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- South Africa-

Analysis of South Africa's Electricity sector - Partial Inforum Application

By David Mullins

Preface

- The Development Bank of Southern Africa (DBSA) commissioned a financial-economic model to be built, to explore the implications of meeting future electricity needs in South Africa.

- Alternative scenarios were modelled to expose issues and trade-offs in meeting the demand for electricity over the next 15 years.

- From the modelling, lessons were learnt, which point to guidelines for optimal provision of electricity in South Africa. These lessons and guidelines are discussed in the latter part of this presentation.

Contents

Clarifying Aspects ... Methodology of the Study - 1

- An integrated financial-economic model was built of the SA electricity sector.
- Two major *economic* modelling components were used:
  - The *SA Inter-Industry Model* (SAFRIM) was used to generate projections of future economic growth and to assess volume/quantity impacts on the SA economy of electricity tariff changes. The model structure was augmented with a detailed export sector demand study and by regression analysis to estimate the impact of electricity tariff changes on exports, imports and thus the Balance of Payments.
  - The latest (2006) 46 economic sector *Social Accounting Matrix* (SAM) for South Africa was used to assess the macro-economic impacts on the country of an optimal electricity supply situation.
- Detailed electricity demand and supply technical and financial sub-models.

Clarifying Aspects ... Methodology of the Study - 2

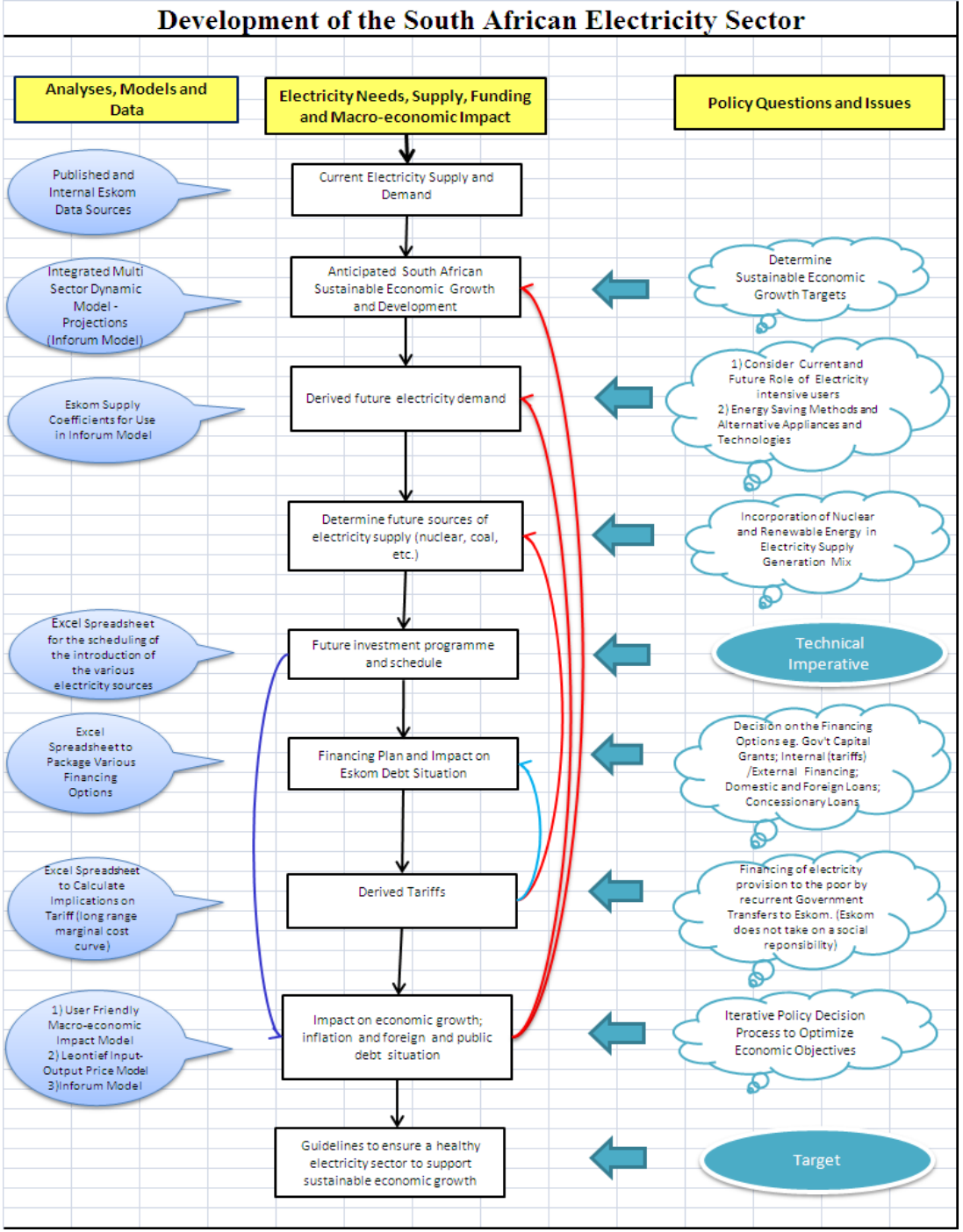
- Cognisance was taken of related studies by Eskom and others:
  - Impact of load shedding.
  - Planned capital investment for expansion.
  - Estimation of the price elasticity of demand for electricity.

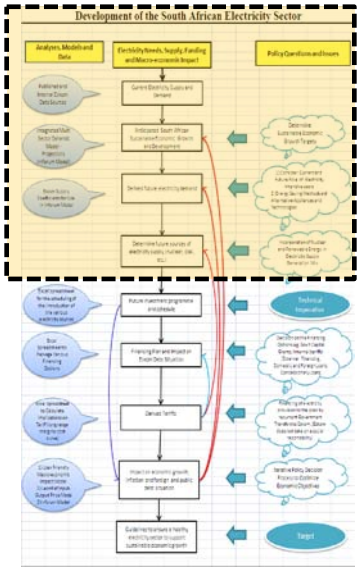
- Outcomes of the modelling:
  - A sustainable long-term economic growth scenario.
  - Calculated future electricity demand.
  - Impact on inflation and foreign and public debt situation.
  - Impact of the financing of electricity sector capital expenditure on macroeconomic variables in the economy.

Clarifying Aspects .... Data Used in the Study

- Standard National Accounts of SA, is the basis of all calculations of volume and tariff impacts.
- The latest (2006) National SAM for South Africa.
- Sectoral Price Elasticities of electricity demand
- Elasticities tested and applied in the study.
- Comparable International Data.
- Specific electricity demand and supply data (the study relied heavily on data from Eskom).

Development of the South African Electricity Sector





Development of the South African Electricity Sector

Analyses, Models and Data

Electricity Needs, Supply, Funding and Macro-economic Impact

Policy Questions and Issues

Published and Internal Eskom Data Sources

Current Electricity Supply and Demand

Integrated Multi Sector Dynamic Model - Projections (Inforum Model)

Anticipated South African Sustainable Economic Growth and Development

Determine Sustainable Economic Growth Targets

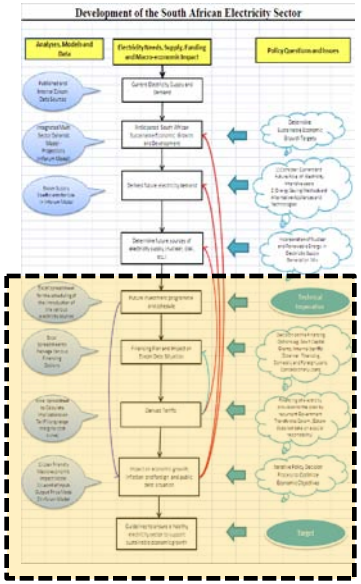
Eskom Supply Coefficients for Use in Inforum Model

Derived future electricity demand

1) Consider Current and Future Role of Electricity intensive users
2) Energy Saving Methods and Alternative Appliances and Technologies

Determine future sources of electricity supply (nuclear, coal, etc.)

Incorporation of Nuclear and Renewable Energy in Electricity Supply Generation Mix



Excel Spreadsheet for the scheduling of the introduction of the various electricity sources

Excel Spreadsheet to Package Various Financing Options

Excel Spreadsheet to Calculate Implications on Tariff (long range marginal cost curve)

1) User Friendly Macro-economic Impact Model
2) Leontief Input-Output Price Model
3)Inforum Model

Future investment programme and schedule

Financing Plan and Impact on Eskom Debt Situation

Derived Tariffs

Impact on economic growth; inflation and foreign and public debt situation

Guidelines to ensure a healthy electricity sector to support sustainable economic growth

Technical Imperative

Decision on the Financing Options eg. Gov't Capital Grants; Internal (tariffs) /External Financing; Domestic and Foreign Loans; Concessionary Loans

Financing of electricity provision to the poor by recurrent Government Transfers to Eskom. (Eskom does not take on a social reponsibility)

Iterative Policy Decision Process to Optimize Economic Objectives

Target

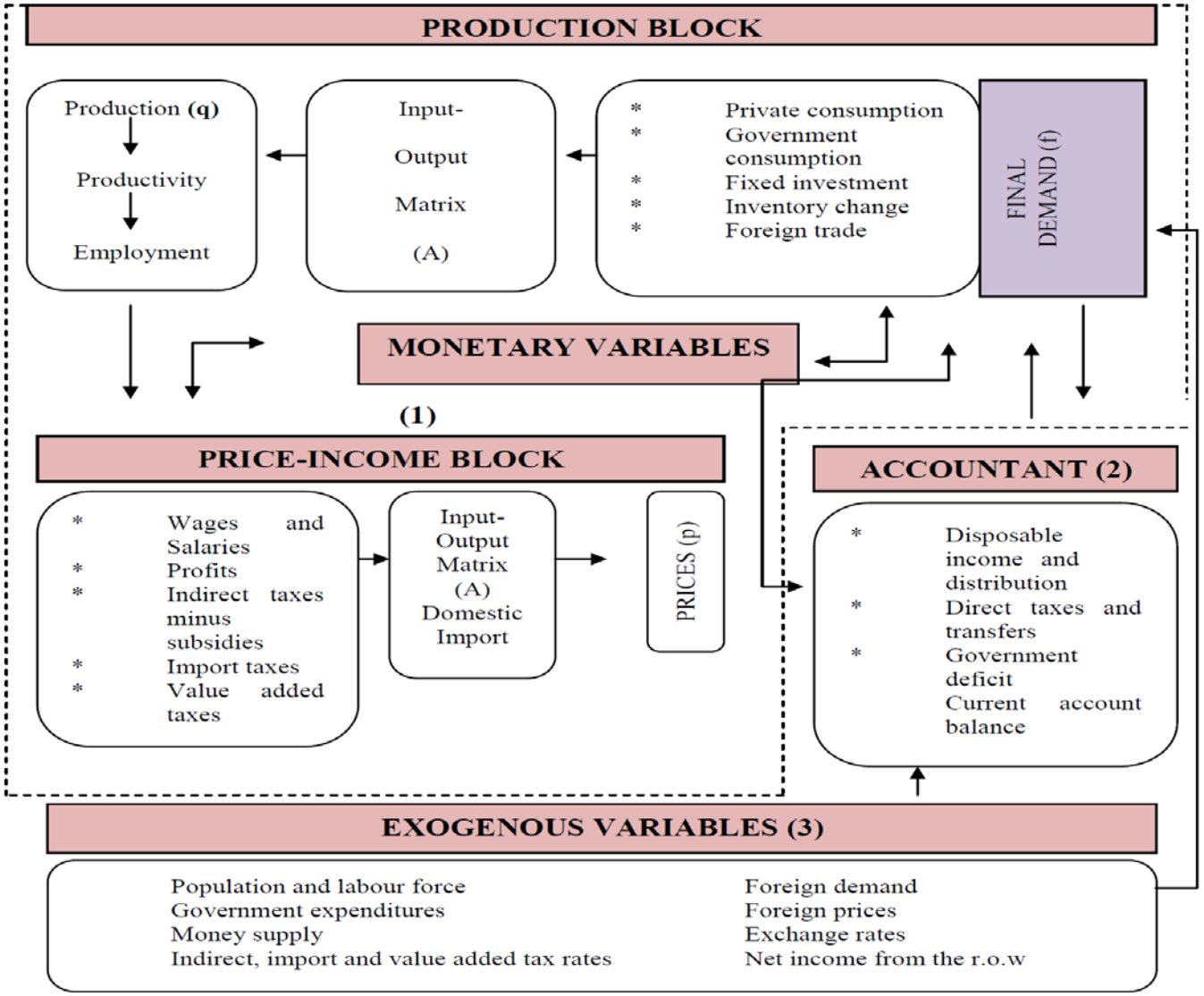
Clarifying Aspects ... The Modules More Specifically

Sectoral Economic Growth (Step 1)	Electricity Demand (Step 2)	Electricity Supply (Step 3)	Electricity Source Mix (Step 4)
Future Investment Programme and Costs (Step 5)	Investment Financing Options (Step 6)	Eskom Debt (Step7)	Public Debt (Step 8)
Derived Electricity Tariffs (Step 9)	Foreign Trade Competitiveness (Step 10)	Macro-Economic Impact (Step 11)	Environmental Impact (Step 12)

Clarifying Aspects ... Step 1: The Economic Forecast Model

- An Economic Forecasting Model estimated growth in the economy on an annual basis for various electricity investment and funding scenarios.
- The model estimates the activity in the national economy at a 46 sector-level over the period 2009 to 2025. This activity is a direct and indirect response to both investment in the electricity sector development programme itself and, to the economic activity enabled by an adequate supply of electricity.

Clarifying Aspects … Step 1: Structure of the SAFRIM (Inforum) Model



Source: Grassini, 1998

Where (1) = Sectoral Section

(2) + (3) = Macro Section

Clarifying Aspects ... Step 2: Electricity Demand Projections - 1

- The economic growth estimate is used to forecast electricity demand in GWh by applying sectoral electricity use ratios to sectoral production levels.
- The sectoral electricity-use production ratios used are based on an electricity-use ratio/multiplier-study previously conducted for Eskom. This was updated with 2009 production and electricity demand data from the Eskom 2009/10 annual report.
- A sectoral price elasticity study was undertaken, based on work by Deloitte (Chartered Accountants) for calculating the economic impacts of changes in electricity prices.
- The model also makes provision for estimation of household demand and for imports and exports of electricity.

Clarifying Aspects ... Step 2: Electricity Demand Projections - 2

- The electricity demand projection is the outcome of:
  - Expected growth of the various economic sectors.
  - Real price of electricity.
- Price changes will have an effect on demand, and demand in turn has an effect on prices.
  - If the average calculated increase in real electricity prices over the period 2010 to 2025 is 3.7% per annum, it implies that the electricity price in real terms will be 97% higher in 2025 than the current price.

Clarifying Aspects ... Step 2: Price Elasticity of Demand - 1

Selected Results of Electricity Demand Studies

Year	Authors	Country	Period	Sector	Long-Term	Short-Term
					Price Elasticity	Price Elasticity
1987	Pouris5	South Africa	1950−1983	Aggregate	-0.9	N/A
1991	Donatos & Mergos6	Greece	1961−1996	Residential	-0.58	-0.21
1998	Diabi7	Saudi Arabia	1980−1992	Aggregate	-0.12	N/A
2004	Hondroyiannis8	Greece	1986−1999	Residential	-0.41	-0.14 insignificant
2004	Filippini & Pachauri9	India	1993−1994	Residential	-0.29	N/A
2005	Narayan & Smyth10	Australia	1969−2000	Aggregate	-0.541	-0.263
2006	De Vita et al.11	Namibia	1980q1−2002q4	Aggregate	-0.54	-0.26
2007	Zachariadis & Pashourtidou12	Cyprus	1960−2004	Residential	-0.43	insignificant
2008	Ziramba13	South Africa	1978−2005	Residential	-0.04 insignificant	-0.02 insignificant

Clarifying Aspects ... Step 2: Price Elasticity of Demand - 2

Long Term Average Sectoral Electricity Demand Price Elasticities for South Africa

Sector	Series Analysis by Deloitte (Unadjusted)	Cross Sectional Analysis by Conningarth (Adjusted)	Sector	Series Analysis by Deloitte (Unadjusted)	Cross Sectional Analysis by Conningarth (Adjusted)
Agriculture	-0.67	-0.20	Metal Products	-0.46	-0.27
Coal Mining	-0.26	-0.26	Machinery	-0.55	-0.32
Other Mining	-0.56	-0.20	Electrical Machinery	-0.51	-0.30
Food	-0.23	-0.14	Communication Equipment	-1.10	-0.06
Beverages	-0.59	-0.35	Professional Equipment	-1.08	-0.64
Tobacco	-0.56	-0.33	Motor Vehicles	-0.43	-0.25
Textiles	-0.62	-0.37	Other Transport Equipment	-1.20	-0.71
Clothes	-0.32	-0.19	Furniture	-0.57	-0.34
Leather	-0.39	-0.23	Other Manufacturing	-1.36	-0.80
Footwear	-0.34	-0.20	Water	-0.38	-0.31
Wood	-0.45	-0.27	Building	-0.35	-0.28
Paper	-0.52	-0.31	Civil Engineering	-0.35	-0.28
Printing	-0.62	-0.37	Trade	-0.28	-0.23
Petroleum Refinery	-0.92	-0.54	Hotels & Restaurants	-0.34	-0.28
Basic Chemicals	-0.84	-0.50	Transport	-0.20	-0.16
Other Chemicals	-0.31	-0.18	Communication	-0.32	-0.26
Rubber Products	-0.76	-0.45	Finance and Insurance Services	-0.62	-0.50
Plastic Products	-0.69	-0.41	Business Services	-0.74	-0.60
Glass	-0.62	-0.37	Medical Services	-0.41	-0.33
Non Metallic Minerals	-0.69	-0.41	Other Services	-0.50	-0.40
Steel	-0.62	-0.37	Other Prod	-0.19	-0.15
Non Ferrous Metals	-1.11	-0.65	General Government	-0.38	-0.30
Average for all Sectors	-0.53	-0.31			
Households	-0.40	-0.20			

Clarifying Aspects ... Step 3: Electricity Supply - 1

- The level of electricity demand generated by the economic model and sectoral electricity-use ratios, forms the demand base for planning required future electricity supply.
- Provision has also to be made for an adequate electricity supply reserve margin. The low reserve margin of 5.6% in 2008 needs to be lifted to a sustainable 15% while at the same time catering for growing demand from an expanding economy and social development needs.
- Ultimately, provision would also have to be made for generation capacity replacement as old power stations are decommissioned. This is not modelled however as it is unlikely to commence before 2025 - falling outside the scope of this study.
- The required electricity supply capacity is estimated in MW.

Clarifying Aspects ... Step 3: Electricity Supply - 2

- Required electricity supply capacity is determined by:
  - Level of electricity demand.
  - Less any electricity demand savings that could be made from energy efficiency programme.
  - Plus the electricity reserve margin.
- *New generation capacity required* is indicated whenever the modelled electricity supply requirement exceeds available supply at any stage during the modelling period.

Clarifying Aspects ... Step 4: Electricity Source Mix

- The study assumes that new generation capacity will include renewable energy sources and nuclear power. Renewable energy sources comprise wind turbines, Solar Thermal/ Concentrated Solar Power (CSP), and solar water heating (SWH).

- Key energy source assumptions used in the study for new generation capacity include:
  - Development of maximum feasible renewable energy capacity.
  - One new Nuclear Power Station is built between 2010 and 2025.

- In the model, new coal-fired capacity is deemed to fill the supply gap between available renewable and nuclear energy and, total electricity requirements.

Clarifying Aspects ... Step 5: Investment Programme and Costs

- The Model determines the capital, operating and maintenance costs associated with constructing and operating required new electricity generation capacity.
- The Model phases in the construction and commissioning of the new electricity generation requirement built during the modelling period. The investment cost associated with the new capacity build programme is determined for each of the years of the study period.
- In the baseline scenario, the total cost (in constant 2009 prices) of the required Investment Programme is R 780 billion, which includes R100 billion for the upgrade of the distribution network.

Clarifying Aspects ... Step 6: Investment Financing Options

- The diverse methods of financing capital expenditure have different short, medium and long run implications for the production cost of electricity.
- Different financing options have different implications for electricity tariffs and thus the options chosen have a bearing on the performance of the economy.
- Four methods of financing electricity infrastructure investment are considered in this model:
  - Loans.
  - Financing from Current Income.
  - Equity.
  - State Grants for Social Provision.

Clarifying Aspects ... Step 7: Eskom Debt

- Eskom debt levels are related to the cost of the fixed assets financed.
- The level of Eskom debt is also dependent on the amount of shareholder equity in Eskom.
- In principle, Eskom's debt situation should be sustainable as long as the duration of loans matches asset life. Cost recovery should not be frontloaded, rather spread over the life of the asset. Tariffs need not continue to rise rapidly as is presently the case.

Clarifying Aspects ... Step 8 Public Debt

- Eskom debt constitutes a significant proportion of public debt.
- To enable continued social and economic development South Africa requires large investments in economic and social infrastructure. The ratio of public debt to national income is set to increase over the longer term.
- Inadequate domestic savings and large public and private sector capital expenditure needs in South Africa raise concerns on long-term trends in the country's foreign indebtedness.
- Eskom will need to obtain a high proportion of its long-term financing from abroad. This will have a material impact on SA's ratio of foreign debt to total debt.

Clarifying Aspects ... Step 9: Determining Electricity Tariffs

- In the model the marginal cost of capital and per annum operational costs form the basis for calculating the long term average electricity supply cost curve.

- The supply cost curve is influenced by:
  - The scale of investment and the nature of the electricity mix given the differing costs of supply from different sources.
  - The financing options selected.

- The real tariff level as calculated by the model depends on the cost of supply and proportion of costs to be covered by operational income.

Clarifying Aspects ... Steps 10 and 11: Economic Impacts - 1

- A core mechanism for transmitting impacts of real electricity tariff increases through an economy is domestic prices. Rising electricity prices lead to inflation in production costs, impacting negatively on the international competitiveness of a country's goods and services.

- Changes in the country's relative competitiveness affect levels of both exports and imports and thus the scale of domestic production in the economy. Therefore, changes in real electricity prices impact not only on inflation and foreign trade but also on output, employment and on the aggregate external balance of payments.

- In terms of the model specification, *economic model* "closure" is achieved by allowing international competitiveness to deteriorate by the additional inflation arising from electricity price increases.

Clarifying Aspects ... Step 10 and 11: Economic Impacts - 2

Estimating International Competitiveness

Exports

- *Impact on Exports = f(World production, Relative prices)*
- *World Production Ξ World GDP expressed in US$*
- *Relative prices = f (South African Inflation (PPI), US inflation rate)*

Imports

- *Impact on Imports = f (RSA production, Relative prices, International trade sanctions)*
- *RSA Production Ξ RSA GDP*
- *Relative prices = f (South African Inflation (PPI), US inflation rate)*

Clarifying Aspects ... Step 10 and 11: Economic Impacts - 3

- Input/Output modelling is used to estimate the production effects of electricity price changes amongst other macro-economic variables.
- In this approach, changes in imports and exports arising from competitiveness shifts, activate consumption expenditure and intermediate demand responses. These define the total sectoral production response to electricity price changes.
- The original economic growth estimate from step 1 (from the economic model) is then adjusted by these production impacts. This new growth rate is then used to derive the impact of the electricity price changes on various macro-economic variables such as the balance of payments and employment.

Clarifying Aspects ... Step 12: Environmental Impacts

- The model allows for variation in the mix of renewable and non-renewable energy sources for required new generation capacity.
- The technology associated with each energy source has typical construction and operating costs and technical efficiencies and also typical environmental impacts e.g. Infrastructure footprint, waste, emissions and water use characteristics.
- National carbon emission reduction commitments imply a need to source zero/low carbon emission energy to the maximum extent possible. Work done for DME (2009) on the business case for renewable energy in SA, informs the energy mix aspect of this study.
- Increasing water scarcity will impact the planning of future generation capacity. Low water use technology will be increasingly sought and, where high volumes of water are needed, water availability will become an increasingly decisive locational factor.

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- Preface
- Clarifying Aspects of the Modelling
- **The Scenario Study: Key Results**
- Lessons Learnt: Guidelines for Optimal Provision of Electricity in South Africa

The Scenario Study – Five Scenarios

- These entail a “preferred” baseline scenario and four alternative scenarios designed to explore financial and economic sensitivities and trade-offs in electricity sector planning.

- The Baseline scenario reflects the view of a realistic average economic growth rate 2010 to 2025 and the preferred generation technology mix and financing mix.

- The three alternative scenarios developed are:
  - A Low Price Elasticity of Demand for Electricity Scenario (leading to high growth in electricity demand and high supply response).
  - A High Loan Funding Scenario.
  - A High Current Income (Tariff) Funding Scenario.

Scenario Key Differentiating Features

Conningarth Scenario Study-Key Outputs and Variables

Model Outputs and Assumptions	Baseline Scenario	Low price Elasticity Scenario-High Demand and Supply Growth Scenario	High Loan Funding Scenario	High Current Income (Tariff) Funding Scenario
Average GDP Growth Outcome (% pa)	3.5	3.5	3.4	3.4
Average Annual Electricity Demand Growth (% pa)	2	3.7	1.3	0.6
Average Annual Required Growth in New Capacity (% pa)	2.7	5.6	2	1.4
Employment (Numbers)	14 775 320	14 821 147	14 595 847	14 487 265
Employment (Numbers) Relative Change to Baseline Scenario	N/A	45 827	-179 473	-288 055
New Capacity Required to 2025 (MW)	22,915	58,518	15,844	10,368
Inflation due to Electricity Price Change (Average over period)	0.50%	0.50%	0.60%	0.70%
Inflation Relative Change to Baseline Scenario	N/A	0.00%	0.20%	0.30%
Real Electricity Tariff in 2025 (2009=31c/kWh)	59	54	68	75
Average Electricity Tariff Increases 2009-2025 (% pa)	3.5	3	4.5	5.2
New Capacity Electricity Mix 2025 (Incremental)				
Wind	3	1.3	4.9	7
Concentrated Solar Power	7	2.8	10.7	15.3
Nuclear	15	5.6	21.6	30.9
New Coal Fired Stations	75	90.3	62.8	46.8
Imports	0	0	0	0
Funding Mix				
Loans- % of funding	60.6	60.6	90.6	50
Current Income (tariffs)- % of funding	0	0	0	50
New Equity- % of funding	30	30	0	0
Social Recurrent Grant- % of funding	9.4	9.4	9.4	0
Price Elasticity of Demand for Electricity	Standard	Inelastic	Standard	Standard

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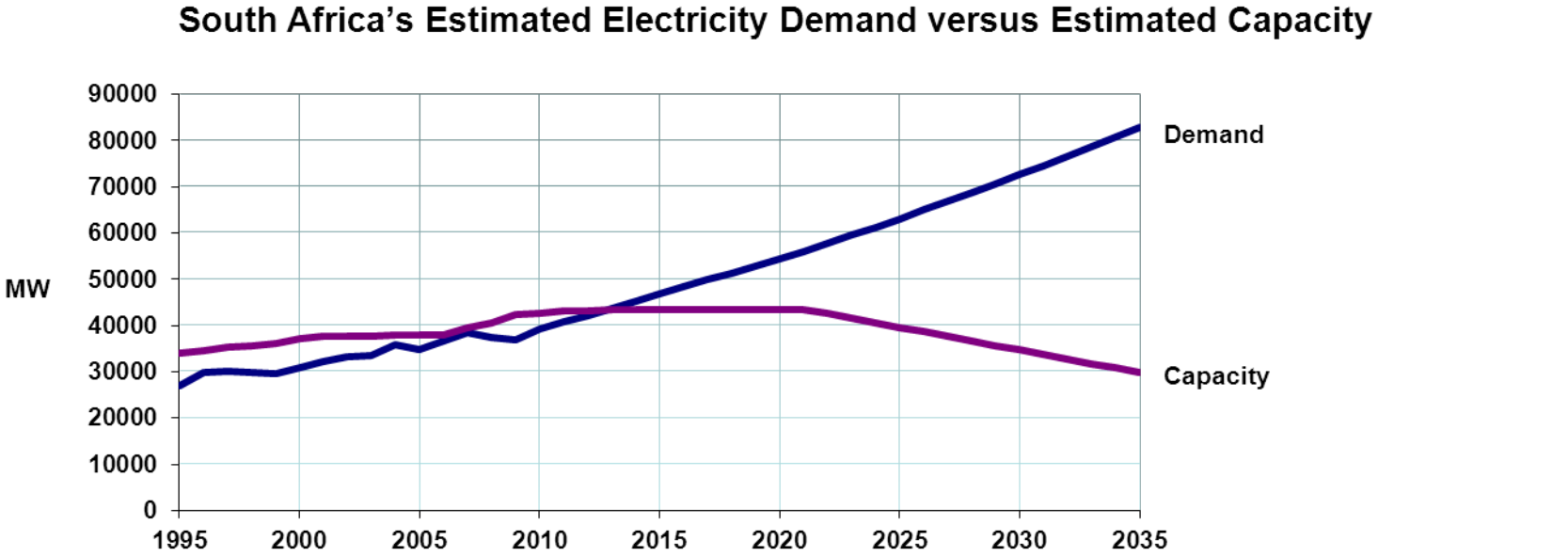
- **Lessons Learnt: Guidelines for Optimal Provision of Electricity in South Africa**

Guidelines from Lessons Learnt: *Optimising Electricity Supply*

Guideline: Under- and over-provision of electricity supply should be avoided as each has significant economic costs

- Unless new capacity is created, supply will fall short of demand by 2013/2014.
- Decommissioning from the mid-2020s will worsen the situation.



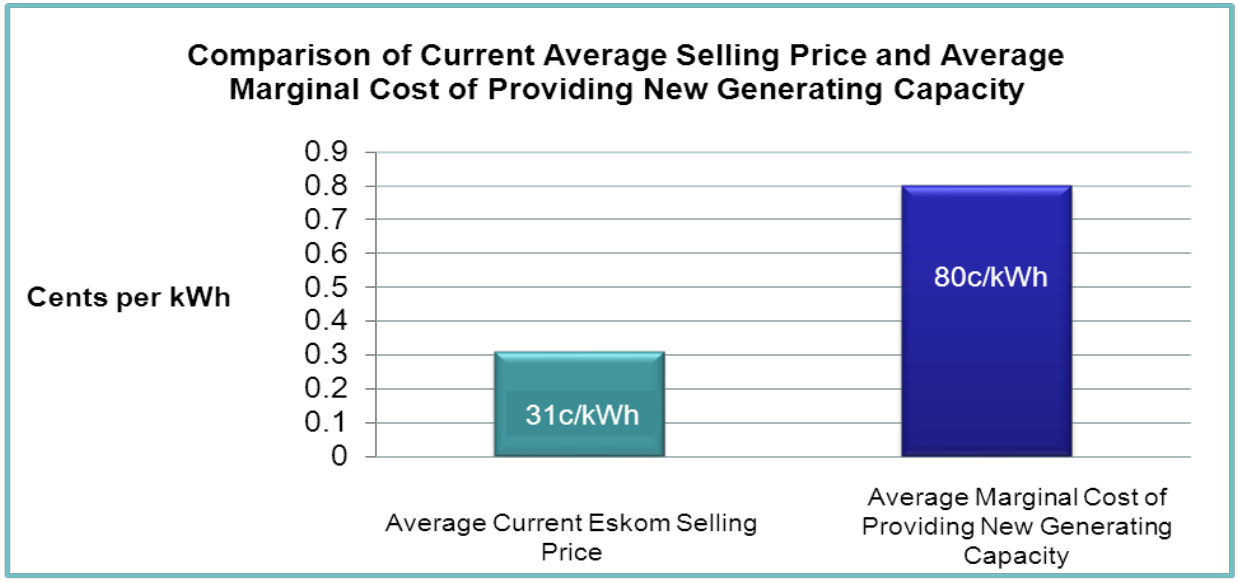
- **Supply and demand for electricity to be closely balanced for both technical and economic reasons**

  - *Under-provision* constrains realization of societal potential as it impacts negatively on economic growth performance and socio-economic development.

  - *Overprovision* leaves expensive assets underutilized . This represents a sub-optimal allocation of scarce capital and this would entail significant opportunity costs for the development of the local and regional economy.

Guideline: The gap between average and marginal costs of electricity provision should be narrowed by linking price increases to marginal costs

- Large differences exist between the current selling price and average marginal cost of providing electricity.



- Tariffs would need to double to cover the marginal cost of supply from new capacity.

- Increases in electricity tariffs have a negative effect on inflation.

Guideline: Strategic decisions made need to be fully implemented

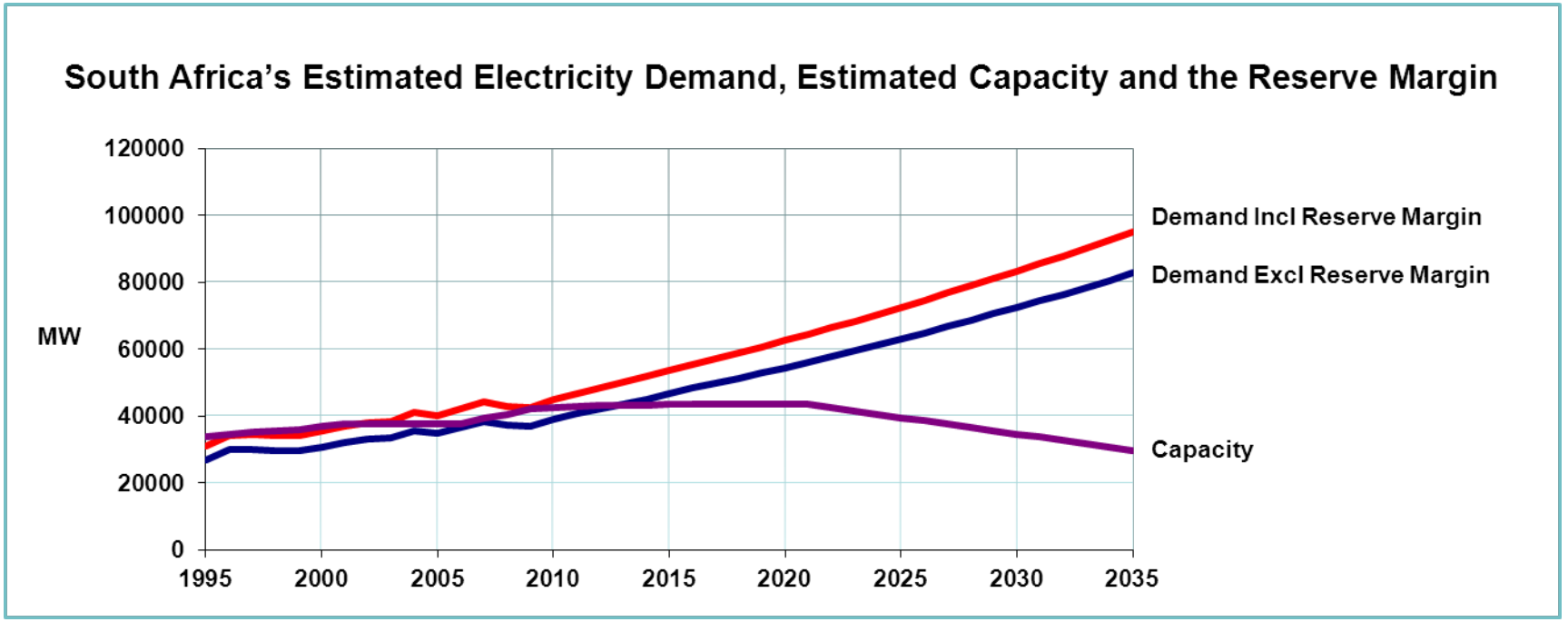
Full implementation of strategy is essential to secure the logic of the strategy choice and thus execute the strategic intent of decision-makers. It is essential to overcome the following:

- Failure to implement needed policies, legislation, regulations and institutional arrangements.
- Failure to deliver projects as planned and on budget.
- Lack of commitment to coordination and execution among responsible parties.

Guidelines from Lessons Learnt:
Restoring Robustness to the National Grid

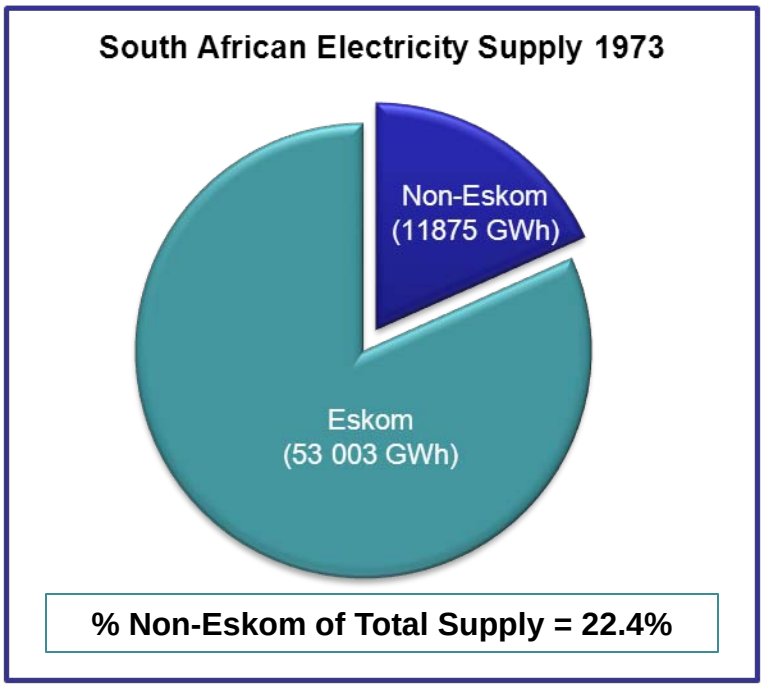
Guideline: Action is required to restore the system reserve margin to a required 15% level

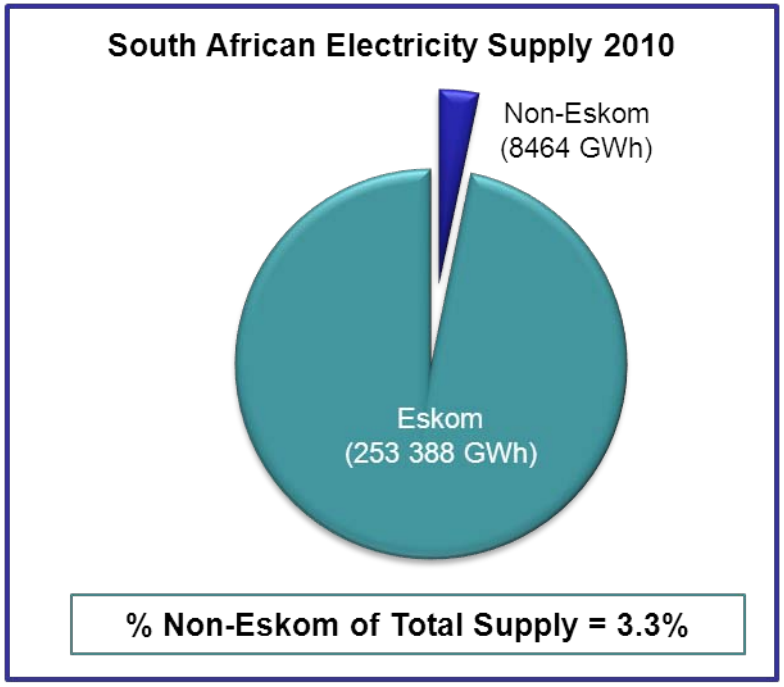
- An Inadequate reserve margin leads to power interruptions.
- Eskom remains a 'supplier of last resort' when non-Eskom supply fails.
- Swift action is required to ensure the reserve margin does not remain under stress in the medium to longer term.



Guideline: Encourage Independent Power Producers to build and operate power stations in South Africa to diversify the electricity supply base

- Eskom's share of total electricity supply has been growing.



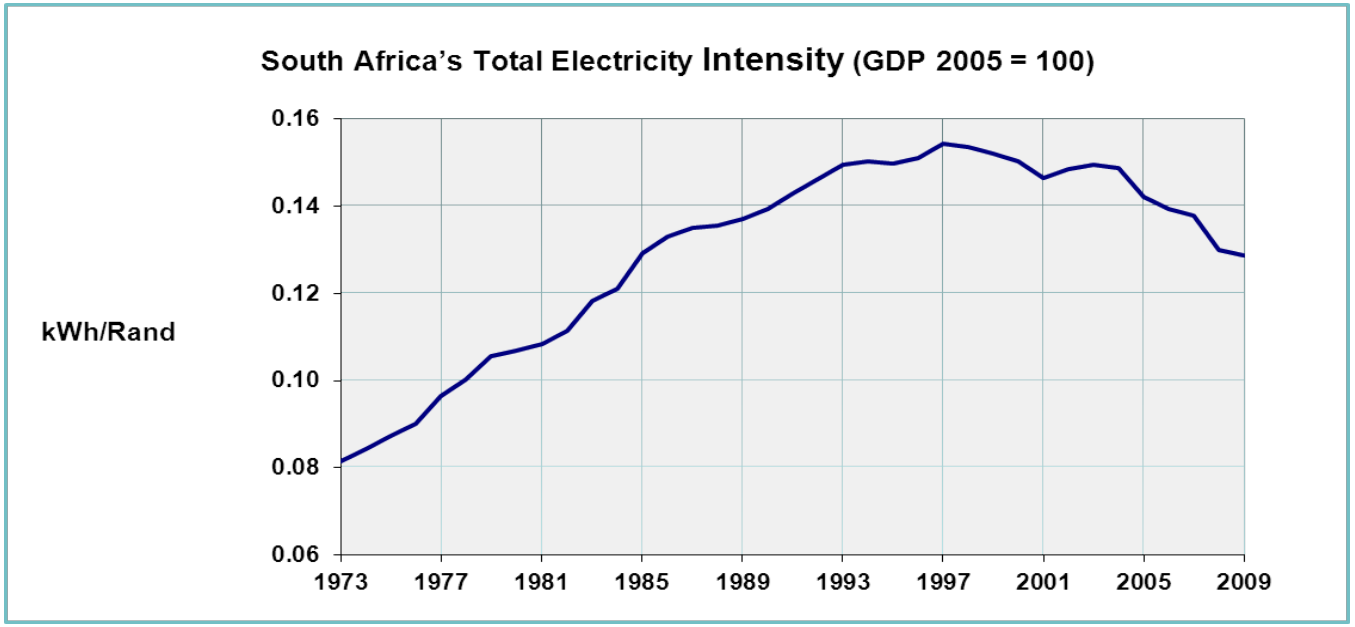


- For strategic planning purposes, the Southern African electricity sector in its entirety i.e. including neighbouring countries, should be considered in forward planning.

Guidelines from Lessons Learnt:
Future Electricity Demand in South Africa

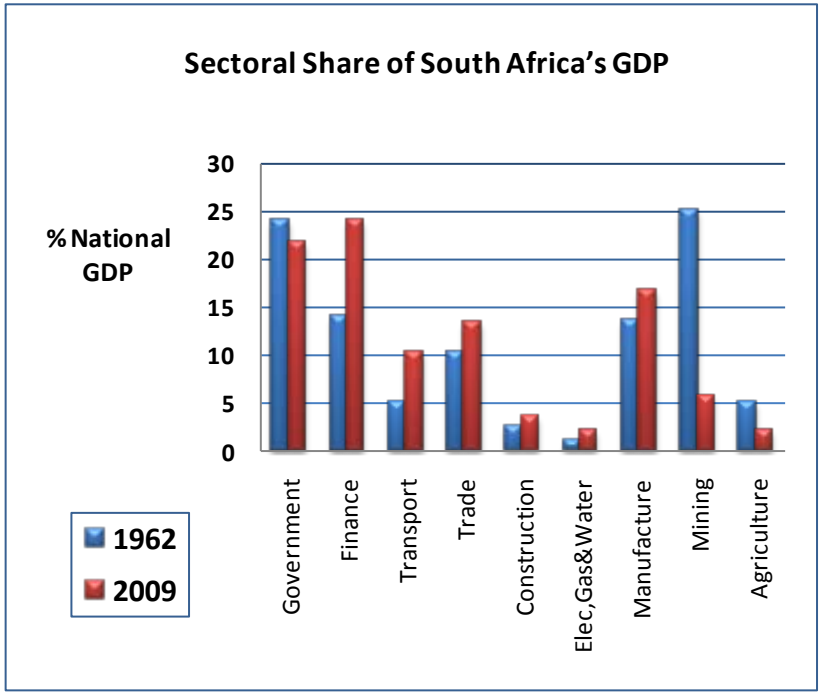
Guideline: In forecasting electricity demand, bear in mind that the South African economy is becoming less electricity intensive

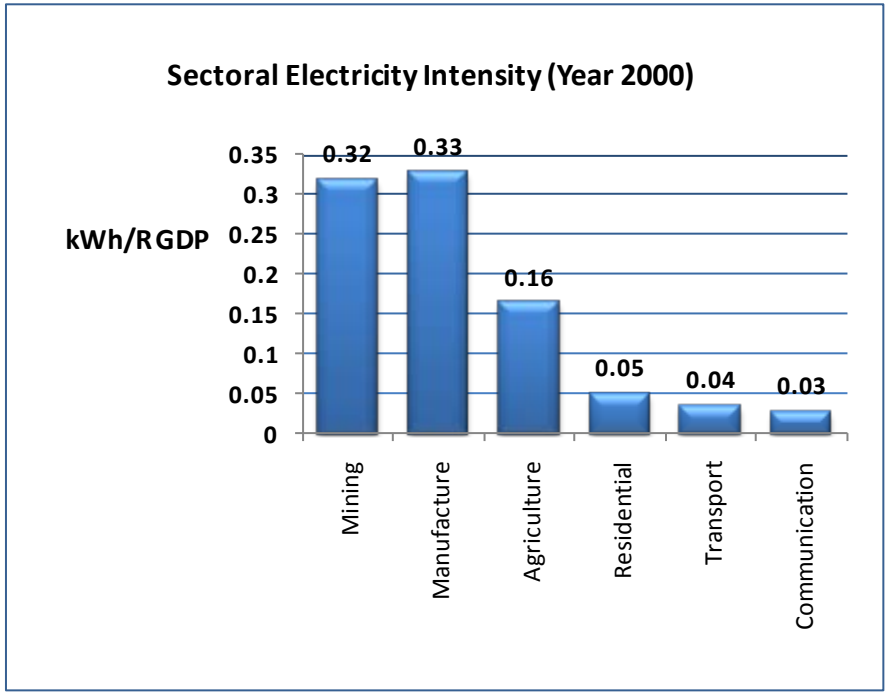
- As the economic structure shifts towards tertiary sectors, electricity intensity typically declines



- This trend would be enhanced by increasing use of energy-saving technologies throughout the economy.
- Rising electricity costs would make certain high-energy intensive sectors uncompetitive and they would either adapt or disappear from the economy.

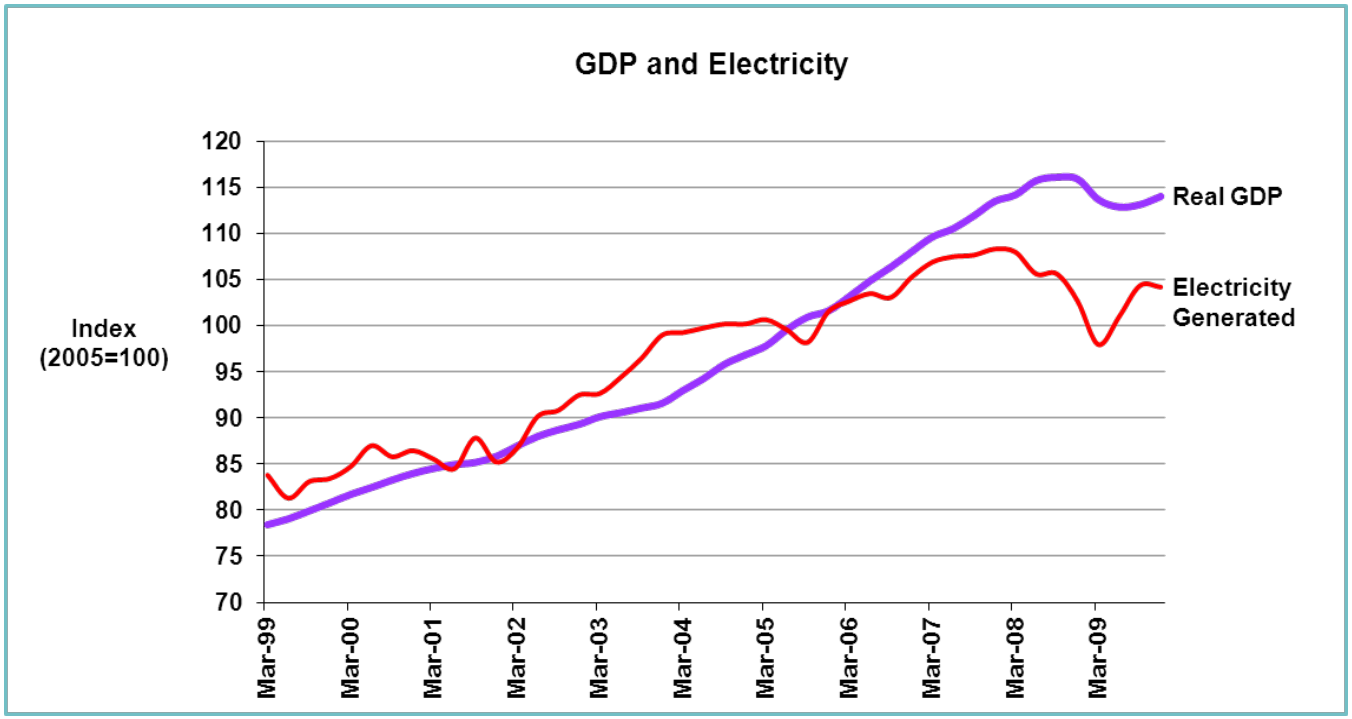
- The South African economy has been progressively changing towards a more services (tertiary sector) orientated economy.
- The tertiary sectors use proportionally less electricity per Rand of GDP created than other sectors.





Guideline: Demand estimation should guard against an over optimistic view of South Africa's future economic growth rate

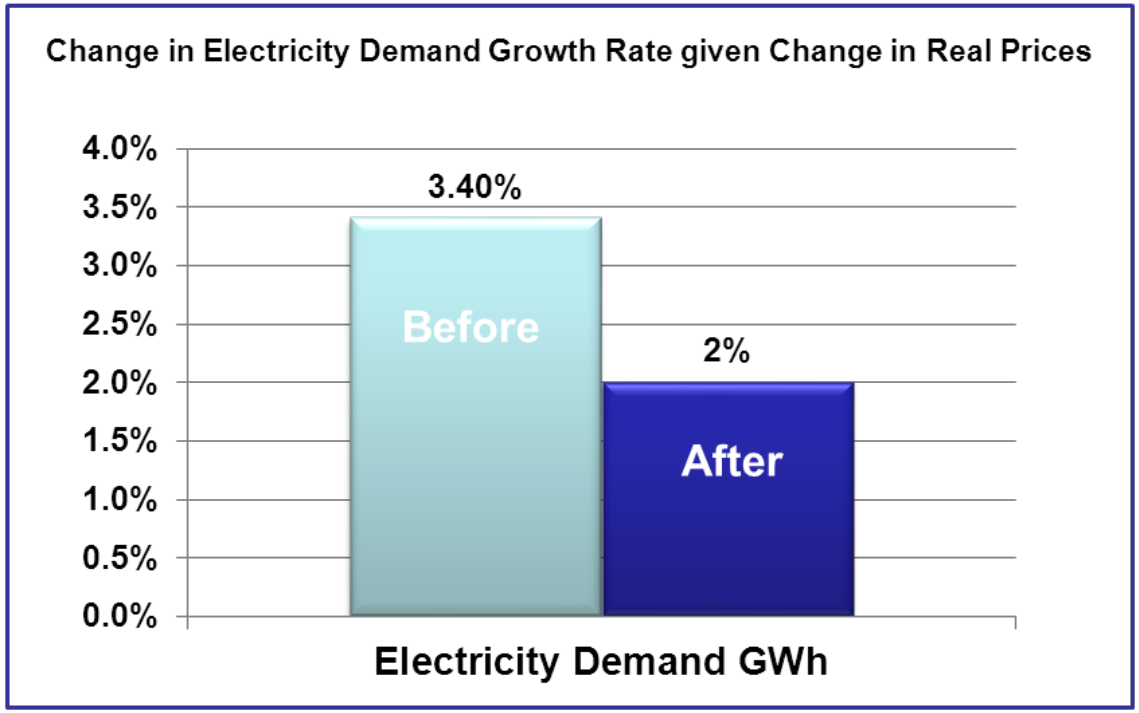
- There is a close correlation between economic activity and electricity demand.



- Over-optimistic views of economic prospects can lead to over-supply of electricity.
- SA's long-term economic growth rate has been between 3% and 4% per annum.
- Changes in the economy's structure and energy efficiency also impact on demand.

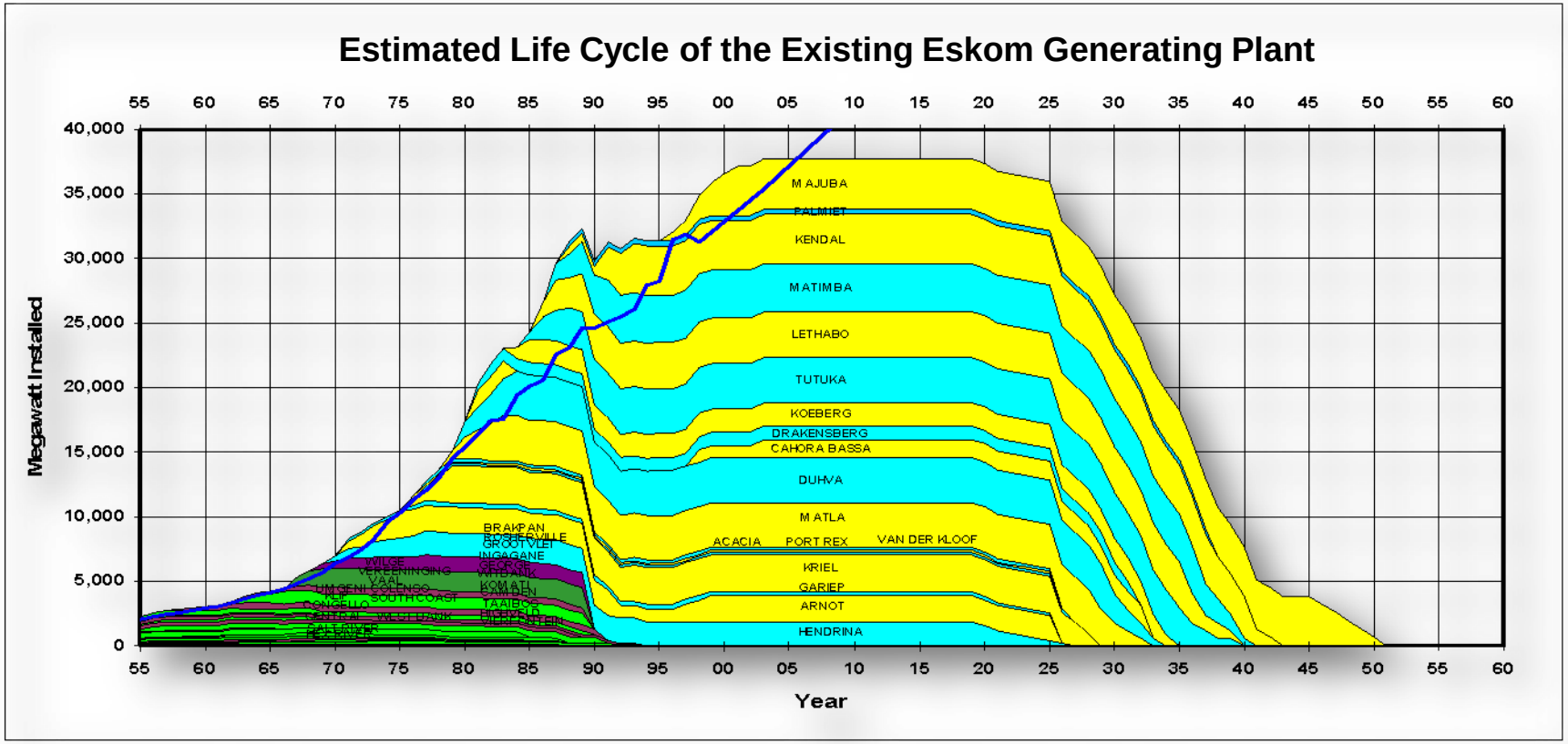
Guideline: Real price increases will contribute to a decrease in the growth rate of electricity demand in South Africa

- Given that demand for electricity is price sensitive, real price increases will reduce the future rate of growth in demand for electricity.
- There is debate on the level of the price elasticity of electricity demand factor for SA i.e. from negligible to significant. A factor of -0.5 is used in this study.



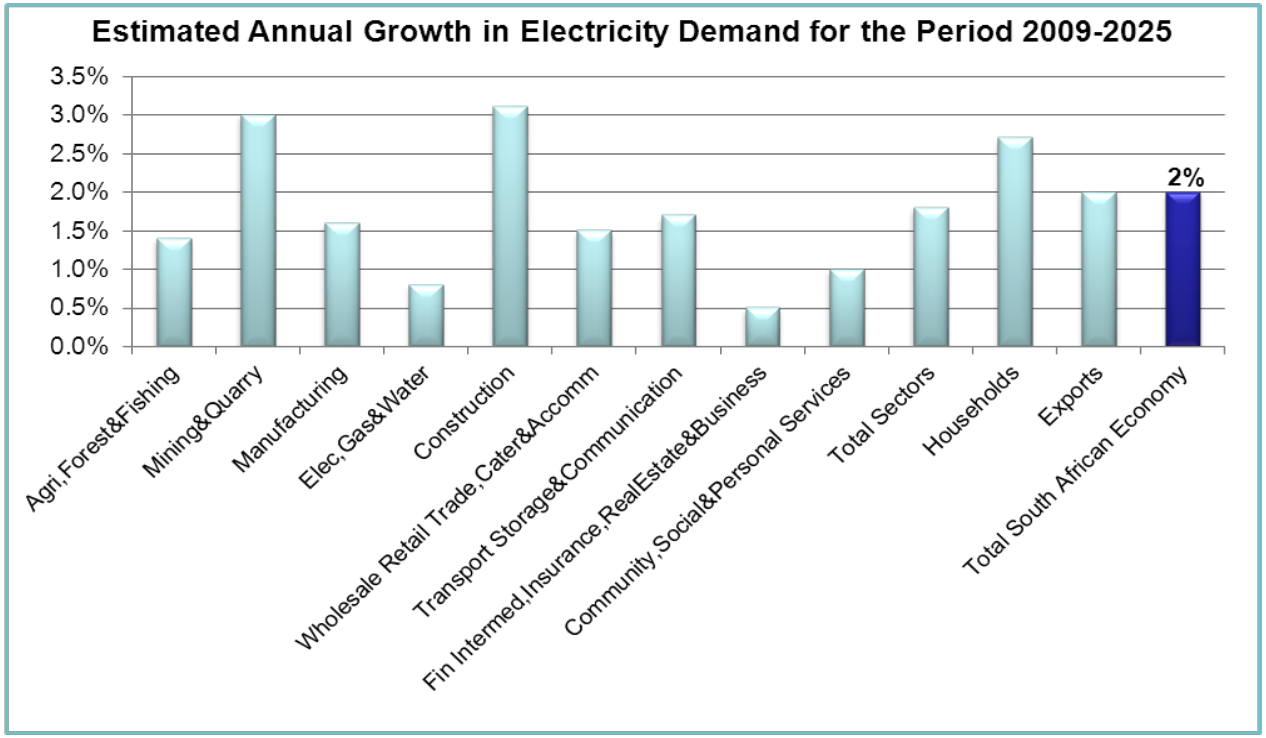
Guideline: The investment programme will also have to make provision for replacement of current power stations as they are decommissioned

- Additional new capacity will begin to be required from about 2025 to replace decommissioned stations.



Guideline: A growth rate in electricity demand over the 2010 to 2025 period of between 2.5% and 3% is recommended for planning purposes

- Growth in electricity demand for the period 2009-2025 is estimated at 2% per annum.

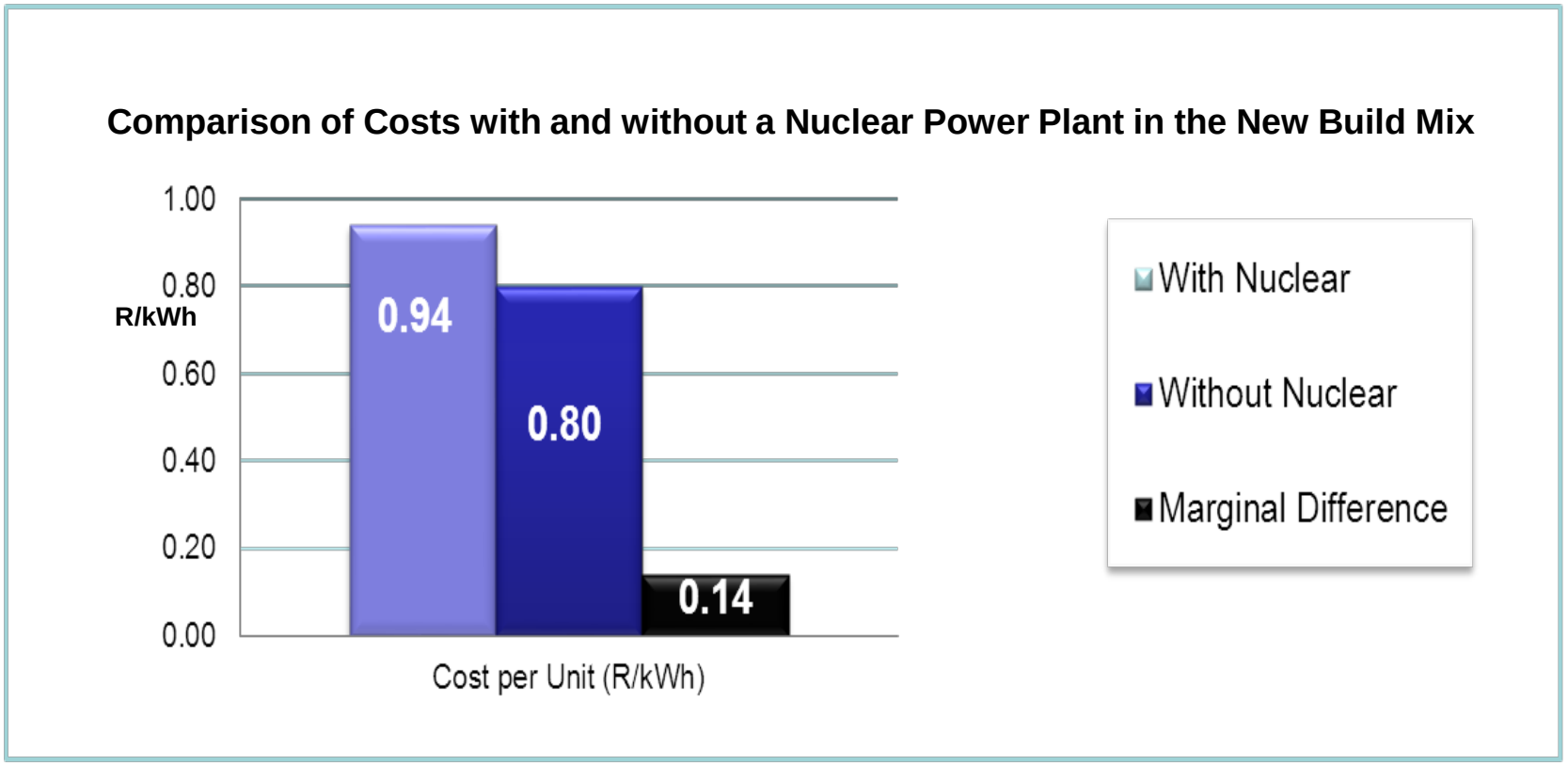


- For planning purposes, an electricity demand growth rate of between 2.5% and 3% is recommended.

Guidelines from Lessons Learnt: *Electricity Generation Sources*

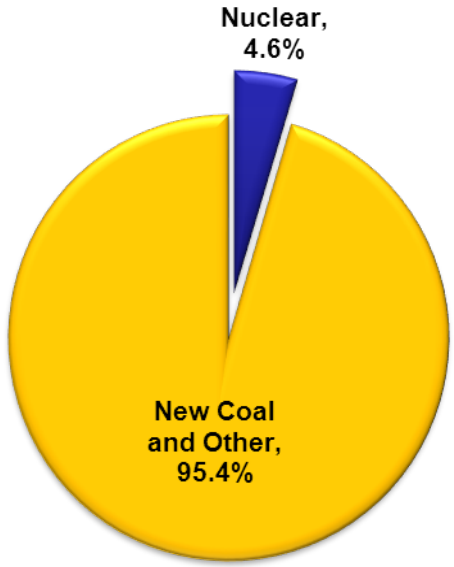
Guideline: Likelihood that only one nuclear power station of 4000MW will be required between now and 2025

- The inclusion of nuclear generation capacity in the new-build mix will however significantly increase the unit cost of electricity.

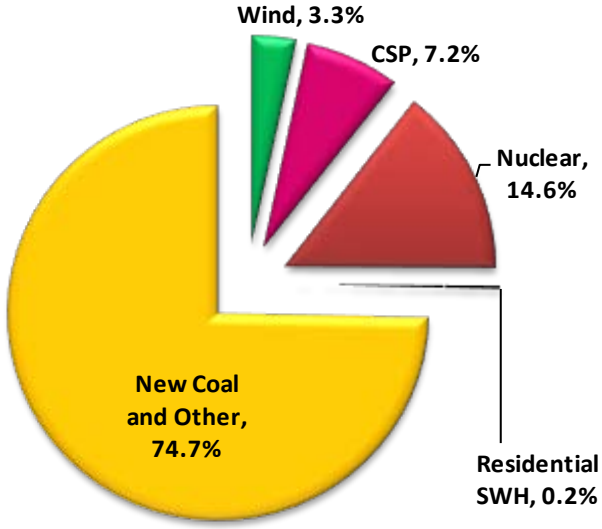


Guideline: The envisaged incremental electricity supply source mix includes nuclear and renewables

Current Electricity Supply Source Mix 2010:
- Percentage of Total Capacity

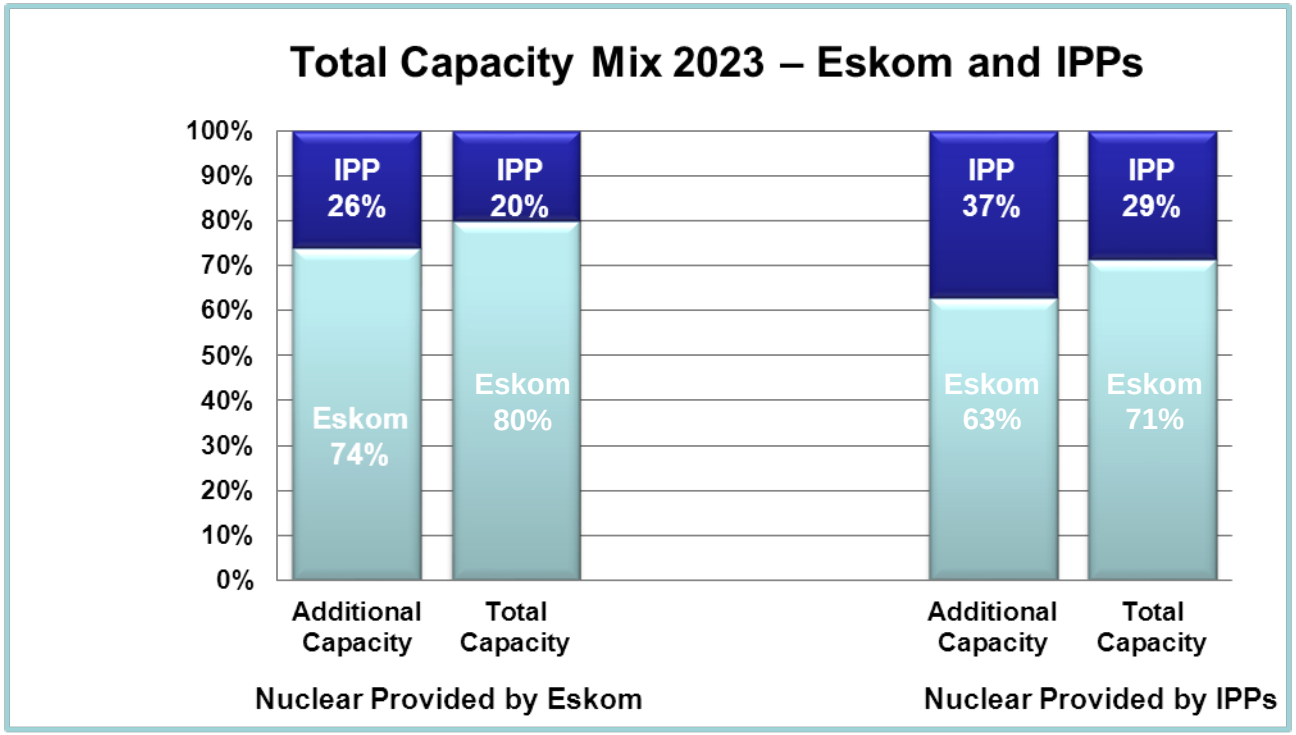


Incremental Future Electricity Supply Source Mix in 2025 - Percentage of New Capacity



Guideline: Renewable energy should mainly be provided by Independent Power Producers (IPPs)

- Government's target: 30% of South Africa's estimated electricity requirement in 2023 to be met by IPPs.



- IPPs could make a larger contribution to supply by providing renewable energy generation capacity

Guideline: Consider the possibility that nuclear power could be provided by a foreign Independent Power Producer (IPP)

- If either Eskom or a South African IPP takes on the responsibility to build, operate and finance a nuclear power station, heavy overseas borrowing would be necessary.
- If instead a foreign IPP takes on this responsibility, a substantial amount of foreign direct investment will flow into South Africa and be positively reflected in South Africa's foreign exchange reserves.
- With foreign-owned base-load nuclear power generation there might however be possible national security and safety issues.

Guideline: Encourage new and existing electricity-intensive users to expand self-generation, including co-generation

- The more electricity supplied by highly electricity-intensive users the less supply is required from Eskom.
- There would be a favourable impact on Eskom's funding requirements.
- The knock-on effect would be a lessening of pressure on local financial markets and where energy intensive users do not pass on the costs to customers, there is a favourable impact on inflation.
- Self-generation and co-generation also have the potential to improve energy utilisation and energy efficiency and bring environmental and social benefits.

Guidelines from Lessons Learnt:
Costs of the Electricity Development Programme

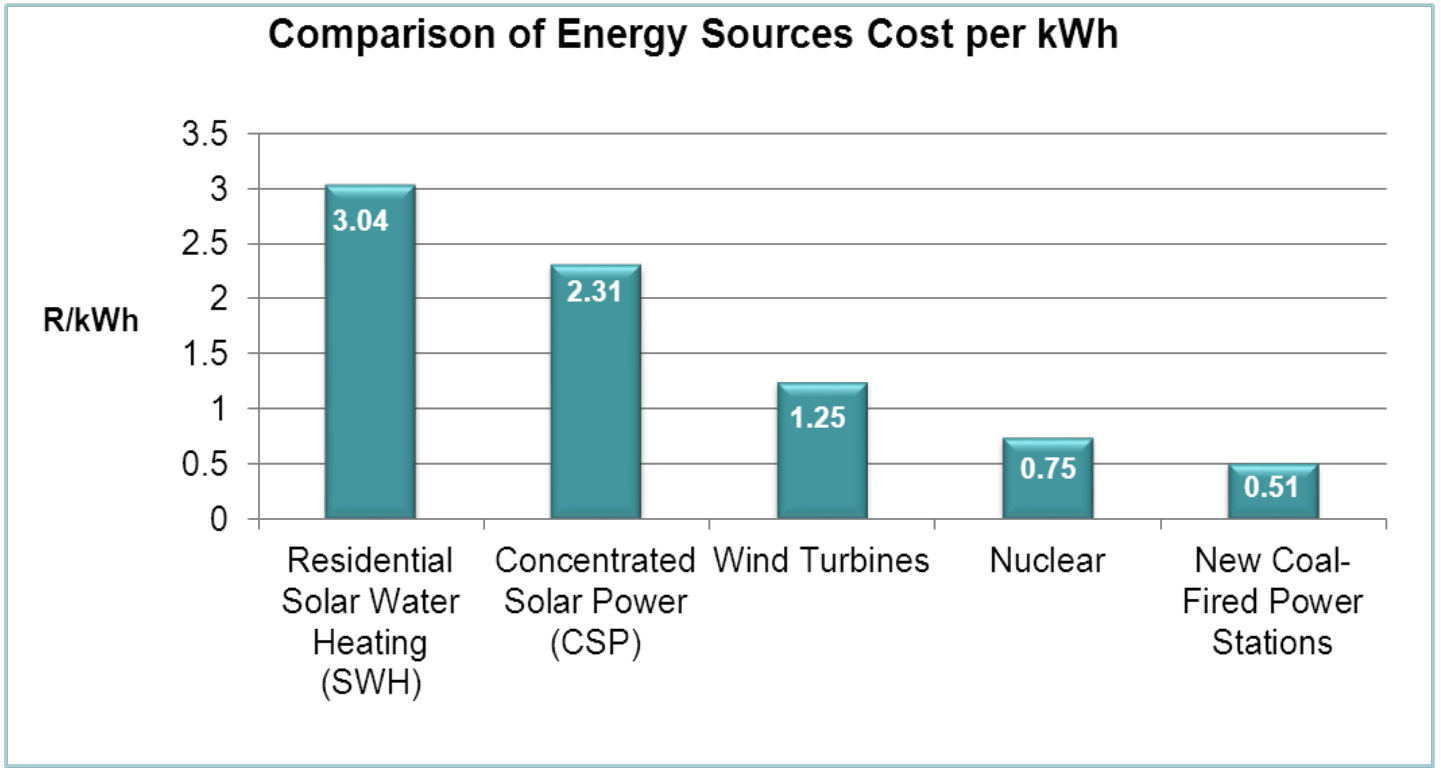
Guideline: The investment costs for new electricity generation infrastructure are in absolute and relative terms massive and cost overruns would have major opportunity costs and implications

- Development of electricity generation capacity holds major financial implications for both Eskom and the economy.
- In the baseline scenario, the total cost of the programme over the programming period is R 780 billion.
- In terms of scale comparatives this is equivalent to:
  - About 20 Gautrains.
  - About 9% of South African gross savings over the period.
  - Or 89% of South African net savings over the period.

Guideline: It is imperative that an electricity infrastructure domestic funding programme does not crowd- out other borrowers from the domestic capital markets

- Given the structurally inadequate levels of domestic saving in South Africa relative to investment needs, there is systemic competition implied in both the public and private sectors for capital to fund fixed investment needs.
- An excessive burden on limited domestic financing resources could crowd out private sector borrowing.
- Structurally inadequate levels of domestic savings ultimately implies an increase in the cost of local funding.
- Although exposed to conversion risk, as much capital as possible should be obtained from sources abroad.
- Foreign direct investment in IPP electricity generation capacity would reduce the load on domestic financial markets and displace risk to the IPP.

Guideline: Renewable energy is environmentally friendly, but costly



- A further challenge is that load factors for renewable energy generation technologies are low and supply less predictable.

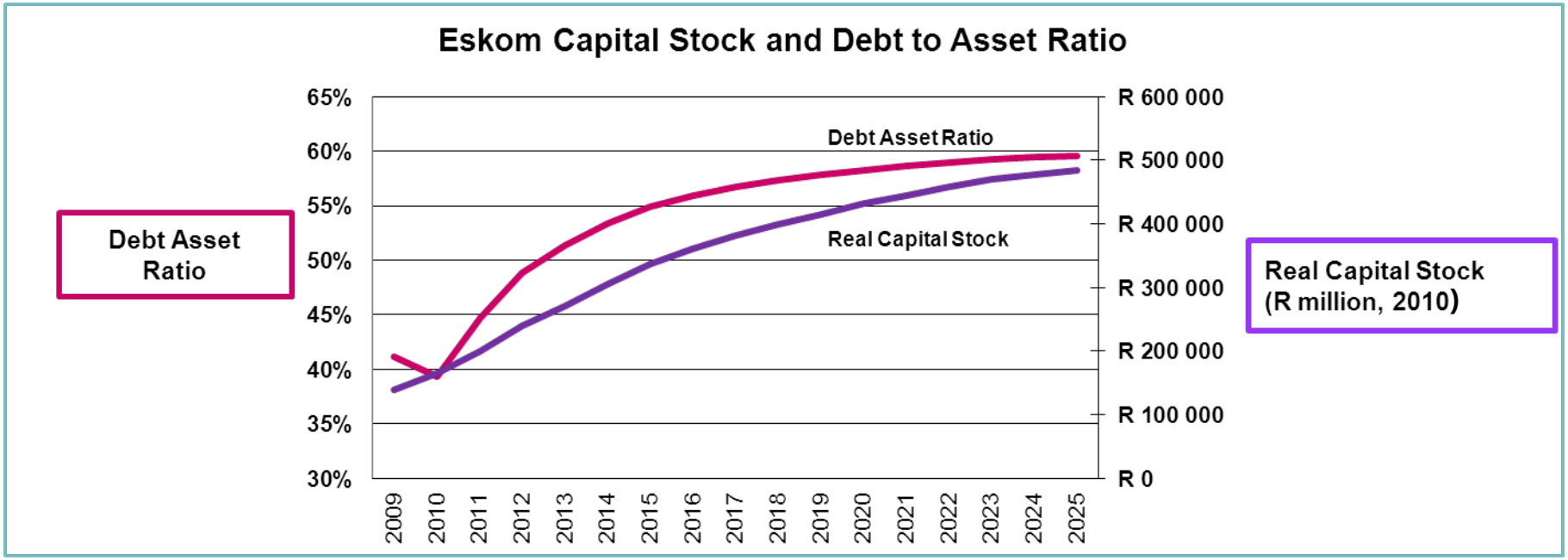
Guidelines from Lessons Learnt:
Funding Eskom's Generation Programme - Implications of Financing Scenarios

Guideline: Minimise the direct funding of capital expenditure from current income

- Capital expenditure should be funded primarily from equity or loans, and not from current income.
- The underlying principle is to avoid ‘front-loading’ the cost of capital assets onto electricity users in the form of substantially higher tariffs.
- Rather, spread costs over the lifetime of the assets. This necessitates loan funding and/or direct equity investment by the owners (government).

Guideline: Minimising funding costs in the capital markets requires a sound balance sheet with an appropriate debt/equity ratio

- If the *status quo* of Eskom's financing practice continues, the debt-to-fixed asset ratio will reach 58% by 2025.



Guideline: Government should provide for the full funding of "social needs electricity" to ensure fiscal transparency and avoid inequitable loading of electricity prices for other users

- Free or subsidised basic electricity (FBE), and losses from non-payment and theft should be for the account of Government.
- This would allow Eskom to assess its marginal production costs and consequent income and tariffs needs, unimpaired by costs not directly related to the core business.
- Such an approach would better position Eskom to compete with IPP's on a level playing field.

Guideline: It is important to appreciate that the tariff level is an outcome of the chosen funding strategy

- The cost of generating and distributing electricity and of providing it to the end user is the main determinant of the electricity price.
- The required tariff is also a derivative of the capital expenditure funding approach i.e. the residual consideration after funding by equity, loans and/or government transfers.

Guideline: Nominal tariff increases must take into account real cost increases as well as inflation

- The nominal increase in electricity tariffs reflects both real price increases and inflationary pressure on production costs.
- By way of illustration, if the real price increase is 3% and the inflation rate is 6%, the nominal tariff increase would be 9.18%
  - i.e. (((1.03x1.06)-1)x100).

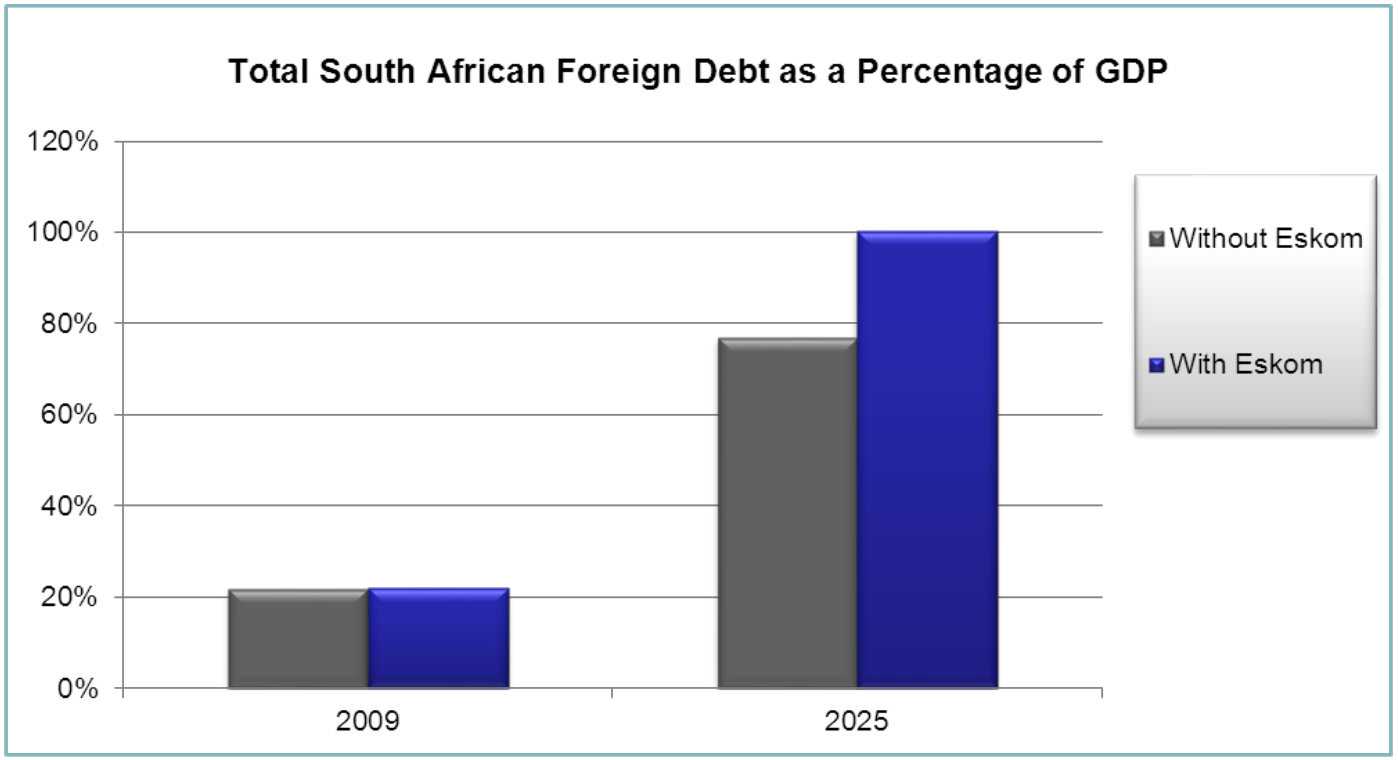
Guideline: Different funding options will have different impacts on the South African economy

- The option of funding exclusively by loans, even if supported by subordination, will substantially increase Eskom's debt-asset ratio, and possibly impact on its credit rating, thus raising funding costs.
- Raising a high proportion of funding for capital expenditure from current income would necessitate a high rate of tariff increase, with negative social and economic consequences.
- Introducing an increase in equity capital into the capital expenditure funding mix would alleviate the more extreme effects of the above two scenarios.

Guidelines from Lessons Learnt:
Impact on South Africa's Foreign Debt Situation

Guideline: Inadequate domestic savings and substantial need for capital by the public and private sectors raise flags on trends in South Africa's foreign indebtedness

- Eskom will have to obtain the bulk of its long-term financing needs from abroad.
- There is a material impact on South Africa's level of foreign debt, in relation to total debt.



Guidelines from Lessons Learnt:
Key Macro-Economic Impacts of the Future Development of the Electricity Industry

Guideline: Any increase in electricity tariffs will have inflationary impacts

- In the baseline scenario modeled, inflation will increase over the programming period of 15 years, by 0.5 % per annum.
- Thus, arithmetically, if the annual inflation rate before electricity tariff increases is already 6% over the 15 year period, when the tariff increase is taken into account, the inflation rate per annum will rise to 6.53%.

Guideline: Increases in electricity tariffs will decrease South Africa's international competitiveness and impact on the balance of payments

- Exported goods and services become comparatively more expensive in foreign markets and imported goods and services relatively cheaper in South African markets.
- The expected behavioral response of economic agents would lead to a decrease in exports and an increase in imports.
- Given these responses the model suggests a negative impact in the baseline scenario on the current account of the balance of payments of R10.7 billion in real terms by 2025.

Guideline: An increase in electricity tariffs will have a negative effect on economic growth

- In the baseline scenario, the average 3.5% real increase in electricity prices will impact negatively on the *average real economic growth rate* over the period 2010 to 2025 as follows:
  - GDP growth rate *before* real electricity price increases: 3.7%
  - GDP growth rate *after* real electricity price increases: 3.5%

Guideline: An increase in electricity tariffs would cause considerable employment losses and job opportunities foregone

- In the baseline scenario of an average real tariff increase of 3.5% per annum, the modelling suggests 492 774 job opportunities could be forgone by 2025 - directly ascribed to tariff increases.
- The modelling also suggests that as much as 2 000 000 potential job opportunities stand to be lost or forgone by 2025, if electricity generation capacity is not increased in line with the baseline scenario.

Guidelines from Lessons Learnt: *Emission Levels and Water Usage of Various Electricity Supply Options*

Guideline: Operation of nuclear and renewable energy supply plants has advantages from an environmental perspective

- Renewable energy is clean energy, from a carbon emission and waste perspective, but there are other problems (load factors and environmental aesthetics).
- With the exception of large scale hydro-generation, energy from renewable sources does not require large amounts of water.
- Carbon emissions from nuclear power generation are minimal but long-term radioactive waste disposal and public acceptance, given perceptions of safety issues, are other factors.
- Nuclear power stations need to be sited adjacent to large water supplies, and are typically sited on the coast.
- Although technology is improving, electricity generation from fossil fuels entails significant emissions and requires plentiful water.

Guideline: Availability of water is a constraint on siting of power stations requiring large quantities of coolant

- Major new coal reserves in Southern Africa are situated in water scarce regions. This has infrastructure and/or technology choice implications for planning location of new fossil fuel power stations.
- Nuclear power stations will need to be situated at the coast, utilising sea water as coolant.
- Water availability is not a significant factor in the siting of plants using the renewable electricity generation technologies considered in this study.