carbon tax should be implemented to discourage future investments in these technologies, while carbon offsets and other innovative incentives such as Renewable Energy Certificates and Energy Efficiency Certificates should be explored and implemented.
- The introduction of cleaner fuel specifications (Clean Fuels 2) will improve vehicle efficiency and thus fuel consumption, which will ultimately reduce dependence on imported crude oil. Requirements for new refining capacity will be reduced and the quality of the environment will improve through the resultant reduction in pollution from vehicles.

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8.6. Water usage

- The Environmental Awareness Scenario presents the lowest total water requirement of all the core scenarios. For electricity generation, implementation of new technologies such as dry-cooling in coal fired power stations and the location of nuclear plants along the coast should continue to be pursued as these assumptions have contributed to the low emissions trajectory as well as significant reductions in water consumption.

8.7. Demand-side interventions

Various demand-side levers can be considered to reduce the energy intensity of the economy. Improvements in end-use technology and fuel-switching are some of the alternatives. Different mechanisms for implementation apply to different sectors.

8.7.1. Agricultural Sector

Since 1993 the demand for energy in the agricultural sector has grown due to the change in the economic structure. There are key government policies such as the Biofuels Industrial Strategy of the Republic of South Africa and the New Growth Path which emphasise the growth of the agro-processing and agricultural sectors to support job growth in South Africa. Lastly the expected increase in temperature in South Africa will have an impact on the amount of electricity needed for irrigation within the sector, as the water requirements are likely to increase. The following initiatives will play a crucial role going forward:

- Increasing investment in technologies which promote the more efficient use of electricity for pumps in the agricultural sector is essential. Currently irrigation is responsible for 8% of total energy demand within the sector and improvements in pumps would go a long way towards saving energy.
- One of the main objectives of the Biofuel Industrial Strategy is the alleviation of poverty and the creating of jobs, especially in disadvantaged communities. During the implementation phase, effort should be taken to ensure that emerging farmers are prioritised to play a key role in meeting the targets identified. Training on energy efficiency should be integrated into training programmes for emerging farmers working as a part of the subsidy programme.

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- Government should develop and implement a package of specifically designed policies and energy savings measures to promote energy efficiency. This should include promotion of high-quality and relevant information on proven practice for energy efficiency that is appropriate for emerging farmers.

8.7.2. Commercial Sector

Energy consumption in the commercial sector (i.e. both public and private buildings) has continued to increase at a rapid rate and this has become an urgent challenge for the country. This rapid increase in energy consumption by the commercial sector has been observed in many countries around the world, resulting in a special declaration at the G8 Summit, held at the United Kingdom in 2005, calling for improvement in energy efficiency. Due to the challenges of energy inefficiency in the sector, the following recommendations are made:

- The development of databases on energy consumption by both public and commercial buildings and efficiency indices for the evaluation and development of relevant policy measures such as the Energy Efficiency Strategy. The database may also be used to allocate energy efficiency targets and/or incentives for specific buildings.
- The provision of information and the granting of incentives in the sector to promote energy conservation.
- A campaign to clarify the benefits resulting from the dissemination of energy conservation technologies and the implementation of energy conserving policies. This will require specific models to verify the effectiveness of energy conservation measures.

There is significant scope for the use of alternative sources of energy, other than electricity, in the commercial sector.

... There is significant scope for the use of alternative sources of energy, other than electricity, in the commercial sector ...

- Use of LPG for space heating and cooking should be advocated. Mechanisms should be put in place to ensure the deployment of LPG.

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- Heat pumps should be installed in public and commercial buildings to provide for hot water requirements.

8.7.3. Industrial Sector

The South African manufacturing sub-sector is highly energy intensive and depends heavily on energy resources to provide fuel, power and steam for the conversion of raw materials into usable products. The efficiency of energy use, together with the cost and availability of energy, therefore have a substantial impact on the competitiveness and economic health of South African manufacturers. When comparing the Base Case Scenario to the other scenarios the penetration of new technology has a large impact on the future energy requirements of the industrial sector, but the high cost of investment is often communicated as a barrier to the uptake of new technologies. Affordable clean energy strategies and effective energy policies will be top priorities for manufacturers and will serve as important differentiators for highly competitive countries and companies.

- Before purchasing new efficient equipment in order to reduce overall cost, companies should implement energy system efficiency improvements which would contribute not only to the bottom line but also to improved reliability and control. Pay back periods for system optimisation projects are typically short – from a few months to three years – and involve commercially available products and accepted engineering practices. South Africa has local programmes in place where practical assistance is given to companies to implement energy system optimisation within plants (e.g. the National Cleaner Production Centre).
- Systematic energy management is one of the most effective approaches to improving energy efficiency in industries, because it equips companies with information and highlights new opportunities for improvement (IEA, 2012). An energy management system is a collection of procedures and practices to ensure the systematic tracking, analysis and planning of energy use in industry. The implementation of energy management programmes to support the monitoring of National Energy Efficiency Targets is critical to monitoring progress towards future targets.

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- Currently almost 67% of energy use in the sector is for process heating, most of which is supplied by coal and to a lesser extent electricity. The industrial sector therefore presents the most significant opportunity for switching to alternative sources of energy such as natural gas. Natural gas provides a cleaner source of energy than coal and is more efficient for thermal use. The iron and steel sub-sector as well as the mining sub-sector constitute the most significant portion of demand and could be the starting point. Sectors where natural gas could be used for both energy end-use and as a feedstock to produce final product (e.g. plastics; paper and pulp; methanol and ethanol; and fertiliser) also present an opportunity for fuel switching.

... The use of rooftop PV solar panels, heat pumps and other initiatives to reduce the reliance on electricity for thermal use in households should be pursued ...

8.7.4. Residential Sector

The residential sector presents different challenges for end-users across different income levels.

- For higher income households, the most significant challenge is to reduce reliance on electricity, especially for thermal application.
 - Fuel switching from electricity to other fuel sources such as LPG for thermal needs should continue to be pursued.
 - More than 65% of household energy end-use goes towards cooking and space heating. This presents a significant opportunity for switching from electricity, and investments in new housing infrastructure should be coupled with investments in piping infrastructure for gas reticulation.
 - The use of rooftop PV solar panels, heat pumps and other initiatives to reduce the reliance on electricity for thermal use in households should be pursued.
 - Projected increases in future household income will have an impact on the future ownership of appliances. Energy efficiency regulations for electrical appliances are therefore critical to ensure that the intensity of household energy consumption continues to decline in the long term.

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- For low income households, the most significant challenge is to provide access to modern forms of energy and to minimise the use of solid fuel sources such as coal, wood, dung and other biomass:
 - Since household income has the greatest impact on the fuel switching potential of households from solid fuels to cleaner fuels such as LPG and electricity, subsidies for LPG in remote areas should be considered. Settlements close to industrial development zones present an opportunity for cross-subsidisation of LPG for low income households by industrial users at specific locations and various pricing structures and models should be considered.
 - Existing programmes such as the one million Solar Water Heating Programme and the Integrated National Electrification Programme (INEP) have the most impact on reducing the use of solid fuels and unsafe fuels for water heating and lighting and should continue to be pursued.
 - The Universal Electrification Strategy seeks to introduce off-grid electricity solutions to the remotest parts of the country and therefore to address energy poverty where households have no access to electricity, or where households can only afford modest quantities of electricity. Implementation of the strategy should be prioritised as part of the INEP.
 - The long-term, persistent use of solid and unsafe fuels within South African households indicates the need for an integrated household energy strategy, which should amongst other factors:
 - Outline an aggressive implementation plan to move households to cleaner forms of energy in order to minimise the negative impacts which are mostly borne by women and children in low income households.
 - Outline interventions to address issues of safety associated with a range of commonly used fuel types in the households.
 - Build on and bring together all programmes and objectives related to household energy and consider demand and supply options in an integrated manner for all household fuels.
 - Develop a long-term vision that clearly articulates the objectives for household energy transitions in the short, medium and long term.

... Energy for transport is expected to grow by between 50% and 100% over the next 36 years based on current fuel availability and the resulting fuel demand for the various operations ...

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8.7.5. Transport Sector

- Energy for transport is expected to grow by between 50% and 100% over the next 36 years based on vehicle fleet structure and the resulting fuel demand for the various scenarios. The factor with the most significant impact on fuel demand is vehicle energy efficiency (or fuel economy) as evident when comparing the Base Case Scenario with any of the other scenarios. This suggests the important role of vehicle energy efficiency within energy policy in order to manage liquid fuel demand. Vehicle efficiency improvements are equivalent to providing virtual refineries but fuel quality improvements are needed to enable these more efficient vehicles.
- Vehicle efficiency and technology switching play an important role in managing transport fuel demands but they require cleaner fuels. Clean fuels therefore should be implemented as these will reduce the dependence on imported crude, reduce required refining capacity and improve quality of the environment.
- Further policies, in addition to vehicle carbon taxes and efficiency labelling, will be needed to ensure more efficient vehicle technologies are adopted. These could include policies such as corporate average fuel consumption targets and subsidies for more efficient vehicles.
- Two of the NATMAP 2050 goals are to minimise the impact of transport on the environment and reduce the carbon-footprint; and to provide energy-efficient transport, using energy sources that are sustainable in the long term. Energy policy should be supportive of this transport policy as it has the positive effect of managing demand of energy.
- For **passenger transport** the simultaneous implementation of the following policy drives should be pursued:
 - Avoidance of travelling
 - Encouraging a shift from motorised to non-motorised and green transport, especially for short distances
 - Improving the efficiency of vehicles and existing systems.
- For short distance and inner city travelling, investment should be made in buses with dedicated bus lanes as has already been implemented in some major cities.
- For long distance travelling, investment should be made in modernising the passenger rail system in order to encourage the shift from small private passenger vehicles. Measures to ensure safety and security of passengers at stations and on trains should be put in place. Adequate ticketing and marshalling systems should be deployed to minimise incidents of non-payment.

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- A fiscal system that rewards the purchase of the most efficient vehicles while penalising the use of carbon intensive vehicles, similar to the carbon tax on new vehicles, should be implemented. The carbon tax alone, which is a once-off penalisation of carbon intensive vehicles, may not have the desired impact as users of such technologies may use them more extensively having already paid the tax.
- Additional variable pricing schemes, where electronic tolling systems can be used as a mechanism to either reward or penalise vehicles, should be considered.
- **Freight road transport** has high external costs and is the source of substantial physical damage to road infrastructure. It is therefore recommended that policies be developed and measures implemented to shift freight from road to rail by introducing the following:
 - Investment in freight transport infrastructure
 - High toll prices for heavy duty vehicles
 - Improved logistics systems through intelligent transport systems.

... Combined with smart technology and intelligent infrastructure generation can form an essential part of the energy grid.

8.7.6. Other considerations

- The International Energy Agency (IEA) developed 25 Energy Efficiency Policy Recommendations (IEA: 2011). These recommendations are categorised into those that are cross-sectoral, as well as those that can be implemented in specific sectors. The IEA recommendations, in addition to those mentioned in the sections above, should be considered during the third review of the National Energy Efficiency Strategy.
- Reliable, timely and detailed data on energy end-uses, markets, technologies and efficiency opportunities in all sectors will contribute to the development of effective energy efficiency strategies and policies. The DoE should continue participating in international forums and reference international data collection methodologies (such as the IEA annual energy efficiency data template) to determine what data to collect and methods for the measurements and monitoring of energy efficiency.

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8.8. Energy access

- According to the National Energy Regulator of South Africa (NERSA), distributed generation is defined as the installation of and operation of electric power generation units connected to the distribution network or connected to the network on the customer side of the meter (NERSA, 2015). Distributed generation also refers to small- and medium-scale technologies that generate electricity and heat close to the location of use, either operating independently or connected to the grid (Scarola, 2011). In contrast to the large-scale sources of power generation, distributed generation can refer to diverse energy systems that rely on renewable energy sources that are not centrally controlled by the system operator.
- Combined with smart technology and metering, distributed generation can form an essential part of the smart grid that is capable of bi-directional flow of electricity from centrally controlled power plants and distributed generators. Such grids allow for the consumption of energy from, and injection of energy into, the power grid. While these technologies may require significant investment in the short term, they do have several advantages over centrally dispatched generation. These include, shorter construction times, smaller space requirements, and fewer and cheaper bulk infrastructure requirements.
- Distributed generators are generally located closer to the demand location, thus increasing reliability and efficiency and reducing transmission and distribution losses.
- The most common technologies for distributed generation include micro-turbines, fuel cells, storage devices, photovoltaics, concentrated solar power (CSP), wind turbines, hydroelectric power, hybrid power and microgrids. These technologies have the added advantage of not emitting greenhouse gases or other pollutants during operation.
- Distributed generation systems can range in size, from several kW to over 100 MW. Small distribution generation systems are typically less than 20 kW and are designed for on-site use at the residential level. Power injection into the grid becomes an option with medium and large distributed generation systems.
- Off-grid or stand-alone systems are a viable technology to increase electricity access to isolated communities, which are generally located far from the national electricity grid and are economically unattractive to the national electrification programme which prioritises the allocation of mass resources. With the maturation of various small scale renewable energy technologies, distributed generation is a viable and cost effective alternative for electrification of such communities.

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- The most widespread use of solar energy has been in the heating of water for domestic use and the provision of electricity to off grid communities in rural areas. Solar energy has also contributed to the provision of electricity for medical facilities, schools and other community establishments. The inclusion of PV in the generation mix enhances security of supply and provides a cost effective alternate source of energy.
- With the escalating price of retail electricity, PV rooftop installations have become a viable option for residential and commercial electricity consumers. It is expected that these consumers will embark on installing small-scale distributed generation to meet some or all of their electricity requirements. It is therefore imperative that national and local government entities formulate regulations and incentives for such installations.
- Several factors have been identified which if effectively implemented could promote further development of the solar industry:
 - The spatial distribution of PV across the country should be optimally configured so as to maximise availability and predictability of the aggregated output.
 - Incentive schemes for a wide-spread roll-out of off-grid PV systems should be implemented.
 - National incentive and regulatory schemes to promote deployment of SWH systems, particularly high pressure systems, should be expanded.
 - Support should be provided for training in the installation and maintenance of roof top PV and SWH systems.
 - Further investigation should be conducted to assess the business case for PV/diesel based micro/island grids to connect remote areas to electricity as an alternative to expansion of the main grid.
 - The potential for PV/diesel/battery augmentation to alleviate grid constraints in those areas that are already grid connected should be explored.
 - A programme should be implemented to retrofit government buildings – in particular to promote SWH system uptake and the use of solar thermal technology for cooling/heating.
- Funding should continue to be provided to ensure the implementation of the INEP and the Universal Electrification Strategy.
- Funding should also be allocated for the development of an Integrated Household Energy Strategy which will ensure that households which are not connected or cannot afford electricity have access to safe alternative fuels and appliances.

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8.9. Research and development

Research and development is recommended in the following areas:

- Explore solar augmentation (concentrated solar heat) for existing coal-fired power stations to reduce daily coal demand, and therefore supply chain pressure and the risks of a failing coal supply chain (e.g. wet coal)
- Investigate the possibilities of (and requirements for) mass producing PV products in South Africa
- Explore innovations that can aid in the reduction of the cost of CSP
- Investigate the heating needs of industry and the use of solar thermal technology to meet part of this demand
- Explore solar/gas hybridisation to reduce gas demand and investigate the optimal energy mix for flexible gas and solar power plants
- Explore PV and solar thermal solutions for use in the mining industry and other energy intensive industrial sectors (e.g. cement)
- Target more funding at longer-term research focus areas in clean coal technologies such as CCS and UCG as these will be essential in ensuring that South Africa continues to exploit its indigenous minerals responsibly and sustainably
- Exploration to determine the extent of recoverable shale gas should be pursued and this needs to be supported by an enabling legal and regulatory framework.

8.10. Other considerations

8.10.1. Data collection

- Ongoing data collection to support evidence-based policy development and planning has long been recognised as a critical enabling factor. Organisations such as SANEDI should play a significant role by partnering with the Department to collect data on energy technologies and conduct studies which provide information on the development and characteristics of future energy technologies. Such studies should include:
 - An impact analysis of the effect of different policy interventions on the development of technology
 - An impact analysis on the energy efficiency savings potential of different technologies
 - More in-depth analysis on the cost curves, scrap curves and residual capacities of various technologies.

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... The energy sector of the future should be one wherein energy security is not interpreted in a narrow sense, but is defined in broad terms to take into account broader national aspirations and sustainability...

8.10.2. Development of capacity within the Energy Sector

- Collaboration with energy research institutes is essential in order to develop much needed human capacity in the sector
- While sponsorships through bursaries are currently provided to students, an internship programme which enables graduates to spend a year working with an energy company or in the energy services division of a company should be developed
- As part of addressing the challenge presented by the dearth of data (mentioned above), a formal qualification in energy statistics should be developed in conjunction with tertiary institutions and relevant international organisations such as the IEA, International Energy Forum and the United Nations Statistics Division. This would make energy statistics an attractive field, specifically for the younger generation. Moreover, it would boost capacity in the field of energy data collection, management and statistics, which is currently experiencing a global 'brain drain' due to most of the experts reaching retirement age.

8.10.3. Co-ordinated policy development and planning

The policy and planning functions within the DoE need to be clearly defined. The roles of the various plans developed, namely the Integrated Energy Plan, Integrated Resource Plan, the Liquid Fuel Roadmap and the Gas Utilisation Masterplan need to be well defined. The Integrated Energy Plan should provide the overall energy sector landscape of the country; should identify policy and regulatory vacuums and make recommendations; should guide the energy mix across all energy sub-sectors; and should propose capacities and indicative timing of new infrastructure development. The sector-specific plans should provide in-depth information on infrastructural matters, such as assessing the potential location for new plants, testing capacity adequacy etc., and directives to guide the implementation thereof.

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Integrated Energy Plan**8.10.4. The role of government agencies established by the Minister of Energy**

The split of the Department of Minerals and Energy into the Departments of Mineral Resources and Energy created ambiguity in the reporting lines and accountability with regard to cross-cutting energy and minerals issues. The strategic role of government agencies established by the Minister of Energy needs to be enhanced and the mandate of the various entities needs to be strengthened. Where relevant, enabling or supporting legislation should be developed or reviewed in order to ensure that the governance frameworks that enable these entities to operate optimally are in place.

8.10.5. Integrated planning across all spheres of government (provincial and local government)

- The linkages and feedback loops between national, provincial and local government energy planning should be strengthened.
- The DoE has identified the need to have representation from local government in its governance structures through SALGA. SALGA should continue to participate and provide feedback through relevant local government structures.
- Likewise, representation of the DoE is essential in the provincial and local government structures. Co-ordination with provincial and local government structures should be facilitated through the DoE's Regional Offices.

The energy planning process has sought to paint a picture of the envisaged energy sector landscape of the country. While the plan has focused on long-term energy options, short-term challenges remain and are addressed through different structures and programmes.

The energy sector of the future should be one wherein energy security is not interpreted in a narrow sense, but is defined in broad terms to take into account broader national aspirations and sustainability. It is a future in which energy security is commonly interpreted as *"ensuring that diverse energy resources, in sustainable quantities and at affordable prices, are available in support of economic growth and poverty alleviation, taking into account environmental management requirements and interactions among economic sectors"*.

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*Integrated Energy Plan***List of annexures**

Annexure A: Technology Assumptions

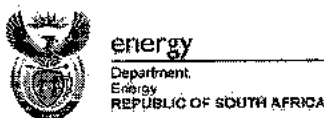
Annexure B: Macroeconomic Assumptions

Annexure C1: Study on Energy Systems Externalities

Annexure C2: Fridge Study

Annexure C3: Report on Mercury in Coal Samples

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Media Release

DoE holds IEP & IRP 2016 update consultation sessions

Durban, 9 December 2016 - The first and second public consultation sessions for the updated draft Integrated Energy Plan (IEP) and Integrated Resource Plan (IRP) 2016 have now been held in Boksburg and Durban. The sessions attracted interested stakeholders from all areas of society including sector professionals and associations, academics, industry, business, media and community members.

The two draft plans were approved for public consultations by Cabinet on 2 November 2016. The aim of the workshops is to present the detailed plans which contain scenarios envisioned for the country's energy mix up to 2050, for comment and inputs by all interested South Africans.

Addressing the interested stakeholders gathered to hear the presentations of the two plans Mr Ompi Aphane, Deputy Director General Policy and Planning, reminded everyone that the plans are drafts, to be shared with all South Africans for inputs and comment. Mr Aphane noted that the IRP update builds on the IRP 2010-30 IRP, and that there is no intention on the part of government to force or exclude any technology from the energy mix. Noting the ongoing updates of the documents based on developments during the consultation process, Aphane encouraged participants to continuously review the document posted on the DoEs website.

DDG Aphane emphasised that the schedule for the consultations was decided upon in line with Cabinet's directive for the DoE to conduct the consultations. Mr Aphane reminded participants and the media present that the public have until end of February 2017 to submit inputs, and should not limit themselves to making inputs and comments during consultations attended.

The IEP is the national umbrella plan which among others will guide policy development in South Africa, set the framework for regulations, and inform the selection of technologies to meet future energy demand up to 2050. In scope the IEP covers the entire energy sector and considers all elements of the energy value chain. Given the substantial scope of the IEP and the fact that a multitude of factors need to be considered, development of the IEP is an extensive process in that the availability of the energy resources must be taken into consideration and demand for all fuels must be included.

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The Integrated Resource Plan (IRP) can be viewed as a subset of the IEP in that it considers only the future demand and supply of electricity, and proposes a capacity expansion plan to ensure that the energy demand needs are met in the most effective way.

The Department of Energy's process for the update of the IRP has set four key milestones, which are (1) settling the key assumptions; (2) developing a base case (Starting point); (3) modelling and analysing the various scenarios; and finally (4) developing the final plan taking into account the various scenarios and policy positions.

The first and second milestones have been completed and are the basis of the public consultation process. The third milestone, which involves testing various scenarios and sensitivities, is currently under way. The fourth milestone, which relates to policy adjustment, will follow once public consultations and scenario analysis are completed.

The IEP and IRP update documents have been released for consultation purposes and a decision will only be made by the government once the consultation process has been concluded.

The DoE appreciates the robust nature of the inputs and engagements from participants, as well as the informative presentations made by among others: Abengoa; Bushveld Energy; Democracy Works South Africa; CEPZA; CSIR; Eton; Fossil Fuel Foundation; GAIA; (KabiSolar); NIASA; PAMSA; SAIPPA; SAREC; Solar Reserve; STELAWorld; and OUTA in Boksburg. While 3Energy, and groundWork presented in Durban, and other inputs have been received via our website.

The draft documents can be accessed on the following links: http://www.energy.gov.za/files/iep_2016.html and <http://www.energy.gov.za/IRP/irp-2016.html>

The remainder of the scheduled workshops for 2016 will take place at 8:30-17:00 as follows:

Tuesday, 13 December 2016, Cape Town ICC

Wednesday, 14 December 2016, Sun International Boardwalk, Port Elizabeth

Look out for information on more workshops during January - February 2017, with all comments and inputs due by end February 2017.

For more information on registration and other information go to www.energy.gov.za.

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REPUBLIC OF SOUTH AFRICA

Members of the media are invited to cover these consultative workshops.

Issued by the Department of Energy

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"The Department of Energy is responsible for ensuring secure and sustainable provision of energy for socio-economic development."

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Petroleum Agency SA

Tygerpoort Building - 7 Mispel Street - Bellville 7530 - P.O. Box 5111 Tygervally 7536 - South Africa
Tel: +27 21 938 3500 - Fax: +27 21 938 3520
E-mail: info@petroleumagencysa.com

NOTICE REGARDING CONSULTATION WITH INTERESTED AND AFFECTED PERSONS IN TERMS OF SECTION 10 READ WITH REGULATION 3 OF THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002 (ACT NO. 28 OF 2002)

File Ref No: 12/4/13 PR

Notice is hereby given in terms of Section 10 (1) of the Act that the Petroleum Agency SA, has on the 19th of September 2022 accepted an application for a production right for petroleum from TotalEnergies EP South Africa B.V, CNR International (South Africa) Limited, Main Street 1549 (Pty) Ltd and Qatar Petroleum International Upstream LLC

APPLICATION DETAILS:	
Date of receipt of application:	05 September 2022
Executive summary together with a sketch plan with co-ordinates depicting the application area are attached as:	Annexure A
Contact Details of the Agency	Postal Address: Chief Executive Officer Attention: Dr Phindile Masangane P.O Box 5111 Tygervally 7536 Physical Address: Chief Executive Officer Attention: Dr Phindile Masangane 7 Mispel Street Bellville 7530 Email: Block11B/12B@petroleumagencysa.com Tel: 021 938 3500 Fax: 021 938 3520

Any person wishing to submit comments on the above application should in accordance with Section 10 (1) (b) of the above Act, do so in writing on or before the 20 January 2023, for the attention of the **Chief Executive Officer** at the address indicated above.

Dated in Cape Town on 3 October 2022.

P.C Masangane

DR. P.C MASANGANE
CHIEF EXECUTIVE OFFICER

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Annexure A

Ref No: 12/4/13 PR

EXECUTIVE SUMMARY**APPLICATION FOR A PRODUCTION RIGHT FOR PETROLEUM IN TERMS OF SECTION 83 OF THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002 (ACT NO. 28 OF 2002) (MPRDA): BLOCK 11B/12B IN THE WESTERN AND EASTERN CAPE PROVINCES**

On the 5th of September 2022, TotalEnergies EP South Africa B.V, CNR International (South Africa) Limited, Main Street 1549 (Pty) Ltd, Qatar Petroleum International Upstream LLC (herein collectively and jointly referred to as "JV Partners") lodged an application for a production right in terms of section 83 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) ("the Act") over Block 11B/12B in the Eastern and Western Cape Provinces. Block 11B/12B is situated about 180 km off the south coast of South Africa with the application area covering approximately 11, 865 km². The sketch for this block is shown below as **Figure 1**.

The period for which the production right is requested is for 30 years. During the tenure of their exploration right, the JV Partners successfully drilled two exploration wells i.e., the Brulpadda 1AX and the Luiperd 1X and made two discoveries for gas and condensate.

Following the two discoveries, the JV Partners intends to develop and commercially produce the gas and condensate resources. The proposed development has been divided into two phases, with the first phase of development envisaged to make use of PetroSA's existing facilities for gas and condensate production. This phase will include the drilling of three development wells and construction of about 110 km-long pipeline and well sub-sea facilities to transport the gas through the F-A Platform.

The second phase of the project, which will commence after the completion of the first phase, will entail the construction of the central processing facility and the drilling

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of up to 14 wells, as well as the construction of the pipeline for transportation of produced gas to shore facilities.

ASSESSMENT OF APPLICATION FOR PURPOSE OF APPROVAL/REFUSAL

The application was accepted on the 19th of September 2022, it is now being subjected to further assessments of several aspects of the MPRDA prior to a decision regarding the approval or refusal thereof. The requirements in terms of the MPRDA, National Environmental Management Act, 1998 and other relevant and applicable legislation will be considered. Amongst other factors that will be considered are:

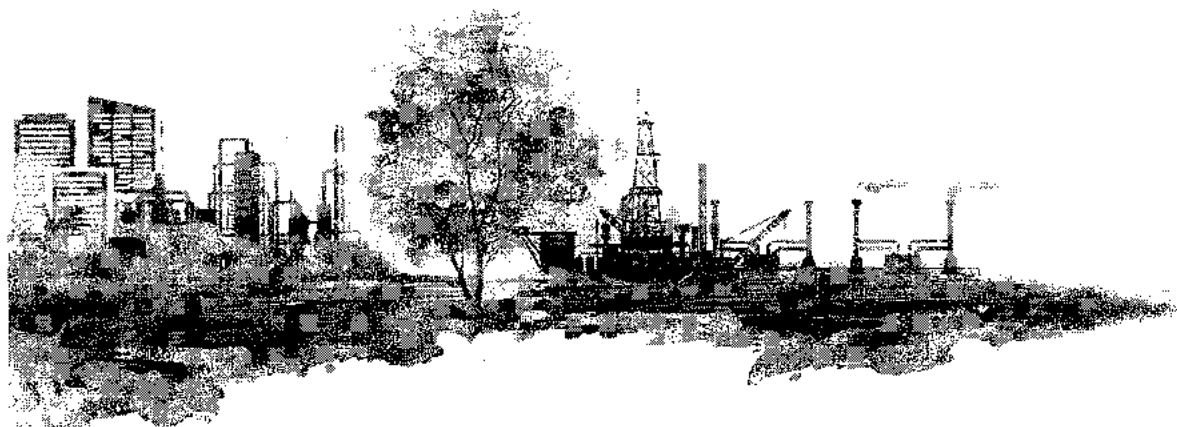
- Financial and technical ability of the JV Partners to conduct the proposed production operation optimally;
- If the JV Partners have provided financial and otherwise for prescribed Social and Labour Plan;
- Compliance with all the requirements for the granting of Environmental Authorisation;
- Meaningful consultation with interested and affected parties;
- If the granting of the production right will substantially and meaningfully expand opportunities for historically disadvantaged persons; and
- If the granting will promote employment and advance social and economic welfare of South Africans.

It is worth noting that the recommendation to grant or refuse the production right will only be made after the decision on an application for an environmental authorisation in terms of the Environmental Impact Assessment Regulations, 2014 is taken. The JV partners have been advised to commence with the application for the environmental authorisation and interested and affected persons will have further opportunity to comment during the environmental impact assessment process.

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CEF Group 2021/2022 Annual Business Performance Results
presented to
The Portfolio Committee: Mineral Resources & Energy

13 October 2022



Group Reset

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PASA Highlights & Lowlights

Highlights

- ✓ PASA operationalized its new executive structure – COO, Manager Comm. & Stakeholder Management
- ✓ The geological modelling of the central Karoo was advanced and the sweet spot for shale gas is now well defined
- ✓ PASA participated in the Upstream Petroleum Resource Development Bill discussions as well as the draft Oil and Gas Tax Regime issued by National Treasury.
- ✓ Cabinet supported the DMRE in their strategy to request the PICC to designate Block 11B/12B as a Strategic Integrated Project (SIP).
- ✓ Entity met its corporate objectives for 2020/2021 except for one which relates to the automation of business processes

Lowlights

- ✓ There are sustained legal challenges against the development of the oil and gas industry, upstream and downstream.
- ✓ The regulated fees of PASA were not revised to support the Long-term financial sustainability of the regulator

GOVERNMENT NOTICES • GOEWERMENTSKENNISGEWINGS**DEPARTMENT OF PUBLIC WORKS AND INFRASTRUCTURE****NO. 1874****11 March 2022****NATIONAL INFRASTRUCTURE PLAN 2050 (NIP 2050) PHASE I**

I, **PATRICIA DE LILLE, MP**, Minister of Public Works and Infrastructure, hereby in terms of section 4 (a) of the Infrastructure Development Act (Act No 23 of 2014), publish Phase I of the National Infrastructure Plan 2050 for implementation.

A copy of the National Infrastructure Plan 2050 is attached hereto.



MS PATRICIA DE LILLE, MP
MINISTER OF PUBLIC WORKS AND INFRASTRUCTURE

Date: 11 March 2022



South Africa's
National Infrastructure Plan 2050

February, 2022

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EXECUTIVE SUMMARY

Infrastructure development is critical to attaining South Africa's long-term economic and social goals. In the context of a developing country seeking significant structural change, the public sector must lead this effort. Infrastructure delivery will be one of the most significant contributors to South Africa's transition from a historically closed minerals economy to one that is globally and regionally integrated, low carbon, inclusive and promoting of dynamism in the industries of the future.

Public infrastructure investment is central to achieving greater productivity and competitiveness, reducing spatial inequality and supporting the emergence of new job-creating sectors. It is therefore one of the non-negotiable foundations of transformation and inclusive growth. The construction of infrastructure generates employment and broad-based black economic empowerment opportunities, further contributing to the goals of the National Development Plan (NDP).

The NDP targeted a 30% investment-to-GDP ratio, one-third of which would be delivered by the state. This is primarily delivered through provincial and local government and state-owned enterprises (SOEs). A small proportion of spending is directed through national government. The cost of delivering infrastructure to meet NDP development objectives is estimated to exceed R6 trillion between 2016 and 2040, with energy and transport accounting for over 72% of this spend.

The National Planning Commission (NPC) prepared an extensive review of public sector and SOE infrastructure delivery and performance, culminating in its December 2020 Review of Economic Progress¹. It found that the delivery of public sector infrastructure is below that required to support the NDP objectives. The NPC makes constructive and concrete recommendations for course correction.

The goal of the National Infrastructure Plan 2050 (NIP 2050) is to create a foundation for achieving the NDP's vision of inclusive growth. Prepared by Infrastructure South Africa (ISA), the NIP 2050 offers a strategic vision and plan that link top NDP objectives to actionable steps and intermediate outcomes. Its purpose is to promote dynamism in infrastructure delivery, address institutional blockages and weaknesses that hinder success over the longer term, as well as guide the way towards building stronger institutions that can deliver on NDP aspirations. The NIP 2050 identifies the most critical actions needed for sustained improvement in public infrastructure delivery. The NIP 2050 will have impact in the short term, but with longer-term imperatives also in view.

This phase of the NIP 2050 focuses on four critical network sectors that provide a platform: energy, freight transport, water and digital infrastructure. There will be a second phase that focuses on distributed infrastructure and related municipal services, as well as approaches to strengthening coordination through DDMs.

The NIP 2050 is organised into six main sections. The first section offers insight into the four mission-critical infrastructure areas, namely energy, freight transport, water and digital communications. There are then five cross-cutting sections focused on the regional agenda for infrastructure, finance, strengthening institutions for delivery, rebuilding the civil construction and supplier sector and the approach to monitoring and reporting on progress. Each section follows the same format: (1) stating the vision, (2) offering a frank assessment of the current status, (3) outlining essential conditions for success and (4) stating what will be done to achieve the vision. With an eye to long-term success, there is significant emphasis on near-term course correction. To this end, the NIP 2050 outlines the changes and

¹ The NPC reports are available at www.nationalplanningcommission.org.za/publications_reports.

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augmentation to government's Strategic Integrated Projects (SIPs) that are relevant to the four sectors, as well as three-year action plans.

The NIP 2050 gives guidance on themes common to the four sectors, with significant emphasis in building capacity in the following:

- **Knowledge and innovation services**, for capability in planning, monitoring, budgeting, finance, procurement, project preparation, project management and sector-specific innovation. This enables evidence-based decision-making, improves cost-effectiveness, mitigates risk and helps optimise and can contribute significantly to improving infrastructure quality, delivery and sustainability. Building these capabilities will be the NIP's top priority.
- **Public-private cooperation and stimulation of competition**, where appropriate, in the delivery of public infrastructure.
- **Spatial transformation** to promote more inclusive development in line with the National Spatial Development Framework (NSDF).
- **Blended project finance** and innovative green finance.
- **Executive management and technical capability within the state and its entities**, so that they are stable and can lead and deliver with confidence.
- **Economic regulation.**
- **Industrial development and localisation** in the design and approach to implementation. Examples are localisation of supplier industries to infrastructure projects, driving the establishment of Special Economic Zones around intermodal transport linkage nodes, and the stimulation of the civil construction and supplier industries.
- **Efficient modes of delivery.**
- **A safe, secure and ethical environment for public infrastructure delivery**
- **Delivery of an Africa regional infrastructure programme.**
- **South African civil construction and supplier industries**, so that local industry gains from state infrastructure investment.

SIGNS OF PROGRESS

Stimulating momentum in public infrastructure delivery is a commitment taken seriously. Concrete movement has been driven by ISA and through Project Vulindlela, amongst others. Some of the most important requirements of the NIP 2050 are already being implemented. Examples are as follows:

- Eskom has made good progress in splitting up into generation, transmission and distribution divisions and is on track to establish an independent transmission entity in this financial year. Eskom has now made a commitment to transition into clean generation and to roll out transmission infrastructure in support of new generation. The Department of Mineral Resources and Energy (DMRE) has lifted the licence limit for embedded generation from 1 MW to 100 MW. These two reforms will have a dramatic effect on available electricity.
- Transnet Freight Rail (TFR) is introducing third-party operators into its branch network and is preparing for the introduction of third-party operators in its main lines. To do so, TFR is commercially separating rail infrastructure from operations, with a target date of 2022/3. TFR is further developing a hook-and-haul service to promote private wagons. The reform in port services has begun with the commitment to establish the Transnet National Ports Authority as an independent subsidiary. These reforms will dramatically improve the freight transport services in rail and ports, with the added value of reducing pressure on the roads.

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- SANRAL has made significant progress in its road projects around the country with nine construction projects valued at R18 billion in progress, and a further eight major projects valued at R 20 billion being awarded in 2021.
- There has been significant improvement in water use efficiency over the past decade. The Presidential Infrastructure Coordinating Commission (PICC) and Department of Water and Sanitation (DWS) are already taking steps towards the implementation of many NIP 2050 requirements.
- There has been good performance in digital infrastructure rollout over the past decade; by 2019, 93% of the population was covered with 4G/LTE, up from 53% in 2015. Over 85% of the population live within 10 km of a fibre access point. This coverage bodes well for NIP 2050 efforts to improve digital access for low-income communities.
- There are signs of emerging appetite and capability in South African capital markets to innovate in financing infrastructure. For example, South Africa has issued the most green bonds in Africa, with a cumulative issuance of US\$2,4 billion. A growing commitment by the South African state to public-private partnerships is demonstrated in the establishment of the Infrastructure Fund. This has been structured through the Development Bank of Southern Africa (DBSA) with aim to use R100 billion of public funding over the next 10 years to crowd in private sector investment through blended finance models.

Energy infrastructure

Energy supply will enable economic growth and development. The energy mix will be bolder on sustainability and in achieving least cost. This will require reduced reliance on coal and growing reliance on renewable energy, especially solar and wind, which play a dominant role as part of a least-cost energy mix and where South Africa has a significant advantage.

By 2050, energy demand is projected to double. Installed generation capacity will therefore need to expand, from 53 GW in 2018 to between 133 GW and 174 GW by 2050, depending on energy demand at that time. By 2030, at least 25 GW will have to be added to installed capacity with the requisite supportive transmission and distribution network infrastructure.

To achieve this vision for energy infrastructure, the NIP 2050 says that:

- the approach to defining the energy mix will become technically strong and responsive. Expanded capacity in a context of accelerated technological change and a changing energy mix requires that the institutional planning and delivery mechanisms become more adaptive, responsive and dynamic, as well as guided by evidence. The Integrated Resource Plan (IRP) will be revised to extend to 2050, and medium-term targets will be updated in 2021/2 to reflect a focus on sustainability and least cost. The IEP will be finalised.
- the market structure will facilitate more responsive and sustainable supply. This will require stabilisation and separation of Eskom, the introduction of greater private participation and more decentralisation in energy generation.
- capacity in the state and its entities will be strengthened to effectively regulate, plan and oversee energy delivery.
- electricity will be delivered in a financially sustainable way.
- energy efficiency policies and measures will be given high priority.
- the transition away from fossil fuels will progress in a measurable, just and sustained manner. New installed capacity consists primarily of wind and solar, where South Africa has a comparative and competitive advantage. Stakeholders, whether business, workers or communities, involved in fossil fuels will be supported through this transition.
- industrial diversification will be promoted through energy infrastructure delivery.

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- a centralised database will be maintained, with the requisite confidentiality protection, for the reporting of existing and expected generation capacity investments by market players to enable informed power system planning and investments for all stakeholders.
- Research infrastructure for using nuclear technology will be sustained through the replacement of SAFARI-1 research reactor with a Multi-Purpose Reactor (MPR) by 2030.
- Effective management of waste emanating from energy generation to support environmental sustainability.

The SIPs will be augmented and 3-year priority actions to 2023/4 are outlined. For example, the independent transmission entity will be established and the 100 MW embedded generation will be regulated in 2021/2. At least 10 municipalities that deliver to large populations will be given support and/or have their capacity developed to adequately maintain distribution systems. A plan to reduce reliance on coal, including elements of a just transition, will be finalised in 2021/2, with implementation starting in 2022/3. The specifics on energy procurement are as follows: regularised prescheduled bi-annual bid windows procuring about 5GW of renewable power annually from independent power producers (IPPs), municipalities enabled to procure power from IPPs, acceleration of transmission and distribution infrastructure investment, and up to 1 000 MW battery storage procured by 2023/4.

Freight transport infrastructure

Freight transport will facilitate domestic and cross-border movement of goods to enable industrialisation, diversification, trade and development. It will deliver in respect of its three roles of supporting economic and industrial progress as well as enabling rural development, while ensuring environmental objectives are met regarding the reduction of emissions, congestion, accidents and waste.

To achieve the vision for freight transport, the NIP 2050 says that:

- transport policy will be integrated and oriented around supply chain needs and the mix drives efficiency. Transport services will become aligned with best practice, ensuring globally competitive economic growth.
- the reform of the freight transport sector will be done in a way that is sustainable and progressive. Market structure should become competitive. Scale is built into the dominant freight corridors to lower cost and improve competitiveness.
- state institutions will become increasingly capable of driving transport sector reform and delivery.
- funding and finance will be increasingly sustainable and make optimal use of opportunities to attract private finance.
- Africa regional transport networks will support interregional trade and better connectivity to global supply chains. South Africa's position will be enhanced as a global maritime hub for Africa and the southern hemisphere.
- transport hubs will stimulate industrial diversification and clustering.

The freight transport SIPs will be augmented and 3 year priority actions to 2023/4 are outlined. For example, the balance of transport projects will be reassessed in anticipation of the shift of cargo off the road to rail; that TFR will complete its accounting and commercial separation and meaningfully accommodate third-party operators by 2022/3; that both the independent ports authority and a single transport economic regulator will be established by 2022/3; that there will be a plan to integrate rail, road, ports and intermodal hubs and freight villages by 2022/3; that a plan for Africa regional freight logistics will be prioritised; that the Port Master Plan, the National Rail Policy and the Road Funding Policy will be finalised; and that the upgrading of the six ports of entry to become one stop border posts be complete by 2025.

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Water infrastructure

There will be universal and reliable access to water of an acceptable quality and quantity in support of a strong inclusive economy and a healthy environment. The institutions involved in managing water resources and services will be effective in achieving this objective.

To achieve the vision for water infrastructure, the NIP 2050 says that:

- decision-making will be accountable and the institutions involved in managing water made effective.
- water resource planning will become proactive, robust, responsive and guided by evidence.
- there will be coherence in water sector policy and support for implementation at the municipal level.
- capacity to finance and deliver water projects will be strengthened, with the private sector being used effectively. The water sector will become financially sustainable.
- existing water infrastructure will be rehabilitated and maintained and water use efficiencies improved.
- ecological infrastructure will be rehabilitated and protected.
- regulatory oversight and licensing regimes will become more robust, addressing both water quantity and quality, as well as pricing and the technical performance and financial sustainability institutions.
- roles and responsibilities will be aligned and consultation should be meaningful.

The existing water SIPs will be reviewed for their viability and augmented as indicated in the NIP. In addition, 3-year priority actions to 2023/4 are outlined. For example, the National Water Resources Infrastructure Agency will be established by 2023/4; a single national water regulator will be established in 2022/3; the raw water pricing strategy will be finalised in 2021/2; that the National Water Programme (NWP) project management office to support municipalities in water management and project development will be established in 2021/2; a plan for ensuring the viability of municipal wastewater plants will be created; a policy for water use in agriculture will be finalised in 2022/3; reconciliation strategies for all water systems will be finalised by 2022/3; at least two irrigated agricultural projects aimed at food production will be driven to implementation by 2023/4; that the viability of the water SIPs will be reviewed and other specific SIP projects will be added such as dam-raising projects for the Tzaneen and Clanwilliam dams, Sundays River subsystem expansion to serve Gqeberha, and water supply augmentation for Mbombela.

Digital communications infrastructure

Communications are the lifeblood of a market economy, and digital communications are increasingly central to that. The increasingly foundational role of digital transformation means that the benefits of becoming a fully digitally enabled society and economy outweigh the costs.

The NDP envisages a seamless information infrastructure that is universally available and accessible, at a cost and quality at least equal to South Africa's peers and competitors.

While South Africa is far off the NDP's goals at 2021, the 2030 goals must remain in place. There is evidence of sufficient capacity to deliver on these objectives if they are implemented through private-public cooperation.

To achieve the vision for digital infrastructure, the NIP 2050 says that:

- high-speed broadband will be universally accessible.
- regulation will enable competitive and universally accessible broadband.

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- public sector capacity will be strong and able to drive the required policy agenda.
- partnerships will be strong and there should be centres of digital excellence promoting a growing knowledge base of delivery and innovation.
- the information and communications technology (ICT) skills base will be broad, robust and ready for the future.
- government services and buildings will be digitally enabled.
- private sector participation in achieving universal broadband access will be prevalent.

The digital SIPs will be deepened and augmented and 3-year priority actions to 2023/4 are outlined. For example, digital migration and spectrum auctions will take place in 2021/2, in that sequence; that the policy for rapid deployment of electronic communications networks and facilities will be finalised in 2021/2; that arrangements will be made to enable private participation in public interest digital delivery projects from 2022/3; that 80% of public buildings will be digitally enabled by 2024/5; that high-speed broadband will be accessible in every community by 2024/5; that there will be consideration of free basic data for low-income users; that government services be digitised; that a data centre strategy will be finalised in 2021/2; and that a satellite communications strategy will be finalised in 2021/2 for implementation beginning by 2022/3.

The NIP 2050 gives direction in respect of participation in regional infrastructure, infrastructure finance, the strengthening of institutions for delivery, an approach to rebuilding an empowered civil construction and supplier industry, and finally the monitoring and evaluation of infrastructure delivery.

Building a regional agenda for infrastructure

South Africa will demonstrate and execute on a bold vision for its infrastructure cooperation in the Africa region.

Initially, the NIP 2050 focuses on enabling delivery on regional projects that are critical to South Africa's domestic needs and are also beneficial to regional development. In the near term, critical energy and water projects will be implemented with greater vigour, as will the development of high-efficiency border posts. In the medium term, South Africa will be an active driver of regional transport corridors in rail, road and ports that will greatly enhance the ease of regional trade. South Africa will also drive regional digital connectivity. As its construction sector is invigorated and infrastructure finance deepened, South Africa will play a greater role as a gateway into Africa and as a participant in delivering regional infrastructure projects and finance.

To achieve the vision for South Africa's participation in regional infrastructure, the NIP 2050 says that:

- projects will progress timeously, with enhanced capacity, political commitment and focus.
- regional capacity to drive projects will be strengthened.
- project monitoring will enable action.
- South Africa will gain from foreign infrastructure investment in Africa
- a Financial Centre of Excellence will be established.
- a top-priority regional infrastructure integration strategy and project pipeline will be developed and implemented.

Infrastructure finance

Capacity will be in place to sustainably fund and finance infrastructure build, operations and maintenance. It is estimated that achieving the United Nation's Sustainable Development

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Goals (SDGs) related to infrastructure and NDP infrastructure goals will cost R6,224 trillion between 2016 and 2040, with transport and energy likely accounting for over 72% of the investment required. As of 2021, the finance gap that needs to be closed is estimated at R2,15 trillion.

South Africa will have a thriving private sector infrastructure investment sector that will be supported by an efficient and reliable public sector procurement framework. This framework will deliver world-class procurement through both on-budget general government procurement and world-class capability in creating partnerships and alliances with the private sector in infrastructure finance, build and operations. Infrastructure projects will be considered from a full-life-cycle perspective: planning from procurement to decommissioning, budgeting, and setting out maintenance schedules that minimise costs over the life of the infrastructure. The public sector will partner with the private sector and development finance agencies to fill a finance gap of approximately one-third of the amount that needs to be invested until 2050. Projects will be chosen for these partnerships where they clearly enhance the value of the infrastructure to the public. Such partnerships will be structured to maximise this value, considering all public policy objectives, with projects designed with risks allocated to partners that are best positioned to manage them. The NIP envisages government-wide capacity to design and launch partnerships with the private sector, eliciting an enthusiastic appetite for investment by the private sector and global development funders.

To achieve the vision for infrastructure finance, the NIP 2050 says that:

- a full-life-cycle planning approach will be adopted.
- value for money will be optimised.
- projects will be designed to meet the risk and return needs of investors.
- projects will be designed to minimise risk.
- partnerships with the private sector will be embraced where they deliver better value for money.
- development of the capital market will be supported by a steady and reliable pipeline of new projects.
- monitoring and reporting will be done in a way that builds investor confidence.

The institutional framework in support of infrastructure delivery

Strengthening institutions responsible for infrastructure planning and delivery will be the top priority of the NIP 2050. There must be a step change in the institutional capability that drives material progress in South Africa's infrastructure ambition. Planning, procurement and execution systems and capabilities will be operating at the highest global standard, commensurate with the country's significant infrastructure transformation agenda. Robust and ever-developing partnerships and alliances between the private and public sectors will be a significant feature in planning and implementation, whether they involve think tanks, financial institutions, business or communities. There will be confidence to drive an increasingly dynamic, high-performance delivery machinery.

The vision recognises that efficient and timely delivery of public infrastructure requires an environment that is safe, secure and ethical.

To achieve the vision for institutional capacity, the NIP 2050 says that:

- there will be significant capacity development within infrastructure procurement and delivery management.
- the regulatory and institutional framework will enable network infrastructure procurement and delivery.

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- a strategic approach will be taken to infrastructure procurement.
- systems of accountability will become aligned with effective infrastructure delivery.
- the asset management function will become robust.
- knowledge and innovation capabilities and services for planning, monitoring, budgeting, finance, procurement, project preparation, project management, risk mitigation (including opportunities for corruption) and sector-specific innovation will be strengthened.
- There will be significant attention to reducing crime and corruption and mitigating its impacts on public infrastructure delivery, especially in relation to: corruption in infrastructure procurement; extortion, political violence and unrest that halts infrastructure project progress; and vandalism and theft of infrastructure assets.

The civil construction and supplier sector

The South African civil construction and supplier sector will be a vibrant and respected, world-class African full-service built-environment delivery provider that supports Southern African development and beyond. It will be cost-effective and offer safe and reliable service with an experienced and skilled workforce as well as world-class products relevant to the development context. It will be an industry that is inclusive in terms of representative ownership and business practices. The industry will have a wide range of continuously improving products and services delivered by companies that range from small domestic-oriented ones to large companies that can deliver regionally and globally.

To achieve the vision for the construction sector, the NIP 2050 says that:

- an explicit effort will be made to enable South Africa's construction and supplier industries to deliver on the national development objectives.
- the state will oversee the procurement and delivery of infrastructure with a high-level of capability.
- the national infrastructure champion will be consolidated with supporting mechanisms and systems established.
- there will be a continuous pipeline of bankable projects that enables the construction sector to plan, invest and develop its people.
- regulations and the issuing of permits will be streamlined.
- there will be active and explicit support to strengthening emerging construction and supplier businesses and empowerment of historically disadvantaged entrepreneurs, while also eliminating mis-use of preferential procurement policies.
- There will be a drive to reduced carbon emissions in materials use and supplier industries.

Monitoring and reporting of major network infrastructure projects

Working with project owners, Infrastructure South Africa (ISA) will monitor the implementation of the NIP 2050. Monitoring and reporting to ISA and the PICC will focus on progress in implementing critical institutional reforms, the required capacity development and high-level information on the most important infrastructure projects. This will be done in a way that is transparent and up to date. ISA will report to the Presidential Infrastructure Coordinating Commission (PICC) Council from time-to-time on progress made in achieving the country's infrastructure delivery vision and strategic objectives. The PICC Council is chaired by the President of South Africa and is comprised of elected representatives from all three spheres of government.

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1 INTRODUCTION: LAYING THE FOUNDATIONS TO ACHIEVE NDP ASPIRATIONS

Infrastructure development is critical to attaining South Africa's long-term economic and social goals. In the context of a developing country seeking significant structural change, the public sector must lead this effort. Infrastructure delivery will be one of the most significant contributors to South Africa's transition from a historically closed minerals economy to one that is globally and regionally integrated, inclusive and host to the dynamic industries of the future.

Public infrastructure investment is central to achieving greater productivity and competitiveness, reducing spatial inequality and supporting the emergence of new job-creating sectors. It is therefore one of the non-negotiable foundations of transformation and inclusive growth. The construction of infrastructure generates employment and broad-based black economic empowerment opportunities, further contributing to the goals of the National Development Plan (NDP).

The NDP targeted a 30% investment-to-GDP ratio, one-third of which would be delivered by the state. This is primarily delivered through provincial and local government and state-owned enterprises (SOEs). A small proportion of spending is directed through national government. The cost of delivering infrastructure to achieve meet NDP development objectives is estimated to exceed R6 trillion between 2016 and 2040, with energy and transport accounting for over 72% of this spend.

The National Planning Commission (NPC) prepared an extensive review of public sector and SOE infrastructure delivery and performance, culminating in its December 2020 Review of Economic Progress². It found that the delivery of public sector infrastructure is below that required to support the NDP objectives. The NPC makes constructive and concrete recommendations for course correction.

The goal of the National Infrastructure Plan 2050 (NIP 2050) is to create a foundation for achieving the NDP's vision of inclusive growth. Prepared by Infrastructure South Africa (ISA), the NIP 2050 offers a strategic vision and plan that link top NDP objectives to actionable steps and intermediate outcomes. The aim is to promote dynamism in infrastructure delivery, address institutional blockages and weaknesses that hinder success over the longer term, as well as guide the way towards building stronger institutions that can deliver on NDP aspirations. The NIP 2050 does not seek to be comprehensive – it is not meant to be a database of all projects, a consolidation of masterplans, a spatial mapping of projects or a mechanism for centralised decision-making. Rather, its purpose is to identify the most critical actions that are needed for sustained improvement in public infrastructure delivery and that will have impact in the short term, but with the longer-term imperatives also in view.

This phase of the NIP 2050 focuses on four critical network sectors that provide a platform: energy, freight transport, water and digital infrastructure. There will be a second phase that focuses on distributed infrastructure and related municipal services, including approaches to improving coordination through DDMs.

MUNICIPAL SUPPORT TO STRENGTHEN PERFORMANCE IN INFRASTRUCTURE DELIVERY

While this phase of the NIP 2050 focuses on national delivery of bulk infrastructure, some drivers of change at the local level are indicated. Capacity building in respect of maintenance and billing systems stand out as a top priority. In the interests of gaining momentum in a troubled context, the NIP 2050 drives a step-by-step approach with a clear 3-year view on every area of delivery. The initial focus of the NIP 2050 municipal capacity

² The NPC reports are available at www.nationalplanningcommission.org.za/publications_reports.

development for infrastructure delivery will focus on the 17 non-delegated municipalities for which National Treasury has oversight. This includes the eight metros, the ten largest secondary cities and one district municipality. They account for 71% of local government spending power. This approach will enable more opportunity for performance-based support programmes, and will leverage National Treasury's broader capacity development efforts in municipal budgeting and financial management.

The NIP 2050 will specifically earmark a subset of the non-delegated municipalities for capacity support in relation to performance in their electricity and water and sanitation business. Those that show political commitment will be incentivised and provided with support for the professionalisation of the service (management and technical capability), with sound and protected governance, and finance linked with performance improvements.

This is an intervention that the City Support Programme in National Treasury has tested and is developing further. The idea is to link turnarounds with financial incentives (grants or private) that are conditional on improved institutional and operational performance.

The NIP 2050 is organised into six main sections. The first section offers insight into the four mission-critical infrastructure areas, namely energy, freight transport, water and digital communications. There are then five cross-cutting sections focused on the regional agenda for infrastructure, finance, strengthening institutions for delivery, rebuilding the civil construction and supplier sector and the approach to monitoring and reporting on progress. Each section follows the same format: (1) stating the vision, (2) offering a frank assessment of the current status, (3) outlining essential conditions for success and (4) stating what will be done to achieve the vision and conditions for success. With an eye to long-term success, there is significant emphasis on near-term course correction. To this end, the NIP2050 offers direction in strengthening and augmenting government's Strategic Integrated Projects (SIPs) that are relevant to the four sectors, as well as three-year action plans.

The NIP 2050 gives guidance on themes common to the four sectors, which would see significant emphasis in building capacity in the following:

- **Knowledge and innovation services**, for capability in planning, monitoring, budgeting, finance, procurement, project preparation, project management and sector-specific innovation. This enables evidence-based decision-making, improves cost-effectiveness, mitigates risk and helps optimise and can contribute significantly to improving infrastructure quality, delivery and sustainability. Building these capabilities will be the NIP's top priority.
- **Public-private cooperation and stimulation of competition**, where appropriate, in the delivery of public infrastructure.
- **Spatial transformation** to promote more inclusive development in line with the National Spatial Development Framework (NSDF).
- **Blended project finance** and innovative green finance.
- **Executive management and technical capability within the state and its entities**, so that they are stable and can lead and deliver with confidence.
- **Economic regulation.**
- **Industrial development and localisation** in the design and approach to implementation. Examples are localisation of supplier industries to infrastructure projects, driving the establishment of Special Economic Zones around intermodal transport linkage nodes, and the stimulation of the civil construction and supplier industries.
- **Efficient modes of delivery.**
- **A safe, secure and ethical environment for public infrastructure delivery**

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- **Delivery of an Africa regional infrastructure programme.**
- **South African civil construction and supplier industries**, so that local industry gains from state infrastructure investment.

The NIP 2050 does not seek to be comprehensive – it is not meant to be a database of all projects, a consolidation of masterplans, a spatial mapping of projects or a mechanism for centralised decision-making. Rather, the aim is to identify the most critical actions that are needed for sustained improvement in public infrastructure delivery and that will have impact in the short term but with the longer-term imperatives in view.

SIGNS OF PROGRESS

Stimulating momentum in public infrastructure delivery is a commitment taken seriously. Concrete movement has been driven by ISA and through Project Vulindlela, amongst others. Some of the most important requirements of the NIP 2050 are already being implemented. Examples are as follows:

- Eskom has made good progress in splitting up into generation, transmission and distribution divisions and is on track to establish an independent transmission entity in this financial year. The Department of Mineral Resources and Energy (DMRE) has lifted the licence limit for embedded generation from 1 MW to 100 MW. These two reforms will have a dramatic effect on available electricity.
- Transnet Freight Rail (TFR) is introducing third-party operators into its branch network and is preparing for the introduction of third-party operators in its main lines. To do so, TFR is commercially separating rail infrastructure from operations, with a target date of 2022/3. TFR is further developing a hook-and-haul service to promote private wagons. The reform in port services has begun with the commitment to establish the Transnet National Ports Authority as an independent subsidiary. These reforms will dramatically improve the freight transport services in rail and ports, with the added value of reducing pressure on the roads.
- SANRAL has made significant progress in its road projects around the country with nine construction projects valued at R18 billion in progress, and a further eight major projects valued at R 20 billion being awarded in 2021.
- There has been significant improvement in water use efficiency over the past decade. The Presidential Infrastructure Coordinating Commission (PICC) and Department of Water and Sanitation (DWS) are already taking steps towards the implementation of many NIP 2050 requirements.
- There has been good performance in digital infrastructure rollout over the past decade; by 2019, 93% of the population was covered with 4G/LTE, up from 53% in 2015. Over 85% of the population live within 10 km of a fibre access point. This coverage bodes well for NIP 2050 efforts to improve digital access for low-income communities.
- There are signs of emerging appetite and capability in South African capital markets to innovate in financing infrastructure. For example, South Africa has issued the most green bonds in Africa, with a cumulative issuance of US\$2,4 billion. A growing commitment by the South African state to public-private partnerships is demonstrated in the establishment of the Infrastructure Fund. This has been structured through the Development Bank of Southern Africa (DBSA) with aim to use R100 billion of public funding over the next 10 years to crowd in private sector investment through blended finance models.

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2 INSIGHTS INTO MISSION CRITICAL NETWORK INFRASTRUCTURE

2.1 ENERGY

HIGHLIGHTS

Features of South Africa's energy profile by 2050

Energy supply will enable economic growth and development. The energy mix will be bolder on sustainability and in achieving least cost. Reliance on coal will be reduced and reliance on renewable energy will be dramatically lifted, especially solar and wind, which play a dominant role as part of a least-cost energy mix and where South Africa has a significant advantage. The goals are to ensure financial and environmental sustainability as well as to ensure that South African exports have lower levels of embedded carbon and hence less susceptible to planned border carbon taxes in our major trade partners.

By 2050, energy demand is projected to double. Installed generation capacity will therefore need to expand from 53 GW in 2018 to between 133 GW and 174 GW by 2050, depending on energy demand at that time. By 2030, 25 GW will have to be added to installed capacity with the requisite supportive transmission and distribution network infrastructure.

How this will be done

- The approach to defining the energy mix will become technically strong. Expanded capacity in a context of accelerated technological change and a changing energy mix requires that the institutional planning and delivery mechanisms become more adaptive, responsive and dynamic.
- The market structure will facilitate more responsive and sustainable supply. This will require stabilisation and separation of Eskom, the introduction of greater private participation and greater decentralisation of electricity supply.
- State capacity will be strengthened to effectively regulate and oversee energy delivery.
- Electricity will be delivered in a financially sustainable way.
- The transition away from fossil fuels will progress in a measurable, just and sustained manner. New installed capacity will consist primarily of wind, solar and nuclear, where South Africa has a competitive and comparative advantage.
- Industrial diversification will be promoted through energy infrastructure delivery.
- A centralised database will be maintained, with the requisite confidentiality protection, for the reporting of existing and expected generation capacity investments by market players to enable informed power system planning and investments for all stakeholders.
- Research infrastructure for using nuclear technology will be sustained through the replacement of SAFARI-1 research reactor with a Multi-Purpose Reactor (MPR) by 2030.
- Effective management of waste emanating from energy generation to support environmental sustainability.

2.1.1 The vision for the energy sector

In line with the National Development Plan (NDP), the energy sector will promote:

- "Economic growth and development through adequate investment in energy infrastructure" (generation, transmission and distribution) and "reliable and efficient energy service at competitive rates, while supporting economic growth through job creation" by stimulating supply chains.
- "Social equity through expanded access to energy at affordable tariffs and through targeted, sustainable subsidies for needy households."
- "Environmental sustainability through efforts to reduce pollution, reduce water usage and mitigate the effects of climate change."

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The NDP set a target that more than 90% of the population should enjoy access to grid-connected or off-grid electricity by 2030. To realise this vision, South Africa's energy system will be supported by effective policies, institutions, governance systems, regulation and, where appropriate, competitive markets. Coal will contribute significantly less to primary-energy needs in the future, while other thermal fuels (distillate and gas) will have an important role in supporting system adequacy. Energy supply will be increasingly dominated by renewable energy resources – especially wind and solar, which are least cost and where South Africa has an advantage. Off-grid innovations such as micro-grid solutions will increasingly contribute to electrification while providing opportunities for industrialisation and empowerment where appropriate. In addition, investment in associated new industries will be promoted, such as the production of green hydrogen, green chemicals and sustainable aviation fuels.

As 11,000MW of coal baseload generating capacity is planned for retirement post 2030 and with the extent and negative impact of load shedding nationally especially when the ageing plants such as Koeberg Nuclear Power Plant in the Western Cape encounter unplanned outages, the implementation of decision 2 (on Koeberg Life Extension) and Decision 8 (on the 2,500MW of nuclear generating capacity) of the 2019 Integrated Resource Plan becomes even more pertinent).

2.1.2 Status of the energy sector in 2021

South Africa has long depended on electricity from coal-fired power stations, delivered by Eskom as a vertically integrated monopoly. In 2010, 87% of 254 TWh of power was coal-fired. By 2019, annual electricity production was 3,5% less, at 245 TWh, with coal accounting for 79% and renewables for 12%. The twin units of Koeberg nuclear power plant contributes about 1,800MW and 5% of the total energy as well as providing stability to the national electricity grid. Of the 18,000 MW of new generation capacity committed to the national Integrated Resource Plan (IRP) 2010, about one-third was from renewable energy independent power producers (IPPs) (with only half of that operational by 2020). Procurement via the Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) was globally recognised as one of the leading initiatives of its kind.

The National Infrastructure Plan 2020 (NIP 2050) aims to create certainty in energy sector reforms, which are expected to address critical blockages to potential economic growth and development.

Load shedding since 2008 has been caused by a combination of factors such as delayed commissioning of new generation capacity, underperformance of existing and new-build coal generation capacity and degradation of the existing Eskom coal fleet, with the result that energy availability factor declined from 94% in 2002 to 67% in 2019. The need for regular maintenance of ageing baseload coal fleet has been a contributing factor. Nevertheless, the Koeberg nuclear power plant scheduled for long term operation beyond 2024/25, is a critical important of the Eskom portfolio and remains a cash-cow to the enterprise. The Koeberg nuclear power plant, since amortised, has been a back-bone of the national electricity grid providing reliable and cheapest electricity within the Eskom's fleet.

Until recently, Eskom's form had not substantially altered. Policy indecision over the past two decades has significantly contributed to Eskom's financial demise, with its pricing not historically in line with depreciation, constraining its ability to retain earnings for future investment. Eskom has declined from a world-leading utility to one that is financially unsustainable, operating at very low levels of energy availability and struggling under the load of poorly designed and project-managed new mega coal projects and the absorption of intermittency costs emanating from off-take agreements for renewable energy.

Sector reform that introduces competition and alternative funding models will be essential going forward: this is for energy security, as well as financial sustainability in energy, for the fiscal stability and for the economy as a whole. It is for this reason that the ring-fencing of Koeberg nuclear power station within the Eskom portfolio is proposed for associated revenues

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to provide the necessary capital fund for future nuclear new build programme. Providing alternative funding models, a portion of c/kWh generation from Koeberg nuclear power station should be directed to funding of research and development for advanced and innovative nuclear energy system such as small modular reactors that are currently attracting global interest in terms of ease of deployment, modular approach to construction, alternate coolant used as opposed to water especially in the midst of climate change impacts on water scarce regions.

Significant strides have been made in addressing challenges at Eskom, as evidenced by the unbundling of the entity into separate Generation, Transmission and Distribution divisions with ring-fenced balance sheets and governance structures. The Transmission division is on track for separation by the end of 2021, giving life to an independent transmission entity.

The lifting of the licence limit for embedded generation from 1 MW to 100 MW is another recent show of government's commitment to market reform and to ensuring electricity supply is available for customers.

There are meant to be two long-term plans issued and regularly updated to guide energy investments. The IRP provides guidance on forecast electricity demand, indicates how that energy demand will be served and at what cost. The National Energy Regulator of South Africa (NERSA) is required by the Electricity Regulation Act, No 4 of 2006, to issue rules designed to implement the IRP. It is meant to be a living document, updated every two years. The Integrated Energy Plan (IEP) is meant to guide infrastructure investments for the entire energy sector, consider all viable energy supply options and guide the selection of appropriate technologies to meet overall energy demand. The National Energy Act, No 34 of 2008, requires the Minister of Mineral Resources and Energy to develop the IEP and then review and update it annually. An IRP 2010–2030 was published in 2011 and then updated in 2019, still with a horizon to 2030.

The approach to electricity planning needs to be substantially strengthened to meet changing demand and supply conditions more effectively, as well as to enable global technological advancements and delivery options. It is also important for the PLEXOS energy planning and modelling tool to be benchmarked and compared with other integrated tools that takes into consideration total system costs (plant-level costs and grid level costs) to level the playing fields for different sources in the energy mix as opposed to the narrow least cost approach. The NDP's electricity sector reforms related to planning, decision-making, institutions and delivery models continue to be relevant in this regard.

The IRP 2019 projects energy demand and supply to 2030, and the Council for Scientific and Industrial Research (CSIR) extended the IRP's view to 2050.³ This assists us to envisage a longer-term result of current plans. The IRP 2019 energy mix sees a falling but still significant role for coal, and a growing role for gas, so that 'dirty power' accounts for 40% of installed capacity by 2030 and includes plans for 'new coal' and peaking gas. By 2050, this path would see coal and gas respectively accounting for about 27% of the energy mix. In contrast, a least-cost path would see coal and gas respectively accounting for about 15% of the energy mix. Storage is very lightly recognised in the IRP2019, whereas it accounts for over 7% of installed capacity in a least-cost scenario by 2050. By then, about 57% of installed capacity would be accounted for by solar and wind as compared with 40% in an extended IRP 2019 view.

The IRP 2019 will need revision and updating to adequately account for the pace of global innovation and cost reductions realised in the renewable energy sector in determining the least-cost electricity plan for the country. Moreover, South Africa is a signatory to the Paris

³ Wright, J and Callitz, J (2020). Systems analysis to support increasingly ambitious CO₂ emissions scenarios in the South African electricity system. Technical report prepared for Meridian Economics. Available at: https://researchspace.csir.co.za/dspace/bitstream/handle/10204/11483/Wright_2020.pdf

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Agreement, under which the world aims to achieve net zero greenhouse gas emissions by 2050. The role of nuclear energy in achieving net-zero emission goals cannot be over emphasised as it is evident in some countries of the G20 that already have Paris Agreement compatible plans and are aggressively deploying or considering ramping the share of nuclear in the energy mix such as France (operating about 58 nuclear power plants) and Canada, Ontario. Seeing that no economy of the world can be powered wholly from renewables, there is room for co-existence of baseload energy source such as nuclear and renewables in so called hybrid energy systems wherein the baseload energy source would kick in to fill the demand/supply curve when intermittent renewables are not available. The shift to a least-cost path that is increasingly reliant on renewables is imperative for four main reasons:

- South Africa cannot afford to overspend while dramatically expanding capacity.
- Renewables can be built quickly and in modular form, thereby avoiding many of the challenges associated with mega projects.
- Trade partners are expected to increasingly impose border carbon taxes, harming South African exports.
- South Africa has committed to emission reductions as a global citizen and will need to demonstrate this commitment to access green finance.

The energy sector globally is experiencing the fastest rate of technological change and innovation ever in history, with significant growth in private participation at all stages of the value chain. However, it should be stated that the markets are indicative of lower costs of clean nuclear energy with the introduction of Small Modular Reactors, this is a game changer in the future energy planning as the latter reactors could also be used in hybrid systems for hydrogen production, industrial process heat and in water desalination. There is clearly appetite in the South African private and public sectors to leverage these opportunities for a course correction.

Scaling-up Energy Efficiency interventions in South Africa is definitely considered one of the most promising solutions to ensure energy security in the country and achieve rapid, ambitious and cost-effective emission reductions. Without the introduction of Energy Efficiency interventions on the demand side, the country will continue to 'oversize' the necessary specifications for installing Renewable Energy technologies on the supply side, which is an expensive, wasteful and very inefficient course of action to take.

2.1.3 Conditions required to ensure that the electricity sector delivers on South Africa's 2050 vision

The significant transformation of achieving least-cost sustainable electricity in quantities that fuel economic development and growth will require public institutions that are responsive and that enable competition and private participation.

The IRP must adequately incorporate the rapid pace of change in the global energy sector, especially in a post-Covid-19 context that has seen a rapidly accelerating global energy transition.

Five conditions must be met to achieve the 2050 vision for the electricity sector:

1 The reform of the energy sector must be sustainable and progressive.

- Sector policy and regulation must become forward-looking, become aligned with global energy transition leading practice and ensure access to energy for all South Africans.

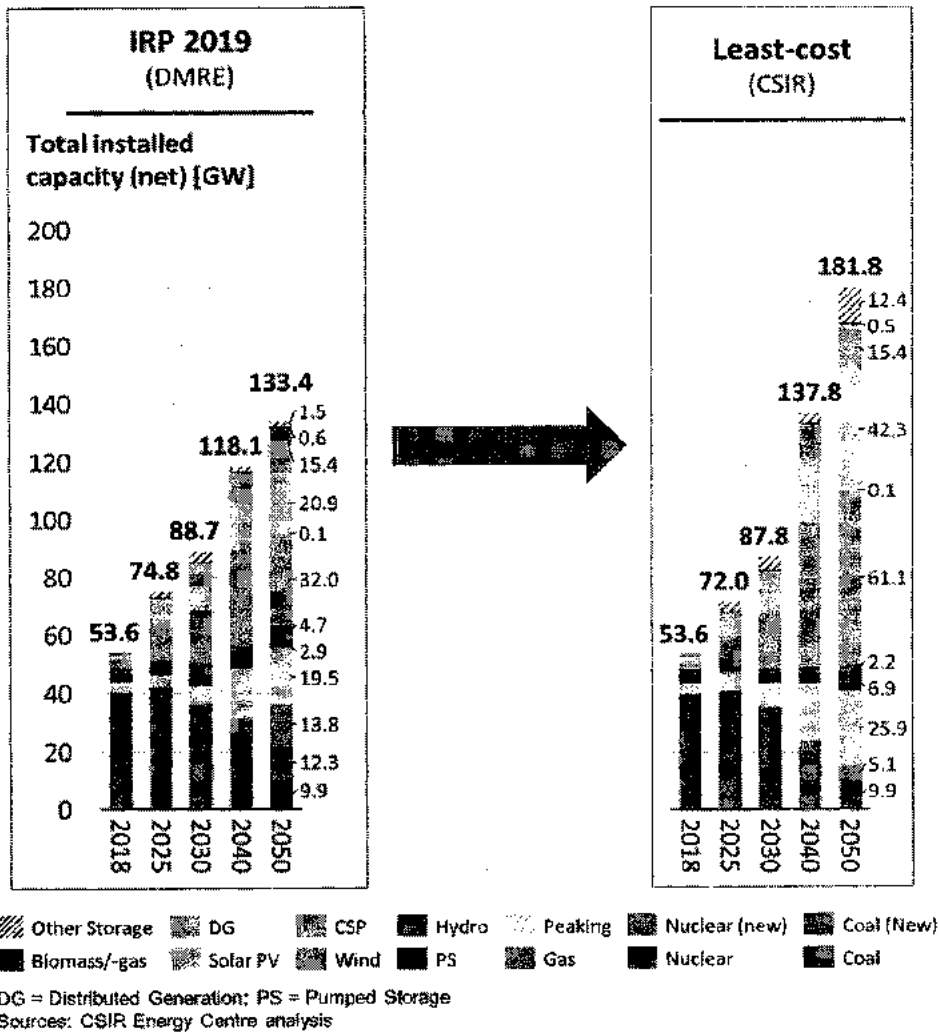
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- There must be recognition of South Africa's commitment to climate mitigation in line with the Paris Agreement, as well as the importance of remaining competitive in this emerging global context.
 - Energy markets must be opened and competitive, with reformed state utility functions focused on ensuring robust national infrastructure energy networks.
- 2 Best-practice energy services must be in play, ensuring globally competitive economic growth.**
- Global technology learning curves must be leveraged to ensure benefits as well as lowest-cost energy and quality of supply for South Africa.
 - A robust national grid capability must be developed, enabling rapid and deep penetration of renewable technologies, including development of storage.
 - The full cost of electricity, including externalities, must be accounted for in regulated pricing.
 - Energy efficiency measures must be given high priority.⁴
- 3 There must be a pivot to a low-carbon energy sector, including a just transition.**
- There must be a significant migration from South Africa's aging fossil fuel asset base to renewable technologies that lower the levelised cost of electricity and supports a low-carbon pivot for the economy.
 - South Africa should embrace the global recognition of nuclear as a clean energy source as already acknowledged in the Nuclear Energy policy of 2008 and the IRP 2019 and take cue from economies of the world that are already compliant with the Paris Agreement on Climate Change through either aggressive deployment of nuclear (planned or installed). The lifecycle GHG emissions from nuclear are comparable with those of intermittent renewables.
 - Low-carbon technology pathways that attract foreign direct investment and stimulate economic activity – such as accelerated rollout of significant renewables capacity, electric vehicles and, in the longer term, green hydrogen – should be accelerated.
 - There should be consideration of thermal fuels (distillate and gas) as a key enabler to support system adequacy in the transition from coal to renewable power and industrialisation.
 - Significant support must be made available to enable the energy transition for communities and companies.

The transition from the IRP 2019 to a least-cost energy mix currently looks like the figure below. This picture needs to be painted to be more accurate through a benchmark and comparison exercise with the use of energy planning and modelling tools that are integrated in approach to include total system costs as opposed to narrow least approach. This is indicative of conditions in 2020 and would have to be updated at least every two years.

⁴ Energy efficiency reduces potential electricity demand, and must become significant contributor to the NIP's effort to promote environmental and financial sustainability. This is particularly done by ensuring that new and existing buildings are as energy efficient as possible and that the materials used in their construction are also lighter and less carbon intensive. Global evidence shows that building and construction account for about 38% of global greenhouse gas emissions, related to energy consumed directly and the materials and services used in their construction.

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4 Access to energy sector opportunities must be enabled.

- Clear, consistent and complementary energy, environmental and industrial policies and regulatory frameworks should incentivise investment and optimises local content and private sector opportunities in the transformation of South Africa's energy sector asset base.
- New technologies and multiyear capital programmes should enable state companies, new local industries and local business to empower youth and create new-age skills and digital capabilities.

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5 State institutions must be capable in driving energy sector reform and delivery.

The regulator (NERSA) must be strong, capable and responsive, and a policy department (the Department of Mineral Resources and Energy – DMRE) must guide and support energy sector reform and delivery. At a minimum this requires the following:

- Eskom's generation, distribution and transmission functions must be separated into legally separate entities.
- Consideration must be given to ring - fencing Koeberg and PBMR technology to form one generation company for effective implementation of the successful Nuclear New Build Programme.
- Eskom must be stabilised financially and operationally, with clarity for its role as a vibrant contributor to an emerging energy sector achieved.
- State oversight must be designed simply. Functions and mandates must be clearly delineated according to proper governance rules.
- The Eskom board must be appointed based on independence and skills as required to strategically guide the organisation.
- Planning systems must be regularised and integrated into policy planning and execution on a regular basis. In addition, reliance on a single energy planning tool (PLEXOS) should be avoided and rather multiple tools be deployed to introduce integrated and holistic modelling approach that take into consideration wider parameters such as total system costs as opposed to narrowing to least cost approach.
- NERSA capacity must be strengthened and decision-making must be independent
- State entities responsible for management waste emanating from energy generation (e.g. National Radioactive Waste Disposal Institute) must be supported to develop and implement technologies to ensure environmental sustainability. examples include the Centralised Interim Storage Facility for spent fuel, and clean coal technologies.
- Energy innovation in the area of sustainable, green energy solutions and the efficient use of available energy resources are two key components that can assist in mitigating the current energy and infrastructure challenges in the country. The South African National Energy Development Institute's (SANEDI) efforts of the promoting awareness and uptake of green energy in South Africa, through a number of strategic programmes should be accelerated. SANEDI is well positioned to make a significant and critical contribution to the rising energy and associated challenges in the country.

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2.1.4 How the 2050 vision will be achieved

Strategic element	2050 Vision – How it will be done
The approach to defining the energy mix becomes technically strong	• The vision and pathway will be identified for the energy mix to 2050, with a focus on sustainability and lowest lifecycle cost • The energy capacity planning process will be pursued with a techno-economic approach • Security of supply at least cost and considering total system costs and other externalities such as environmental considerations will become paramount • Energy projects become increasingly modular and more geographically distributed
Market structure comes to enable supply that is more responsive and sustainable	• Competition will be stimulated where appropriate, starting with the establishment of an independent transmission entity in 2021/2. A Distribution System Operator will be established to enable distributed energy resources integration, smart grid and enable competitive energy markets. Consideration will be given to transition of the independent transmission entity to a publicly owned company, which in turn, removes need for sovereign guarantees for IPPs. • Multi-markets will be stimulated, with centrally procured IPPs selling to the grid and other IPPs selling to traders or qualifying customers; there will be an introduction of electricity consumers acting as suppliers. It is noted that central procurement may bear a lot more risk than the liberated market and appropriate regulation will be considered to transition to a market. • There will be clarity in the construction of electricity tariffs in respect of generation and transmission. • The independent transmission entity will ensure there is regular market-serving data available such as on system flows. • The inclusion of nuclear energy systems in the Green Taxonomy is essential to ensure that a low carbon future can be attained and net-zero is realistically achievable on a fair playing field.
State capacity is strengthened to effectively regulate and oversee energy delivery	• Capacity in the DMRE will be strengthened in respect of policy coherence, stability and leadership. • Energy planning capacity and link to policy planning will increasingly work with independent centres of energy planning excellence. • Build capacity within the DMRE for energy planning and modelling to benchmark and compare with the of independent centres • The IRP will be extended to 2050. It will be reviewed on a regular basis (at least every two years) to be adapted to new circumstances, while still offering certainty to stakeholders. • The appointment of regulators will be done in a way that enables NERSA to operate independently, with a transparent appointments committee. Clear criteria will exist for qualifications and experience, which should include some regulators with regulatory economics capability. • An appeal process similar to that found in the Competition Act, No 89 of 1998, will be created to strengthen accountability for regulatory decisions. • Systems of accountability will be introduced to ensure DMRE and NERSA are implementing planning, rule-making and regulating according to legislative requirements (as set out in the ERA and NERA).

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Strategic element	2050 Vision – How it will be done
Electricity is delivered in a financially sustainable way	• SOE capacity will be strengthened, starting with stable and capable top executive and boards appointed according to acceptable governance norms. • Municipal capacity to maintain distribution systems and billing will be strengthened. • Blended finance models and private participation in energy infrastructure projects will become a prominent source of energy finance. • Eskom finances will be stabilised and the Eskom corporate model serves long-term sustainability in respect of Eskom and the sector in which it operates. • Revenue collection will be strengthened. • Ring-fence the Koeberg nuclear power plant portfolio within Eskom Enterprises so that generated revenues provide capital fund for nuclear newbuild programme. • A short-term solution will be found to ensure that companies that pay for electricity in municipalities that do not in turn pay Eskom are not shut off. • Externality costs will be internalised in the pricing of electricity. • New and innovative revenue streams will be sought. • Pricing policy will reflect costs of investment and operations and reduce reliance on the state to underwrite or provide guarantees for new capacity. There will be a move away from government guarantees towards assessing new forms of guarantees, such as performance guarantees. Clarity will be given in respect of planned models such as a BOT, concessions, sales and leasebacks, amongst others, so that there is a well understood and fair sharing of risk. • Energy efficiency will be given high priority, with the aim of promoting continuous improvement in regard to new and existing buildings and construction. • The introduction of private sector participation in electricity distribution through long term grid concessions with SLAs will be considered as an option.
The transition away from fossil fuels progresses in a convincing and just manner	• Reliance on coal will be significantly reduced and the reliance on renewable energy dramatically lifted, especially in solar and wind, where South Africa has a significant advantage. • Consider both repurposing and retrofitting baseload coal fleet with advanced and innovative baseload nuclear energy systems that can be deployed inland which provide an opportunity for reskilling and retention of the existing coal workforce. • Incentives will encourage transition and discourage resistance to this change. • Green finance opportunities will abound. • Stakeholders involved in traditional energy sources (business, workers, communities) and coal plant decommissioning will be supported through the energy transition. • The just elements of the Just Energy Transition will be prioritised.
Energy infrastructure delivery stimulates industrial diversification	• Manufacturing and services related to energy delivery will be stimulated ultimately due to the predictability and certainty of investment in renewable energy. • Digital services will become the norm across the sector (advanced metering, distribution system monitoring, etc). • Energy diversification opportunities will be found in sectors such as green hydrogen, electric vehicle manufacture, and mining needed for new technologies including rare-earth mining for batteries and similar.

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Strategic element	2050 Vision – How it will be done
	• Innovation in related products and services will be stimulated to the point that they become leaders globally. • Infrastructure will be supportive of green energy diversification. The Green Hydrogen Society Roadmap that was re-endorsed by Cabinet in Sept 2021 will be pursued, with the Department of Science and Innovation's partnership with the private sector in the Hydrogen Valley initiative being one example of programmes giving life to this agenda. Critical infrastructure will include sufficient renewable energy, energy storage, hydrogen pipeline distribution networks, hydrogen refuelling mobility infrastructure and port infrastructure for hydrogen and hydrogen derivative exports. • The Energy Diversification opportunities in nuclear does result in establishment of waste management solutions such as the centralised Interim Storage Facility for spent nuclear fuel, which then contributes to environmental sustainability.
There is a comprehensive database of energy projects	A centralised database will be maintained, with the requisite confidentiality protection, for the reporting of expected generation capacity investments by market players to enable transmission and distribution planning
Top-priority Strategic Integrated Projects (SIPs)	• SIP 8 includes green energy projects, including procurement of renewable energy under the REIPPPP. • SIP 9 includes the expansion of electricity generation capacity, including that from Kusile and Medupi, with attention to reducing the carbon footprint being given. • SIP 10 includes the expansion of electricity transmission and distribution network. • SIP (no 20) includes the following: ◦ Emergency or Risk Mitigation Power Purchase Procurement Programme (2,000 MW) – national. ◦ Embedded Generation Investment Programme (EGIP) (400 MW) – national. • The energy SIPs will be augmented as outlined in the three-year actions below. • With the 2,500MW of nuclear generating capacity as provided for by Decision 8 in the 2019 IRP and same being identified in the Economic Recovery and Reconstruction Plan of Government, consider designating the project as a SIP • Replacement of the SAFARI-1 reactor with a Multi-Purpose Reactor by 2030 will be crucial to sustain and grow South Africa's leading role in medical isotopes production and research and development in almost every industrial and scientific field including energy.
Three-year actions	• The IRP 2019 will be revised to extend to 2050 and the medium-term targets will be updated and revised in 2021/2 and in 2023/4, with focus on sustainability and least cost. The IEP will be finalised. • Eskom will be restructured into three legally separated entities for generation, transmission and distribution. The independent transmission entity will be established by 2021/2. An energy planning centre of excellence will be established in 2022. • The commitment to lift the licence limit to 100 MW self-generation will be implemented in 2021/2. This will include distribution infrastructure with a focus on electrification through micro-grids to drive industrialisation and localisation. There will be a central database of projects to enable effective planning, especially of transmission and distribution infrastructure.

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Strategic element	2050 Vision – How it will be done
	• The process of appointing NERSA councillors will be reviewed to ensure independence. An appeals process will be created to ensure accountability for regulatory decisions. • SOE leadership capacity, starting with Eskom, at board and executive levels will be according to acceptable governance norms by 2022. There will be an approved plan to stabilise Eskom as well as a turnaround pathway to long-term viability and vibrancy. • At least 10 non-delegated municipalities that deliver to large populations and that demonstrate significant challenges will have support and/or capacity to adequately maintain distribution systems and billing systems. They will be chosen on the basis of demonstrated political commitment, and support will be contingent on performance (see page 12). • There will be a plan to reduce reliance on coal including a just transition by 2021/2, with meaningful implementation beginning 2022/3. • Plans will be finalised in respect of thermal fuels (distillate and gas) to enable associated infrastructure planning in ports, pipelines, terminals and storage, and potentially refining infrastructure of bio-derived fuels. • Progress in implementing the SIPs by 2023/4 will include the following: ○ There will be procurement of about 5 GW power from renewable IPPs annually, through regularized bi-annual scheduled bid windows. ○ 800–1 000 MW battery storage will be procured by 2023/4, of which 513 MW battery storage procured by 2022. Substantially more is required, with targets determined in 2021 and added to SIPs. ○ Municipalities will be enabled to procure power from IPPs. ○ Target for embedded generation investment will be increased to 4 500 MW by 2030. ○ SIP 9 accelerated to be completed by 2023. ○ SIP 10 accelerated, with a national plan for transmission and distribution infrastructure investment finalised and funded in 2021/2, with implementation beginning in 2021/2. ○ A green hydrogen strategy finalised by 2022/3. ○ The Feasibility Report > Basic Design, site License and Environmental Impact Assessment for the Multi-Purpose Reactor will be completed by 2024, and the project will be at a shovel ready stage.

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2.2 FREIGHT TRANSPORT

HIGHLIGHTS

Features of freight transport by 2050 Freight transport will facilitate domestic and cross-border movement across supply chains to enable industrialisation, diversification, trade and development. It will deliver to its three roles in supporting economic and industrial progress, enabling rural development, while ensuring environmental objectives are met in respect of the reduction of emissions, congestion, accidents and waste. How it will be done: • Transport policy will be integrated and oriented around supply chain needs and the mix will drive efficiency. Transport services will become aligned with best practice, ensuring globally competitive economic growth. • The reform of the freight transport sector will be done in a way that is sustainable and progressive. The market structure will become competitive. • State institutions will become increasingly capable of driving transport sector reform and delivery. • Funding and finance will be increasingly sustainable and makes optimal use of opportunities to attract private finance. • Africa regional transport networks will support interregional trade and better connectivity to global supply chains. • Transport hubs will stimulate industrial diversification and clustering.

2.2.1 The vision for freight transport

The NDP envisages a freight transport sector that facilitates domestic and cross-border movement across supply chains to enable industrialisation, diversification and trade and development. To do so, it will be efficient, reliable, resilient, financially sustainable and consistent with a low-carbon future. The NDP envisaged *“smooth flowing corridors linking its various modes of transport (road, rail, air, seaports and pipelines)”* to ensure that industrial supply chains are globally competitive and make the best use of available infrastructure platforms.

Part of this effort includes upgrading and modernising the infrastructure networks, particularly for rail and ports, to improve predictability and reliability, reduce costs and enhance intermodal linkages. Shifting to intermodal solutions will lift pressure off the road network, reduce carbon emissions and reduce transport costs. A reformed transport system must support a reorientation of production away from the apartheid legacy of a spatially separate economy and enable the industries of the future. It must also enable Africa regional trade and investment.

The freight system will be comprised of globally competitive supply chains for all industries and sectors that enable industrial diversification and trade growth. A number of strategic challenges confronting the freight system will be addressed by improving cross-border trade corridors, shifting long distance freight from road to rail and improving maritime connectivity. This will reduce the cost and carbon intensity of supply chains, while also increasing supply chain speed and reliability.

The state oversees the transport system and as such must have the competence, information gathering, planning facilities and the necessary leadership to achieve these goals. Outside of natural monopolies, competition will be promoted to give customers choice, spur innovation and reduce the need for economic regulation. Government will enable an appropriate regulatory framework and associated licensing mechanisms to enable this to happen.

Some of the elements in this vision include:

- An integrated, efficient freight transport system covering rail, road, ports and aviation that supports industrial progress.

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- Supply chains and logistics that are optimised to counterbalance the competitive disadvantage in unavoidable costs of an economy that is small relative to the country's land mass, and far away from foreign markets, making South Africa a spatially challenged country.
- Globally competitive supply chains for key industries and sectors such as mining, fuel, manufacturing, agriculture and others that enable economic growth, industrialisation and diversification.
- Economies of scale in export channels that minimise cost and improve competitiveness.
- A Durban hub port connections with dominant international shipping flows that reduce the cost of container exports from the region to global trading partners.
- Rural and developing commercial farmers, miners and producers that can reach domestic and international markets easily and competitively.
- A step change in logistics services for non-traditional export sectors and agriculture.
- Intermodal hubs that become core elements of logistics and industrial clusters and drive economies of scale to reduce costs.
- Institutional reform that makes freight transport more dynamic and adaptive as well as enables a wider investment base.
- Alternative fuel options that are studied, with standardised solutions for classes of freight vehicles adopted and institutionalised (battery size, type, highway in-motion charging, road catenary system, hydrogen powertrains and refuelling infrastructure).
- The flow of goods between South Africa and key African trade partners that is facilitated by road, rail and ports networks, South Africa's non-traditional manufactured exports to the African region growing by at least 10% pa, and regional industrialisation being stimulated.
- Logistics costs as a percentage of gross domestic product (GDP) that are less than 10%.

2.2.2 Status of the freight transport sector in 2021

South Africa is a country that has a disproportionately large land mass and coastline. Rail freight transport tends to favour traditional basic mining and minerals industries. Road is the main transport mode for higher-value goods. The country faces built-in comparative disadvantage in its distance from global markets and the challenges of Africa regional trade arising from poor logistics infrastructure in the continent. This intensifies the importance of delivering super-competitive logistics since it is one way to counterbalance this disadvantage. It is one of the few cross-cutting factors that is within our power to do and that would help myriad newer industries. It is estimated that 'waste' alone (such as inefficiency in ports and intermodal connections) creates a 10,5% elevation in the cost of trade logistics.

The freight transport system has served traditional industries relatively well. However, it has not sufficiently improved service to non-traditional industries and agriculture – the sectors meant to drive future growth, dynamism and employment creation. Rigidity is partly explained by an institutional context of state monopoly provision, very limited private participation, and weak regulation. Policy integration between modes of transport has been limited, in a context where multimodal transport is essential, particularly in the industries that are meant to drive South Africa forward.

The freight transport network is sufficient in the sense that there is a mature road, rail and ports network. From an installed-network perspective, South Africa's road, rail and port network benchmarks well. However, the transport mix does not support an efficient result, mainly because of poor efficiency, quality, positioning and pricing in rail, ports and rural and district roads. Intermodal transport connections are hardly present.

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Freight traffic in South Africa is dominated by road use, with around 63% of tonne-kilometres (tkm) of all freight moving on road. If ring-fenced export machines such as the bulk export lines are removed, the figure is 90% of tonne-kilometres on road. While not all freight rail is suitable, there is significant potential to shift from road based to intermodal solutions, particularly on the corridors linking the major cities in South Africa.

Major road corridors are overly congested, often suffering from overloading, and are a major contributor to South Africa's carbon emissions. Axle load regulations on the primary network are now increasingly enforced: SANRAL has now set up weighbridges on national routes that saw about 5.6 million heavy vehicles screened in 2020/1, working with local law enforcement authorities to impose penalties for overloading. The rural road network is limited and outdated. Further, the rural road network in some areas carries large volumes of minerals that should be on rail – something for which it was not designed.

The combination of excessive freight demand, caused by long transport distances, and inefficient supply, due to modal imbalance and infrastructure deterioration, causes transport costs to be higher than in competing economies.

Rail has an important role to play in a low-carbon freight system.

SA has the most comprehensive freight rail network in Africa, all in the domain of Transnet. Even though South Africa's GDP is 0,4% of global GDP, 2% of the global rail network is in South Africa. Rail is currently very competitive in a number of segments, particularly in the export of bulk minerals, where a number of growth opportunities exist. In most other market segments, goods are transported by road, especially in supply chains linked to activities meant to contribute to South Africa's future industrial profile. The envisaged road-to-rail migration of freight has not materialised, leading to higher costs, congestion and carbon emissions.

The reforms in freight rail transport outlined in the NIP 2050 have begun with some initial significant steps. Recent examples are the following:

- Transnet Freight Rail (TFR) is introducing third-party operators into its branch network through concessions and is preparing the ground for the introduction of the third-party operators into the main lines in the future.
- To do so, TFR is implementing a process of commercially separating rail infrastructure from operations. This will ultimately enable the railway to formulate tariffs for third parties. This was an essential action for Telkom previously to enable wholesale-retail separation, and is also essential for Eskom's divisional separation. TFR will complete this accounting separation by the end of 2021. It will complete its commercial separation in 2022/3.
- TFR is also developing a hook-and-haul service offering to encourage private wagons. Private wagons are predominant in Russia and in North America, two very large and successful freight rail markets.

Ports are critical connection points to the global freight system.

South Africa has a relatively well-developed port system, with specific regulation under the National Ports Act, No 12 of 2005. High port tariffs and relatively low efficiency, as benchmarked globally, harm South Africa's competitive positioning and hamper further diversification in South Africa's trade.

South Africa's port efficiency generally lags global averages, which is adding to the high cost of logistics and is eroding the competitiveness of South Africa's economy through the elevated total cost of transport. Many of these problems have been attributed to the monopolistic nature of port operations for key segments such as container terminals and automotive terminals, which are provided by Transnet Port Terminals. Steps must be taken to promote a more competitive environment in port terminal operations.

The reforms in port services outlined in the NIP 2050 have begun, starting with the commitment to establish the Transnet National Ports Authority as an independent subsidiary

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of Transnet, in line with the National Ports Act No. 12 of 2005. This will require the end of cross-subsidies between rail and port operations and will ensure the ring-fencing of port charges for reinvestment in the port system.

For the container freight system, international container shipping prices is a key limiting factor to the competitiveness of export-focused manufacturers, domestically and regionally. High prices are largely a function of three drivers: weak maritime connectivity, terminal efficiency and challenged hinterland connectivity caused by port congestion. Consolidation of container volumes and massively improving vessel turnaround at a 'hub'-focused port would drive improved connectivity and attract larger vessel sizes that now dominate global trade. This would over time reduce the price of container shipping and facilitate improved transshipment and feeder services to neighbouring ports in the region. Terminal competition should promote terminal efficiency and port congestion to the hinterland, which will also be improved by capitalising on the existing rail connections into ports.

Three key interrelated strategic actions are envisaged to enhance South Africa's global trade positioning: a review of the investments and positioning in the Port of Durban to enhance its attractiveness as a global shipping hub, a significantly more competitive rail solution on the corridor between Durban and Gauteng, and a review of the entry point and support of the industrial base of Gauteng through more attractive locations for intermodal transfers within the province.

Transnet should explore a range of partnerships designed to improve the competitiveness of the key supply chains in which it is involved, and it has started to do so. Transnet's strategy should be directed towards improving the competitiveness, capacity and profitability of key market segments by partnering with the private sector to grow, fund and implement identified growth opportunities.

Air freight expanded five-fold between 1994 and 2012, but then declined by more than 50% to 2019. Domestic air freight has a relatively small share when surface freight is efficient. Surface capacity should nearly always suffice. Air freight capacity and processes are more important for high-value global connections.

The following are noted:

- Containerised air freight is expected to penetrate and increase in the air freight market in future. Research is required into the future potential industrial development that will support demand for air freight, especially around the major air freight hubs in Gauteng, Cape Town and eThekweni.
- Planning for air freight capacity has been focused on the OR Tambo International Airport, the Cape Town International Airport and the new Dube Trade Port at the King Shaka International Airport. Space constraints at the OR Tambo International Airport will become a problem within the planning horizon.
- The freight village concept should include airports, but with more expansive modal integration than, for instance, the Dube Trade Port.

South Africa's perspective on the freight system has to extend beyond its own borders and assume a more regional concern. Deeper regional economic integration is a critical foundation pillar for any post-covid-19 economic plan. For South Africa to enjoy reconstructive, transformative and inclusive growth, it is necessary for the region and continent to prosper. In this respect, particular attention has to be given to the efficiency and effectiveness of cross-border infrastructure networks, reducing truck standing time at borders, and increasing regional road, rail, maritime and air connectivity.

Cross-border production networks have yet to fully blossom in Africa and as a result intraregional trade is low. Part of the reason is the absence of good-quality cross-border infrastructure networks (and services) for road, rail, sea and air travel. The development of

such networks can stimulate intraregional trade while its absence tends to make trade impossible.

Freight transport across Africa has tended to follow historical colonial imperatives that sought to extract minerals with their north-south direction from the northern hinterland (as far north as the Congo) through southern ports, especially Durban. There are efforts, albeit very slow to implement, to create more future-oriented regionally integrated freight transport networks. There are indications that South Africa may be losing ground in these processes.

There are a number of reasons that South Africa should instead be a 'vanguard' in the effort to ease the flow of goods across Africa, given that African markets are the most significant destination for South Africa's manufactured exports. There is mutual advantage to promoting a thriving interconnected region, which will become an even more important source of trade in the context of the African Continental Free Trade Area (AfCFTA).

At the most basic level, there are significant delays at important border posts such as Beitbridge and Komatipoort, with long-standing but unrealised commitments to improving their efficiency. By example, the border post elevates the cost of transporting one truck between Johannesburg and Harare to more than double the cost between Johannesburg and Cape Town, despite Harare being 15% closer.

2.2.3 Conditions required to ensure that freight transport delivers on South Africa's 2050 vision

Four conditions must be met to achieve the 2050 vision for freight transport:

1 The reform of the freight transport sector must be sustainable and progressive.

- Sector policy and regulation must be forward-looking and aligned with "Transport 4.0". This aligns freight transport with Fourth Industrial Revolution (4IR) principles, eliminating waste and fostering growth through the dynamic linking of the cybernetic and physical world, encouraged and supported by relevant policy and regulation.
- Transport markets must be liberalised to enable competition and private participation, with reformed state utility functions focused on ensuring robust national infrastructure transport platforms.
- Points of production and consumption should be brought closer together, mitigating South Africa's spatially challenged position.
- Freight transport systems and supporting infrastructure should be supply-chain-centric and stimulate industrialisation, diversification, inclusive business, agriculture and regional and global trade.

2 Transport services must be in line with best practice, ensuring globally competitive economic growth.

- The freight system must be designed around customers' needs, with greater focus on understanding supply chain performance for key customers and industries such as fuel importers, export-focused manufacturers, domestic-focused manufacturers, farmers and similar.
- Efficiency should be optimised in three ways:
 - **Systemic change** – shifting from road to rail, and seamless synchromodality.
 - **Logistics improvements** that reduce the number of kilometres per task, eg leveraging productive freight villages and maximum use of freight capacity.

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- **Technical Improvements** that render more efficient kilometres, eg new drive trains, driver training, infrastructure use culture shifts. These reduce cost as well as carbon emissions.
- Global technology should be leveraged to ensure benefits as well as lowest-cost transport. Technological and digital solutions must be integrated into transport infrastructure investments. There is preparation underway for hydrogen-powered vehicles and EVs.
- There must be a shift to a more optimal transport mix, with more freight transported by rail and deeper investment in intermodal linkages and supporting transport hubs. It is envisaged that the ratio of road to rail will transform the current deficit of 40 billion tkm on road that should be on rail as follows:

Split of freight transported by road and rail in South Africa (billion tkm)

	Road	Rail
Current split	164	141
Current optimal split	124	181
30-year target	239	276

Source: Prof Jan Havenga, University of Stellenbosch

- Intermodal connections should facilitate optimal transport decisions. Intermodal hubs such as freight villages should enable modal shift, improve logistics, counter the intermediate scattering of supply and demand, and enable technology deployment. Decisions and Master Planning on the locations of these hubs are critical to city planning processes.
- 3 Africa regional transport networks must support interregional trade.**
- Border posts must be efficient and larger to accommodate well-designed freight villages.
 - South Africa should be at the vanguard of efforts to create more future-oriented regionally integrated freight transport networks, actively participating and leading regional trade and investment-facilitating transport routes in road, rail, air and sea.
- 4 State institutions must be capable in driving transport sector reform and delivery.**
- A strong, capable and responsive regulator and policy department must be capable of guiding and supporting transport sector reform and delivery. Policy positioning and regulatory frameworks must be clear and consistent, creating incentives for private investment and optimising local content.
 - Transnet must be financially and operationally sustainable, with clarity for its role as a vibrant contributor to an emerging transport sector.
 - State oversight must be simply designed. Functions and mandates must be clearly delineated according to proper governance rules.
 - Planning systems must be regularised and integrated into policy planning and execution on a regular basis. Planning must be bolstered by robust information systems and evidence.

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2.2.4 How the 2050 vision will be achieved

Strategic element	2050 vision – How it will be done
Transport policy is integrated and the mix drives efficiency	• Transport policy will be integrated in its vision for rail, road, aviation and ports and oriented around the needs of supply chains. • Points of production and consumption will be driven closer together. • All rail-friendly freight transport currently on road will shift to rail. Road will carry lighter, high-value and time-sensitive cargo, with the balance moved by rail through effective intermodal corridors. • The 26% of rail-friendly freight (as found in 2021) of mainly palletised long-distance freight will shift off road. These proportions may change over time. • Half of the 12 billion km driven by trucks (as found in 2021) will shift off road, with 25% eliminated by modal shift and 25% reduced with better logistics. • The shift from road to rail will be implemented by appropriate investments in rail and road (primary, district and rural) that encourage the switch, improved terminal densities, attention to product uniformity in palletised freight services (with freight villages, consolidation processes to pallets and containers, and bulk handling) and a policy regime that commits to 'the user pays' principles and externality charging. Incentives to business to encourage the shift from road to rail may be considered for temporary period. • Ports will be integrated into freight transport corridors, linking into a small number of mega hubs and 20–30 associated nodes, including privately developed freight villages and dry ports.
Market structure is competitive	• Private participation and competition will be stimulated, starting with ports and rail.
State capacity is in place to effectively regulate and oversee freight transport delivery	• A centre(s) of transport planning excellence will be promoted. • Transport regulation will be integrated and strengthened, starting with the Single Transport Economic Regulator (STER). • Department of Transport (DoT) technical capacity will be strengthened and leadership will be stabilised.
Funding and finance are sustainable	• Blended finance models and private participation in transport infrastructure projects will be stimulated and prevalent. • Transnet will become sustainable financially and operationally. Finances will be transparent and cross-subsidies will no longer be found between port and rail, acting as one enabler of change in pricing and encouraging private participation. • Revenue collection will be strengthened and become more robust. • The transition will be made to lower-price and higher-volume rail and ports. • SANRAL financial pressures will be addressed as demand for new roads are eased.
Industrial diversification is stimulated	• The transport investments will be driven in a way that promotes jobs and industrialisation in supplier industries.

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Strategic element	2050 vision – How it will be done
through transport hubs	• Special Economic Zone (SEZ)-type developments will surround intermodal linkage nodes. These will be owned and driven by local authorities and/or privately with private investment and monetisation. ◦ "Super hubs" (freight villages, ports, dry ports and border posts). ◦ Logistic service centres and intermodal terminals. ◦ Rural hubs.
Regional logistics enable manufactured exports	• Regional transport systems will be developed that lift trade and investment. A clear, concrete and transparent plan for freight transport will be created, with concrete projects developed, financed and implemented. This will include upgrading of critical cross-border roads, rail and ports, as well as freight hubs and villages, in a network that optimises efficiency in support of regional value chain development and trade. • Regional shipping will be promoted to create new freight corridors and to support the development of regional load centres for containers. • Amongst other things, this will include the North-South Corridor linking Durban and Dar es Salaam, and the development of regional ports linked to multimodal surface and maritime transport networks. • Six ports of entry will be redeveloped as one stop border posts by 2025, including Beitbridge, Lebombo, Maseru Bridge, Kopfontein, Oshoek and Ficksburg.
Top priority SIPs	SIP (no 2) includes: The Durban-Free State-Gauteng logistics and industrial corridor. This includes strengthening logistics and transport corridors between the main industrial hubs, improving access to Durban's export and import facilities, integrating the Free State industrial strategy activities into the corridor, establishing Durban as a hub port and an aerotropolis around OR Tambo Airport. SIP (no 5) includes: Saldanha-Northern Cape development corridor, including integrated rail and port expansion and back-of-port industrial capacity. SIP (no 21) includes: • Road upgrading or maintenance of the N1, N2 and N3 in the Free State, Limpopo and Kwazulu-Natal. • Small Harbours development – national. • Begeebai Port and Rail Infrastructure Project – Northern Cape. The SIPs will be augmented with the following priorities: • Review of the balance of SIP projects to reflect that the role of road will change in freight transport. • The development of critical strategic projects to facilitate the integration of rail, roads, ports and freight villages within South Africa and across Africa into key trade and investment partners. The development of a national freight intelligence system that includes detailed origin and destination data for different commodities and modes between districts, imports, exports and long-term forecasts to inform planning. • Implementation of emergency measures turnaround decline in the Durban port, Natal corridor and Gauteng link.

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Strategic element	2050 vision – How it will be done
Three-year actions	• The protection of rail freight assets (and Passenger Rail Agency of South Africa (PRASA) assets that rail freight requires) from further decline and waste through vandalism. • Transnet Freight Rail will implement accounting and commercial separation by 2022/3, providing a sound basis to evaluate and accommodate third-party rail operators into the future. • The independent National Ports Authority will be established by 2022/3. • A 25-year plan for integrating rail, road, ports, intermodal hubs and freight villages to facilitate freight handling for key sectors of the economy will be finalised by 2022/3. SEZ projects will be framed to leverage industrialisation opportunities. Private-sector-led implementation of intermodal hubs will begin in 2021. • A regional freight transport plan with top-priority projects connecting rail, road and ports with freight hubs will be developed by 2022/3. Amongst these priorities will include South Africa's role in the North-South Corridor and the exploration of the development of a regional ports network linked to multimodal surface transport. • A centre of transport planning excellence will be established in 2022/3. • The STER will be established in 2022. • The balance of SIPs transport projects will be reviewed with the expectation that the pressure of freight on the road system will fall. • With a view to integration, the Port Master Plan, the National Rail Policy and the Road Funding Policy will be finalised. There will be stakeholder consultation in the process to ensure alignment to social and economic needs. • Six ports of entry will be redeveloped as one stop border posts by 2025, including Beitbridge, Lebombo, Maseru Bridge, Kopfontein, Oshoek and Ficksburg.

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2.3 WATER

HIGHLIGHTS

Features of water infrastructure by 2050

The NDP envisages universal and reliable access to water of an acceptable quality and quantity in support of a strong inclusive economy and a healthy environment by 2030, a commitment that is sustained thereafter. This will be supported by an efficient, resilient, well-managed, and sustainable integrated national bulk water supply system that responds to the economic needs of the country. The institutions involved in managing water resources will be effective in achieving this objective.

How it will be done

- Decision-making will be accountable and the institutions involved in managing water made effective
- Water resource planning will become proactive, robust and responsive
- There will be coherence in water sector policy and support for implementation at the municipal level
- Capacity to finance and deliver water projects will be strengthened, and the private sector will be used effectively. The water sector will become financially sustainable
- Existing water infrastructure will be rehabilitated and maintained and water use efficiencies improved
- Ecological infrastructure will be protected
- Regulatory oversight and licensing regimes will become more robust, addressing both water quantity and quality, as well as pricing and the technical performance and financial sustainability of institutions
- Roles and responsibilities will be aligned and consultation will be meaningful
- Cross-sectoral cooperation for planning and managing water efficiently will be put in place. For example, a transition to renewables in the energy sector will make significant volumes of potable water available for other uses.

2.3.1 The vision for water infrastructure

The vision for the water sector, set out in the NDP, is for universal and reliable access to water of an acceptable quality and quantity in support of a strong inclusive economy and a healthy environment.

The draft National Water and Sanitation Master Plan identifies key elements necessary to achieve this vision: resilient and fit-for-use water supply; universal water and sanitation provision; equitable sharing and allocation of water resources; effective infrastructure management, operation and maintenance; and a reduction in future water demand, protecting and restoring ecological infrastructure⁵ and addressing declining water quality.⁶

2.3.2 Status of the water sector in 2021

South Africa can be characterised as a water-scarce country, with low rainfall and high variability, with increasing uncertainty as a result of climate change, including higher risks of drought in some regions. Only 10% of land area accounts for 50% of river water, supporting more than 64% of the economy, and 70% of irrigation water and more than 50% of the population. About 35% of South Africa's annual fresh renewable water resources have been

⁵ Ecological infrastructure, for the purposes of this document, is defined as functioning natural ecosystems that 'catch' and supply water in and from the important water catchments.

⁶ The National Water and Sanitation Master Plan has not yet been approved by Cabinet.

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exploited to date. It may be possible to increase this to about 45% but new freshwater schemes will become increasingly expensive.

Water is essential to life and to supporting economic activity, including the operation of numerous industries. In this context, sound management of water resources is critical to supporting economic growth and well-being. Without timely and effective interventions, attempts to ensure a decent life for all will be undermined.

According to the National Water and Sanitation Master plan, in the absence of timely interventions, the demand for water will exceed the available supply at the planned level of assurance by between 1,6 billion and 2,7 billion cubic metres by 2030, a deficit of around 10% to 15% of required water.⁷ Without significant changes in how water is managed, this deficit will continue to grow, with an increasing constraint on investments, job creation and economic growth. There is a high risk of water restrictions being imposed in all of South Africa's metropolitan areas over the next five years, with restrictions currently in place in six of the eight metros. Current estimates indicate that seven out of 13 major water systems could be in deficit in 2040.⁸ Although interventions have been identified for all the major water systems, decisions and implementation have been delayed.

Addressing South Africa's water management challenges will not get easier.

Water demands will continue to grow as a result of economic growth, urbanisation and rising standards of living. Non-agricultural water demands are projected to increase by more than 40% between 2020 and 2050, much of this driven by an increase in demand for water in urban areas. Simply to maintain current crop yields, irrigated water use (which accounts for 60% of current use) may need to grow by 6%.⁹ Increases in irrigated area will need to be achieved through a combination of expanded water availability and more efficient use of existing water use rights. Water use in South Africa's urban areas is high and there are high levels of non-revenue water and water losses.

Water quality is declining in the rivers and wetlands are being degraded as a result of increases in pollution from urban, industrial, mining and agricultural activities, reducing water availability and increasing treatment costs. Of particular concern is the poor state and performance of wastewater treatment plants. Many plants are under-capacity and have been poorly maintained.¹⁰ This has significant economic impacts, particularly for downstream users.

Changes in temperature and rainfall patterns are anticipated due to climate change, resulting in increases in evaporation and greater uncertainty in the amount and distribution of rainfall.

Robust government planning systems and execution capability are especially critical in this context of growing demand, limited and increasingly costly supply interventions, increasing water quality challenges and higher levels of uncertainty as a result of climate change.

⁷ The national reconciliation of demand and supply needs to be updated. The estimates provided are uncertain.

⁸ The 13 major water systems refer to the Vaal, Orange River, Crocodile West (Rustenburg), Western Cape, KwaZulu-Natal Coast, Olifants, Limpopo (Polokwane), uMhlathuze/Richards Bay, Levuvhu & Letaba, Algoa (NMB/Gamtoos), Amatola (Buffalo City), Mangaung and Mbombela (Crocodile East) water supply systems. The first three systems accounted for over 70% of water use in 2020. These three systems are interconnected and the overall system is at risk until Phase 2 of the Lesotho Highlands Water Project is completed (now due in 2027, after delays). Further significant augmentation will be necessary over the planning period to 2050. The Western Cape Water Supply System is also at risk until new sources of water are commissioned (surface water, groundwater, reuse and desalination) over the next 10 years and beyond. The Nelson Mandela Bay system is currently in crisis. A significant new augmentation scheme is needed to supply eThekweni and surrounding regions.

⁹ Cullis et al (2017).

¹⁰ South Africa has internationally recognised legislation for environmental flow requirements and DWS has made progress in undertaking reserve studies and developing resource quality objectives (RQOs) to protect critical ecosystems. Implementation is now required, particularly where it comes to water quality issues as well as managing EWR releases and ensuring compliance (ie preventing illegal pumping).

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The NIP 2050 addresses specific gaps in government's water resource planning capacity. This capacity and associated institutional memory have diminished and water system reconciliations are out of date. Important supply interventions have experienced significant delays and efforts to improve water use efficiency have had mixed success.¹¹ Transparency and accountability in decision-making related to measures to balance water supply and demand have declined and there is contestation between spheres of government that appears to hinder progress in critical interventions.¹²

The legally mandated National Water Resources Strategy (NWRS 2013), the water sector's equivalent of the IRP in the energy sector, urgently needs to be updated. A proper census of water resources needs to be done urgently and regularly updated. Information provided at a national level on water requirements, the quantity of water available and the resulting water balances can be seen as only indicative, as they are based on outdated information.

Water systems are both local and interconnected. Current institutional arrangements must be altered so that there are catchment management agencies with devolved mandates set up with appropriate boundaries.¹³

Much of irrigated agriculture water use, which accounts for about 60% of South Africa's water at a lower level of assurance, does not compete directly with stressed and higher-cost water systems serving the power generation sector, industry and the major urban areas.¹⁴ Irrigated water quality requirements are also lower and much of this water is sourced from return flows. Nevertheless, there is scope for further water use efficiency improvements. For example, the large government irrigation schemes reported an average water loss of 27%, which is above unavoidable seepage and evaporation losses in concrete canals of about 12%.¹⁵

Mining, which accounts for about 2% of water use, has a major impact on water quality, affecting the availability and cost of water. Particular concerns are degradation and acidification¹⁶ of current or potential water supplies, the licensing backlog, illegal mining and corruption in licensing processes.

Water supplied through municipal-managed systems accounts for about 30% of water use. This use includes domestic, industrial, commercial and institutional use. The vast majority of this use is in urban areas.¹⁷ It is anticipated that urban water demand may increase by 43% by 2050. The water business is poorly managed in many municipalities, with high levels of water losses, low reliability of supply, weak revenue collection, poor financial performance, inadequate maintenance and replacement of assets, and deteriorating services.

Very significant investments are needed in the rehabilitation of existing infrastructure as well for providing for additional capacity for both water resources infrastructure (for which national government is responsible) and the water services infrastructure (for which municipalities are

11 Water demand in Cape Town was reduced by about 50% during its drought crisis. Water use has not been effectively reduced in Nelson Mandela Bay during the current water crisis.

12 System status reports and steering committee minutes are no longer routinely available to the public. There has been a long-running dispute over the next augmentation scheme to supply the Mangaung metro.

13 For example, the integrated Western Cape Water System straddles both the Berg and Breede River catchments that are overseen by separate institutions. The Berg River is managed by DWS (as a "proto-CMA") and the Breede by the Breede-Gouritz CMA.

14 There are some exceptions. The Western Cape Water Supply System serves both urban users (mainly Cape Town) as well as irrigated agriculture. Illegal irrigation use in the upper Vaal extracts expensive water from the Lesotho Highlands Water project.

15 According to the draft National Water and Sanitation Master Plan.

16 Including the phenomenon of acid mine drainage related to gold mining on the Witwatersrand.

17 Water supplied to households living in rural areas accounts for a small fraction of total municipal use nationally.

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responsible). The capacity of the sector to support the financing of these investments is weak as a result of low water tariffs, high levels of non-revenue water and weak revenue collection.

However, the corner is turning in the use and management of water resources:

- South Africa has a set of well-developed, integrated water supply systems that are, on the whole, well adapted to South Africa's unique water challenges. These need to be well maintained and expanded as is appropriate in response to growing demand. The National Water Policy and National Water Act, No 36 of 1998, have been acclaimed internationally as providing a sound basis for water management. The Lesotho Highlands Water Project offers a good model for international cooperation on shared water resources.
- There have been meaningful improvements in water use efficiency by some water use sectors, and the DWS is driving the effort to succeed through further savings and efficiencies.
- Water for power generation, which accounts for an estimated 2.5% of water demand at present, has been steadily declining and the transition away from coal to renewables will significantly reduce water demand for energy production.
- Companies using water in their industrial processes have become more efficient and have played a leading role in initiatives promoting water stewardship.¹⁸ Direct industrial use accounts for about 3% of total use.¹⁹
- South Africa is a world leader with regard to investing in ecological infrastructure, through the Working for Water programme, wetland rehabilitation and other invasive-alien-clearing programmes, and is pioneering direct potable reuse in Beaufort West and Cape Town.
- Hydrology and reconciliation studies for all the major systems and a national water balance study have been commissioned. Studies to define and implement water resource quality objectives have been initiated and the National Climate Change Strategy is being updated.
- In April 2021, the Presidential Infrastructure Coordinating Commission (PICC) Council approved actions that would address many of the institutional challenges, mostly through the DWS. Furthermore, an Inter-ministerial Committee is being established to improve coordination on water and sanitation. The approved actions include the following:
 - Fast-tracking the establishment of the National Water Resource Infrastructure Agency. In this regard, a critical path for its establishment has been developed and resources allocated.
 - Attending to the backlog on water licensing, with a commitment to providing an answer to licence applications within 90 days.
 - Establishing catchment management agencies.
 - Establishing an independent national water regulator and separating regulation from water resource management and water services provision.
 - Developing a transparent national water tariff policy and a rigorous revenue collection or management strategy at all stages of the water value chain to ensure sustainable revenue for the water sector, and fast-tracking the review of the Raw Water Pricing Strategy to ensure effective pricing and cost-reflective tariffs.
 - Enabling the planning and coordination function of the water component of the District Development Model through the implementation of a national water

¹⁸ For example, the CEO Water Mandate (<https://ceowatermandate.org/developer/sasol/>).

¹⁹ Use that is not included as part of municipal (urban and domestic) use.

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programme management office, jointly owned by the DWS and Department of Cooperative Governance and Traditional Affairs (COGTA).

- o Strengthening the preparation and planning of municipal water infrastructure to enable so that blended finance can be accessed in the Infrastructure Fund.

2.3.3 Conditions required to ensure that the water sector delivers on South Africa's 2050 vision

There are seven critical conditions that need to be in place to achieve the 2050 vision for the water sector:

1 Water resource planning capacity must be proactive, robust and responsive.

- Water resources planning must be proactive, programmatic and well-resourced, informing strategy and implementation.
- Data informing planning must be comprehensive and up to date.
- Planning must be done with recognition of the local characteristics, complexity and interconnectedness of major water systems.²⁰
- There should be cross-sectoral cooperation to optimise national water use.

2 Decision-making must be accountable and institutions effective.

- Institutional accountabilities and mandates must be aligned for effective decision-making.
- There must be accountability for building water security and resilience in each major water system and at the municipal level.
- Decision-making must be transparent and water users should be able to provide inputs into the decision-making processes.
- Institutional mandates and roles and responsibilities should be clearly defined.
- Leadership in key institutions – government (national, provincial, municipal), regulators, Trans-Caledon Tunnel Authority (TCTA), water infrastructure agency, water boards, water service providers, water user associations and other irrigation institutions – must be capable and stable.
- Management must be effective, and human resources capability must match roles and responsibilities.
- Revenue sources must be sufficient and sustainable.
- Institutions must become soundly governed, open and transparent.
- Institutions must regularly achieve clean audits.

3 Capacity to finance and deliver water projects must be robust, with the private sector being used effectively, and the water sector must become financially sustainable.

- Financing and implementation arrangements must be clear for all priority projects and execution capacity must be robust.
- Private sector capacity must be effectively used to contribute skills and financing and to improve sector efficiencies.

²⁰ For example, the seven major dams in the Integrated Vaal River System need to be managed as an interconnected system to increase security of supply and reduce evaporation losses.

- Revenues from tariffs, together with secure and predictable government budgets, must be sufficient to finance and fund the necessary capital expenditure and meet efficient operating costs.
 - Robust procedures must be in place to review, set and approve tariffs in the water sector through the full value chain.
 - Conditions must be created for the increased use of commercial finance in the sector.
- 4 Existing water infrastructure must be rehabilitated and maintained and water use efficiencies improved.**
- Institutions involved in managing water infrastructure must pay as much attention to the maintenance and rehabilitation of existing infrastructure as to the creation of new infrastructure.
 - Water leakages must be addressed.
 - Asset management best practices must be implemented.
 - Effective use must be made of the private sector to increase institutional capacity to operate and maintain infrastructure.
 - Non-revenue water must be significantly reduced and overall water use efficiency improved.
 - Irrigation water use efficiencies must be improved where appropriate, especially in water-stressed systems.²¹
- 5 Ecological infrastructure must be protected.**
- Institutional responsibilities must be clarified for the protection of key natural ecosystems supplying the major share of South Africa's water.
 - Reserve requirements should be enforced and resource quality objectives implemented.
 - Financing mechanisms to support ecosystem protection and rehabilitation must be established.
- 6 Regulatory oversight and licensing regime must become robust.**
- Local government and national legislation should be aligned.
 - The water allocation and licensing processes must become just, equitable, predictable and stable.
 - Sufficient professional and administrative capacity must be created and maintained for the sector's important economic regulation and licensing functions.
 - Regulatory and licensing administrative processes must be effective and efficient.
- 7 Roles and responsibilities must be aligned and consultation meaningful.**
- Roles and responsibilities of all role players should be well aligned, from the line department, catchment management agencies (CMAs), regulator, TCTA, National Water Infrastructure Agency, water boards, water user associations, water services providers, private sector and social partners.
 - The consultative processes must be deep and meaningful.

²¹ There are areas where low capital-intensive irrigation makes sense and water use efficiencies will be lower.

2.3.4 How the 2050 vision will be achieved

Strategic element	2050 Vision – How it will be done
The institutions involved in managing water are effective	- Executive leadership in DWS, the water boards and other institutions managing water will be stabilised and appointed based on capability. - The National Water Resources Infrastructure Agency will be operational and robust. - There will be an infusion of management capability into the sector, resulting in the turnaround of municipal water businesses (financial and technical performance), financial viability (revenues matches expenses), reduction in non-revenue water and water losses, and management of demand. There will be a particular focus on the top 12 municipalities accounting for 65% of urban water demand. - Irrigation systems will be rehabilitated and maintained and water use efficiencies improved.
Water resource planning is robust and enables responsiveness	- The legally mandated National Water Resources Strategy will be updated every five years. - A robust water resources planning, regulation and management monitoring framework will be established. - The collection, analysis and accessibility of hydrological, rainfall and other base data will enable effective planning and adaptation. - Monitoring information will be transparent and accessible to the public and researchers; will be useful in informing policy, strategy and implementation; and will be published regularly in accessible formats. - Climate change mitigation and adaptation will be integrated into water resources management at national, catchment and water system levels. - Steering committees will be functioning, representative and transparent. Users will participate in governance of catchment management agencies and in steering committees overseeing water systems. Processes and decisions will be transparent and feedback loops for effective remedial and corrective actions will be in place. - Water use policy for agriculture will be clear and enable agricultural production, water use efficiency, fair distribution of the water resource and cost recovery.
There is coherence in water sector policy and support for implementation at the municipal level	- A National Water Programme (NWP) that acts through a PMO centre of excellence will be established to support water and sanitation project development and implementation at the municipal level. - Key expertise and support will be housed and developed in partnership with universities, centres of learning and research entities. - The NWP PMO will house advanced capability in blended finance solutions for water projects, especially at the municipal level. This will draw together public sector, private sector and development finance for funding of water and sanitation projects. - The NWP PMO will work with government's Infrastructure Asset Management Programme, once it has been established in 2022, which is intended to assist municipalities with planning, budgeting and executing asset care and management responsibilities. This will enable the extension of life of assets as well as the efficient replacement and renewal of existing assets.
Decision-making is accountable	Institutional accountability will be created at the level of the major water systems (and not by individual catchment).

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Strategic element	2050 Vision – How it will be done
	• Systems will be established to oversee, make, implement, monitor and report on decisions on critical-path items to build water security and resilience in each major water system. • Active steering committees will be maintained for each major water system, with user involvement, transparent decision-making and public reporting of minutes and status reports.
Capacity to finance and deliver water projects is robust, and the private sector is used effectively	• Key interventions will be identified for each major water system, and programmes and projects to implement these interventions will be clearly specified. • Capacity will be created to support effective planning and implementation of wastewater treatment expansion and rehabilitation, water reuse and desalination (because these will increase in importance over time). • The most promising opportunities for expanding food production through irrigated agriculture will be identified, and programmes and projects to implement these interventions will be clearly specified. • A national priority project pipeline will be maintained and regularly reviewed. • Dedicated capacity will be created to support effective use of the private sector for project implementation, including the use of development and commercial finance, especially for wastewater treatment, reuse and desalination projects. • Programme and project decision-making and implementation progress will be tracked and reported regularly in an accessible way to the public.
The water sector is financially sustainable	• The raw water pricing strategy will be finalised; cost recovery, infrastructure financing, irrigation subsidies, waste discharge charges and water resource management charges (and how these are used) will be addressed. • Norms and standards will be finalised for all bulk WSPs • Raw water, bulk potable and municipal tariffs will be regulated to ensure predictable cost recovery pricing with sufficient institutional and technical capacity. • Specific initiatives to make greater and effective use of development finance institutions (DFIs) and commercial financing for the sector will be undertaken.
Existing water infrastructure is rehabilitated and maintained, and water use efficiencies are improved	• Critical national and regional water infrastructure systems will be rehabilitated and well maintained, including dam safety. • Irrigation systems will be rehabilitated and initiatives to improve water use efficiencies undertaken. Water policy and management in agriculture, accounting for 61% of water usage, will get explicit attention. There will be a step change in capabilities for continuous improvement in water use efficiency and technological innovation, monitoring of usage, tariff structures (which will be fair, predictable and efficient) and the approach to allocating water to agriculture. • Municipal water and wastewater infrastructure will be rehabilitated and well maintained, non-revenue water will be reduced and water and wastewater treatment plants will meet regulated quality standards. • Free basic water services funding formula will include the need to cover associated rehabilitation and similar costs.
Ecological infrastructure is protected	• Priority areas for ecological infrastructure will be identified. • Programmes will be developed and implemented. • A monitoring and reporting framework will be developed and implemented.

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Strategic element	2050 Vision – How it will be done
Regulatory oversight and licensing regime are robust	• Licensing administrative processes will be robust and responsive, with strong capacity in place. • The regulatory framework will be reformed to enable private participation in water provision, especially for financing and implementation of desalination, reuse and wastewater upgrade projects. • Capacity for effective economic regulation will be developed and continuously improved.
Roles and responsibilities are aligned, and consultation is deep and meaningful	• Roles and responsibilities of all role players will be well aligned, from the line department and CMA or regulator to institutions managing water infrastructure, water user associations, private sector and social partners. • The consultative processes will become deep and meaningful.
Top-priority SIPs	• SIPs (Project 19) include the following projects: ◦ Vaal River System, including Phase 2 of the Lesotho Highlands Water Project – Gauteng. ◦ Phase 2A of the Mokolo/Orocoule River (West) Augmentation Project – Limpopo. ◦ Olifants River Water Resource Development Project Phase 2 – Limpopo. ◦ Groot Letaba River Water Development Project Nwamitwa Dam – Limpopo. ◦ uMkhomazi Water Project – KwaZulu Natal. ◦ Umzimvubu Water Project – Eastern Cape. ◦ Berg River Voelvlei Augmentation Scheme – Western Cape. ◦ Orange-Riet Canal Increase of Bulk Raw Water Supply – Free State. ◦ Rustfontein Water Treatment Works – Free State. ◦ Vaal-Gamagara scheme to improve water security for mines in the Northern Cape. ◦ Rehabilitation of the Vaalharts-Taung Irrigation Scheme – Northern Cape and North West. • The SIPs will be reviewed and potentially augmented with the following priorities: ◦ Dam-raising projects for Tzaneen and Clanwilliam dams. ◦ Review of projects in ensuring viability of municipal wastewater plants as has been done for Emfuleni. ◦ Expansion of the Sundays River subsystem and other projects to serve Gqeberha. ◦ Water supply augmentation for Mbombela, Mpumalanga.
Three-year action steps	• The National Water Resources Infrastructure Agency will be established and functioning in 2023/4, providing direction to bulk water and national water security. • An independent single national water regulator will be established in 2022/3. Regulation to enable private participation will be implemented by 2023/4. Water tariffs will be regulated by an independent water regulator that will be established in 2022/3 and regulate tariffs by 2023/4. The National Water Resources Strategy is being updated in 2021/2. • The water licensing backlog will be addressed.

Strategic element	2050 Vision – How it will be done
	• The raw water pricing strategy will be finalised in 2021/2. • The NWP PMO is being established in 2021/2 to support municipalities, with partnership agreements signed and functioning. The NWP Centre of Excellence for blended finance solutions in water and sanitation will be established and housed in the NWP PMO in 2021/2. A water planning centre of excellence for municipalities will be established in the NWP PMO in 2022/3 with legally mandated functions. The NWP PMO will build capacity in planning and implementation of municipal level wastewater treatment, non-revenue-water, water reuse and desalination, and will be finalised in 2021/2. Implementation will begin in 2022/3. Government's municipal infrastructure asset management programme will be established in 2022/3 by COGTA or Municipal Infrastructure Support Agent (MISA). The NWP PMO will work with government's Municipal Infrastructure Asset Management Programme and assist municipalities with planning, budgeting and executing asset care and management responsibilities. • A strategy for climate change mitigation will be finalised in 2022/3. Aspects of ecological infrastructure will be addressed and included in the scope and mandate of the NWP PMO. • A policy for water use in agriculture will be gazetted in 2022/3, after public consultation in 2021/2. • All major water systems will have active steering committees established, which committees will engage with users. • At least 10 non-delegated municipalities that deliver to large populations and that demonstrate significant challenges will have support and/or capacity to adequately maintain distribution systems and billing systems. They will be chosen on the basis of demonstrated political commitment, and support will be contingent on performance (see page 12). They will be assisted with technical and financial capacity to achieve acceptable levels of financial viability in water delivery and a meaningful reduction in non-revenue water. • The SIP water project priority list will be updated to be aligned with the NIP 2050 in 2021/2. The following applies: ◦ The water SIPs will be reviewed for their viability. They will be subjected to cost-benefit analysis applying robust methodology and in a transparent way. ◦ Reconciliation strategies for the four major water systems that serve large populations will be updated and finalised in 2021/2. This will include the Vaal, Orange and Crocodile West (Rustenburg) Rivers, which account for 70% of water use, and the Western Cape system, which is severely at risk. Reconciliation strategies will be finalised for the other nine water systems in 2022/3. Implementation in the first four water systems indicated will be underway by 2022/3. ◦ Targets for a minimum number of irrigation systems to be rehabilitated and maintained from 2021/2 to 2023/4 will be set. At least two irrigated agricultural projects aimed at food production will be identified in 2022 and driven to implementation by 2023.

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2.4 DIGITAL COMMUNICATIONS

HIGHLIGHTS

Features of digital communications infrastructure by 2050

Communications are the lifeblood of a market economy, and digital communications are increasingly central to that. The increasingly foundational role of digital transformation means that the benefits of becoming a fully digitally enabled society and economy outweigh the costs.

The NDP envisages that, by 2030, a seamless information infrastructure should be universally available and accessible, at a cost and quality at least equal to South Africa's peers and competitors.

While South Africa is far off the NDP's goals in 2021, the 2030 goals must stay. There is evidence of sufficient capacity to deliver on these objectives if they are implemented through private-public cooperation.

How it will be done

- High-speed broadband will be universally accessible.
- Regulation will enable competitive and universally accessible broadband.
- Public sector capacity will be strong and able to drive the required policy agenda.
- Partnerships will be strong and there will be centres of digital excellence promoting a growing knowledge base of delivery and innovation.
- The information and communications technology (ICT) skills base will be robust.
- Government services and buildings will be digitally enabled.
- Private sector participation in achieving universal broadband access will be prevalent.

2.4.1 2050 vision for digital infrastructure

Communications are the lifeblood of a market economy, and digital communications are increasingly central to that. The increasingly foundational role of digital transformation means that the benefits of becoming a fully digitally enabled society and economy outweigh the costs.

The NDP envisages that, by 2030, a seamless information infrastructure that is universally available and accessible, at a cost and quality at least equal to South Africa's peers and competitors. There should be continuous improvement thereafter.

More specifically, by 2030, 100% of the population should have easy access to affordable broadband of at least 10 Mbps. All government buildings should have high-speed broadband of at least 100 Mbps, and where relevant participate in leveraging this to underserved areas and communities.

The vibrancy of private investment in telecommunications and digital infrastructure, products and services will be continuously encouraged. There will be an ever-growing ability to forge public-private partnerships in the development and delivery of digital solutions, always at the cutting edge of global capability as relevant for South African society and economy.

Government will be enabled to strengthen the delivery of services digitally, and the private sector will evolve innovative digital solutions that create ever-increasing access by low-income communities to commercial and social services.

While South Africa is far off the NDP's goals at 2021, given the increasingly essential nature of connectivity, the 2030 goals must remain in place. There is evidence of sufficient capacity in South Africa to deliver on these goals if they are coordinated and implemented through private-public cooperation.

2.4.2 Status of digital infrastructure delivery in 2021

There has been good performance on infrastructure rollout over the past decade. South Africa performs well in global digital infrastructure indices. For example, by 2019, 93% of the

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population were covered with 4G/LTE, a dramatic improvement from 53% in 2015. Urban areas were fully covered with 4G/LTE and most provinces had rural coverage of 4G/LTE exceeding 80%.

In 2013, 86% of the population lived within 10 km of a fibre access point. Since then, there has been further fibre rollout, including to base stations in the delivery of LTE. Nevertheless, fibre tends to be located in urban areas, with significant network duplication.

International bandwidth usage more than doubled between 2016 and 2018, enabled by competition in international submarine cables that expanded capacity and reduced prices.

South Africa ranks 96th and 60th globally in its fixed-broadband and mobile download speeds, respectively [see Independent Communications Authority of South Africa (ICASA), 2020, and Ookla Speedtest Intelligence]. While fixed-broadband speeds in South Africa are uncompetitive, mobile upload and download speeds compare favourably with those of BRICS and many other peer countries.

Between 2015 and 2019, there was investment in telecommunications of about R177 billion, driven by the private operators (ICASA, 2020). The public sector has lagged rather than led in this domain. This poor progress in digital inclusion is due to the network high prices even as the network is available, and the last mile is required for lower-income communities and to public services.

However, **digital access is poor**. This does not contradict the previous statement: While there is excellent broadband availability across the country, it is not easily accessible to most households in a way that would indicate meaningful digital connectivity.

South Africa performs poorly in global indices on demand-side indices such as internet use, skills and digital awareness. This is the main explanation for South Africa's slippage down the International Telecommunication Union (ITU) ICT Development Indices from 78th to 92nd (of 192 countries) between 2002 and 2018. For example, government had targeted connecting 90% of the population with at least 5 Mbps by 2020. There was significant improvement in the percentage of the population with access to a cell phone, rising from 76% in 2011 to 90% in 2018. While broadband access improved, its accessibility was still poor. The percentage of households with at least one person who had access to the internet rose from 33% to 64,7%, almost completely explained by mobile connectivity. Only 10% had access to internet in the home and/or an internet café or school facilities. Internet penetration varies significantly by region, where, as an example, 75% have some connectivity when compared with 46% in Limpopo²².

The majority of mobile subscribers are prepaid, at a cost significantly higher than with postpaid. For example, in 2020 the cost of 1 GB of prepaid data was about R100 to R120 – more than double that of postpaid data, at R40 to R79²³.

There has been very **poor progress on digital enablement of government services**. Broadband has the potential to enhance the provision of government services, including e-health, e-education and e-government. Importantly, the digitisation of government services could be used to improve the quality of service delivery, reduce costs to the fiscus and access marginalised and remote areas and communities. E-services have the potential to reduce the cost of living of citizens, for instance by reducing or eliminating the need to travel and queue

²² Statistics South Africa (2017). Poverty trends in South Africa: An examination of absolute poverty between 2006 and 2015. Available at: <http://www.statssa.gov.za/?p=10341>.

²³ ICASA (2020). The State of the ICT Sector Report in South Africa 2020. March 2020. Available at: <https://www.icasa.org.za/uploads/files/State-of-the-ICT-Sector-Report-March-2020.pdf>.

for many government services. They could offer a key accountability and feedback loop mechanism through real-time data tracking and other methods.

State capacity in ICT is weak in respect of design and procurement. There has been institutional instability across the ICT state institutions – ministers and directors-general have changed almost annually over the past 12 years. This frequent change in leadership has caused disruption and discontinuity, resulting in delayed implementation and learnings have been lost. Policy levers that could have been used to drive pricing down and stimulate the industry, like spectrum, have been delayed and therefore their benefits not realised. There have been high expectations of ICT SOE delivery to roll out broadband and digital services across government [amongst others, the State Information Technology Agency (SITA), Broadband Infraco (BBI) and Sentech], but SOEs do not have the capacity nor scale to deliver as needed. Funding has also been a major constraint to faster deployment of broadband.

After a number of false starts in implementing South Africa Connect (2013), the National e-Government Strategy and Road map and the National e-Strategy (2017), attention shifted to piloting broadband rollout to public buildings in National Health Insurance sites located in eight district municipalities and seven provinces. This was to be implemented by BBI and SITA. This 'Phase 1' was initiated in 2017/18 and was meant to connect 6 135 government buildings but to date has connected only 970 government sites – mainly clinics and schools. A further 35 211 government sites still need to be connected to achieve the goals of South Africa Connect. It is estimated that doing this would cost a minimum of about R30 billion and potentially up to R80 billion, depending on the pace and design of the programme. Slow delivery and constrained finances have resulted in the South Africa Connect budgets being cut dramatically, with about R 581 million allocated over 2020/1 to 2022/3.

The Universal Service Access Fund (USAF), now rolled into the new Digital Development Fund (DDF), was meant to drive an accelerated delivery of digital services to underserved communities. It has not made a mark on this goal: its expenditure is simply too small, at less than R 300 million annually, and its 2018/19 Annual Report says it failed to achieve on 90% of its objectives. It has also suffered with governance challenges similar to those found in other SOEs and was in administration.

ICT procurement is fragmented, rife with uncertainties in respect of mandates and responsibilities. The approach to investment in connecting public buildings and in enabling digital services and platforms is essential to enabling e-government and digital infrastructure expansion. The capabilities for oversight and implementation of digital public platforms are very limited. The result is that there are targets, policy frameworks, plans and commitments but very limited progress in critical deliverables. Important foundational work has been done to initiate open-data policy, government data systems, national back-office digitisation, a national ID system, and movement to a national e-government central portal. The Covid-19 pandemic has pushed some processes forward. Interesting partnerships such as those surrounding CovidConnect, CovidAlert and GovChat.org have emerged.

Most notable is the delay in digital migration and spectrum reassignment, which, once implemented, could have the effect of improving quality and reducing mobile pricing. Parts of this spectrum is also suitable for 5G coverage requirements (a key enabler for 4IR applications). This spectrum, which is in the 700 MHz and 800 MHz bands, is still in the process of being migrated from analogue television broadcasting. The regional deadline for this migration was 2015. South Africa has not released sub-1 GHz spectrum since 1993, nor mid-band spectrum since 2003.

The National Broadband Plan should have seen delivery against South Africa Connect targets, especially in respect of connecting public buildings. All schools should have been connected by 2020 but only 30% were. More information that is actionable will be needed going forward on the quality of connectivity and how it is being used to optimise service delivery impact. Other critical areas of digital rollout – such as in the commitment to interoperability of services

and of a central government portal – will benefit from clearer road maps and better monitoring of progress and impact.

2.4.3 Conditions required to achieve the 2050 vision for digital infrastructure

Eight conditions must be met to achieve the 2050 vision for digital infrastructure:

- 1 There must be continuous improvement in driving towards universal readiness for a digital world, including the achievement of universal broadband access, digitisation of government services, deepening of ICT skills and capabilities, and enablement of e-commerce, digital finance and digital entrepreneurship.
- 2 There must be a strong and competitive base of private sector that continues to invest, maintain, upgrade and innovate.
- 3 A public sector broadband and digital services delivery model must effectively engage the private sector, through a growing range of innovative ways of partnering and cooperating.
- 4 There must be sufficient and sustainable public and private finance that enables continuous improvement in delivering universal broadband and supportive ICT services to currently underserved communities and households and to public institutions.
- 5 Government must have substantial internal professional and technical capability in procuring and overseeing the implementation of universal-broadband delivery and e-government services that operate at a global standard suited to South African conditions and that are continuously improving.
- 6 The regulator must deliver effectively in enabling progress of digital enablement and 4IR progress, including that related to competition, spectrum allocation and price regulation, amongst other areas. The regulator must be stable, independent and accountable. It should have oversight and staff with the appropriate level and balance of skill, experience and qualifications.
- 7 Spectrum must be treated as a national resource that is optimised for South Africa's development. It should be done in a way that supports enhanced competition as well as universal access obligations. Wholesale network services should enable sustainable services that are accessible and promote appropriate levels of competition.
- 8 There should be centres of excellence and think tanks that support private and public sectors to operate inclusively and innovatively to deliver on South Africa's digital imperatives in development.

2.4.4 How the 2050 vision for digital infrastructure will be achieved

Strategic element	2050 Vision – How it will be done
High-speed broadband is universally accessible	• High-speed broadband will be available in underserved areas and will be affordable and accessible to low-income communities. • Investment in last-mile connectivity, mainly through a complementary mix of wireless broadband technologies, targeting rural and underserved populations, will take place. • Lessons from South Africa Connect and universal access initiatives will be reviewed to improve delivery and impact in future. • There will be better coordination of infrastructure projects to leverage complementary resources (such as roads or electricity).

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Strategic element	2050 Vision – How it will be done
Government services and buildings are digitally enabled	• All government buildings will be connected with high-speed broadband and have sufficient services to make the broadband usable (local area network – LAN, wide area network – WAN, equipment). • All government buildings will offer low-income users free Wi-Fi. • Government will implement the National e-Strategy and e-Government Strategy and Roadmap (2017). There will be clear role identification and approaches to ensure interoperability and data sharing. • Government e-enablement will be leveraged to promote a digital society and universal connectivity. There will be a target of 10GB to home by 2023/4 and 50GB to home by 2025/6. There will be an accelerated focus on enhancing service delivery with eHealth and eEducation. • Universal access and public sector connectivity will primarily rely on government as procurer and regulator, with SOEs and private sector implementing. The Western Cape and Tshwane offer two different examples. • Digitisation in transport, energy and water infrastructure will be prioritised as a way of modernising and strengthening efficiencies in maintenance and operations. • There will be transparent monitoring and evaluation of digital services in the public sector.
Regulation enables competitive and universally accessible broadband	• ICASA's regulatory capability will be benchmarked as the best globally. • The appointment of ICASA regulators will be transparent, with clear criteria. • ICASA will be held accountable for the quality of regulation with respect to spectrum pricing, infrastructure sharing and similar. • There will be a robust model for wholesale data services that is effectively regulated.
Public sector capacity is strong and can drive the required policy agenda	• Government capacity to design and procure digital infrastructure and services projects will be technically sound. • There will be commitment to institutional stability, good governance and appropriate capacitation through senior appointments. • There will be attention to leveraging state infrastructure from non-ICT SOEs to enable faster deployment of broadband.
Private sector participation in achieving universal broadband access is prevalent	• The model of delivery will increasingly leverage vibrant private sector participation and blended financing. It is envisaged that R30 billion to R80 billion will be raised to finance the rollout of government broadband and services in the medium term. • There will be special vehicles promoting blended finance in public broadband infrastructure. Amongst other things, these provide incentives for de-risking private sector investments in rural areas and accelerating broadband delivery in peri-urban areas, demand-side schemes for subsidising low-income consumers communication costs, and innovative use of unlicensed spectrum (Wi-Fi, TV whitespace). • The allowable period for public procurement of telecommunication companies (telecoms) and digital services will be lengthened, to enable private provision in ways that also deliver services to underserved communities, and monetised over 10–20 years.

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Strategic element	2050 Vision – How it will be done
	The capability and regulatory frameworks will be strengthened to enable different forms of partnership and alliances between public and private sectors, as discussed in Section 4 of the NIP 2050
Partnerships are strong and there are centres of digital excellence promoting a growing knowledge base of delivery and innovation	Globally, governments and regulators struggle to keep up with fast-moving digital trends. This is also true for South Africa. Meaningful sustained partnerships and knowledge forums will be leveraged and engage government, business and other stakeholders in a focused practical manner. These will enable governments and regulators to keep up with fast-moving digital trends and contribute to strengthening private-public cooperation and joint learning. There will be a number of formations that could serve this need, such as the Presidential Commission on 4IR (PC4IR) and/or the Public-Private Growth Initiative (PPGI).
The ICT skills base is robust	The ICT skills base will be continuously improving, creating an e-savvy nation and offering sufficient support to private and public investments. Some of the priorities include the following: - Connecting all schools by 2023, with supportive digital services in the school and in the cloud, and providing free Wi-Fi to low-income households nearby. - Centres of excellence being supported to innovate in digital teaching and learning methodology from school to post-school education and training (PSET). ICT training would need to be core in teacher professional development curriculum and in ongoing professional development. - Stronger partnerships between vocational training and industry, to ensure relevance of curriculum and pathway into digital apprenticeships and workplace learning. - The causes of poor throughput of high-quality ICT graduates being identified and addressed. - Opportunities for unemployed youth to gain digital literacy and related vocational skills being created and acting as a significant channel to work. - Critical technical skills to operate and maintain digital infrastructure being developed and available in South Africa. - Innovation in the ICT industry and testing of newer cost-effective technologies for broadband penetration taking place. - Links to international accelerator programmes through ICT organisations like ITU and GSMA to boost the youth e-readiness being enhanced.
Top-priority SIPs	SIPs: - Square Kilometre Array (SKA) and MeerKAT – no 16. - Space Infrastructure Hub – South African National Space Agency (SANSA) – no 22. - Digitising of government information – no 30. - South Africa Connect Programme – no 35. Priority projects to augment the list of SIPs: - To be augmented as listed in the 'three-year action steps' below.
Three-year action steps	- Digital migration will be concluded and spectrum will be released in 2021/2. - Spectrum auction will be done with careful attention to competition objectives.

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Strategic element	2050 Vision – How it will be done
	• Policy will be concluded for rapid deployment of electronic communications networks and facilities in 2021/2. • Executive leadership of government departments, entities and the regulator responsible for digital delivery will be stabilised and appointed according to capability. • Review of approach to wholesale regulation and service provision will be done by 2021/2. The wholesale regulatory approach will be evaluated – whether a wholesale open-access network (WOAN) or promoting competition through stronger wholesale regulation and obligations tied to spectrum allocation and/or spectrum set-asides to encourage access by operators with less access to capital. • Arrangements required to enable private participation in public interest digital delivery will be in place by 2022/3. Most immediately, this will include special vehicles to promote blended finance and procurement rules that enable long-term partnerships such as the proposed Broadband Fund. • 80% of public buildings, especially schools, health facilities and police, will be connected by 2024/5, in line with the targets of government's Medium-Term Strategic Framework (MTSF). • High-speed broadband will be available and accessible in all communities by 2024/5, achieving access comparable to competitor nations. There will be consideration of free basic data for low-income users, similar to such access to water and electricity. • SIPs reviewed in 2021/2 will include e-enablement of all government buildings. Amongst others, this includes the following: ◦ At least 80% of schools being connected by December 2022. ◦ Local and provincial government broadband and related ICT initiatives being streamlined and rationalised, with mandates, roles and responsibilities being clarified. ◦ The model for public-private partnerships being progressed with material impact on delivery. Government will identify three top-priority pilots where partnerships are used to introduce overarching digital modernisation. Examples are policing, health, education, water and smart cities. • Digitisation of government services will be scoped and projects identified and funded. • A data centre strategy will be finalised in 2021/2. • A satellite communications strategy will be finalised in 2021/2 and implementation will begin 2022/3. • A SKA regional digital rollout strategy will be finalised in 2021/2. • There will be consideration of smart city policies.

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3 BUILDING A REGIONAL AGENDA FOR INFRASTRUCTURE

HIGHLIGHTS

Features of South Africa's interface with regional infrastructure by 2050

South Africa will demonstrate and execute on a bold vision for its infrastructure cooperation in the Africa region.

Initially, the vision is to enable delivery on regional projects that are critical to South Africa's domestic needs and are also beneficial to regional development. In the near term, critical energy and water projects will be implemented with greater vigour, as will the development of high-efficiency border posts. In the medium term, South Africa will be an active driver of regional transport corridors in rail, road and ports that greatly enhance the ease of regional trade. South Africa will drive regional digital connectivity. As South Africa's construction sector is invigorated (section 6) and infrastructure finance deepened, the country will play a greater role as a gateway into Africa and as a participant in delivering regional infrastructure projects and finance.

How it will be done

- Projects will progress timeously.
- Regional capacity to drive projects will be robust.
- Project monitoring will enable action.
- South Africa will gain from foreign infrastructure investment in Africa.
- A financial centre of excellence will be established.
- A top-priority regional infrastructure integration strategy and project pipeline will be implemented.
- Predictability and certainty will stimulate local manufacturing in regional corridors.

3.1 Vision for regional infrastructure by 2050

South Africa will demonstrate and execute on a bold vision for its infrastructure cooperation in the Africa region.

Initially, it will enable delivery on regional projects that are critical to South Africa's domestic needs and are also beneficial to regional development. In the near term, critical energy and water projects will be implemented with greater vigour, as will the development of high-efficiency border posts. In the medium term, South Africa will be an active driver of road-, rail- and sea-based regional transport corridors that will support the development of cross-border production networks and greatly enhance the ease of regional trade. South Africa will drive regional digital connectivity. As South Africa's construction sector is invigorated (section 6) and infrastructure finance deepened, the country will play a greater role as a gateway into Africa and as a participant in delivering regional infrastructure projects and finance.

3.2 Status of regional infrastructure participation in 2021

The South African government has prioritised a number of important regional infrastructure projects such as the Inga III Hydropower involving the Democratic Republic of Congo (DRC) and the Lesotho Highlands Water Project Phase II. These will provide critical energy and water supply to South Africa.

- Inga is envisaged to create hydropower generation capacity of more than 44 GW and is one of 13 flagship projects under the Programme for Infrastructure Development in Africa (PIDA). Inga I was commissioned in 1972 and Inga II in 1982. The African Development Bank (AfDB) financed a development study in 2010 and to date has committed US\$100 million in technical assistance to the DRC for potential projects of more than US\$80 billion. It has received the high-level advocacy it requires, from the African Union (AU), United Nations Economic Commission for Africa (UNECA), African Union

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Development Agency (AUDA), AfDB, DRC and South Africa. However, so far there are no confirmed off-takers nor committed creditworthy developers. The memoranda of understanding (MoUs) with funders have been signed but there are no power purchase agreements. Multiple challenges exist, specifically various political, governance, procurement and technical challenges.

- The Lesotho Highlands Water Project Phase II is critical to water security as previously discussed. The water delivery system to augment water supply to South Africa is paid for by South Africa. It includes a hydropower generation system to enhance electricity generation for Lesotho paid for by South Africa. It is one of the largest development projects globally, involving complex engineering. It is therefore vulnerable to many risks, notwithstanding the delays posed by Covid-19. It is already running three to six years behind schedule.

There are other similar regional infrastructure projects that South Africa participates in, but they are not treated with similarly high priority. They are also being developed at a slow pace, belying their strategic importance for South Africa and the region. Amongst others, they include the Southern African Power Pool (SAPP), other potential regional water projects and regional digital connectivity.

Infrastructure to facilitate regional trade is also a critical NDP objective and continues to be a stated strategic objective of the South Africa Government. The majority of South Africa's manufactured exports are destined for African markets, especially into Southern Africa. The NDP sought growth of non-traditional exports of 10% per annum and expected 25% to 30% of trade to ultimately be with the region. Moreover, two-way trade and investment are critically important for South Africa and regional growth and development. South Africa, with its deep capacity, is best placed to act as a pivotal driver and contributor to the opening up of these channels.

Yet, transport infrastructure has been a binding constraint. UNECA estimates that African firms lose 13% of sales due to inefficient infrastructure, thin credit markets and a poor regulatory environment. Moreover, South Africa is losing ground and being bypassed in regional infrastructure development as previously indicated.

By global comparison, sub-Saharan Africa (SSA) has the longest time to export, the highest cost to export, and the highest cost to import from a border compliance perspective, with SSA also the poorest performer on the World Bank's Logistics Performance Index. Transport costs along Southern African Development Community (SADC) corridors are the highest in the world: For example, almost eight days is needed to cover 2 000 km from the Durban port to Lusaka. Border posts impose significant costs, adding monetary cost and time delays.

There has been significant commitment to improving productivity at the Beitbridge border post and to promoting South Africa as a hub for manufacturing and supply of rail stock for the continent.

- Beitbridge is the busiest road border post in Southern Africa, recording the movement of 5,4 million people per annum. In 2015, a PPP was assembled to redevelop it and five other posts as one-stop border posts (OSBPs) with the aim of enhancing trade competitiveness through reducing trade time and costs incurred. The Infrastructure Investment Committee (IIC) in April 2021 approved for the project to be placed on the Infrastructure Fund's blended financing pipeline. This is a prime example of the potential role of blended finance. A draft OSBP policy is expected to be released for public comment in 2021. It is also expected that a preferred bidder will be appointed in 2021, with construction and redevelopment envisaged to take three years (completion in 2024/25) based on a 20-year concession. There are a number of regulatory matters still to be addressed. For example, the development requires finalisation and enactment of the Border Management Authority Bill to clarify the role of key organs of state in

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implementation. A memorandum of agreement (MoA) must still be signed with neighbouring countries.

- There is a process to develop South Africa as a rail manufacturing hub for Africa. An AU resolution endorsed appointing South Africa in this regard. Stakeholders involved include Transnet, PRASA, the private sector, international original equipment manufacturers (OEMs) and DBSA.

There are other critical regional projects that South Africa is involved in and that should be treated with far higher priority. In particular, these relate to regional transport projects that could facilitate the movement of goods regionally via ports, rail and road with support of intermodal linkages and freight hubs. An example is the North-South Corridor Railway System. The five railway companies on the North-South Corridor have agreed to prepare a single, coordinated corridor development plan to address the modal imbalance between road and rail on the North-South Corridor. The North-South Rail Corridor infrastructure and logistics study will focus on the rehabilitation and upgrade of the rail corridor and is being financed by the SADC Infrastructure Project Preparation Fund, managed by the DBSA through the New Partnership for Africa's Development (Nepad) Business Foundation (NBF). This project will provide support to the railway corridor development plan. Its development is at feasibility stage. There is potential to promote a system of ports, facilitating sea transport with shorter overland freight transport required.

For South Africa and the region, international container shipping prices are a key limiting factor to the competitiveness of export-focused manufacturers. High prices are largely a function of weak maritime connectivity (the number and frequency of sailings to and from ports).

Consolidation of container volumes into a regional network of hub ports will drive improved maritime connectivity, both regionally and globally, and will enable new freight routes and allow manufacturers to plug into global value chains (GVCs) more easily.

PIDA has forecast significant capacity gaps across Africa's Regional Transport Infrastructure Network (ARTIN) to 2040. PIDA, the AU, the AfDB, Nepad and other actors have identified 51 programmes of regional importance across network industries that require US\$360 billion to 2040. Southern Africa's share of this cost is 18,6%. PIDA's transport infrastructure plan estimates potential efficiency gains of US\$172 billion.

North American and European countries play a very significant role in the finance of African infrastructure. The role of China also deserves mention, given its significant position in internationally contracted infrastructure projects in Africa. South Africa has a relatively sophisticated financial and industrial base and emerging financial partnerships such as that with Standard Bank and the Industrial and Commercial Bank of China (ICBC). In the medium term, it would be strategic for South Africa to partner with China and with North American and European nations as an African hub for regional infrastructure finance and support.

Regional infrastructure projects globally are a great challenge to implement, and progress in Africa is even more challenging. Despite broad political consensus on the need for infrastructure integration, progress on implementing regional commitments has been slow and is frequently blamed on political will, regulatory barriers and capacity constraints. The regional infrastructure project information is quite opaque and obscure, and roles and responsibilities require greater clarification.

3.3 Conditions required to achieve the 2050 vision for regional infrastructure

The following conditions must be met to achieve the 2050 vision:

- 1 There must be momentum in the rollout of critical regional infrastructure projects, so that they progress timeously.

- 2 Regional capacity to drive projects must be robust.
- 3 Project monitoring must be updated timeously and enable early intervention to keep projects on course.
- 4 South Africa and its regional partners must optimise gains from China's involvement in Africa.
- 5 South Africa should establish a financial centre of excellence that supports regional infrastructure projects.
- 6 A top-priority regional infrastructure integration strategy and project pipeline must be implemented.
- 7 A New Open City Initiative should be expedited.

3.4 How the 2050 vision will be achieved

Strategic element	2050 Vision – How it will be done
Projects progress timeously	The reasons for slow progress in regional infrastructure projects will be attended to. At a minimum, this will include ensuring there is sufficient political championing of projects, and that South Africa invests in commercial diplomacy as recommended in the NDP.
Regional capacity to drive projects is robust	Capacity will be developed in cooperation with regional partners for project preparation and execution, finance and enablement of private participation.
Project monitoring enables action	Monitoring of top-priority regional projects will be strengthened, with high-quality data communicated transparently.
South Africa gains from foreign infrastructure investment in Africa, with special attention given to China	South Africa will determine more strategic partnerships with foreign national investors in African infrastructure, with special attention given to China.
A financial centre of excellence is established	South Africa will establish a regional financial centre of excellence for promoting blended project finance.
A top-priority regional infrastructure integration strategy and project pipeline are implemented	• Projects that deliver to South Africa needs are as follows: Inga and Lesotho Highlands, which are both mentioned in the MTSF and both need greater attention and are badly delayed. More active involvement is required in the SAPP, Regional Digital Connectivity and other regional water projects. • Projects to facilitate trade will be as follows: The Beitbridge border post, which will be expedited along with others in Southern Africa as part of the One-Stop Border Posts infrastructure investment programme. Strategic regional infrastructure projects such as the North-South Corridor Rail System will be elevated and/or identified and pursued such that a system of ports to support interregional trade and regional roads is established.
The New City Open City Initiative	• A Strategy and Plan of Action that will enable informed decisions related to the development of a new, open city in South Africa. • An evaluation framework and methodology for a brief that can be used by Government to procure services related to a new, open city. The evaluation framework should ensure value-for-money, best practice in planning, design

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	and implementation; inclusive and accountable governance and delivery; innovative technology and operations; and stakeholder engagement.
Top-priority SIPs	SIP 17 – Regional integration for African cooperation and development. SIP no 17 needs to be restructured, augmented and executed on, as indicated below:
Three-year action steps	• A top-priority regional infrastructure integration strategy and project pipeline action plan will be finalised in 2022/3. SIP 17 will be expanded to include these top-priority projects. A top-priority project pipeline will be funded and moved to readiness and implementation from 2022/3. • Six ports of entry will be redeveloped as one stop border posts by 2025, including Beitbridge, Lebombo, Maseru Bridge, Kopfontein, Oshoek and Ficksburg. • Capacity (technical, financial, diplomacy) to drive regional projects will be reviewed and strengthened, in conjunction with regional partners. • Regional project monitoring information will be introduced and made transparent. • A proposal for a regional financial centre of excellence will be finalised. • A strategy will be finalised to strengthen gains from foreign infrastructure investment in Africa. • Centres of research excellence will be established to improve strategic capability and intelligence in these domains. • Strategy and Plan of Action for the new, open city in South Africa.

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4 FINANCING INFRASTRUCTURE AND MAINTENANCE

HIGHLIGHTS

Features of infrastructure finance by 2050

Capacity will be in place to sustainably fund and finance infrastructure build and maintenance. It is estimated that achieving SDGs and NDP goals related to infrastructure will cost R6,224 trillion between 2016 and 2040, with transport and energy likely accounting for over 72% of the investment required. As of 2021, the finance gap that needs to be closed is estimated at R2,15 trillion.

South Africa will have a thriving private sector infrastructure investment sector that will be supported by an efficient and reliable public sector procurement framework that will deliver world-class procurement through both on-budget general government procurement and world-class capability in creating partnerships and alliances with the private sector in infrastructure finance, build and operations. Infrastructure projects will be considered from a full-life-cycle perspective, planning from procurement to decommissioning, budgeting and setting out maintenance schedules that minimise costs over the life of the infrastructure. The public sector will partner with the private sector and development finance agencies to fill a finance gap of approximately one-third of the amount that needs to be invested until 2050. Projects will be chosen for these partnerships where they clearly enhance the value of the infrastructure to the public. Such partnerships will be structured to maximise this value, as PPPs or other forms of partnership, considering all public policy objectives, with projects designed with risks allocated to partners that are best positioned to manage them. PPPs are particularly important in economic infrastructure, but in some circumstances may also be the optimal approach for social infrastructure. The NIP envisages government-wide capacity to design and launch partnerships with the private sector, eliciting an enthusiastic appetite for investment by the private sector and global development funders.

How it will be done

- A full-life-cycle planning approach will be adopted.
- Value for money will be optimised.
- Projects will be designed to meet the risk and return needs of investors.
- Projects will be designed to minimise risk.
- Partnerships with the private sector will be embraced where they deliver better value for money.
- Capital market development will be supported by a steady and reliable pipeline of new projects.
- Monitoring and reporting will build investor confidence.
- There will be a shift away from government guarantees towards new forms of guarantees, such as performance guarantees for decarbonisation.

4.1 Vision for finance and funding to deliver network infrastructure

South Africa will have a thriving private sector infrastructure investment sector, supported by an efficient and reliable public sector procurement framework that delivers world-class procurement through both on-budget general government procurement and world-class capability in creating partnerships and alliances with the private sector in infrastructure finance, build and operations. Infrastructure projects will be considered from a full-life-cycle perspective: planning from procurement to decommissioning, budgeting, and setting out maintenance schedules that minimise costs over the life of the infrastructure. The public sector will partner with the private sector and development finance agencies to fill a finance gap of approximately one-third of the amount that needs to be invested until 2050. Projects will be chosen for these partnerships where they clearly enhance the value of the infrastructure to the public. Such partnerships will be structured to maximise this value, considering all public policy objectives, with projects designed with risks allocated to partners that are best positioned to manage them. The NIP 2050 envisages government-wide capacity to design and launch partnerships and alliances with the private sector, eliciting an enthusiastic appetite for investment by the private sector and global development funders.

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4.2 Status of infrastructure finance and funding in 2021

The South African government has an explicit ambition to expand infrastructure investment, in support of economic and social objectives. This move is also meant to act as an economic stimulus. Since the election of President Cyril Ramaphosa, several initiatives have been launched to improve infrastructure investment, in support of economic and social objectives, and to stimulate the economy. These initiatives are aimed at reversing a negative trend: Between 2015 and 2019, spending by general government on infrastructure fell from 3,5% to 2,7% of GDP, while spending by SOEs fell from 3,8% to 2,7%. This negative trend reflects both pressure on budgets and capacity shortages in the public sector.

About R6,224 trillion is estimated to be needed in infrastructure finance between 2016 and 2040. There is a finance gap driven largely by fiscal pressure, a weak credit outlook for government and SOEs, and high commodity costs. This is the difference between current available financing and the amount needed to meet infrastructure requirements for economic growth. The gap that will need to be closed is estimated at R2,15 trillion²⁴. Electricity and transport may account for about 72% of the investment required²⁵. In a context of constrained public finances, the funding gap will have to be filled by new sources of funding, including new instruments that access domestic and foreign private sector capital, and global development funding.

Ultimately, infrastructure can be funded only by two sources: taxes and user payments²⁶. While finance can be raised from multiple sources, its availability and cost depend on the reliability of funding plans to service and ultimately repay any finance.

Historically, infrastructure has been financed by tax revenue and through debt issued by government or SOEs. However, the opportunities to raise finance through other means have developed considerably over the past two decades. Several specialist infrastructure funds have developed in the private sector and banks have built capabilities in infrastructure finance. Increasingly, pension funds and insurance companies are also investing in infrastructure.

South Africa primarily leverages PPPs for private sector infrastructure finance, having begun doing so in the 1990s with toll road projects. Despite this history, PPPs are an underutilised opportunity to raise private investment in public infrastructure, with the exception of the Renewable Energy Independent Power Producers Programme (REIPPP), which used a form of PPP to commission over 100 energy projects that collectively raised investment of over R200 billion. Outside of REIPPP, there is very little PPP activity and it is dwindling. Of the R791 billion planned infrastructure spending over the 2021/2–2023/4 Medium-Term Expenditure Framework (MTEF), PPPs account for just R18,5 billion or 2% of the public sector infrastructure budget.

On some projects, government guarantees a minimum revenue stream, or that public entities will procure output, imposing contingent liabilities. Amongst PPPs, office accommodation and

²⁴ The method to calculate the finance gap is sourced from the G20's Global Infrastructure Outlook and includes only economic infrastructure. In future, ISA and National Treasury will ensure that independent and periodically updated assessments are done.

²⁵ Estimates are highly sensitive to the following:

- Cost of new infrastructure (new energy generation has been falling, but commodity prices have driven up general construction costs).
- Existing financing conditions (deteriorating balance sheets of SOEs are reducing the fundraising capacity and cost of funding for SOEs).
- Economic growth rate and infrastructure intensity of that growth.

²⁶ States can also raise funding by selling assets or generating profits through some activities.

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the Gautrain are the biggest contributors to current contingent liabilities, which stand at R8,7 billion, down from 13,7 billion in 2017/18. The contingent liabilities are also incurred by projects under the REIPPPP, which are expected to amount to R156 billion in 2021/22. However, contingent liabilities do not all have the same probability of becoming actual liabilities and in many PPPs the contingent liabilities have a very low risk of being called.

The number of new project transactions has decreased over the past decade. There are a number of PPPs under review, including the expansion of the Gautrain, the redevelopment of six border posts and the construction of government offices. There are some notable reforms currently underway, including a review of Regulation 16 of the Public Finance Management Act, No 1 of 1999 (PFMA), which governs PPPs, the Infrastructure Fund, the Municipal Investment Programme Project Preparation Facility, and the establishment of Infrastructure South Africa, together with the SIDS methodology.

Most public sector infrastructure is procured by general government through the Framework for Infrastructure Delivery and Procurement Management (FIPDM) guidelines by National Treasury. This concerns procurement of infrastructure on government budget by organs of state under the PFMA.

The FIPDM does not require or encourage organs of state to consider forms of procurement that would attract private funding. In particular, there is no early-stage requirement to consider PPPs as an alternative procurement mechanism. FIPDM and Regulation 16 are currently being reviewed to improve functioning and efficiency of PPP and other procurement mechanisms and improve attractiveness for private investment.

Regulation 16 of the PFMA and equivalent regulations in terms of the Municipal Finance Management Act, No 56 of 2003 (MFMA) governing PPPs at national, provincial and municipal levels entail a heavy requirement to demonstrate that PPPs are preferable to normal on-budget procurement. The MFMA makes it difficult to encumber future cashflows from rates to fund PPPs.

Certain other organs of state, particularly SOEs, and, through recent changes, financially stable municipalities can issue debt to raise finance for infrastructure. However, poor credit ratings have made this increasingly difficult.

There are signs of emerging appetite and capability in South African capital markets to innovate in financing infrastructure. Therefore, this has primarily been evident in green finance and green bonds. South Africa has issued the most green bonds in Africa, with a cumulative issuance of US\$2,4 billion (although some are offshore-listed), followed by Morocco (US\$400 million) and Nigeria (US\$136 million). Overall, South Africa leads in Africa but lags Europe (USD\$455 billion), Asia-Pacific (US\$287,4 billion), the United States (US\$194,4 billion) and Latin America (US\$103,8 billion)²⁷.

A growing commitment by the South African state to partnering with the private sector is demonstrated in the establishment of the Infrastructure Fund. This has been structured through the DBSA with aim to use R100 billion of public funding over the next 10 years to crowd in private sector investment through blended finance models. It has assembled a project origination team to work with public sector institutions to develop projects for financing through blends of public and private sources. The Infrastructure Fund will work with Public Facility for Infrastructure in National Treasury to access public budgets for projects. Moreover, National Treasury is currently revising the frameworks for on-budget and PPP procurement to facilitate an increased flow of PPPs.

²⁷ <https://www.climatebonds.net/market/data/>

4.3 Conditions required to achieve the 2050 vision for infrastructure finance

The following conditions must be met to achieve the 2050 vision:

1 A full-life-cycle planning approach must be adopted.

The costs and benefits of infrastructure can span decades. These full infrastructure life cycles must be budgeted for upfront, covering planning, construction, operations, maintenance, and in some cases, through to decommissioning. This shows the "real" project cost, which should be weighed against the multi-decade benefits of a potential project.

Budget and funding decisions often focus on the capital expenditure for the creation of the infrastructure. This contributes to poor maintenance planning and misleading estimates for the lifecycle cost of infrastructure. Life cycle budgeting is critical to the appropriate financing and prioritisation of infrastructure.

Much public infrastructure currently faces a "run to failure" approach, with maintenance only conducted when the infrastructure fails. Most public sector procurement currently focuses on the MTEF period (three to five years) and budgets are not structured for the full lifetime of infrastructure. Maintenance is often excluded in infrastructure budgeting, contributing to the lack of planned maintenance. The Department of Public Works and Infrastructure (DPWI) has set a strategic aim to move to a maintenance budget that is 80/20 in favour of scheduled maintenance.

While there are no reliable estimates of the cost of reactive or emergency maintenance when compared with scheduled planned maintenance, it is widely accepted that reactive maintenance is far more expensive as failure can cause knock-on failures and wider costs to the economy stemming from the unavailability of the infrastructure. Planning upfront allows for a project design that minimises lifecycle costs.

Lifecycle planning considers the full cost of planning, constructing, operating and maintaining infrastructure as well as the full benefits of the infrastructure. It is defined as "the combination of management, financial, economic, engineering and other practices applied over the full lifecycle of physical assets to provide the required level of service for present and future customers in the most cost-effective way" (NAMS Group 2006).

2 Value for money must be optimised.

Multiple policy objectives must be traded against each other to determine an optimal procurement strategy. Explicit upfront decisions must be taken on how to balance cost, time, quality and other public policy objectives like employment, local content and BEE. Once priorities have been determined, focus must be trained on maximising returns to each priority through the procurement design.

Lifecycle plans should reduce overall costs, reduce risks and maximise benefits, leading to lower finance requirements and more reliable funding sources. The reduced costs lead to a reduced capital requirement, which in turn lowers the cost of finance and raises the viability of the asset.

Costs must be minimised by ensuring that:

- the procurement framework has a clear legal basis, reliable timetable and high-quality documents (for both on-budget procurement, and those involving cooperation between public and private sectors);
- project risks are reduced where appropriate through guarantees and other measures (where the public value impact on the project is greater than the cost to the government of absorbing risk); and

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- risk allocations can be fine-tuned through PPPs to ensure better-value-for-money projects.

3 There must be sufficient access to additional sources of finance to deliver on South Africa's Infrastructure aspirations.

Infrastructure finance has developed significantly over the last decade around the world. The global movement towards investment linked to environmental, social and corporate governance (ESG) indicators has supported this innovation as private sector investors seek to support environmental and social objectives. Innovation in instrument-type and project structures makes it possible to access new funding pools (eg ESG specialist funds for impact, green and social finance instruments).

However, the vast majority of infrastructure in South Africa continues to be financed by standard debt instruments like general government and SOE bonds.

Economic infrastructure is more amenable to private sector funding, especially where there are cashflows from the users of infrastructure. This is especially so for pure economic infrastructure such as commercial ports and for mixed economic infrastructure such as that related to municipal water or electricity supply, for which minimum amounts are provided free to consumers and they can be paid for by users or a third party. Social infrastructure such as schools, clinics and police stations are less amenable to private sector financing, although various options have been used around the world such as availability payments through which government pays private partners to ensure public infrastructure is available.

Both domestic and international investors are eager to invest in infrastructure assets if projects are designed appropriately. Investors have different risk appetites and liquidity needs that projects designs must accommodate. For example, the range of risk tolerance is indicated as follows:

- Banks – short term (0–5 years); high risk tolerance.
- Private equity – medium term (5–7 years); high risk tolerance.
- Pension funds – long term (20 years); low risk tolerance.
- Insurance companies – long term (20 years); low risk tolerance.
- Multilateral financiers – long term; high development impact.

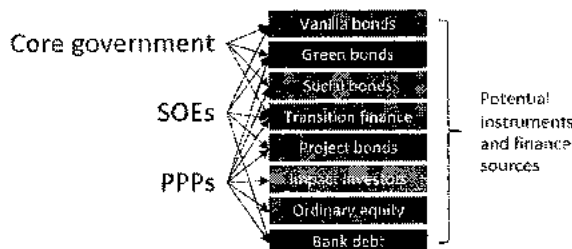
Critically, funding (tax or user payments) must be clearly determined to make projects bankable – ie the cashflows must reliably meet the financing costs.

South Africa has a sophisticated and sizeable institutional investment market. Pension funds hold R4,3 trillion in assets, with the Government Employees Pension Fund being the largest, holding assets of R1,8 trillion. The private equity industry is a key catalyst in infrastructure projects by providing equity and absorbing the most risk. Banks hold R5,8 trillion in assets and can finance debt into infrastructure projects using sophisticated risk-pricing models. Insurance companies often hold debt and private equity instruments that back infrastructure with part of their R2,7 trillion in assets. These domestic investors should be complemented by global investment into infrastructure.

Different public institutions should be enabled to issue different types of instruments. Typically, government raises funding to cover the budget deficit through its bond issuance programme. Recently, governments elsewhere have also issued green and social bonds to raise finance for specific infrastructure and other social objectives. Such finance is earmarked for specific expenditure that meets the social and environmental objectives of the investor. Such bonds typically impose more stringent reporting and monitoring standards on governments to provide investors with information to verify that the social or environmental goals are being met. SOEs can also issue such specialised bonds, and banks and other private financiers can as well, which can then finance partnerships and alliances between public and private sectors. South

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Africa's banks and finance SOEs have issued several such instruments over the past decade, particularly in the last year.



4 Projects must be designed to minimise risk.

Risks must be allocated to the party best able to absorb and manage them: this is the party best able to control the probability of risk eventuating, able to reduce the impact of risk if it does eventuate, and has the balance sheet (size or correlations) best able to absorb eventuated risk. Where risks are inappropriately allocated, costs balloon and projects can become unsustainable. Some risks should be absorbed by government, but others are more appropriately absorbed by private sector partners. Typically, operating risks should be absorbed by the private sector, on the assumption that private partners can innovate and tap global expertise to ensure operations run according to plan. Demand risks, being the risk that user demand is less than predicted, can be carried by either private or public sector partners, depending on the details of the infrastructure. Finance risks should be tailored to the particular risks a project faces, with government absorbing low-probability risks to ensure projects are bankable.

5 Partnerships and alliances between the public and private sectors must be embraced.

Partnerships and alliances between the public sector and the private sector must allow for tailored project designs that assign roles to multiple partners to maximise value and meet policy goals. The legal and regulatory framework must be shaped to reduce the cost and complexity of all forms of partnerships and alliances between public and private sectors that enhance public interest value in infrastructure finance, build and operation, to encourage more such activity. This requires substantial investment in public sector capacity to be able to decipher value and manage these relationships in the public interest with confidence.

Partnerships between public and private sectors are designed to be partly or fully privately financed. This is the key differentiator from normal infrastructure procurement, which is always financed by the government. Risks are allocated between public and private sectors and are calibrated to reduce the cost of finance and maximise the public benefit from the infrastructure. Partnerships are not always the optimal mechanism for procurement, particularly where transaction costs are higher than the benefits when compared with standard on-budget public financing of infrastructure. However, private sector financing typically comes at lower cost in terms of the engineering, procurement and construction of projects, as well as the operations and maintenance of infrastructure. Partnerships between private and public sectors can assign the private sector various roles, including build, own, operate, finance and ultimately transfer to the state. The requests for proposals in any framework aimed at crowding in private sector finance or participation should specify clear public benefit requirements, optimising for the competing public policy goals.

There are many ways that the public and private sector can partner in infrastructure

There are many ways that the public and private sectors can work together to deliver infrastructure. One of these are through formal public-private partnerships (PPPs), which

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are regulated by specific regulations under the Public Finance Management Act and Municipal Finance Management Act. But there are many other examples of partnerships in a more generic sense, ranging from specific programmes like the Renewable Energy Independent Power Producers Programme to concessions that are granted for private businesses to operate on public property. Many examples of procurement also include a level of partnership where there is some degree of risk sharing involved - for instance, the procurement of new infrastructure can require private operators to build, but also design, operate and finance infrastructure. These forms of partnerships are not PPPs in the formal sense but are also important ways that infrastructure can be delivered by drawing on the resources and capabilities of both the public and private sector in partnership. In the NIP 2050, the term PPPs refers to the specific construct under PPP regulations, and "partnerships" refer to a more generic concept of joint risk sharing and work between public and private sectors through different procurement or other contracting models

6 Capital market development must be supported.

South African capital markets should be encouraged to build on their recent initiatives in developing green bonds and other innovative financing instruments to fund infrastructure, in tandem with global developments. Such innovation should be spurred by appropriate procurement strategies that allow for investors with different risk appetites at different points of project lifecycles to participate, and that provides a steady pipeline of new projects entering the market to raise finance. If procurement is gradual, it will allow financing innovation to evolve. Given the prospect of an accelerated infrastructure pipeline for public sector projects, the financial sector has been in discussion regarding new instruments that can be developed to direct institutional funding into greenfield projects, while several infrastructure finance specialist funds have been building capacity. A clear and reliable flow of projects will allow such tentative steps to accelerate and build institutional capability for a substantial flow of investment into public infrastructure. The public sector will support these efforts by embracing financial innovation, including the use of green bonds and other infrastructure instruments, to build capital market capacity and volumes alongside the private sector.

7 Monitoring and reporting must build investor confidence.

As infrastructure is seen as an important asset for investors' ESG mandates, projects must build in appropriate monitoring and reporting frameworks to be able to give investors feedback on the performance of the asset. These functions do add to the cost of infrastructure, but support their governance. Particularly in the case of green and social bonds, issuers must implement reporting capabilities to obtain international certification of compliance with green or social bond standards. High-quality market reporting on performance must be in place to build investor confidence and increase appetite for investment in future projects.

4.4 How the 2050 vision for financing of network infrastructure will be achieved

Strategic element	2050 Vision – How it will be done
A full-lifecycle planning approach is adopted	The full lifecycle of infrastructure projects, which can span decades, will be budgeted for upfront, covering construction, maintenance, through to decommissioning. This will show the "real" cost which is weighed against the multi-decade benefits of a potential project.
Value for money is optimised	Multiple policy objectives will be effectively balanced to determine optimal procurement strategy. Explicit upfront decisions will be taken on how to balance cost, time, quality and other public policy objectives like employment, local content and BEE. Once priorities are determined, focus will be trained on maximising returns to each priority through procurement design.

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Strategic element	2050 Vision – How it will be done
Projects are designed to meet the risk and return needs of investors	Infrastructure projects will be designed in a way that facilitates ready access by both domestic and international investors. Different risk appetites and liquidity needs will be accommodated. Funding (tax or user payments) will be clearly determined to make projects bankable.
Projects are designed to minimise risk	Project partners will be allocated risks they are best able to manage. Project design considers which parties will incur the many risks that arise from demand (use) risk through to exchange rate risk. Some risks will be absorbed by government, others will more appropriately be absorbed by private sector partners.
Partnerships and alliances between public and private sector are embraced	Partnerships and alliances between public and private sectors will have tailored project designs that assign roles to multiple partners to maximise value and meet policy goals. The approach, rules and regulations related to enabling public and private sector partnerships and alliances will be reformed to reduce the cost and complexity. There will be investment in public sector capacity to engage in such partnerships with confidence.
Capital market development is supported	South Africa capital markets will have a growing sophistication and continuous development of innovative infrastructure financing instruments. This will be supported with in an infrastructure project environment that has clear project designs and predictable pipelines.
Monitoring and reporting build investor confidence	From construction to operation and maintenance, the performance of the asset will be monitored with regular reporting to investors (and public at large) to build confidence and trust.
Three-year action steps	• The infrastructure procurement framework (FIDPM) will be revised to require public institutions to consider partnering with private sector partners as an optimal procurement option. • The PPP regulations (Regulation 16) will be revised to simplify approval processes, standardise models for certain types of infrastructure, and speed up the time from initiation to procurement of PPPs. • The approach, rules and regulations for partnerships and alliances between the private and public sectors will be widened aimed at substantially deepening and expanding this opportunity for finance, build and operation. • Lifecycle planning will be applied to all infrastructure, with full budgets determined upfront and measured against lifecycle benefits in ascertaining optimal infrastructure procurement. • The Infrastructure Fund will deliver a robust pipeline of projects through blended finance models with significant participation from the private sector. • The capacity at all levels of the public sector will be developed to design bankable projects and manage them through to completion. • Capacity will be built at national and local government level to issue specialist green finance instruments such as green bonds.

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5 STRENGTHENING INSTITUTIONS FOR DELIVERY

HIGHLIGHTS

Features of the institutional framework and capacity by 2050

There will be a step change in the institutional capability that drives material progress in South Africa's infrastructure ambition. Planning, procurement and execution systems and capabilities will be operating at the highest global standard, commensurate with South Africa's significant infrastructure transformation agenda. Robust and ever-developing partnerships and alliances between public and private sectors will be a significant feature in planning and implementation, whether think tanks, financial institutions, business or communities. There will be confidence to drive an increasingly dynamic, high-performance delivery machinery.

Public infrastructure will be delivered and maintained in an environment that is safe, secure and with a high ethical standard.

How it will be done

- There will be significant capacity development within infrastructure procurement and delivery management.
- The regulatory and institutional framework will enable network infrastructure procurement and delivery.
- A strategic approach will be taken to infrastructure procurement.
- Systems of accountability will be aligned with effective infrastructure delivery.
- The asset management function will become robust.
- Services and support for safety, security and ethics will be strengthened.
- Knowledge services will be strengthened.

5.1 Vision for institutional capability to plan and deliver network infrastructure

There will be a step change in the institutional capability that drives material progress in South Africa's infrastructure ambition. Planning, procurement and execution systems and capabilities will be operating at the highest global standard, commensurate with South Africa's significant infrastructure transformation agenda. Robust and ever-developing partnerships and alliances between public and private sectors will be a significant feature in planning and implementation, whether think tanks, financial institutions, business or communities. There will be confidence to drive an increasingly dynamic, high-performance delivery machinery. This will align delivery with the Constitutional imperative (section 195) to promote the "efficient, economic and effective use of resources" and to ensure that public administration is "development-oriented".

The vision recognises that large-scale public network infrastructure projects have some characteristics that make them unique and require differentiated approaches to charting their delivery. More than anything else, they continuously experience risk events over the course of protracted delivery periods. Their scale and complexity mean that these risks can require high-impact evidence-based decision-making with very material implications for costs and outcomes. The buyer-supplier relationship therefore differs from most other government projects in that the buyer or "client" function requires significant professional capability throughout the process of conceptualisation to implementation and maintenance, that is, through the full life-cycle of the project.

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The vision also recognises that efficient and timeous delivery of public infrastructure requires an environment that is safe, secure and ethical.

5.2 Status of institutional planning and execution capability in 2021

There is considerable evidence of diminishing capability to plan, finance, procure and implement critical network infrastructure. While there is also evidence of success, overall, the aggregate numbers show diminishing outcomes that are not delivering to South Africa's long-term agenda for employment, equity and poverty eradication.

The NIP 2050 seeks to strengthen the capacity to deliver and address areas that are hindering progress. The National Planning Commission (NPC) (2020) revealed the following concerns:

- A dearth of properly prepared and bankable projects.
- Significant underspending against annual budgets, resulting in the five-year spending trajectory having been adjusted downwards every year since 2017.
- Significant cost and time overruns and, relatedly, significant delays in the implementation of identified projects.
- Infrastructure projects not resolving the issues they set out to achieve.
- Existing infrastructure not being effectively maintained to ensure it continues to effectively serve the purpose for which it exists.
- Opportunities being missed and suboptimal developmental outcomes in terms of BBBEE, employment, local production and content.
- Late payments to service providers.
- Unintended consequences of regulations and instructions that are not sufficiently and timeously reigned in (such as those related to 'mafia'-style tactics to forcibly secure participation in infrastructure), including removing unpredictable and harmful procurement practices.
- Poor project outcomes in terms of value for money.

The NPC cites gaps in human capacity and in the administrative and regulatory framework to procure and oversee major infrastructure projects as one of the key barriers to success in this domain. Other key barriers including the following:

- Ineffective interventions aimed at basic management practices, increasing the throughput of engineering undergraduates, and the deployment of technical assistance and semi-retired engineers. These interventions have failed to address the key challenges outlined by the Construction Industry Development Board (CIDB) in 2003, which include weak delivery management skills, inefficient or inappropriate systems and processes, and inconsistent procurement procedures.
- Public sector supply chain management (SCM) practices that have misplaced infrastructure procurement within financial processes and treated procurement as a general administrative (back-office) function requiring relatively low skills level rather than a professional strategic function linked to those responsible for delivering infrastructure.
- Differences in understanding and interpretation of regulation, policy and practice within an excessively rigid, fragmented and complex legislative regime that does not recognise or appropriately address the specificities of infrastructure delivery.

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- An administrative paradigm in the way in which SCM units focus on the “ticking of boxes”, where compliance with rules is more important than project outcomes and procurement is centrally and remotely controlled through the office of the chief procurement officer.
- Failure to accommodate the way risks inherent to the procurement and delivery of infrastructure are commonly mitigated.
- Poor procurement practices and poor management of outsourced functions.
- Lack of appropriate capacity, appropriate skills and experience in the specifying, procuring and overseeing of the delivery of infrastructure and its regulation.
- Exclusion or marginalisation of built-environment professionals in key processes.
- Difficulties in obtaining licences and permits due to excessive bureaucracy and slow decision-making.

There have been efforts to strengthen delivery over this period. Examples are as follows:

- The Infrastructure Delivery Improvement Programme (IDIP) was in place between 2003 and 2017 and aimed to address communication and coordination amongst user departments and implementing agents.
- Infrastructure Delivery Management Toolkits (2004, 2006, and 2010) were developed through IDIP.
- The Cities IDMS (CIDMS) (2016) was developed by National Treasury through the Cities Support Programme to establish principles, methodologies, processes, techniques and case studies to assist infrastructure planners and decision-makers within cities.
- A National Infrastructure Plan with 18 identified Strategic Integrated Projects (SIPs) was developed and adopted by Cabinet in 2012. The Infrastructure Development Act, No 23 of 2014 was gazetted, which saw the establishment of the Presidential Infrastructure Coordinating Commission (PICC) Council, Management Committee and Secretariat. A PICC Technical Task Team was established to support the Commission Structures plus create technical capacity in infrastructure.
- There are some notable successes in changing the course of the quality of human settlements. Over the decade from 1995 to 2005, the City of Johannesburg drove a transformation programme in Soweto, from dormitory to decent living, with investment in tarred roads, parks, sidewalks, theatres, shopping precincts, churches, places of entertainment, transport nodes and community centres.
- An integrated strategy for the reconstruction, growth and development of the construction industry was implemented.
- A documented body of knowledge and a set of best practices in the delivery management of infrastructure were provided.
- External expertise from semi-retired personnel and their deployment to the most vulnerable and underperforming municipalities were leveraged.
- The throughput of tertiary institutions of higher learning was increased.
- Technical assistance to departments and municipalities on infrastructure project management and organisational development was provided.
- The South African public procurement system was modernised and overseen.

In the main, the model for delivering network infrastructure relies on state institutions to do all functions up to implementation. There is considerable reliance on state institutions for policy and regulation and on monopoly SOEs to raise finance and procure services. The delivery of digital infrastructure differs in the sense that there is significant private sector leadership.

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However, the government's model of delivering continues to rely on SOEs, with limited scope for partnerships. If performing well, this model can deliver big infrastructure when the context is well understood and not changing much. However, the conditions for delivery in all four sectors – energy, freight transport, water and telecommunications – are transforming faster than ever before. This context **requires** partnerships that take on board emerging ways of planning, financing and executing so that they are lower-cost and more efficient and adaptable.

Safety and security have been critical binding constraints to the progress of public infrastructure – in building and operations. Providing infrastructure services at the lowest possible cost to users depends on minimizing avoidable costs, especially those merely drain resources away from the provision of infrastructure through theft, extortion and corruption. Core challenges that have been identified by many stake-holders include:

- Corruption in tendering processes that raise the costs of delivering infrastructure and, at the extreme, result in the failure of infrastructure
- The extortion of firms and workers by the so-called "construction mafia", whose activities act as a tax on infrastructure development or even halt infrastructure projects.
- The violent extortion of firms and workers providing services using infrastructure such as the attacks on truck drivers
- The theft and destruction of infrastructure by those seeking to recycle stolen commodities through the scrap metals industry
- Unlawful consumption of infrastructure services through illegal connections and the non-payment of fees and charges
- Political and social unrest targeted at extraction

These challenges are regarded by industry role-players as significant risks to the viability and implementation of the NIP2050. Resolving them requires a combination of community-based mobilization and involvement, increased provision for security costs in the delivery of infrastructure, and much more effective policing and law enforcement.

The emergent partnership between PRASA, Transnet, SAPS, safer city projects in three metropolitan areas, commuter forums and community police forums in 2020/1 resulted in a substantial fall in reported rail theft and 341 arrests. The Justice Crime Prevention and Security Cluster has been tasked with fighting extortion at infrastructure sites increasingly applying proactive approaches involving crime intelligence and coordinated dedicated task teams at national and provincial levels.

5.3 Conditions required to achieve the required institutional planning and execution to enable delivery of critical network infrastructure

Previous sections of the NIP 2050 identify approaches to sector reform and finance. Here, the conditions required for effective project execution in relation to project prioritisation, optimisation, planning, procurement and execution are further detailed.

Government must become a sophisticated "client" in its procurement of infrastructure, operating at a global standard commensurate with the significance and complexity required to deliver on South Africa's long-term economic imperatives. There must be continuous improvement in its Infrastructure Procurement and Delivery Management (IPDM).

The following conditions must be met to achieve the 2050 vision:

1. Public sector competencies must operate at a high professional level.

Competence to procure and deliver must be high in respect of ability, knowledge and skill.

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2. The regulatory framework must enable network infrastructure procurement and delivery.

- The regulation of SCM for infrastructure must enable integrated projects (to include demand, acquisition, logistics, disposal and risk management), with built-environment professionals playing a significant role. SCM for infrastructure must be handled as a strategic function, not simply a financial one.
- The procurement of infrastructure must be differentiated from that of other goods and services.

3. A strategic approach must be taken to infrastructure procurement.

- Value for money must be a focus and prioritised over lowest cost. This must include robust cost-benefit analysis.
- There must be trust and understanding with suppliers.
- Departments and entities with large infrastructure procurement budgets must have a chief procurement officer, with sufficient built-environment professional capacity leading the procurement process.

4. Infrastructure delivery must be managed as an "enterprise" and not an ad hoc collection of projects.

5. The asset management function must be robust.

6. The environment for public infrastructure delivery must be safe, secure and ethical.

5.4 How the 2050 vision for institutional capability will be achieved

Strategic element	2050 Vision – How it will be done
Significant capacity is developed in public sector infrastructure procurement and delivery management	• Professional procurement capacity will be developed. It will be recognised as a profession requiring high-level specialised capabilities in procurement, contracts, tender procedures, price determination documents and contract administration. • There will be a growing cohort of public sector professionals registered with built-environment bodies and councils, as relevant to the function such as in architecture, landscape architecture, quantity surveying, cost-benefit analysis, engineering, construction management or project construction management. Suitably experienced and registered built-environment specialists will be appointed to all technical and technical management posts, including procurement, where they perform work identified by the Council for the Built Environment. • Client delivery managers, individuals who lead infrastructure projects with a single point of accountability, will be in possession of certification of competence in terms of SANS-ISO 21500 (of the South African National Standards). • The state will actively support the development of systems and institutions that deliver built-environment professionals.
The regulatory and institutional framework enables network infrastructure	• The regulatory framework will be designed specifically for infrastructure procurement and delivery.

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Strategic element	2050 Vision – How it will be done
procurement and delivery	- ISA will lead the process of preparing an approach to the Auditor General to guide audits in the development of state infrastructure procurement and delivery management. - A specialised section in National Treasury, staffed with suitably qualified and experienced built-environment professionals, will oversee the regulatory framework for IPDM.
A strategic approach is taken to infrastructure procurement	- The IPDM will be designed to focus on value for money rather than least cost. In infrastructure procurement and delivery, decisions in this regard will be taken throughout the project lifecycle in an accountable and development-oriented manner. - Infrastructure SCM will become a strategic function and not a back-office or purely financial function. - Specialised professional judgement will be incorporated into infrastructure procurement processes. - IPDM will be delinked from centralised purchasing and led by a chief procurement officer and/or high-level office specifically mandated and capacitated with built-environment professionals to procure and deliver infrastructure.
Systems of accountability are aligned with effective infrastructure delivery	- Infrastructure delivery will be managed as an enterprise and not an ad hoc collection of projects. - Oversight and delivery will be led by top executive leadership with suitable professional qualifications and experience. - Delegations of authority will enable timeous decision-making and organisational accountability. - ISA will be empowered to initiate interventions and advise National Treasury to add conditionalities to budgets linked to the attainment of the IPDM system milestones to ensure organs of state deliver and to address persistent underperformance in infrastructure procurement and delivery.
The asset management function is robust	- A framework will be developed and implemented for infrastructure asset management in consultation with ISA. - National Treasury will require a prescribed percentage of all infrastructure budgets of all relevant organs of state be allocated to maintain existing infrastructure so that it remains fit for purpose, unless it can be demonstrated that this is unnecessary. - Statutory councils or SOEs with an infrastructure mandate will put in place certification schemes in accordance with the provisions of SANS ISO 55001 to certify the competence of individuals to perform specific jobs related to infrastructure asset management.
The environment for infrastructure delivery is safe, secure and ethical	- The economic and security clusters involved in overseeing infrastructure and safety, security and justice will work closely together to ensure that crime and violence do not hinder timeous delivery and efficient operations of critical infrastructure. - A plan to mitigate financial risks associated with crime and violence at infrastructure sites will be developed, with possible attention to Risk Insurance Instruments. - Relevant municipal, business, community and labour stakeholders will be engaged in strategies to stabilise the infrastructure delivery environment

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Strategic element	2050 Vision – How it will be done
Knowledge services support infrastructure delivery	• There will be a commitment to driving an ethics culture in public infrastructure delivery, and demonstrable progress in consequence management. Knowledge and innovation capabilities and services will be strengthened to support the evidence-based and dynamic approach required to deliver on the NIP 2050. The Department of Science and Innovation (DSI) will mobilise existing players, audit existing services and capabilities and, guided by the ISA, identify key gaps to be filled and how best these gaps can be filled. Underutilised or defunct capabilities within publicly funded institutions will be identified and consolidated.
Three-year action steps	• A plan to build critical capabilities (and ensure accreditation where relevant) in the procurement and delivery of infrastructure will be finalised in 2022/3. Budgets and partnerships required to implement the plan will be approved in 2022/3 for implementation in 2022/3. • The regulatory and institutional framework for procuring and delivering network infrastructure will be reviewed and modified to be more enabling, while ensuring good governance, by 2022/3. The accountabilities, mandates and powers across DPWI, ISA, National Treasury, DMRE, DCDT, DWS, DoT, Cogta and relevant national agencies will be clarified to ensure coherence, alignment and performance. • A framework will be developed and implemented for infrastructure asset management, including rules related to budgeting for infrastructure maintenance. • A plan for securing infrastructure delivery and operations from crime, violence, extortion and corruption will be finalised and budgeted for by 2022/3. Risk mitigation will form part of this plan. • A plan for knowledge services in support of the NIP 2050 will be developed and finalised by DSI in 2022/3.

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6 REBUILDING A VIBRANT AND EMPOWERED CIVIL CONSTRUCTION AND SUPPLIER SECTORS

HIGHLIGHTS

Features of the civil construction and supplier sector by 2050

The South African civil construction and supplier sector will be a vibrant and respected, world-class African full-service built-environment delivery provider that supports Southern African development. It will be cost-effective and offer safe and reliable service with an experienced and skilled workforce as well as world-class products relevant to the development context. It will be an industry that is inclusive in terms of representative ownership and business practices. The industry will have a wide range of continuously improving products and services delivered by companies that range from small domestic-oriented ones to large companies that can deliver regionally and globally.

How it will be done

- The state will oversee the procurement and delivery of infrastructure with a high level of capability.
- There will be a national infrastructure champion.
- There will be a pipeline of bankable projects that enables the construction sector to plan, invest and develop its people.
- Regulations and the process of issuing permits will be streamlined.
- There will be an explicit effort to build South African construction and supplier industries for deliver against national development objectives.

6.1 Vision for the civil construction sector by 2050

The South African civil construction and supplier sector will be a vibrant, respected and world-class African full-service built-environment delivery provider that supports Southern African development and beyond. It will be cost-effective and offer safe and reliable service with an experienced and skilled workforce as well as world-class products relevant to the development context. It will be an industry that is inclusive in terms of representative ownership and business practices. The industry will have a wide range of continuously improving products and services delivered by companies that range from small domestic-oriented ones to large companies that can deliver regionally and globally.

The sector will be known for:

- consistently delivering quality projects on time, within budget and to the right quality in a sustainably responsible manner that satisfies investors' expectations;
- being well served by qualified and experienced local professionals and locally manufactured and produced goods;
- having a reliable, experienced and skilled workforce trained through study and work experience;
- sustainably generating a high number of jobs per unit of expenditure while being able to absorb low-skilled labour workers; and
- embracing and contributing to government's transformational agenda.

6.2 Status of the construction sector in 2021

The construction industry plays an indispensable role by providing physical infrastructure. It is an important employer, especially for low- and semi-skill workers, and has important linkage effects into related goods and services.

The construction industry operates in a uniquely project-specific and complex environment, combining different investors, clients, contractual arrangements and consulting professions; different site conditions, design, materials and technologies; and different contractors, specialist subcontractors and the workforce assembled for each project.

The sector is almost entirely based on a competitive market environment in terms of project cost, schedule and performance delivery and is reliant on fair competition, predictability in procurement outcomes, appropriate risk allocations and prompt payment.

Government's relationship with the construction industry was damaged by proven anti-competitive and collusive behaviour. The industry faced substantial fines (R1,46 billion) and a contribution to the voluntary rebuilding programmes (R1,5 billion)

The construction sector is highly regulated by many acts, many of which require permits in advance of construction in terms of slow and cumbersome processes. The Infrastructure Development Act, No 23 of 2014 (IDA), recognises the considerable statutory planning and implementation obstacles facing infrastructure delivery. This act provides a statutory instrument by which obstacles to the expeditious implementation of the national infrastructure plan can be removed via facilitated and expedited approvals, authorisations, licences, permissions or exemptions that may be required in terms of legislation. Yet, the World Bank's 2020 Ease of Doing Business ranking placed South Africa 98th out of 190 countries on regulations relating to construction permits and 108 regarding the registering of property.

There are several organs of state tasked with supporting, regulating or developing the industry but no single national champion within the public sector to address the complex and often cross-cutting challenges facing the industry or the harmful unintended consequences of the regulatory environment that arise from time to time. Regulators have been slow to address issues, some of which are long standing and well understood, which has a negative impact on industry, creates inefficiencies or retards growth.

Government accounts for over two-thirds of civil works revenue and about 40% of non-residential construction revenue. The fall and uncertainty in government construction spending after 2014 has therefore had a material effect on the health of the South Africa construction sector, and especially the sector involved in civil works.

Construction is a low-margin business and therefore requires constant cash inflow to maintain employment, improve on business processes, build up a balance sheet and train and develop staff. Weakening project flow and spending by the public sector have led many large civil construction companies to turn their attention to foreign contracts and/or to survive in South Africa by shifting their commercial activity away from construction. There is evidence of an unprecedented number of large contractors having filed for business rescue or liquidation, largely attributed to a combination of a lack of large government infrastructure contracts, late payment, and the taking on of problematic and loss-making contracts. The value of public listed construction companies fell by 60% to 70% between 2008 and 2018, although some part of this may have been caused by the sale of companies to black-empowered entities that are not listed. There has also been some business failure and significant skills emigration overseas. Construction employment fell by about 35% between 2014 and 2019²⁸.

²⁸ See IMESA (2019). The Challenges of Construction in 2019: Picking up the pieces. Presentation to IMESA (Western Cape) Branch Meeting, 29 May 2019.

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The state infrastructure investment drive will be calling on a severely depleted delivery sector, which may result in increased introduction of foreign businesses to assist in the delivery of major projects.

Government's infrastructure investment drive will act as an economic stimulus if delivered by South Africa construction companies and domestic supplier industries. The pace at which this can happen depends substantially on the ability of the state to create confidence in the sector. This in turn will require a transparent and credible pipeline of projects and reformed procurement processes as outlined in sections 4 and 5 above.

6.3 Conditions required to ensure the civil construction sector can deliver on South Africa's 2050 vision

The following conditions must be met to achieve the 2050 vision:

- 1 **The state must operate its IPDM processes in a way that creates certainty and confidence.**
- 2 **Workflow must be consistent.**

Low-margin business require constant cash inflow to maintain employment, improve on business processes and build up a balance sheet. A project pipeline must enable civil construction companies to plan and structure their work as well as make decisions around capital and human resource investments.

- 3 **Regulations and the process of issuing permits must be streamlined.**

- 4 **Professional capacity must be available, skilled, experienced and competent.**

Consulting engineering and construction are a knowledge-based service industry that needs to invest in developing future skills while ensuring business sustainability. Experienced staff are essential to the success of a construction and consulting engineering business. Skilled and competent people must manage very expensive resources and provide the most cost-effective innovative solutions as small errors can lead to large losses.

- 5 **There must be an explicit commitment to building "South Africa Inc" civil construction and supplier firms**

6.4 How the 2050 vision for a thriving construction sector will be achieved

Strategic element	2050 Vision – How it will be done
The state oversees the procurement and delivery of infrastructure with a high level of capability	The approach to developing institutional IPDM capacity stated in the NIP 2050, section 5, will be implemented.
There is a national infrastructure champion	ISA will be designated as the national infrastructure champion, with the authority and leadership capabilities to resolve blockages as they arise.
There is a pipeline of bankable projects that enables the construction sector to plan, invest and develop its people	ISA will enable the development of a pipeline of bankable projects. It will also publicise the projects and report on their progress at regular intervals. ISA will further be responsible for project assurance processes, as determined in the SIDS Methodology.

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Strategic element	2050 Vision – How it will be done
	Infrastructure delivery processes will be digitised to drive efficiency, speed, transparency, adjudication assistance and implementation monitoring.
Regulations and the issuing of permits are streamlined	• ISA will champion the removal of red tape and work closely with legislative initiatives aimed at easing or reducing the cost of doing business, eg the Ease of Doing Business Bill (B6-2021), which seeks to provide for the assessment of regulatory measures developed by the Executive, members and committees of Parliament and self-regulatory bodies to detect and reduce red tape and the cost of red tape on businesses. • South Africa will fall into the top quartile of the World Bank's Ease of Doing Business ranking in respect of regulations relating to construction permits and the registering of property.
There is an explicit effort to build South African construction and supplier industries to deliver on national development objectives	• A civil construction and supplier master plan will be developed and implemented. • Support mechanisms will be investigated and implemented. • There will be an explicit commitment to providing training, education and work experience opportunities. • Public and private cooperation and partnership will be strengthened. • There will be active and explicit support to strengthening emerging construction and supplier businesses and empowerment of historically disadvantaged entrepreneurs. Action will be taken to ensure that the Preferential Procurement Policy Framework enables access to opportunity for historically disadvantaged business and black industrialists and that misuse of these provisions is stopped. • Strategies will be identified and implemented to drive reduced carbon emissions in supplier industries. This will include innovation in existing materials such as steel and cement as well as innovation in materials usage.
Three-year action steps	The steps will all be implemented within one to three years.

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7 MONITORING AND REPORTING ON PROGRESS

HIGHLIGHTS

Features of how progress is monitored and reported

This NIP 2050 is a 30-year plan for critical network infrastructure, with a focus on energy, freight transport, water and digital infrastructure. The development of capacity and systems to drive its implementation will be an ongoing process. Working with project owners, the PICC and ISA will monitor the implementation of the NIP 2050. Monitoring and reporting to ISA and the PICC will focus on progress in implementing critical institutional reforms, the required capacity development and high-level information on progress of the most important infrastructure projects.

How it will be done

- There will be a transparent and up-to-date database of significant network infrastructure projects
- ISA will do the following:
 - Establish a database that is transparent and open to government and stakeholders. This database will house the most important information in respect of critical areas required for a successful implementation of the NIP 2050 related to institutional strengthening and project development and delivery
 - Set the data standards for proactive reporting
 - Ensure that a publicly accessible portal is in place
 - Engage with any independent assurance teams who identify key issues of concern, gaps in the data, etc. and address the shortcomings with the relevant organ of state
 - Monitor the reporting of data and engage with organs of state that fail to do so
 - Promote the use of apps that analyse the data that enables more effective infrastructure delivery
- It will be a requirement by relevant organs of state that they report into this database. The reporting requirements will be kept to a minimum and, as far as possible, be limited to information that organs of state are already producing as part of their existing performance reporting requirements. Where possible, ISA will use existing performance reporting reports of organs of state to collect information rather than request organs of state to do additional reporting.
- ISA will be empowered and required to report on NIP 2050 progress, and to act on major areas that need course correction.

7.1 Vision for the monitoring and evaluation of critical network infrastructure planning and execution

This NIP 2050 is a 25-year plan for critical network infrastructure, with a focus on energy, freight transport, water and digital infrastructure. The development of capacity and systems to drive its implementation will be an ongoing process. Working with project owners, the PICC and ISA will monitor the implementation of the NIP 2050. Monitoring and reporting to ISA and the PICC will focus on progress in implementing critical institutional reforms, the required capacity development and high-level information on important Strategic Integrated Projects and other identified infrastructure projects in the NIP2050. ISA will then report to the PICC Council, which is chaired by the President of South Africa, on a regular basis on progress in implementing NIP 2050 and on achieving the outcomes of the strategic agenda of South Africa.

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7.2 Status of monitoring and evaluation capability in 2021

South Africa does not have a culture of making infrastructure-related information publicly accessible. For example, the CIDB established a register of projects in 2004, which according to its founding act it is, amongst other things, required to gather information on the nature, value and distribution of construction works projects. No data from this register is made publicly available for analysis. Likewise, no publicly accessible information is available on progress or the attainment of milestones on the pipeline of 18 strategic integrated projects (SIPs), as gazetted in Schedule 3 of the Infrastructure Development Act, 2014. A lack of access to information makes it difficult to hold organs of state to account and provide much-needed information to the construction industry to enable this industry to make informed decisions around capital and human resource development investments in order to ensure that local capacity exists to plan, design and deliver the envisaged pipeline of public infrastructure projects.

The information provided by organs of state is frequently insufficient for informed decision-making and the exercising of governance functions when projects are failing to achieve what was planned and corrective action is necessary. Such corrective action needs to happen early enough in the project development and implementation process to ensure projects are delivered. As indicated in section 5, large infrastructure projects, or SIPs, of this nature are highly complex and challenges are expected as a norm in their development and implementation. There is a large number of public infrastructure projects that for various reasons fail to be delivered on time or within budget or fail to solve the problem that they were meant to solve. Early-warning systems are essential to their success.

7.3 Conditions required to achieve the 2050 vision for monitoring and evaluation

The following conditions must be met to ensure effective monitoring and evaluation that ensures quality and accountability:

- 1 **There must be a central high-priority infrastructure projects database that is open to government and other stakeholders.** This should contain information on progress in relation to the most important milestones for institutional reform, capacity development and major NIP 2050 infrastructure projects (SIPs).
- 2 **There must be a requirement for information to be provided to this central database** by relevant organs of state. This requirement should be aligned to current reporting and not add additional reporting obligations, but it should not be voluntary.
- 3 **There must be open reporting on infrastructure projects** at various stages of development and implementation, in line with the Open Contracting Partnership and CoST Infrastructure Transparency Initiative. Open-data portal dashboards provide key information, including who is winning contracts, time and cost overruns, and variations in infrastructure investment. This means the data can be used by the private sector, civil society, the media and public to identify red flags relating to competition, efficiency and corruption, thereby bolstering efforts to reform infrastructure development. The open reporting should also provide useful market intelligence to the private sector. The Ukraine is currently using this approach to reform the delivery of highways, with great effect.

7.4 How the 2050 vision for monitoring and evaluation will be achieved

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Strategic element	2050 Vision – How it will be done
There is a transparent and up-to-date database of significant network infrastructure projects	ISA will establish and manage a publicly accessible, single database. It will contain high-level, mission-critical information on progress of the development and implementation of the NIP 2050. This will include critical institutional reforms, capacity development and major infrastructure projects in particular strategic infrastructure projects (SIPs). This will be high-level information that will be focused on the most important milestones in development and delivery.
It is a requirement that relevant organs of state must report into this database	ISA will develop guidelines relating to the information required by the central database that will assist in the monitoring and reporting on NIP 2050 progress. The central database will be aligned with current reporting and not add additional reporting requirements, other than those required by legislation. The submission of information will not be voluntary. ISA will: • set the data standards for proactive reporting, ie identify the data points in the project cycle and describe the data that needs to be uploaded on the open portal; • ensure that a publicly accessible portal is in place where organs of state can upload their data; • engage with any independent assurance teams who identify key issues of concern, gaps in the data, etc, and address the shortcomings with the relevant organ of state; • monitor the reporting of data by organs of state and engage with organs of state who fail to do so; and • promote the use of software apps that analyse the data that enables more effective infrastructure delivery.
ISA will be empowered and required to report on NIP 2050 progress	ISA will provide quarterly and annual reports on NIP 2050 development and implementation. ISA will be empowered to act on major areas that require course correction.
Three-year action steps	The steps must all be implemented within one to three years.

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Council for Geoscience

Annual Report 2021/22

Presentation to the Portfolio Committee on Mineral Resources and Energy
October 2022



**mineral resources
& energy**

Department:
Minerals Resources and Energy
REPUBLIC OF SOUTH AFRICA

A proud entity of the Department of Mineral Resources and Energy



Council for Geoscience

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Analysis of Government Grant Allocations from FY2022/23 to FY2025/26

ITEM	2022/23	2023/24	2024/25	2025/26
Baseline allocation	R207.9m	R205.0m	R214.2m	R223.8m
Water Ingress Project	* _	* _	* _	* _
Rehabilitation of D&O Mines (Research Portion)	* _	* _	* _	* _
			R30.0m	R31.0m
Baseline Increase : Geological Mapping for Exploration of Mining	R147.8m	R154.5m	R161.4m	R168.7m
Total Government Grant (2022 MTEF DMR Final Allocation letter 8 February 2022)	R355.7m	R559.5m	R675.6m	R705.9m

*Technical adjustments implemented in the 2022 MTET projects where funding was moved to commercial revenue to align to the DMRE's budget classifications.

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A PRESIDENTIAL CLIMATE COMMISSION REPORT

A Framework for a Just Transition in South Africa

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sector declined from its peak of roughly 130,000 jobs to its lowest point of around 50,000 jobs before rising to 90,000 in the 2010s (Makgetla 2021b). Future projections suggest declines, driven externally by reduced global demand for South African coal exports, potentially exacerbated by domestic trends to automation and the digital economy (Strambo et al. 2019; Makgetla 2021b). Most miners have matric qualifications yet earn around 50 percent more than the median for the formal sector. This makes it harder to find equivalent livelihoods outside of mining (Makgetla 2021b).

Coal production is geographically concentrated with 80 percent occurring in Mpumalanga and over 70 percent of South Africa's total value added from coal coming from just four towns—eMalahleni (Witbank), Steve Tshwete (Middelburg), Govan Mbeki and Msukaligwa (Ermelo) (Patel et al. 2020; Makgetla 2021b). Around 1.1 million people live in these districts (Stats SA 2011). Besides the direct employment effects, the downsizing in coal will affect a range of businesses and informal sector work that support the mines' labour force. Moreover, the municipalities depend on Eskom and the mines to provide some infrastructure and services (Patel et al. 2020).

With appropriate planning and support, some of the job losses in the coal value chain can be offset by further development of the domestic renewable energy manufacturing industry. The Draft South African Renewable Energy Masterplan (SAREM) outlines some of the potential benefits that can be realized by industrialising the renewable energy value chain, including targeted job creation in areas where former coal sector employees live (DMRE, dtic and DSI 2022). As the SAREM is aligned with the Integrated Resource Plan (IRP), any updates to the IRP that increase the renewable energy targets for 2030 or beyond would likely result in increases to the projected job and GDP growth potential of the plan.

Auto Value Chain

The auto industry depends on exports to Europe and the United States, which have committed to accelerating the introduction of electric vehicles (EVs) (Maseko et al. 2020; European Parliament 2022; The White House 2021). If the South African auto industry does not keep up with this global transition, local producers risk exclusion from these crucial markets. Production of EVs, however, requires far fewer inputs and jobs than petroleum-based cars, though jobs may be created to

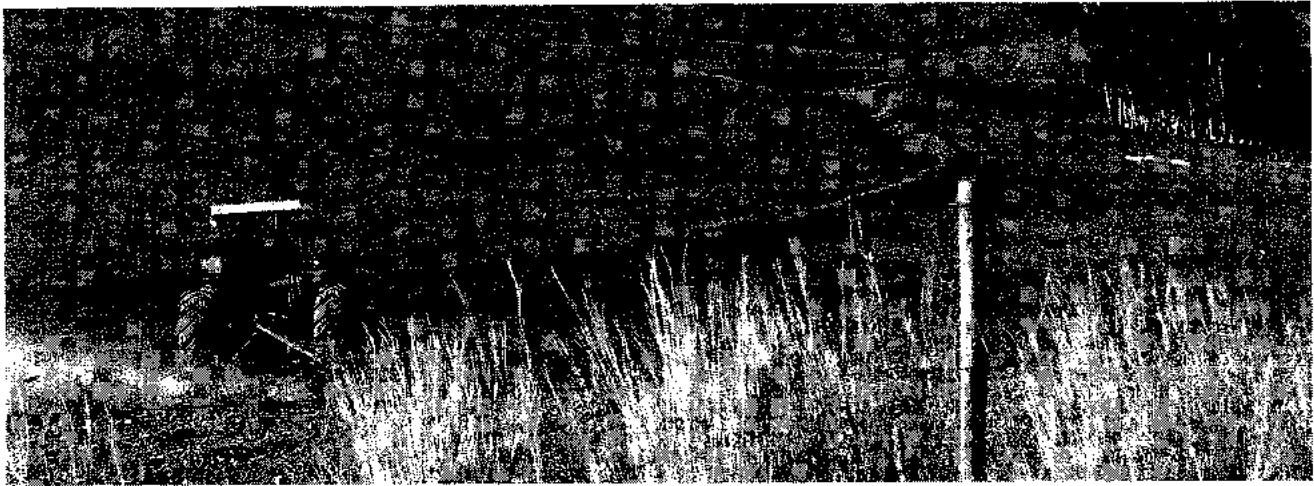


develop the infrastructure for charging stations, as well as the activities flowing from battery management (e.g., safe disposal, recycling, and refurbishment) (Maseko et al. 2020). The timeframes for the transition away from petroleum-based transport depend largely on developments in the global North and, to a lesser extent, regional markets. Europe and the United States have committed to mass use of EVs by 2030 (European Parliament 2022; The White House 2021). A reduction in demand for petrol and diesel will also have knock-on impacts for the liquid fuels sector.

Currently, around 100,000 people work in auto manufacturing (Maseko et al. 2020). The industry centres on Tshwane, eThekweni, Nelson Mandela Bay and Buffalo City (Maseko et al. 2020). The Eastern Cape could face particularly harsh outcomes unless the province is able to develop alternative production clusters (Maseko et al. 2020). The largest employment impacts will be in support industries rather than auto production itself. Around 250,000 people work as auto mechanics, over a third in the informal sector (Maseko et al. 2020). Informal mechanics are predominantly self-employed. An additional 250,000 people are taxi owners and drivers; this group will face growing pressure to procure new e-vehicles, however, most will not be able to afford the investment without some form of state support (Maseko et al. 2020). It is not yet clear how petrol stations will adapt. They make much of their profits on retail sales but rely on petrol to attract customers (Makgetla et al. 2019). Petrol stations employ around 130,000 people and just over half of employees have matric (Makgetla et al. 2019).

While the global transition towards net-zero emissions creates risks to the auto value chain, there are also opportunities. The Department of Trade, Industry and Competition's draft Auto Green Paper on the Advance-

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ment of New Energy Vehicles in South Africa lays out a policy framework for advancing the EV market, among others, with interventions including tax reforms to stimulate greater domestic demand for EVs as well as an EV industrialisation strategy (dtic 2021).

Agriculture

Agriculture is a labour-intensive sector both in terms of employment per unit of output and in terms of its potential as an employment multiplier. Agriculture has already begun to experience the impacts of increasingly volatile weather, with ever-deeper fluctuations in production through the 2010s (DFFE 2019). The sector has faced persistent droughts in some areas; shifts in seasonal rainfall; intense rainfalls, which caused floods and, especially in labour-sending regions, worsened erosion; and generally higher temperatures and humidity, affecting farmworkers, affecting animals and crops directly, as well as incubating new pests and increasing water demand (DFFE 2019). These trends will intensify over the coming years. Climate change is also likely to create permanent changes in the suitability of regions to produce different crops in South Africa.

Climate-induced changes in water availability are likely to have the most immediate and significant impact on the sector. Agriculture accounts for over sixty percent of all water usage in South Africa (Beukman and Reeler 2021). The extent to which farmers can more efficiently use water and adopt other climate adaptive practices and technologies will significantly influence impacts on the sector. Commercial farmers have begun to invest in more resilient infrastructure and crops, such as shade for orchards, drip irrigation and heat-resistant varieties (Chisoro-Dube and Roberts 2021). Many smallholder farmers, however, lack the resources to invest in climate-smart approaches without support from the government or financial incentive schemes (Beukman and Reeler 2021).

The difference in adaptive capacity between commercial and smallholder farmers is representative of the power dynamics in the sector. The agricultural value chain is highly concentrated, with relatively few agro-industrial farms producing most products; roughly 50,000 industrial farms were responsible for over 90 percent of agricultural products sold in formal retail outlets in the 2010s and around 70 percent of all agricultural income is earned by less than 7 percent of farms (Makgetla et al. 2020a; NBI 2021a). Labour force surveys suggest that around a quarter of formal farm owners are black and black farmers account for just five percent of water use (Makgetla et al. 2020a; Beukman and Reeler 2021). Addressing these existing inequalities within the sector must be considered as part of the just transition.

Farmworkers typically have less education (only 15 percent have matric), lower pay, and fewer assets than other formal employees (Makgetla et al. 2019). Moreover, they often live on isolated settlements on farms, making it harder for them to organise or to find new livelihoods. Under 5 percent are union members (Makgetla et al. 2019). Because droughts affect seasonal workers (around half of the total) particularly severely, it proves difficult to track their employment effects (Makgetla et al. 2019). The outcomes appear, not as retrenchments, but as a failure to hire temporary workers, which farmers do not have to report.

Median earnings for farmworkers came to R2,500 a month for women in 2017, and R2,800 for men. For other formal employees, the median earnings for women were R4,000 a month, and R5,000 for men (Makgetla et al. 2019). The median woman farmworker earned a little over half than her counterpart in other formal industries, while the median man earned 63 percent. The gender pay gap in farming, while apparent, is lower than in the rest of the economy (Makgetla et al. 2019).

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In historic labour-sending regions, about 1.7 million people are engaged in farming or gardening and roughly 154,000 depend on it as their primary income or food source (Makgetla et al. 2020a). Most do not have matric. In contrast to commercial farms, almost none have capital or access to financing for more resilient production technologies (Makgetla et al. 2019). Small-scale farmers in the labour-sending regions usually have no alternative employment opportunities nearby, which is particularly acute for women subsistence farmers (Makgetla et al. 2019).

There are, however, opportunities to stimulate new and decent work in agriculture, while at the same time reducing greenhouse gas emissions, more efficiently using water resources, and improving rural livelihoods. For example, the restoration of degraded lands, the improvement of biodiversity, and/or the implementation of climate-smart agriculture are job creators, while bringing important climate and environmental benefits. The empowerment of community-based organisations to implement micro-projects will also support climate and broader societal resilience, particularly in rural or labour-sending regions. The agriculture sector will also benefit enormously from successful global climate change mitigation, since the most severe impacts of climate change on agriculture will be avoided if global warming can be restricted to well below 2°C.

Tourism

Tourism faces a variety of pressures because of climate change. Climate-driven degradation and disruption to cultural and natural heritage negatively affects the tourism sector, reduces the attractiveness of destinations, and lessens the economic opportunities for local communities. This is because natural and cultural resources are the foundation for the tourism sector's competitiveness, some of which are threatened by increasing heat, droughts, and rainfall (Makgetla et al. 2020b). Indeed, the recent catastrophes in Mozambique, Zimbabwe,

and South Africa are evident that our region is on the leading edge of climate impacts. Adverse global publicity around water shortages in Cape Town during the 2016 drought also saw a marked fall in visitors, with only a slow recovery (Makgetla et al. 2020b). In addition, overseas tourism – a small but highly lucrative part of the market—faces growing pressure from efforts to reduce emissions from long-distance air travel (Makgetla et al. 2020b). It is not clear how this trend will affect foreign tourism to South Africa, or over what timeframes.

Data on tourism are always problematic, because the sector does not report as a separate category in the national accounts. Moreover, the COVID-19 pandemic led to sharp downsizing in 2020, making it harder to discern trends (Stats SA 2021). In 2018, there were nearly 600,000 employees in catering and accommodation (a large proportion of these women), and an estimated 700,000 in the sector (Makgetla et al. 2020b). Two thirds of both employees and businesses were in Gauteng, the Western Cape and KwaZulu Natal (Makgetla et al. 2019).

Responsible tourism (as set out in the National Minimum Standard for Responsible Tourism (SANS 1162) can reduce greenhouse gas emissions, conserve energy and water, reduce waste and plastic consumption and ensure that fair benefits accrue to communities and employees (Department of Tourism n.d.)

Phases and Timeframes for Impacts

The years ahead will be marked by steadily increasing global mean temperatures with associated physical impacts, alongside the increasing urgency of the global mitigation response. In the next five years (2021 – 2025), the global energy transition will accelerate, with increasing pressure on disinvestment in fossil fuels. By 2030 a global carbon price will be established, with constraints on emissions entrenched in trading sys-



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Table 1 • Projected impacts to select at-risk sectors and value chains through 2050

YEARS	TRADE ENVIRONMENT	COAL VALUE CHAIN	AUTO VALUE CHAIN	AGRICULTURE	TOURISM
2021-2025	Major trading partners initiate border adjustment taxes Growing pressure from civil society and major businesses to reduce emissions from freight transport and personal flights	Non-closures of Eskom plants to meet emissions targets, but some aging out Increased renewables generation Surge in coal prices due to pandemic recovery and reduced supply followed by decline Sasol plans new feedstock; energy intensive refineries begin to use renewable energy or to downsize	Major export markets commit to e-vehicles as predominant mode from end of 2020s Initial investment in e-vehicle production and infrastructure in South Africa Growing need for a modal shift (freight and passenger) from road to rail, or raise prices to cover emissions Continued periodic severe floods, often localised, damaging physical infrastructure	Continued periodic severe droughts and floods, often localised Heat begins to affect farmworkers, livestock and crop production, leading to some adaptation of products and investment in mitigation technologies by commercial farmers Water use in this sector comes under increasing pressure as most catchments have more demand than available water Low adaptive capacity increases vulnerability	Initial recovery from COVID-19 pandemic faces rising pressure due resistance to high-carbon long-haul flights Eco-tourism sites face growing problems from droughts and floods, and from internal and regional climate migration
2025-2030	Border adjustment taxes increase in most countries Decline in demand for conventional vehicles in global North and for coal internationally Innovations provide opportunities to reduce emissions from freight and travel, but may cost more at least initially	Depending on strategic choices around electricity and carbon taxes, start to see downsizing in coal production and employment Coal districts in Mpumalanga begin to see impact of energy transition on economies	Accelerated transition to production and use of electric vehicles internationally, with greater adoption in SA Reduced need for private vehicles, including through densification and public transport Continued intensification in floods, with growing impact on physical infrastructure	Continued intensification in droughts and floods, with growing impact on employment and livelihoods in affected regions Shifts in demand nationally and globally increase pressure to reduce emissions (especially meat) and trade (especially bulk products, including horticulture)	Continued stagnation in overseas tourism (and potentially local tourism) unless there are more consistent measures to reduce travel emissions and conserve sites
2030-2040	Intensification of efforts to reduce emissions in production and trade	Accelerating decline in coal demand, production, and related employment	Accelerating use of e-vehicles	Gradual relocation of some production to mitigate impacts of climate crisis Innovations in production and freight transport permit stabilisation despite worsening climate conditions Pressure from regional and domestic climate migration	Stabilisation in high-end overseas tourism but limited prospects for substantial growth
2040-2050	Intensification of efforts to reduce emissions in production and trade	Coal largely phased out, with workers and communities engaged in new livelihoods	Transport no longer depends primarily on petrochemicals	As above	As above

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