TRANSMISSION DEVELOPMENT PLAN 2019 to 2028 (Public Version)

FOREWORD BY GROUP EXECUTIVE

Electricity is the lifeblood of the 21st-century lifestyle in ways many of us take for granted. People whose homes, workplaces, schools, and clinics are connected to the grid for the first time find their lives transformed for the better in ways they could previously only dream of.

Electricity is generated in power stations all over South Africa. The bulk of South Africa's electricity is still produced by coal-fired power stations located on the coalfields of the Mpumalanga Highveld and near Lephalale. The renewable energy independent power producer (REIPP) programme of the Department of Energy (DoE) has resulted in increasing amounts of electricity produced from renewable sources, mainly wind and solar, located primarily in the Eastern Cape, Western Cape, and Northern Cape. To date, the REIPP programme has procured around 6 400 MW of energy from 106 independent power producers (IPP) projects, with about 4 000 MW already in commercial operation. It is anticipated that the transformation of the South African energy mix will continue over the next 10-year period, as more electricity from renewable sources is integrated into the national grid in accordance with the Integrated Resource Plan (IRP).

The transmission system's primary role is to transport electricity in bulk from wherever it is generated to load centres throughout South Africa and the region. From there, distribution networks owned by Eskom, the metros, and municipalities deliver electricity to individual end users. The system requires augmentation and reinforcement to connect new loads and sources of generation to the grid, as well as to meet the changing needs of customers, both with regard to load and generation. The transmission system also requires regular planned maintenance, as well as refurbishment or replacement of plant that has reached the end of its operational lifespan, to ensure that it performs its role safely and efficiently. Accordingly, the plans outlined in this document constitute the minimum transmission infrastructure development requirements in South Africa over the next 10-year period.

There are also cross-border transmission lines to Namibia, Botswana, Zimbabwe, Mozambique, Swaziland, and Lesotho, allowing electricity to be traded with the rest of Southern Africa. It is one of the Eskom Transmission Group's strategic objectives to increase the capacity of these interconnections to allow for greater volumes of electricity to be traded to improve efficiency and security of electricity supply in South Africa in the longer term.

The benefits of a reliable and secure electricity supply to South Africa must be weighed against the associated costs to ensure that electricity consumers, who ultimately fund the investments through tariffs, receive fair value for money. 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 contributed to the development and publication of this report. It is a difficult and complex process, requiring extensive consultation and multiple iterations.

Regards

Willy Majola
GROUP EXECUTIVE: TRANSMISSION (ACTING)
October 2018

DISCLAIMER

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

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

EXECUTIVE SUMMARY

This publication contains information about projects intended to extend or augment the transmission system that have been completed in the past year as well as about projects that are planned for the next 10 years. The transmission network (220 kV to 765 kV lines and substations) is the primary network of interest covered in this publication, with a few sub-transmission networks (88 kV and 132 kV lines and substations) 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 to the load centres from the new power stations (conventional and renewable) connecting to the grid. This document also contains the reliability projects required to ensure that the levels of reliability and adequacy of the transmission network as prescribed by the grid code are sustained as load demand increases and new sources of generation are connected to the network. The final group of projects comprises network expansions needed to connect new and growing loads and load centres to the network.

Eskom's current liquidity position will impact the execution of the TDP. NERSA is assessing Eskom funding and revenue requirements for 2019/20 to 2021/22 and is expected to announce Eskom's tariff determination for MYPD4 (fourth multi-year price determination) by 1 March 2019. The plan will have to be revised to fit in with the available budget by reprioritising projects to minimise the impact on customers and the national economy of any delays arising from a shortage of funding or delays in obtaining sites and servitudes and environmental and other statutory approvals.

It is regrettable, but unavoidable, that the funding constraints will result in it taking a longer period of time to bring the transmission system into compliance with the reliability and redundancy requirements prescribed by the grid code. The effects on customers and the national economy will be minimised through consultation with customers and activation of risk mitigation measures. A public forum was held with identified stakeholders to disseminate the content of this plan and get feedback on it. Some of these comments were incorporated into this final report where possible, while the rest of the comments will be taken into account when the plan is revised.

During the second quarter of 2015, customers (load and generation) were offered the self-build option, in terms of which they could elect to design, procure, and construct their own connection to the transmission system instead of Eskom providing the network connection and charging the customer a connection charge. The self-build option was introduced by Eskom in order to give customers greater control over risk factors affecting their network connection. The self-build option has since been expanded to allow customers to also self-build associated works that will be shared with other customers, subject to approval by Eskom based on an assessment of associated risks to the system and other customers. The option of Eskom constructing the customer's network connection and the customer paying a connection charge remains available to the customer as before, since the self-build option is purely voluntary.

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 load 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, strategic projects (including facilities), production equipment and strategic capital spares. Strategic projects include the upgrading of the EMS (energy management system) used by the System Operator to control the system and respond to emergencies, as well as security measures to combat criminal activity, such as theft and vandalism. Acquisition of sites and servitudes and associated EIAs (environmental impact assessments) and other statutory approvals for the construction of transmission infrastructure are also defined in the grid code as strategic projects. Facilities consist of buildings and associated works located at sites other than substations that Transmission uses for offices, for 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., which are kept as strategic stock to allow units that fail in service and cannot be repaired on site to be replaced as soon as possible, thereby minimising the risk that customers 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.

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ABBREVIATIONS AND DEFINITIONS

BQ – budget quote

Quotation giving customers costs and scope at 85% accuracy level.

CCGT – combined-cycle gas turbine

Open-cycle gas turbine (OCGT) fitted with a waste heat recovery boiler and steam turbines to increase electricity output by using the exhaust gases of the combustion turbine to raise steam.

CoCT – City of Cape Town

CLN – customer load network

The network within a specific geographical area which, in turn, is a subdivision of a grid; for example, Johannesburg CLN falls within the Central Grid in Gauteng.

DEA – Department of Environmental Affairs

DoE – Department of Energy

EHV – extra-high voltage

EIA – environmental impact assessment

GAU – grid access unit

GCCA – grid connection capacity assessment

GDP – gross domestic product

GUMP – gas utilisation master plan

HVDC – high-voltage direct current

ICE – indicative cost estimate

Cost estimate giving a non-binding indication of the order of magnitude costs.

IDZ – industrial development zone

IPP – independent power producer

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

IRP – integrated resource plan

MTPPP – medium-term power purchase programme

MVA – megavolt-ampere

A million volt-amperes of apparent power, being the vector sum of real power (MW) and reactive power (MVar).

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.

MW – megawatt

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

MYPD3 – multi-year price determination 3

The third multi-year price determination for tariff increases awarded to Eskom by NERSA, being 8% per annum over the period 1 April 2013 to 31 March 2018.

MYPD4 – multi-year price determination 4

The fourth multi-year price determination for tariff increases awarded to Eskom by NERSA. The annual price increase and period duration will be decided by NERSA by 31 March 2019 and will come into effect from 1 April 2019.

MTS – main transmission system

These are substations owned and operated by a TNSP.

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.

NTC – National Transmission Company

The body that is licensed as the national provider of transmission services.

OCGT – open-cycle gas turbine

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

PPA – power purchase agreement

RE – renewable energy

REBID – renewable energy bids programme

REDZ – renewable energy development zones

REIPP – renewable energy independent power producer

REIPPPP – renewable energy independent power producers procurement programme

RTS – return to service

A previously mothballed power station undergoing recommissioning.

SEA – strategic environmental assessment

TDP – transmission development plan

A development plan produced annually by Eskom Transmission detailing how the network will develop in the next 10 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.

TNSP – transmission network service provider

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

TOSP – time of system peak

TS – transmission system

1 INTRODUCTION

1.1 CONTEXT OF THE TDP

Eskom Holdings is the major producer of electricity in South Africa. It also transmits electricity via the 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, which is the National Transmission Company (NTC). Planning augmentation of the transmission network is the responsibility of the Grid Planning Department in the Transmission Group. According to the grid code, NERSA requires the NTC to publish a minimum five-year-ahead transmission system (TS) annually, indicating the major capital investments planned (but not yet necessarily approved). This plan covers a 10-year window. The requirements, furthermore, stipulate that the plans should include at least:

- the acquisition of servitudes for strategic purposes;
- a list of planned investments, including costs;
- diagrams displaying the planned changes to the 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 NTC should annually host a public forum to disseminate the intended TS development plan in order to facilitate a joint planning process. The eighth TDP was published in October 2017. This is the ninth publication based on the TDP for the period 2019 to 2028.

The 10-year TDP seeks to meet the long-term requirements of the electricity consumers in South Africa by maintaining the legislated adequacy and reliability of the transmission grid. The objective is to produce a plan containing the expected development projects for the TS for this 10-year period. These expected projects consist of the approved projects that are currently in execution, the projects that are in business case development phase and the projects that are based on a desktop assessment of the transmission requirements with further engineering feasibility assessment to be conducted at a later stage.

In order to undertake the system adequacy studies to determine the weakness in the system, a number of assumptions need to be made. These assumptions are required in order to assure consistency in the network studies and analysis as well as to inform the organisation of the basis of the TDP for the defined period.

1.2 MAJOR CHANGES FROM THE 2017 TDP

There have been minor changes in the input assumptions from the previous TDP, which was published in 2017. As a result, the 2018 revision of the TDP has not resulted in significant changes in the transmission network requirements and associated development plans. The bulk of the changes in this version of the TDP are attributed to two main factors, namely capital constraints and protracted land acquisition processes. These factors necessitated the reprioritisation of the plan based on need criticality assessment and readiness to implement.

The IPPs that have been assigned preferred bidder status in rounds 4 and 4B of the renewable energy independent power producer procurement programme (REIPPPP) are expected to be connected to the national grid within this TDP period. The connection dates for these IPPs have been adjusted in accordance with the realistic project execution timelines, resulting in minor deferment of the associated integration plans.

1.2.1 Capital constraints

Due to capital constraints emanating from Eskom’s liquidity position, projects had to be reprioritised to fit in with the available budget. The reprioritised projects maximise the benefits accruing from the available capital investment budget, while minimising the risks to security and reliability of supply. The high-priority projects were accelerated, provided that the enabling factors are in place.

The reprioritisation process will be repeated after each tariff increase ruling by NERSA and Eskom’s Corporate Plan approval to ensure optimal use of the available budget.

1.2.2 Land and servitudes acquisition

The procurement of land and servitudes for substation and line construction projects is one of the essential transmission infrastructure development enablers. The projects affected by challenges in the land acquisition process were mainly deferred in line with the revised project schedule.

1.2.3 REIPP rounds 4 and 4B connection assumptions

The 26 preferred bidder projects in REIPPPP bid windows 4 and 4B were assumed to be integrated into the national grid by 2019 in the previous version of the TDP. The connection dates have now been adjusted in line with the realistic connection schedule following the acceptance of the budget quotations in 2018 and advancement to financial closure.

1.3 STRUCTURE OF THE DOCUMENT

The document is structured in the following manner:

Chapter 2, GENERATION ASSUMPTIONS, outlines generation assumptions for the 2018 revision of the TDP. These generation assumptions are the key driving factor for infrastructure development to transmit electricity from Eskom and IPP generation to the distributors or large energy users. Due to the level of anticipated generation integration, a significant expansion of the transmission network has been identified to evacuate power from the power stations to the load during this TDP period.

Chapter 3, DEMAND FORECAST, provides the location and magnitude of electricity demand forecast (MW) to be supplied within the TDP period. The demand forecast gives context to the planning activity by determining how the supply network is planned in accordance with the applicable reliability criteria.

Chapter 4, TRANSMISSION EXPANSION PROJECTS UPDATES, provides a summary of the progress made in executing transmission expansion projects since the 2017 revision of the TDP was published. It also provides a list of transmission projects expected to be commissioned in the first half of the 2018 TDP period, based on the latest available information. The major changes between the information published in the 2017 TDP and this update was mainly due to the reprioritisation of projects in line with the capital constraints and land acquisition challenges. This chapter also focuses on the grid connection applications processed by Eskom.

Chapter 5, NATIONAL OVERVIEW, 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 TDP and a high-level summary of the installed transmission infrastructure.

Chapter 6, BREAKDOWN OF THE TDP PROJECTS BY PROVINCE, focuses in detail on the planned projects and the impact they will have on the network. Generation integration and reliability projects are discussed per province. 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 EIA and obtain environmental approval, which includes consultation with affected stakeholders, prior to construction.

Chapter 7, INDEPENDENT POWER PRODUCER PROGRAMME, deals with the transmission plans to enable connection of the IPPs in the medium to long term. These plans are predominantly made up of transmission infrastructure upgrades in the Northern Cape, Eastern Cape and Western Cape, which are projected to be the hub of future generation in South Africa.

Chapter 8, CAPITAL EXPENDITURE PLAN, outlines the forecasted costs of implementing the TDP. The costs provided in this publication are high-level costs intended to illustrate the financial requirements of the current revision of the TDP. The actual costs per individual project in the TDP will be refined subsequent to feasibility assessment, and followed by approval of the associated business case before projects advance to execution.

Chapter 9, CONCLUSION, provides the conclusion of the 2018 version of the TDP.

2 GENERATION ASSUMPTIONS

The generation assumptions discussed in this section were used as a supply-side input to the TDP. The generation assumptions are based the IRP, which is released by the DoE. The IRP is intended to drive all new generation capacity development for South Africa. These generation assumptions are based on the official 2010 IRP as well as the revised draft version released in 2016. Consideration has also been given to the proposed IPP programmes of the DoE, such as future REIPPPP bid windows for renewables, a coal IPP programme and a gas-generation programme (to be based on the gas utilisation master plan [GUMP] proposals).

Starting from the 2017 version of the TDP, alternative generation scenarios have been included in the TDP. This was after an agreement was reached with the DoE IPP Office to include such scenarios to cater for spatial uncertainty since areas where REIPPPP bids will be accepted are not known upfront. The scenarios have been revised in this version of the TDP. The new scenarios will also be described in this document. The existing and planned capacities are shown in Figure 2-1. The generation is further classified into dispatchable and variable, the proportion of dispatchable to variable resources will decrease drastically over the TDP period as more renewable sources are installed.

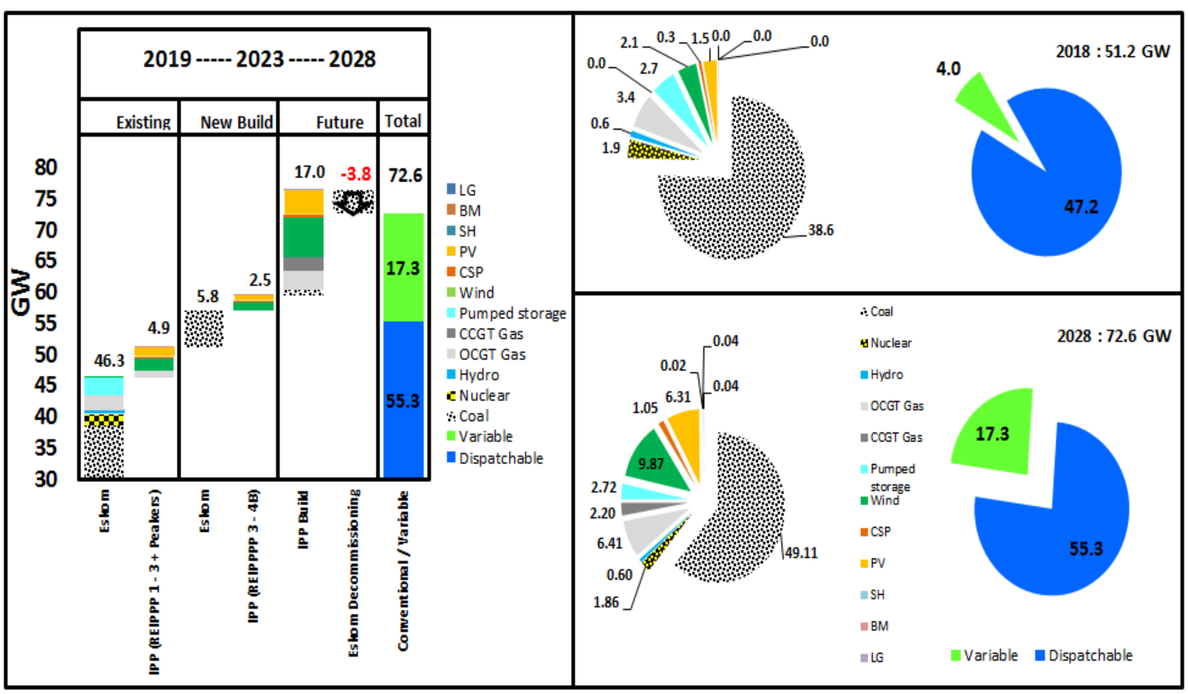


Figure 2-1: TDP base case generation

In order to achieve the proposed IRP 2010, a number of assumptions regarding size and location of the future planned generation plant had to be made. These assumptions are discussed in detail in the sections that follow. The generation assumptions for the TDP period were fixed in February 2018 based on what was known and expected at the time, guided by the IRP 2010 and the 2016 Draft IRP.

2.1 Generation forecast

The generation forecast for the TDP period is shown in Figure 2-2. The installed capacity will increase from 51 GW to 72 GW driven mostly by renewables and gas. The existing generation fleet is assumed to be available over the TDP period, except for the units expected to be decommissioned at three power stations by 2020 in line with their decommissioning schedules

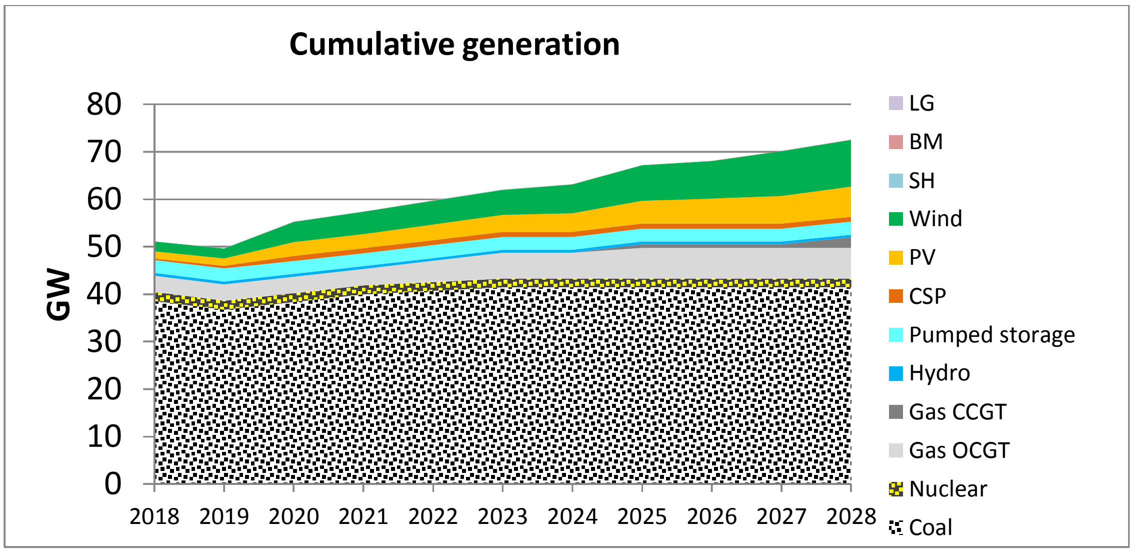


Figure 2-2: Generation forecast for the TDP period

The spatial allocation of the generation is provided in Figure 2-3. The renewable energy (RE) increase is clearly demonstrated by the green and yellow circles, which represent wind and solar generators respectively.

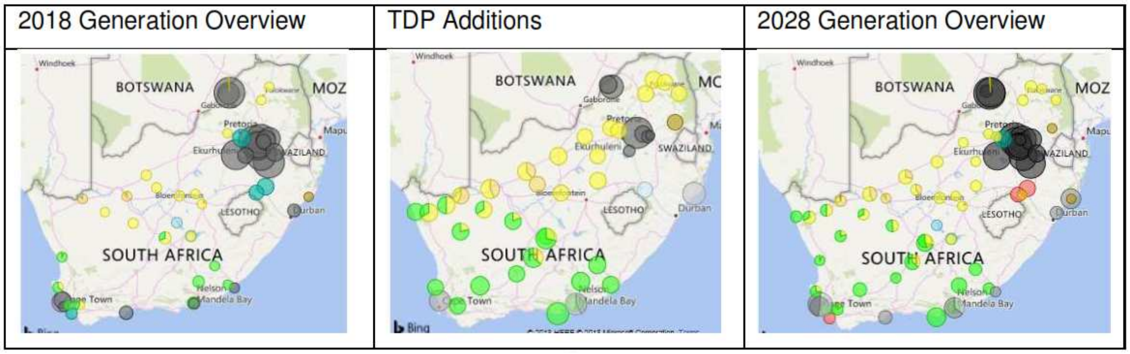


Figure 2-3: Current and future generation spatial footprint

The various primary resource technologies constituting the generation forecast are discussed in the next few sections.

2.2 DoE OCGT power stations

The two DoE OCGT plants (peaking) are assumed to be available for the 2018 system peak. These are modelled as follows:

- 2 x 167,5 MW units at Dedisa (335 MW)
- 4 x 167,5 MW units at Avon (670 MW)

These were treated as peaking plant in the TDP studies where they were only used during system peak or, if required, under contingency conditions. For provincial studies, they were set at full output under the local grid peak conditions and light load to ascertain that all the power can be evacuated.

2.3 Ingula Pumped Storage

The Ingula Pumped Storage Station has been completed with a capacity of 1 332 MW (4 x 333 MW). It is mainly used during peak conditions for generation, and during light load conditions as a pumping load.

2.4 Coal generation

Baseload coal (Medupi and Kusile)

The construction of Medupi and Kusile baseload coal power stations is progressing well, Medupi has achieved commercial operation for three (of six) units and Kusile has achieved commercial operation for one unit. The completion schedules for Medupi and Kusile are shown in Figure 2-4. Medupi is expected to be completed by 2020 and Kusile by 2024. For the purposes of planning studies, the capacities indicated can be assumed to be available in the years indicated.

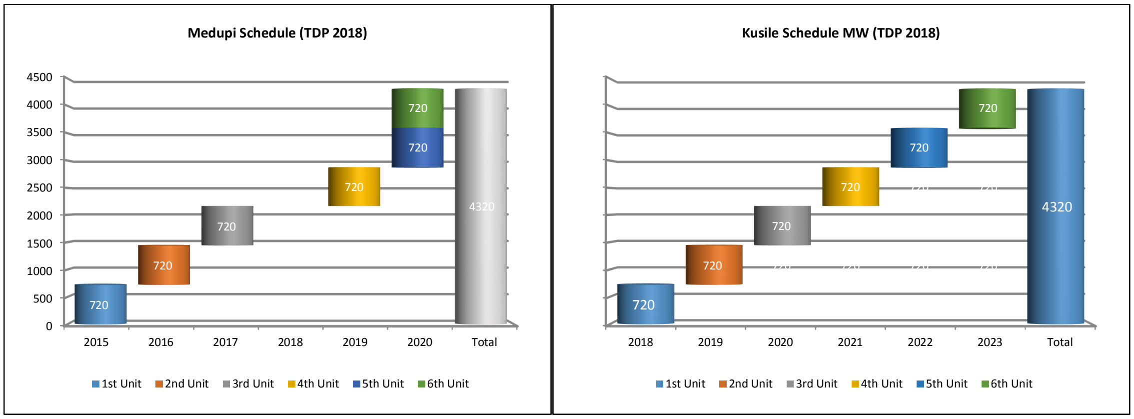


Figure 2-4: Completion schedules for Medupi and Kusile

Co-generation projects and MTPPP

A total of 1 800 MW of co-generation plant has been allocated in the Ministerial Directive issued on 18 August 2015. There is no indication of what size the plant will be and where these plants will be located. The MTPPP programme, which offers PPA contracts to any generators that fall below a certain price level, are not considered at Transmission level as most of the units were less than 20 MW in size. Co-generation plant will be located on existing industrial sites and will therefore have existing network in place, which can be used for the evacuation of the power. Thus, based on the likelihood of existing network and the unknown locations, this co-generation is not considered in the TDP studies. Any large specific co-generation plant will be studied on submission of a generation connection application.

2.5 Coal IPP projects

In October 2016, the Minister of Energy approved approximately 900 MW of new coal generation. This consists of two power stations, Khanyisa (300 MW) and Thabametsi (600 MW). The IRP update has no further provision for new coal-fired power stations beyond the allocated 900 MW. These new power stations will be completed in 2023.

2.6 Nuclear generation

Nuclear generation has been completely removed from the generation assumptions. This is because of the amount of time it takes to construct a nuclear power station and the fact that at the time of the assumptions paper, there was yet no decision on nuclear. There is enough wind generation in the vicinity of Thyspunt and gas generation in the Cape to enable Grid Planning to test the network and cater for the remote eventuality of nuclear being included.

2.7 Future OCGT and CCGT stations

The schedules for the proposed new OCGT and combined-cycle gas turbine (CCGT) are shown in Figure 2-5. New OCGT generation will increase from the current 1 005 MW DoE peakers to 4 005 MW in 2025, whereas approximately 2 200 MW of CCGT is expected between 2025 and 2028. These units will be used as flexible generation due to the increasing levels of variable RE plants, meaning that they can be operated as mid-merit plant.

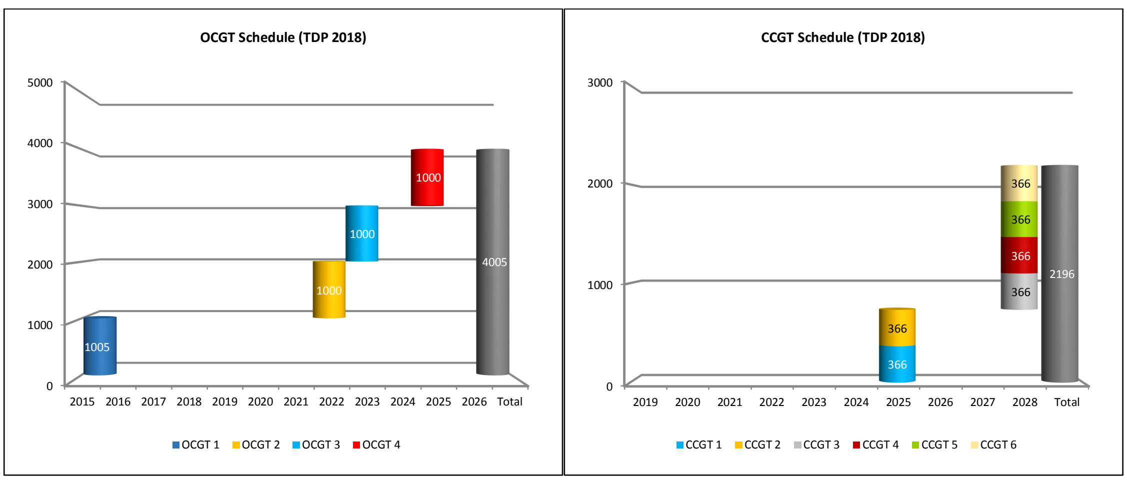


Figure 2-5: OCGT and CCGT schedules in the TDP period

2.8 Imported hydropower

In the past, there was an assumption that about 1 200 MW of imported hydro generation would materialise in the TDP period. The IRP update has no imported hydro in the TDP period. The initial imports from Inga are anticipated in 2030, which is well outside the TDP period.

2.9 REIPP generation

The Government REIPPPP (also known as the REBID programme) has gone out for procurement with windows 1; 2; 3; 3,5; 4; and 4B completed and the successful bidders confirmed or shortlisted. The REBID allows IPPs to bid tariffs within maximum tariff limits for the following renewables:

- Wind
- Biomass
- Small hydro
- Landfill gas
- Concentrated solar
- Photovoltaic (PV)

2.10 Successful and shortlisted RE bidders

For the purposes of the TDP planning studies it is assumed that the successful and shortlisted IPPs for windows 1 to 4B will be in place in the year according to their submission up until 2020.

The renewable generators were modelled as discrete generators per project on the LV busbars (132 kV, 88 kV, or 66 kV) of the MTS substation that either supplies the distribution network that they are connected to or is the point of connection, as the case may be. The purpose is to determine how much the renewable generators offset the load being supplied by the MTS transformers. This modelling philosophy applies to all the types of RE plants that are greater than 5 MW. Each different IPP unit is identified by the unique IPP ID number allocated by the DoE REBID process and grouped into the different types of generation.

2.11 Future RE generation

From 2020 to 2028, RE plants have been allocated at various transmission substations to determine the overall impact on the transmission power flows. The minimum size of plant for PV and wind has been set at 100 MW and multiple units have been placed at some of the substations where more than 100 MW is anticipated.

2.11.1 Wind generation

In order to investigate the potential impact of wind generation, the successful wind plants from windows 1 to 4B of the REBID programme are modelled for 2018 to 2019 as well as proxy wind generators at the assumed allocation of future wind plants for 2020 to 2028.

The future wind generation has been assumed based on, among others:

- the proposed REDZ areas from the Government SIP 8 project
- the Eskom study to map and quantify RE developer interest
- the Eskom proposals to DoE for phased transmission projects to increase grid connection capacity for RE generators
- assessment of RE generation connection applications received by Eskom for the various REIPPPP bid windows
- discussions with the IPP Office on potential sites and their report on IPP generation forecast input for the TDP process

Figure 2-6 shows the schedule for wind generation capacity, the total installed capacity will reach 9,8 GW by 2028.

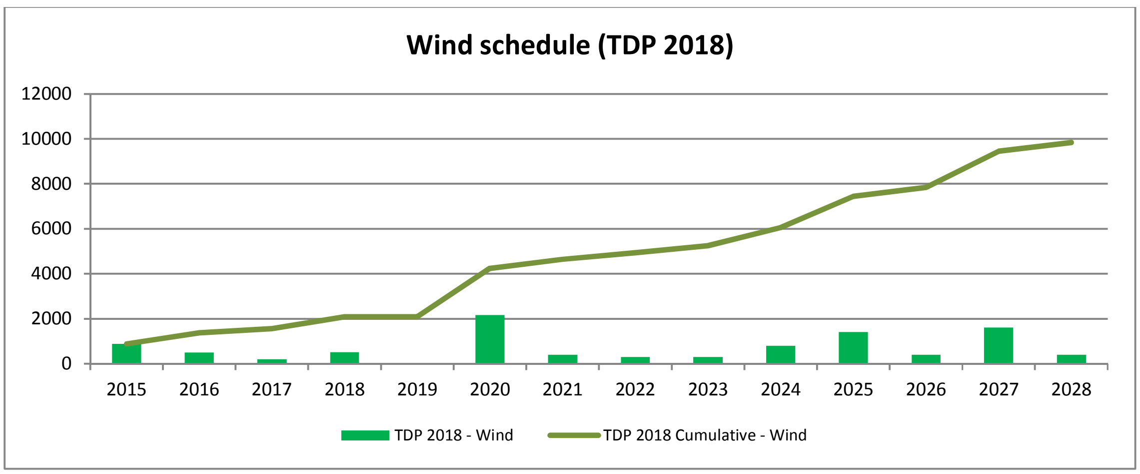


Figure 2-6: Wind schedule in the TDP period

Cumulatively, wind generation will have an impact on the power flows at transmission level under certain operating conditions. For the purposes of TDP studies it is proposed that they be studied under the following operating conditions:

- 30% output at time of system peak (TOSP) all (national - the base case)
- Zero output at TOSP load (national)
- 60% output at TOSP load (national)
- Zero, 30% and 60% output at the local time of grid peak (provincial)

- Zero, 30% and 60% output at system low load (national)
- Full 100% output at the local low load (provincial)
- Zero and 30% output at the local low load (provincial)
- Zero, 30% and 60% output at midday load high (national and provincial)
- Zero, 30% and 0% output at local midday load low (national and provincial)

This is to determine the capacity and potential weakness under extreme generation conditions based on the assumed connection at the MTS substations. For the normal TOSP modelling, the wind generation is set at 30% of rated output, in line with the assumptions utilised for the 2010 IRP studies and recommendations.

2.11.2 PV solar generation

A significant amount of solar PV has been allocated under new build options in the IRP update with approximately 6 300 MW allocated by 2028 as shown in Figure 2-7. PV can only generate when there is sunlight and will therefore not be available for system peak. Effectively, PV does not contribute to meeting the peak system demand or add to the generation at the time of system minimum in the early hours of the morning. Thus, the PV can be excluded for studies of these two network conditions.

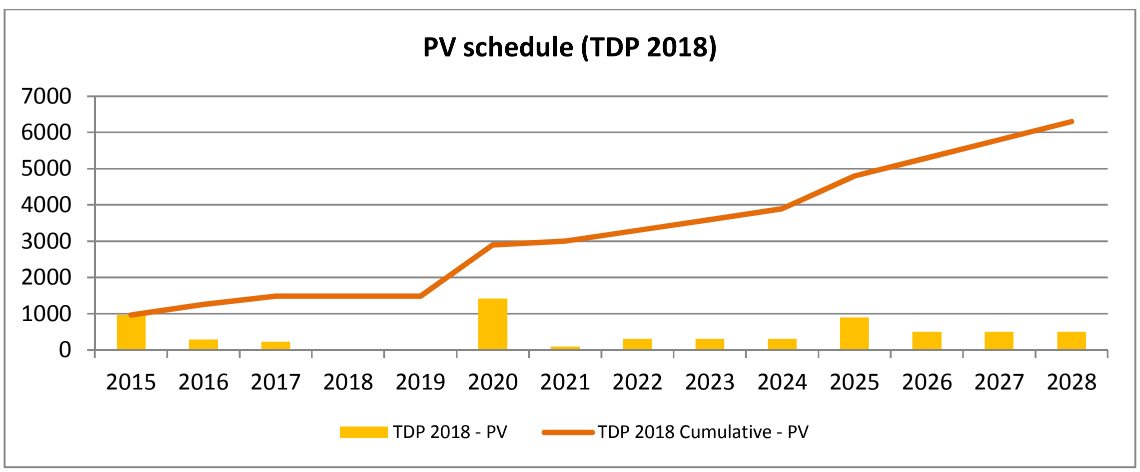


Figure 2-7: PV schedule in the TDP period

The cumulative effect of PV during the daylight hours will have an impact, particularly at peak output during low daytime loading and where they are connected to other generation within an MTS supply area. In order to investigate any potential impact, the successful PV plants from windows 1 to 4B of the REBID programme were modelled for 2017 to 2019 as well as at the assumed allocation of future PV plants for 2020 to 2028.

These generators were *switched off during normal studies for the peak load and low load cases* and only used when studying the daytime network condition. The following network conditions and PV output were studied:

2.11.2.1 System-wide

Midday load high with PV at 95% output (weekday)
Midday load low with PV set at 95% output (weekend)

2.11.2.2 Province-wide

Midday load high with PV at 100% output (weekday)
Midday load low with PV set at 100% output (weekend)

The objective is to identify the risk of network violations for high PV output, the magnitude of impact and whether new transmission lines or transformers would be required, especially for the assumed PV distribution after 2020.

2.11.3 Concentrated solar power (CSP) generation

The total CSP generation has been set at 1 050 MW in the IRP update. For the purposes of the TDP studies, the seven successful CSP projects amounting to 600 MW from the REBID programme have been allocated as follows:

- Ferrum 100 MW
- Garona 50 MW x 2
- Olien 100 MW
- Paulputs 100 MW x 2
- Upington 100 MW

It is assumed that the balance of the IRP allocation for CSP will be in the year 2020 based on 150 MW plants. The capacity has been allocated at Ferrum (150 MW) and Upington (300 MW). These units will be run at maximum output during both the system peak and the local (provincial) peak as well as for the midday load conditions. They will not be run during the low load conditions at night. The CSP schedule is shown in Figure 2-8, the total CSP allocation will be capped at 1 050 MW.

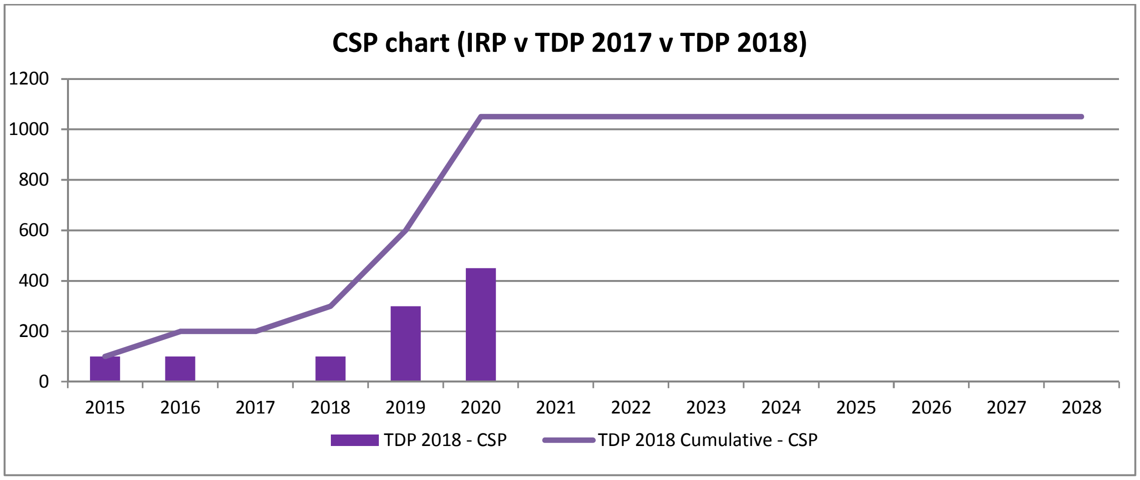


Figure 2-8: CSP schedule for the TDP period

2.12 Other REIPP renewable generation

The majority of the REIPPPP is expected to be wind generation, PV, and CSP with the balance made up of landfill gas, biomass, and small hydro. The landfill and small hydro are a mixture of relatively small units and they are most likely to be connected to the Distribution networks (Eskom or municipal). These were not be modelled on the TS as it is believed that their impact will not be material.

2.13 Assumed generation decommissioning

The 2016 Draft IRP indicates that the initial decommissioning of large coal units will start in 2020. However, the schedule for the decommissioning has not been finalised. As a result, decommissioning schedule assumptions were made in order to assess the impact on the transmission network pending the final decision. According to the latest production schedule from Eskom Generation, decommissioning will start in 2019, with 3 200 MW distributed between Hendrina, Grootvlei, and Komati. The remaining 570 MW will be decommissioned in 2020, as shown in Figure 2-9.

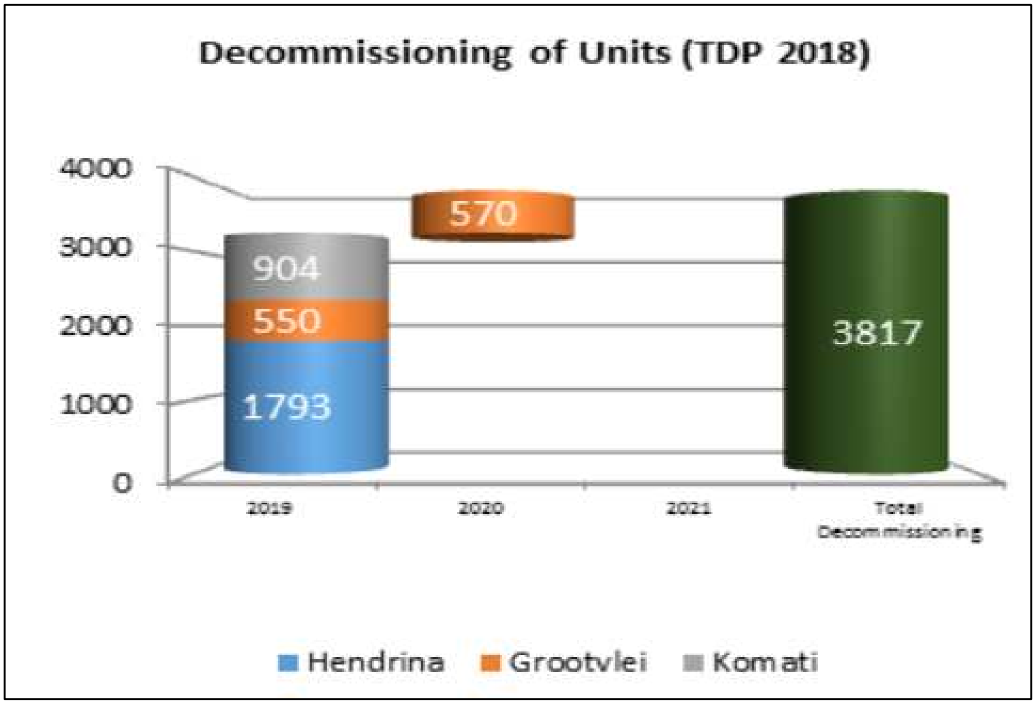


Figure 2-9: Generation reduction assumptions

2.14 Generation scenario studies

The IRP is not specific about the spatial allocation of generators. This creates a problem in terms of the robustness of the plans. For that reason, an agreement was made with the IPP Office, representing the DoE, that the TDP updates would take into consideration alternative generation scenarios. The scenarios are generated by shifting generating units between provinces while keeping the total generation by the end of the TDP period constant. Allocation of alternative sites and the spread of future generation are made from 2020 to 2028, but the main year of consideration will be 2028, when the full impact of these scenarios can be identified.

This section describes the alternative generation scenarios considered for this TDP update to assess their impact on the TDP baseline for this period. The different scenarios are listed below:

The scenarios are as follows:

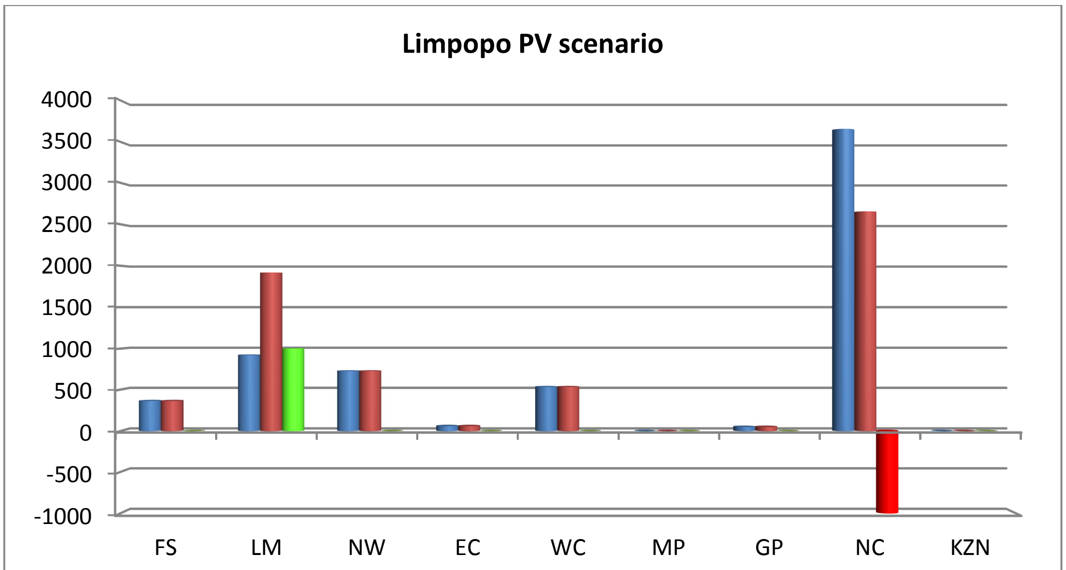
- Limpopo PV scenario
- Northern Cape wind scenario
- Western Cape wind, gas and nuclear scenario
- Generation decommissioning of coal plant older than 50 years

Table A6, Table A7 and Table A8 in Appendix A contains tables with the allocation of the future RE generation using the above scenarios. The tables following indicate the redistribution of the future generation to meet the three alternative generation scenarios.

2.14.1 Scenario 1: Limpopo (solar PV)

The purpose of this scenario is to determine the impact on the transmission network within Limpopo if 1 000 MW of solar PV generation is moved from the Northern Cape to Limpopo. As described, this is not new generation, but generation that is displaced from the Northern Cape to Limpopo. The Limpopo network study should consider the base case as well this scenario to check if the network is still sufficient. If the network is not sufficient, mitigation plans should be proposed. Table A6 in Appendix A shows the generation reallocation under this scenario. The highlighted portion indicates where generation has been reduced and where it has been added, with green showing additions and red showing reductions.

Of the future solar PV, 1 000 MW was allocated to the following locations in Limpopo as alternatives to the baseline allocation. Table A6 in Appendix A shows the movement of PV generation at substation level, and Figure 2-10 shows the total movement at provincial level.



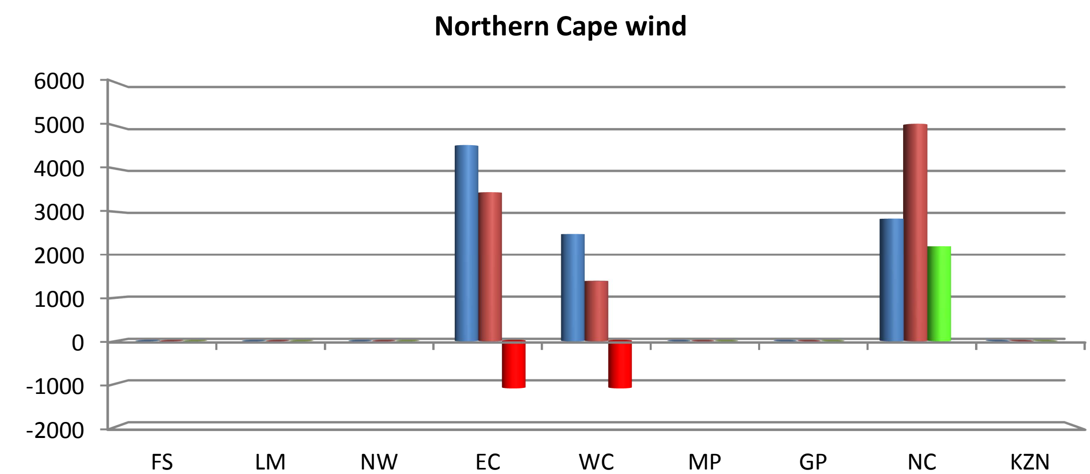
	FS	LM	NW	EC	WC	MP	GP	NC	KZN
Base PV	364	918	725	60	534	0	50	3655	0
Lim PV	364	1918	725	60	534	0	50	2655	0
Difference	0	1000	0	0	0	0	0	-1000	0

Figure 2-10: Limpopo PV scenario generation comparison to base case

2.14.2 Scenario 2: Northern Cape wind scenario

The purpose of this scenario is to determine the impact on the transmission network within the Northern Cape if around additional 2 200 MW of wind generation is moved into the Northern Cape.

The Eastern Cape and Western Cape wind generation can be left at the normal rated output of 30% and the wind in the Northern Cape can run at 100% output. Any network violations should be noted and initial proposals made on how these violations are likely to be mitigated. Table A7 in Appendix A and Figure 2-11 illustrate the scenario in a table as well as a summary graph respectively.



	FS	LM	NW	EC	WC	MP	GP	NC	KZN
Base Wind	0	0	0	4550	2483	0	0	2840	0
NC Wind	0	0	0	3450	1383	0	0	5040	0
Difference	0	0	0	-1100	-1100	0	0	2200	0

Figure 2-11**:** Northern Cape wind scenario comparison to base case generation

2.14.3 Scenario 3: Western Cape wind, gas and nuclear

The purpose of this scenario is to determine the impact on the transmission network within Western Cape if more gas, wind, and nuclear generation are to be relocated from other provinces to this province.

The studies should be run at peak load and low load with all the generation in Western Cape switched as applicable to the generation type. Any network violations should be noted and initial proposals made on how these violations are likely to be mitigated.

This scenario is modelled as follows:

2.14.3.1 CCGT gas stations

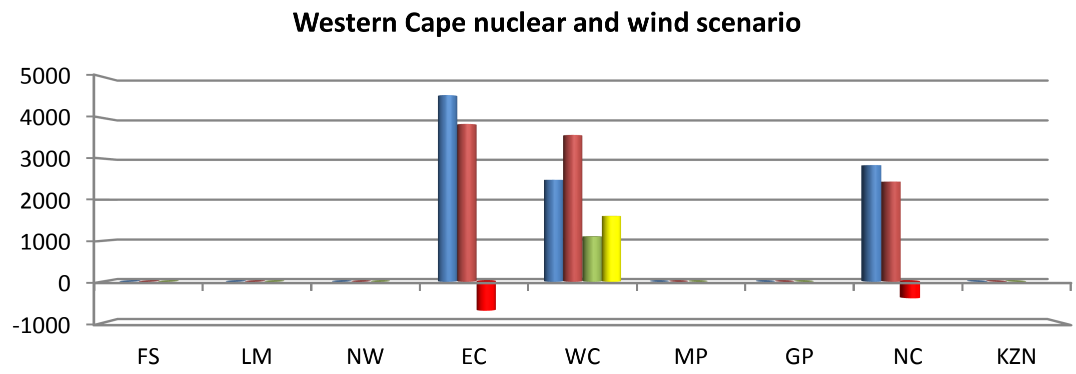
A total of 732 MW of CCGT gas is relocated from Dedisa in the Eastern Cape to Ankerlig in the Western Cape.

2.14.3.2 Nuclear

In this instance, 1 600 MW of nuclear generation is allocated at Duynefontein in the Western Cape in 2028 to test the network in the case nuclear capacity will eventually be built there. It must be noted that the amount of nuclear was already much lower than in the previous TDP.

2.14.3.3 Wind generation

A total of around 1 000 MW of wind was moved from the Eastern Cape and Northern Cape to the Western Cape. Of this total, 1 000 MW was relocated from the Northern Cape and 1 200 MW was relocated from the Eastern Cape. The Eastern Cape and Northern Cape wind generation can be left at the normal rated output of 30% and the wind in the Western Cape can run at 100% output. Any network violations should be noted and initial proposals made on how these violations are likely to be mitigated. This scenario is illustrated in Table A8 in Appendix A and Figure 2-12.



	FS	LM	NW	EC	WC	MP	GP	NC	KZN
Base Wind	0	0	0	4550	2483	0	0	2840	0
WC NW Wind	0	0	0	3850	3583	0	0	2440	0
Difference	0	0	0	-700	1100	0	0	-400	0
Nuclear					1600				

Figure 2-12: Western Cape wind-nuclear scenario comparison to base case generation

2.14.4 Scenario 4: Generation decommissioning of coal plant older than 50 years

This assumptions paper makes reference to three power stations that will be decommissioned in the TDP period as identified by Generation Planning. There are other power stations that will be 50 years old in the TDP period. It is recommended that an additional scenario considering the decommissioning of those plants be studied in the TDP period. To cater for the deficit in generation in the case file, the planners involved in the areas concerned can increase the output from remote renewable generation sources and study the impact in their areas. The additional units included in the impact assessment of higher than estimated level and rate of decommissioning of the baseload power stations older than 50 years are shown in Table A9 in Appendix A.

3 DEMAND FORECAST

Demand forecasting is a fundamental requirement in the Transmission planning cycle. The availability of sufficient transmission network capacity in any country is important to enable economic growth. Eskom's Grid Planning Department, in consultation with the relevant Distribution operating units, metros and municipalities, compiles a forecast per point of supply for the network model.

A double S-curve methodology, combined with normative quantitative and qualitative techniques is used to produce the national forecast scenarios. A balancing algorithm method is then applied to balance the national forecast from the top down to create a forecast per main transmission supply point. This year, the forecast was improved by creating three distinct national scenarios each with its own set of assumptions. A transmission high scenario, a moderate scenario and a low scenario was developed and will now be briefly discussed.

Transmission high scenario

The transmission high scenario (Tx high) is based on assumptions that will take South Africa from a developing country to a developed country and therefore indicates optimistic growth figures in line with the ambitions set by the current National Development Plan (NDP). This high scenario is in line with the projected 3% GDP and GVA-R average year-on-year growth expected for the TDP period 2019 to 2028 with a target network of 65 GW at year 2040. The nominal value of 65 GW was taken from the NDP with an assumption that the past 10 years caused a lag in development rate and therefore the target network was postponed to 2040 from 2030 as stipulated by the NDP document created in 2010. This scenario is optimistic and assumes the return of current suppressed industries due to world economic conditions, and trade contracts influencing imports, exports and local production. The Tx high forecast assumes a national value of 51 GW at TOSP in year 2028, at the end of the TDP period.

Transmission moderate scenario

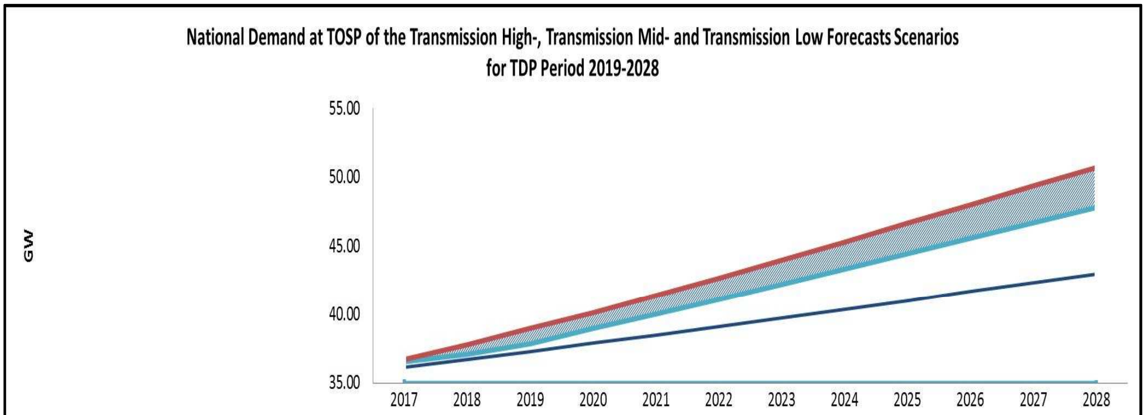
The transmission moderate scenario (Tx Mid) is based on a network scenario where the increase in uptake on alternative energy generation associated with the increase in energy efficiency and decrease in energy intensity are the main determinants in the use of electricity from the Eskom grid. This scenario speaks to phenomena where technology advances in storage and alternative energy generation solutions become increasingly affordable and may surpass the rising cost of electricity. Assumptions were made towards this scenario, incorporating the TDP generation assumptions report as published in March 2017 and regression analysis done on the combined contribution at TOSP by renewable and co-generation sources to simulate the expected growth of technological advanced energy generation and storage sources.

The main assumption of this scenario is that renewable technology and alternative energy generation methods should be taken into account when considering planning for the future. It is assumed that a variable amount of demand in the country will be excluded from the Transmission grid either by the effect of grid defection and thereby off-grid facilitation, smart grid technology and renewable capacity linked up to distribution networks that may take strain off the conventional supply. It is, however, recognised that a main capacity of transmission network is still needed as alternative generation sources but that it may also be facilitated back into the transmission network from generation connection points on either the transmission grid or the distribution grid and should be considered for transfer capacities.

The calculations and assumptions lead to a 6% difference in the value of the national system forecast for the end of the TDP at year 2028, with a capacity value of 48 GW at TOSP.

Transmission low scenario

The transmission low scenario is based on assumptions that there will be a continued suppressed development rate in the country and most of the industries will not return to their original status. This is a pessimistic view in line with the recent junk status economic scenarios. It has also been investigated by the CSIR and the Energy Forecasting Department and has a nominal capacity of 50 GW at the year 2040. This scenario assumes correlation with a low overall economic average growth of 0,7%, lower than the projected GDP and GVA-R Total industry figures. A summary of the three scenarios is shown in Figure 3-1.

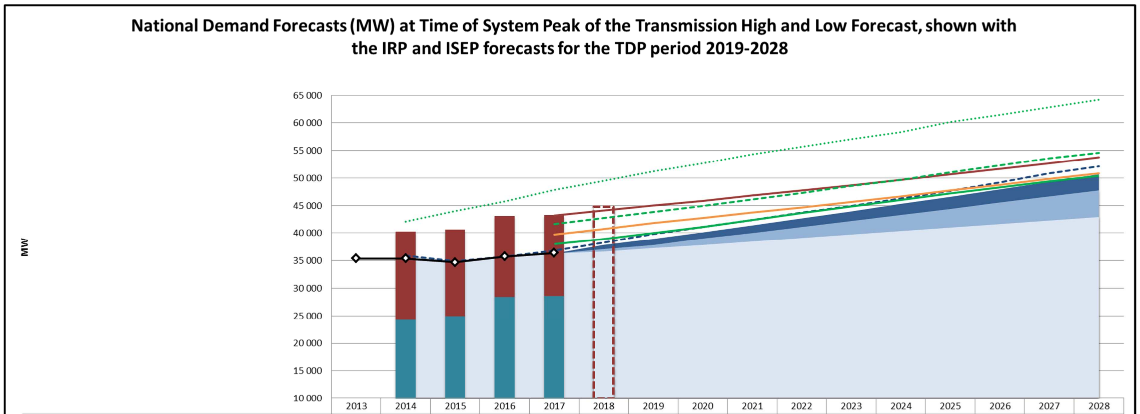


	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Portion of potential DER influence- Off Grid	0.18	0.72	1.10	1.17	1.36	1.56	1.77	1.99	2.21	2.44	2.68	2.93
Maximum System Demand(MSD) Tx Mid (58GW @2040)	36.57	37.12	37.87	38.99	40.04	41.11	42.21	43.32	44.45	45.57	46.69	47.80
Maximum System Demand(MSD) Tx High (65GW @2040)	36.76	37.84	38.97	40.16	41.40	42.67	43.98	45.31	46.66	48.02	49.38	50.73
Maximum System Demand(MSD) Tx Low (50GW @2040)	36.16	36.73	37.31	37.91	38.52	39.14	39.76	40.40	41.04	41.69	42.34	42.99

Figure 3-1: Transmission forecast scenarios for TDP period 2019-2028

These load forecasts, including the projected 2016 Draft IRP load forecast, can be seen in the graph in Figure 3-2. The notified maximum demand (NMD) contractual values for 2015 and 2016 (top and mid-sized customers) are indicated, demonstrating the commitment of the consumers beyond the economic downturn.

While the actual peak demand (indicated by the black line) has been on the decline over the past few years, mainly due to generation constraints, transmission development planning is based on meeting the high forecast. Therefore, the planning process still enables capacity to serve the baseload throughout all feasible network operating conditions.



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
2018 TDP Demand Transmission High (MW) (65GW @2040)		35850	34850	35742	36303	37835	38973	40162	41398	42674	43981	45312	46660	48017	49376	50731
2018 TDP Demand Transmission Medium (MW) (58GW @2040)		35850	34850	35742	36319	37115	37872	38993	40036	41111	42210	43325	44449	45574	46694	47802
2018 TDP Demand Transmission Low (MW) (50GW @2040)		35850	34850	35742	36331	36729	37312	37908	38517	39136	39764	40400	41041	41687	42336	42987
KSACS Customer NMD (MW)		15979	15673	14708	14691											
Distribution Customer NMD (MW)		24295	24943	28369	28549											
Projected Total Customer NMD (MW)						44772										
Customer Growth Projection at 2%					43240	44105	44987	45887	46805	47741	48695	49669	50663	51676	52709	53764
2017 TDP Demand (MW) - Transmission High		35850	34850	35742	36816	38245	39826	41051	42415	43708	44924	46255	47694	49232	50864	52182
2010 IRP Demand (MW)		42129	43994	45786	47870	49516	51233	52719	54326	55734	57097	58340	60150	61500	62850	64200
2016 Base Draft IRP Demand (MW)					41682	42702	43831	44916	46130	47336	48547	49656	51015	52307	53561	54567
2017 Draft IRP Demand (MW)					37961	38948	40039	41108	42371	43612	44856	46029	47207	48324	49405	50387
ISEP 2017					39770	40720	41810	42750	43710	44680	45680	46710	47750	48783	49818	50852
Actual Peak Demand (MW) *Instantanious	35359.9	35343	34695	35742	36359											

Figure 3-2: The Eskom TS demand forecast

4 TRANSMISSION EXPANSION PROJECTS UPDATES

4.1 TRANSMISSION RELIABILITY PROJECTS

This section provides a summary of transmission expansion projects completed since publication of the previous TDP in 2017, as well as all the transmission expansion projects scheduled to be completed within the first five years of the 2018 TDP period. The project lists exclude all the customer-dedicated components of the projects resulting from connection applications received.

Table 4-1: Completed projects since publication of 2017 TDP

Province	Project name
Limpopo	Borutho 400/132 kV substation (2 x 500 MVA transformers)
	Borutho 400 kV loop-in (Matimba-Witkop 1st 400 kV line)
Northern Cape	Garona strengthening: Kronos-Cuprum 1st and 2nd 132 kV
	Garona strengthening Kronos 400_132 kV transformation
	IPP Kathu CSP integration at Ferrum
Eastern Cape	Grassridge-Dedisa 132 kV line
North West	Dinaledi 3rd 500 MVA 400/132 kV 275 kV transformer
Mpumalanga	Normandie extension 2nd 250 MVA 400/132 kV transformer
KZN	Avon 3rd 250 MVA 275/132 kV transformer
	Incandu 3rd 400/132 kV transformer (500 MVA unit)
	Mersey 3rd 250 MVA 275/132 kV transformer

Table 4-2: Projects in execution and planned to be completed by FY2023/24

Province	Project name
Gauteng	Sesiu 400/88 kV integration
	Soweto phase 2 – Quattro 275/132 kV
	Simmerpan phase 1B 275/88 kV and lines
	Soweto phase 1: Quattro 275/88 kV integration
	Tshwane Metro – Wildebees phase 1
	Benburg 3rd 250 MVA 275/132 kV transformer
Limpopo	Foskor-Merensky 275 kV line 2
Mpumalanga	Mulalo 400/132 kV S/S integration
	Emkhiweni 400/132 kV S/S integration
	Benella 450 MW integration for IPP
Northern Cape	Kimberley strengthening phase 2: Ferrum Ext 1st and 2nd 500 MVA 400/132 kV transformers
	Kimberley 400 kV strengthening phase 2: Ferrum-Mookodi (Vryburg) 1st 400 kV line
	Kimberley 400 kV strengthening phase 2: Mercury-Mookodi (Vryburg) 1st 400 kV line
	Northern Cape strengthening: Ferrum-Nieuwehoop 400 kV line
	Aggeneis – Paulputs 220 kV line
	Upington MTS 2nd 500 MVA 400/132 kV transformer for IPPs
	Paulputs Ext 2nd 250 MVA 220/132 kV transformer
	Juno SS: transformers upgrade for Transnet orex load
	Helios: transformers upgrade for Transnet orex load
	Nama MTS Transformers Upgrade
Eastern Cape	PE strengthening phase 3: Poseidon; Delphi; Grassridge; Dedisa Shunt Capacitors
Western Cape	Koeberg 400 kV busbar reconfiguration and transformer replacement – risk reduction
	Muldersvlei 3rd 500 MVA 400/132 kV transformer
North West	Dwarsberg (Dwaalboom) strengthening: 132 kV switching station
	Ngwedi (Mogwase) 2 x 500 MVA 400/132 kV (4 x 500 MVA) S/S

4.2 GRID CONNECTION APPLICATIONS

Table 4-3 outlines the number of cost estimate letters (CELs) / ICEs and budget quotations (BQs) that were processed during the 2017/18 financial year (April 2017 to March 2018). These were as a result of applications for grid connections to the transmission network, according to the South African grid code.

Table 4-3: Connection applications received/issued and accepted in the FY2017/18

Indicative cost estimates		Budget quotations	
Received/Issued	**Accepted**	**Received/Issued**	**Accepted**
56	16 (28,57%)	42	9 (21,43%)

As shown in Table 4-3, CELs and BQs were issued for all the received transmission connection applications received during the FY2017/18. The number of connection applications received during the 2018 financial year (98) was substantially lower than the total of 211 and 200 applications that were received in the 2015 and 2016 financial years respectively, but slightly higher than the 87 quotations received in 2017 financial year. The decline in the number of connection requests is mainly attributable to the reduced number of applications for DoE’s REIPPPP over the past two years. The identities of individual applicants are not reported on, in order to protect the confidentiality of the parties involved.

5 NATIONAL OVERVIEW

Significant lengths of new transmission lines and associated substations and substation equipment are being added to the system. These additions are mainly due to the major 765 kV network reinforcements required for the supply to the Cape and KwaZulu-Natal. The integration of the new Medupi Power Station in the developing Limpopo West Power Pool requires significant additional lengths of transmission line.

The establishment of large-scale RE generation is becoming the primary driver of network development in the three Cape provinces, apart from the Cape Corridor projects, the base metals mining area in the Northern Cape and the established metropolitan load centres of Cape Town, Port Elizabeth, and East London. 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 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 conditions where the system is healthy and is experiencing contingency conditions.

The development of the transmission backbone and the associated regional power corridors was reviewed as part of the Strategic Grid Study, which considered the potential development scenarios beyond the 10-year horizon of the TDP. 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. It also ensures that the most appropriate technologies are used for this purpose by testing whether other technologies (for example, HVDC) would likely yield better, more practical, and more cost-effective solutions.

The additional transformer capacity added to the TS is an indication of the increase in load demand and in the firm capacity requirements of the customers, as well as what is required to achieve compliance with the minimum N-1 redundancy requirements contained in the grid code.

Additional capacitive support is required to support areas of the network under contingency conditions to ensure that the required voltage levels are maintained and enable more expensive network strengthening, such as additional lines to be deferred. It also improves system efficiency by reducing network losses.

Additional shunt 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. They are needed to enable safe and secure operation of the system and to prevent overvoltage during light loading conditions. Some projects have associated distribution projects to enable customers to benefit from them. For example, a new 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.

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

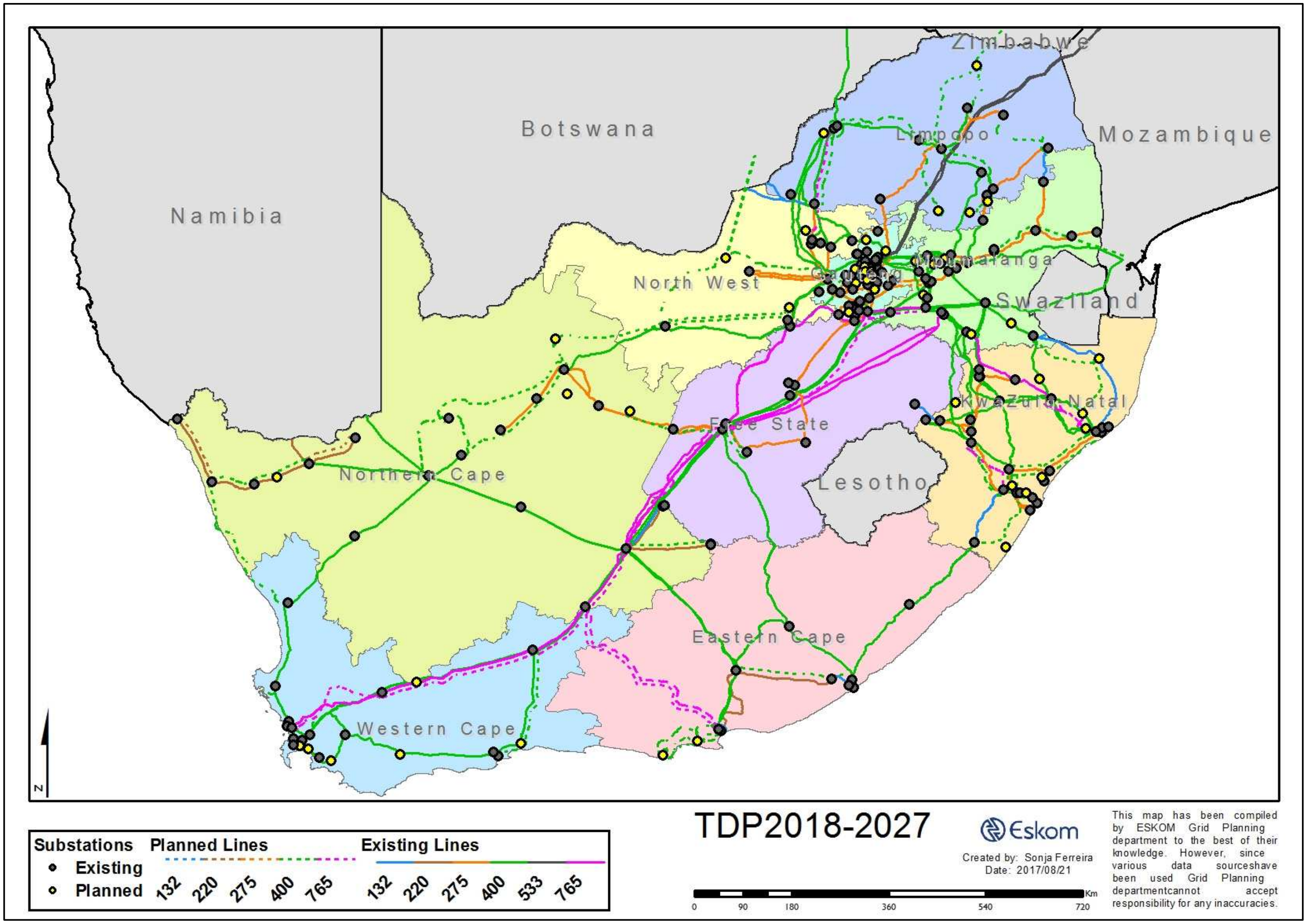


Figure 5-1: Map showing relative location of the major TDP scheme projects

The major new assets that have either been approved or that are planned to be added to the TS over the next 10 years are summarised in Table 5-1.

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

Transmission assets for national view	New assets expected in 2019-2023	New assets expected in 2024-2028	Total new assets
Power lines (km)			
765 kV	98	300	398
400 kV	2 235	3 422	5 657
275 kV	298	182	480
Total length (km)	**2 631**	**3 904**	**6 535**
Transformers			
Number of units	43	72	115
Total capacity (MVA)	**16 630**	**29 270**	**45 900**

6 BREAKDOWN OF THE TDP PROJECTS BY PROVINCE

6.1 GAUTENG

6.1.1 Background

Gauteng is the smallest province by landmass and yet the most populated province in South Africa, due it being the hub of economic activity in South Africa and accounting for about 27% of electricity consumption in the country. The province houses major financial institutions, including the Johannesburg Stock Exchange (JSE), as well as large commercial and industrial establishments. It is home to large industrial zones such as the East Rand, Midrand, and Vanderbijlpark, along with South Africa’s largest cities, Johannesburg and Pretoria, which are the respective capitals of Gauteng and South Africa. Large municipalities (redistributors) are the dominant players, accounting for about 75% of electricity consumption in the province.

The provincial load peaked at 10 231 MW in 2017, and it is expected to increase to about 14 967 MW by 2028. The Gauteng transmission network is predominantly connected at the 275 kV level, with a few transmission stations connected at 400 kV as shown in Figure 6-1. Gauteng comprises six CLNs, namely West Rand, Johannesburg South, Tshwane, East Rand, Johannesburg North, and the Vaal. The East Rand, Johannesburg North, West Rand, and Vaal CLNs consume approximately 61% of the demand in the province, while the Johannesburg South and Tshwane CLNs account for the remaining 39% of the provincial demand. There is a steady increase in demand for electricity supply in Gauteng, which is mainly attributable to commercial and residential developments.

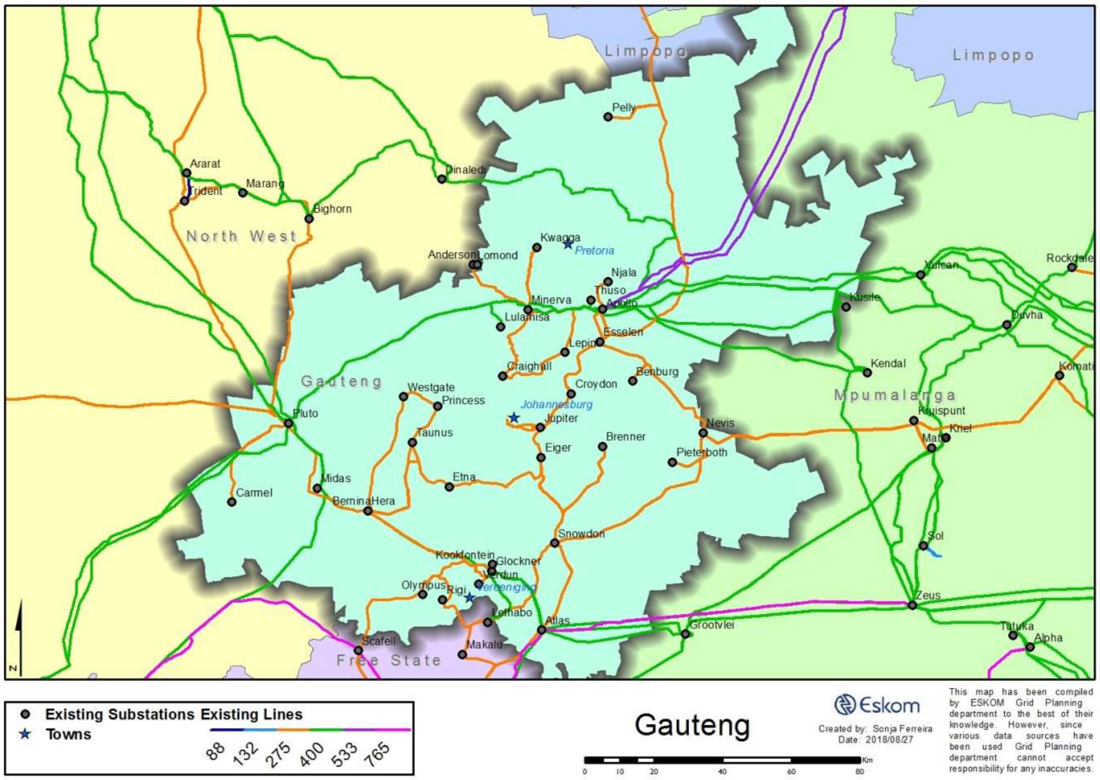


Figure 6-1: Current Gauteng network diagram

6.1.2 Generation

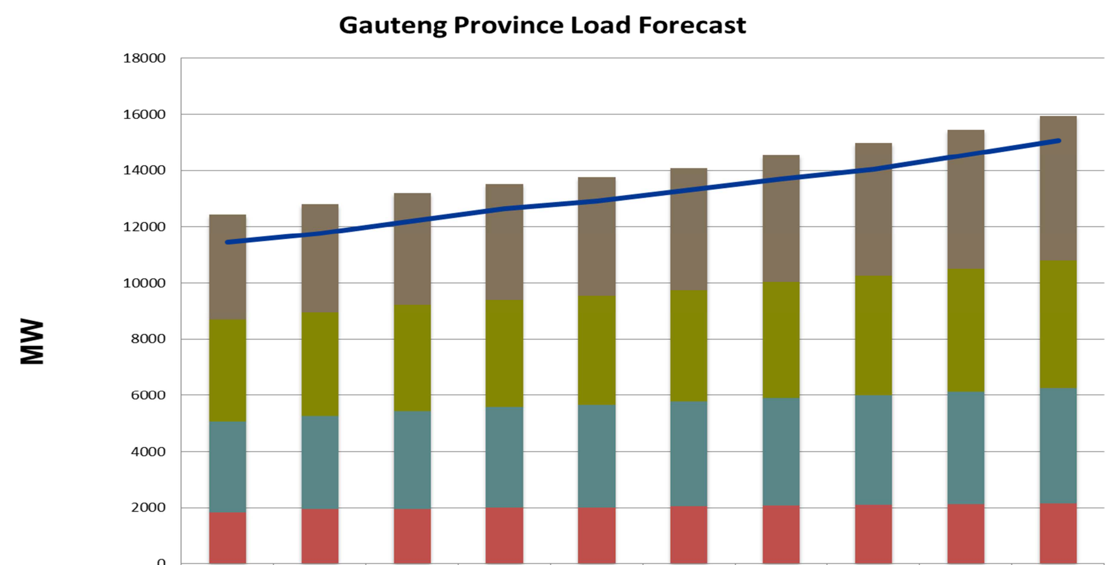
Kelvin Power Station (in Johannesburg) and Rooiwal Power Station (in Tshwane) are currently the only large-scale IPPs that lie within Gauteng. In addition, five small IPP projects with a total capacity of 22,7 MW from landfill gas were approved as part of the DoE REIPP bid round 3 programme.

Most of the power consumed within Gauteng is sourced from the power stations in neighbouring Limpopo, Free State, and Mpumalanga, as well as from Cahora Bassa in Mozambique. The power supply to Gauteng is primarily transported though the Apollo-Cahora Bassa HVDC lines, as well as the HVAC transmission lines from Lethabo, Matla, Kendal, Duvha, Grootvlei, Kusile, and Matimba Power Stations.

6.1.3 Load forecast

The load forecast for Gauteng is shown in Figure 6-2. The economic mix in Gauteng comprises redistributors and gold mines, commercial, and industrial consumers. The unconstrained load growth in Gauteng is forecasted at about 3% annually, from 11 439 MW in 2019 to 15 057 MW by 2028. The Gauteng customer load networks have been reduced from six to four CLNs, namely: East Rand, Johannesburg, Vaal and West Rand CLNs.

Most of the substations in the Johannesburg North and South CLNs were incorporated into a new CLN called Johannesburg. Fordsburg and Prospect were incorporated into the West Rand CLN and Eiger was incorporated into the Vaal CLN. The West Rand CLN is expected to experience the highest rate of load growth, followed by the East and Johannesburg CLNs. The rate of load growth in the Vaal CLN is expected to be the lowest load in the province.



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
West Rand	3749	3841	3966	4113	4213	4334	4508	4721	4942	5138
Johannesburg	3600	3687	3794	3832	3896	3966	4141	4267	4398	4542
East Rand	3248	3314	3476	3579	3629	3717	3813	3889	3985	4100
Vaal	1838	1957	1972	2006	2025	2063	2093	2111	2135	2165
Diversified Grid Peak	11439	11751	12204	12634	12901	13299	13702	14033	14547	15057

Figure 6-2: Gauteng load forecast

6.1.4 Major schemes

The major TDP schemes planned in Gauteng are as follows:

Johannesburg North strengthening

The scheme is required to resolve the thermal and voltage constraints in the Johannesburg North CLN and supports future loads in the Midrand and Tembisa areas. Currently two 150 MVar capacitor banks are being installed at the Lepini Substation 275 kV busbar, and this will be followed by construction of the Apollo-Lepini 275 kV line to increase capacity.

Johannesburg East strengthening: Jupiter B integration

This scheme provides a new power corridor into the Johannesburg CLN and entails construction of the 2 x 400 kV lines (operated at 275 kV) from Matla Power Station to the new transmission switching station in the Germiston area, named Jupiter B (near the existing Jupiter Transmission Substation). At least five transmission lines will be connected to the Jupiter B station, which will increase thermal capacity in the Johannesburg South area.

Johannesburg East strengthening: Mesong (North Rand) integration

This scheme addresses network constraints in the East Rand CLN. The planned upgrade of the existing North Rand Distribution Substation into a transmission substation (named Mesong) and the looping in of the Apollo-Croydon 275 kV line plus terminal equipment upgrades will result in increased transfer limits in the East Rand and Johannesburg CLNs. The Sebenza-Mesong corridor comprising two 400 kV lines (energised at 275 kV) might be developed through the looping in of the Esselen-Jupiter 275 kV line into the new Sebenza MTS. Furthermore, the Sebenza Substation that City Power is building will deload Prospect Substation and create more capacity in the East Rand.

Simmerpan strengthening: Sisimuka (Simmerpan) 275 kV integration

Simmerpan strengthening addresses unfirm transformation at the Jupiter Substation in the Germiston area and alleviates constraints at the Simmerpan 88 kV Distribution Substation, which are attributed to load growth in the Ekurhuleni and East Rand area. Sisimuka 275/88 kV Substation will be energised from the planned new switching substation, Jupiter B, via the existing 1x Jupiter-Simmerpan 275 kV line (currently energised at 88 kV). The 2nd Jupiter-Sisimuka 275 kV line will continue to run at 88 kV until Sisimuka load reaches threshold levels to trigger a second 275/88 kV transformer (expected after 2030). A provision will be made during construction for potential future expansion of the Simmerpan Substation to accommodate 2 x 250 MVA 275/132 kV transformers, subject to load growth in the Croydon 132 kV network.

Vaal strengthening

The scheme entails the construction of two Glockner-Etna 400 kV lines and the uprating of underrated terminal equipment in order to deload the overloaded lines in the Vaal and West Rand CLNs. These lines will be energised at 275 kV voltage level until the need for integrating a 400 kV line at Etna Substation materialises.

Johannesburg Central strengthening

The main purpose of this transmission infrastructure investment scheme is to ensure grid code compliance for the Taunus and Fordsburg Substations, as well as to address the expected thermal constraints in the distribution network. The scope of work includes establishing the new Quattro Substation, which will cater for four 315 MVA 275/88 kV transformers belonging to City Power and two 500 MVA 275/132 kV transformers belonging to Eskom. Two 400 kV lines, energised at 275 kV, will also be built from Etna to Quattro.

West Rand strengthening

This scheme addresses future thermal and voltage constraints of the transmission network, as well as the distribution network constraints in the West Rand area. The project entails establishing a 400 kV line at Westgate, building the Hera-Westgate 400 kV line and installing a 500 MVA 400/132 kV transformer at Westgate.

Tshwane reinforcement

The Tshwane reinforcement schemes address the transmission substation’s firm capacity constraints due to load increases in the Tshwane CLN. The project entails establishing two new transmission substations in Tshwane CLN; one to the north (near Soshanguve) and the other east of Tshwane (near Mamelodi).

The TDPs for Gauteng are shown in Figure 6-3.

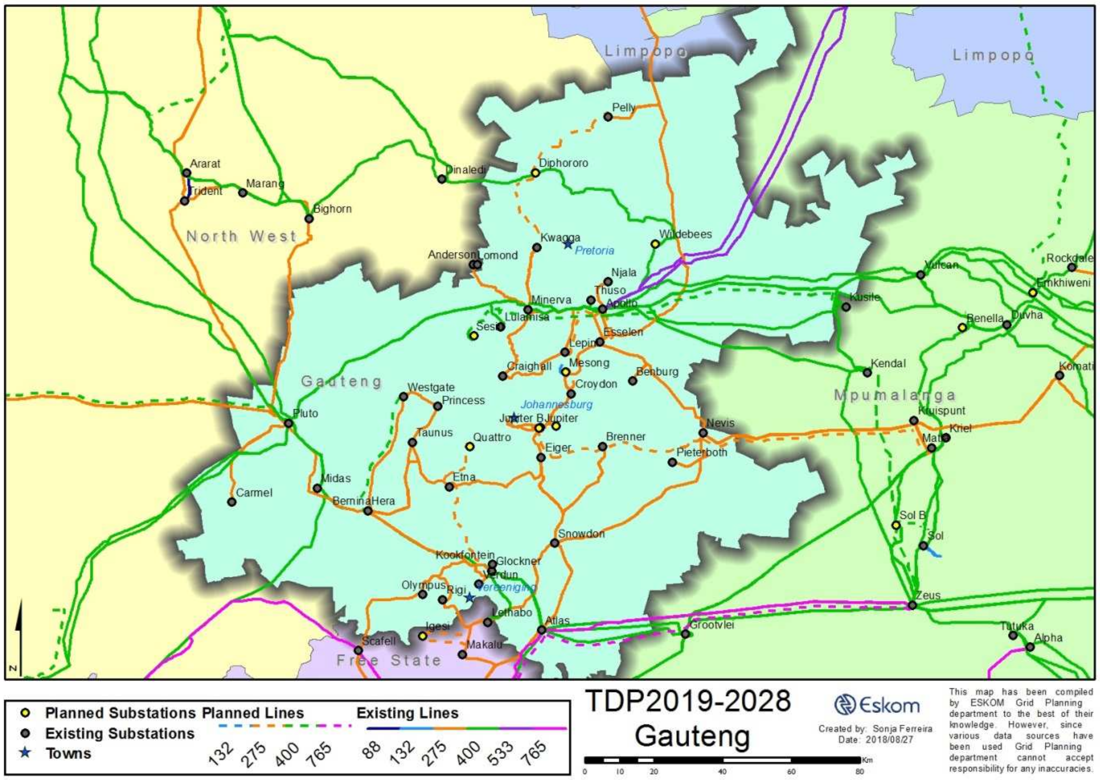


Figure 6-3: Future Gauteng network diagram

6.1.5 New substations

The following new substations will be established in Gauteng in order to address load growth:

Load growth in the East Rand CLN will necessitate the introduction of the following 400/132 kV substation:

- Lesokwana Substation in the Ekurhuleni area

Load growth in the Johannesburg CLN will necessitate the introduction of the following 400/132 kV substation:

- Sesiu Substation in the Dalkeith area

6.1.6 Reactive power compensation

The following capacitor banks will be installed for voltage support in Gauteng:

- 2 x 48 MVar capacitor bank at Etna 88 kV
- 1 x 72 MVar capacitor bank at Taunus 132 kV
- 1 x 72 MVar capacitor bank at Quattro 132 kV
- 2 x 48 MVar capacitor bank at Brenner 88 kV
- 2 x 150 MVar capacitor bank at Lepini 275 kV

6.1.7 Provincial summary

A summary of all projects and scheme planned for this province is provided in Table 6-1.

Table 6-1: Gauteng– summary of projects and timelines

<table>
<tr><th>TDP scheme</th><th>Project name</th><th>Expected CO year</th></tr>
<tr><td>Benburg 3rd transformer</td><td>Benburg Ext 275/132 kV 250 MVA 3rd transformer</td><td>2017</td></tr>
<tr><td>JHB North strengthening phase 1</td><td>Lepini Ext 275 kV 2 x 150 MVar capacitors (project currently in construction)</td><td>2017</td></tr>
<tr><td>Brenner strengthening phase 1</td><td>Brenner 2 x 88 kV 48 MVar capacitors</td><td>2019</td></tr>
<tr><td rowspan="3">Waterberg fault level Project</td><td>Waterberg fault level project : Midas Substation</td><td rowspan="2">2019</td></tr>
<tr><td>Waterberg fault level project: Apollo Substation</td></tr>
<tr><td>Waterberg fault level project: Pluto Substation</td><td>2021</td></tr>
<tr><td>Vaal strengthening phase 2</td><td>Glockner-Etna 1st and 2nd 400 kV line (operate at 275 kV)</td><td>2020</td></tr>
<tr><td rowspan="2">Tshwane reinforcement: Diphororo phase 1</td><td>Diphororo Ext 400/132 kV Substation (1st and 2nd 500 MVA transformers)</td><td rowspan="2">2021</td></tr>
<tr><td>Diphororo 400 kV loop-in (Apollo-Dinaledi 400 kV line)</td></tr>
<tr><td>Tshwane reinforcement – Wildebees phase 1</td><td>Wildebees 400/132 kV (Customer 2 x 315 MVA transformers) and Apollo-Dinaledi 400 kV line into Wildebees</td><td>2021</td></tr>
<tr><td rowspan="3">Johannesburg Central strengthening</td><td>Etna-Quattro 1st and 2nd 400 kV lines (energised at 275 kV)</td><td rowspan="3">2021</td></tr>
<tr><td>Quattro 275/88 kV Substation (400/88 kV construction) (City Power 1st and 2nd 315 MVA transformers)</td></tr>
<tr><td>Quattro 275/132 kV Substation (400/132 kV construction) (1st and 2nd 500 MVA transformers)</td></tr>
<tr><td rowspan="2">JHB North strengthening: Demeter 400 kV integration</td><td>Loop-in Pluto-Thuso 400 kV into Demeter</td><td rowspan="2">2022</td></tr>
<tr><td>Demeter 400/88 kV transformation (1st, 2nd and 3rd 315 MVA transformers and 400 kV busbar)</td></tr>
<tr><td rowspan="2">Simmerpan 275 kV integration phase 1</td><td>Jupiter B-Simmerpan 1st and 2nd 275 kV lines (uprate of 88 kV lines)</td><td rowspan="2">2023</td></tr>
<tr><td>Simmerpan 275/88 kV Substation (expand existing Distribution substation)
(2 x 315 MVA transformers)</td></tr>
</table>

JHB North strengthening phase 2	Apollo-Lepini 1st 275 kV line	2024
West Rand strengthening phase1	Westgate 400/132 kV Substation (1st 500 MVA transformer)	2025
	Hera-Westgate 1st 400 kV line	
West Rand reactive power project	1 x 48 MVar cap banks at Princess 88 kV	2026
	1 x 72 MVar cap bank at Taunus 132 kV	
	1 x 72 MVar cap at Quattro 132 kV	
	1 x 72 MVar cap at Westgate 132 kV	
JHB East strengthening: North Rand integration	North Rand Ext 2 x 500 MVA 275/132 kV transformers	2027
	North Rand-Sebenza lines (to be energised at 275 kV)	
	North Rand-Chloorkop 1st and 2nd 132 kV lines	
	Connect Esselen-North Rand 1st 275 kV line (currently operated at 132 kV) to the North Rand 275 kV busbar	
	Bypass Chloorkop S/S with Esselen-Chloorkop 132 kV and Chloorkop–North Rand 132 kV to form Esselen-North Rand 2nd 275 kV line (currently operated at 132 kV)	
	Construct a 15 km double circuit 400 kV line (to be energised at 275 kV) from Apollo towards Esselen and bypass Esselen by connecting the double circuit line to the Esselen-North Rand 1 and two 275 kV lines to form two Apollo-North Rand 275 kV lines	
JHB East strengthening: Jupiter B integration	Jupiter B 275 kV Switching Station	2024
	Matla-Jupiter B 1st and 2nd 400 kV line (operated at 275 kV)	2027
	Jupiter B 275 kV loop-ins (Prospect-Sebenza 1 and 2, Jupiter-Prospect 1, Jupiter-Fordsburg 1)	2028
Brenner strengthening phase 2	Lesokwana (Brenner B) 275/88 kV (built at 400 kV)	2027
	Loop-in and out Snowdon-Brenner and Matla-Jupiter B 275kV lines into Lesokwana	
Tshwane reinforcement: Phoebus phase 2	Phoebus/Diphororo 400/275kV Substation (1st and 2nd 400 MVA 400/275 kV transformers)	2027
	Phoebus (Diphororo)-Kwagga 1st 275 kV line	
	Pelly-Phoebus/Diphororo 1st 275 kV line (energise Hangklip-Pelly 132 kV line)	

6.2 KWAZULU-NATAL (KZN)

6.2.1 Background

KwaZulu-Natal is situated on the eastern seaboard of South Africa, along the Indian Ocean. The capital of the province is Pietermaritzburg, with its largest city being Durban. The provincial economy is mainly driven by activities concentrated around the port of Durban and the capital, Pietermaritzburg, with significant contributions in the Richards Bay-Empangeni area, the Ladysmith-Ezakheni area and the Newcastle-Madadeni regions.

The port of Durban and the Richards Bay harbour play a key role in the import and export of goods to South Africa and the neighbouring countries. Between these two seaports, the province has also established the Dube Tradeport as an air logistics platform to promote access to global trade and tourist nodes. It opens up new opportunities for the production and export of high-value perishable products and manufactured goods and to ship them directly from the King Shaka International Airport. The Dube Tradeport and the Richards Bay Industrial Development Zone have been designated as Special Economic Zones, providing incentives to attract potential investors to the province. These zones are linked to a number of agri-parks and industrial economic hubs, which are being established to offer strong production linkages as well as clustering potential.

The provincial electricity demand peaked at around 6 221 MW in 2017 and is expected to increase to about 7 562 MW by 2028. The main transmission supply network to KwaZulu-Natal is predominantly connected at 400 kV voltage level, with the local transmission stations predominantly connected at 275 kV as shown in Figure 6-4. The KwaZulu-Natal grid comprises four CLNs, namely Empangeni, Ladysmith, Newcastle, and Pinetown. The Empangeni and Pinetown CLNs are the two main load centres in the province, consuming approximately 29,8% and 52,7% of the load respectively. The Ladysmith and Newcastle CLNs make up the remaining 17,5 % of the demand in the province. The current transmission network is shown in Figure 6-4.

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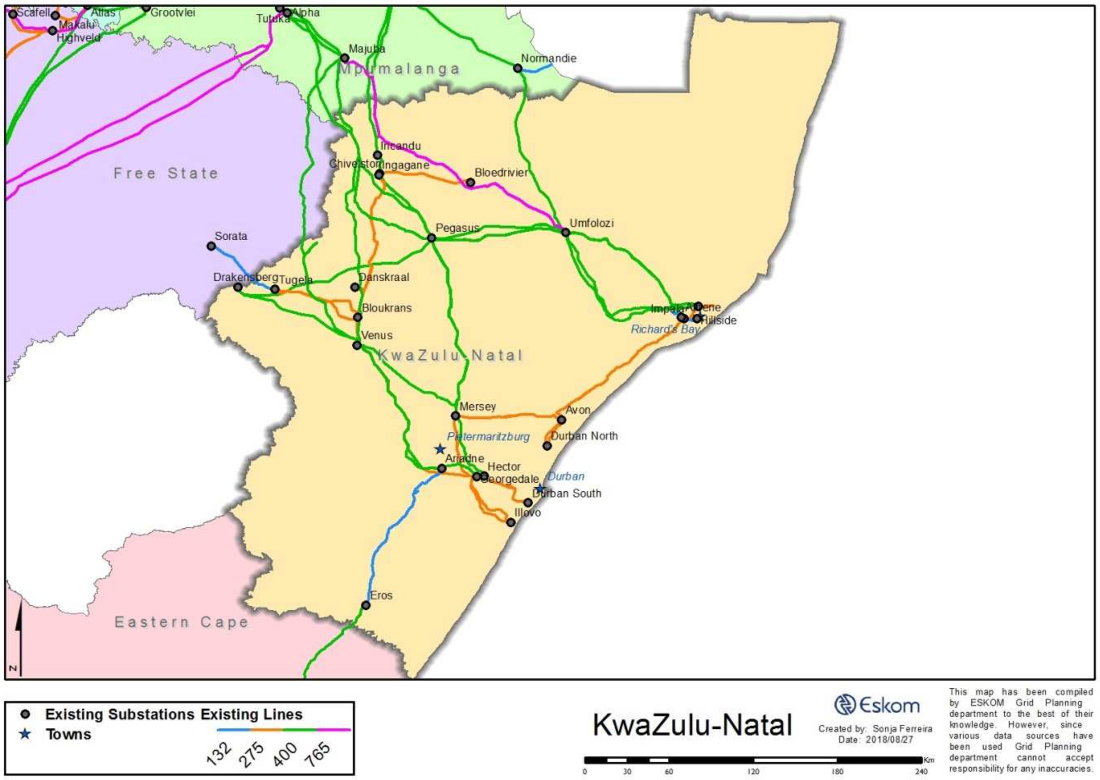


Figure 6-4: Current KZN transmission network

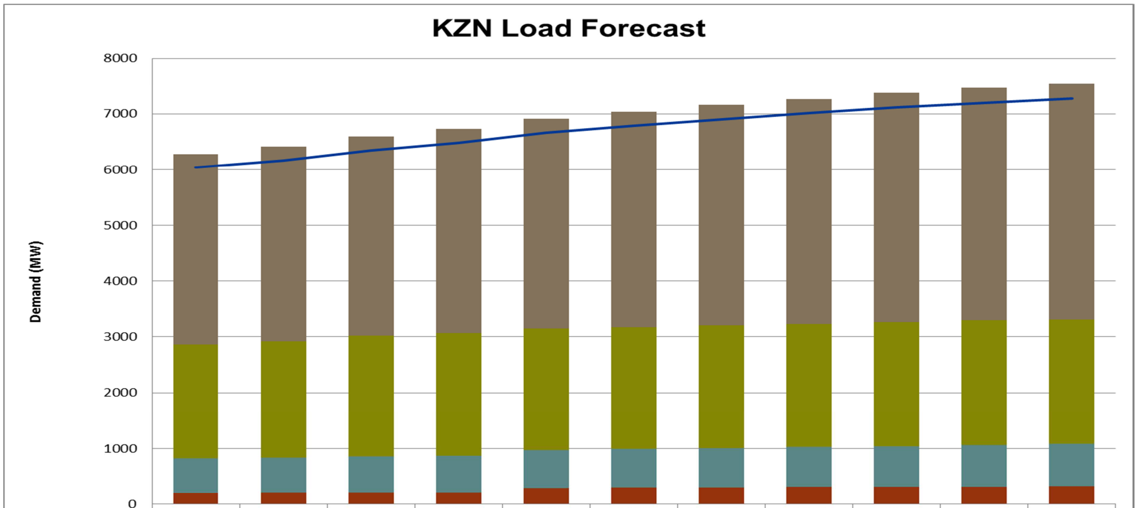
6.2.2 Generation

Drakensberg and Ingula Pumped Storage Schemes are the only power stations that lie within the defined KwaZulu-Natal borders. Most of the power consumed within this province is sourced from the power stations in Mpumalanga.

The 2016 Draft IRP has allocated approximately 2 000 MW of gas plant around the Richards Bay harbour. It is part of the 3 000 MW gas-to-power initiative.

6.2.3 Load forecast

The economic mix in KwaZulu-Natal comprises redistributors, commercial customers, and industrial customers. The load in KwaZulu-Natal is forecasted to grow steadily at about 2% annually, from 6 281 MW in 2018 to 7 562 MW by 2028. The highest provincial load growth is expected in the Pinetown and Empangeni CLNs due to industrial, commercial, and residential developments. The load forecast for the KwaZulu-Natal is shown in Figure 6-5.



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Pinetown	3411	3491	3579	3667	3755	3849	3940	4024	4107	4164	4221
Empangeni	2049	2084	2165	2193	2184	2196	2212	2218	2229	2240	2241
Newcastle	615	631	645	660	675	689	704	718	732	746	759
Ladysmith	203	206	209	213	295	300	304	307	311	316	320
TOSP	6040	6169	6348	6476	6662	6783	6903	7008	7116	7201	7275
Grid Peak	6279	6412	6598	6732	6925	7051	7176	7285	7397	7485	7562

Figure 6-5: KZN load forecast

6.2.4 Major schemes

The major schemes for KwaZulu-Natal are as follows:

KZN 765 kV strengthening

The KZN 765 kV strengthening project entails establishing 765 kV in the Pinetown and Empangeni areas, which will run from the power pool in the north and integrate it with the 400 kV network in both areas. The Pinetown and Empangeni 765 kV networks will also be linked via two 400 kV lines. The project will be executed in various stages. The trigger for each stage will be the growth in demand (generation and/or load).

South Coast strengthening: St. Faiths 2 x 500 MVA 400/132 kV Substation

This includes construction of the second Ariadne-Eros 400 kV 132 kV multi-circuit line and establishment of St. Faiths 400/132 kV Substation near Port Shepstone. The trigger for St. Faiths Substation will be demand growth along the South Coast.

eThekwini Electricity Network strengthening (GP_14/15) – This project involves:

- The establishment of Shongweni 2 x 500 MVA 400/132 kV Substation and the construction of two 400 kV lines from Hector to the proposed Shongweni Substation to deload the Hector 400/275 kV transformers, the Hector-Klaarwater 275 kV lines and the Klaarwater Substation. It will also cater for the planned developments west of the eThekwini metropolitan.
- The establishment of Inyaninga 2 x 500 MVA 400/132 kV Substation by looping into one of the planned Isundu-Mbewu 400 kV lines to form Isundu-Inyaninga 400 kV line and Inyaninga-Mbewu 400 kV line. This substation will deload the Mersey-Avon 275 kV system and provide supply to the Dube Tradeport development.

NKZN strengthening: Iphiva 2 x 500 MVA 400/132 kV Substation

This project involves the establishment of Iphiva 400/132 kV Substation around Candover-Mkuze to address supply constraints around Pongola, Makhatini Flats, and iSimangaliso (Greater St. Lucia) Wetland Park. The planned Iphiva Substation will be supplied by two 400 kV lines, namely Normandie-Iphiva and Duma-Iphiva 400 kV lines. The Duma Substation is part of the planned Ermelo-Richards Bay coal link upgrade.

Ariadne Substation strengthening

Grid Planning is currently investigating options either to increase the transformation capacity at Ariadne Substation or to strengthen the 132 kV interconnection between Mersey Substation and Ariadne Substation to provide backup for transformer outages at the Ariadne Substation.

The TDPs for KwaZulu-Natal are shown in Figure 6-6.

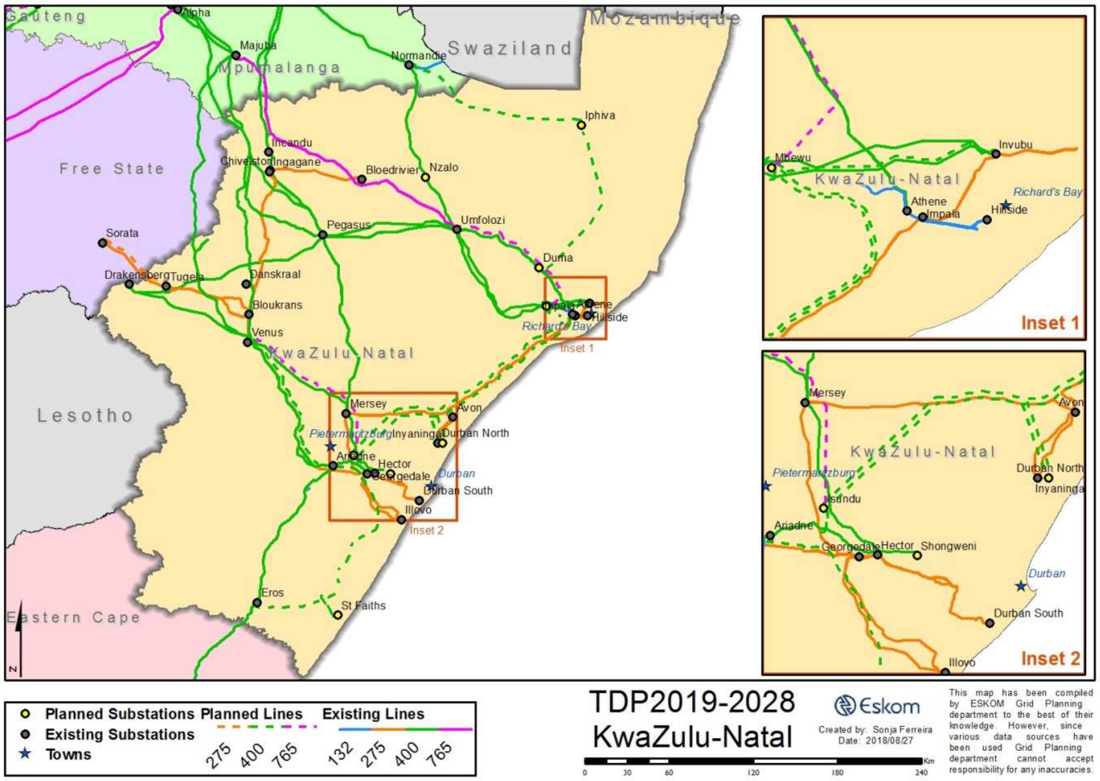


Figure 6-6: Future KZN network diagram

6.2.5 Reactive power compensation

Within KwaZulu-Natal there are plans to:

- Refurbish the Athene Static Var Compensator (SVC)
- Decommission the Impala SVC
- Reconfigure the Illovo SVC and only retain the 100 MVar capacitor bank

6.2.6 Provincial summary

A summary of all projects and scheme planned in KwaZulu-Natal is provided in Table 6-2.

Table 6-2: KZN– summary of projects and timelines

TDP scheme	Project name	Expected CO date
Transnet coal-line upgrade	3 of 1 x 160 MVA 400/88 kV Substations	Customer dependent
	Loop-in Camden-Normandie 1 400 kV line, Normandie-Umfolozi 1 400 kV line and Pegasus-Athene 1 400` kV line respectively	
Ariadne-Venus 2nd 400 kV line	Ariadne-Venus 2nd 400 kV line (recycle Georgedale-Venus 1 or 2 275 kV line)	2020
KZN 765 kV strengthening - Empangeni integration	Mbewu 400 kV Switching Station	2023
	Loop-in Athene-Umfolozi 1 400 kV line and Invubu-Umfolozi 1 400 kV line into Mbewu Substation	
	Umfolozi-Mbewu 765 kV line (extension of Majuba-Umfolozi 1 765 kV line), operate at 400 kV	
	Invubu-Mbewu 2nd 400 kV line	
	Establish 400 kV feeder bay for Mbewu-Umfolozi 765 kV line	
KZN 765 kV strengthening - Pinetown integration	Isundu 400 kV Switching Station	2027
	Isundu-Venus 765 kV line (operated at 400 kV)	
	Ariadne-Isundu 400 kV line	
	Hector-Isundu 400 kV line	
KZN 765 kV strengthening - 400 kV lines	Isundu-Mbewu 1st and 2nd 400 kV lines	2031
eThekwini electricity network strengthening	Inyaninga 2 x 500 MVA 400/132 kV Substation	2029
	Loop-in Isundu-Mbewu 1 400 kV line into Inyaninga Substation	
	Shongweni 2 x 500 MVA 400/132 kV Substation	2027
	2 x Hector-Shongweni 1st and 2nd 400 kV lines	
South Coast strengthening	Ariadne-Eros 2nd 400 kV line	2021
	St. Faiths 2 x 500 MVA 400/132 kV Substation	2030
	Loop-in Ariadne-Eros 2 400 kV line into St. Faiths Substation	2030
NKZN strengthening phase 1	Iphiva 400 kV busbar	2026
	Normandie-Iphiva 1st 400 kV line	
	Iphiva 1 x 500 MVA 400/132 kV transformer	
NKZN strengthening phase 2	Duma-Iphiva 1st 400 kV line	2028
	Iphiva 1 x 500 MVA 400/132 kV transformer	
Ariadne 3rd 500 MVA 400/132 kV transformer	Ariadne 3rd 500 MVA 400/132 kV transformer	2027

6.3 LIMPOPO

6.3.1 Background

Limpopo is situated on the most northern part of South Africa and is named after the Limpopo River. The largest city in the province is Polokwane, and the province shares international borders with Botswana, Mozambique and Zimbabwe. The provincial economy is mainly driven by mining, exporting primary products, and importing manufactured goods.

The Northern Grid consists of three CLNs, namely Lephalale, Polokwane, and Phalaborwa. Each CLN is made up of a number of main transmission substations (MTS). The MTS are interconnected through 400 kV, 275 kV as well as through the 132 kV underlying distribution network. The Polokwane and Phalaborwa CLNs consume approximately 38% of the total load in Limpopo each, while the Lephalale CLN consumes the remaining 24%.

The Lephalale CLN is the only CLN that experienced load growth in this period. The load increased by 30,5% when compared to last year's CLN peak. This was due to the new Borutho Substation taking load on 21 March 2017, which peaked at 196 MW during this period, deloading Polokwane CLN. Polokwane CLN peaked at 1 158 MW. This was only 22 MW less than last year's peak of 1 180 MW. The Phalaborwa CLN's peak loading increased from 1 135 MW to 1 136 MW, a total increase of 0,09%.

Growth in Limpopo is primarily due to the platinum group metals (PGMs), ferrochrome mining and processing activities, located in the Polokwane and Steelpoort areas. The establishment of coal mines is a key driver for expansion in the Lephalale area. There are also large electrification projects underway throughout Limpopo.

Figure 6-7 shows the geographical diagram of the existing Northern Grid transmission network.

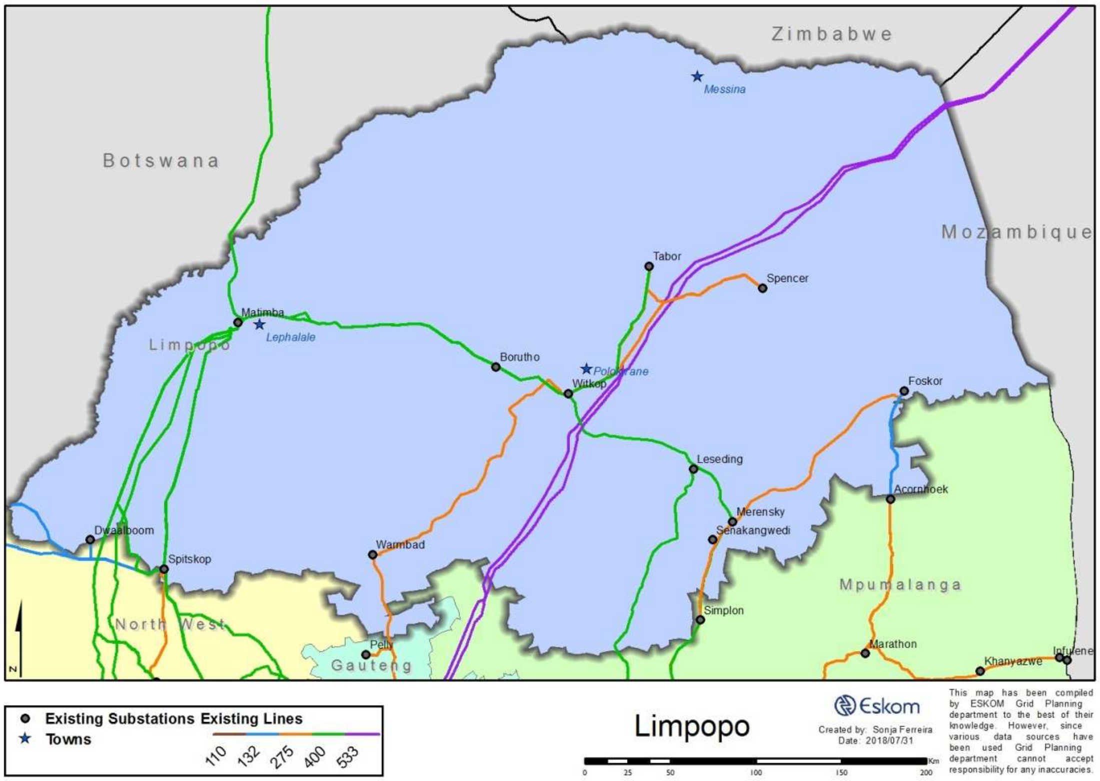


Figure 6-7: Current Limpopo network diagram

6.3.2 Generation

The baseload generation in Limpopo is located in the Lephalale area, which is rich in coal reserves. There are two coal-fired power stations located in this area, namely the new Medupi Power Station and the existing Matimba Power Station. On completion, the Medupi Power Station together with the Matimba coal-fired Power Station will provide almost 8,5 GW of generation to the South African grid. Imported generation from Botswana is expected to be limited to approximately 150 MW in this TDP period, with the integration of the Morupule B Power Station.

Matimba Power Station: The coal-fired power station is designed to generate 3 990 MW. Matimba, the Tsonga word for "power", is the largest direct dry-cooled power station in the world, with 6 x 665 MW turbo-generator units.

Medupi Power Station: Medupi Power Station will have a nominal generating capacity of 4 356 MW (6 x 726 MW units) to be verified. On completion, Medupi Power Station will be the largest dry-cooled power station in the world. It will be 25% larger than the existing Matimba Power Station in terms of operation, design, and dimensions.

Thabametsi Power Station: Thabametsi Power Station will have a nominal generating capacity of 600 MW (2 x 300 MW units).

Table 6-3 shows a summarised list of baseload generation capacity in Limpopo.

Table 6-3: Generation capacity for Limpopo

Scenario description	Number of units in specified operating mode at each power station		
	Matimba Power Station	**Future Medupi Power Station**	**Future Thabametsi Power Station**
Type	Baseload	Baseload (By 2020)	Baseload (By 2022)
Total capacity (MW)	3 990 MW	5 076 MW	630 MW
Normal operation for planning studies	6 x 665 MW	6 x 846 MW	2 x 315 MW

6.3.3 Renewable generation

Three photovoltaic (PV) RE plants have been integrated in Limpopo:

TABOR PV PLANT: The Tabor PV Plant (28 MW) was integrated with the Tabor Substation 132 kV undelaying network in the Polokwane CLN in 2014. It is directly connected to Distribution's Soutpans 132/22 kV Substation in the northern part of the province.

WITKOP PV PLANT: Witkop PV Plant (30 MW) was integrated with the Witkop Substation 132 kV busbar in the Polokwane CLN in 2014. It is directly connected to the Tabor Substation near Polokwane.

MATIMBA PV PLANT (TOM BURKE): Matimba PV Plant (60 MW) was integrated with Matimba Substation 132 kV undelaying network in the Lephalale CLN in 2016. It is directly connected to Distribution's Tom Burke 132/22 kV Substation in the northwestern part of the province.

6.3.4 Load forecast

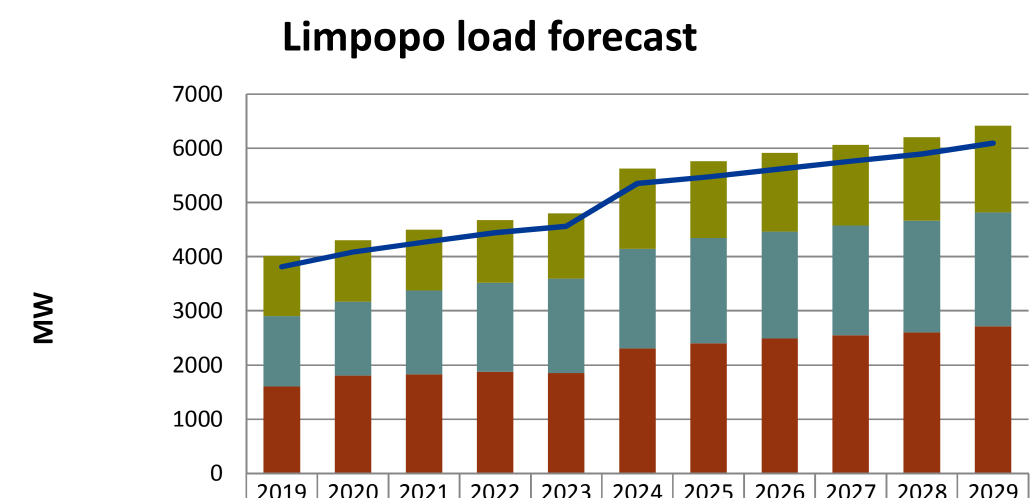
The CLNs in the Northern Grid are expected to experience positive growth over the next ten years. The Lephalale CLN will have a steady growth rate at 8,9%. This can be attributed to the heavy industry expected and the resulting light industry together with commercial and residential developments as spin-offs.

Mining activities are also expected in the areas of Lephalale CLN, the introduction of Borutho Transmission Substation will cater for these expected new mining loads in the surrounding areas of Mokopane.

The Polokwane CLN is expected to experience a load growth of 9%. The introduction of the Nzhelele Transmission Substation will make additional capacity available for the new mines and residential developments expected in the area.

The Phalaborwa CLN is expected to grow by 6%, which is attributable to the increase in mining activities and possible smelting operations near Leseding MTS.

The load in Limpopo is forecasted to grow steadily at about 4,1%, from 3 810 MW in 2019 to 5 896 MW by 2028. The load forecast for Limpopo is shown in Figure 6-8.



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Polokwane	1108	1132	1120	1156	1203	1484	1413	1452	1489	1546	1598
Lephalale	1301	1365	1551	1641	1741	1835	1944	1973	2027	2060	2101
Phalaborwa	1602	1802	1823	1876	1855	2310	2403	2489	2546	2600	2716
Limpopo Grid Peak	4011	4299	4494	4673	4799	5629	5760	5914	6062	6206	6415
Limpopo Grid (TOSP)	3810	4084	4269	4439	4559	5348	5472	5618	5759	5896	6094

Figure 6-8: Limpopo load forecast

6.3.5 Major schemes

The TDP scheme projects for the province involves the integration of the Medupi Power Station and extension of the 400 kV and 275 kV networks, which entails installation of additional transformers at existing and new substations. The main schemes in Limpopo are as follows:

Medupi transmission integration (400 kV and 765 kV)

The project is part of the original scope for Medupi Power Station integration into the grid. It entails the construction of the following 400 kV and 765 kV lines from the vicinity of Medupi Power Station to bulk power evacuation points in Polokwane CLN and North West.

Waterberg generation 400 kV stability enhancement

The following projects were later recommended due to future planned generation projects around the Waterberg area. The projects were raised to ensure compliance with the grid code in terms of transient stability.

- Construct 1 x 400 kV line from Medupi to Witkop (~200 km)
- Construct 1 x 400 kV line from Borutho to Silimela (~100 km)

Nzhelele 400 kV integration

The integration of 400 kV into Nzhelele is required to deload the Tabor and Spencer Substations. The 400 kV supply to enable this project will be sourced from the Tabor and Borutho Substations through two 400 kV lines.

Limpopo East corridor strengthening

The project entails building a new 110 km 400 kV line from the Foskor Substation to the Spencer Substation and the establishment of 400/132 kV transformation at the Spencer Substation. The project will also require the second Merensky-Foskor 275 kV line to be operated at 400 kV. A new 400/275 kV transformation will be established at the Foskor Substation.

Silimela Transmission Substation

A new transmission substation will be constructed next to the existing Wolwekraal Distribution Substation to mitigate network constraints in the Mapoch and Kwaggafontein areas beyond 2019. This new transmission substation will deload the Simplon Substation and also supply the long-term future load growth in the south-western part of the Phalaborwa CLN.

Sekhukhune Transmission Substation

A new transmission substation will be constructed near Uchoba Distribution Substation to create additional transmission network capacity for forecasted future load growth in the Steelpoort area.

Dwarsberg (Dwaalboom) 132 kV Switching Station

A 132kV switching station will be established to improve performance of the supply to existing Eskom customer in the Dwaalboom area, as well as the supply to Gaborone area in Botswana.

The TDPs for Limpopo are shown in Figure 6-9 with future planned projects shown in dotted lines.

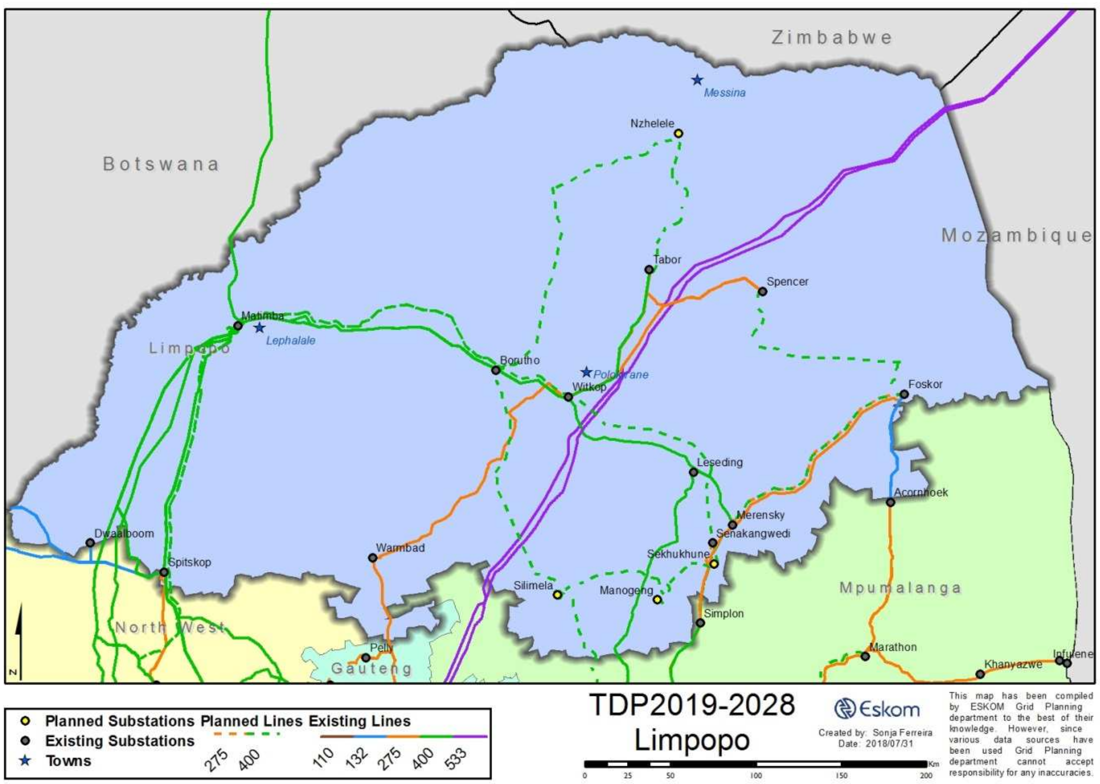


Figure 6-9: Future Limpopo network diagram

6.3.6 New substations

The transmission substations to be established in Limpopo over the TDP period are included in Section 6.3.5.

6.3.7 Reactive power compensation

The following capacitor banks will be installed for voltage support in Limpopo:

- 2 x 36 MVar capacitor banks on the 132 kV busbar with associated bays at the Tabor Substation
- 2 x 36 MVar capacitor banks on the 132 kV busbar with associated bays at the Spencer Substation

6.3.8 Provincial summary

The following projects in
Table 6-4 are planned for the period 2019 to 2028:

Table 6-4: Limpopo– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Dwarsberg 132 kV Switching Station	Dwarsberg 132 kV Switching Station	2018
Medupi Tx integration	Medupi-Mogwase 1st 400 kV line	2018
	Medupi-Mogwase 1st 765 kV line (Energised at 400 kV)	
Foskor and Acornhoek 275/132 kV transformation upgrades	Foskor-Merensky 2nd 275 kV line	2021
Highveld North-West and Lowveld North reinforcement phase 2	Silimela 400/132 kV Substation	2019
	Manogeng 400 kV Switching Station	
	Loop-in Duvha-Leseding 400 kV line into Manogeng Switching Station	
	Manogeng-Silimela 400 kV line	
Highveld North-West and Lowveld North reinforcement phase 1	Emkhiweni-Silimela 400 kV line	2022
Waterberg Generation 400 kV stability enhancement	Medupi-Witkop 1st 400 kV line	2020
	Borutho-Silimela 1st 400 kV line	
Tubatse strengthening scheme phase 1	Sekhukhune 400/275 kV Substation (1 x 800 MVA 400/1275 kV transformer)	2023
	Loop-in Arnot-Merensky 400 kV into Sekhukhune Substation	
	Manogeng-Sekhukhune 1st 400 kV line	
	Sekhukhune-Senakangwedi 1st 275 kV line	
	Sekhukhune 400/132 kV Substation (2 x 500 MVA 400/132 kV transformers)	
Tubatse strengthening scheme phase 2	Witkop-Sekhukhune 1st 400 kV line	2025

TDP scheme	Project name	Expected CO year
Nzhelele 400 kV integration	Nzhelele 2 x 500 MVA 400/132 kV	2023
	Tabor- Nzhelele 400 kV line	2023
	Borutho-Nzhelele 1st 400 kV line	2023
Polokwane reactive power compensation	Spencer 2 x 36 MVar capacitor banks	2023
	Tabor 2 x 36 MVar capacitor banks	2022
Limpopo East corridor strengthening	Foskor-Spencer 1st 400 kV line (110 km)	2024
	Merensky-Foskor 2nd 275 kV line changeover to 400 kV line	
	Foskor 400/275 kV transformation (1st 400 MVA 400/275 kV transformer)	
	Spencer 400/132 kV transformation (1st 500 MVA 400/132 kV transformer)	
Warmbad transformation upgrade	Warmbad 1st 250 MVA 275/132 kV transformer	2022
Leseding transformation upgrade	Leseding 3rd 500 MVA 400/132 kV transformer	2022
Borutho transformation upgrade	Borutho 3rd 500 MVA 400/132 kV transformer	2022
Acornhoek transformation upgrade	Acornhoek 3rd 125 MVA 400/132 kV transformer	2023

Note: The following substation name changes have been made in the past few years:

New name	Previous name
Mogwase	Ngwedi
Silimela	Marble Hall
Mogwase	Ngwedi
Manogeng	Tubatse
Sekhukhune	Pholo/Maphutha/Senakangwedi B
Dwarsberg	Dwaalboom
Emkhiweni	Rockdale B

6.4 MPUMALANGA

6.4.1 Background

Mpumalanga is a province located in the north-eastern part of South Africa, which shares international borders with Mozambique and Swaziland. The capital of Mpumalanga is Nelspruit, the major city in the Mbombela Local Municipality. The provincial economy is mainly driven by farming, mining, heavy industry, and tourism associated with attractions like the Kruger National Park, Sudwala Caves and the Blyde River Canyon.

Mpumalanga is considered the generation hub of South Africa's electricity network due to the concentration of power stations in this region and their close proximity to the large load centres. The transmission grid in Mpumalanga comprises mainly of 275 kV and 400 kV overhead lines. The supply to the Cape Corridor is via the Alpha and Zeus 400/765 kV Substations located in Mpumalanga. International customers, namely, Mozambique and Swaziland, also connect to the Eskom network at 132 kV, 275 kV, and 400 kV.

Currently; 12 of the 14 Eskom coal-fired power stations, namely Arnot, Camden, Duvha, Grootvlei, Hendrina, Kendal, Komati, Kriel, Kusile, Matla, Majuba, and Tutuka, are located in Mpumalanga. One of the two Eskom power stations that are currently under construction, namely the Kusile Power Station, is located in Mpumalanga and has necessitated the need to construct additional 400 kV lines to evacuate power. Additional 400/132 kV substations will also be established due to load growth, in order to remain compliant with the grid code and to create additional capacity.

Mpumalanga consists of four CLNs and each CLN is made up of a number of substations, as follows:

- **Highveld South CLN** – Sol, Camden, Alpha, Tutuka, Normandie, Majuba, Grootvlei, and Zeus
- **Lowveld CLN** – Marathon, Prairie, Simplon, Khanyazwe, Komatipoort, and Gumeni
- **Middelburg CLN** – Rockdale, Hendrina, Duvha, Komati, and Arnot
- **Witbank CLN** – Vulcan, Matla, Kendal, Kriel, Kruispunt, and Kusile

The current transmission network is shown in Figure 6-10.

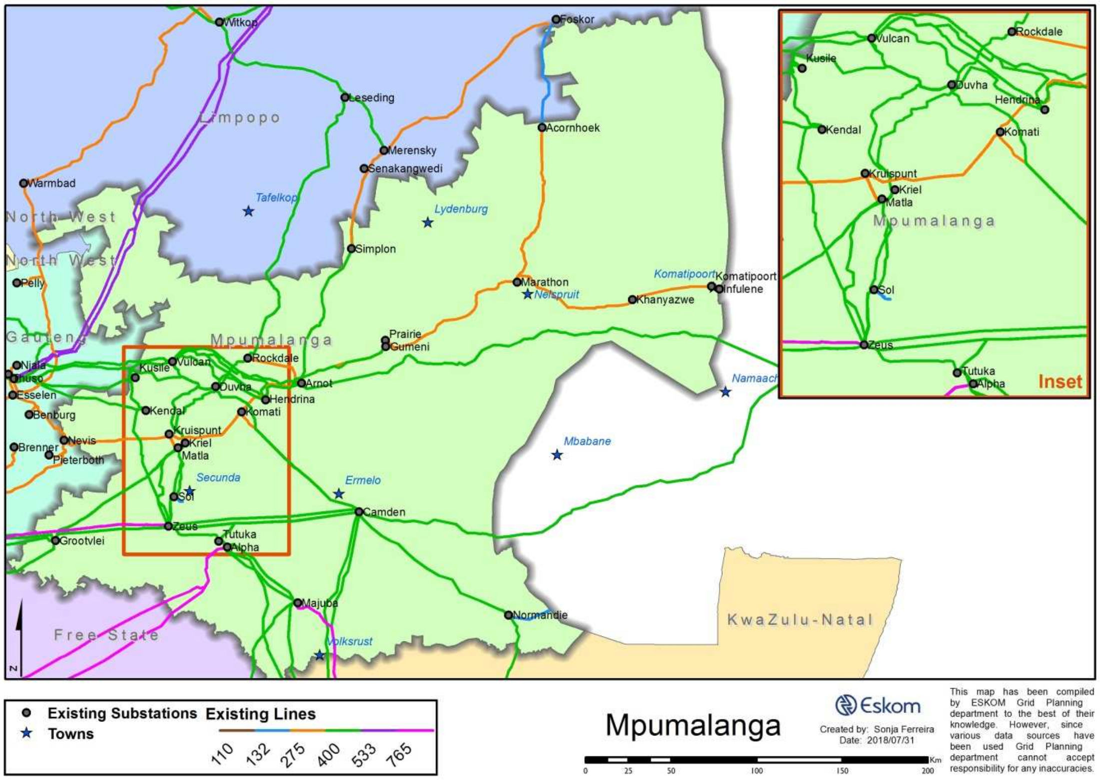


Figure 6-10: Current Mpumalanga network diagram

6.4.2 Generation

The total capacity of Kusile Power Station on completion is expected to be 5 076 MW. Table 6-5 shows the schedule that was assumed for the Kusile units going into commercial operation. Additional generation of approximately 300 MW in the form of IPP-operated coal-fired power stations was assumed to be integrated into Mpumalanga in 2019 but may only be commercially available in 2022.

Table 6-5: Kusile Power Station schedule

Generator	Planned CO date
Unit 1	2017
Unit 2	2019
Unit 3	2020
Unit 4	2021
Unit 5	2022
Unit 6	2023

Figure 6-11 shows a single-line diagram (SLD) of the full Kusile Power Station integration plan. The dotted lines represent the new 400 kV lines and new loops in and out from the existing 400 kV lines.

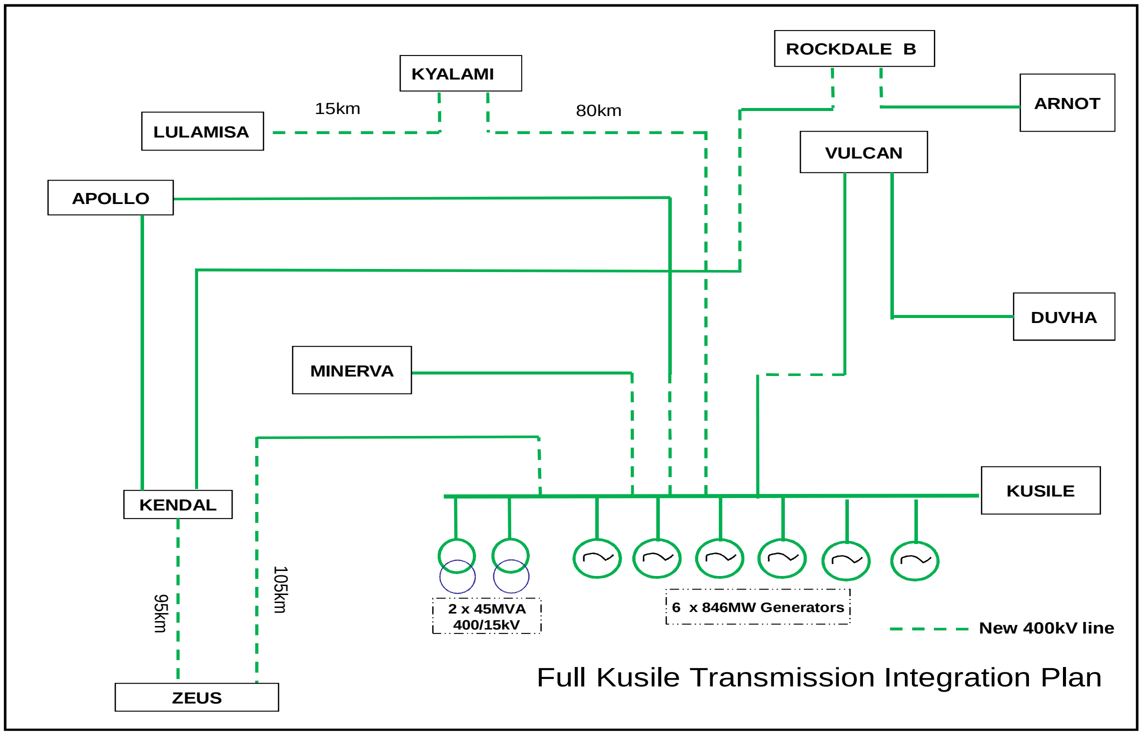


Figure 6-11: Kusile Power Station integration SLD

Hendrina, Grootvlei and Komati Power Stations are close to reaching the end of their economic life. Table 6-6 shows the Eskom power station units that are assumed to be decommissioned within the analysis period.

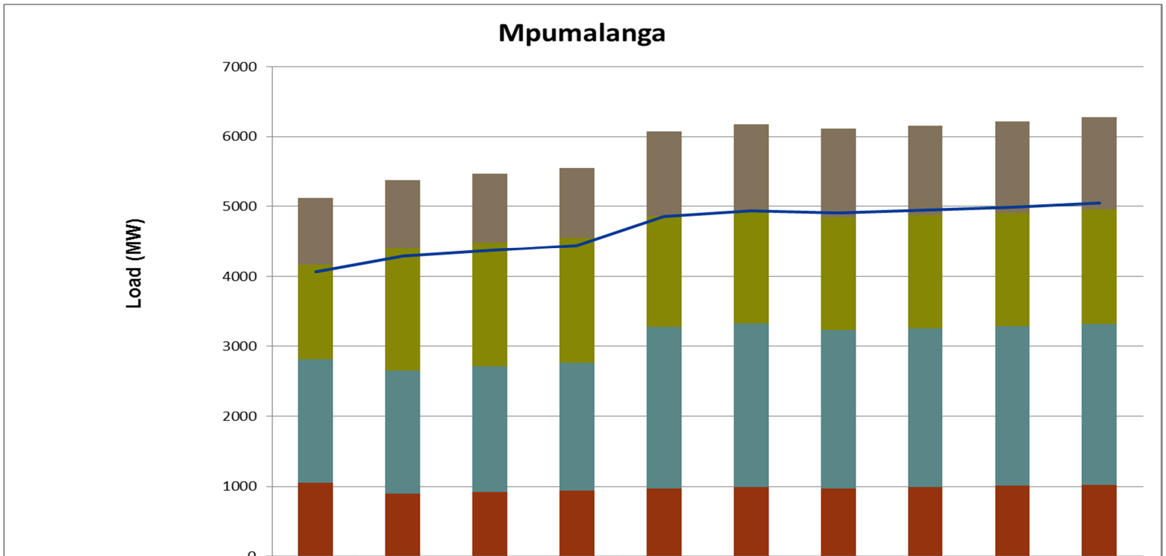
Table 6-6: Ageing generators decommissioning schedule

Year	Hendrina		Grootvlei		Komati	
	Unit	MW	Unit	MW	Unit	MW
2019	1	187	1	190	1	114
	2	187	2	190	2	114
	3	187	3	190	3	114
	4	187			4	91
	5	185			5	91
	6	185			6	114
	7	185			7	90
	8	165			8	86
	9	165			9	90
	10	160				
2020			4	190		
			5	180		
			6	180		
Total per station	1 793		1 120		904	
Total assumed generation reduction						**3 817**

6.4.3 Load forecast

Steady load growth is expected in the province as a result of commercial development, electrification and the establishment of the industrial development zone (IDZ). The future load mix is not expected to differ from the existing one, and comprises redistributors and mining, commercial, and industrial customers. The load growth within the TDP period is estimated at 2,4% per annum, from 4 270 MW (at provincial peak) in 2019 to 5 299 MW in 2028.

The load forecast for Mpumalanga is shown in Figure 6-12.



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Middelburg @ Grid Peak	956	968	989	1002	1209	1242	1269	1283	1299	1324
Witbank @ Grid Peak	1352	1746	1763	1778	1587	1600	1611	1614	1619	1629
Highveld South @ Grid Peak	1761	1768	1800	1826	2315	2345	2266	2274	2284	2305
Lowveld @ Grid Peak	1051	888	916	945	966	987	969	988	1008	1023
Mpumalanga @ TOSP	4067	4288	4370	4437	4859	4942	4910	4945	4988	5048

Figure 6-12: Mpumalanga load forecast

6.4.4 Major schemes

Several projects and schemes that aim to address the long-term requirements of the province have been initiated in order to accommodate the forecasted load and generation.

The main schemes in Mpumalanga are as follows:

Emkhiweni 400/132 kV integration

This scheme entails the establishment the new Emkhiweni 400/132 kV Substation, which is required to address both the Vulcan and Rockdale unfirm transformations. The substation will comprise 2 x 500 MVA transformers. This project is currently in the execution phase.

Mulalo (Sol B) 400/132 kV integration

This scheme entails the establishment the new Mulalo 400/132 kV Substation, which is required to address the unfirm transformation and fault level exceedance at the Sol Substation. The substation will comprise 4 x 500 MVA transformers as well as a fifth standby transformer. This project is currently in the design phase.

Marathon 400/132 kV integration

This project is required to address the low voltages under the loss of any 275 kV line in that corridor. The scope of work for this phase is the following:

- Marathon 400/132 kV Substation (1st 500 MVA 400/132 kV transformer)
- Marathon-Gumeni 400 kV line

Underrated equipment

The underrated equipment at the transmission substations in Mpumalanga will be addressed as follows:

Mpumalanga underrated equipment upgrade phase 1

- Equipment replacement at both ends of the following lines to ensure alignment with line capacity:
    - Apollo-Kendal 1 and 2 400 kV line
    - Duvha-Minerva 400 kV line
    - Duvha-Matla 400 kV line
    - Kendal-Minerva 400 kV line
    - Kriel-Zeus 400 kV line

Mpumalanga underrated equipment upgrade phase 2

- Upgrade of underrated equipment at the following substations:
    - Vulcan 400 kV
    - Rockdale 132 kV
    - Hendrina 400 kV
    - Kruispunt 132 kV
    - Komati 275 kV
    - Zeus 400 kV
    - Arnot 400 kV and 275 kV
    - Marathon 275 kV and 132 kV

Mpumalanga underrated equipment upgrade phase 3

- Equipment upgrades involving the following substations:
    - Tutuka 400 kV
    - Alpha 400 kV
    - Majuba 400 kV
    - Matla 275 kV, as well as FCLRs

Highveld South reinforcement phase 1: Sol MTS FCLR and equipment replacement

- Sol Substation FCLRs in series with existing 400/132 kV transformers
- Replacement of all underrated equipment at Sol Substation

SASOL fault level mitigation: Interim solution

- Installation of FCLRs on the 132 kV lines to SASOL 2 and SASOL 3

The TDPs for Mpumalanga are shown in Figure 6-13.

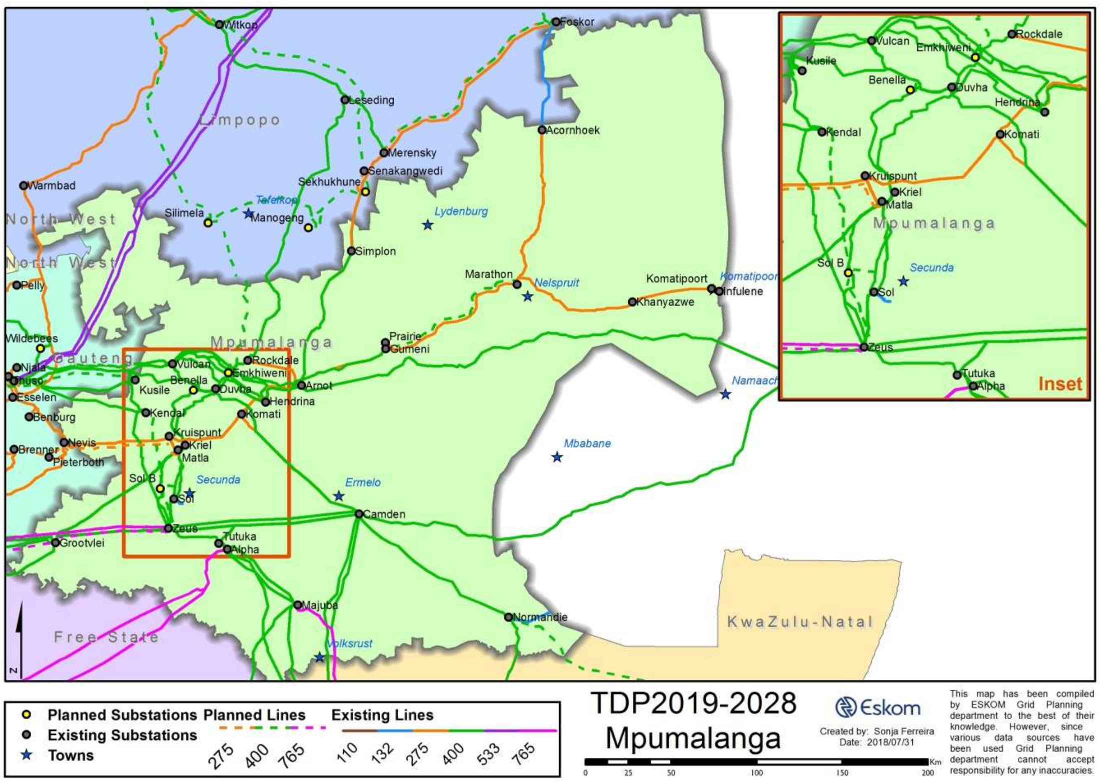


Figure 6-13: Future Mpumalanga network diagram

6.4.5 New substations

- Emkhiweni Substation integration will address both the Vulcan and Rockdale unfirm transformations
- Mulalo (Sol B) Substation integration will address the unfirm transformation at Sol Substation

6.4.6 Reactive power compensation

There are no reactive power compensation projects in Mpumalanga.

6.4.7 Provincial summary

A summary of all projects and scheme planned in Mpumalanga is provided in Table 6-7.

Table 6-7: Mpumalanga– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Highveld North-West and Lowveld North reinforcement – phase 1	Turn in Kendal-Arnot 400 kV line into Emkhiweni 400/132 kV Substation	2023
	Emkhiweni 400/132 kV Substation	
	Emkhiweni-Silimela 400 kV line	
Highveld South reinforcement	New Mulalo 400/132 kV Substation	2023
	Turn in Kriel-Zeus 400 kV line into Mulalo Substation	
	Turn in Kriel-Tutuka 400 kV line into Mulalo Substation	
Khanyisa Power Station integration	Benella 400 kV Switching Station	2019
	Turn in Kusile-Vulcan 400 kV line into Benella Switching Station	
Kusile integration phase 2: Lulamisa	Kusile-Lulamisa 1st 400 kV line	2022
Kusile integration phase 3A: 400 kV Duvha bypass	Kusile 400 kV bypass Duvha (to form Kusile-Vulcan 400 kV line)	2018
Lowveld strengthening phase 2B	Gumeni-Marathon 400 kV line	2024
	Marathon 400/132 kV Substation	
Normandie Ext. 2nd 250 MVA 400/132 kV transformer	Normandie Ext. 2nd 250 MVA 400/132 kV transformer	2018
Mpumalanga underrated equipment upgrade (MURE)	Upgrade underrated equipment at Vulcan 400 kV, Rockdale 132 kV, Hendrina 400 kV, Kruispunt 132 kV, Komati 275 kV, Zeus 400 kV and Arnot 400 kV and 275 kV, Tutuka 400 kV, Alpha 400 kV, Majuba 400 kV, and Matla 275 kV, install Matla FCLRs	2020

6.5 NORTH WEST

6.5.1 Background

North West, also known as the platinum province, is bounded on the north by Botswana, and domestically on the south by the provinces of Free State and the Northern Cape, and on the northeast as well as east by the Limpopo and Gauteng. Much of the province consists of flat areas with scattered trees and grassland.

North West is enriched with various mineral resources, such as PGMs, dimensions stone, fertile and vast agriculture soil, a strong manufacturing sector, and opportunities in RE and agro-processing. North West is home to the largest platinum refinery and two of the largest platinum mines as well as the fourth largest integrated ferrochrome producer. In addition, tourism activities and tourism investment opportunities thrive in the province, which boasts among others internationally renowned tourism hubs such as the Big 5 Pilanesberg located in the crater of an extinct volcano, and Madikwe Game Reserve, the Sun City Entertainment and Golf complex, the Taung Skull heritage site, and the ever popular Hartebeespoort dam.

The North West Transmission network consists of a highly connected 400 kV network with an underlying 275 kV network. The complete integration of the Medupi Power Station will further enhance the major power corridors into Rustenburg and extend into the Carletonville customer load networks.

The provincial load peaked at around 3 263 MW in 2017 which represents a 2,8% increase over 2016 loads. The load within the province is projected to increase to about 4 600 MW by 2028. North West comprises two CLNs, namely Rustenburg and Carletonville. The Rustenburg CLN consumes approximately 63% of the load, with the Carletonville CLN making up the remaining 37% of the demand in the province.

The current North West Transmission network is shown in Figure 6-14.

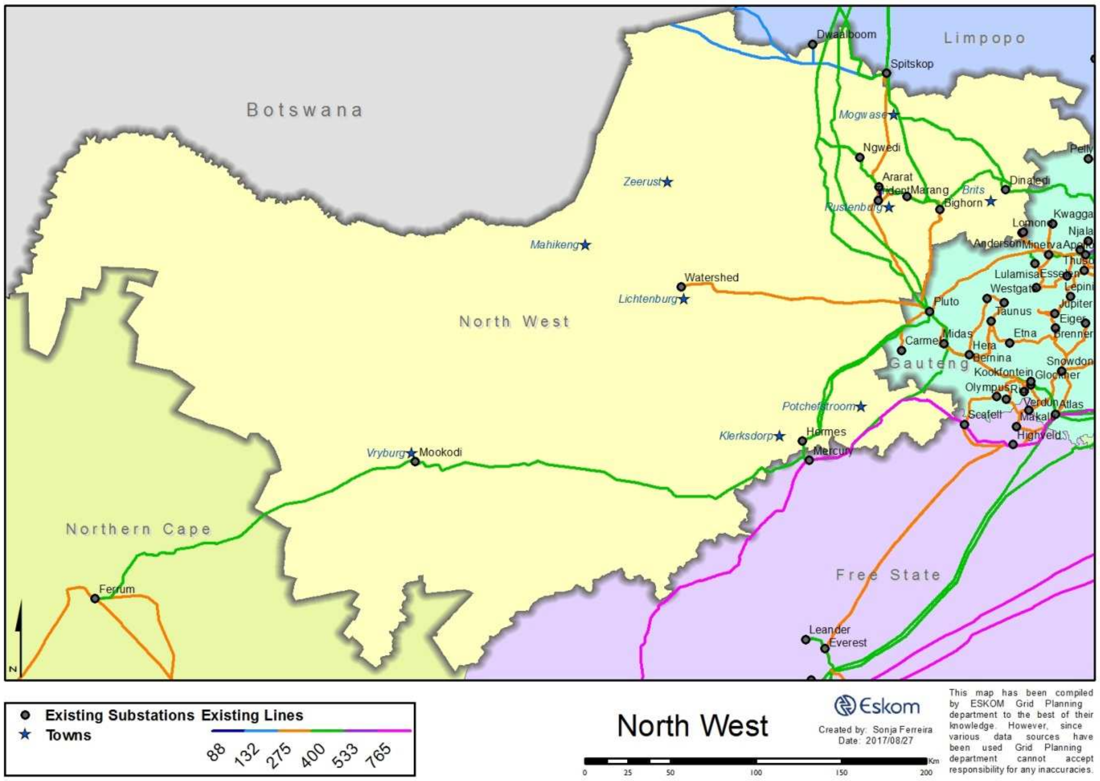


Figure 6-14: Current North West network diagram

6.5.2 Generation

There are no power stations within North West. All the power consumed within this province is sourced from power stations in Limpopo and Mpumalanga. The load flows will change after the integration of the Medupi Power Station and most of the power into North West will be supplied from Limpopo.

6.5.2.1 RE generation

There are no major RE generation plants in North West. As of 30 June 2018, only 7 MW of PV power generation was integrated into North West. There are four RE projects that were signed as part of the REIPPPP bid 4B. These projects will result in an additional 268 MW of PV generation in North West. Table 6-8 shows the approved projects in North West under REIPPPP bid 4B.

Table 6-8: Approved REIPPPP bid 4B projects in North West

Name of project	Type	Capacity (MW)	Transmission substation
De Wildt Solar Park	PV	50	Lomond
Bokamoso Solar Park	PV	68	Mercury
Zeerust Solar Park	PV	75	Watershed
Waterloo Solar Park	PV	75	Mookodi

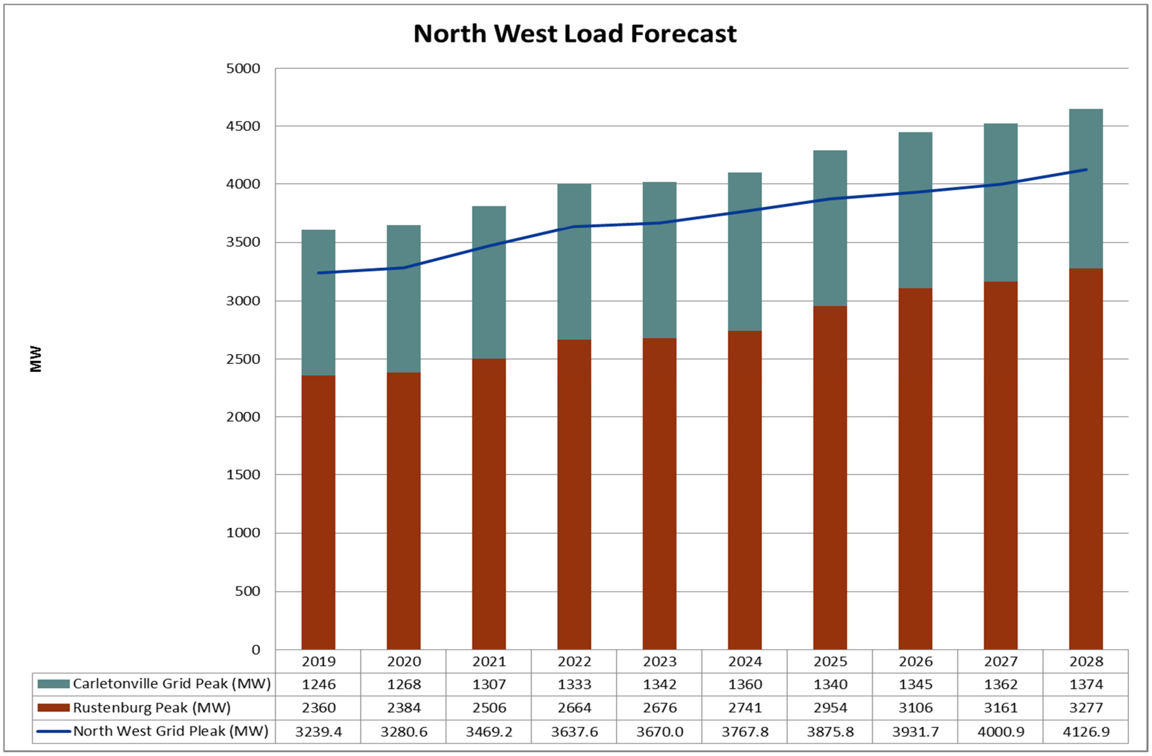
There has been an interest in renewable generation, mostly solar generation, particularly near Vryburg and neighbouring towns, that is, Lichtenburg, which lies in the Carletonville CLN.

The planned Mahikeng Substation, which lies approximately 60 km west of Watershed, has been identified as a potentially optimal location for connecting some of the new renewable plants, and a possible strategic connection corridor to the SADC region through Botswana as a first point of entry.

6.5.3 Load forecast

The mainstay of the economy of North West is mining, which generates more than half of the province’s gross domestic product. The chief minerals are gold, mined at Carletonville, Orkney, and Klerksdorp; uranium, mined at Klerksdorp; platinum, mined at Rustenburg and Brits; and diamonds, mined at Lichtenburg, Christiana, and Bloemhof. The northern and western parts of the province have many sheep farms and cattle and game ranches. The eastern and southern parts are crop-growing regions that produce maize (corn), sunflowers, tobacco, cotton, and citrus fruits. The entertainment and casino complex at Sun City and the Lost City also contributes to the provincial economy.

The load in North West is forecasted to grow steadily at about 2,6%, from 3 606 MW in 2019 to 4 651 MW by 2028. The load forecast is shown in Figure 6-15.



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Carletonville Grid Peak (MW)	1246	1268	1307	1333	1342	1360	1340	1345	1362	1374
Rustenburg Peak (MW)	2360	2384	2506	2664	2676	2741	2954	3106	3161	3277
North West Grid Pleak (MW)	3239.4	3280.6	3469.2	3637.6	3670.0	3767.8	3875.8	3931.7	4000.9	4126.9

Figure 6-15: North West load forecast

6.5.4 Major schemes

Several projects and schemes have been initiated to meet and cater for the forecasted load demand and generation integration in the province. The following major schemes are planned for the 2019 to 2028 period:

Rustenburg strengthening phase 2

Rustenburg strengthening phase 2 refers to the extension of Marang Substation, which will introduce a 132 kV voltage level at the Marang Substation. The Distribution network will also be upgraded from 88 kV to 132 kV in conjunction with the introduction of a 132 kV line at the Marang Substation.

Rustenburg strengthening phase 3

The scheme is expected to address low voltages in the Rustenburg CLN under the N-1 loss of the Medupi-Marang 400 kV line. The low voltages at Marang, Bighorn and Dinaledi Substations will be addressed by installing shunt capacitors at those respective substations that will also provide reactive power support in the Rustenburg CLN.

Watershed strengthening

This scheme addresses substation transformation capacity and the under-voltage on the 275 kV Watershed busbar under N-1 conditions. Further, the switching voltage step-change problems associated with the existing 88 kV shunt capacitors will be addressed. A new 250 MVA 275/132 kV transformer will be installed, together with 1 x 30 MVar 88 kV and 2 x 30 MVar 132 kV shunt capacitor banks.

Watershed (Backbone) strengthening phase 3

The current network constraints at the Watershed Substation are capacity shortages and poor voltage regulation, emanating from the N-1 of 275 kV in-feeds into the Watershed Substation. Approximately 180 MVA will be shifted from the Watershed Substation to Mookodi and Ngwedi Substations. Furthermore, a new Mahikeng (Watershed B) 2 x 315 MVA 400/88 kV Substation is planned approximately 60 km west of the Watershed Substation to create additional capacity for future load growth. The substation in-feeds will be comprised of the construction of the Pluto-Mahikeng 200 km 400 kV line and Mookodi-Mahikeng 160 km 400 kV line.

The TDPs for North West are shown in Figure 6-16.

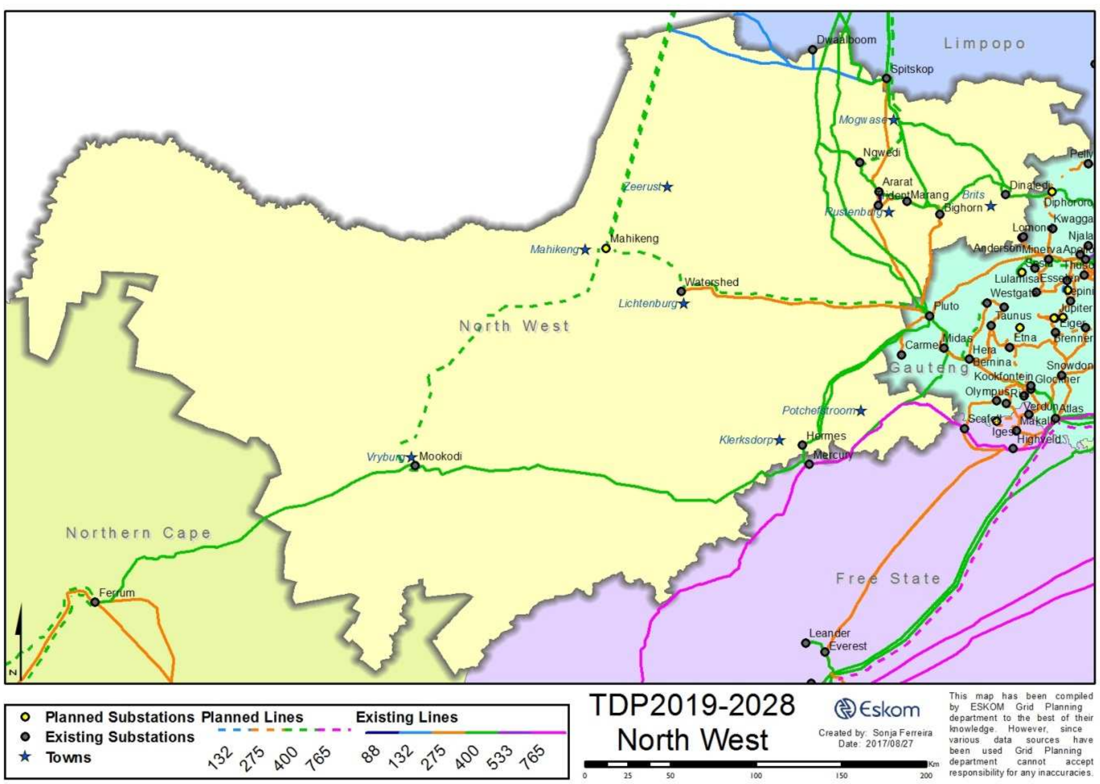


Figure 6-16: Future North West network diagram

6.5.5 New substations

Load growth in Mahikeng will necessitate introduction of the new Mahikeng 400/88 kV Substation to create additional capacity for future load growth:

6.5.6 Reactive power compensation

The following capacitor banks will be installed for voltage support in North West:

- Watershed Substation 88 kV reactive power compensation (1 x 30 MVar shunt capacitor bank)
- Watershed Substation 132 kV reactive power compensation (2 x 30 MVar shunt capacitor banks)
- Bighorn reactive power compensation (2 x 72 MVar 132 kV and 3 x 48 MVar 88 kV shunt capacitor banks)
- Marang reactive power compensation (5 x 48 MVar 88 kV shunt capacitor banks)
- Dinaledi reactive power compensation (3 x 72 MVar 88 kV shunt capacitor banks)

6.5.7 Provincial summary

A summary of all projects and scheme planned in North West is provided in Table 6-9.

Table 6-9: North West– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Watershed strengthening	Watershed MTS 132 kV reactive power compensation (2x30 MVar capacitors)	2021
	Watershed MTS 88 kV reactive power compensation (1x30 MVar capacitors)	
	Watershed 275/132 kV Substation 250 MVA 275/132 kV transformer	2021
Kimberley strengthening phase 2	Mercury-Mookodi (Vryburg) 1st 400 kV line,	Commissioned
	Mookodi-Ferrum 400 kV line, and establishment of Mookodi 2 x 250 MVA 400/132 kV MTS	
	Distribution 132 kV integration at Mookodi Substation (distribution lines)	2016-2022
Watershed (Backbone) strengthening phase 3	Pluto-Mahikeng 400 kV	2024
	Mahikeng 1st 315 MVA 400/88 kV transformer	
	Mookodi-Mahikeng 400 kV	2029
	Mahikeng 2nd 315 MVA 400/88 kV transformer	
Kimberley strengthening phase 3	Hermes-Mookodi (Vryburg) 1st 400 kV line	2026
Rustenburg strengthening phase 1	Bighorn 2 x 500 MVA 400/132 kV transformer	2027
Rustenburg strengthening phase 2	Marang extension 2 x 500 MVA 400/132 kV Substation	deferred
Rustenburg strengthening phase 3	Bighorn reactive Compensation (2 x 72 MVar 132 kV and 3 x 48 MVar 88 kV shunt capacitors)	2028
	Marang reactive compensation (5 x 48 MVar 88 kV shunt capacitors)	
	Dinaledi reactive compensation (3 x 72 MVar 88 kV shunt capacitors)	
Medupi integration phase 2A: Mogwase	Ngwedi 2 x 500 MVA 400/132 kV Substation	Commissioned
	Ngwedi 400 kV loop-in (Matimba-Midas and Mara-Midas 400 kV lines)	
	Medupi-Ngwedi 1st 400 kV line	2019
	Medupi-Ngwedi 1st 765 kV line (Energised at 400 kV)	
Ararat-Trident 88 kV lines coupling	Ararat-Trident 88 kV lines coupling	2022

6.6 FREE STATE

6.6.1 Background

Free State is South Africa's most centrally located province and has Bloemfontein as its capital. It has borders with most other provinces and has Lesotho as its eastern neighbour. For many decades, mining and agriculture were the bedrock of the economy in the province, but the mining sector's productivity has been on a steady decline. This has a negative impact on the economy and the employment numbers.

Important road and rail links traverse the province, including two of the busiest national highways, the N1 (Cape Town-Johannesburg) and the N3 (Durban-Johannesburg). There are plans to leverage this advantage through the creation of development corridors, the promotion of manufacturing, warehousing, and storage opportunities. The Harrismith Logistics Hub (HLH) on the N3 is at the centre of these plans. The Free State Development Corporation (FDC) is actively searching for investors in areas such as Harrismith and Botshabelo.

The provincial load peaked at around 1 524 MW in 2017, and it is expected to increase to about 2 298 MW by 2029. Free State comprises three CLNs, namely Sasolburg, Bloemfontein, and Welkom. The Welkom CLN consumes approximately 47% of the load. The Sasolburg and Bloemfontein CLNs make up the remaining 53% of the demand in the province. The province has a number of development plans, including a number of public infrastructure delivery projects. These programmes will not only improve services, but will also benefit local suppliers and boost the construction sector. The current transmission network is shown in
Figure 6-17.

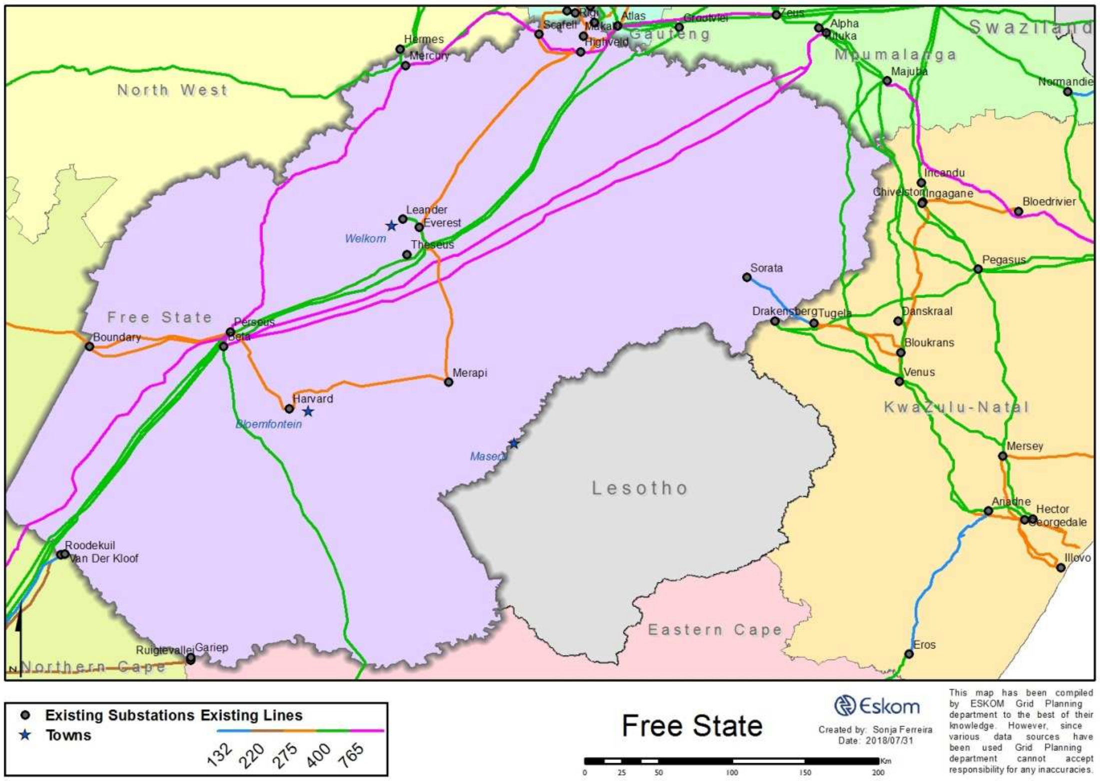


Figure 6-17: Current Free State network diagram

The 765 kV network is primarily used to transmit power through the grid to the Cape. The projects for Free State are mainly the introduction of 400 kV lines and transformation to support or deload the 275 kV networks.

6.6.2 Generation

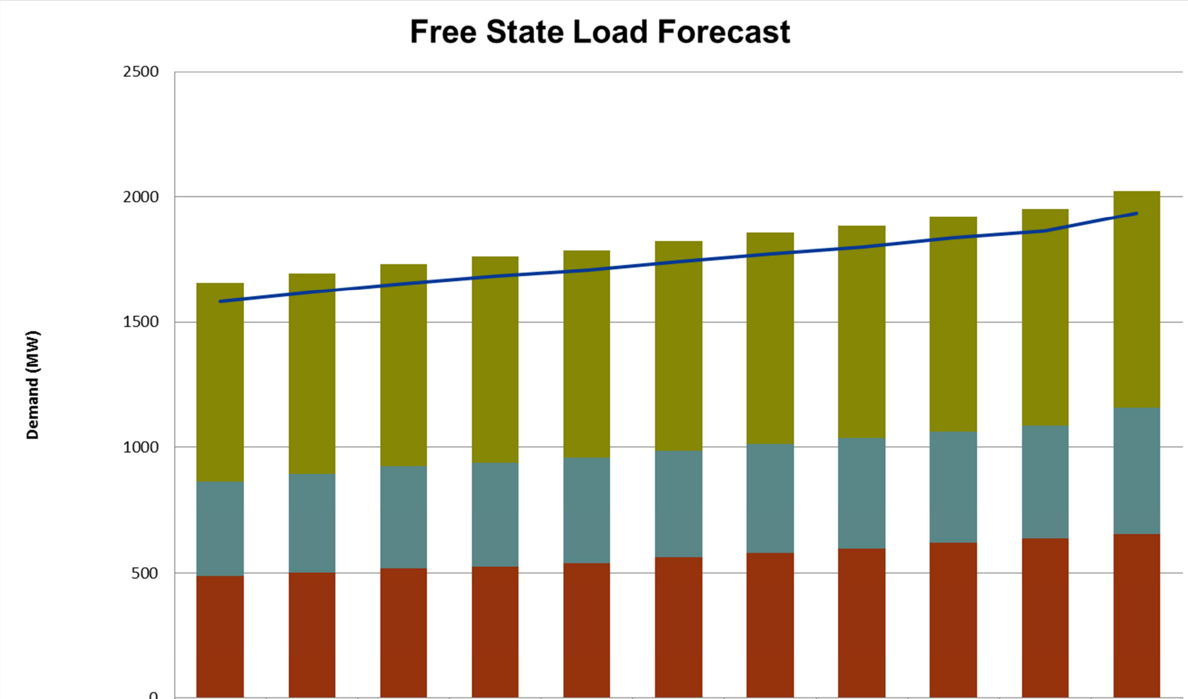
The power supply into the province is predominantly sourced from Lethabo Power Station and Mpumalanga through 400 kV and 275 kV transmission lines. Lethabo Power Station is a coal-fired power station located in the Vaal Triangle area of the Free State, and it is designed to generate a total capacity of 3 558 MW.

6.6.2.1 RE Generation

IPPs have shown interest in solar generation in the province, especially the western parts of the province. Since the inception of the REIPPPP 124 MW PV plants have been integrated into the grid.

6.6.3 Load forecast

The economic mix in Free State is predominantly comprised of mining, commercial customers, and residential customers. The load in Free State is forecasted to grow steadily at about 2% annually, from 1 658 MW in 2018 to 1 952 MW by 2028. The highest provincial load growth is expected in the Sasolburg CLN. The load forecast for Free State is shown in Figure 6-18.



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Welkom	794	800	806	823	829	836	843	849	856	863	866
Sasolburg	377	392	407	413	419	425	432	437	444	450	502
Bloemfontein	487	502	517	524	538	561	581	598	621	638	655
TOSP	1583	1618	1653	1682	1706	1741	1772	1800	1835	1864	1933
Grid Peak	1658	1694	1731	1762	1787	1823	1856	1885	1921	1952	2024

Figure 6-18: Free State load forecast

6.6.4 Major schemes

The major schemes for Free State are as follows:

Bloemfontein strengthening phase 1B

The project involves establishing a 275 kV line from the Everest Substation to the Merapi Substation, built at 400 kV specifications and operated at 275 kV.

Bloemfontein strengthening phase 2

The project involves acquiring servitudes for future 400 kV lines, that is, the Beta-Harvard and the Harvard-Merapi lines and the introduction of 400 kV at the Harvard and Merapi Substations. The project will be executed in various stages. The trigger for each stage will be the growth in demand (generation and/or load).

Harrismith strengthening phase 1

This project addresses network capacity constraints in the Harrismith region, which includes the Tugela Substation in KwaZulu-Natal and the Sorata 132 kV Switching Station in Free State. The Sorata 132 kV Switching Station will be extended to a 275/132 kV substation to deload the Tugela Substation. The Sorata Substation will be supplied by the existing Tugela-Sorata 275 kV line, which is currently operated at 132 kV.

Sorata Substation strengthening

This project involves the construction of the second Sorata-Tugela 275 kV line (400 kV line operated at 275 kV), as well as installing a second 275/132 kV transformer at the Sorata Substation.

Makalu Substation Strengthening

This project involves establishing the Igesi 275/88 kV Substation and to loop into one of the Lethabo-Makalu 275 kV lines to form Lethabo-Igesi and Igesi-Makalu 275 kV lines. The Igesi Substation will deload the Makalu Substation and will also assist in reducing network fault levels around the Makalu Substation.

The TDPs for Free State are shown in Figure 6-19.

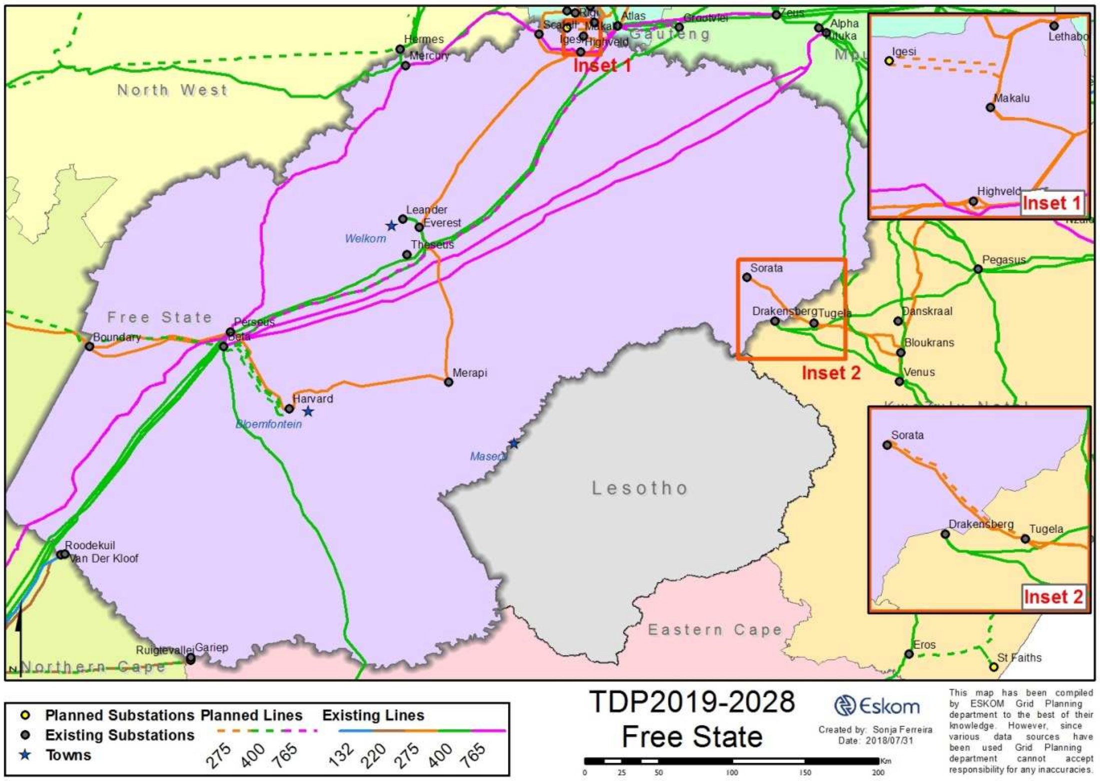


Figure 6-19: Future Free State network diagram

6.6.5 New substations

The transmission substations to be established in Free State over the TDP period are included in Section 6.6.4.

6.6.6 Reactive power compensation

There are no reactive power compensation projects within the Free State.

6.6.7 Provincial summary

A summary of all projects and scheme planned in Free State is provided in Table 6-10.

Table 6-10: Free State– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Bloemfontein strengthening phase 1B	• Everest-Merapi 400 kV line (operated at 275 kV)	2020
Bloemfontein strengthening phase 2	• 2 x Beta-Harvard 400 kV lines • 2 x 500 MVA 400/132 kV Harvard Substation • Harvard–Merapi 400 kV line • 2 x 500 MVA 400/132 kV Merapi Substation	2028
Harrismith strengthening phase 1	• Sorata 1st 275/132 kV 250 MVA transformer, operate Tugela-Sorata at 275 kV • Sorata 400 kV busbar (operated at 275 kV)	2021
Makalu strengthening	• Establish 2 x 315 MVA 275/88 kV Igesi Substation • Loop-in one of Lethabo-Makalu 275 kV lines into Igesi Substation • Refurbishment of existing Makalu Substation	2024
Sorata Substation strengthening	• Recycle Groenkop-Tugela 132 kV line 1 and construct Sorata-Tugela 400 kV line (operated at 275 kV). Estimated line length is 60 km • Sorata 2nd 275/132 kV 250 MVA transformer	2028

6.7 NORTHERN CAPE

6.7.1 Background

Northern Cape is situated in the northwest part of South Africa and is the largest province by landmass as well as being the most sparsely populated province in South Africa. It has Kimberley as its capital. The majority of economic activity is concentrated in Kimberley and Upington, which are located to the east and northern region of the province respectively. The landscape of the Northern Cape provides the perfect environment for the high- and medium-frequency arrays, which has made it the preferred location for the world's largest telescope, the Square Kilometre Array (SKA). It also consists of vast tracts of land with good sunshine. For that reason, it has attracted the most solar PV and CSP projects of all the provinces in South Africa. Furthermore, the increased interest in mining operations in the Kimberley area is expected to increase the demand for electricity in the province.

The provincial load peaked at 980 MW in 2019 and it is expected to increase to about 1 479 MW by 2028. The Northern Cape comprises four CLNs, namely Kimberley, Karoo, Namaqualand, and West Coast. Kimberley CLN is the main load centre in the province, consuming approximately 52 % of the load. Karoo, Namaqualand, and West Coast CLNs make up the remaining 48% of the demand in the province. Kimberley is supplied by means of the 275 kV network at Ferrum and Namaqualand by a radial 275 kV network supported by the 400 kV line from North West. The traditionally weak radial transmission network, high demand growth together with the high potential for the development of generation from Renewable Energy Sources (RES) makes Northern Cape the centre of network development activities within this planning horizon. The introduction of tie Nieuwehoop Substation will link the Aries and Ferrum 400 kV networks in order to strengthen the TS in the province.

The current transmission network is shown in Figure 6-20.

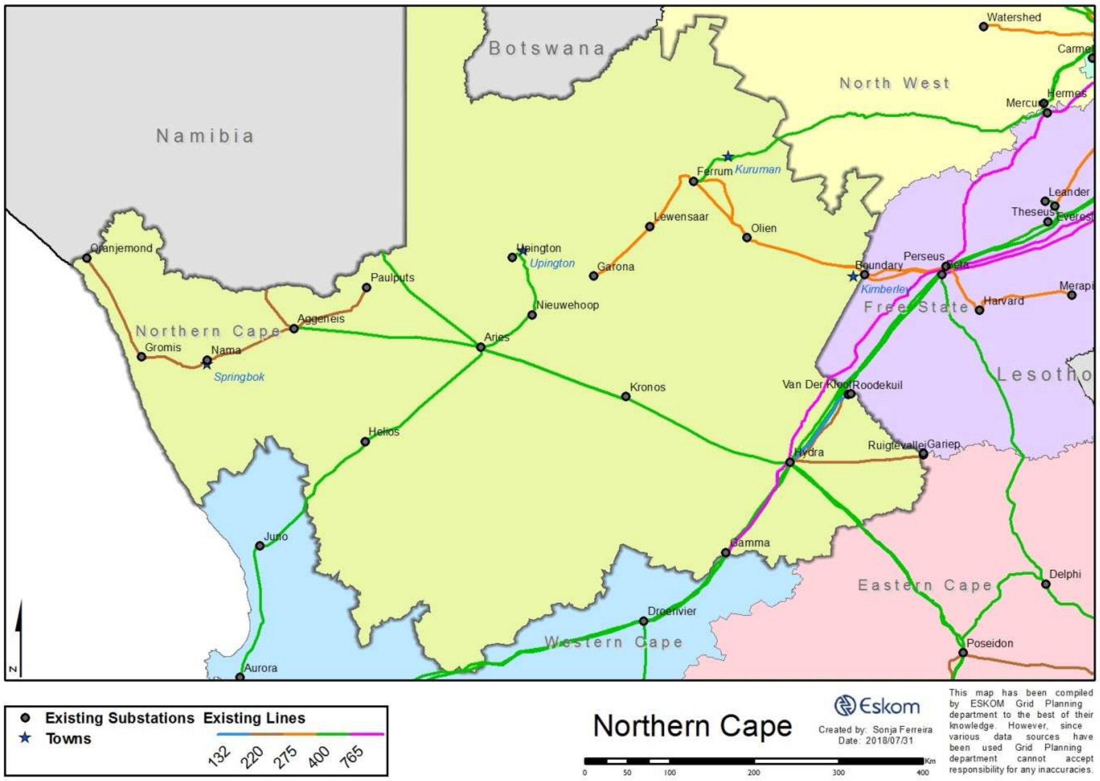


Figure 6-20: Current Northern Cape network diagram

6.7.2 Generation

There is one generation plant located in the Northern Cape named the Van der Kloof Power Station. It is a hydro power station with two units generating 120 MW each, providing a total capacity of 240 MW.

6.7.2.1 RE Generation

The REIPPPP has provided a platform for the private sector to invest in RE that would be connected to the South African electrical grid. The Northern Cape climate has made it a popular province for renewable energy with PV, CSP and wind technology installed and connected to the grid via the REIPPPP rounds held by the DoE. In the Northern Cape thus far, from rounds 1 to 4B there is approximately 42% PV, 41% wind and 17% CSP committed.

Table 6-11: Approved projects under the REIPPPP in the Northern Cape

Technology	REIPPP in the Northern Cape					
	Round 1 (MW)	Round 2 (MW)	Round 3 (MW)	Round 3,5 (MW)	Round 4 (MW)	Round 4B (MW)
CSP	150	50	200	200	0	0
WIND	72,75	3	590,5	0	279,8	514
PV	461,75	269,7	225	0	415	130
Total	**684,5**	**322,7**	**1 015,5**	**200**	**694,8**	**644**

6.7.3 Load forecast

The load forecast for the Northern Cape is shown in Figure 6-21. The load forecast confirms that the Kimberley CLN is the main load centre in this province. The anticipated manganese and iron ore mining in the Kimberley CLN area as well as possible smelter operations associated with these mines explains the hike in 2026. From the load forecast it can be seen that the remaining CLNs show a natural load growth.

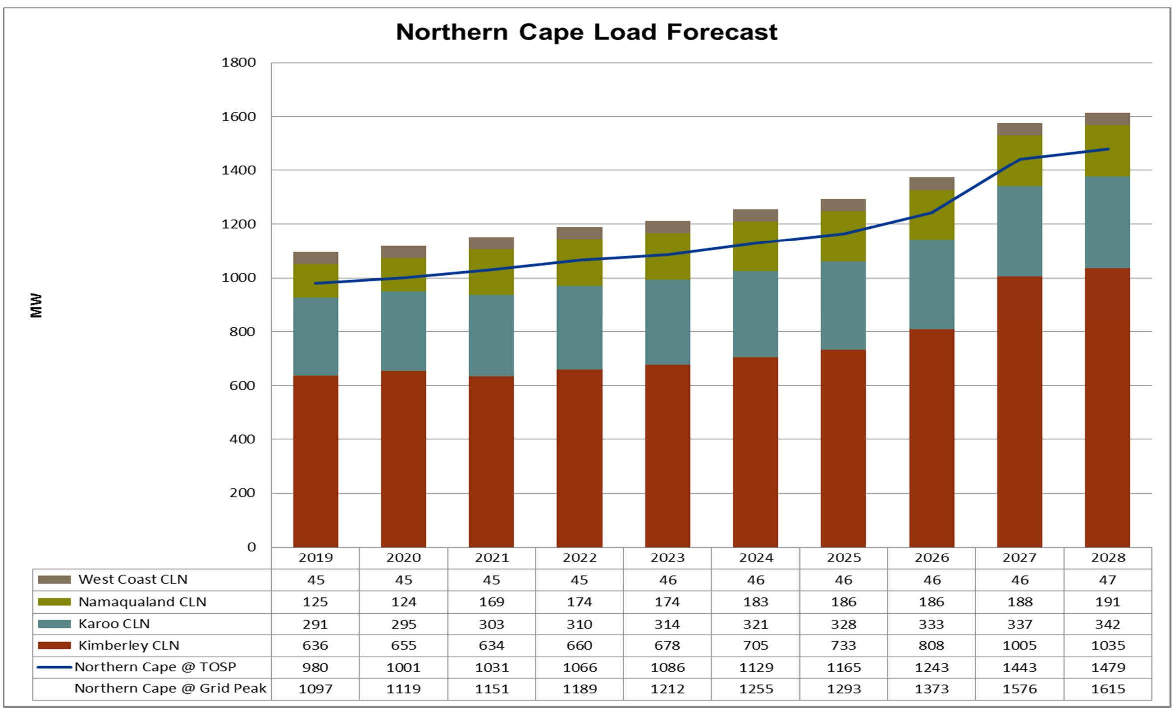


Figure 6-21: Northern Cape load forecast

6.7.4 Major schemes

The Northern Cape network requires strengthening to achieve security, N-1 grid code compliance and to cater for the increasing load as mentioned in the load forecast. The following projects have been raised to accomplish this:

- **Namaqualand redundancy project** – The Namaqualand redundancy evaluation project introduces redundancy into the Namaqualand CLN. The project entails building the Juno-Gromis 400 kV line banked at the Gromis Substation to 220 kV and the Gromis-Oranjemund 220 kV line (constructed at 400 kV).

- **Namaqualand strengthening: Aggeneis-Paulputs second 220 kV and Paulputs transformation framework** – This project introduces the second Aggeneis-Paulputs 220 kV line built at 400 kV to meet the N-1 security standard for Paulputs area.

- **Kimberley strengthening phase 3** – This strengthening entails the construction of Hermes (later Selemo)–Mookodi, Mookodi-Hotazel and Hotazel-Ferrum 400 kV lines, which is to cater for the increasing load in the area.

- **Upington integration** – The integration includes the construction of two Upington-Aries 400 kV lines, Upington-Niewehoop and Upington-Ferrum 400 kV lines.

- **Kimberley strengthening phase 4 – Part A** – This is a strategic project to enable the evacuation of potential renewable generation in the Kimberley area.

Since the introduction of renewable generation within the Northern Cape it was understood that the network will need to be strengthened to evacuate the renewable power out of Northern Cape to other parts of the country. The projects below have been raised to achieve such.

- **Aries and Aggeneis IPP integration (GP Report_15/60)** – In the Namaqualand CLN, the introduction of 400/132 kV with the first 500 MVA transformer at the Aries and Aggeneis Transmission Substation is recommended.

- **Garona strengthening for RE IPP (GP Report_15/58)** – The project entails the introduction of 400 kV at Garona existing transmission station by looping in and out of the newly built Nieuwehoop-Ferrum 400 kV line.

- **Helios transformation strengthening for RE IPP (GP Report_15/59)** - The installation of the second 500 MVA 400/132 kV transformer at the Helios Transmission Substation.

While Northern Cape has become the most popular province for PV and CSP (59%) there has been some wind generation (42%) connected to the grid. The Namaqualand strengthening for renewable generation integration (first Gromis-Nama-Aggeneis 400 kV line) has been raised to strengthen the network to enable evacuation of the renewable wind generation out of Northern Cape.

The future Northern Cape transmission network is shown in Figure 6-22.

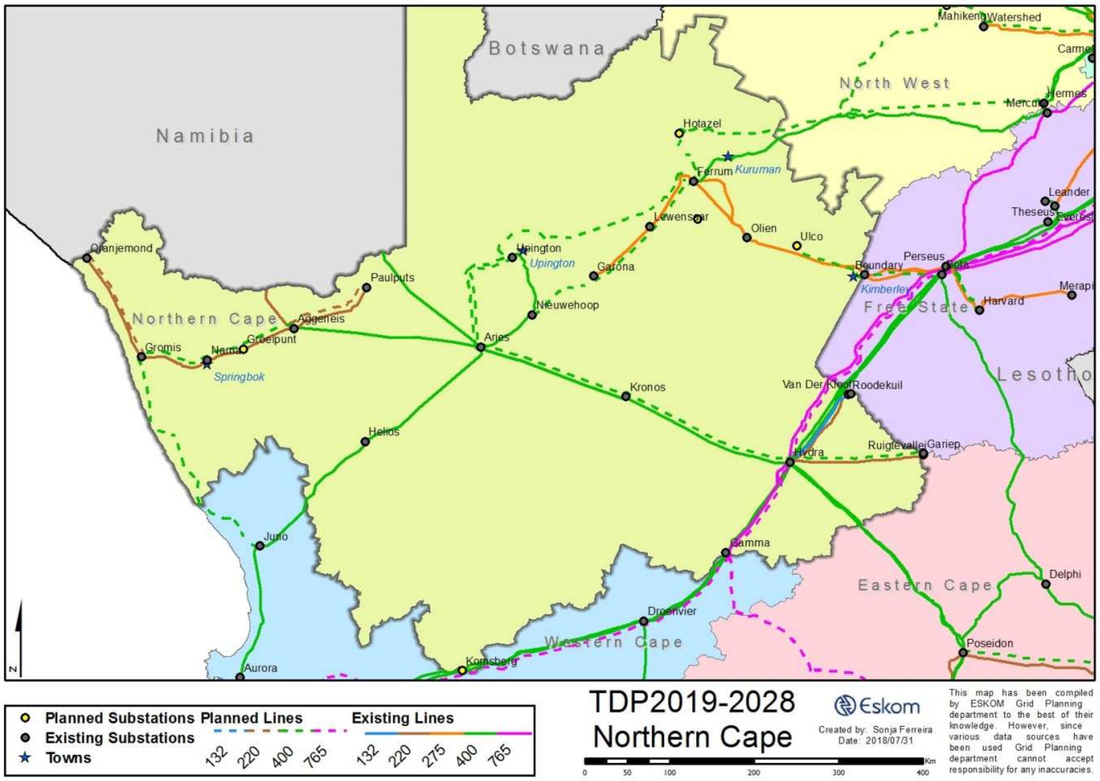


Figure 6-22: Future Northern Cape network diagram

6.7.5 Major schemes under NC wind scenario

Namaqualand strengthening for renewable generation integration: Gromis-Nama-Aggeneis 400 kV line

This project recommends the first Gromis-Nama-Aggeneis 400 kV line for the evacuation of the anticipated renewable generation in the Namaqualand CLN under the Northern Cape wind generation scenario.

Kimberley strengthening phase 4 – Part A

This is a strategic project to enable the evacuation of potential renewable generation in the Kimberley.

6.7.6 New substations

The following new substations will be established in the Northern Cape:

- Groeipunt 220/132 kV Substation (IPP)
- Hotazel 400/132 kV Substation
- Ulco 400/132 kV Substation
- Manganore 400/132 kV Substation

6.7.7 Reactive power compensation

Additional 132 kV capacitor banks will be installed at the Hotazel and Ferrum Substations as part of the Kimberley strengthening phase 3 project and the Northern Cape reinforcement project respectively. The following shunt capacitor will be established in the Northern Cape:

- Hotazel 132 kV (36 MVar)

6.7.1 Provincial summary

A summary of all projects and scheme planned in the Northern Cape is provided in Table 6-12.

Table 6-12: Northern Cape– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Aggeneis-Paulputs 2nd 220 kV line	Aggeneis-Paulputs 2nd 220 kV line (built at 400 kV)	2022
Northern Cape reinforcement	Aries dynamic device	2020
Namaqualand strengthening	Juno-Gromis 1st 400 kV line	2021
	Gromis 400/220 kV transformation	
	Gromis-Oranjemund 2nd 220 kV line	2018
Nama MTS transformers upgrade	Nama MTS transformers upgrade	2019
Northern Cape voltage unbalance	Northern Cape line transposition	2023
Oranjemond shunt cap	Decommission 15MVar 66kV Shunt Cap	2019
Paulputs 3rd 220/132 kV 250 MVA transformer	Paulputs 3rd 220_132 kV 250 MVA transformer	2023
Aggeneis strengthening 1 (IPP)	Aggeneis 400/132 kV transformation strengthening 1 (IPP)	2022
Aries strengthening 1 (IPP)	Aries 400/132 kV transformation strengthening 1 (IPP)	2022
Helios strengthening 1 and 2 (IPP)	Helios 2nd 500 MVA 400/132 kV transformation strengthening phase 2 (IPP)	2025
Gromis-Nama-Aggeneis 400 kV lines(IPP)	Gromis-Nama 400 kV line	2026
Gromis transformation	Gromis 2nd 400/220 kV transformation	2026
New Groeipunt 220-132 kV MTS (IPP)	Loop-in and out of existing Nama-Aggeneis 220 kV line New Groeipunt 220/132kV MTS (IPP)	2018

Nama IPP transformation (Customer)	Install 2 x 400/132 kV 500 MVA transformers	2026
Kimberley strengthening phase 3	Hermes (later Selemo)-Mookodi (Vryburg) 1st 400 kV line	2030
	Ferrum-Mookodi (Vryburg) 2nd 400 kV line (via Hotazel)	
	Hotazel 400 kV loop-in (Ferrum-Mookodi (Vryburg) 2nd 400 kV line)	
	Hotazel 400_132 kV substation (1st and 2nd 500 MVA 400_132 kV transformers)	
	Hotazel Ext 132 kV 1st 36 MVar capacitor	
Garona strengthening phase 2 IPP	Garona MTS 1st 500 MVA 400/132 kV Loop-in and out of Nieuwehoop-Ferrum 400 kV line	2025
Kimberley strengthening phase 4	Part A: Beta-Ferrum (Beta-Ulco looping into Ulco) 400 kV lines	2031
	PART B - (Boundary strengthening)	2032
	PART C: (Olien strengthening 400_132 kV 4 x 250 MVA transformation)	
Upington strengthening (IPP) phase 3	Aries-Upington 1st 400 kV lines	2026
	Aries-Upington 2nd 400 kV lines	
	Upington 5th 500 MVA 400_132kV transformation	
Upington strengthening (IPP) phase 2	Upington 3rd and 4th 500 MVA 400/132 kV transformation	2024
	Ferrum-Upington 1st 400 kV line	
Northern Cape transformation	Helios 1 x 20 MVA 132/66 kV transformer	2023
Western and Northern Cape series caps decommissioning	Decommission Helios series cap	2019
Western and Northern Cape series caps decommissioning	Decommission Hydra series cap	2023
Kronos transformation (Customer)	Kronos 2nd 500 MVA 400/132 kV transformation	2020
Gariep network strengthening*	Ruigtevallei-Hydra derate 220 kV line to 132 kV	2020
	Ruigtevallei 132 kV feeder bay to Dreunberg	
Hydra 400 and 132 kV equipment upgrade	Hydra equipment rating upgrade	2018
Hydra-Aries 400 kV line	Hydra-Aries 2nd 400 kV lines	2028
Hydra B 400/132 kV Substation	New Hydra B 400/132 kV Substation	2026
Ruigtevallei MTS transformation	Ruigtevallei 3rd 20 MVA 132/66 kV transformer	2022

6.8 EASTERN CAPE

6.8.1 Background

Eastern Cape is South Africa's second largest province by landmass and is located on the south-eastern coast of South Africa. The capital city of Eastern Cape is Bhisho, which is derived from the Xhosa word for buffalo. The two largest cities in the province are Port Elizabeth and East London. The provincial economy is mainly driven by the automotive sector, which is the biggest manufacturing sector in the urban areas of the Eastern Cape. Nelson Mandela Bay Metro in Port Elizabeth as well as Buffalo City Metro in East London are the two major motor manufacturing hubs in the province. Due to its excellent wind energy resource, the Eastern Cape has attracted a significant share of the RE projects procured to date. It is also expected that the majority of future generation from wind energy will be located in the Eastern Cape.

The provincial load for the Eastern Cape peaked at 1 716 MW in 2017, and it is expected to increase to about 2 620 MW by 2028. There is a high potential for developments in the Nelson Mandela Bay Metro in the Port of Ngqura, as it is popularly known. As a result, the peak demand for electricity in the Port Elizabeth area is forecasted to increase from 1 086 MW to about 1 604 MW in the next 10 years. The bulk of expected load increase in the CLN is attributable to the industrial development at Coega. The Port Elizabeth area is supplied by means of three 400 kV transmission lines and a single 220 kV line, which also supports the manganese traction line.

The East London area has a mixture of rural and urban loads. Most of the rural electrification is anticipated in the northern parts of East London CLN, in and around the Mthatha area. The Vuyani Substation and associated 400 kV supply lines are expected to unlock future electrification in the Mthatha area. The capacity of Vuyani Substation has the potential of unlocking the electrification of more than 125 000 homes currently. The number of in-feeds into East London consists of three 400 kV lines and a single 220 kV line to Bhisho.

The current transmission network is shown in Figure 6-23.

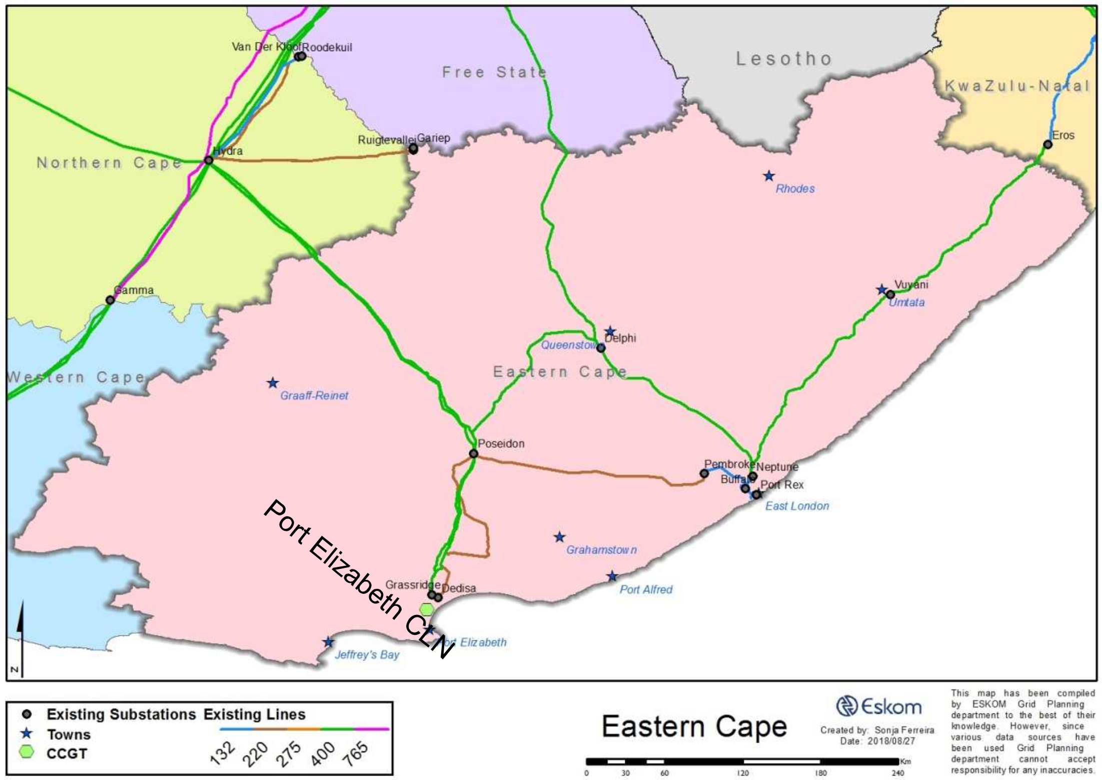


Figure 6-23: Current Eastern Cape network diagram

6.8.2 Generation

Historically, the Eastern Cape has not had much internal generation capacity. The only sizeable generation in the province was Port Rex, with a capacity of 3 x 57 MW, which operates as a peaking plant. Gariep Hydro Power Station, located on the provincial border of Northern and Eastern Cape has a generating capacity of 360 MW, with four units rated at 90 MW each. It evacuates power directly onto Hydra 220 kV busbar via 220 kV and 132 kV lines. The power deficit in the Eastern and Northern Cape implies that the above-mentioned generators operate as support for baseload plant even outside the typical peak periods.

Furthermore, there is high interest in RE projects in the Eastern Cape, as demonstrated by the number of RE bids from the previous REIPPPP rounds. A total capacity of 1 494 MW was approved in the Eastern Cape, comprising 151 MW in the East London CLN and 1 343 MW in the Port Elizabeth CLN.

The interest in connecting renewable power projects in the subsequent rounds of the DoE REIPPPP is expected to remain strong due to excellent wind resources in the province.

There is also an interest in the integration of generation from natural gas close to the Port of Ngqura, amounting to approximately 1 000 MW. If all these generation plans materialise, the Eastern Cape will be a net exporter of energy.

6.8.2.1 RE generation

The total capacity that has been approved in the Eastern Cape since the rise of REIPPs in the Eastern Cape amounts to 1 432 MW, which comprises 150 MW in the East London CLN and 1 282 MW in the Port Elizabeth CLN. The composition is shown in
Table 6-13.

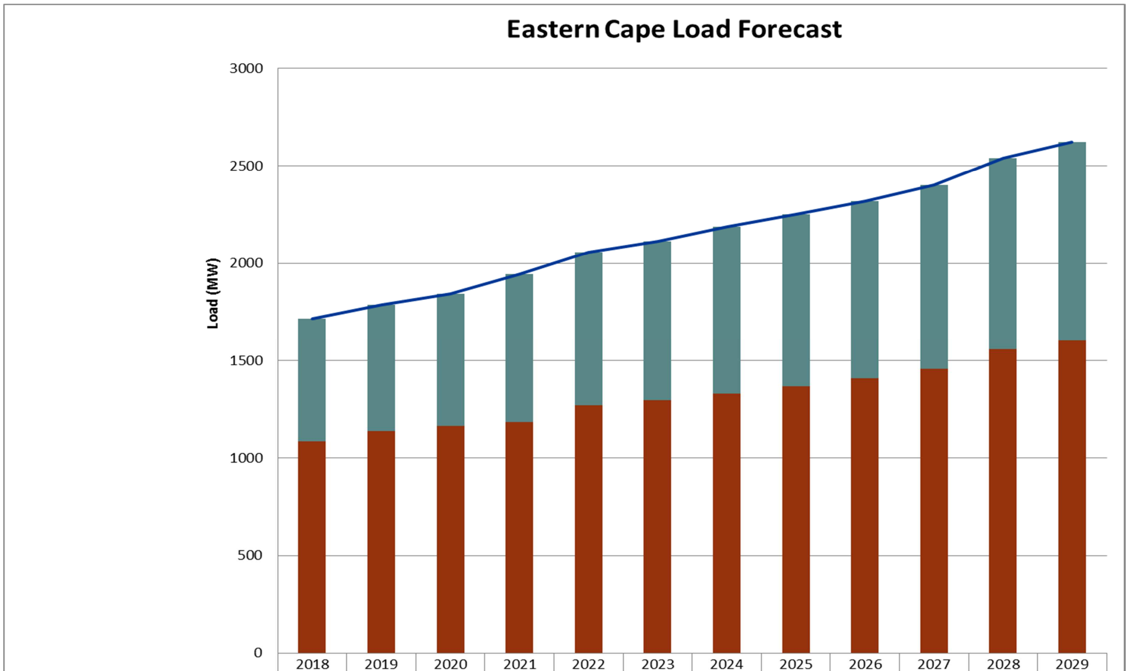
Table 6-13: Approved projects in the Eastern Cape under the REIPPPP

REIPPPP round	Technology	Capacity (MW)
1	Wind	470
REIPPPP 1 capacity		470
2	Wind	337
REIPPPP 2 capacity		337
3	Wind	197
3	Solar	60
REIPPPP 3 capacity		257
4	Wind	397
REIPPPP 4 capacity		397
4B	33	33
REIPPPP 4B capacity		430
Eastern Cape total generation capacity		1 494

6.8.3 Load forecast

The major economic drivers in the Eastern Cape are the manufacturing sector, construction, and, in recent times, the renewable IPP sector and supporting industries. The rate of load growth has reduced significantly when compared to previous TDP cycles, with anticipated predictions of an annual growth rate of 6,6% or higher.

The main reason for the decline in load forecast is the slow realisation of anticipated projects in the Coega IDZ commercial and residential developments. The load forecast for the Eastern Cape is shown in Figure 6-24.



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
East London Peak (MW)	630	650	678	759	785	816	854	882	910	945	980	1016
Port Elizabeth Peak (MW)	1086	1136	1164	1187	1273	1297	1331	1368	1409	1457	1559	1604
Eastern Cape Grid Peak (MW)	1716	1786	1842	1946	2058	2112	2186	2250	2318	2401	2539	2620

Figure 6-24: Eastern Cape load forecast

6.8.4 Major transmission development schemes

The major schemes planned in the Eastern Cape are as follows:

Greater East London strengthening phase 3 and 4

The Greater East London strengthening phase 3 entails the establishment of 400 kV at Pembroke Substation and building the Neptune-Pembroke 400 kV line and the installation of the first 400/132 kV 500 MVA transformer. The Greater East London strengthening phase 4 will introduce the second 400 kV corridor into Pembroke; construction of the Poseidon-Pembroke 400 kV line and installation of the second 400/132 kV transformer.

Southern Grid strengthening phase 3 and 4

Southern Grid strengthening phase 3 is an infrastructure investment project that entails the introduction of 765 kV into the Eastern Cape by means of the first Gamma-Grassridge 765 kV line. The Southern Grid strengthening phase 4 refers to integration of the second Gamma-Grassridge 765 kV line.

Port Elizabeth Substation integration

The project involves establishing a new 400/132 kV substation near Port Elizabeth. This substation will serve as an additional source of supply for the city to cater for anticipated load growth and to enable the integration of generation south-west of the city.

The TDPs for Eastern Cape are shown in Figure 6-25.

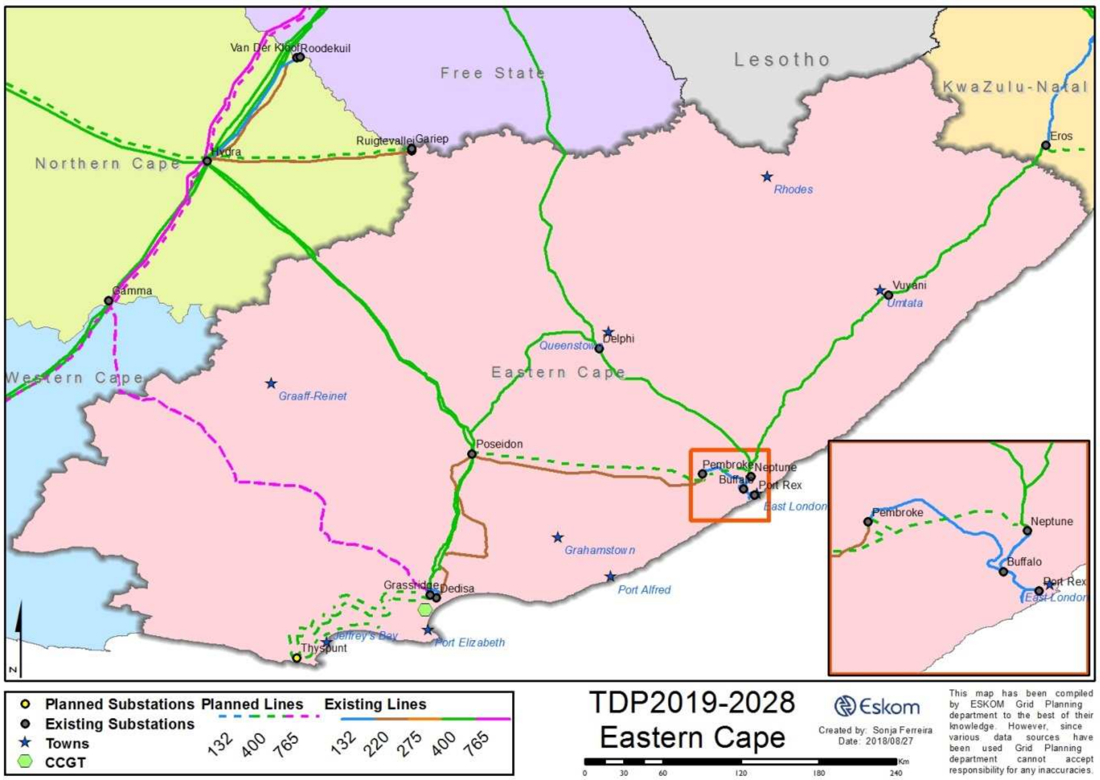


Figure 6-25: Future Eastern Cape network diagram

6.8.5 New substations

The transmission substations to be established in the Eastern Cape over the TDP period are included in Section 6.8.4.

6.8.6 Reactive power compensation

The envisaged load growth in the Port Elizabeth CLN will result in under-voltages at Grassridge and Dedisa under contingencies. Shunt compensation projects that entail installation of 100 MVar capacitor banks at 400 kV will be implemented for voltage support at the following substations:

- Grassridge
- Dedisa
- Poseidon
- Delphi

6.8.7 Provincial summary

A summary of all projects and scheme planned in the Northern Cape is provided in Table 6-14.

Table 6-14: Summary of Eastern Cape projects and timelines

TDP scheme	Project name	Expected CO year
PE strengthening phase 3	PE strengthening phase 3: 100 MVar shunt cap banks at Poseidon, Delphi, Grassridge and Dedisa	2018
Buffalo and Pembroke transformer normalisation	Buffalo and Pembroke transformer normalisation	2018
Greater EL phase 3	Greater EL phase 3: Neptune-Pembroke 400 kV line	2022
Greater EL phase 3	Greater EL phase 3: Pembroke 1st 400/132 kV 500 MVA transformer	2022
Greater EL phase 3	Greater EL phase 3: Pembroke 1st 132/66 kV 160 MVA transformer	2022
Grassridge 3rd 500 MVA 400/132 kV transformer	Grassridge 3rd 500 MVA 400/132 kV transformer	2023
Dedisa 3rd 500 MVA 400/132 kV transformer	Dedisa 3rd 500 MVA 400/132 kV transformer	2023
Delphi 120 MVA 400/132 kV transformer	Delphi 120 MVA 400/132 kV transformer	2024
Southern Grid phase 3	Southern Grid phase 3: 1st Gamma-Grassridge 765 kV line	2026
Greater EL phase 4	Greater EL phase 4: Poseidon-Pembroke 400 kV line	2026
Greater EL phase 4	Greater EL phase 4: Pembroke 2nd 400/132 kV 500 MVA transformer	2026
Greater EL phase 4	Greater EL phase 4: Pembroke 2nd 132/66 kV 160 MVA transformer	2026

6.9 WESTERN CAPE

6.9.1 Background

The Western Cape is situated in the south-western part of South Africa and has Cape Town as its capital. The provincial economy is mainly driven by the tourism, financial services, business services, real estate, agriculture, and manufacturing sectors. Cape Town is the economic hub of the province, with a robust clothing and textile industry that provides significant employment opportunities in the province.

The Western Cape region of South Africa is also noted for its abundance of wind resources, which makes it one of South Africa’s ideal locations for wind energy projects, a number of which are already in operation. To date, 550 MW of RE plants have been integrated in the Western Cape, one of which is Sere Wind Farm, a 100 MW Eskom wind generating facility, which was completed in January 2015. There has also been considerable interest in gas and oil imports as well as gas generation.

The provincial load peaked at around 3 900 MW in 2017 and it is expected to increase to about 4 500 MW by 2028. The Western Cape comprises three CLNs, namely the Peninsula, Southern Cape and West Coast. The Peninsula CLN is the main load centre in the province, consuming approximately 67% of the load. Southern Cape and West Coast CLNs make up the remaining 33% of the demand in the province.

The Western Cape Transmission network consists mostly of 400 kV lines. It stretches over a distance of about 550 km from the Gamma Substation (near Victoria West) to the Philippi Substation (near Cape Town).

Local strengthening is planned across the province, mainly comprising new 400/132 kV substations. Additional 400 kV line infrastructure is also required, primarily to integrate these substations and to assist with power evacuation from the existing power stations.

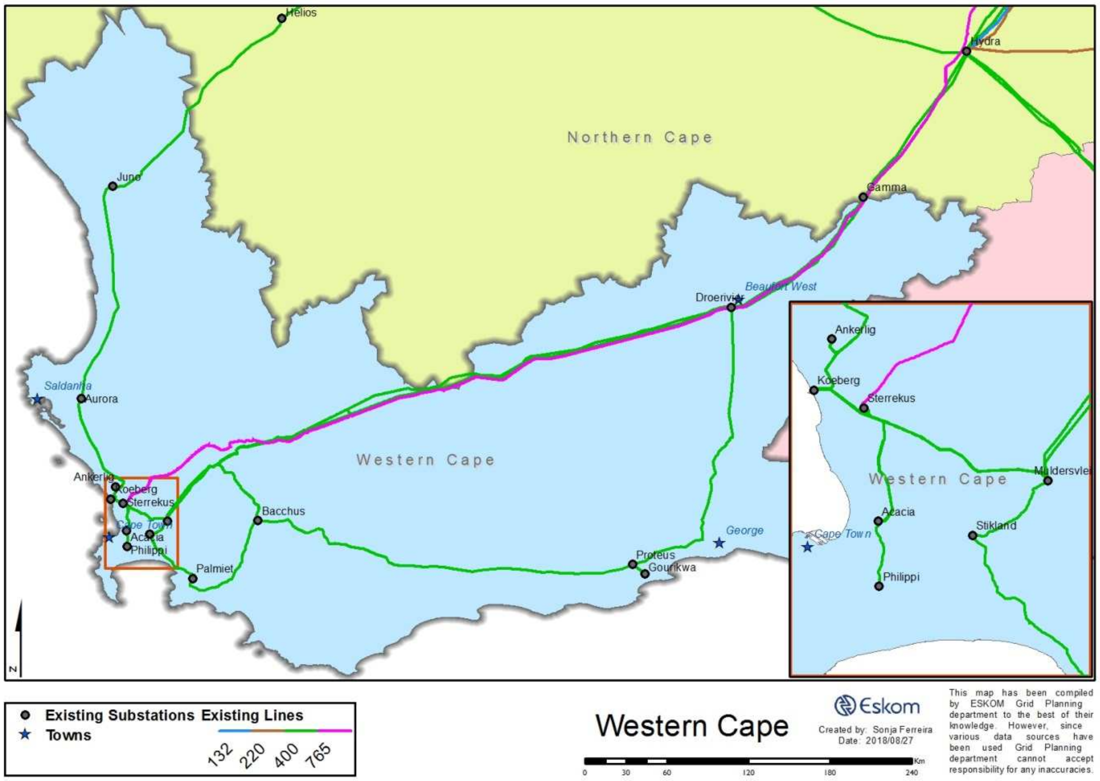


Figure 6-26: Current Western Cape network diagram

6.9.2 Generation

Koeberg Power Station is the only baseload power station situated locally in the Western Cape. There are also four Eskom peaking plants in the Western Cape, consisting of pumped storage and gas turbine generation, which help to meet the demand in the Western Cape as well as in the national grid during generation shortages. These comprise of the Palmiet Pumped Storage Station, Ankerlig and Gourikwa OCGT Stations and the Acacia Gas Turbine Station. Three City of Cape Town-owned (CoCT-owned) peaking plants in Cape Town help to manage the CoCT demand. These are the Steenbras Pumped Storage Station and the Athlone and Roggebaai Gas Turbine Stations. The Western Cape has also benefited from RE generation due to its climate and proximity to the coastline.

The deficit between local generation and the Greater Cape (Western Cape, Eastern Cape and Northern Cape) load is offset by the generation pool in the Highveld via the Cape Corridor.

Koeberg Power Station

Koeberg Power Station is situated at Duynefontein, 27 km north of Cape Town on the Atlantic coast. Koeberg ensures a reliable supply of electricity to the Western Cape, one of the fastest growing regions in South Africa. It has operated safely and efficiently for over 30 years and has a further active life of about 20 years. Koeberg Power Station has a generating capacity of 1 860 MW. The two units are rated at 930 MW each.

Acacia Power Station

Acacia Power Station forms part of the peaking group of power stations and consists of 3 x 57 MW gas turbine engines at an installed capacity of 171 MW. Acacia also operates predominantly in synchronous condenser mode of operation (SCO) to regulate the voltage. In addition, it provides an off-site electrical supply to Koeberg Power Station according to the National Nuclear Regulator licencing requirement.

Ankerlig and Gourikwa Power Stations

The OCGTs were built to meet the rapidly increasing demand for peaking power on the Eskom grid. The gas turbine engines are similar to those used in the aviation industry and use liquid fuel (diesel). Some of the units have been fitted with dual fuel burners in anticipation of conversion to CCGTs. In addition to their generating capabilities, some of the units at these two power stations are also used to regulate network voltages when running in SCO.

Ankerlig Power Station is located at Atlantis in the Western Cape and has an installed capacity of 1 350 MW (9 x 150 MW). Gourikwa Power Station is located at Mossel Bay and has an installed capacity of 750 MW (5 x 150 MW).

Palmiet Pumped Storage Scheme

Palmiet Pumped Storage Scheme is a joint venture between Eskom and the Department of Water Affairs and Forestry. It is situated in the ecologically sensitive Kogelberg Nature Reserve in the Western Cape near Grabouw.

The power station delivers 400 MW (2 x 200 MW) of peak power into the Eskom national grid and carries out a frequency and voltage regulating role. It is also part of an inter-catchment water transfer project supplying water to Cape Town.

For generating purposes, water flows from an upper reservoir to the machines located in an underground power station. The water is collected in a lower reservoir and pumped back to the upper reservoir during off-peak periods.

Steenbras Pumped Storage Scheme

Steenbras Dam is an earth-fill type dam located on the Steenbras River in the Hottentots-Holland Mountains, high above Gordons Bay, near Cape Town. In 1979, the Steenbras Dam became part of the first pumped storage scheme in the country to supplement Cape Town's electricity supply during periods of peak demand.

Steenbras Pumped Storage Scheme is a CoCT generating facility. It consists of 4 x 45 MW units and is integrated into the City's network.

Athlone and Roggebaai Power Stations

The Roggebaai and Athlone Gas Power Stations are two gas turbine stations that are owned and operated by CoCT. They are used to generate electricity over much shorter time periods as they make use of much more expensive fuel (Aviation Jet-A1).

Athlone Power Station is located at the site of the demolished Athlone coal-fired power station along the N2 highway near Pinelands and has an installed capacity of 36 MW. Roggebaai Power Station is situated at the V&A Waterfront and has an installed capacity of 42 MW.

Both power stations are used for reducing the CoCT's peak load but can also be used to supply local loads during emergencies.

Klipheuwel Wind Energy Demonstration Facility

The Klipheuwel Wind Energy Demonstration Facility is an Eskom wind generating facility, which was completed in February 2003 and has a capacity of 3,16 MW comprising three wind turbines (660 kW, 1,75 MW and 750 kW). It is located around 50 km north of Cape Town, in Durbanville.

Since the commercial operation of the facility, the plant has reached the end of its useful life and Eskom is in the process of decommissioning this demonstration facility. One of the turbines will be used for practical training at the South African Renewable Technology Centre (SARETEC) situated in Bellville, Cape Town. The remainder of the wind farm (land

and the two Vestas wind turbines) will be disposed of following Eskom's commercial processes.

Darling Wind Power

The Darling Wind Power generating facility is a DoE demonstrator site which was completed in 2008 and has a capacity of 5,2 MW. It is located 70 km north of Cape Town, between Darling and Yzerfontein on the west coast of South Africa.

Sere Wind Farm

Sere Wind Farm is an Eskom wind generating facility, which was completed in January 2015 and has a capacity of 100 MW. It is located north-west of Vredendal in Skaapvlei, approximately 300 km north of Cape Town.

REIPPs

The REIPPPP has resulted in over 1 000 MW of wind and PV generation being procured in the Western Cape. As of 30 June 2018, there is 450 MW in commercial operation according to Table 6-15.

Table 6-15: Commissioned projects in the Western Cape under the REIPPPP

Round	Name of project	Type	Capacity (MW)	Transmission substation
1	Dassiesklip Wind Energy Facility	Wind	26	Bacchus 132 kV
	Hopefield Wind Farm	Wind	65	Aurora 132 kV
	SlimSun Swartland Solar Park	PV	5	Aurora 132 kV
	Touwsrivier Project	PV	36	Bacchus 132 kV
2	Gouda Wind Facility	Wind	135	Muldersvlei 132 kV
	West Coast 1	Wind	90	Aurora 132 kV
	Aurora	PV	9	Aurora 132 kV
	Vredendal	PV	9	Juno 66 kV
3	Electra Capital (Pty) Ltd	PV	75	Aurora 132 kV

6.9.3 Load forecast

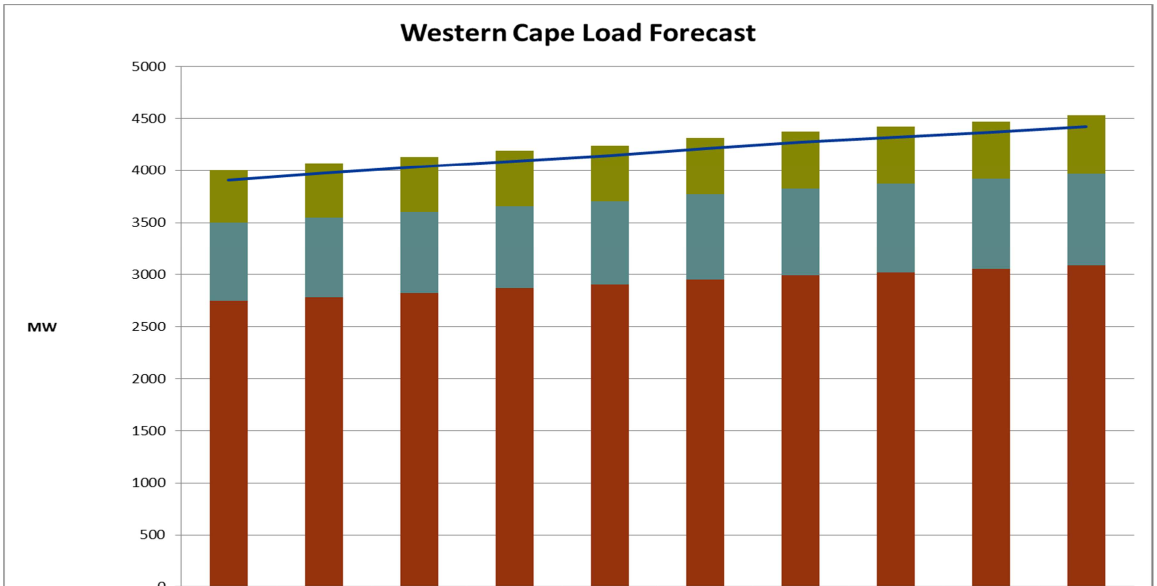
The Western Cape GDP is the third-highest contribution to the country's total at around 15% and has one of the fastest growing economies in the country. Industries in the Western Cape comprise financial and business services, manufacturing, tourism, agriculture, fishing, and wine. The province's economy is dominated by the City of Cape Town where the vast majority of all non-agricultural economic activity takes place. The electricity business in terms of new RE and gas are also major drivers of the economy across the province.

The past strong residential, commercial, and light industrial load growths in the Peninsula area are expected to continue for a number of years. Some areas of interest are the area around Philippi and Mitchell's Plain, where higher density residential properties are being developed on existing residential areas.

Substantial load growth in the West Coast is expected due to the Saldanha Bay IDZ. The 120-hectare area, which was designated as an IDZ in October 2013, is well situated to service the marine oil and gas markets within the African continent.
The Western Cape Department of Economic Development is also investigating the feasibility of establishing a floating liquefied natural gas terminal for the importation of gas.

Historical data has shown that the Western Cape does not peak at the TOSP. The province peak tends to be about 2,5% higher than the province load at the TOSP. The province peak is expected to grow by 15% from ~3 900 MW to ~4 500 MW by 2028.

The load forecast is shown in Figure 6-27.



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
West Coast	497	525	528	531	535	538	546	549	552	557
Outeniqua	751	764	775	788	800	822	835	853	867	880
Peninsula	2751	2782	2827	2870	2905	2951	2993	3022	3053	3090
TOSP	3910	3978	4035	4093	4145	4214	4274	4323	4369	4422
Provincial Peak	3999	4070	4130	4190	4240	4312	4374	4424	4472	4527

Figure 6-27: Load forecast for the Western Cape

6.9.4 Major schemes

The Cape Corridor comprises of 400 kV and 765 kV lines originating from the Zeus Substation (near Bethal) and the Alpha Substation (near Standerton) in Mpumalanga to Hydra Substation (near De Aar) in the Northern Cape. It then extends into the Western Cape and terminates at the Muldersvlei Substation (near Klapmuts) and the Sterrekus Substation (near Melkbosstrand).

The immediate problems in the corridor between Beta, Perseus, and Hydra Substations have been alleviated by the strengthening north of De Aar. The Beta-Delphi 400 kV line has also brought additional relief to this corridor. In addition, the OCGT power stations in the Western Cape provide assistance to this corridor during the peak. However, the planned duty cycle for the OCGTs and associated fuel costs of running these generators may not be able to cater for the energy growth.

The Cape Corridor has been strengthened with the first 765 kV line comprising the following sections that were commissioned and energised over the last five years:

- Zeus-Mercury and Mercury-Perseus in December 2012

- Hydra-Perseus in July 2013
- Perseus-Gamma and Hydra-Gamma in February 2014
- Gamma-Kappa in April 2015
- Kappa-Sterrekus in December 2016

Additional improvements in the transfer limits will be brought about by the following strengthening projects in the Northern Cape:

- Aries-Nieuwehoop-Ferrum 400 kV line
- Juno-Gromis 400 kV line
- Aries SVC

Some of the existing 400 kV series capacitor installations contain PCBs and an Eskom directive that requires these be removed from the system by 2023 in compliance with SANS 290, the “Regulation to phase-out the use of Polychlorinated Biphenyl (PCB) materials and Polychlorinated Biphenyl (PCB) contaminated materials”. In accordance with this, the series capacitors at Juno, Helios, Victoria, and Hydra will be decommissioned.

The Bacchus series capacitor will be bypassed with the integration of the planned Agulhas Substation (near Swellendam) and the Proteus series capacitor will be relocated to the planned Narina Substation (near George). Due to the addition of a 400/132 kV substation at Komsberg, the Komsberg 2 series capacitor will be downsized.

All of the above projects will result in Cape Corridor network adequacy until ~2027. Beyond 2027, the preferred strengthening to provide additional transfers into the Cape is the construction of a second Zeus-Sterrekus 765 kV line.

The future Western Cape Province transmission network is shown in Figure 6-28.

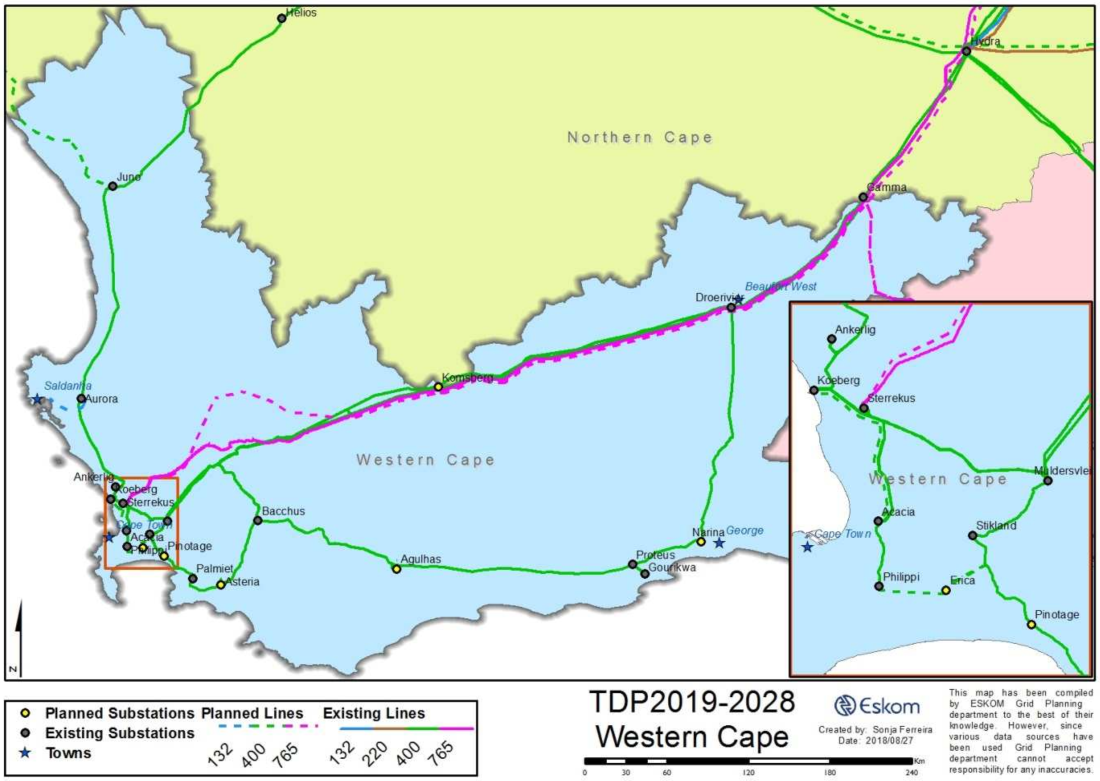


Figure 6-28: Future Western Cape Transmission network diagram

6.9.5 New substations

The following new substations will be established in the Western Cape in order to address load growth as well as IPP integration:

Load growth in the Peninsula in the residential, commercial, and light industrial sectors will necessitate the introduction of the following 400/132 kV substations:

- Pinotage Substation in the Stellenbosch area
- Asteria Substation in the Houhoek area
- Erica Substation in the Mitchell's Plain area

Load growth in the Southern Cape CLN in the residential, tourism, and agricultural sectors will necessitate the introduction of two new 400/132 kV substations, namely:

- Agulhas Substation in the Swellendam area
- Narina Substation in the George area

Furthermore, IPP integration in this CLN will necessitate the following developments:

- Construction of Komsberg 400 /132 kV Substation

- Introduction of 132 kV at Kappa Substation

There are plans to establish an IDZ in Saldanha; in order to support this development, the new Bokkom 400/132 kV Substation will be integrated into the West Coast CLN.

6.9.6 Reactive power compensation

Additional 132 kV capacitor banks will be installed at Aurora and Bacchus Substations as part of the Cape Corridor Shunt Capacitor Strengthening Project. Table 6-16 shows a list of the banks and respective sizes (total MVar).

Table 6-16: Future shunt capacitor banks in the Western Cape

Capacitor designation	Nominal output QN (MVar)
Aurora 1	72
Aurora 2	72
Bacchus 11	72

6.9.7 Provincial summary

A summary of all projects and scheme planned in the Western Cape is provided in Table 6-17.

Table 6-17: Western Cape– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Pinotage Substation (Firgrove Transmission Substation)	Pinotage Substation (1st and 2nd 400/132 kV 500 MVA transformers)	2018
	Loop-in and out of Palmiet-Stikland 400 kV line	
Muldersvlei 3rd 400/132 kV transformer & 132 kV series reactors	Replace the 2 x 240 MVA units with a 3rd 500 MVA 400/132 kV transformer	2018
	Install 132 kV transformer FCLRs	
Establish Koeberg off-site supply at Ankerlig Power Station	Establish Koeberg off-site supply at Ankerlig Power Station	2019
	Loop-in and out of Koeberg-Dassenberg 132 kV line	
Komsberg Substation	Komsberg 400/132 kV Substation (1st 500 MVA transformer)	2020
	Loop-in and out Droërivier-Kappa 2 400 kV line	
	Resize Komsberg 2 series capacitor bank	
Kappa Substation extension	Kappa ext. 400/132 kV (1st 500 MVA transformer)	2018
Ankerlig-Sterrekus 1st and 2nd 400 kV lines	Ankerlig-Sterrekus 1st and 2nd 400 kV lines	2019
PCB phase-out plan	Decommission Helios series capacitor	2019
Koeberg 400 kV busbar reconfiguration and transformers upgrade	Koeberg 400 kV GIS busbar	2022
	Replace 2 x 250 MVA transformers with new 250 MVA units	
	Koeberg 400 kV lines rerouting to the new busbar	
Juno Substation transformation upgrade	Replace the 2 x 120 MVA 400/132 kV units with 2 x 125 MVA units	2016
	Replace the 2 x 40 MVA 132/66 kV units with 2 x 80 MVA units	2021
	Install an additional 20 MVA 66/22 kV unit with the existing 10 MVA unit	
2nd Koeberg-Acacia 400 kV line	2nd Koeberg-Acacia 400 kV line	2021
Erica Substation (Mitchells Plain Transmission Substation) (Phase 1)	Erica Substation (1st and 2nd 400/132 kV 500 MVA transformers)	2023
	Philippi-Erica 400 kV line	
Erica Substation (Mitchells Plain Transmission Substation) (Phase 2)	Loop-in and out Pinotage-Stikland 400 kV line	2025
Philippi Substation extension (Phase 1)	Establish 400 kV busbar	2022
	Install 3rd 400/132 kV 500 MVA transformer as a hot standby	
Philippi Substation extension (Phase 2)	Extend 132 kV GIS busbar	Deferred
	Install 132 kV transformer FCLRs	
Agulhas Substation (Vryheid Transmission Substation)	Agulhas Substation (1st and 2nd 400/132 kV 500 MVA transformers)	2026

TDP scheme	Project name	Expected CO year
	Loop-in and out Bacchus-Proteus 400 kV line	
	Bypass Bacchus series capacitor bank	
Saldanha Bay Network Strengthening (Phase 1)	At Aurora Substation, replace two of the four existing 400/132 kV 250 MVA units with 2 x 500 MVA units as part of refurbishment	2025
	Strategically acquire a substation site in the Saldanha Bay area	
	Construct 2 x 400 kV lines (operated at 132 kV) from Aurora Substation to the new Distribution Blouwater Substation	
Saldanha Bay Network Strengthening (Phase 2)	Bokkom Substation (1st and 2nd 400/132 kV 500 MVA transformers)	Deferred
	Loop-in Ankerlig-Aurora 1 400 kV line	
Asteria Substation (Houhoek Transmission Substation)	Asteria Substation (1st and 2nd 400/132 kV 500 MVA transformers)	2021
	Loop-in and out Palmiet-Bacchus 400 kV line	
Narina Substation (Blanco Transmission Substation)	Narina Substation (1st and 2nd 400/132 kV 500 MVA transformers)	2025
	Loop-in and out Droërivier-Proteus 400 kV line	
	Relocate Proteus series capacitor bank to Narina	
PCB phase-out plan	Decommission Juno, Victoria and Hydra series capacitors	2022
Cape Corridor Phase 3b: Series compensation on the 765 kV lines between Perseus and Kappa	Series compensation on the 765 kV lines between Perseus and Kappa	Deferred
Cape Corridor phase 4: 2nd Zeus-Sterrekus 765 kV line	Zeus-Perseus 1st 765 kV line	Deferred
	Series compensation at Zeus and Perseus	
	Perseus-Gamma 2nd 765 kV line	
	Gamma-Kappa 2nd 765 kV line	2028
	Kappa-Sterrekus 2nd 765 kV line	Deferred
	Loop-in and out Koeberg-Stikland 400 kV line into Sterrekus	
	Sterrekus Substation 2nd 765/400 kV 2 000 MVA transformer	
Droërivier-Narina-Gourikwa 400 kV line	Droërivier-Narina-Gourikwa 400 kV line	Strategic EIA
	Bypass series capacitor at Narina	
Windmill Transmission Substation	Windmill 400/132 kV Substation (1st and 2nd 500 MVA transformers)	Deferred
	Loop-in and out Bacchus-Muldersvlei 400 kV line	
Stikland 132 kV transformer FCLRs	Stikland 132 kV transformer FCLRs	Deferred

7 INDEPENDENT POWER PRODUCER PROGRAMME

The IPP procurement programme was established in 2010 as one of the South African government's measures to enhance power generation capacity nationally. The key outcomes of the programme are to facilitate private sector investment into grid-connected generation from renewable and non-renewable energy sources in South Africa, as well as to enable diversification of energy sources by introducing RE as part of the energy mix. This programme has stimulated participation of the private sector in addressing the electricity needs of South Africa. The DoE IPP Unit has to date procured or initiated the process to procure energy from IPPs through the following programmes:

- REIPPPP
- Small Projects REIPPs Procurement Programme
- Coal Baseload IPP Procurement Programme
- The Co-generation IPP Procurement Programme
- Gas IPP Programme
- The Solar Parks Project

The distribution of IPP technology for the announced procurement programmes to date, totalling 8 269 MW, is as shown below:

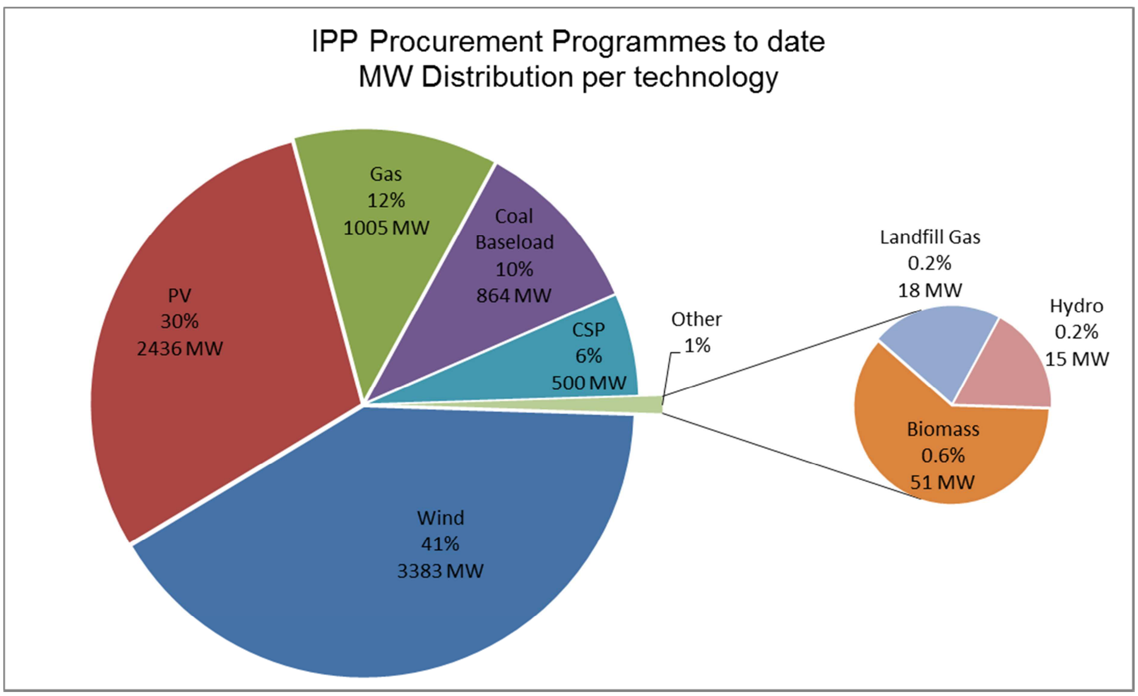


Figure 7-1: IPP procurement programmes in MW per technology

Of the above-mentioned IPP procurement programmes, the gas peakers programme amounting to a total of 1 004,5 MW is the most advanced, with all projects commissioned and in commercial operation. These projects are located at the Dedisa Substation, near Port Elizabeth, and the Avon Substation, approximately 30 km to the north of Durban. The second most advanced programme is the REIPPPP with all projects in bid windows 1 and 2 connected and in commercial operation, while 17 of the 23 projects in bid windows 3 and 3,5 are commissioned and in commercial operation. The IPPs in bid windows 4 and 4B are at the financial closure phase and are expected to be integrated with the national grid within the current TDP period. The Small REIPP and Coal Baseload IPP are in the budget quotation phase, while the Co-generation IPP, the Solar Parks, and the gas-to-power programmes are in different phases of the development and concept stage.

Furthermore, the Draft IRP versions released the DoE in December 2016 and August 2018 demonstrate that RE generation will form substantial part of the future generation mix in the country by 2040. Although the IRP indicates how much RE needs to be connected, it does not indicate geographical location within the country. This spatial uncertainty makes it difficult to formulate plans for grid enhancements. Moreover, the initial rounds of the programme have consumed much of the available connection capacity in the areas with good RE generation resources, necessitating substantial electrical infrastructure investment in these areas to enable future REIPP integration with the national grid. This section outlines the transmission infrastructure investment plans to enable the approved IPPs, as well as the concept plans that forms part of the strategic plan to facilitate speedy connection of the future IPPs based on the latest available information and the TDP assumptions.

7.1 DEVELOPMENT PLANS TO ENABLE APPROVED IPPs

The REIPPP has to date procured around 6 401 MW of energy from 106 IPP projects. Since 2011, 64 projects (3 924 MW) of the REIPPP were connected with the national grid, 96% (3 774 MW) of which are in commercial operation. This new generation capacity is vital in meeting the needs of the economy as well as the objectives of the Integrated Resource Plan 2010 (IRP2010). The grid integration of these projects has exhausted the grid capacity that was previously available, particularly in the Northern Cape, Western Cape, and Eastern Cape. Consequently, substantial grid infrastructure investments will be required to enable power evacuation from the majority of locations within these provinces to integrate additional IPPs.

The 26 preferred bidder projects in REIPPPP bid windows 4 and 4B are currently in the financial closure phase and are expected to be connected with the national grid in the first half of the current TDP period. Furthermore, the budget quotation process for the two preferred bidders for Coal Baseload IPP Procurement Programme is also in progress. These projects, which have been allocated a total capacity of 863,5 MW, are located in Limpopo and Mpumalanga, namely Thabametsi and Khanyisa Power Stations respectively. The transmission integration scope of work for the integration of these projects has been finalised and the expected grid connection is also expected to be in the current TDP period. The approved IPP projects, together with the associated grid connection status, are tabled below in Table 7-1.

Table 7-1: Approved IPP project list

Programme	No. of projects	MW contribution	Current status
REIPPPP BW 1	28	1 436	All projects connected
REIPPPP BW 2	19	1 054	All projects connected
REIPPPP BW 3 and 3,5	23	1 656	14 projects connected, eight in execution, one project in BW 3,.5 awaiting financial close
REIPPPP BW 4	13	1 121	Budget quotation phase
REIPPPP BW 4B	13	1 084	Budget quotation phase
DoE peakers	2	1 004,5	All projects connected
Coal Baseload	2	863.5	Budget quotation phase
Total	**110**	**8 219**	

The IPP projects in the above list that have not reached grid connection status will be enabled by the following transmission expansion projects as well as the supplementary distribution projects not listed below:

REIPP programme projects

- Groeipunt 220/132 kV Substation integration
- Komsberg 400/132 kV Substation integration
- Kappa 400/132 kV Substation integration
- Kronos 400/132 kV Transformation upgrade

Coal Baseload programme projects

- Thabametsi PS 400 kV integration plan (BQ phase)
- Khanyisa PS 400 kV integration plan (BQ phase)

7.2 DEVELOPMENTS PLANS TO ENABLE FUTURE IPPs

The IRP2010 calls for the diversification of electricity generating resources, particularly an increase in RE resources, which will be spread across wider areas of the country. The Draft IRP versions that were released by the DoE in December 2016 and August 2018 also show ambitions to integrate substantial RE generation in the future. Although the IRP outlines the total capacity per technology to be connected per year, it does not indicate the geographical location of the projects within South Africa. This spatial uncertainty makes it difficult to formulate plans for grid enhancements, particularly for REIPPPP. The location of potential sites for large-scale power generation from gas are relatively easy to predict compared to REIPPPP, which minimises the risk to development as the network-enabling activities can be initiated prior to the announcement of the preferred projects. This is because the locations of gas-generation power plants are generally expected to be developed in close proximity to existing ports along the coast of South Africa.

On the contrary, the location of the REIPPPP projects is only confirmed subsequent to the announcement of the preferred bidders, which presents a risk to timeous development of the enabling grid connection infrastructure, particularly long transmission lines and new substations. The process to implement major transmission infrastructure projects could take up to 10 years from inception to commissioning. The key components of the transmission project development cycle resulting in this long project establishment timelines include planning, environmental authorisation, land acquisition, procurement, and construction. In contrast, the IPP plant infrastructure can be developed in relatively short periods at specific locations. The disjoint in the length of time between IPP plant development and establishment of backbone transmission infrastructure is thus of concern. If new transmission projects are required for the IPPs, it is difficult for such projects to be delivered within the desired target dates, which provides challenges for the future IPP programmes.

Eskom is fully committed to mitigating these challenges and enabling the execution of future IPP procurement programmes in accordance with future ministerial determinations. A number of initiatives have been undertaken to facilitate the connection of future DoE IPP programmes to the national grid. These include:

- Establishment of the grid access unit (GAU) and the single buyer office to facilitate the connection requests of IPP developers and the buying of the energy, respectively;
- Creation of a simpler, efficient connection application process, specifically for all new generation plant, which is applicable to both IPPs and new Eskom power plants;
- Recommending enhancement to the applicable grid codes and connection agreements to encompass renewable generation plant;
- Publication of the grid connection capacity assessment (GCCA) document to guide stakeholders to available network capacity in relation to the RE resources and across the country for any type of IPP project;

- Commitment of resources to work closely with the DoE IPP Office, with the intention of aligning the IPP programme with feasible network expansion plans;
- Introduction of a self-build procedure document that provides IPPs with the option to "self-build" their own dedicated connection infrastructure as well as shared network in exceptional cases;
- Identification of strategic transmission line routes to unlock network capacity to connect future IPPs and collaborating with the Department of Environmental Affairs (DEA) to complete strategic environmental impact assessments (SEAs) of these routes;
- Participation in several external independent studies to identify the best resource areas for development, such as renewable energy development zones (REDZs) and the impact of the integration of large volumes of renewable energy generation; and
- Participation in the grid enablement working group to facilitate the development of the Transmission and Sub-transmission grid for future IPPs.

7.2.1 Potential locations for future IPPs

The initial bid windows of the DoE REIPP Programme have taken advantage of the available generation connection capacity on the existing transmission grid. Most of this capacity has been rapidly allocated, especially in the areas with excellent RE resources like the Northern Cape, Eastern Cape, and Western Cape. While there are still some areas with relatively more connection capacity particularly in North West, Free State and Limpopo, the capacity connection capacity in the Northern Cape, Eastern Cape and Western Cape areas has been exhausted. Moreover, there are also a number of areas with very good RE resources that have no transmission grid access at all.

The locations of the successful and shortlisted bidders in the REIPPPP Windows 1 to 4B are known, as shown in Figure 7-2. The locations of the approved renewable generation as well as the information on historical customer applications data was used to predict the potential locations for future REIPP projects. In addition to this information, the REDZ study outcomes and the EIA information for prospective REIPPs were incorporated into the input assumptions to determine the potential volumes as well as the dispersion of future RE resources.

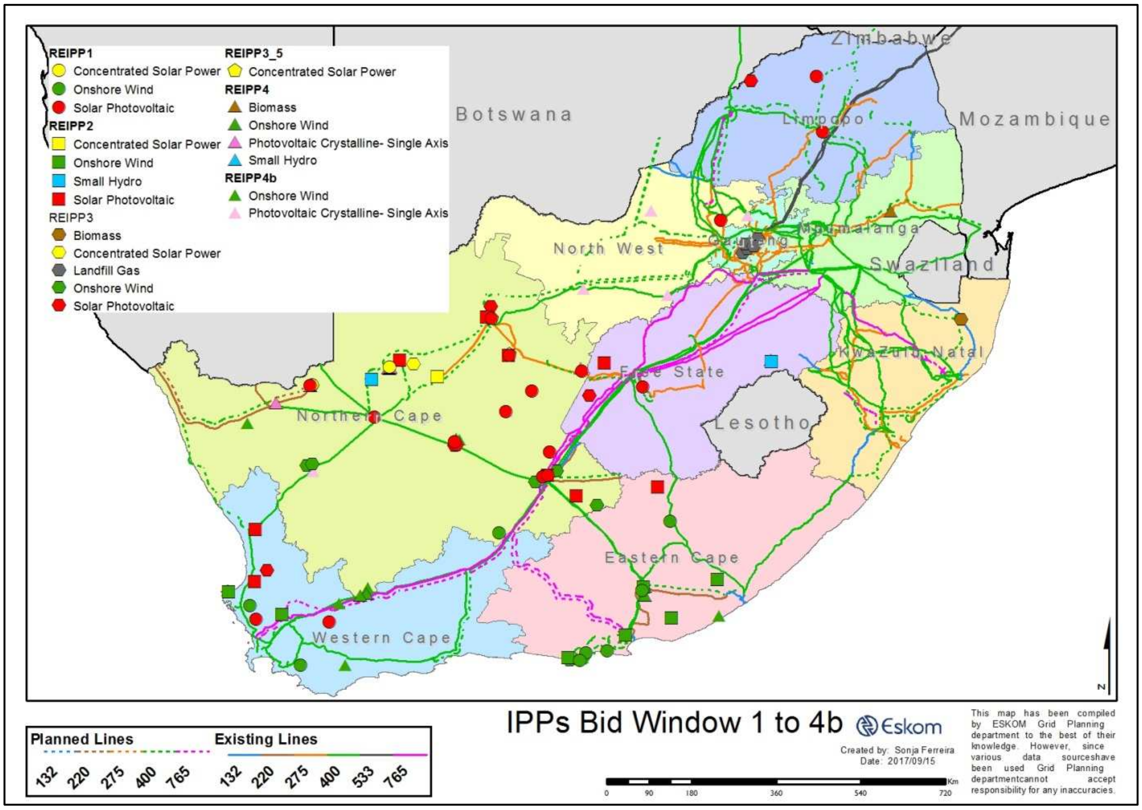


Figure 7-2: REIPP bid window 1 – 4B projects by technology

Wind generation will be distributed between the Northern Cape, Eastern Cape and Western Cape, mainly in the areas in and around the towns of Somerset East, Queenstown Humansdorp, Cradock, Middelburg, De Aar, Beaufort West, and Victoria West. On the contrary, solar PV is expected to be spread across the Northern Cape, Eastern Cape and Western Cape, Free State, North West, and Limpopo. The Northern Cape is expected to remain the most dominant destination for renewable generation projected over the current TDP period.

The gas-to-power programme will also require significant investment within the current TDP period. The potential sites that were used determine the transmission network requirements to facilitate connection of the planned large-scale gas-to-power generation are Richards Bay and Ngqura.

To enable successful integration of future IPPs with the national grid, the grid will have to be expanded to create more access for the bid windows beyond round 4B, specifically for the period 2023 to 2028. The TDPs to integrate these IPP programmes were based on the various generation assumptions scenarios, as the specific IPP project size, technology, location, and timelines were not stated in the IRP. Scenario planning serves as a sensitivity test to mitigate transmission infrastructure over-investment as the projects required to integrate generation in all potential locations would lead to excess capacity in many areas, as well as enormous requirement of capital to execute. Taking into account the generation assumptions, IPP connection requests, internal assessments, independent studies, and interactions with the DoE and other stakeholders, a number of potential transmission infrastructure projects have been identified to enhance the transmission connection capacity in the medium to long term, that is from 2023 to 2028, as well as the key transmission projects to enable post TDP grid connection access for IPPs.

7.2.2 Transmission expansion plans for future REIPPs up to 2028

The following projects are proposed for N-1 compliance, as well as to enhance the grid connection capacity for IPPs in the medium to long term, particularly in the Northern Cape, Eastern Cape and Western Cape, which are perceived as the hub of future power generation in South Africa. All these projects are expected to be commissioned within the current TDP period.

- Gromis-Oranjemund 220 kV line
- Juno-Gromis 400 kV line
- Aggeneis-Paulputs 400 kV line (Operated at 220 kV)
- Aries-Upington 400 kV line
- Aggeneis-Nama-Gromis 400 kV line
- Aries, Aggeneis and Nama 400 kV integration
- Grassridge-Humansdorp (Thyspunt) 400 kV line

Furthermore, a number of potential new substation sites have been identified. However, provision for a total of two new transmission substations for IPP integration has been made during this TDP period in additional to existing substations expansion for the same purpose as shown below:

- Aries 400/132 kV integration (Expansion)
- Aggeneis 400/132 kV integration (Expansion)
- Gromis 400/132 kV integration (Expansion)
- Nama 400/132 kV integration (Expansion)
- Pembroke 400/132 kV integration (Expansion)
- Humansdorp (Thyspunt) 400/132 kV new substation
- Hydra B 400/132 kV new substation

It should be noted that the substation locations (including expansions, which are not currently in execution phase) are not fixed at this stage as the investment decisions will be contingent upon the approval of individual business case underpinned by the successful bidder announcement by the DoE IPP Office.

7.2.3 Transmission expansion plans for future OCGT and CCGT IPPs up to 2028

In order to create a power system that has the potential to meet reliability needs, the envisaged high penetration of RE will be complemented by flexible generation. The proposed flexible generation in the current period will be in form of OCGT and CCGT, which is expected to be commissioned between 2025 and 2028. The total capacity of flexible generation expected in this period is 5 196 MW, which will be allocated to the Athene Substation near Richards Bay, the Dedisa Substation near Ngqura, and the existing Ankerlig Power Station in Cape Town as follows:

Table 7-2: Flexible generation (OGCT and CCGT) allocation per substation

Year	Athene (MW)	Dedisa (MW)	Ankerlig (MW)	Total per year (MW)
2022		1 000		1 000
2023	1 000			1 000
2024				0
2025	1 000	732		1 732
2026				0
2027				0
2028			1 464	1 464
Grand total				5 196

The integration of these power stations will be dependent on the following transmission investment plans:

Transmission infrastructure requirements for gas integration at the Dedisa Substation:

- Dedisa Substation extension
- Gamma-Grassridge 765 kV line and associated expansion at both substations
- Poseidon-Neptune 400 kV line

Transmission infrastructure requirements for gas integration at the Athene Substation:

- New 400 kV substation
- Loop-in and loop-out of Athene-Invubu and Athene-Umfolozi 400 kV lines for integration of the new 400 kV substation

Transmission infrastructure requirements for gas integration at the Ankerlig Substation:

- None

7.2.4 Transmission expansion plans for future IPPs beyond 2028

In accordance with the Draft IRP, significant amount of power from RE sources will be connected to the national grid in the years beyond the current TDP period. The location of the IPPs to be connected during this period is also expected to be distributed in line with the current TDP assumptions, which shows predominant penetration in the Northern Cape, Western Cape and Eastern Cape. The high-level analysis of the transmission network has demonstrated that the thermal constraints on some of the 400 kV transmission corridors for Namaqualand will the emerging constraint for successful integration of more REIPPs beyond the current TDP period. The main objective of this exercise was to identify a strategic servitude requirement in the period after the TDP as a risk mitigation measure to ensure timeous commissioning of the transmission infrastructure, particularly long lines. The following projects were identified:

- Aries-Aggeneis 400 kV line
- Paulputs 400 kV integration
- Upington-Ferrum 400 kV line
- Ferrum-Hermes 400 kV strengthening (via Umtu)
- Aries-Hydra 400 kV corridor strengthening (via Kronos MTS)
- Beta-Ferrum 400 kV corridor strengthening

The network overview of the transmission expansion plans in the medium to long term for the integration of IPPs is shown below in Figure 7-3.

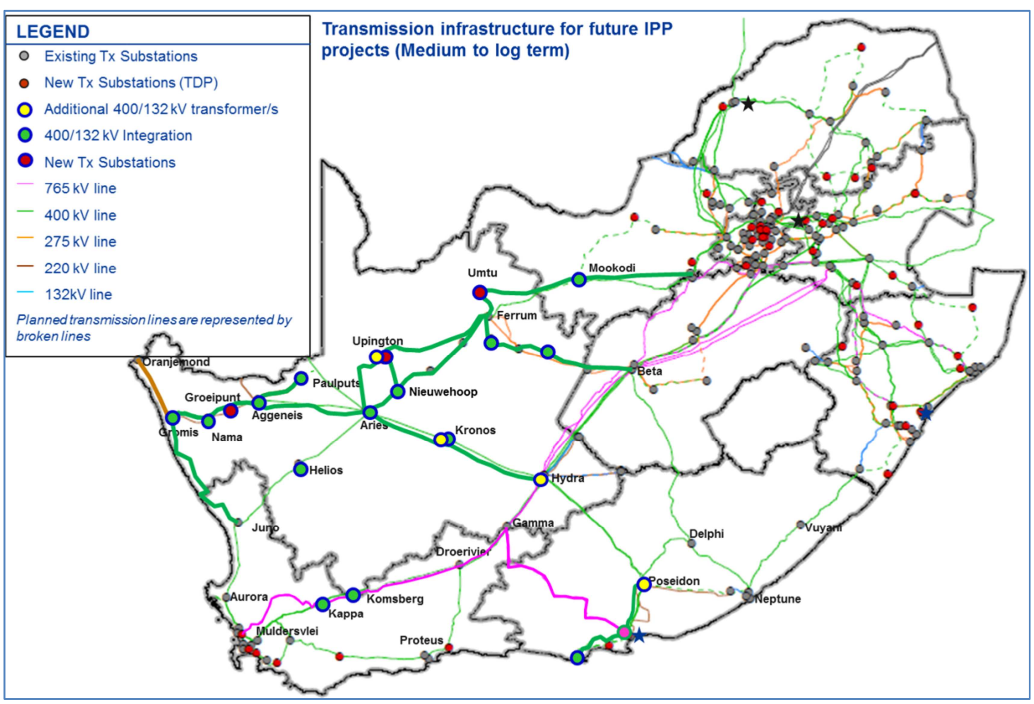


Figure 7-3: Medium to long-term transmission network to enable IPP integration

7.3 IMPACT OF THE DoE GENERATION SCENARIOS

The TDP is based on the baseline generation assumptions. To adjust for spatial uncertainty and allow for prudent planning, generation scenarios were agreed upon by the stakeholders during assumptions formulation phase. The scenarios are aimed at facilitating more robust plans and help in expediting the EIA and land acquisition processes. The period of consideration for these scenarios was 2028, as only the full impact was considered, not the phased roll-out of these scenarios.

These generation scenarios are listed below and the specific assumptions and likely impact of each scenario are discussed separately. The different scenarios, as introduced earlier in this chapter, are as follows:

- Limpopo PV scenario
- Northern Cape wind scenario
- Western Cape wind, gas and nuclear scenario
- Generation decommissioning of coal plant older than 50 years

7.3.1 Limpopo PV scenario

Limpopo has a huge potential of power generation from renewable sources, specifically solar. There are currently three projects that have been allocated generation capacity from the approved REIPPPP id windows. There have also been several enquiries from potential PV generators in the province. The following scenario was considered for additional solar PV generation in Limpopo by 2028:

Solar PV generation amounting to a total of 1 000 MW moved from the Northern Cape to Limpopo as an alternative to the baseline allocation. The additional solar PV generation capacity output was allocated at the following substations to test robustness of the planned TDP in the province:

- Medupi
- Witkop
- Nzhelele
- Tabor
- Spencer
- Foskor

It was observed that, this scenario will not require additional infrastructure investment in Limpopo for power evacuation purposes. However, the evacuation of additional power is contingent upon completion of the following projects, which are currently in execution:

- Waterberg Generation 400 kV stability enhancement, consisting of Medupi-Witkop 400 kV line and Borutho-Silimela 400 kV line.

7.3.2 Northern Cape wind scenario

The Northern Cape is an ideal location for generation from renewable sources in South Africa. The majority of approved projects under the REIPPPP to date are located in the Northern Cape. Moreover, the highest number of applications processed for the REIPPPP expedited programme was located in the Northern Cape, which confirms the province as the hub of generation from renewable sources. The following scenario was considered for additional wind generation in the Northern Cape by 2028:

Wind generation amounting to a total of 2 200 MW moved to the Northern Cape as an alternative to the baseline allocation. This total capacity output was allocated to the following substations in the Northern Cape in order to test network agility to accommodate the potential generation under this scenario:

- Aries
- Kronos
- Gamma
- Nama
- Gromis
- Aggeneis
- Oranjemund
- Hydra B

The study took into account the massive diversity between the Northern Cape and the Eastern Cape, and Western Cape wind generation. The following strengthening projects were recommended to evacuate additional power from wind generation in the Northern Cape:

- In addition to the Juno-Gromis 400 kV line, this scenario will require Gromis-Nama-Aggeneis 400 kV line: This project will enable the evacuation of the anticipated renewable generation in the Namaqualand CLN under the Northern Cape wind generation scenario through the Juno and Aries Substations.

7.3.3 Western Cape wind, gas and nuclear scenario

There are two designated REDZs in the Western Cape, namely Overberg and Komsberg. These have been identified as areas with high potential for RE generation and were gazetted as such in February 2016.

The Western Cape is also one of the prime locations for wind generation in South Africa with some potential for PV generation, as well as for nuclear and gas generation. There have been several enquiries for large-scale potential gas-generation integration in the vicinity of Atlantis, near Ankerlig Power Station. As a result of this, the following scenario was conceived for additional generation in the Western Cape by 2028:

- 732 MW of CCGT gas is relocated from Dedisa in the Eastern Cape to Ankerlig in the Western Cape.
- A total of around 1 000 MW of wind was moved from the Eastern Cape and Northern Cape to the Western Cape.
- An allocation of 1 600 MW of nuclear generation at Duynefontein in the Western Cape in 2028 to test the network in the case of eventual trigger for the construction of nuclear capacity in country.

For renewable generation, this is in addition to what has already been commissioned or allocated to preferred bidder up to REIPPPP bid window 4B. This scenario results in the Western Cape becoming a net exporter of power, with as much as 6 GW of excess generation. Additional infrastructure will be required to evacuate the power from the Western Cape; this will be in the form of 765 kV and 400 kV lines, especially in the northern ring.

Integration plans for the nuclear and gas have already been developed and the renewable generation will require mostly additional transformers at existing substations. For the most part, the line routes lie within the recently gazetted electricity grid infrastructure (EGI) corridors. Furthermore, some environmental authorisations are already in place for the lines required for the Nuclear 1 Integration at Duynefontein.

The project scope for the integration of Nuclear 1 is dependent on the completion of the second Gamma-Kappa 765 kV line and the second Kappa-Sterrekus 765 kV line as part of Cape Corridor phase 4. Moreover, the following six Transmission lines will be required to integrate Duynefontein with the national grid:

- 3 x 400 kV lines to Sterrekus (3 x ~10 km)
- 1 x 400 kV line to Acacia (~32 km)

- 2 x 400 kV lines to Stikland (~2 x 46 km)

The Transmission infrastructure required to integrate renewables in the Overberg and Komsberg areas comprises the following:

- Additional 400/132 kV transformers in existing substations, that is, Droërivier, Kappa and Komsberg.
- Establishment of Koring Substation between Droërivier and Komsberg by turning in the Droërivier-Komsberg 2 400 kV line and bypassing the Komsberg 2 series capacitor bank.

Additional infrastructure over and above this will be required to deliver the power to the load centres in the central and eastern parts of the country. This scope builds on strengthening provided by projects such as Kimberley strengthening phase 4, the proposed Cape Corridor phase 5 as well as the Prieska Solar Park integration.

A second 765 kV line from Mercury to Sterrekus will need to be established. There is also a need to provide an additional 400 kV evacuation path out of Kronos. The backbone strengthening can be summarised as follows:

- A second Mercury-Sterrekus 765 kV line with series compensation between Lereko (Hotazel) and Mercury.
- An additional 765/400 kV transformation at Juno, Aries and Lereko (Hotazel), Sterrekus, Hydra, and Zeus
- 1 x Kronos-Ferrum 400 kV line
- 1 x Kronos-Boundary-Beta 400 kV line

7.3.4 Generation Decommissioning of coal Plant older than 50 years

This scenario considers the decommissioning of some of the old coal-fired power stations in Mpumalanga within the period of the current TDP. The criteria for identifying the power stations likely to be affected by this hypothetical decommissioning are power stations with 50 years of commercial service and above. The units that will reach the age of 50 years within the current TDP and considered for decommissioning as part of this scenario are at Arnot, Camden, and Kriel Power Stations:

The network analysis results indicated that no additional infrastructure investment will be required to enable the level of decommissioning that is higher than assumed in the base scenario. However, additional generation will be required elsewhere in the country to offset the deficit that will be introduced by the additional decommissioning of coal-fired generation. This may necessitate additional power evacuation infrastructure (not included in this plan) depending on the location of such generation.

8 CAPITAL EXPENDITURE PLAN

The total capital expenditure for Transmission amounts to R109,345 billion and is summarised in Table 8-1. It is clear that the majority of the cost will be related to capital expansion projects, compared to other categories of expenditure, because this relates directly to the strengthening of the network to accommodate new customers as well as new generation.

Table 8-1: Capital expenditure per category of projects during FY2019 to FY2028

Categories	Rand (billions)
Capital expansion	91,217
Refurbishment	14,874
Production equipment	0,585
Land and rights	2,670
Total	**109,345**

Refurbishment is required to prolong the life of assets and land acquisition projects are required to purchase the land on which to build the expansion assets.

Table 8-2 shows the provincial split for transmission expansion projects, which amounts to R91,2 billion over the next ten years.

Table 8-2: Capital expenditure per province for expansion projects during FY2019 to FY2028

Province	Rand (Billions)
Eastern Cape	8,145
Free State	3,461
Gauteng	14,896
KwaZulu-Natal	23,431
Limpopo	9,457
Mpumalanga	8,038
North West	3,762
Northern Cape	11,623
Western Cape	8,404
Total	**91,217**

9 CONCLUSION

The most visible difference between this TDP and the 2015 TDP is the rephasing of projects in the execution phase. The acquisition of servitudes for lines and sites for new substations continues to be a challenge for Eskom Transmission, sometimes necessitating rephasing. Projects required for the first three rounds of the DoE REIPPPP that are under construction have been added, as well as the projects required for the 26 additional IPP successful bidders announced by the DoE in rounds 4 and 4B. There is an assumed plan for future REIPP programmes based on current estimates of technology, size, and location.

The result is a realistic and achievable development plan, within the constraints imposed by funding, site and servitude acquisition, and supplier and construction lead times. The slower rate of completion of projects, regrettably, increases the overall risk to the network. However, this risk can be managed, as the N-1 criterion refers to the strict deterministic level, which assumes that an N-1 contingency event will happen at the time of the peak loading. 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. Customers are consulted when compiling or reviewing emergency preparedness plans to ensure that emergencies necessitating load reduction are managed in a way that minimises the impact on individual customers and South Africa at large.

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 is generally on the critical path of connecting and integrating large new loads and generation due to the long lead times for securing corridors. It is recommended that, for planning purposes, developers should allow for at least seven years’ lead time for new corridors. It should also be noted that, in the EIA process, there are increasing objections from landowners and other stakeholders to proposed power line routes, which may further prolong the time to implement projects. The EIA and environmental approval process is prescribed by law. Changes to the relevant environmental legislation can therefore have a significant effect on lead times for new projects.

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, albeit at a later date than previously envisaged mainly due to funding constraints.

APPENDIX A: GENERATION ASSUMPTIONS

Table A1: The conventional generation plan for the TDP 2019 to 2028

Year	Medupi	Kusile	Ingula	DoE OCGT 1 Dedisa	DoE OCGT 2 Avon	New coal		OCGT		CCGT		Generation decommissioning assumption					
	MW	MW	MW	MW	MW	Location	MW	Location	MW	Location	MW	Station	MW	Station	MW	Station	MW
2016	720			167,5	167,5												
2016	720			167,5	167,5												
2016					167,5												
2016					167,5												
2017			331														
2017			331														
2017			331														
2019	720	726										Hendrina	-187	Komati	-114	Grootvlei	-190
2019												Hendrina	-187	Komati	-114	Grootvlei	-180
2019												Hendrina	-187	Komati	-114	Grootvlei	-180
2019												Hendrina	-187	Komati	-91		
2019												Hendrina	-185	Komati	-91		
2019												Hendrina	-185	Komati	-114		
2019												Hendrina	-185	Komati	-90		
2019												Hendrina	-165	Komati	-86		
2019												Hendrina	-165	Komati	-90		
2019												Hendrina	-160				
2020	720	726														Grootvlei	-190
2020	720															Grootvlei	-190
2020																Grootvlei	-190
2021		726				Khanyisa	300										
2021						Thabametsi	300										
2021						Thabametsi	300										
2022		726						Dedisa	250								
2022								Dedisa	250								
2022								Dedisa	250								
2022								Dedisa	250								
2023		726						Athene	250								
2023								Athene	250								
2023								Athene	250								
2023								Athene	250								
2025								Athene	250	Dedisa	366						
2025								Athene	250	Dedisa	366						
2025								Athene	250								
2025								Athene	250								
2028										Ankerlig	366						
2028										Ankerlig	366						
2028										Ankerlig	366						
2028										Ankerlig	366						

Table A2: The annual solar PV allocation per substation for the TDP 2019 to 2028

Substation	Solar PV generation allocation per year														Total per substation
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	
Aggeneis						140					100				240
Aries	10					200									210
Aurora	9	5	75												89
Bacchus	36														36
Bighorn	7												100		107
Boundary	78	75				75			100						328
Ferrum	149		75			100					100	100		100	624
Foskor													100		100
Garona	9														9
Harvard	64														64
Helios						75									75
Hydra	245	75													320
Hydra B								100		100		100		100	400
Juno	8,8														8,8
Kappa								100			100	100		100	400
Kronos	20	75	75			55									225
Lomond						50									50
Matimba		60													60
Mercury						67,9									68
Mookodi						75			100	100	200				475
Nama										100	100	100		100	400
Olien	139														139
Paulputs	10					75									85
Perseus	60														60
Ruigtevallei	75														75
Spencer													100		100

Tabor	28						100				200		100		428
Theseus						100						100		100	300
Upington						325			100		100				525
Watershed						75									75
Witkop	30							100					100		230
Total / year	**978**	**290**	**225**			**1 413**	**100**	**300**	**300**	**300**	**900**	**500**	**500**	**500**	**6 306**

Table A3: The annual wind allocation per substation for the TDP 2019 to 2028

Substation	Wind generation allocation per year														Total per substation
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	
Aggeneis						237									237
Aries							100								100
Aurora	159					100									259
Bacchus	27					32						100		100	259
Delphi	100					100	100			100	200				600
Droërivier						100				100					200
Grassridge	304	95	110			140									649
Gromis											200	100		100	400
Helios				276											276
Hydra	75	79		235											389
Hydra B						100		200	100	100	300	100		100	1 000
Juno	100														100
Komsberg						619					200				819
Kappa						108	100		100	200	200				708
Kronos						238									238
Muldersvlei		138													138
Nama								100		100					200
Pembroke		21				33			100	100	100				353
Poseidon	140	164	87			357	100			100		100		100	1 147
Thyspunt											200		1 600		1 800
Total / year	**906**	**497**	**197**	**511**		**2 163**	**400**	**300**	**300**	**800**	**1 400**	**400**	**1 600**	**400**	**9 873**

Table A4: The annual CSP allocation per substation for the TDP 2019 to 2028

Substation	CSP energy allocation per year														Total per substation
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	
Ferrum					100	150									250
Garona		100													100
Olien					100										100
Paulputs	100			100											200
Upington					100	300									400
Total / year	**100**	**100**		**100**	**300**	**450**									**1 050**

Table A5: Other generation allocation per substation for the TDP 2019 to 2028

Substation	CSP energy allocation per year														Total per substation
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	
Esselen					6,3										6,3
Etna					6										6
Fordsburg		20													20
Impala		16													16
Marathon						25									25
Paulputs	10														10
Princess			4												4
Taunus			5,1												5,1
Tugela				4,3		4,7									9
Total / year	**10**	**36**	**9,1**	**4,3**	**12,3**	**29,7**									**101,4**

Table A6: Limpopo PV scenario

Year	MTS	Solar PV		
		IPP ID	Programme	MW
2020	Aries	LimPV	Future	-100,0
2020	Ferrum	LimPV	Future	-100,0
2020	Medupi	LimPV	Future	100,0
2020	Spencer	LimPV	Future	100,0
2024	Hydra B	LimPV	Future	-100,0
2024	Nama	LimPV	Future	-100,0
2024	Tabor	LimPV	Future	100,0
2024	Nzhelele	LimPV	Future	100,0
2025	Aggeneis	LimPV	Future	-100,0
2025	Ferrum	LimPV	Future	-100,0
2025	Nama	LimPV	Future	-100,0
2025	Spencer	LimPV	Future	100,0

Year	MTS	Solar PV		
2025	Medupi	LimPV	Future	100,0
2025	Witkop	LimPV	Future	100,0
2026	Ferrum	LimPV	Future	-100,0
2026	Nama	LimPV	Future	-100,0
2026	Hydra B	LimPV	Future	-100,0
2026	Tabor	LimPV	Future	100,0
2026	Nzhelele	LimPV	Future	100,0
2026	Foskor	LimPV	Future	100,0

Table A7: Northern Cape wind scenario

Year	MTS	Solar PV		
		IPP ID	Programme	MW
2020	Komsberg	NCWind	Future	-100
2020	Gromis	NCWind	Future	100
2021	Delphi	NCWind	Future	-100
2021	Kappa	NCWind	Future	-100
2021	Poseidon	NCWind	Future	-100
2021	Gamma	NCWind	Future	100
2021	Kronos	NCWind	Future	100
2021	Nama	NCWind	Future	100
2023	Kappa	NCWind	Future	-100
2023	Pembroke	NCWind	Future	-100
2023	Gamma	NCWind	Future	100
2023	Oranjemund	NCWind	Future	100
2024	Droërivier	NCWind	Future	-100
2024	Delphi	NCWind	Future	-100
2024	Kappa	NCWind	Future	-200
2024	Pembroke	NCWind	Future	-100

Year	MTS	Solar PV		
2024	Aggeneis	NCWind	Future	200
2024	Aries	NCWind	Future	100
2024	Gamma	NCWind	Future	100
2024	Kronos	NCWind	Future	100
2025	Delphi	NCWind	Future	-200
2025	Komsberg	NCWind	Future	-200
2025	Kappa	NCWind	Future	-200
2025	Pembroke	NCWind	Future	-100
2025	Thyspunt	NCWind	Future	-200
2025	Aggeneis	NCWind	Future	100
2025	Aries	NCWind	Future	200
2025	Kronos	NCWind	Future	100
2025	Gamma	NCWind	Future	100
2025	Nama	NCWind	Future	100
2025	Oranjemund	NCWind	Future	200
2025	Kronos	NCWind	Future	100
2026	Poseidon	NCWind	Future	-100
2026	Bacchus	NCWind	Future	-100
2026	Aries	NCWind	Future	100
2026	Kronos	NCWind	Future	100

Table A8: Western Cape wind, gas and nuclear scenario

Year	MTS	Solar PV		
		IPP ID	Programme	MW
2020	Aggeneis	WC WN	Future	-100
2020	Aurora	WC WN	Future	100
2021	Poseidon	WC WN	Future	-100
2021	Delphi	WC WN	Future	-100
2021	Droërivier	WC WN	Future	100
2021	Komsberg	WC WN	Future	100

Year	MTS	Solar PV		
2021	Agulhas	WC WN	Future	100
2021	Poseidon	WC WN	Future	-100
2022	Hydra B	WC WN	Future	-100
2022	Juno	WC WN	Future	100
2023	Pembroke	WC WN	Future	-100
2023	Bacchus	WC WN	Future	100
2024	Delphi	WC WN	Future	-100
2024	Nama	WC WN	Future	-100
2024	Pembroke	WC WN	Future	-100
2024	Bacchus	WC WN	Future	100
2024	Komsberg	WC WN	Future	100
2024	Kappa	WC WN	Future	100
2024	Agulhas	WC WN	Future	100
2024	Asteria	WC WN	Future	100
2024	Delphi	WC WN	Future	-100
2024	Hydra B	WC WN	Future	-100
2027	*Thyspunt	Proxy W	Future	300
2027	*Thyspunt	Proxy W	Future	300
2027	*Thyspunt	Proxy W	Future	300
2027	*Thyspunt	Proxy W	Future	300
2027	*Thyspunt	Proxy W	Future	300
2027	*Thyspunt	Proxy W	Future	100
2028	*Duynefontein	Nuclear	Future	1600

Table A9: Higher generation decommissioning scenario

Power stations	Province	MTS	Year first commissioned	Decommissioning year to use	Total nominal capacity MW
Arnot	Mpumalanga	Arnot	1975	2025	380
Arnot	Mpumalanga	Arnot	1975	2025	380
Arnot	Mpumalanga	Arnot	1975	2025	376
Arnot	Mpumalanga	Arnot	1975	2025	376
Arnot	Mpumalanga	Arnot	1975	2025	370
Arnot	Mpumalanga	Arnot	1975	2025	350
Camden	Mpumalanga	*Camden	1967	2025	185
Camden	Mpumalanga	*Camden	1967	2025	180
Camden	Mpumalanga	*Camden	1967	2025	175
Kriel	Mpumalanga	Kriel	1976	2026	475
Camden	Mpumalanga	*Camden	1968	2026	186
Camden	Mpumalanga	*Camden	1968	2026	185
Kriel	Mpumalanga	Kriel	1977	2027	475
Kriel	Mpumalanga	Kriel	1977	2027	475
Camden	Mpumalanga	*Camden	1969	2027	190
Camden	Mpumalanga	*Camden	1969	2027	190
Camden	Mpumalanga	*Camden	1969	2027	190
Total	***Life extended due to RTS**				**5 138**

APPENDIX B: PUBLICATION TEAM

Although the publication of the document did not comprise a formal team, the following people were instrumental in its release. The Grid Planning staff, who are responsible for formulating the strategic grid plan as well as the regional grid plans are acknowledged for their invaluable contribution.

Team members	**Title**	**Role**
Leslie Naidoo	Snr Manager Grid Planning	Reliability Plans
Makoanyane Theku	Middle Manager Grid Planning	Project Management
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