South Africa's Future Energy Mix and Role Out

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Presentation delivered at the

Chair for Consulting Engineers SA (CESA),

Johannesburg – South Africa

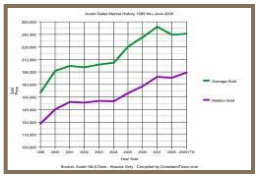
01 June 2011

Overview of this presentation

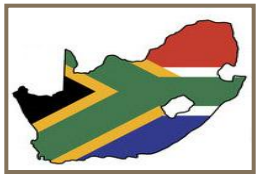
- Overview of Eskom
- Outlook of South Africa's electricity requirements
- World Energy Mix
- Key Energy Solutions for SA
- Eskom response to energy mix and environmental considerations
- Conclusions

Overview of Eskom

Overview of Eskom



- Generates approximately 95% of electricity used in South Africa
- Generates approximately 45% of electricity used in Africa
- 25 Operational Power Stations
- Imports of about 1520MW.
- More than 85% coal-fired. Mix of nuclear, open cycle gas turbines, hydro and pumped storage plant in remaining 20%
- 4.3 million customers
- Largest 138 customers consume nearly 40% of the energy
- Largest 40 000 customers consume nearly 75% of the energy
- Net Maximum Installed Capacity: 40 870 MW
- 381 700 Km of power lines and cables (all voltages)
- 37 857 employees (plus 30 000 contractors)



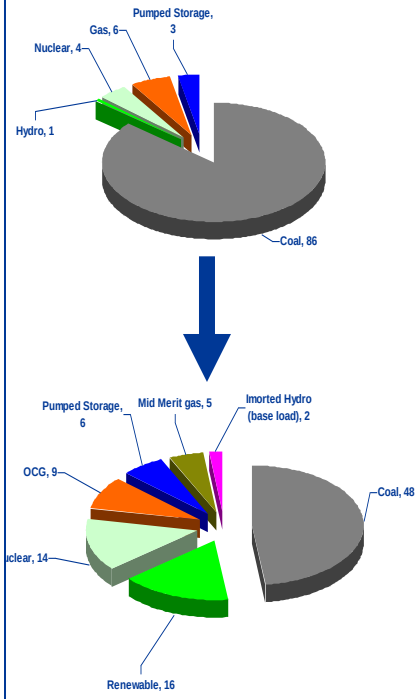
Outlook of South Africa's electricity requirements

South Africa needs to create more than 50GW of new electricity capacity by 2028 – more than doubling the current requirements

- This assumes:
  - GDP growth rate of 4.6% over the next 20 years
  - Decommissioning of 10GW of existing capacity
  - At least 3.4 GW of demand side management programmes
  - As well as a gradual reduction in electricity intensity due to increased efficiency and a diversification to secondary and tertiary sectors in the economy
- In the scenario where the most likely risks realise, there will be two periods in the next 20 years when the risk of supply interruptions significantly increases in South Africa: from 2011-2013, and then again from 2018-2024.
- South Africa needs to take urgent action in order to ensure security of supply for the country for the next 20 years.
- This must be integrated into the wider infrastructure development plan (IRP)

Integrated Resource Planning in South Africa

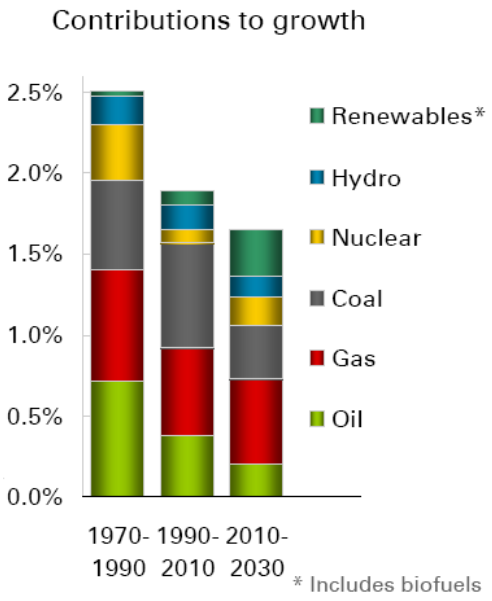
- The Department of Energy has published the Integrated Resource Plan (IRP) that will guide the development of the future energy mix
- The integrated resource plan starts to set out a path for South Africa's long-term energy future, introducing new players and diversifying our sources of electricity
- The plan aims to balance affordability with the need to reduce carbon emissions and ensure security of supply
- The department of Energy is proposing that coal contributes 46% to the energy mix by 2030, renewable energy 26%, nuclear 13%, open cycle gas turbines 8%, pumped storage 3%, combined cycle gas turbines 3%
- Demand-side management is hardwired in the first few years



World Energy Mix

The global energy mix is diversifying. This can be seen most clearly in terms of contributions to growth

- World primary energy consumption grew by 45% over the past 20 years, and is likely to grow by 39% over the next 20 years
- Global energy consumption growth averages 1.7% p.a. from 2010 to 2030, with growth decelerating gently beyond 2020
- The fastest growing fuels are renewables (including biofuels) which are expected to grow at 8.2% p.a. 2010-30
- Among fossil fuels, gas grows the fastest (2.1% p.a.)
- Renewables (including biofuels) account for 18% of the growth in energy to 2030
- The rate at which renewables penetrate the global energy market is similar to the emergence of nuclear power in the 1970s and 1980s

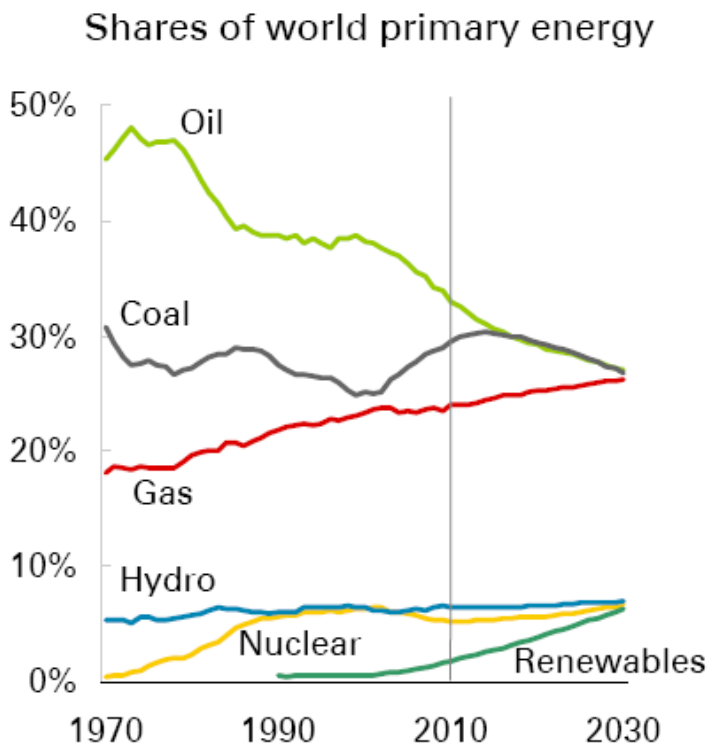


- **Over the period 1990-2010, fossil fuels contributed 83% of the growth in energy**
- **Over the next twenty years, fossil fuels contribute 64% of the growth**
- **Renewables account for 18% of the growth in energy by 2030**

Sources: 1. BP Energy Outlook 2030 (2011 report)
2. EIA 2010

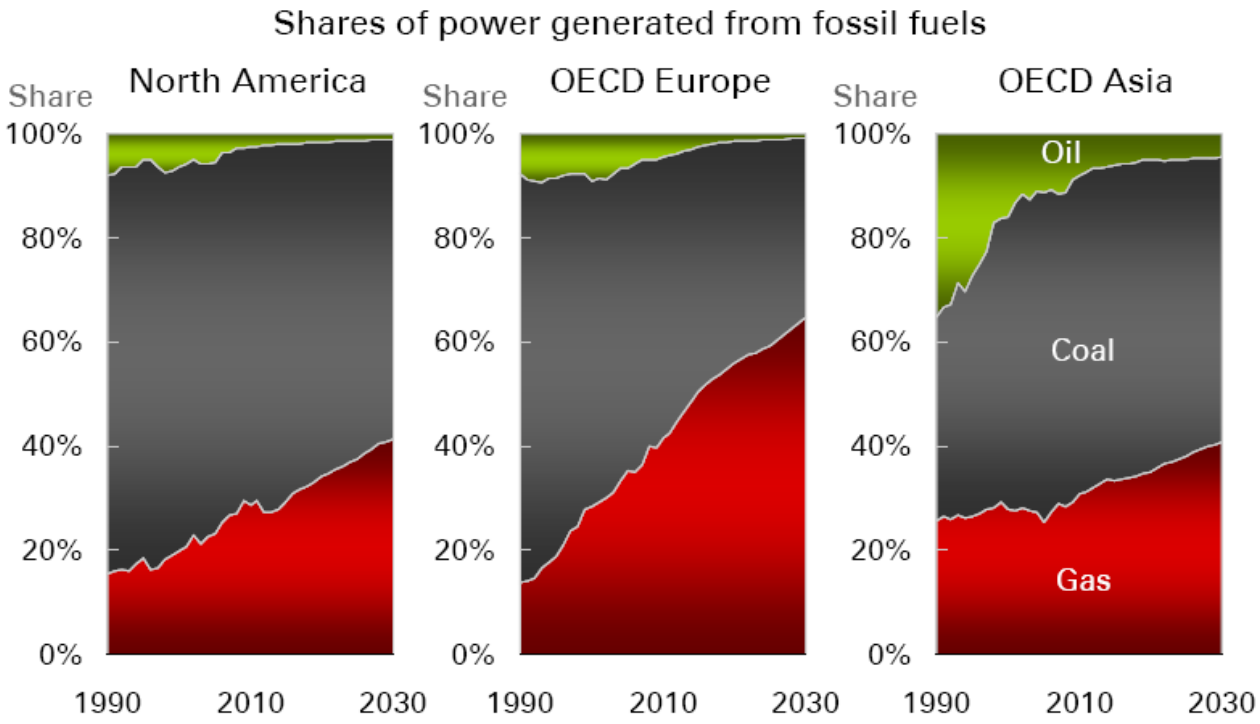
Share of world primary energy to 2030

- The three fossil fuels (coal, oil and gas) are converging on market shares of 26-27%, and the major non-fossil fuel groups on market shares of around 7% each.
- Oil continues to suffer a long run decline in market share, while gas steadily gains.
- Coal's recent gains in market share, on the back of rapid industrialisation in China and India, are reversed by 2030.
- The fuel mix changes relatively slowly, due to long asset lifetimes, but gas and non-fossil fuels gain share at the expense of coal and oil.



Sources: 1. BP Energy Outlook 2030 (2011 report)
2. EIA 2010

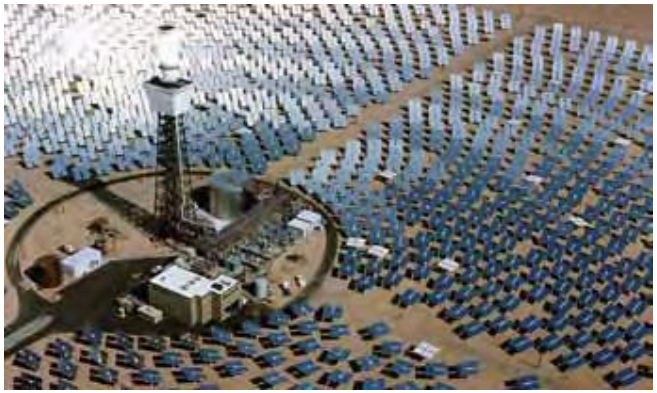
Globally gas is the fastest growing fossil fuel in power generation



- In North America, gas's share in fossil fuel generation reaches 41% in 2030
- In Europe the gas share in fossil fuel generation grows from 42% in 2010 to 65% in 2030
- In Asia gas share grows to 40% in 2030

Globally gas grows its share in generation from fossil fuels from 30% in 2010 to 37% in 2030. Its share in total electricity generation increases from 20.5% to 22%.

Sources: 1. BP Energy Outlook 2030 (2011 report)
2. EIA 2010



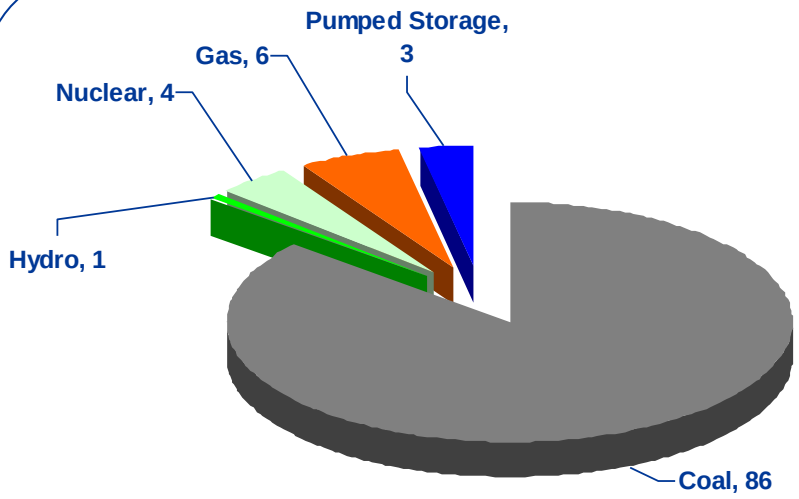
Key energy solutions for South Africa

There are a number of key considerations and questions regarding the South African Energy Mix

- What are the electrical energy requirements for South Africa to achieve its economic growth aspirations?
- By when is the capacity needed?
- What is the appropriate mix of technologies to meet the vision?
- How does climate change impact on the future energy technologies?
- What are the linkages and dependencies on other resources such as water, primary energy sources, skills, sorbents, transmission infrastructure and land?
- What is the role of Government, Eskom, IPPs and other stakeholders in meeting these needs whilst building a sustainable industry?
- What will it cost to meet these needs and how will it be funded? What will be the impact on future electricity prices and will they remain competitive?
- What is required to implement this plan, what is the level of confidence in achieving this, what are the commitments required and who are these required of ?

These questions culminates into a number of key challenges facing the South African electricity industry

The DoE requires a greener energy mix by 2030



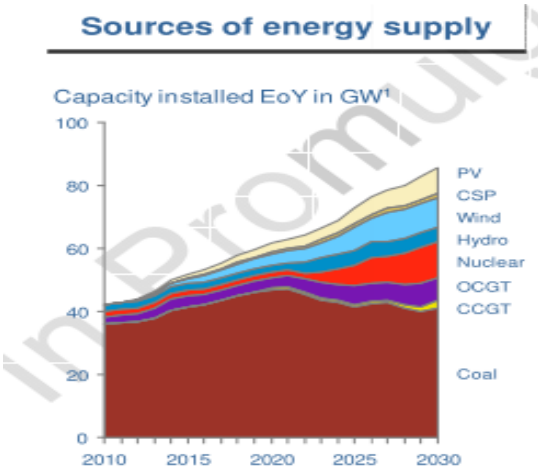
2010

Fossil fuels (coal, oil and gas) make up more than 92% of the current share in South Africa

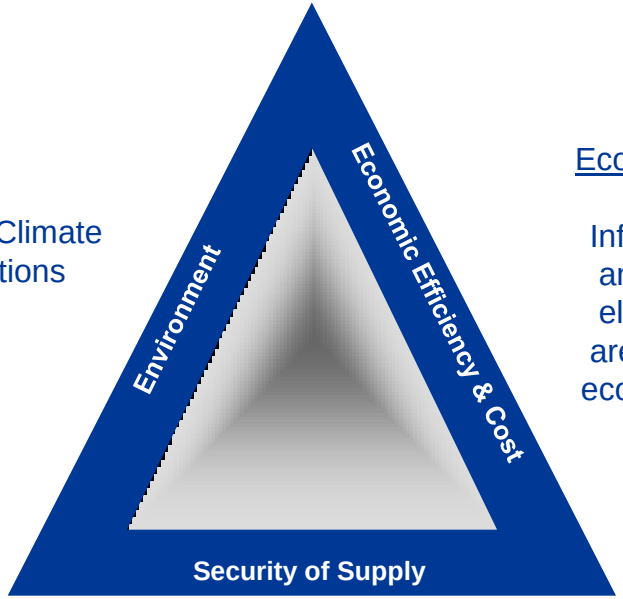
2030

By 2030 the DoE requires that Renewables should contribute about 26% and Nuclear about 13% of the share.

The share of fossil fuels should reduce to about 57 %



But the Industry need to consider a trade-off between three fundamental challenges



Environment

Contribute to Global Climate Change considerations

Economic Efficiency and Cost

Infrastructure development and a globally competitive electricity supply chain are drivers of macro economic development

Security of Supply

Sufficient electricity and primary energy resources are enablers of economic growth

Taking this into consideration, South Africa have a number of options going forward

1 Coal

Impact

- SA has abundant coal reserves (reserves are estimated at 53 billion tonnes, with almost 200 years of supply left).
- Coal-fired power stations are reliable.
- South Africa's infrastructure to generate electricity from coal is well established.
- Generation cost of South African Coal Fired Stations are relatively low
- Coal stations emit sulphur and nitrogen oxides, organic compounds, heavy metals, radioactive elements, greenhouse gases and a lot of ash.
- Building a coal-fired power station is a long and expensive process.
- South Africa's coal fields are concentrated in Mpumalanga and Limpopo, which limits the location options for power stations.
- Requires water to generate electricity.

Internationally, coal is currently the most widely used primary fuel, accounting for approximately 30% of the world's electricity production. This situation is likely to remain until at least 2020.

2 Gas

Impact

- Produces less CO2 than coal.
- Requires less water than coal fired power stations.
- It is a known technology.
- Relatively short construction times and costs.
- Relatively responsive - can start-up fairly quickly in times of high demand.
- Fuel requires no pre-processing and no special disposal safeguards.
- SA does not have abundant supplies of gas (forcing more imports at higher costs).
- Not sustainable.
- The world's natural gas reserves are limited.

Natural gas is projected to be the fastest growing fossil fuel globally to 2030, but slows relative to historic patterns as the market base expands and demand-side efficiency measures gain hold.

3 Nuclear

Impact

- Low operating costs.
- Normally does not produce any significant atmospheric pollutants.
- Quantity of waste produced is relatively small.
- High capital costs and long lead time in planning horizon and construction.
- The lead time in building a nuclear power station is around ten to 15 years.
- Safe long-term disposal of nuclear waste required.
- Viable base-load option.
- Usually requires significant government support.

The South African IRP Balanced reserve Scenario provides for 6 new nuclear stations with a total capacity of 9600 MW to be built in South Africa by 2030

4 Pumped Storage

Impact

- Low operational cost.
- Quick start-up in peak times. Generation is almost instantaneous.
- Once established it is fairly environmentally friendly.
- Water can be reused for other applications.
- SA does not have enough water resources to sustain the development of many pumped storage schemes.
- Very high capital cost for dam construction.
- Requires power from the grid (mostly generated by Coal) for pumping water back to the top reservoir.
- Synergies with renewables.

Eskom is currently constructing the Ingula Pumped Storage Scheme that will produce 1332 MW of peak capacity by 2015

5 Renewables - Wind

Impact

- Low operational cost.
- Sustainable .
- Once established it is very environmentally friendly.
- Uses no water for generation.
- Cannot be used as base load.
- Contribution to capacity currently relatively small in comparison to other sources in South Africa.
- Significant potential in South African wind resources.
- Funding sources readily available.

Eskom is in process to develop South Africa's first commercial wind farm that will be constructed in the Western Cape with a total capacity of 100 MW. Future Wind developments include a wind projects of 500 MW.

6 Renewables - CSP

Impact

- Abundance of sun in South Africa.
- High construction cost.
- Low operational cost.
- New technology for South Africa on a commercial scale.
- Sustainable .
- Environmentally friendly.
- Uses water for generation.
- Higher operating factors can be made possible due to storage.

South Africa aims to build Solar, CSP and PV plants to be in commercial operation between 2016 and 2019 with a total capacity of 400 MW

Eskom's response to a diversified energy mix

Eskom has already made substantial progress to move to a more diversified and greener energy mix

- **Making the existing and new coal capacity cleaner**

  - Development of a clean coal technology roadmap and involvement in the SA process
  - Co-firing with Biomass
  - Supercritical technology for Medupi and Kusile,
  - Underground coal gasification pilot
  - Development of a Carbon capture and storage strategy and involvement in developing an atlas for SA

- **Renewables**

  - National Policy Interventions supporting renewables e.g. Renewable Energy Feed-In tariff (REFIT)
  - Funding for 100MW wind and CSP via World Bank
  - Solar Water Heater (SWH) programme established
  - Off-grid options, grid connected Photovoltaic (PV)

- **Nuclear**

  - Awaiting direction from government on implementation framework

- **Import options**

  - On-going assessment of potential

Eskom seek to lower CO2 emissions through a comprehensive 6 step approach

1. **Diversification of generation mix** by increasing nuclear, gas, renewables, and clean coal, 100MW wind farm
2. **Energy efficiency measures** to reduce demand by 8 000MW in 2025 (= ~2 coal fired power stations), **Biomass co-firing**
3. **Adaptation to impact of climate change**, e.g. by using air-cooling on Medupi/Kusile

4. **Innovation through R&D** into ideas like 100MW solar thermal plant or underground coal gasification
5. **Investments** in an emerging global market trading CO_2 emissions
6. **Progress** through advocacy, partner-ship, and collaboration with environmental organizations

Source: Frost & Sullivan

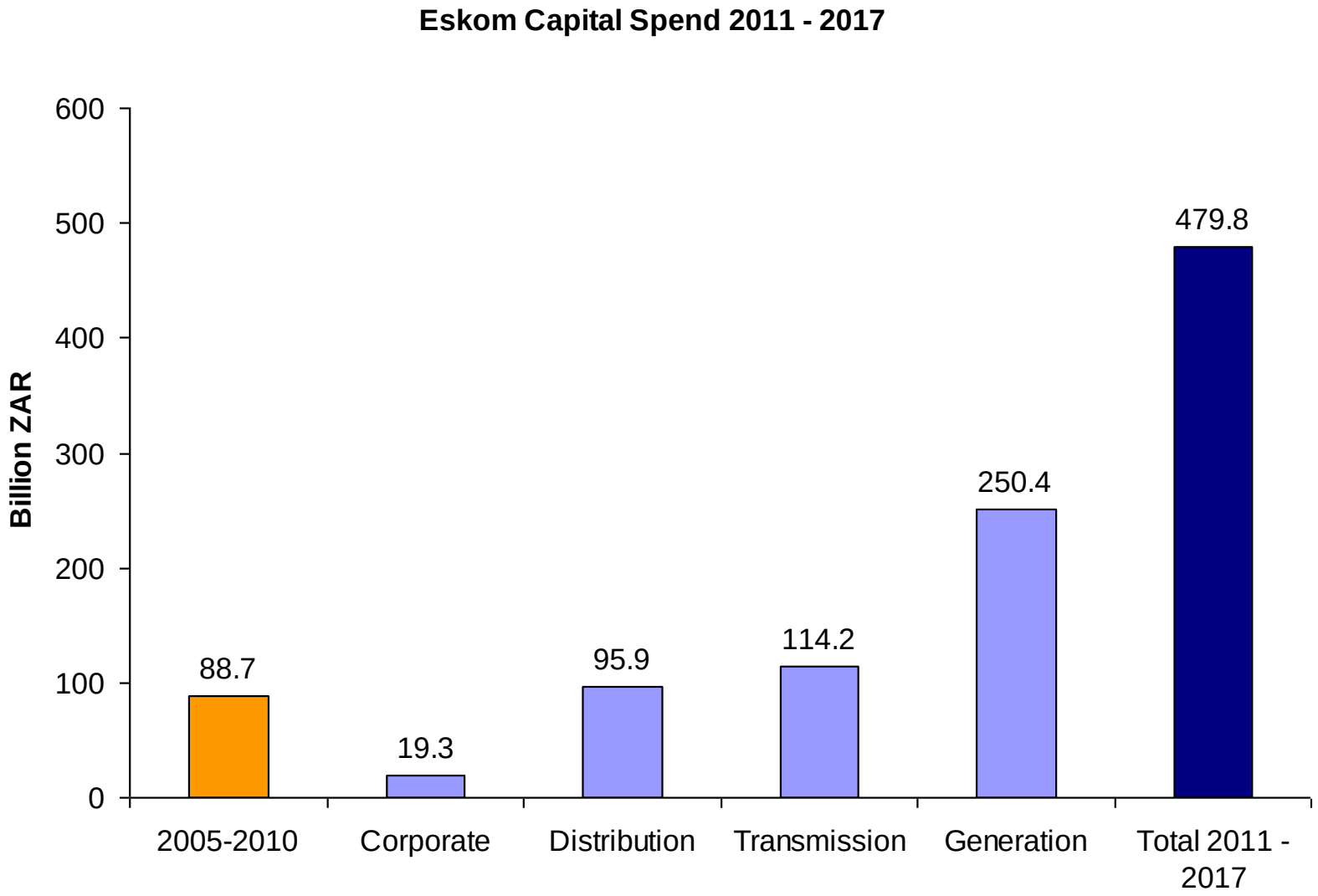
Impact of carbon constraints

- It is clear that carbon constraints and climate change mean a change in the generation mix for South Africa and a move away from coal in favour of low-carbon technologies.
- Eskom is committed to reducing its carbon footprint and helping South Africa achieve its targets by transitioning to a cleaner energy mix.
- Transition from carbon-based to a low carbon environment will require the combined effort of Eskom, Industry and Government to proactively address risks to the implementation of the IRP.



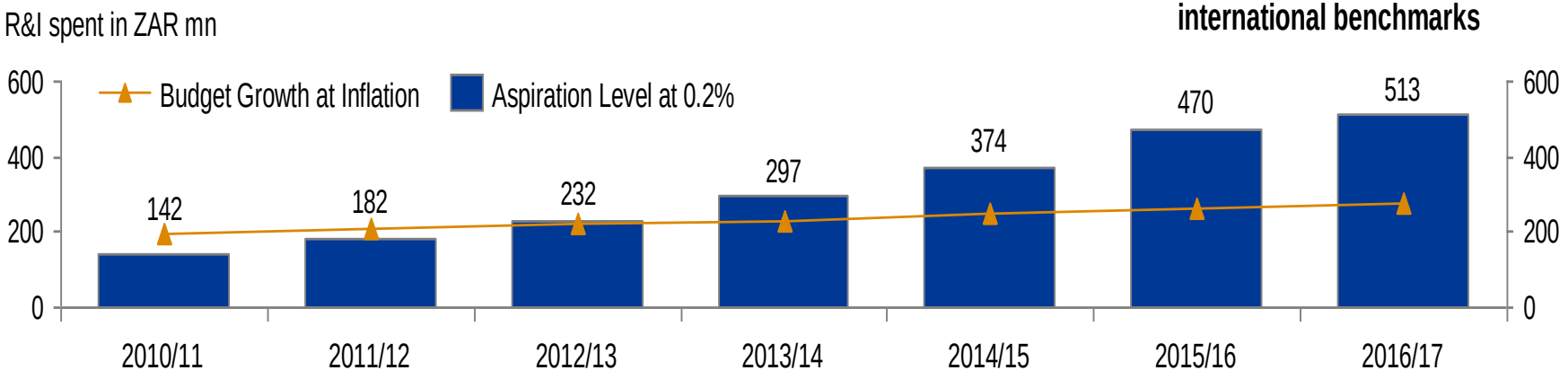
Summary and close

Capital Expenditure 2011 to 2017

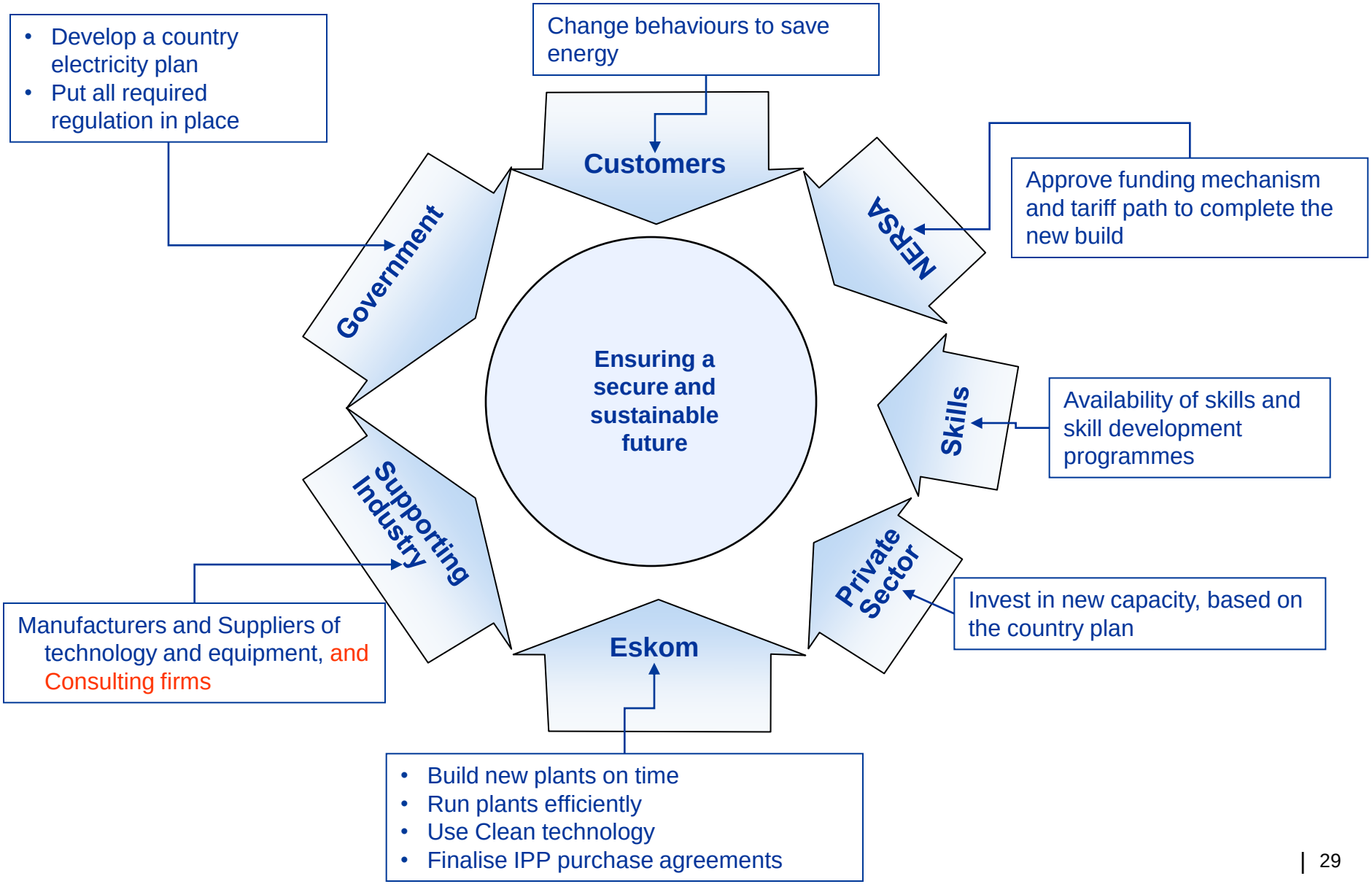


Research Expenditure 2011 to 2017

Status quo	Measures to close gap	Aspiration
...	Increase Research & Innovation investments to 0.2% of company turnover	Develop a world-class research and innovation facility meeting international benchmarks



The achievement of a greener energy mix is a combined effort by a number of key players in South Africa.



Thank You

Questions ?

Ankerlig

Back up slides

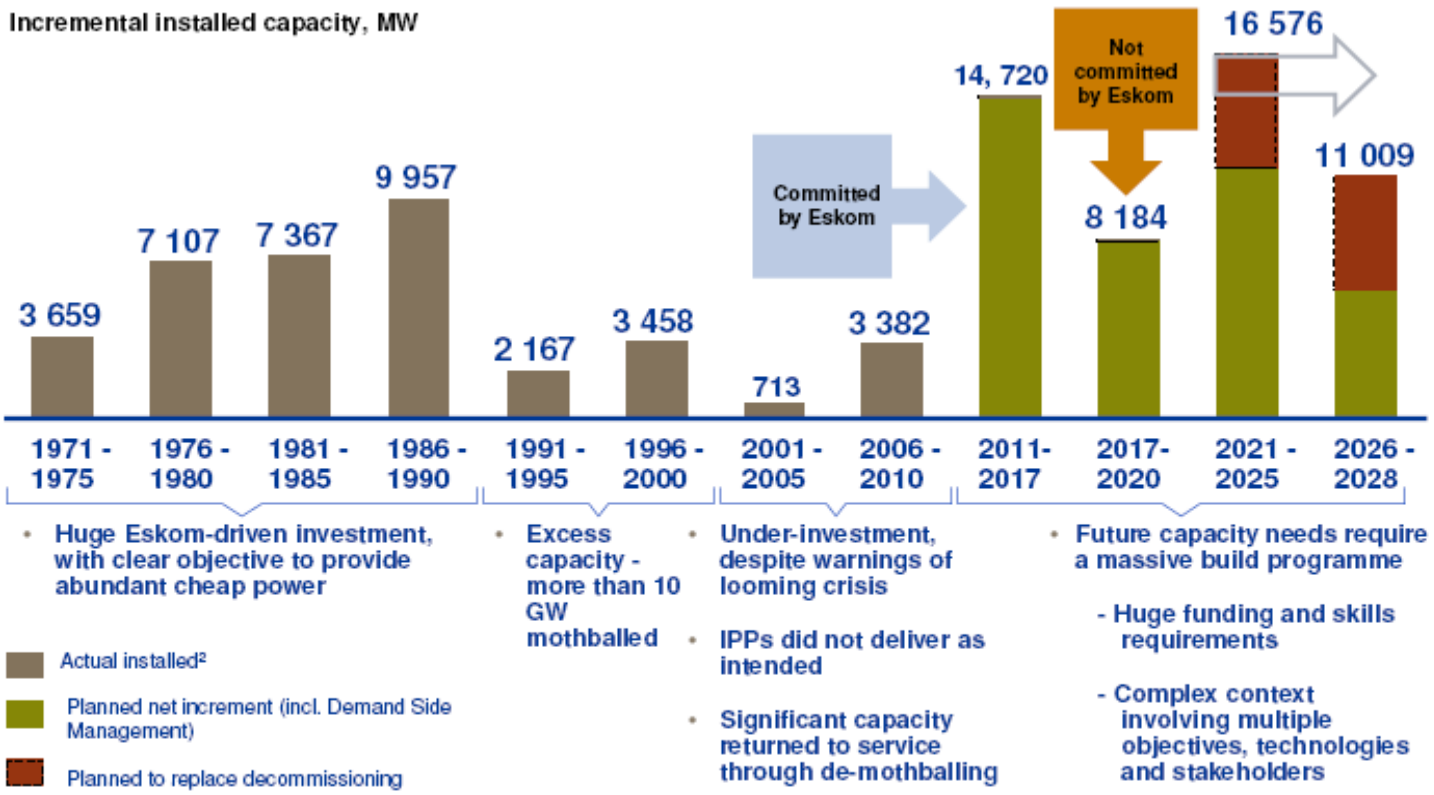
IRP – Policy Adjusted Scenario

Table 4. Policy-Adjusted IRP capacity

	Total capacity		Capacity added (including committed) from 2010 to 2030		New (uncommitted) capacity options from 2010 to 2030	
	MW	%	MW	%	MW	%
Coal	41071	45.9	16383	29.0	6250	14.7
OCGT	7330	8.2	4930	8.7	3910	9.2
CCGT	2370	2.6	2370	4.2	2370	5.6
Pumped Storage	2912	3.3	1332	2.4	0	0.0
Nuclear	11400	12.7	9600	17.0	9600	22.6
Hydro	4759	5.3	2659	4.7	2609	6.1
Wind	9200	10.3	9200	16.3	8400	19.7
CSP	1200	1.3	1200	2.1	1000	2.4
PV	8400	9.4	8400	14.9	8400	19.7
Other	890	1.0	465	0.8	0	0.0
Total	89532		56539		42539	

Notes: (1) Committed generation capacity includes projects approved prior to IRP 2010 (refer to Table 3).

Balancing the energy mix should take into consideration the relationship between demand and supply



1 Including 10GW needed to replace decommissioned capacity, and 5GW of DSM (embedded in planned)
2 Historical figures do not include capacity to replace decommissioning

Eskom seek to lower CO2 emissions through a comprehensive 6 step approach

1 **Diversification of generation mix** by increasing nuclear, gas, renewables, and clean coal, 100MW wind farm

- **Continual reviewing of the investments strategy and portfolio analysis**
- **Clean coal technologies**
  - i. Coal strategy - Coal roadmap
  - ii. UCG - Carbon Capture and Storage Strategy
  - iii. Futuregen (through EPRI)
- **Renewables**
  - i. Policy interventions
  - ii. 1600 MW by 2025
  - Iii. 100 MW wind
  - iv. Gariep upgrade
  - v. Feasibility on 100 MW solar thermal
  - vi Solar water heating
  - vii Research and Development
- **Nuclear**
- **Gas**
  - On –going assessment of potential

Source: Frost & Sullivan

Eskom seek to lower CO2 emissions through a comprehensive 6 step approach

2 **Energy efficiency measures** to reduce demand by 8 000MW in 2025 (= ~2 coal fired power stations), **Biomass co-firing**

- **Billion Kilowatt Hour**
  - Identification and M&V
  - Funding
  - Advocacy & Communication
  - International Liaison
  - National participation
  - Research
  - Integration into business practices
- **Accelerated DSM**
  - The short term target is to save 3000 MW over the next 6 years and 8000 MW by 2025. In reality this equates to about two 6 pack coal fired power stations.

Source: Frost & Sullivan

Eskom seek to lower CO2 emissions through a comprehensive 6 step approach

3 Adaptation to impact of climate change, e.g. by using air-cooling on Medupi/Kusile

Increasing the robustness of infrastructure designs and long-term investments

- Less water
- Long term plant health
- Shifting load centres
- Transmission infrastructure
- Distribution grid (innovations)

Reversing trends that increase vulnerability

- Re-looking siting of generation plant (not all in one area, smaller capacities, more dispersion (e.g UCG, PBMR)
- Develop load centres closer to primary energy resources
- Emergency preparedness – mobile generators etc.

Improving employee / societal awareness and preparedness for future climate change

- Increasing employee awareness about climate change – realities and myths

Source: Frost & Sullivan

Eskom seek to lower CO2 emissions through a comprehensive 6 step approach

- Development of technology roadmaps – coal, nuclear, renewables.
- Underground coal gasification pilot which can improve efficiency, reduce environmental impacts and possible provide a mechanism for the sequestration of CO2,
- The Johansson gasifier biomass pilot for small scale applications,
- The Pebble Bed Modular Reactor which is an inherently safe, modular nuclear technology and
- 100 MW Solar Thermal plant which may overcome the barrier of intermittency and generate a local industry

Innovation through R&D into ideas like 100MW solar thermal plant or underground coal gasification **4**

Source: Frost & Sullivan

Eskom seek to lower CO2 emissions through a comprehensive 6 step approach

- CDM
  - CDM projects are underway
  - Eskom is one of the co-chairs of a project to begin to look at post 2012 off-set mechanisms through IETA
- Carbon Price
  - A shadow price has been determined it will have to be regularly updated
- Carbon trading strategy
  - Carbon trading strategy is almost complete which will determine what we do with any credits generated.
- Green financing
  - lower cost green money
  - International funds are being explored to look for grant money
  - Partners are being identified to share risk and in some cases take equity investments.
- Other trading mechanisms
- Renewable energy and white certificates

Source: Frost & Sullivan

Eskom seek to lower CO2 emissions through a comprehensive 6 step approach

- Continued internal and external communication
- Strategic partnerships with specific aims
- Participation on government delegation to the climate change negotiations
- Various international business and government initiatives

Progress through advocacy, partner-ship, and collaboration with environmental organizations **6**

Source: Frost & Sullivan

The current new build program will add some 18.6GW to the national grid up to 2017

	Return-to-service (RTS)	New coal	Peaking	Mpumalanga refurbishment
				
Portfolio	Return-to-service (RTS)	New coal	Peaking	Mpumalanga refurbishment
Programmes / Projects	► Komati ► Camden ► Grootvlei	► Medupi ► Kusile	► Ankerlig (OCGT and GAS 1) ► Gourikwa (OCGT and GAS 1) ► Ingula ► Tubatse ► Sere	► Duvha ► Kriel ► Matla ► Arnot ► Majuba rail
MWs	**3 800MW**	**9 564MW**	**5 016MW**	**300MW**

- **>18 600MW of new capacity plus**
- **~4 700km of required transmission network**

SOURCE: Eskom Build Programme