Eskom

Transmission Development Plan

2010-2019

Revision 1

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Foreword by Managing Directors

The Electricity Supply Industry's value chain consists of generators of electricity, the transmission network (or "electricity delivery "highway") and the distribution network to the end users of electricity. The Transmission network, much like road highways, needs to be kept in good condition and sized correctly to ensure there are no blockages and that it supports economic growth.

The National Energy Regulator of South Africa (NERSA), through the Grid Code, has published a set of criteria according to which the investments in the Transmission network must be made. Eskom, as the licensed Transmission Network Service Provider, develops plans according to this Code and once the funding is approved through the regulatory tariff, builds the network according to these plans. These plans do take into account resource and funding constraints while trying to meet the reliability criteria as soon as possible.

The Transmission Development Plan (TDP) for the period 2010 to 2019 is the second such plan that is being published in the public domain. It follows on the first plan published in 2009. The major focus of the plans continues to be to ensure that the new power stations are integrated into the national power system and that there is a 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 2019.

The 2010 TDP will be the first plan presented to a Public stakeholder forum following on the first ever publication of the 2009 TDP for public comment.

We estimate that, in nominal terms, an investment of R87.3 billion is needed in the period 2011 to 2015 and this will increase to R175 billion in nominal terms to the end of the financial year 2020. The expansion related component over this period is approximately R145 billion. These are significant investments on their own if one compares them to transport and water projects. These investments already consider constraints in funding and resource availability as ideally they would have been accelerated. These investments will result in the reliability standards only being completely met in the period 2015 to 2020.

It is clear that the electricity supply industry of South Africa is a key enabler for economic growth and that 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. We hope that this document will assist in this dialogue, and we welcome comments and queries on 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, requiring extensive consultation and multiple iterations.

Kind regards
Mongezi Ntsokolo and
Kannan Lakmeeharan

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far left:
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Disclaimer

The purpose of publishing the Transmission Development Plan (TDP) 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 the TDP should therefore not be used for any other purpose other than for the sharing of information.

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While the TDP 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 purpose of publishing the TDP 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, requiring the Transmission Network Service Provider (TNSP) to annually publish plans on how the network will develop. This is the second publication of the TDP.

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 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 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 planned projects is approximately R145 billion in the next ten-years, of which approximately R 4 billion is Customer related projects, R36 billion is generation integration projects, and approximately R105 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. 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 to customers of 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

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A previously mothballed Power Station undergoing re-commissioning

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. The Eskom financial year commences in April and concludes in March of the following year, in this case TDP 2010 - 2019 covers a period from 1st April 2010 to 31st March 2020.

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

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

1. Introduction

1.1. Context of the Transmission Development Plan

Eskom Holdings is the biggest producer of electricity in South Africa; it is also a sole transmitter of electricity via a transmission network which supplies electricity at high voltages to a number of large customers and distributors. Eskom is a vertically integrated company licensed to generate, transmit and distribute electricity. The transmission licence is held by Eskom Transmission division, the transmission network service provider, (TNSP). Planning the transmission network is the responsibility of 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 forum(s) to share such plans with stakeholders in order to facilitate a joint planning process with stakeholders. The first ten-year plan was published in 2009, this is the second publication based on the TDP for 2010 to 2019 which was finalised internally in the latter parts of 2009.

1.2. Structure of the Document

The document is structured in the following way:

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 happened since the completion of the previous published TDP. The changes that occurred included 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 discusses 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 also to inform stakeholders of 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 TDP period and a high-level summary of the installed transmission infrastructure.

Chapter 6 focuses on planned projects in more detail and the impact they will have on the network. Generation integration and reliability projects will be discussed per Grid. In both instances, sites and servitudes are required to accommodate placement of substations and lines respectively. In either case, the Environmental Protection Act requires Eskom to conduct an EIA (environmental impact assessment) and obtain environmental approval, which includes the affected public, prior to construction.

Chapter 7 deals with the capital expenditure of the TDP, while

Chapter 8 presents various conclusions based on the content in this document

2. Load Demand Forecast & Generation Scenarios

2.1. Load Forecast

For a transmission network planning cycle, load forecasting is a fundamental requirement. Availability of sufficient transmission network capacity in any country is important for economic growth. Grid Planning, in consultation with the relevant Distribution regions and stakeholders, compiles a forecast per point of supply on an annual basis. The geographically differentiated loads indicate that the growth rates and load profiles differ substantially from one substation or area to another.

The overall system demand is based on the Eskom 2007 forecast, as the forecast of the overall system demand has not changed significantly despite the recent economic downturn. These demand figures are currently under review to determine the exact impact the downturn has had, but this downturn is viewed as a short-term impact, it is believed that the demand will return rapidly once the economy starts to revive and quickly get back on track to the forecasted loadings.

Due to the 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** below.

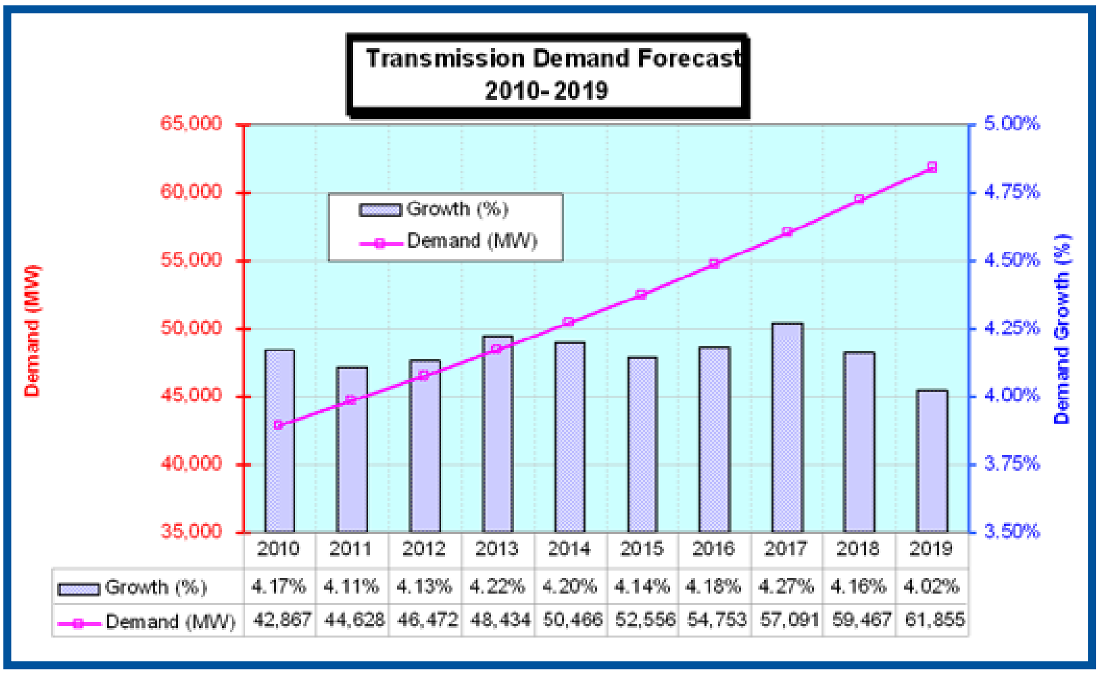


Figure 2 - 1 : The Eskom transmission system demand forecast

The planning studies for the TDP were based on meeting the 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.

2.2. General Assumptions

The existing generation capacity was included as full 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.

Two scenarios were considered, the Foundation Plan, which assumes that all the new generation will be coal based, and the Nuclear B Plan, which assumes that the first new nuclear power station will be started by 2018, known as Nuclear 1. In both cases the proposed Coal 3 power station will be required. Thus for this TDP the main power corridor transmission infrastructure for Coal 3 was included in both scenarios. The installed capacity of this corridor will be able to be used to integrate the first two units from Coal 4 and is therefore common to both scenarios.

The main difference between the two scenarios is the local 400kV infrastructure required to connect either Coal 4 or Nuclear 1. As Nuclear 1 is well understood and likely to be more than what is required for Coal 4 the 400kV infrastructure for Nuclear 1 has been included in the TDP to cater for either project in terms of major equipment, lengths of line and costs. This is discussed in more detail below.

Coal 3 base load generation and the Waterberg

There is a 4800MW (6 x 800MW units) base load coal-fired power station that is required to come on line by 2016, referred to as Coal 3. For the purposes of this TDP it has been assumed that the proposed Mmamabula power station in Botswana is limited to 1200MW in line with the current negotiations for a power purchase agreement. For the Foundation Plan option the first two units of Coal 4 (2 x 800MW) will also be required to be in service by 2019.

Nuclear 1 generation

Regarding the proposed Nuclear 1 power station the major assumption is that the power station will be located at the proposed Thuyspunt site near Port Elizabeth. Although the site selection process is underway and not concluded it was felt prudent that the Nuclear 1 power station be included in the TDP to give an indication of the expected transmission requirements. If the nuclear option materialises it has been assumed that 3150MW will be available from the Nuclear 1 power station at the proposed Thuyspunt site, based on 3x 1050MW units. The first units will come on line in 2018 and Coal 3 will still be required.

Cogeneration initiative

Eskom has embarked on a cogeneration programme to attract new cogeneration partners onto the Eskom system. From a transmission system view most cogeneration projects are reflected as a reduction of the demand in the area where they are connected. The transmission system still has to be planned to be able to supply the connected loads if the cogeneration is not available. Therefore no cogeneration is considered in the TDP or included in the TDP projects. However there is opportunity to optimise and if found viable and achievable, this will be reflected in the next TDP update.

Renewable generation

Eskom is pursuing a number of renewable generation pilot projects which include wind generation and solar power. There are a large number of potential wind energy facilities that have applied for connection to the transmission grid, especially on the West Grid. These are under investigation and there is no clarity on how much will have to be connected and when. The initial wind farm connections should be those closest to the transmission system which will result in the least amount of new infrastructure required. Therefore only 132kV feeder bays are expected for the first connections and will not impact the TDP significantly. Larger connections requiring a new 400/132kV substation to collect the power will take time to initiate and implement due to environmental impact assessment (EIA) regulations. They will only have an impact in the later stages of the TDP.

The transmission system still has to be planned to be able to supply the connected loads if connected renewable generation plant is not available. Therefore no renewable generation is considered in the TDP studies or included in the TDP projects at this stage. However it is anticipated that renewable generation projects and their associated transmission projects will be included in future updates of the TDP.

Conversion of Gourikwa from OCGT to CCGT

There is a proposal to convert some or all of the OCGT units at Gourikwa to CCGT by adding waste heat recovery boilers and steam turbo-generator sets. This would have the effect of increasing the station's total output without increasing fuel consumption. Running cost per kWh of output would be reduced, but would still be higher than coal fired stations, however, its carbon footprint would be smaller. No date has been set, so it is assumed for purposes of this document that it will be in 2019. It has not been included in the generation scenarios used to compile this TDP due to the high level of uncertainty associated with the project, but has been included in this document to give stakeholders an idea of associated transmission requirements.

Ingula power station

Ingula power station will be a pumped-storage scheme located in the Eastern Region; it will primarily be used during peak times.

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** and **Figure 2 - 3** below.

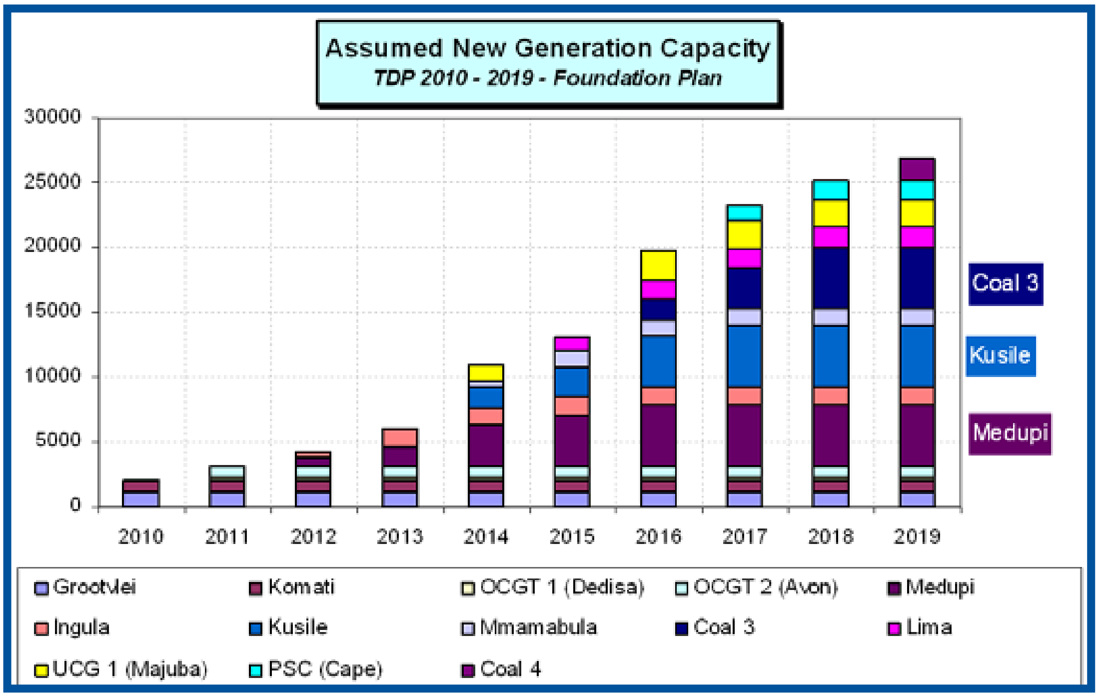


Figure 2 - 2: Power station capacity introduction by year

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 in emergencies, making it necessary to plan the network to meet local load without them being available for use.

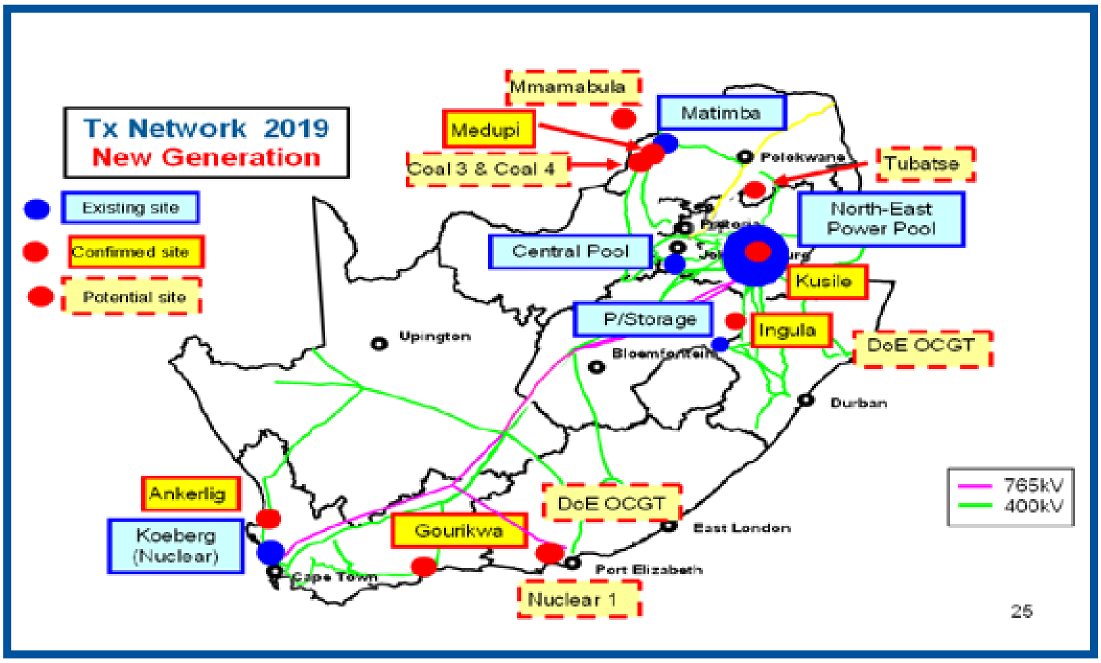


Figure 2 - 3: Planned Power Station Capacity by 2019

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

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 factors were related to an improved understanding of the geospatial load centres and forecast, the Strategic Grid Study of the main power corridors to 2030, and the potential generation scenarios. These three 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

There was no overall change to the system peak load forecast as the forecast for total system demand has not changed significantly despite the recent economic downturn. These demand figures are currently under review to determine the exact impact the downturn has had, but this downturn is viewed as a short-term impact and it is believed that the demand will return rapidly once the economy starts to recover and quickly get back on track to the forecasted loadings

The changes in the load forecast from the previous TDP are largely based on newly available information. As a result, some of the load has moved between substations and the need for new substations has been identified. The revision of the demand forecast resulted in a number of new projects required within the TDP period as well as several of the projects identified in the previous TDP being reconfigured or re-phased.

3.2. Generation Assumptions

The major changes in the generation assumptions from the previous TDP are the inclusion of Coal 3 and the optional scenario of Nuclear 1.

The Coal 3 generation is assumed to be in the Waterberg area close to Medupi 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 an HVDC converter station in the vicinity of Coal 3 to cater for the final configuration of six 800MW units.

The HVDC lines will connect to terminal stations in the Central Grid and the East Grid. These HVDC lines should cater for the first two 800MW units for a proposed Coal 4 power station in the same area. The Coal 4 units could be replaced by IPP units in the same area. This is in line with the long-term integration requirements identified in the Strategic Grid Plan for 2030 for future large generation in the Waterberg area.

Mmamabula will be limited to 1200MW (2 x 600MW) in line with the current power purchase agreement negotiations. The first unit will be connected in 2014 and the second unit in 2015.

Nuclear 1 is considered, as in the previous TDP, to be located at the Thuyspunt site. As the transmission integration requirements only need around 300km of new 400kV line (some of which will still be required for the new Port Elizabeth 400/132kV substation if Nuclear 1 does not materialise) and a new 400kV switchyard, the projects have been included in the TDP. Their overall impact on the TDP requirements is relatively small and only in the last years of the TDP period. They will provide an indication of the lengths of line that will be required on other projects if Nuclear 1 does not happen, such as the lines from the Coal 4 power station or IPP developments in the Waterberg area to Delta substation and the HVDC terminal station.

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 TDP 2009 - 2018, some RTS power stations were anticipated to be completed in 2009. 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:

Camden RTS: this power station has now been fully returned to service and the project is complete.

Grootvlei RTS: only generator bays 5 and 6 are still outstanding and completion anticipated in 2010/11 financial year.

Komati RTS: only generator bays 1, 2, 3, 4, and 5 are still outstanding, and completion is anticipated in the 2010/11 financial year.

4.2. Update on transmission reliability projects

This section discusses all the projects that were reflected in the TDP 2009 - 2018 for commissioning in FY2009/10. 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 project to install a 3rd 315MVA 275/88kV transformer at Rigi Substation near Van der Bijlpark has been completed.

Johannesburg North Strengthening Phase 1 entailed installation of additional transformation capacity at Lulamisa substation (Fourways area), Craighall substation (Bryanston) and Lepini (Tembisa). The transformation installations at Lulamisa substation (3rd transformer) and at Craighall substation (3rd transformer) have been completed. The installation of the 3rd and 4th transformers at Lepini substation is outstanding.

East Grid

The implementation of Empangeni Phase 1 Scheme is in progress. The construction of the Majuba - Umfolozi 400 kV (765 kV design) is nearing completion, and is expected to be completed in June 2010.

The project to introduce 400kV into Eros substation has been completed, with the planned 400/132kV transformer having been commissioned.

North East Grid

The projects for the installation of additional transformation capacity at Malelane (1 x250 MVA) and Marathon (2 x 500 MVA) substations are in progress, but are running behind schedule. The Sol B switching station project has been cancelled, and is being reconfigured into a full substation. This project is linked to developments in the Secunda supply area.

North Grid

A number of projects to upgrade transformation capacity in the North Grid have either been completed or are at finalisation stage. These include the Spitskop 3rd 500MVA transformer and Marang 4th transformer, both of which are at finalisation, as well as the Witkop 3rd transformer project, which is completed. The Tabor-Spencer Scheme, which entailed constructing the Tabor-Spencer 1st 275kV line as well as a 2nd transformer at Spencer has been completed. The commissioning of the Bighorn 2nd transformer has been delayed to 2011.

South Grid

The integration of Dedisa 400/132 kV substation is at the finalisation stage. A number of projects relating to the South Grid Strengthening Scheme have been deferred. This is primarily as a result of the uncertainty surrounding the establishment of an Aluminium Smelter in the Port Elizabeth area, as well as potential substantial step loads in this supply area.

4.3. Grid connection applications

A total of *thirteen feeder bays* were completed to connect customers to the network. Details are however withheld to protect the confidentiality of the customers concerned. **Table 4 - 1** outlines the number of Feasibility Quotations (FQ's) and Budget Quotations (BQ's) that have been processed during the period January 2009 to February 2010. These are as a result of applications for grid connections, as per the Grid Code.

Table 4 - 1: Connection Applications Quoted and Accepted

Grid	Feasibility Quotations		Budget Quotations	
	Applications	Accepted	Applications	Accepted
Central	8	4	4	3
East	8	2	4	1
North East	14	4	7	0
North West	0	0	2	0
North	21	2	6	1
South	11	0	2	0
West	4	1	3	1
Total	**66**	**13**	**28**	**6**
% Acceptance		**20%**		**21%**

As shown in **Table 4 - 1** above, the number of customer applications for grid connections processed is fairly high, while the acceptance rate is low. The results above indicate that there is potential wasteful use of scarce resources to process quotes which are not accepted. Further analysis and consultation with customers is required to understand opportunities to improve this performance.

5. National Overview

The map below in **Figure 5 - 1** 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.

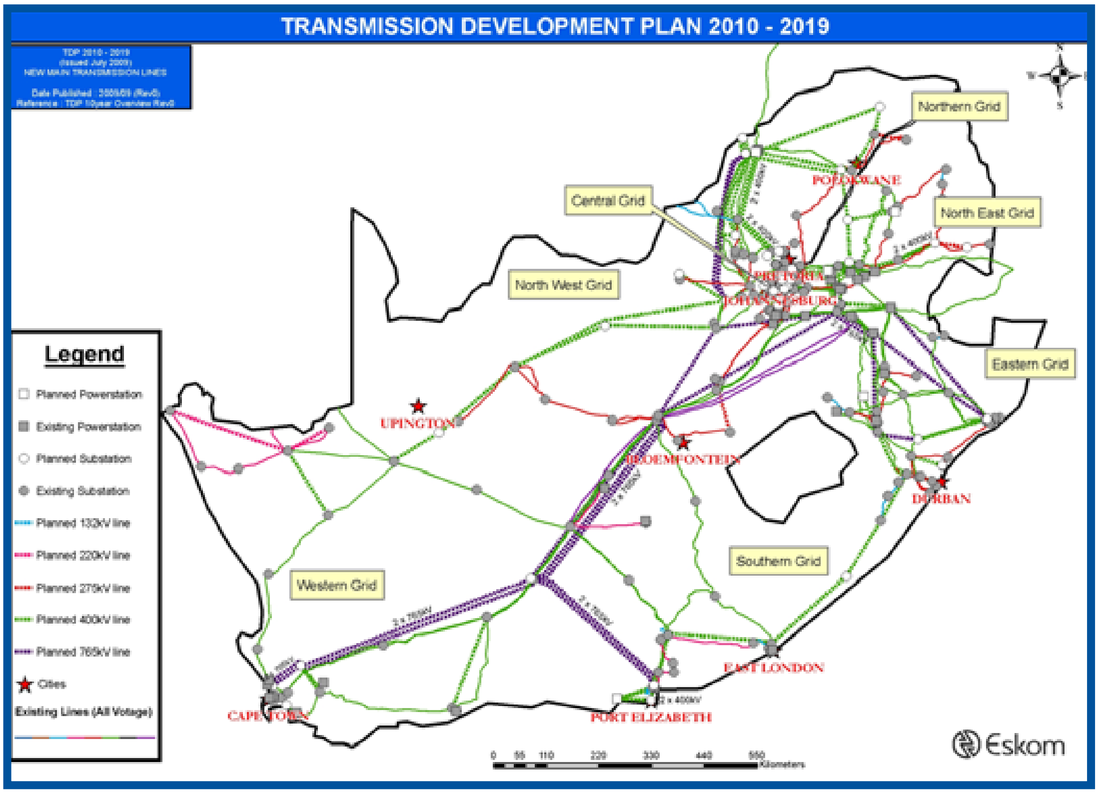


Figure 5 - 1: Map showing relative location of the major TDP scheme projects

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** below.

Table 5 - 1: Major TDP transmission assets expected to be installed

TDP New Asset	Total
HVDC Lines (km)	1 700
765kV Lines (km)	6 770
400kV Lines (km)	8 355
275kV Lines (km)	831
Transformers 250MVA+	103
Transformers <250MVA	29
Total installed MVA	67 840
Capacitors	19
Total installed MVAr	2 366
Reactors	56
Total installed MVAr	14 600

A significant amount of new transmission lines is being added to the system with over 6,700 km of 765kV and over 8,300 km of 400kV lines either approved or proposed over the ten-year TDP period. This is due to the major network reinforcements required for the supply to the Cape (South and West Grids) and the supply to the 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 requires significant lengths of transmission line as the power stations 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 the Central and East Grids, requiring 1,700km of 800kV constructed HVDC lines.

The large amount of 400kV transmission lines is also as a result of a more meshed transmission 400kV network being developed to provide higher reliability within the grids 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 ten-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 ten-year TDP to be aligned with the future long-term development of the whole Eskom system.

The addition of over 67000 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. The 2,366 MVars of capacitive support are required to support areas of the network under contingency conditions to ensure that the required voltage levels are maintained.

The 14600 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 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.

Currently six new SVCs have been identified in the TDP; two large SVCs with a range of +350/-100 MVAr in the Eastern Cape (South Grid) to support the Coega demands, two new SVCs are proposed to support the Northern Cape (West Grid) and the proposed Sishen-Saldhana Spoornet expansion, namely a +200/-100 MVAr SVC at Aries and a smaller one of +45/-100 MVars at Garona. Two +100/-100 MVAr SVCs are required for dynamic voltage support in the North West Grid at Ferrum and Merapi. There is a seventh SVC project to decommission the existing 132kV SVC at Grassridge.

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.

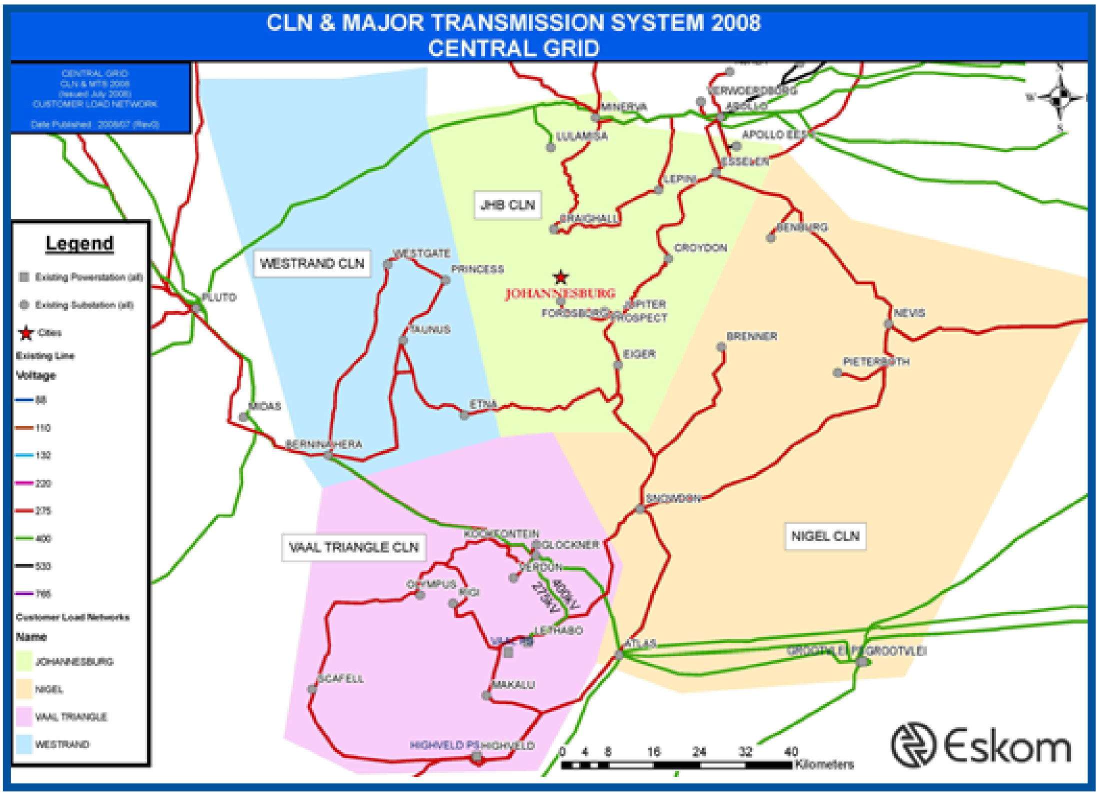


Figure 6 - 1: Current Central Grid network and CLNs

The expected peak CLN demands by 2019 and the average percentage load increase for the period for each CLN are given in **Table 6 - 1** below.

Table 6 - 1: Central Grid CLN load forecast and percentage load increases

CLN	Actual Peak Load 2008 (MW)	Forecasted Load (MW) 2009	2015	2019	Ave. Annual % Load Increase
Johannesburg	4106	5139.4	6165	7448.4	4.11
West Rand	1935	2147.3	2327	2400.7	1.18
Nigel	1666	1879	1989	2037.6	1.05
Vaal Triangle	1443	1929.4	2047	2122.5	1.09

The TDP schemes for the Central Grid consist of extending the 275kV network (built at 400kV insulation level) 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 2014 and end 2019 and the cumulative total are shown in **Table 6 - 2.**

Table 6 - 2: New transmission assets for the Central Grid

Transmission Asset for Central Grid	New Assets expected in 2010 - 2014	New Assets expected in 2015 - 2019	Total New Assets expected
Total kms of line	633	346	979
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	0 625 8	0 296 50	0 921 58
Total installed Transformer MVA	3 285	7 860	11 145
Transformers (no. of)	11	18	29
Capacitors (no. of)	2	0	2
Reactors (no. of)	0	0	0

6.1.1. Johannesburg CLN

The customer load network (CLN) maximum load for 2008 was 4106 MW. The loads are forecasted for a ten-year period from 2010 to 2019. Lepini, Lulamisa, Craighall and Croydon substations have the highest annual load increases for the ten-year period. Especially in the Lulamisa and Lepini supply areas (Midrand and Johannesburg North), 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 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.

The main drivers behind the load growth in the Johannesburg CLN are:

- Craighall/Croydon (Randburg, Sandton and Kempton Park): urban development mainly housing and extensions to existing shopping malls and development of new ones, as well as office blocks and office parks. The trend of companies relocating from the Johannesburg city centre, especially to the Sandton CBD, has also created a demand for additional hotel accommodation.
- Lepini/Lulamisa (Midrand and Johannesburg North): expansion of existing affordable housing in Ivory Park, Diepsloot and emerging affordable housing in Cosmo City (25 000 affordable houses are planned for the next five years). New residential developments (high and very high income) in Johannesburg North and part of Midrand. Development of commercial office blocks, shopping centres, and light industrial loads is also on the increase.
- Delta/Fordsburg/Prospect: mainly residential development and light industrial loads.

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.

The main projects in the Johannesburg CLN are described below. Almost all of the projects are the same as those in the previous TDP 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	2013
Johannesburg Reactive Power Project	
• Eiger and Jupiter 88kV 48MVAr shunt capacitor bank	2012
• Croydon and Benburg 132kV 72MVAr shunt capacitor	2012
Johannesburg East Strengthening	
• Phase 1A: Esselen second 275/88kV 315MVA transformer	2010
• Phase 1B: Esselen–North Rand 275kV line strengthening	2015
• Phase 2: North Rand MTS strengthening	2016
• Phase 3 A-D: Jupiter B MTS integration	2014
• Phase 3 E-F: Sebenza integration	2017
Johannesburg Strengthening	
• Establish Sebenza-Craighall 275kV lines	2017
• Establish 1x 275kV GIS feeder at Craighall MTS	2017
• Establish new 400/132kV Craighall B GIS MTS	2019
• Loop Craighall–Lepini/Sebenza lines into Craighall B	2019
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)	
• Install 2x500MVA 275/132kV transformers	2016
• Build 6x132kV new feeder bays at the Quattro substation	2016
Simmerpan MTS Strengthening – Phase 1(built at *400kV, operated at 275kV)	
• Establish new Simmerpan MTS 275kV *busbar	2015
• Operate Jupiter–Simmerpan 2x88kV lines at 275kV	2015
• Install 2x275/88kV 160MVA transformers	2015
Simmerpan Strengthening – Phase 2(built at *400kV, operated at 275kV)	
• Install 2x250MVA 275/132kV transformers	2016
• Build 6x 132kV new feeder bays at the Simmerpan	2016
Kyalami 400kV Strengthening	
• Construct the new Kyalami 275/132kV GIS station	2014
• Loop the Kusile-Lulamisa 400kV line into Kyalami MTS	2014
Lulamisa MTS Transformation Strengthening	
• Install a forth 400/88kV 315MVA transformer.	2019
HVDC Terminal B	
• Establish an HVDC converter station close to Jupiter B MTS	2017
• Build an 800kV line from Terminal B to Coal 3 via Epsilon	2017

6.1.2. West Rand CLN

This CLN consists of six transmission substations supplying both residential and industrial loads. The CLN maximum load for 2008 was 1935 MW at time of area peak, and the loads are forecasted for a ten year period from 2010 to 2019. In 2019 the CLN load is expected to reach 2400 MW at time of CLN peak. 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. **2015**
- Construct Demeter-Lulamisa 400kV line (30km) **2015**
- Construct Demeter-Lomond 400kV line (50km) **2015**
- Construct Etna-Taunus 400kV line (energised at 275kV) **2015**

West Rand Reinforcement

- Establish Westgate B 400/132kV substation **2017**
- Install first 400/132kV 500MVA transformer **2017**
- Construct Hera-Westgate B first 400kV line **2017**
- Construct Taunus-Westgate B first 400kV line **2017**
- Construct Taunus Ext 400/132kV transformation (1 x 500MVA) **2017**
- Construct Etna-Taunus first 400kV line (energised at 400kV) **2017**
- Construct Glockner-Hera first 400kV line **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). The CLN maximum load for 2008 was 1666 MW. In 2019, the CLN load is forecasted to be 2037 MW. Grootvlei and Benburg show considerable load increases.

The load growth in the Nigel CLN is driven by the following:

- Residential loads (normal load growth), some of which are: Boksburg North, Boksburg, Meyerton, Heidelburg and Vosloorus.
- Light industrial loads (normal load growth): for example, Paper and Concrete industries.
- Mining (Normal Load growth); Gold mining and ferrous metals smelting

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. **2017**

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 CLN

This CLN consists of seven transmission substations and one power station supplying both residential and heavy industrial loads. The CLN maximum load for 2008 was 1443MW at time of CLN peak. In 2019, the CLN load is expected to reach 2122MW at CLN peak. The anticipated high load growth nodes are at Makalu and at Verdun MTS.

The major contributors to the load growth are,

- Residential/Commercial load (normal growth): Boipatong, Sebokeng, Vaalpark, Vanderbijlpark etc, and
- Industrial light and heavy load (high load growth)

The Makalu transformation project that was in the last TDP has been cancelled as it is no longer needed due to load shifts. The main projects in the Vaal CLN are as follows:

Vaal Strengthening Phase 1 (closing of the Hera-Bernina 275kV link)	
• Replacement of underrated equipment due to high fault levels	2011
• Glockner third 400/275kV 800MVA transformer	2011
• Glockner 275kV busbar replacement to tubular	2011
Vaal Strengthening Phase 2	
• Construct Glockner-Etna 2x 400kV lines operated at 275kV.	2011
Vaal Strengthening Phase 3	
• Operate Glockner-Etna 2x400kV lines operated at 400kV	2017
• Construct Etna 2x800MVA 400/275kV.	2017
Kookfontein Transformation Phase 1	
• Install 2 x 88kV 48 MVar capacitor banks at Kookfontein	2011
Kookfontein Transformation Phase 2	
• Install a third 275/88kV 315MVA transformer	2015
• Build a third Glockner-Etna 275kV line	2015
Olympus Transformation Strengthening	
• Install a third 275/132kV 250MVA transformer	2017

A network diagram showing the major projects in the Central Grid is shown in **Figure 6 - 2** below.

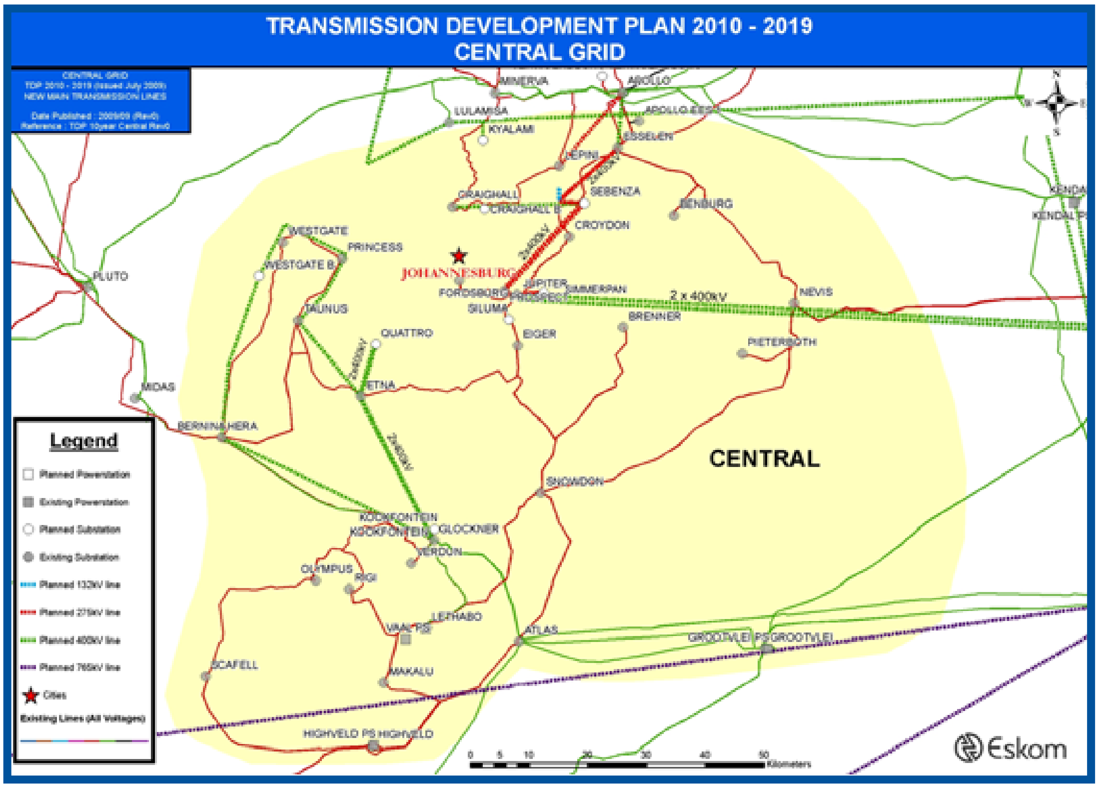


Figure 6 - 2: Central Grid network diagram

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.

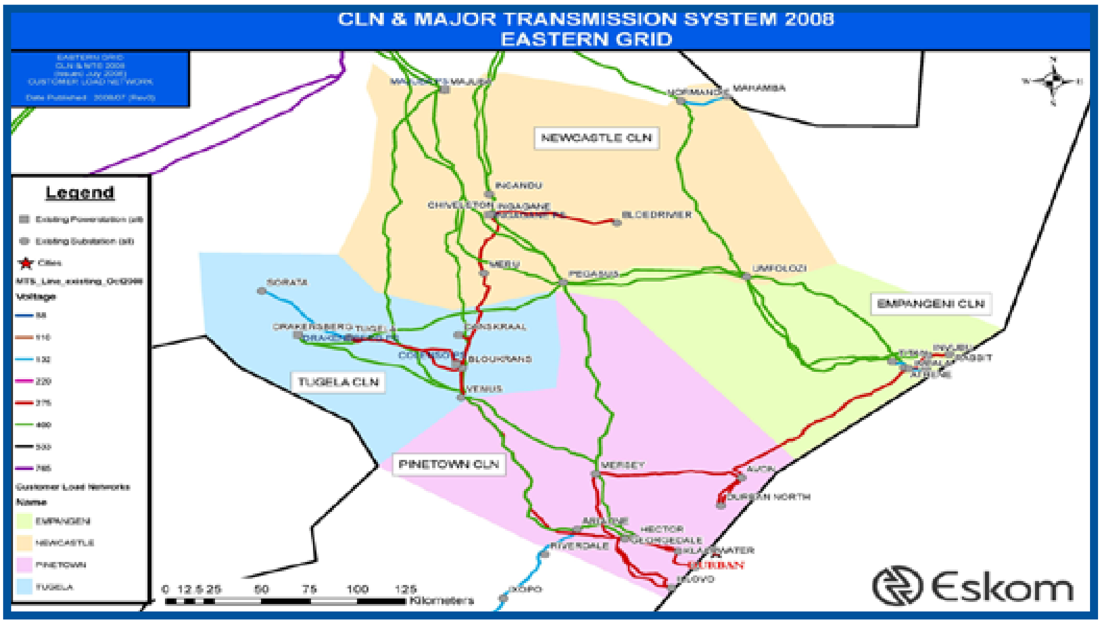


Figure 6 - 3: Current East Grid network and CLNs

The expected area peak demands by 2014 and 2018 and the average percentage load increase for the period for each CLN are given in **Table 6 - 3** below.

Table 6 - 3: East Grid CLN load forecast and percentage load increase

CLN	Peak Load (MW) 2008	Forecasted Load (MW) 2015	2019	Ave. Annual % Load Increase
Ladysmith and Newcastle	1158	1392	1513	2.3 %
Empangeni	2049	3110	3303	4.0%
Pinetown	3212	3724	3922	2.0%

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 as listed in the project summary list that are required to strengthen the network.

The increase in transmission assets by end 2013 and end 2018 and the cumulative total are shown in **Table 6 - 4.**

Table 6 - 4: East Grid new transmission assets

Transmission Asset for Eastern Grid	New Assets expected in 2010 - 2014	New Assets expected in 2015 - 2019	Total New Assets expected
Total kms of line	1 690	620	2 310
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	990 700 0	530 85 5	1 520 785 5
Total installed Transformer MVA	7 145	1 475	8 620
Transformers (no. of)	10	5	15
Capacitors (no. of)	1	0	1
Reactors (no. of)	7	2	9

6.2.1. Ladysmith and Newcastle CLNs

The average annual load growth in Ladysmith and Newcastle CLNs is projected at about 2.31% (35MW) over the next ten years. 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:

Install a Shunt Capacitor at Bloedrivier — 2013

Install Incandu third 315MVA-400/132kV transformer — 2015

Ingula Power Station Integration (Generation Integration)
- Establish a 400kV busbar at Ingula — 2012
- Loop Majuba-Venus 400kV line into Ingula — 2012
- Construct Ingula-Venus 78km 400kV line — 2012

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 Pinetown CLN via Impala substation.

The projects planned in this CLN are discussed below. The Empangeni 400/132kV transformation project that was in Empangeni Phase 3 in the previous TDP has been cancelled, as it is no longer needed; consequently Empangeni Phases 4, 5, and 6 have been changed to Empangeni Phases 3, 4, and 5.

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 2012
- Construct Umfolozi-Theta 765kV line to be operated at 400kV 2012
- Loop Umfolozi-Athene 400kV line into Theta 2012
- Loop Umfolozi-Invubu 400kV line into Theta 2012
- Construct Theta-Invubu 400kV line 2012

Empangeni Strengthening Phase 3

- Establish 765/400kV at Theta 2015
- Convert Majuba-Umfolozi-Theta line to Zeus-Theta to 765kV 2015

Pinetown-Empangeni Interconnection (previously Pinetown Phase 3)

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

Empangeni Strengthening Phase 4

- Construct Camden–Theta 765kV line to be operated at 400kV 2015

Empangeni Strengthening Phase 5

- Establish 765kV at Camden 2017
- Operate Camden–Theta 765kV line at 765kV 2017

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 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 2013

Pinetown Strengthening Phase 2 2015

- 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.**

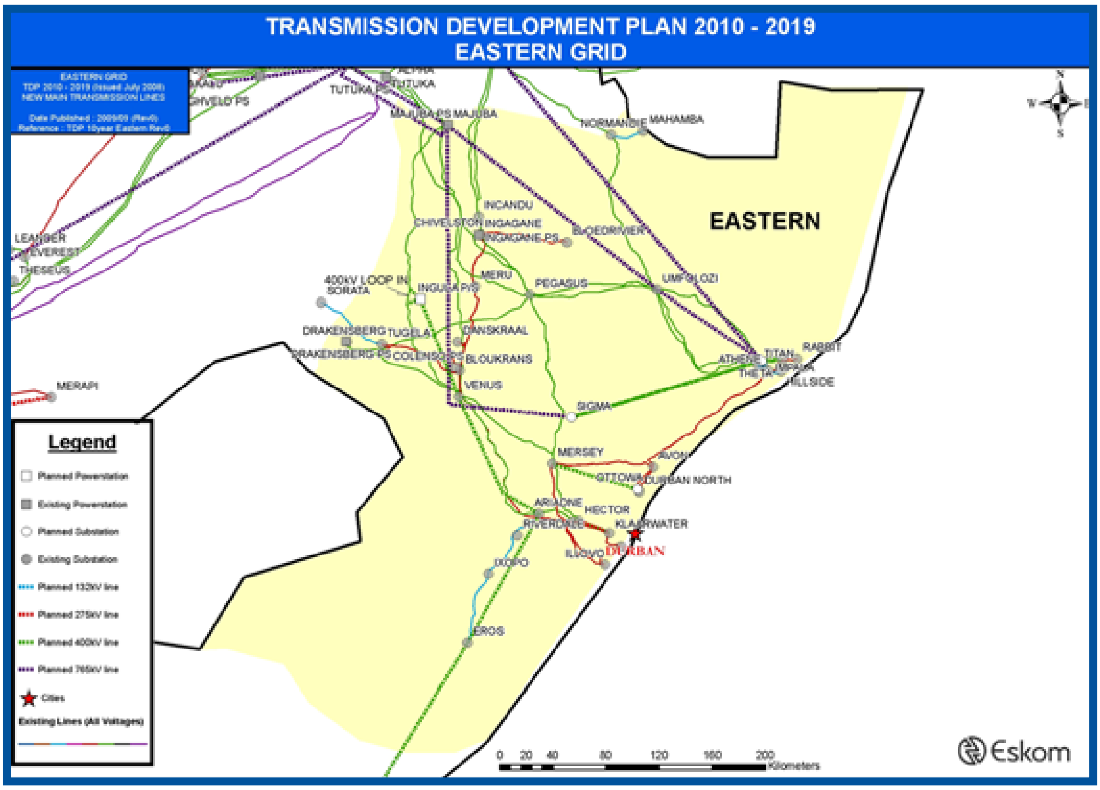


Figure 6 - 4: East Grid geographical network diagram

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.

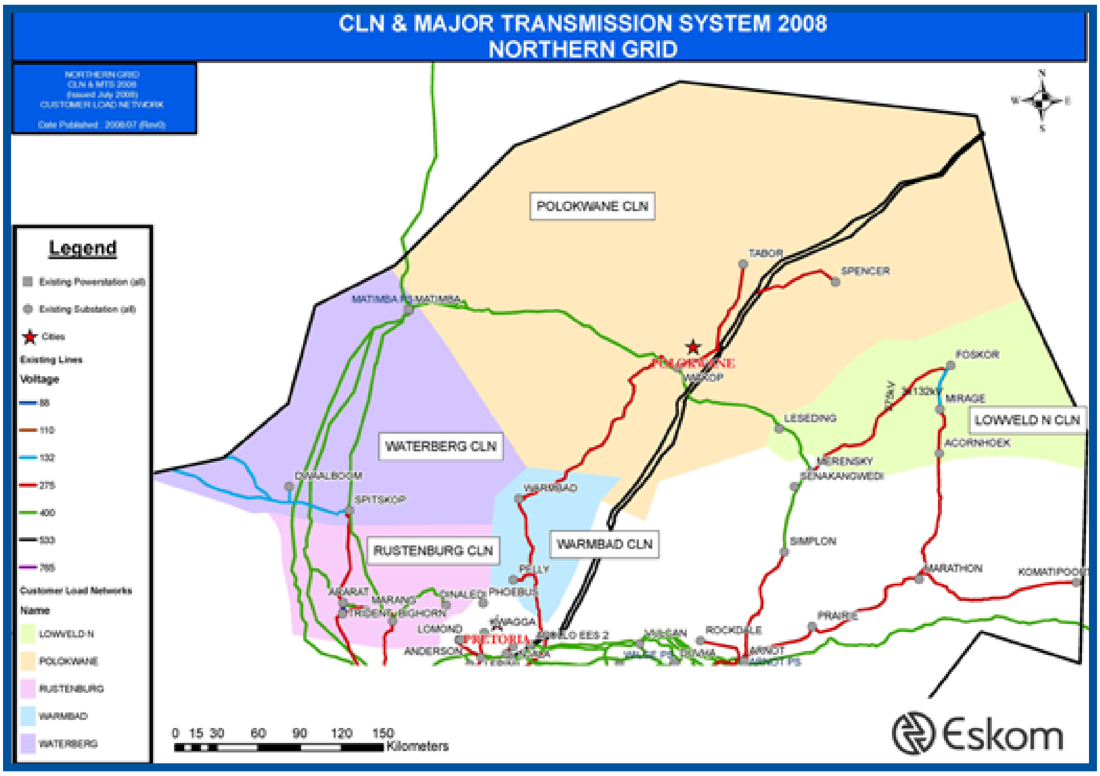


Figure 6 - 5: Current North Grid network and CLNs

The expected peak demands by 2015 and 2019 and the average percentage load increase for the period for each CLN are given in **Table 6 - 5** below.

Table 6 - 5: North Grid CLN load forecast and percentage load increases

CLN	Peak Load (MW) 2008	Forecasted Load (MW) 2015	Forecasted Load (MW) 2019	Ave. Annual % Load Increase
Waterberg	618	1322	1927	21.2
Rustenburg	1880	2891	2956	5.7
Lowveld North	581	1150	1210	10.8
Warmbad	543	682	704	3.0
Polokwane	1010	1495	1639	6.2

The North Grid load is mainly platinum group metals (PGM) and ferrochrome mining and processing located in Rustenburg, Polokwane and Lowveld North (Steelpoort area). The Waterberg CLN has had the highest average annual growth of about 21% followed by Lowveld with 10.8%, Polokwane with 6.2%, Rustenburg with 5.7% and Warmbad with 3.0%. The average annual growth for the North Grid for the period 2009 to 2019 is expected to be 8.2%.

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 Mmamabula), and the installation of additional transformers at existing and new substations. The increase in transmission assets by end 2013 and end 2018 and the cumulative total are shown in **Table 6 - 6.**

Table 6 - 6: North Grid new transmission assets

Transmission Asset for Northern Grid	New Assets expected in 2010 - 2014	New Assets expected in 2015 - 2019	Total New Assets expected
Total kms of line	2 551	1 170	3 721
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	350 1 966 235	350 820 0	700 2 786 235
Total installed Transformer MVA	5 370	9 500	14 870
Transformers (no. of)	12	8	20
Capacitors (no. of)	0	0	0
Reactors (no. of)	5	3	8

6.3.1. Waterberg CLN

The Waterberg CLN contains the Medupi 4800MW coal-fired power station that is under construction. It is also the where two additional coal-fired power stations are likely to be developed. They are referred to as Coal 3 and Coal 4, with six 800MW units and two 800MW, respectively, expected to be in service by 2019.

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 has now been reduced to 1200MW, which is currently under negotiation for power purchase agreement.

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 Mmamabula integration:

- Construct the Medupi-Spitskop first 400kV line 2011
- Construct the Medupi-Spitskop second 400kV line 2011
- Construct the Medupi-Marang first 400kV line 2012
- Construct the Mogwase 2x500MVA 400/132/22kV substation 2013
- Loop the Matimba-Midas 400kV line into Mogwase 2013
- Construct the Matimba-Mogwase first 400kV line 2014
- Construct the Medupi-Mokopane first 400kV line 2014
- Construct the Medupi-Witkop first 400kV line 2014
- Construct the Delta 400/765kV substation 2014
- Construct the Epsilon 765/400kV substation 2014
- Construct the Delta-Epsilon first 765kV line operated at 400kV line 2015
- Construct the Delta-Epsilon second 765kV line operated at 400kV line 2015
- Construct the Mmamabula-Delta/Medupi first 400kV line 2012
- Construct the Mmamabula-Delta/Medupi second 400kV line 2012
- Construct the Mmamabula-Delta/Medupi third 400kV line 2013
- Construct the Mmamabula-Delta/Medupi fourth 400kV line 2013
- Loop the Hermes-Pluto first 400kV line into Epsilon 2015
- Loop the Hermes-Pluto second 400kV line into of Epsilon 2015

Coal 3 and Coal 4 Integration:

- Establish 765/400kV transformation at Delta 2016
- Establish 765/400kV transformation at Epsilon 2016
- Energise Delta-Epsilon first and second 765kV lines at 765kV 2016
- Construct Coal 3 – Delta first, second and third 400kV lines 2016
- Construct HVDC Terminal A–Delta first and second 400kV lines 2017
- Construct Coal 3–HVDC Terminal A first 400kV lines 2017
- Establish HVDC Terminal A (Lephalale) 2017
- Construct HVDC 800kV Line 1 (Lephalale-Jupiter B) 2017
- Establish HVDC Terminal B (Jupiter B/Johannesburg) 2017
- Construct Coal 3–HVDC Terminal A second and third 400kV lines 2018
- Construct HVDC 800kV Line 2 (Lephalale-Durban) 2018
- Establish HVDC Terminal C (Durban) 2018

6.3.2. Rustenburg CLN

The Rustenburg CLN high load growth, 20% over the past 13 years and averaging 15% over 24 years, is mainly driven by platinum group metals (PGM) and ferrochrome.

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 Mmamabula power stations. This has resulted in portions of the Medupi and Mmamabula integration included in the Rustenburg CLN.

Rustenburg 400kV Strengthening:

- Construct Medupi–Marang 400kV line 2011
- Establish Mogwase 2x 500MVA 400/132/22kV substation 2013
- Loop the Matimba-Midas 400kV line into Mogwase 2013
- Construct Medupi-Mogwase 400kV line 2013
- Establish Brits West 2x 500MVA 400/132/22kV substation 2017
- Loop the two Spitskop-Dinaledi 400kV lines into Brits West 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. To link the Warmbad CLN with the Central Grid, the following 400kV strengthening is proposed:

Construct the Dinaledi-Lomond 400kV line	2014
Establish Lomond 400/275kV transformation	2014
Construct the 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:

Establishment of the New Mokopane 400/132kV Substation

• Establish Mokopane 2x 500MVA 400/132/22kV substation	2013
• Loop Matimba-Witkop second 400kV line into Mokopane	2013
• Construct Medupi-Mokopane first 400kV line	2014
• Construct Medupi-Witkop first 400kV line	2014
• Construct Mokopane-Witkop first 400kV line	2014
• Construct Mokopane-Marble Hall first 400kV line	2014
• Construct the Tabor-Witkop first 400kV line	2012
• Construct the Tabor 400/132kV substation (1x 500MVA transformer)	2012

Establishment of the new Nzhelele 400/132kV Substation

• Establish Nzhelele 400/132kV substation north of Tabor	2015
• Construct Tabor-Nzhelele first 400kV line	2015
• Construct Medupi-Nzhelele first 400kV line	2017

6.3.5 Lowveld North CLN

The Lowveld CLN forecast changed drastically from July 2008 with the prospects of the existing phosphate mining load increasing at Foskor as well as a new step load customer application at Leseding. This has resulted in the need to revise the Acornhoek –Foskor network to come up with a long-term solution that will address both the 275/132kV.

The projects proposed in this CLN are as follows:

• Foskor-Merensky 2nd 275kV line	2013
• Foskor 3rd 250MVA 275/132kV transformer	2013
• Leseding 3rd 400/132kV 500MVA transformer	2013

A network diagram showing the major projects in the North Grid is shown in Figure 6 - 6 below. The HVDC lines are not indicated but they will run parallel to the two 765kV routes until the Epsilon substation where they will bypass and head into the Central and East Grids.

A network diagram showing the major projects in the North Grid is shown in **Figure 6 - 6** below. The HVDC lines are not indicated but they will run parallel to the two 765kV routes until the Epsilon substation where they will bypass and head into the Central and East Grids.

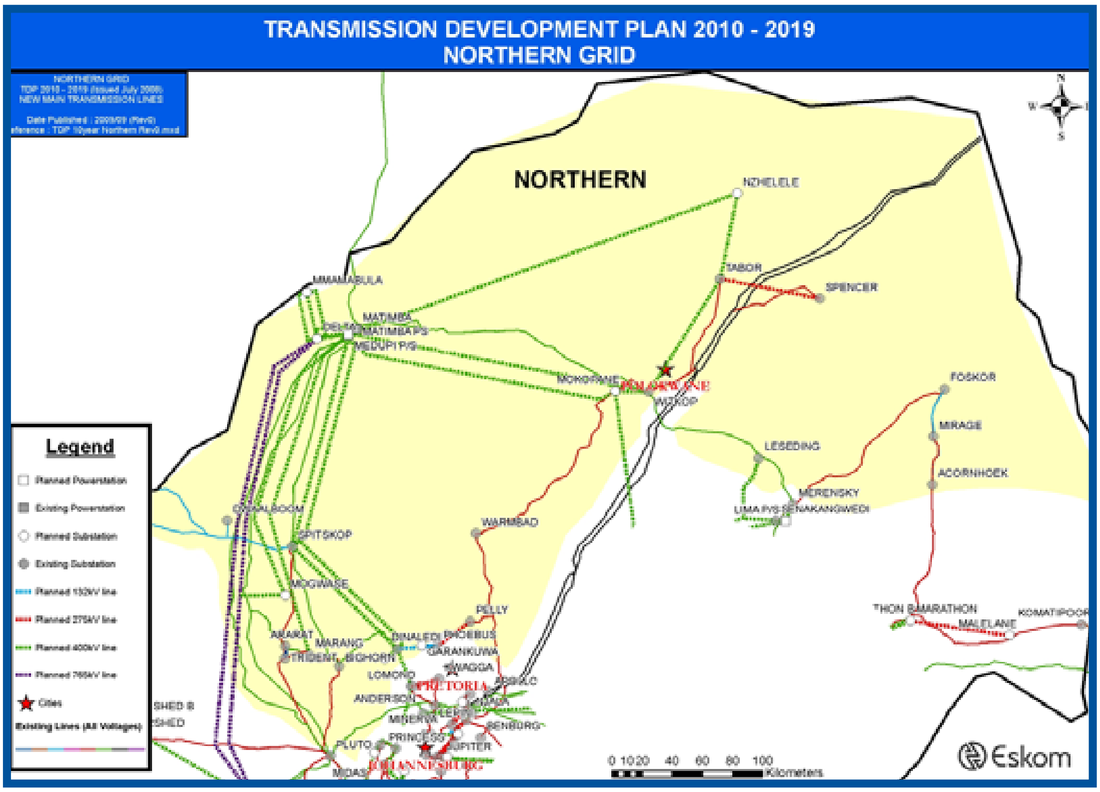
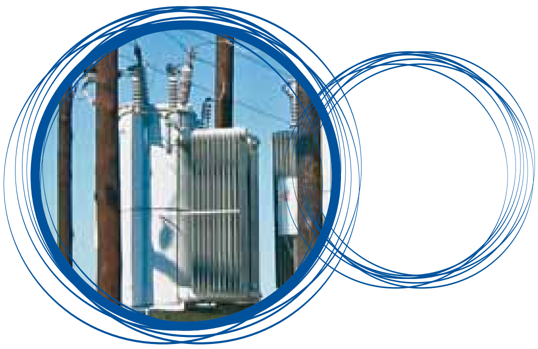


Figure 6 - 6: North Grid geographical network diagram



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.

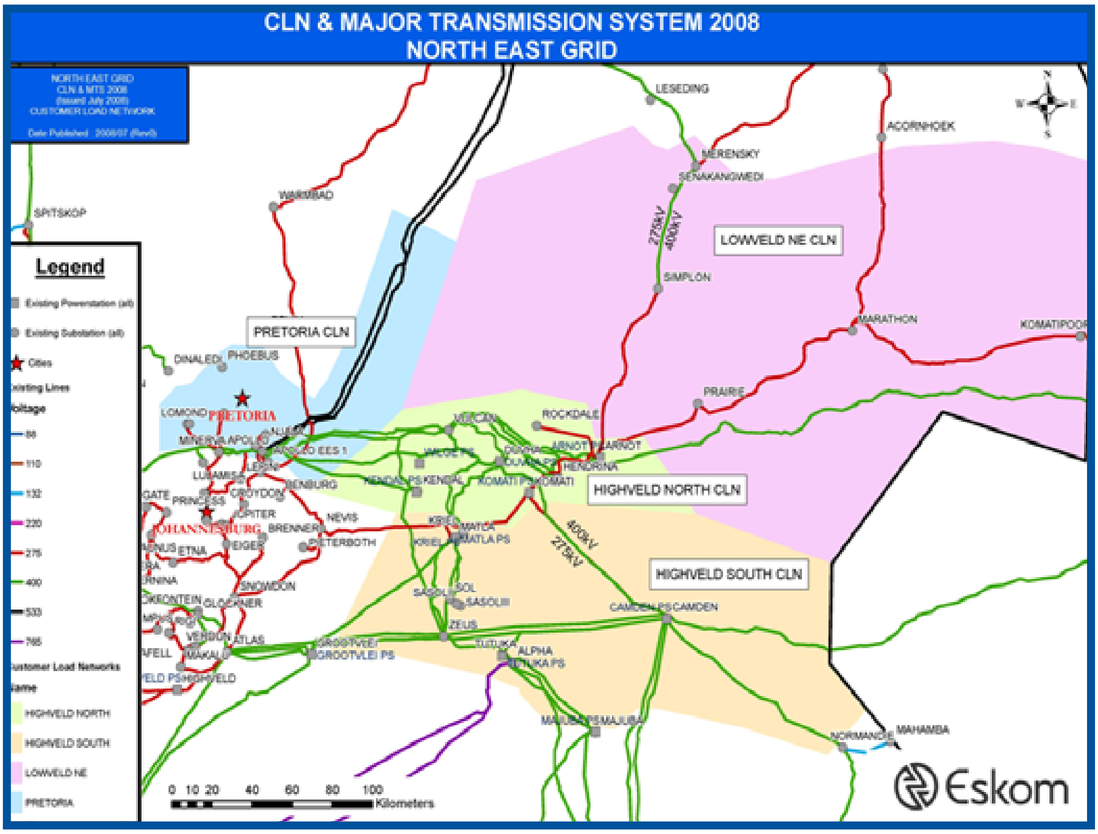


Figure 6 - 7: Current North East Grid network and CLNs

The expected peak demands by 2014 and 2018 and the average percentage load increase for the period for each CLN are given in **Table 6 - 7** below.

Table 6 - 7: North East Grid CLN load forecast and percentage load increases

CLN	Peak Load (MW) 2008	Forecasted Load (MW) 2015	2019	Ave. Annual % Load Increase
Highveld North	2273	2698	2910	2.3
Highveld South	991	1072	1415	3.5
Lowveld	1844	2389	2760	3.8
Pretoria	2196	2815	3380	4.1

The TDP schemes for the North East Grid consist of extending the 400kV network, the integration of two power stations (Kusile and Tubatse), and the installation of additional transformers at existing and new substations. The increase in transmission assets by end 2014 and end 2019 and the cumulative total are shown in **Table 6 - 8.**

Table 6 - 8: Cumulative TDP transmission assets for the North East Grid

Transmission Asset for North-East Grid	New Assets expected in 2010 - 2014	New Assets expected in 2015 - 2019	Total New Assets expected
Total kms of line	1 167	215	1 382
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	0 1 124 49	0 155 80	0 1 279 103
Total installed Transformer MVA	8 000	4 200	12 850
Transformers (no. of)	21	6	27
Capacitors (no. of)	2	0	2
Reactors (no. of)	0	0	0

6.4.1. Highveld North CLN

The proposed new Gumeni 400/132kV and Rockdale B 400/132kV substation projects will supply increased loads in the Middelburg and Machadodorp areas and remove network constraints. Kusile power station, currently under construction, is located in this CLN. The main projects in the Highveld North CLN are as follows:

Highveld/Lowveld Reinforcement

- Loop the Kendal-Duvha 400kV line into Vulcan 2010
- Establish Kendal-Arnot first 400kV line 2010
- Install Gumeni first 400/132kV 500MVA transformer 2010
- Construct Hendrina-Gumeni 400kV line 2010
- Establish Kendal-Gumeni first 400kV line 2014

Highveld North Reinforcement

- Install the Rockdale B 400/132kV, 2x500MVA transformers 2011
- Install the Rockdale B 132/88kV, 2x160MVA transformers 2010

Kusile Power Station Integration

- Construct the Kusile 400kV switching station 2011
- Loop the Duvha-Minerva first 400kV line into Kusile 2011
- Construct the Kusile-Lulamisa 400kV line 2012
- Loop the Kendal-Apollo first 400kV line into Kusile 2013
- Bypass Duvha to form the Kusile-Vulcan 400kV line 2013
- Construct the Kendal-Zeus 400kV line 2014
- Construct the Kusile-Zeus 400kV line 2014

6.4.2 Highveld South CLN

The Highveld South CLN network will be placed under additional strain as a result of the Cape 765kV network strengthening, in addition to local load growth and East Grid load growth.

The proposed Highveld South strengthening project will take into account all the issues mentioned above. The only major project that is taking place in Highveld South is shown below, the Sol B switching station that was in the previous TDP is no longer necessary.

Highveld South Strengthening

- New Sol B 400/132kV with 2x 120MVA transformers — 2013
- Loop Kriel-Zeus 400kV line into Sol B,. — 2013
- Loop Matla-Grootvlei 400kV line into Sol B — 2013
- Decommissioning the Sol B-Zeus portion — 2013

6.4.3. Lowveld CLN

With the fast growth in Lowveld CLN, especially in the Steelpoort and Groblersdal area, it is necessary to strengthen the transmission network to meet the future development. One new 400/132kV substations will be needed in the Lowveld north-west area at Marble Hall, and Senakangwedi will need reinforcement. The proposed new pumped-storage power station Tubatse will be located in Lowveld CLN near Steelpoort. The potential increased power export to Mozambique will also require network strengthening in the Lowveld CLN. The main projects in the Lowveld CLN are as follows:

Lowveld Strengthening Phase 1

- Install the Malelane second 275/132kV 1x 250MVA transformer — 2014
- Construct the Marathon–Malelane second 275kV line — 2014

Lowveld Strengthening Phase 2

- Establish Marathon B first 400/275kV 800MVA transformer — 2012
- Construct the first Gumeni–Marathon B 400kV line — 2012
- Construct the second Marathon B-Gumeni 400kV line — 2014

Tubatse Pumped-storage Power Station Integration

- Construct Tubatse–Leseding first 400kV line — 2014
- Construct Tubatse–Duvha first 400kV line — 2014
- Construct Tubatse–Merensky first 400kV line — 2014

Lowveld West Strengthening

- Establish Marble Hall 2x 500MVA transformers — 2014
- Construct Marble Hall Rockdale B first 400kV line — 2014
- Construct Marble Hall–Tubatse first 400kV line — 2014
- Construct Marble Hall–Mokopane first 400kV line — 2014

Lowveld North Strengthening

- Senakangwedi 1x 400MVA 400/275kV transformer — 2014
- Senakangwedi 1x 250MVA 400/132kV transformer — 2014
- Loop Tubatse – Merensky 400kV line into Senakangwedi — 2014

6.4.4. Pretoria CLN

Rezoning 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 Pretoria CLN are as follows:

Tshwane Metro Rezoning

- Establish 400/275/132kV substation at Phoebus 2012
- Establish 400kV busbar at Phoebus 2012
- Install 2x250MVA, 400/132kV line bank transformer at Phoebus 2012
- Convert the Hangklip-Pelly 132kV line into Phoebus-Pelly line and energise at 275kV 2012
- Loop Apollo-Dinaledi 400kV line into Phoebus 2011
- Upgrade the 132kV Garankuwa-Hangklip line 2012
- Establish 400kV busbar at Wildebees 2012
- Loop and out Apollo-Phoebus 400kV line at Wildebees 2012
- Establish a 400/275/132kV substation at Phoebus 2012
- Install 1x250MVA, 400/132kV transformer at Phoebus 2012
- Install 1x400MVA, 400/275kV at Phoebus 2012
- Operate Hangklip-Pelly 132kV line as Phoebus-Pelly at 275kV 2012
- Loop the Apollo-Dinaledi 400kV line into Phoebus 2012
- Upgrade the 132kV Garankuwa-Hangklip line 2012
- Loop Apollo-Phoebus 400kV line into Wildebees 2013
- Establish a 400kV busbar at Verwoerdburg 2012
- Loop Apollo-Pluto 400kV line into Verwoerdburg 2012
- Install 2x250MVA, 400/132kV transformers at Verwoerdburg 2012
- Construct 1x275kV line from Lomond to Kwagga 2013
- Construct Dinaledi-Hangklip first 132kV twin Kingbird line 2017
- Install Verwoerdburg third 250MVA, 400/132kV transformer 2017
- Install Phoebus second 250MVA, 400/132kV transformer 2022

A network diagram showing the major projects in the North East Grid is shown in **Figure 6 - 8** below.

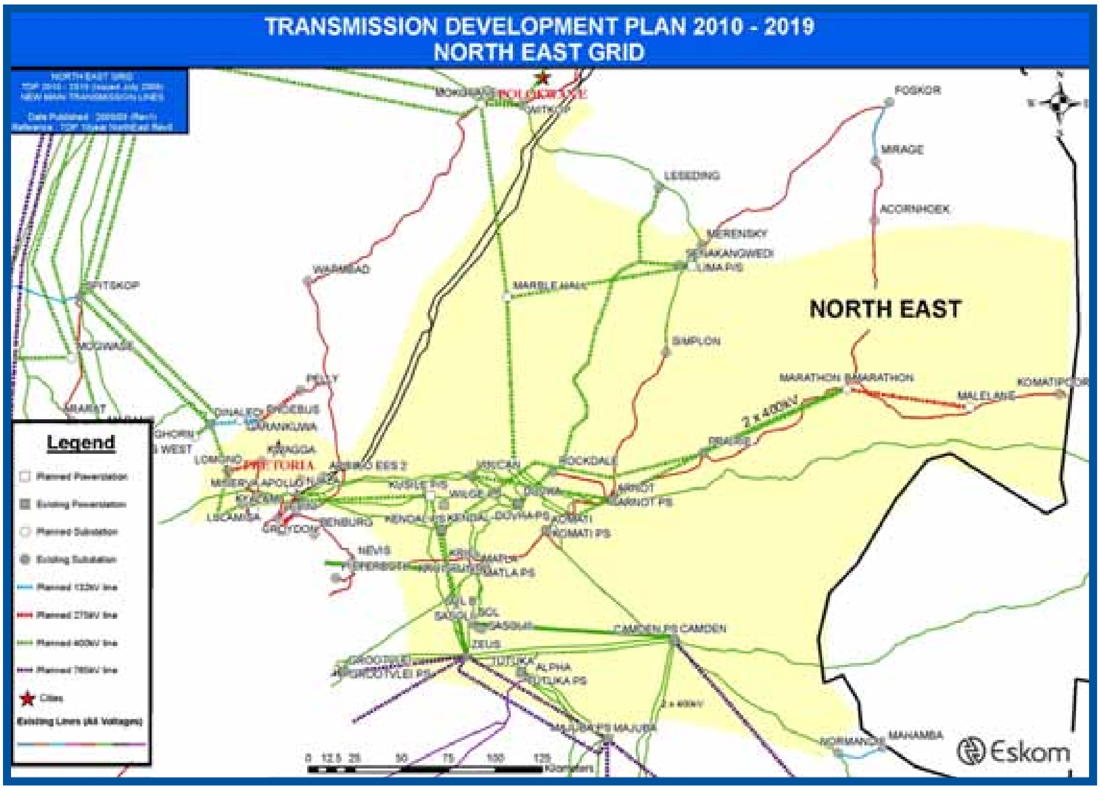


Figure 6 - 8: North-East Grid network diagram

6.5. North West Grid

The North-West Grid is composed of four CLNs namely Bloemfontein, Carletonville, Kimberly, and Welkom. The current transmission network and CLNs are shown in **Figure 6 - 9** below.

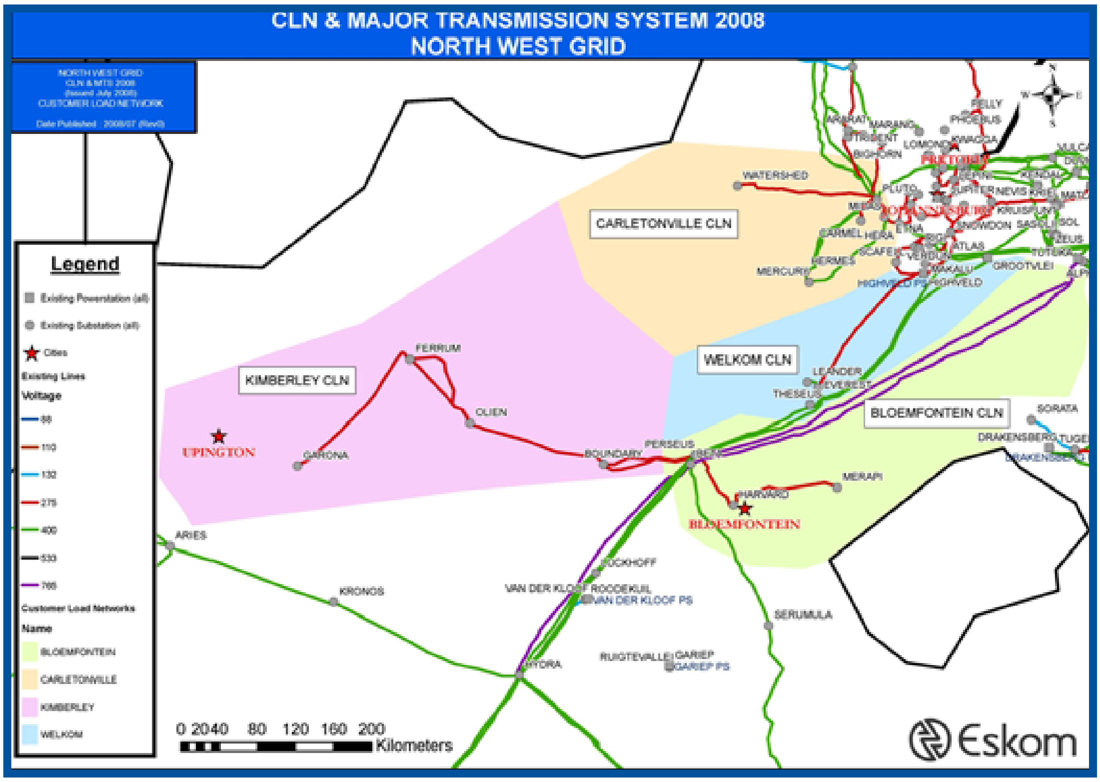


Figure 6 - 9: Current North West Grid network and CLNs

The 765kV network is primarily used for transport 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 below in **Table 6 - 9.**

Table 6 9: North West Grid CLN load forecast and percentage load increases

CLN	Peak Load (MW) 2008	Forecasted Load (MW) 2015	2019	Ave. Annual % Load Increase
Bloemfontein	447	496	517	2
Carletonville	1732	2064	2094	2
Kimberley	531	745	1742	8
Welkom	758	868	944	1

The next stage of the reinforcement of the Main Cape Corridor if required in 2019 will pass through the North West grid, linking 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 2014 and end 2019 and the cumulative total are shown in **Table 6 - 10**.

Table 6 - 10: Cumulative assets for North West grid

Transmission Asset for North-West Grid	New Assets expected in 2010 - 2014	New Assets expected in 2015 - 2019	Total New Assets expected
Total kms of line	2 325	1 335	3 660
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	1 825 390 110	740 595 0	2 565 985 110
Total installed Transformer MVA	3 500	2 125	5 625
Transformers (no. of)	5	5	10
Capacitors (no. of)	3	0	3
Reactors (no. of)	11	7	18

6.5.1. Carletonville CLN

Carletonville CLN is dominated by gold mining load, which is expected to remain static. Growth is expected to come from electrification and throughput load from the Waterberg power stations to the West Rand, and from 2013 to Kimberley CLN via Vryburg. Additional load growth may occur due to new platinum mines north of Watershed. The only project in the CLN is as follows:

Watershed B 400/132kV Substation

- Build a 400kV line from Epsilon to Watershed B substation **2017**
- 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:

Bloemfontein Strengthening

- Install a +100/-100 MVar SVC at Merapi **2012**
- Construct the Everest-Merapi 275kV line **2017**
- Construct the Merapi third 275/132kV 180MVA transformer **2017**

6.5.3. Welkom CLN

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. Intensive agriculture along the Orange River is also a major contributor. The Kimberley CLN is supplied by the long 275kV network to Ferrum which now requires reinforcement. The North West 400kV reinforcement scheme will provide a link between the Kimberley CLN and the Carletonville CLN by 2013. This will assist with the integration of the Medupi, Coal 3 and Mmamabula power stations. The 400kV link will be extended via Garona and Nieuwehoop to Aries by 2017 to support additional railway traction load, the north-western part of West Grid, and Namibia (West Grid projects).

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 Ferru — 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 Epsilon–Vryburg first 400kV line — 2016

North West 400kV Strengthening Phase 4

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

North West 400kV Strengthening Phase 5

- Loop 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.

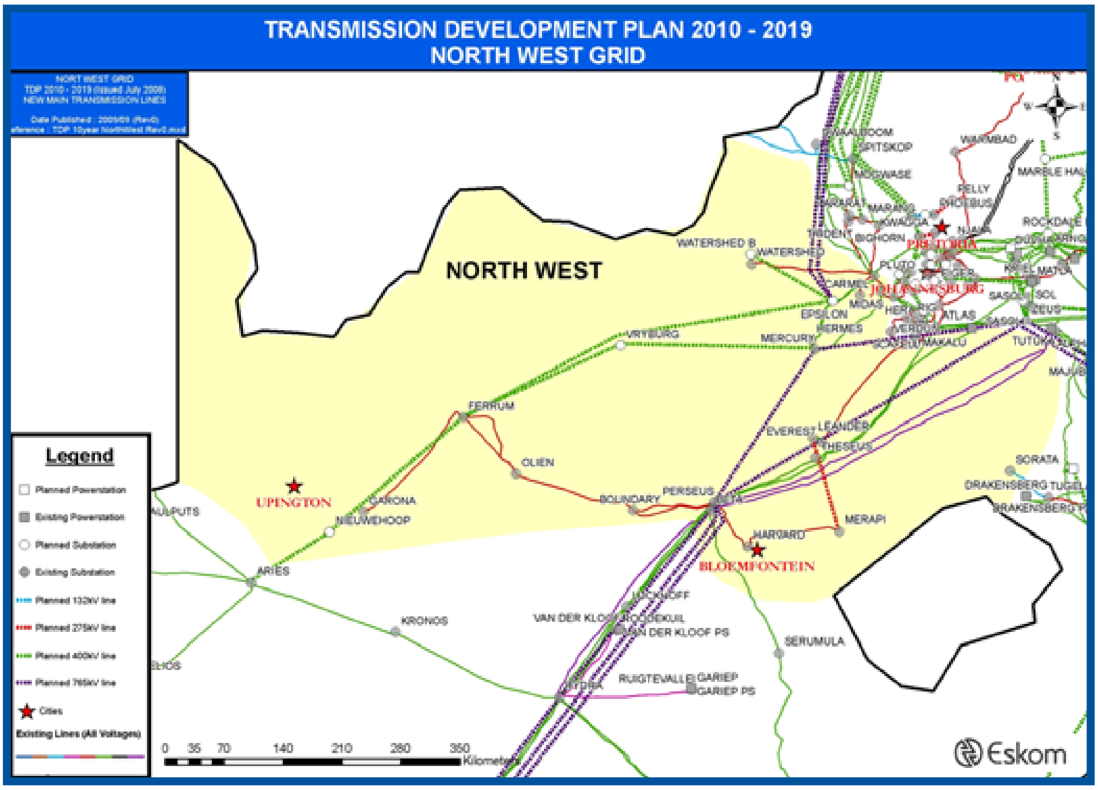


Figure 6 - 10: North West Grid geographical network diagram

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 the Karoo. The current transmission network and CLNs are shown in **Figure 6 - 11** below.

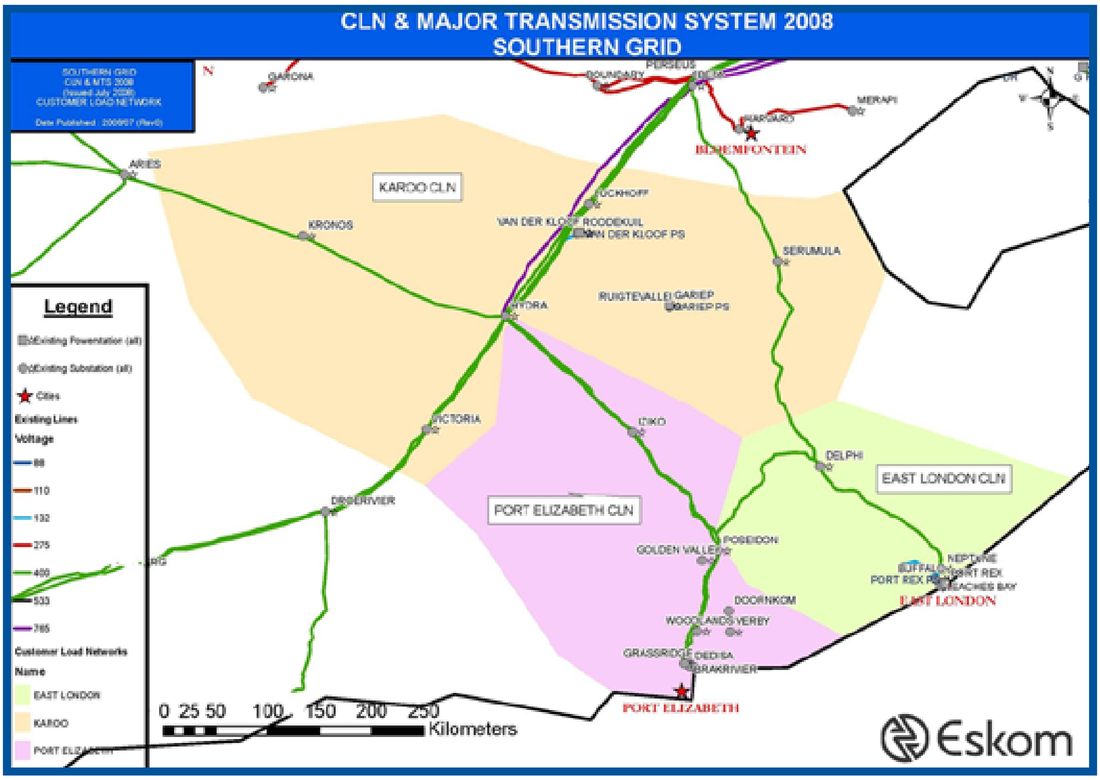


Figure 6 - 11: Current South Grid network and CLNs

The forecasted average growth rate for Port Elizabeth CLN until about 2019 is approximately 39%. This high growth rate is attributed to the new Industrial Development Zone (IDZ) near Port Elizabeth. The average annual load growth rate forecasted for East London and the Karoo CLN is 7.6% and 0.6%, respectively. The expected peak demands by 2015 and 2019 and the average percentage load increase for the period for each CLN are given in **Table 6 - 11** below.

Table 6 - 11: South Grid CLN load forecast and percentage load increases

CLN	Peak Load (MW) 2008	Forecasted Load (MW) 2015	Forecasted Load (MW) 2019	Ave. Annual % Load Increase
Karoo	310	327	332	0.6%
East London	676	1035	1244	7.6%
Port Elizabeth	874	2889	4625	39%

The TDP schemes for the South Grid consists of the integration of the new Dedisa 400/132kV substation, the Grassridge 765kV integration, Iziko, and Serumula series compensation as proposed for the supply to the Coega IDZ. Further, the Greater East London Strengthening Scheme, which includes the integration of a new 400/132kV substation around Mthatha, has already been approved.

The increase in transmission assets by end 2014 and end 2019 and the cumulative total are shown in **Table 6 - 12.**

Table 6 - 12: Cumulative TDP transmission assets for the South Grid

Transmission Asset for Southern Grid	New Assets expected in 2010 - 2014	New Assets expected in 2015 - 2019	Total New Assets expected
Total kms of line	1 467	941	2 406
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	1260 207 0	410 531 0	1 670 738 0
Total installed Transformer MVA	4 580	1 000	5 580
Transformers (no. of)	8	3	11
Capacitors (no. of)	8	0	8
Reactors (no. of)	8	2	11

6.6.1. Port Elizabeth CLN

The Port Elizabeth CLN consists of the greater Port Elizabeth metropolitan area (Nelson Mandela Bay Municipality) and surrounding rural areas. The greatest drivers of load growth are the Coega IDZ and Port of Ngqura, which are expected to host energy-intensive industries in addition to the cargo handling and warehousing facilities usually found at a modern port. The aluminium smelter proposed for Coega has been placed on hold, but it is assumed for purposes of the current TDP that it will require its permanent supply in 2013.

The TDP network developments in this CLN entail the following:

Aluminium Smelter Potline 1 (dedicated) Scheme

- Construct the Aluminium 400kV switching station (2x 400kV feeders to smelter) 2013
- Construct the Aluminium-Dedisa first 400kV line 2013
- Construct the Aluminium-Grassridge first 400kV line (extension of Dedisa- 2013
- Construct the Grassridge 400kV line with bypass) 2013
- Construct the Dedisa Ext 400kV first SVC 2013
- Grassridge Decommissioning first 132kV SVC 2013
- Construct the Grassridge Ext 400kV first SVC 2013

Port Elizabeth Strengthening Scheme Phase 3

- Install the first 400kV 100MVAr capacitor at Dedisa Ext 2013
- Install the first 400kV 100MVAr capacitor at Delphi Ext 2013
- Install the first 400kV 100MVAr capacitor at Grassridge Ext 2013
- Install the first 400kV 100MVAr capacitor at Poseidon Ext 2013

Port Elizabeth Strengthening Scheme Phase 4

- Install the first 400kV 100MVAr capacitor at Dedisa Ext 2013
- Install the first 400kV 100MVAr capacitor at Delphi Ext 2013
- Install a second 400kV 100MVAr capacitor at Grassridge Ext 2013
- Install a second 400kV 100MVAr capacitor at Poseidon Ext 2013

South Grid Strengthening Phase 3

- Construct Gamma-Grassridge first 765kV line 2013
- Install Grassridge Ext 765/400kV transformation 2013

DME OCGT Integration at Dedisa 400kV

- Install Dedisa Ext 3x 400kV feeder bays (DME OCGT integration) 2012

Grassridge Ext third 400/132kV 500MVA transformation

- Install Grassridge Ext third 400/132kV 500MVA transformer 2015

Aluminium Smelter Potline 2 (dedicated)

- Establish Aluminium 400kV switching station 1x 400kV feeder 2013

South Grid Strengthening Phase 4

- Construct Gamma-Grassridge second 765kV line 350km 2014

Port Elizabeth substation integration-Phase 1: Port Elizabeth Substation

- Install Port Elizabeth 400/132kV substation (new) 2016
- Construct a Port Elizabeth – Grassridge 40km, 400kV 2016

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 Collywobbles (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:

Pembroke 132kV Feeder (Debe Nek)

- Construct the Pembroke Ext 132kV feeder bay (Debe Nek) — 2012

Greater East London Phase 1

- Establish Vuyani 400/132kV Substation — 2012
- Construct Eros-Mthatha (Vuyani) 400kV line to improve voltages at Mthatha — 2012

Greater East London Phase 2 (South Grid Project with impact on East Grid)

- Construct Vuyani-Neptune 400kV line — 2013
- Construct Poseidon-Neptune 400kV line — 2013

Greater East London Strengthening Phase 3

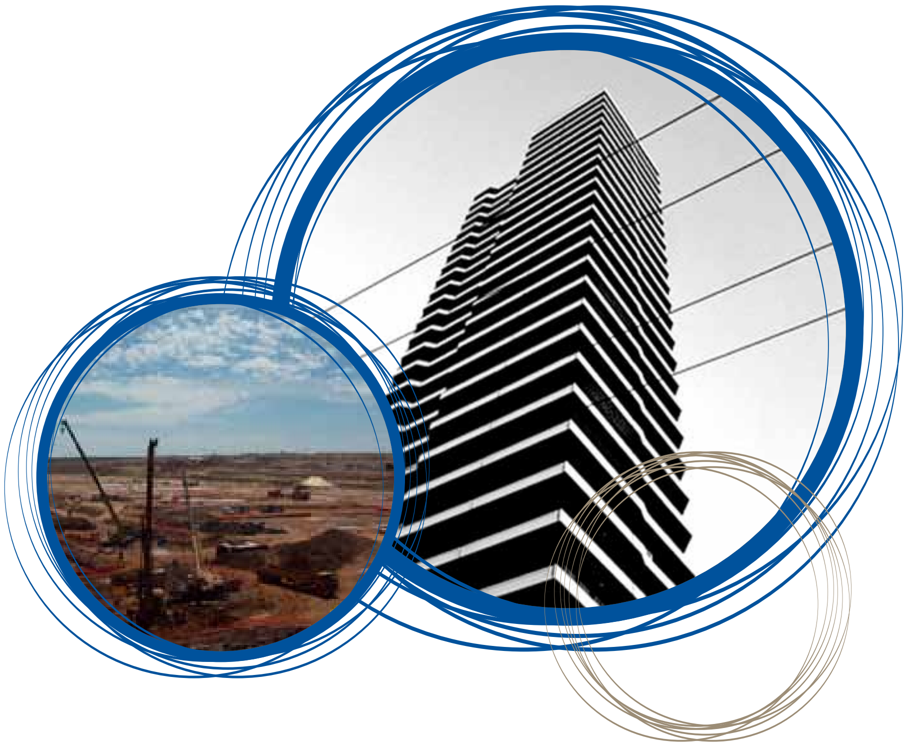
- Construct the Pembroke B 400/132kV substation and 400kV turn-ins — 2016

6.6.3. Karoo CLN

The Karoo CLN consists of Hydra, Ruigtevallei, Roodekuil, and Van Der Kloof substations. Hydra is a major hub on the Cape Corridor. The Cape strengthening projects will reduce the Cape's dependence on Hydra. The latter three stations integrate Gariep and Van Der Kloof hydro power stations into the network and supply loads on either side of the upper Orange River. Load growth is not expected to be sufficient in its own right to trigger reinforcement projects, except to cater for throughput to other areas. However, parts of the network were not designed to meet the network redundancy requirements specified in the March 2008 update of the Grid Code, since they were not previously a requirement. Funding shortages, however, mean that only those constraints that can be addressed by adding another transformer can be addressed at present.

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 project will be commissioned within the boundaries of the Karoo CLN to improve the transmission corridor capacity to the entire South and West Grid between 2010 and 2019. The Karoo CLN network development involves the following:

Cape Corridor Strengthening Scheme Phase 1	
• Construct the Gamma Ext 765kV busbar	2012
• Construct the Gamma Ext second 400MVar 765kV busbar reactor	2012
• Construct the Hydra-Gamma first 765kV line	2012
South Grid Strengthening Phase 3	
• Construct the Gamma Ext 765kV busbar	2012
Cape Corridor Strengthening Scheme Phase 2	
• Construct the Gamma-Kappa first 765kV line	2010
• Construct the Kappa 765/400kV substation	2010
• Construct the Kappa Ext 400kV 100MVAr shunt reactor	2010
Cape Corridor Strengthening Scheme Phase 4	
• Construct the Gamma-Kappa first 765kV line	2016



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

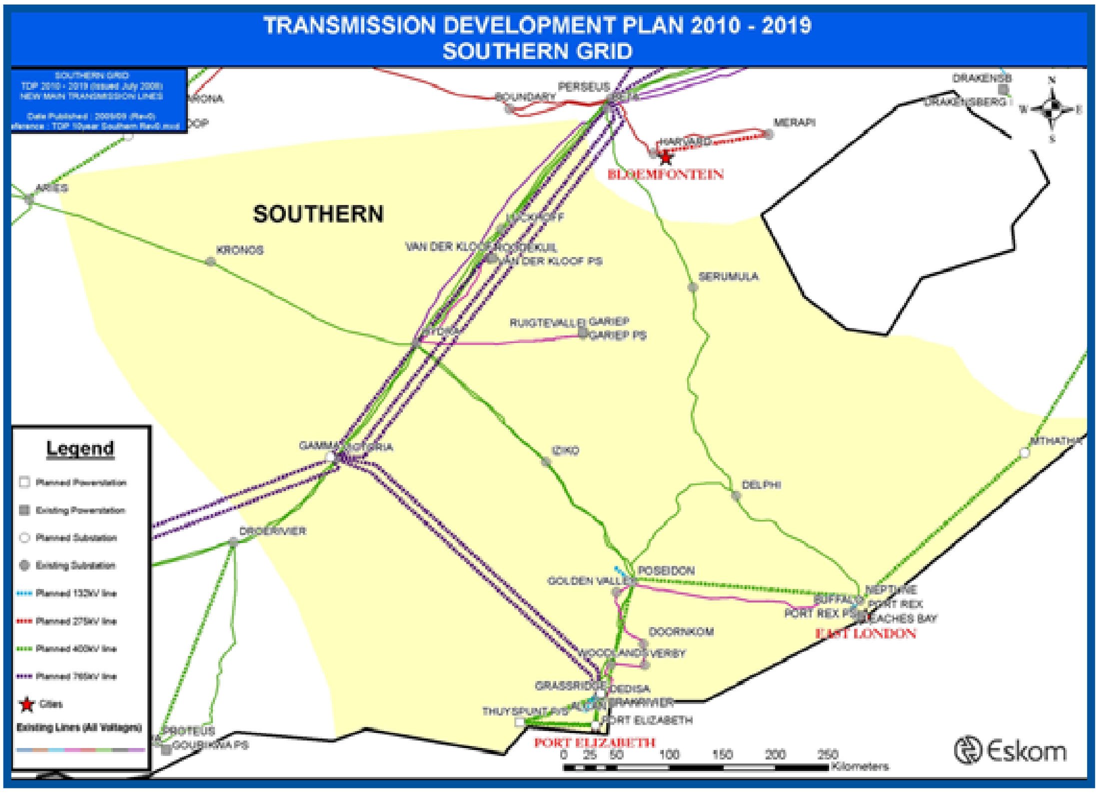


Figure 6 - 12: The South Grid networks diagram

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.

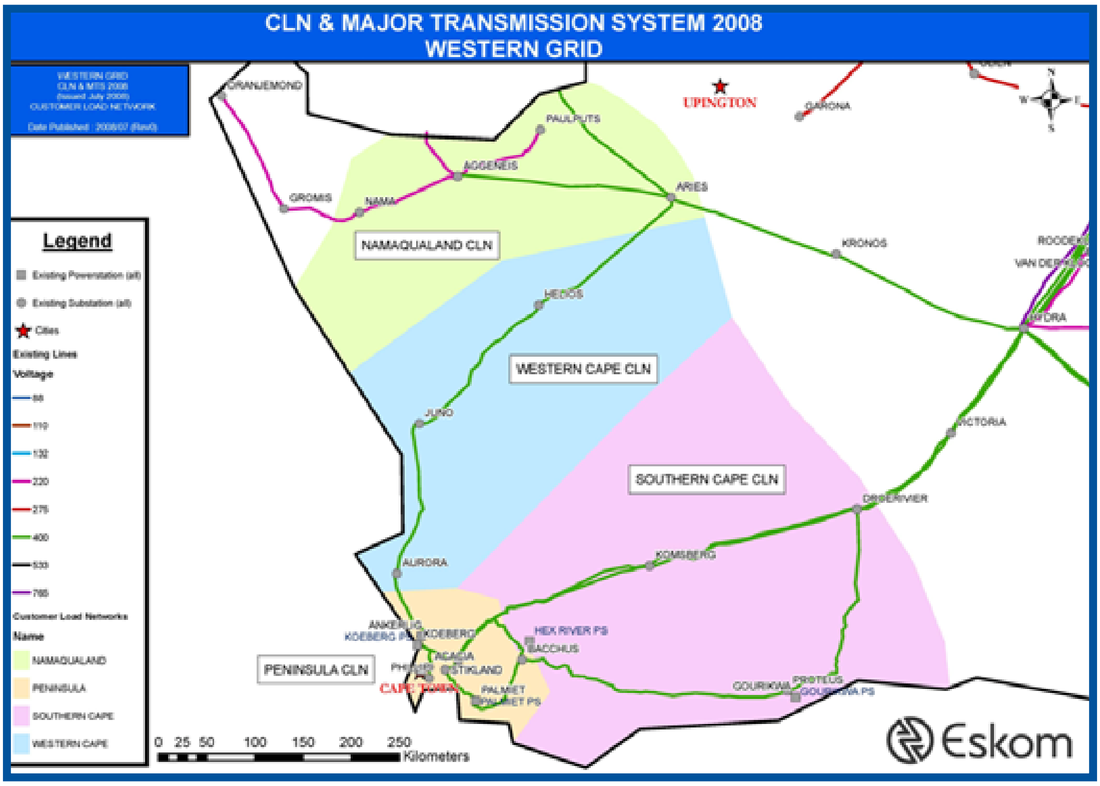


Figure 6 - 13: Current West Grid network and CLNs

The Western Cape customer base consists of consumers within the South African border, as well as international customers (NamPower and Skorpion in Namibia). Natural load growth for the South African consumers is forecasted to be in the region of 2.5% per year for the West Cape as a whole. The expected peak demands by 2015 and 2019 and the average percentage load increase for the period for each CLN are given in **Table 6 - 13** below.

Table 6 - 13: West Grid CLN loads and percentage load increases

CLN	Peak Load (MW) 2008	Forecasted Load (MW) 2015	Forecasted Load (MW) 2019	Ave. Annual % Load Increase
Namaqualand	177	211	233	2.9%
West Coast	521	542	556	0.6%
Southern Cape	845	1017	1135	3.0%
Peninsula	2477	2861	3122	2.4%
International + future step loads	200	200	300	4.5%

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 2014 and end 2019 and the cumulative total are shown in **Table 6 - 14.**

Table 6 - 14: Cumulative TDP transmission assets for the West Grid

Transmission Asset for Western Grid	New Assets expected in 2010 - 2014	New Assets expected in 2015 - 2019	Total New Assets expected
Total kms of line	280	1 216	1 496
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	165 115 0	150 746 320	315 861 320
Total installed Transformer MVA	6 025	3 125	9 150
Transformers (no. of)	16	4	20
Capacitors (no. of)	3	0	3
Reactors (no. of)	2	8	10

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 2008 the combined demand of the West and South grids was ±5500MW. 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 765kV line **2012**

Cape Corridor 765kV – Phase 4

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

If there is no additional nuclear generation in the Cape, then the Main Cape Corridor will have to be reinforced again by 2019. It is proposed that the 765kV be extended from Epsilon via Perseus down to Gamma to reinforce the Main Cape Corridor. This 765kV line extension is included in the TDP as a proposed project to indicate that a significant project is required by 2019. This 765kV may be either further reinforced or possibly replaced by an HVDC line from either Coal 3 via Epsilon or from the Witbank area via Zeus down to either Gamma or Omega.

6.7.2. Cape Peninsula CLN

The network in this area supplies primarily the Cape Town metropolitan area. Additional 400/132kV transformers will be required at Acacia and Philippi. The latter will be relocated to Mitchells Plain when that substation is built. The proposed second Koeberg-Acacia 400kV line will provide additional in-feed capacity for Cape Town at Acacia and Philippi beyond 2012. This line will be formed by energising the existing Koeberg-Acacia 132kV line at 400kV, which was built to 400kV standards in anticipation of this upgrade. Firgrove 400/132kV substation is to be built near Somerset West to supply the Somerset West, Strand, and Stellenbosch areas. 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 Firgrove substation.

The projects within the Cape Peninsula CLN are as follows:

- Install Acacia third 500MVA 400/132kV transformer **2010**
- Install Philippi third 500MVA 400/132kV transformer **2013**
- Establish Gas 1 off-site supply **2012**
- Establish Firgrove 400/132kV substation **2013**
- Install Muldersvlei third 500MVA transformer and series reactor **2013**
- Establish Mitchells Plain 400/132kV substation **2015**

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, including one between Aries and Garona, near Nieuwehoop – around 2013/14. In order to achieve this, a 400kV line will be constructed from Aries to Nieuwehoop where the 400kV traction substation will be established.

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

- Construct the Aries SVC — 2012
- Construct Sishen Saldanha Phase 1 (1x275/50kV s/s + Garona SVC) — 2012
- Construct Sishen Saldanha Phase 2 (4x400/50kV s/s + Aries-Nieuwehoop line) — 2013/14
- Construct the Ferrum-Nieuwehoop 400kV line — 2015
- Upgrade Juno to 2x80MVA, 132/66/22kV transformers — 2016

6.7.4. Namaqualand CLN

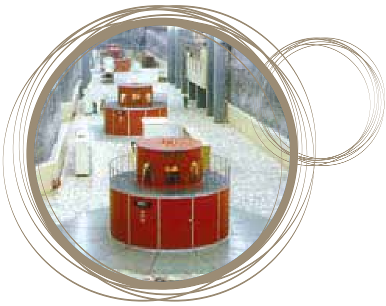
The Namaqualand CLN is supplied via the Aggeneis MTS. All the stations in this CLN have single in-feeds. A number of projects are included to bring it into compliance with the minimum security standard of N-1 redundancy.

The projects within the Namaqualand CLN are as follows:

- Install Paulputs second 220/132kV 125MVA transformer — 2015
- Construct Aggeneis-Helios 400kV line — 2016
- Construct Aggeneis-Nama-Gromis-Oranjemund second 220kV line — 2016
- Construct Aggeneis-Paulputs second 220kV line — 2016

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 is, therefore, assumed that it will materialise around 2019. 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 2019

A diagram showing the major projects in the West Grid is shown in **Figure 6 - 14** below.

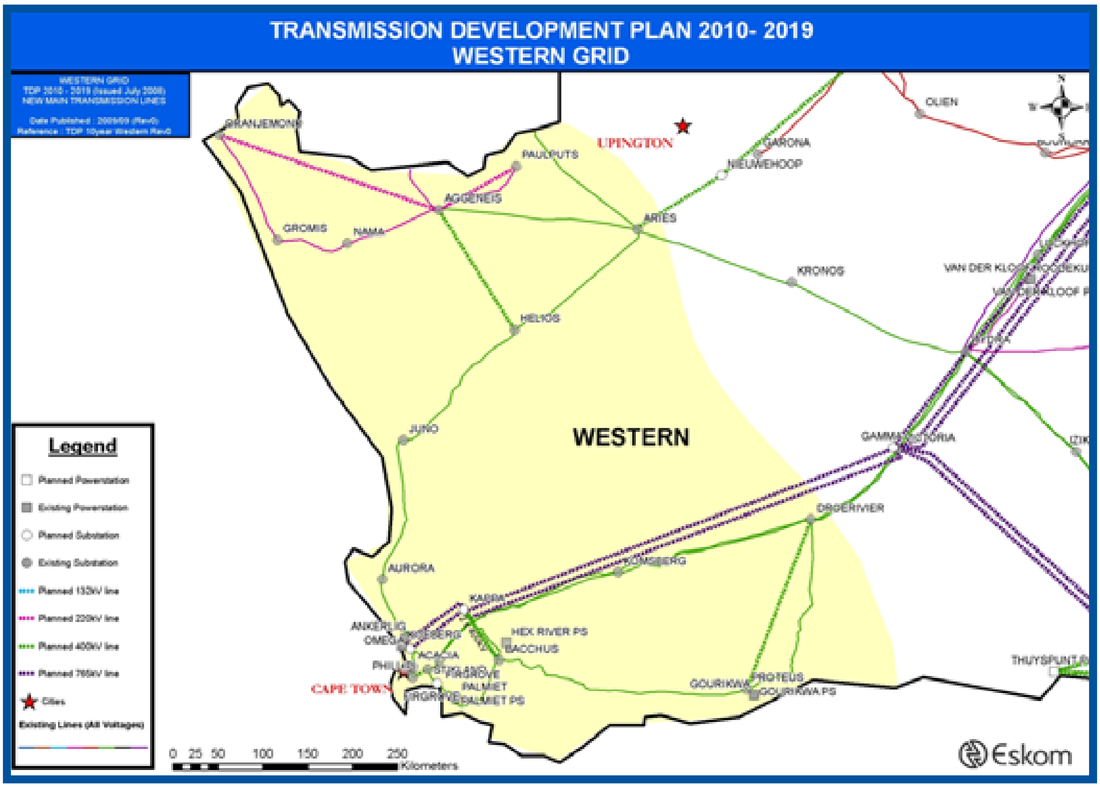
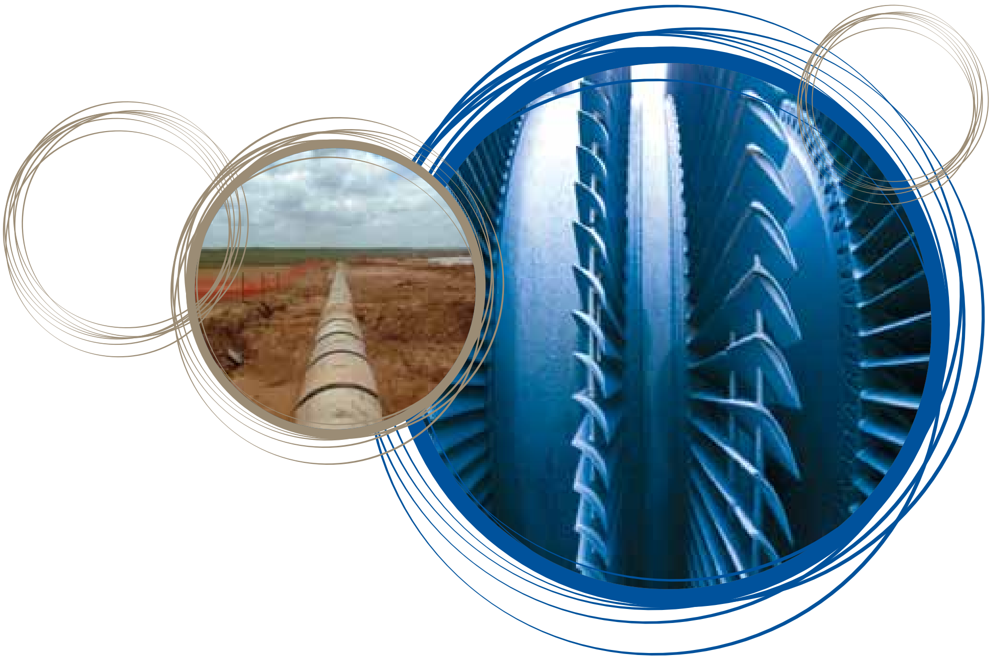


Figure 6 - 14: West Grid geographical network diagram

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. 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 176 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.

Table 7 - 1: Capital Expenditure per year for different categories of projects

Capital Expenditure for Year Ending (R'Mil)											
Categories	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Totals
Refurbishment	812	883	1,235	1,505	1,529	1,600	1,650	1,700	1,750	1,800	14,464
Expansion	12,693	9,281	14,696	14,580	20,064	21,091	21,399	9,921	10,417	10,938	145,081
Other	228	510	396	692	582	513	667	207	226	227	4,249
Land Acquisition	569	681	839	750	804	576	605	635	667	700	6,827
Capital Spares	709	454	478	450	473	496	521	547	574	603	5,305
Production Equipment	98	69	62	66	63	74	77	81	85	93	770
	15,110	**11,877**	**17,706**	**18,045**	**23,514**	**24,351**	**24,920**	**13,092**	**13,720**	**14,362**	176,695

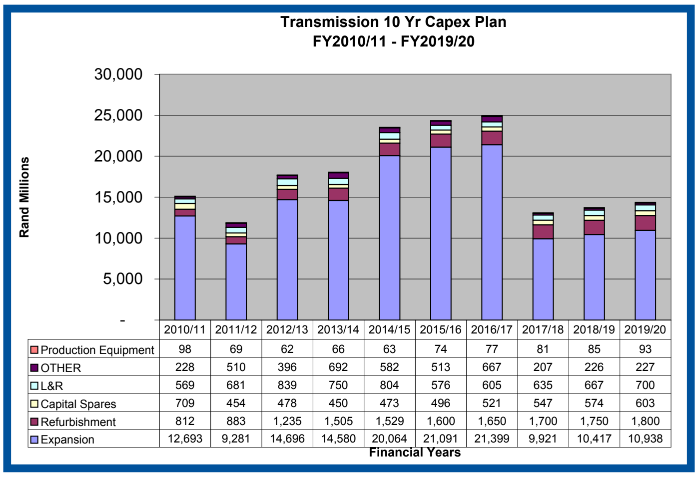


Figure 7 - 1: Summary of Capital Expenditure in the Transmission Division

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.

A summary of expansion capital expenditure per project type required to realise this TDP is shown in **Table 7 - 1.** The total expenditure is expected to be approximately of R 145 billion, this is approximately R 35 billion higher than the previous TDP. This is as a result of new integration work required for the new power stations that have been included in this TDP. It should be noted that the amounts submitted for the MYPD tariff application may differ slightly from the amounts shown here, especially for expansion projects. this is due to adjustments made for the eventuality of some Generation scenarios materialising.

Table 7 - 2: Reliability capital expenditure per project type

Type	Total R'mil
Customer	3,783
Generation	35,902
Reliability	105,395
Grand Total	**145,080**

Please note that the amounts in the tables represents cash flows in the TDP period, 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.

The details of costing per CLN and Project type are shown in Appendix B.

8. Concluding Remarks

The economic slowdown as well as efforts to promote demand side management through the use 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 TDP has many similarities with the previous one as far as projects are concerned. At the end of the period of this TDP, it is expected that the transmission network will be fully compliant to the reliability requirements of the Grid Code that were amended in 2008. It is also expected that there will less stress on the supply side as most of the new power stations will be on line.

The TDP clearly indicates that extensive expansion of the transmission system is required. This is because many parts of the transmission network are not fully compliant with the reliability and/or quality of supply standards. In addition, due to the expected continued electricity demand growth network capacity limitations are being approached in many areas of the network. Moderate step loads may trigger significant backbone strengthening.

Re-phasing and prioritisation of projects to meet process, resource and capital constraints has resulted in numerous projects being deferred. The result is that the period to attain Grid Code compliance has been prolonged. This implies that there is increased risk to the network as there are more MTS sites and transmission corridors that are or will be un-firm for longer periods. 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 introduction of new power stations as well as transmission strengthening lead to switchgear short circuit current ratings of equipment being approached or breached. Unless well co-ordinated, this may pose a safety, health and environmental risk. Upgrades and/or network re-configuration are required to mitigate these risks.

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. While good progress is noted with regard to development of distribution master plans, efforts to implement improved spatial transmission forecast need to be intensified and sustained.

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.

Appendix A: Generation Assumptions

Appendix A1: Generation capacity assumptions - Coal 4

Year	Power Station Name	New Units	Total Units	Unit Details	Total Capacity
2010	Grootvlei Komati	2 6	6 9	190MW coal fired 101MW PF units	1128MW 918MW
2011	OCTG 1 (Dedisa) OCTG 2 (Avon)	2 5	2 5	147MW LNG gas 147MW LNG gas	294MW 735MW
2012	Medupi Ingula	1 1	1 1	800MW coal fired 333MW pmp/strg	800MW 333MW
2013	Medupi Ingula	1 3	2 4	800MW coal fired 333MW pmp/strg	1600MW 1332MW
2014	Medupi Kusile Mmamabula UCG 1 (Majuba)	2 2 1 4	4 2 1 4	800MW coal fired 800MW coal fired 600MW coal fired 275MW coal gas	3200MW 1600MW 600MW 1100MW
2015	Medupi Kusile Mmamabula Lima (Steelpoort)	1 1 1 3	5 3 2 3	800MW coal fired 800MW coal fired 600MW coal fired 371MW pmp/strg	4000MW 2400MW 1200MW 1113MW
2016	Medupi Kusile Coal 3 (Waterberg) Lima (Steelpoort) UCG 1 (Majuba)	1 2 2 1 4	6 5 2 4 8	800MW coal fired 800MW coal fired 800MW coal fired 371MW pmp/strg 275MW coal gas	4800MW 4000MW 1600MW 1484MW 2200MW
2017	Kusile Coal 3 (Waterberg) PS C (Western Cape)	1 2 3	6 4 3	800MW coal fired 800MW coal fired 371MW pmp/strg	4800MW 3200MW 1113MW
2018	Coal 3 (Waterberg) PS C (Western Cape)	2 1	6 4	800MW coal fired 380MW pmp/strg	4800MW 1484MW
2019	Coal 4 (Waterberg)	2	2	800MW coal fired	1600MW

Appendix A2: Generation capacity assumptions - Nuclear 1

Year	Power Station Name	New Units	Total Units	Unit Details	Total Capacity
2010	Grootvlei	2	6	190MW coal fired	1128MW
	Komati	6	9	101MW PF units	918MW
2011	OCTG 1 (Dedisa)	2	2	147MW LNG gas	294MW
	OCTG 2 (Avon)	5	5	147MW LNG gas	735MW
2012	Medupi	1	1	800MW coal fired	800MW
	Ingula	1	1	333MW pmp/strg	333MW
2013	Medupi	1	2	800MW coal fired	1600MW
	Ingula	3	4	333MW pmp/strg	1332MW
2014	Medupi	2	4	800MW coal fired	3200MW
	Kusile	2	2	800MW coal fired	1600MW
	Mmamabula	1	1	600MW coal fired	600MW
	UCG 1 (Majuba)	4	4	275MW coal gas	1100MW
2015	Medupi	1	5	800MW coal fired	4000MW
	Kusile	1	3	800MW coal fired	2400MW
	Mmamabula	1	2	600MW coal fired	1200MW
	Lima (Steelpoort)	3	3	371MW pmp/strg	1113MW
2016	Medupi	1	6	800MW coal fired	4800MW
	Kusile	2	5	800MW coal fired	4000MW
	Coal 3 (Waterberg)	1	1	800MW coal fired	800MW
	Lima (Steelpoort)	1	4	371MW pmp/strg	1484MW
	UCG 1 (Majuba)	4	8	275MW coal gas	2200MW
2017	Kusile	1	6	800MW coal fired	4800MW
	Coal 3 (Waterberg)	1	2	800MW coal fired	1600MW
	PS C (Western Cape)	3	3	371MW pmp/strg	1113MW
2018	Coal 3 (Waterberg)	2	3	800MW coal fired	2400MW
	PS C	1	4	380MW pmp/strg	1484MW
	Nuclear 1 (Thyspunt)	2	2	1050MW nuclear	2100MW
2019	Nuclear 1 (Thyspunt)	1	3	1050MW nuclear	3150MW

Appendix B: Costing Details

Appendix B1: Costing per project type

Type	Total R'mil
Customer	3,783
Generation	35,902
Reliability	105,395
Grand Total	**145,080**

Please note that the amounts in the tables represents cash flows in the TDP period, 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.

Appendix B2: Costing of reliability projects per CLN

Grid	Total R'mil
Central	17,164
East	13,993
North East	10,180
North West	9,398
North	3,977
South	21,475
West	29,207
Grand Total	**105,395**

Please note that the amounts in the tables represents cash flows in the TDP period, 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.



Appendix B3A: Costing for Central grid projects

CLN	Scheme	Cost R' mil	CLN Total	Grid Total
Johannesburg	Croydon Ext 3rd 250MVA 275/132kV transformer	60	9330	17164
	Johannesburg East Strengthening-Phase 1A	517		
	Johannesburg East Strengthening-Phase 2	583		
	Johannesburg East Strengthening-Phase 3 A-D	1630		
	Johannesburg East Strengthening-Phase 3 E-F	1982		
	Johannesburg North-Phase 2	203		
	Johannesburg Reactive Power Project	54		
	Johannesburg Strengthening	207		
	Kyalami Integration	1400		
	Lulamisa Ext 4th 315MVA 400/88kV transformer	181		
	Simmerpan 275/132kV substation	212		
	Simmerpan 275/88kV substation	483		
	Soweto Strengthening Phase 1-275kV	569		
	Craighall B 400kV SS Establish and Integration	1248		
Nigel	Benburg Ext 3rd 250MVA 275/132kV	351	1248	
	Nevis Ext 3rd 250MVA 275/132kV	250		
	Siluma 275/88kV MTS	624		
	Snowdon transformer upgrade	24		
Vaal	Kookfontein 275kV transformer reinforcement	211	2469	
	Kookfontein Phase 1	21		
	Olympus 3rd 250MVA 275/132kV transformer	358		
	Vaal Strengthening Phase 1: Glockner 400/275kV Trfr and Hera-Bernina	399		
	Vaal Strengthening Phase 2	222		
	Vaal Strengthening Phase 3	1257		
West Rand	Demeter 400kV Integration	1254	4117	
	West Rand Reinforcement	367		
	West Rand Strengthening Phase 2	2497		

Please note that the amounts in the tables represents cash flows in the TDP period, 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.

Appendix B3B: Costing for East grid projects

CLN	Scheme	Cost R' mil	CLN Total	Grid Total
Empangeni	Empangeni Local Network Strengthening	521	7728	13993
	Empangeni Strengthening-Phase 2	1381		
	Empangeni Strengthening-Phase 3	1488		
	Empangeni Strengthening-Phase 4	1898		
	Empangeni Strengthening-Phase 5	985		
	Invubu Ext 3rd 500MVA 400/132kV TRFR	193		
	Pinetown-Empangeni Interconnection	1261		
Ladysmith and Newcastle	Incandu Ext 3rd 315MVA 400/132kV transformer	184	593	
	Ingagane Ext 4th 75MVA 275/88kV transformer	50		
	Normandie MTS : 2nd 250MVA 400/132kV TRFR	160		
	Venus Ext 3rd 800MVA 400/275kV transformer	200		
Pinetown	Avon Ext 3rd 250MVA 275/132kV transformer	168	5672	
	Eros Reinforcement-Ariadne-Eros 400kV	1119		
	Georgedale Ext 4th 150MVA 275/132kV transformer	90		
	Hector Ext 3rd 800MVA 400/275kV transformer	112		
	Klaarwater Reinforcement-Phase 1	45		
	Klaarwater Reinforcement-Phase 2	90		
	KZN Shunt Capacitor Compensation-Phase 3: Avon	47		
	Mersey Ext 3rd 250MVA 275/132kV transformer	113		
	Ottowa Reinforcement	156		
	Pinetown Strengthening-Phase 1	2576		
	Pinetown Strengthening-Phase 1d	33		
	Pinetown Strengthening-Phase 2	1123		

Please note that the amounts in the tables represents cash flows in the TDP period, 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.

Appendix B3C: Costing for West grid projects

CLN	Scheme	Cost R' mil	CLN Total	Grid Total
Main Cape Corridor	Cape Corridor Phase 3: 765kV Series Capacitors (NOH)	730	21626	29207
	Cape Corridor Phase 4: 2nd Zeus-Per-Gam-Ome 765kV Line	20895		
Namaqualand	N Cape reinforcement: Aries SVC	603	695	
	Paulputs Ext 2nd 125MVA 220/132kV transformer	92		
Peninsula	Acacia 3rd 400/132kV 500MVA TRFR TX	106	5718	
	Firgrove Substation Establishment (2x 500MVA 400/132kV trfrs)	562		
	Mitchells Plain 400kV Substation	657		
	N Cape reinforcement: Aggeneis-Paulputs 2nd 220kV	477		
	N Cape reinforcement: Aggeneis-Helios 1st 400kV	1085		
	N Cape reinforcement: Aggeneis-Oranjemund 2nd 220kV	1322		
	N Cape reinforcement: Ferrum-Garona-Nieuwehoop 400kV	1366		
	Philippi Ext 3rd 500MVA 400/132kV transformer	143		
Southern Cape	Droërivier Ext 3rd 10MVA 132/22kV TRFR	62	1169	
	Droerivier-Proteus 2nd 400kV line	1106		

Please note that the amounts in the tables represents cash flows in the TDP period, 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.

Appendix B3D: Costing for South grid projects

CLN	Scheme	Cost R' mil	CLN Total	Grid Total
East London	Buffalo and Pembroke TRFR LV Supply Norm	93	3280	21475
	Greater East London Strengthening-Phase 1: Eros-Mthatha and SS	2038		
	Greater East London Strengthening-Phase 3: Pembroke B	1060		
	South Grid-Transmission Transformer Normalisation	89		
Karoo	Cape Corridor 132kV 72MVAr Shunt Capacitor	7	6773	
	Cape Corridor Phase 2: Gamma-Omega 765kV Integration	4744		
	Cape Corridor Phase 2: Zeus-Hydra 765kV Integration	2022		
Port Elizabeth	Alcan Potline 1 (dedicated)	1286	11422	
	Grassridge Ext 3rd 400/132kV 500MVA transformation	214		
	PE Phase 3: Poseidon, Delphi, Grassridge and Dedisa Shunt compensation	219		
	PE Phase 4: Poseidon, Delphi, Grassridge and Dedisa Shunt compensation	193		
	Port Elizabeth substation integration-Phase 1	773		
	South Grid-Phase 3 : 1st Gamma Grassridge 765kV Line	4308		
	South Grid-Phase 4: 2nd Gamma Grassridge 765kV Line	4429		

Please note that the amounts in the tables represents cash flows in the TDP period, 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.

Appendix B3E: Costing for North East grid projects

CLN	Scheme	Cost R' mil	CLN Total	Grid Total
Highveld North	Highveld North-West and Lowveld North Reinforcement-Phase 1	2241	3779	10180
	Kruispunt Reinforcement	75		
	Lowveld 400kV strengthening-Phase 3	1463		
Highveld South	Highveld South Reinforcement-Phase 1	562	730	
	Highveld South Reinforcement-Phase 2	168		
Lowveld	Leseding 400kV Reinforcement	96	3207	
	Lowveld 400kV Strengthening-Phase 2: Marathon B	1796		
	Lowveld Transformation Capacity Enhancement	187		
	Malelane 275kV Reinforcement-Phase 2	1128		
Pretoria	Tshwane Reinforcement-Phoebus Phase 1	2368	2464	
	Tshwane Reinforcement-Wildebees Phase 1	96		

Please note that the amounts in the tables represents cash flows in the TDP period, 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.

Appendix B3F: Costing for North West grid projects

CLN	Scheme	Cost R' mil	CLN Total	Grid Total
Bloemfontein	Bloemfontein Strengthening	864	1182	9398
	Merapi 132kV SVC	319		
Carletonville	Watershed 400kV Reinforcement	2085	2085	
Kimberley	Ferrum 132kV SVC	333	6130	
	North West 400kV Strengthening Phase 4	229		
	North-West 400kV Strengthening Phase 2	2197		
	North-West 400kV Strengthening Phase 3	3371		

Please note that the amounts in the tables represents cash flows in the TDP period, 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.

Appendix B3G: Costing for North grid reliability projects

CLN	Scheme	Cost R' mil	CLN Total	Grid Total
Polokwane	Foskor 275/132kV transformation upgrade	58	2669	3977
	Nzhelele 400kV reinforcement	1995		
	Pelly 132/22kV transformation upgrade	35		
	Tabor and Spencer Reinforcement-Phase 1	3		
	Tabor and Spencer Reinforcement-Phase 2	579		
Rustenburg	Brits 400kV Reinforcement	1127	1308	
	Dwaalboom 132kV switching station	52		
	Rustenburg Transformation Reinforcement	44		
	Spitskop 400/132kV Transformation	85		

Please note that the amounts in the tables represents cash flows in the TDP period, 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.

Appendix B4: Summary of generation integration costs

Generation Scheme	Cost R'mil
Coal 3 Phase 2-800kV HVDC	12,000
Gas 1 offsite supply	83
Ingula Pumped Storage P/S Integration	1,106
Kusile Integration Phase 1: 400kV Loop-ins	2,799
Medupi Integration (Alpha) Phase 1A: Spitskop and Dinaledi	10,140
Medupi Integration (Charlie) Phase 2A: Mogwase	598
Medupi Integration (Charlie) Phase 2B: Mokopane	656
Medupi Integration (Mmamabula) Phase 3A: Delta	2,222
Nuclear 1 Integration	5,150
OCGT GAS 1 Integration	87
Tubatse LIMA P/S integration	809
Medupi Fault level Plan	250
Grand Total	**35,902**

Please note that the amounts in the tables represents cash flows in the TDP period, 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.

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	**Role**
Caswell Ndlhovu	Compiler 1
Roy Estment	Compiler 2
Camille Shah and Manana Maboe	Printing and Communications
Camintha Moodley	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.

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Revision Information

This document was first issued on the 31st of March 2010 at the public forum with stakeholders in the form of a CD Rom. Some suggestions for corrections have since been received, these are highlighted below:

Revision 1

a) The title has been changed to "Transmission Development Plan 2010 - 2019", this is to allow flexibility in case the TNSP want to increase the number of years covered by the TDP. Changes and grammatical implications associated with this name change are repeated throughout the document.

b) A few grammatical corrections which do not have any material implications on the meaning and sense of the original document have also been made at various places in the document.

c) Three paragraphs were removed in chapter 5 (page 12) due to duplication.

d) "Foskor –Merensky 2nd 275kV line" project was repeated and subsequently removed in page 26.

e) Explanation of the variance between the TDP and the MYPD submission is given in chapter 7 paragraph 3.

f) The caption on the disc has been changed to include the full name.

Notes

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