

Transmission Ten-Year Development Plan 2011-2020



Public Version





Foreword by Divisional Executive

A reliable supply of electricity is essential for South Africa's economy to grow and generate the additional job opportunities that our people so desperately need. A reliable Transmission network of adequate capacity to meet the country's needs is a necessary condition for the provision of a reliable electricity supply to South Africa, and to support the Government's initiatives to create jobs. The Transmission network does not only require regular preventative maintenance and timeous repair of faults to remain reliable, but it must be developed and extended as well to meet the increasing demands made upon it; or alternatively connect new loads and power stations should be connected to the network.

The National Energy Regulator of South Africa (NERSA) has published, in the Grid Code; the rules governing investment in the Transmission network. Eskom, as the licensed Transmission Network Service Provider plans the network according to this Code and, subject to funding and other resource constraints, builds the network according to these plans. Where sufficient funds are not available to develop the network, a consistent set of rules is applied to prioritise projects and allocate funding in such a way that the maximum benefit is gained for South Africa.

The Transmission Development Plan for the period 2011 to 2020 is the third such plan that is being published in the public domain. It follows on the second such plan published in 2010. The major focus of the plans continues to ensure that the new power stations

are integrated into the national power system and that there is minimum infrastructure to meet prescribed reliability criteria. Funding constraints mean that the time it will take to meet the full requirements of the Grid Code could be as late as 2020 .

We estimate that, in nominal terms, an investment of R166 billion is required to the end of the financial year 2020. This is a significant investment on its own if one compares it to what is needed for transport and water projects. These investments already consider constraints in funding and resource availability as they have ideally been accelerated. These investments will result in the reliability standards only being completely met in the period 2015 to 2020.

It is clear that electricity is the lifeblood of South Africa's economy and hence there is a need for the country to understand what is required to ensure a reliable and secure supply and what investment levels are required to achieve it. We hope that this document will assist in this dialogue, and we welcome comments and queries on the content and format.

We would also like to take this opportunity to thank the team that has worked and continues to work on the development of these plans. It is a difficult and complex process which requires extensive consultation and multiple iterations.

Kind regards
Mongezi Ntsokolo

Disclaimer

The purpose of publishing the Transmission Ten-year plan is to inform stakeholders about the proposed developments in the Eskom transmission network. These plans are subject to change as and when better technical solutions are identified or when more accurate developmental information becomes available. The information contained in Transmission's Ten-year plan should therefore not be used for any other purpose other than sharing of information.

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While the Transmission Ten-year plan is updated periodically, Eskom makes no representation or warranty as to the accuracy, reliability, validity, or completeness of the information in this document. Eskom does, however, endeavour to release plans based on the best available information at its disposal at all times to ensure that the stakeholders are kept informed about the developments in the transmission network. Thus, the information contained in this document represents the most up-to-date information that was available at the time it was released.

Executive Summary

Eskom Holdings is a vertically integrated company licensed to generate, transmit, and distribute electricity in South Africa. The Transmission Division of Eskom Holdings is tasked with the responsibility of developing the transmission network. The publication of the Transmission Ten-year plan is to inform stakeholders about Eskom's plans with regard to the development of the transmission network. This publication fulfils the requirements of the South African Grid Code, which requires the Transmission Network Service Provider (TNSP) to annually publish plans on how the network will develop. This is the third publication of the Transmission Ten-year plan.

A public forum will be held with identified stakeholders to further disseminate and get feedback about the contents herein. These comments will be taken into account when the plan is revised. This publication contains projects intended to extend or reinforce



the transmission system that have been completed in the past year as well as projects that are planned for the next ten years. The transmission network is the primary network of interest covered in this publication. This covers electrical networks with voltages ranging from 220 kV to 765 kV and the transmission substations where these networks terminate. A few 88 kV and 132 kV electrical networks are included due to their strategic nature.

The projects that are covered in this document include, *inter alia*, *generation integration projects* required to ensure that the network is adequate to evacuate and dispatch power from the source to the load centres.

The publication also includes the transmission network strengthening plans required to carry the power from the new power stations, and *reliability projects* required to ensure that the reliability and adequacy of the transmission network are sustained as load demand increases on the network.

The estimated rand value of the planned projects is approximately R166 billion in the next ten years, of which approximately R 6 billion is for customer-related projects; R31 billion for generation integration projects, and approximately R129 billion is related to reliability projects. The costs given in the document are, in general, high-level estimates and can change as global economic conditions change; that is, costs are sensitive to foreign exchange, commodity price fluctuations, and global demand.

In general, the impact of reliability projects on the customers is to improve availability of supply under normal and contingency operating conditions, whereas customer and generation integration projects allow generating plant and the load to be optimally connected to the network.

Eskom Transmission also undertakes capital expenditure in respect of refurbishment of ageing infrastructure, facilities, production equipment, and strategic capital spares.

Facilities consist of buildings located at sites other than substations that are used by Transmission for offices, operation and control of the system, or as maintenance depots and workshops.

Production equipment consists of office furniture and equipment, computer hardware and software, tools and other equipment used by maintenance personnel, and vehicles.

Strategic capital spares are items not available from suppliers ex stock; for example, large power transformers, circuit breakers, etc. that are kept as a strategic stock to allow units that fail in service and cannot be repaired on site to be replaced as soon as practicable, thereby minimising the risk of customers experiencing a lengthy outage.

Projects dealing with refurbishment of ageing infrastructure, facilities, production equipment, and strategic capital spares are not included in greater detail in this document, but a summary of their costs is illustrated in the chapter dealing with capital expenditure.



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Abbreviations

CLN (Customer Load Network)

A network supplying a subdivision of a grid, usually a significant geographical landmass or political boundary served, e.g. Johannesburg CLN within the Central Grid

TNSP (Transmission Network Service Provider)

A legal entity that is licensed to own and maintain a transmission network

MW (Megawatts)

A million watts – a watt is a unit of electrical power production or demand

MVA (Megavolt-amperes)

A million volt-amperes-volt-ampere depicts vectoral summation of real power (MW) and apparent power (Mvars)

NERSA (National Energy Regulator of South Africa)

A regulatory body for all forms of energy production and usage in South Africa

MTS – Main Transmission Substation

These are mainly substations that step the voltage down to Distribution Voltages

RTS – Return to Service

A previously mothballed Power Station undergoing re-commissioning

REFIT – Renewable Energy Feed in Tariff

The NERSA promulgated tariffs payable to producers of renewable energy.

IPP – Independent Power Producer

These are power stations owned by independent parties other than Eskom.

TDP – Transmission Development Plan

A development plan produced annually by Grid Planning detailing how the network will develop in the next ten years. This comprises the proposed new projects listed in this document as well as the customer projects omitted from this document due to their commercial sensitivity.

OCGT – Open Cycle Gas Turbine

Combustion turbine fuelled by liquid fuel or gas, used to drive a generator.

CCGT – Combined Cycle Gas Turbine

OCGT fitted with a waste heat recovery boiler and steam turbines to increase electricity output using the combustion turbine's exhaust gases.

HVDC – High Voltage Direct Current

IQ – Indicative Quote

Quotation giving a non-binding indication of order of magnitude costs

FQ – Feasibility Quote

Quotation giving customers costs and scope at 65% accuracy level

BQ – Budget Quote

Quotation giving customers costs and scope at 85% accuracy level



I. Introduction

I.1 CONTEXT OF THE TRANSMISSION TEN-YEAR PLAN

Eskom Holdings is the biggest producer of electricity in South Africa; it also transmits electricity via a transmission network which supplies electricity at high voltages to a number of key customers and distributors. Eskom is a vertically integrated company licensed to generate, transmit and distribute electricity. The transmission licence is held by Eskom Transmission, the transmission network service provider, (TNSP). Planning the transmission network is the responsibility of the Grid Planning Department, in the System Operations and Planning Division.

The TNSP is required to abide by the regulatory requirements to annually publish a document detailing the plans of how the transmission network will develop in the next five years. The requirements further stipulate that the published document should include:

- the acquisition of servitudes for strategic purposes;
- a list of planned investments, including costs;
- diagrams displaying the planned changes to the transmission system (TS);
- an indication of the impact on customers in terms of service quality and cost; and
- any other information as specified by the NERSA from time to time.

A further requirement is that the TNSP holds public forums to share such plans with stakeholders in order to facilitate a joint planning process with them. The second ten-year plan was published in 2010, this is the third publication based on the TDP for 2011 to 2020 (also called the 2010 TDP internally to Eskom) which was finalised internally during the latter parts of 2010.



I.2 STRUCTURE OF THE DOCUMENT

The document is structured in the following manner:

Chapter 2 deals with the electricity demand forecast and generation assumptions. The demand forecast determines how the network is planned and it contextualises the planning activity while the generation assumptions outlines the generation build that informs some of the planned transmission network, as significant transmission network is required to evacuate power from the power stations to the load.

Chapter 3 focuses on the major changes that have occurred since the completion of the previous published Ten-year plan. The changes that occurred include the enhancement of geospatial forecasting, which improves the forecasting of load at a spatial level, and the changes from the previous generation assumptions to the ones informing this plan.

Chapter 4 focuses on projects that have been completed in the past year and the impact they have had on network reliability. This is partly to demonstrate the value of the projects as they are completed and to also inform stakeholders about the progress of projects thus far.

Chapter 5 deals with the national overview, which gives a high level explanation of the planned transmission infrastructure. This is intended to give a snapshot of the major projects that are planned for the entire Ten-year plan period and a high-level summary of the installed transmission infrastructure.

Chapter 6 focuses on planned projects in detail and the impact they will have on the network. Generation integration and reliability projects are discussed per Grid. In both instances, sites and servitudes are required

to accommodate substations and lines respectively. In either case, the Environmental Protection Act requires Eskom to conduct an Environmental Impact Assessment (EIA) and obtain environmental approval, which includes consultation with affected stakeholders, prior to construction.

Chapter 7 deals with the capital expenditure of the ten-year plan.

Chapter 8 deals with various conclusions based on the content of this document.



2. Load Demand Forecast and Generation Scenarios

2.1 LOAD FORECAST

Load forecasting is a fundamental requirement for a Transmission planning cycle. Availability of sufficient transmission network capacity in any country is important for economic growth. Grid Planning, in consultation with the relevant Distribution regions, compiles a forecast per point of supply for the network computer model.

The geographically differentiated loads indicate that the growth rates and load profiles differ substantially from one substation or area to another. The forecast that was used for the 2011 – 2020 TDP (2010 TDP) was developed using the 2009 July System peak load.

The effects of the economic crisis have resulted in a significant impact on the demand in late 2008 and early 2009. Hence the load forecast presented in this report indicates relatively smaller system load demand as compared to the load forecast used in the 2010 – 2019 TDP (2009 TDP). See Figure 2-1, on the next page, that illustrates the difference.

Due to the long lead times and EIA requirements, the transmission planning studies were based on this load forecast to provide enough time to initiate the necessary transmission infrastructure projects. The forecasted system peak demand for each year is given in Figure 2-1 on the next page including the percentage growth for each year for the latest forecast.

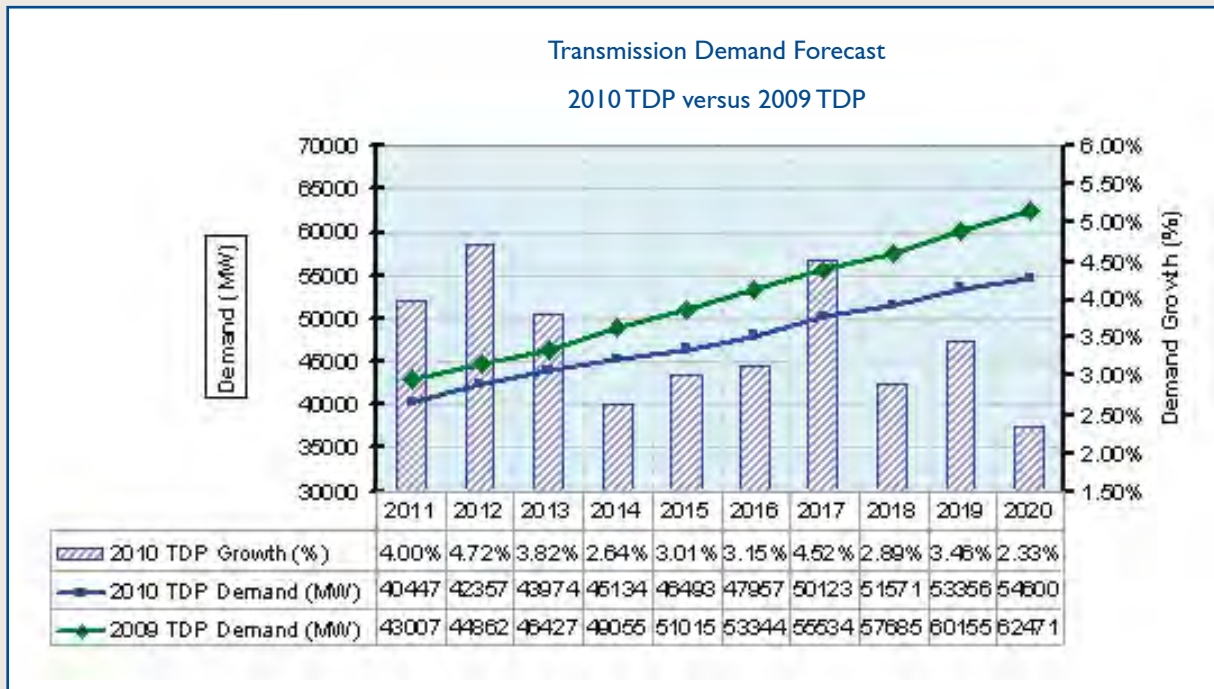


Figure 2.1: The Eskom Transmission System Demand Forecast

The planning studies for the TDP were based on meeting the 2010 TDP load forecast in Figure 2.1. Further monitoring and analysis of the load growth are being undertaken to determine more accurately the location of the new loads as a result of the economic recovery and progress on customer-initiated developments. For purposes of the TDP, loads are allocated to a CLN according to the location of the transmission substation supplying them, even if they are physically located in a different CLN.

2.2 GENERATION ASSUMPTIONS

The existing generation capacity was included as fully installed generation capacity in the year of the study. Cahora Bassa power import was modelled at a maximum of 1200MW. The future approved power plant integration projects were incorporated in the year in which they are expected to be commissioned.

The expected official release of the IRP was December 2009. In order to comply to the TDP process timelines, an assumed generation rollout has been detailed

based on the draft document "Integrated Resource Plan for Electricity 2009 Report – Version 1" which was compiled by the System Operations and Planning Division in October 2009. This draft document was anticipated to be in line with the IRP. The generation plan in this report was then compared with the official IRP and any significant variances were to be highlighted.

A number of scenarios were considered when developing the IRP. These were based on a reference plan with the impact of certain factors taken into account to develop the potential scenario. These scenarios were as follows:

- Reference plan
- Domestic emission (Emission Constraint 1)
- Regional emission (Emission Constraint 2)
- Delayed regional emission (Emission Constraint 3)
- Carbon Tax
- IPP alternates 1
- IPP alternates 2
- Lowest CO₂
- Policy portfolio
- Risk-adjusted emission portfolio (MYPD capacity)

Analysis of the various factors and the practicalities and likelihood of implementation of the different scenarios showed that the "Risk-adjusted emission portfolio (MYPD capacity)" scenario was the most likely one to manifest. This was the recommended and expected IRP scenario.

Therefore the TDP Generation Plan for the period 2011 to 2020 is based on this scenario as detailed in the IRP report. The detail of this plan is discussed below:

Return to Service stations

The Return-to-Service (RTS) units at Grootvlei and Komati power stations are approved projects which are assumed to be completed in 2010 and 2011 as per the project schedules.

DoE OCGT power stations

The IRP indicates that the Department of Energy (DoE) will implement the two OCGT power stations in 2011. These are assumed to be as previously proposed by the DoE with one close to the Dedisa MTS and the other close to the Avon MTS. They will be based on 147MW units and will be modelled as follows:

- 2 x 147MW units at Dedisa
- 5 x 147MW units at Avon

These are treated as peaking plant in the TDP studies and are used under contingency conditions or if required

during system peak, but for integration studies, they are studied at full output under system peak conditions to ensure that all the power can be evacuated.

REFIT Renewable Generation

The REFIT programme will be going out for procurement in the near future. The REFIT offers special tariffs for the following renewables:

- Wind
- Small hydro
- Landfill gas
- Concentrating solar thermal
- Solar photovoltaic

The total REFIT generation is expected to be 725MW, with wind generation allocated 400MW. There is presently no indication of the REFIT applicants that will be granted licences by NERSA, and they are widely dispersed geographically. The 325MW of REFIT stations other than wind are not modelled for purposes of the TDP due to the uncertainties surrounding both their location and output.

The 400MW REFIT Wind may be a small number of large wind farms or a large number of small wind farms. This makes it difficult to model in the transmission network files. Based on the location of wind and applications for wind generation connection, it has been decided to model the 400MW as four representative wind farms



of 100MW which represent a cumulative total of generation at that point. They are connected directly to the 132kV busbars of existing MTS substations.

The four MTS substations are:

- Juno (2011)
- Proteus (2011)
- Aurora (2012)
- Bacchus (2012)

In addition, it is assumed that the Eskom 100MW wind farm at Sere will also be established in 2011 and integrated as per the study proposal.

Since these are intermittent sources of generation in the TDP studies, they are studied under two conditions, namely:

- Zero output at system peak
- Full output at system peak

This is to determine the capacity and potential weakness under both generation conditions.

It is acknowledged that significantly more wind generation may be connected to the network before 2020. However, it is difficult to determine the exact transmission requirements for the TDP without the actual location and size of the wind farms. Taking into account that the normal average load factor of wind farms is of the order of 35%, this means that they will not have a significant impact on the capacity design of the network. The applications for wind farms will be handled on a case by case basis, but only the above allocated 500MW of wind generation has been included in the TDP studies.

Moamba OCGT Generation

The Moamba project is a proposed OCGT power station in Mozambique, situated approximately 30km from the South African border near Komatipoort. The power station will be integrated by looping in the existing 275kV line to the site. In addition, a new 60km

400kV line energised at 275kV will be constructed from the Moamba site directly to the 400/275kV substation in Maputo. A new 275kV line (60km) between the Moamba site and the Infulene substation in Maputo is also proposed.

The Moamba total capacity is 664MW, modelled as two 332MW units. This will be a base load power station which will be run during system peak, but can be scaled down during low load conditions if required.

Ingula pumped storage

The Ingula pumped storage power station is an approved project which is assumed to have units 1 and 2 completed in 2013 and units 3 and 4 completed in 2011 as per the project schedule.

Base Load Coal

The Base Load Coal power stations at Medupi and Kusile are approved projects; the new units of which are assumed to be completed between 2012 and 2017 as per the project schedules and in line with the IRP.

An additional base load coal power station is required, which is assumed to be the proposed Coal 3 power station at Lephalale, close to the Medupi site. The first unit will come on line in 2017 with an additional unit each year until there are 4 units by 2020. This is in line with the IRP. The assumed size is 750MW units with a projected sent out power of 714MW per unit.

Nuclear I Generation

The Nuclear I site, selected for the purposes of the TDP, is the Thuyspunt site near Port Elizabeth. Although it is acknowledged that the site selection has not been completed, the Thuyspunt site is the preferred site from a transmission aspect. The initial unit size is assumed to be a 1500MW unit for the purposes of the TDP studies in line with the IRP assumption. Obviously, the integration requirements will change if a different site is selected, and may change if the size or the number of units change.

Co-generation Projects and MTPPP

There are a number of initiatives to introduce co-generation projects into the Eskom power system. These have the effect of essentially reducing the demand at the point on the network where these co-generation plants are connected. However, the network is still required to be able to supply the load if the co-generation plant is not in service.

As a result, they do not have a significant impact on the network capacity design. In certain cases, the co-generation may exceed the local load and the power transfer into the system will have to be accommodated. These will have to be treated on a case by case basis to determine if they will have a significant impact on the network. Therefore co-generation projects were not considered for the TDP studies.

One specific programme is the MTPPP programme which offers PPA contracts to any generators that fall below a certain price level. The expected level of the MTPPP generation in the IRP is around 420MW. Except for one large co-generation project and one medium size co-generation project, the rest are all below 20MW. Effectively, these are all co-generation projects and are therefore not included in the transmission network model for the TDP studies. Instead they will be treated on a case by case basis as specified above.

Embedded Generation

There are a number of embedded municipal generation power plants within the network such as Kelvin in Johannesburg and Rooiwal in Tshwane. These have been accounted for in the load demand forecast and are assumed to be available. No communication is known with regard to these embedded generation plants increasing output, reducing output or shutting down within the TDP period. In the IRP, allowance is made for some generation reduction, but there is no correlation or allocation to specific power station units. Therefore these reductions are ignored for the transmission network model.

It is the responsibility of the relevant Eskom Chief Planning Engineers to identify if there will be any change to the embedded generation within their respective grids within the TDP period. Changes in the embedded generation will only be accounted for and included in the TDP studies if there is a high level of confidence in the changes.

Demand Side Management programmes

The IRP has a large component of Demand Side Management (DSM) which is proposed to exceed 5000MW by 2020. However, there are no details provided on how and more importantly where this DSM will be achieved. If such a large amount of DSM is achieved, it would have effectively altered consumer behaviour and should be reflected in the load forecast. The transmission grid is still required to be able to supply the projected load demand in case the DSM does not materialise. The DSM is therefore not considered for the purposes of the TDP studies for the period 2011 to 2020.

Imported Power Options

Several generation project opportunities in the Southern African region are currently being actively investigated and pursued by Eskom to identify which projects could be economically and strategically justified. However, the IRP did not consider any significant levels of imported power by 2020 other than the Moamba OCGT project and no other imports will be considered for the purposes of the TDP studies apart from existing plant (e.g. Cahora Bassa).



Potential imported power projects were treated as separate sensitivity analysis studies in the 20 year transmission strategic grid studies.

Any promising imported power projects can then be included and incorporated in future TDP updates once a sufficient level of confidence in the timing and implementation is attained.

New Generation summary

A summary of the new plant and the year that the last unit at the power station becomes commercially available is given in Appendix A. These generation units were assumed to be in service at the expected dates.

This is graphically illustrated in Figure 2 2 below and Figure 2 3 on the next page.

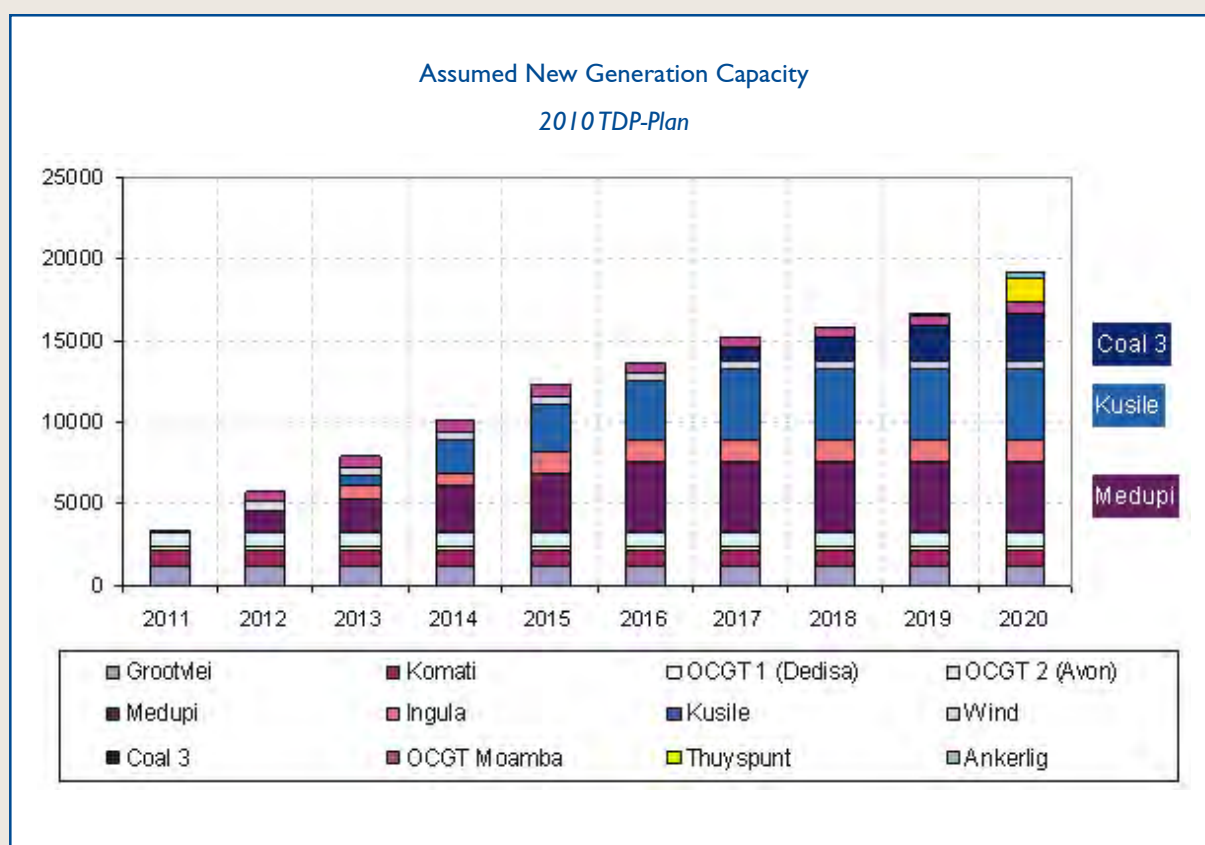


Figure 2.2: Power station capacity introduction by year

The proposed OCGT IPP plants to be provided by the Department of Energy (DOE) are not specifically included in the studies. However, the two known sites in the East and South Grids have been studied, and effectively, only the feeder bays at the relevant Eskom MTS substations are required to integrate them into the network.

These plants are designed for operation only during

peak load periods or during emergencies, making it necessary to plan the network to meet local load without them being available for use.

It is also acknowledged that the Tubatse (or Lima) pumped-storage scheme project near Steelpoort has been put on hold, but most of the infrastructure will still be required for system reliability purposes in order to meet the needs of local loads.

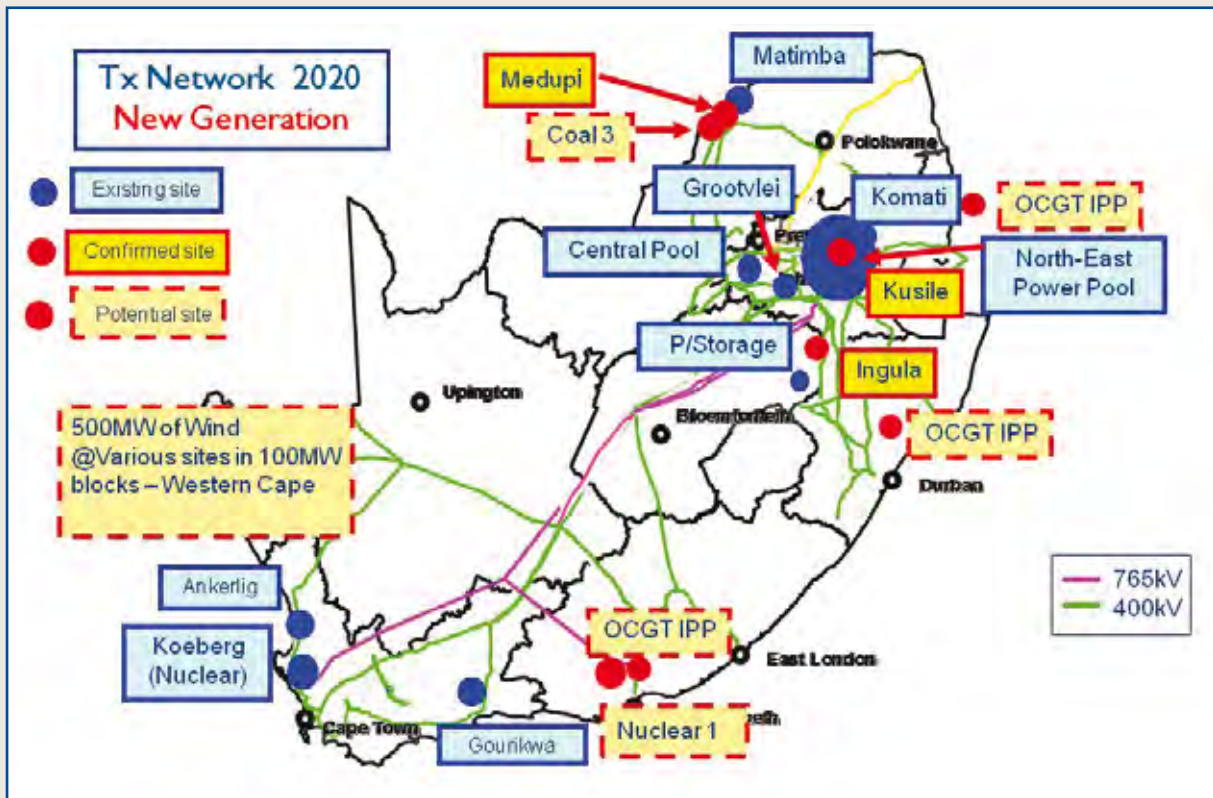


Figure 2.3: Planned Power Station Capacity by 2020

3. Major Factor Changes from Previous TDP

There have been some changes in the factors influencing the selection and timing of projects for the TDP from the previous TDP. The main factor was related to an even better understanding of the geospatial load centres and forecast, and the potential generation scenarios.

These two factors are briefly discussed in this section as background to the motivation of the projects and their timing in the TDP.

3.1 GEOSPATIAL LOAD FORECAST

The effects of the economic crisis have resulted in a significant impact on the demand in late 2008 and early 2009. Hence the load forecast presented in this report indicates relatively smaller system load demand as compared to the load forecast presented last year.

The changes in the Load Forecast from the previous TDP are also due the revised/improved allocation of the expected load and load growths at the relevant load busbars based on a geospatial analysis of the load developments. These changes were based on the strategic grid planning analysis and newly available information.

As a result, some of the load has moved between substations and the need for new substations has been identified. The improved distribution of the demand forecast resulted in a number of new projects being required within the TDP period as well as several of the projects identified in the previous TDP being reconfigured or re-phased. These changes were undertaken in consultation with the Transmission Grids, Distribution and the major Metro authorities.

3.2 GENERATION ASSUMPTIONS

The major change in the generation assumptions from the previous TDP is the inclusion of Wind Generation.

The Coal 3 generation is still assumed to be in the Waterberg area, close to Medupi and in line with the current project development with the target date for the first units in 2016. The integration of the first units at Coal 3 will utilise the new Delta 765/400kV substation and the Delta-Epsilon lines will be energised at 765kV.

It is proposed to implement two HVDC schemes with a HVDC converter station in the vicinity of Coal 3 to cater for the final configuration of six 750MW units. Coal 4 is assumed to be out of this TDP period.

The HVDC lines will connect to HVDC rectifier terminal stations in Gauteng and Kwa Zulu Natal (Central and East Grids).

Nuclear 1 is considered, as in the previous TDP, to be located at the Thuyspunt site.

4. Completed Projects Since Last TDP

This chapter contains a list of projects completed since the last TDP. A project may consist of a number of sub-projects, which may be placed into commercial operation before the entire project is completed. This is done to ensure that the network and customers enjoy the benefits of the new assets as soon as practicable.

4.1 COMPLETED GENERATION INTEGRATION PROJECTS

According to the Transmission Ten-Year Plan 2010-2019, some RTS power stations were anticipated to be completed in 2010. Parts of some of these projects have since been completed, and the resultant benefits are being realised. The completion status of the projects is as follows:

Grootvlei RTS: generator bays 5 and 6 are still outstanding and completion is anticipated in the 2011/12 financial year.

Komati RTS: generator bays 4, 5, 6, 7, 8 and 9 are still outstanding, and completion is anticipated in the 2011/12 financial year. Unit 3 was commissioned.

4.2 UPDATE ON TRANSMISSION RELIABILITY

This section discusses all the projects that were reflected in the Transmission Ten-Year Plan 2010-2019

for commissioning in FY2010/11. Over and above that, there are other projects that were not mentioned in that plan (due to the fact that they were near completion) that have since been concluded.

Central Grid

The installation of the 3rd and 4th transformers at Lepini substation is completed.

The transformers that were planned to be commissioned in 2010 were at Croydon, Eiger and Esselen substations. Esselen has been completed. Croydon and Eiger are outstanding.

Western Grid

There were no projects planned to be commissioned in 2010/11.

East Grid

The construction of the Majuba Umfolozi 400 kV (765 kV design) is completed.

The transformers that were planned to be commissioned in 2010 were at Hector and Eros substations. Both these projects have been completed.

North East Grid

The projects for the installation of additional

transformation capacity at Malelane and Marathon substations are in progress. The 400kV line projects planned to be commissioned in 2010 have not been completed.

North Grid

The planned Spitskop, Marang, Witkop and Spencer transformer projects for 2010/11 are completed.

South Grid

There were no projects planned to be commissioned in 2010/11.

North West Grid

There were no projects planned to be commissioned in 2010/11.

4.3 GRID CONNECTIONS APPLICATIONS

Table 4.1 outlines the number of Indicative Quotations (IQ's), Feasibility Quotations (FQ's) and Budget Quotations (BQ's) that have been processed during the period January 2010 to December 2010. These are as a result of applications for grid connections, as per the Grid Code.

Grid	Indicative Quotations		Feasibility Quotations		Budget Quotations	
	Issued	Accepted	Issued	Accepted	Issued	Accepted
Central	0	8	6	4	3	
East	0	2	1	1	1	
North East	4	9	4	3	2	
North West	3	0	0	0	0	
North	2	15	5	0	0	
South	11	3	0	2	2	
West	16	3	2	3	2	
Total	36	40	18	13	10	
% Acceptance			45%		77%	

Table 4.1: Connection Applications Quoted and Accepted

As shown in Table 4.1 above, the number of customer applications for grid connections processed is fairly high. Acceptance rates have increased when compared to last year. Furthermore, analysis and consultation with customers is required to understand

opportunities to improve this performance. There have been a high number of Indicative Quote applications (most of the 36 applications above) received to connect Renewable Energy Generation onto the Transmission Grid.

5. National Overview

The map in Figure 5.1 below shows a high-level view of the major TDP scheme projects where the

relative location of the new transmission lines and the associated MTS substations are indicated schematically.

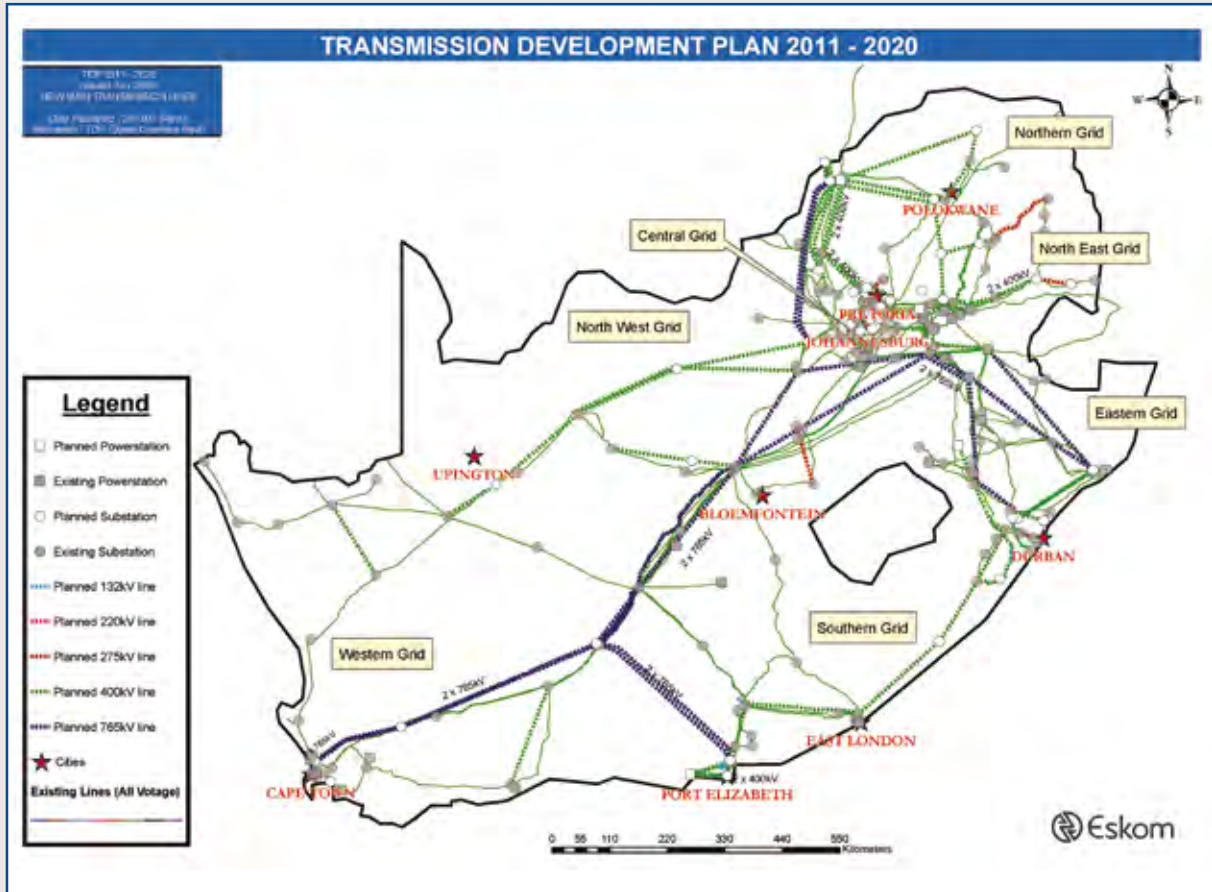


Figure 5.1: Map showing relative location of the major TDP scheme projects

A summary of the major new assets that are either approved or proposed to be added to the transmission system over the next ten years are listed in Table 5.1 on the following page.



TDP New Assets	Total
HVDC Lines (km)	1,700
765kV Lines (km)	6,085
400kV Lines (km)	8,083
275kV Lines (km)	741
Transformers 250MVA+	100
Transformers <250MVA	28
Total installed MVA	72,390
Capacitors	30
Total installed MVA	2,812
Reactors	63
Total installed MVA	14,903

Table 5.1: Major TDP transmission assets expected to be installed

A significant amount of new transmission lines is being added to the system with over 6,000 km of 765kV and over 8 000 km of 400kV lines either approved or proposed over the 10-year TDP period. This is mainly due to the major network reinforcements required for the supply to the Cape (South and West Grids) and Kwa Zulu Natal (East Grid). The integration of new power stations in the developing Limpopo West Power Pool (Medupi and Coal 3 close to Matimba and the IPP Mmamabula in Botswana) also require significant lengths of transmission line as they are very remote from the main load centres. New HVDC lines are required to export the excess power from Coal 3 in the Waterberg directly to load centres in Gauteng and Kwa Zulu Natal (Central and East Grids) requiring 1 700km of 800kV constructed HVDC lines.

The large amount of 400kV transmission line is also as a result of a more meshed transmission 400kV network

being developed to provide higher reliability and thus improve the levels of network security.

These new transmission lines form part of the long-term strategy to develop a main transmission backbone from which regional power corridors can be supported. These power corridors will connect generation pools to each other and to the major load centres in the country. This backbone and regional power corridor network structure will allow for the increasing system demand to be supplied and the power from new power stations to be integrated more efficiently into the transmission network and distributed where required, both under system healthy and system contingency conditions.

The development of the transmission backbone and the associated regional power corridors was reviewed as part of the Strategic Grid Study which considered the potential development scenarios beyond the 10-year

horizon of the TDP up until 2030. The objective of this strategic study was to align the transmission network with the requirements of the generation future options and the growing and future load centres. This Strategic Grid Study has enabled the 10- year TDP to be aligned with the future long-term development of the whole Eskom system.

The addition of over 72 000 MVA of transformer capacity to the transmission system is an indication of both the increasing load demand and the increasing firm capacity requirements of the customers. Approximately 2 800 MVars of capacitive support are required to support areas of the network under contingency conditions to ensure that the required voltage levels are maintained. They also improve system efficiency by reducing network losses.

Approximately 14 900 MVars of reactors are a direct result of the long lengths of both 765kV and 400kV

transmission lines that will be constructed over this period. There are also a number of series compensation projects required on the 765kV and 400kV lines required to improve the power transfer capability of the Cape power corridors.

Two new SVCs are proposed to support the Northern Cape (West Grid) and the proposed Sishen-Saldanha Spoornet expansion, namely a +200/-100 MVar SVC at Aries and a smaller one of +45/-100 MVars at Garona.

Some projects have associated distribution projects to enable customers to benefit from them. For example, a new MTS substation may require distribution infrastructure to link it to the existing distribution network or to connect new bulk loads. Distribution infrastructure and individual feeder bays to connect distribution infrastructure or bulk loads are not reported on individually in this report.



6. Breakdown of the TDP Projects by Grid

6.1 CENTRAL GRID

The Central Grid consists of four customer load networks (CLNs), namely; Johannesburg, Vaal Triangle, West Rand and Nigel. The current transmission network and CLNs are shown in Figure 6.1 below.

The expected peak CLN demands by 2020 and the average percentage load increase for the period for each CLN are given in Table 6.1 on the following page.

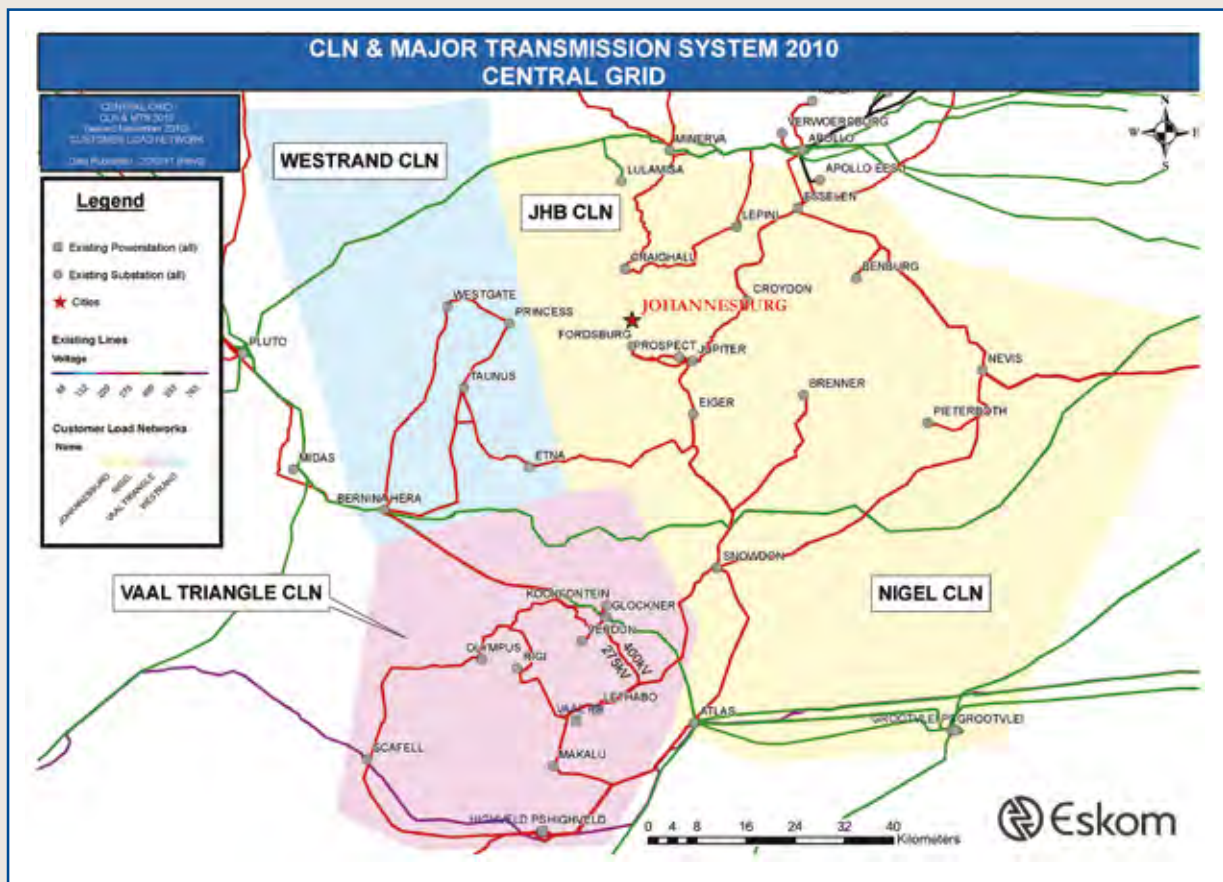


Table 6.1: Current Central Grid network and CLNs



CLN	Actual Peak Load 2009 (MW)	Forecasted Load (MW)			Ave. Annual % Load Increase
		2011	2016	2020	
Johannesburg	4202	4432	5720	6550	4.2
West Rand	1980	2221	2287	2553	1.4
Nigel	1668	1907	1979	2082	1
Vaal Triangle	1262	1459	1560	1627	1.1

Table 6.1: Central Grid CLN load forecast and percentage load increases

The TDP schemes for the Central Grid consist of extending the 275kV network (built at 400kV insulation level to allow for future upgrade to 400kV) the installation of additional transformers at existing substations, as well as the construction of seven new

substations. The integration of Medupi and Kusile power stations will result in the Central Grid 400kV network being strengthened as well. The increase in transmission assets by end 2015 and end 2020 and the cumulative total is shown in Table 6-2.

Transmission Assets for Central Grid	New Assets expected in 2011 - 2015	New Assets expected in 2016 - 2020	Total New Assets expected
Total kms of line	623	329	952
765kV Lines (km)	0	0	0
400kV Lines (km)	597	295	892
275kV Lines (km)	26	34	60
Total installed Transformer MVA	3,095	6,340	9,435
Transformers (no. of)	8	14	22
Capacitors (no. of)	8	0	8
Reactors (no. of)	0	0	0

Table 6.2: New transmission assets for the Central Grid

6.1.1 JOHANNESBURG CLN

Especially in the Lulamisa and Lepini supply areas, Johannesburg North and Midrand respectively, the energy growth has been increasing for the past five years at 5.7% per annum with an associated increase of 6% per annum in the demand. The Lepini 3rd and 4th 275/88kV 315MVA transformer and Lulamisa 400/88kV 315MVA were commissioned in 2009. The City Power substations Delta, Fordsburg and Prospect will also be experiencing considerable load growth. The Kelvin power station is still assumed to be in service as City Power have not formally notified Eskom of any change in status.

The type of load supplied by the Johannesburg CLN is very important in terms of the profile of the businesses

in the area, including many national and regional company head offices. There is also considerable residential development for all income groups, as well as new shopping centres and office parks. The main growth in business activity is in the services industries and head or regional offices.

The main projects in the Johannesburg CLN are described below. Almost all of the projects are the same as those in the previous ten-year plan but most of the dates have changed. This is due to a number of reasons such as increased certainty where projects are done in collaboration with customers, delays in servitude acquisitions and reprioritisation of projects. A similar trend is noticeable for all other grids and CLNs.

Croydon Transformation strengthening

- Third 275/132kV 250MVA transformer at Croydon MTS 2010

Johannesburg North – Phase 2 Network Strengthening

- Apollo-Lepini 275kV line 2013
- Lepini Ext 275kV 2x 150MVar capacitors 2012

Johannesburg Reactive Power Project

- Eiger and Jupiter 88kV 48MVar shunt capacitor bank 2012
- Croydon and Benburg 132kV 72MVar shunt capacitor 2012

Decommissioning of the Apollo 400kV fault limiting reactors

- Decommissioning of the Apollo 400kV fault limiting reactors 2012

Johannesburg East Strengthening

- **Phase 1A:** Esselen MTS Strengthening 2010
 - o 2nd 275/88kV 315MVA transformer
- **Phase 1B:** Esselen MTS Strengthening 2015
 - o Operate Esselen-North Rand No.1 132kV line (16km) at 275kV and line bank 1x 275/132kV 500MVA transformer at Northrand MTS from Esselen MTS.
- **Phase 2:** North Rand MTS Strengthening 2016
 - o Construct 400kV Busbar operated at 275kV
 - o Operate Esselen-North Rand No.2 132kV line (16km) at 275kV and connect 1st and 2nd 275/132kV 500MVA transformers to Northrand MTS 275kV busbar.

Johannesburg East Strengthening *continued*

- **Phase 3 A-D:** Jupiter B MTS Integration 2014
 - o Matla- Jupiter B 1&2 400kV (150km) operated at 275kV.
 - o New Jupiter B MTS with 10x 275kV line bays and 275kV busbar (New 400/275kV MTS site required to contain 4x 400/275kV transformers)
 - o Turn the Matla - Esselen 275kV line and Matla – Benburg 275kV line into Nevis MTS and disconnect section of Matla Nevis section of the Matla - Benburg and Matla - Esselen 275kV Line
 - o Apollo - Esselen 3 400kV (12km) operated at 275kV.
- **Phase 3 E-F:** Sebenza Integration 2017
 - o New 400kV Sebenza MTS operated at 275kV.
 - o Loop-in the Sebnza -Prospect 1 and 2 275kV line (loop-in built at 400kV) and Jupiter - Fordsburg 275kV and Jupiter – Prospect 275kV line into Jupiter B MTS.
 - o Construct 2x 400kV lines from North Rand to Sebenza MTS.

Soweto Strengthening Phase 1 (built at 400kV, operated at 275kV)

- Establish new Quattro MTS 275kV *busbar 2014
- Build 2x 275kV Quattro-Etna 15km *lines 2014

Soweto Strengthening Phase 2 (built at 400kV, operated at 275kV)

- Establish Quattro 1 32kV yard with 2x500MVA 275/132kV transformers 2016

Simmerpan MTS Strengthening – Phase 1 (built at 400kV, operated at 275kV)

- Construct 400kV Busbar operated at 275kV at new Simmerpan MTS 2015
- Operate Jupiter –Simmerpan 1&2 88kV line at 275kV and connect 1st and 2nd 275/88kV 160MVA 2015

Simmerpan Strengthening – Phase 2 (built at 400kV, operated at 275kV)

- Establish Simmerpan 1 32kV yard with 2x250MVA 275/132kV transformers 2016

Kyalami 400kV Strengthening

- Construct Kyalami 400/132kV GIS MTS 2014
- Loop Kusile - Lulamisa 400kV line into Kyalami MTS 2014
(This is dependent on Kusile Integration)

HVDC Terminal B

- Establish an HVDC converter station close to Jupiter B MTS 2017
- Build an 800kV HVDC line from Terminal B to Coal 3 via Selemo (Epsilon) 2017



6.1.2 WEST RAND CLN

This CLN consists of six transmission substations supplying both residential and industrial loads. The load growth in this CLN is stable; no new large loads are expected. The main projects in the West Rand CLN are as follows:

Establishment and Integration of Demeter 400 kV Substation

- Install new Demeter 400/88kV MTS 2x 315MVA transformers.
- Loopin the Proposed Verwoerdburg – Pluto 400kV 400kV line into Demeter 400kV(30km) 2015

West Rand Reinforcement

- Westgate B 400/132kV substation (1st 500MVA transformer) 2017
- Hera-Westgate B 1st 400kV line 2017
- Taunus-Westgate B 1st 400kV line 2017
- Taunus Ext 400/132kV transformation (1 x 500MVA) 2017
- Etna-Taunus 1st 400kV line (energised @ 400kV) 2017
- Glockner-Hera 1st 400kV line 2017
- Glockner-Enta 1&2 400kV lines operated at 400kV 2017
- 400kV Busbar at Etna S/S 2017
- Construct Etna 2x800MVA 400/275kV 2017

6.1.3 NIGEL CLN

This CLN consists of six substations which are supplied from Lethabo power station (via Brenner), Matla power station (via Nevis and Benburg) and Kriel (via Zeus-Grootvlei). Grootvlei and Benburg show considerable load increases.

In 2013, load will be moved from Snowdon to Kookfontein, thus reducing the loading on Snowdon.

The main projects in the Nigel CLN are as follows:

Snowdon Transformation Upgrade

- Replace 4x 275/88kV 90MVA with 3x 160MVA transformers 2012

Benburg Transformation Strengthening

- Install a third 275/132kV 250MVA transformer at the Benburg MTS 2016

Nevis Transformation Strengthening

- Install a third 275/132kV 500MVA transformer at the Nevis MTS 2017

Siluma 275/88kV MTS Establishment

- Establish new Siluma MTS 2017
- Loop the Lethabo–Eiger, Snowdon–Brenner into Siluma 2017
- Loop the Brenner–Eiger 275kV line into Siluma 2017
- Install 2x 275/88kV 315MVA transformers 2017

6.1.4 VAAL CN

This CLN consists of seven transmission substations and one power station supplying both residential and heavy industrial loads. The anticipated high load growth nodes are at Makalu and at Kookfontein MTS. The main projects in the Vaal CLN are as follows:

Vaal Strengthening Phase I (Closing of the Hera-Bernina 275kV link)

- Uprating of terminal equipment at Hera, Bernina, Taunus, Princess, Westgate, Glockner, Kookfontein, Verdun and Scafell S/S
 - Bernina S/S refurbishment
 - Glockner 3rd 400/275kV 800MVA transformer
 - Glockner 275kV Busbar replacement to tubular
- 2011

Vaal Strengthening Phase 2 (Glockner-Etna 2x400kV lines operated at 275kV)

- Glockner-Etna 1&2 400kV lines operated at 275kV
 - 2x 275kV lines bays at Glockner S/S
 - 2x 275kV lines bays at Etna S/S
- 2011

Kookfontein Transformation Phase I strengthening involves the addition of 2 x 88kV 48 MVAR capacitor banks at Kookfontein substation.

2011

Kookfontein Transformation Phase 2 strengthening involves the 3rd 275/88kV 315MVA transformer and 3rd Glockner Kookfontein 275kV line (Customer dependent)

2015

A network diagram showing the major projects in the Central Grid is shown in Figure 6.2 below:

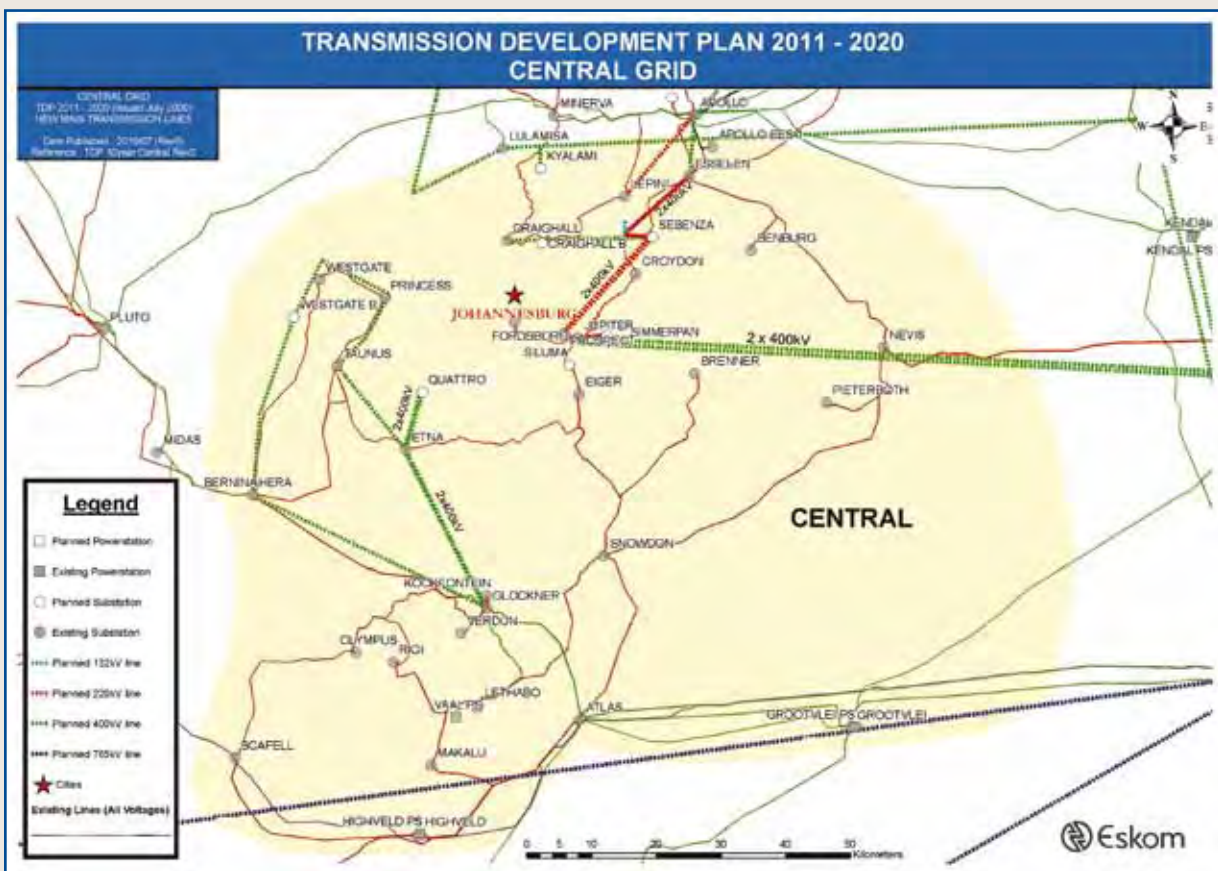


Figure 6.2: Central Grid network diagram

6.2 EAST GRID

The East Grid consists of four CLNs namely, Ladysmith, Newcastle, Empangeni and Pinetown. The current transmission network and CLNs are shown in Figure 6.3 below.

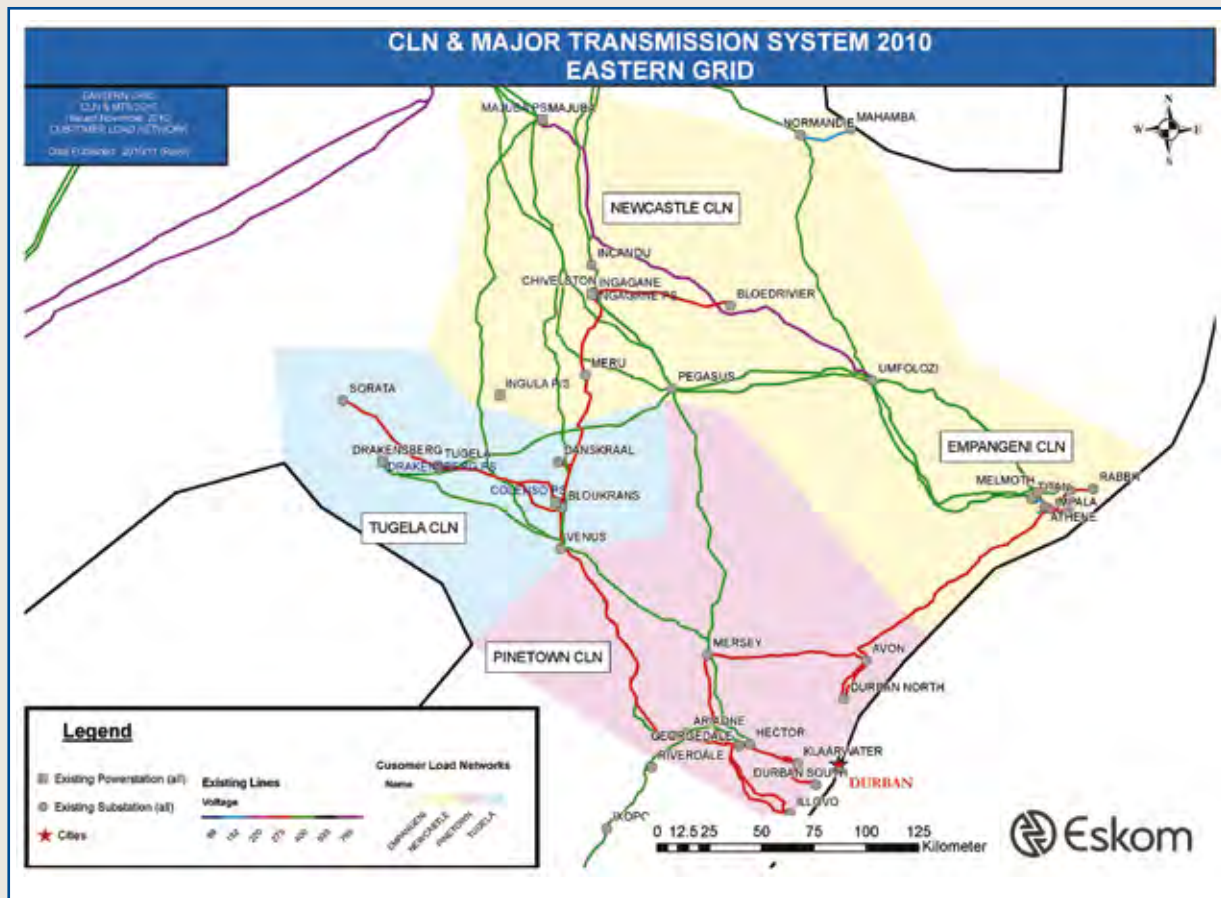


Figure 6.3: Current East Grid network and CLNs

The expected area peak demands by 2011, 2015 and 2020 and the average percentage load increase for the period for each CLN are given in Table 6.3 below.

CLN	Forecasted Load (MW)			Ave. Annual % Load Increase
	2011	2016	2020	
Ladysmith and Newcastle	1292	1390	1590	2.3 %
Empangeni	2227	2308	2638	2.7%
Pinetown	3515	3777	4490	3%

Table 6.3: East Grid CLN load forecast and percentage load increase

The TDP scheme projects for the East Grid consist primarily of the strengthening of the 400kV networks that transmits power into Empangeni and Pinetown CLNs and the introduction of 765kV. In addition to the above TDP scheme projects, there are other projects that are listed in the project summary list which are required to strengthen the network.

The increase in transmission assets by end-2015 and end-2020 and the cumulative total are shown in Table 6.4.

Transmission Assets for Eastern Grid	New Assets expected in 2011 - 2015	New Assets expected in 2016 - 2020	Total New Assets expected
Total kms of line	1,310	392	1,702
765kV Lines (km)	580	280	860
400kV Lines (km)	730	107	837
275kV Lines (km)	0	5	5
Total installed Transformer MVA	9,295	7,710	17,005
Transformers (no. of)	10	10	20
Capacitors (no. of)	0	0	0
Reactors (no. of)	6	2	8

Table 6.4: East Grid new transmission assets

6.2.1 LADYSMITH and NEWCASTLE CLNs

The Ladysmith and Newcastle CLNs are agricultural, with coal mining and associated industries in the Newcastle CLN. The Tugela third transformer project in the previous ten-year plan has been cancelled as load can be shifted to other stations during contingencies. The following projects are planned:

Strengthening in these CLNs entails addressing N-1 transformer contingencies and they are as follows:

- Looping into Bloukrans, the Venus – Tugela 275kV Line 2013
- Normandie 2nd 250MVA - 400/132kV transformer 2013
- Incandu 3rd 315MVA - 400/132kV transformer 2014
- Normandie 3rd 160MVA - 400/88kV transformer 2016

As part of the Generation plans, there is a project to integrate Ingula Power station in 2012 as follows:

- Loop in Majuba - Venus 400kV Line
- Construct new Ingula - Venus 400kV Line

6.2.2 EMPANGENI CLN

The Empangeni CLN consists mainly of industrial load. The load profile for this area is fairly flat. There are four 400kV lines that supply power into this network, with 275kV lines linking this CLN to the Pinetown CLN via Impala substation. The following strengthening is proposed:

Empangeni Strengthening Phase 1 (under construction)

- Completion of the Majuba-Umfolozi 765kV line operated at 400kV 2010

Empangeni Strengthening Phase 2

- Establish Theta 400kV switching station 2013
- Construct Umfolozi-Theta 765kV line to be operated at 400kV 2013
- Loop Umfolozi-Athene 400kV line into Theta 2013
- Loop Umfolozi-Invubu 400kV line into Theta 2013
- Construct Theta-Invubu 400kV line 2013

Empangeni Strengthening Phase 3

- Establish Lambda 400/765kV substation next to Majuba Power Station 2015
- Establish 765/400kV at Mbewu (Theta)
- Convert Majuba - Umfolozi – Mbewu (Theta) line to Lamda – Mbewu (Theta) and operate at 765kV

Pinetown-Empangeni Interconnection (previously Pinetown Phase 3)

- Construct Sigma–Theta 400kV first and second Lines (double circuit) 2015

Empangeni Strengthening Phase 4

- Establish 400/765kV at Camden 2016
- Construct Camden – Mbewu (Theta) 765kV line to be operated at 765kV
- Install 2nd 765/400kV Transformer at Mbewu (Theta)

6.2.3 PINETOWN CLN

The Pinetown load is mostly residential and commercial in nature. There are four 400kV and two 275kV lines that supply power into this network. As mentioned under Empangeni CLN, the Pinetown and Empangeni CLNs are linked with a 275kV line via Avon substation. The following major projects are planned:

Pinetown Strengthening Phase 1

- Establish Sigma 400kV switching station 2013
- Construct Majuba-Sigma 765kV (via Venus) line operated at 400kV 2013
- Construct new Sigma-Hector 2x 400kV lines. 2013

Pinetown Strengthening Phase 1B

- Recycle Venus –Georgedale line into second Venus–Ariadne 400kV line

Pinetown Strengthening Phase 2

- Establish 765/400kV at Sigma 2015
- Convert Majuba-Sigma line to Zeus-Sigma and operate at 765kV 2015

A geographical network diagram indicating the major projects in the East Grid for the ten-year period is shown in Figure 6.4.

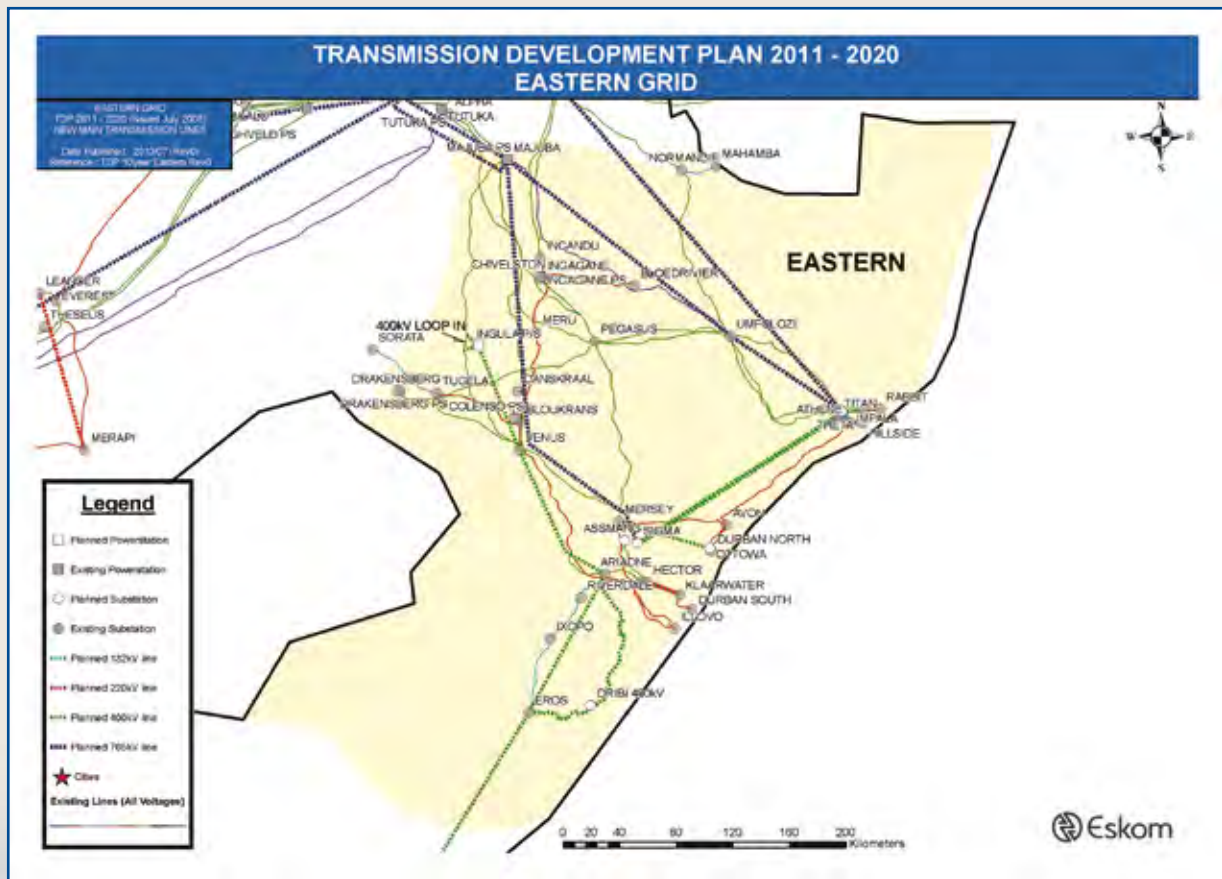


Figure 6.4: East Grid geographical network diagram



6.3 NORTH GRID

The North Grid consists of five CLNs namely, Waterberg, Rustenburg, Lowveld (northern part), Warmbad and Polokwane. The current transmission network and CLNs are shown in Figure 6.5 below.

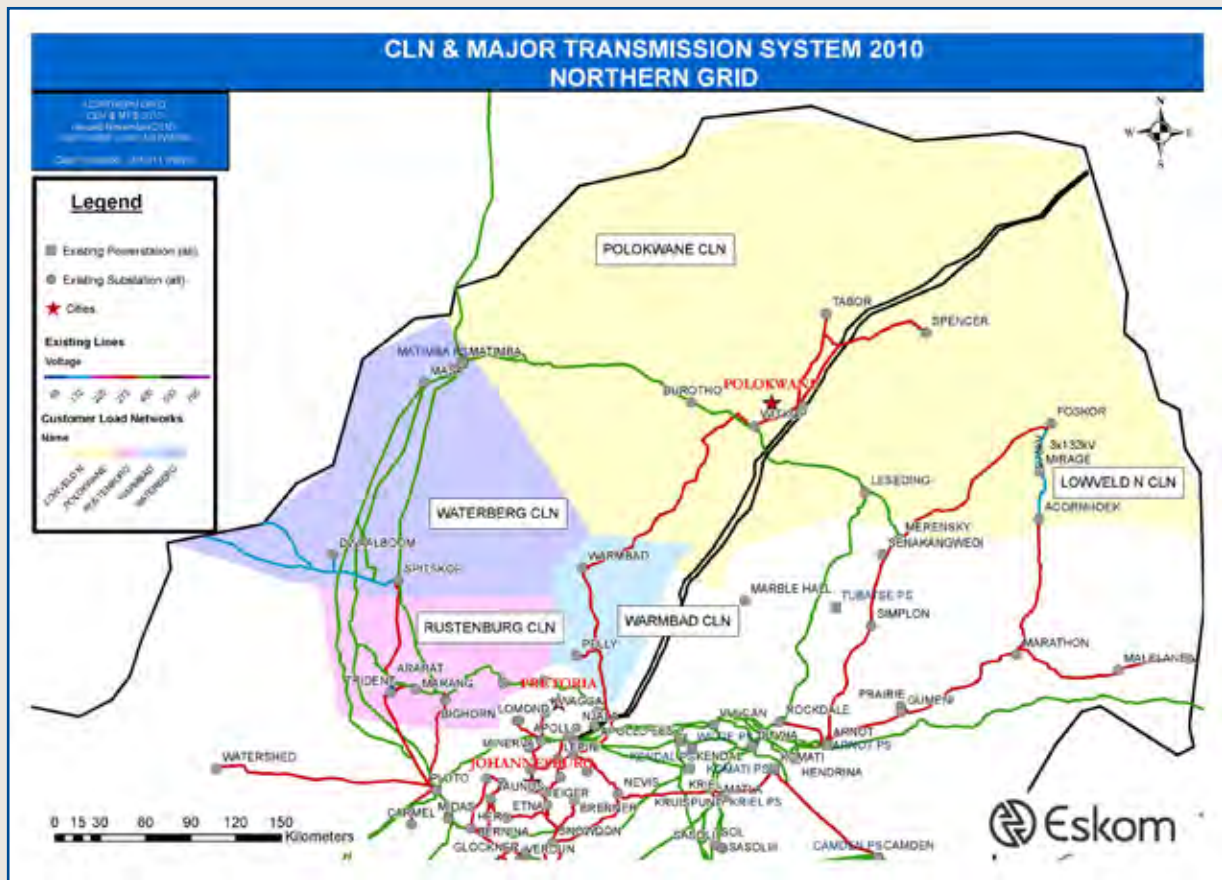


Figure 6.5: Current North Grid network and CLNs

The expected peak demands by 2016 and 2020 and the average percentage load increase for the period for each CLN are given in Table 6.5 below.

CLN	Peak Load (MW) 2009	Forecasted Load (MW) 2016	Forecasted Load (MW) 2020	Ave. Annual % Load Increase
Waterberg	544	1107	1443	9.78
Rustenburg	1704	2438	2732	4.43
Lowveld North	1456	2099	2315	4.39
Warmbad	271	243	261	-0.23
Polokwane	1177	1712	1808	4.16

Table 6.5: North Grid CLN load forecast and percentage load increases

The Northern Grid load growth is mainly due to platinum group metals (PGM) and ferrochrome mining and processing activities located in the Rustenburg, Polokwane and Steelpoort areas. The load demand for the years from 2009 to 2020 is expected to reflect the average annual percentage load increases shown in Table 7-3-1 above.

The TDP Scheme Projects for the Northern Grid consist of extending the 400kV and 275kV networks as well as establishing the 765kV network, the integration of two power stations (Medupi and Coal 3) and the installation of additional transformers at existing and new substations.

These main schemes are as follows:

- Tabor and Spencer in the Polokwane area consists of 275kV and 400kV reinforcements.
- Rustenburg 400kV reinforcement.
- Medupi and Coal 3 power stations 400kV and 765kV integration.
- Brits 400kV reinforcement.

The TDP scheme projects for the North Grid consist of extending the 400kV and 275kV networks as well establishing the 765kV network, the integration of two power stations (Medupi and Coal 3), and the installation of additional transformers at existing and new substations. The increase in transmission assets by end-2015 and end-2020 and the cumulative total are shown in Table 6.6.

Transmission Assets for Northern Grid	New Assets expected in 2011 - 2015	New Assets expected in 2016 - 2020	Total New Assets expected
Total kms of line	2,816	820	3,636
765kV Lines (km)	700	0	700
400kV Lines (km)	2,116	670	2,786
275kV Lines (km)	0	150	150
Total installed Transformer MVA	3,820	9,500	13,320
Transformers (no. of)	10	8	18
Capacitors (no. of)	0	0	0
Reactors (no. of)	6	2	8

Table 6.6 North Grid new transmission assets

6.3.1 WATERBERG CLN

The Waterberg CLN contains the Medupi 4800MW coal-fired power station that is under construction.

The Waterberg coal bed extends westwards across the Limpopo River to neighbouring Botswana. The shallow coal deposits in the Waterberg area have attracted extensive explorations that have resulted in an independent power producer proposing to establish the Mmamabula power station some 80km west of Medupi. At one stage, this was proposed to be 4200MW, but it has now been reduced to 1200MW, which is currently under negotiation for a power purchase agreement. However, the first unit at Mmamabula is now only expected to be commissioned in 2021 or later, and is hence excluded from the TDP.

The Waterberg generation pool will integrate with the Polokwane, Rustenburg, West Rand, and Brits areas through 400kV and 765kV lines. The 400kV lines will radiate to substations within 300km, and beyond 300km, the 765kV network will eventually form the main backbone down the north-west side of the country.

Medupi and Coal 3 integration:

• Medupi-Spitskop 1st 400kV line	2011
• Medupi-Spitskop 2nd 400kV line	2011
• Medupi-Marang 1st 400kV line	2012
• Ngwedi 2x500MVA 400/132/22kV substation	2014
• Medupi-Ngwedi 1st 400kV line	2014
• Medupi-Masa-Selemo 1st 765kV line operated at 400kV line turned into Ngwedi	2014
• Medupi-Witkop 1st 400kV line	2016
• Masa 400/765kV substation	2016
• Selemo 765/400kV substation	2016
• Coal 3-Masa/Medupi 1st 400kV line	2016
• Coal 3-Masa/Medupi 2nd 400kV line	2016
• Coal 3-Masa/Medupi 3rd 400kV line	2017
• Coal 3-Masa/Medupi 4th 400kV line	2018
• Hermes-Pluto 1st 400kV line looped in- and out of Selemo	2015
• Hermes-Pluto 2nd 400kV line looped in- and out of Selemo	2015
• Establish 765/400kV transformation at Masa	2016
• Establish 765/400kV transformation at Selemo	2016
• Energise Masa-Selemo 1st and 2nd 765kV lines at 765kV	2016
• HVDC Terminal A – Masa 1st and 2nd 400kV lines	2017
• Coal 3 – HVDC Terminal A 1st 400kV lines	2017
• Establish HVDC Terminal A (Lephalale)	2017
• HVDC 800kV Line 1 (Lephalale-Jupiter B)	2017
• Establish HVDC Terminal B (Jupiter B/Johannesburg)	2017
• Coal 3 – HVDC Terminal A 2nd and 3rd 400kV lines	2018
• HVDC 800kV Line 2 (Lephalale-Durban)	2018
• Establish HVDC Terminal C (Durban)	2018

6.3.2 RUSTENBURG CLN

Rustenburg CLN is within a radius of 300km from the Waterberg generation pool which makes it the first port of call for 400kV lines integrating Medupi and Coal 3 power stations. This has resulted in portions of the Medupi and Coal 3 integration being included in the Rustenburg CLN.

Rustenburg 400kV Strengthening:

- Medupi-Marang 400kV line 2012
- Establish Ngwedi 2x 500MVA 400/132/22kV substation by looping in and out the Matimba-Midas 400kV line 2014
- Medupi-Ngwedi 400kV line 2014
- Medupi-Masa-Selemo 1st 765kV line operated at 400kV line turned into Ngwedi 2014
- Establish Brits West 2x 500MVA 400/132/22kV substation by looping in and out the two Spitskop-Dinaledi 400kV lines 2017

6.3.3 WARMBAD CLN

The Warmbad CLN consists of Dinaledi, Pelly and Warmbad substations. Load growth is mainly due to PGM mining and new ferrochrome smelting plants, as well as industrial and residential growth. The decrease in load in 2011 is due to load transfers to substations in other CLNs. The projects to establish Phoebus 400/275/132kV substation and 400kV infeed to Wildebees form part of the Tshwane Metro Strengthening, and are listed under Pretoria CLN.

To link the Warmbad CLN with the Central Grid the following 400kV strengthening is proposed:

- Dinaledi-Lomond 400kV line 2014
- Establish Lomond 400/275kV transformation 2014
- Lomond-Lulamisa 400kV line 2014

6.3.4 POLOKWANE CLN

The Polokwane CLN is within a 200km radius from the Waterberg generation pool and is experiencing a high rate of growth. The western portion of the Polokwane load growth is mainly driven by the PGM and ferrochrome growth. The northern part of the Polokwane CLN is mainly rural. Load growth is driven mainly by the electrification programme.

The projects proposed in this CLN are as follows:

- Burotho 2x 500MVA 400/132/22kV substation 2014
- Loop-in and out Matimba-Witkop 2nd 400kV line into Burotho 2014
- Medupi-Burotho 1st 400kV line 2014
- Medupi-Witkop 1st 400kV line 2016
- Burotho-Witkop 1st 400kV line 2014
- Burotho-Marble Hall 1st 400kV line 2014

The 400kV loop-in is a short length of line and it is anticipated that the first 400kV line from Medupi can be completed by 2014. There is a risk in finalising the line routes as they pass through prime game farm areas.

The northern part of the Polokwane CLN is mainly rural with a massive electrification programme and has two radial 275kV lines from Witkop supplying Tabor and Spencer substations. It is proposed to establish a new MTS substation to the north of Tabor at a site yet to be determined by 2017.

The projects in this scheme are as follows:

- Tabor-Witkop 1st 400kV line 2012
- Tabor 400/132kV substation (1x 500MVA transformer) 2012
- Nzhelele 400/132kV substation north of Tabor 2016
- Tabor-Nzhelele 1st 400kV line 2017
- Medupi-Nzhelele 1st 400kV line 2017

6.3.5 LOWVELD CLN

The Lowveld CLN consists of Leseding, Foskor and Acornhoek MTS in the Steelpoort and Phalaborwa areas. Platinum group metals and rural electrification loads dominate this CLN.

- 3rd Foskor 275/132kV 250MVA 275/132kV transformation 2014
- New Acornhoek 2x 125MVA transformers 2014
- 2nd Merensky-Foskor 275kV 150km line 2016

A network diagram showing the major projects in the North Grid is shown in Figure 7-3-1 below. The HVDC lines are not indicated but they will run parallel to the two 765kV routes until the Selemo substation where they will by-pass and head into the Central and Eastern Grids.

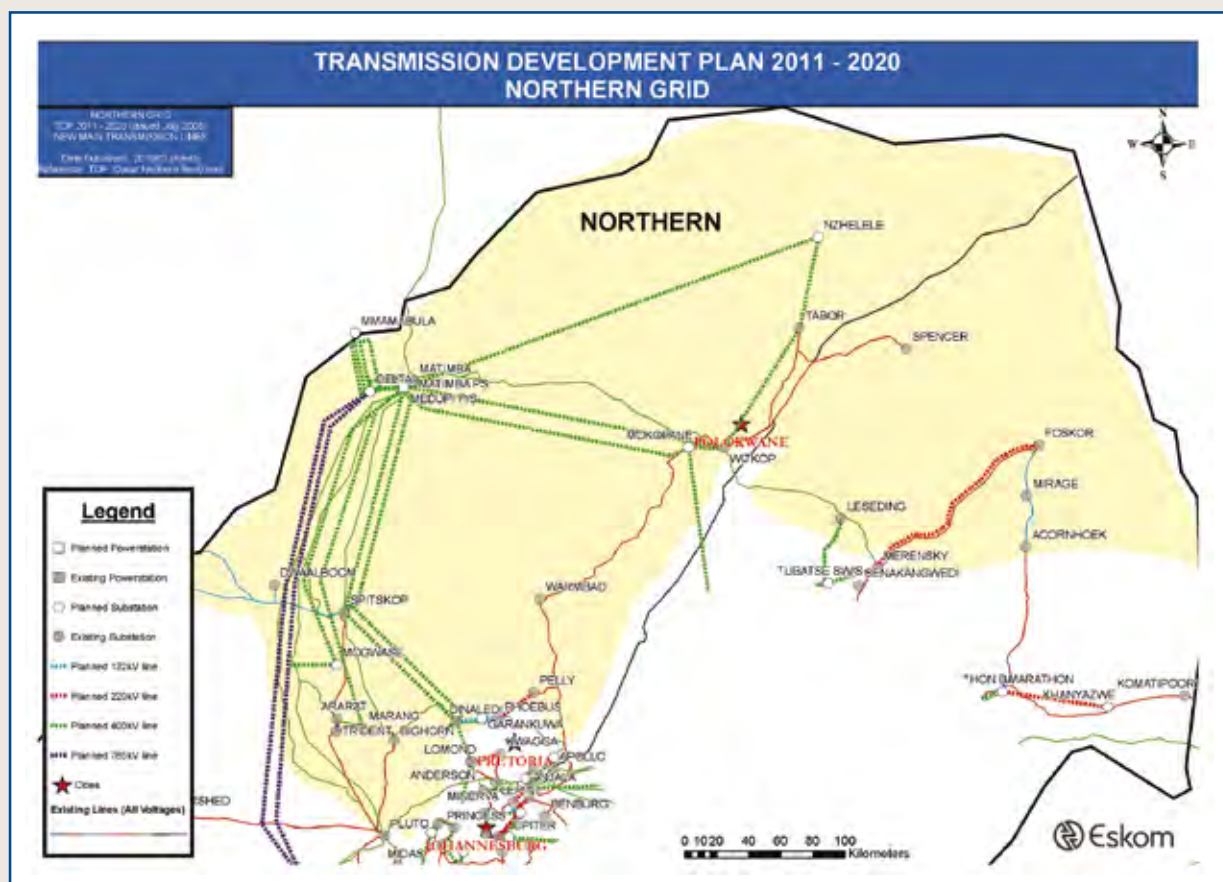


Figure 6.6: North Grid geographical network diagram

6.4 NORTH EAST GRID

The North East Grid consists of four CLNs namely, Highveld North, Highveld South, Lowveld (southern part), and Pretoria. The current transmission network and CLNs are shown in Figure 6.7 below.

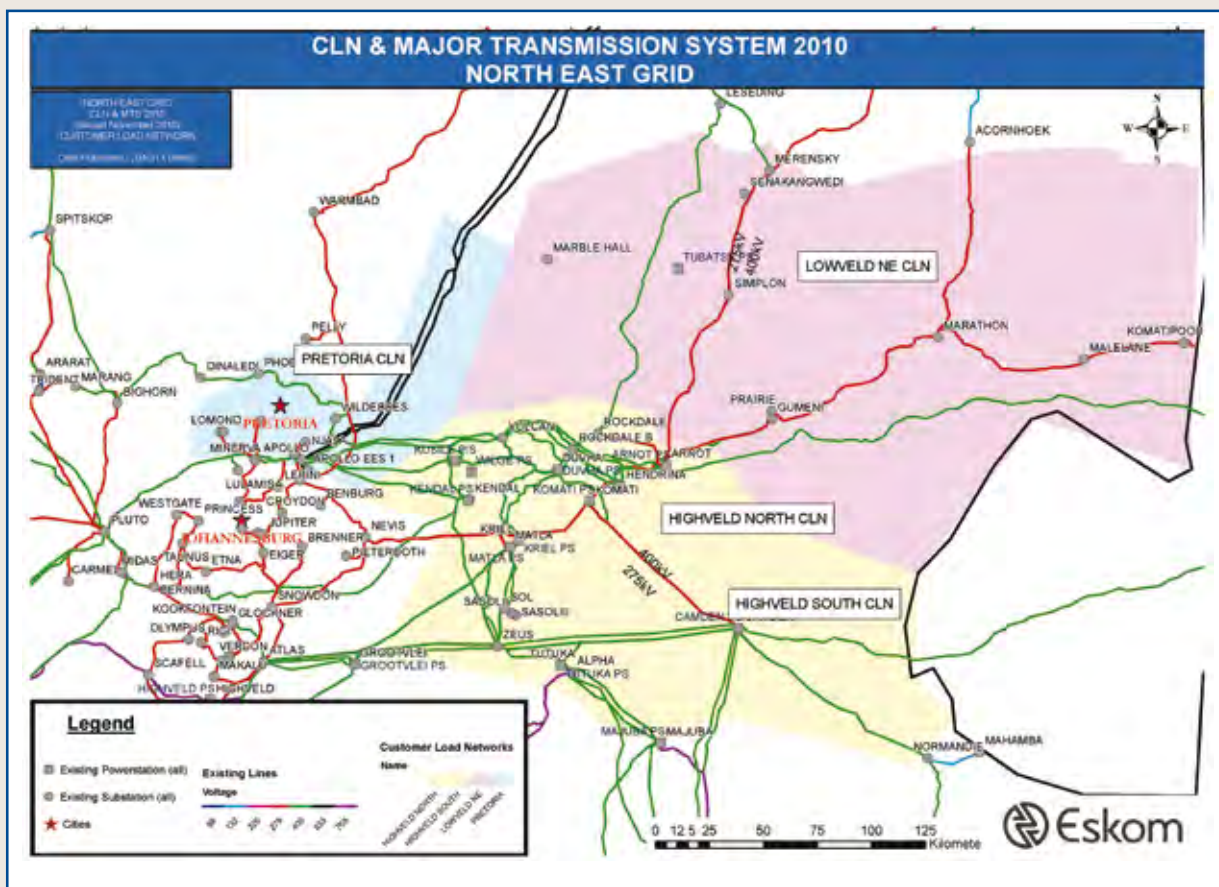


Figure 6.7: Current North East Grid network and CLNs

The expected peak demands by 2016 and 2020 as well as the average percentage load increase for the period for each CLN are given in Table 6-7 below.

CLN	Peak Load (MW) 2009	Forecasted Load (MW)		Ave. Annual % Load Increase
		2016	2020	
Highveld North	2521	2808	2982	1.54%
Highveld South	1052	1900	2440	8.61%
Lowveld	1456	2099	2315	4.39%
Pretoria	2326	3107	3701	4.32%

Table 6.7: North East Grid CLN load forecast and percentage load increases

The TDP schemes for the North East Grid consist of extending the 400kV network, the integration of Kusile power station, and the installation of additional transformers at existing and new substations. The increase in transmission assets by end 2015 and end 2020 and the cumulative total are shown in Table 6.8.

Transmission Assets for North-East Grid	New Assets expected in 2011 - 2015	New Assets expected in 2016 - 2020	Total New Assets expected
Total kms of line	876	182	1,058
765kV Lines (km)	0	0	0
400kV Lines (km)	840	122	962
275kV Lines (km)	36	60	96
Total installed Transformer MVA	7,600	3,800	11,400
Transformers (no. of)	18	5	23
Capacitors (no. of)	2	0	2
Reactors (no. of)	0	0	0

Table 6.8: Cumulative TDP transmission assets for the North East Grid

6.4.1 HIGHVELD NORTH CLN

The high load growth in Highveld North, especially around Prairie and Rockdale, will cause the substations to exceed their installed capacity. Arnot is feeding Prairie and Rockdale via its 275kV network. The Arnot-Prairie-Marathon 275kV network forms a backbone for the whole Lowveld area. The Arnot-Prairie line N-1 contingency results in violation of the remaining line's terminal rating. The proposed new Gumeni 400/132kV substation will remove these constraints at Prairie and Arnot. The new Rockdale B 400/132kV substation project will remove the 275kV constraints while de-loading the existing Rockdale and Vulcan transformation. It also provides the flexibility to allow the future development in the area.

The main projects in the Highveld North CLN are as follows:

Highveld/Lowveld Reinforcement

- Kendal-Duvha 400kV line loop in-out Vulcan 2011
- Kendal-Vulcan 1st 400kV line and the Arnot-Vulcan 1st 400kV line to form the Kendal-Arnot 1st 400kV line 2011
- Gumeni 1st 400/132kV 500MVA transformer 2011
- Hendrina-Gumeni 400kV line 2011
- Extend the Kendal-Arnot 1st 400kV line to Gumeni, then re-cycle the Prairie-Arnot 275kV to 400kV, to form the Kendal-Gumeni 1st 400kV line 2019

Highveld North Reinforcement

- Rockdale B 400/132kV, 2x500MVA transformers 2013
- Rockdale B 132/88kV, 2x160MVA transformers 2013

Kusile power station integration

- Kusile 400kV switching station 2011
- Duvha-Minerva 1st 400kV line looped into Kusile 2011
- Kusile-Lulamisa 400kV line 2012
- Kendal-Apollo 1st 400kV line looped into Kusile 2013
- Kusile by-pass Duvha to form the Kusile-Vulcan 400kV line 2013
- Kendal-Zeus 400kV line 2013
- Kusile-Zeus 400kV line 2013

6.4.2 HIGHVELD SOUTH CLN

For the current network configuration, which is under system healthy conditions, the Highveld South CLN may experience line loading problems due to the strong Cape 765kV corridor. The power from the Hendrina and Kriel power stations will flow to Zeus to be sent to the Cape. This has changed the normal power flow in the Highveld South CLN and could cause the Kriel-Zeus 400kV line to overload. Sol substation no longer meets the N-2 firm supply. Sasol have applied to reinstate the N-2 firm supply.

The proposed Highveld South strengthening project will take into account all the issues mentioned above. The Highveld South strengthening project involves the following scope of work:

- New Sol B 400/132kV with 2x 120MVA transformers 2014
- Kriel-Zeus, Kriel - Tutuka 400kV lines looped into Sol B 2014

6.4.3 LOWVELD CLN

With the fast growth in Lowveld CLN, especially in Steelpoort and Groblersdal area, it is necessary to strengthen the transmission network to meet the future development. Currently, under system healthy condition and under contingencies, the Lowveld CLN will not experience any voltage violation problems, either over or under voltage. With the load growth, the existing transformation will not be adequate. This study proposed a new 400kV MTS site in the Lowveld Northwest area at Marble Hall. The 400kV injection into Merensky MTS will also be reinforced. This includes two of the 400kV lines proposed for the now deferred Tubatse pumped storage power station, which are now required to meet the needs of local loads.

The increased power export to EdM will require at least the network strengthening in the Lowveld CLN OR commissioning of the Moamba OCGT. The main projects in the Lowveld CLN are as follows:

Lowveld strengthening Phase 1

- Malelane 2nd 275/132kV 1x 250MVA transformer 2016
- Marathon – Malelane 2nd 275kV line 2016

Lowveld strengthening Phase 2

- Marathon 1st 400/275kV 800MVA transformer 2012
- 1st Gumeni– Marathon B 400kV line 2014
- 2nd Marathon -Gumeni 400kV line (Recycling the 1st Marathon-Prairie 275kV line) 2019

Lowveld West strengthening

- Marble Hall 2x 500MVA transformers 2013
- Marble Hall – Rockdale B 1st 400kV line 2013
- Marble Hall – Tubatse 1st 400kV line 2013
- Marble Hall – Mokopane 1st 400kV line 2014

Lowveld North strengthening

- Steelpoort 400kV switching station 2013
- Steelpoort loop in and out of Duvha – Leseding 2013
- Tubatse – Merensky 400kV line 2014

6.4.4 PRETORIA CLN

Strengthening of the Tshwane Metro network is necessary to ensure adequate capacity for the city's development. Transmission network injections will be needed at Tshwane Metro's existing Buffel supply point and Wildebees. The other substations supplying Tshwane Metro will also experience load growth, namely, Kwagga, Njala, and Verwoerdburg. The projects in the Pretoria CLN are as follows:

Tshwane Metro Strengthening

- Establishing 400/275/132kV substation at Phoebus 2013
- Establishing 400kV busbar at Phoebus 2013
- 1x250MVA, 400/132kV line bank to Hangklip at Phoebus 2013
- 1x400MVA, 400/275kV line bank to Pelly at Phoebus 2013
- Operate the Hangklip-Pelly 132kV line to Phoebus-Pelly at 275kV 2013
- Loop in-out Apollo-Dinaledi 400kV line into Phoebus 2013
- Establish 400kV busbar at Wildebees 2014
- Loop in and out Apollo-Phoebus 400kV line at Wildebees 2014
- Establish 400kV busbar at Verwoerdburg 2012
- Loop in and out Apollo-Pluto 400kV line at Verwoerdburg 2012
- 2x250MVA, 400/132kV transformers at Verwoerdburg 2012
- 1x275kV line from Lomond to Kwagga 2013
- Verwoerdburg 3rd 250MVA, 400/132kV transformer 2017

A network diagram showing the major projects in the North East Grid is shown in Figure 6.8 below.

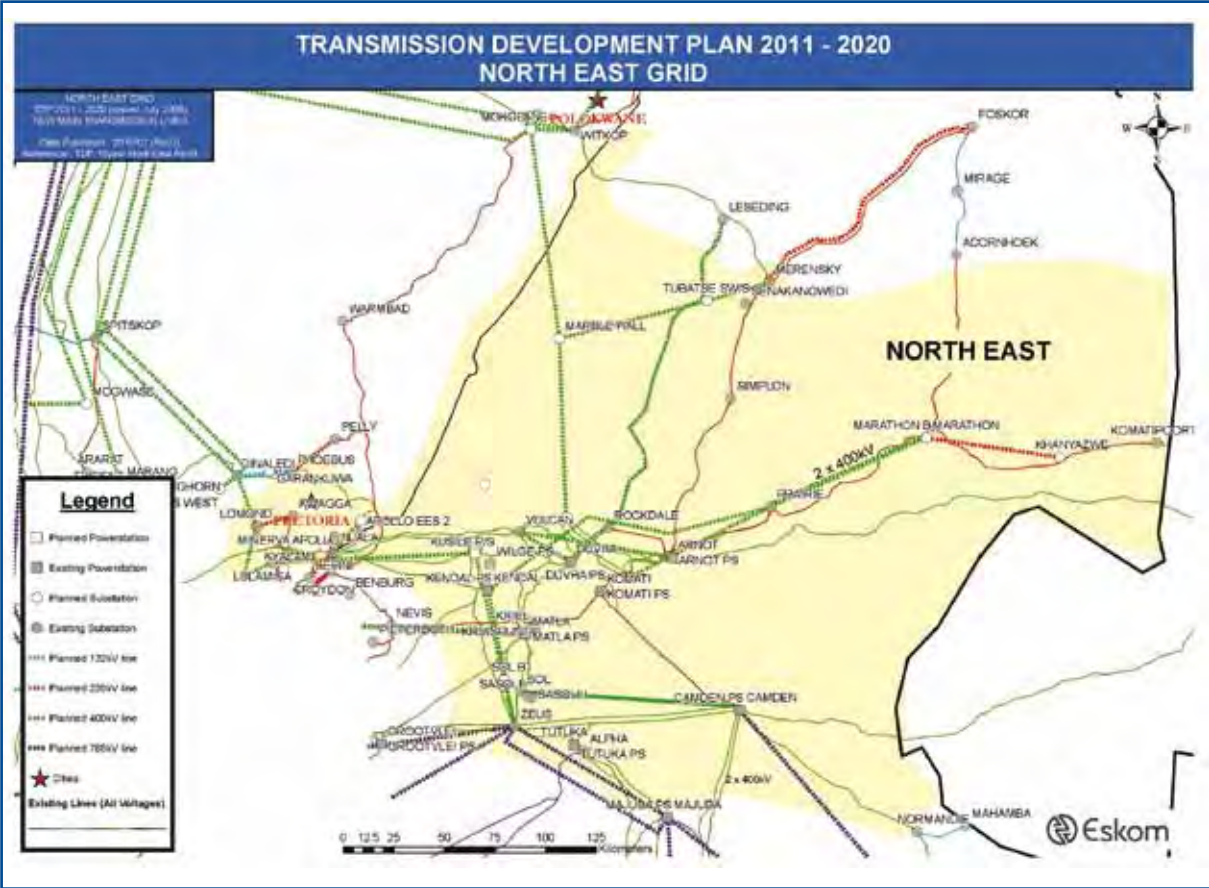


Figure 6.8: North-East Grid network diagram



6.5 NORTH WEST GRID

The North-West Grid is composed of four CLNs namely Bloemfontein, Carletonville, Kimberley, and Welkom. The current transmission network and CLNs are shown in Figure 6.9 below.

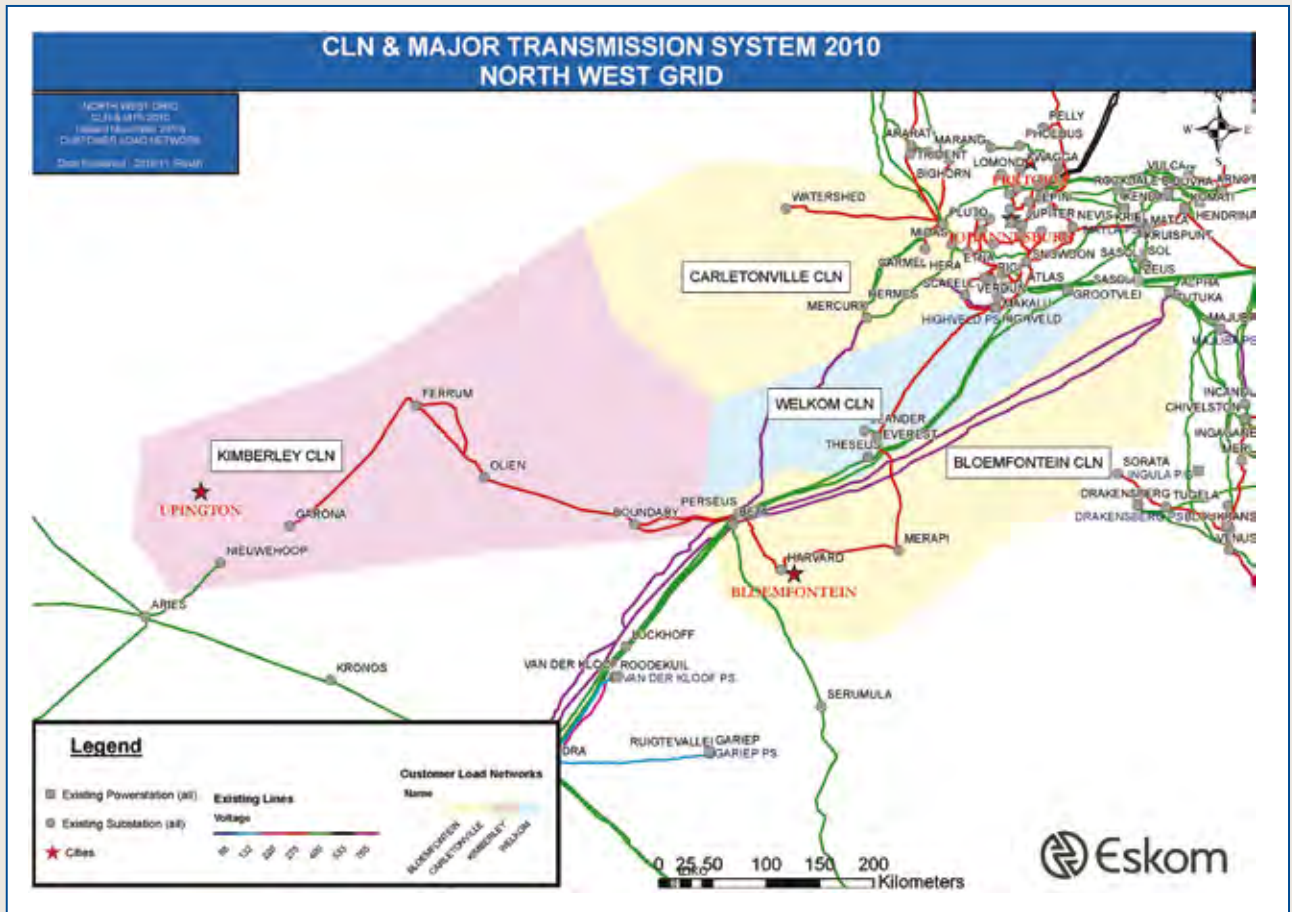


Figure 6.9: Current North West Grid network and CLNs

The 765kV network is primarily used for the transportation of power through the grid to the Cape. The projects for the North West Grid are mainly the introduction of 400kV lines and transformation to support or relieve the 275kV networks. The load growth in the grid is shown in Table 6.9 below.

CLN	Peak Load (MW) 2009	Forecasted Load (MW)		Ave. Annual % Load Increase
		2016	2020	
Bloemfontein	435	518	562	2.36%
Carletonville	1568	1621	1661	0.53%
Kimberley	547	874	1184	7.90%
Welkom	785	797	833	0.54%

Table 6.9: North West Grid CLN load forecast and percentage load increases

The next stage of the reinforcement of the Main Cape Corridor, if required in 2019, will pass through the North West grid, linking Selemo (Epsilon) 765kV to Gamma 765kV via Perseus 765kV. The total length of this 765kV line project has been allocated to this grid.

The increase in transmission assets by end 2015 and end 2020 and the cumulative total are shown in Table 6.10.

Transmission Assets for North-West Grid	New Assets expected in 2011 - 2015	New Assets expected in 2016 - 2020	Total New Assets expected
Total kms of line	1,345	2,349	3,694
765kV Lines (km)	955	1,600	2,555
400kV Lines (km)	390	639	1,029
275kV Lines (km)	0	110	110
Total installed Transformer MVA	4,250	1,750	6,000
Transformers (no. of)	8	5	13
Capacitors (no. of)	9	0	9
Reactors (no. of)	7	10	17

Table 6.10: Cumulative assets for North West grid

6.5.1 CARLETONVILLE CLN

The North-West Grid is composed of four CLNs namely Bloemfontein, Carletonville, Kimberley, and Welkom. The current transmission network and CLNs are shown in Figure 6.9 below.

The new Watershed B 400/132kV substation west of Watershed is proposed; it is intended to de-load and provide support to Watershed via the 132kV network by 2017. Load growth in the area is driven by the cement industry and mining activity. Platinum and ferrochrome mining and processing activity is expected to materialise north of Watershed.

The project will comprise the following:

- | | | |
|---|--|------|
| 7 | Build a 400kV line from Selemo (Epsilon) to Watershed B substation | 2017 |
| 8 | Establish 400/132kV transformation at Watershed B | 2017 |

6.5.2 BLOEMFONTEIN CLN

The Bloemfontein CLN is largely agricultural, with the commercial and industrial hub of Bloemfontein. It also supplies Lesotho via Merapi substation, which supplies other load in the central and south eastern Free State. The project running in this CLN is as follows:

The scope of work will be as follows:

- Build a 275kV line (110km) from Everest MTS to Merapi MTS
Merapi 275/132kV transformer 250MVA 2016

6.5.3 WELKOM CLN

The Welkom CLN is dominated by gold mining, which is expected to remain static over the next ten years, given the assumption that the gold price will remain static in real terms. No projects are identified in this CLN.

6.5.4 KIMBERLEY CLN

The Kimberley CLN load consists mainly of base metal and diamond mining, the former being the main driver of load growth, especially iron and manganese. Intensive agriculture along the Orange River is also a major contributor. A new 400/132kV substation will be required at Vryburg to support the distribution networks in the area, which are all loaded to capacity. Although it is likely to be allocated to the Carletonville CLN on completion, it is included here since it forms an integral part of the North-West 400kV strengthening projects. The proposed new 400/132kV substation will support the Vryburg, Delareyville, Edwardsdam, Taung, and Jan Kemp Dorp areas, all of which are experiencing strong growth due to electrification. The availability of adequate electricity supplies north of Vryburg will also allow for the expansion of existing gold mining activities.

The following projects are proposed for Kimberley CLN:

North West 400kV Strengthening Phase 1

- Install 2 x 36MVar shunt capacitors at Olien 2010
- Install 1 x 72MVar shunt capacitor at Ferrum 2010
- Install a 132kV +/-100MVar SVC at Ferrum 2011

North West 400kV Strengthening Phase 2

- Install 2 x 500MVA 400/132kV transformers at Ferrum 2012
- Construct the Ferrum-Vryburg first 400kV line 2012
- Construct the Mercury-Vryburg first 400kV line 2013
- Construct the Vryburg 400/132kV substation 2013

North West 400kV Strengthening Phase 3

- Construct the Selemo (Epsilon)-Vryburg first 400kV line 2016

North West 400kV Strengthening Phase 4

- Construct the Selemo (Epsilon)-Vryburg second 400kV line (via Hotazel) 2017

North West 400kV Strengthening Phase 5

- Loop Selemo (Epsilon)-Vryburg second 400kV line into Hotazel 2019
- Construct the Hotazel 400/132kV substation 2019

A network diagram showing the major projects in the North West Grid is shown in Figure 6.10 below.

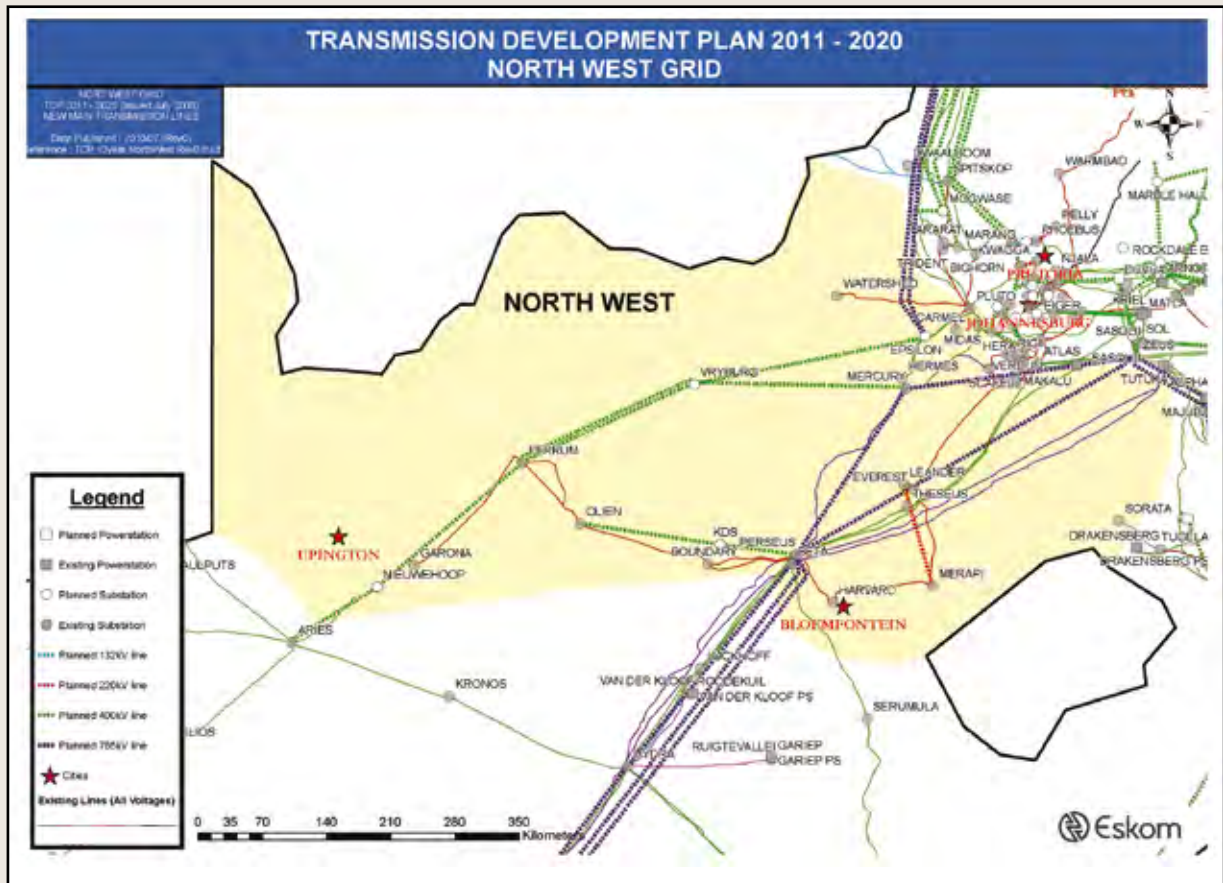


Figure 6.10: North West Grid geographical network diagram



6.6 SOUTH GRID

The South Grid consists of the area to the south-eastern side of Hydra substation, which predominantly falls within the Eastern Cape Province boundary. It comprises three Customer Load Networks (CLNs), namely: Port Elizabeth, East London, and Karoo. The current transmission network and CLNs are shown in Figure 6.11 below.

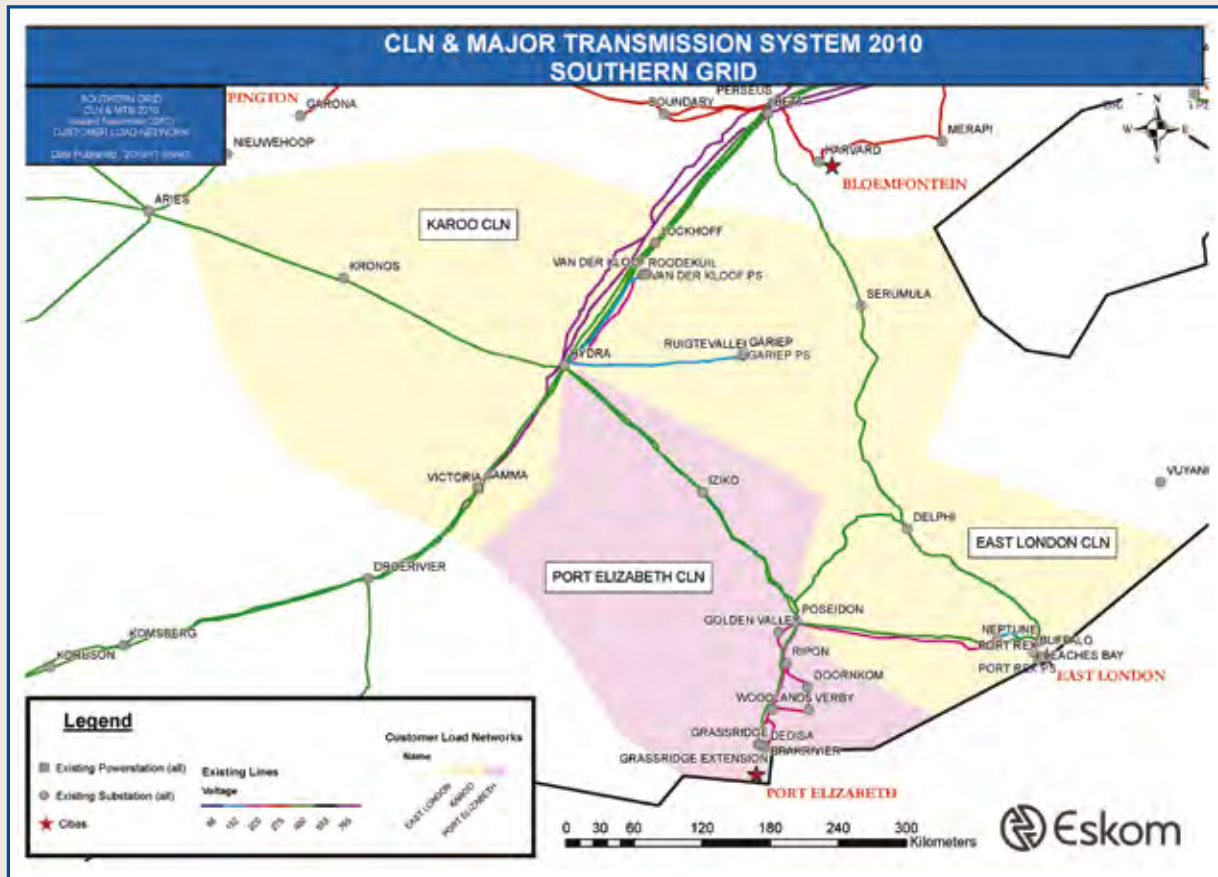


Figure 6.11: Current South Grid network and CLNs

The high forecasted average growth rate for Port Elizabeth CLN is mainly attributed to the new Industrial Development Zone (IDZ) at Coega near Port Elizabeth. The expected peak demands by 2016 and 2020 as well as the average percentage load increase for the period, for each CLN are given in Table 6.11 below.

CLN	Peak Load (MW) 2009	Forecasted Load (MW)		Ave. Annual % Load Increase
		2016	2020	
Karoo	234	256	273	1.41%
East London	507	827	924	6.04%
Port Elizabeth	813	1784	2772	12.59%

Table 6.11: South Grid CLN load forecast and percentage load increases

The TDP schemes for the South Grid consists of the integration of the DME OCGT power station at Dedisa, reinforcement of the greater Port Elizabeth metro area including the Coega IDZ, and the Greater East London Strengthening Scheme, which includes the integration of Vuyani 400/132kV substation at Mthatha to supply the central and southern Transkei area. If the first Nuclear 1 unit materialises at Thuyspunt in 2020, three additional 400kV lines will be required to link it to Grassridge and Dedisa via the new Port Elizabeth 400/132kV substation. The increase in transmission assets by end 2015 and end 2020 as well as the cumulative total are shown in Table 6.12.

Transmission Assets for Southern Grid	New Assets expected in 2011 - 2015	New Assets expected in 2016 - 2020	Total New Assets expected
Total kms of line	1,090	1,291	2,381
765kV Lines (km)	910	760	1,670
400kV Lines (km)	180	531	711
275kV Lines (km)	0	0	0
Total installed Transformer MVA	1,080	4,500	5,580
Transformers (no. of)	7	4	11
Capacitors (no. of)	3	5	8
Reactors (no. of)	5	5	10

Table 6.12: Cumulative TDP transmission assets for the South Grid

6.6.1 PORT ELIZABETH CLN

Load growth is dominated by industries in the Coega IDZ and associated spinoff developments in the Port Elizabeth metro area. The new 400/132kV Port Elizabeth substation will be required to the west of the city by 2016. If the first Nuclear 1 unit materialises at Thuyspunt in 2020, three additional 400kV lines will be required to link it to Grassridge and Dedisa via the new Port Elizabeth 400/132kV substation. Additional lines will be required later to accommodate additional units. This infrastructure has been omitted from the TDP due to the level of uncertainty regarding Nuclear 1's timing, location, and size.

The TDP network developments in this CLN entail the following:

- | | |
|--|-------------|
| DME OCGT Integration at Dedisa 400kV | 2014 |
| • Dedisa Ext 3x 400kV feeder bays (DME OCGT Integration) | |
| • Grassridge Ext 3rd 400/132kV 500MVA transformer | 2015 |

Port Elizabeth Strengthening Scheme Phase 3	2016
<ul style="list-style-type: none"> • Dedisa Ext 400kV 1st 100MVA capacitor • Delphi Ext 400kV 1st 100MVA capacitor • Grassridge Ext 400kV 1st 100MVA capacitor • Poseidon Ext 400kV 1st 100MVA capacitor 	
Port Elizabeth Strengthening Scheme Phase 4	2016
<ul style="list-style-type: none"> • Dedisa Ext 400kV 2nd 100MVA capacitor • Delphi Ext 400kV 2nd 100MVA capacitor • Grassridge Ext 400kV 2nd 100MVA capacitor • Poseidon Ext 400kV 2nd 100MVA capacitor 	
Southern Grid Strengthening Phase 3	2016
<ul style="list-style-type: none"> • Gamma-Grassridge 1st 765kV line • Grassridge Ext 765/400kV transformation 	
Port Elizabeth Substation Integration - Phase I	2016
<ul style="list-style-type: none"> • Port Elizabeth 400/132kV substation (New) • 40km, 400kV line • Grassridge Ext 3rd 400/132kV 500MVA transformer and busbar upgrade 	
Southern Grid strengthening Phase 4	2019

6.6.2 EAST LONDON CLN

The East London CLN consists of the Greater East London metropolitan area, Queenstown area, and southern half of the former Transkei. Load growth is dominated by electrification in the former Ciskei and Transkei, with a further contribution from the East London IDZ at Leach's Bay. A new 400/132kV substation (Vuyani) will be required at Mthatha to address low voltages and overloading on the distribution network, especially when the hydro generation at Umtata first and second Falls and Collywobblers (Mbashe) is not available. Vuyani will be supplied from the proposed Eros-Vuyani-Neptune 400kV line, which, together with the Poseidon-Neptune 400kV line comprises the Greater East London Strengthening, which will supply South Grid and East London CLN in particular, from East Grid.

Future network developments in this CLN entail the following:

Greater East London strengthening Phase 1	2012
<ul style="list-style-type: none"> • Vuyani 400/132kV substation integration • Eros-Vuyani 1st 400kV line 	
Greater East London strengthening Phase 2	2012
<ul style="list-style-type: none"> • Neptune-Vuyani 1st 400kV line • Neptune-Poseidon 1st 400kV line 	
Greater East London strengthening Phase 3	2016
<ul style="list-style-type: none"> • Pembroke B 400/132kV substation and 400kV turn-ins 	

6.6.3 KAROO CLN

For the current network configuration, which is under system healthy conditions, transformation and thermal limit violations are experienced in the Karoo CLN around Hydra, Ruigtevallei and Roodekuil substation mostly during maximum generation at Van der Kloof and Gariiep. N-1 reliability criteria were not catered for at Roodekuil, since the planning criteria in force at the time did not require it. Single transformers were commissioned at Roodekuil 220/132kV and 132/22kV. The project Gariiep Upgrade will ease most of constraints around Ruigtevallei MTS by strengthening the local distribution network.

In addition to Transmission projects identified to resolve capacity and security of supply constraints in the Karoo CLN, some of the Cape corridor strengthening scheme projects will be commissioned within the boundaries of the Karoo CLN to improve the Transmission corridor capacity to the entire Southern and Western Grid between 2009 and 2018.

The Karoo CLN network development involves the following:

Cape Corridor Strengthening Scheme Phase 2&3	2012
<ul style="list-style-type: none">• Gamma Ext 765kV busbar establishment• Gamma Ext 2nd 400MVar 765kV busbar reactor• Hydra-Gamma 1st 765kV line• Gamma-Kappa 1st 765kV line• Kappa 765/400kV substation• Kappa Ext 400kV 100MVar shunt reactor	
Southern Grid strengthening Phase 3	2016
<ul style="list-style-type: none">• Gamma Ext 765kV busbar	
Cape Corridor Strengthening Scheme Phase 4	2016
<ul style="list-style-type: none">• Gamma-Kappa 2nd 765kV line	

The geographical network of the South Grid is shown in Figure 6 12 below.



The geographical network of the South Grid is shown in Figure 6.12 below.

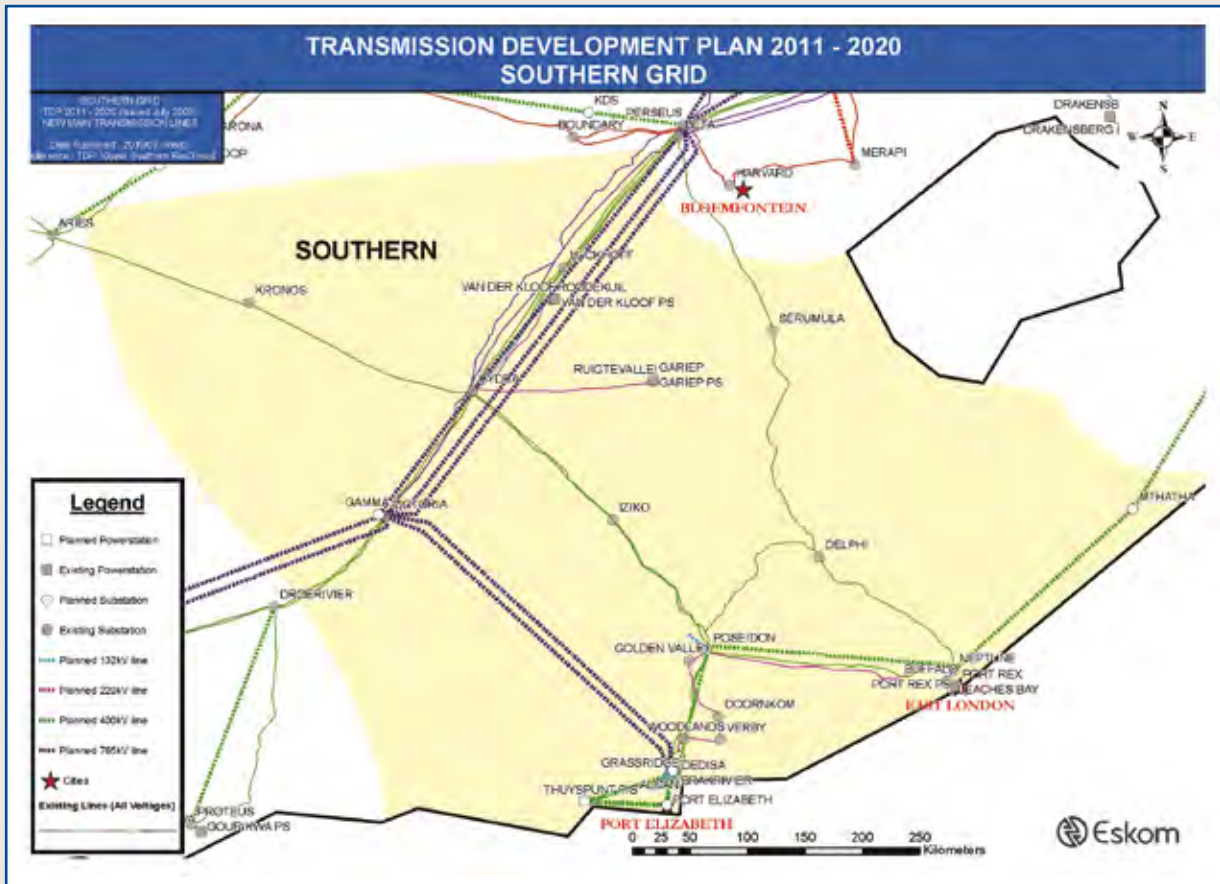


Figure 6.12: The South Grid networks diagram



6.7 WEST GRID

The West Grid consists of four CLNs namely, Peninsula, Southern Cape, West Coast and Namaqualand. The current transmission network and CLNs are shown in Figure 6.13 below.

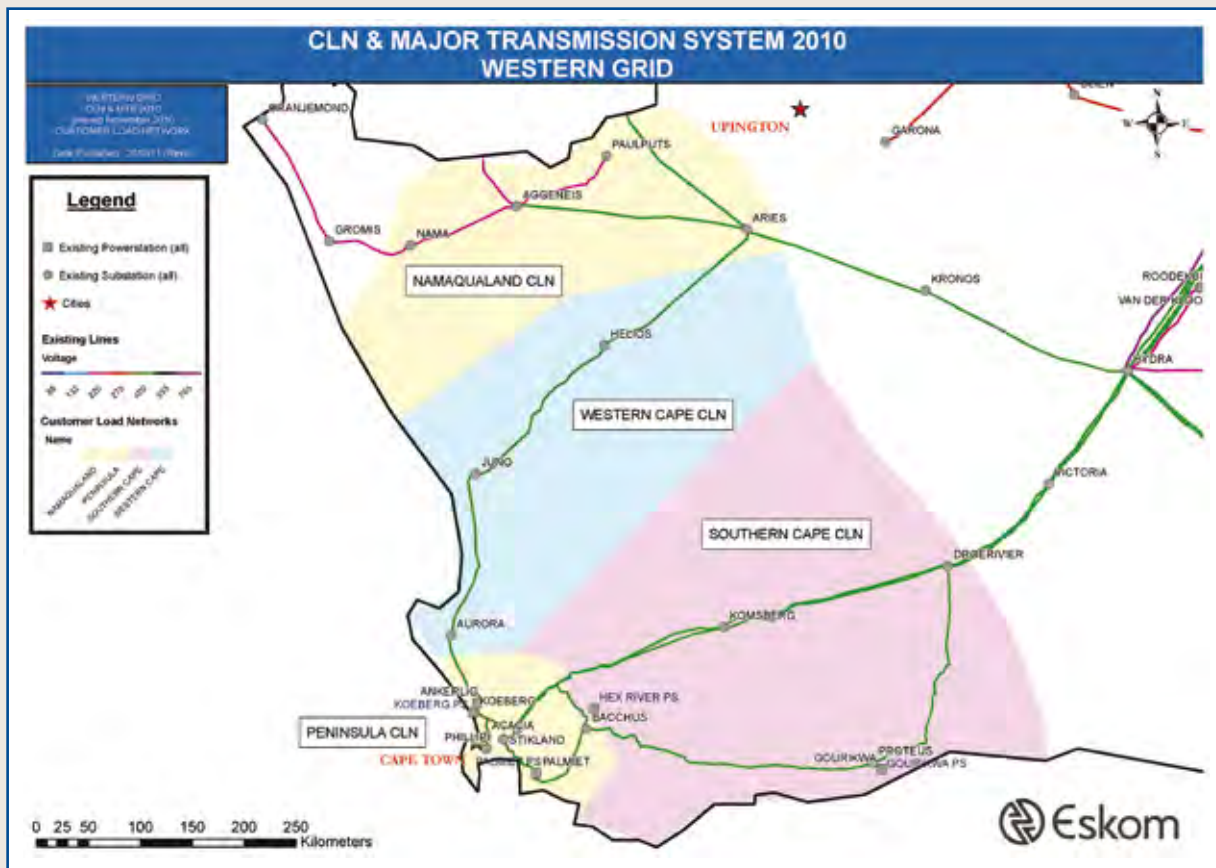


Figure 6.13: Current West Grid network and CLNs

The Western Cape customer base consists of consumers within the South African border, as well as international customers (NamPower and Skorpion in Namibia). The expected peak demands by 2015 and 2020 and the average percentage load increase for the period for each CLN are given in Table 6.13 below.

CLN	Peak Load (MW) 2009	Forecasted Load (MW)		Ave. Annual % Load Increase
		2016	2020	
Namaqualand	135	174	193	2.9%
West Coast	460	547	566	2%
Southern Cape	793	947	1072	2.8%
Peninsula	2549	2836	3173	2.1%
International + future step loads	200	200	300	4.5%

Table 6.13: West Grid CLN loads and percentage load increases

Included in the TDP studies is the forecasted export to Namibia via the 400kV and 220kV interconnections. The export amount has been assumed to remain constant over the TDP period.

The TDP schemes for the West Grid consist of extending the 400kV network and introducing 765kV injection at two points, namely Omega and Kappa. There is also the installation of additional transformers at existing and new substations.

The projects associated with Nuclear 1 integration in the West Grid are specifically excluded from this summary, as it has been assumed, for the purposes of this TDP that the Nuclear 1 site will be at Thuyspunt on the South Grid.

The increase in transmission assets by end 2015 and end 2020 and the cumulative total are shown in Table 6.14.

Transmission Assets for Western Grid	New Assets expected in 2011 - 2015	New Assets expected in 2016 - 2020	Total New Assets expected
Total kms of line	270	1,216	1,486
765kV Lines (km)	150	150	300
400kV Lines (km)	120	746	866
275kV Lines (km)	0	320	320
Total installed Transformer MVA	6,525	3,125	9,650
Transformers (no. of)	17	4	21
Capacitors (no. of)	3	0	3
Reactors (no. of)	12	8	20

Table 6.14: Cumulative TDP transmission assets for the West Grid

6.7.1 MAIN CAPE CORRIDOR

The West and the South grids are supplied from the common Cape corridor to the north of Gamma substation. In 2009, the combined demand of the West and South grids was ± 5473 MW. The difference between the combined output of local generation and the load must be supplied from the generation pool in the Highveld via the transmission lines. The main corridor schemes are as follows:

Cape Corridor 765kV – Phases 2 and 3,

- Construct the first Zeus-Perseus-Gamma-Kappa-Omega 765kV line 2012
- Establish 765kV series compensation of the corridor north of Beta/Perseus + first Hydra-Gamma 2012 765kV line

Cape Corridor 765kV – Phase 4

- Construct the second Zeus-Perseus-Gamma-Omega 765kV line 2017

If there is no nuclear generation in the Cape then the Main Cape Corridor will have to be reinforced again around 2020. The reinforcement may be HVDC, in light with the current strategic grid plan.

6.7.2 CAPE PENINSULA CLN

The 400kV in-feeds into Muldersvlei, Stikland and Acacia nodes provide N-1 redundancy but the Acacia-Philippi in-feed will reach capacity in 2012. The proposed 2nd Koeberg-Acacia 400kV line will ensure continued N-1 redundancy for Acacia beyond 2012. Firgrove substation will be needed to supply Somerset West and surrounding areas. To address the Philippi transformation capacity problem, it is proposed to establish a new 400/132kV substation in the Mitchells Plain area to relieve the loading at Philippi by constructing two 400kV lines from either Stikland or Firgrove substation. There is a proposal to convert units at Ankerlig from OCGT to CCGT, starting in 2020. This would require an Ankerlig-Omega 400kV line to meet Grid Code requirements. It has been omitted from the TDP due to the uncertainties regarding the project.

The projects within the Cape peninsula CLN are as follows:

- Acacia 3rd 500MVA 400/132kV transformer 2010
- Philippi 3rd 500MVA 400/132kV transformer (spare) 2013
- Koeberg off-site Supply relocate & Associated work 2012
- Firgrove 400/132kV substation 2014
- Muldersvlei 3rd 500MVA transformer & Series Reactor 2013
- Mitchells Plain 400/132kV substation 2016

6.7.3 WEST COAST CLN

The West Coast, Namaqualand, and parts of the Peninsula CLN are supplied via the Hydra-Aries-Aurora power corridor. It is proposed to create a new Ferrum-Aries 400kV power corridor once both the Mercury-Ferrum and Epsilon-Ferrum 400kV corridors have been established.

Sishen-Saldanha traction upgrade

In addition to the strengthening projects, the Sishen-Saldanha traction upgrade project would result in the establishment of four new 400kV traction substations, one new 275kV substation, two SVCs, and the Aries-Nieuwehoop 400kV line. Although the 275kV infrastructure will be in the Kimberley CLN, it is listed here because it is an integral part of the Sishen-Saldanha traction upgrade scheme.

The strengthening projects within the West Coast CLN are as follows:

- Construct the Aries SVC 2016
- Construct Sishen Saldanha Phase 1 (1x275/50kV s/s + Garona SVC) 2012
- Construct Sishen Saldanha Phase 2 (4x400/50kV s/s + Aries-Nieuwehoop line) 2014/2015
- Construct the Ferrum-Nieuwehoop 400kV line 2016/2017
- Upgrade Juno to 2x80MVA, 132/66/22kV transformers 2016/2017

6.7.4 NAMAQUALAND CLN

The Namaqualand CLN is supplied via the Aggeneis MTS. All the stations in this CLN have single in-feeds. A number of projects are included to bring it into compliance with the minimum security standard of N-1 redundancy. The Kronos 400/132kV transformer is needed to strengthen the local distribution network which is expected to become loaded to capacity.

The projects within the Namaqualand CLN are as follows:

- Install Paulputs second 220/132kV 125MVA transformer 2014/2015
- Construct Aggeneis-Helios 400kV line 2017
- Construct Aggeneis-Nama-Gromis-Oranjemund second 220kV line 2017
- Construct Aggeneis-Paulputs second 220kV line 2017
- Kronos 400/132kV transformer 2017

Northern Cape Reinforcement Ferrum–Garona–Nieuwehoop 400kV

- Install Garona 1 x 125MVA 400/132kV transformer 2017
- Construct Ferrum–Garona first 400kV line 2017
- Construct Garona–Nieuwehoop first 400kV line 2017

6.7.5 SOUTHERN CAPE CLN

This CLN includes Beaufort West, Oudtshoorn, the Garden Route, and the Overberg. The main strengthening foreseen in this CLN is to accommodate the conversion of OCGT generation at Gourikwa to CCGT, which will require additional 400kV lines to evacuate the resulting increased output. The date of this project is uncertain, and it has therefore been omitted. The projects within the Southern Cape CLN are as follows:

- Establish the Blanco 400/132kV substation 2016
- Construct the third Gourikwa-Proteus 400kV line 2019
- Construct the second Proteus-Droërivier 400kV line 2017



A diagram showing the major projects in the West Grid is shown in Figure 6.14 below.

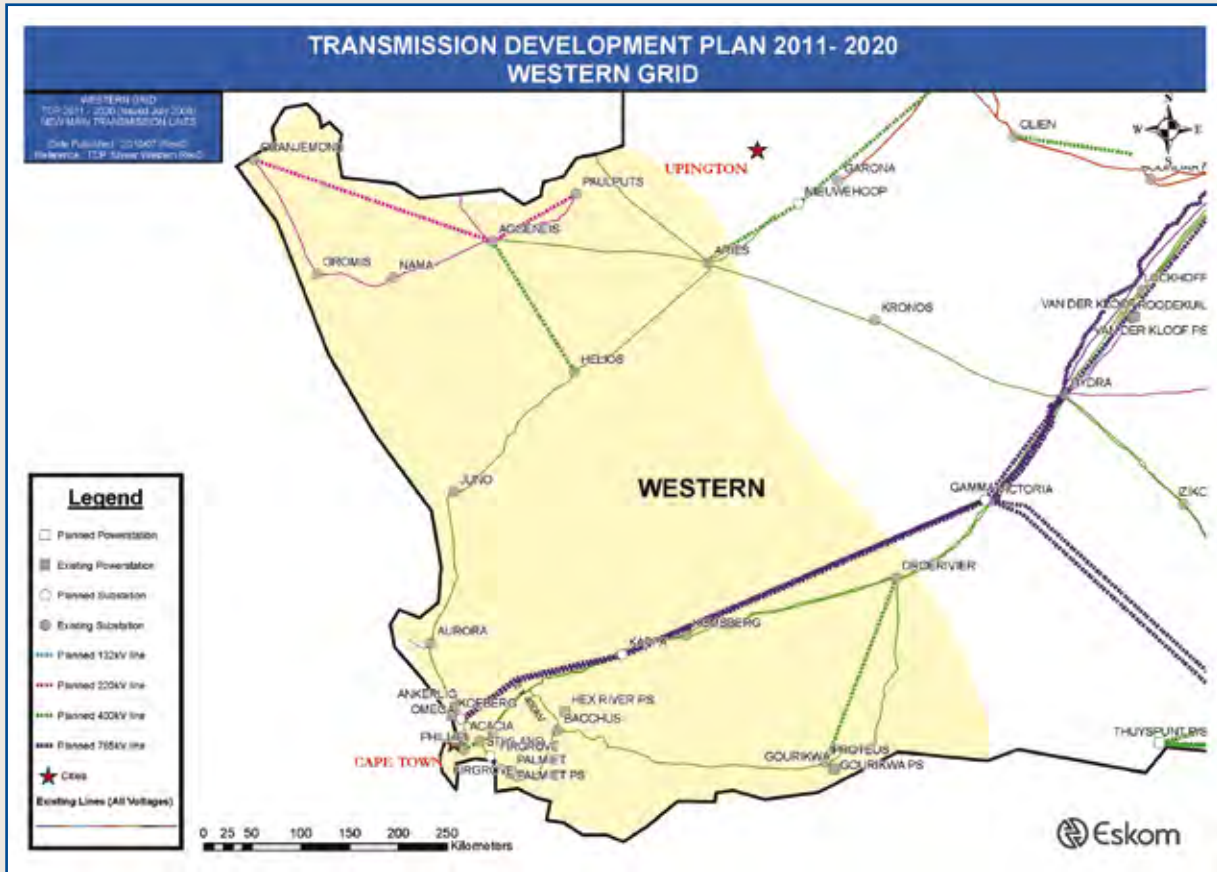


Figure 6.14: West Grid geographical network diagram

6.8 STRATEGIC SERVITUDES UNDER INVESTIGATION

All the line projects and new substation projects that are proposed in the document need to go through a full environmental impact assessment (EIA) process before implementation. This process includes public participation meetings, which are advertised in the media. Concerns of the public and affected parties are addressed at the public participation meetings. Eskom Holdings will not commence construction of any line or substation without the EIA process (Record of Decision being signed and servitudes acquired) being concluded.

The proposed lines shown in various schematics in this document give an estimation of where various proposed lines will run. The outcome of the EIA process will determine the exact position of the lines. The projects in this document are at various stages of the EIA process.

7. Capital Expenditure Plan

The total capital expenditure including expansion, refurbishment, facilities, production equipment, and land acquisition project costs amount to R 204.2 billion. This summary is shown in Table 7.1 and Figure 7.1 below. It is clear that the majority of the cost will be expansion related as this relates directly to the strengthening of the network to accommodate new customers as well as new generation.

TOTALS AS at 15 Sep 10												
Categories	FY2012-2021 Plan											Totals
	YE 2011	YE 2012	YE 2013	YE 2014	YE 2015	YE 2016	YE 2017	YE 2018	YE 2019	YE 2020	YE 2021	
Expansion	5,790	10,161	12,428	17,660	21,291	24,850	25,490	15,734	18,540	10,361	9,796	166,310
Refurbishment	789	1,069	1,268	1,385	1,953	2,186	1,900	1,687	2,171	2,213	2,388	18,219
Capital Spares	118	768	503	600	630	429	437	548	575	604	634	5,729
L&R	38	636	689	786	835	763	801	841	883	927	973	8,134
OTHER	168	445	427	474	692	1,095	687	262	342	347	351	5,122
Production Equipment	141	90	71	67	52	63	60	63	67	70	73	676
	5,806	13,169	15,386	20,972	25,453	29,385	29,374	19,135	22,579	14,521	14,216	204,190

Table 7.1: Capital Expenditure per year for different categories of projects



Figure 7.1: Summary of Capital Expenditure in the Transmission Division

Refurbishment and land acquisition projects are the second and third-most expensive items in the capital expenditure, respectively. Refurbishment is required to prolong the life of assets and land acquisition projects are required to purchase the land in which to build the expansion assets.

The summary of expansion capital expenditure per project type required to realise this ten-year plan is shown in Table 7.2. The total expenditure is expected to be approximately of R 166 billion, this is approximately R 21 billion higher than the previous ten-year plan.

The main reasons for this variance are because:

- A provision was added covering the 2020 (a new year in the planning window) year list of projects.
- Of project cost escalations due to re-phasing.
- Of new projects added.

Type	Total R'mil
Customer	6,100
Generation	31,200
Reliability	127,000
Grand Total	164,300

Table 7.2: Capital expenditure per project type

Please note that the amounts in the tables represents cash flows in the Ten-year plan periods, any cash flows not falling within this period have not been added, consequently the total cost of the plan may be higher than reflected here. The total excludes Scope Definition Costs.

The details of costing per Grid and Project type are shown in Appendix B. For purposes of confidentiality the planned or exact costs per project of Customer Projects have been excluded from the table, however the total sum of all customer projects are indicated in Table 7.2 above.

8. Concluding Remarks

The most visible difference between this TDP and the previous year's TDP is the phasing and spread of the projects over the planning period. There has been some re-phasing of the existing projects, using more realistic completion dates based on execution timelines, as well as to address financial constraints resulting from the current shortage of capital.

There have been a number of additional projects included in the middle part of the planning period mainly due to new substation injection points and existing substation transformer expansion. This is mainly due to a better positioning of loads due to spatial load forecasting techniques applied.

There has been a reduction in the transformation capacity requirements (by 4) over the new TDP period compared to the previous TDP which is mainly due to an increase in the number of transformers expected to be commissioned in the year 2010 (by 8) which is outside of the new TDP window.

The total kilometres of additional lines has reduced from the previous TDP (by approx a total of 1100km) mainly due to lines commissioned in 2010 (approx 550km) and the re-phasing of existing projects beyond the 2020.

The resultant is an improved and more realistic or achievable spread of the transmission line projects and transformer installations. The result of the slower rate of completion of the transmission lines and new transformers is the increase of the risk to the network overall. This can be seen by the number of N-1 unfirm substations which take a longer period to be resolved as opposed to the previous TDP. However this risk can be managed as the N-1 unfirm refers to the strict deterministic level which assumes that the N-1 event will happen at the time of the loading peak. In reality there is a limited chance of this happening and operational mitigation plans will cater for most of the events until the required projects are completed.

Some of the risk mitigation measures under consideration include higher reliance on the following: utilisation of Strategic Spares, the use of Capacitors in the short term for voltage support, as well as Emergency Preparedness Plans.

The economic slowdown as well as efforts to promote demand side management through the use of solar geysers, compact fluorescent lamps and encouraging saving of electricity has greatly assisted in reducing major supply constraints. The impact of the recession is, however, expected to be short term in nature, and there should be a return to pre-recession demand levels and forecasts soon. Hence we believe it will be necessary to proceed with the planned infrastructure development.

This Ten Year Plan has many similarities with the previous one as far as projects are concerned. At the end of the period of this Ten Year Plan, it is expected that the transmission network will be fully compliant to the reliability requirements of the Grid Code that were amended in 2008.

Robust and efficient planning requires the timely exchange of credible information between stakeholders. In particular stakeholders are requested to note that spatial data and information are critical for effective transmission network planning and development.

Transmission infrastructure could easily become the critical path in connecting and integrating generation due to long lead times for securing corridors. We recommend that for planning purposes, a provision of at least 7-year lead time be made for new corridors. It should also be noted that there are increasing objections from land owners to proposed power line routes through the EIA process, which may further prolong the time to implement projects.

Research and feasibility studies are required on HVDC technology to ensure its availability for major corridors for coastal nuclear or Waterberg coal scenarios. In addition, recycling of certain transmission networks (especially 275kV to 400kV) in Gauteng and KwaZulu-Natal will be needed in the long term.

The conclusion is that the transmission projects in this TDP will result in the overall network becoming Grid Code compliant while catering for increased load growth and integration of new generation. The system will be running at risk in some areas and careful operational mitigation planning will have to be undertaken until the transmission projects and new generation are in place.



Appendix A: Generation Assumptions

TDP 2010 Generation Plan		RTS Grootvlei		RTS Komati		CCGT1 Debiha		CCGT2 Avon		Wind Genetec		Moamba CCGT		Ingula Pirbright		Medupi		Kudu		Coal 3		Rue 1 Thuyapunt		CCGT Ankerlig			
Calendar year	1st 2nd Half	Case File year	Unit	MW	sent/Out	Unit	MW	sent/Out	Unit	MW	sent/Out	Unit	MW	sent/Out	Unit	MW	sent/Out	Unit	MW	sent/Out	Unit	MW	sent/Out	Unit	MW	sent/Out	
2010	1	2010	5	190		3	101																				
2010	1	2010	6	190		4	101																				
2010	1	2010				5	101																				
2011	1	2011				6	101	1	147	A	100																
2011	1	2011				7	101	2	147	B	100																
2011	1	2011				8	101			C	100																
2011	1	2011				9	101	1	147																		
2011	1	2011						5	147																		
2012	1	2012								D	100	1	332				1	738									
2012	1	2012								E	100	2	332														
2012	2	2013																									
2013	1	2013																									
2013	1	2013																									
2013	1	2013																									
2013	2	2014																									
2014	1	2014																									
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2015	1	2015																									
2016	1	2016																									
2017	1	2017																									
2018	1	2018																									
2019	1	2019																									
2019	1	2019																									
2020	1	2020																									

Notes for Wind Generation:-
 A 100MW Generation Wind farm at 132kV Debiha
 B 100MW Generation Wind farm at 132kV Avon
 C 100MW Generation Wind farm at 132kV Debiha
 D 100MW Generation Wind farm at 132kV Debiha
 E 100MW Generation Wind farm at 132kV Debiha

Generation Plant used for the TDP studies

Appendix B: Costing Details

APPENDIX B1: COSTING PER PROJECT TYPE

Type	Total R'mil
Customer	6,100
Generation	31,200
Reliability	127,000
Grand Total	164,300

Please note that the amounts in the tables represents cash flows in the Ten-year plan periods, any cash flows not falling within this period have not been added, consequently the total cost of the plan may be higher than reflected here. Scope Definition Costs are excluded.

APPENDIX B2: COSTING OF PROJECTS PER CLN

Grid	Total R'mil
Central	17,856
East	21,505
North East	12,895
North West	15,269
North	33,880
South	17,980
West	45,093

Please note that the amounts in the tables represents cash flows in the Ten-year plan periods, any cash flows not falling within this period have not been added, consequently the total cost of the plan may be higher that reflected here. Scope Definition Costs are excluded. Includes Customer and Eskom Generation Integration projects.

APPENDIX B3A: COSTING FOR CENTRAL GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
Central	Benburg Ext 3rd 250MVA 275/132kV	145	17,856
	Croydon Ext 3rd 250MVA 275/132kV transformer	144	
	Demeter 400kV Integration	1,115	
	Eiger Ext 3rd 80MVA 88/33kV transformer	30	
	Johannesburg Reactive Power Project	50	
	Johannesburg East Strengthening - Phase 1	460	
	Johannesburg East Strengthening - Phase 2	615	
	Johannesburg East Strengthening- Phase 3 A-D	2,165	
	Johannesburg East Strengthening - Phase 3 E-F	1,928	
	Johannesburg North - Phase 2a	208	
	Johannesburg North - Phase 2b	83	
	Johannesburg Strengthening	2,437	
	Kookfontein Phase 1	17	
	Kookfontein Phase 2	132	
	Kyalami Integration	1,775	
	Siluma 275/88kV MTS	821	
	Simmerpan 275/132kV substation	396	
	Simmerpan 275/88kV substation	497	
	Snowdon transformer upgrade	116	
	Vaal Strengthening Phase 1: Glockner 400/275kV Trfr & Hera-Bernina	509	
	Vaal Strengthening Phase 2	317	
	West Rand Strengthening - Phase: Etna 400kV	590	
	Soweto Strengthening Phase 2 - 275/132kV	563	
	Soweto Strengthening Phase 1 - 275kV	616	
	West Rand Strengthening - Phase: Glockner and Hera 400kV	326	
	Coal 3 Phase 2 - 800kV HVDC	0*	
	West Rand Strengthening - Phase: Westgate B and Taunus 400kV	1801	

* Cost included in Coal 3 Phase 2 - 800kV HVDC (Northern Region)

Please note that the amounts in the tables represents cash flows in the Ten-year plan periods, any cash flows not falling within this period have not been added, consequently the total cost of the plan may be higher that reflected here. Excludes Customer Project and includes Eskom Generation Projects.

APPENDIX B3B: COSTING FOR EAST GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
Eastern	Ariadne-Venus 2nd 400kV Line	809	21,496
	Assmang MTS	317	
	Avon Ext 3rd 250MVA 275/132kV transformer	93	
	Invubu Ext 1st and 2nd 500MVA 400/132kV transformers	888	
	Empangeni Strengthening - Phase 1	1,007	
	Empangeni Strengthening - Phase 2	1,352	
	Empangeni Strengthening - Phase 4	3,893	
	Eros Reinforcement - Ariadne-Eros 400kV	1,154	
	Eros Reinforcement - Eros 2nd transformer	133	
	Hector Ext 3rd 800MVA 400/275kV transformer	112	
	Hector Ext 4th 800MVA 400/275kV transformer	157	
	Incandu Ext 3rd 315MVA 400/132kV transformer	147	
	Klaarwater Reinforcement - Phase 1	37	
	Klaarwater Reinforcement - Phase 2	273	
	KZN 765kV Integration	3,786	
	Ottowa Reinforcement	125	
	Pinetown Strengthening - Phase 1	3,495	
	South Coast Strengthening	751	
	Pinetown - Empangeni Interconnection	1,668	
	Normandie Ext 3rd 160MVA 400/88kV transformer	77	
	Normandie Ext 2nd 250MVA 400/132kV transformer	102	
	Mersey Ext 3rd 250MVA 275/132kV transformer	92	
	Venus-Tugela 275kV Line Loop into Bloukrans	21	
Ingula Pumped Storage P/S Intergration	1,007		

Please note that the amounts in the tables represents cash flows in the Ten-year plan periods, any cash flows not falling within this period have not been added, consequently the total cost of the plan may be higher that reflected here. Excludes Customer Projects and includes Eskom Generation Projects.

APPENDIX B3C: COSTING FOR WEST GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
Western	Cape Corridor Phase 2: Gamma-Omega 765kV Intergation	7,078	42,900
	Cape Corridor Phase 2: Zeus - Hydra 765kV Integration	5,921	
	Cape Corridor Phase 2: Kappa 765kV Integration	0*	
	Cape Corridor Phase 4: 2nd Zeus-Per-Gam-Ome 765kV line	20,918	
	Droerivier-Proteus 2nd 400kV line		
	Firgrove Substation Establishment (2x 500MVA 400/132kV TRFR's)	1,383	
		378	
	Gas I off-site relocation to Ankerlig	471	
	Mitchells Plain 400kV Substation	1,147	
	Muldersvlei Ext 3rd 500MVA 400/132kV transformer & 132kV Series Reactors	153	
	N Cape reinforcement: Ageneies-Paulputs 2nd 220kV	508	
	N Cape reinforcement: Aggeneies-Helios 1st 400kV	1,176	
	N Cape reinforcement: Aggeneis-Oranjemund 2nd 220kV	1,415	
	N Cape reinforcement: Aries SVC	463	
	N Cape reinforcement: Ferrum-Garona-Nieuwehoop 400kV	1,714	
	Paulputs Ext 2nd 125MVA 220/132kV transformer	74	
Philippi Ext 3rd 500MVA 400/132kV transformer	101		

* Costs included in Cape Corridor Phase 2: Gamma-Omega 765kV Integration

Please note that the amounts in the tables represents cash flows in the Ten-year plan periods, any cash flows not falling within this period have not been added, consequently the total cost of the plan may be higher that reflected here. Excludes Customer Projects and Includes Eskom Generation Projects.



APPENDIX B3D: COSTING FOR SOUTH GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
Southern	Cape Corridor Phase 2: : Kappa 765kV Integration	0*	17,970
	Cape Corridor Phase 3: 765kV Series Capacitors (NOH)	906	
	Grassridge Ext 3rd 400/132kV 500MVA transformation	150	
	Greater East London Strengthening - Phase 1: Eros-Vuyani & SS	1,550	
	Greater East London Strengthening - Phase 2: Neptune-Vuyani & SS	0**	
	Greater East London Strengthening - Phase 3	0**	
	Nuclear 1 Integration	5,810	
	PE Phase 3: Poseidon, Delphi, Grassridge and Dedisa Shunt compensation	127	
	PE Phase 4: Poseidon, Delphi, Grassridge and Dedisa Shunt compensation	149	
	Port Elizabeth substation integration - Phase 1	503	
	Southern Grid - Phase 3 : 1st Gamma Grassridge 765kV Line	4,584	
	Southern Grid - Phase 4: 2nd Gamma Grassridge 765kV Line	4,110	
	Southern Grid - Transmission Transformer Normalisation	81	

* Cost Included in the Cape Corridor Phase 2: Gamma-Omega 765kV Integration (Western Grid)

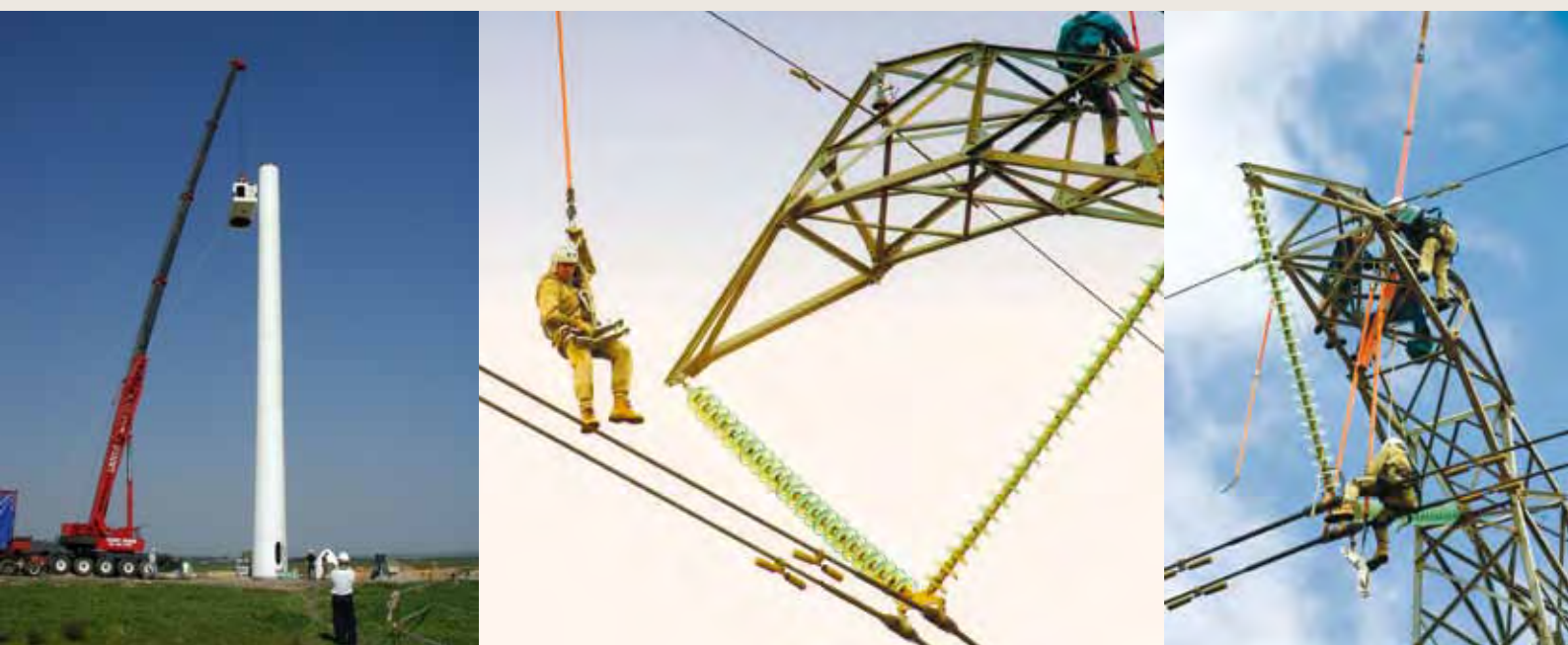
** Cost included in Greater East London Strengthening - Phase 1: Eros-Vuyani & SS

Please note that the amounts in the tables represents cash flows in the Ten-year plan periods, any cash flows not falling within this period have not been added, consequently the total cost of the plan may be higher that reflected here. Excludes Customer Projects and Includes Eskom Generation Projects.

APPENDIX B3E: COSTING FOR NORTH-EAST GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
North-East	Alpha Ext 4th 765/400kV transformer	611	12,824
	Highveld North-West and Lowveld North Reinforcement - Phase 1	1,567	
	Highveld North-West and Lowveld North Reinforcement - Phase 2	551	
	Highveld South Reinforcement	780	
	Kruispunt Reinforcement	42	
	Kusile Integration Phase 1 - 4	2,438	
	Lowveld 400kV Strengthening - Phase 1&2: Gumeni	1,301	
	Lowveld 400kV strengthening - Phase 3	1,349	
	Lowveld Transformation Capacity Enhancement	344	
	Malelane 275kV Reinforcement - Phase 2	545	
	Steelpoort Strengthening Scheme	750	
	Tshwane Reinforcement - Phoebus Phase 1 - 3 &	1,834	
	Verwoerdburg Phase 1 - 2		
	Tshwane Reinforcement - Wildebees Phase	125	
Leseding 400kV Reinforcement	587		

Please note that the amounts in the tables represents cash flows in the Ten-year plan periods, any cash flows not falling within this period have not been added, consequently the total cost of the plan may be higher that reflected here. Excludes Customer Projects and Includes Eskom Generation Projects.



APPENDIX B3F: COSTING FOR NORTH-WEST GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
North-West	Bloemfontien Strengthening	455	15,264
	Boundary Strengthening	930	
	Cape Corridor Phase 2: Zeus-Hydra 765kV Integration	5,921	
	Cape Corridor Phase 3: 765kV Series Capacitors (NOH)	906	
	Garona Strengthening	404	
	Kimberley 400kV Strengthening Phase 1	28	
	Kimberley 400kV Strengthening Phase 2	1,900	
	Kimberley 400kV Strengthening Phase 3	3,272	
	Olein Strengthening	1,282	
	Watershed 275kV Reinforcement	166	

Please note that the amounts in the tables represents cash flows in the Ten-year plan periods, any cash flows not falling within this period have not been added, consequently the total cost of the plan may be higher that reflected here. Excludes Customer Projects and Includes Eskom Generation Projects.



APPENDIX B3G: COSTING FOR NORTH GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
Northern	Acornhoek Upgrade 2x 125MVA 275/132kV transformers	17	33,777
	Brits 400kV Reinforcement	949	
	Coal 3 Phase 1 - 765kV	0*	
	Coal 3 Phase 2 - 800kV HVDC	12,000	
	Dwaalboom 132kV switching station	45	
	Foskor 275/132kV transformation upgrade	1,096	
	Foskor 275kV Reinforcement	0**	
	Medupi Integration (Alpha) Phase 1A: Spitskop and Dinaledi	10,140	
	Medupi Integration (Charlie) Phase 2A: Mogwase	647	
	Medupi Integration (Charlie) Phase 2B: Mokopane	647	
	Medupi Integration (Charlie) Phase 2C: Epsilon and Delta	4,599	
	Nzhelele 400kV reinforcement	2,387	
	Pelly 132/22kV transformation upgrade	28	
	Rustenburg Transformation Reinforcement	194	
	Spitskop 400/132kV Transformation	221	
	Tabor and Spencer Reinforcement - Phase 1	185	
	Tabor and Spencer Reinforcement - Phase 2	622	
Medupi Integration (Alpha) Phase 1B: Marang	0***		

* Cost is included in Coal 3 Phase 2 - 800kV HVDC (also includes HVDC costs in the Central and East Grids)

**Costs included in Foskor 275/132kV transformation upgrade

***Costs in Medupi Integration (Alpha) Phase 1A: Spitskop and Dinaledi

Please note that the amounts in the tables represents cash flows in the Ten-year plan periods, any cash flows not falling within this period have not been added, consequently the total cost of the plan may be higher that reflected here. Excludes Customer Project and includes Eskom Generation Projects.

Appendix C: Publication Team

Although the publication of the document did not comprise a formal team, the following people were instrumental in bringing the document to life. Credit is also given to all the Grid Planning staff, who are responsible for formulating the Strategic Grid Plan as well as the different Grid Plans.

Team Members

Nishan Rathanlall

Roy Estment

Camille Shah and Nomfi Nomjana

Camintha Moodley

Role

Compiler 1

Compiler 2

Printing and Communications

Legal/Regulations

Appendix D: Contact Details

This document will be available via the Eskom website (www.eskom.co.za), but should you have any queries please contact the following people.

Transmission Communications

Camille Shah

Tel: + 27 11 800 4742

Email: Camille.shah@eskom.co.za

Fax: +27 11 800 2336

Grid Planning

Nishan Rathanlall

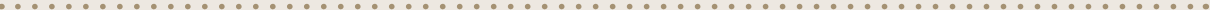
Tel: 011 800 6879

Email: Nish.Rathanlall@eskom.co.za

Fax: +27 11 800 2175



Notes



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Eskom Transmission Division

Megawatt Park Maxwell Drive Sunninghill Sandton

PO Box 1091 Johannesburg 2000 SA

www.eskom.co.za