Eskom

Transmission Development Plan
2020-2029

FOREWORD BY GROUP EXECUTIVE

"As we do our best to meet our commitments in terms of the TDP, we will certainly face challenges; however, our hope is that, through collaboration, we can all own this plan and support its funding and execution in order to co-create an energy future in support of the economic growth of our country."

Segomoco Scheppers

FOREWORD BY GROUP EXECUTIVE

The growth and development of our country's economy to meet the demands of a 21st century lifestyle relies heavily on a secure and reliable supply of electricity at affordable prices. It is obvious that people whose homes, workplaces, schools, and clinics are connected to the grid for the first time will find their lives transformed for the better in ways they could never previously have imagined.

The bulk of South Africa's electricity is still produced by Eskom's coal-fired power stations located in the coalfields of the Mpumalanga Highveld and near Lephalale, but the landscape for power generation is rapidly changing. The Renewable Energy Independent Power Producer (REIPP) Programme of the Department of Mineral Resources and Energy has resulted in increasing amounts of electricity produced from renewable sources, mainly wind and solar projects 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 Producer (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 becomes integrated in the national grid in accordance with the Integrated Resource Plan (IRP) 2019.

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 these load centres, the Distribution networks owned by Eskom, the metros, and municipalities deliver electricity to individual end users. The system has to be expanded and reinforced to connect new loads and more sources of generation to the grid, as well as to meet the changing needs of customers. The Transmission system also requires regular planned maintenance, as well as the refurbishment or replacement of plant that has reached the end of its operational or economic life, to ensure that the system performs its role safely and efficiently. Accordingly, the plans outlined in this document constitute the critical requirements for the development of Transmission infrastructure in South Africa over the next 10-year period, to meet the anticipated growth in demand, and supply the future generation pattern.

With regard to cross-border Transmission inter connectors, our analysis highlights the need to strengthen a number of our cross-border Transmission lines into neighbouring countries, in order to support increased cross-border electricity trade. This is expected to result in reduced upward pressure on tariffs and improved security of electricity supply both in South Africa and the region.

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.

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 complex process, requiring extensive consultation and multiple iterations.

Regards

Segomoco Scheppers

GROUP EXECUTIVE: TRANSMISSION

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. While considerable care is taken to ensure that the information contained in this document is accurate and up to date, the TDP is only intended for information sharing.

The contents of this document do not constitute advice, and Eskom makes no representations regarding the suitability of using the information contained in this document for any purpose. All such information is provided "as is" without warranty of any kind and is subject to change without notice. The entire risk arising from its use remains with the recipient. In no event shall Eskom be liable for any direct, consequential, incidental, special, punitive, or any other damages whatsoever, including, but not limited to, damages for loss of business profits, business interruption, or loss of business information.

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

The purpose of the TDP is to assess network requirements and propose plans to meet the load demand and generation integration that is forecasted in the next ten-year period. This publication contains information about projects intended to extend or reinforce 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 is the primary network of interest covered in this publication. This covers electrical networks with voltages ranging from 220 kV to 765 kV and the Transmission substations where these networks terminate. A few 88 kV and 132 kV electrical networks are included due to their strategic nature. The TDP 2020-2029 was formulated to address the following:

- Attain Grid Code compliance by resolving both substation and line violations
- Determine new network infrastructure requirements to sustain and allow for future demand growth
- Determine new network infrastructure requirements to integrate new generation (Eskom and IPPs)

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 South African 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 as well as the NERSA’s decision on Eskom’s futue tariff determination will impact the execution of the TDP. In the event of capital expenditure restrictions due to any of the above, the plan will have to be revised to fit in with the available budget by reprioritising projects. This will be done in a way that minimises the impact on customers and the national economy of any delays arising from a shortage of funding or any delays in obtaining environmental authorisations, servitudes acquisitions and other statutory approvals.

It is regrettable, but unavoidable, that the funding constraints will result in a longer period of time being taken to bring the Transmission system into compliance with the reliability and redundancy requirements prescribed by the South African Grid Code . The effects on customers and the national economy will be minimised through consultation with customers and the 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 in 2020.

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 the Transmission assets required to enable 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 rates and commodity prices. 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 of 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.

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

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

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.

MYPD – multi-year price determination for tariff increases awarded to Eskom by NERSA.

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.

SAPP – Southern African Power Pool

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 in South Africa. 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 ninth TDP was published in October 2018. This is the tenth publication based on the TDP for the period 2020 to 2029.

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.

1.2 MAJOR CHANGES FROM THE 2018 TDP

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 ensure consistency in the network studies and analysis as well as to inform the stakeholders and interested parties of the basis of the TDP for the defined period.

There have been minor changes in the input assumptions from the previous TDP, which was published in 2018. As a result, the 2019 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 Transmission integration plans required to enable connection of these IPPs are now in the execution phase, with the scheduled grid connection dates of between the second half of 2019 to 2021.

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 approval of Eskom's Corporate Plan to ensure optimal allocation 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 Power Purchase Agreements (PPA) for 26 preferred bidder projects in REIPPPP bid windows 4 and 4B, and one project in REIPPPP 3.5 were signed in April 2018. All these projects are expected to be integrated into the national grid by the end of 2021, with the scheduled individual connection dates of between 2019 and 2021.

1.3 STRUCTURE OF THE DOCUMENT

The document is structured in the following manner:

Chapter 2, GENERATION ASSUMPTIONS, outlines generation assumptions for the 2019 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 and 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 centres during this TDP period.

Chapter 3, LOAD 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 2018 revision of the TDP was published. It also provides a list of Transmission projects expected to be commissioned in the first half of the 2019 TDP period, based on the latest available information. This chapter also provides a summary of the grid connection applications processed by Transmission since 2018 TDP publication.

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 2019 version of the TDP.

2. GENERATION ASSUMPTIONS

2.1 INTRODUCTION

The generation assumptions in this section were used as a supply-side input into the 2019 TDP. The Department of Energy (DoE) is accountable for the country's energy plan; hence the generation assumptions are based on the latest Integrated Resource Plan (IRP), as 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 Draft IRP Report 2018 which was tabled in Parliament last year. The document is still in draft while stakeholders are given an opportunity to comment on it. Although the basis of the assumptions is the IRP, necessary adjustments were made to align with the decommissioning plan that Eskom Generation envisages, thus the decommissioning in the assumptions deviates slightly from that latest IRP.

Furthermore, 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 the exact areas where the REIPPPP bids will be accepted are not known upfront.

The purpose of the TDP is to assess network requirements and propose plans to meet the load demand and Generation integration that is forecasted in the subsequent ten-year period. The plans in the TDP must meet the reliability criteria that are set out in the South African Grid Code.

The major outputs from the Generation assumptions are as follows:

(i) The generation that will be installed in the next ten years by Eskom,

(ii) The generation that will be installed in the next ten years by IPP's, and

(iii) The generation that is expected to be decommissioned in the same period.

The assumptions allocates capacities for each technology type in spatial (space) and temporal (time) domains. Technology type refers to the primary generation technology that will provide the energy, including, but not limited to Solar Photovoltaic (PV), Wind, Open Cycle Gas Turbines (OCGT), Closed Cycle Gas Turbines (CCGT), Nuclear, and Coal. The spatial requirements are met by indicating the nearest Transmission substation where the generation has been allocated, and the time is given in the form of yearly generation capacity allocations in those substations.

This information, together with the load forecast, will allow planners to run various studies to ensure a reliable Transmission network over the TDP period. Because of the different types of profiles from different generation supply side options, it is important to specify the technology used to allow the planners to allocate the correct capacity for the time of study, for instance, all the PV generation should be OFF at the time of system peak as the sun is typically not irradiating at that time.

Since it is not possible to predict the future precisely, forecasting the generation sources accurately is also a challenge. There are temporal and spatial variations that will always deviate from the forecast. This is because the source information for the assumptions is provided at an aggregated level without any spatial resolution and limited temporal resolution. For that reason the Generation Assumptions provides various scenarios that seek to make the assumptions as robust as possible, the scenarios are briefly discussed in the section that follows.

2.2 ALTERNATIVE SCENARIOS

Alternative scenarios are used to stress-test the robustness of the TDP to compensate for temporal and spatial uncertainties embedded in the assumptions.

The following three alternative scenarios were formulated;

(i) The first is to test a scenario where more PV is allocated in Limpopo

(ii) The second scenario is more Wind in the Northern Cape

(iii) The last scenario tests for higher coal generation decommissioning as indicated by the IRP.

The alternative scenarios are named according to provinces which will be most affected by the scenario (for example, Northern Cape Wind). The impact of these scenarios over and above the base assumptions were tested during the TDP analysis.

The assumptions are based on the preferred scenario as indicated in Table 7 (p 41) of the Draft IRP document. For brevity, this is also shown in Figure 2.1.

The projects contained in the TDP can further be classified into three categories

(i) Those that are in implementation and will be commissioned within the next three years or so;

(ii) Those that are in detailed studies/design phase with business cases being concluded, aiming for implementation within the next seven years; and

(iii) The projects beyond the seven-year horizon that still have a level of uncertainty, and are the ones most likely to be revised in terms of scope.

2.3 INTERCONNECTORS WITH OTHER COUNTRIES

Eskom participates in the Southern African Power Pool (SAPP) and its various sub-committees on behalf of South Africa. However, Grid Planning is only responsible for the planning of inter-connectors between South Africa and neighbouring countries and not for inter-connectors between other countries within the SAPP network. The TDP study will be restricted to interconnectors between South Africa and other countries. The size of the "Eskom Power Pool" will dominate the behaviour of the interconnected regional grid. The interconnections between South Africa and neighbouring countries are assumed to be available. Part of the TDP studies is to determine if these interconnections are still adequate for the expected levels of power transfer.

	Coal	Nuclear	Hydro	Storage (Pumped Storage)	PV	Wind	CSP	Gas / Diesel	Other (CoGen, Biomass, Landfill)	Embedded Generation
2018	39 126	1 860	2 196	2 912	1 474	1 980	300	3 830	499	Unknown
2019	2 155					244	300			200
2020	1 433				114	300				200
2021	1 433				300	818				200
2022	711				400					200
2023	500									200
2024	500									200
2025					670	200				200
2026					1 000	1 500		2 250		200
2027					1 000	1 600		1 200		200
2028					1 000	1 600		1 800		200
2029					1 000	1 600		2 850		200
2030			2 500		1 000	1 600				200
TOTAL INSTALLED	33 847	1 860	4 696	2 912	7 958	11 442	600	11 930	499	2600
Installed Capacity Mix (%)	44.6	2.5	6.2	3.8	10.5	15.1	0.9	15.7	0.7	

Installed Capacity
Committed / Already Contracted Capacity
New Additional Capacity (IRP Update)
Embedded Generation Capacity (Generation for own use allocation)

Figure 2.1: IRP preferred scenario used for Generation assumptions

2.4 GENERATION FORECAST

The generation forecast for the TDP period is shown in Figure 2.2. It is anticipated that there will be a total of approximately 19GW of renewable energy, 34GW of coal, and 12GW of gas installed in the system by 2030. Some of these plants exist, while others are in execution or future plants. The generation capacities in the Draft IRP 2016 is 3GW less for the same period when compared to the 2018 IRP. Generating plants that have reached end-of-life will be decommissioned in the TDP period according to a decommissioning schedule, received from Eskom Generation Division. All decommissioning in this document is aligned to the Generation Production plan that was valid at the time the document was authorised. It is anticipated that approximately 10.6GW will be decommissioned by the year 2030, and most of this capacity will be replaced by renewables and gas.

Nuclear generation

There is no new nuclear generation in the TDP period in the 2018 Draft IRP, thus the TDP assumptions also do not have nuclear generation. Possible high-level integration of nuclear have now been tested at all possible sites, so it is not necessary to test it again in the current TDP period.

Gas generation

The IRP does not differentiate between OCGT and CCGT; however, for the sake of the TDP the volumes were split in half, also, in the TDP, known unit sizes were used to simplify dynamic studies.

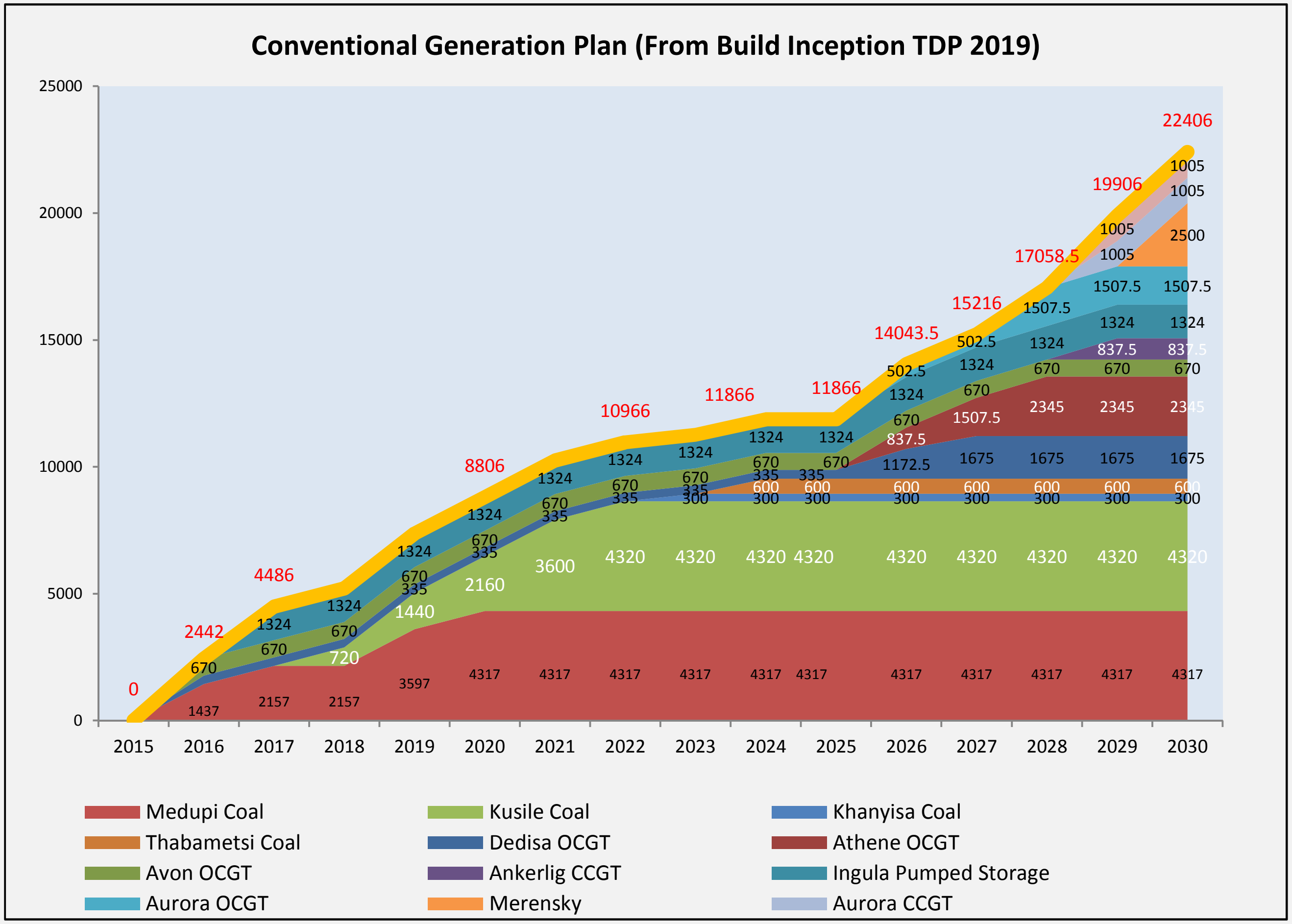


Figure 2.2: Conventional energy cumulative schedule

Conventional generation

The TDP Generation capacity plan for the period 2020 to 2029 (extended to 2030 for the IPP study) is somewhat different from the generation capacity plan of the previous TDP. The main driver for the differences is the late start of the renewable roll-out, the lower load forecast as well as the higher decommissioning rates. Figure 2.2 shows that the cumulative conventional capacity allocation, the total for conventional capacity that will be added in the system (including units from inception), is 19 906 MW by 2029 increasing to 2 2406 MW by 2030. The additional capacity in 2030 is the anticipated 2 500 MW hydro generation from Inga.

New coal

The new coal stations are those that have been approved in the coal/base-load IPP Procurement Programme, that is, Khanyisa and Thabametsi. Although the Draft IRP 2018 anticipates 100 MW more coal from the approved coal projects, this has been kept to 900 MW for Thabametsi and Khanyisa in accordance with the DoE announcements concerning the coal/base-load IPP programme. The expected completion dates for the projects have been moved to 2023 and 2024 due to the expected delays in reaching financial closure.

2.5 RENEWABLE GENERATION

The total for renewable capacity that will be added in the system (including units from inception) is 17 680 MW by 2029, as shown in Figure 2.3. The total allocation for both conventional and renewable energy is 37 586 MW by 2029.

There is a high level of alignment between Draft IRP 2018 and the 2019 TDP Assumptions. The allocation of renewable energy (RE) capacity at different substations was informed by potential at those substations based on previous applications to connect capacity.

PV generation

In the 2019 TDP Assumptions, PV is expected to reach 5958 MW by 2028 (4 813 MW in the previous TDP Assumptions), this will increase to 6 958 MW and 7 958 MW in 2029 and 2030.

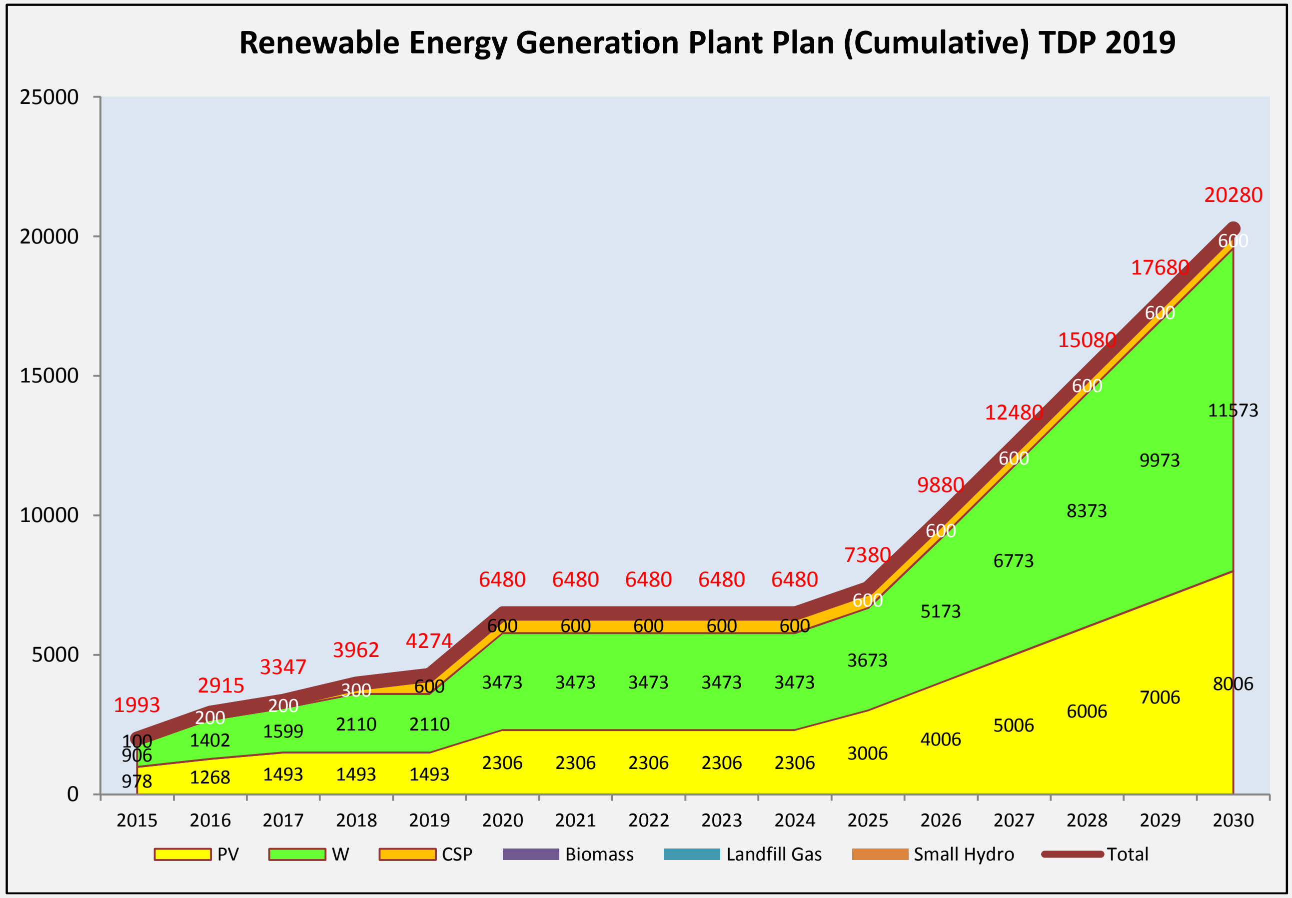


Figure 2.3: Renewable Energy Cumulative Schedule

Wind generation

In the 2019 TDP Assumptions, wind is expected to reach 8 242 MW by 2028 (7 763 MW in the previous TDP Assumptions), this will increase to 9 842 MW and 11 422 MW in 2029 and 2030.

Concentrated solar power generation

In the 2019 TDP Assumptions, Concentrated solar power (CSP) is expected to reach 600 MW by 2028 (1 050 MW in the previous TDP Assumptions).

2.6 DECOMMISSIONING OF COAL FIRED STATIONS

The previous Generation Assumptions indicated that Hendrina, Grootvlei and Komati will be decommissioned. The latest generation production plan indicates that the same power stations will be decommissioned during the TDP period, but more stations have been added to the decommissioning list. The total decommissioning in the previous TDP was 3 817 MW. This has increased by 267% to 10 215 MW in the 2019 TDP period and a total of 10600 MW by 2030. Most of the stations will be decommissioned after 2026. These include coal as well as gas stations, as seen in the bottom chart in Figure 2.4.

2.7 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 maintaining the total generation by the end of the TDP period constant. Allocation of alternative sites and spread of the future generation is made from 2020 to 2027, but the main year of consideration will be 2027, when the full impact of these scenarios can be identified.

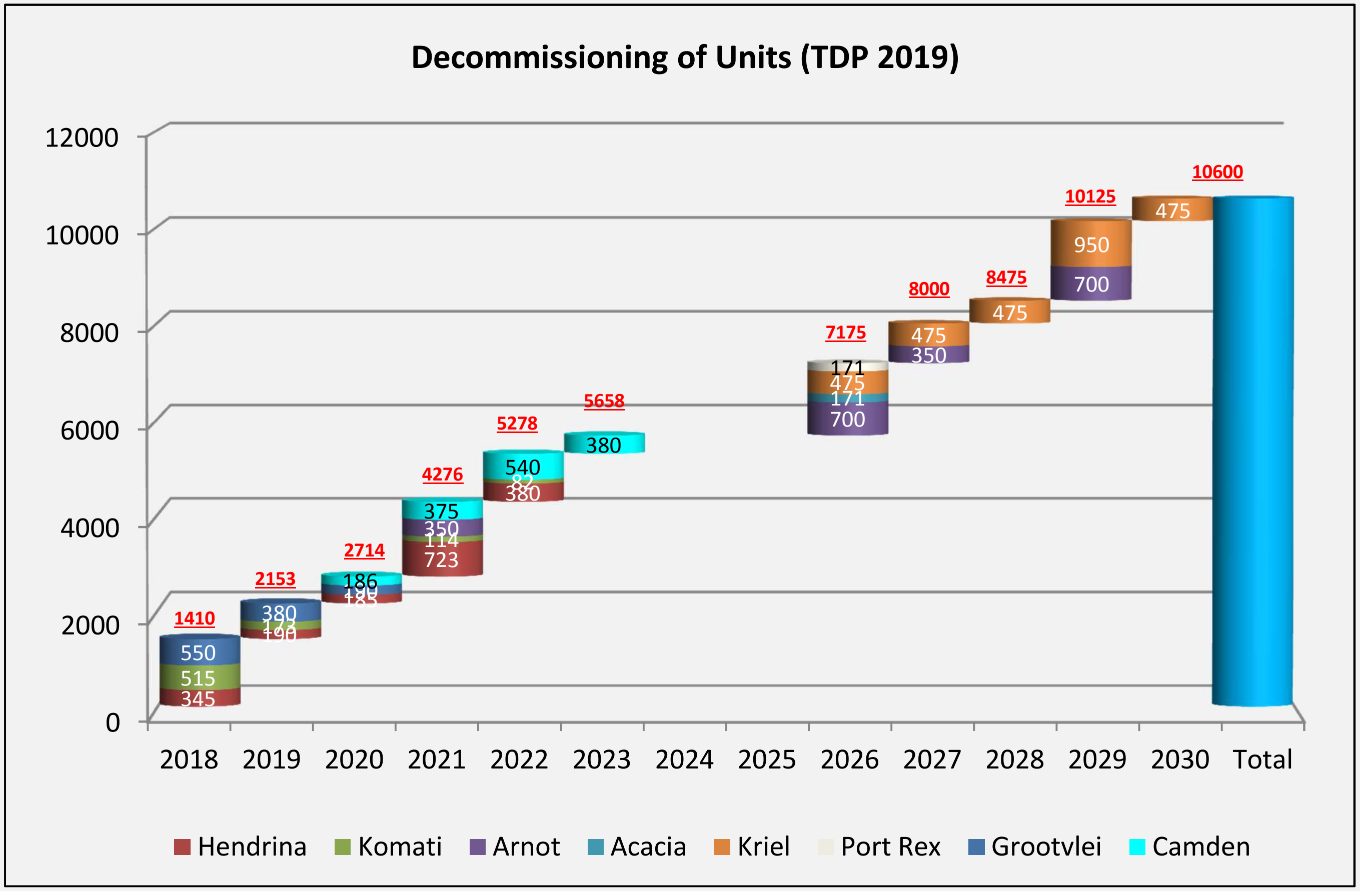


Figure 2.4: Decommissioning Schedule TDP 2019

This section describes the alternative generation scenarios to be 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
- High decommissioning Scenario

Scenario 1: Limpopo (solar PV) scenario

The purpose of this scenario is to determine the impact on the Transmission network within Limpopo if 800 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 and Free State to Limpopo.

The Limpopo network study has considered the base case as well this scenario to determine if the network is sufficient. If the network is not sufficient, mitigation plans are proposed. Figure 2.5 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. The graph indicates that 800 MW of the future solar PV was allocated at different locations in Limpopo as alternatives to the baseline allocation.

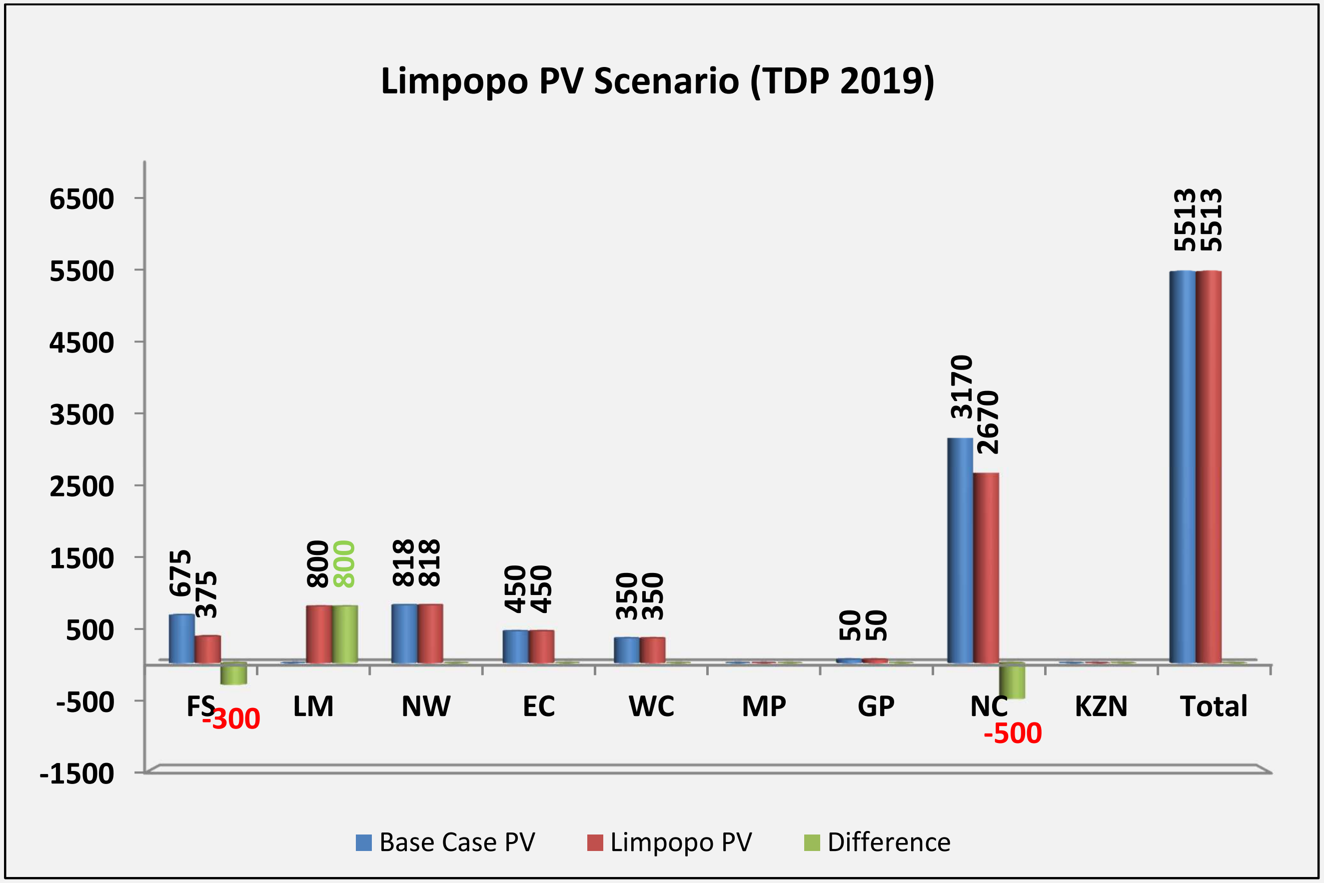


Figure 2.5: Limpopo PV scenario generation comparison to base case

Scenario 2: Northern Cape wind scenario

The purpose of this scenario is to determine the impact on the Transmission network within Northern Cape if around an additional 1 700 MW of wind generation is moved into the Northern Cape.

Figure 2.6 illustrate the scenario in a summary graph. The Eastern Cape and Western Cape wind generation run at 30% of the normal rated output and wind in the Northern Cape runs at full 100% output. Any network violations are noted, and initial proposals made on how these violations are likely to be mitigated.

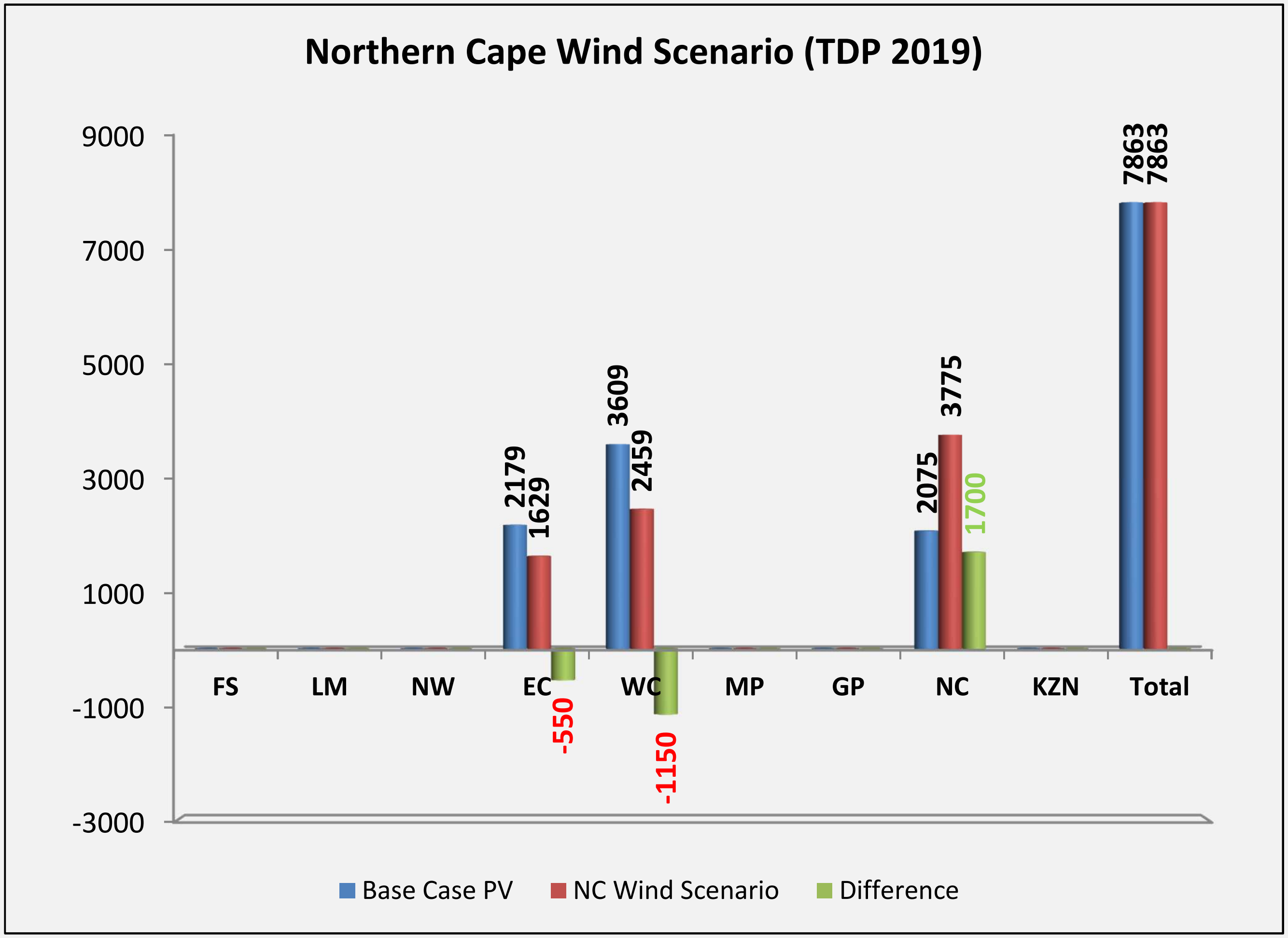


Figure 2.6: Northern Cape Wind Scenario Comparison to Base Case

Scenario 3: High decommissioning scenario

In the high decommissioning scenario shown in Figure 2.7, 12.9 GW is decommissioned by the end of the TDP period in accordance with the Draft IRP 2018, instead of 10.2 GW in accordance with the Eskom production plan at the time the assumptions were approved.

2.8 CONCLUSION

In conclusion the Generation Assumptions tabled in this section will ensure that there is sufficient generation for the forecasted load. Furthermore, the various scenarios that have been tested will result in a robust TDP.

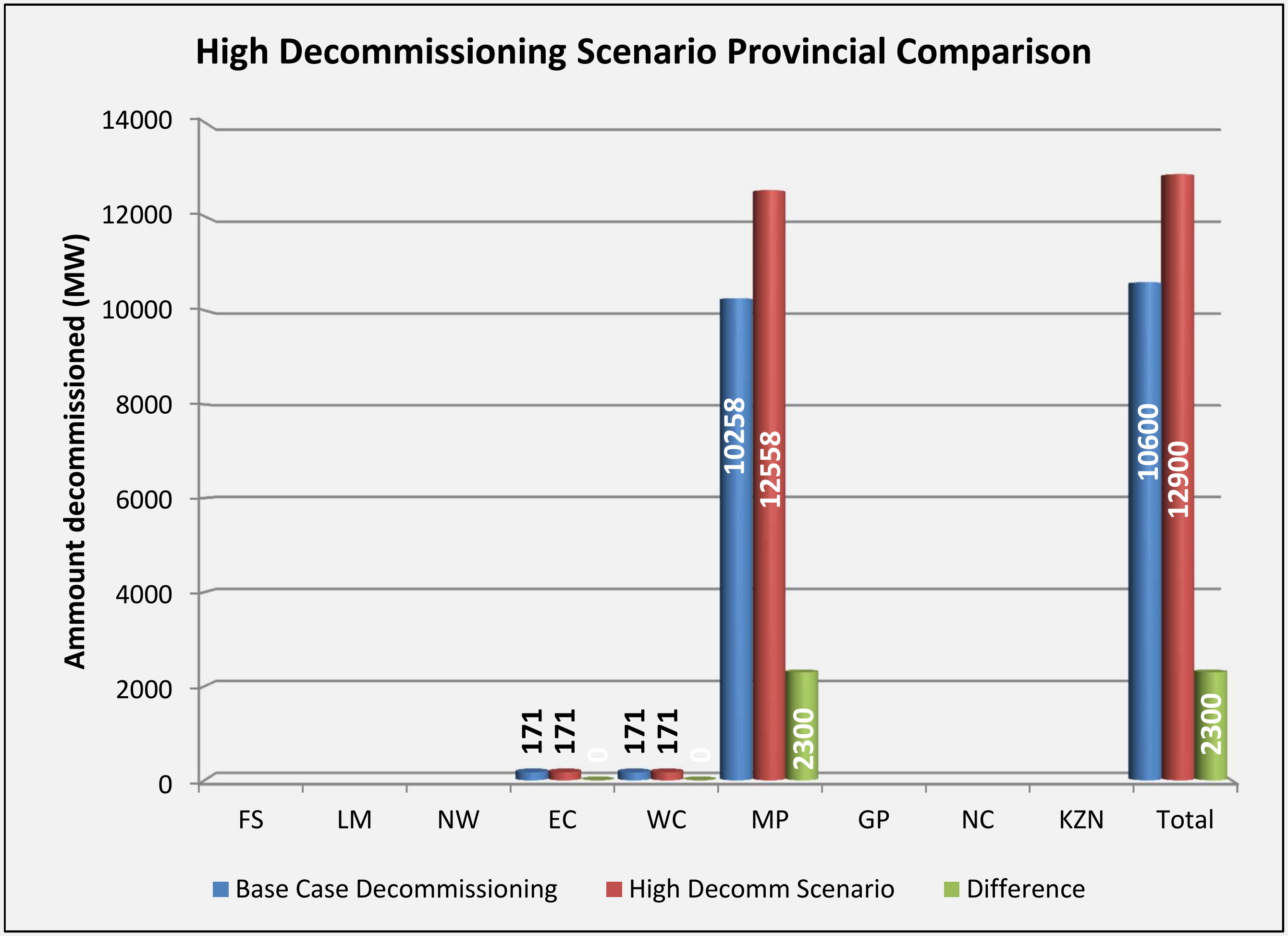
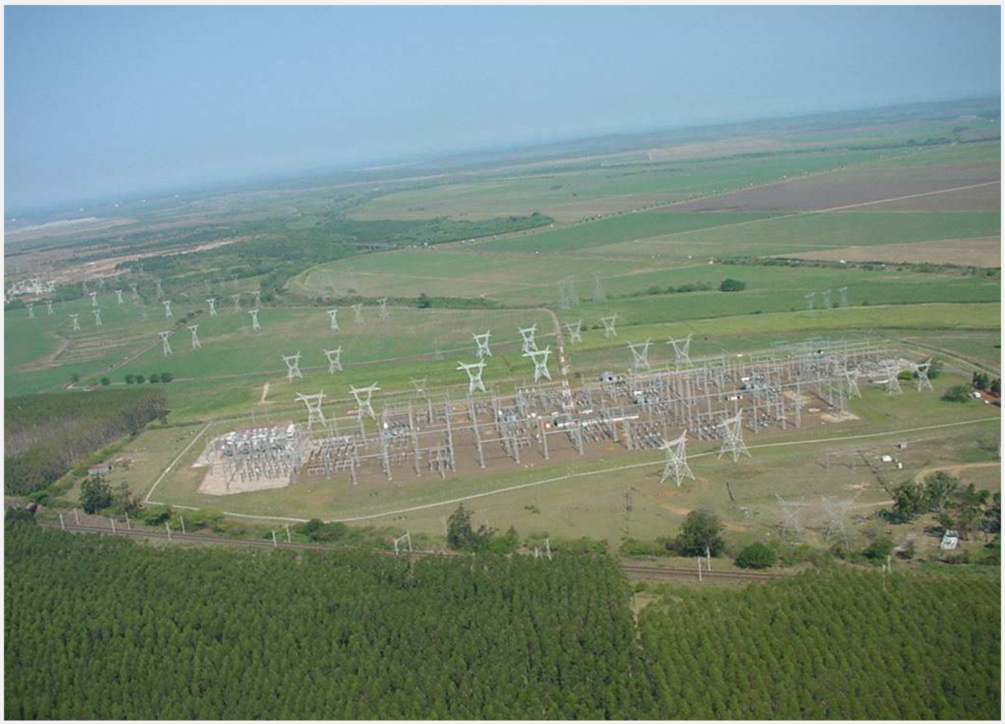


Figure 2.7: High Decommissioning scenario cumulative comparison

3. DEMAND FORECAST



3.1 INTRODUCTION

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 TS development projects for this 10-year period. These expected projects will consist of the approved projects, the projects that are to be prepared for approval and the projects likely to be taken for approval over the defined period.

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.

3.2 PRINCIPLE ASSUMPTIONS ON TRANSMISSION FORECAST 2019

The following principle assumptions were made and will be applicable to all forecast scenarios documented in this report.

- Transmission responsibilities will stay similar to the current operations within the Eskom structure, irrespective of the pending restructuring.
- Eskom remains a going concern as current main utility for South Africa.
- Transmission networks link main conventional- as well as IPP generation sources for Distribution of electricity through South Africa and into the SAPP regions.
- The socio-political environment is assumed to stabilise or improve in the medium to long term.

3.2.1 Transmission forecast scenarios 2019

The four scenarios will be briefly described and detailed assumptions per scenario will be provided in further sections of the report.

Transmission high scenario:

"Fly high and enable"

The Transmission high scenario 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 5% GDP and GVA-R average year-on-year growth, and a capacity demand of 2.8% average year on year expected for the TDP period 2021 to 2030 with a target network of 65 GW at year 2040. It was assumed that the past 10 years caused a lag in growth. Therefore 65 GW at 2030 in accordance with NDP, was postponed to 2040 to accommodate for the lag of the past 10 years. This scenario assumes that more renewable generation sources will be linked to the grid for Transmission that will enable growth. 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 50 GW at time of system peak (TOSP) in year 2030, at the end of the TDP period and approximately 65 GW at TOSP in year 2040.

This scenario coincides with new "Nayi le Walk: a nation in step with itself" Scenario 1 from The Indlulamithi SA Scenarios 2030 of what South Africa could look like by 2030.

Transmission moderate high scenario

"Fly with caution, enable and collaborate with off grid solutions"

The Transmission moderate high scenario is based on an explorative approach where similar growth experienced in the past is simulated into the future. This scenario is still in line with the NDP requirements of a 65 GW target network; however it is allowed to reach the 65 GW determined by the simulation of the past trend into the future. This scenario foresees return of main industries in South Africa, however at a slower pace, an average year-on-year growth of 1.9 %. It relates well to the 3% GPD forecasted growth during the TDP 2021-2030 period when considering a margin of 1.5%. This scenario produces a forecast of 65 GW by 2052, 57 GW at TOSP in year 2040 and 46 GW by the end of the TDP period. It can be assumed that the majority of power will be served by a centralised Eskom. Increasing trends of low to medium grid deflection and Small-scale embedded generation (SSEG) penetration exist, with high amount of grid tied connections in place. It assumes changes in the structure of the economy with less energy intensive industries rising above demand needs of industrial high energy intensive sectors.

This scenario coincides with new "iSbhujwa: an enclave bourgeois nation" Scenario 2 from The Indlulamithi SA Scenarios 2030 of what South Africa could look like by 2030

Transmission medium (energy efficient) scenario

"Sharing the energy supply market"

The Transmission medium scenario is based on a network scenario where the increase in uptake on alternative energy generation associated with the increase in energy efficiency and the decrease in energy intensity are main determinants in the use of electricity from the Eskom Grid. This scenario speaks to the phenomenon where technology advances in storage and alternative energy generation solutions become increasingly affordable and may surpass the rising cost of electricity cost as provided by the country utility. Assumptions were made according to 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 calculations and assumptions lead to a 10% difference in electricity supplied by Eskom to the value of the national system forecast for South Africa's energy needs by the end of the TDP at year 2030, with a capacity value of 46 GW at TOSP and a final forecasted value of 57 GW at year 2040.

Transmission low scenario

"Losing market share in the industry, persistent slow economy"

The Transmission low scenario is based on assumptions that there will be a continued suppressed development rate in the country and that most of the industries will not return to original status. This is a pessimistic, however an increasingly popular view in line with the recent low economic scenarios also investigated by the CSIR and energy forecasting department and has a nominal capacity of 42 GW at year 2030 and 46 GW at TOSP in 2040. This scenario assumes correlation with a low overall economic average growth of 1.3% average annual growth up to 2030, lower than the projected GDP & GVA-R total industry figures.
This scenario coincides with new "Gwara Gwara: a floundering false dawn" scenario 3 from The Indlulamithi SA Scenarios 2030. A summary of the three scenarios is showed in Figure 1-1. The figure shows the difference in GW from the August 2018 report. Reasons for lowering the demand is clarified in further sections of the report below.
The main purpose of the Transmission Demand Forecast is for capacity planning of the Transmission networks. Therefore it is suggested that the optimistic scenario, high Transmission forecast should be utilised for planning of the Transmission grid. A separate alignment study was done on the high forecast to compare it the Draft IRP 2016 Energy planning forecast. This was done for validation purposes and substantiates the use of the high forecast for network planning of the Transmission grid.

3.2.2 Current economic and political landscape in South Africa

Latest trends and economic indicators were analysed from February 2019 and the following contributions can be noted as having a significant impact on the forecast going forward:

Negative Economic views:

- Ratings firm Moody's lowered South Africa's GDP growth prospects for 2019 – forecast of 1.3% down to 1.0%.
- Contributed to by the cut to the GDP numbers -a decline of 3.2% published by Stats SA in Q1 2019. According to Moody's the quarterly decline, the largest in ten years, is credit negative for the government of South Africa's revenue and policy options.
- The potential credit downgrade seems to have caused international investment to decrease.
- This will affect investor confidence and may have implications for future investments as Eskom restructures.
- Year-on year growth in mining production declined to -1.5% in April, from -0.7% in March.
- Eskom projected annual sales figures for the year ending December 2019 to show a decline of 6% in sales VS December 2018 actuals. This could be offset to some extent by the use of alternative energy generation sources.

- Fitch Solutions Macro Research 10-year forecast indicates that South Africa will underperform compared to its emerging market peers over the coming ten years owing to a range of factors including intermittent power shortages, industrial action and divestment from the platinum and gold mining sectors.
- They forecast real GDP growth of approximately 2.4% on average over 2019 to 2028.
- Uncertainty on the execution of structural issues in Eskom including severe debt ratios and revenue collection, suggests further load-shedding, which will have a negative effect on a number of sectors, notably manufacturing and mining, and will likely act as a further constraint on business and investor confidence.
- Sector composition tends to change into the future with overall sectorial growth still proposed into the future.
- Fitch Solutions Pty Ltd ranked South Africa as second on their risk reward outlook. More details available at www.fitchsolutions.co.za. The short term forecast on demand growth was lowered for 2019 to 2024 with a no-growth trend.

Positive economic view:

- The largest positive contributions to the overall growth rate were from the production of basic iron and steel, non-ferrous metal products, metal products and machinery and the production of motor vehicles, parts and accessories and other transport equipment.
- These sectors continue to be strategic to South Africa's economic sustainability and should be protected.
- President Cyril Ramaphosa's investment drive has gathered momentum, with the latest quarterly bulletin from the South African Reserve Bank (SARB) indicating that inflows more than doubled in 2018.
- Ramaphosa received pledges from local and international business leaders at the inaugural Presidential Investment Summit in October 2018 of over R200billion.
- Major investors include mining and metals group Anglo American, auto manufacturer Mercedes-Benz, Naspers, and drug maker Aspen Pharmacare to name a few.
- The NDP 2.0 is underway and a supporting scenario study was compiled by industry experts, namely, "The Indlulamithi SA Scenarios 2030 on the South African outlook for 2030".
- Regrouping of priorities listed in the original NDP is set out for execution to enable growth in the economy and decrease unemployment. The new administration's immediate priority has focused on improving governance and restoring confidence.

3.3 ASSUMPTIONS ON LOWERING OF DEMAND SCENARIOS

The Latest economic information, bottom up integration and alignment exercises with both internal and external forecasts were done. This led to a lowering demand scenarios and a suggested scenario to use as input to the TDP forecast and case file modelling.

The following assumptions were delivered to support a lowered-growth scenario as the proposed planning scenario for the TDP input.

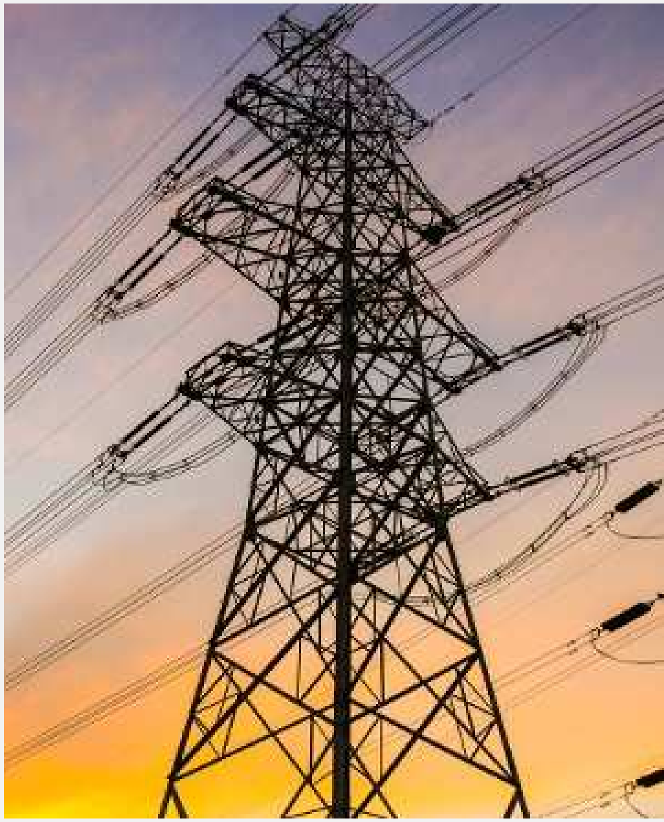
- Electricity demands from 2013 did not realise in accordance with NDP visions;
- Additional capacity planned and commissioned not on track and producing as planned;
- Generation constraints restrict economic development and therefore demand growth;
- Technology costs is still on downward trend opposing tariff hikes still on the rise and approved for next 3 years by NERSA
- Slower economic growth projected for short term at 1,5 % average year on year for the next five years;
- Within the TDP period, the forecasted average annual growth rate to rise to 1.9% in 2023 and 2.8% in 2030;

- Latest growth for 2019 from the International Monetary Fund was lowered from projection of 1.4% to 1.2% for the year, making it the worst performer in Sub-Saharan Africa.
- Ongoing closing down or relocation of some energy intensive smelters.
- When considering economic cycles, the next cycle relates to less energy intensive industries on the rise.
- Expected economic forecast supports growth in secondary and tertiary sectors rather than primary, which alludes to less energy intensive sectors contributing to GDP growth.
- Underperformance of thermal capacity and large financial headwinds facing Eskom will be key challenges in the country's power sector, and power cuts will remain a risk. While renewables will be the growth outperformer, its contribution will remain below 10% of total power output.

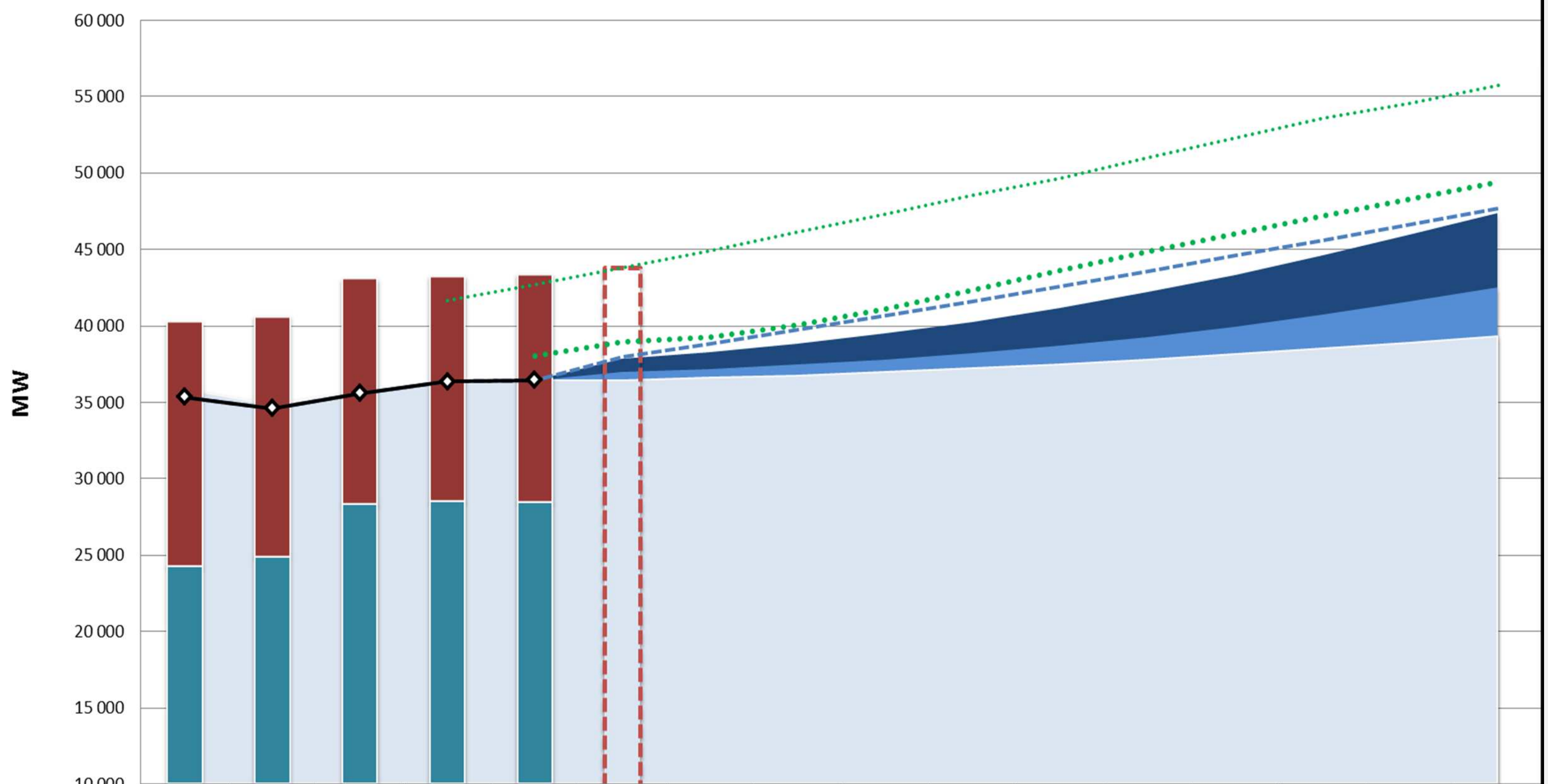
3.4 NATIONAL TRANSMISSION FORECAST 2019

The different load growths (MW figures) are studied at the time when the Transmission system reaches its maximum peak. The Transmission Forecasts were analysed and three scenarios was produced as the forecast for the period 2020 to 2040. This assumes the current availability of generation to meet the demand as specified by the TDP Generation Assumptions.

Figure 3.1 shows the MSD scenarios at TOSP with actual Transmission metering, variable generation load and the forecasts for the three scenarios up to year 2040. The actuals are displayed by the black line and it is clear that the additional generation produced by Eskom in the past year has alleviated the constraints, there has been no further decline of actual metering and rather an increase in national demand. The time of system peak was observed in 2018 on 16 July at 18:00 as 36.44 GW. A significant amount of renewables of >900 MW were observed during this hour. The dotted blue line shows the 2018 National Transmission high forecast, which was slightly adjusted to suit actual values. However, the target network of 65 GW at year 2040 is still adhered to. Three of the four scenarios can be observed by the area graphs. The dotted blue line represents the Transmission high forecast for 2018 which was lowered due to significant slowdown in economic activity and financial constraints. The second scenario for 2018 aligns with the target network for the TDP high scenario for 2019. This will add approximately 13 GW to the grid within the TDP period. The lighter blue shaded area shows significant slowdown in the capacity built planned in this scenario, with around 6 GW added for the TDP period. The lightest blue shaded scenario is the lowest growth possibility adding only 4 GW in the next 10 years to the national grid. The lag from the 2018 forecast scenarios to the 2019 scenarios is approximately 5 to 7 years respectively, due to slow down in investment, and the economy and fiscal constraints currently experienced by South Africa.



Demand Forecasts (MW) for the TDP period 2020-2029



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
2019 Maximum System Demand(MSD) Tx High (65GW @2040)	35850	34850	35742	36359	36447	37864	38302	38846	39504	40283	41186	42212	43357	44609	45958	47388
2019 Maximum System Demand(MSD) Tx Moderate High (58GW @2040)	35850	34850	35742	36359	36447	37009	37223	37494	37830	38240	38731	39309	39979	40741	41596	42540
2019 Maximum System Demand(MSD) Tx Low (50GW @2040)	35850	34850	35742	36359	36447	36441	36583	36756	36962	37201	37475	37782	38122	38493	38891	39314
Projected Total Customer NMD (MW)						43792										
KSACS Customer NMD (MW)	15979	15673	14708	14691	14883											
Distribution Customer NMD (MW)	24295	24943	28369	28549	28475											
2018 Maximum System Demand(MSD) Tx Moderate High (65GW @2040)	35343	34607	35608	36359	36447	37958	38831	39734	40666	41623	42601	43596	44604	45622	46645	47670
Actual Peak Demand (MW) *Instantanious	35343	34607	35608	36359	36447											
2016 Base Draft IRP Demand (MW)				41682	42702	43831	44916	46130	47336	48547	49656	51015	52307	53561	54567	55738
2018 Draft IRP Demand (MW)					38048	38948	39248	40039	41108	42371	43612	44856	46029	47207	48324	49405

Figure 3.1: Demand scenarios

4. TRANSMISSION EXPANSION PROJECTS UPDATES

4.1 INTRODUCTION

This section provides a summary of Transmission expansion projects completed since publication of the previous TDP in 2018. The project lists exclude all the customer-dedicated components of the projects resulting from connection applications received.

4.2 TRANSMISSION RELIABILITY PROJECTS

Table 4.1: Completed projects since publication of 2018 TDP

Province	Project name
Northern Cape	Upington Strengthening Phase 1 - Upington Nieuwehoop
	Kimberley Network Strengthening phase 2
	Northern Cape Strengthening: Aries -Nieuwehoop
	Northern Cape Strengthening: Ferrum- Nieuwehoop
	Ferrum Nieuwehoop
	Gromis Oranjemond 400kV line
	Upington Strengthening Phase1:Nieuwehoop Upington
	Aggeneis Gamsberg 1 x 40 MVA Transformer
Limpopo	Medupi: Ngwedi loop in lines
	Medupi:Borutho Witkop
	Medupi-Ngwedi 400 kV line 1
Mpumalanga	Highveld South Strength: Sasol 2 and 3 Series Reactors
	Highveld South Reinforcement Project: Sol
	Kusile: Kusile Zeus 400kV (Kendal Bypass)
	Kusile: Kendal Zeus 1st 400kV line
Western Cape	Pinotage (Firgrove) New MTS
	Koeberg 400kV busbar risk reduction
Eastern Cape	Grassridge-Dedisa 1st 132kV line
Free state	Everest-Merapi 400 kV line
North West	Ngwedi 400 kV loop in (Matimba-Midas and Mara-Midas 400 kV lines)
	Ngwedi 2 x 500 MVA 400/132 kV Substation

4.3 GRID CONNECTION APPLICATIONS

Table 4.2 outlines the number of cost estimate letters (CELs)/ICEs and budget quotations (BQs) that were processed during the 2018/19 financial year (April 2018 to March 2019). These were as a result of applications for grid connections to the Transmission network, according to the South African Grid Code.

The number of connection applications received during the 2019 financial year (59) was substantially lower than the 98 quotations received in 2018 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.

Quotation type	Indicative cost		Budget quotations	
	Received	Accepted	Received	Accepted
Generation	23	2	3	-
Load	18	8	15	7
Total	**41**	**10**	**18**	**7**

Table 4.2 Connection applications received and accepted in the FY2018/2019

5. NATIONAL OVERVIEW

5.1 INTRODUCTION

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 as well as the integration of the new Medupi and Kusile Power Stations.

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.

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.

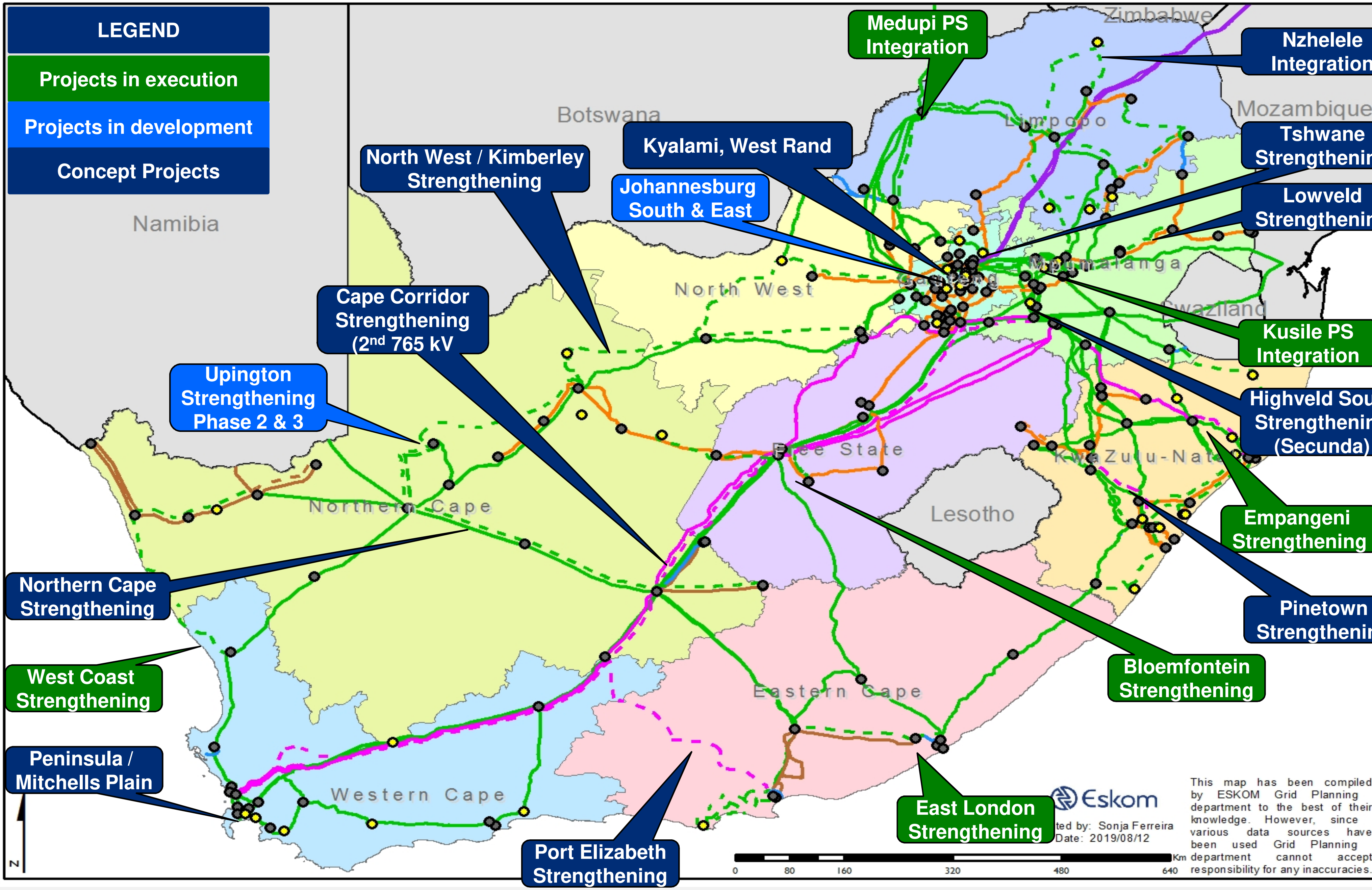


Figure 5.1: High-level overview of the major TDP scheme projects

Table 5.1: Major TDP Transmission assets expected to be installed

Transmission assets for national view	New assets expected in 2020-2024	New assets expected in 2025-2029	Total new assets
Power lines (km)			
765 kV	178	190	368
400 kV	1389	2793	4182
≤ 275 kV	172	122	294
Total length (km)	1 739	3 105	4 844
Transformers			
Number of units	29	58	87
Total capacity (MVA)	11 050	24 280	35 330

6. BREAKDOWN OF THE TDP PROJECTS BY PROVINCE

6.1 EASTERN CAPE

6.1.1 INTRODUCTION

Eastern Cape is South Africa's second largest province by landmass and is located on the south-eastern coast of the South African continent. The capital city of Eastern Cape is Bhisho which is derived from the Xhosa word for buffalo and also the name of Buffalo River. 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 and enviable wind energy sources, the Eastern Cape has attracted a significant share of the renewable energy 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 3 931MW by 2030. There is high potential for developments in the Nelson Mandela Bay Metro in the Port of Ngqura, 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 11 186 MW in the next 10 years. The bulk of expected load increase in the Customer Load Networks (CLNs) 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 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 currently has the potential of unlocking the electrification of more than 125 000 homes. The number of in-feeds into East London consists of three 400 kV lines and a single 220 kV line to Bhisho.

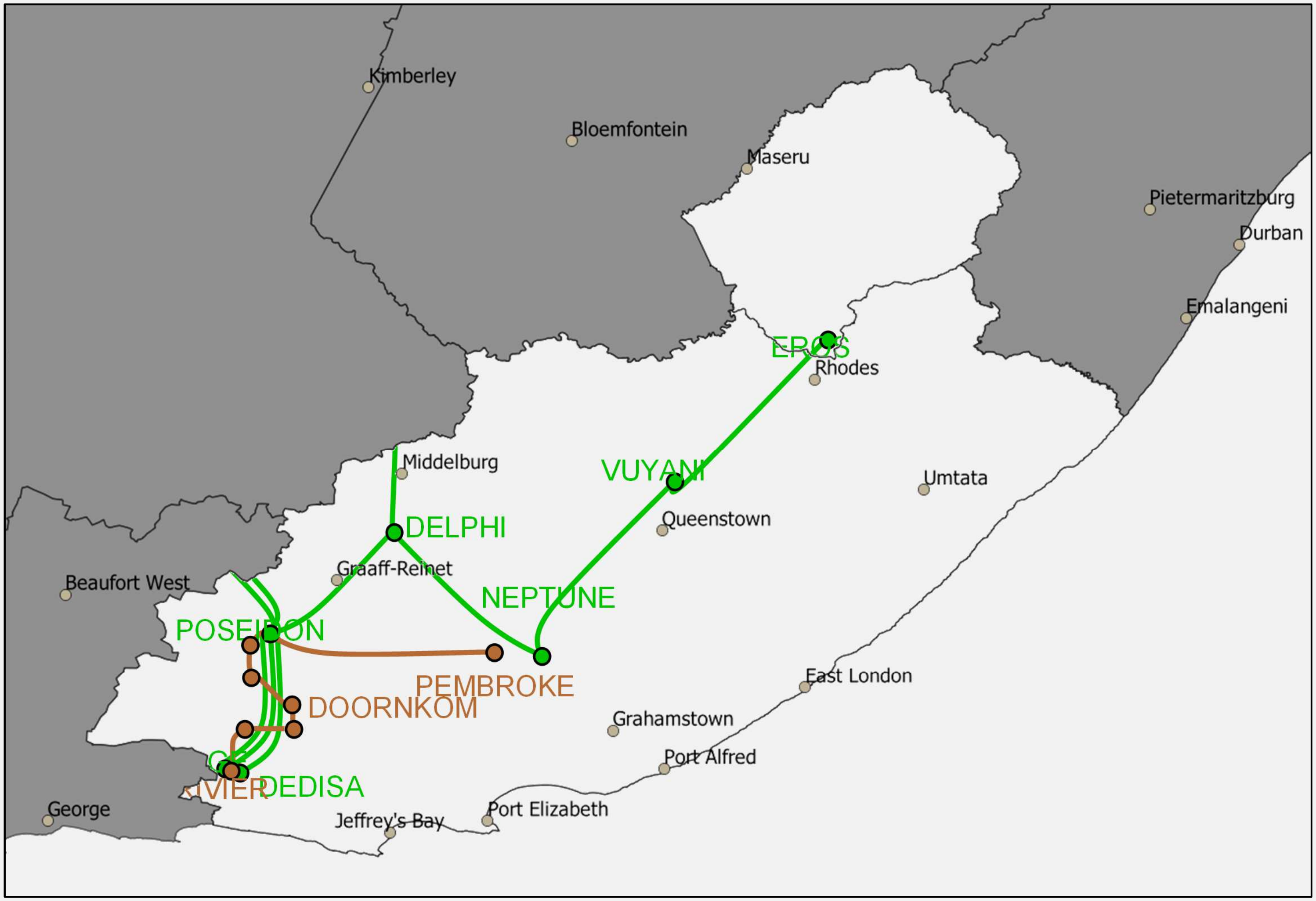


Figure 6.1.1: Current Eastern Cape Transmission network

6.1.2 GENERATION

Historically, the Eastern Cape did not have a huge amount of 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 base load plant even outside the typical peak periods.

There is also an interest in the integration of generation from natural gas close to Coega, amounting to approximately 3 000 MW. If all these generation plans materialise, the Eastern Cape will be a net exporter of energy.

6.1.3 RENEWABLE GENERATION INTEGRATION

Furthermore, there is high interest in renewable energy projects in the Eastern Cape, as demonstrated by the number of renewable energy bids from the previous REIPPPP rounds. A total capacity of 1 502 MW was approved in the Eastern Cape. The composition is shown in Table 6 .1.1.

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.

Table 6.1.1: Approved projects in the Eastern Cape under the REIPPPP

Programme	Wind	PV	Grand total
RE IPP 1	470	-	470
RE IPP 2	337	70	406
RE IPP 3	197	-	197
RE IPP 4	397	-	397
RE IPP 4B	33	-	33
Grand Total	1 432	70	1 502

6.1.4 LOAD FORECAST

The load forecast for the Eastern Cape is shown in Figure 6.1.2.T he 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.

The main reason for the decline in load forecast is the slow realisation of anticipated projects in the Coega Industrial Development Zone (IDZ), commercial and residential developments.

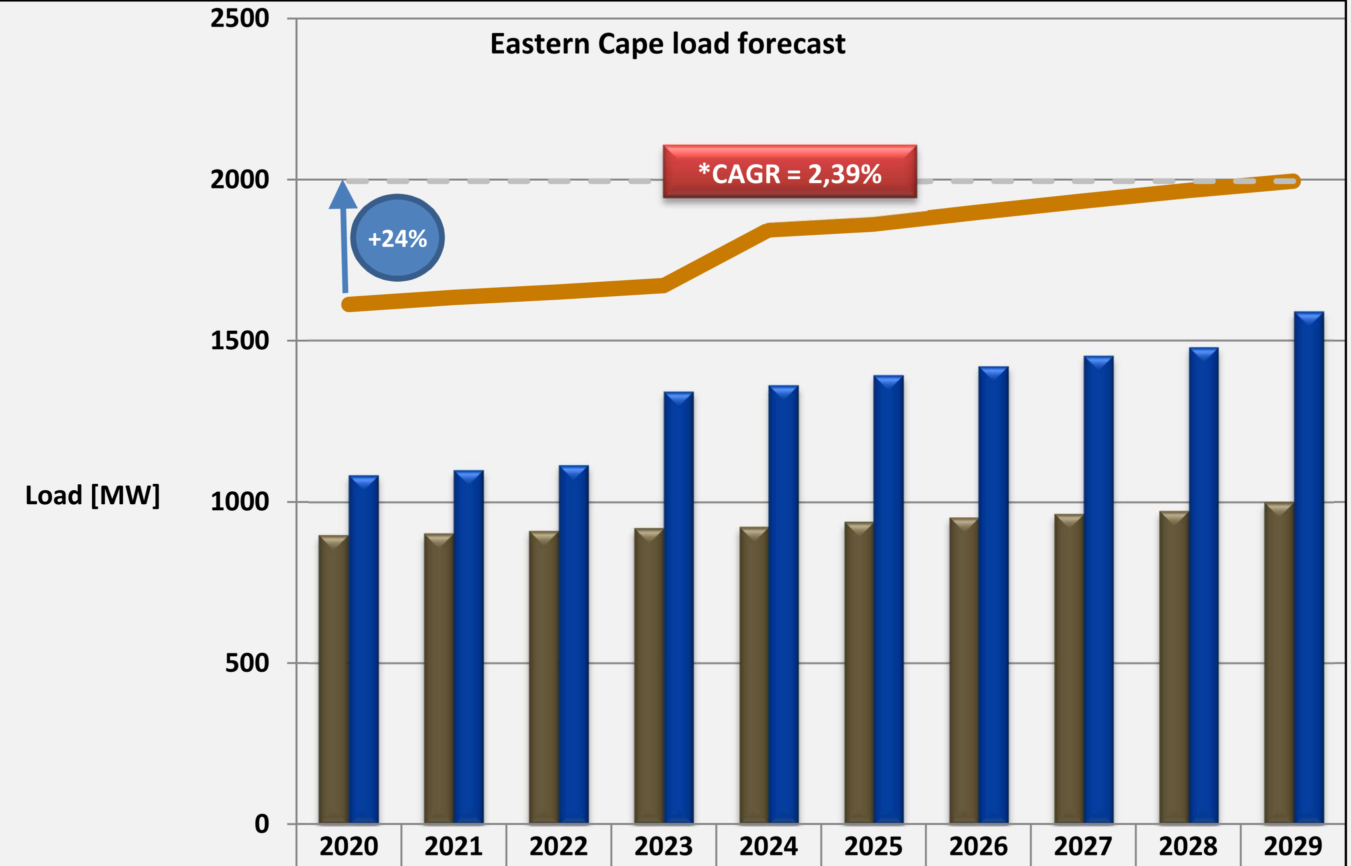
6.1.5 REACTIVE POWER COMPENSATION

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 , and
- Delphi.

6.1.6 NEW SUBSTATIONS

There are no new substations planned in the Eastern Cape.



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
East London	898	903	912	920	924	939	953	964	973	1000
Port Elizabeth	1083	1100	1116	1343	1362	1393	1422	1453	1480	1590
Grid Peak	1613	1634	1652	1671	1844	1862	1899	1933	1967	1995
2029 Peak	1995	1995	1995	1995	1995	1995	1995	1995	1995	1995

Figure 6.1.2: Eastern Cape load forecast

6.1.7 MAJOR SCHEMES

The major TDP 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; building the Neptune-Pembroke 400 kV line and installation of the 1st 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 2nd 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 1st Gamma - Grassridge 765 kV line. The Southern Grid Strengthening Phase 4 refers to integration of the 2nd 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.

6.1.8 PLANNED PROJECTS

The following projects are planned for the period 2020 to 2029:

Table 6.1.2: Eastern Cape - Summary of projects and timelines

TDP scheme	Project name	Expected CO year
Grassridge 3rd 500 MVA 400/132 kV transformer	Grassridge 3rd 500 MVA 400/132 kV transformer	2027
Dedisa 3rd 500 MVA 400/132 kV transformer	Dedisa 3rd 500 MVA 400/132 kV transformer	2023

6.1.9 PROVINCIAL SUMMARY

The increase in Transmission assets by the end of 2024 and the end of 2029 and cumulative total are shown in Table 6.1.3.

Table 6.1.3: Cumulative TDP Transmission assets for Eastern Cape.

Transmission Assets	New Assets expected in 2020 - 2024	New Assets expected in 2025 - 2029	Total New Assets
Power lines (km)			
765 kV	-	190	190
400 kV	40	2	42
<=275 kV	-	-	-
Total length (km)	40	192	232
Transformers			
Number of units	2	5	7
Total capacity (MVA)	660	2020	2 680
Capacitors			
Number of banks	8	-	8
Total capacity (Mvar)	400	-	400
Reactors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-

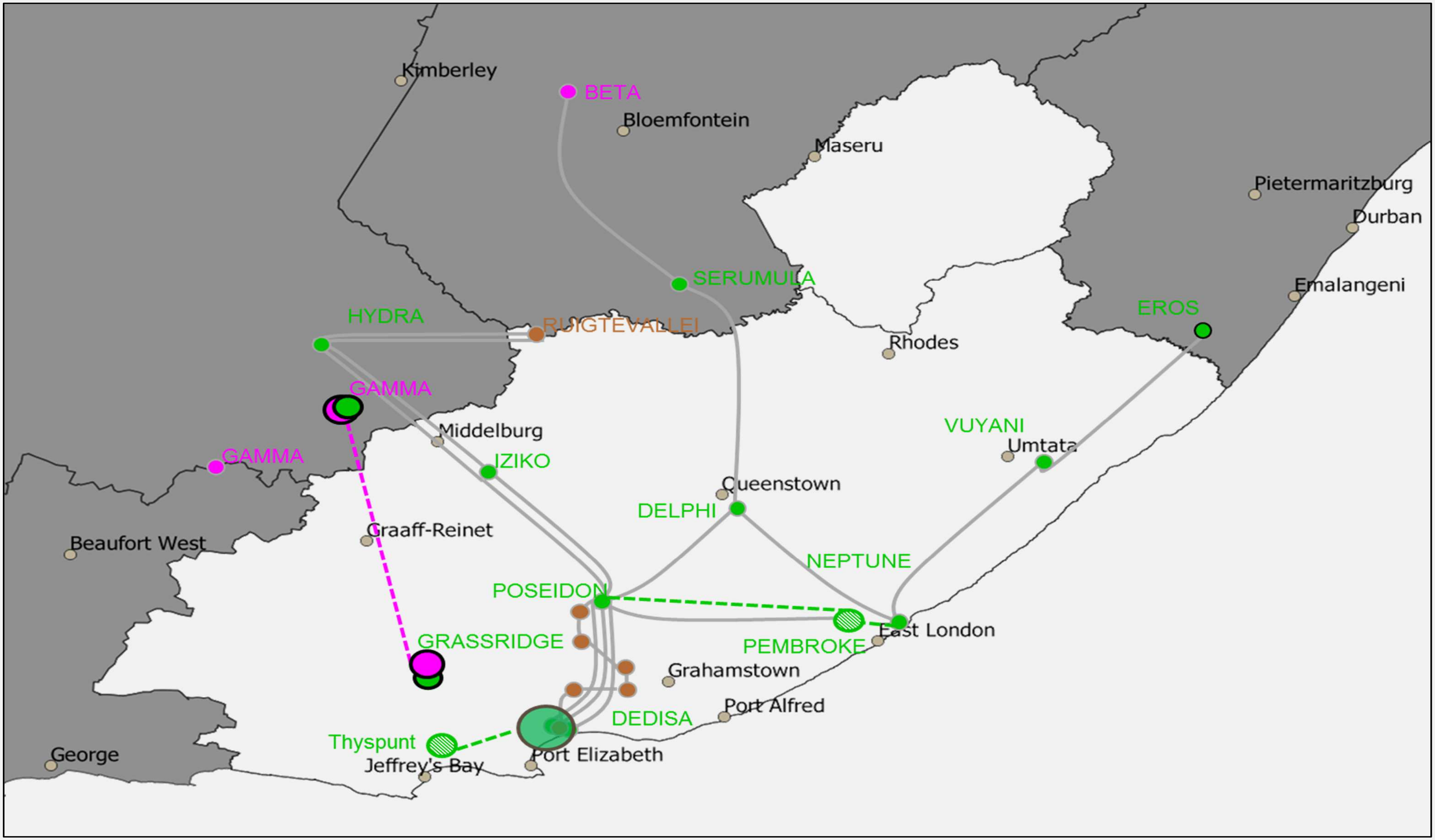


Figure 6.1.3: Future Eastern Cape network diagram

6.2 FREE STATE

6.2.1 INTRODUCTION

The Free State is South Africa's most centrally located province, and it has Bloemfontein as its capital. It has borders with most other provinces and has Lesotho as its eastern neighbour. Mining and agriculture were for many decades the bedrock of the economy in the province, but the mining sector's productivity has been on a steady decline. This has had a negative impact on the economy and employment. 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 1697 MW in 2018, and it is expected to increase to about 2225 MW by 2029. The Free State comprises of three CLNs, namely Sasolburg, Bloemfontein and Welkom. The Welkom CLN consumed approximately 47% of the load. 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 6.2.1.

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

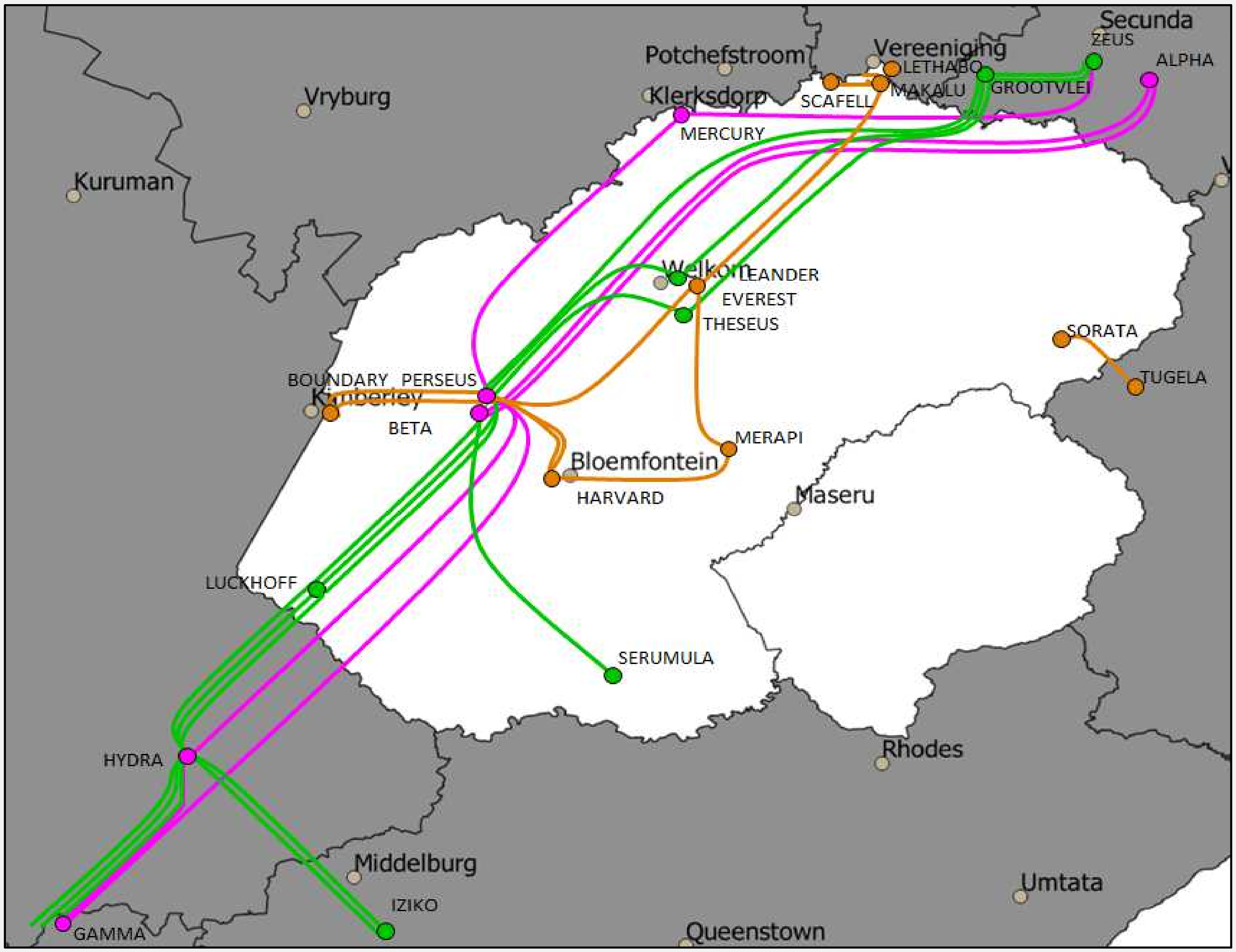


Figure 6.2.1: Current Free State network diagram

6.2.2 GENERATION

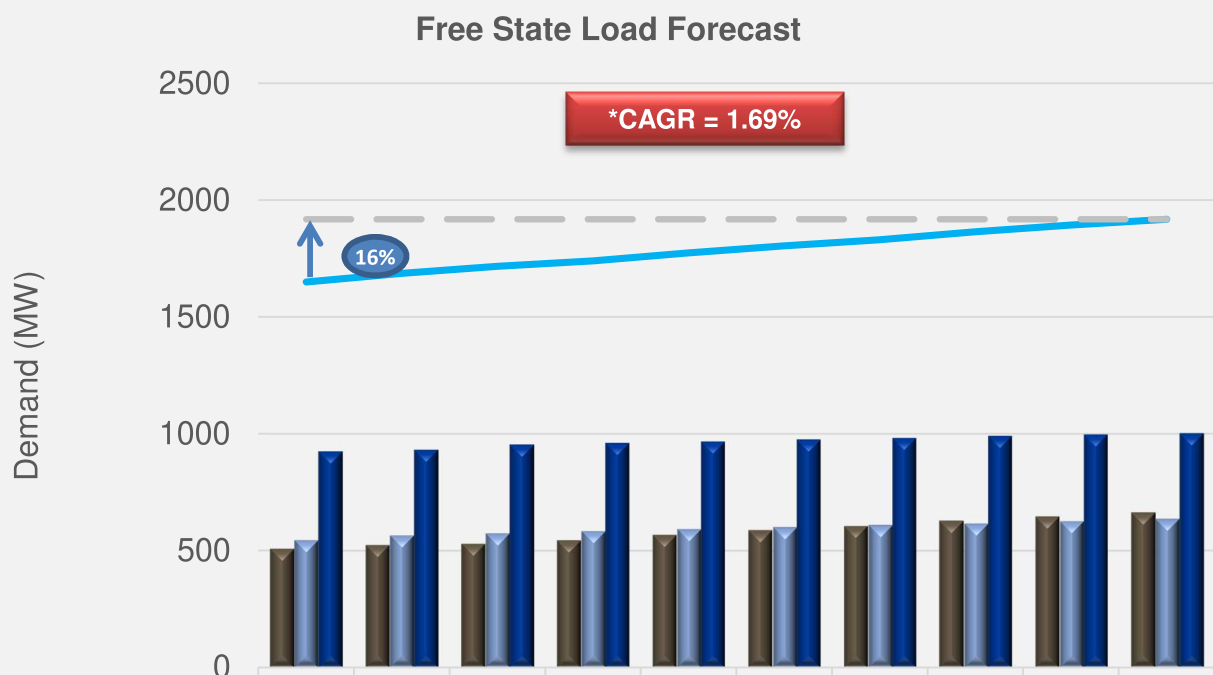
The power supply into the province is predominantly sourced from Lethabo Power Station and Mpumalanga via 400 kV and 275 kV Transmission lines. Lethabo Power Station is a coal-fired power station located in the Vaal Triangle area of the Free State. It has a generating capacity of 3 558 MW.

6.2.3 RENEWABLE GENERATION INTEGRATION

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

6.2.4 LOAD FORECAST

The economic mix in the Free State is predominantly comprised of mining, commercial customers and residential customers. The load in Free State is forecasted to grow steadily at approximately 2% annually, from 1 697 MW in year 2018 to 2 225 MW by year 2029. The highest provincial load growth is expected in the Sasolburg CLN. The load forecast for the Free State is shown in figure 6.2.2.



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Bloemfontein	508	524	530	544	567	588	605	628	646	663
Sasolburg	545	566	574	583	592	600	609	617	626	635
Welkom	925	932	953	960	967	975	982	990	998	1002
Grid Peak	1650	1686	1716	1740	1774	1804	1831	1864	1893	1918
2029 Peak	1918	1918	1918	1918	1918	1918	1918	1918	1918	1918

Year

Figure 6.2.2: Free State load forecast

6.2.5 REACTIVE POWER COMPENSATION

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

6.2.6 NEW SUBSTATION

No new substations.

6.2.7 MAJOR SCHEMES

The major TDP schemes planned in the Free State are as follows:

Bloemfontein Strengthening Phase 1B

This project involved establishing a 275 kV line from Everest Substation to Merapi Substation, built at 400 kV specifications and operated at 275 kV. It was commissioned in April 2019.

Bloemfontein Strengthening Phase 2

The project involves acquiring servitudes for future 400 kV lines, that is, Beta-Harvard and Harvard – Merapi lines and the introduction of 400 kV at 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 Tugela Substation in the KwaZulu-Natal and Sorata 132 kV switching station in Free State. Sorata 132 kV Switching Station will be extended to a 275/132 kV Substation to de-load Tugela Substation. 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 2nd Sorata-Tugela 275 kV line (400 kV line operated at 275 kV), as well as installing a 2nd 275/132 kV transformer at Sorata Substation.

Makalu Substation Strengthening

This project involves establishing Igesi 275/88 kV Substation and to loop into one of the Lethabo- Makalu 275 kV lines to create Lethabo-Igesi and Igesi-Makalu 275 kV lines. Igesi Substation will de-load Makalu Substation and it will also assist to reduce the network fault levels around Makalu Substation.

6.2.8 PLANNED PROJECTS

The following projects are planned for the period 2020 to 2029:

Table 6.2.1: Free State - Summary of projects and timelines

TDP scheme	Project name	Expected CO year
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	2026
Sorata Substation Strengthening	Construct Sorata-Tugela 400 kV line (operated at 275 kV) Sorata 2nd 275/132 kV 250 MVA transformer	2028

6.2.9 PROVINCIAL SUMMARY

The increase in Transmission assets by the end of 2024 and the end of 2029 and cumulative total are shown in Table 6.1.2.

Table 6.2.2: Cumulative TDP Transmission assets for Free State

Transmission Assets	New Assets expected in 2020 - 2024	New Assets expected in 2025 - 2029	Total New Assets
Power lines (km)			
765 kV	-	-	-
400 kV	-	130	130
<=275 kV	-	14	14
Total length (km)	-	144	144
Transformers			
Number of units	1	5	6
Total capacity (MVA)	250	1 380	1 630
Capacitors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-
Reactors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-

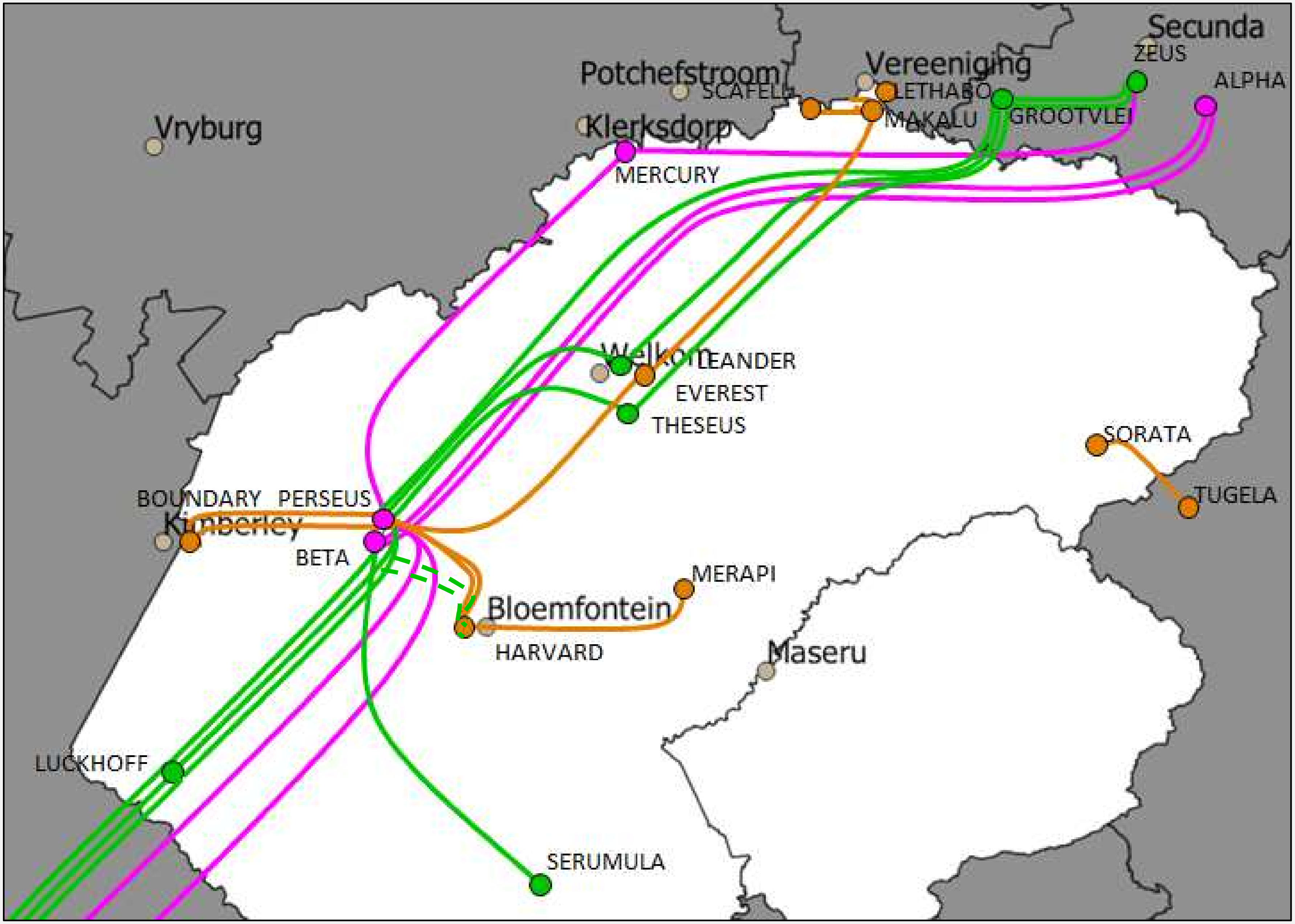


Figure 6.2.3: Future Free State network diagram

6.3 GAUTENG

6.3.1 INTRODUCTION

Gauteng is the smallest province by landmass and yet the most populated province in South Africa. This is due to the fact that it is the hub of economic activity in South Africa and accounting for about 30% 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 capitals of Gauteng and South Africa respectively. Large municipalities (redistributors) are the dominant players, accounting for about 75% of electricity consumption in the province. Figure 6.3.1 shows the boundaries of Gauteng and the existing Transmission network.

The provincial load peaked at approximately 11 GW in 2019, and it is expected to increase to about 14.5 GW by 2029. 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 6.3.1. Gauteng comprises four CLNs, namely: West Rand, Tshwane, East Rand, and Johannesburg. There has been a steady increase in demand for electricity supply in Gauteng, in recent years, which is mainly attributable to commercial and residential developments.

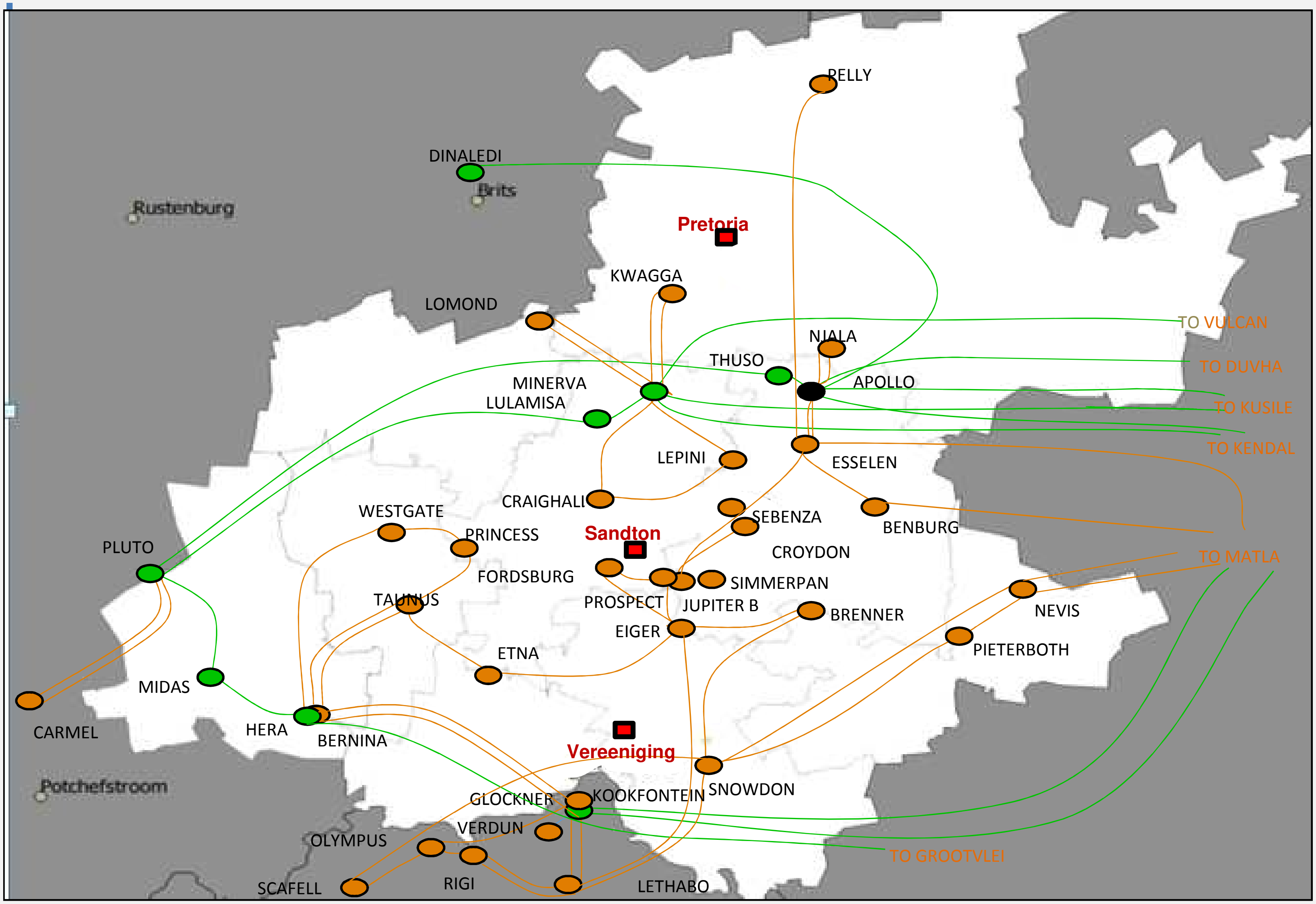


Figure 6.3.1: Current Gauteng network diagram

6.3.2 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 just over 20 MW from landfill gas were identified as part of the DoE REIPP 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 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.

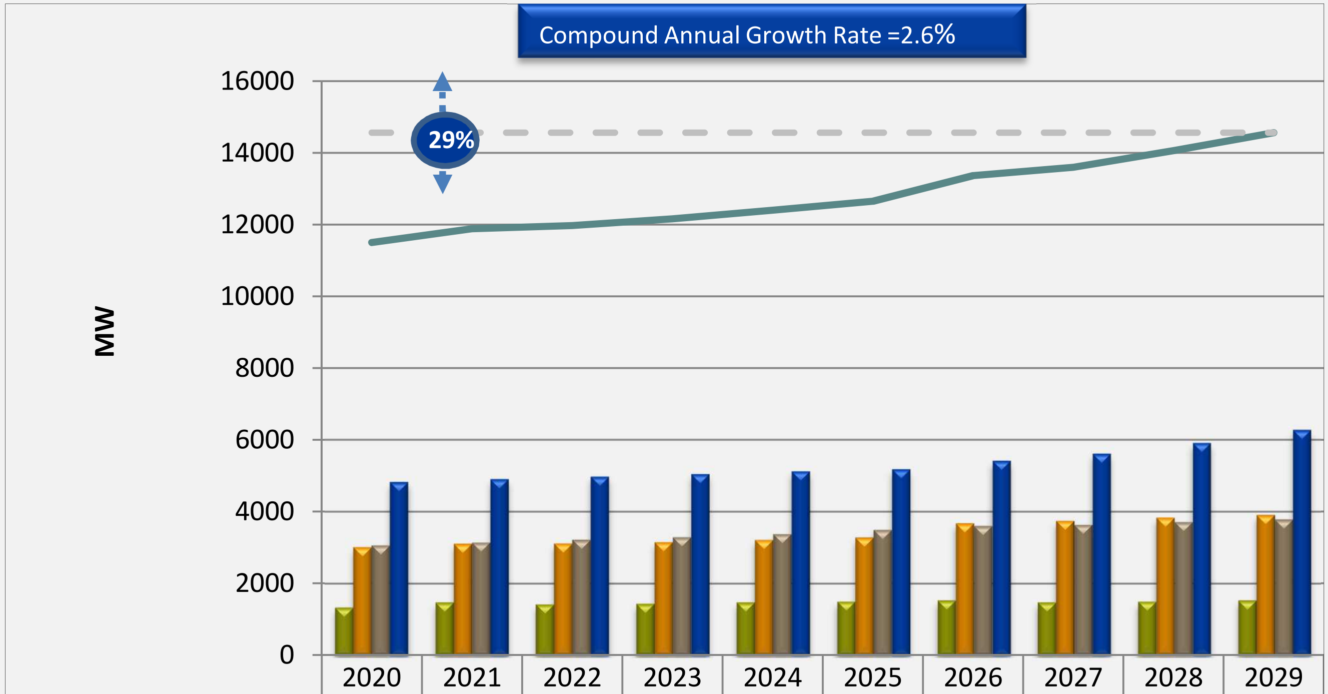
6.3.3 RENEWABLE GENERATION INTEGRATION

No RE plants will be integrated into the grid.

6.3.4 LOAD FORECAST

The load forecast for Gauteng is shown in Figure 6.3.2. The economic mix in Gauteng comprises predominantly mining, industrial, logistics, commercial, and tertiary sectors. The unconstrained load growth in Gauteng is forecasted at about 2.6% annually, from approximately 11 GW in 2019 to about 14.6 GW by 2029.

The Gauteng customer load networks have been reduced from six to four CLNs, namely: East Rand, Johannesburg, Vaal and West Rand CLNs. West Rand CLN is expected to experience the highest rate of load growth, followed by the East Rand and Johannesburg CLNs. The rate of load growth in the Vaal CLN is expected to be the lowest in the province. The load forecast is shown in Figure 6.3.2.



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Vaal	1338	1479	1421	1442	1474	1505	1531	1476	1505	1535
East Rand	3012	3113	3121	3153	3215	3281	3675	3748	3836	3908
West rand	3063	3144	3221	3294	3375	3491	3603	3635	3712	3781
Johannesburg	4822	4904	4977	5045	5131	5184	5411	5612	5911	6273
Provincial Peak	11501	11881	11974	12158	12403	12654	13367	13603	14066	14566
2029 Peak	14566	14566	14566	14566	14566	14566	14566	14566	14566	14566

Figure 6.3.2: Gauteng Province load forecast

6.3.5 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 Sandton, Midrand and Tembisa areas. Currently two 150 MVar capacitor banks are being installed at the Lepini Substatio7n 275 kV busbar, and this will be followed by construction of the Apollo-Lepini 275 kV line to increase capacity in the Minerva-Craighall-Lepini 275 kV ring.

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 and transformation 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. Sebenza Substation,recently commissioned by City Power de-loads Prospect Substation and creates more transformation capacity in the East Rand. Additional reinforcements to the Sebenza node will be achieved through looping in of the Esselen-Jupiter 275 kV line into the new Sebenza MTS.

Simmerpan strengthening: Sisimuka 275 kV integration
Simmerpan strengthening addresses unfirm transformation at the Jupiter Substation in the Germiston, to support 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 132 kV network currently supplied by Croydon MTS.

Vaal strengthening
The scheme entails the construction of two Glockner-Etna 400 kV lines to deload the overloaded Hera MTS and improve voltage support 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 first phase entails establishing a 400 kV busbar at Westgate, building the Hera-Westgate 400 kV line and installing a 500 MVA 400/132 kV transformer at Westgate. The next phase will be rolled out in stages and includes additional transformation at Westgate; the Pluto-Westgate 400 kV line; shunt capacitors at various substations; and a 400 kV injection at Taunus Substation.

6.3.6 REACTIVE POWER COMPENSATION

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

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

6.3.7 NEW SUBSTATION

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

- Lesokwana 400/132 Substation in the Ekurhuleni area
- Sesiu 400/88 Substation in the Dalkeith area
- Mesong 275/132 Substation in the Chroorkop area
- Diphororo 400/132 Substation in Soshanguve
- Wildebees 400/132 kV MTS in PTA East
- Quattro 275/132/88 kV MTS in the Soweto area
- Sisimuka 275/ 88 kV in the Germiston area

6.3.8 PLANNED PROJECTS

The following projects in table 6.3.1 are planned for the period 2020 to 2029.

Table 6.3.1: Cumulative TDP Transmission assets for Gauteng

TDP scheme	Project name	Expected CO year
JHB North Strengthening Phase 1	Lepini Ext 275 kV 2 x 150 MVAr capacitors	2020
Benburg Ext 3rd 250 MVA 275/132 kV	Benburg Ext 3rd 250 MVA 275/132 kV transformer	2020
Vaal Strengthening Phase 2	Glockner-Etna 1st and 2nd 400 kV line (operate @ 275 kV)	2022
Brenner Strengthening Phase 1	Brenner 2 x 88 kV 48 MVAr capacitors	2022
Tshwane Metro – Diphororo Phase 1	Diphororo 400/132 kV Substation Integration	2023
Tshwane Metro – Wildebees Phase 1	Wildebees 400 kV Substation Integration	2024
Tshwane Metro: Thuso 3rd transformer	Thuso 400/132 kV Substation (3rd 250 MVA transformer)	2025
Etna Strengthening: 3rd transformer	Etna 275/88 kV Substation (3rd 315 MVA transformer)	2028
Soweto Phase 1: Quattro 275/88 kV	Quattro 275/88 kV Substation Integration	2027
Soweto Phase 2: Quattro 275/132 kV	Quattro 275/132 kV Substation Integration	2027

TDP scheme	Project name	Expected CO year
West Rand Ph2a: Caps and Westgate TRFR	1 x 72 MVAr Cap Banks at Westgate 132 kV	2027
JHB North Phase 2	JHB North: Apollo-Lepini 1st 275 kV line	2025
Simmerpan Phase 1B	Sisimuka 275/88 kV Substation Integration	2026
JHB North: Sesiu Integration	Sesiu 400/88 kV Substation Integration	2028
JHB East: Jupiter B integration	Jupiter B 275 kV Switching station	2029
	Matla-Jupiter B 1st and 2nd 400 kV lines	
	Jupiter B 275 kV Loop-ins (Prospect-Sebenza 1 & 2, Jupiter-Prospect 1, Jupiter-Fordsburg 1)	
Brenner Phase 2: Lesokwana Substation	Lesokwana 275/88 kV Substation integration	2029

6.3.9 PROVINCIAL SUMMARY

The increase in Transmission assets by the end of 2024 and the end of 2029 and cumulative total are shown in Table 6.3.2.

Table 6.3.2: Cumulative TDP Transmission assets for Gauteng

Transmission Assets	New Assets expected in 2020 - 2024	New Assets expected in 2025 - 2029	Total New Assets
Power lines (km)			
765 kV	-	-	-
400 kV	66	112	178
<=275 kV	1	16	17
Total length (km)	67	128	195
Transformers			
Number of units	3	6	7
Total capacity (MVA)	1250	2540	3790
Capacitors			
Number of banks	12	-	12
Total capacity (Mvar)	596	-	596
Reactors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-

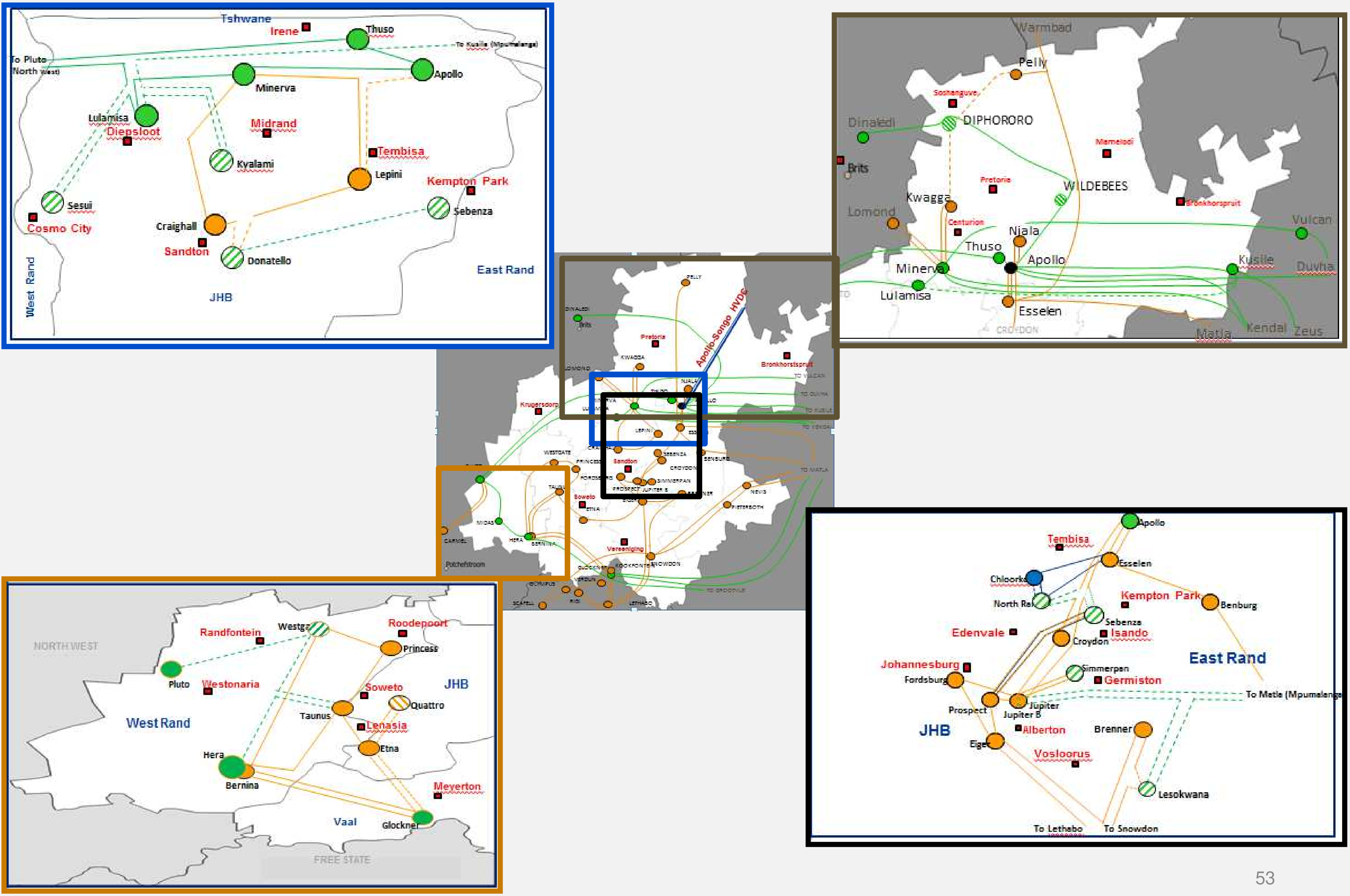


Figure 6.3.3: Future Gauteng network diagram

6.4 KWAZULU NATAL

6.4.1 INTRODUCTION

KwaZulu-Natal is situated on the eastern seaboard of South Africa, along the Indian Ocean. The capital of the province is Pietermaritzburg and its largest city is 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 in 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 IDZ 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 that are being established to offer strong production linkages as well as clustering potential.

The provincial electricity demand peaked at around 5900 MW in 2018 and it is expected to increase to about 7314 MW by 2029. 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 1. The KwaZulu-Natal Grid comprises of four CLNs, namely Empangeni, Ladysmith, Newcastle and Pinetown. The Empangeni and Pinetown CLNs are the two main load centres in the province, consuming approximately 32% and 55% of the load respectively. Ladysmith and Newcastle CLNs make up the remaining 13% of the demand in the province. The current Transmission network is shown in Figure 6.4.1.

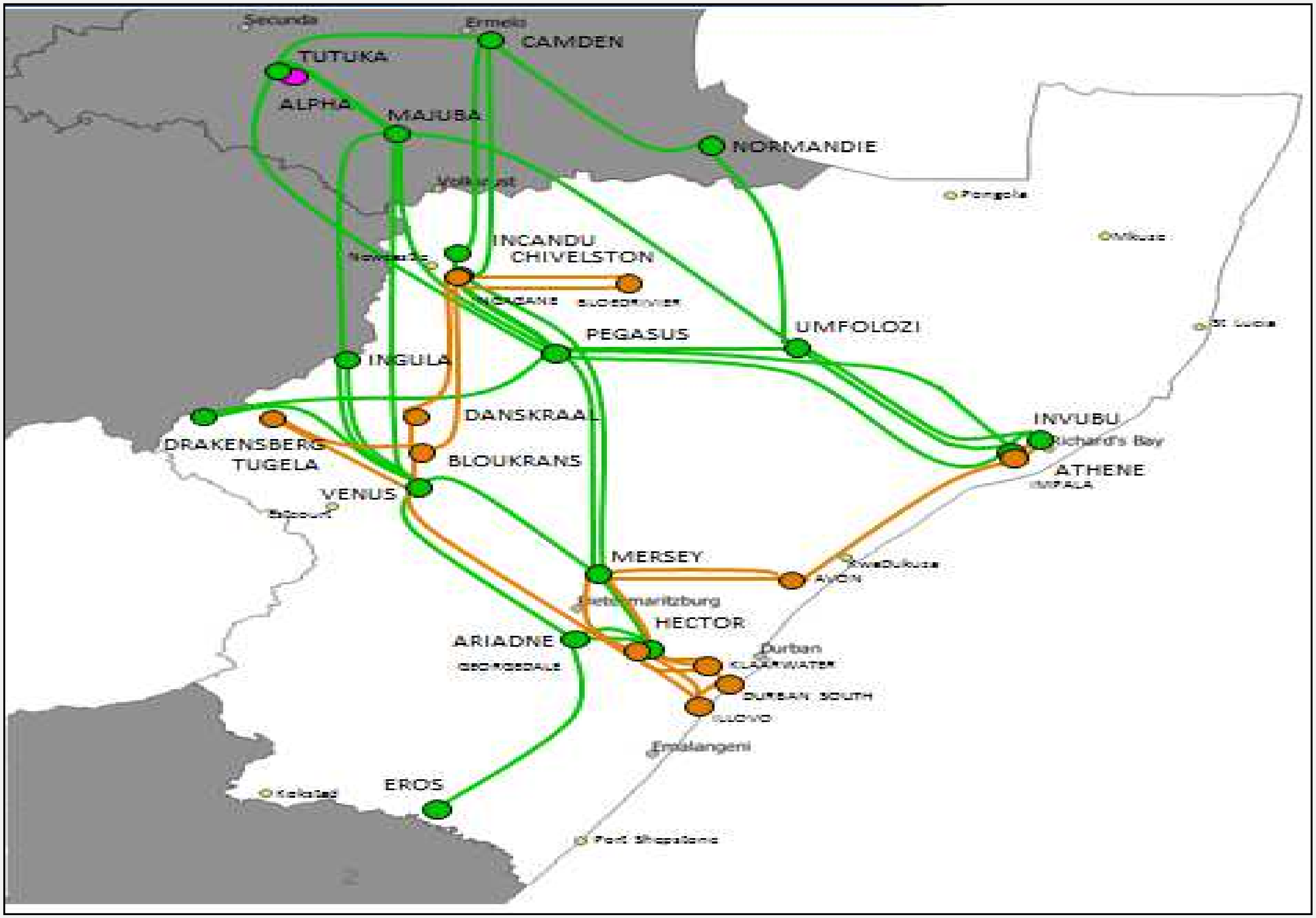


Figure 6.4.1: Current KwaZulu-Natal Province network diagram

6.4.2 GENERATION

Most of the electricity consumed in KwaZulu-Natal is sourced from the power stations in Mpumalanga via 400 kV Transmission lines.

There are three peaking plants in the province consisting of a gas plant and two pumped storages. These comprise of Avon Open OCGT, Drakensberg and Ingula Pumped Storages. Avon OCGT has a generating capacity of 680 MW. Drakensberg and Ingula Pumped Storages have generating capacities of 1000 MW and 1333 MW respectively.

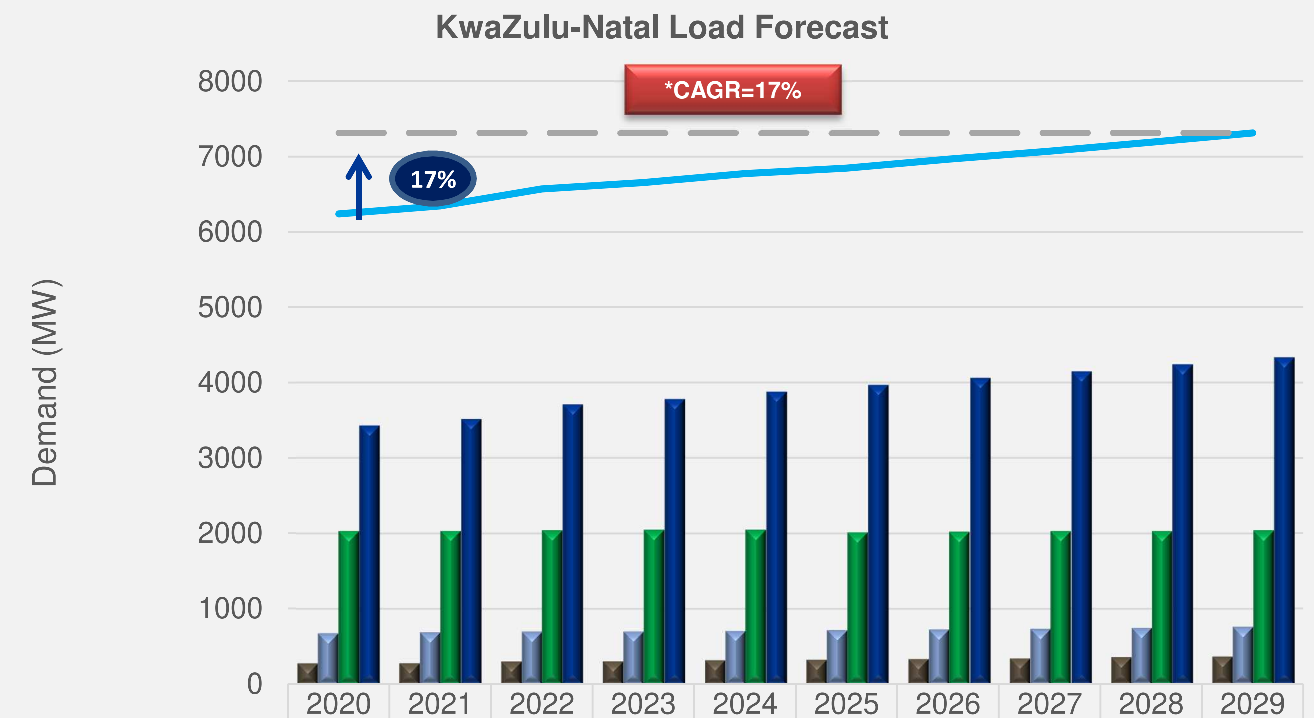
Richards Bay has been identified as one of the potential sites for the planned gas-to-power programme in accordance with the Draft IRP 2018. The estimated allocation for Richards Bay ranges between 2 000 MW and 3 000 MW.

6.4.3 RENEWABLE GENERATION INTEGRATION

No RE plants will be integrated into the grid.

6.4.4 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 1.8% annually, from 5900 MW in year 2018 to 7314 MW by year 2029. The highest provincial load growth is expected in the Pinetown and Empangeni CLN due to industrial, commercial and residential developments. The load forecast for KwaZulu-Natal is shown in Figure 6.4.2.



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Ladysmith	277	283	305	310	320	328	339	348	358	369
Newcastle	680	689	699	703	711	720	728	739	752	764
Empangeni	2031	2036	2041	2048	2052	2017	2026	2031	2034	2042
Pinetown	3432	3521	3711	3783	3879	3971	4062	4148	4241	4336
Grid Peak	6237	6345	6569	6655	6771	6847	6963	7072	7190	7314
2029 Peak	7314	7314	7314	7314	7314	7314	7314	7314	7314	7314

Figure 6.4.2: KZN province load forecast

6.4.5 REACTIVE POWER COMPENSATION

Within KwaZulu-Natal there are plans to:

- Refurbish the Athene Static Var Compensator (SVC)
- The Illovo SVC, but retain the 100 Mvar capacitor bank component of the SVC

6.4.6 NEW SUBSTATIONS

No new substations.

6.4.7 MAJOR SCHEMES

The major TDP schemes planned in the KwaZulu-Nata 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 integrating it into 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).

Ariadne -Venus 2nd 400 kV Line

This project involves dismantling an existing Georgedale – Venus 275 kV line and constructing a second Ariadne – Venus 400 kV line. Construction of the line is already underway.

South Coast Strengthening: Ariadne-Eros 2nd 400 kV Line

This project involves the construction of a 400/132 kV multi-circuit line between Ariadne Substation and Eros Substation. The 400 kV circuit will extend all the way from Ariadne Substation to Eros Substation, but the 132 kV circuit will go from Ariadne and terminate in Port Shepstone. Construction of the line is already underway.

eThekwini Electricity Network Strengthening

- This project involves the establishment of Shongweni 2x 500 MVA 400/132 kV Substation and the construction of two 400 kV lines from Hector to the proposed Shongweni Substation to de-load Hector 400/275 kV transformers, Hector-Klaarwater 275 kV lines and Klaarwater Substation. It will also cater for the planned developments west of 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 de-load the Mersey-Avon 275 kV system and provide supply to the Dube Tradeport development.

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

This project involves the establishment of Iphiva 400/132 kV Substation near 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. Duma Substation is part of the planned Ermelo-Richards Bay Coallink upgrade.

6.4.8 PLANNED PROJECTS

The following projects are planned for the period 2019 to 2030:

Table 6.4.1: KwaZulu Natal – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Ariadne – Venus 2nd 400 kV Line	Ariadne – Venus 2nd 400 kV line (recycle Georgedale – Venus 1 or 2 275 kV line)	2021
South Coast Strengthening	Ariadne – Eros 2nd 400 kV line	2021
NKZN Strengthening Phase 1	Iphiva 400 kV busbar Normandie – Iphiva 1st 400 kV line Iphiva 1 x 500 MVA 400/132 kV transformer	2028
KZN 765 kV Strengthening -Pinetown Integration	Isundu 400 kV switching station Isundu-Venus 765 kV line (operated at 400 kV)Ariadne-Isundu 400 kV line Hector-Isundu 400 kV line	2029
eThekwini Electricity Network Strengthening	Inyaninga 2 x 500 MVA 400/132 kV Substation Inyaninga – Mbewu 400 kV line 1 and 2	2029
	Shongweni 2 x 500 MVA 400/132 kV Substation 2 x Hector – Shongweni 1st and 2nd 400 kV lines	2030

6.4.9. PROVINCIAL SUMMARY

A summary of all projects and scheme planned for this province is provided in Table 6.4.2

Table 6.4.2: Cumulative TDP Transmission assets for KwaZulu Natal Province

Transmission Assets	New Assets expected in 2020 - 2024	New Assets expected in 2025 - 2029	Total New Assets
Power lines (km)			
765 kV	98	-	98
400 kV	235	605	840
<=275 kV	96	-	96
Total length (km)	429	605	1034
Transformers			
Number of units	-	3	3
Total capacity (MVA)	-	1 500	1 500
Capacitors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-
Reactors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-

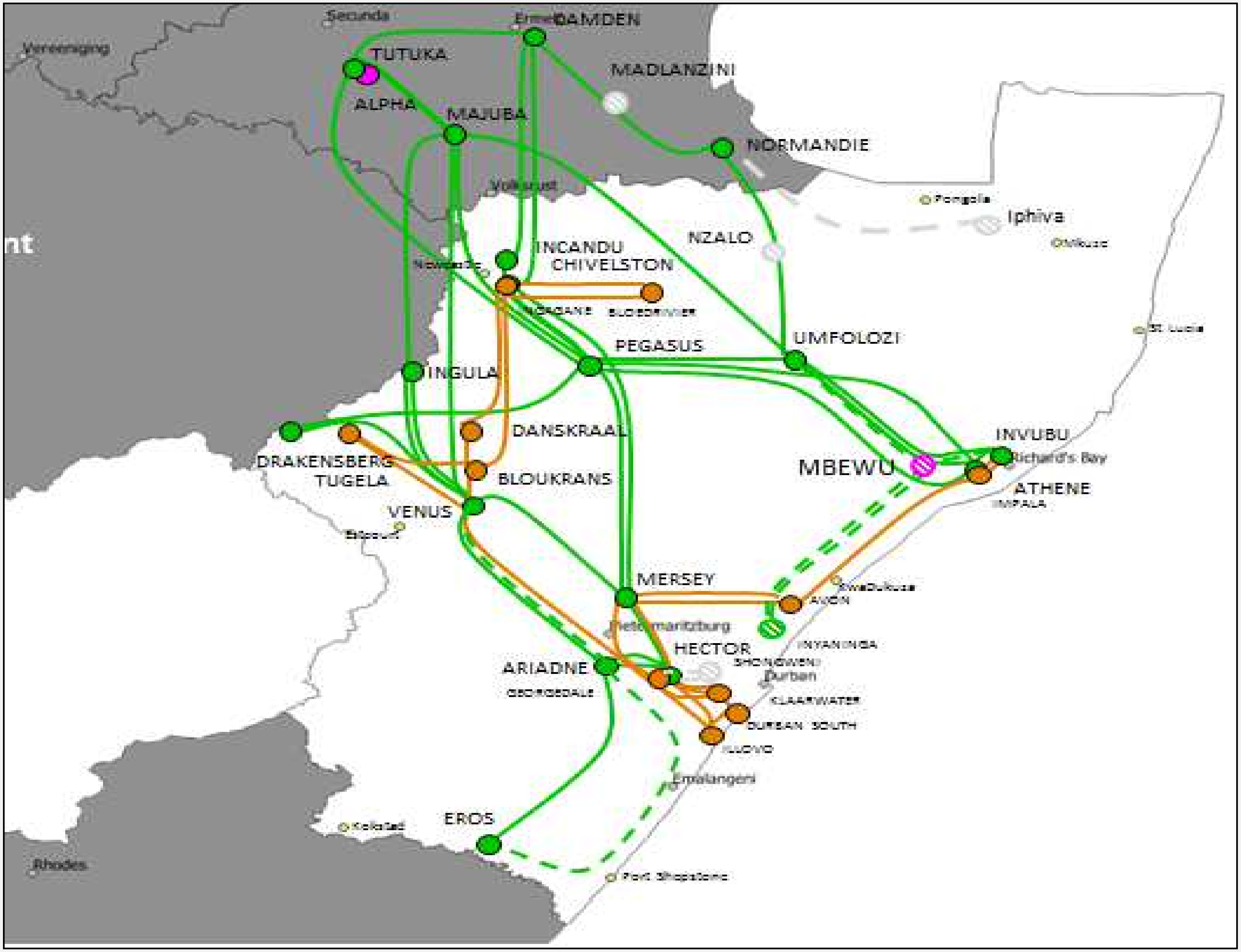


Figure 6.4.3: Future KwaZulu-Natal network diagram

6.5 LIMPOPO

6.5.1 INTRODUCTION

Limpopo is situated on the northernmost 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 CLN, namely Lephalale, Polokwane, and Phalaborwa. Each CLN is made up of a number of MTS. The MTS are interconnected through 400kV, 275kV as well as through the 132kV underlying Distribution network. The 2018 peak load for the Northern Grid was at 3 011 MW. Growth in Limpopo is primarily due to the platinum group metals (PGM) and, 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 6.5.1 shows the geographical diagram of the existing and future Northern Grid Transmission network with future planned projects shown in dotted lines. These were envisaged in the previous TDP reports. The new main corridor under construction is illustrated by the shaded area, which entails all the projects for Medupi integration. Indicative time-lines for key projects that are in the execution phase are given (based on the latest information at the time of writing this report).

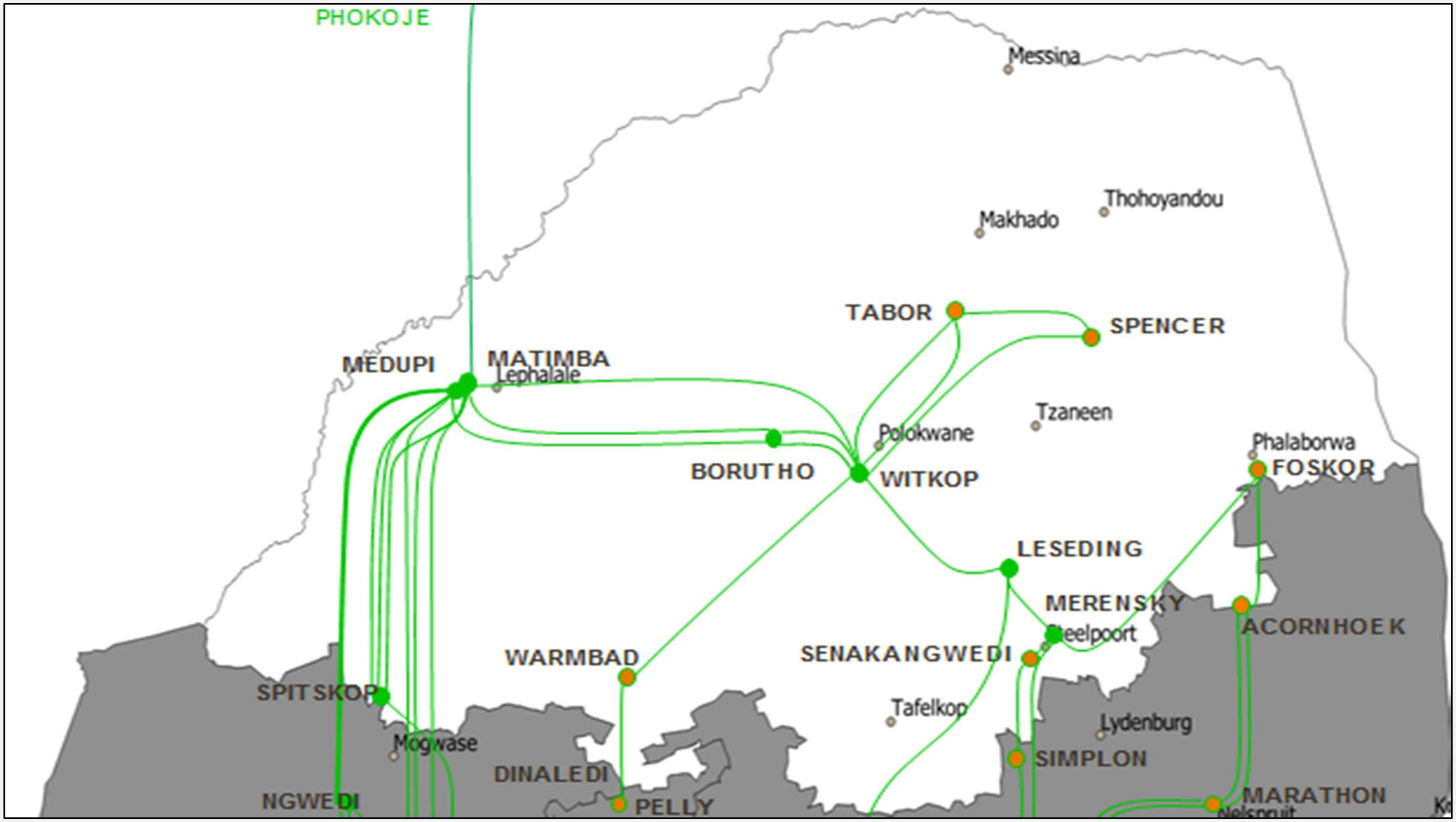


Figure 6.5.1: Current Limpopo network diagram

6.5.2 GENERATION

Base load generation

The base load 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 Matimba Power Station. On completion, Medupi together with Matimba Coal-fired Power Stations 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 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. The adjacent Grootegeluk colliery has sufficient coal reserves to guarantee Matimba a minimum lifespan of 35 years, extending to a possible 50 years.

Medupi Power Station: Medupi Power Station will have a nominal generating capacity of 4 356 MW (6 x 726 MW units). 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.

The end-state total base-load generation expected in the Lephalale area will be approximately 20 GW by 2030. This will be possible with the commissioning of two more coal-fired power stations similar in size to Medupi Power Station.

6.5.3 RENEWABLE GENERATION INTEGRATION

Three PV Renewable Energy Plants have been integrated in Limpopo:

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

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

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

Table 6.5.1: Base Load Generation capacity for Limpopo

Scenario Description	Number of units in specified operating mode at each power station	
	Matimba Power Station	Future Medupi Power Station
Type	Base-load(2018)	Base-load (2020)
Total Capacity (MW)	3 990	4 356
Normal operation for Planning load flow studies (MW)	6 x 665	6 x 726

6.5.4 LOAD FORECAST

The CLN's in the Northern Grid are expected to experience positive growth over the next ten years. The Lephalale CLN will have a steady growth rate of 4.24%. This can be attributed to the expected heavy industry and the resulting light industry together with commercial and residential developments as spin-offs.

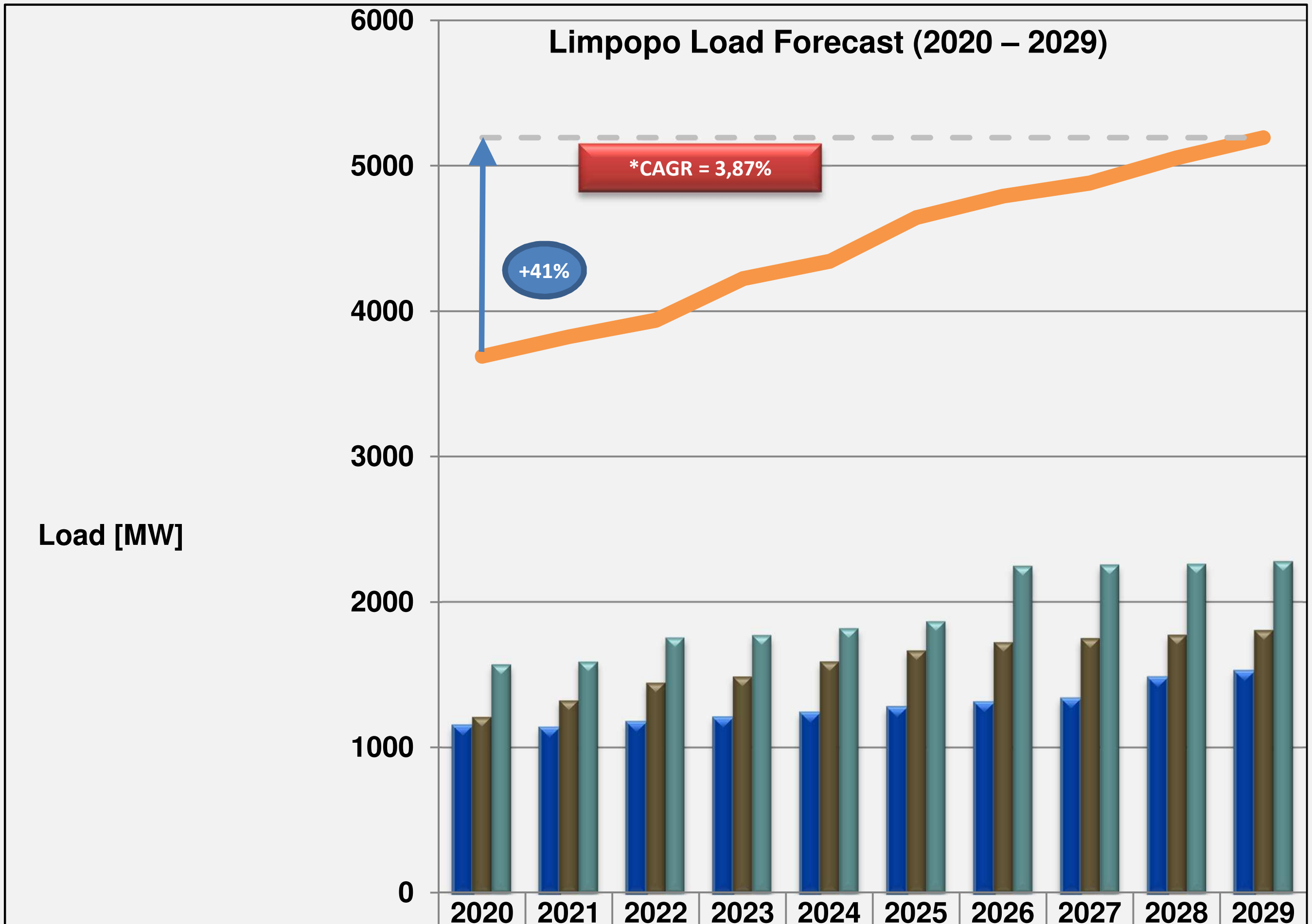
Mining activities are also expected in the areas of Lephalale CLN, the introduction of Borutho Transmission Substation will cater for these expected new mining loads in the surrounding areas of Mokopane town.

Polokwane CLN is expected to experience a load growth at 2.81%, the introduction of Nzhelele Transmission Substation will provide capacity for the new mines and residential developments that are expected in the area.

The Phalaborwa CLN will have a growth rate at 3.62%. This can be attributed to an increase in mining activities and possible smelting operations near Leseding MTS.

The load in Limpopo is forecasted to grow steadily at about 4.03% over the next 10 years.

The load forecast for Limpopo is shown in figure 6.5.2



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Polokwane CLN Peak	1148	1136	1173	1203	1238	1273	1309	1335	1480	1523
Lephalale CLN Peak	1210	1324	1446	1485	1591	1665	1724	1750	1773	1804
Phalaborwa CLN Peak	1570	1588	1756	1770	1817	1866	2246	2253	2260	2278
Provincial Peak	3690	3824	3938	4221	4342	4643	4791	4881	5054	5193
2029 Peak	5193	5193	5193	5193	5193	5193	5193	5193	5193	5193

Figure 6.5.2: Limpopo load forecast

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

6.5.6 NEW SUBSTATION

New Substations will be established as part of scheme projects.

6.5.7 MAJOR SCHEMES

The major TDP schemes planned in the Limpopo area:

The TDP scheme projects for the province consists of the establishment the 765 kV network (operated at 400 kV), integration of the Medupi Power Station, and extension of the 400 kV and 275 kV networks, which entail installation of additional transformers at existing and new substations.

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

Nzhelele 400 kV Integration

Expand Nzhelele 132 kV Distribution SWS to a 400/132 kV MTS.The integration of 400 kV into Nzhelele is required for de-loading the Tabor Substation and Spencer Substation. The 400 kV supply to enable this project will be sourced from 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 Foskor Substation to Spencer Substation and the establishment of 400/132 kV transformation at Spencer Substation. The project will also require the 2nd Merensky - Foskor 275 kV line to be operated at 400 kV. A new 400/275 kV transformation will be established at 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 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 Transmission development plans for Limpopo are shown in Figure 6 9.

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

New name	Previous name
Mogwase	Ngwedi
Silimela	Marble Hall
Mogwase	Ngwedi
Manogeng	Tubatse
Dwarsberg	Dwaalboom
Emkhiweni	Rockdale B
Sekhukhun e	SenakangwediB

6.5.8 PLANNED PROJECTS

The following projects are planned for the 2019 to 2029 period:

The following projects are planned for the period 2019 to 2029:

Table 6.5.2: Limpopo – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Dwarsberg 132 kV Switching Station	Dwarsberg 132 kV Switching Station	2020
Foskor & Acornhoek 275/132 kV Transformation Upgrades	Foskor-Merensky 2nd 275 kV Line (build at 400 kV specification)	2025
Waterberg Generation 400 kV Stability Enhancement	Medupi – Witkop 1st 400 kV line	2020
Highveld North-West and Lowveld North Reinforcement-Phase 2	Borutho – Silimela 1st 400 kV line	2027
	Silimela 400/132 kV Substation	
	Manogeng 400 kV Switching Station	
	Loop in Duvha – Leseding 400 kV line into Manogeng Switching Station	
	Manogeng – Silimela 400 kV line	
Sekhukhune Integration Phase 1	Sekhukhune 400/275/132 kV Substation (1 x 800 MVA 400/275 kV transformer & 2 x 500 MVA 400/132 kV transformers)	2027
	Loop in Arnot –Merensky 400 kV into Sekhukhune Substation	
	Manogeng – Sekhukhune 1st 400 kV line	
	Sekhukhune - Senakangwedi 1st 275 kV line	
Nzhelele 400 kV Integration	Nzhelele 400/132 kV Substation (2 x 500 MVA 400/132 kV Transformers)	2028
	Tabor - Nzhelele 400 kV line	
	Borutho-Nzhelele 1st 400 kV line	
	Establish 400 kV busbars at Spencer Substation and Foskor Substation	
Limpopo East Corridor Strengthening	Establish 400 kV busbars at Spencer Substation and Foskor Substation	2028
	Foskor 1st 400 MVA 400/275 kV Transformer	
	Spencer 1st 500 MVA 400/132 kV Transformer	
	Foskor - Spencer 1st 400 kV line (110km)	
	Merensky-Foskor 2nd 275 kV line change-over to 400 kV line	
Polokwane Reactive Power Compensation	Spencer 2 x 36 Mvar Capacitor Banks	2024
	Tabor 2 x 36 Mvar Capacitor Banks	
Warmbad Transformation Upgrade	Warmbad 1st 250 MVA 275/132 kV transformer	2023
	Spencer 2 x 36 Mvar Capacitor Banks	2023
Leseding Transformation Upgrade	Leseding 3rd 500 MVA 400/132 kV transformer	2024

TDP scheme	Project name	Expected CO year
Medupi Transmission Integration	Medupi-Ngwedi 1st 400 kV line	2027
	Medupi-Ngwedi 1st 765 kV line(Energised at 400 kV)	
Acornhoek Transformation Upgrade	Acornhoek 3rd 125 MVA 400/132 kV transformer	2025
Borutho Transformation Upgrade	Borutho 3rd 500 MVA 400/132 kV transformer	2027

6.5.9 PROVINCIAL SUMMARY

A summary of all projects and scheme planned for this province is provided in Table 6.5.3.

Table 6.5.3: Cumulative TDP Transmission assets for Limpopo

Transmission Assets	New Assets expected in 2020 - 2024	New Assets expected in 2025 - 2029	Total New Assets
Power lines (km)			
765 kV	81	-	81
400 kV	192	655	847
<=275 kV	70	95	165
Total length (km)	343	1 400	1 743
Transformers			
Number of units	3	11	14
Total capacity (MVA)	1 250	4 325	5 575
Capacitors			
Number of banks	4	-	4
Total capacity (Mvar)	72	-	72
Reactors			
Number of banks	-	1	1
Total capacity (Mvar)	-	300	300

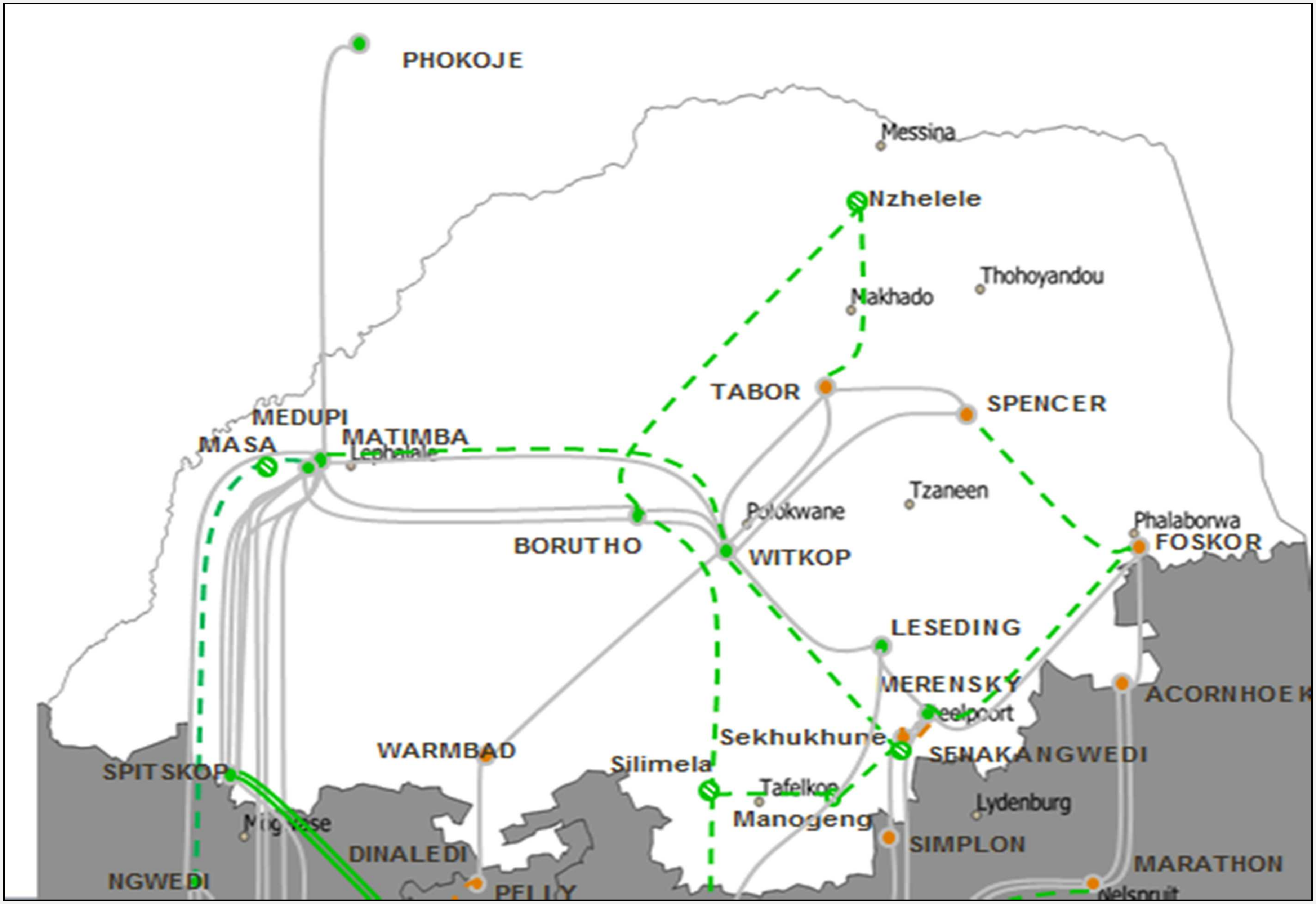


Figure 6.5.3 Future Limpopo network diagram

6.6 MPUMALANGA

6.6.1 INTRODUCTION

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 thanks to attractions like the Kruger National Park, the 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 14 of Eskom's 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, 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 Grid Code compliant 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.
- Middleburg CLN – Rockdale, Hendrina, Duvha, Komati and Arnot.
- Witbank CLN – Vulcan, Matla, Kendal, Kriel, Kruispunt and Kusile.

Figure 6.6.1 represents the current Transmission network in Mpumalanga.

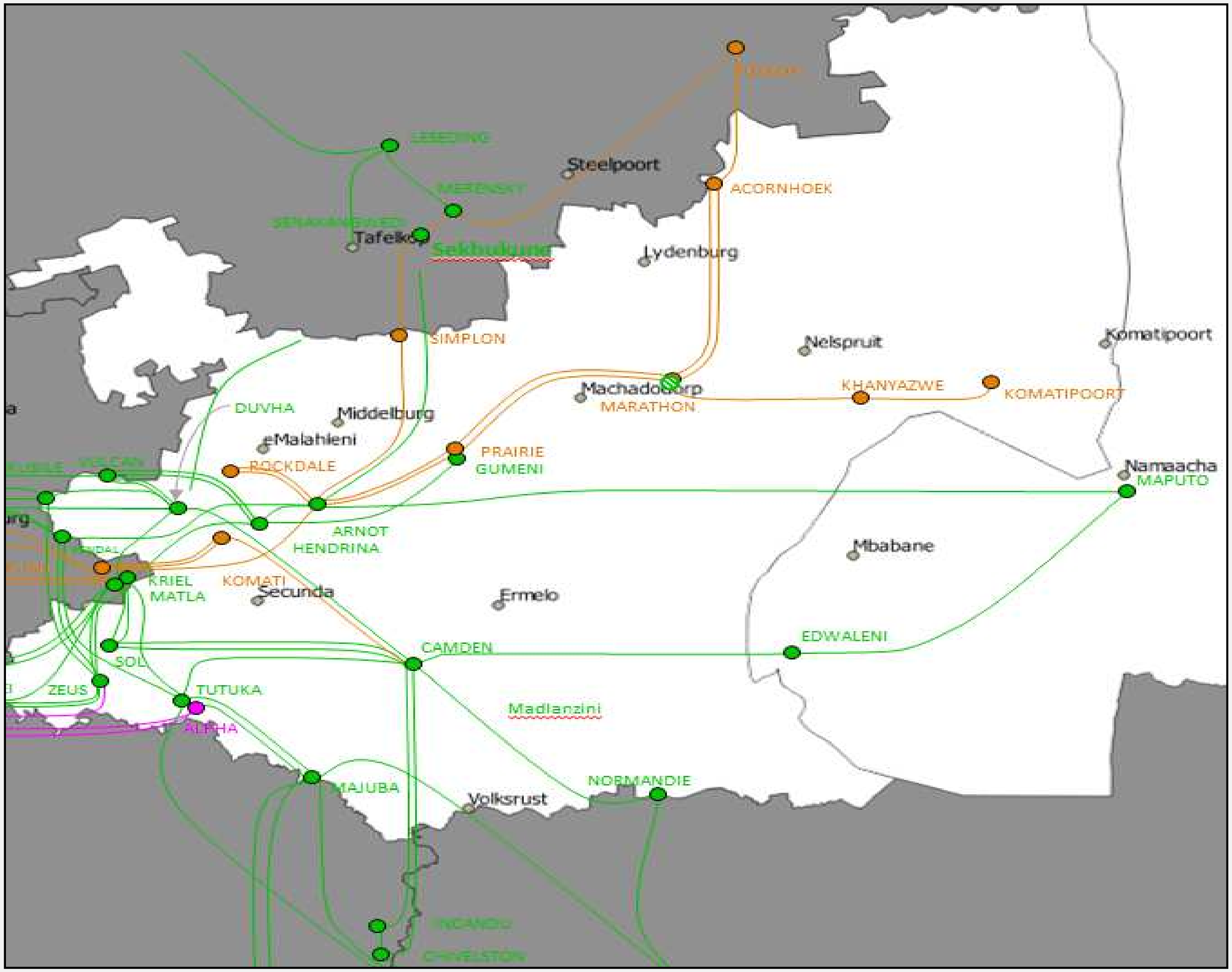


Figure 6.6.1: Current Mpumalanga network diagram

6.6.2 GENERATION

The total capacity of Kusile Power Station on completion is expected to be 5076 MW. Table 6.6.1 details the programme for the Kusile units becoming commercially available. 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 available in 2024.

Table 6.6.1: Kusile Power Station schedule

Generator	Planned CO date
Unit 1	2018
Unit 2	2019
Unit 3	2020
Unit 4	2021
Unit 5	2021
Unit 6	2022

Kusile Power Station is being integrated as shown in Figure 6.6.2. The dotted lines represent the new 400 kV lines and new turn-ins from existing 400 kV lines. At the time of publishing this report, the only remaining project is the Kusile-Lulamisa line. This project is delayed due to servitude acquisition challenges and is required before unit 5 is commissioned.

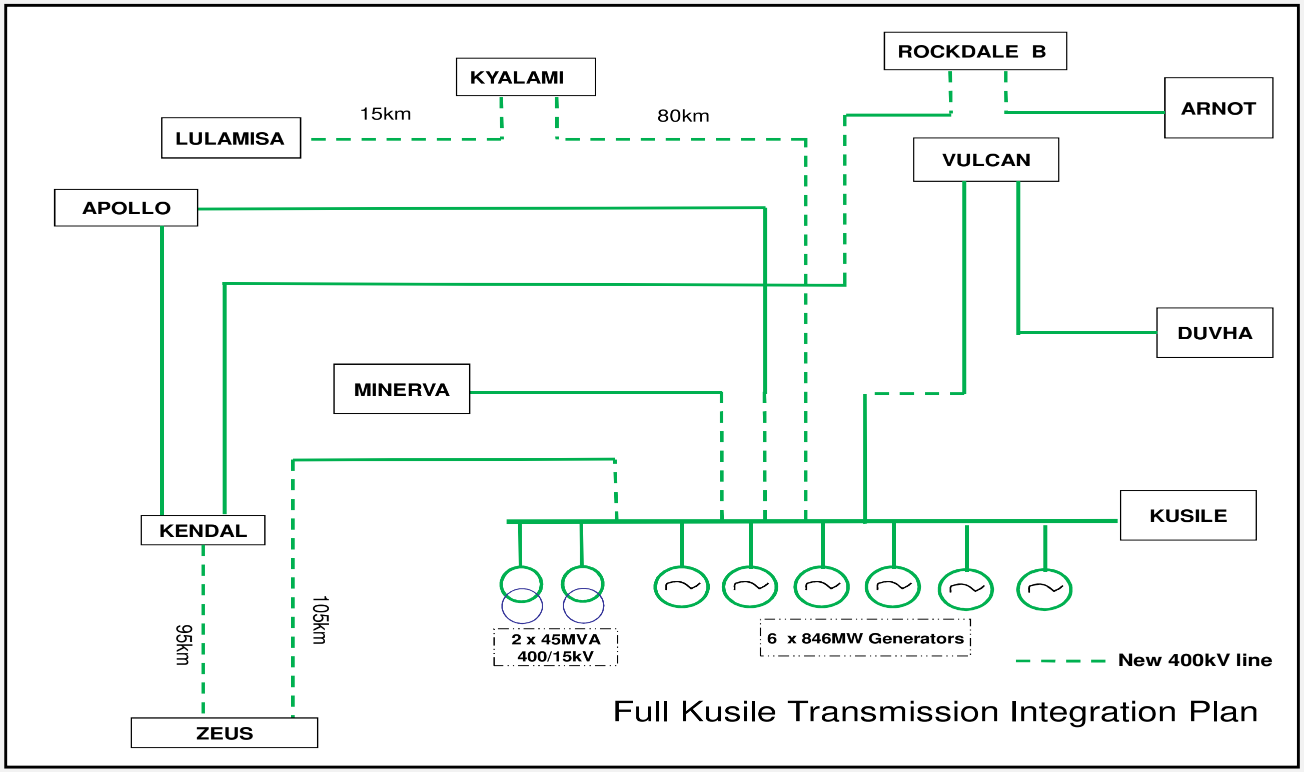


Figure 6.6.2: Kusile Power Station Integration single-line diagram

Hendrina, Grootvlei and Komati Power Stations are close to reaching the end of their economic life. Table 6.6.2 shows the Eskom power station units that are assumed to be decommissioned within the analysis period. Approximately 11 GW of capacity is assumed to be removed from the Mpumalanga generation pool over the next 10 years.

Table 6.6.2: Ageing generators decommissioning schedule

Power Station	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total per station
Arnot						2352					2352
Camden								570	391	600	1561
Grootvlei						400				190	590
Hendrina	168	340	195	390	200	200	200	200			1893
Komati		90	250	250	200	100	100				990
Kriel							500	1000	500	1000	3000
Matla										600	600
Total per annum	168	430	445	640	400	3 052	800	1 770	891	2 390	10 986

6.6.3 RENEWABLE GENERATION INTEGRATION
No potential RE.

6.6.4 LOAD FORECAST
Load growth is expected in the province as a result of development in the commercial, electrification and industrial environment. The future load mix is not expected to differ from the existing one, which is mainly comprised of redistributors, mining, commercial and industrial customers. The load growth within the TDP period is estimated at 1.34% per annum, from 4 396 MW (at provincial peak) in year 2020 to 5 068 MW in year 2029.

6.6.5 REACTIVE POWER COMPENSATION
There are no reactive power compensation projects expected in Mpumalanga for this TDP period. However, Distribution is planning to add some compensation in the Lowveld network to improve voltages under contingency.

6.6.6 NEW SUBSTATIONS
- Emkhiweni Substation integration will address both Vulcan and Rockdale unfirm transformations and improve safe working conditions over burning grounds
- Wonderkrag (Sol B) Substation integration will address the unfirm transformation and high fault levels at Sol Substation
- Normandie Substation is expecting a 2nd 400/132 kV transformer before the end of 2019 to address the unfirm transformation at 132 kV

6.6.7 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:

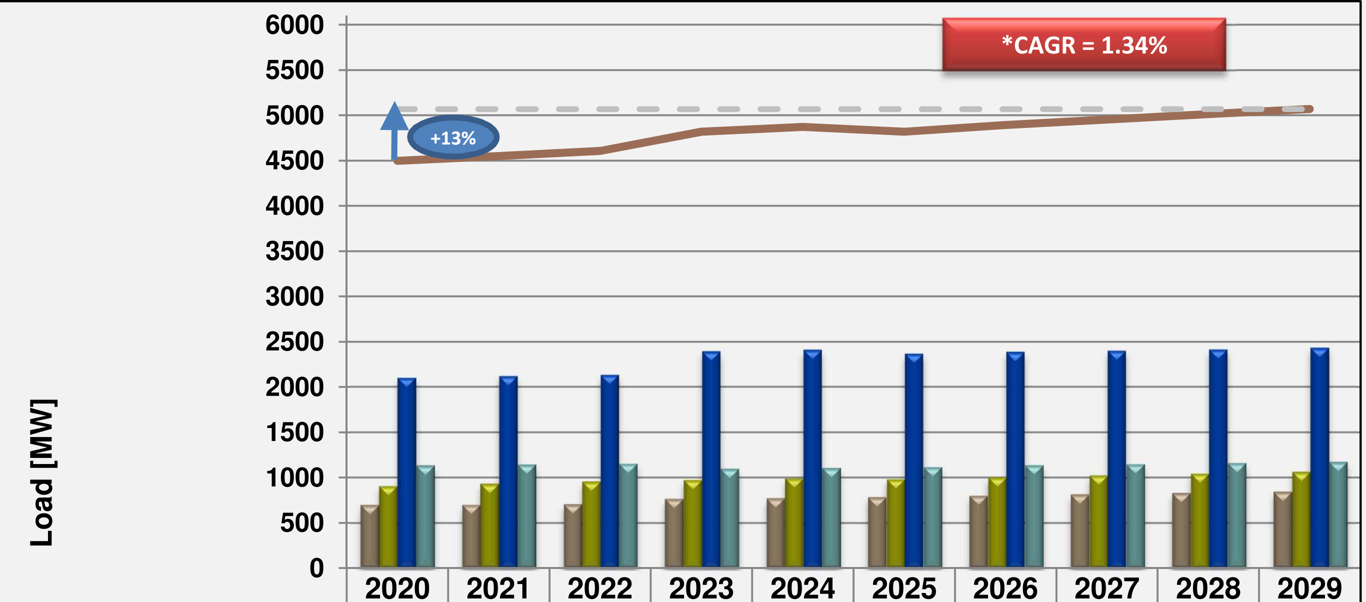
- Tutuka 400 kV
- Alpha 400 kV
- Majuba 400 kV
- Matla 275 kV, as well as FCLR's

Highveld South Reinforcement Phase 1:

Sol MTS FCLR and Equipment Replacement

Sol Substation FCLR's in series with existing 400/132 kV transformers

Replacement of all underrated equipment at Sol Substation.



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Middelburg	697	701	705	763	772	781	800	814	829	841
Lowveld	906	930	954	971	990	982	1002	1024	1042	1060
Highveld South	2099	2116	2133	2390	2406	2367	2384	2397	2413	2429
Witbank	1132	1143	1155	1096	1105	1115	1134	1147	1161	1171
Provincial Peak	4496	4551	4607	4819	4871	4818	4893	4954	5015	5068
2029 Peak	5068	5068	5068	5068	5068	5068	5068	5068	5068	5068

Figure 6.6.3: Mpumalanga load forecast

6.6.8 MAJOR SCHEMES

The major TDP schemes planned 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 Vulcan and Rockdale unfirm transformations. The project is also integral to the line deviation projects planned by Eskom Distribution, related to undermining and burning grounds. The project will comprise of 2 x 500 MVA transformers and turn-ins from the existing Arnot-Vulcan 400 kV line. This project is currently in the execution phase but is facing servitude challenges. The project scope of work has also grown to include the Emkhiweni-Silimela 400 kV line as the Silimela integration project in Limpopo is at an advanced stage, and is expected to be completed before the Emkhiweni integration.

Wonderkrag (Sol B) 400/132 kV Integration

This scheme entails the establishment the new Wonderkrag 400/132 kV Substation which is required to address the unfirm transformation and fault level exceedance at Sol Substation. The substation will be comprised of 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

This project has been delayed for longer than expected as the servitude challenges include an expropriation process.

6.6.9 PLANNED PROJECTS

The following projects are planned for the period 2019 to 2029:

Table 6.6.3: Mpumalanga – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Emkhiweni 400 kV Integration(Highveld North-West and Lowveld North Reinforcement – Phase 1)	Turn in Kendal-Arnot 400 kV line into Emkhiweni 400/132 kV Substation	2024
	Emkhiweni 400/132 kV Substation	
	Emkhiweni-Silimela 400 kV line	
Wonderkrag 400 kV Integration(Highveld South Reinforcement Phase 3)	New Wonderkrag 400/132 kV Substation	2024
	Turn in Kriel-Zeus 400 kV line into Wonderkrag Substation	
	Turn in Kriel-Tutuka 400 kV line into Wonderkrag Substation	
Khanyisa Power Station Integration	Benella 400 kV switching station	2025
	Turn in Duvha-Apollo 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)	2025
Marathon 400 kV Integration(Lowveld Strengthening Phase 2B)	Gumeni-Marathon 400 kV line	2026
	Marathon 400/132 kV Substation	
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 FCLR's	2024

6.6.10 PROVINCIAL SUMMARY

A summary of all projects and scheme planned for this province is provided in Table 6.6.4.

Table 6.6.4: Cumulative TDP Transmission assets for Mpumalanga Province.

Transmission Assets	New Assets expected in 2020 - 2024	New Assets expected in 2025 - 2029	Total New Assets
Power lines (km)			
765 kV	-	-	-
400 kV	551	237	788
<=275 kV	-	-	-
Total length (km)	551	237	788
Transformers			
Number of units	6	6	12
Total capacity (MVA)	2 750	2 630	5 380
Capacitors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-
Reactors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-

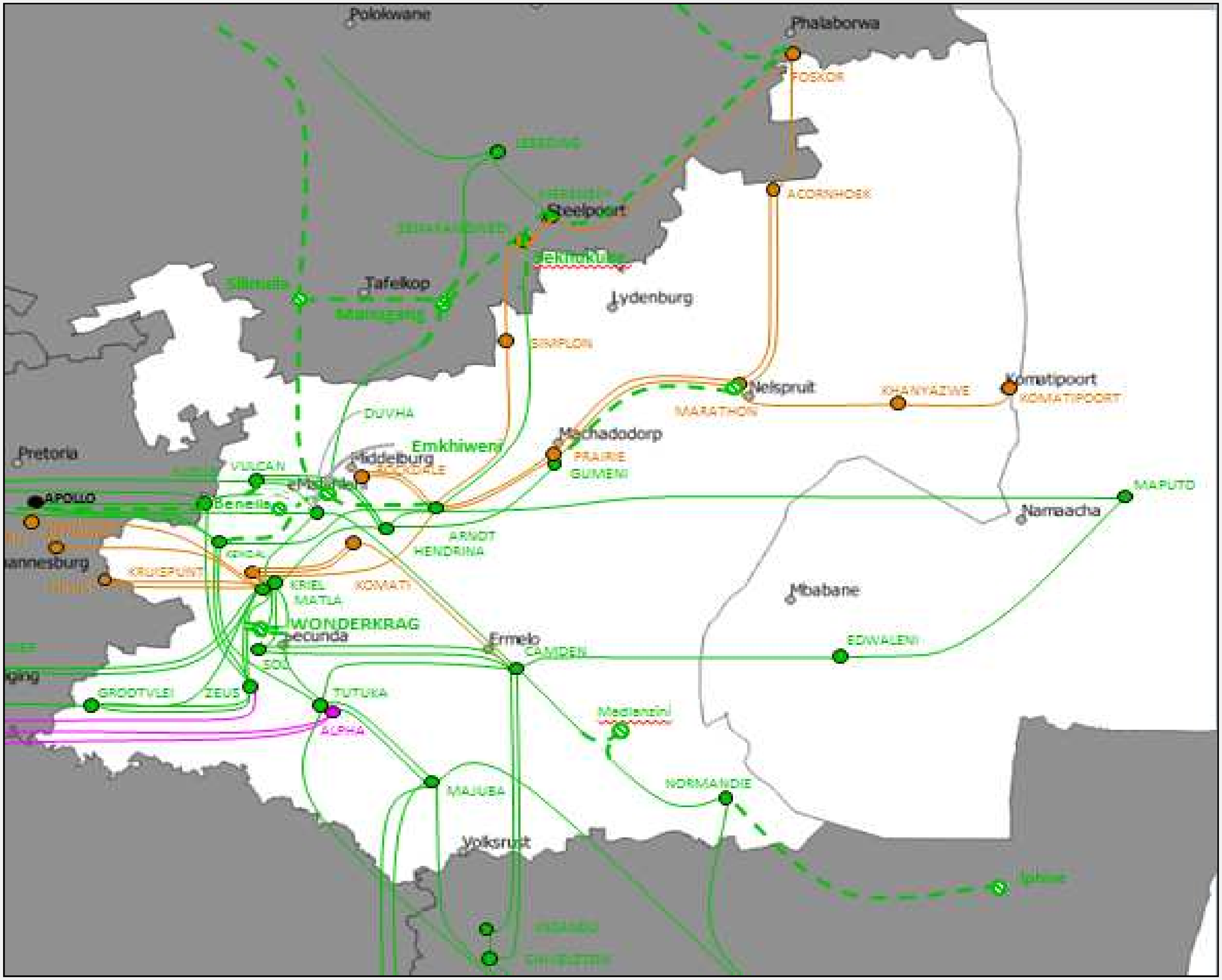


Figure 6.6.4: Future Mpumalanga network diagram

6.7 NORTHERN CAPE

6.7.1 INTRODUCTION

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

The provincial load peaked at around 1 100 MW over the last year and it is expected to increase to about 1 582 MW by 2029. The Northern Cape Province comprises three CLNs, namely Kimberley, Karoo and Namaqualand. Kimberley CLN is the main load centre in the province, consuming approximately 60 % of the load. The Karoo and Namaqualand CLNs make up the remaining 40 % of the demand in the province. Kimberley, traditionally supplied by means of the 275 kV network at Ferrum, has now been further strengthened by the 400 kV Aries-Nieuwehoop-Ferrum 400 kV integration. Namaqualand is supplied by a radial 275 kV network, which is supported by the 400 kV backbone from Aries. The traditionally weak radial Transmission network, forecasted demand as well as the high potential for the development of generation from Renewable Energy Sources (RES) makes the Northern Cape a key centre for network development activities within this planning horizon. The current Transmission network is shown in Figure 6.7.1.

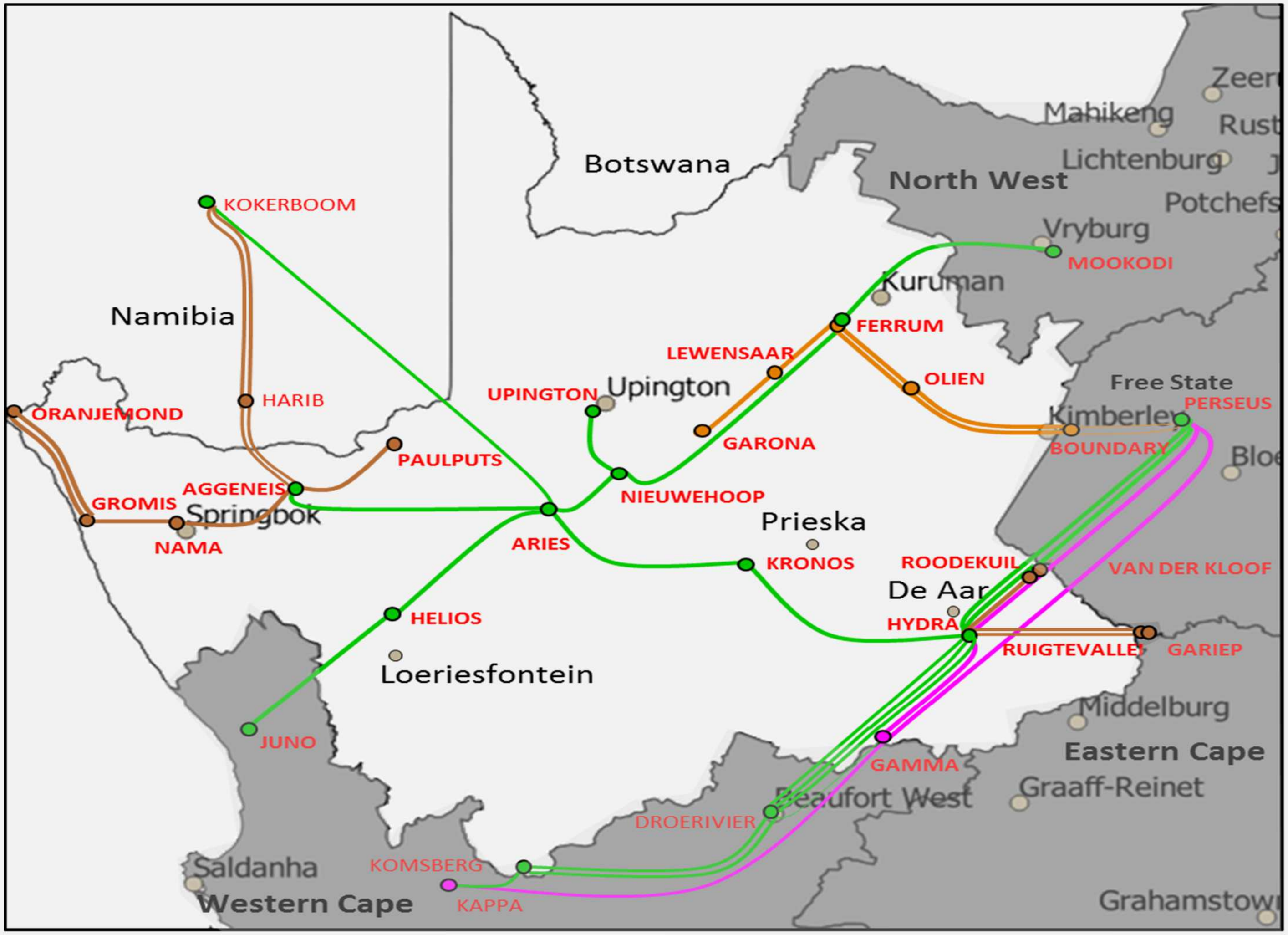


Figure 6.7.1: Current Northern Cape Province network diagram

6.7.2 GENERATION

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

6.7.3 RENEWABLE GENERATION INTEGRATION

The REIPPPP has provided a platform for the private sector to invest into RE that would be connected to the South African power grid. The Northern Cape climate has made it a popular province for RE 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, around 3 561 MW of RE plants have been connected or are committed for integration with the power grid from Rounds 1 to 4B of which there is approximately 42% PV, 41% wind and 17% CSP. A summary of the approved projects in the Northern Cape under the REIPP programme are indicated in Table 6.7.1

Table 6.7.1: Approved projects under the REIPPP Programme in the Northern Cape

Programme	CSP	Wind	PV	Hydro	Grand Total
RE IPP 1	150	73	462		685
RE IPP 2	50		270	10	330
RE IPP 3	200	591	225		1016
RE IPP 3.5	200				200
RE IPP 4		280	415		695
RE IPP 4B		514	130		644
Grand Total	**600**	**1457**	**1501**	**10**	**3569**

6.7.4 THE LOAD FORECAST

The load forecast for the Northern Cape is shown in Figure 6.7.2. The load forecast confirms that the Kimberly CLN is the main load centre in the province. The anticipated manganese and iron ore mining in the Kimberley area as well as possible smelter operations associated with these mines explains the increase in 2026. The forecast for the remaining CLNs show s a natural load growth.

6.7.5 REACTIVE POWER COMPENSATION

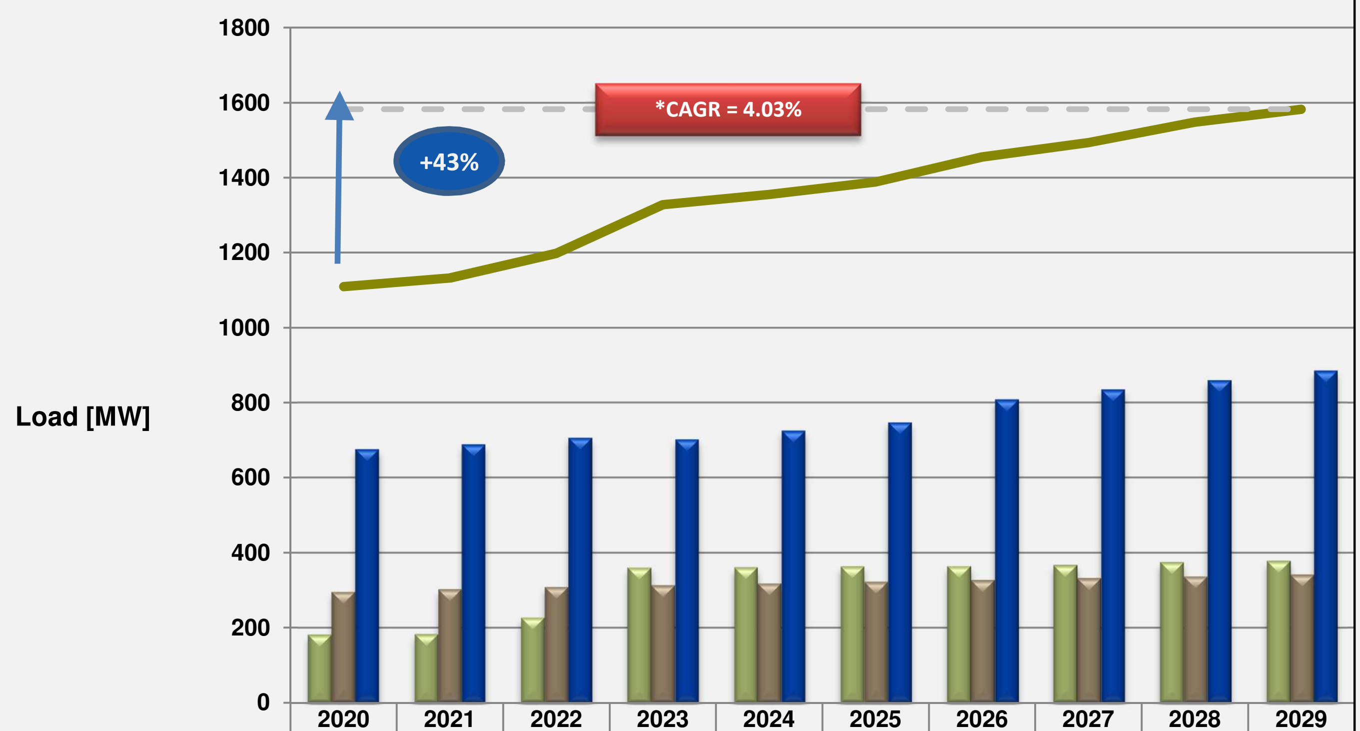
Additional reactive compensation devices will be installed at Aries Substation as part of the Northern Cape reinforcement projects. The following devices are proposed in the Northern Cape within the current TDP period:

- Aries 400 kV dynamic device (+250 MVAr; -150 MVAr)

6.7.6 NEW SUBSTATIONS

The following new substation is planned in the Northern Cape for the current TDP period:

- Groeipunt 220/132kV Substation (IPP)



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Namaqualand	181	183	227	360	361	363	364	366	375	378
Karoo	296	303	309	313	318	322	327	332	337	341
Kimberley	676	688	706	702	725	747	808	834	859	885
Provincial Peak	1109	1132	1198	1328	1355	1389	1455	1494	1548	1582
2029 Peak	1582	1582	1582	1582	1582	1582	1582	1582	1582	1582

Figure 6.7.2: Northern Cape load forecast

6.7.7 MAJOR SCHEMES

The Northern Cape network requires strengthening to achieve system security and N-1 Grid Code compliance for the increasing demand as well as for the integration and evacuation of RE generation. 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, Gromis 400/220 kV transformation and the Gromis-Oranjemond 220 kV line (constructed at 400 kV). The Gromis-Oranjemund 220 kV line has been completed and energised in 2018.

Aggeneis - Paulputs 2nd 220kV line

This project introduces the 2nd Aggeneis-Paulputs 220 kV line built at 400kV to meet the N-1 security standard for the Paulputs area.

Since the introduction of renewable generation within the Northern Cape, it was clear that the network will need to be strengthened to enable the integration and evacuation of renewable power out of the province to other parts of the country. The projects below have been proposed to achieve this and will be optimally phased with due consideration to preferred bidders, network requirements and available resources.

Groeipunt 220/132 kV MTS

This project entails the establishment of a new 220/132 kV Substation about 10 km from Nama Substation for the evacuation of committed and future renewable generation in the vicinity.

Upington Strengthening

The integration includes the phased construction of two Upington – Aries 400 kV lines, an Upington-Ferrum 400 kV line and 400/132 kV 500 MVA transformation at Upington. The Upington- Nieuwehoop 400 kV line, along with the Aries- Nieuwehoop and Ferrum-Nieuwehoop 400 kV lines (Northern Cape Reinforcement), were completed in the latter part of 2018.

Hydra B 400/132 kV Substation

In the Karoo CLN, a new Hydra B 400/132 kV Substation is proposed within a 20 km radius of the existing Hydra MTS.

Hydra – Aries 2nd 400 kV Corridor

This project entails the construction of the second Hydra – Kronos – Aries 400 kV line which will serve as an evacuation corridor for the large concentration of RE in the province.

Gromis - Nama - Aggeneis 400 kV line

The proposed project entails the construction of a 400 kV line from Gromis Substation to Nama Substation and from Nama Substation to Aggeneis Substation to evacuate the renewable generation within the Namaqualand CLN.

Nama and Gromis IPP transformation

These projects entail the introduction of 400/132 kV transformation at Nama and Gromis Substations.

Aries and Aggeneis IPP Strengthening

These projects entail the introduction of 400/132 kV transformation at Aries and Aggeneis substations.

Garona IPP Strengthening

The proposed project entails the introduction of 400kV at the existing Garona Substation by looping in and out of the newly built Nieuwehoop-Ferrum 400kV line.

Helios IPP Strengthening

The installation of the 2nd 500MVA 400/132kV transformer at Helios Substation.

Paulputs 3rd 220/132 kV transformer The installation of the 3rd 220/132kV transformer at Paulputs Substation.

Kronos IPP Transformation

The phased installation of additional 400/132 kV transformers at Kronos.

Gamma IPP Strengthening

The proposed project entails the establishment of 400/132 kV transformation at Gamma Substation by looping in and out of one of the Hydra – Droerivier 400 kV lines.

Korana 400/132 kV Substation

The proposed project entails the establishment of a new 400/132 kV Substation about 40 km from Aggeneis Substation by looping in and out of the Aries-Aggeneis 400 kV line. The second phase will be to establish a new Aries -Aggeneis 400 kV line.

Oranjemond IPP Strengthening

The proposed project entails the establishment of 400/132 kV transformation at Oranjemond Substation to allow for the integration of renewable generation in the vicinity.

6.7.8 PLANNED PROJECTS

The following projects are planned for the period 2019 to 2029.

A summary of all Eskom related reliability and strengthening projects planned in the Northern Cape is indicated in Table 6.7.2.

Table 6.7.2: Northern Cape summary of projects and timelines

TDP scheme	Project name	Expected CO year
Aggeneis – Paulputs 2nd 220 kV line	Aggeneis-Paulputs 2nd 220kV line (built at 400 kV)	2026
Northern Cape reinforcement	Aries Dynamic Device	2022
Namaqualand Strengthening	Juno-Gromis 1st 400 kV line - 2020	2023
	Gromis 400/220 kV transformation	
Northern Cape Voltage Unbalance	Northern Cape Line Transposition	2023
Northern Cape Transformation	Helios 1 x 20MVA 132/66 kV transformer	2023
Western & Northern Cape Series Caps decommissioning	Decommission Hydra Series Cap	2022
Gariep Network Strengthening	Ruigtevallei - Hydra derate 220kV line to 132kV	2020
	Ruigtevallei 132 kV Feeder bay to Dreunberg	
Gariep Network Strengthening	Ruigtevallei - Hydra derate 220kV line to 132kV	2020
	Ruigtevallei 132 kV Feeder bay to Dreunberg	
Ruigtevallei MTS Transformation	Ruigtevallei 3rd 10MVA 132/66 kV transformer	2028
Hydra – Roodekuil Strengthening	Re-build Hydra – Roodekuil 132 kV line	2023
Oranjemond Shunt Cap	Decommission 15 MVAr 66 kV Shunt Cap	2021

6.7.9. PROVINCIAL SUMMARY

The increases in Transmission assets by the end of 2024, the end of 2029 as well as the cumulative total are shown in Table 6.7.3.

Table 6.7.3: Cumulative TDP Transmission assets for Northern Cape

Transmission Assets	New Assets expected in 2020 - 2024	New Assets expected in 2025 - 2029	Total New Assets
Power lines (km)			
765 kV	-	-	-
400 kV	281	804	1 085
<=275 kV	-	-	-
Total length (km)	281	804	1 085
Transformers			
Number of units	5	12	17
Total capacity (MVA)	1 560	5 750	7 310
Capacitors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-
Reactors			
Number of banks	-	3	3
Total capacity (Mvar)	-	360	360

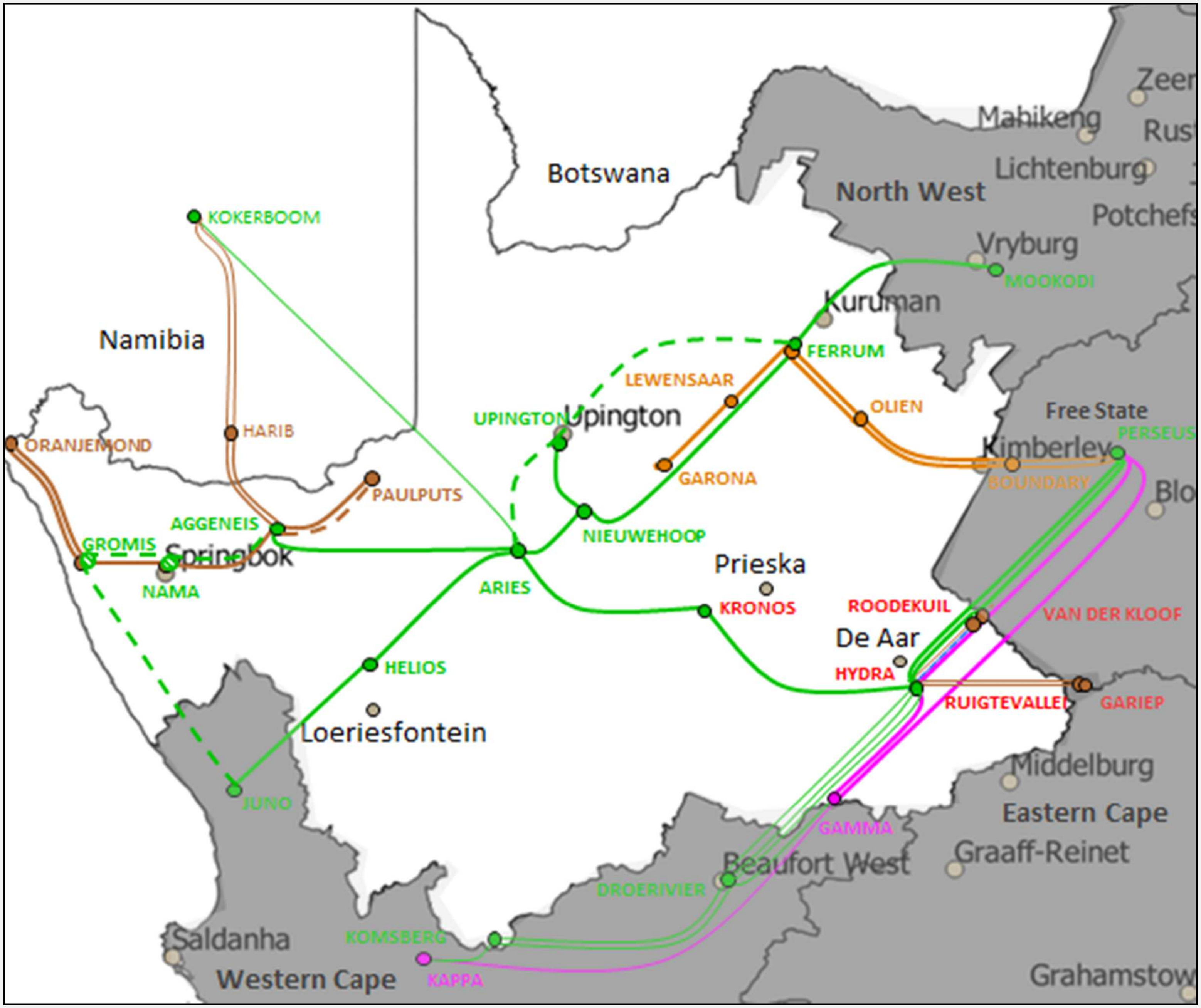


Figure 6.7.3: Future Northern Cape network diagram

6.8 NORTH WEST

6.8.1 INTRODUCTION

The 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 north-east and the east by Limpopo and Gauteng. Much of the province consists of flat areas of scattered trees and grassland.

North West is enriched with various mineral riches such as platinum group metals, dimensions stone, fertile and vast agriculture soil, a strong manufacturing sector and plentiful opportunities in renewable energy and agro-processing. The 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 Reserves, 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 Medupi power station will further enhance the major power corridors into Rustenburg and extend into the Carletonville CLN. The provincial load peaked at around 3 263 MW in the previous year. The load within the province is projected to increase to about 3 956 MW by 2029. The North West comprises of two CLNs, namely Rustenburg and Carletonville. Rustenburg CLN consumes approximately 66% of the load, with Carletonville CLN making up the remaining 34% of the demand in the province.

The current North West Transmission network is shown in Figure 6.8.1.

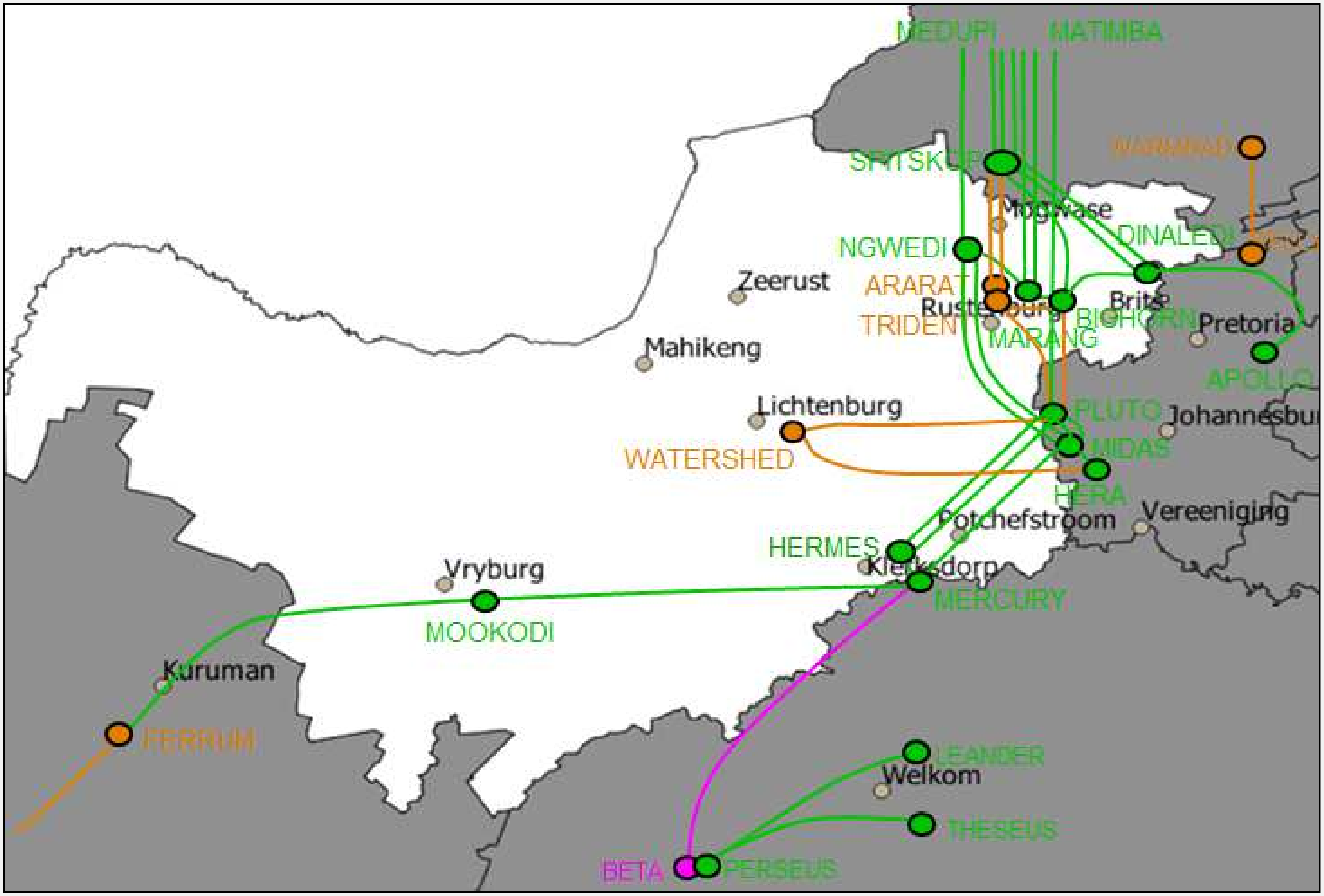


Figure 6.8.1: Current Free State network diagram

6.8.2 GENERATION

There are no power stations in the 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 complete integration of the Medupi power station and most of the power into the province will be supplied from Limpopo.

6.8.3 RENEWABLE GENERATION INTEGRATIONRENEWABLE

There are no major RE generation plants in the North West. As of 30 July 2019, only 7 MW of PV power generation plant has been integrated into the North West. There are four RE projects which were signed as part of the REIPPPP) Bid 4B. These projects will result in additional 268 MW of PV generation in the North West. Table 6.8.1 shows the approved projects in North West under REIPPPP Bid 4B.

There has been an interest in renewable generation mostly solar generation, particularly near Vryburg and neighboring towns, i.e., 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.

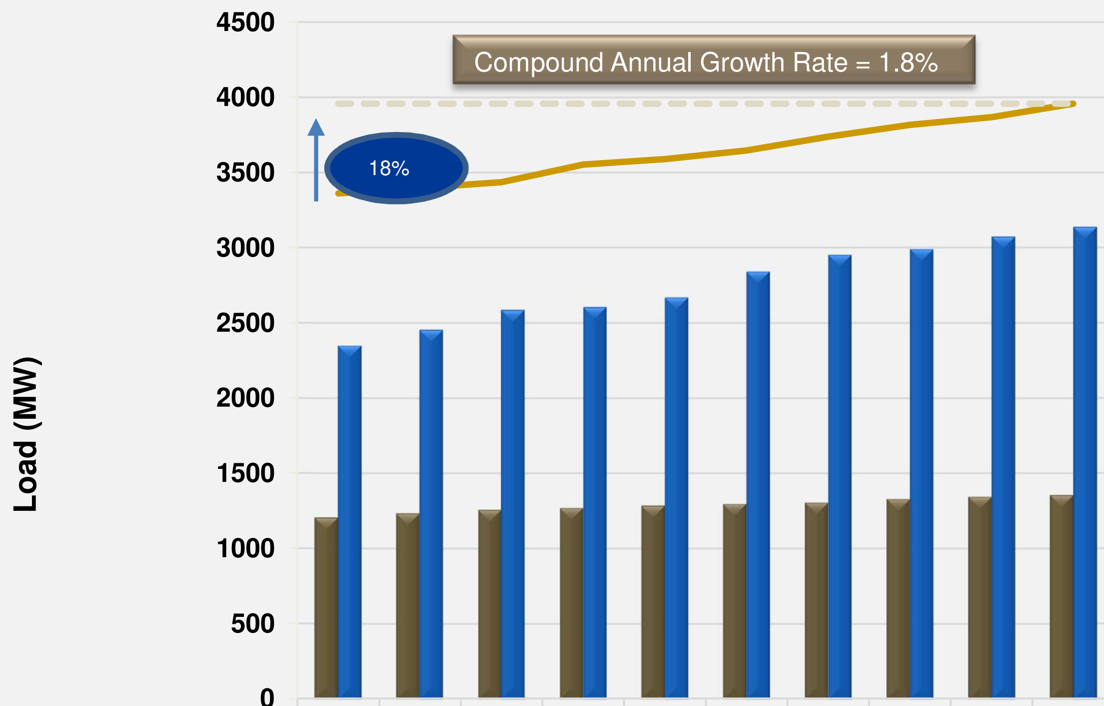
6.8.4 LOAD FORECAST

The backbone 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 the Sun City and the Lost City also contributes to the provincial economy.

The load in North West is forecasted to grow steadily at about 1.8%, from 3 360 MW in year 2020 to 3 956 MW by year 2029. The load forecast is shown in Figure 6.8.2.

Table 6.8.1: Approved REIPPPP bid 4B projects in the North West

Programme	PV	Grand Total
RE IPP 1	7	7
RE IPP 4B	268	268
Grand Total	**275**	**275**



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Carletonville CLN	1205	1233	1256	1269	1283	1296	1306	1328	1344	1355
Rustenburg CLN	2349	2453	2585	2605	2668	2841	2952	2990	3074	3137
Provincial Peak	3360	3396	3435	3552	3588	3646	3737	3816	3869	3956
2029 Peak	3956	3956	3956	3956	3956	3956	3956	3956	3956	3956

Figure 6.8.2: North West load forecast

6.8.5 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 banks)
- 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 132 kV shunt capacitor banks)

6.8.6 NEW SUBSTATIONS

Load growth in the Mahikeng area will necessitate the introduction of the following new Mahikeng 400/88 kV substation to create additional capacity for future load growth.

6.8.7 MAJOR SCHEMES

The major TDP schemes planned in North West are as follows:

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 2020 to 2029 period:

- Rustenburg Strengthening Phase 2
- Rustenburg Strengthening Phase 3
- Watershed Strengthening
- Watershed (Backbone) Strengthening Phase 3

Rustenburg Strengthening Phase 2

Rustenburg Strengthening Phase 2 refers to the extension of Marang Substation which will introduce a 132 kV voltage level at 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 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 which will also provide reactive power support to 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 1x30 MVar 88 kV and 2x30 MVar 132 kV shunt capacitor banks.

Watershed (Backbone) Strengthening Phase 3

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

The Transmission development plans for North West are shown in Table 6.8.3.

6.8.8 PLANNED PROJECTS

The following projects are planned for the period 2019 to 2029:

Table 6.8.2: 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	
Watershed (Backbone) Strengthening Phase 3	Pluto-Mahikeng 400 kV	2028
	Mahikeng 1st 315MVA 400/88 kV transformer	
	Mookodi-Mahikeng 400 kV	2030
	Mahikeng 2nd 315MVA 400/88 kV transformer	
Rustenburg Strengthening Phase 1	Bighorn 2 x 500 MVA 400/132 kV transformer	2028
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 72MVAr 132 kV Shunt Capacitors)	
Trident – Ararat 2 x 88kV lines capacity uprate	Trident – Ararat 2 x 88 kV lines capacity uprate	2023
Medupi Integration Phase 2A: Mogwase	Medupi-Ngwedi 1st 400 kV line	2019
	Medupi-Ngwedi 1st 765 kV line (Energised at 400 kV)	2020

6.8.9 PROVINCIAL SUMMARY

A summary of all projects and scheme planned for this province is provided in Table 6.8.3

Table 6.8.3: Cumulative TDP Transmission assets for North West

Transmission Assets	New Assets expected in 2020 - 2024	New Assets expected in 2025 - 2029	Total New Assets
Power lines (km)			
765 kV	-	-	-
400 kV	-	200	200
<=275 kV	-	-	-
Total length (km)	-	200	200
Transformers			
Number of units	1	3	5
Total capacity (MVA)	250	1 315	1 565
Capacitors			
Number of banks	3	13	16
Total capacity (Mvar)	90	744	834
Reactors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-

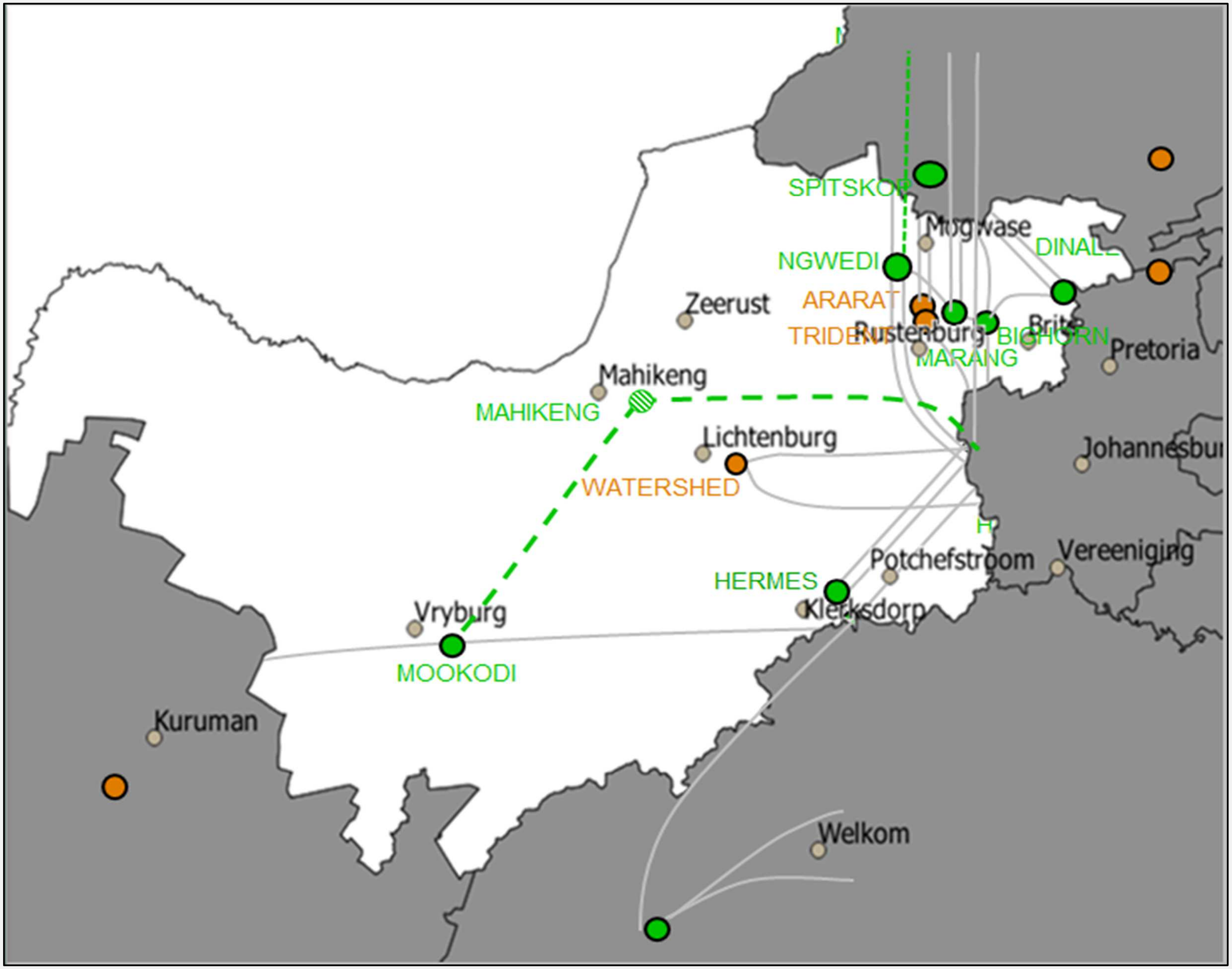


Figure 6.8.3: Future North West Transmission network diagram

6.9 WESTERN CAPE

6.9.1 INTRODUCTION

The Western Cape Province is situated in the south-western part of South Africa with Cape Town as its capital. The provincial economy is mainly driven by 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 renewable energy plants have been integrated into 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 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. The provincial load peaked at around 3 800 MW in 2018 and it is expected to increase to about 4 400 MW by 2029.

The Western Cape Transmission network consists mostly of 400 kV lines. It stretches over a distance of about 550 km from Gamma Substation (near Victoria West) to Philippi Substation (near Mitchells Plain). The current transmission network is shown in Figure 6.9.1.

Local strengthening is planned across the province, mainly comprising of 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. Further strengthening of the recently completed 765 kV Cape Corridor is also envisaged.

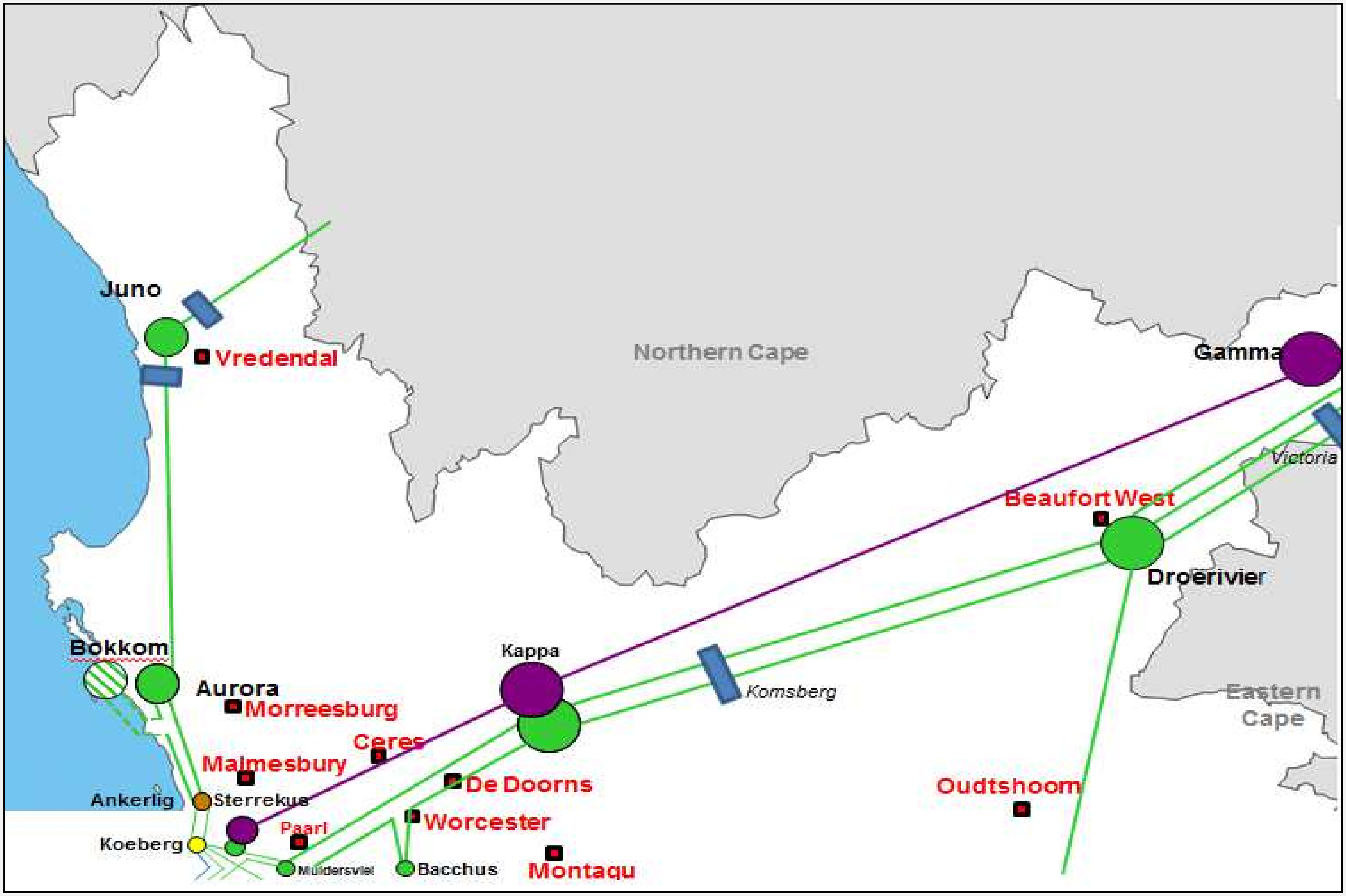


Figure 6.9.1: Current Western Cape network diagram

6.9.2 GENERATION

Koeberg Power Station is the only base-load power station situated locally in the Western Cape near Cape Town. 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 open-cycle gas turbine (OCGT) stations and Acacia gas turbine station. There are also three CoCT-owned peaking plants in Cape Town which help to manage the CoCT demand. These are Steenbras pumped-storage station and Athlone and Roggebaai gas turbine stations. The Western Cape has also benefited from renewable energy generation due to its climate and proximity to the coastal line.

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.

It has operated safely and efficiently for 30 years and has a further active life of about 20 years. Koeberg Power Station has a generating capacity of 1860 MW (sent-out). The 2 units are rated at 970 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 predominantly operates in synchronous condenser mode (SCO) to regulate the voltages in the area. In addition, it provides an off-site emergency supply to Koeberg Power Station as per the National Nuclear Regulator licensing requirement.

Ankerlig and Gourikwa Power Stations

The open-cycle gas turbines (OCGT) 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 closed-cycle gas turbines (CCGT). 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.

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.

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, 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 City of Cape Town (CoCT) generating facility. It consists of 4 x 45 MW units and is integrated into the CoCT network.

Athlone and Roggebaai power stations
Athlone and Roggebaai power stations are two gas turbine stations which 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
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 of 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 has decommissioned 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 (i.e. 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 Department of Energy 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.

6.9.3 RENEWABLE GENERATION INTEGRATIONRENEWABLE

The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) has resulted in over 1 000 MW of wind and PV generation being procured in the Western Cape.

Projects from Round 1 to 3 amounting to 450 MW are already in commercial operation.

The integration of the projects for Rounds 4 and 4B amounting to 558 MW will lead to additional Transmission infrastructure.

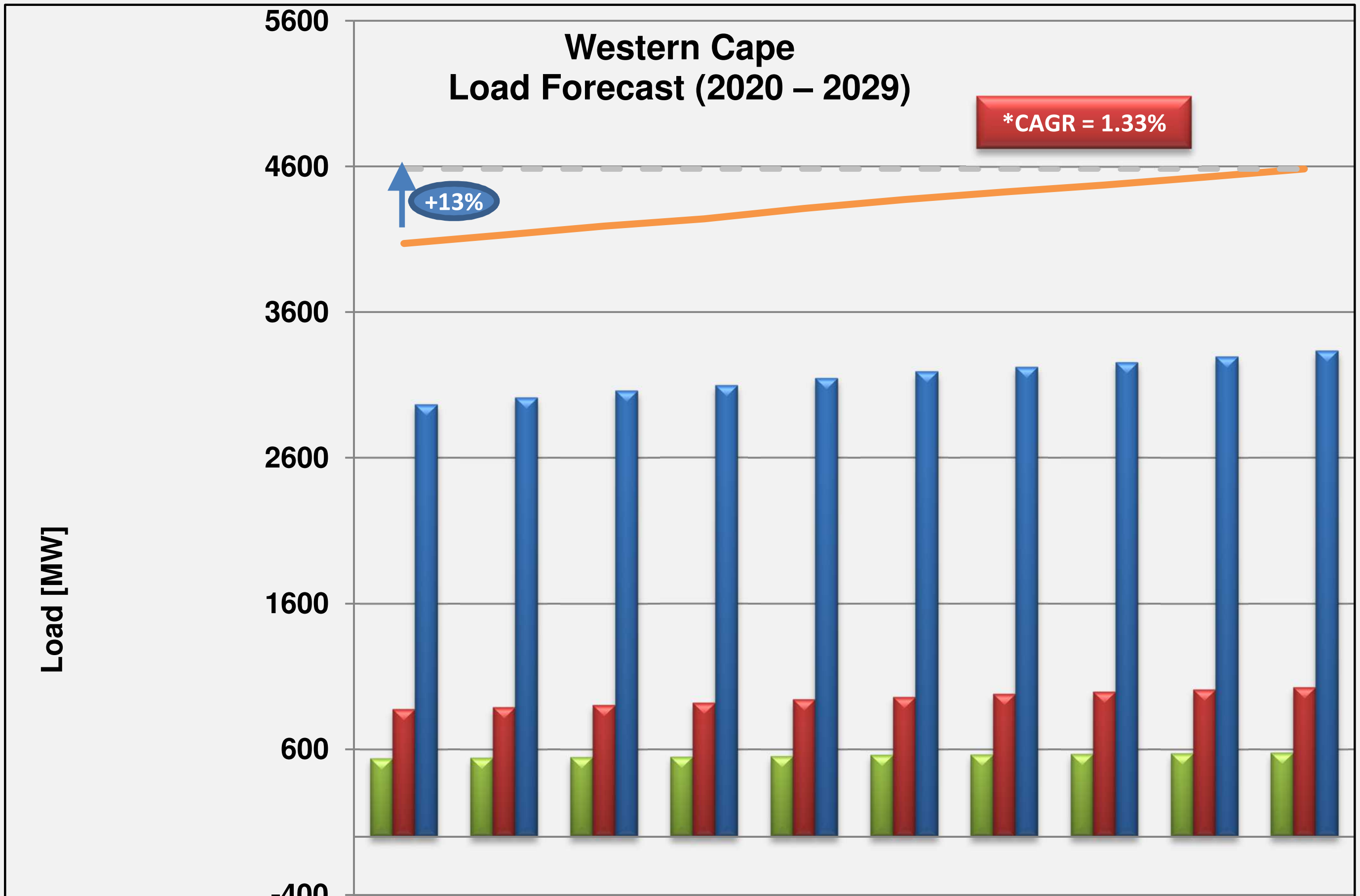
6.9.4 LOAD FORECAST

The Western Cape comprises of three Customer Load Networks (CLNs), namely Peninsula, Outeniqua and West Coast. The Peninsula CLN is the main load centre in the province, consuming approximately 67% of the load. Outeniqua and West Coast CLNs make up the remaining 33% of the demand in 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.

The load is forecasted to grow from ~4 070 MW in 2020 to ~4 600 MW in 2029. This translates to ~500 MW (13%) over the next 10 years with a compound annual growth rate (CAGR) of 1.3%. The load forecast is shown in Figure 6.9.2.



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
West Coast	539	543	547	550	554	562	565	568	573	578
Outeniqua	877	891	905	920	945	959	980	996	1011	1027
Peninsula	2968	3016	3062	3098	3148	3192	3224	3257	3296	3336
Provincial Peak	4070	4130	4190	4240	4312	4374	4424	4472	4527	4583
2029 Peak	4583	4583	4583	4583	4583	4583	4583	4583	4583	4583

Figure 6.9.2: Load forecast for the Western Cape

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:

In the Peninsula CLN, load growth 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

In the Outeniqua CLN, load growth 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 Industrial Development Zone (IDZ) in Saldanha; in order to support this development, the new Bokkom 400/132 kV Substation will be integrated in the West Coast CLN.

6.9.6 NEW LINES

The Ankerlig – Sterrekus double circuit 400 kV line which is currently in execution will provide for the required level of reliability to evacuate the total power in the Koeberg and Ankerlig generation pool especially under planned Transmission line maintenance in the area. The existing 2nd Koeberg – Acacia line which is currently operated at 132 kV must be energised at 400 kV, in order to achieve further reliability. This is expected to be commissioned when the Koeberg off-site supply is relocated to Ankerlig.

A strategic EIA has been initiated for a Gourikwa – Narina and Narina – Droërivier 400 kV line in order to ensure that servitudes are acquired timeously to cater for additional gas generation projects which may emanate in the Mossel Bay area as well as potential renewable generation projects towards Beaufort West.

All of the above projects will also allow for an increase in power output at the existing generating facilities.

6.9.7 REACTIVE POWER COMPENSATION

Additional 72 Mvar capacitor banks have been installed at Aurora and Bacchus substations in 2017 which formed part of the "Cape Corridor Shunt Capacitor Strengthening Project". There are no additional reactive power compensation projects planned for the Western Cape for the period 2020-2029.

6.9.8 MAJOR SCHEMES

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.

The Cape Corridor comprises of transmission lines originating from Zeus Substation (near Bethal) and 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 Muldersvlei Substation (near Klapmuts) and 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 released some capacity on 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 growth.

To further increase capacity on the corridor and to reduce reliance on the expensive OCGTs, the corridor has been strengthened with the first 765 kV line which was introduced over the last seven years, comprising of the following sections:

- 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

The completion of the Aries – Nieuwehoop and Nieuwehoop – Ferrum 400 kV lines in the Northern Cape have provided additional relief to corridor. Further relief will be brought about once the Juno – Gromis 400 kV line is completed and the Aries static Var compensator (SVC) is installed.

Some of the existing 400 kV series capacitor installations contain PCBs and an Eskom directive requires that these be removed from the system 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 by 2023.

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).

All of the above projects will result in the Cape Corridor adequacy until 2028. Beyond 2028, the preferred strengthening to provide additional transfers into the Greater Cape is the construction of a second 765 kV line.

6.9.9 PLANNED PROJECTS

The following projects are planned for the period 2020 to 2029:

Table 6.9.1: Western Cape – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Pinotage Substation	• Pinotage Substation (1st and 2nd 400/132 kV 500 MVA transformers) • Loop-in and out of Palmiet – Stikland 400 kV line	2020
Establish Koeberg off-site supply at Ankerlig Power Station	• Establish Koeberg off-site supply at Ankerlig Power Station • Loop-in and out of Koeberg – Dassenberg 132 kV line	2020
Komsberg Substation	• Komsberg 400/132 kV Substation (1st 400/132 kV 500 MVA transformer) • Loop-in and out Droërivier – Kappa 2 400 kV line	2020
Kappa Substation extension	• Kappa ext. 400/132 kV (1st 400/132 kV 500 MVA transformer)	2020
Ankerlig-Sterrekus 1st and 2nd 400 kV lines	• Ankerlig – Sterrekus 1st and 2nd 400 kV lines	2020
PCB phase-out plan	• Decommission Helios series capacitor	2019
Koeberg 400 kV busbar reconfiguration and transformers upgrade	• Koeberg 400 kV GIS busbar • Replace 2 x 250 MVA 400/132 kV transformers with new 250 MVA units • Koeberg 400 kV lines rerouting to the new busbar	2024
Juno Substation transformation upgrade	• Replace the 2 x 40 MVA 132/66 kV units with 2 x 80 MVA units • Install an additional 20 MVA 66/22 kV unit with the existing 10 MVA unit.	2024
2nd Koeberg-Acacia 400 kV line	• 2nd Koeberg – Acacia 400 kV line	2022
Erica Substation	• Erica Substation (1st and 2nd 400/132 kV 500 MVA transformers) • Philippi – Erica 400 kV line	2026
	• Loop-in and out Pinotage – Stikland 400 kV line	2027
Philippi Substation extension (Phase 1)	• Establish 400 kV busbar • Install 3rd 400/132 kV 500 MVA transformer as a hot-standby	2023

TDP scheme	Project name	Expected CO year
Agulhas Substation	• Agulhas Substation (1st and 2nd 400/132 kV 500 MVA transformers) • Loop-in and out Bacchus – Proteus 400 kV line • Bypass Bacchus series capacitor bank	2026
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.	2024
	• 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.	2026
Saldanha Bay Network Strengthening (Phase 2)	• Bokkom Substation (1st and 2nd 400/132 kV 500 MVA transformers) • Loop-in Ankerlig – Aurora 1 400 kV line	Deferred
Asteria Substation	• Asteria Substation (1st and 2nd 400/132 kV 500 MVA transformers) • Loop-in and out Palmiet – Bacchus 400 kV line	2024
Narina Substation	• Narina Substation (1st and 2nd 400/132 kV 500 MVA transformers) • Loop-in and out Droërivier – Proteus 400 kV line • Relocate Proteus series capacitor bank to Narina	2028
PCB Phase-Out Plan	• Decommission Juno, Victoria and Hydra series capacitors	2022
Cape Corridor phase 4: 2nd Zeus-Sterrekus 765 kV line	• Zeus – Perseus 1st 765 kV line • Series compensation at Zeus and Perseus • Perseus – Gamma 2nd 765 kV line	Deferred
	• Gamma – Kappa 2nd 765 kV line	Deferred
	• Kappa – Sterrekus 2nd 765 kV line • Loop-in and out Koeberg – Stikland 400 kV line into Sterrekus • Sterrekus Substation 2nd 765/400 kV 2000 MVA transformer	Deferred
Droërivier-Narina-Gourikwa 400 kV line	• Droërivier – Narina – Gourikwa 400 kV line • Bypass series capacitor at Narina	Strategic EIA

6.9.10 PROVINCIAL SUMMARY

A summary of all new assets planned for this province is provided in Table 6.9.2.

Table 6.9.2: Cumulative TDP transmission assets for Western Cape Province

Transmission Assets	New Assets expected in 2020 - 2024	New Assets expected in 2025 - 2030	Total New Assets
Power lines (km)			
765 kV	-	-	-
400 kV	21	95	116
275 kV	-	-	-
Total length (km)	21	95	116
Transformers			
Number of units	2	5	7
Total capacity (MVA)	1 000	2 500	3 500
Capacitors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-
Reactors			
Number of banks	-	-	-
Total capacity (Mvar)	-	-	-

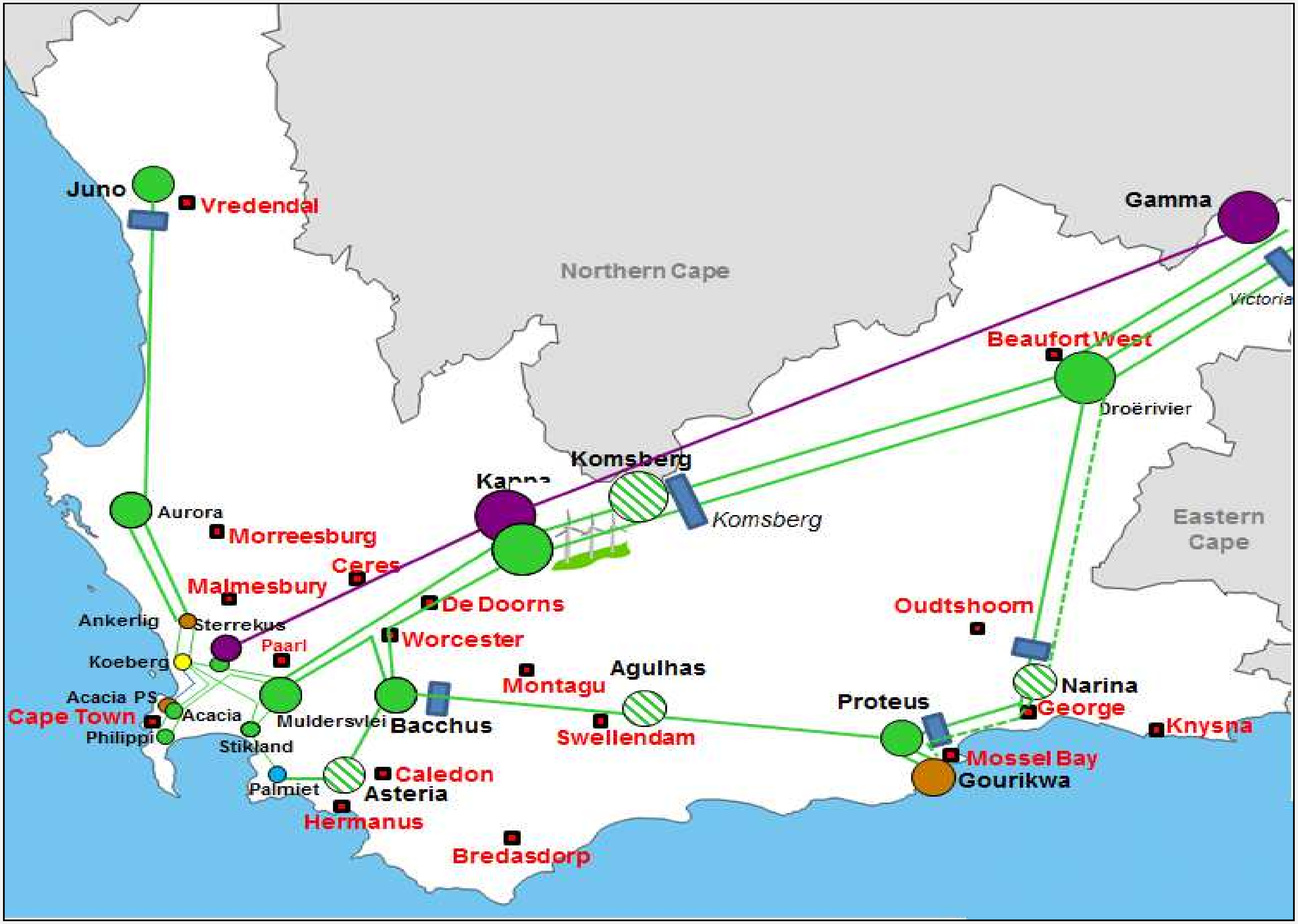


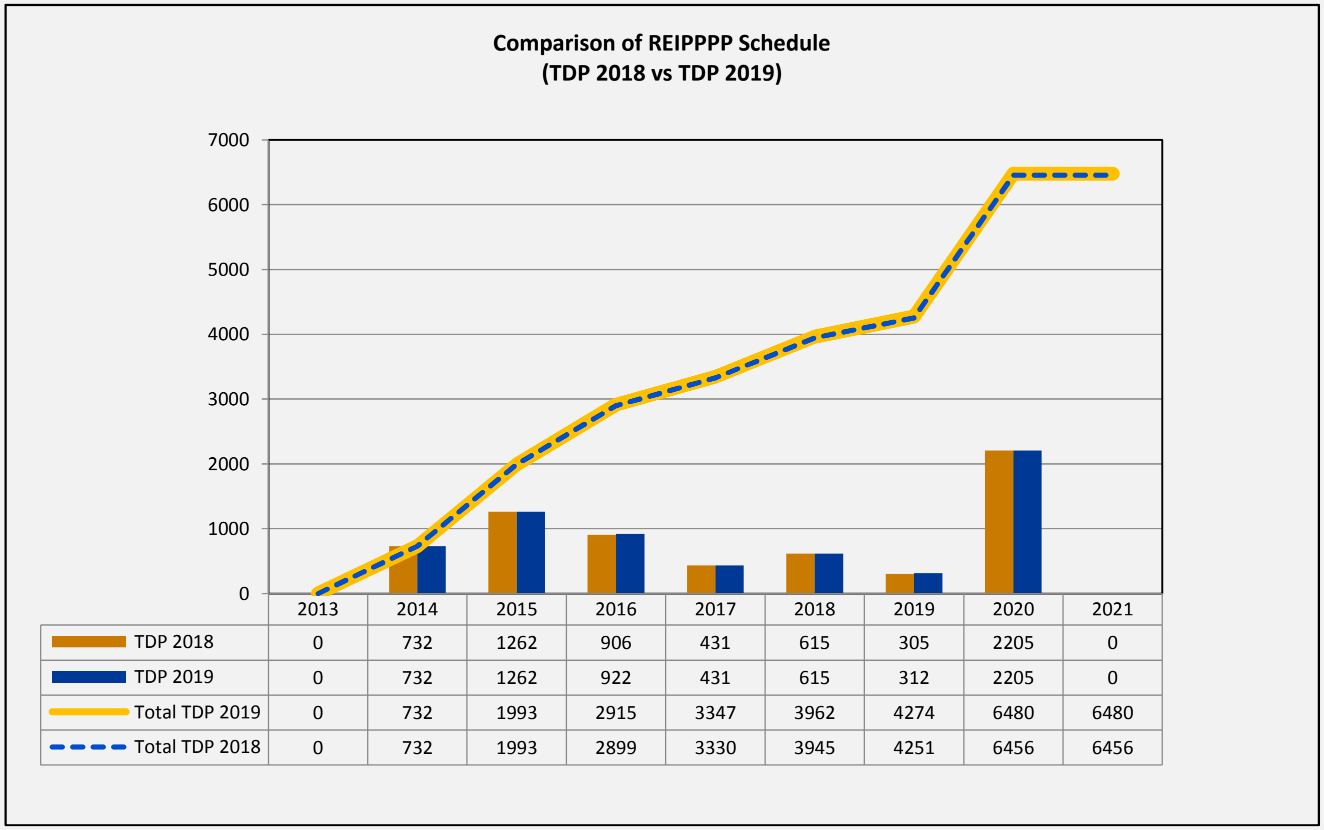
Figure 6.9.3: Future Western Cape Transmission network diagram

7.1 INTRODUCTION

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 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 Independent Power Producers through the following programmes:

- REIPPP
- Small Projects REIPPP
- Coal base-load IPP Procurement Programme
- The Cogeneration Independent Power Producers Procurement Programme
- Gas Independent Power Producers Programme
- The Solar Parks Project

The capacity comparison, by technology, of the approved REIPPPP rounds up to 4B is shown in Figure 7.1, there is no material difference between the previous TDP publication and the current in respect of the projected schedule for the integration of the approved REIPPPP.



	2013	2014	2015	2016	2017	2018	2019	2020	2021
TDP 2018	0	732	1262	906	431	615	305	2205	0
TDP 2019	0	732	1262	922	431	615	312	2205	0
Total TDP 2019	0	732	1993	2915	3347	3962	4274	6480	6480
Total TDP 2018	0	732	1993	2899	3330	3945	4251	6456	6456

Figure 7.1: Composition of REIPPPP Schedule

The outstanding connections (Round 4 and 4B) are now in execution phase, and expected to be commissioned between 2019 and 2021.

Changes from previous TDP Generation Assumptions

The allocations for conventional and RE capacities in the two different TDP's are contrasted in Figure 7.2, the allocations in the diagram is for the ten year period between 2020 and 2029 for TDP 2019 and between 2019 to 2028 for TDP 2018. It can be seen that the allocations were not that different if only the TDP window is considered. The allocation for TDP 2019 shows a slightly higher capacity for Conventional and RE, this is despite a lower load forecast and a higher decommissioning .

Renewable Generation

The differences between the Draft IRP 2018, previous TDP assumptions and these Assumptions for different Renewable technology types are illustrated in the next few diagrams. There is a high level of alignment between Draft IRP 2018 and the TDP2019 Assumptions Paper as expected. There is a divergence between the previous assumptions and the current assumptions. The allocation of renewable energy capacity at different substations was informed by potential at those substations informed by previous applications to connect capacity.

The TDP compares favorably with the draft IRP 2018 and 2018 TDP Assumptions. However, Gas has increased substantially from the previous TDP Assumptions. Further, no further CSP and Nuclear is anticipated in the period of study. The generation plan showing cumulative generation expansion as well as the decommissioning is shown in Figure 7.3.

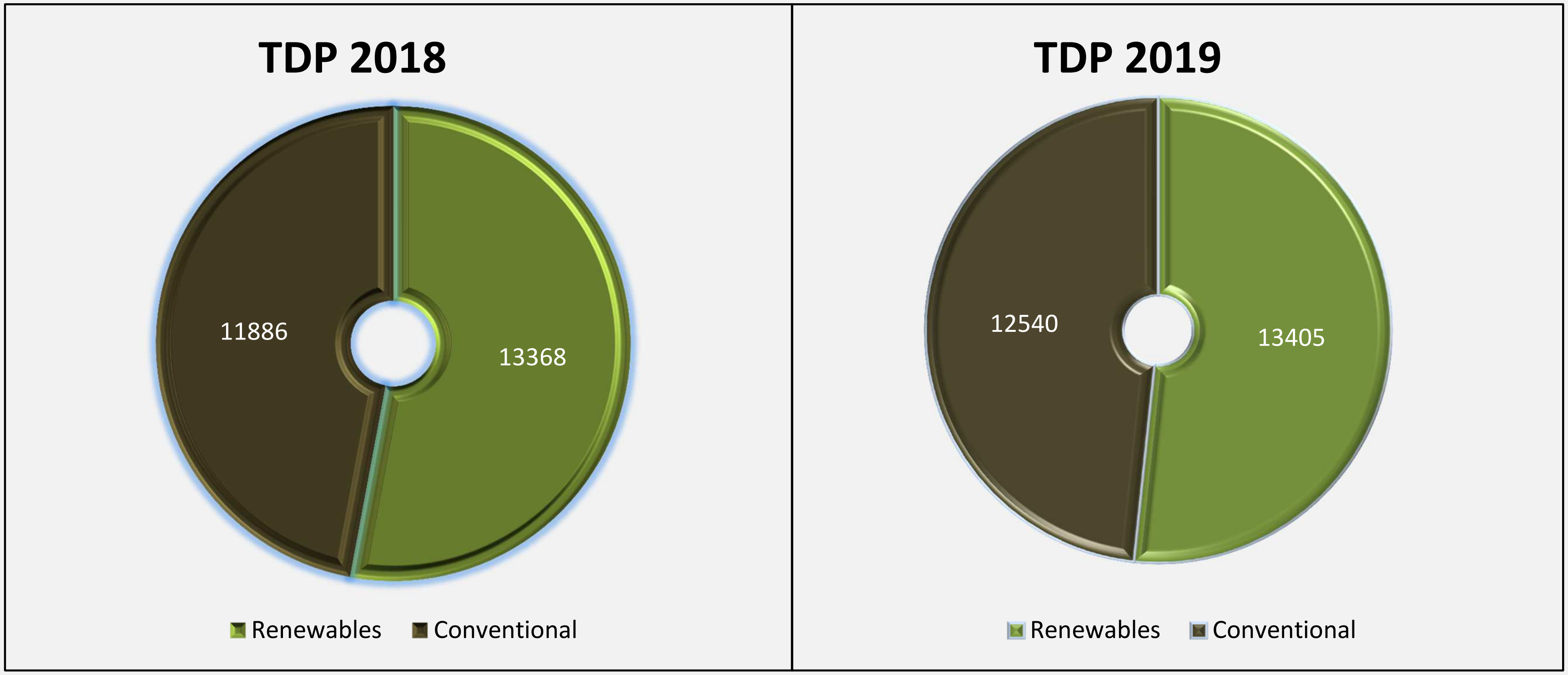


Figure 7.2: Composition of Generation Resources

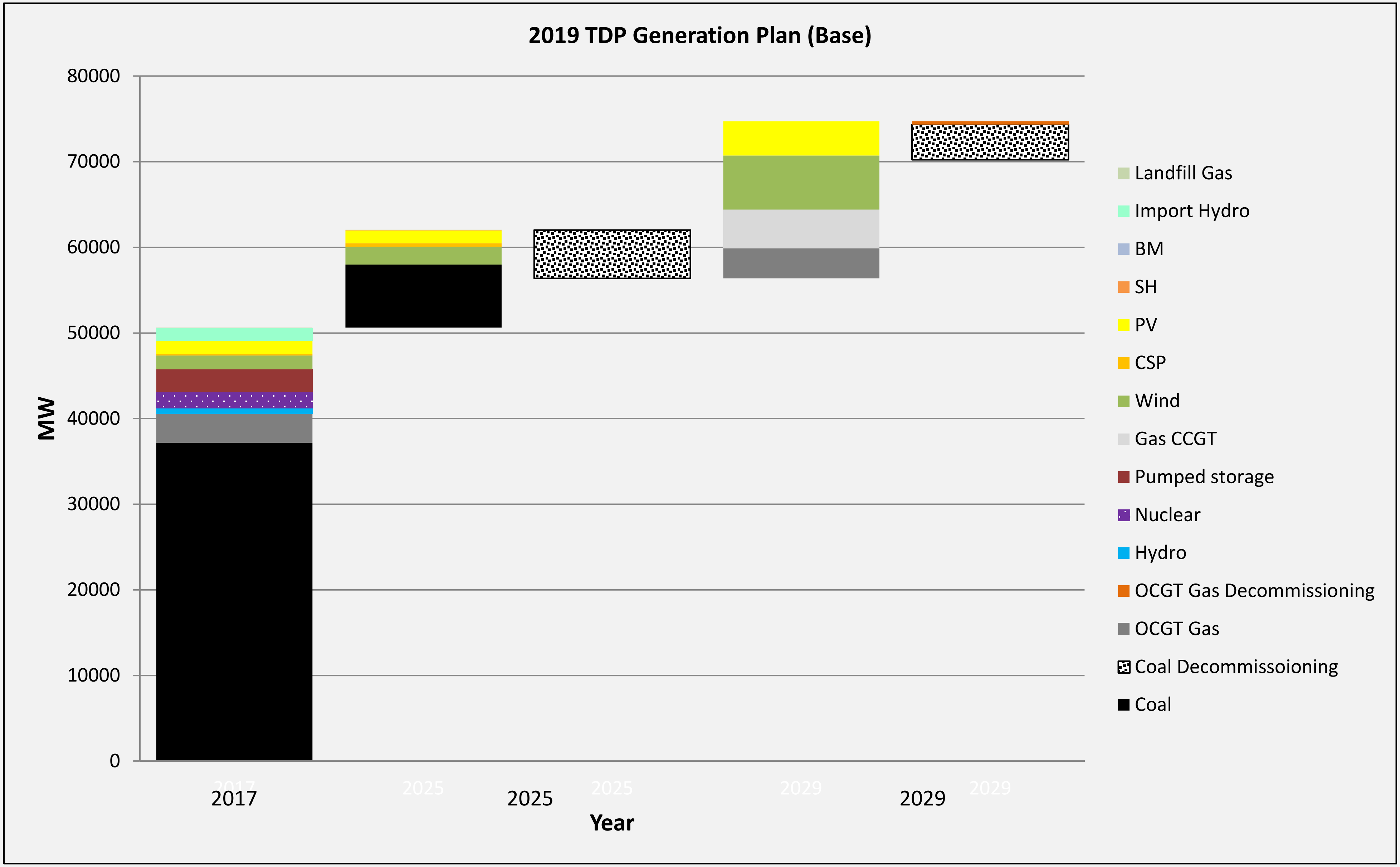


Figure 7.3: TDP 2019 Base Generation Plan

7.2 DEVELOPMENT PLANS TO ENABLE APPROVED IPPs

The DoE IPP programme has to date procured around 8 415 MW of energy from 120 IPP projects. Since 2011, 69 projects amounting to 5 241 MW have been commissioned. A total of 4 041 MW of these commissioned IPP projects are renewable energy based. This new generation capacity is vital in meeting the needs of the economy as well as the objectives of the IRP2010. The grid connection 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 27 preferred bidder projects in REIPPPP Bid windows 3.5, 4 and 4B are currently in the execution phase and are expected to be connected to the national grid between 2019 and 2021. Furthermore, the budget quotation process for the two preferred bidders for Coal Baseload IPP Procurement Programme, which have been allocated a total capacity of 863,5 MW is also in progress. These projects 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. An overview of the DoE IPP Programme to date, focusing of the approved projects in shown in Figure 7.4.

The Transmission network strengthening projects that are currently in execution for the purpose of completing connection of the approved REIPP projects in the bid windows 3.5, 4 and 4B are as follows:

- 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

Furthermore, the Transmission strengthening projects required for the connection of Coal Baseload programme projects have been developed, and will be implemented upon completion of the procurement process. These projects will enable the connection of:

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

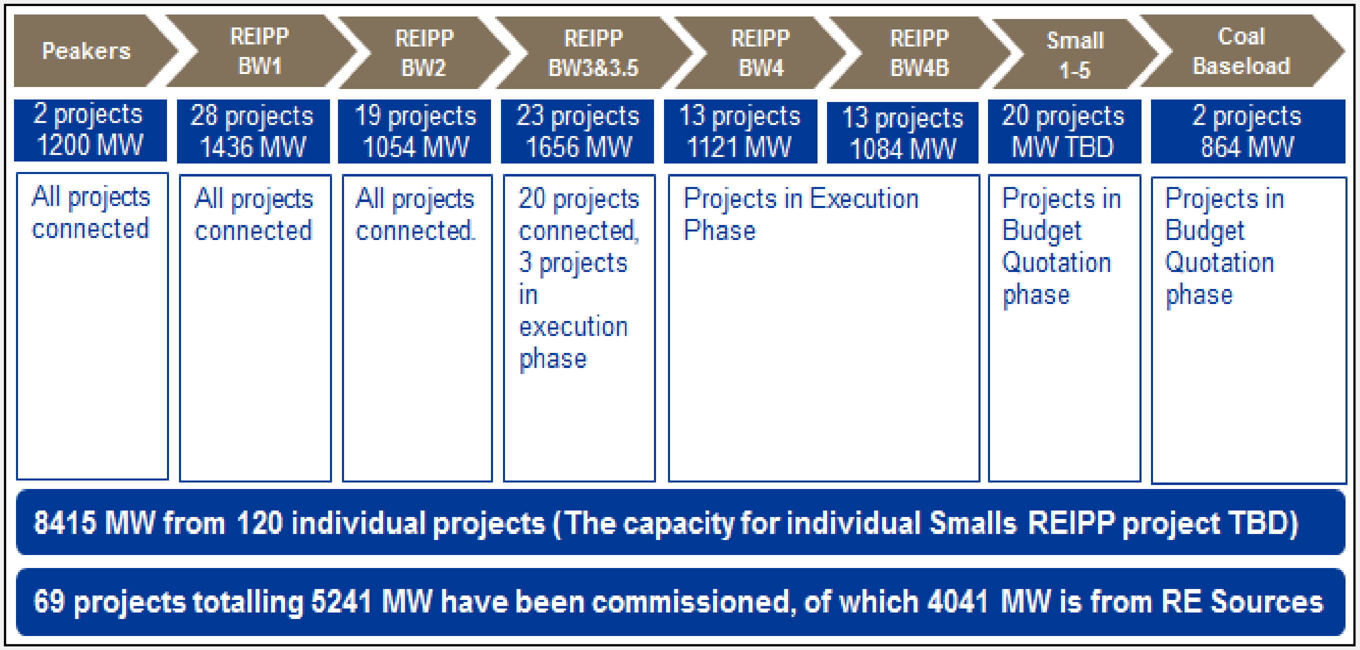


Figure 7.4: overview of the DoE IPP Programme

7.3 POTENTIAL LOCATIONS FOR FUTURE IPPs

Aa mentioned, 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 the North West, Free State and Limpopo Provinces, most of 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.

Further, the location of the approved renewable generation projects as well as the information on historical customer applications data played a key role in predicting the potential locations for future REIPP projects. It is expected that wind generation will be distributed between the Northern Cape, Eastern Cape and Western Cape, mainly in the areas in and around the towns of Springbok, Graaff-Reinet, Somerset East, Queenstown, Humansdorp, Cradock, Middelburg, DeAar, Beaufort West and Victoria West. Solar PV is expected to be spread across Northern Cape, Eastern Cape,Western Cape, Free State, North West and Limpopo Provinces. The Northern Cape is expected to remain the most dominant area of interest for renewable generation projects 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 into 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 2029.

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 2023 – 2029, as well as the key Transmission projects to enable post TDP grid connection access for IPPs.

7.4 DEVELOPMENTS PLANS TO ENABLE FUTURE IPPs

Eskom has committed Capital Costs to enable the integration of successful bidders (Bid Window 1-4B, including Small REIPPs) into the national grid. The Transmission strengthening projects associated with REIPP round 4-4B are currently in execution, and it is anticipated that the Transmission capacity to enable connection of future IPP will be severely constrained in some parts of the country, particularly in the Northern Cape.

The main limiting factor for the connection of future IPPs in the high interest areas will be the Transmission line capacity. This constraint is exacerbated by the long lead timelines for the construction of a Transmission line. Conversely, there are a number of substation projects that could potentially be developed within a relatively shorter period of time for future IPP integration, provided that the line corridor capacity permits the power evacuation. These together with the approved REIPP round 4 & 4B associated projects are shown in Figure 7.5.

The Transmission corridor enhancement projects for enabling connection of future IPPs have been identified in the TDP. The commissioning dates for these projects will be contingent upon the announcement of the preferred bidders for future IPP programmes.

The Transmission projects that are required for network reliability as well as to enable the connection of the projected IPPs into the Transmission network within the current TDP period are as follows:

- Aries -Upington line
- Aggeneis- Nama - Gromis line
- Aggeneis -Paulputs line
- Ferrum -Upington line

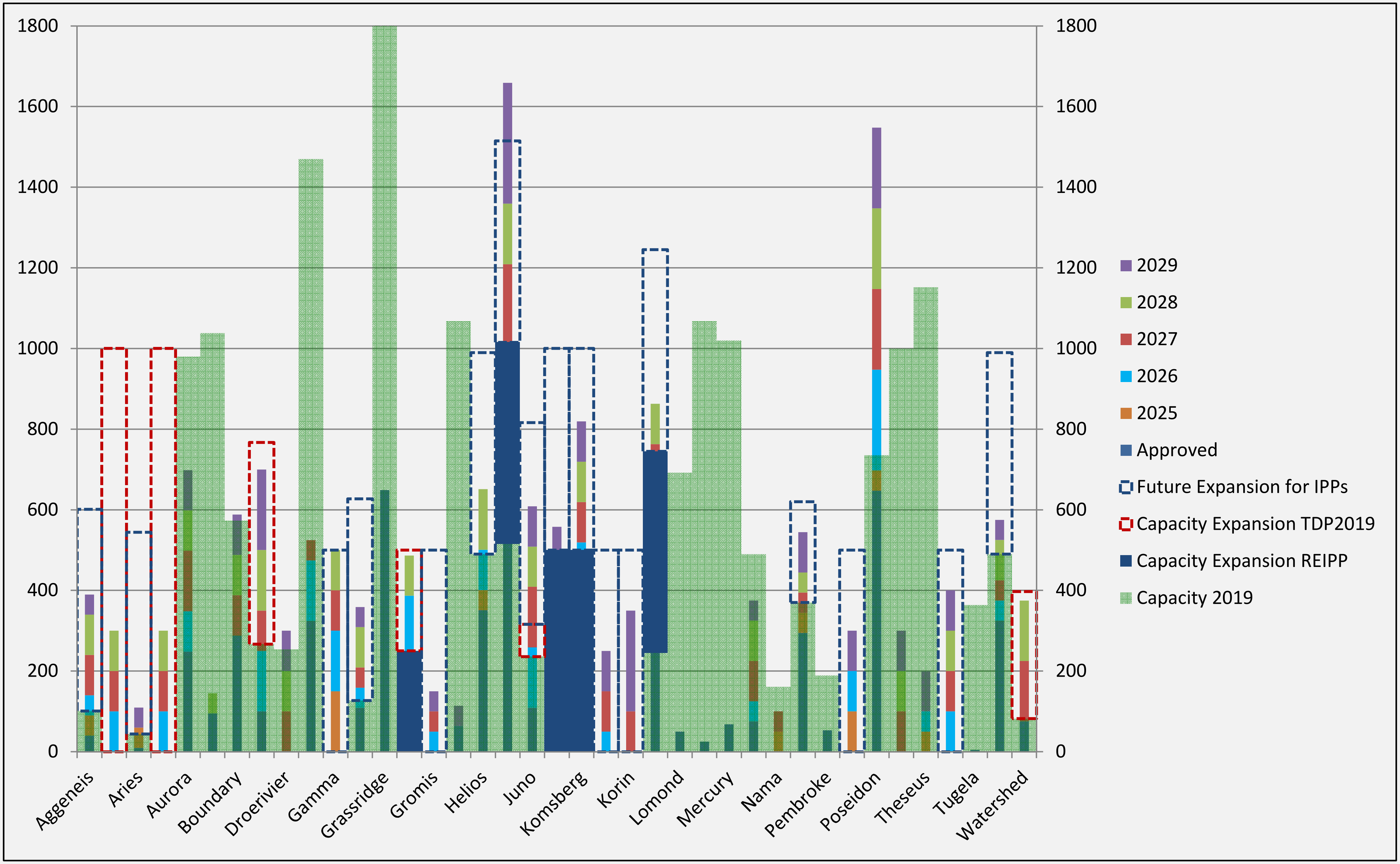


Figure 7.5: Transformer capacity enhancement for IPP integration- TDP 2020 - 2029

Furthermore, the following additional projects have been identified as critical Transmission projects that need to be investigated and developed within the current TDP period in order to make a success of future IPP programmes.

- Gamma – Grassridge line
- Grassridge – Thyspunt line

The TDP projects and proposed strategic projects that are beneficial to the DoE IPP programme are presented in Figure 7.6.

New Transmission substations located near the current Transmission infrastructure with sufficient corridor capacity could be developed in a relatively shorter period of time. This makes these type of projects favourable for the REIPP programme, as the commitment of capital investment for the infrastructure can only be made after the announcement of preferred bidders, leaving shorter window for project execution. The following were identified as potential sites for new Transmission substations required to enable connection of future IPPs in addition to the above Transmission lines:

- 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)
- Hydra B 400/132 kV new substation
- Poseidon 400/132 kV new Substation
- Dealesville 400/132 kV new Substation

These projects will only be developed in the event that the related IPP projects are announced as preferred bidders.

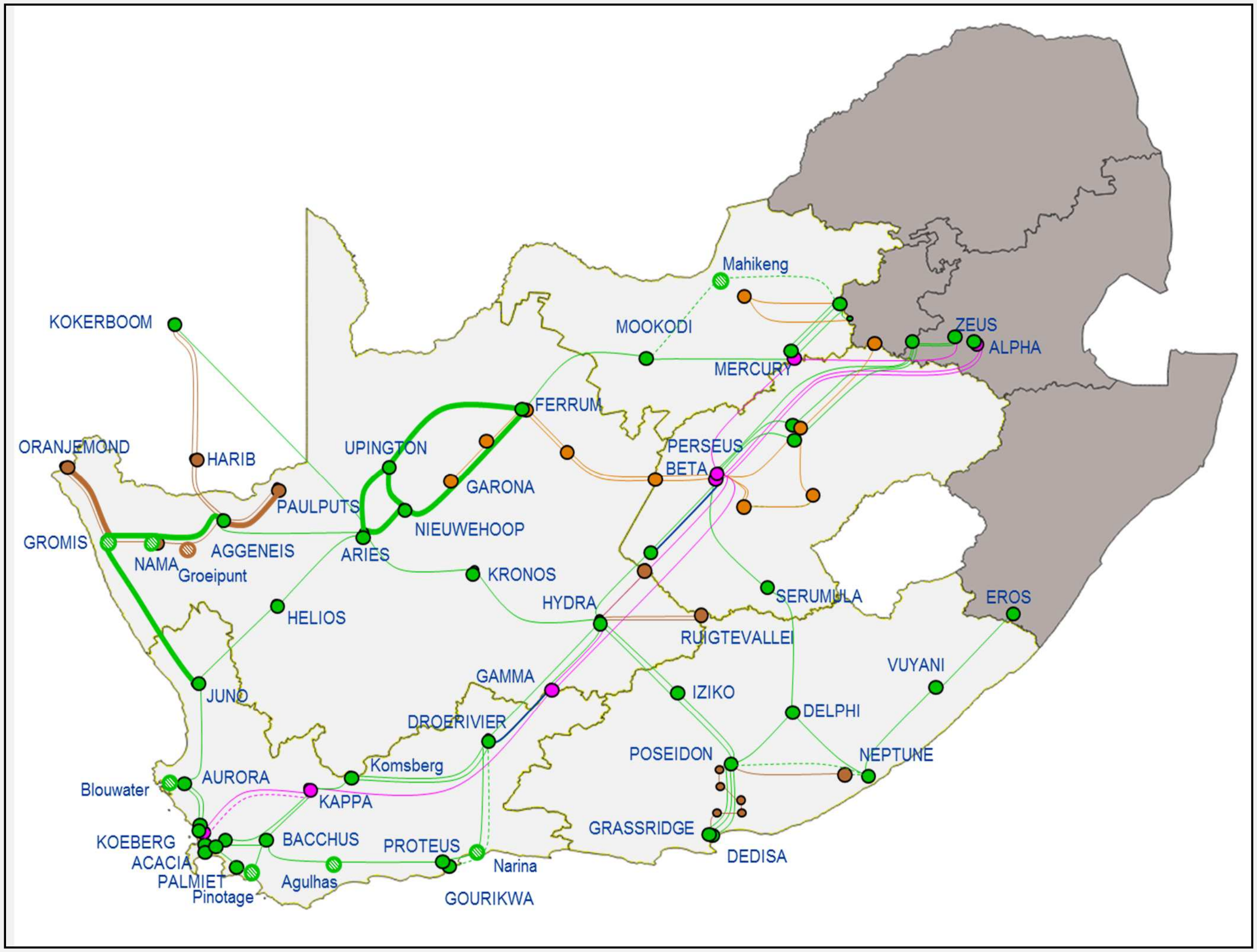


Figure 7.6: TDP projects for future IPPs

Transmission expansion plans for future OCGT and CCGT IPPs up to 2029

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. In addition to the current OCGT capacity of about 3414 MW, it is expected that additional 3 518 MW of OCGT and 4 523 of CCGT will be commissioned by 2029. It is also expected that 342 MW of generation from OCGT will be decommissioned within the period, which will result in the total generation capacity of 11112 MW of generation from Gas technology by 2019 as shown in Table 7.1.

Table 7.1: Cumulative Gas generation projection

Generation Technology	2017	2029
OCGT Gas	3414	3518
OCGT Gas decommissioning	0	-342
CCGT Gas	0	4523
Cumulative Total Generation (MW)	**3414**	**11112**

Gas generation to be commissioned within the current TDP period has been allocated to the Athene Substation near Richards Bay, the Dedisa Substation near Ngqura and the existing Ankerlig Power Station in Cape Town The Transmission network strengthening projects required to enable the connection of the additional OCGT and CCGT Port Elizabeth and Richards Bay are as follows:

Dedisa Substation extension

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

New 400 kV substation near Athene

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

7.5DEVELOPMENTS PLANS FOR ALTERNATIVE GENERATION SCENARIOS

As mentioned in Section 2, alternative scenarios were studied to stress-test robustness of the TDP, should the location and timing of the future generation differ from the base assumptions of this TDP. 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. Thus, no financial provision has been made for the Transmission infrastructure identified for the purpose of connecting alternative generation scenarios. However, a list of identified projects is used to identify the potential EIA and land requirements and the associated risk assessment.

The results of the network assessment based on the considered alternatives were as follows:

Limpopo PV Scenario

No additional Transmission network over and above the base TDP would be required cater for the Limpopo PV scenario.

Northern Cape wind scenario

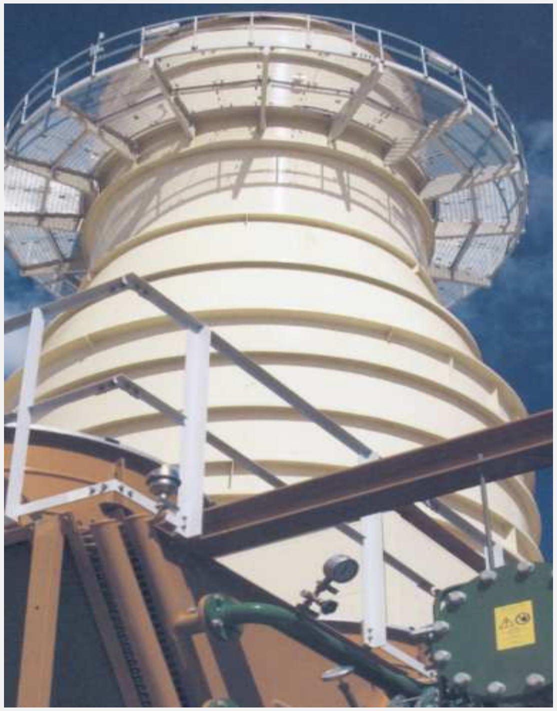
This scenario assumes that the Northern Cape Wind generation will be 1700 MW higher than the total base generation forecast in the Province.

The following additional Transmission network strengthening projects will be required to enable the evacuation of additional generation from Norther Cape at the TOSP:

- Aggeneis -Aries line
- Aries -Kronos -Hydra line
- Ferrum -Hotazel -Mookodi -Hermes line

High Decommissioning scenario

No additional Transmission network will be required in the TDP period in the event of high coal generation decommissioning schedule, namely 12.9 GW by the end of the TDP period instead of 10.2 GW.



7.6 TRANSMISSION EXPANSION PLANS FOR FUTURE IPPs BEYOND 2029

In accordance with the Draft 2018 IRP, additional power from RE sources will be connected to the national grid in the years beyond the current TDP period. Furthermore, it is anticipated that renewables will continues to be a critical part of the South African energy mix going forward. The location of the IPPs to be connected beyond the TDP period is expected to be distributed in line with the current TDP assumptions, which shows predominant penetration in the Northern Cape, Western Cape and Eastern Cape Provinces. The Free State and North West are also expected to account for the significant amount of the renewable generation to be commissioned during this period. The high level analysis of the Transmission network has demonstrated that the thermal constraints on some of the Transmission corridors in the Northern Cape and North West will emerge as leading constraint for successful integration of more REIPP beyond the current TDP period. The main objective of this exercise was to identify 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 400kV integration
- Upington -Ferrum 400 kV line
- Ferrum -Hotazel –Mookodi- Hermes line
- Aries-Hydra 400 kV corridor strengthening (via Kronos MTS)
- Beta-Ferrum 400 kV corridor strengthening

The network overview of the medium to long term Transmission expansion plans for the integration of IPPs is shown below in Figure 7.7.

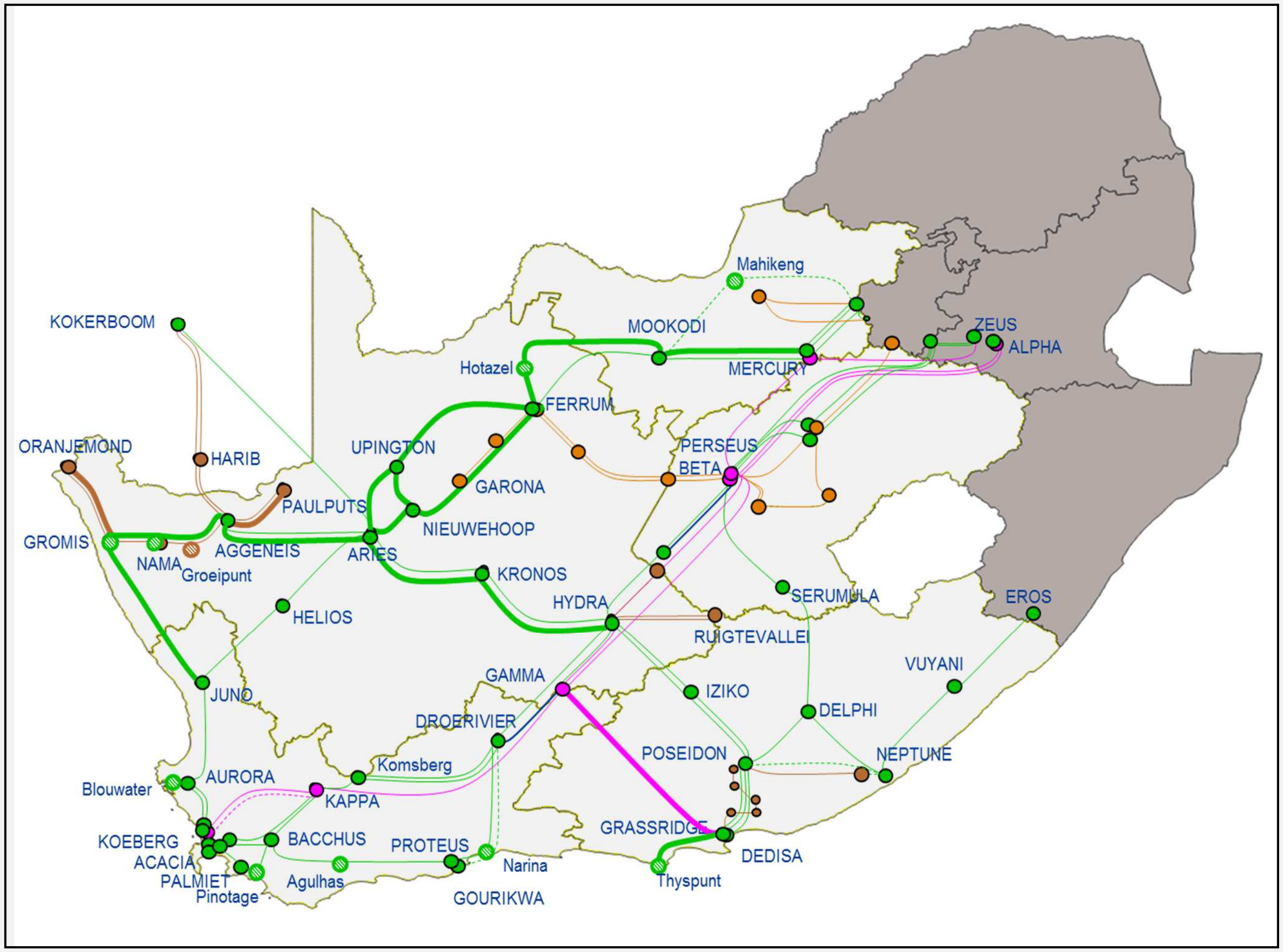


Figure 7.7: Medium to long term Transmission expansion plans for IPPs

8. CAPITAL EXPENDITURE

8.1 CAPITAL EXPENDITURE PLAN

The total capital expenditure for Transmission amounts to R 98.639 billion, and is summarised in Table 8.1. It is clear that the majority of the cost will be related to expansion, 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 for FY2020 to FY2029

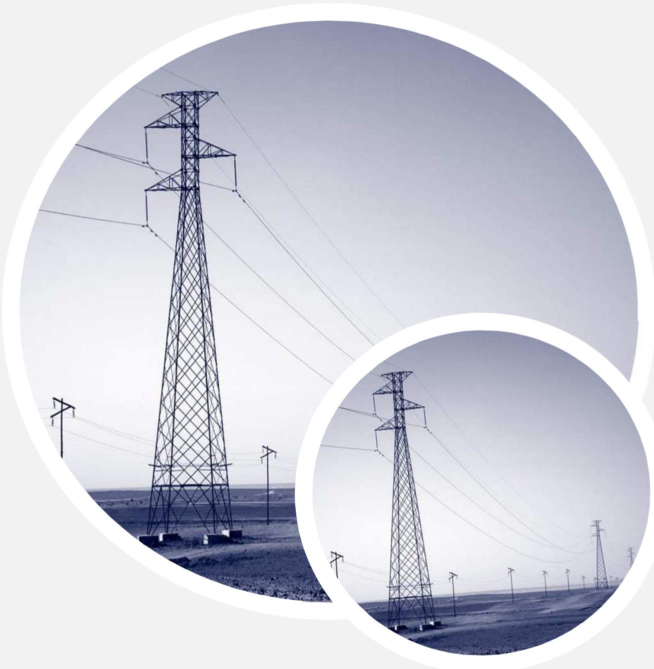
Categories	Rand (billions)
Capital expansion	78.878
Refurbishment	16.732
Production equipment	0.819
Land and rights	2.210
Total	98.639

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 that amount to R78.878 billion over the next ten years.

Table 8.2: FY2020 to FY2029 Capital expenditure per province for expansion projects

Province	Rand (billions)
Eastern Cape	4.154
Free state	3.553
Gauteng	7.039
Kwa-Zulu Natal	16.025
Limpopo	12.419
Mpumalanga	10.064
North West	4.422
Northern Cape	12.170
Western Cape	9.028
Total	78.878



9. CONCLUSION

This revision of the TDP is similar to the 2018 TDP as the load and generation assumptions are similar, with the exception of a significant amount of additional gas generation forecasted in the current TDP period. Thus, the main difference between this TDP and the 2018 TDP is the re-phasing of projects in the execution phase. The acquisition of servitudes for the lines and sites for new substations continues to be a challenge for Eskom Transmission, sometimes necessitating re-phasing of projects. Transmission expansion plans required for the integration of approved 27 DoE REIPPPP Round 3.5, 4 and 4B projects are under construction and expected to be commissioned between 2019 and the end of 2021. The TDP also caters for projected future REIPP integration projects, provided that the technology, size and location of successful bidders align with the TDP assumptions..

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 the implementation of emergency preparedness plans. The affected 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 development timeline 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 protracted land acquisition process and funding constraints.

APPENDIX A: GENERATION ASSUMPTIONS

Table A1: The Conventional Generation Plan for the TDP 2019 to 2029

Conventional Generation Allocation (MW)													
Classification	**Power Station**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	Total
Coal	**Medupi**	3597	720	0	0	0	0	0	0	0	0	0	4317
Coal	**Kusile**	1440	720	720	720	720	0	0	0	0	0	0	4320
Hydro	**Ingula**	1324	0	0	0	0	0	0	0	0	0	0	1324
OCGT Peaker	**Dedisa**	0	0	0	335	335	335	335	335	0	837.5	0	2512.5
OCGT Peaker	**Avon**	670	0	0	0	0	0	0	0	0	1005	0	670
Hydro	**Merensky**	0	0	0	0	0	0	0	0	0	0	0	0
New Coal	**Khanyisa**	0	0	0	300	0	0	0	0	0	0	0	300
New Coal	**Thabametsi**	0	0		0	0	600	0	0	0	0	0	450
New Coal	**Kriel**	0	0	0	0	0	0	0	0	0	0	0	225
New OCGT	**Athene**	0	0	0	0	0	0	0	837.5	670	837.5	0	2345
New CCGT	**Dedisa**	0	0	0	0	0	0	0	0	0	1005	0	1005
New OCGT	**Aurora**	0	0	0	0	0	0	0	502.5	502.5	502.5	0	1507.5

Table A2: The annual PV allocation per Substation for the TDP 2019 to 2029

PV Allocation per Substation per year (MW)												
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Aggeneis	0	100	0	0	0	0	100	0	0	100	50	350
Aries	0	200	0	0	0	0	0	0	0	0	50	250
Aurora	0	0	0	0	0	0	0	0	0	0	0	0
Bacchus	0	0	0	0	0	0	0	0	0	0	0	0
Bighorn	0	0	0	0	0	0	0	0	100	0	0	100
Boundary	0	0	0	0	100	0	0	0	0	0	100	200
Ferrum	0	100	0	0	0	0	100	100	0	0	0	300
Foskor	0	0	0	0	0	0	0	0	100	0	0	0
Garona	0	0	0	0	0	0	0	0	0	50	100	150
Harvard	0	0	0	0	0	0	0	0	0	0	50	50
Helios	75	0	0	0	0	0	0	0	0	50	0	125
Hydra	0	0	0	0	0	0	0	0	0	50	100	150
Hydra B	0	0	0	100	0	100	0	100	0	0	0	300
Juno	0	0	0	0	0	0	0	0	0	0	0	0
Koruson	0	0	0	100	0	0	100	100	0	0	0	300
Kronos	55	0	0	0	0	0	0	0	0	0	100	155
Lomond	50	0	0	0	0	0	0	0	0	0	0	50
Matimba	0	0	0	0	0	0	0	0	0	0	0	0
Medupi	0	0	0	0	0	0	0	0	0	0	0	0
Mercury	68	0	0	0	0	0	0	0	0	0	0	68

Table A3: The annual PV allocation per Substation for the TDP 2019 to 2029

PV Allocation per Substation per year (MW)												
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Mercury	68	0	0	0	0	0	0	0	0	0	0	68
Mookodi	75	0	0	0	100	100	200	0	0	0	0	475
Nama	0	0	0	0	0	100	100	100	0	0	0	300
Nzhelele	0	0	0	0	0	0	0	0	0	0	0	0
Olien	0	0	0	0	0	0	0	0	0	0	0	0
Paulputs	0	0	0	0	0	0	0	0	0	0	0	0
Perseus	0	0	0	0	0	0	0	0	0	0	0	0
Ruigtevallei	0	0	0	0	0	0	0	0	0	0	0	0
Spencer	0	0	0	0	0	0	0	0	100	100	100	300
Tabor	0	0	100	0	0	0	200	0	100	100	100	600
Theseus	0	100	0	0	0	0	0	100	0	0	100	300
Upington	225	100	0	0	100	0	100	0	0	100	50	675
Watershed	75	0	0	0	0	0	0	0	0	150	0	225
Witkop	0	0	0	100	0	0	0	0	100	0	0	200

Table A4: The annual wind allocation per Substation for the TDP 2019 to 2029

Wind Allocation per Substation per year (MW)												
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
Aggeneis	137	100	0	0	0	0	0	0	0	0	0	237
Aries	0	0	100	0	0	0	0	0	0	0	0	100
Aurora	0	100	0	0	0	0	0	0	0	100	100	300
Bacchus	32	0	0	0	0	0	0	100	0	0	0	132
Delphi	0	100	100	0	0	100	200	0	0	0	200	700
Droerivier	0	100	0	0	0	100	0	0	0	100	100	400
Grassridge	0	0	0	0	0	0	0	0	0	0	0	0
Gromis	0	0	0	0	0	0	200	100	0	100	0	400
Helios	0	0	0	0	0	0	0	0	0	0	0	0
Hydra	0	0	0	0	0	0	0	0	0	100	200	300
Hydra B	0	100	0	200	100	100	300	100	0	0	0	900
Juno	0	0	0	0	0	0	0	0	0	100	100	200
Komsberg	279	200	0	0	0	0	200	0	0	100	100	879
Koruson	108	0	100	0	100	200	200	0	0	0	0	708
Kronos	238	0	0	0	0	0	0	0	0	0	0	238
Muldersvlei	0	0	0	0	0	0	0	0	0	0	0	0
Nama	0	0	0	100	0	100	0	0	0	0	0	200
Pembroke	33	0	0	0	100	100	100	0	0	0	0	333
Poseidon	139	100	100	0	0	100	0	100	0	200	200	939
Thyspunt	0	0	0	0	0	0	200	0	0	0	0	200
Total												5646

Table A5: The annual CSP allocation per Substation for the TDP 2019 to 2029

CSP Allocation (MW)													
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2027**	**2028**	**2029**	**Total**
Ferrum	0	0	0	0	0	0	0	0	0	0	0	0	0
Garona	0	0	0	0	0	0	0	0	0	0	0	0	0
Olien	100	0	0	0	0	0	0	0	0	0	0	0	100
Paulputs	0	0	0	0	0	0	0	0	0	0	0	0	0
Upington	0	0	0	0	0	0	0	0	0	0	0	0	0
	100	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**100**

Table A6 (a): Northern Cape Wind Scenario

	WIND			
Year	MTS	IPP ID	Prgm	MW
2020	Komsberg	NCWind	Future	-100
2020	Gromis	NCWind	Future	100
2021	Delphi	NCWind	Future	-100
2021	Koruson	NCWind	Future	-100
2021	Poseidon	NCWind	Future	-100
2021	Gamma	NCWind	Future	100
2021	Kronos	NCWind	Future	100
2021	Nama	NCWind	Future	100
2023	Koruson	NCWind	Future	-100
2023	Pembroke	NCWind	Future	-100
2023	Gamma	NCWind	Future	100
2023	Oranjemund	NCWind	Future	100
2024	Droerivier	NCWind	Future	-100
2024	Delphi	NCWind	Future	-100
2024	Koruson	NCWind	Future	-200
2024	Pembroke	NCWind	Future	-100
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	Koruson	NCWind	Future	-200
2025	Pembroke	NCWind	Future	-100
2025	Thyspunt	NCWind	Future	-200

Table A6 (b): Northern Cape Wind Scenario

	WIND			
Year	MTS	IPP ID	Prgm	MW
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 A7: Western Cape Wind , Gas and Nuclear Scenario

	WIND			
Year	MTS	IPP ID	Prgm	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	Droerivier	WC WN	Future	100
2021	Komsberg	WC WN	Future	100
2021	Agulhas	WC WN	Future	100
2021	Poseidon	WCWN	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	Koruson	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

Table A8: Coal plants commissioning and Decommissioning

Power Stations	Province	MTScommissioning	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**				**5138**

Table A9: Limpopo PV Scenario

MTS	Province	2025	2026	2027	2028	2029	Movement
Aggeneis	NC	-50	-50	-100	-100	-50	-350
Aries	NC	-50	0	0	0	-50	-100
Boundary	FS	0	0	-100	-100	-100	-300
Ferrum	NC	0	150	-50	0	0	-50
Nzhelele	LM	50	50	100	100	50	350
Spencer	LM	50	0	0	0	50	100
Tabor	LM	0	0	100	100	100	300
Witkop	LM	0	0	50	0	0	50

Table A10: Northern Cape Wind Scenario

MTS	Province	2025	2026	2027	2028	2029	Movement
Aurora	WC	0	-100	-100	-100	-100	-400
Delphi	EC	0	-150	-100	-100	-200	-550
Droerivier	WC	0	0	-100	-100	-100	-300
Gromis	NC	0	100	100	100	100	400
Juno	WC	0	-150	-100	-100	-100	-450
Kronos	NC	0	150	100	100	200	550
Nama	NC	0	0	100	100	100	300
Oranjemond	NC	0	150	100	100	100	450

APPENDIX B: LOAD FORECAST

Table B1: Tx High System Demand at TOSP

PROVINCE	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
EASTERN CAPE	1472.20	1521.79	1541.84	1558.31	1576.25	1740.08	1756.64	1791.76	1823.74	1855.26	1881.83
FREE STATE	1686.29	1798.92	1826.53	1848.11	1832.14	1881.96	1923.45	1949.72	1972.33	2020.47	2040.09
GAUTENG	11076.90	11244.29	11696.23	12091.38	12399.39	12795.75	13234.56	13641.75	14327.88	14829.36	15431.76
KWAZULU NATAL	5031.87	5096.32	5220.10	5229.34	5415.94	5361.33	5596.02	5420.81	5251.68	5614.73	5447.02
LIMPOPO	3149.90	3448.64	3574.30	3680.18	3945.15	4057.78	4338.90	4477.58	4561.66	4722.94	4853.52
MPUMALANGA	4444.45	4382.64	4436.43	4491.01	4836.44	4886.45	4834.96	4907.59	4966.55	5025.51	5077.36
NORTH WEST	3462.04	3658.79	3758.08	3939.06	3963.86	4041.29	4140.15	4231.61	4355.51	4482.18	4576.23
NORTHERN CAPE	1132.90	1175.41	1205.80	1231.95	1220.89	1251.18	1278.55	1425.83	1559.17	1595.59	1623.40
WESTERN CAPE	3844.34	3971.99	4075.07	4191.77	4281.02	4385.62	4487.83	4605.13	4786.57	4952.49	5082.31

Table B2: Tx High System Demand at Low Load

PROVINCE	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
EASTERN CAPE	861.04	892.49	903.70	913.77	923.69	1025.54	1035.91	1056.00	1074.42	1093.32	1109.17
FREE STATE	1194.41	1231.93	1253.54	1270.83	1260.32	1284.46	1304.94	1319.99	1333.70	1358.23	1370.24
GAUTENG	6022.99	6113.17	6473.55	6661.62	6775.55	6963.71	7168.71	7357.13	7649.99	7890.14	8239.74
KWAZULU NATAL	3410.30	3480.66	3554.00	3540.93	3675.22	3612.99	3793.94	3692.70	3546.69	3808.04	3655.71
LIMPOPO	2232.39	2421.62	2499.26	2574.45	2810.83	2890.58	3141.23	3250.39	3309.62	3425.99	3519.52
MPUMALANGA	3562.66	3515.63	3555.19	3595.33	3944.13	3982.48	3962.46	4018.21	4063.23	4109.36	4150.03
NORTH WEST	2819.36	2841.94	2910.51	3070.96	3084.10	3142.44	3202.00	3273.54	3358.61	3454.25	3520.75
NORTHERN CAPE	1158.33	1206.02	1237.77	1265.98	1263.08	1295.55	1324.98	1444.34	1558.22	1593.66	1622.25
WESTERN CAPE	2427.56	2505.79	2574.94	2649.14	2770.80	2839.38	2894.49	2969.39	3005.90	3106.52	3188.28

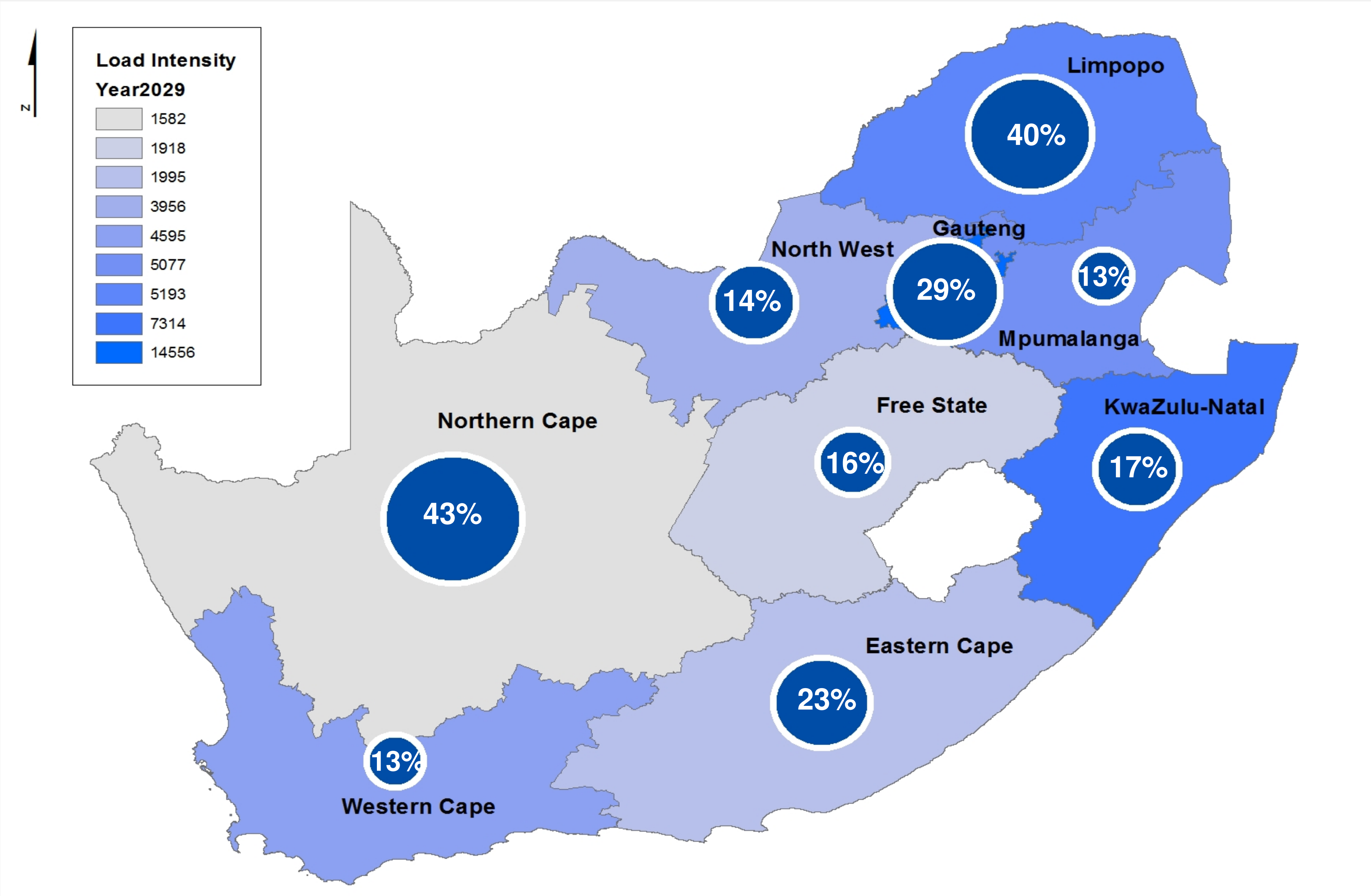


Figure B1: Key growth areas for TDP period 2020-2029

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

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