ENERGY SECURITY MASTER PLAN - ELECTRICITY

2007- 2025

the dme

Department:
Minerals and Energy
REPUBLIC OF SOUTH AFRICA

Table of Contents

EXECUTIVE SUMMARY

SYNOPSIS

- The Master Plan is premised on achieving certain goals that have been set for the electricity sector. Due to the uncertainty over the planning horizon, some assumptions are made regarding demand projections and the economic outlook. After consideration of the Energy White Paper and the regulatory policy framework, the current electricity generation, transmission and distribution sectors are appraised, in terms of the challenges confronting these sectors.
- Security of supply standards are set for generation and transmission (in terms of supply adequacy) and interventions are proposed that are necessary to achieve the respective adequacy measures, given projections about demand growth. Other interventions proposed include accelerated DSM, the acceleration of RTS, transmission expansion, universal access to electricity (for households, schools and clinics), REDS and IPPs.
- The Master Plan needs to be reviewed regularly and the proposed period is at least 3 years, to ensure that it is implementable and that it stays relevant to the challenges facing the electricity sector

Glossary

Item	Definition
ASGISA	Accelerated and Shared Growth Initiative
BEE	Black Economic Empowerment
BWO	Black Woman Owned
CCGT	Combined Cycle Gas Turbine
CDM	Clean Development Mechanism
CFBC	Circulating Fluidized Bed Combustion
CEE	Commercial Energy Efficiency
CLM	Commercial Load Management
CUE	Cost of Unserved Energy
DG	Distributed Generation
DSM	Demand Side Management
EDI	Electricity Distribution Industry
EIA	Environmental Impact Assessment
EWP	Energy White Paper
ESCO	Energy Services Company
FGD	Flue Gas Desulphurisation
IEP	Integrated Energy Plan
IPP	Independent Power Producers
ISEP	Integrated Strategic Energy Plan
LNG	Liquefied Natural Gas
LP Gas	Liquefied Petroleum Gas
MEE	Mining Energy Efficiency
MLM	Mining Load Management
MTS	Main Transmission Substation

Item	Definition
MYPD	Multi Year Price Determination
NERSA	National Energy Regulator of South Africa
NIRP	National Integrated Resource Plan
NOX	Nitrogen Oxides
OCGT	Open Cycle Gas Turbine
PBMR	Pebble Bed Modular Reactor
PFFGG	Pulverised Fuel with Flue Gas Desulphurisation
PFMA	Public Finance Management Act
PS	Pumped Storage
REDs	Regional Electricity Distributors
REE	Residential Energy Efficiency
RSEE	Residential Solar Energy Efficiency
RLM	Residential Load Management
RTS	Return to Service
SHS	Solar Home System
SOX	Sulphur Oxides
SVC	Static Variable Compensator
TDP	Transmission Development Plan

1. INTRODUCTION

As South Africa enters the 8th year of a sustained period of economic growth, the security of electricity supply has become very critical. The supply of reliable electrical power ensures that economic growth is not hampered but rather enabled. This Electricity Master Plan is based on a systematic approach as illustrated below. The process followed provides for:

(i) The setting of goals for the Master Plan.

(ii) Insofar as generation, the adoption of a security standard for electricity supply, in a way that seeks to simultaneously avoid over-investment. The reserve margin is defined on this basis.

(iii) Insofar as transmission infrastructure, the amelioration of transmission constraints in key corridors like Western Cape, Eastern Cape and Kwazulu-Natal.

(iv) Insofar as distribution infrastructure, the acceleration of universal access to electricity by building key bulk infrastructure; in addition, ensuring that economic development is not stymied either by the poor state of distribution infrastructure or by the lack of distribution capacity.

(v) The acceleration of DSM and energy efficiency initiatives as an integral part of measures to achieve the supply-demand balance.

2. GOVERNMENT POLICY AND OBJECTIVES

The goals of the Masterplan are premised on broad government policy and objectives as presented in the 1998 Energy White Paper. The objectives are to:

- Address energy requirements of the poor;
- Enhance the competitiveness of the economy by provision of low cost, high quality energy inputs to industrial, mining and other sectors; and
- Achieve environmental sustainability of natural resources;

The White Paper on Energy Policy also outlines the medium term objectives as far as the development of electricity is concerned. Those medium term objectives are:

- Giving customers the right to choose their electricity supplier;

- Introducing competition into the industry, especially the generation sector;
- Permitting open, non – discriminatory access to the transmission system; and
- Encouraging private sector participation in the electricity industry

The White Paper further outlines the following objectives with regards to the governance of the sector:

- Improved governance of the energy sector;
- Consultation with stakeholders in the formulation and implementation of new energy policies;
- Coordination between government departments with regards to energy policies; and
- Electricity supply quality and development of reliability standards

3. HISTORICAL CONTEXT

The Energy White Paper further alludes to the manner in which the restructuring of the electricity industry will be undertaken. Various Cabinet decisions were made to ensure that the restructuring of the electricity sector is undertaken as outlined in the White Paper on Energy Policy. The strategy included:

- Unbundling of Eskom;
- Selling of 30% of electricity generation;
- Gradually increasing private sector participation by ensuring that all new generation capacity is built by private sector;

However, after Cabinet decision to restructure the electricity industry in April 2001, a number of international events happened, which had a significant impact on the electricity markets worldwide, namely;

- Collapse of energy markets in California in May 2001;
- Collapse of energy markets in Ontario in 2001;
- Stalled privatization of electricity markets in Singapore in 2002;
- Enron bankruptcy in 2002;
- The economic collapse in Argentina between 1999 and 2001; and
- The North Eastern United States and Europe power blackouts in 2004

All these events had an impact on the “investor appetite” for the energy sector and provided valuable lessons for the public sector that seeks to embark on restructuring its power markets.

It was in this context that a different strategy to plan and procure new generation capacity had to be adopted. This Masterplan is therefore based on the assumption that, while the strategy in which broad government objectives will be met might change, the objectives remains the same.

4. GOALS OF THE ELECTRICITY MASTERPLAN

The goals of the Electricity Master Plan for South Africa are as follows:

- Supporting economic growth and development;
- Improving the reliability of electricity infrastructure;
- Providing a reasonably priced electricity supply;
- Ensuring the security of electricity supply as set by a security of supply standard;
- Diversifying the primary energy sources of electricity;
- Meeting the renewable energy targets as set in the EWP;
- Increasing access to affordable energy services;
- Reducing energy usage through energy efficiency interventions;
- Accelerating household universal access to electricity;
- Clarifying some of the policy issues in the context of an evolving electricity sector.

5. UNCERTAINTY AND THE VALUE OF FLEXIBILITY

It is essential to realise that the long term plans outlined herein are subject to uncertainty. These uncertainties can only be resolved over time and after the requisite studies and expenditure has been incurred. An example thereof is the original plan to built new CCGT plant in the Coega area around 2010. At the time those plans were made natural gas prices were at about half their current levels. Based on recent offer prices for natural gas the viability of this option is questionable. Similarly on the PBMR project, the full extent of implementation can only be decided once certain milestones proving its technical and commercial viability have been reached. All capacity projects have such associated uncertainties of which perfect knowledge is not possible in advance, certainly not 20 years in advance. Even the outcome of an environmental impact assessment (EIA) could prove to be a fatal flaw in a project.

It is essential to grasp this concept so that one can interpret the long term expansion plans. A better way of contextualising these plans would be to visualise a decision tree, with key project uncertainties representing branch points in the tree. The plans described in this document describe the current optimal trajectory through this tree of new capacity additions, based on the assumptions we have at present.

It is therefore a key objective in any electricity plan to maximise the amount of flexibility that is available. This enables the accommodation of uncertainties without compromising reliability.

6. PLANNING ASSUMPTIONS

The plan is premised on a number of assumptions:

(i) Detailed economic, social and environmental impact assessment has not been done in respect of the various options that are taken. The assumption is that infrastructure development in South Africa intuitively will result in positive impact. It must also be indicated that impact assessment will be done at project level.

(ii) Integration opportunities between electricity supply and primary energy carriers exist as far as the use of coal, gas, LP Gas, LNG and other liquid fuels. Ensuring optimal energy balances, particularly regarding the usage of liquid fuels, is a process that will be integrated later into the choices that are made regarding the types of power station technologies used.

(iii) The Masterplan is developed in a manner that policy decisions can be assessed and be quantified. The nuclear energy as a supply option is not considered in this Masterplan, but it is part of the broader nuclear energy strategy. This plan will assist in quantifying the policy choices that are made.

(iv) During the development of the masterplan, a deliberate decision was taken to choose cleaner technologies in order to mitigate against climate change. The objectives that focus on the protection of the environment as embodied in the White

Paper on Energy Policy, the White Paper on Renewable Energy Policy and the Energy Efficiency Policy and Strategy have been used as the guiding principles in the development of the masterplan

In addition, the key driving forces associated internal challenges and relevant planning assumptions are summarised in the table below:

External Driving Force	Challenge	Assumption
• Global expansion in infrastructure projects and the need to compete for skills, supplier capacity, & materials.. • Growth in global nuclear industry and the impact on the availability of components and suppliers	• Limited availability of appropriate skills • Need for supplier development interventions in order to optimise local content. • Initiate decisions to build earlier	• Planned delivery times may be compromised • Skills will continue to be a challenge over the planning horizon; Need to focus on retention and optimisation of existing skills.

• Increasing cost of primary energy such as coal, oil and gas.
• Availability and quality of water.
	• Need to maintain high load factors – burning more fuel and limited time for planned maintenance
	• System capacity constraints, given the 8% reserve margin and ageing plant
	• Financial sustainability and emphasis on cost management, given:
	  • Increasing energy diversification, with gas plant and move towards big nuclear and renewable energy
	  • Coal generation will increase and continue to be a major component of Eskom's portfolio.
		• Fuel supply availability will not constrain the operation of any existing or new supply options over the longer term
		• The OCGT plant will be run beyond the 6% load factor if the need arises
		•

• The need to contribute to the projected economic growth targets , both in terms of enabling an accelerated economic growth rate, as well as social development initiatives, e.g. access to energy as the key driver to meet millennium development goals • Meet the increasing electricity demand associated with an accelerating economic growth rate • Optimising the build programme to	• Accelerate build projects and the associated capital expenditure • Fast track EIA's due to the potential impact on delaying build projects • Intensified Demand Side Management and energy efficiency, including the exploration of distributed generation options • Meaningful support to social development objectives to ensure real empowerment and	• Average annual demand growth for the base case will be 4% for electricity, which will ensure that the projected economic growth target is met • Expansion projects are assumed to be brought on-line at the official commissioning dates, unless otherwise stated • The accelerated Demand Side Management programme will achieve its targets

grow local industry,	sustainable poverty alleviation	• Eskom will continue to provide 70% of new capacity and the Independent Power Producers (IPPs) will provide the balance • The IPP will deliver the first expected additional capacity by 2009 • Whilst BEE, local content and Black Women Owned businesses targets will be met, capacity expansion timelines and technical quality of new plant will not be compromised

• Pressures arising out of policy & regulatory uncertainties, particularly relating to the funding of new capacity, network charges, expropriation rights, primary energy, energy planning, energy efficiency, demand side management, EDI restructuring roadmap, long term view of industry structure, etc.	• Conflicting requirements e.g.
	  • Availability of new capacity vs maintaining low electricity prices
	  • Electricity capacity growth and supply to drive economic growth vs delays in processing EIA's, expropriation rights and mining rights
		• Electricity Regulation Amendment Bill will provide guidance on electricity pricing through the value chain.
		• Future electricity price adjustments will move towards the desired Return On Assets (ROA)
		• The current industry configuration will be maintained until such time as the EDI restructuring is implemented

• Increasing environmental performance expectations including, climate change response strategies, energy efficiency, air quality and water management	• Move towards energy diversification, particularly nuclear energy and renewable energy • Intensified Demand Side Management and energy efficiency, including the exploration of distributed generation options	• The accelerated Demand Side Management programme will achieve its targets
• Universal access and the need to accelerate the electrification drive to provide access to electricity to all South Africans by 2012	• Need to increase connections exponentially, • Electrification funding competing with other government initiatives and social spending	• Funding will be made available to ensure that the electrification of households is adequately resourced
• Environmental Impact Assessments (EIAs), both in terms of the increasing importance of Corporate Social Responsibility and engagement with communities and other stakeholders, as well as the challenge posed by lengthy regulatory processing timelines.	• Need to fast track EIAs due to the potential impact on delaying build projects • Need to have focused, pro-active stakeholder engagement	• Stakeholder engagement will ensure that the required EIAs are secured.
• Impact of HIV and Aids on available	• Managing the impact of HIV and	• Impact of HIV and Aids will be felt

pool of skills • Importance of Occupational Health and Safety	AIDS on the skills pools through strategies developed with social partners • Improve health and safety to reduce fatalities	but not significant enough to disrupt business operations. • The cost associated with efforts to reduce the prevalence and managing opportunistic diseases will increase • A target of minimal fatalities within the energy sector in five years will be pursued (that is 0.01%)
• Increasing private sector participation in new electricity generation capacity		• Eskom will continue to provide 70% of new capacity and the IPP will provide the balance • In spite of this, Eskom will continue to plan to meet 100% of National capacity under the "Braamhoek" model • The IPP will deliver the 1st expected additional capacity by 2009
• Increasing negative image on the back of supply interruptions	• System capacity constraints, given the 8% reserve margin and ageing plant • Moving from a "maintain" to a "build" culture, improved safety culture & entrench a customer service culture • Need to have focused, pro-active stakeholder engagement	• System capacity constraints, and increasing customer interruptions
• Electricity Distribution Industry (EDI) restructuring	• Limited resources vs. EDI restructuring and the associated demand on resources	• Business as usual until such time as the policy environment dictates otherwise. • Current industry configuration will be maintained until such time as the EDI restructuring is implemented

The following economic forecasts are assumed for the next five years.

	2007/8	2008/9	2009/10	2010/11	2011/12	2012/13
Rand/Dollar Exchange Rate	7.35	7.80	8.50	9.10	9.60	9.80
Rand/Euro Exchange Rate	9.84	10.56	9.35	10.01	10.56	10.78
GDP Growth Rate	4.4%	4.7%	5.2%	5.2%	5.2%	5.2%
Inflation Rates						

~ CPIX	5.2%	4.8%	4.6%	4.6%	4.6%	4.6%
~ PPI	7.4%	5.6%	5.2%	5.2%	5.2%	5.2%

7. ANALYSIS OF CURRENT SITUATION

7.1 Economic outlook[1]

South Africa's economy has been in an upward phase of the business cycle since September 1999 - the longest period of economic expansion in the country's recorded history.

During this upswing - from September 1999 through to June 2005 - the annual economic growth rate averaged 3.5%. In the decade prior to 1994, economic growth averaged less than 1% a year.

According to the South African Reserve Bank, there is no sign of this period of expansion coming to an end. Gross domestic product (GDP) growth was running at an annualised 4.8% in the second quarter of 2005 (compared to 3.7% in 2004 and 2.8% in 2003).

Consumer inflation has been on a downward trend since 2002, when consumer prices increased to an average 9.3% following the September 11 tragedy in New York. Consumer inflation averaged 6.8% in 2003 and 4.3% in 2004 - compared to 9.8% in 1994.

At the same time, prudent fiscal management has seen South Africa's budget deficit come down from 5.1% of GDP in 1994 to 2.3% of GDP in 2004. In the first quarter of 2005, this figure fell to 1.6%, with the SA Revenue Service collecting nearly US$3.5-billion more than expected.

The source of the revenue windfall was not higher individual or corporate taxes - both have fallen since 1994 - but the performance of the economy, consumer confidence, and a dramatic increase in the number of registered taxpayers, from 2-million in 1994 to more than 5-million in 2004.

[1] Source: South Africa Alive with possibility website

SA: SELECTED ECONOMIC INDICATORS					
	2001	2002	2003	2004	2005
Real GDP	2.7%	3.6%	2.8%	3.7%	4.3%
CPI	5.7%	9.2%	5.8%	1.4%	3.9%
CPIX	6.6%	9.3%	6.8%	4.3%	4.3%
Unemployment	29.5%	30.5%	28.2%	26.2%	25.3%
National debt (%GDP)	41.4%	37.1%	35.7%	35.8%	35.1%
External current account balance (% GDP)	0.1%	0.7%	-1.5%	-3.2%	-3.7%
External debt (% GDP)	26%	29.5%	22.4%	19.8%	19.1%
Gross reserves (in months of total imports)	2.9	2.8	2.2	3.1	3.7
Int. liquidity of SARB (in US$-billion)	-4.8	-1.6	4.8	11.4	19.8
US$ exchange rate (in rands)	12.13	8.64	6.64	5.64	...

Source: IMF country report 2005

South Africa is also the lowest cost producer of electricity in the world, a position that we would like to retain for strategic reasons. In the face of dwindling electricity generation capacity, new investments are necessary. A number of challenges have arisen in the past few months, related to the security of electricity supply, and it is in that context that it has become imperative to conclude the Master Plan that will address those challenges.

Though the impact of electricity in the economy in case where we experience total blackout has not been investigated and cannot be quantified in monetary terms at this stage, the impact will be severe to the economy of the country. The economy of the country will literally come to a complete standstill because the major sectors of the economy such as mining, manufacturing, wholesale & retail trade, hotels and restaurants depends on electricity. The supply interruption to hospitals, airports, traffic lighting and other security installations is something that is not desirable.

7.2 Generation outlook[2]

Generation is dominated by Eskom, a state owned power utility. A small contingent of private players, which mainly generates for their own consumption through co-generation schemes,

[2] Source: South Africa Alive with possibility website

also exists. Eskom generates about 96% of the South African electricity needs. Most of the generation plants are coal based with one nuclear power station and the balance being hydro, pumped storage and gas.

South Africa is a member of the Southern African Power Pool (SAPP) which facilitates electricity trading within the SADC region. In the current trading scheme South Africa is the net exporter of power in the region. South Africa's main trading partner is Mozambique with an import of over 1000 MW from the Cahorra Bassa hydro scheme. We are currently investigating the possibility of importing from the proposed Mamabula Coal Fired Power Station in Botswana. Other possibilities in the region are Namibia's kudu gas project, INGA 2 in the Democratic Republic of Congo (DRC). For the purpose of security of supply, there is a need to introduce a policy that will guide and stipulate parameters to be adhered to when trading. It is important to note that the policy will not be inimical to regional goals. South Africa is also supportive of the initiatives to develop the GRAND INGA Hydro Scheme in the DRC.

The nominal installed generation capacity is 42 011MW and recently power demand has surged to a peak of around 36 474 MW[3].

7.3 Transmission outlook

Transmission is a natural monopoly owned and operated by Eskom with around 27 000 km of high voltage lines from 132kV and above. The transmission infrastructure is vast and it is spread through the length and breadth of South Africa. The recent upward trajectory of energy consumption and demand has put the transmission infrastructure under tremendous pressure. This necessitates a speedy review of the national transmission grid code and its application.

[3] Eskom record peak demand as at June 2007

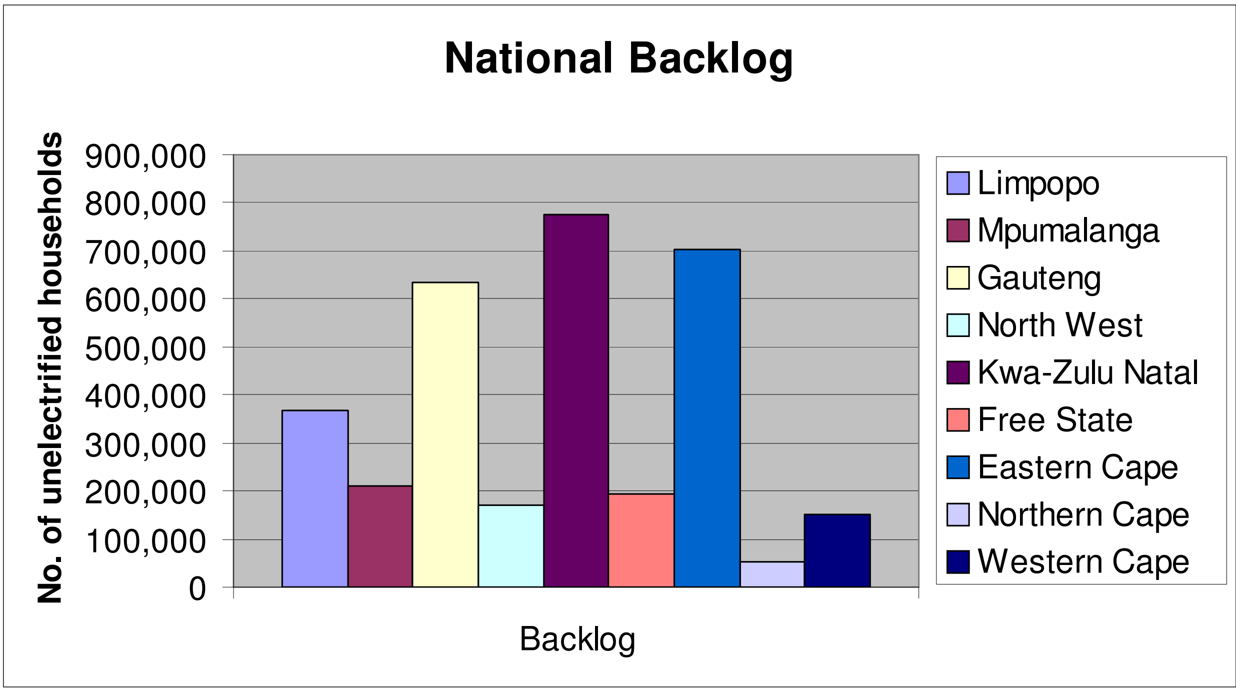
7.4 Distribution outlook

7.4.1 Residential electricity infrastructure

One of the biggest challenges in the distribution sector is the need to achieve universal access to electricity, through the electrification programme. Whilst this is recognized as a social infrastructure programme that is not economical, other consideration related to the socio-economic impact of electrification strongly motivate for an acceleration of this programme, with a target date of 2012 for 100% access by households, schools and clinics to electricity.

The level of electrification in South Africa currently stands at 73% (3.4 million households remain un-electrified with 2% focus annualised growth), with backlogs as indicated above.

Schools and clinics backlogs are shown below.



Province	**Schools**	**Clinics**
Limpopo	263	0
Mpumalanga	400	5
Gauteng	0	0
North West	151	21
Kwazulu-Natal	2230	0
Free State	157	0
Eastern Cape	1924	150
Northern Cape	6	8
Western Cape	0	0
Total	**5131**	**184**

It is evident that to connect the remainder of the houses, innovative approaches must be used in terms of technology, funding strategy and cost optimisation. This is due to the fact that it is now largely the remotest of corners of South Africa that remain without the necessary bulk substations, and this would be the most difficult hurdle to overcome. It is in that context that alternative energy technologies are considered for universal access.

7.4.2 Non-grid technologies

Alternative technologies (non-grid) are useful in complementing grid electricity in areas where remoteness, difficult topography etc. do not warrant grid electrification as a solution. Three districts in South Africa are currently concessioned for non-grid technologies, mainly Solar Home Systems. Whilst SHS are adequate to provide small power and lighting, it is acknowledged that they must be complemented by a thermal solution for space heating and cooking, lest the beneficiary households continue traditional carriers like firewood for their thermal needs.

Apart from the SHS concessions in Eastern Cape, Kwazulu-Natal and Limpopo, non-grid technologies are used to achieve schools and clinics universal access. It is estimated that of the 7000 schools and clinics yet to be electrified, more than 50% will be connected using non-grid technologies.

7.4.3 Economic infrastructure

The National Energy Regulator (NERSA) recently commissioned a Technical Audit[4] on 11 Distributors to determine the state of the electricity distribution network. The Distributors audited include 2 regions of Eskom Distribution (North West and Southern); the 6 metropolitan municipalities (City of Cape Town, Nelson Mandela, eThekwini, Ekurhuleni, City of Johannesburg and Tshwane) plus Mangaung (Centlec Pty Ltd); Rustenburg Municipality, Emfuleni Municipality and Msunduzi Municipality.

The findings of the North West and Eskom Southern distributors show that they are well-run and managed undertakings.

The general findings about Eskom Distribution include:

- Excellent and comprehensive asset management and maintenance systems
- Adequate funding for both maintenance and refurbishment. (The average age of assets is very low)
- Adequate staffing at all skills levels
- Adequate resources throughout
- Access to sound and competent technical expertise

[4] NERSA Technical Audit Report 2007

- Focus has shifted from the erstwhile “cheapest electricity” to “quality of supply and reliability” with investments to suit. (e.g. installation of sectionalisers and auto-reclosers on long remote rural lines).

Large Municipal Undertakings and Metros display a level of robustness, but it is evident that it is faltering. The networks have been well designed and installed and display a high level of supply security. But lack of investment since the advent of the EDI restructuring hiatus, is now evident. It is increasingly evident that the death of skilled staff has resulted in the embrittlement of the management resources and loss of control over essential technical elements (planning, protection etc). The classification includes some of the ring-fenced utilities, and the effectiveness of the implementation of that process is questioned, but it is acknowledged that it is still early days in the process and such findings are beyond the brief of this assignment, nevertheless, they have influence on the sustainability of the systems in the future.

Specific findings regarding Large Municipal Undertakings include:

- Governance and management is too intrusive.
- Robust, well-designed base networks have been established.
- Investment in the refurbishment and maintenance processes is insufficient.
- Corporate processes (HR, Procurement and Finance) that were designed for social service type of operation are often inappropriate for application in an operating electricity utility.
- Continual loss of skills and any limited efforts to train and develop new staff technical competences. Average age of the skilled senior staff is increasing.
- The success of “ring fencing” is questioned as all of the corporate policies are still driven from the corporation and not the utility.
- Generally well managed at present with a good level of quality of supply.

Smaller municipalities are generally in poor shape and often do not deliver the quality of supply required of them. They are heavily under-resourced and stressed in the delivery of the necessary levels of service. There is little doubt that serious customer complaints are in the pipeline.

This class of utility is very dependent on one or two individuals in the technical management structure for its well being. It is easy to generalise incorrect as there are many dedicated individuals carrying out their functions in an exemplary fashion with little resource at their disposal.

General findings regarding small municipal undertakings are as follows:

- The networks were established to a high level of security of supply with some compromises in the load sharing options. (e.g. Momentary interruptions will occur when the loads are rebalanced after a fault).
- Networks are in poor state of repair and there are some instances where basic contingency requirements are not met.
- Staff are de-motivated and often under skilled for the requirements of the job.
- Very few formal systems are in place for the management of the Maintenance process. Great reliance is placed on individual engineers and technicians for their decisions in these regards. This adds to risk when individuals leave service. It also limits the introduction of modern, innovative technologies and systems, thus ensuring that these utilities will remain static.
- Housekeeping is poor and operating procedures are not always formalised.
- Some of these utilities are not viable in the medium term and will shortly cost their municipalities dearly.

7.4.4 Under-investment in economic infrastructure

The aggregated refurbishment backlog as at the end of 2005 for utilities audited is R431 million. This figure grows each year that no refurbishment takes place. The estimated average requirement to maintain the present service level in future is R422 million annually, of which R431 million must be added. The aggregated figure has been adjusted to allow for some services that will be retired permanently. The implications of this backlog must be considered in respect to the ability of the supply chain to deliver new equipment. The weighted average of all distribution assets plant in service is between 25 and 30 years. This is young by international standards and the issue of renewing and refurbishing plant and equipment in South Africa is, therefore, a new and growing problem.

It was this realisation that prompted the drafting of the quality of supply regulations under the auspices Electricity Regulation Amendment Act, which seeks to ensure that investment in infrastructure is catered for in the tariff. The regulations seek to ensure that these funds are ring- fenced and utilised for rehabilitation and upgrading of electricity distribution infrastructure.

7.5 Energy efficiency and Demand Side Management

7.5.1 Background

The term 'demand-side management' (DSM) was first used in the United States in the early 1980s to describe the 'planning and implementation of utility activities designed to influence the time, pattern and/or amount of electricity demand in ways that would increase customer satisfaction, and co-incidentally produce desired changes in the utility's load-shape' (Gellings 1989).

In South Africa, DSM is still a relatively new concept to most. While Eskom formally recognised DSM in 1992 when integrated electricity planning (IEP) was first introduced, the first DSM plan was only produced in 1994. In this plan, the role of DSM was established and a wide range of DSM opportunities and alternatives available to Eskom were identified (Ellman & Alberts 1999). Some municipalities and local service providers currently undertake activities seeking to 'produce desired changes in the utility's load shape'. Some of these activities can be classified as DSM initiatives, others not. The reason for this, generally, is that this latter group of activities tends to focus on achieving load impacts, and are not necessarily geared towards bringing about increased customer satisfaction.

In the White Paper on Energy Policy, the South African government recognises the importance and potential of energy efficiency, and commits itself to promoting the efficient use of energy in all demand sectors. It also commits itself to investigating the establishment of 'appropriate institutional infrastructure and capacity for the implementation of energy efficiency strategies'.

DSM is applicable to any customer who, through an initial walk through audit, is identified with potential to implement specific initiatives. This includes sectors such as:

- Commercial sector e.g. (Hospitality sector, Tertiary institutions, Government & private hospitals, correctional services establishments, office parks)
- Industrial sector e.g. (mining, steel, petroleum etc)
- Redistributors & Residential sector e.g. (municipalities, residences)
- Hospitality sector
- Hotels
- Tertiary Institutions
- Government and private hospitals
- Correctional services establishments

7.5.2 DSM Acceleration

DSM could be accelerated through the following interventions:

- De-marketing to gas (cooking)
- De-marketing to gas (space heating)

- Acceleration of Efficient Lighting
- Industrial and Mining Load Control
- Industrial and Mining Efficiency
- Geyser Load Control
- Solar Water Heating
- Intelligent metering

Table 4 indicates the estimated costs of the various interventions.

Table 1
DSM Program Costs

Demand Side Management (DSM)[5]	Levelised Variable Cost (R/MWh)	Levelised Fixed Cost (R/kW/a)	Total Overnight Capex (R/kW)	Total PV Capex (R/kW)	Levelised[6] Cost (R/kW/a)	Carrying Charge (%)
Commercial Load Management (CLM)	5	63	2,529	2,941	224	8.0
Industrial & Mining Load Management (IMIM)	5	63	2,451	2,762	210	8.0
Residential Load Management (RIM)	40	28	2,343	2,721	207	8.0
Commercial Energy Efficiency (CEE)	21	0	4,926	5,855	445	8.0
Industrial & Mining Energy Efficiency (IMEE)	41	0	3,906	4,567	347	8.0
Residential Energy Efficiency (REE)	11	0	1,945	2,264	172	8.0
Residential (Solar) Renewable Energy Efficiency (RREE)	49	0	19,005	22,125	1,682	8.0
Demand Market Participation (DMP 1)	800	0	6	6	1	9.59
Demand Market Participation (DMP 2)	600	0	9	10	1	9.59

7.5.3 DSM targets

[5] The DSM programs were aggregated into a single resource for the PAR simulations

[6] The discount rate assumed in the DSM levelised cost is 7.6%

South Africa is among a few countries worldwide that have set comprehensive targets for energy efficiency improvements. The Energy Efficiency Strategy compiled by the DME for South Africa proposes the following energy efficiency targets:

- ***A final energy demand reduction of 12% by 2015.***
- ***DSM long term goal is to save 4 255 MW over a period of 20 years.***

The DSM overall target/objective is to save 4 255 MW over a period of 20 years, to mitigate the negative impact on the environment via the energy efficiency targets and to support local job creation. There is currently an annual DSM target of 152 MW that will be increased to higher levels as the markets gain momentum in the DSM implementation. This annual target is divided into energy efficiency and load management targets for the residential, industrial and commercial sectors.

7.5.4 DSM Activities

The DSM programme themes include:

- Residential, commercial and industrial programmes - The main objective of this programme is to transform the South African electricity market into an energy efficient industry.

- Public education - The primary objective of this programme is to increase awareness about energy efficiency. The programme includes a broad range of marketing and public relations activities, and feeds directly into programmes in different income segments as well as residential, commercial, industrial and institutional programme activities.

- Schools programme - The objective of this programme is to highlight the benefits and importance of using electricity efficiently to school pupils. DSM seek to increase the awareness of students and faculties on energy efficient measures through providing participating institutions with resources packs, including teacher, learner and electricity audit guides.

- Stakeholder activities – aimed at keeping DSM stakeholders abreast of DSM changes, objectives, and programmes and also at outlining how to assist to promote the energy efficiency message.

Today the amount of DSM program participation is relatively insignificant in relationship to the size of the demand in South Africa. The base level of DSM (152 MW) is less than 1% of the South African supply mix. However, if DSM programs were to grow significantly in the future then DSM should be seriously considered as an important part of the future resource mix.

8. ELECTRICITY DEMAND FORECAST

The demand forecast methodology is based on a sectoral approach and not a pure econometric model. The forecast predicts national plus foreign demand, with a cone approach to cater for uncertainty. The market is divided into more than 100 individual sectors, with a forecast for each individual sector, including a market trend analysis.

The moderate forecast makes provision for major energy intensive projects, but strong growth is provided for in platinum mining and ferrochrome industries, e.g.

- Alcan ~ 1300 MW plus the expansion of existing smelters ~ 950 MW
- Mineral Sands ~ 570 MW (Corridor Sands 500 of 570 MW)
- Sasol synfuels refinery II ~ 100 MW
- Steel mill ~ 160MW
- Tata Steel Richards Bay ~ 140 MW
- Paper & Pulp mill Richards Bay ~ 140 MW
- Projected Residential load – 2000 MW (over a 20 year period)

Structural changes in the South African economy are monitored and taken into account. In particular there has been in a reduction in the contribution of energy intensive processes, such as mining, to local GDP. Similarly there has been an increase in less energy intensive activities, such as financial services. The outcome is evident in Figure 1.

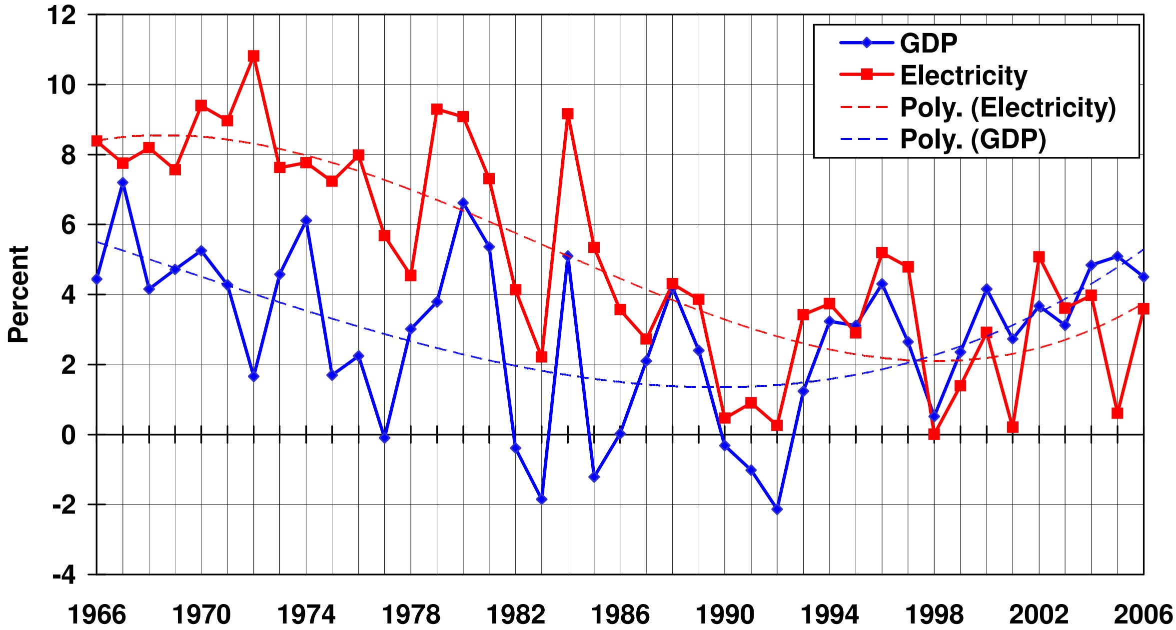


Figure 1: GDP and electricity sales relationship

The ASGISA initiative targets a GDP of 6% between 2010 and 2014. Whilst the model employed is essentially a bottom-up one that aggregates individual forecasts and is not simply an econometric model linking demand to GDP, the analysis concludes that the ASGISA objectives can be achieved with a 4% average annual growth. This is the line labelled “Position” in Figure 2.

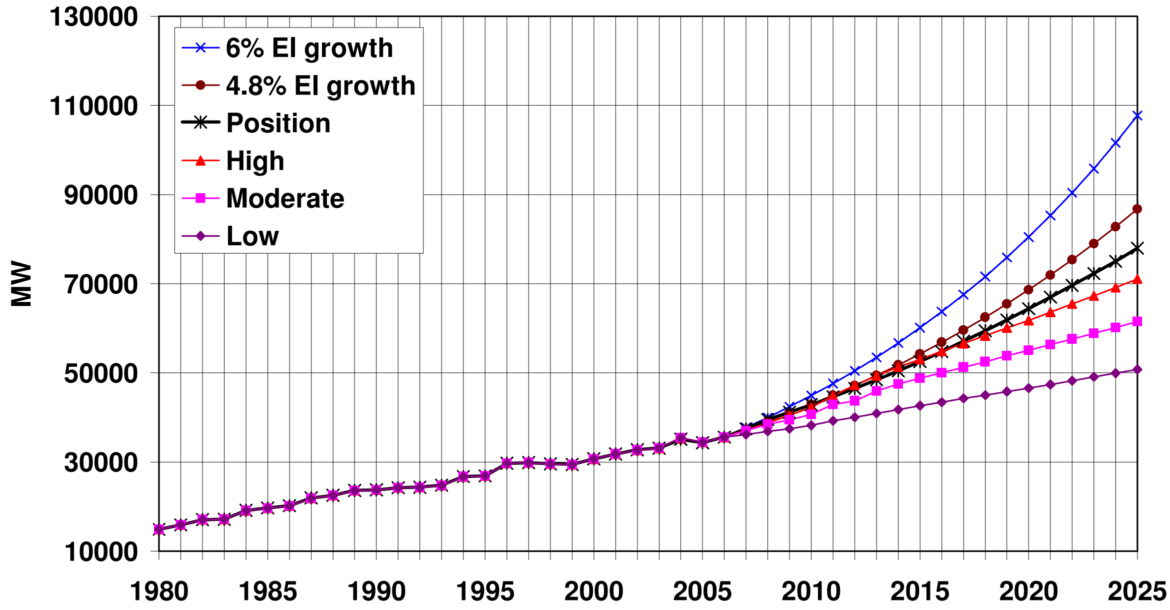


Figure 2: Load Growth Scenarios

Table 2 gives the new ASGISA Maximum System Demand for the year 2026 as well as the peak System Demand for 2005. The System Demand is broken down into the Area Demand at the time of system peak.

	2005 MAX SYSTEM DEMAND	2026 NORMAL LOAD	2026 ASGISA LOAD	2026 NORMAL & ASGISA LOAD
Total (MW)	**33658**	**60242**	**20757**	**80999**
Power Stations (MW)	**25**	**32**	**0**	**32**
International (MW)	**2300.1**	**3137.2**	**6595.1**	**9732.3**
Forecast Areas (MW)	**30195**	**54965**	**13435**	**68400**
3.5% Tx losses (MW)	**1138.2**	**2108.5**	**726.5**	**2835**
Botswana	370.2	376	0	376
Mozambique	1057.1	1676.1	4224.5	5900.8
Namibia	198.2	95	0	95
Swaziland	132.8	146	0	146
Zimbabwe	541.8	743.9	2370.6	3214.5
Johannesburg	3858.9	7304.5	675.3	7979.8
Nigel	1650.5	1941.0	51.4	1992.4
Vaal Triangle	1470.1	1699.9	136.1	1836.0
West Rand	1909.0	2267.4	111.0	2378.4
Empageni	2121.1	3170.1	617.7	3787.7
Ladysmith	358.0	444.2	106.2	550.5
New Castle	630.0	757.6	132.4	890.0
Pinetown	2885.0	3998.0	457.0	4455.0
Polokwane	928.4	1959.6	1744.5	3704.1

Rustenburg	1510.0	3547.1	1859.9	5407.0
Warmbad	285.3	341.1	13.4	354.5
Waterberg	397.8	973.1	432.0	1405.1
Highveld North	2038.5	2878.1	409.1	3287.3
Highveld South	975.3	1521.0	350.0	1871.0
Lowveld	1204.4	2894.9	1341.7	4236.6
Pretoria	1854.2	3847.9	258.1	4105.9
Bloemfontein	385.5	534.9	17.0	551.9
Kimberley	443.9	1291	1051.6	2342.6
Klerksdorp	1591.6	1756.3	741.6	2497.9
Welkom	772.2	854.7	264.8	1119.6
Karoo	250.3	282.1	7.0	289.1
East London	432.5	627.6	927.6	1555.2
Port Elizabeth	803.5	5165.1	602.5	5767.6
Namaqualand	137.9	275.2	222.2	497.4
Peninsula	2229.0	3199.5	264.8	3464.3
Southern Cape	709.4	938.7	336.7	1275.4
West Coast	456.7	494.3	303.5	797.7

Table 2: ASGISA load forecast

9. STATUTORY AND REGULATORY CONTEXT

The Electricity Regulation Act was promulgated in October 2006, to replace the Electricity Act of 1987. In terms of this legislation, the Minister of Minerals and Energy is entrusted with the mandate to ensure security of electricity supply. In this regard, the Minister can prescribe by regulation measures that need to be put in place to achieve the security of supply mandate.

It is therefore critical to define *security of supply standards*, which would then indicate the level of adequacy of any measures to reach that security standard. We consider the adequacy of measures relating to generation and transmission security of supply in detail hereunder.

To contextualize the need for security standards, the Cape Town power disruption incidents of 2005, 2006 and 2007 are a useful example. Whilst it is agreed that the true financial impact of power disruptions cannot be determined, numerous estimates have been presented. The Cape Town Regional Chamber of Commerce estimates that R5.6bn was the extent of the losses incurred by business, due to:

Direct costs – running alternative sources like diesel and gas generators;

Consequential costs – loss of revenue in the retail sectors, production losses, logistical disruptions to just in time delivery systems (due to non-functioning traffic signals, non-functioning cold chains etc.).

Nonetheless system reliability comes at a cost. The cost of a blackout must be higher than the cost of the reliability intervention, before the reliability intervention could be justified.

Supply security standards must therefore be defined in such a way that one can achieve the necessary balance between electrical systems with a high reliability on one hand (due to over-investment), versus underinvested systems with a high cost of blackouts.

9.1 Generation adequacy measures

It is important to define standards for security of supply, in respect of which the Master Plan will be designed. We therefore define some of these standards:

Reserve margin **means**

"The total supply-side capacity (including Independent Power Producer's, capacity purchases and minus capacity sales), divided by the natural annual peak demand reduced by all demand-side resources".

In simple terms, this represents the insurance that the country is prepared to keep, over and above the normal supply side capacity.

The natural annual peak demand implies the annual peak demand not influenced by those demand-side initiatives that would only take place with special tariff incentive or capital incentive schemes, including interruptible supply agreements. Demand-side initiatives already implemented are part of the natural forecast.

Loss of Load Expectation (LOLE) **means**

"The expected number of days or hours in a specified period in which demand will exceed available supply"

This is essentially a time-based measure and therefore does not relay information about the magnitude of load that was impacted during the events

Expected Energy Not Supplied (EENS) **means**
"The amount of energy that will not be supplied in a specified period, during which demand exceeds supply"

This reflects both the duration and magnitude of the event. It is equivalent to the term "*unserved energy*" or blackout, excluding consequential costs and damages.

Cost of Unserved Energy **(CUE) means**
"The value associated with each unit of unserved energy or a blackout". These words will be used interchangeably.

9.1.1 Appropriate Reserve Margin

Previously South Africa enjoyed a more than adequate reserve margin as a result of over investment in the past. The surplus capacity has been diminishing for some time as a result of a more than projected upswing in the electricity demand.

There are significant improvements (i.e., reductions) in the total CUE as the reserve margin progresses from 13% to 19%. After 19%, there is very little improvement in CUE. This, combined with the relatively low cost of new OCGTs, is what drives the economic approach to the reserve margin calculation to arrive at a 19% answer. Another way of looking at this is that, in risk management terms, the economic impact of overbuilding in South Africa is much smaller than the economic impact of not maintaining an adequate reserve margin and risking costly load shedding events. For example, in the US it is not uncommon for utilities to maintain reserve margins above the reliability standard since supply disruptions are looked upon as unacceptable to the public and having a surplus of capacity essentially acts as an insurance policy for the reliability of the electricity system.

It is recommended that long term planning be conducted with a higher reserve margin, as high as 19%, as that is the level resulting from the economic analysis and it is, coincidentally, the reserve margin consistent with a 1 day in 10 year standard used in the US and many other industrialized countries. The higher reserve margin target could also be used to protect against other generation reliability risks, such as transmission congestion, delays in project commissioning, fuel availability, and hydro availability.

Table 1 below shows the reserve margin requirements for a sampling of electric planning areas in the US. The reserve margin requirements are those developed by the planning areas based on the *"1 Day in 10 Year" reliability standard*. Reserve margins generally vary by region due to resource mix, import capability, and weather patterns.

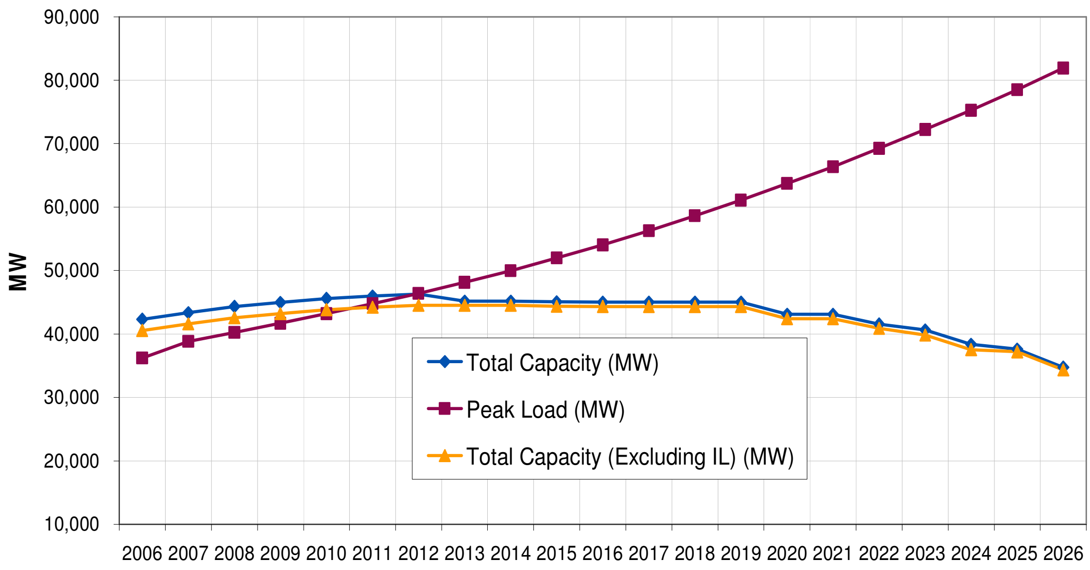
Table 3
Sample Reserve Margin Requirements in the US

Jurisdiction	Reserve Margin Target or Guideline
California Investor Owned Utilities[7]	15-17%
Energy Reliability Council of Texas (ERCOT)	12.5%
Midwest Independent System Operator (MISO)	14-15%
Midwest Reliability Organization (MRO)	14-15%
New York ISO	16.5%
PJM RTO[8]	15%

Figure 3
South Africa Capacity and Demand Outlook (2006-2026)

[7] Pacific Gas& Electric, Southern California Edison, San Diego Gas & Electric

[8] Pennsylvania-Jersey-Maryland Regional Transmission Organization



9.1.2 Reliability Summary

The results from the analysis indicate that South Africa must maintain a 14% reserve margin in order to meet the "1 Day in 1 Year" reliability standard and a 13% reserve margin if the reliability standard is deemed to be "2 Days in 1 Year". For comparison purposes a 19% reserve margin would satisfy the United States of America's reliability standard of "1 Day in 10 Year". Table 2 below lists the amount of expected un-served energy (EUE) and loss of load hours (LOLH) associated at each corresponding reserve margin.

Table 4
Reliability Summary Statistics

Reserve Margin	Expected Unserved Energy (EUE) - MWh	Loss of Load Hours (LOLH) in 1 Year	Loss of Load Days (LOLD) in 1 Year	Loss of Load Probability (LOLP)
8%	242,200	188	7.8	2.14%
9%	164,203	129	5.4	1.47%
11%	108,249	90	3.8	1.03%
12%	69,044	61	2.6	0.70%
13%	44,007	41	1.7	0.47%
14%	26,781	27	1.1	0.31%
15%	16,009	17	0.7	0.19%
16%	9,353	10	0.4	0.11%
18%	5,212	6	0.2	0.07%
19%	2,580	3	0.1	0.03%

Reserve Margin	Expected Unserved Energy (EUE) - MWh	Loss of Load Hours (LOLH) in 1 Year	Loss of Load Days (LOLD) in 1 Year	Loss of Load Probability (LOLP)
20%	1,803	2	0.1	0.02%
21%	1,038	1	0.1	0.02%

Figure 2 below shows the LOLH decreasing as reserve margin increases.

Figure 4
Loss of Load Hours vs. Reserve Margin

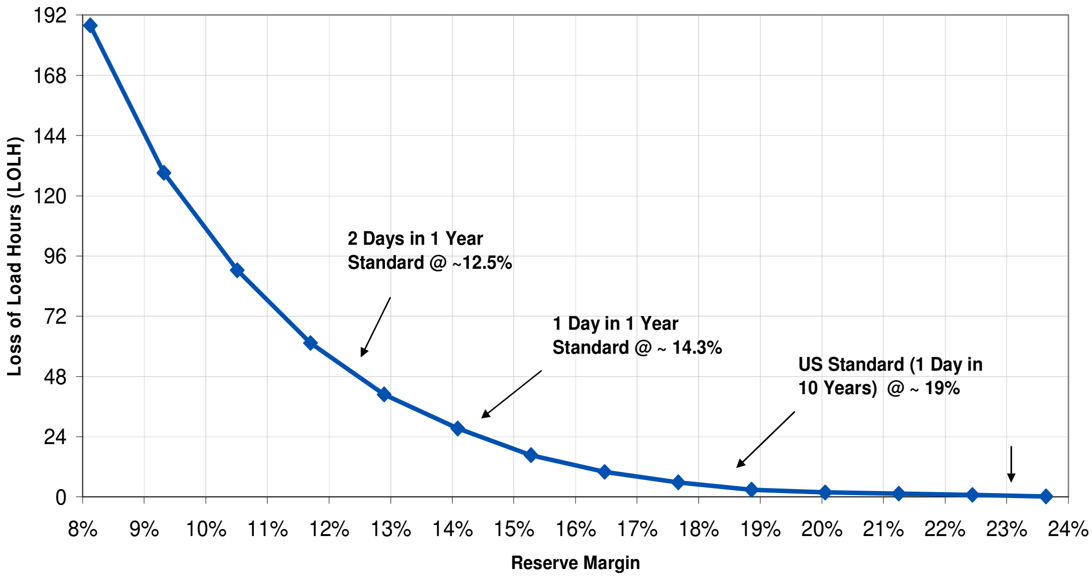


Figure 3 shows a similar concept, illustrating that the amount of expected un-served energy (EUE) also decreases with increasing reserve margin.

Figure 5
EUE vs. Reserve Margin

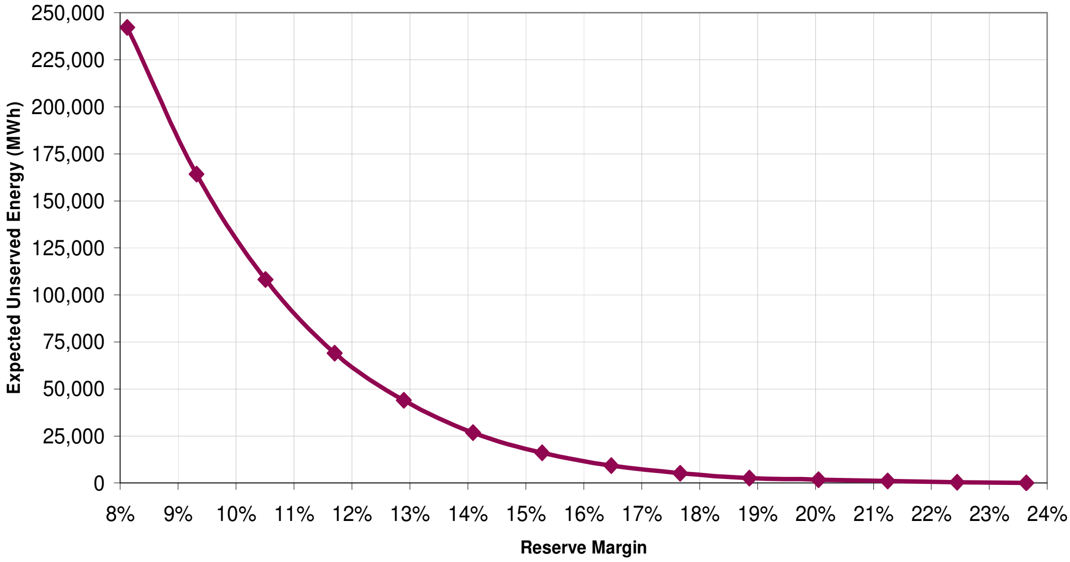


Table 3 summarizes the costs of reliability at each reserve margin level. The cost of adding additional OCGT capacity to improve reliability was R2,982 /kW. The OCGT construction costs levelised over the 25-year life expectancy was assumed to be R263/kW-yr[9].

Table 5
Cost of Reliability Summary

Reserve Margin	OCGT Capital Cost[10] (R 000)	CUE Cost (R 000)	DSM Capital Cost	Total Reliability Cost (R 000)
8%	252,480	18,164,985	61,983	18,479,448
9%	378,720	12,315,215	61,983	12,755,918
11%	504,960	8,118,671	61,983	8,685,614
12%	631,200	5,178,328	61,983	5,871,511
13%	757,440	3,300,500	61,983	4,119,923
14%	883,680	2,008,596	61,983	2,954,259
15%	1,009,920	1,200,649	61,983	2,272,552
16%	1,136,160	701,489	61,983	1,899,632
18%	1,262,400	390,868	61,983	1,715,251
19%	**1,388,640**	**193,502**	**61,983**	**1,644,125**
20%	1,514,880	135,241	61,983	1,712,104
21%	1,641,120	77,828	61,983	1,780,931

[9] The OCGT levelized carrying charged rate was assumed to be 8.812%. This was approximated from ISEP-10 data by applying that study's differential between its OCGT levelized carrying rate (8.407%) and the study's real discount rate (7.595%) to this study's real discount rate (8.0%). The exact calculation is [8.0 + (8.407 – 7.595) = 8.812].

[10] Changes in system operating costs (for both the new OCGTs and the balance of system) are considered second order effects in such an analysis and therefore are not included here.

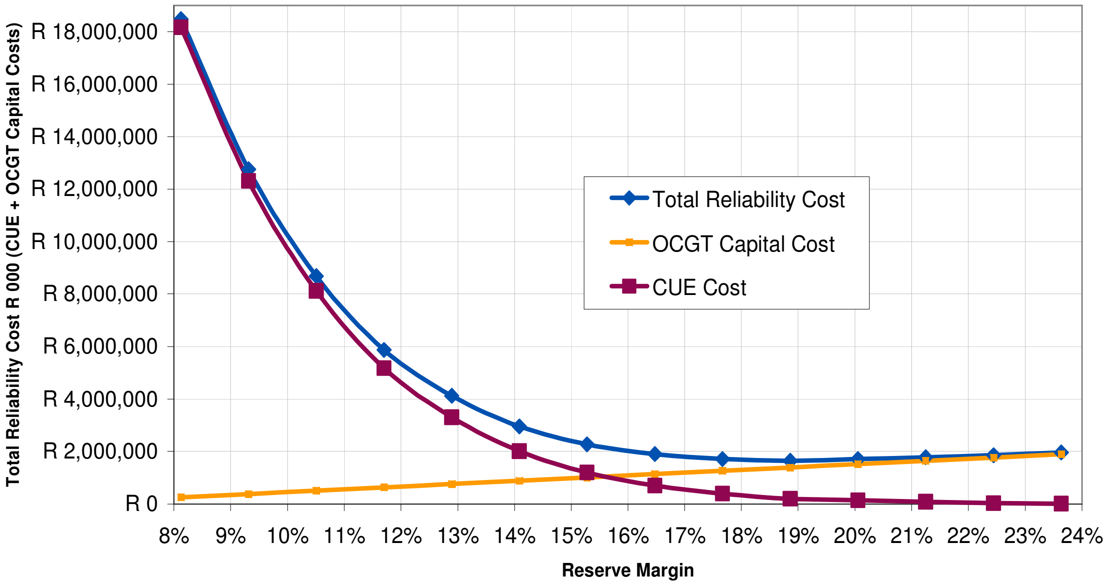
The second part of this analysis was to determine the reliability worth vs. cost trade-off. The trade-off between reliability and costs can be best depicted in the reliability worth vs. cost curve shown in Figure 4 below. The reliability cost curve is the composite of the three costs derived in earlier tables, namely (1) the CUE which declines as reserve margin increases and (2) the cost of additional capacity which increases as reserve margin increases, and (3) the cost of DSM. The cost of DSM is constant across all reserve margin levels. Overall, the reliability cost curve illustrates how the reliability cost profile changes with each incrementally higher reserve margin.

In this calculation the CUE is valued at 75 R/kWh and the levelized cost of building OCGTs to reduce EUE is assumed to be R 263/kW-yr. At lower reserve margins the costs of reliability coming from CUE is much larger in relation to the capital cost of building OCGTs. Whereas, at higher reserve margins the net impact of adding OCGTs to eliminate EUE is greatly diminished and as a result is not a cost effective strategy to address EUE.

In Figure 4 below the inflection (minimum cost) point at 19% suggests that, if tradeoffs between costs and reliability were taken into account, the optimum reserve margin would be at approximately 19%. The incremental *costs* of reliability after 19% would not justify the amount of EUE eliminated. Therefore maintaining a 19% reserve margin for the South African electric system would optimize the trade-off between reliability and costs. Interesting enough a 19% reserve margin would also satisfy the US reliability standard of “1 Day in 10 Years”.

Figure 6

Reliability Worth vs. Cost Curve



9.2 Transmission adequacy measures

Definitions

Circuit means any transmission line connecting any two points on the network.

Item of plant means any equipment connected at a substation, such as transformers, shunt or series capacitors, shunt or series reactors and SVCs. It also means any generator connected to the network.

System Healthy means the normal operation of the power system with all circuits and items of plant available for service.

Single Contingency or *N-1 Contingency* means that one single circuit, one double circuit or one item of plant is tripped and locked out of service from the system healthy condition.

N-1-1 Contingency means that a second circuit or item of plant is tripped and locked out of service from the N-1 contingency condition, but corrective action in the form of re-dispatch of generation, transformer tapping or the switching in or out of plant such as capacitors or reactors has taken place.

Double Contingency or *N-2 Contingency* means that a second circuit or item of plant is tripped and locked out of service from the N-1 contingency condition and no corrective action has been taken, i.e. the two contingency events are simultaneous or quickly follow each other.

9.2.1 Level of Security of Supply

New levels of security of supply have been proposed for Transmission Planning Criteria which will be referred to as reliability planning. The TDP studies will identify the areas in the network where the new reliability criteria are not met. These areas of weakness will be recorded and options considered for resolving the weakness. The reliability capacity criteria to be used in the TDP update studies are as follows:

9.2.1.1 General N-1 Capacity

The general reliability capacity criteria is that the transmission network shall meet the single contingency or N-1 contingency criteria on a deterministic basis, i.e. a probability of failure of one will be used in the economic justification.

9.2.1.2 N-1-1 Capacity for Maintenance

The N-1-1 capacity for maintenance criteria will determine if the transmission network can be maintained adequately during the year.

The maintenance reliability capacity is determined by applying the N-1 contingency and then applying a second contingency, the N-1-1 event. However before the second contingency there will be sufficient time to take corrective control actions to prepare the network for the second contingency. The control actions can take the form of re-dispatch of generation, adjustment of transformer taps and switching of reactive devices. These actions will determine the N-1-1 capacity of the network in that specific area.

The philosophy of this approach is to determine if all the required maintenance for a particular area can be undertaken without undue risk to the network. The N-1-1 capacity of the area must be compared to the annual load profile for the area to determine if any load is at risk and for what period of the year. If the period that the annual load profile is below the N-1-1 capacity level exceeds the total period required for all maintenance in that area for the year, then the area can be adequately maintained. This will only be undertaken in areas where maintenance constraints are identified as a possible issue in this TDP update.

9.2.1.3 Load centres and Power Corridors exceeding 500MW N-1-1 Capacity

Load centres and power corridors that exceed 500MW under normal operating conditions will be required to meet the N-1-1 capacity criteria to ensure a reliable supply. For these load centres a probability of failure of one will be used for the first and second contingency in the economic justification.

9.2.1.4 Critical Transmission Nodes and Power Corridors N-2 Capacity

Transmission nodes and power corridors that are considered critical will be required to meet the N-2 capacity criteria to ensure a reliable supply. After the application of the N-1 contingency a second one will be applied, i.e. the N-2 event. There will be no time before the second contingency to take corrective control actions to prepare the network for the second contingency. A probability of failure of one will be used for the first and second contingency in the economic justification.

10. DECISION MAKING CONSIDERATIONS

10.1.1 Environmental Impact Assessments (EIA's)

In order to conclude feasibility studies as efficiently as possible and ensure a minimum of project delays, an EIA strategy will be developed and implemented that will:

- Reduce the time taken to undertake EIAs,
- Reduce the time taken to obtain EIA authorisation and
- Minimise the risk of appeals and legal challenges to project EIAs

10.1.2 Site selection and optimisation

As the accelerated and shared growth initiative for South Africa (ASGI-SA) gathers momentum, urbanisation increases, legislation relating to development becomes more rigorous and South Africa becomes integrated into the global community, access to suitable land to establish electricity related infrastructure becomes increasingly limited. Thus to support value creation, network expansion plans must optimise the use of existing servitudes.

By 2050, Eskom's coal-fired fleet (assuming a 70% share of total capacity) would exceed 90 000MW. Policy on gaseous emissions requires that:

- No retrofitting of operating power stations with Flue Gas Desulphurization (FGD).
- Should a decision be taken not to install FGD, the power station will be designed to accommodate an FGD plant.
- Tall stacks will be the primary means of controlling ground level concentrations of SO_X and NO_X.
- New capacity will include a requirement for low NO_X technology.

In addition, the availability of water resources in areas where new power plants will be located will be key in site selection.

10.1.3 Climate change

South Africa has acceded to the Kyoto Protocol and as such is eligible to participate in the Clean Development Mechanism (CDM). The CDM is a project based mechanism that allows projects to earn carbon credits if those projects result in a reduction of greenhouse gases against a baseline. Eskom is in a relatively unique situation because the generation mix is heavily biased towards coal; therefore the baseline is dominated by coal. Few other economically viable options are available and because of this, it is critical to take climate change issues into account and take advantage of carbon credits that translate into direct financial benefits. Carbon credits will be included in decision making in all future major investment decisions.

10.1.4 Renewable energy

Internationally there is increasing pressure on countries to increase their share of renewable energy because of concerns such as climate change and exploitation of resources. In this regard various renewable energy technologies are being explored especially the conversion of solar energy to usable energy.

10.1.5 Funding and Resourcing

Eskom' funding requirement for the 5 year planning period is determined mainly by the revenue generated from operations as well as the tariff price increases that are received from NERSA. The funding plan covers the multi year price determination period as there is fair certainty during that period regarding the expected revenue. The funding requirement will continue to be significant during the planning period due to the build programme.

Furthermore, it is critical that adequate resources, such as the appropriate skills and information management systems, are available in order to ensure that the current business is sustained, and that the build programme is delivered successfully.

10.1.6 Forecasting and phasing of capital expenditure

Given the magnitude of the cash in and out flows in the Eskom business, the accuracy and completeness of forecasting and the phasing of capital expenditure is important so as to prevent the unnecessary raising of funds which would result in additional financing costs, the holding back of cash resources that if not utilized could have been invested in interest bearing instruments. In order to better manage this, forecasting and the accuracy thereof is a key performance indicator in performance contracts.

10.1.7 Skills Management

Globally there is a drive to increase electricity supply capacity, particularly in India and China. As a result, there is a growing local and international demand for scarce technical skills. A shortage of critical build skills and operation and maintenance skills requires a focused skills acquisition and retention strategy.

10.1.8 EDI Restructuring

Cabinet approved the proposal to create six Regional Electricity Distributors (REDs) which will be established as public entities. Whilst priorities will be the migration of the Distribution business into the 6 Reds and ensuring fair value compensation for migrated assets, details of the roadmap to achieve EDI restructuring will unfold over the planning period.

10.1.9 Research and Technology

Focused research and development will enable meeting technical performance and capacity expansion objectives. Electricity/energy-based technology development and innovation is imperative to productivity and growth of the country. Technology has the potential to be the foundation and can provide the core elements of sustained growth in the global economy of unprecedented expansion and social transformation into the future. Electricity and, in particular, technology development, innovation and leadership around electricity/energy, is expected to play a profound role in assisting society in grasping the opportunities and managing the threats emerging in the new century.

The pace and scope of technological change in the electricity industry is greater today than ever before and, as such, the need to appropriately position South Africa, from a technological perspective is critically important in particular, with regards to the demonstration and piloting of appropriate technologies. This also allows the development of internal capability whilst also reducing the cost of the eventual roll out for a particular technology.

10.1.10 The 2010 FIFA World Cup

The availability of sufficient and reliable quality of electricity supply during the 2010 World Cup will be one of the critical success factors of the event. Government’s key responsibility is to evaluate the capacity of Eskom and the re-distributors to deliver the electricity required during and prior to the event.

10.1.11 Nuclear Energy

The abundant uranium resources in the country present an opportunity for South Africa to introduce diversity in base load electricity generation capacity. Nuclear Energy presents a viable alternative to coal in that no only would it deal with diversity of primary energy sources but also would lead to a significant reduction in greenhouse gas emissions. Nuclear energy generation will also support Government's mineral beneficiation drive. Government has recently taken a decision to invest in nuclear power generation including the development of a nuclear industrial base. The details on Government's vision for nuclear energy are contained in the draft nuclear energy policy and strategy, which is being finalised. The finalisation of institutional arrangements to realise the vision for nuclear energy will have to be accelerated.

11. INTERVENTION PLANS

11.1 Integrated Resource Plan

The following integrated resource plan[11] indicates the type of plant and primary energy source to achieve the supply-demand balance. The plan does not indicate the actual projects, which will be the responsibility of Eskom to develop based on the Masterplan.

Name	MW	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Alpha-Char	702	0	0	0	0	702	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alpha-Char	702	0	0	0	0	0	702	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alpha-Char	1404	0	0	0	0	0	0	1404	0	0	0	0	0	0	0	0	0	0	0	0	0
Alpha-Char	1404	0	0	0	0	0	0	0	1404	0	0	0	0	0	0	0	0	0	0	0	0
Grootvlei1-	380	380	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grootvlei3-	570	0	570	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grootvlei6	190	0	0	190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Komati1	102	0	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Komati2-6	510	0	0	510	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Komati7-9	306	0	0	0	306	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CFBC1-2	300	0	0	0	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cogen1-2	200	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cogen3-4	200	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cogen5-6	200	0	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DMEIPP1-7	960	0	0	960	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GasOne1-6	882	0	882	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GasOne7	147	0	0	147	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Braamhoek	1332	0	0	0	0	0	1332	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLM	80	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
IMLM	720	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
RLM	760	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
CEE	240	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
IMEE	300	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
REE	600	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
RSREE	90	18	18	18	18	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PFFGD-Ref	33282	0	0	0	0	0	0	0	0	0	774	2322	1548	2322	3096	3096	3096	3870	3870	4644	4644
CFBC-Ref	900	0	0	0	0	0	0	300	300	300	0	0	0	0	0	0	0	0	0	0	0
CCGT	8127	0	0	0	0	1161	0	774	0	1161	1161	0	774	0	0	387	387	387	0	1161	774
Nuke-Ref	6800	0	0	0	0	0	0	0	0	0	0	1800	0	0	0	2600	0	0	0	2400	0
OCGT-Ref	8400	0	0	0	720	720	0	480	360	840	480	240	360	480	840	480	600	120	720	480	480
PS-Ref1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS-Ref2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS-Ref3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PS-Ref4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Tot	63990	533	1707	2160	1679	2936	2169	3093	2199	2436	2550	2697	2817	2937	4071	4098	4218	4512	4725	6420	6033
	Total	42775	45977	48438	50176	53141	55309	57301	59500	61876	64325	67021	69793	72729	75849	78997	82454	86025	89610	93804	97501

It must also be emphasized that this plan represents the least cost approach to achieving a demand-supply balance. It specifically excludes other government policy imperatives like

[11] This NIRP3 process has yet to be ratified by the stakeholder-driven Advisory Review Committee. The intention is to update the plan every 3 years, after broad stakeholder consultation

renewable energy and nuclear technology. These supply options have to be factored in through direct policy intervention (irrespective of the least cost approach) to cater for renewable energy targets and the introduction of nuclear energy in the supply mix. The idea is for this risk adjusted diversified plan to be updated regularly, as discussed later.

The plan is premised on achieving a 19% reserve margin as indicated before. It is worth noting that the revenue requirement (2007 present value) is around R460 billion.

11.2 Capacity Expansion Programme

Projects approved to date, together with the planned dates for delivery are indicated in the diagram below.

Approved Projects	**Megawatts**	**Project Stage**	**1st unit in CO**	**Last unit in CO / Project Completion**
Camden RTS	1520	Implementation	June 2005	March 2008
Grootvlei RTS	1128	Implementation	March 2007	October 2009
Komati RTS	961	Implementation	September 2008	October 2011
OCGT – 1st tranche	1027	Implementation	January 2007	April 2007
Gas 1 (OCGT)	1000	Project Execution Planning	May 2008	September 2008
Arnot Capacity Increase	300	Implementation	April 2006	November 2010
Alpha	2100	Project Execution Planning	September 2010	September 2012
Hotel	1332	Implementation	March 2012	December 2012
Platinum Basin (Tx)	N/A	Implementation	N/A	August 2006
Cape Strengthening	N/A	Implementation	N/A	July 2007
Southern Cape Strengthening (Tx)	N/A	Implementation	N/A	June 2007
765 kV Zeus to Omega (Tx)	N/A	Project Execution Planning	N/A	June 2009

11.3 Total System Capacity and Reliability Plan

Through the planning processes for the 18 month and 7 year period, the indications are of a tight reserve margin being prevalent, with the key risks for these periods have been identified. These risks were identified and actions developed to ensure mitigation.

	Risk	Action
1	**Komati (910 MW) return-to-service:** In Service Dates - first unit October or February 2008. Cost increases**.**	Finalise RTS scope. Revise business case.
2	**Non-Eskom Generation (440 to 590 MW) as mitigation:** Name / Capacity (MW) / Load Factor / In Service Sasol Secunda 282 60%+ 01 July 2009 Mittal Vanderbijlpark 100 60% 01 July 2009 Tshwane Rooiwal 0 to 118 01 Jan 2008 Bloemfontein Centlec 50 01 Jan 2008 Sasol Infrachem 11 to 42 01 Jan 2008 Sasol Secunda and Mittal are new co-generation options. Tshwane, Bloemfontein and Sasol Infrachem are existing unutilised capacity.	Expedite negotiations and confirm whether achievable within given mandate and timelines. Finalise business cases if appropriate.
3	**Kudu (1 150 MW) included in Base Case:** Capacity: 400 MW CCGT in Namibia + 9 x 83 MW additional for conversion from OCGT to CCGT at Ankerlig. In service date: Assumed as 30 April 2011 for first units in both Namibia and at Ankerlig.	Expedite negotiations. Finalise business case if appropriate.
4	**New Demand-side measures as mitigation:** **Demand-side Management** Energy Efficiency, high → medium load factor - Current Pipeline 42 MW from 2008 - CFL Roll-out 544 MW from 2008 - Solar Water Heating 68 MW from 2008 - Other ICEE 100 MW from 2009 - Street Lighting 25 MW from 2009 Load Management, low load factor - Current Pipeline 180 MW from 2008 - Residential 75 MW from 2009	Processes in place to achieve these capacities and timelines. Ongoing review and "fine-tuning".

	- Industrial and Mining 80 MW from 2009 Peak Clipping, low load factor - Current Pipeline 22 MW from 2008 - Power Alert 400 MW from 2008 New DMP → 200 MW (2008) to 310 MW (2011) New Emergency DMP → 160 MW (2008) to 550 MW (2011)	
5	**Deterioration in existing coal-fired plant performance:** Planned outages → 7,5% Unplanned outages → 5,5% EAF → 87% for coal-fired plant	Processes in place to achieve performance as a minimum Ongoing review and "fine-tuning".
6	**Coal supply:** Coal required by existing coal-fired stations is higher than historical levels. **Liquid fuel supply to OCGT's:** Logistics and impact of Kudu.	Investigate coal supply options to the power stations. Plans in place for 2007 liquid fuel procurement. Situation after 2007 must be assessed considering outcome of Kudu negotiations.

11.4 Transmission Expansion

Based on the load forecast and the future generation capacity, a transmission "Super Grid" for the future network can be developed. This transmission Super Grid will consist of a main power corridor backbone and major regional corridors. The main power corridor backbone forms the link among all the power pools while the major regional corridors indicate the flow of power into the major load consumption regions.

Figure 7 below shows the proposed main power corridor backbone of the super grid. Figure 8 and Figure 9 indicate the related major regional corridors. These proposed corridors are based on analysis of the ASGISA load forecast and generation capacity expected for 2026.

Table 6 below briefly describes the power corridors of the proposed super grid which are indicated in the Figure 7, Figure 8 and Figure 9.

No.	MAIN CORRIDORS	ROUTE
1	East to West power corridor	Witbank power pool – Central Grid power pool
2	North Western power corridor	Central power pool – West Tx node (Rustenburg to Klerksdorp area) - Matimba power pool
3	Northern power corridor	Matimba power pool– Venda power pool – Witbank power pool
4	Eastern power corridor	Witbank power pool- Kwa-Zulu Natal East Coast
5	North to South power corridor	Witbank and Central power pools to Welkom power pool
6	Cape power corridor	Beta/Perseus-Hydra-Gamma-Omega 765kV & Beta-Hydra-Gamma-Omega 400kV network
	MAJOR REGIONAL CORRIDORS	**ROUTE**
7	Central Grid corridors	Witbank power pool – JHB North
8		Klerksdorp – JHB North
9		Witbank power pool – Central JHB
10		Central power pool – Central JHB
11	Northern Grid corridors	Matimba power pool - Polokwane
12		Matimba power pool - Rustenburg
13	North Eastern Grid corridors	Witbank power pool - Highveld North - Marathon
14		Witbank power pool – Lowveld - Polokwane
15		Matimba power pool – Pretoria – Witbank power pool
16	North Western Grid corridor	Central Grid power pool – Ferrum (Kimberley)
17	Eastern Grid corridors	Witbank power pool- Empangeni
18		Witbank power pool - Pinetown
19	Southern Grid corridor	Gamma – Coega (Dedisa)
20	Western Grid corridor	Hydra/Gamma – Cape Peninsula

Table 6: Description of the super grid corridors

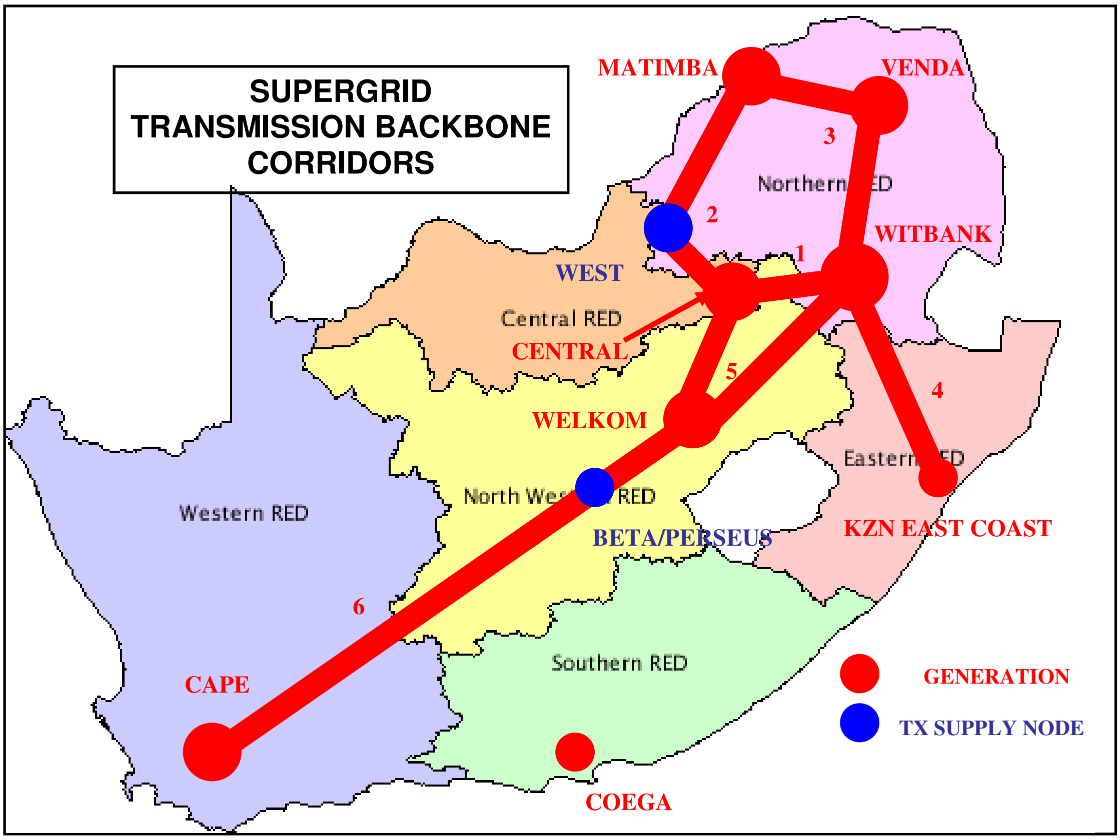


Figure 7: The main power corridor backbone

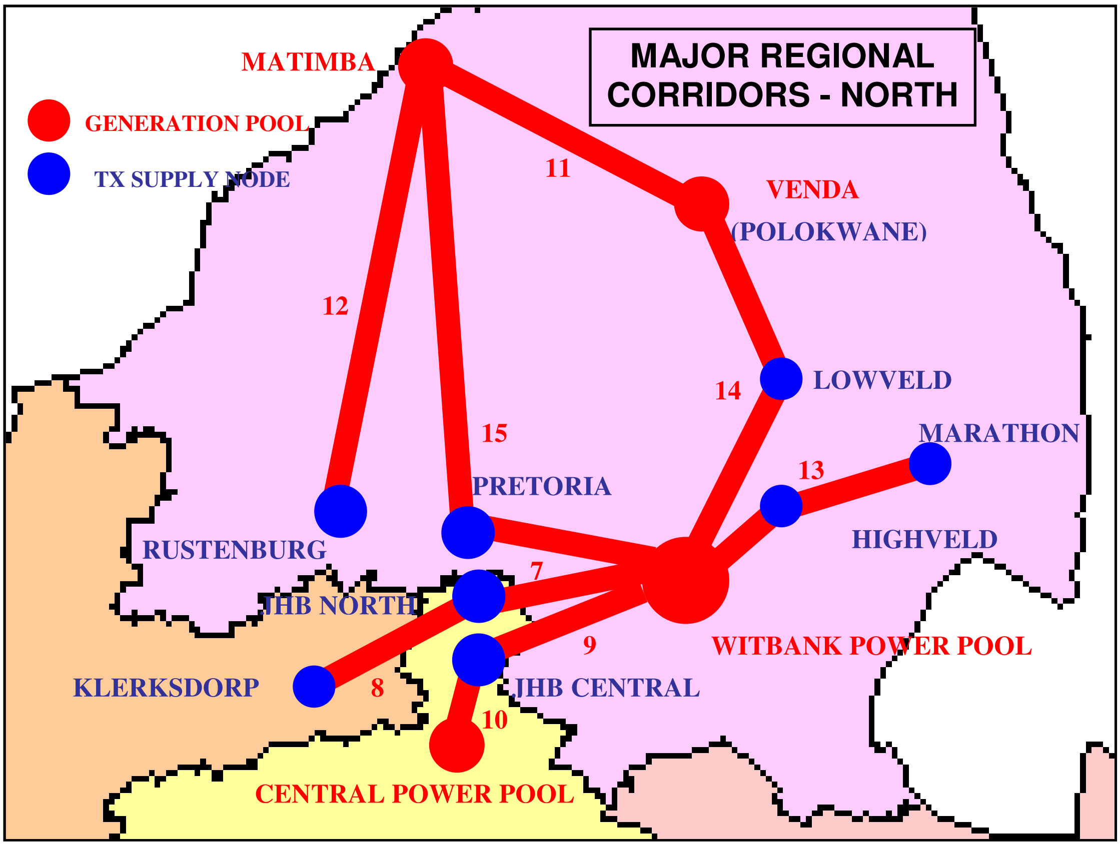


Figure 8: The regional corridors in the southern part of the country

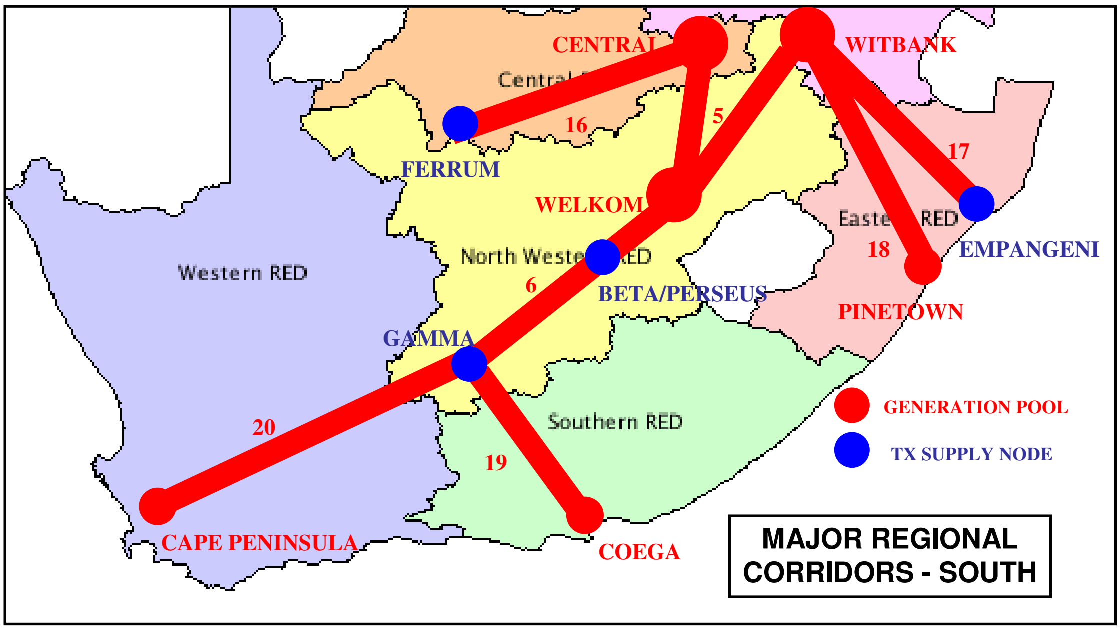


Figure 9: The regional corridors in the northern part of the country

This 2026 review is focused primarily on the development of the main and regional corridors in order to meet the challenges of supplying the future loads of the country.

It is recognised that since there is only some level of certainty of the new generation up until 2018, the Super Grid must have a high degree of flexibility to enable it to transport power around the country from wherever the future generation is established.

The above defined corridors should be developed towards providing an ***N-2 level of security*** supply.

11.5 REDS

The electricity value chain requires that all constituent parts must work well for it to maintain its integrity. It is recognized that despite generation and transmission adequacy, without a functional and reliable distribution system, the reliability of the system cannot be maintained.

It was for this reason that in March 1997 Cabinet approved consolidation of the Electricity Distribution Industry (EDI) into the maximum number of and yet to be determined financially viable Regional Electricity Distributors (REDs).

The EDI proposals envisaged the creation of REDs, which will ensure better electricity service delivery. These distributors will be responsible for:

- Electricity distribution to consumers within their boundaries at an equitable tariff system;
- Provision of the electricity supply to new consumers, especially in rural areas;
- Combining the Eskom areas of supply in distribution with those of municipal electricity distributors to ensure cross – pollination of best practices;
- Supporting government objectives of poverty alleviation through local economic development by providing the necessary supporting electrical infrastructure

Over the years, the establishment of the REDs have been met with limited success. In an attempt to address the challenges that the distribution sector faces, on 25 October 2006 Cabinet approved:

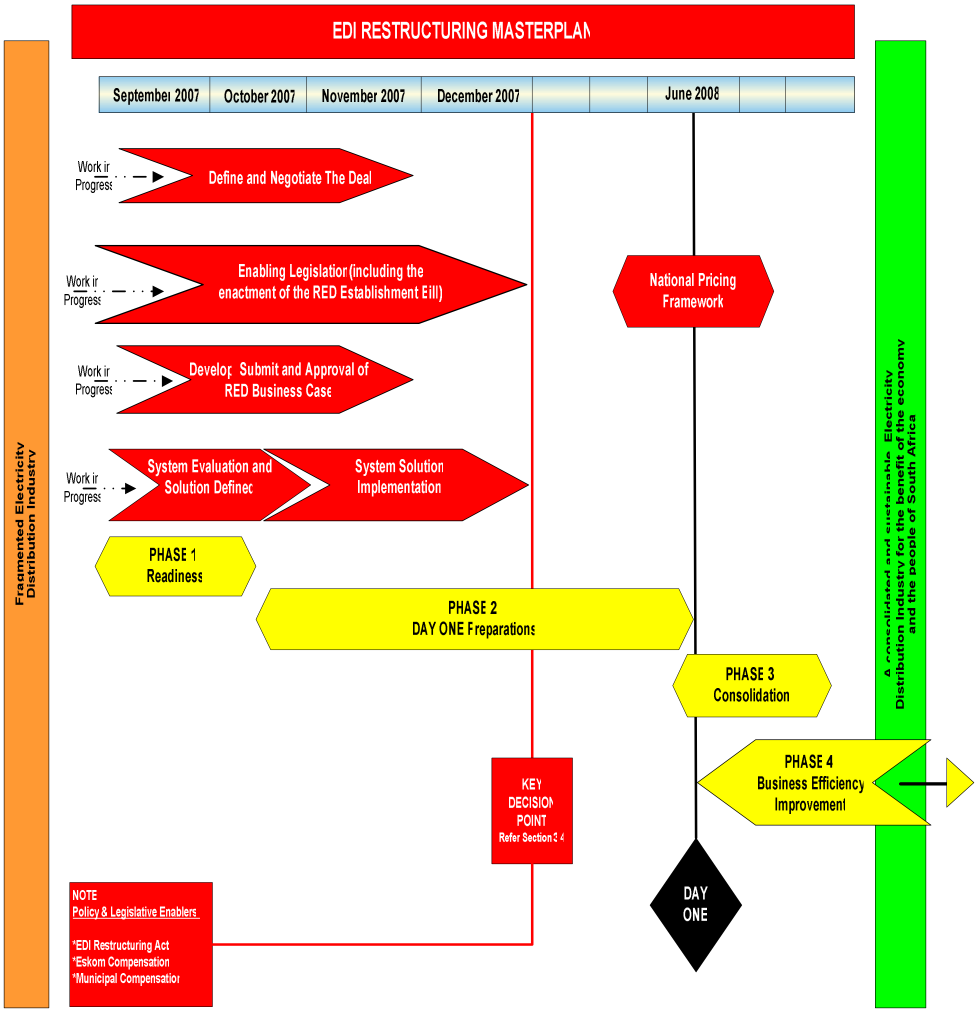
- The creation of six “wall-to-wall” Regional Electricity Distributors (REDs);
- The REDs to be created as public entities, in terms of the Public Finance Management Act and the Electricity Regulation Act;
- That DME, through EDI Holdings, will oversee and control the establishment of REDs;
- That a Roadmap will be put in place to move from the current scenario into the future industry structure;
- That a strategy needs to be developed to deal with capital investment requirements for the REDs;
- That EDI Restructuring legislation will be introduced; and
- That a National electricity pricing system will be developed.

Cabinet has also committed to the following implementation enablers to ensure rapid transformation of the sector.

These are:

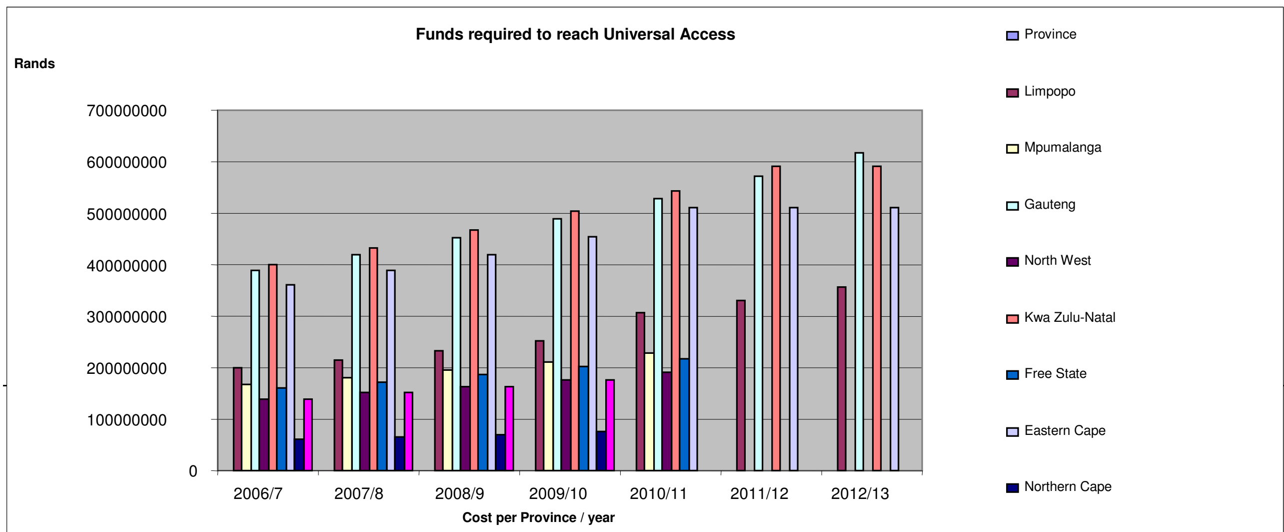
- Governance of the REDs;
- Promulgation of Asset Transfer Framework to enable effective and orderly transfer of assets from Local Government and Eskom to the REDs;
- National Tariff Harmonisation Framework to ensure rationalisation of tariffs nationally;
- Salary Harmonisation Framework;
- Infrastructure Investment Strategy;
- Surcharge Principles Framework;

It is within this context that the Generic Roadmap below has been developed.

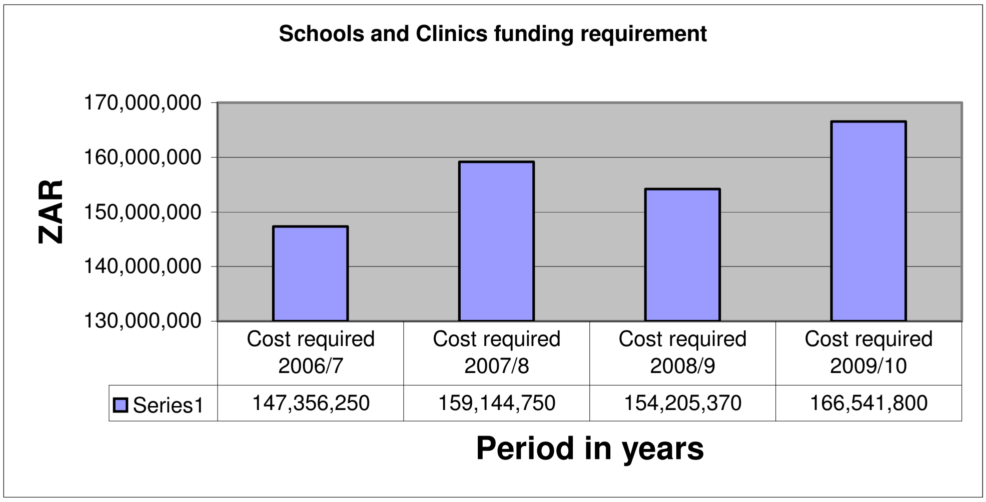


11.6 Electrification of Households, Schools and Clinics

The illustration below indicates that the universal access can be reached in two provinces (Northern Cape and Western Cape) in four years (2009/10). The other provinces (Free State, North West and Mpumalanga) could achieve universal access in the fifth year (2010/11) and the remaining provinces (Limpopo, Kwazulu – Natal, Eastern Cape and Gauteng) in 2012/13.

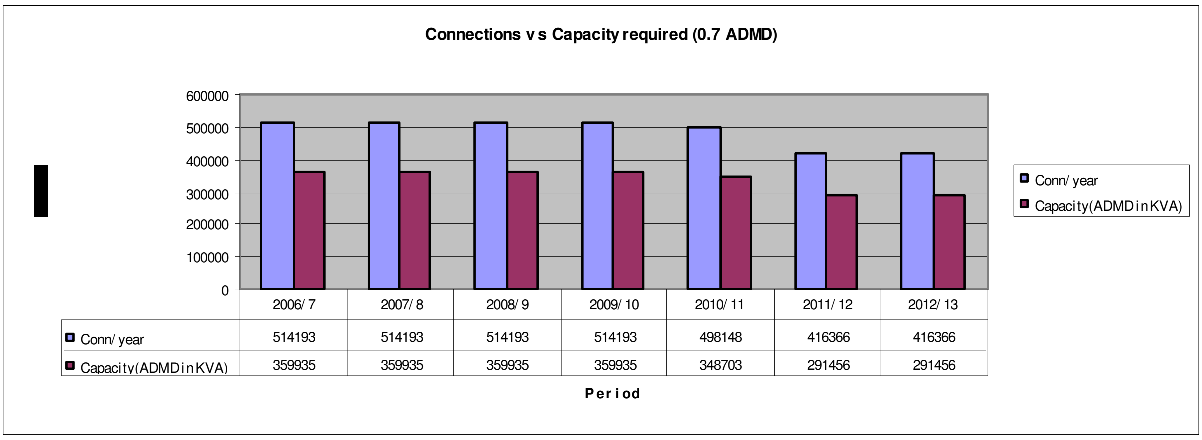


Schools and Clinics



With regard to schools and clinics electrifications the backlog will be eradicated in four years. This means that provinces like Gauteng, North West, Northern Cape and Western Cape will reach universal access in two years (2008/9), and the remaining provinces 2010/11.

Electrical network capacity requirements



The increase in demand for network capacity is directly proportional to the number of connections expected in a particular year. By 2012/13; a total of 2 .7GVA (2700MVA) additional capacity is required.

11.7 Maintenance and Refurbishment of Generating Plant

The current fleet of generators is experiencing mid life refurbishment. This coincides with an unprecedented growth in energy demand resulting in very high plant load factors, often beyond the design parameters of the existing stations. Over the planning period, extensive investment will be required on maintenance and refurbishment. Under conditions of high plant utilisation, the importance of sufficient preventative maintenance becomes more critical in that any significant plant failure will negatively impact on the ability to supply customers reliably.

11.8 Accelerated Demand Side Management (DSM)

Current planned capacity expansion initiatives are not expected to meet the demand requirements cost effectively within the required timeframes. Planning is therefore being reconsidered and a comprehensive strategy to address demand, incorporating both supply and demand management solutions, is being developed. To this end an aggressive demand side management programme that will reduce demand by approximately 3,000 MW by 2012 and a further 5,000 MW in the subsequent 13 years to 2025 with the intent to alleviate the imminent supply constraints and to displace the need for more costly supply options currently under consideration.

	2007	2008	2009	2010	2011	2012
Annual Demand (MW)	400	800	700	600	400	100
Cumulative MW		1,200	1,900	2,500	2,900	3,000
Annual Energy (GWh)	350	556	930	1,262	944	521
Cumulative GWh		906	1,836	3,098	4,042	4,563
Cumulative Water (kl)	441k	1,141k	2,313k	3,903k	5,093k	5,750k
Cumulative Coal (ton)	175k	453k	918k	1,549k	2,021k	2,282k

Cumulative Ash (ton)	98	254	514	867	1132	1,277
Cumulative SO2 (ton)	3.1k	7.9k	16,1k	27.2k	35.5k	40k
Cumulative NOx (ton)	1.4k	3.5k	7,1k	12k	15.6k	17.7k
Cumulative CO2 (ton)	0.3k	0.9k	1.7k	2.9k	3.9k	4.4k

It should be noted that the Accelerated DSM Programme is expected to meet almost 90% of the identified capacity (MW) requirements, but will fall short of the energy (GWh) requirements identified. The shortfall must be filled through non-Eskom generation and co-generation opportunities.

The focus is now on the extension of the accelerated programme to a National level, hence on a significantly larger scale, and with greater sustainability demands. For this purpose a comprehensive and pro-active demand side management approach has been developed that incorporates:

- Energy Efficiency
- Energy Conservation;
- De-marketing to alternative energy sources;
- Distributed Generation;
- Load Management (including Demand Management Participation (DMP))
- Self Generation
- Additional Sales Curtailment for certain market segment

Demand and energy savings will be pursued nationally, but with specific focus on areas with network constraints and urban areas

Independent Power Producers

Given that the cost of generation from existing assets is in the order of 13c/kWh and that from new generation it will be at least 25c/kWh, whether it is built by Eskom or others; there is a very weak case for full competition on a merchant basis. As such it is anticipated that any private participation in the electricity industry will be via the IPP mechanism with a power purchase agreement with Eskom (single-buyer model).

Government has already signalled a preference that up to 30% of new generation be built by IPPs and the balance built by Eskom.

In order to achieve 30% private sector participation in the generation sector, certain strategic considerations had to be undertaken, namely;

- The appropriate technologies that can be undertaken by private sector;
- The risk appetite for certain projects;
- The one best positioned to deal with environmental and safety risks (e.g. nuclear energy)
- The type of primary energy sources

It was therefore decided that IPP will be invited to bid mainly to develop and operate gas and oil fuel power plants. The IPP's were not considered for the development of nuclear power plants.

12. IMPLEMENTATION MATRIX

This section outlines the recommended interventions identified in section (10). Each intervention has been assigned a time frame.

Action	Time Frame	Responsibility
Integrated resource plan	October 2007	DME
Capacity expansion	Immediate	Eskom
Total system capacity and reliability	Immediate	Eskom
Transmission expansion	Immediate	Eskom
REDS establishment	In progress	EDI Holdings
Electrification of households, schools and clinics	In progress	DME
Maintenance and refurbishment of generation plant	In progress	Eskom
Independent Power Producers	November 2007	DME
Accelerated DSM	Immediate	Eskom/DME/ Municipalities

13. MASTER PLAN REVIEW

A three year cycle is proposed for the review of the Master Plan, in order to update it and to assess its relevance in the context of an evolving electricity sector.

14. STAKEHOLDER CONSULTATION

The Department of Minerals and Energy will lead the further development of the Electricity Master Plan, its updating and its implementation. This means that DME will coordinate the activities of key players and ensure that all important stakeholders are involved in the process.

Key stakeholders include:

- NERSA, who are responsible for the implementation of regulations, the development of procedures and rules governing electricity production, transmission, distribution and trading.

- Department of Public Enterprises, who are Eskom's sole shareholder, charged with the responsibility to ensure proper governance at Eskom, in terms of the PFMA.

- Eskom, as the monopoly system operator who are responsible for ensuring the balance of the system. They are also a licensed distributor, generator and trader.
- Municipalities, especially insofar as distribution.
- Organized labour and business.

15. RECOMMENDATIONS

During the development of the Masterplan, a number of policy gaps were identified. In order to be able to measure the performance of implementers of the masterplan, certain recommendations are made in the interests of electricity security:

It is therefore recommended that:

- In order to address the power generation adequacy measures (that is the production of electricity), the reserve margin is no less than 14% targeting 19%;
- The reliability standard for power generation should be the "1 day in 10 years" standard. This means only one day blackout in 10 years will be an acceptable standard. This is consistent with the reserve margin of 19% over time;

- For the transmission network, there must always be more than one transmission line to ensure that bulk transportation of power is not interrupted in the case of one line being out of service for Western Cape, Eastern Cape and Kwa – Zulu Natal;

- The level of investment in the maintenance and rehabilitation of transmission and distribution infrastructure should be regulated, in line with the objects of the Electricity Regulation Amendment Act;

- Over and above the EWP, the policy statements outlined in Annexure 1 need to be adopted around the following critical matters, to ensure successful Masterplan implementation:

    - Electricity price path, to finance the implementation of this plan;
    - Import/export of electricity;
    - Cogeneration, DSM and other energy efficiency measures;
    - Leveraging private sector participation (IPPs) in generation;
    - Supply of gas for primary energy diversification;
    - Attraction of energy intensive investments as a strategy for development.

References:

1. *South Africa Alive with possibilities website*
2. *NIRP 3 report (NERSA)*
3. *Technical Audit report (NERSA)*
4. *Eskom's Demand Side Management (DSM) website*

Annexure 1: Statements on various electricity policy matters to support the Masterplan

Electricity price path;

Import and export of electricity;

Cogeneration, DSM and other energy efficiency measures;

Private sector participation in generation (IPPs);

Leveraging private sector participation (IPPs) in generation;

Supply of gas for primary energy diversification;

Attraction of energy intensive investments as a strategy for development.