Eskom

Transmission Ten-Year Development Plan

2012-2021

Foreword by Divisional Executive

A reliable transmission network with adequate capacity to meet customer needs is a necessary condition for the provision of a reliable electricity supply to South Africa, and to support the Government's initiatives to create jobs, provide quality education and health care, and uplift previously disadvantaged communities. To remain reliable, the transmission system requires not only maintenance, but must also be developed and extended to meet changing customer needs or connect new loads or power stations to the network.

The National Energy Regulator of South Africa (NERSA), has published the rules governing investment in the Transmission network in the Grid Code. Eskom, as the licensed Transmission Network Service Provider, plans the network according to this Code, and subject to funding and other resource constraints, builds the network according to these plans. Where insufficient funds are available to develop the network, a consistent set of rules is applied to prioritise projects and allocate funding in such a way that the maximum benefit is gained for Eskom and South Africa.

The major focus of the plans is to ensure that the new power stations currently under construction are integrated into the network and that there is minimum infrastructure to meet prescribed reliability criteria. Funding constraints mean that the time it will take to meet the full requirements of the Grid Code could be as late as 2020. A new challenge will be the integration of renewable energy stations (wind, solar photovoltaic, solar thermal, etc.) into the network, to help meet South Africa's commitment to reduce carbon emissions.

The total cost of the projects included in this plan, up to and including 2021, is estimated at R 171 billion in nominal terms. South Africa cannot prosper and grow without a reliable supply of electricity. Hence there is a need for stakeholders to understand what is required to ensure a reliable and secure supply and what investment levels are required to achieve it. I hope that this document will assist in this dialogue, and I welcome comments and queries on the content and format.

I 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.

Mongezi Ntsokolo
October 2011

Disclaimer

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

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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 has the responsibility of developing the transmission network. The publication of the Transmission Ten-Year Plan is to inform stakeholders about Eskom's plans for the development of the transmission network. This publication fulfils the requirements of the South African Grid Code, which requires the Transmission Network Service Provider (TNSP) to publish plans annually on how the network will develop. This is the fourth publication of the Transmission Ten-Year Plan.

A public forum will be held with identified stakeholders to disseminate further and get feedback on the contents of this plan. These comments will be taken into account when the plan is revised. This publication contains information about projects intended to extend or reinforce the transmission system, which have been completed in the past year, as well as about projects which are planned for the next ten years.

The transmission network is the primary network of interest covered in this publication. This covers electrical networks with voltages ranging from 220 kV to 765 kV and the transmission substations where these networks terminate. A few 88-kV and 132-kV electrical networks are included due to their strategic nature.

The projects covered in this document include the *generation integration projects* required to ensure that the network is adequate to evacuate and dispatch power from the source to the load centres. The publication also includes the plans for strengthening the transmission network that is required to carry the power from the new power stations, and the reliability projects required to ensure that the reliability and adequacy of the transmission network are sustained as load demand increases on the network.

The estimated rand value of the planned projects is approximately R171 billion in the next ten years, of which approximately R4 billion is for customer related projects; R27 billion for generation integration projects, and approximately R140 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 fluctuations in foreign exchange and commodity prices and to global demand.

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

Eskom Transmission also undertakes capital expenditure in respect of the refurbishment of ageing infrastructure, facilities, production equipment and strategic capital spares. Facilities consist of buildings located at sites other than substations, which Transmission uses for offices, the 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 staff 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 which fail in service and cannot be repaired on site, to be replaced as soon as practicable, thereby minimising the risk that customers may experience a lengthy outage.

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

Table of Contents

APPENDICES

TABLE OF FIGURES

LIST OF TABLES

Abbreviations

CLN (Customer Load Network)
The network within a specific geographical area, which in turn is a subdivision of a Grid, e.g. Johannesburg CLN falls within the Central Grid

TNSP (Transmission Network Service Provider)
A legal entity that is licensed to own, operate, and maintain a transmission network

MW (Megawatts)
A million watts – a watt is a unit of electrical power production or demand

MVAr (Megavolt-ampere reactive)
A million volt-amperes reactive – a volt-ampere reactive is a unit of the electrical power required to maintain electromagnetic fields

MVA (Megavolt-ampere)
A million volt-amperes of apparent power, being the vector sum of real power (MW) and reactive power (MVAr)

NERSA (National Energy Regulator of South Africa)
The body established by an Act of Parliament to regulate the production, sale, and pricing of electricity, liquid fuels, and fuel gas in South Africa

MTS – Main Transmission Substation
These are substations owned and operated by a TNSP

RTS – Return to Service
A previously mothballed Power Station undergoing re-commissioning

REFIT – Renewable Energy Feed in Tariff
The NERSA promulgated tariffs payable to producers of renewable energy

IPP – Independent Power Producer
These are power stations owned by independent parties other than Eskom

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

OCGT – Open Cycle Gas Turbine
Combustion turbine fuelled by liquid fuel or gas, used to drive a generator

CCGT – Combined Cycle Gas Turbine
OCGT fitted with a waste heat recovery boiler and steam turbines to increase electricity output by using the combustion turbine's exhaust gases to raise steam

HVDC – High Voltage Direct Current

IQ – Indicative Quote
Quotation giving a non-binding indication of the order of magnitude costs

FQ – Feasibility Quote
Quotation giving customers costs and scope at a 65% accuracy level

BQ – Budget Quote
Quotation giving customers costs and scope at an 85% accuracy level

TOSP – Time of System Peak

1. Introduction

1.1 CONTEXT OF THE TRANSMISSION TEN-YEAR PLAN

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

The TNSP is required to abide by the regulatory requirements to publish a document annually, detailing the plans for the way that the transmission network will develop in the next five years. The requirements furthermore 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 NERSA from time to time.

A further requirement is that the TNSP should hold public forums to share such plans with stakeholders in order to facilitate a joint planning process with them. The third ten-year plan was published early in 2011; this is the fourth publication based on the TDP for 2012 to 2021 (also called the 2011 TDP internally to Eskom) which was finalised internally during the latter part of 2011.

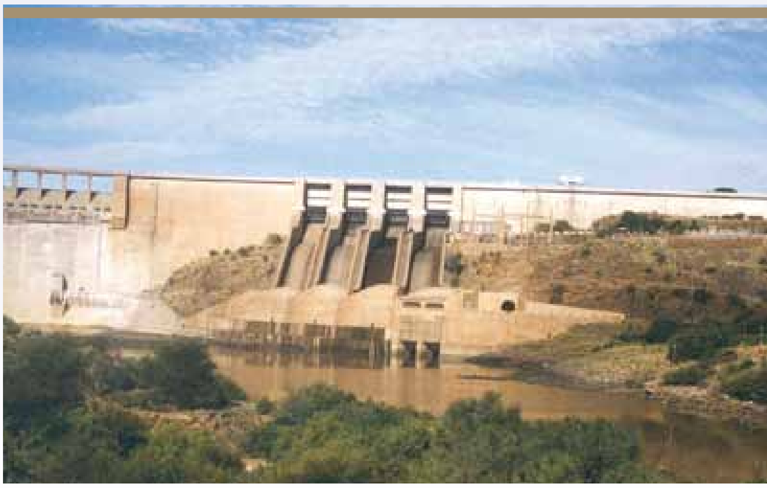
1.2 STRUCTURE OF THE DOCUMENT

The document is structured in the following manner:

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

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

Chapter 4 focuses on projects that have been completed in the past year and the impact they have had on network reliability. This is partly to demonstrate the value of the projects as they are completed and to also inform stakeholders about the progress made with 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 period of the Ten-Year Plan and a high-level summary of the installed transmission infrastructure.

Chapter 6 focuses in detail on the planned projects and the impact they will have on the network. Generation integration and reliability projects are discussed per Grid. In both instances, sites and servitudes are required to accommodate substations and lines respectively. In either case, the National Environmental Management Act requires Eskom to conduct an Environmental Impact Assessment (EIA) and obtain environmental approval, which includes consultation with affected stakeholders, prior to construction.

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

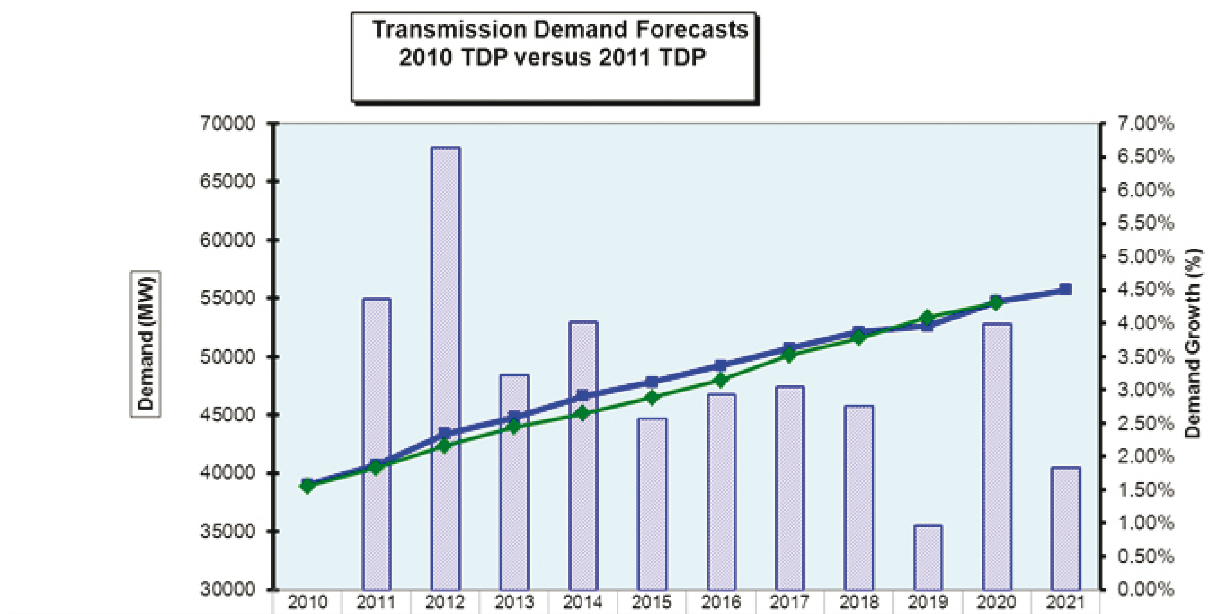
Chapter 8 deals with various conclusions based on the content of this document.

2. Load Demand Forecast and Generation Scenarios

2.1 LOAD FORECAST

Load forecasting is a fundamental requirement for a Transmission planning cycle. The availability of sufficient transmission network capacity in any country is important for economic growth. Grid Planning, in consultation with the relevant Distribution Regions, compiles a forecast per point of supply for the network computer model. A number of improvements have been made to the forecast for this TDP. The most notable improvement is the enhanced spatial format of the forecast as well as a link to the economic forecast for the country in terms of Gross Value Added (GVA) estimates.

At the Combined Forecasting Forum held in June 2010, forecasts were discussed with all parties and it was agreed that the ***Balanced Base Line System Demand*** at the time of System Peak (illustrated by the 2011 TDP forecast in Figure 2-1 below) and its associated point of supply and area forecasts would be used for transmission planning purposes by the Grid Planning Department for the Transmission Development Plan (TDP) network studies for the period 2012 to 2021. The expected peak demand for 2021 is 55,7 GW.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
2011 TDP Growth (%)		4.4%	6.6%	3.2%	4.0%	2.6%	2.9%	3.0%	2.8%	1.0%	4.0%	1.8%
2011 TDP Demand (MW)	39000	40700	43400	44800	46600	47800	49200	50700	52100	52600	54700	55700
2010 TDP Demand (MW)	38893	40447	42357	43974	45134	46493	47957	50123	51571	53356	54600	

Figure 2.1: The Eskom Transmission System Demand Forecast

The 2011 TDP forecast is marginally higher than the 2010 TDP forecast between the years 2011 to 2018. This is fundamentally because of the more positive signs of economic recovery from the recent economic recession. It is also attributed to more accurate forecasting linked to spatial forecasting techniques and economic sector growth. This forecast also assumes maximum load usage by existing customers. For the purposes of the TDP, loads are allocated to a CLN according to the location of the transmission substation supplying them, even if they are physically located in a different CLN.

2.2 GENERATION ASSUMPTIONS

Please note that the Generation assumption for this TDP was prepared in the latter part of 2010. The existing generation capacity was included as fully installed generation capacity in the year of the study. Power import from Cahora Bassa was modelled at a maximum of 1 200 MW. The future approved power plant integration projects were incorporated in the year in which they are expected to be commissioned.

The draft IRP 2010 was published for public consultation in the latter part of 2010. The official release of the final IRP 2010 was expected early in 2011. In order to comply with the TDP process timelines, an assumed generation rollout has been detailed based on the draft IRP 2010 document. This draft document was anticipated to be in line with the IRP. The generation plan in this report was then compared with the official IRP and any significant variances were highlighted.

In order to achieve the proposed draft IRP 2010 Plan, a number of assumptions had to be made about the size and location of the future planned generation plant. The details of this plan are discussed below:

Return to Service stations

The Return-to-Service (RTS) units at the Grootvlei and Komati Power Stations are approved projects. They have been delayed compared to the timing expected in the last TDP. It is now assumed that Grootvlei will be completed in time for the 2011 system peak, with units 5 and 6 taken into service as per schedule. Komati will be completed in time for the 2012 system peak with units 4, 5 and 6 for the 2011 system peak and the last three units, units 1, 2 and 3, completed in time for the 2012 system peak.

DoE OCGT power stations

The IRP indicates that the Department of Energy (DoE) will implement the two OCGT power stations by 2013, two years later than indicated in the previous TDP. It is assumed that they will be completed in time for the 2013 system peak. These are assumed to be located as previously proposed by the DoE, namely one close to the Dedisa MTS and the other close to the Avon MTS. They will be based on 147-MW units and will be modelled as follows:

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

These will be treated as peaking plant in the TDP studies, where they will only be used under contingency conditions or if required during system peak. For the integration studies, however, they will be studied at full output under the local Grid peak conditions to ensure that all the power can be evacuated.

Ingula pumped storage

The Ingula pumped-storage power station is an approved project. The project has been delayed and it is now assumed that units 1 and 2 will be completed in time for the 2014 system peak and units 3 and 4 in time for the 2015 system peak as per the project schedule.

Base Load Coal (Medupi and Kusile)

The Base Load Coal power stations at Medupi and Kusile are approved projects. Both projects have been delayed, however, particularly Kusile, and the assumption is now that the new units will be completed between 2013 and 2019 as per the project schedules and in line with the IRP.

No further base load coal-fired power stations were expected for the TDP period of 2012 to 2021.

Co-generation Projects and MTPPP

There are a number of initiatives to introduce co-generation projects into the Eskom power system. These have the effect of essentially reducing the demand at the point on the network where these co-generation plants are connected, but the network still has to be able to supply the load if the co-generation plant is not in service. As a result, the co-generation plants do not have a significant impact on the network capacity design. In certain cases the co-generation may exceed the local load and then the power transfer into the system will have to be accommodated. These will have to be treated on a case-by-case basis to determine whether they will have a significant impact on the network. For these reasons, co-generation projects are not considered in the TDP studies.

One specific programme is the MTPPP programme which offers PPA contracts to any generators that fall below a certain price level. The expected level of the MTPPP generation in the IRP is around 400 MW. Apart from one large co-generation project and one medium-size co-generation project, the rest are all below 20 MW. Effectively these are all co-generation projects and therefore will not be included in the transmission network model and the TDP studies. Instead they will be treated on a case-by-case basis as specified above.

A further 1 050 MW of co-generation plant is included in the draft IRP 2010 from 2013 to 2015. There is no indication of plant sizes or where these plants will be located. Based on the studies for the proposed SASOL co-generation plant, three 200-MW units will be assumed to be located at Sol B as per the studies. The rest will be ignored until there is clarity about the programme.

REFIT Renewable Generation and Wind Generation

The REFIT programme was to be going out for procurement at the time of preparing these Generation assumptions. REFIT was to offer special tariffs for the following renewables:

- Wind
- Small hydro
- Landfill gas
- Concentrated solar

The first phase of REFIT generation was set at 1 025 MW, with 700 MW allocated to wind generation and 100 MW allocated to the Eskom wind farm, Sere.

The 700-MW REFIT Wind may be a small number of large wind farms or a large number of small wind farms. This makes it difficult to model in the transmission network files. Based on the location of wind and applications for wind generation connection, decided decision was made to model the 700 MW as five representative wind farms, namely two of 100 MW, two of 150 MW and a single 200-MW wind farm. They will be connected directly to the 132-kV busbars of existing MTS substations.

The six MTS substations are the following:

- Juno (2012) 100 MW (Eskom wind farm)
- Poseidon (2012) 200 MW
- Grassridge (2013) 100 MW
- Delphi (2013) 100 MW
- Aurora (2014) 150 MW
- Droerivier (2014) 150 MW

Subsequent to the REFIT, the draft IRP2010 provides for another 3 200 MW of wind generation. This will be modelled as a number of 200-MW wind farms at different points on the network. In all cases, except Kappa, the wind farms will be a single 200-MW unit connected at the 132-kV busbar. In the case of Kappa, it will be connected directly to the 400-kV busbar. The list of sites and number of units with the year expected is shown in Table 1.

Without information about the actual location and size of the wind farms, it is difficult to determine the exact transmission requirements for the TDP. Taking into account that the normal average load factor of wind farms is of the order of 35%, this means that they will not have a significant impact on the capacity design of the network. The impact will be very localised and it is proposed that all wind farm applications should be handled on a case-by-case basis.

It is useful, however, to include some wind generation in the TDP studies under certain operating conditions. For the purposes of the TDP studies, it is proposed that wind generation should be studied under the following operating conditions:

- For the base case Time-of-System peak, all wind generators to be set at 15% output.
- Zero output to be tested at the local Time-of-Grid peak.
- Full 100% output to be tested at the local Time-of-Grid peak.
- Full 100% output to be tested at the local Time-of-Grid low load.

This is intended to determine the capacity and potential weakness under extreme generation conditions, based on the assumed connection to MTS substations. A plan as well as a budget allocation for the above assumptions is included in this TDP update.

Concentrated Solar Power (CSP) Generation

The output of Concentrated Solar Power (CSP) generation has been set at 400 MW in the draft IRP 2010. This was expected to increase significantly in later versions of the IRP, hence for the purposes of this TDP update, the results of the integration study to connect a 1 100 MW of Solar Generation (mostly CSP) for the DoE's Upington Solar Park initiative has been included in this TDP update. The result of this study was presented at the Upington Solar Park Investors Conference in 2010.

The CSP units are assumed to be run at maximum output during the both the system peak and the local peak. They will not be run during the low load conditions at night.

Combined Cycle Gas Generation (CCGT)

A number of Combined-Cycle Gas Turbine (CCGT) generation plants are proposed in the draft IRP 2010, giving a total of 1 896 MW but there is no indication of the size, configuration and location of these units. Based on the assumption that natural gas delivery infrastructure will be required, it is assumed that these CCGT units will be placed at or near the sites of the current OCGT units. The proposed amounts can be divided into equal amounts of a unit size of 237 MW and this is assumed to be the output of a single unit.

Their locations have been assumed as follows:

- Gourikwa (2 x 237 MW) 2019
- Avon (3 x 237 MW) 2020
- Dedisa (3 x 237 MW) 2021

These units can be run at Time-of-System peak and local Time-of-Grid peak if required, as they are more efficient than OCGT units. However, they should not be run during low load conditions.

Imported hydro power

The draft IRP 2010 assumes that 1 110 MW of hydro power will be imported. The most likely assumed place from which this hydroelectric power will come in the TDP time frame is from northern Mozambique. This is assumed to be transported down to the Maputo area via the proposed Mozambique Transmission Backbone Project (referred to as CESUL). This will in effect relocate the power to Maputo. For the purposes of the TDP studies, this will in effect relieve the MOZAL load in Maputo which Eskom must supply. Therefore the hydro import can be modelled as three generators placed at the Maputo 400-kV substation.

This will be studied in detail as a separate study and only serves to hold a place in the potential generation. The impact of not having this generation will have to be assessed and documented, as it is not a confirmed project.

Omissions from previous TDP Generation assumptions

A number of generation projects that were assumed to be in place for the TDP studies for the period 2011 to 2020 have been omitted from the generation assumptions for this TDP update period. These are discussed below.

Moamba OCGT Generation

The Moamba Project is a proposed OCGT 664-MW power station in Mozambique, situated approximately 30 km from the South African border near Komatipoort. This was assumed to be in service by 2012 for the previous TDP studies. However, this project is not included in the draft IRP 2010 and is therefore excluded from the assumptions for this TDP update.

Nuclear 1 Generation

In the previous TDP it was assumed that the first nuclear power station of the proposed nuclear fleet, Nuclear 1,

would be in service in 2019. The Nuclear 1 site selected for the purposes of the TDP studies was the Thuyspunt site near Port Elizabeth, but in the draft IRP 2010, the Nuclear 1 power station is only expected in 2022. It is therefore excluded from the TDP period of 2012 to 2021. It should be borne in mind though, that if the target date of 2022 is to be met, some of the transmission lines for the integration may have to be in place by 2021 or earlier for commissioning tests.

Coal 3 Generation

In the previous TDP studies, an additional base load coal-fired power station was required to meet the expected load demand. This was assumed to be the proposed Coal 3 power station at Lephalale, close to the Medupi site. The first unit would have come on line in 2017, but the draft IRP 2010 does not include this coal-fired power station. Accordingly, it is excluded from this TDP update.

Embedded Generation

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

Changes to the embedded generation will only be accounted for and included in the TDP studies if there is a high level of confidence in such changes.

Demand Side Management programmes

The draft 2010 IRP has a large component of Demand Side Management (DSM) which is proposed to exceed 3 000 MW by 2021 but no details are provided on how and more importantly where this DSM will be achieved. The transmission grid is still required to be able to supply the projected load demand in case the DSM does not materialise. Accordingly, the DSM is not considered for the purposes of the TDP studies for the period 2012 to 2021.

Imported power options

Several generation project opportunities in the Southern African region are currently being actively investigated and pursued by Eskom to identify which projects could be economically and strategically justified. However, the draft 2010 IRP does not consider any significant levels of new imported power by 2021 other than a potential import of hydroelectricity totalling 1 110 MW between 2020 and 2021. For the purposes of the TDP studies, this import has been assumed to come from Mozambique, based on whether the proposed Mozambique backbone project (referred to as the CESUL project) will be in place and delivering hydro power to Maputo. The power will therefore effectively be imported from the Maputo area.

Potential imported power projects will be treated as separate sensitivity analysis studies in the 20 to 30-year transmission strategic grid studies. Any promising imported power projects can then be included and incorporated in future TDP updates, once a sufficient level of confidence in the timing and implementation has been attained.

Discussion on impact of differences between the final 2010 IRP and the draft 2010 IRP on the TDP

The TDP process overlaps the IRP process. The generation assumptions for this TDP update were based on the Draft 2010 IRP.

Two major differences were noticed between the two plans for the TDP period:

- There was an addition of 3 000 MW of Solar PV.
- There was an addition of 750 MW of coal generation in the later part of the period.

It can be assumed that the Solar PV will be dispersed in small amounts around the country, most probably connected to the Distribution networks. This spread and the fact that Solar PV will not generate at the Time–of-System peak (which is at night around 20:00), mean that the existing plan is still valid. The daytime peaks of this generation and lower loading conditions will have to be tested in future updates of the TDP. It is anticipated at this stage, however, that this scenario will have only a marginal impact on the design of the network or this plan.

The plan will have to be updated in future to accommodate for the 750 MW of coal-fired generation, depending on its location and likelihood. There are Transmission plans for Coal 3 (now deferred) but certain Transmission Projects for Coal 3 may need to be brought forward (in future TDP updates) if the 750 MW materialises or is likely to materialise in the Waterberg (close to Medupi Power Station) area.

New generation summary

A summary of the new plant and the year that the last unit at the power station will become commercially available appear 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.

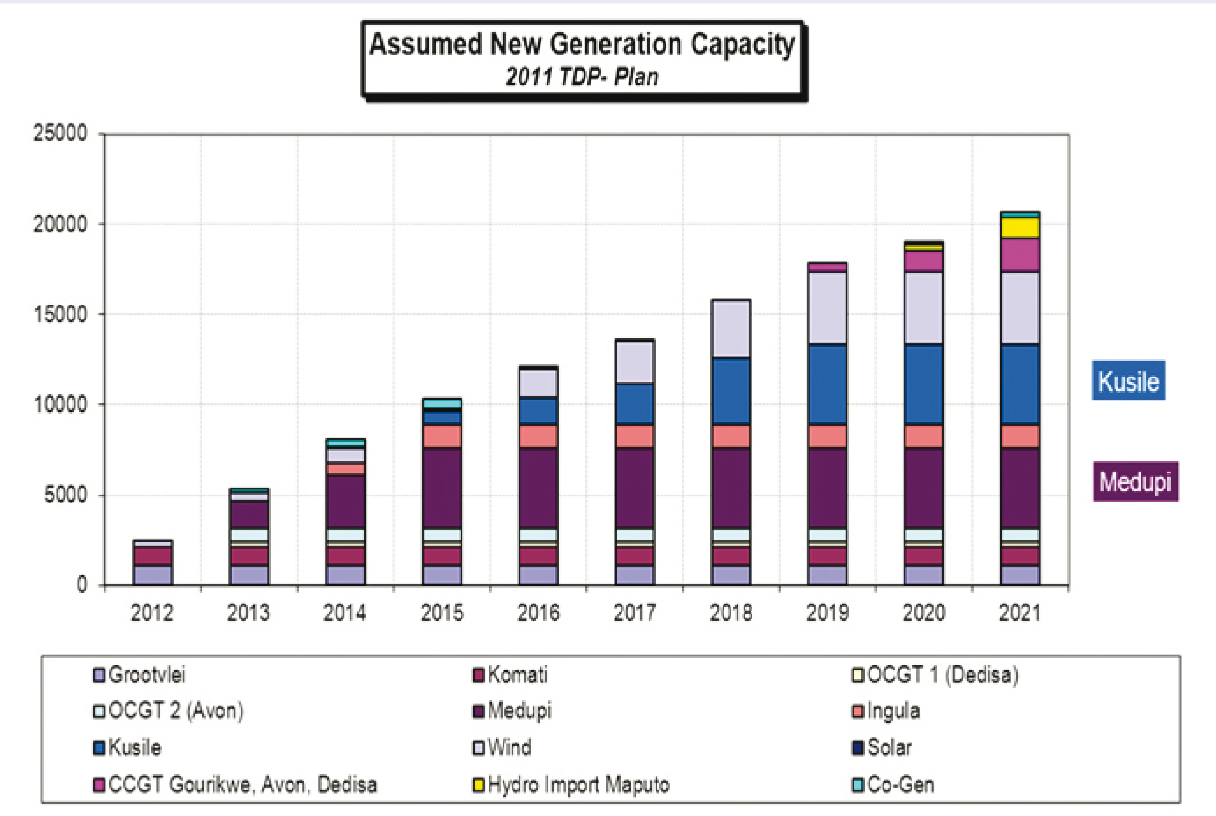


Figure 2.2: Power station capacity introduction by year

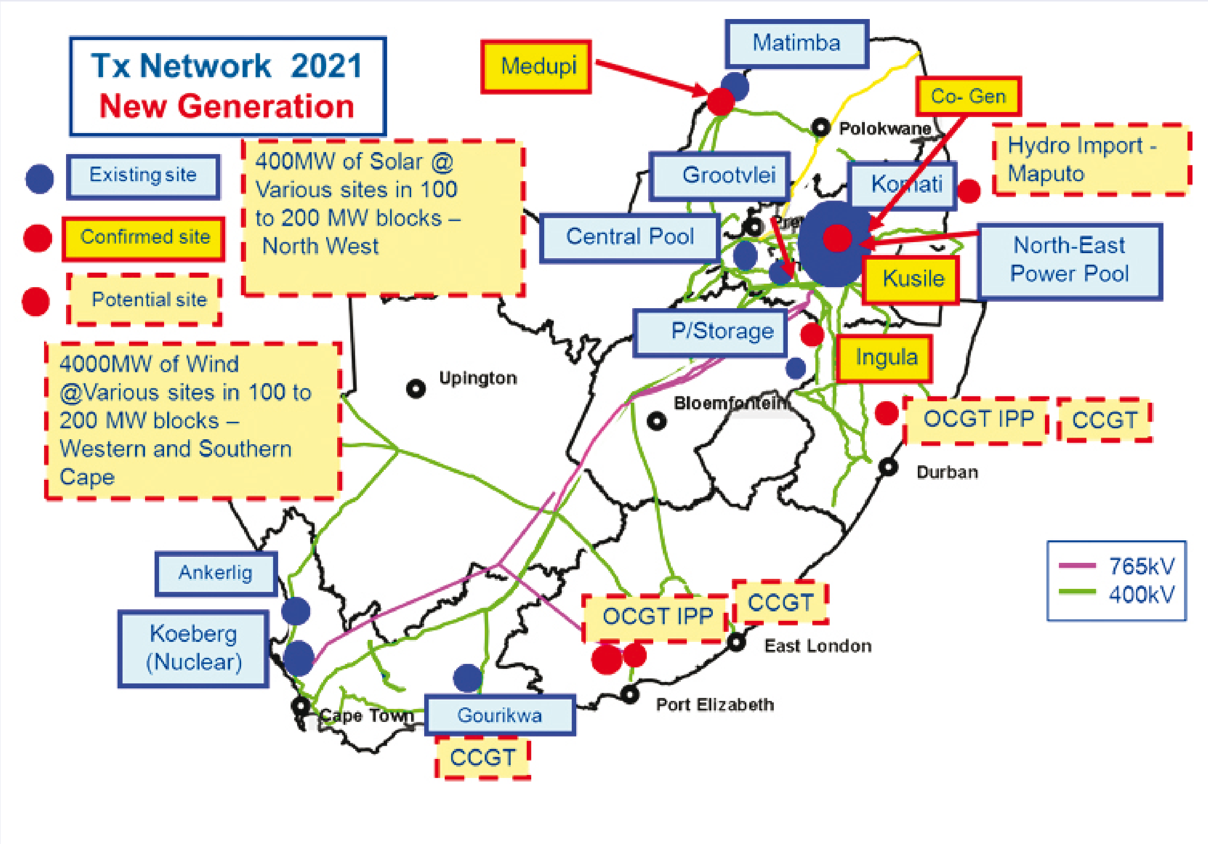


Figure 2.3: Planned Power Station Capacity by 2021

3. Major Factor Changes from previous TDP

There have been some changes in the factors influencing the selection and timing of projects for the TDP from the previous TDP. The main factor was related to an even better understanding of the geospatial load centres and forecast, and the potential generation scenarios. These two factors are briefly discussed in this section as background to the motivation of the projects and their timing in the TDP.

3.1 GEOSPATIAL LOAD FORECAST

The economic crisis had a significant impact on the demand for electricity in late 2008 and early 2009. Hence the load forecast presented in this report indicates a relatively larger system load demand than the load forecast presented last year.

The 2011 TDP forecast is marginally higher than the 2010 TDP forecast between the years 2011 to 2018. This is fundamentally due to more positive signs of economic recovery from the recent economic recession. It is also attributed to more accurate forecasting linked to geospatial forecasting techniques and economic sector growth. This forecast also assumes maximum load usage (contracted values) by existing customers. For the purposes of the TDP, loads are allocated to a CLN according to the location of the transmission substation supplying them, even if they are physically located in a different CLN.

Some of the load has moved between substations and the need for new substations has been identified.

As a result of the improved distribution of the demand forecast, a number of new projects are required within the TDP period as well as a need to reconfigure or re-phase several of the projects identified in the previous TDP. These changes were undertaken in consultation with the Transmission Grids, Distribution and the major Metro authorities.

3.2 GENERATION ASSUMPTIONS

The major change in the generation assumptions from the previous TDP is the inclusion of Wind Generation, Solar CSP, Co-Gen and CCGTs. A plan is also included for Wind and Solar integration.

The Coal 3 generation that would be in the Waterberg area close to Medupi is assumed to have been deferred in this plan. The integration of the first units at Coal 3 involved building the new Delta 765/400-kV substation and energising the Delta-Epsilon lines at 765-kV. It is proposed that two HVDC schemes with an HVDC converter station in the vicinity of Coal 3 should be implemented to cater for the final configuration of six 750-MW units. The HVDC lines will connect to HVDC rectifier terminal stations in Gauteng and KwaZulu-Natal (Central and East Grids). The entire scheme for Coal 3 has been deferred, but parts of this scheme could be brought forward in future TDP updates if required.

Nuclear 1 is also considered as being deferred in this plan to 2022, and would be located at the Thuyspunt site. Although the integration (400-kV local integration and 765-kV backbone strengthening) for this power station has been removed from this TDP period, some project work will be required earlier and the budget for this work is included in the Capital Plan presented later in this report.

4. Completed Projects since last TDP

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

4.1 COMPLETED GENERATION INTEGRATION PROJECTS

According to the Transmission Ten-Year Plan 2011-2020, the anticipation was that the RTS of some power stations would be completed in 2010. Parts of some of these projects have since been completed, and the resultant benefits are being realised. The completion status of these projects is as follows:

- **Grootvlei RTS:** 5 of the 6 units have been commissioned. The remaining unit has not yet been completed.
- **Komati RTS:** 3 of the 9 units have been commissioned. The remaining 6 units have not been completed. There are 2 units that are planned to be commissioned by year-end.

4.2 UPDATE ON TRANSMISSION RELIABILITY

This section discusses all the projects reflected in the Transmission Ten-Year Plan 2011 2020 which were due for commissioning in 2011. Over and above them, certain other projects were not mentioned in that plan (because they were nearing completion) and have been concluded since then.

Central Grid

The installation of the transformers at the Eiger substation has been completed. The Croydon transformer is planned to be completed by year-end.

The following projects were planned to be commissioned in 2011:

- Decommissioning of the Apollo 400-kV fault-limiting reactors
- Hera-Bernina 275-kV Link closed (uprate of breakers)
- Glockner Ext 3rd 800-MVA 400/275-kV transformer
- Glockner-Etna 1st 400-kV line (operate @ 275-kV)
- Glockner-Etna 2nd 400-kV line (operate @ 275-kV)

The Glockner transformer has been completed but the remaining projects have not yet been completed.

Western Grid

No projects were planned to be commissioned in 2011.

East Grid

No projects were planned to be commissioned in 2011.

North East Grid

The Duvha-Leseding 1st 400-kV line has been completed.

The project for the installation of additional transformation capacity at the Malelane substation has not been completed. The Zeus 400-kV by-pass (to create new Camden-Sol 1st & 2nd 400-kV lines) is planned to be completed by year-end.

North Grid

The Spencer 1st 275 kV line has been completed.

The following projects were planned to be commissioned in 2011:

- Dinaledi-Spitskop 1st 400-kV line
- Medupi-Spitskop 1st 400-kV line
- Medupi-Spitskop 2nd 400-kV Line
- Pelly 2nd 20 MVA 132/22-kV transformer

The above lines projects have not been completed and are planned to be commissioned in 2012. The Pelly transformer has been deferred to 2014 in this new plan.

South Grid

No projects were planned to be commissioned in 2011.

North West Grid

The following projects that planned to be commissioned in 2011:

- Mercury-Perseus 1st 765-kV (Operate @ 400 kV)
- Series Compensation on Alpha-Beta 1st and 2nd 765-kV lines
- Series Compensation on Mercury-Perseus 1st 765-kV line
- Ferrum Ext 132-kV 1 x 72 MVAr shunt capacitors
- Olien Ext 132-kV 2 x 36 MVAr shunt capacitors

The shunt capacitor projects have been completed. The line and series capacitor projects are planned to be completed in 2013.

4.3 GRID CONNECTIONS APPLICATIONS

Table 4.1 outlines the number of Indicative Quotations (IQs), Feasibility Quotations (FQs) and Budget Quotations (BQs) that have been processed during the period **January 2011 to July 2011**. These are as a result of applications for grid connections, as per the Grid Code.

As shown in Table 4.1 below, the number of customer applications for grid connections processed for the seven-month period is fairly high, indicating high connection requirements due to increasing load and generation activity. The acceptance rates for budget quotations are fairly low, however. Further analysis and consultation with customers are required to understand the opportunities that would improve this acceptance rate. A large number of Indicative Quote applications (most of the 37 applications above) were received to connect Renewable Energy Generation onto the Transmission Grid. The number of applications received from **January 2010 to July 2011** totals 72, also mostly due to Renewable Energy Generation applications linked to REFIT.

Grid	Indicative Quotations	Feasibility Quotations		Budget Quotations	
	Issued	Issued	Accepted	Issued	Accepted
Central	0	3	3	1	2
East	2	4	0	0	0
North East	1	4	3	6	1
North West	2	2	0	0	0
North	6	6	6	7	3
South	7	3	3	4	1
West	19	4	2	0	0
Total	**37**	**26**	**17**	**18**	**7**
% Acceptance			**65%**		**39%**

Table 4.1: Connection Applications Quoted and Accepted

5. National Overview

The map in Figure 5 1 below shows a high-level view of the major TDP scheme projects. The relative location of the new transmission lines and the associated MTS substations are indicated schematically in the figure.

The major new assets that have either been approved or it is proposed should be added to the transmission system over the next ten years are summarised in Table 5.1 on the following page.

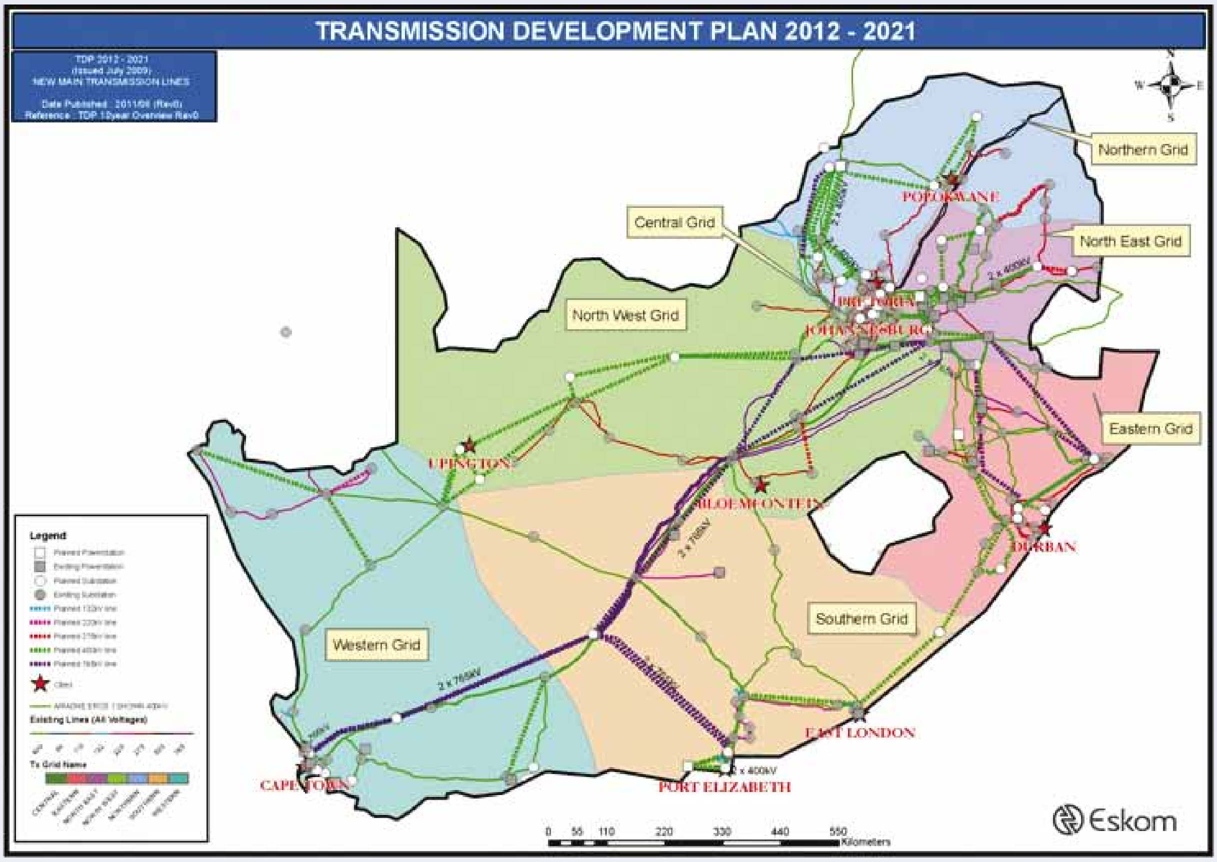
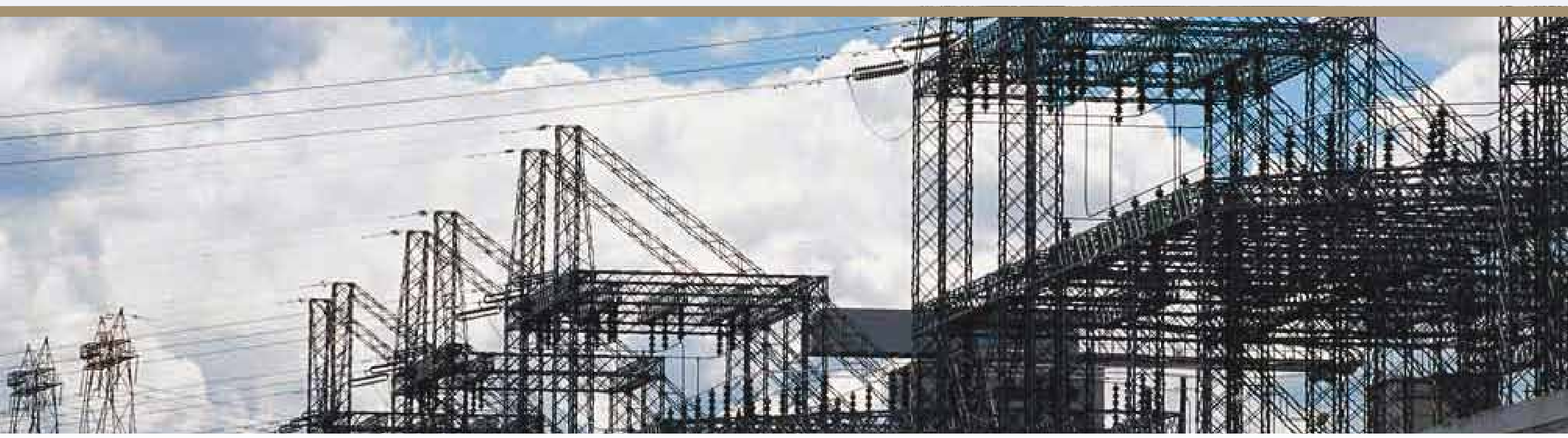


Figure 5.1: Map showing relative location of the major TDP scheme projects



TDP New Assets	Total
HVDC Lines (km)	0
765kV Lines (km)	4,430
400kV Lines (km)	7,830
275kV Lines (km)	501
Transformers 250MVA+	119
Transformers <250MVA	25
Total installed MVA	73,985
Capacitors	19
Total installed MVAr	2,094
Reactors	55
Total installed MVAr	12,603

Table 5.1: Major TDP transmission assets expected to be installed

Significant lengths of new transmission lines are being added to the system: over 4 000 km of 765-kV and over 7 800 km of 400-kV lines have either been approved or proposed over the 10-year TDP period. This addition is mainly due to the major network reinforcements required for the supply to the Cape (South and West Grids) and KwaZulu-Natal (East Grid). The integration of the new Medupi Power Station in the developing Limpopo West Power Pool (Medupi is close to Matimba) also requires significant lengths of transmission line as it is a long distance away from the main load centres. Additional 765-kV lines and HVDC lines that were required in the previous TDP to export the power from Coal 3 in the same area directly to load centres, have been deferred or removed from this TDP period because Coal 3 has been deferred in the IRP. Lines that were required for local and backbone strengthening for Nuclear 1 (at Thyspunt) were also removed from this TDP period.

The large length of 400-kV transmission line is also the result of the development of a more meshed transmission 400-kV network to provide greater reliability and thus improve the levels of network security

These new transmission lines form part of the long-term strategy to develop a main transmission backbone from which regional power corridors can be supported. These power corridors will connect generation pools to one another and to the major load centres in the country. This backbone and regional power corridor network structure will allow 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 were reviewed as part of the Strategic Grid Study which considered the potential development scenarios beyond the 10-year horizon of the TDP until 2030. The objective of this strategic study was to align the transmission network with the requirements of the generation future options and those of the growing and future load centres. This Strategic Grid Study has enabled the 10-Year TDP to be aligned with the future long-term development of the whole Eskom system.

The addition of over 73 000 MVA of transformer capacity to the transmission system is an indication of the increase in load demand and in the firm capacity requirements of the customers. This figure also includes the transformation capacity required to integrate Renewable Energy Generation.

Approximately 2 000 MVars of capacitive support are required to support areas of the network under contingency conditions to ensure that the required voltage levels are maintained. They also improve system efficiency by reducing network losses.

Approximately 12 500 MVArs of reactors are a direct result of the long lengths of the 765-kV and the 400-kV transmission lines that will be constructed over this period. A number of series compensation projects are also required on the 765-kV and 400-kV lines in order to improve the power transfer capability of the Cape power corridors.

Two new SVCs are proposed for supporting the Northern Cape (West Grid) and the proposed Sishen-Saldanha Spoornet expansion, namely a +200/-100 MVAr SVC at Aries and a smaller one of +45/-100 MVars at Garona. Two additional SVCs have been added, owing to Wind and Solar generation Integration requirements. SVCs are required to manage the voltage variation on the Transmission Grid.

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

6. Breakdown of the TDP Projects by Grid

6.1 CENTRAL GRID

The Central Grid consists of four customer load networks (CLNs), namely Johannesburg, Vaal Triangle, West Rand and Nigel. The current transmission network and CLNs are shown in Figure 6 1 below.

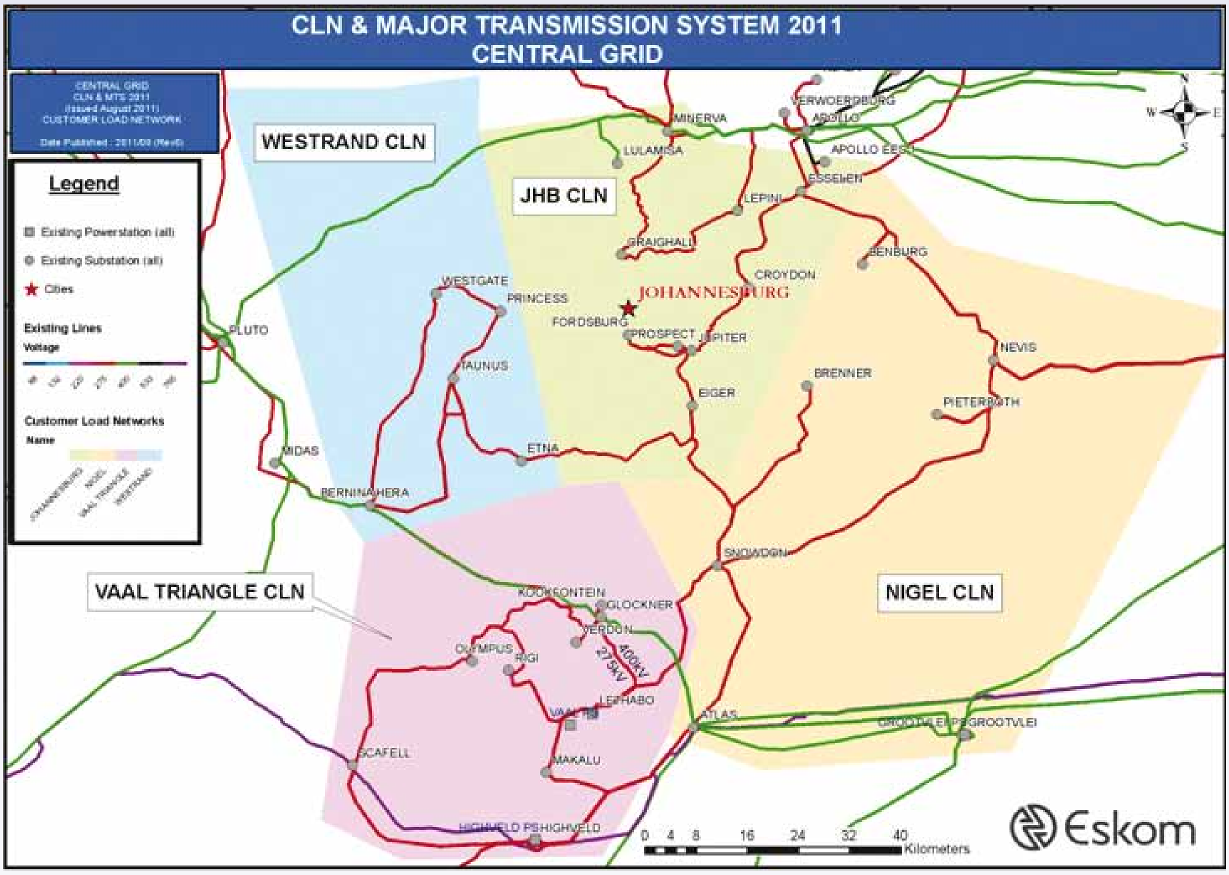


Figure 6.1: Current Central Grid network and CLNs

The expected peak CLN demands by 2021 at TOSP and the average percentage load increase for the period for each CLN are given in Table 6 1 on the following page.

CLN	Forecast Load (MW) 2012	2017	2021	Ave. annual % load increase
Johannesburg	4847	5586	6188	3%
West Rand	2076	2892	3086	4%
Nigel	1854	2016	2165	2%
Vaal Triangle	1636	1779	1856	2%

Table 6.1: Current Central Grid network and CLNs

The TDP schemes for the Central Grid consist of extending the 275-kV network (built at 400-kV insulation level to allow for future upgrading to 400 kV) and the installation of additional transformers at existing substations, as well as the construction of new substations. The increase in transmission assets by the end of 2016 and end of 2021 and the cumulative total are shown in Table 6-2.

Transmission assets for Central Grid	New assets expected in 2012 - 2016	New assets expected in 2017- 2021	Total new assets expected
Total kms of line	579	234	813
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	0 539 40	0 234 0	0 773 40
Total installed Transformer MVA	2925	4545	7470
Transformers (no. of)	8	10	18
Capacitors (no. of)	2	0	2
Reactors (no. of)	0	0	0

Table 6.2: New transmission assets for the Central Grid

The following projects are planned for the 2012 to 2021 period:

Sub-project Name	TDP Scheme Project	Grid	New expected year
Benburg Ext 3rd 250 MVA 275/132 kV	Benburg Ext 3rd 250 MVA 275/132 kV	Central	2014
Demeter Ext 400/88-kV transformation (1st, 2nd and 3rd 315-MVA transformers and 400-kV busbar)	Demeter 400-kV integration	Central	2017
Loop in Pluto-Verwoerdburg 400 kV into Demeter	Demeter 400-kV integration	Central	2017
Esselen-North Rand 1st 275-kV line upgrade (existing 132 kV)	Johannesburg East strengthening – Phase 1B	Central	2015
North Rand Ext 1st 500 MVA 275/132-kV transformer (line Banked) and Esselen 275-kV busbar rearrangement	Johannesburg East strengthening – Phase 1B	Central	2015
Esselen-North Rand 2nd 275-kV line upgrade (existing 132 kV)	Johannesburg East strengthening – Phase 2	Central	2016
North Rand Ext 2nd 500 MVA 275/132-kV transformer and 275-kV busbar establishment	Johannesburg East strengthening – Phase 2	Central	2016
Jupiter B 275-kV Loop-ins (Prospect-Sebenza 1 & 2, Jupiter-Prospect 1, Jupiter-Fordsburg 1)	Johannesburg East strengthening – Phase 3 A-D	Central	2014
Apollo-Esselen 1st 400 kV (energised @ 275 kV)	Johannesburg East strengthening – Phase 3 A-D	Central	2014
Matla-Jupiter B 1st 400-kV line (operated @ 275 kV)	Johannesburg East strengthening – Phase 3 A-D	Central	2014
Matla-Jupiter B 2nd 400-kV line (operated @ 275 kV)	Johannesburg East strengthening – Phase 3 A-D	Central	2014
Prospect-Sebenza 1st 275-kV line (energise existing 88-kV line)	Johannesburg East strengthening – Phase 3 A-D	Central	2014
Prospect-Sebenza 2nd 275-kV line (energise existing 88-kV line at 275 kV)	Johannesburg East strengthening – Phase 3 A-D	Central	2014
Jupiter B 275-kV switching station	Johannesburg East strengthening – Phase 3 A-D	Central	2014
North Rand-Sebenza 1st 275-kV line (Sebenza bays are GIS)	Johannesburg East strengthening – Phase 3 E-F	Central	2017
North Rand-Sebenza 2nd 275kV line (Sebenza bays are GIS)	Johannesburg East strengthening – Phase 3 E-F	Central	2017
Sebenza substation (400-kV busbar operated @ 275 kV)	Johannesburg East strengthening – Phase 3 E-F	Central	2017
Lepini Ext 275 kV 2 x 150 Mvar capacitors	Johannesburg North – Phase 2a	Central	2012
Apollo-Lepini 1st 275-kV line	Johannesburg North – Phase 2b	Central	2013
Craighall-Craighall B-Sebenza 1st 400-kV line (operated @ 275 kV) (reuse existing Delta-Kelvin 88-kV servitude)	Johannesburg strengthening	Central	2023

Sub-project Name	TDP Scheme Project	Grid	New expected year
Craighall B 400/88-kV GIS Substation	Johannesburg strengthening	Central	2023
Kookfontein Ext 3rd 315 MVA 275/88-kV transformer and 3rd Glockner-Kookfontein 275-kV line establishment	Kookfontein Phase 2	Central	2014
Kyalami 400-kV loop-in (Kusile-Lulamisa 1st 400 kV)	Kyalami integration	Central	2017
Kyalami 400/132-kV substation (1st & 2nd 500 MVA transformers) (All bays are GIS)	Kyalami integration	Central	2017
Decommissioning of the Apollo 400-kV fault-limiting reactors	Reactive power support for Johannesburg	Central	2012
Simmerpan ext 275/132-kV transformation (2 x 250 MVA)	Simmerpan 275/132-kV substation	Central	2021
Jupiter B-Simmerpan 1st & 2nd 275-kV lines (uprate of 88-kV lines)	Simmerpan 275/88-kV substation	Central	2016
Simmerpan 275/88-kV substation (expand existing Dx station)	Simmerpan 275/88-kV substation	Central	2016
Quattro 275/88kV substation (1st and 2nd 315-MVA transformers) (400/88-kV construction)	Soweto strengthening Phase 1 – 275 kV	Central	2014
Etna-Quattro 1st and 2nd 400-kV lines (energised @ 275 kV)	Soweto strengthening Phase 1 – 275 kV	Central	2014
Quattro 275/132-kV substation (1st and 2nd 500-MVA transformers) (400/132-kV construction)	Soweto strengthening Phase 2 – 275/132 kV	Central	2016
Etna-Glockner 1st & 2nd 400-kV lines upgrade	West Rand strengthening – Phase: Etna 400 kV	Central	2022
Etna Ext 400/275-kV transformation (2 x 800 MVA)	West Rand strengthening – Phase: Etna 400 kV	Central	2017
Glockner-Hera 1st 400-kV line	West Rand strengthening – Phase: Glockner and Hera 400 kV	Central	2022
Westgate B 400/132-kV substation (1st 500-MVA transformer)	West Rand strengthening – Phase: Westgate B and Taunus 400 kV	Central	2019
Hera-Westgate B 1st 400-kV line	West Rand strengthening – Phase: Westgate B and Taunus 400 kV	Central	2019
Taunus-Westgate B 1st 400-kV line	West Rand strengthening – Phase: Westgate B and Taunus 400 kV	Central	2019
Etna-Taunus 1st 400-kV line (energised @ 275 kV)	West Rand strengthening – Phase: Westgate B and Taunus 400 kV	Central	2022
Taunus Ext 400/132-kV transformation (1 x 500 MVA)	West Rand strengthening – Phase: Westgate B and Taunus 400 kV	Central	2022

Changes compared to the 2010 TDP:

Removed from the TDP:

- Siluma 275/88-kV MTS integration removed due to insufficient motivation for the project.

New projects/schemes in the TDP:

- Olympus 3rd 275/132 kV 250-MVA transformer: Customer request.

Modified:

- Decommissioning of the Apollo 400-kV fault-limiting reactors and changed to by-passing the Apollo 400-kV fault-limiting reactors.
- Johannesburg East strengthening – Phase 3 A-D: Johannesburg East strengthening – Phase 3B was cancelled and 2 x 275-kV new Matla-Jupiter B lines (400 kV built) are to be established.
- West Rand strengthening: Hera – Westgate B 400 kV and new Westgate B 400 kV S/S were changed to 1st 500 MVA; 400/132-kV transformer at Westgate, fed from a double circuit line from Hera.
- Vaal strengthening – Phase 3 time-lines were moved to 2022 from 2017 and scope has increased to accommodate a strategic 400-kV servitude from Westgate to Taunus (via Princess) to Etna.

A network diagram of the major projects in the Central Grid is shown in Figure 6 2 below:

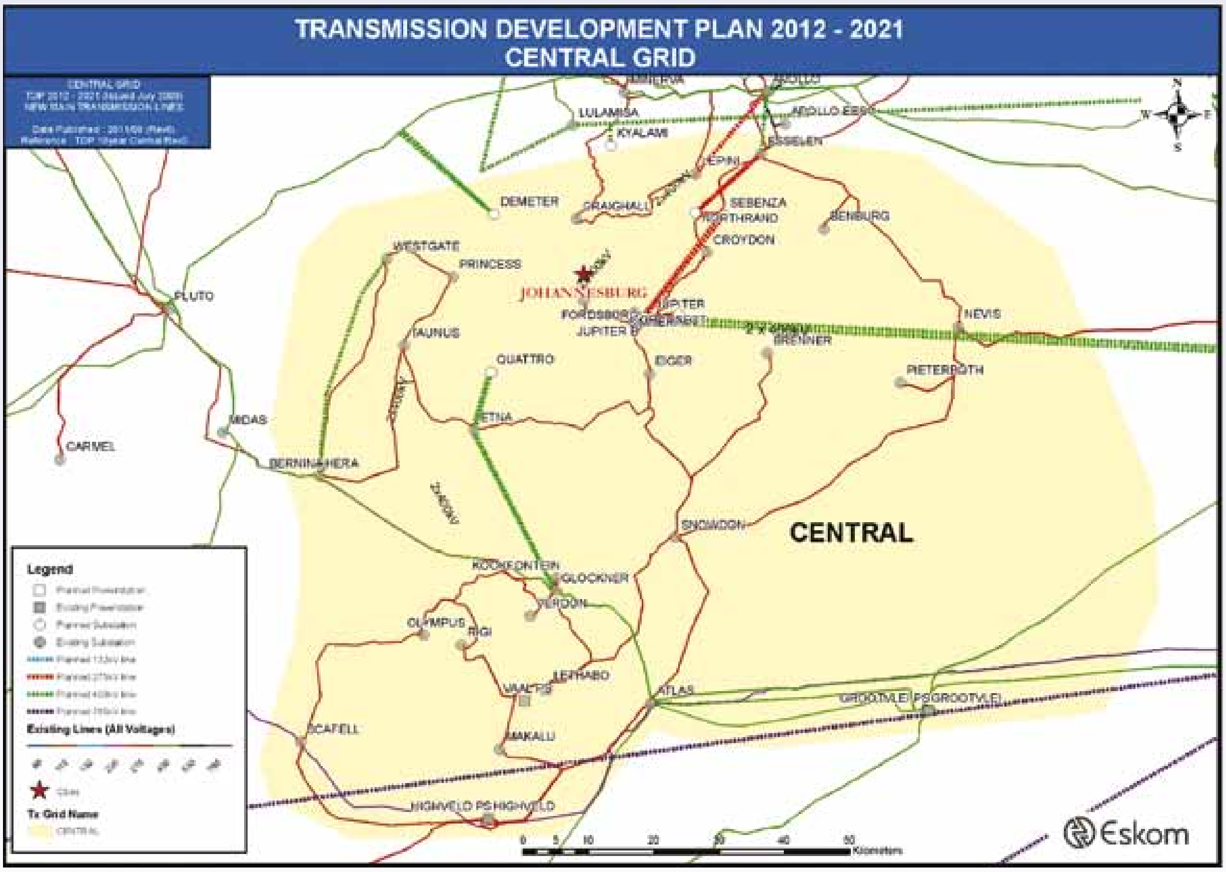


Figure 6.2: Central Grid network diagram

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.

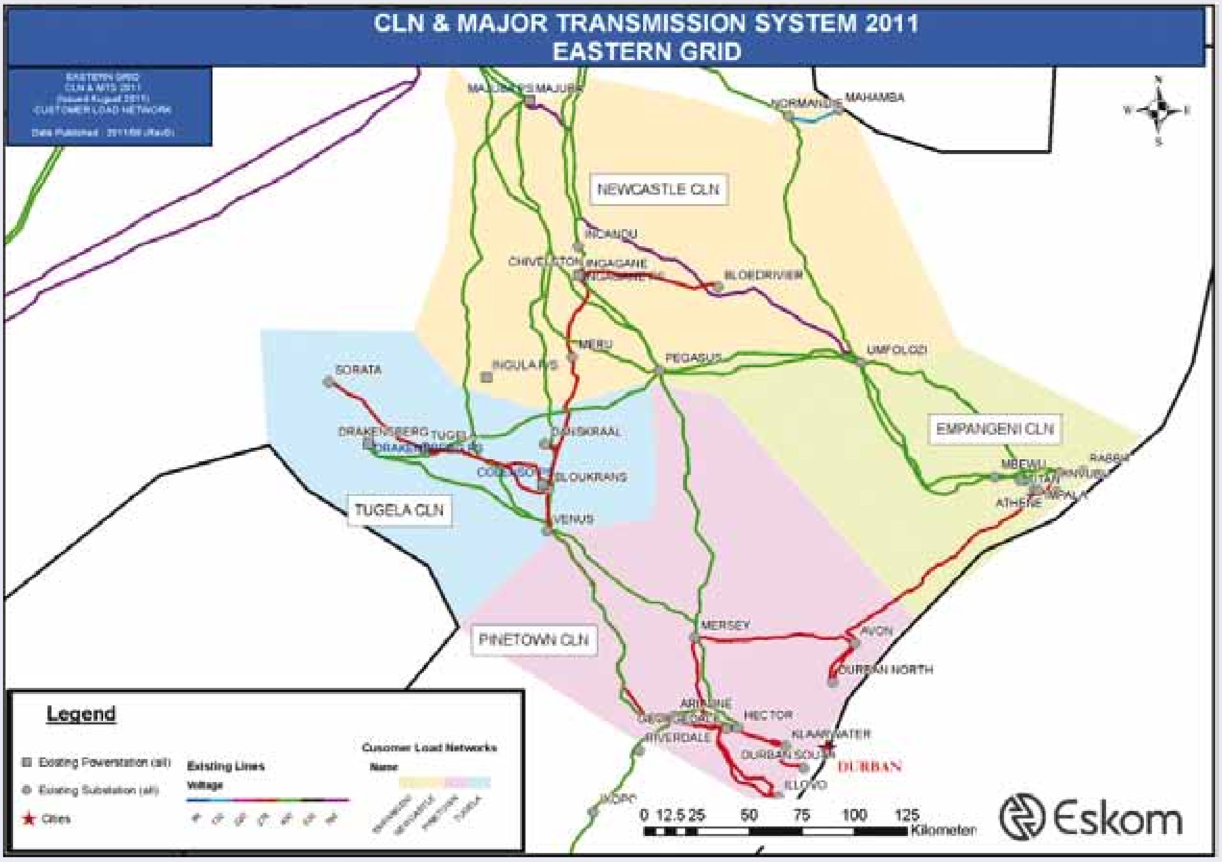


Figure 6.3: Current East Grid network and CLNs

The expected peak CLN demands by 2021 at TOSP and the average percentage load increase for the period for each CLN are given in Table 6 3 below.

CLN	Forecast load (MW)			Ave. annual % load increase
	2012	2017	2021	
Ladysmith and Newcastle	1 293	1 445	1 593	2%
Empangeni	2 335	2 571	2 931	3%
Pinetown	3 462	3 806	4 462	3%

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

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

The increase in transmission assets by the end of 2016 and end of 2021 and the cumulative total are shown in Table 6 4.

Transmission Assets for Eastern Grid	New assets expected in 2012 - 2016	New assets expected in 2017 - 2021	Total new assets expected
Total kms of line	1 487	385	1 872
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	490 992 5	280 105 0	770 1 097 5
Total installed Transformer MVA	10 795	6 050	16 845
Transformers (no. of)	13	6	19
Capacitors (no. of)	0	0	0
Reactors (no. of)	6	2	8

Table 6.4: East Grid new transmission assets

The following projects are planned for the 2012 to 2021 period:

Sub-project Name	TDP Scheme Project	Grid	New expected year
Ariande-Venus 2nd 400-kV line	Ariadne-Venus 2nd 400-kV line	East	2015
Assmang 400/132-kV substation	Assmang MTS	East	2016
Loop into Assmang 400/132-kV substation the Mersey – Hector 400-kV line	Assmang MTS	East	2016
Avon Ext 3rd 250 MVA 275/132-kV transformer	Avon Ext 3rd 250 MVA 275/132-kV transformer	East	2014
Invubu Ext 1st and 2nd 500 MVA 400/132-kV transformers	Empangeni local network strengthening	East	2016
Umfolozi-Theta (Mbewu) 765-kV line (operate @ 400 kV)	Empangeni strengthening – Phase 2	East	2016
Invubu-Theta (Mbewu) 2nd 400-kV line	Empangeni strengthening – Phase 2	East	2016
Theta (Mbewu) 400-kV loop-ins (Athene-Umfolozi 1st 400 kV & Invubu-Umfolozi 1st 400-kV line)	Empangeni strengthening – Phase 2	East	2016
Theta (Mbewu) 400-kV switching station	Empangeni strengthening – Phase 2	East	2016
Camden-Theta (Mbewu) 1st 765-kV line (operated @ 765 kV)	Empangeni strengthening – Phase 4	East	2017

Sub-project Name	TDP Scheme Project	Grid	New expected year
Camden Ext 765/400-kV transformation	Empangeni strengthening – Phase 4	East	2017
Theta (Mbewu) Ext 2nd 765/400-kV transformation	Empangeni strengthening – Phase 4	East	2017
Ariadne-Eros 2nd 400-kV line	Eros reinforcement – Ariadne-Eros 400 kV	East	2015
Eros-Vuyani 1st 400-kV line	Greater East London strengthening – Phase 1: Eros-Mthatha & SS	East	2013
Hector Ext 4th 800 MVA 400/275-kV transformer	Hector Ext 4th 800 MVA 400/275-kV transformer	East	2018
Incandu Ext 3rd 315 MVA 400/132-kV transformer	Incandu Ext 3rd 315 MVA 400/132-kV transformer	East	2014
Ingula 400-kV loop in (Majuba-Venus 1st 400-kV line)	Ingula Pumped Storage P/S integration	East	2013
Ingula-Venus 2nd 400-kV line	Ingula Pumped Storage P/S integration	East	2013
Ingula 400-kV busbar establishment (integration of P/S gens)	Ingula Pumped Storage P/S integration	East	2013
Hector-Klaarwater 3rd 275 kV (extend Georgedale-Klaarwater and bypass Georgedale)	Klaarwater reinforcement – Phase 1	East	2016
Hector-Klaarwater 1st 400 kV (operated @ 275 kV)	Klaarwater reinforcement – Phase 2	East	2017
Lambda-Theta (Mbewu) 765-kV line (extend Majuba-Theta (Mbewu) 765-kV line)	KZN 765-kV integration	East	2016
Theta (Mbewu) Ext 765/400-kV transformation	KZN 765kV integration	East	2016
2 X Majuba – Lambda 400-kV lines	KZN 765kV integration	East	2016
Lambda 400/765-kV substation and transformation	KZN 765-kV integration	East	2016
Lambda-Sigma (Isundu) 765kV line (extend Majuba-Sigma (Isundu) 765kV line)	KZN 765-kV integration	East	2016
Sigma (Isundu) Ext 765/400-kV transformation	KZN 765-kV integration	East	2016
Mersey Ext 3rd 250 MVA 275/132-kV transformer	Mersey Ext 3rd 250 MVA 275/132-kV transformer	East	2017
Normandie Ext 2nd 250 MVA 400/132-kV transformer	Normandie Ext 2nd 250 MVA 400/132-kV transformer	East	2013
Mersey-Ottawa 1st 400 kV (operated @ 275 kV)	Ottawa reinforcement	East	2017
Sigma (Isundu)-Theta (Mbewu) 1st and 2nd 400-kV line	Pinetown – Empangeni interconnection	East	2016

Sub-project Name	TDP Scheme Project	Grid	New expected year
Majuba-(via Venus)-Sigma (Isundu) 1st 765-kV line (operated @ 400 kV)	Pinetown strengthening – Phase 1	East	2016
Hector-Sigma (Isundu) 1st 400-kV line	Pinetown strengthening – Phase 1	East	2016
Hector-Sigma (Isundu) 2nd 400-kV line	Pinetown strengthening – Phase 1	East	2016
Oribi 400/132-kV substation	South Coast strengthening	East	2020
Loop into Oribi 400/132-kV substation the Ariadne-Eros 2nd 400-kV line	South Coast strengthening	East	2020
Spoornet coal-line upgrade (Natal)	Spoornet coal-line upgrade (Natal)	East	2014

Changes compared to the 2010 TDP:

Changes in the execution dates for the expansion projects affect the power transfers into the Empangeni and Pinetown CLNs. Network analysis studies show that this could be mitigated by improving the power factor of eThekwini Electricity from 0,9 to at least 0,95. At present eThekwini Electricity is already engaged in improving the power factor. They have installed/reinstated capacitor banks at the Klaarwater and Durban North substations and optimised transformer tap-changer positions in the 132-kV network. Additional capacitor banks are planned for installation in the network in 2013.

There are no new network risks. The plans as they currently stand are still valid and address the identified gaps.

A geographical network diagram indicating the major projects in the East Grid for the ten-year period is shown in Figure 6 4.

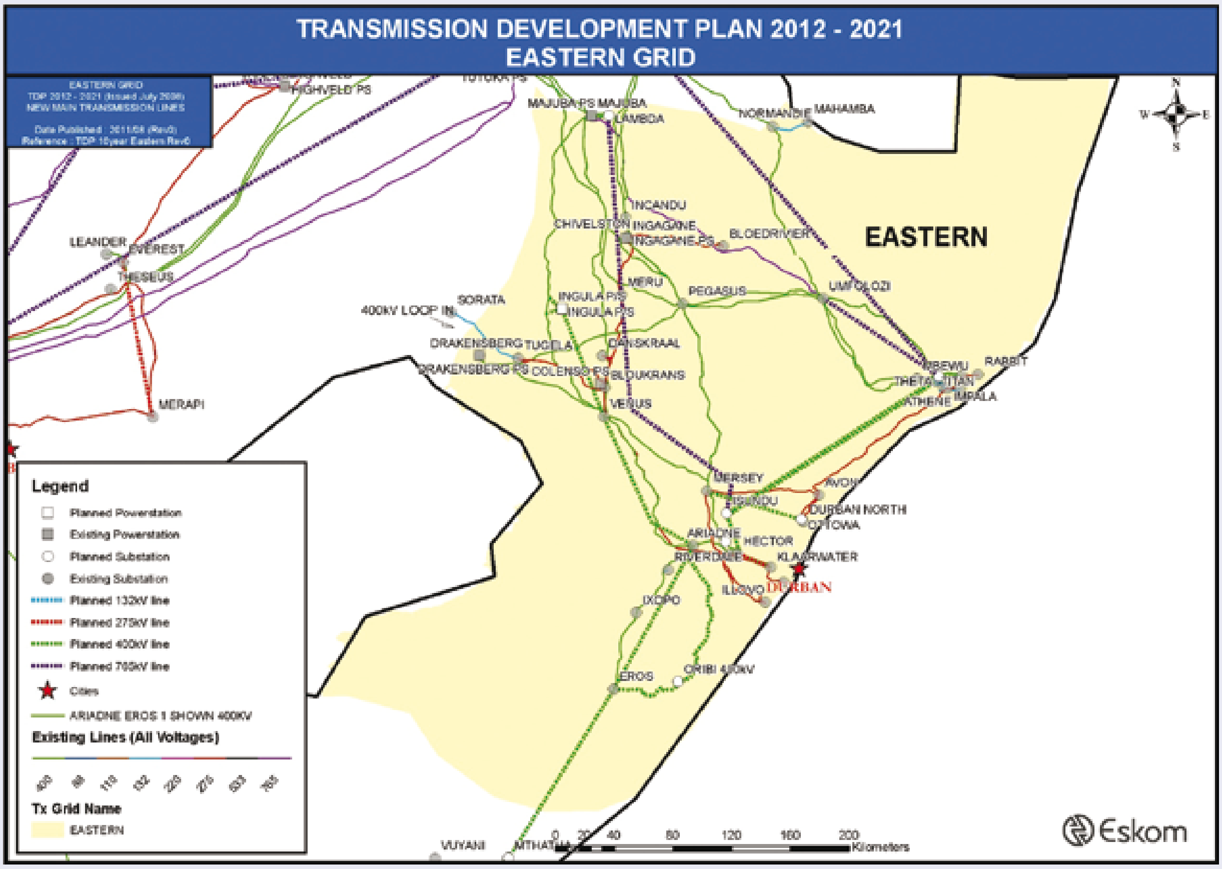


Figure 6.4 East Grid geographical network diagram

6.3 NORTH GRID

The North Grid consists of five CLNs, namely Waterberg, Rustenburg, Lowveld (northern part), Bela-Bela (formerly Warmbad) and Polokwane. The current transmission network and CLNs are shown in Figure 6 5 below.

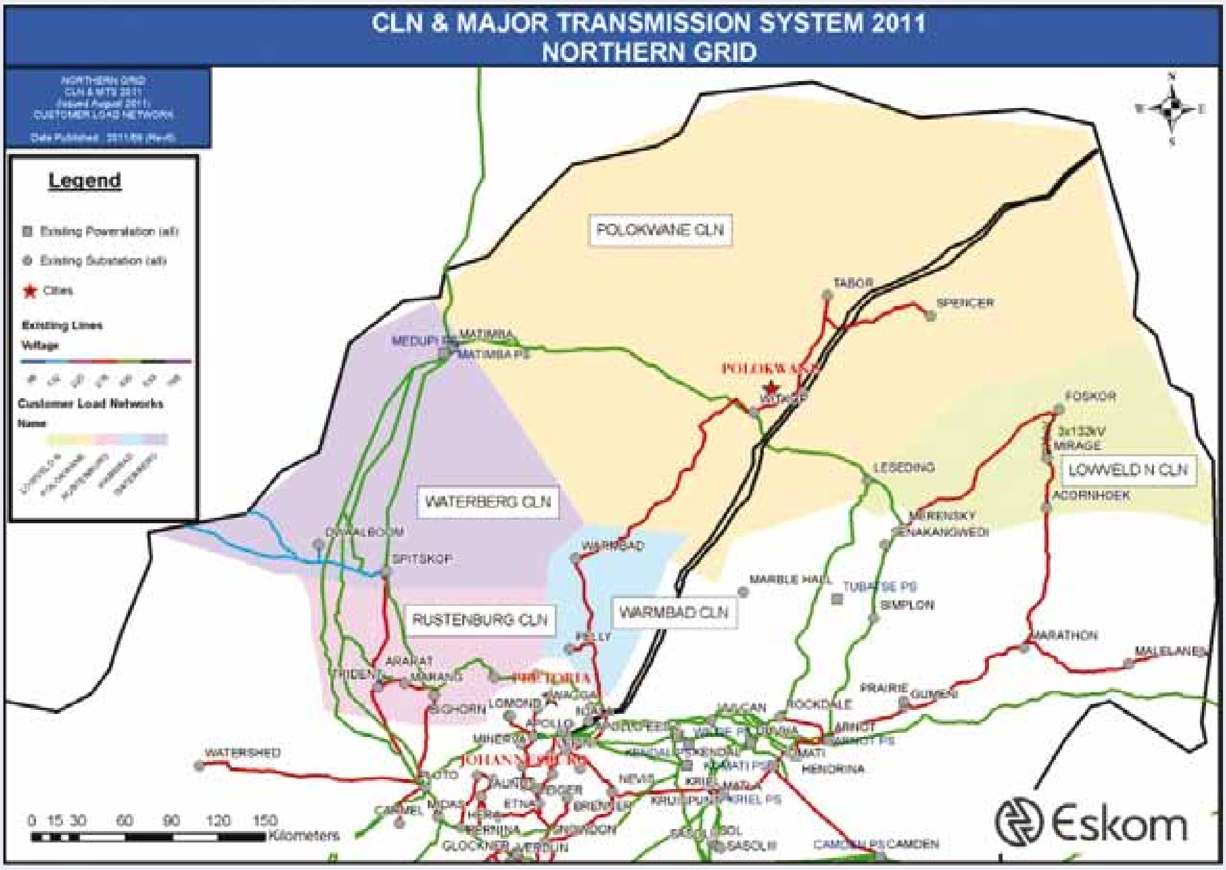


Figure 6.5: Current North Grid network and CLNs

The expected peak CLN demands by 2021 at TOSP and the average percentage load increase for the period for each CLN are given in Table 6 5 below.

CLN	Forecast load (MW)			Ave. annual % load increase
	2012	2017	2021	
Waterberg	680	801	1 085	8%
Rustenburg	1 763	2 305	2 399	3%
Lowveld North	1 708	2 698	2 931	6%
Bela-Bela (Warmbad)	642	832	895	4%
Polokwane	1 144	1 751	1 935	6%

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

The Northern Grid load growth is mainly due to the platinum group metals (PGM) and ferrochrome mining and processing activities located in the Rustenburg, Polokwane and Steelpoort areas.

The TDP Scheme Projects for the Northern Grid consist of extending the 400-kV and 275-kV networks as well as establishing the 765-kV network, integrating the Medupi Power Station and installing additional transformers at existing and new substations.

The increase in transmission assets by the end of 2016 and the end of 2021 and the cumulative total are shown in Table 6 6.

Transmission Assets for Northern Grid	New assets expected in 2012 - 2016	New assets expected in 2017 - 2021	Total new assets expected
Total kms of line	1 950	490	2 440
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	200 1 600 150	0 490 0	200 2 090 150
Total installed Transformer MVA	4 635	1 500	6 135
Transformers (no. of)	12	4	16
Capacitors (no. of)	0	0	0
Reactors (no. of)	2	2	4

Table 6.6 *North Grid new transmission assets*

The following projects are planned for the 2012 to 2021 period:

Sub-project Name	TDP Scheme Project	Grid	New expected year
Brits West loop-in (Dinaledi-Spitskop 1st 400 kV)	Brits 400 kV reinforcement	North	2017
Brits West substation 400/132 kV	Brits 400 kV reinforcement	North	2017
Brits West-Dinaledi 2nd 400 kV	Brits 400-kV reinforcement	North	2017
Dinaledi 3rd 500 MVA 400/132-kV transformer	Dinaledi 3rd 500 MVA 400/132-kV transformer	North	2014
Dwaalboom 132-kV switching station	Dwaalboom 132-kV switching station	North	2013
Acornhoek upgrade 2 x 125 MVA 275/132-kV transformers	Foskor & Acornhoek 275/132-kV transformation upgrades	North	2014
Foskor 3rd 250 MVA 275/132-kV transformer	Foskor & Acornhoek 275/132-kV transformation upgrades	North	2014
Foskor-Merensky 2nd 275-kV line	Foskor & Acornhoek 275/132-kV transformation upgrades	North	2016
Dinaledi-Spitskop 1st 400-kV line	Medupi integration (Alpha) Phase 1A: Spitskop and Dinaledi	North	2012
Dinaledi-Spitskop 2nd 400-kV line	Medupi integration (Alpha) Phase 1A: Spitskop and Dinaledi	North	2013
Medupi-Spitskop 1st 400-kV line	Medupi integration (Alpha) Phase 1A: Spitskop and Dinaledi	North	2012
Medupi-Spitskop 2nd 400-kV Line	Medupi integration (Alpha) Phase 1A: Spitskop and Dinaledi	North	2012
Medupi-Marang 1st 400 kV	Medupi integration (Alpha) Phase 1B: Marang	North	2012
Medupi-Ngwedi (Mogwase) 1st 400-kV line	Medupi integration (Charlie) Phase 2A: Mogwase	North	2014
Ngwedi (Mogwase) 400-kV loop in (Matimba-Midas 1st 400 kV)	Medupi integration (Charlie) Phase 2A: Mogwase	North	2014
Ngwedi (Mogwase) 400/132-kV substation (2 x 500 MVA transformers)	Medupi integration (Charlie) Phase 2A: Mogwase	North	2014
Medupi-Ngwedi (Mogwase) 1st 765-kV line (energised at 400 kV)	Medupi integration (Charlie) Phase 2A: Mogwase	North	2016
Burotho (Mokopane) 400-kV loop-in (Matimba-Witkop 1st 400-kV line)	Medupi integration (Charlie) Phase 2B: Mokopane	North	2014
Burotho(Mokopane) 400/132-kV substation (2 x 500 MVA transformers)	Medupi integration (Charlie) Phase 2B: Mokopane	North	2014
Medupi-Burotho(Mokopane) 1st 400-kV line	Medupi integration (Charlie) Phase 2B: Mokopane	North	2014
Burotho(Mokopane)-Witkop 2nd 400-kV line	Medupi integration (Mmamabula) Phase 3C: Mokopane	North	2014

Sub-project Name	TDP Scheme Project	Grid	New expected year
Nzhelele-Tabor 1st 400-kV line	Nzhelele 400-kV reinforcement	North	2017
Nzhelele 400/132-kV substation (1st & 2nd 250 MVA)	Nzhelele 400-kV reinforcement	North	2017
Burotho (Mokopane)-Nzhelele 1st 400-kV line	Nzhelele 400-kV reinforcement	North	2017
Pelly 2nd 20MVA 132/22-kV transformer	Pelly 132/22-kV transformation upgrade	North	2014
Bighorn 2nd 800 MVA 400/275-kV transformer	Rustenburg transformation reinforcement	North	2012
Tabor Ext 1st 500 MVA 400/132-kV transformer	Tabor and Spencer reinforcement – Phase 2	North	2012
Tabor-Witkop 1st 400kV line	Tabor and Spencer Reinforcement – Phase 2	North	2012
Trident 3rd 315 MVA 275/88-kV transformer	Trident 275/88-kV transformation upgrade	North	2014

Changes compared to the 2010 TDP:

The following projects linked to Coal 3 have been deferred:

- Medupi-Delta 2nd 400-kV line (link to Mmamabula-Delta 1st 400-kV line)
- Medupi-Delta 1st 400-kV line (link to Delta-Epsilon 1st 400-kV line)
- Delta 400-kV switching station (future 765-kV transformation)
- Mmamabula-Delta 1st 400-kV line (link to Medupi-Delta 2nd 400-kV line)
- Mmamabula-Delta 2nd 400-kV line (link to Delta-Epsilon 2nd 765kV line @ 400 kV)
- Delta-Epsilon 1st 765-kV line (energised @ 400 kV) (link to Medupi-Delta 1st 400-kV line)
- Mmamabula-Delta 3rd 400-kV line (link to Delta-Witkop 1st 400-kV line)
- Delta-Epsilon 2nd 765-kV line (energised @ 400 kV) (link to Mmamabula-Delta 2nd 400-kV line)
- Delta Ext 765/400-kV transformation (1st and 2nd 2 000 MVA transformers)
- Delta-Epsilon 1st 765-kV line (energised @ 765 kV)
- Delta-Epsilon 2nd 765-kV line (energised @ 765 kV)
- Coal 3-Delta 1st 400-kV line
- Coal 3-Delta 2nd 400-kV line
- Coal 3-Delta 3rd 400-kV line
- Coal 3-HVDC Terminal A 1st 400-kV line
- Delta-HVDC Terminal A 1st 400-kV line
- Delta-HVDC Terminal A 2nd 400-kV line
- HVDC Terminal A (Lephalale)
- HVDC 800-kV line 1 (Lephalale-Jupiter B)
- Coal 3-HVDC Terminal A 2nd 400-kV line
- Coal 3-HVDC Terminal A 3rd 400-kV line
- HVDC 800-kV line 2 (Lephalale-Durban)

The following new projects are recommended:

- Trident 3rd 315 MVA 275/88-kV transformer
- Pelly 2nd 20 MVA 132/22-kV transformer
- Dinaledi 3rd 500 MVA 400/132-kV transformer
- Borutho-Nzhelele 400-kV line instead of the Medupi-Nzhelele 400-kV line

A network diagram of the major projects in the North Grid is shown in Figure 6.6 below.

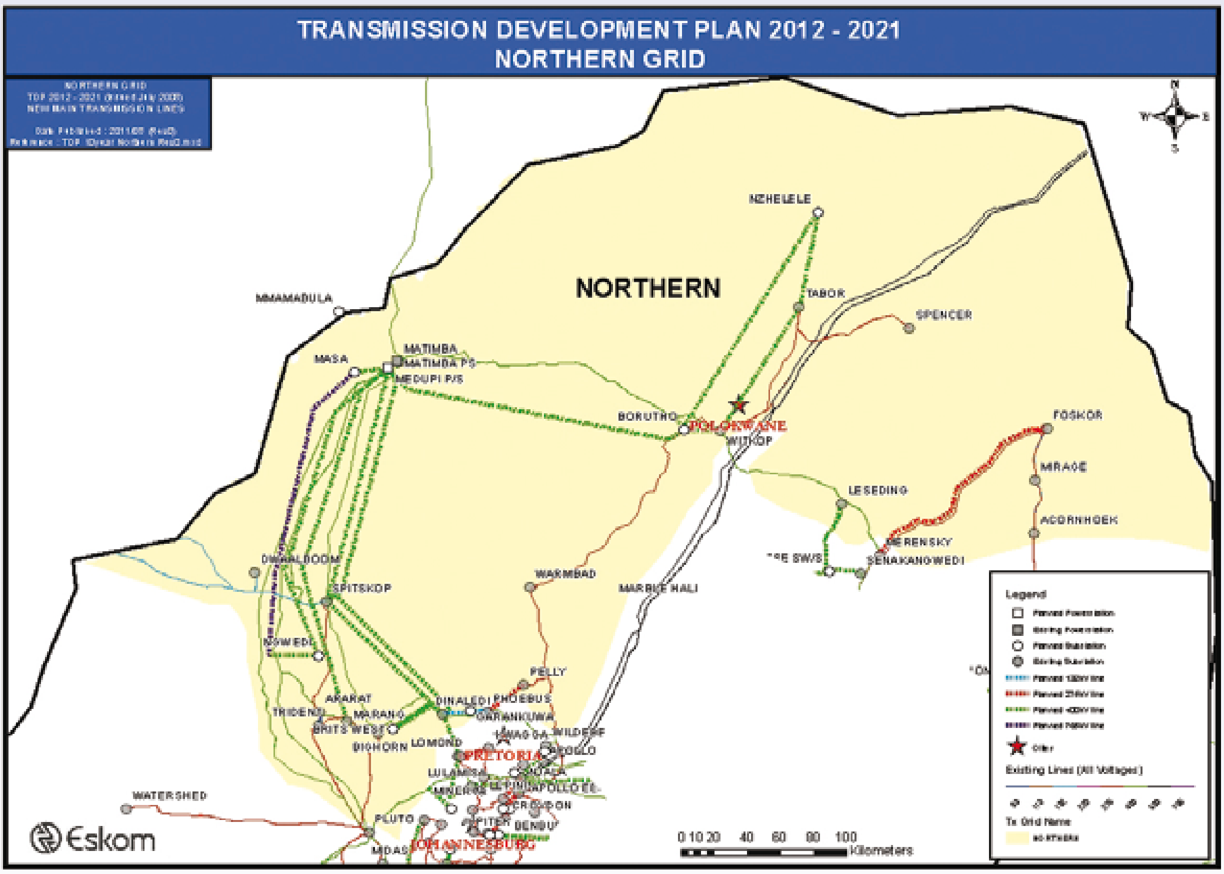


Figure 6.6: North Grid geographical network diagram

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.

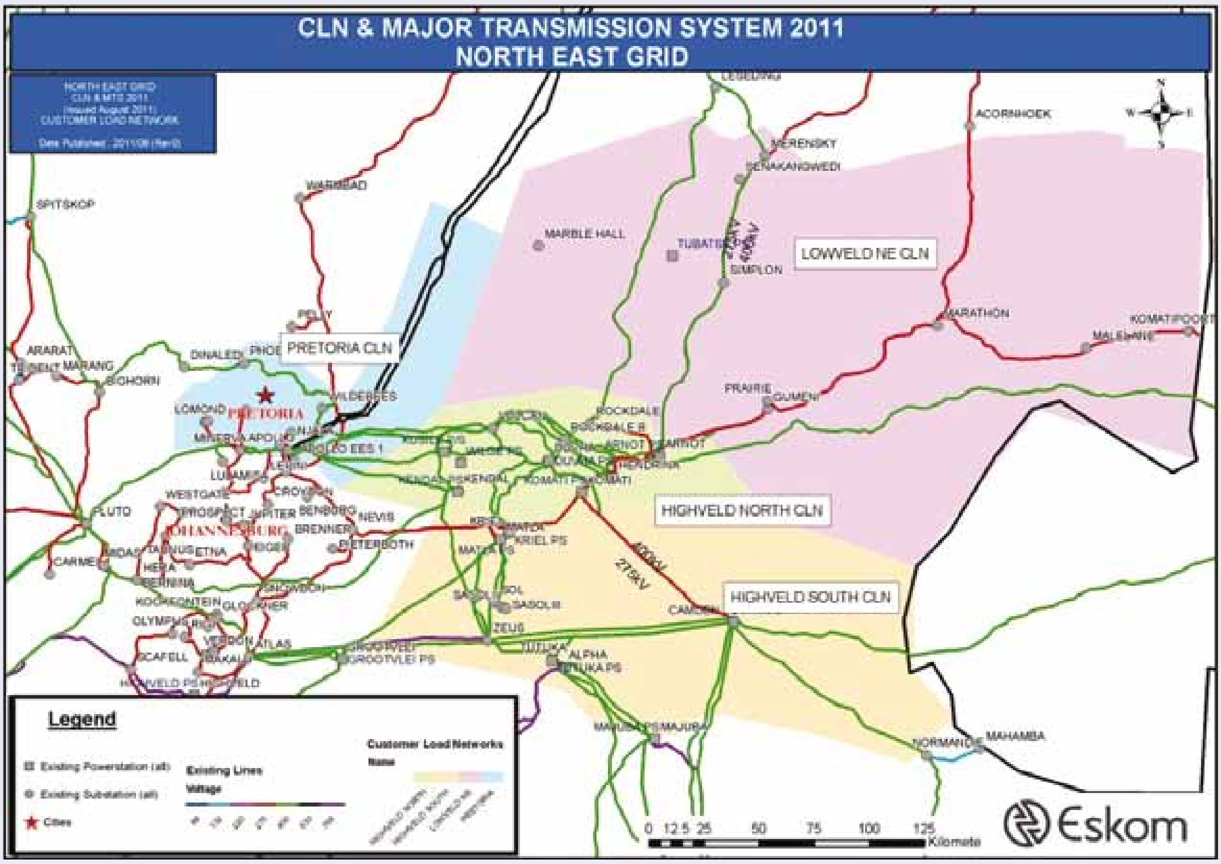


Figure 6.7: Current North East Grid network and CLNs

The expected peak CLN demands by 2021 at TOSP and the average percentage load increase for the period for each CLN are given in Table 6.7 below.

CLN	Forecast load (MW)			Ave. annual % load increase
	2012	2017	2021	
Highveld North	2 347	2 680	3 270	4%
Highveld South	1 127	2 032	2 062	7%
Lowveld	1 708	2 698	2 931	6%
Pretoria	2 254	2 544	2 938	4%

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

The TDP schemes for the North East Grid consist of extending the 400-kV network, the integration of the Kusile Power Station and the installation of additional transformers at existing and any new substations added. The increase in transmission assets by the end of 2016 and the end of 2021 and the cumulative total are shown in Table 6.8.

Transmission assets for North-East Grid	New assets expected in 2012 - 2016	New assets expected in 2017 - 2021	Total new assets expected
Total kms of line	864	90	954
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	0 768 96	0 90 0	0 858 96
Total installed Transformer MVA	8 850	5 365	14 215
Transformers (no. of)	21	8	29
Capacitors (no. of)	3	0	3
Reactors (no. of)	0	0	0

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

The following projects are planned for the 2012 to 2021 period:

Sub-project Name	TDP Scheme Project	Grid	New expected year
Alpha Ext 4th 765/400-kV 2 000-MVA transformer	Alpha Ext 4th 765/400-kV transformer	N-East	2018
Terminal equipment replacement (Apollo-Kendal, Duvha-Minerva, Minerva-Vulcan, Prairie-Marathon1 & 2)	Highveld North terminal equipment upgrade	N-East	2012
Rockdale 132-kV breakers upgrading	Highveld North-West and Lowveld North reinforcement – Phase 1	N-East	2013
Arnot-Kendal 400-kV line loop in-out Rockdale B	Highveld North-West and Lowveld North reinforcement – Phase 1	N-East	2013
Rockdale B 400/132-kV substation (1st & 2nd 500 MVA 400/132-kV transformers)	Highveld North-West and Lowveld North reinforcement – Phase 1	N-East	2013
Marble Hall-Rockdale B 1st 400-kV line	Highveld North-West and Lowveld North reinforcement – Phase 2	N-East	2014

Sub-project Name	TDP Scheme Project	Grid	New expected year
Marble Hall-Tubatse (Steelpoort) 1st 400-kV line	Highveld North-West and Lowveld North reinforcement – Phase 2	N-East	2014
Marble Hall 400/132-kV substation (1st & 2nd 500 MVA 400/132-kV transformers)	Highveld North-West and Lowveld North reinforcement – Phase 2	N-East	2014
Tubatse 400-kV loop-in (Duvha-Leseding 1st 400-kV line)	Highveld North-West and Lowveld North reinforcement – Phase 2	N-East	2014
Tubatse 400-kV switching station	Highveld North-West and Lowveld North reinforcement – Phase 2	N-East	2014
Rockdale B 400/132-kV substation extension (3rd 500 MVA 400/132-kV transformer)	Highveld North-West and Lowveld North reinforcement – Phase 3	N-East	2017
Rockdale B 400/132-kV substation extension (4th 500 MVA 400/132-kV transformer)	Highveld North-West and Lowveld North reinforcement – Phase 4	N-East	2021
Sol B 400-kV loop in (Kriel-Tutuka 1st 400-kV line)	Highveld South reinforcement	N-East	2014
New Sol B 400/132-kV substation (1st, 2nd, 3rd and 4th 500 MVA transformers)	Highveld South reinforcement	N-East	2014
Sol B turn in (Kriel-Zeus 1st 400 kV to form new Kriel-Sol B 2nd 400-kV line)	Highveld South reinforcement	N-East	2014
Kruispunt 275-kV loop-in (Komati-Matla 1st 275-kV line)	Kruispunt reinforcement	N-East	2013
Kusile 400-kV loop-in (Duvha-Minerva 1st 400-kV line)	Kusile integration – Phase 1: 400-kV loop-ins	N-East	2012
Kusile 400-kV busbar HV yard establishment (integration of P/S gens)	Kusile integration – Phase 1: 400-kV loop-ins	N-East	2012
Vulcan 400-kV bypass and reconfiguration (loop in Duvha-Kendal 1st 400-kV line and loop out Arnot-Vulcan 1st 400-kV lines to form Duvha-Vulcan 2nd 400 kV and Arnot-Kendal 1st 400 kV)	Kusile integration – Phase 1: 400-kV loop-ins	N-East	2012
Kusile-Lulamisa 1st 400-kV line	Kusile integration – Phase 2: Lulamisa	N-East	2014
Kusile 400 kV by-pass Duvha	Kusile integration – Phase 3A: 400-kV Duvha by-pass	N-East	2013
Kusile 400-kV loop-in (Apollo-Kendal 1st 400-kV line)	Kusile integration – Phase 3B: 400-kV loop-in	N-East	2013

Sub-project Name	TDP Scheme Project	Grid	New expected year
Kusile 400-kV by-pass Kendal (Kendal by-pass required to form the Kusile-Zeus 400-kV line from the Kusile-Kendal and Kendal-Zeus lines)	Kusile integration – Phase 4A: 400-kV Kendal by-pass	N-East	2014
Kendal-Zeus 1st 400-kV line	Kusile integration – Phase 4B: Zeus	N-East	2013
Kusile-Zeus 1st 400-kV line (Construct Kendal-Zeus portion then by-pass Kendal to form the Kusile-Zeus 400-kV line – linked with Kusile 400-kV by-pass Kendal)	Kusile integration – Phase 4B: Zeus	N-East	2014
Lomond 3rd 275/88=kV transformer (1 X 315 MVA)	Lomond MTS transformation upgrade	N-East	2018
Hendrina-Gumeni 1st 400-kV line	Lowveld 400-kV strengthening – Phase 1: Gumeni	N-East	2012
Gumeni 400/132-kV substation (1st 500 MVA 400/132-kV transformer)	Lowveld 400 kV Strengthening – Phase 1: Gumeni	N-East	2012
Gumeni-Marathon 1st 400-kV line	Lowveld 400 kV Strengthening – Phase 2: Marathon B	N-East	2014
Marathon 400/275kV substation (1st 800 MVA 400/275-kV transformer)	Lowveld 400 kV strengthening – Phase 2: Marathon B	N-East	2014
Gumeni Ext 2nd 500 MVA 400/132-kV transformer	Lowveld 400 kV strengthening – Phase 3a	N-East	2016
Arnot-Gumeni 1st 400-kV line (recycle one of the Arnot-Prairie 275-kV lines)	Lowveld 400 kV strengthening – Phase 3a	N-East	2016
Gumeni-Marathon 2nd 400-kV line (recycle one of the 275-kV servitudes)	Lowveld 400 kV strengthening – Phase 3b	N-East	2019
Marathon B Ext 2nd 800 MVA 400/275-kV transformer	Lowveld 400 kV strengthening – Phase 3b	N-East	2019
Malelane 275-kV loop-in (Marathon-Komatipoort 1st 275-kV line)	Lowveld transformation capacity enhancement	N-East	2012
Malelane 275/132-kV substation (1st 250 MVA 275/132-kV transformer)	Lowveld transformation capacity enhancement	N-East	2012
Malelane-Marathon 400-kV line (operated as 2nd 275-kV line)	Malelane 275 kV reinforcement – Phase 2	N-East	2016
Malelane Ext 2nd 250 MVA 275/132-kV transformer	Malelane 275 kV reinforcement – Phase 2	N-East	2016

Sub-project Name	TDP Scheme Project	Grid	New expected year
Malelane 132 kV, 72-MVar Capacitor bank	Malelane 275 kV reinforcement – Phase 2	N-East	2016
Phoebus 400/275/132-kV substation (1st & 2nd 400 MVA 400/275-kV transformer)	Tshwane reinforcement – Phoebus Phase 1	N-East	2016
Phoebus Ext 400/132-kV transformation (1st 250 MVA 400/132-kV transformer)	Tshwane reinforcement – Phoebus Phase 1	N-East	2016
Pelly-Phoebus 1st 275-kV line (energise Hangklip-Pelly 132-kV line)	Tshwane reinforcement – Phoebus Phase 1	N-East	2016
Phoebus 400-kV loop-in (Apollo-Dinaledi 1st 400-kV line)	Tshwane reinforcement – Phoebus Phase 1	N-East	2016
Phoebus-Mabopane-Garankuwa 132-kV line upgrading	Tshwane reinforcement – Phoebus Phase 2	N-East	2016
Dinaledi-Phoebus 1st 132-kV line (twin Kingbird)	Tshwane reinforcement – Phoebus Phase 3	N-East	2016
Apollo-Pluto 400-kV loop in-out Verwoerdburg	Tshwane reinforcement – Verwoerdburg Phase 1	N-East	2013
Verwoerdburg 400/132-kV substation (1st & 2nd 250 MVA transformers)	Tshwane reinforcement – Verwoerdburg Phase 1	N-East	2013
Phoebus-Kwagga 1st 275-kV line	Tshwane reinforcement – Verwoerdburg Phase 2	N-East	2016
Dinaledi-Anderson 1st 400-kV line	Tshwane reinforcement – Verwoerdburg Phase 2	N-East	2016
Anderson 400/132-kV substation (1st & 2nd 250-MVA transformers)	Tshwane reinforcement – Verwoerdburg Phase 2	N-East	2016
Verwoerdburg 400/132-kV substation (3rd 250-MVA transformer)	Tshwane reinforcement – Verwoerdburg Phase 2	N-East	2017
Wildebees 400/132-kV substation (Customer 250 MVA transformers)	Tshwane reinforcement – Wildebees Phase 1	N-East	2014
Wildebees 400-kV loop in-out (Apollo-Dinaledi 1st 400 kV)	Tshwane reinforcement – Wildebees Phase 1	N-East	2014
Tubatse-Senakangwedi 1st 400-kV line	Tubatse strengthening scheme – Phase 1	N-East	2016
Arnot-Merensky 400-kV loop-in to Senakangwedi	Tubatse strengthening scheme – Phase 1	N-East	2016
Senakangwedi 400/275 kV (1 X 800 MVA)	Tubatse strengthening scheme – Phase 1	N-East	2016
Senakangwedi 400/132-kV substation (2 X 500 MVA)	Tubatse strengthening scheme – Phase 2	N-East	2020
Senakangwedi Ext 275-kV shunt cap	Xstrata Phase 2 customer project – Transmission reinforcement	N-East	2012

Changes compared to the 2010 TDP:

Tshwane Reinforcement Phases 1 and 2 have been taken as cancelled for the 2012 – 2021 TDP due to the change in key assumptions (load forecast and Tshwane's network development plans).

The Marble Hall Mokopane 400-kV line has been cancelled for the 2012 – 2021 TDP for the following reason:

- The planned Marble Hall MTS integration plans would be able to support the forecast load at Marble Hall without the Marble Hall-Mokopane 400-kV line, according to the latest network optimisation study.

The Marble Hall-Mokopane 400-kV line may be required if the planned future coal-fired power stations, Coal 3 and Coal 4, go ahead in the Northern Grid.

The following new projects are recommended:

- Malelane 132-kV, 72-MVar capacitor bank
- Arnot-Merensky 400-kV loop-in to Senakangwedi
- Senakangwedi 400/275-kV (1 X 800 MVA)
- Senakangwedi 400/132-kV substation (2 X 500 MVA)
- Rockdale B 400/132-kV substation extension (3rd 500 MVA 400/132-kV transformer)
- Rockdale B 400/132-kV substation extension (4th 500 MVA 400/132-kV transformer)
- Lomond 3rd 275/88-kV transformer (1 X 315 MVA)
- Terminal equipment replacement (Apollo-Kendal, Duvha-Minerva, Minerva-Vulcan, Prairie-Marathon1 & 2)

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

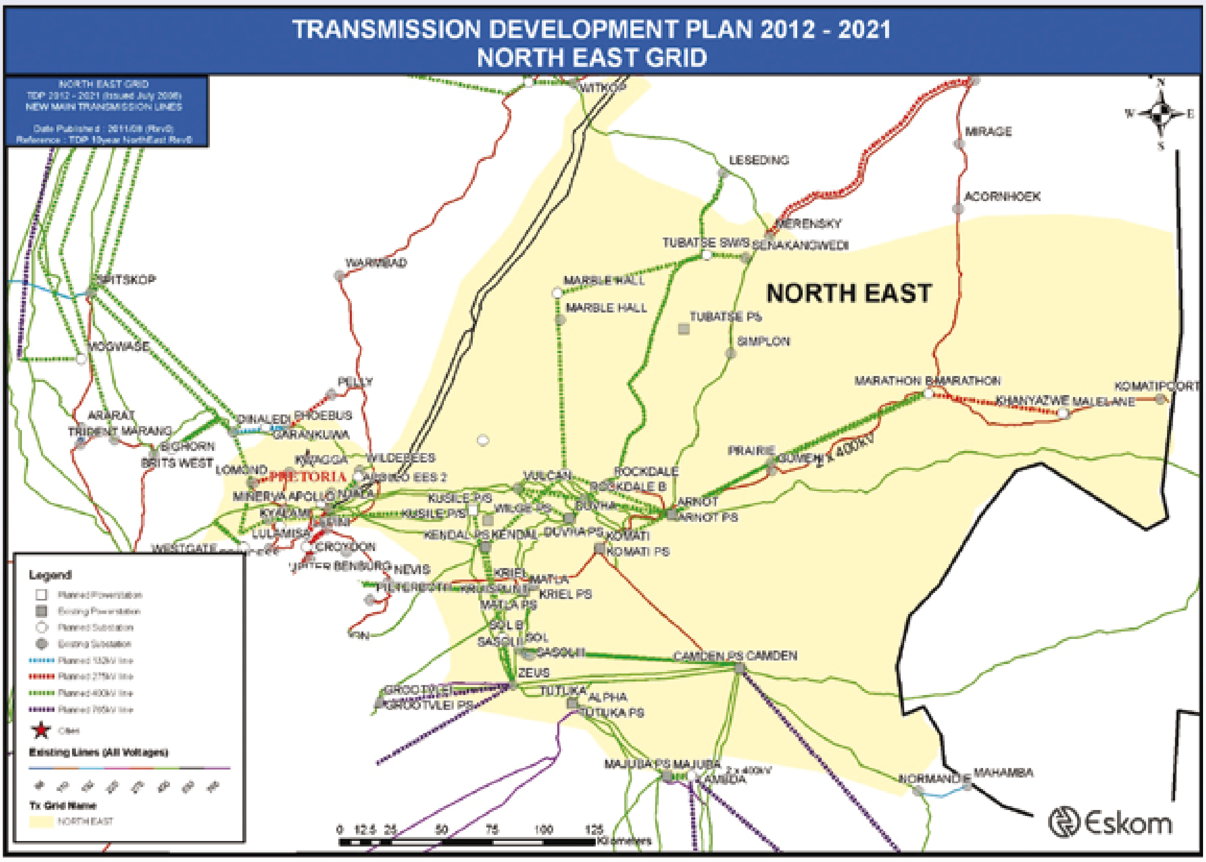


Figure 6.8: North-East Grid network diagram

6.5 NORTH WEST GRID

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

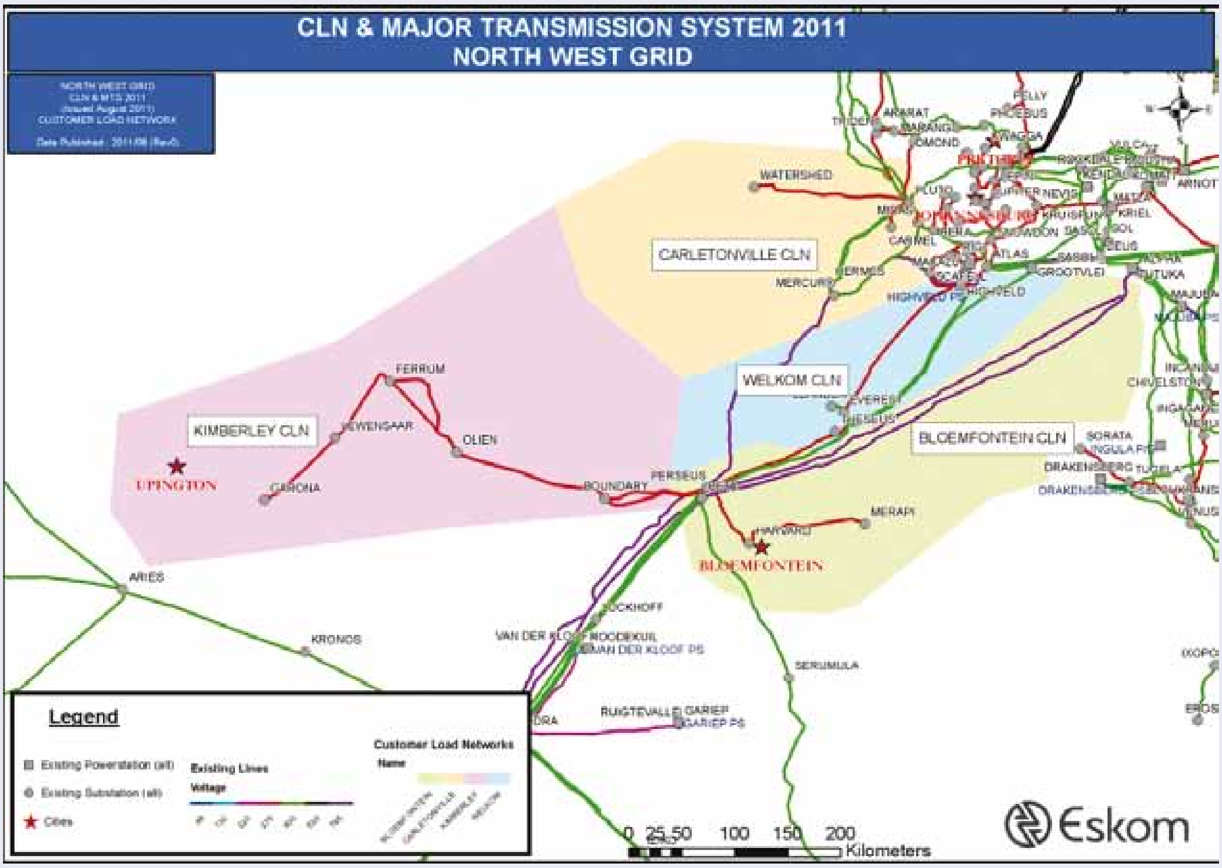


Figure 6.9: Current North West Grid network and CLNs

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

CLN	Forecast load (MW)			Ave. annual % load increase
	2012	2017	2021	
Bloemfontein	471	519	554	2%
Carletonville	1580	1558	1574	0.05%
Kimberley	547	1 084	1 242	9%
Welkom	887	911	929	0,5%

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

The North West Grid includes the 765 kV integration required for the Cape Corridor and 400 kV integration to enable load growth in the local areas. It also includes a plan to integrate 1 100 MW of solar generation in the Upington area.

The increase in transmission assets by the end of 2016 and the end of 2021 and the cumulative total are shown in Table 6.10.

Transmission assets for North West Grid	New assets expected in 2012 - 2016	New assets expected in 2017 - 2021	Total new assets expected
Total kms of line	2 370	875	3 245
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	970 1 290 110	870 5 0	1 840 1 295 110
Total installed Transformer MVA	7 080	1 000	8 080
Transformers (no. of)	16	2	18
Capacitors (no. of)	6	1	7
Reactors (no. of)	10	4	14

Table 6.10: Cumulative assets for North West Grid

The following projects are planned for the 2012 to 2021 period:

Sub-project Name	TDP Scheme Project	Grid	New expected year
Everest-Merapi 275-kV line	Bloemfontein strengthening	N-West	2016
Merapi Ext 3rd 250 MVA 275/132-kV transformer	Bloemfontein strengthening	N-West	2016
Mercury-Perseus 1st 765 kV (operate @ 400 kV)	Cape Corridor Phase 2: Zeus-Hydra 765-kV integration	N-West	2013
Beta-Perseus 1st 765-kV line	Cape Corridor Phase 2: Zeus-Hydra 765-kV integration	N-West	2013

Sub-project Name	TDP Scheme Project	Grid	New expected year
Gamma-Perseus 1st 765-kV line	Cape Corridor Phase 2: Zeus Hydra 765-kV Integration	N-West	2013
Zeus-Mercury 1st 765-kV line (to form Zeus-Perseus 1st 765-kV) (by-pass Mercury)	Cape Corridor Phase 2: Zeus-Hydra 765-kV integration	N-West	2013
Perseus Ext 765/400-kV transformation	Cape Corridor Phase 2: Zeus-Hydra 765-kV integration	N-West	2013
Relocate Beta-Hydra 765-kV line to form Perseus-Hydra 1st 765-kV line	Cape Corridor Phase 2: Zeus-Hydra 765-kV integration	N-West	2013
Series compensation on Alpha-Beta 1st and 2nd 765-kV lines	Cape Corridor Phase 3: 765-kV series capacitors (NOH)	N-West	2013
Series compensation on Mercury-Perseus 1st 765-kV line	Cape Corridor Phase 3: 765-kV series capacitors (NOH)	N-West	2013
Series compensation on Zeus-Mercury 1st 765-kV line	Cape Corridor Phase 3: 765-kV series capacitors (NOH)	N-West	2013
Series compensation on Zeus-Perseus 1st 765-kV line	Cape Corridor Phase 4: 2nd Zeus-Perseus-Gamma-Omega 765-kV line	N-West	2020
Gamma-Perseus 2nd 765-kV line	Cape Corridor Phase 4: 2nd Zeus-Perseus-Gamma-Omega 765-kV line	N-West	2020
Zeus-Perseus 2nd 765-kV line (most direct line)	Cape Corridor Phase 4: 2nd Zeus-Perseus-Gamma-Omega 765-kV line	N-West	2020
Kronos 400/132-kV transformation	Garona strengthening	N-West	2014
Kronos-Cuprum 1st & 2nd 132 kV	Garona strengthening	N-West	2014
Ferrum-Mookodi (Vryburg) 1st 400-kV line	Kimberley 400-kV strengthening – Phase 2	N-West	2013
Ferrum Ext 1st & 2nd 500 MVA 400/132-kV transformers	Kimberley 400-kV strengthening – Phase 2	N-West	2013
Mercury-Mookodi (Vryburg) 1st 400-kV line	Kimberley 400-kV strengthening – Phase 2	N-West	2013
Mookodi (Vryburg) 400/132-kV substation (1st and 2nd 250 MVA 400/132-kV transformers)	Kimberley 400-kV strengthening – Phase 2	N-West	2013
Hermes-Mookodi (Vryburg) 1st 400-kV line	Kimberley strengthening – Phase 3	N-West	2016
Ferrum-Mookodi (Vryburg) 2nd 400-kV line (via Hotazel)	Kimberley strengthening – Phase 3	N-West	2016

Sub-project Name	TDP Scheme Project	Grid	New expected year
Hotazel 400-kV loop-in (Ferrum-Mookodi (Vryburg) 2nd 400-kV line)	Kimberley strengthening – Phase 3	N-West	2019
Hotazel 400/132-kV substation (1st and 2nd 2 500 MVA 400/132-kV transformers)	Kimberley strengthening – Phase 3	N-West	2019
Hotazel Ext 132 kV 1st 36 MVAr capacitor	Kimberley strengthening – Phase 3	N-West	2020
Theseus Ext 400 kV 1st 100 MVAr reactor	Kimberley strengthening – Phase 3	N-West	2019
Phase 1: Sishen-Saldanha Spoornet new traction stations (1 x 275/50-kV substation with 2 x 40 MVA transformers)	Sishen-Saldanha full solution (supply for new Spoornet Traction)	N-West	2012
Garona Ext 275-kV SVC	Sishen-Saldanha full solution (supply for new Spoornet Traction)	N-West	2012
Watershed 275/132-kV substation 250 MVA 275/132-kV transformers	Watershed strengthening	N-West	2014
Aries-Upington 1st & 2nd 400-kV lines	Upington strengthening – Phase 1	N-West	2016
Ferrum-Upington 1st 400-kV line	Upington strengthening – Phase 1	N-West	2016
Nieuwehoop-Upington 1st 400-kV line	Upington strengthening – Phase 1	N-West	2016
Upington 5x 500MVA 400/132-kV transformation	Upington strengthening – Phase 1	N-West	2016
Watershed MTS 132-kV reactive power compensation	Watershed strengthening	N-West	2014
Watershed MTS 88-kV reactive power compensation	Watershed strengthening	N-West	2014

Changes compared to the 2010 TDP:

The following projects have been deferred:

- Perseus-KDS 400-kV line
- KDS 400/132-kV transformation
- Garona132-kV reactive power compensation
- Gamma-Perseus 3rd 765-kV line
- Epsilon-Perseus 1st 765-kV line
- KDS-Olien 400-kV line
- Olien 1st 250 MVA 400/132-kV transformation
- Garona Ext 1st 125 MVA 400/132-kV transformer

The following new projects are recommended:

- Hortazel Ext 132 kV 1st 36 MVAr capacitor
- Aries-Upington 1st & 2nd 400-kV lines
- Ferrum-Upington 1st 400-kV line
- Nieuwehoop-Upington 1st 400-kV line
- Upington 5 x 500 MVA 400/132-kV transformation
- Theseus Ext 400 kV 1st 100 MVAr reactor

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

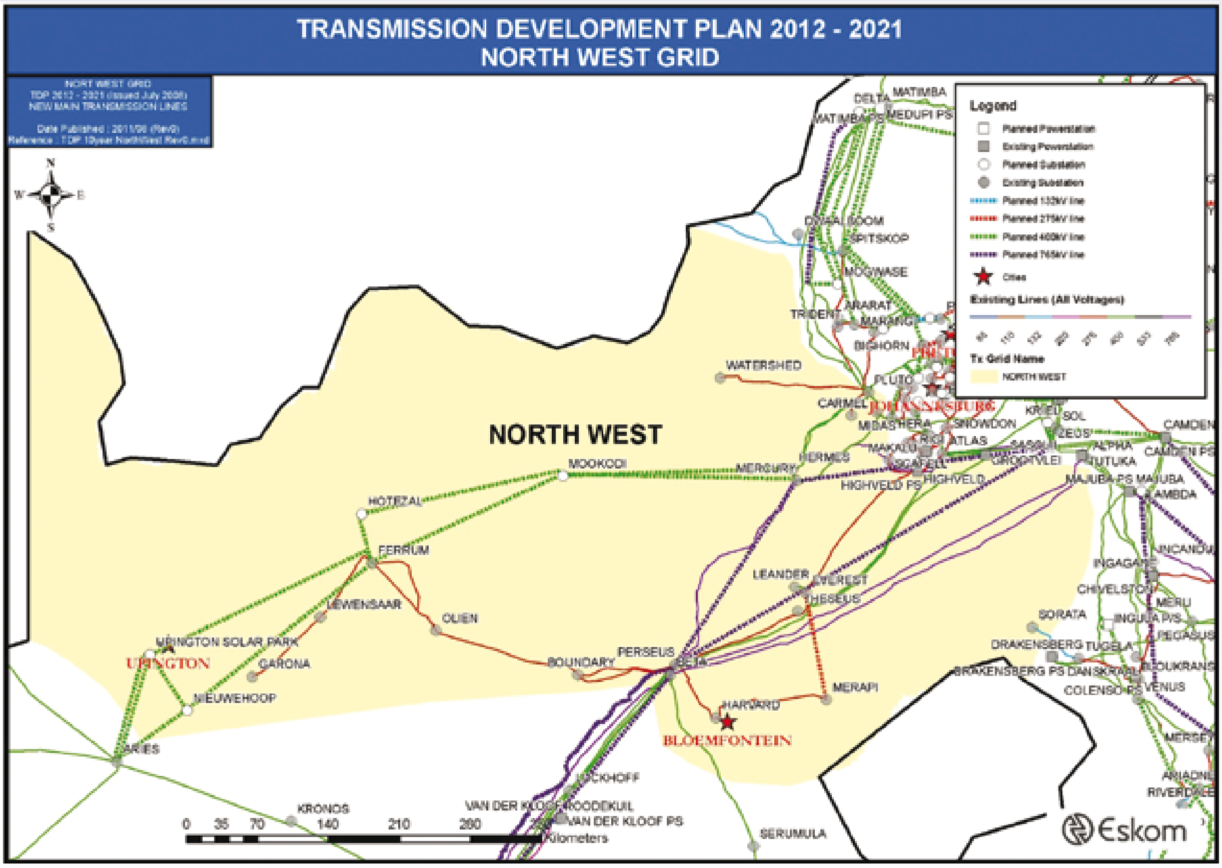


Table 6.10: North West Grid geographical network diagram

6.6 SOUTH GRID

The South Grid consists of the area to the south-eastern side of the Hydra substation, which area predominantly falls inside the boundary of the Eastern Cape Province. 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.

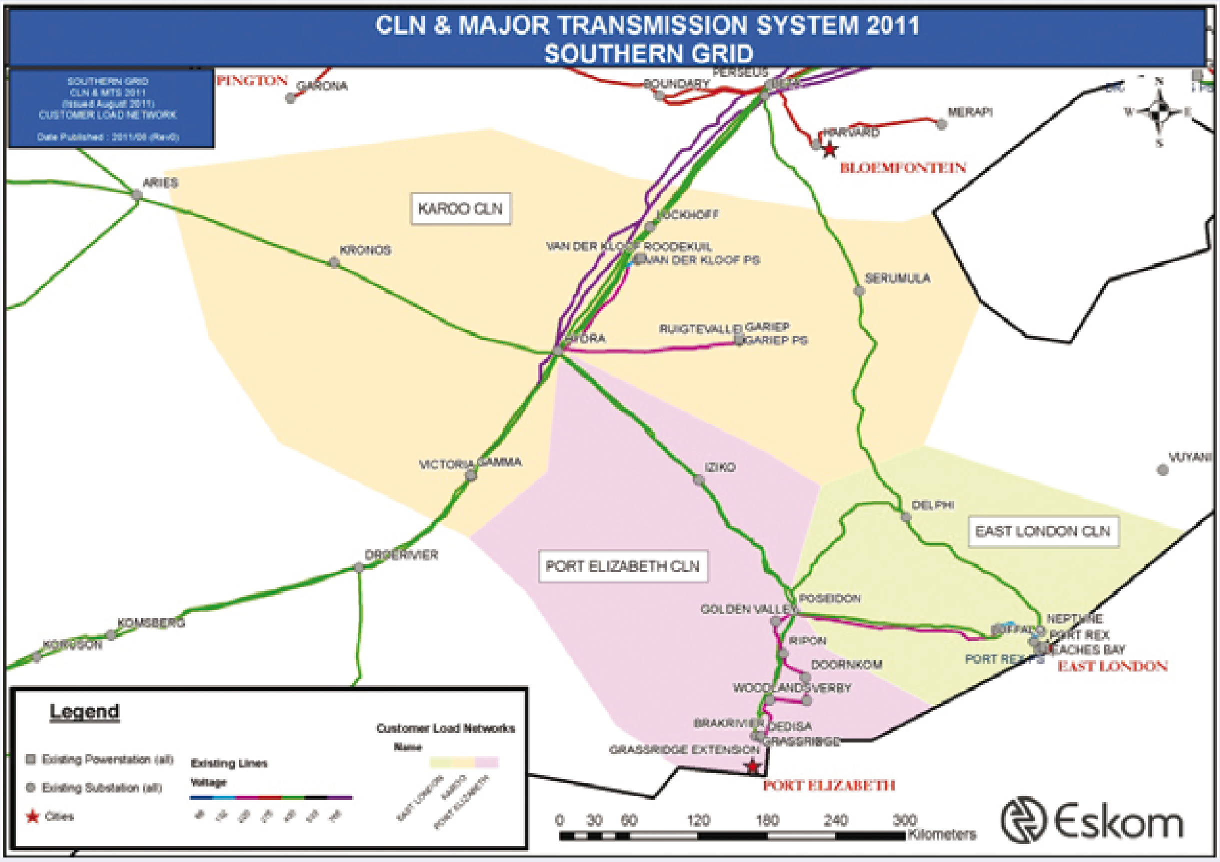


Figure 6.11: Current South Grid network and CLNs

The expected peak demands by 2021 as well as the average percentage load increase for the period, for each CLN, are given in Table 6.11 below.

CLN	Forecast load (MW)			Ave. annual % load increase
	2012	2017	2021	
Karoo	260	300	308	2%
East London	620	742	852	5%
Port Elizabeth	977	1 533	1 916	8%

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

The TDP schemes for the South Grid consist of the integration of the DME OCGT power station at Dedisa, the reinforcement of the greater Port Elizabeth metro area including the Coega IDZ, and the Greater East London strengthening scheme, which includes the integration of the Vuyani 400/132-kV substation at Mthatha to supply the central and southern Transkei area. If the first Nuclear 1 unit materialises at Thuyspunt in 2022, three additional 400-kV lines would be required to link it to Grassridge and Dedisa via the new Port Elizabeth 400/132-kV substation. The integration for Thuyspunt has been excluded from this TDP as it falls outside the planning period. The increase in transmission assets by the end of 2016 and the end of 2021 as well as the cumulative total are shown in Table 6.12.

Transmission assets for Southern Grid	New assets expected in 2012 - 2016	New assets expected in 2017 - 2021	Total new assets expected
Total kms of line	931	760	1 691
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	560 371 0	760 0 0	1 320 371 0
Total installed Transformer MVA	1 295	6 500	7 795
Transformers (no. of)	9	8	17
Capacitors (no. of)	4	0	4
Reactors (no. of)	4	5	9

Table 6.12: Cumulative assets for the South Grid

Sub-project Name	TDP Scheme Project	Grid	New expected year
Gamma Ext 765-kV busbar establishment	Cape Corridor Phase 2: Gamma-Omega 765-kV integration	South	2013
Gamma-Kappa 1st 765-kV line	Cape Corridor Phase 2: Gamma-Omega 765-kV integration	South	2013
Gamma Ext 2nd 400 MVar 765-kV busbar reactor	Cape Corridor Phase 2: Kappa 765-kV integration	South	2013
Hydra-Gamma 1st 765-kV line	Cape Corridor Phase 3: 765-kV series capacitors (NOH)	South	2013
Gamma-Kappa 2nd 765-kV line	Cape Corridor Phase 4: 2nd Zeus-Perseus-Gamma-Omega 765-kV line	South	2020
Delphi 3rd 120 MVA 400/132-kV transformer	Delphi 3rd 120 MVA 400/132-kV transformer	South	2014
Ruigevallei-Hydra derate 220-kV line to 132-kV	Gariep network strengthening	South	2013
Grassridge 132-kV equipment upgrade (fault level requirements)	Grassridge 132-kV equipment upgrade (fault level requirements)	South	2017
Grassridge Ext 3rd 400/132-kV 500 MVA transformer and busbar upgrade	Grassridge-Dedisa strengthening	South	2017
Dedisa Ext 3nd 500 MVA 400/132-kV transformer	Grassridge-Dedisa strengthening	South	2018
Grassridge-Dedisa 1st 132-kV line	Grassridge-Dedisa strengthening	South	2014
Vuyani (Mhatha) 400/132-kV substation (1st and 2nd 250 MVA)	Greater East London strengthening – Phase 1: Eros-Mthatha & SS	South	2012
Neptune-Vuyani 1st 400-kV line	Greater East London strengthening – Phase 2: Neptune-Mthatha & SS	South	2012
Poseidon-Neptune 1st 400-kV line	Greater East London strengthening – Phase 3	South	2015
Pembroke B 400/132-kV substation	Greater East London strengthening – Phase 3	South	2017
Hydra 400 & 132-kV equipment upgrade (fault level requirements)	Hydra 400 & 132-kV equipment upgrade (fault level requirements)	South	2017
Pembroke B loop-in and out Poseidon-Neptune 1st 400kV line		N-East	2016
Delphi Ext 400 kV 1st 100 MVAr capacitor	PE Phase 3: Poseidon, Delphi, Grassridge and Dedisa shunt compensation	South	2015

Sub-project Name	TDP Scheme Project	Grid	New expected year
Grassridge Ext 400 kV 1st 100 MVAr capacitor	PE Phase 3: Poseidon, Delphi, Grassridge and Dedisa shunt compensation	South	2015
Poseidon Ext 400 kV 1st 100 MVAr capacitor	PE Phase 3: Poseidon, Delphi, Grassridge and Dedisa shunt compensation	South	2015
Dedisa Ext 400 kV 1st 100 MVAr capacitor	PE Phase 3: Poseidon, Delphi, Grassridge and Dedisa shunt compensation	South	2015
Pembroke 3rd 90 MVA 220/66-kV transformer (dual ratio 220/132/66 kV)	Pembroke 3rd 90MVA 220/66-kV transformer (dual ratio 220/132/66kV)	South	2014
Gamma Ext 765-kV busbar extension	Southern Grid – Phase 3: 1st Gamma Grassridge 765-kV line	South	2017
Gamma-Grassridge 1st 765kV line	Southern Grid – Phase 3 : 1st Gamma Grassridge 765-kV line	South	2017
Grassridge Ext 765/400kV transformation	Southern Grid – Phase 3: 1st Gamma Grassridge 765-kV line	South	2017
Buffalo, Pembroke, Roodekuil and Ruigtevallei transformer LV supply normalisation	Southern Grid – transmission transformer normalisation	South	2014

Changes compared to the 2010 TDP:

The following projects have been deferred:

- Thyspunt-Dedisa 1st 400-kV line
- Thyspunt-Grassridge 1st 400-kV line
- Thyspunt HV yard
- Grassridge-Port Elizabeth 2nd 400-kV line
- Thyspunt-Port Elizabeth 1st 400-kV line
- Thyspunt-Port Elizabeth 2nd 400-kV line

The following new projects are recommended:

- Dedisa Ext 3nd 500 MVA 400/132-kV transformer
- Grassridge-Dedisa 1st 132-kV line
- Ruigevallei-Hydra derate 220-kV line to 132 kV
- Delphi 3rd 120 MVA 400/132-kV transformer
- Pembroke 3rd 90 MVA 220/66-kV transformer (dual ratio 220/132/66 kV)
- Hydra 400 & 132-kV equipment upgrade (fault level requirements)
- Grassridge 132-kV equipment upgrade (fault level requirements)

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

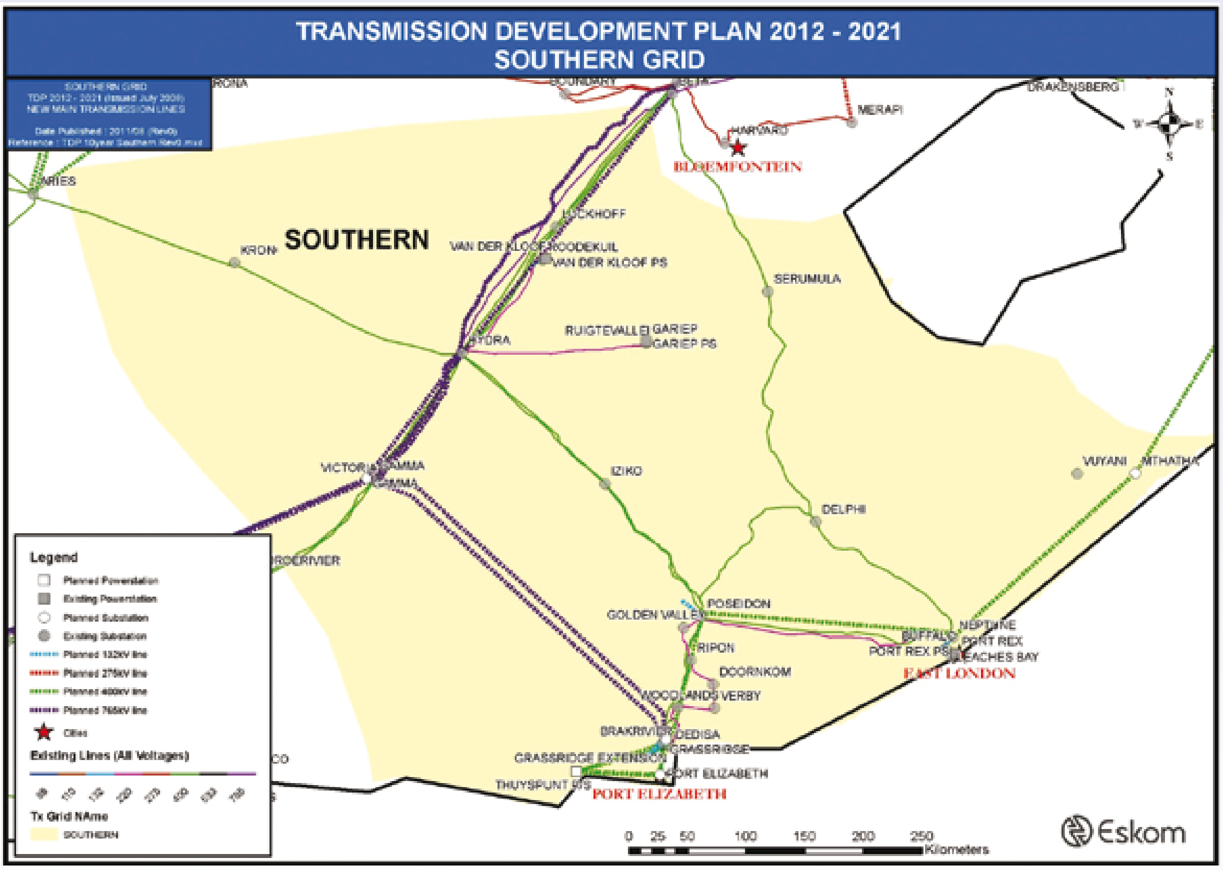


Figure 6.12: The South Grid network diagram

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.

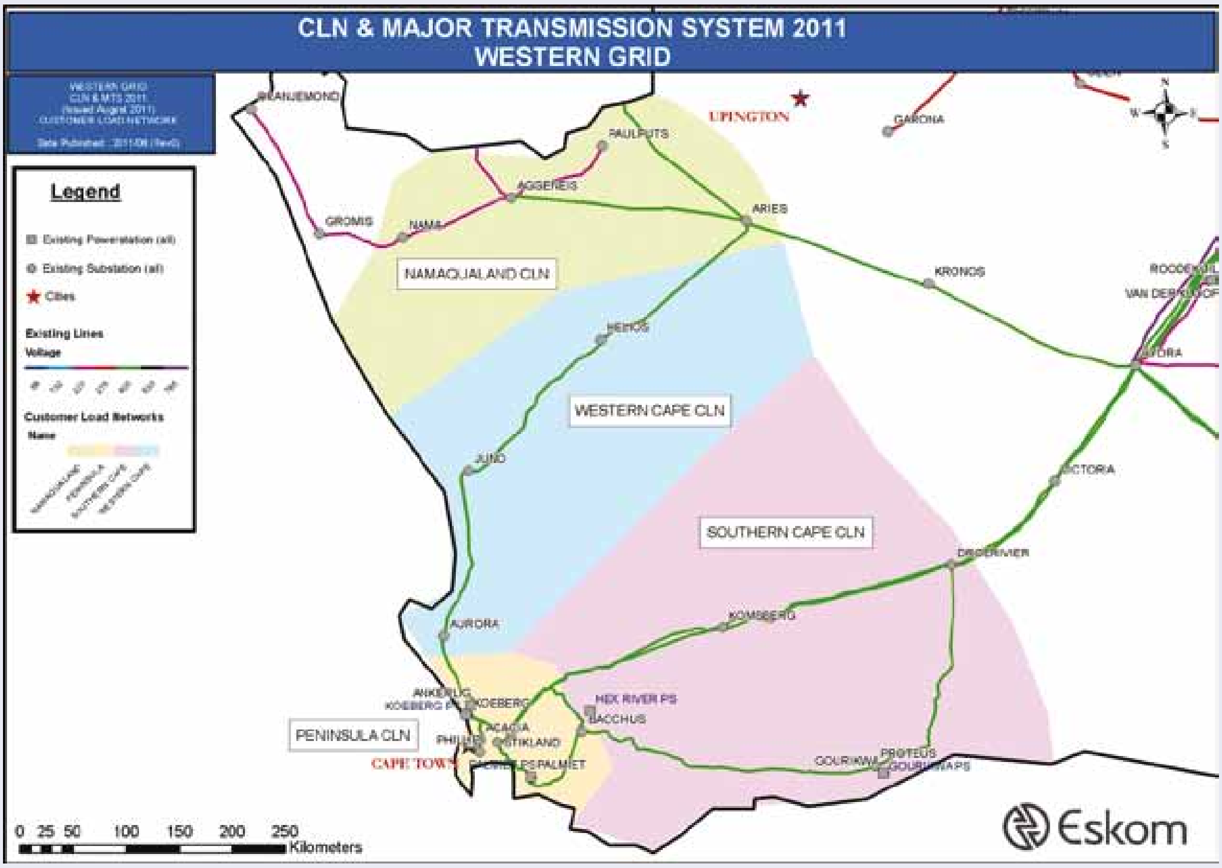


Figure 6.13: Current West Grid network and CLNs

The Western Cape customer base consists of consumers within the borders of South Africa, as well as international customers (NamPower and Skorpion in Namibia). The expected peak demands by 2021 and the average percentage load increase for the period for each CLN are given in Table 6.13 below.

CLN	Forecast load (MW)			Ave. annual % load increase
	2012	2017	2021	
Namaqualand	129	181	197	4%
West Coast	479	526	550	2%
Southern Cape	905	1 008	1 104	2%
Peninsula	2 858	3 474	3 766	4%

Table 6.13: West Grid CLN load forecast and percentage load increases

Included in the TDP studies is the forecast export to Namibia via the 400-kV and 220-kV 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 400-kV network and introducing 765-kV injection at two points, namely Omega and Kappa. There is also the installation of additional transformers at existing and new substations.

The increase in transmission assets by the end of 2016 and the end of 2021 and the cumulative total are shown in Table 6.14.

Transmission assets for Western Grid	New assets expected in 2012 - 2016	New assets expected in 2017 - 2021	Total new assets expected
Total kms of line	838	908	1 746
765kV Lines (km) 400kV Lines (km) 275kV Lines (km)	450 588 100	150 758 0	300 1 346 100
Total installed Transformer MVA	7 820	5 625	13 445
Transformers (no. of)	17	9	26
Capacitors (no. of)	3	0	3
Reactors (no. of)	14	6	20

Table 6.14: Cumulative TDP transmission assets for the West Grid

The following projects are planned for the 2012 to 2021 period:

Sub-project Name	TDP Scheme Project	Grid	New expected year
Blanco 400-kV line loop-in (Proteus-Droerivier 1st 400-kV line)	Blanco Substation Establishment (2 x 500 MVA 400/132-kV TRFRs)	West	2018
Blanco 400/132-kV Substation (1st and 2nd 500 MVA transformers)	Blanco Substation Establishment (2 x 500 MVA 400/132kV TRFRs)	West	2018
Omega 400kV Loop-in (Koeberg-Muldersvlei 400-kV line)	Cape Corridor Phase 2: Gamma-Omega 765-kV integration	West	2014
Kappa-Omega 1st 765-kV line	Cape Corridor Phase 2: Gamma-Omega 765-kV integration	West	2014
Omega 765/400-kV substation	Cape Corridor Phase 2: Gamma-Omega 765-kV integration	West	2014
Kappa 400-kV loop-ins (Droerivier-Bacchus & Droerivier-Muldersvlei 400-kV lines)	Cape Corridor Phase 2: Kappa 765-kV integration	West	2013
Kappa Ext 400-kV 100 MVAr shunt reactor	Cape Corridor Phase 2: Kappa 765-kV integration	West	2013
Kappa 765/400-kV substation	Cape Corridor Phase 2: Kappa 765-kV integration	West	2013
Kappa-Omega 2nd 765-kV line (recycle Bacchus-Muldersvlei and Bacchus-Kappa 400-kV lines)	Cape Corridor Phase 4: 2nd Zeus-Perseus-Gamma-Omega 765-kV line	West	2020
Omega Ext 2nd 2 000 MVA 765/400-kV transformer	Cape Corridor Phase 4: 2nd Zeus-Perseus-Gamma-Omega 765-kV line	West	2020
Droerivier-Proteus 2nd 400-kV line	Droerivier-Proteus 2nd 400-kV line	West	2018
Firgrove 400-kV line loop-in (Palmiet-Stikland 1st 400-kV line)	Firgrove substation Establishment (2 x 500 MVA 400/132-kV TRFRs)	West	2013
Firgrove 400/132-kV substation (1st and 2nd 500 MVA transformers)	Firgrove substation establishment (2 x 500 MVA 400/132-kV TRFRs)	West	2013
Ankerlig 132-kV loop-in Koeberg-Dussenberg 132-kV line	Gas 1 off-site relocation to Ankerlig	West	2013
Houwhoek 400-kV line loop-in (Palmiet-Bacchus 1st 400-kV line)	Houwhoek substation establishment (2 x 500 MVA 400/132-kV TRFRs)	West	2018
Houwhoek 400/132-kV substation (1st and 2nd 500 MVA transformers)	Houwhoek substation establishment (2 x 500 MVA 400/132-kV TRFRs)	West	2018

Sub-project Name	TDP Scheme Project	Grid	New expected year
Mitchells Plain 400/132-kV substation (1st and 2nd 500 MVA transformers)	Mitchells Plain 400-kV substation	West	2016
Firgrove-Mitchells Plain 1st 400-kV line	Mitchells Plain 400-kV substation	West	2016
Firgrove-Mitchells Plain 2nd 400-kV line	Mitchells Plain 400-kV substation	West	2016
Muldersvlei Ext 3rd 500 MVA 400/132-kV transformer & 132-kV series reactors	Muldersvlei Ext 3rd 500 MVA 400/132-kV transformer & 132-kV series reactors	West	2014
Aggeneis-Paulputs 2nd 220-kV line	N Cape reinforcement: Ageneies-Paulputs 2nd 220 kV	West	2016
Aggeneis-Helios 1st 400-kV line	N Cape reinforcement: Aggeneis-Helios 1st 400 kV	West	2016
Aggeneis-Oranjemond 2nd 220-kV line (built at 400 kV)	N Cape reinforcement: Aggeneis-Oranjemond 2nd 220 kV	West	2016
Aries Ext 400 kV 1st SVC	N Cape reinforcement: Aries SVC	West	2016
Ferrum-Garona 1st 400-kV line	N Cape reinforcement: Ferrum-Garona-Nieuwehoop 400 kV	West	2017
Garona-Nieuwehoop 1st 400-kV line	N Cape reinforcement: Ferrum-Garona-Nieuwehoop 400 kV	West	2017
Paulputs Ext 2nd 125 MVA 220/132-kV transformer	Paulputs Ext 2nd 125 MVA 220/132-kV transformer	West	2017
Philippi Ext 3rd 500 MVA 400/132-kV transformer	Philippi Ext 3rd 500 MVA 400/132-kV transformer	West	2014
Aries-Nieuwehoop 1st 400-kV line	Sishen-Saldanha Full Solution (supply for new Spoornet traction)	West	2016
Series compensation of 400-kV lines (reconfiguration of Northern Cape capacitors)	Sishen-Saldanha Full Solution (supply for new Spoornettraction)	West	2016
Sishen-Saldanha Spoornet new traction stations (4 sites with 8 transformers stepping down to 50 kV)	Sishen-Saldanha Full Solution (supply for new Spoornet traction)	West	2016

Changes compared to the 2010 TDP:

The following new projects are recommended:

- Houwhoek 400-kV line loop-in (Palmiet-Bacchus 1st 400-kV line)
- Blanco 400-kV line loop-in (Proteus-Droerivier 1st 400-kV line)
- Houwhoek 400/132-kV substation (1st and 2nd 500 MVA transformers)
- Blanco 400/132-kV substation (1st and 2nd 500 MVA transformers)

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

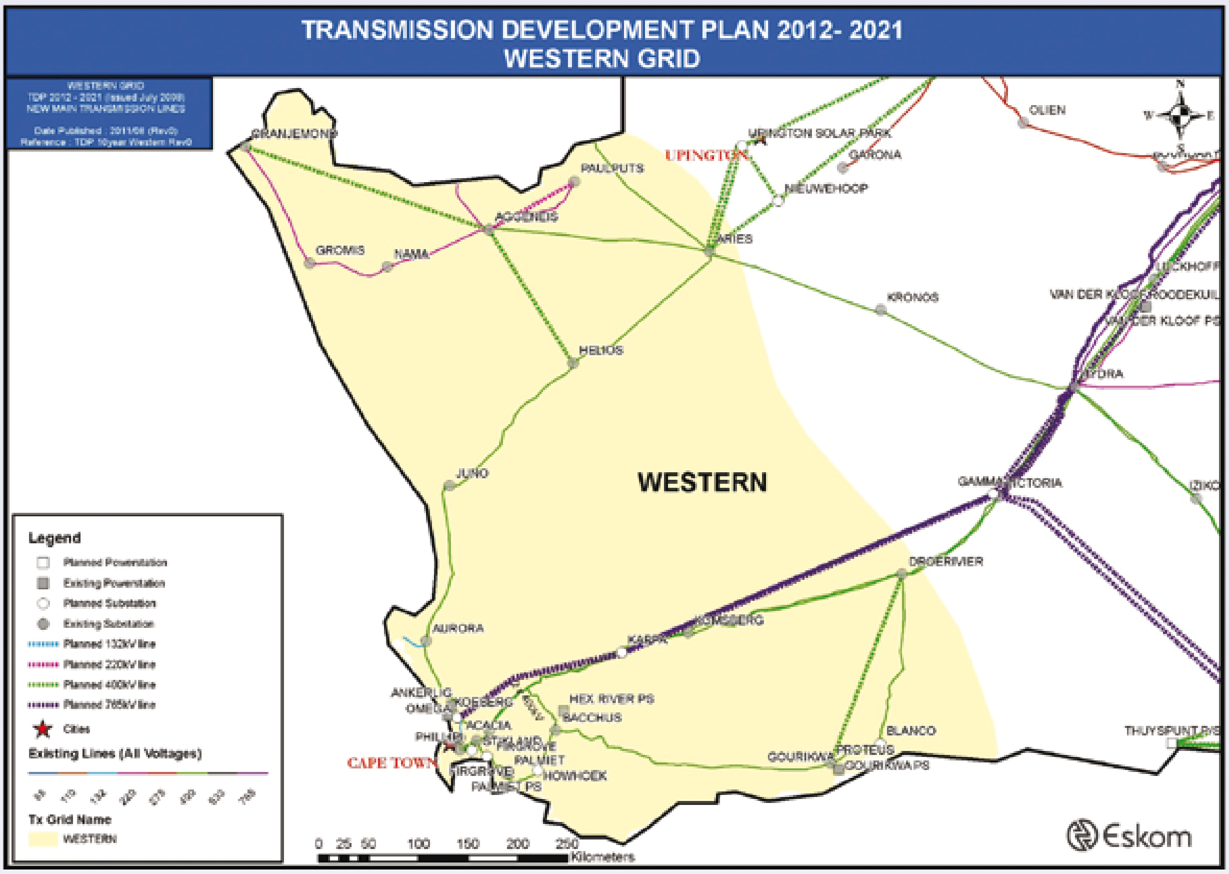
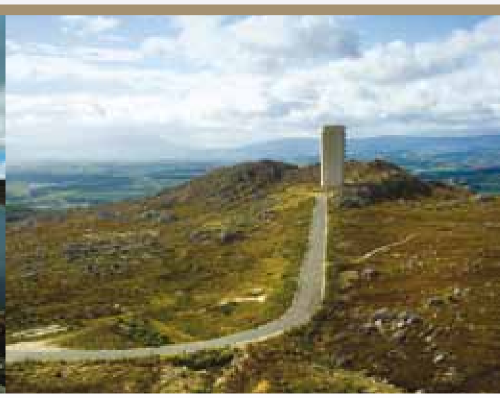


Figure 6.14: West Grid geographical network diagram



6.8 A PLAN FOR WIND AND SOLAR

A plan is contained in this TDP update to include the integration of wind and solar generation based on the assumptions of the location and size made in Section 2.2 above of the generation assumptions. It should be noted that this is merely an assumption at this stage, especially as regards to the locations selected for the wind farms which are next to existing Transmission substations. The Upington Solar Park can be assumed to be more accurate, considering that the area represents some of the highest sources of solar radiation in the country. The main reason for producing this plan at this stage was to compile a financial budget for this type of generation integration for the Transmission Ten-Year Supply Plan. The TDP will be updated annually with more accurate information on the location and size of new wind and solar generation facilities, based on the Connection Quotation applications received.

The following projects result from this plan:

Sub-project Name	TDP Scheme Project	Grid	New expected year
Aries-Upington 1st & 2nd 400-kV lines	Upington strengthening – Phase 1	N-West	2016
Ferrum-Upington 1st 400-kV line	Upington strengthening – Phase 1	N-West	2016
Nieuwehoop-Upington 1st 400-kV line	Upington strengthening – Phase 1	N-West	2016
Upington 5x 500 MVA 400/132-kV transformation	Upington strengthening – Phase 1	N-West	2016
Juno Ext 132-kV feeder bay (wind)	Juno Wind Phase 1	West	2012
Delphi Ext 132-kV feeder bay (wind)	Delphi Wind Phase 1	South	2013
Aurora Ext 132-kV feeder bay (wind)	Aurora Wind Phase 1	West	2014
Aurora Ext 2 X 132-kV feeder bay (wind)	Aurora Wind Phase 2	West	2017
Droerivier Ext 132-kV feeder bay (wind)	Droerivier Wind Phase 1	West	2014
Droerivier Ext 2 X 132-kV feeder bay (wind)	Droerivier Wind Phase 3	West	2019
Delphi Ext 1st 400-kV SVC	Delphi Wind Phase 2	South	2019
Bacchus Ext 2 X 132-kV feeder bay (wind)	Bacchus Wind Phase 1	West	2016
Bacchus Ext 2 X 132-kV feeder bay (wind)	Bacchus Wind Phase 2	West	2019
Grassridge Ext 132-kV feeder bay (wind)	Grassridge Wind Phase 1	South	2013
Hydra Ext 132-kV feeder bay (wind)	Hydra Wind Phase 1	South	2017
Nama Ext 220-kV feeder bay (wind)	Nama Wind Phase 1	West	2018

Sub-project Name	TDP Scheme Project	Grid	New expected year
Gromis Ext 220-kV SVC	Nama Wind Phase 1	West	2018
Merapi Ext 2 X 132-kV feeder bay (wind)	Merapi Wind Phase 1	N-West	2019
Grassridge Ext 2 X 132-kV feeder bay (wind)	Grassridge Wind Phase 2	South	2016
Grassridge Ext 2 X 132-kV feeder bay (wind)	Grassridge Wind Phase 3	South	2019
Poseidon Ext 1 X 132-kV & 66-kV feeder bay (wind)	Poseidon Wind Phase 1	South	2012
Poseidon Ext 400/132-kV (1 X 500 MVA) substation (edicated 132-kV supply for new wind integration)	Poseidon Wind Phase 2	South	2016
Delphi Ext 400/132-kV (1 X 500 MVA) substation (dedicated 132-kV supply for new wind integration)	Delphi Wind Phase 2	South	2019
Kappa Ext 400/132-kV (1 X 500 MVA) substation (new dedicated 132-kV supply for new wind integration)	Kappa Wind Phase 1	West	2016
Droerivier Ext 400/132-kV (1 X 500 MVA) substation (dedicated 132-kV supply for new wind integration)	Droerivier Wind Phase 2	West	2017
Hydra Ext 400/132-kV (1 X 500 MVA) substation (dedicated 132-kV supply for new wind integration)	Hydra Wind Phase 2	South	2018
Gromis Ext 400/132-kV (1 X 500 MVA) substation (dedicated 132-kV supply for new wind integration)	Gromis Wind Phase 1	West	2018
Juno-Gromis 1st 400-kV line	Gromis Wind Phase 1	West	2018
Juno Ext 400/132-kV (1 X 500 MVA) substation (dedicated 132-kV supply for new wind integration)	Juno Wind Phase 2	West	2017

A diagram of the major projects in the West Grid is shown in Figure 6.15 below.

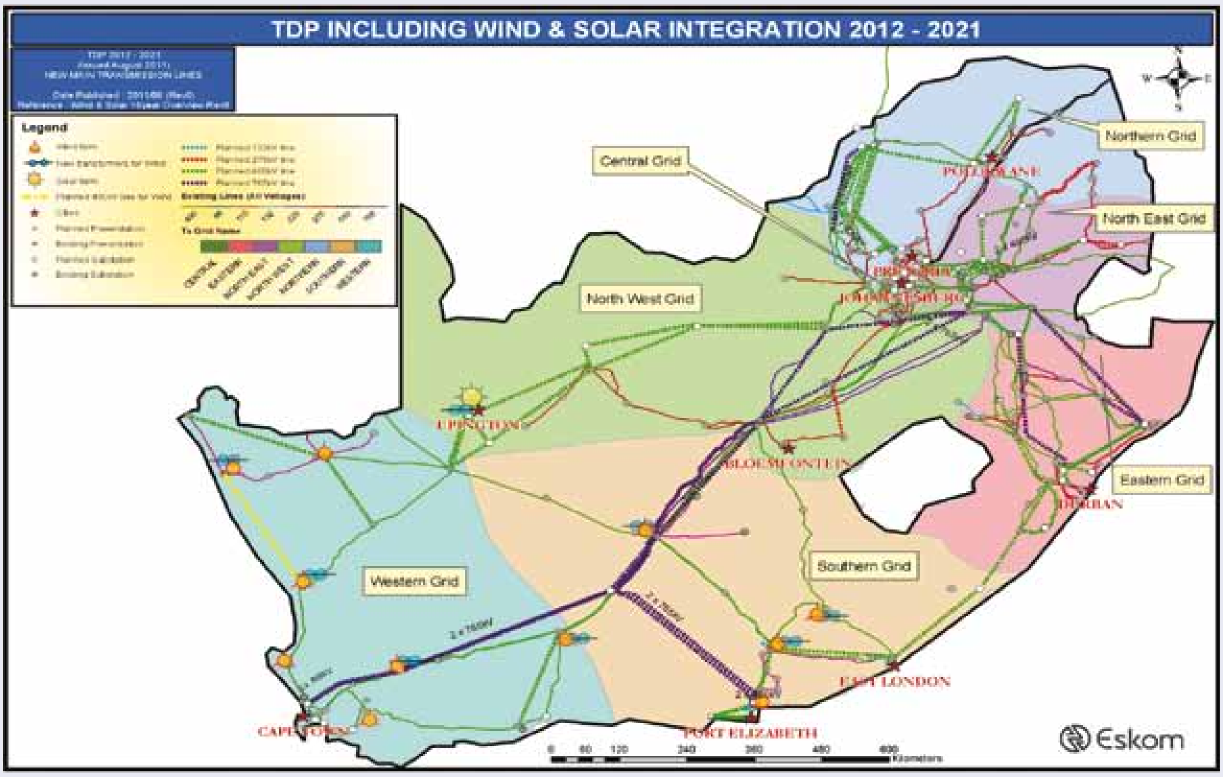


Figure 6.15: Map of TDP scheme projects including a plan for wind and solar generation

This plan resulted in a lot of simple feeder-bay requirements at most of the selected Transmission stations initially, as there is spare capacity. As this capacity runs out, new transformers will have to be added to ensure Grid Code Criteria are met. A 400-kV line will be required between the Juno and Gromis substations as the 220-kV network in the Northern Cape runs out of capacity. Two SVCs have been placed on the system in order to ensure the voltage requirements are met. One was placed at the Gromis substation and the other at the Delphi substation.

6.9 STRATEGIC SERVITUDES UNDER INVESTIGATION

All the line projects and new substation projects that are proposed in the document need to go through a full environmental impact assessment (EIA) process before implementation. This process includes public participation meetings, which are advertised in the media. The concerns of the public and affected parties are addressed at the public participation meetings. Eskom Holdings will not commence the construction of any line or substation unless the EIA process (Record of Decision signed and servitudes acquired) has been concluded.

The proposed lines shown in various schematics in this document give an estimation of where the 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 for Transmission including expansion, refurbishment, facilities, production equipment, and land acquisition project costs amount to R 209.9 billion. This summary is shown in Table 7 1. It is clear that the majority of the cost will be related to expansion because this relates directly to the strengthening of the network to accommodate new customers as well as new generation.

Categories	FY12-21
Expansion	170,888
Refurbishment	17,363
Capital Spares	5,729
L&R	8,134
OTHER	7,021
Production Equipment	744
Total	**209,879**

Table 7.1: Capital Expenditure (10 Year Plan) for different categories of projects

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

The summary of expansion capital expenditure per project type required to realise this ten-year plan is shown in Table 7.2. The total expenditure is expected to be approximately of R 171 billion, this is approximately R 5 billion higher than the previous ten-year plan. The main reasons for this variance are as follows:

- A provision was added covering the 2021 (a new year in the planning window) year list of projects.
- Project cost escalations due to re-phasing.
- The net effect of new projects added and existing projects deferred.

Type	Total R'mil
Customer	3,647
Generation	26,734
Reliability	140,507
Grand Total	**170,888**

Table 7.2: Capital expenditure per project type

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

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

8. Concluding Remarks

The most visible difference between this TDP and the previous year's TDP is the reduction in the amount of Transmission line by approximately 3 800-km. This is mainly due to the deferment of the coal and nuclear projects linked to the TDP Generation Assumptions made. The Cape Corridor projects have also been deferred to beyond the TDP period.

The other difference between this TDP and the previous year's TDP is the phasing and spread of the projects over the planning period. There has been a re-phasing of the existing projects (55% of the total number of projects), using more realistic completion dates based on execution time-lines.

A number of additional projects have been included in the later part of the planning period, mainly due to new existing substation transformer expansion linked to the assumptions made about solar and wind generation. New substations have been included, mainly owing to a better positioning of loads resulting from the spatial load-forecasting techniques applied.

The result is an improved and more realistic or achievable spread of the transmission line projects and transformer installations. The slower rate of completion of the transmission lines and new transformers increases the overall risk to the network. However this risk can be managed as the N-1 unfirm refers to the strict deterministic level which assumes that the N-1 event will happen at the time of the loading peak. In reality there is a limited chance of this happening and operational mitigation plans will cater for most of the events until the required projects have been completed. Some of the risk mitigation measures under consideration include higher reliance on the following: utilisation of strategic spares, the use of capacitors in the short term for voltage support, as well as Emergency Preparedness Plans.

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

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

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

Transmission infrastructure could easily become the critical path in connecting and integrating large new loads and generation, due to the long lead times for securing corridors. We recommend that for planning purposes, developers should allow for at least 7 years' lead time for new corridors. It should also be noted that in the EIA process, there are increasing objections from llandowner's and other stakeholders to proposed power line routes, 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 the coastal nuclear or Waterberg coal scenarios. In addition, the recycling of certain transmission networks (especially 275 kV to 400 kV) in Gauteng and KwaZulu-Natal will be needed in the long term.

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

The estimated rand value of the planned projects is approximately R171 billion in the next ten years, of which approximately R 4 billion is for customer related projects; R27 billion for generation integration projects, and approximately R140 billion is related to reliability projects.

PSSE Casefile	Grootvlei		Komati		Medupi		Kusile		Ingula		DoE OCGT 1 Dedisa		Doe OCGT 2 Avon			Co-Gen	Co-Gen		Wind	Wind		CSP	CSP		CCGT	CCGT		HYDRO Import	HYDRO Import
Year	Unit	MW	Unit	MW	Unit	MW	Unit	MW	Unit	MW	Unit	MW	Unit	MW	Unit	Location	MW	Unit	Location	MW	Unit	Location	MW	Unit	Location	MW	Unit	Location	MW
2011	5	190	4	101																									
	6	190	5	101																									
			6	101																									
2012			7	101														1	Juno (Sere)	100									
			8	101														1	Poseidon	200									
			9	101																									
2013					1	738					1	147	1	147	1	SASOL (Sol)	200	1	Grassridge	100									
					2	738					2	147	2	147				1	Delphi	100									
													3	147															
													4	147															
													5	147															
2014					3	738			1	333					2	SASOL (Sol)	200	1	Aurora	150	1	Upington	100						
					4	738			2	333								1	Droerivier	150									
2015					5	738	1	738	3	333					3	SASOL (Sol)	200				1	Renum	100						
					6	738			4	333																			
2016							2	738										2	Poseidon	200	1	Gordonia	100						
																		1	Bacchus	200									
																		1	Kappa	200									
																		2	Grassridge	200									
2017							3	738										2	Juno	200	1	Upington	100						
																		2	Aurora	200									
																		2	Droerivier	200									
																		1	Hydra	200									
2018							4	738										2	Hydra	200									
							5	738										1	Merapi	200									
																		1	Nama	200									
																		1	Gromis	200									
2019							6	738										3	Droerivier	200				1	Gourikwa	237			
																		2	Delphi	200				2	Gourikwa	237			
																		3	Grassridge	200									
																		1	Bacchus	200									
2020																								1	Avon	237	1	Maputo	360
																								2	Avon	237			
																								3	Avon	237			
2021																								1	Dedisa	237	2	Maputo	375
																								2	Dedisa	237	3	Maputo	375
																								3	Dedisa	237			

Generation Plant used for the TDP studies

Appendix B: Costing Details

APPENDIX B1: COSTING PER PROJECT TYPE

Type	Total R'mil
Customer	3,647
Generation	26,734
Reliability	140,507
Grand Total	170,888

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

APPENDIX B2A: COSTING FOR CENTRAL GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
Central	Benburg Ext 3rd 250MVA 275/132kV	145	15,620
	Croydon Ext 3rd 250MVA 275/132kV transformer	144	
	Demeter 400kV Integration	1,115	
	Eiger Ext 3rd 80MVA 88/33kV transformer	30	
	Johannesburg Reactive Power Project	45	
	Johannesburg East Strengthening - Phase 1	460	
	Johannesburg East Strengthening - Phase 2	615	
	Johannesburg East Strengthening- Phase 3 A-D	1,900	
	Johannesburg East Strengthening - Phase 3 E-F	1,928	
	Johannesburg North - Phase 2a	208	
	Johannesburg North - Phase 2b	83	
	Johannesburg Strengthening	2,337	
	Kookfontein Phase 1	15	
	Kookfontein Phase 2	125	
	Kyalami Integration	1,770	
	Simmerpan 275/132kV substation	396	
	Simmerpan 275/88kV substation	497	
	Snowdon transformer upgrade	110	
	Vaal Strengthening Phase 1: Glockner 400/275kV Trfr & Hera-Bernina	500	
	Vaal Strengthening Phase 2	317	
	Soweto Strengthening Phase 2 - 275/132kV	563	
	West Rand Strengthening - Phase: Westgate B and Taunus 400kV	1,701	
	Soweto Strengthening Phase 1 - 275kV	616	

Please note that the amounts in the tables represent cash flows as a total scheme cost that may fall outside of the Ten-year plan periods

APPENDIX B2B: COSTING FOR EAST GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
Eastern	Ariadne-Venus 2nd 400kV Line	1,021	26,999
	Assmang MTS	400	
	Avon Ext 3rd 250MVA 275/132kV transformer	117	
	Invubu Ext 1st and 2nd 500MVA 400/132kV transformers	1,120	
	Empangeni Strengthening - Phase 1	1,271	
	Empangeni Strengthening - Phase 2	1,706	
	Empangeni Strengthening - Phase 4	4,912	
	Eros Reinforcement - Ariadne-Eros 400kV	1,456	
	Eros Reinforcement - Eros 2nd transformer	168	
	Hector Ext 3rd 800MVA 400/275kV transformer	141	
	Hector Ext 4th 800MVA 400/275kV transformer	198	
	Incandu Ext 3rd 315MVA 400/132kV transformer	185	
	Klaarwater Reinforcement - Phase 1	47	
	Klaarwater Reinforcement - Phase 2	344	
	KZN 765kV Integration	4,777	
	Ottowa Reinforcement	158	
	Pinetown Strengthening - Phase 1	4,410	
	South Coast Strengthening	948	
	Pinetown - Empangeni Interconnection	2,105	
	Normandie Ext 2nd 250MVA 400/132kV transformer	129	
	Mersey Ext 3rd 250MVA 275/132kV transformer	116	
	Ingula Pumped Storage P/S Intergation	1,271	

Please note that the amounts in the tables represent cash flows as a total scheme cost that may fall outside of the Ten-year plan periods.

APPENDIX B2C: COSTING FOR WEST GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
Western	Cape Corridor Phase 2: Gamma-Omega 765kV Intergation	5,525	37,723
	Cape Corridor Phase 2: Kappa 765kV Integration	1,200	
	Cape Corridor Phase 4: 2nd Zeus-Per-Gam-Ome 765kV line*	20,873	
	Droerivier-Proteus 2nd 400kV line	1,383	
	Firgrove Substation Establishment (2x 500MVA 400/132kV TRFR's)	378	
	Gas 1 off-site relocation to Ankerlig	471	
	Mitchells Plain 400kV Substation	1,147	
	Muldersvlei Ext 3rd 500MVA 400/132kV transformer & 132kV Series Reactors	153	
	N Cape reinforcement: Ageneies-Paulputs 2nd 220kV	508	
	N Cape reinforcement: Aggeneies-Helios 1st 400kV	1,176	
	N Cape reinforcement: Aggeneis-Oranjemund 2nd 220kV	1,415	
	N Cape reinforcement: Aries SVC	463	
	N Cape reinforcement: Ferrum-Garona-Nieuwehoop 400kV	1,714	
	Paulputs Ext 2nd 125MVA 220/132kV transformer	74	
	Howhoek Substation Establishment (2x 500MVA 400/132/kV TRFR's)	571	
	Blanco Substation Establishment (2x 500MVA 400/132/kV TRFR's)	571	
	Juno Wind Phase 1	0**	
	Aurora Wind Phase 1	0**	
	Aurora Wind Phase 2	0**	
	Droerivier Wind Phase 1	0**	
	Droerivier Wind Phase 3	0**	
	Bacchus Wind Phase 1	0**	
	Bacchus Wind Phase 2	0**	
	Kappa Wind Phase 1	0**	
	Droerivier Wind Phase 2	0**	
	Juno Wind Phase 2	0**	
	Gromis Wind Phase 1	0**	
	Nama Wind Phase 1	0**	
	Philippi Ext 3rd 500MVA 400/132kV transformer	101	

* Total Cost for projects across CLNs
**A cost of R1.7bil for all Wind Assumed Projects, is additional

Please note that the amounts in the tables represent cash flows as a total scheme cost that may fall outside of the Ten-year plan periods.

APPENDIX B2D: COSTING FOR SOUTH GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
Southern	Cape Corridor Phase 2: Gamma-Omega 765kV Integration	0*	13,141
	Grassridge Ext 3rd 400/132kV 500MVA transformation	150	
	Greater East London Strengthening - Phase 1: Eros-Vuyani & SS	1,550	
	Greater East London Strengthening - Phase 2: Neptune-Vuyani & SS	0**	
	Greater East London Strengthening - Phase 3	0**	
	Nuclear 1 Integration***	5,810	
	PE Phase 3: Poseidon, Delphi, Grassridge and Dedisa Shunt compensation	127	
	PE Phase 4: Poseidon, Delphi, Grassridge and Dedisa Shunt compensation	149	
	Port Elizabeth substation integration - Phase 1	503	
	Southern Grid - Phase 3 : 1st Gamma Grassridge 765kV Line	4,584	
	Delphi Wind Phase 1	0****	
	Delphi Wind Phase 2	0****	
	Grassridge Wind Phase 1	0****	
	Hydra Wind Phase 1	0****	
	Grassridge Wind Phase 2	0****	
	Grassridge Wind Phase 3	0****	
	Poseidon Wind Phase 1	0****	
	Poseidon Wind Phase 2	0****	
	Delphi Wind Phase 2	0****	
	Hydra Wind Phase 2	0****	
	Grassridge-Dedisa Strengthening	167	
	Gariep Network Strengthening	20	
	Delphi 3rd 120MVA 400/132kV transformer	0*****	
	Pembroke 3rd 90MVA 220/66kV transformer (Dual ratio 220/132/66kV)	0*****	
	Hydra 400 & 132kV equipment upgrade (Fault level requirements)	0*****	
	Grassridge 132kV equipment upgrade (Fault level requirements)	0*****	
	Southern Grid - Transmission Transformer Normalisation	81	

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

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

****Although Nuclear 1 is required in 2022, most of the projcet will have to be done in this TDP window and is hence shown*

*****A cost of R1bil for all Wind Assumed Projects, is additional*

******Costing for the project is not complete*

Please note that the amounts in the tables represent cash flows as a total scheme cost that may fall outside of the Ten-year plan periods

APPENDIX B2E: COSTING FOR NORTH EAST GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
North-East	Alpha Ext 4th 765/400kV transformer	611	15,817
	Highveld North-West and Lowveld North Reinforcement - Phase 1	770	
	Highveld South Reinforcement	780	
	Kruispunt Reinforcement	42	
	Kusile Integration Phase 1 - 4	2,438	
	Lowveld 400kV Strengthening - Phase 1&2: Gumeni	1,301	
	Lowveld 400kV strengthening - Phase 3	1,349	
	Lowveld Transformation Capacity Enhancement	344	
	Malelane 275kV Reinforcement - Phase 2	545	
	Steelpoort Strengthening Scheme	750	
	Tshwane Reinforcement - Phoebus Phase 1 - 3 & Verwoerdburg Phase 1 - 2	1,834	
	Tshwane Reinforcement - Wildebees Phase	125	
	Malelane 275kV Reinforcement - Phase 2	512	
	Tubatse Strengthening Scheme Phase 1	692	
	Tubatse Strengthening Scheme Phase 2	231	
	Highveld North-West and Lowveld North Reinforcement - Phase 2	2,280	
	Highveld North-West and Lowveld North Reinforcement - Phase 3	142	
	Highveld North-West and Lowveld North Reinforcement - Phase 4	167	
	Lomond MTS transformation upgrade	0*	
	Highveld North terminal equipment upgrade	0*	
	Leseding 400kV Reinforcement	587	

*Project not costed yet

Please note that the amounts in the tables represent cash flows as a total scheme cost that may fall outside of the Ten-year plan periods.

APPENDIX B2F: COSTING FOR NORTH WEST GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
North-West	Bloemfontien Strengthening	753	19,782
	Cape Corridor Phase 2: Zeus-Hydra 765kV Integration	8,151	
	Cape Corridor Phase 3: 765kV Series Capacitors (NOH)	963	
	Kimberley 400kV Strengthening Phase 1	28	
	Kimberley 400kV Strengthening Phase 2	1,900	
	Kimberley 400kV Strengthening Phase 3	3,272	
	Merapi Wind Phase 1	10	
	Upington Strengthening Phase 1	4,300	
	Garona Strengthening	205	
	Watershed 275kV Reinforcement	200	

Please note that the amounts in the tables represent cash flows as a total scheme cost that may fall outside of the Ten-year plan periods.

APPENDIX B2G: COSTING FOR NORTH GRID PROJECTS

Grid	Project	Cost R' mil	Grid Total
Northern	Acornhoek Upgrade 2x 125MVA 275/132kV transformers	17	18,991
	Brits 400kV Reinforcement	949	
	Dwaalboom 132kV switching station	45	
	Foskor 275/132kV transformation upgrade	1,096	
	Foskor 275kV Reinforcement	0**	
	Medupi Integration (Alpha) Phase 1A: Spitskop and Dinaledi	11,100	
	Medupi Integration (Charlie) Phase 2A: Ngwedi	647	
	Medupi Integration (Charlie) Phase 2B: Borutho	647	
	Nzhelele 400kV reinforcement	2,387	
	Pelly 132/22kV transformation upgrade	28	
	Rustenburg Transformation Reinforcement	194	
	Spitskop 400/132kV Transformation	221	
	Tabor and Spencer Reinforcement - Phase 1	185	
	Tabor and Spencer Reinforcement - Phase 2	622	
	Trident 275/88kV transformation Upgrade	0*	
	Dinaledi 3rd 500 MVA 400/132kV Transformer	0*	
	Brits 400kV Reinforcement	853	
	Medupi Integration (Alpha) Phase 1B: Marang	0***	

* Project not costed as yet
**Costs included in Foskor 275/132kV transformation upgrade
***Costs in Medupi Integration (Alpha) Phase 1A: Spitskop and Dinaledi

Please note that the amounts in the tables represent cash flows as a total scheme cost that may fall outside of the Ten-year plan periods



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 Regional Grid Plans.

Team Members	Role
Nishan Rathanlall	Compiler 1
Roy Estment	Compiler 2
Camille Shah and Nomfi Nomjana	Printing and Communications
Juan La Grange	Legal/Regulations

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