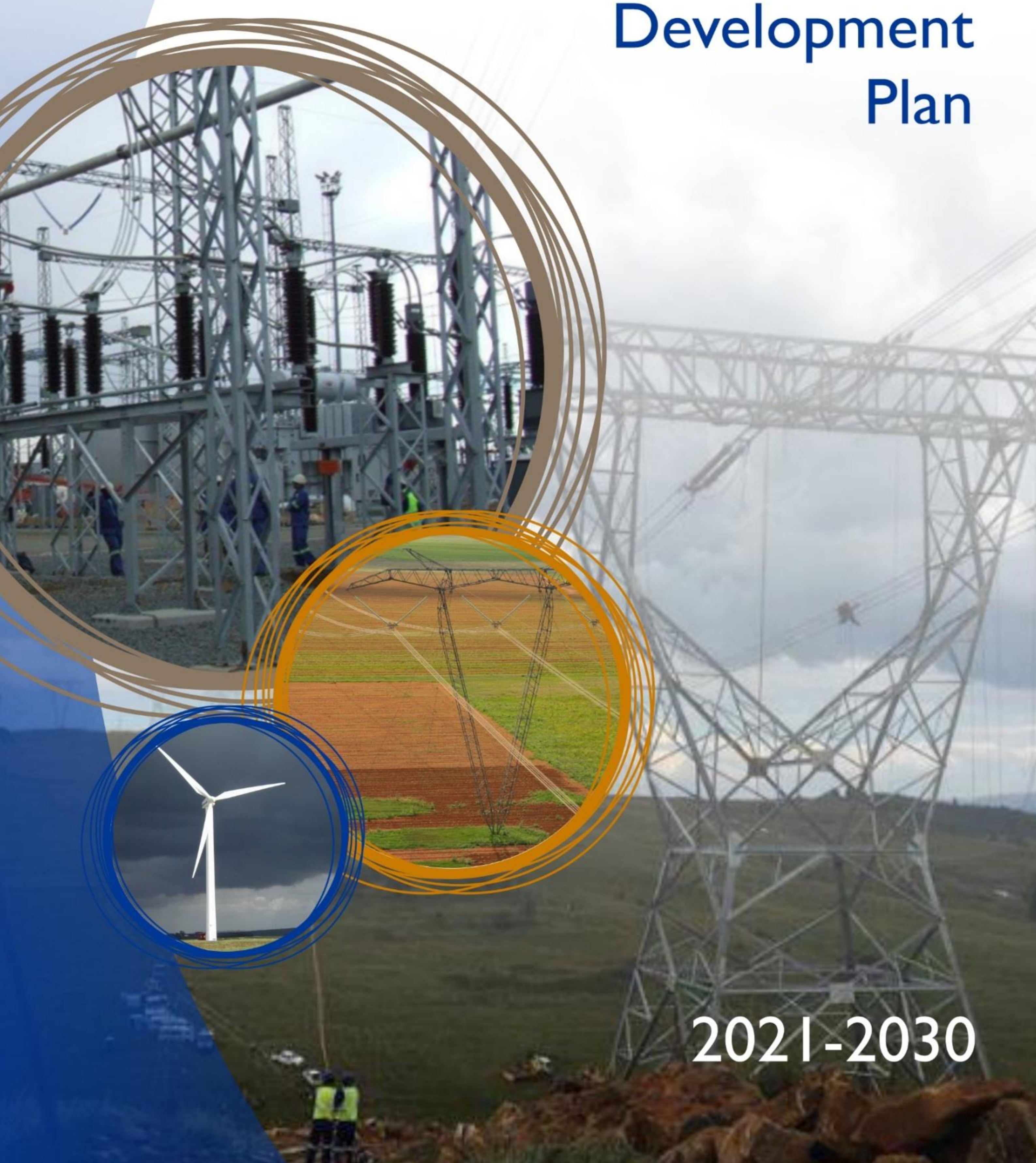
Eskom

Transmission Development Plan



2021-2030

FOREWORD BY GROUP EXECUTIVE

"Now is the time to act quickly and boldly to place South Africa on a rapid growth trajectory. We cannot continue with business as usual. We will use this moment of crisis to build a new economy and unleash South Africa's true potential." - President Ramaphosa

As announced by Statistics South Africa in early September 2020, the gross domestic product (GDP) fell by just over 16% between the first and second quarters of 2020, giving an annualised growth rate of -51%, pushing the country deeper into recession. Now more than ever, South Africa's investment in its electricity network infrastructure is one of the catalysts for economic growth and development in the country.

Eskom fully supports the government's Integrated Resource Plan of 2019 (IRP 2019), which signalled an important move to a wider range of fuel options for power generation in the country and supports a diverse energy mix to ensure the security of South Africa's electricity supply. We have a potentially important and enabling role to play in the implementation of the plan. Some of the many ways of doing this include repowering our older power stations with cleaner fuel technologies and renewables and developing renewable projects on available land around each of the power plants. In this way, we will be taking advantage of existing transmission infrastructure, networks, and connections to continue extending economic opportunities to those communities that have supported Eskom over the past 50 years.

Transmission remains one of the key components in the electricity value chain. The transmission system's primary role is to transport electricity in bulk from various generating sources to load centres throughout South Africa and into the Southern African Development Community (SADC) region. From there, Eskom's distribution networks, the metros, and municipalities deliver electricity to individual households and end users.

The transmission system requires periodic augmentation and reinforcement to connect new loads and sources of generation to the grid and meet customers' changing needs in both load and generation. Accordingly, the plans outlined in the Transmission Development Plan

(TDP) highlight the critical transmission infrastructure development requirements in South Africa over the next 10 years in anticipation of demand growth and the future generation mix.

I am very pleased that Transmission has completed the following projects since the publishing of the previous TDP in October 2019:

- Additional transformers at Benburg Substation on the East Rand, Normandie Substation in Mpumalanga, Sorata Substation in the Free State, and at Paulputs Substation in the Northern Cape; and
- Integration of successful IPPs from Bid Window 4 into the transmission grid, underpinned by investments in new substations and additional transformers at existing substations.

For the period ahead, I would like to highlight the following:

- With the 2020 TDP, we aim to increase the transmission infrastructure by approximately 8 250 km of high-voltage lines and 52 125 MVA of transformer capacity in the next 10 years.
- The Medupi and Kusile Power Stations are due to be fully commissioned, along with any remaining transmission network reinforcements to accommodate the full output of these power stations.
- A significant amount of investments are required to strengthen the grid to accommodate the new generation capacity in accordance with the IRP 2019. Thirty GW of new generation capacity is expected mainly from renewable energy sources in areas with limited network infrastructure.
- In addition, considerable investment is required for the refurbishment of existing transmission substations and lines.
- Some of the TDP requirements have been moderated by rephasing transmission capital investment in light of financial constraints and to align with the project execution timelines associated with servitude acquisitions.

As we do our best to meet our commitments in terms of the TDP, we will certainly face challenges. However, we hope that with your support, and through collaboration with various key stakeholders, we can all own this plan and promote its funding and execution to co-create an energy future in support of the economic growth of our country.

I would like to take this opportunity to thank the team that continues to work on the development and implementation of these plans diligently. Their commitment to this challenging and complex process is commendable. I also wish to thank the relevant authorities for their support and assistance in the past, but also have to say that we will require much more help to deliver on the requirements of the TDP in the future. Lastly, a special thanks to all of the identified stakeholders who participated in the virtual public forum hosted via Microsoft Teams on 20 October 2020. Some of the comments received 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 2021.

Regards

Segomoco Scheppers

GROUP EXECUTIVE: TRANSMISSION

DISCLAIMER

The purpose of publishing the TDP is to inform stakeholders about the proposed developments in the Eskom transmission network. These plans are subject to change as and when updated 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 or indirect damages, consequential, incidental, special, punitive, or any other damages whatsoever and howsoever arising, 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 of publication.

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.

For the upstream transmission network strengthening projects required to enable the connection of future independent power producers (IPP), Transmission will conduct the necessary feasibility assessment and develop these projects to the extent possible within the confines of the approved TNSP's capital investment process. However, capital investment in these projects will only be considered if the related IPP projects are announced as preferred bidders in the DMRE IPP Procurement Programme.

EXECUTIVE SUMMARY

The transmission network is the primary network of interest covered in this publication. This mainly covers electrical networks with voltages ranging from 220 kV to 765 kV and the associated transmission substations. A few subtransmission networks are included due to their strategic nature or when Transmission owns them.

The purpose of the TDP is to assess network requirements and propose plans to meet the load demand and generation integration forecasted in the subsequent 10-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 TDP 2021-2030 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-owned as well as IPPs, conventional and renewable)
- evacuate and dispatch power to the load centres from the power stations connected to the grid.

Eskom Transmission also carries out projects in respect of the refurbishment of ageing infrastructure, strategic projects, environmental authorisations and acquisition of sites and servitudes, facilities, production equipment, and strategic capital spares:

- The transmission system requires regular planned maintenance, as well as renewal or replacement of plant that has reached the end of its operational or economic life, to ensure that network continues to perform its role safely, reliably and efficiently.
- Strategic projects include the upgrading of the energy management system (EMS) used by the system operator to monitor, control, and optimise the power system’s performance and respond to network emergencies.
- Acquisition of sites and servitudes and associated EIAs (environmental impact assessments) and other statutory approvals to construct transmission infrastructure.

- Facilities consist of buildings and associated works located at sites other than substations that Transmission uses for offices, the operation and control of the system, or as maintenance depots and workshops.
- Production equipment consists of office furniture and equipment, computer hardware and software, tools and other equipment used by maintenance staff, and vehicles.
- Strategic capital spares are items not available from suppliers out of stock, for example, large power transformers and circuit-breakers. These are kept as strategic stock to allow for units that fail and cannot be repaired on site to be replaced as soon as possible, thereby minimising long-duration outages to customers.

These types of projects are not detailed in this document, but a summary of their costs appears in the chapter on capital expenditure.

During the second quarter of 2015, Transmission introduced a self-build option to both load and generation customers, in which they can elect to design, procure, construct, and hand over the transmission network assets required to enable their connection to the transmission system. The intention is 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.

Eskom’s current liquidity position as well as NERSA’s decision on Eskom’s future 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 due to any delays arising from a shortage of funding or any delays in obtaining environmental authorisations, servitude acquisitions, and other statutory approvals.

It is regrettable but unavoidable that the funding constraints will result in more 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 activation of risk mitigation measures.

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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 combustion turbine's exhaust gases 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.
DMRE	Department of Mineral Resources and 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 which is 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

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 and the customer projects omitted from this document due 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

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 for the expansion of the transmission network is the responsibility of the Grid Planning and Development Department in the Transmission Group.

1.1 CONTEXT OF THE TDP

According to the Grid Code, NERSA requires the NTC to publish a minimum five-year-ahead transmission system (TS) development plan annually, indicating the major capital investments planned (but not yet necessarily approved). The requirements, furthermore, stipulate that the plans shall 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 annually hosts a public forum to disseminate the intended TS development plan to facilitate a joint planning process.

This is the eleventh publication of the TDP, which was shared at a virtual public forum hosted via Microsoft Teams on 20 October 2020.

The TDP, which covers a 10-year period from 2021 to 2030, seeks to meet the long-term requirements of 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, projects in the developmental phase, and projects that are in the inception phase based on a desktop assessment of the transmission requirements with further engineering feasibility assessment to be conducted during the TDP period.

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

(i) Those that are in implementation and will be commissioned within the next three years or so (projects in execution);
(ii) Those that are in detailed studies/design phase with business cases being concluded aimed for implementation within the next seven years (projects in development); and
(iii) Projects beyond the seven-year horizon still have a level of uncertainty and are most likely to be revised in terms of scope (concept projects).

1.2 MAJOR CHANGES FROM THE 2019 TDP

The major change from the 2019 TDP to this revision of the 2020 TDP is associated with assumptions on the country's future generation capacity. Whereas the 2019 TDP was based the draft IRP 2018, the 2020 TDP was informed by the IRP 2019 that was gazetted in November 2019. The fundamental difference is that the IRP 2019 proposes an accelerated new generation capacity programme where 9.8 GW of new capacity is proposed for integration onto the system by 2025 followed by some 17 GW of generation capacity by 2030. A significant amount of this new capacity is from renewable energy (RE) resources that are in areas with limited network capacity. Since this additional capacity was not considered in the 2019 TDP and Transmission's capital plan, the success of the IRP 2019 is therefore dependent on an accelerated generation integration programme.

Apart from the expedited new generation capacity expectations in accordance with the IRP 2019, the development plans for the 2020 TDP remain aligned with that of the 2019 TDP regarding the plans for the integration of IPPs from Bid Windows 4 and 4B of the renewable energy independent power producer procurement programme (REIPPPP), network reliability enhancements, demand growth, safety, and regulatory network strengthening requirements.

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 between 2019 and 2021.

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.

1.2.1 Capital Constraints

Due to capital constraints emanating from Eskom's liquidity position, projects had to be reprioritised to fit in with the available budget. The reprioritised projects maximise the benefits accruing from the available capital investment budget while minimising the risks to security and reliability of supply. The high-priority projects were accelerated, provided that the enabling factors are in place. The reprioritisation process will be repeated after each tariff increase ruling by NERSA and Eskom's Corporate Plan approval to ensure optimal 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.

1.3 STRUCTURE OF THE DOCUMENT

The document is structured in the following manner:

Chapter 2, GENERATION ASSUMPTIONS, outlines generation assumptions for the 2020 revision of the TDP, which was primarily informed by the IRP 2019.

Chapter 3, DEMAND FORECAST, provides the location and magnitude of electricity demand forecast (MW) to be supplied within the TDP period.

Chapter 4, COMPLETED PROJECTS, summarises the completed projects since the 2019 TDP was published.

Chapter 5, CUSTOMER APPLICATIONS, provides a summary of the grid connection applications processed by Transmission during the 2019/20 financial year (April 2019 to March 2020).

Chapter 6, NATIONAL OVERVIEW, is a high-level description of the planned transmission infrastructure. This is intended to give a national overview of the major projects planned for the entire period of the TDP and a high-level summary of the planned transmission infrastructure.

Chapter 7, PROVINCIAL DEVELOPMENT PLANS, focuses on the planned generation integration and reliability projects per province.

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 after feasibility assessment and will be followed by approval of the associated business case before projects advance to execution.

Chapter 9, CONCLUSION, provides the concluding remarks on the 2020 version of the TDP.

2 GENERATION ASSUMPTIONS

The generation assumptions are used as a supply-side input into the 2020 TDP. The Department of Mineral Resources and Energy (DMRE) is accountable for the country's energy plan. Hence, the generation assumptions are based on the latest Integrated Resource Plan (IRP 2019), as released by the DMRE. The IRP is intended to drive all new generation capacity development for South Africa.

These generation assumptions are based on the official IRP Report of 2019, approved in Parliament last year. More specifically, the generation assumptions are centred on the preferred scenario, as indicated in Table 5 (pg. 47) of the IRP document. For brevity, this is also shown in Figure 2-1 below.

	Coal	Coal (Decommissioning)	Nuclear	Hydro	Storage	PV	Wind	CSP	Gas & Diesel	Other (Distributed Generation, CoGen, Biomass, Landfill)
Current Base	37149		1860	2100	2912	1474	1980	300	3830	499
2019	2155	-2373					244	300		Allocation to the extent of the short term capacity and energy gap.
2020	1433	-557				114	300			
2021	1433	-1403				300	818			
2022	711	-844			513	400 1000	1600			
2023	750	-555				1000	1600			500
2024			1860				1600		1000	500
2025						1000	1600			500
2026		-1219					1600			500
2027	750	-847					1600		2000	500
2028		-475				1000	1600			500
2029		-1694			1575	1000	1600			500
2030		-1050		2500		1000	1600			500
TOTAL INSTALLED CAPACITY by 2030 (MW)	33364		1860	4600	5000	8288	17742	600	6830	
% Total Installed Capacity (% of MW)	43		2.63	5.84	6.35	10.52	22.53	0.76	8.1	
% Annual Energy Contribution (% of MWh)	58.8		4.5	8.4	1.2	6.3	17.8	0.6	1.3	

- Installed Capacity
- Commited / already Contracted Capacity
- Capacity Decommissioned
- New Additional Capacity
- Extension of Koeberg Plant Design Life
- Includes Distributed Generation Capacity for own use

Figure 2-1: IRP preferred scenario used for generation assumptions

Although the assumptions are based on 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 given in the IRP. This is necessary to align with the “Consistent Data Set” produced by Eskom Generation.

Furthermore, alternative generation scenarios have been included in the TDP. This was after an agreement was reached with the IPP Office to include such scenarios to cater for spatial uncertainty since the exact areas where the REIPPPP bids will be successful are not known upfront.

The major outputs from the generation assumptions are as follows:

(i) The generation capacity that will be installed in the next 10 years by Eskom;
(ii) The generation capacity that will be installed in the next 10 years by IPPs; and
(iii) The generation that is expected to be decommissioned in the same period.

The assumptions allocate capacities for each technology type in spatial and temporal domains. Technology type refers to the primary generation technology that will provide the energy, including, but not limited to solar photovoltaic (PV), wind, OCGT, closed-cycle gas turbines (CCGT), nuclear, and coal. Because of the different types of profiles from different generation supply-side options, it is important to specify the technology used in order to allocate the correct capacity for the time of the 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. The spatial requirements are met by indicating the nearest transmission substation where the generation has been allocated. The time is given in the form of yearly generation capacity allocations in those substations.

2.1 GENERATION FORECAST

The generation composition of all the technologies forecasted for the TDP period is shown in Figure 2-2. It is anticipated that there will be a total of approximately 26 GW of RE, 34 GW of coal, and 6 GW of gas installed in the system by 2030. Some of these plants exist, while others are in execution or future plants. Furthermore, it is anticipated that there will be 2 GW of battery storage by 2030.

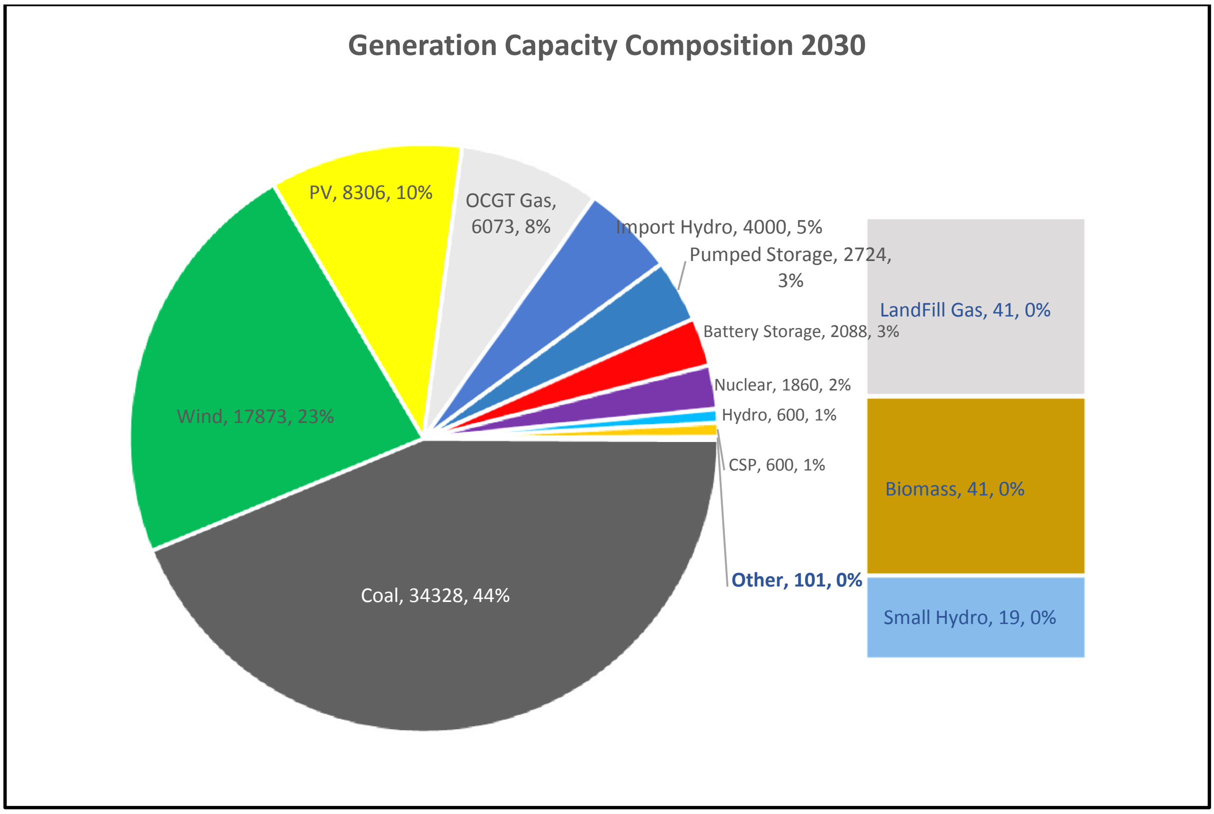


Figure 2-2: Generation composition of all the technologies forecasted in 2030

Comparing the generation capacities in the draft IRP 2018 and IRP 2019 for the period between 2020 and 2030 indicates that the generation capacities in the draft IRP 2018 is 4 GW less than when compared to the IRP 2019. There is also an increase of 9.8 GW in the period between 2020 and 2025. This means that much generation has been brought forward to the earlier period of the TDP. The TDP generation capacity plan for 2021 to 2030 is somewhat different from the previous TDP's generation capacity plan. The total allocation for both conventional and RE in the TDP period is 29 560 MW by 2030. The total added generation from build inception is 44 847 MW by 2030.

2.2 CONVENTIONAL GENERATION

The main difference as far as conventional generation is concerned is the lower gas capacity during the TDP period. Figure 2-3 shows the cumulative conventional capacity allocation, the total for conventional capacity that will be added in the system (including units from inception) is 17 967 MW by 2030. During the TDP period, 9 160 MW of conventional generation will be added in the system.

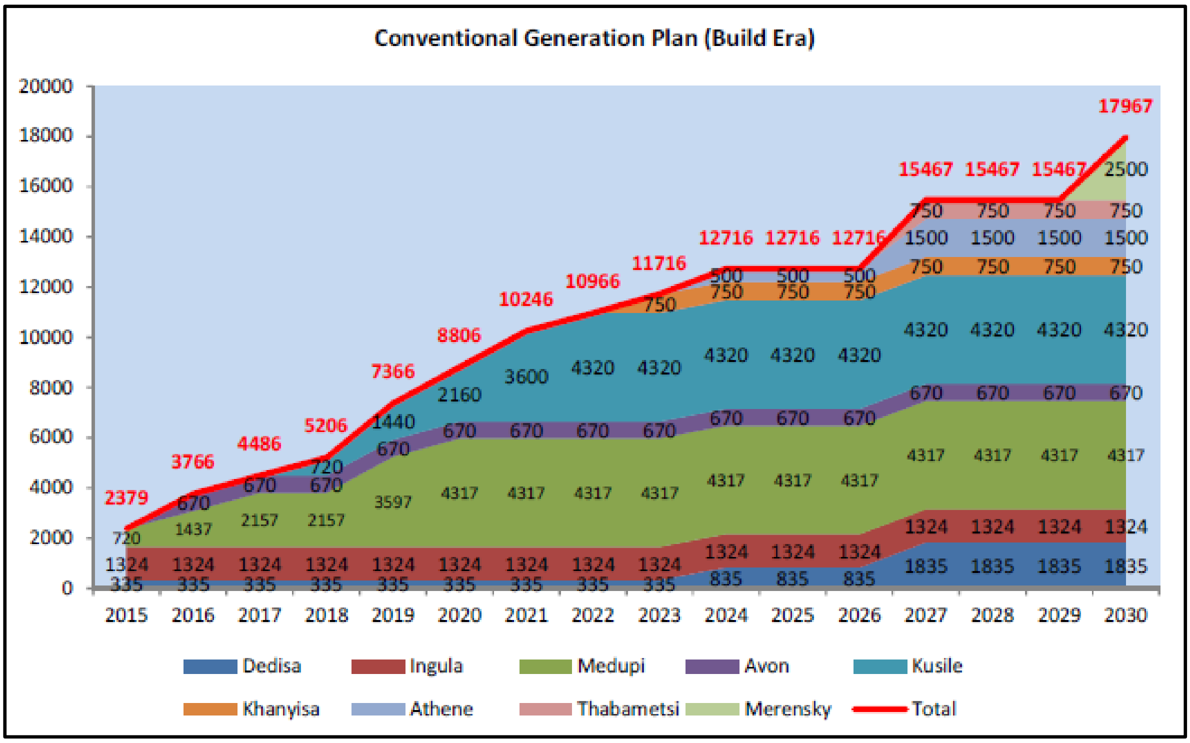


Figure 2-3: Conventional generation cumulative capacity schedule

2.2.1 Nuclear Generation

There is no new nuclear generation in the TDP period in the IRP 2019. Thus, the generation assumptions also do not have nuclear generation. Possible high-level integrations of nuclear have now been tested at all possible sites, so it is unnecessary to test it again in the current TDP period.

2.2.2 Gas Generation

The IRP 2019 has only allocated 3 000 MW of gas in the current TDP period. This is a reduction of 9 040 MW from the previous allocation. The gas has been allocated equally to the sites that show great potential.

2.2.3 New Coal

The new coal stations are those that have been approved in the coal / Baseload IPP procurement programme, that is, Khanyisa and Thabametsi. Although in the draft IRP 2018 the amount of new coal was 900 MW, this was revised to 1 500 MW in the approved IRP

2019. The generation assumptions have allocated 750 MW each to the two power stations in 2023 and 2027, respectively.

2.3 RENEWABLE GENERATION

The total of renewable generation capacity added in the system (including units from inception) is 26 880 MW by 2030, as shown in Figure 2-4. The total renewable capacity that will be added in the TDP period is 20 400 MW. The allocation of RE capacity at different substations was informed by potential at those substations based on previous applications to connect capacity.

2.3.1 PV GENERATION

PV is expected to reach 6 306 MW by 2028 (which was 5 958 MW in the 2019 generation assumptions). This will increase to 7 306 MW and 8 306 MW in 2029 and 2030, respectively.

2.3.2 WIND GENERATION

Wind is expected to reach 14 673 MW by 2028 (which was 8 242 MW in the 2019 generation assumptions). This will increase to 16 673 MW and 17 873 MW in 2029 and 2030, respectively.

2.3.3 CSP GENERATION

Concentrated solar power (CSP) is expected to reach 600 MW by 2030. This is the same as the 2019 generation assumptions.

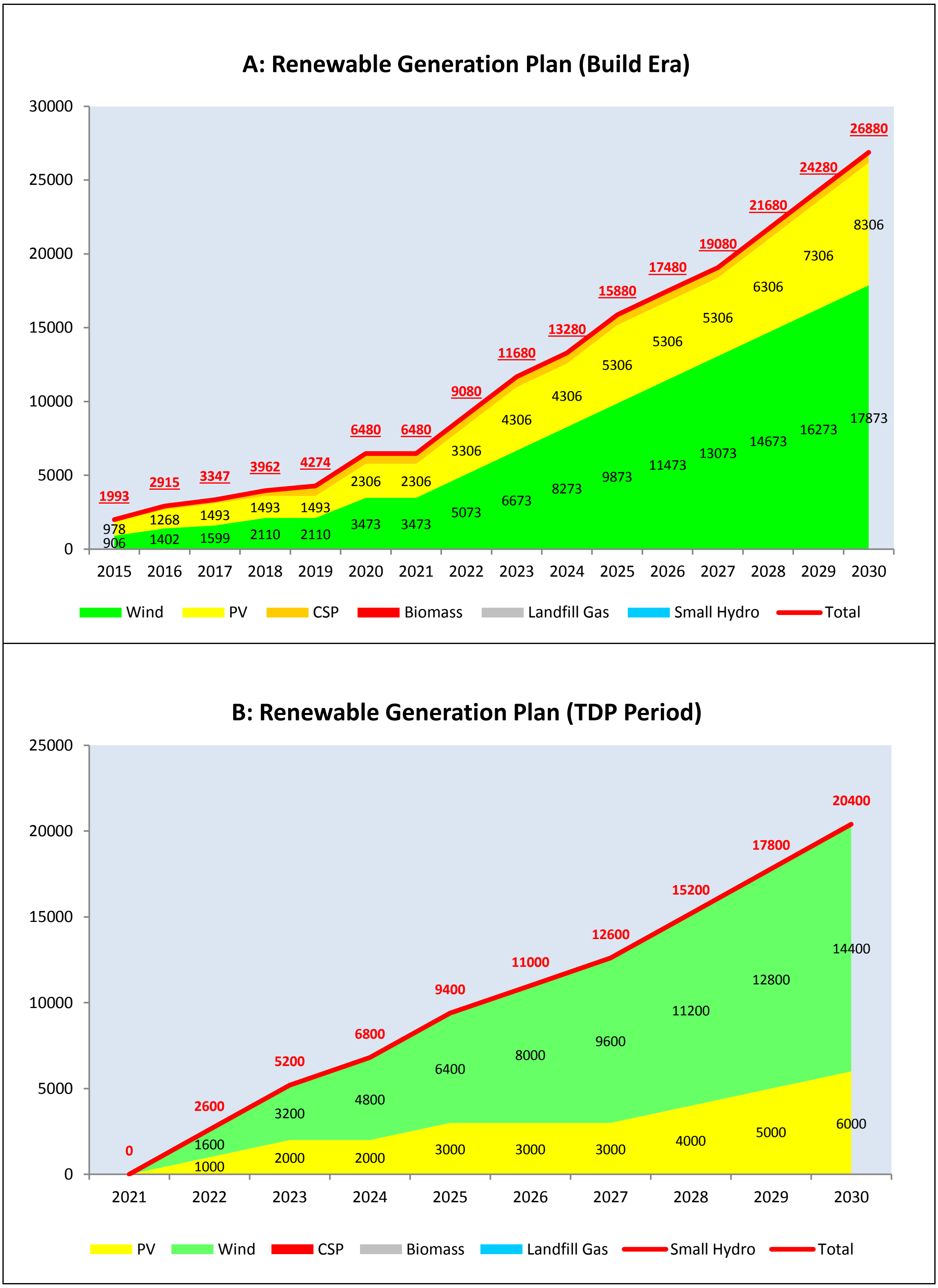


Figure 2-4: Renewable energy cumulative schedule (build era (A) and TDP period (B))

2.4 DECOMMISSIONING OF COAL-FIRED STATIONS

Generating plants that have reached end of life will be decommissioned in the TDP period according to a decommissioning schedule, received from Eskom Generation. All decommissioning in this document is aligned with the Generation Production Plan that was valid when the document was authorised. It is anticipated that approximately 11.4 GW and 0.3 GW of coal and gas, respectively, will be decommissioned by 2030.

The 2019 generation assumptions indicated that Hendrina, Grootvlei, and Komati would 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 period was 7 972 MW. This has decreased by 6% to 7 434 MW in the 2020 TDP period. A total decommissioning from inception of decommissioning to 2030 has increased from 10 600 MW to 11 750 MW by 2030. Most of the stations will be decommissioned after 2026. These include coal and gas stations, as seen in the lower chart in Figure 2-5 below.

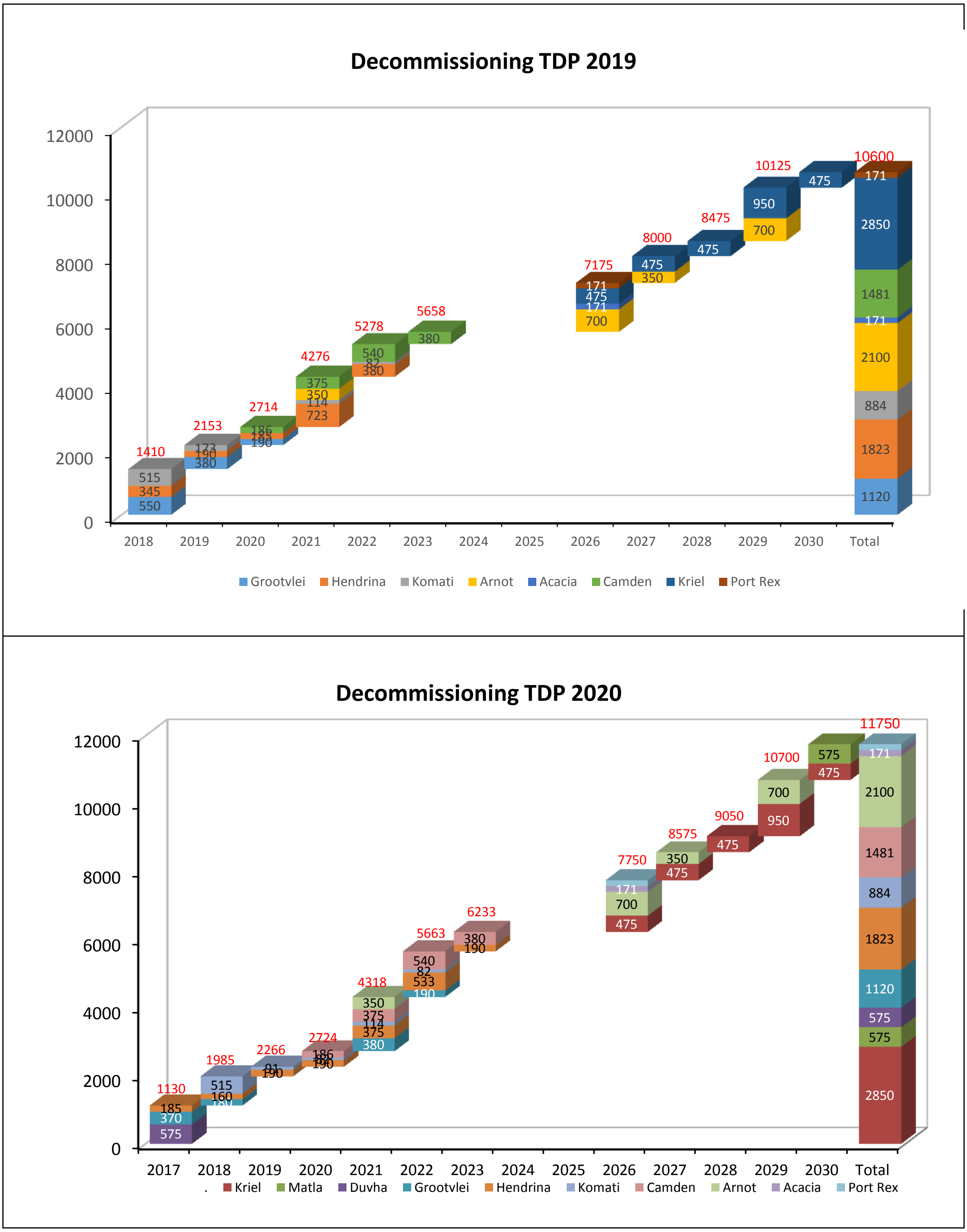


Figure 2-5: Decommissioning schedule TDP 2019 vs TDP 2020

2.5 ALTERNATIVE GENERATION SCENARIOS

Since it is impossible to predict the future precisely, accurately forecasting the generation sources 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, that is, the IRP is not specific about the spatial allocation of generators. This creates a problem in terms of the robustness of the plans.

Thus, the generation assumptions provide various scenarios that seek to make the assumptions as robust as possible. Alternative scenarios are used to stress-test the robustness of the TDP to compensate for temporal and spatial uncertainties embedded in the assumptions. 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 the spread of the future generation is made from 2021 to 2030; however the main year of consideration will be 2030 when the full impact of these scenarios can be identified.

Five alternative scenarios were formulated. The alternative scenarios are named according to provinces or area which will be most affected by the scenario. The scenarios are as follows:

(i) The first scenario, Limpopo PV, is to test a scenario where more PV is allocated in Limpopo;
(ii) The second scenario, Richards Bay Gas, tests for all new gas (3 000 MW) being allocated at Richards Bay;
(iii) The third scenario, Coega Gas, tests for all new gas (3 000 MW) being allocated at Coega;
(iv) The fourth scenario, Saldanha Bay Gas, tests for all new gas (3 000 MW) being allocated at Saldanha Bay; and
(v) The last scenario, Northern Cape Battery, tests the impact of battery storage if all of it is allocated in the Northern Cape.

The impact of these scenarios over and above the base scenario is tested during the TDP analysis. The network study will consider the base case as well as the applicable scenario to determine if the network is sufficient. If the network is not sufficient, additional mitigation plans are proposed.

2.5.1 SCENARIO 1: LIMPOPO PV

This scenario aims to determine the impact on the transmission network within Limpopo if 1 000 MW of solar PV generation is moved from the Northern Cape to Limpopo. This is not new generation, but generation that is displaced from the Northern Cape and Free State to Limpopo.

Figure 2-6 shows the generation reallocation under this scenario. The graph indicates that 1000 MW of the future solar PV was allocated at different locations in Limpopo as alternatives to the baseline allocation.

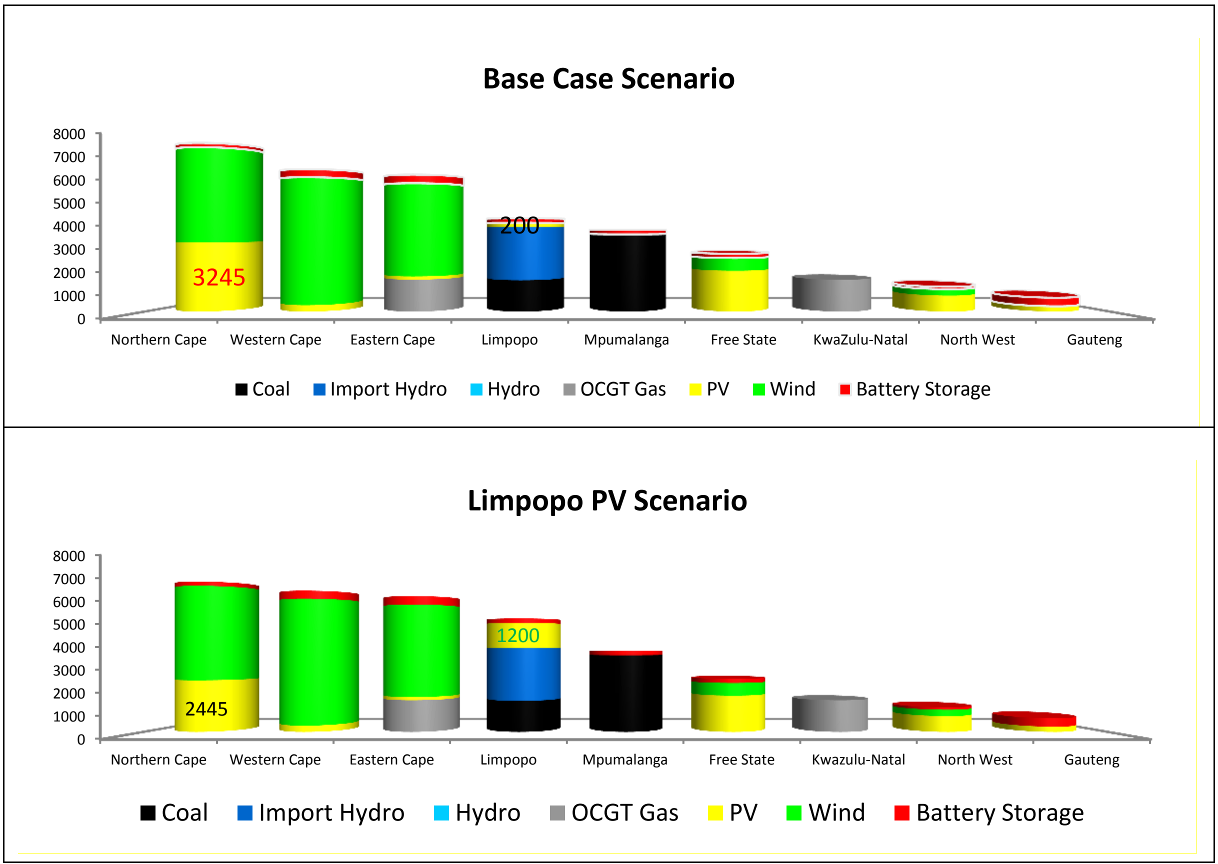


Figure 2-6: Limpopo PV scenario generation comparison to the base case scenario

2.5.2 Scenario 2: Richards Bay Gas

This scenario aims to determine the impact on the transmission network within KwaZulu-Natal if all the new gas is located in Richards Bay. This will mean that Richards Bay will have to accommodate 3 000 MW of gas capacity and Coega will have none, as the 1 500 MW allocated there will be relocated to Richards Bay. Figure 2-7 illustrates the total movement at grid level.

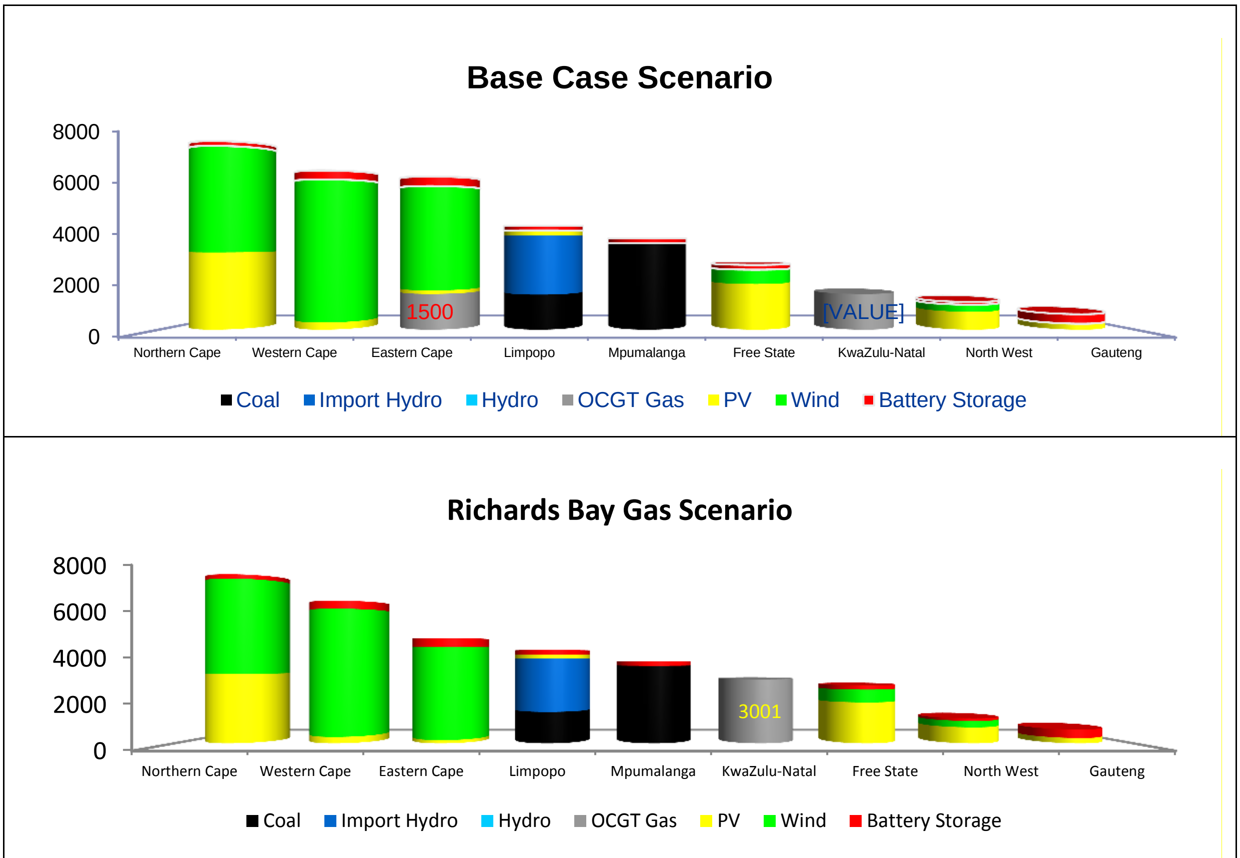


Figure 2-7: Richards Bay gas scenario compared to the base case scenario

2.5.3 Scenario 3: Coega Gas

The purpose of this scenario is to determine the impact on the transmission network within the Eastern Cape if all the new gas is located in the Coega Development Zone. This will mean that Coega will have to accommodate 3 000 MW of gas capacity and Richards Bay will have none, as the 1 500 MW allocated there will be relocated to Coega. Figure 2-8 illustrates the total movement at grid level.

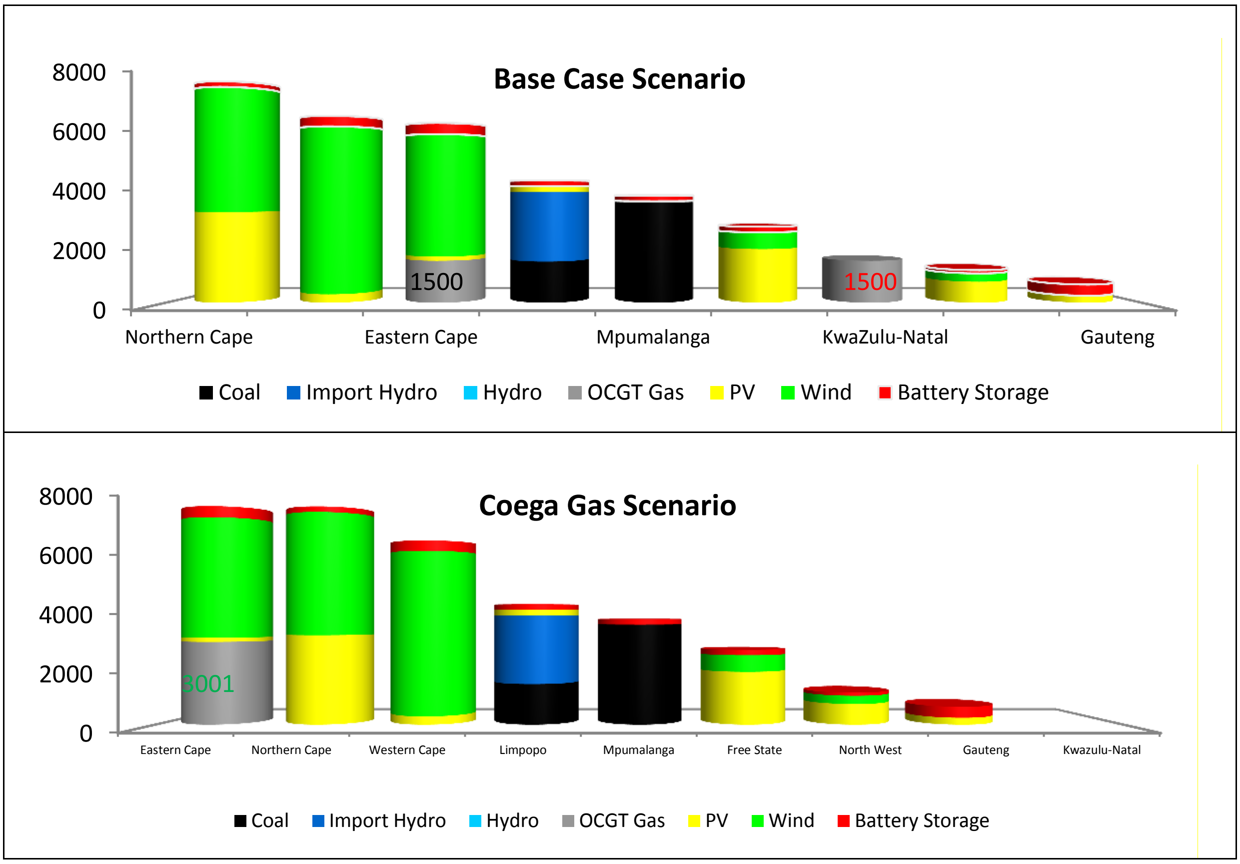


Figure 2-8: Coega gas scenario compared to the base case scenario

2.5.4 Scenario 4: Saldanha Bay Gas

The purpose of this scenario is to determine the impact on the transmission network within the West Coast if all the new gas is located in Saldanha Bay. This will mean that Saldanha Bay will have to accommodate 3 000 MW of gas capacity and Richards Bay and Coega will have none, as the 1 500 MW allocated in each of these sites will be relocated to Saldanha Bay. Figure 2-9 illustrates the total movement at grid level.

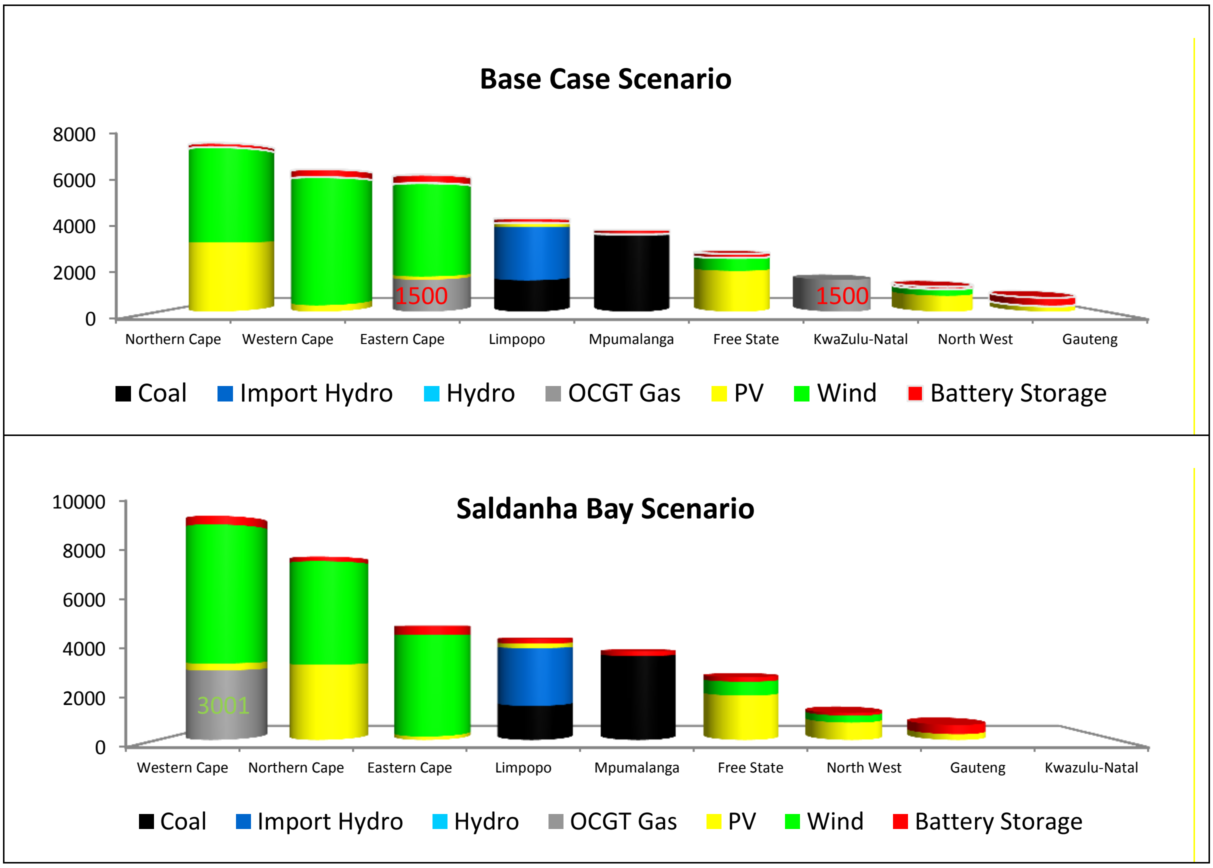


Figure 2-9: Saldanha Bay gas scenario compared to the base case scenario

2.5.5 Scenario 5: Northern Cape Battery

The purpose of this scenario is to determine the impact on the transmission network within the Northern Cape if all the battery storage is allocated to Northern Cape. The battery allocation in the IRP is 2 088 MW, and all of it will be allocated in the Northern Cape instead of being distributed in the entire country in accordance with the base case scenario. Figure 2-10 illustrates the total movement at grid level.

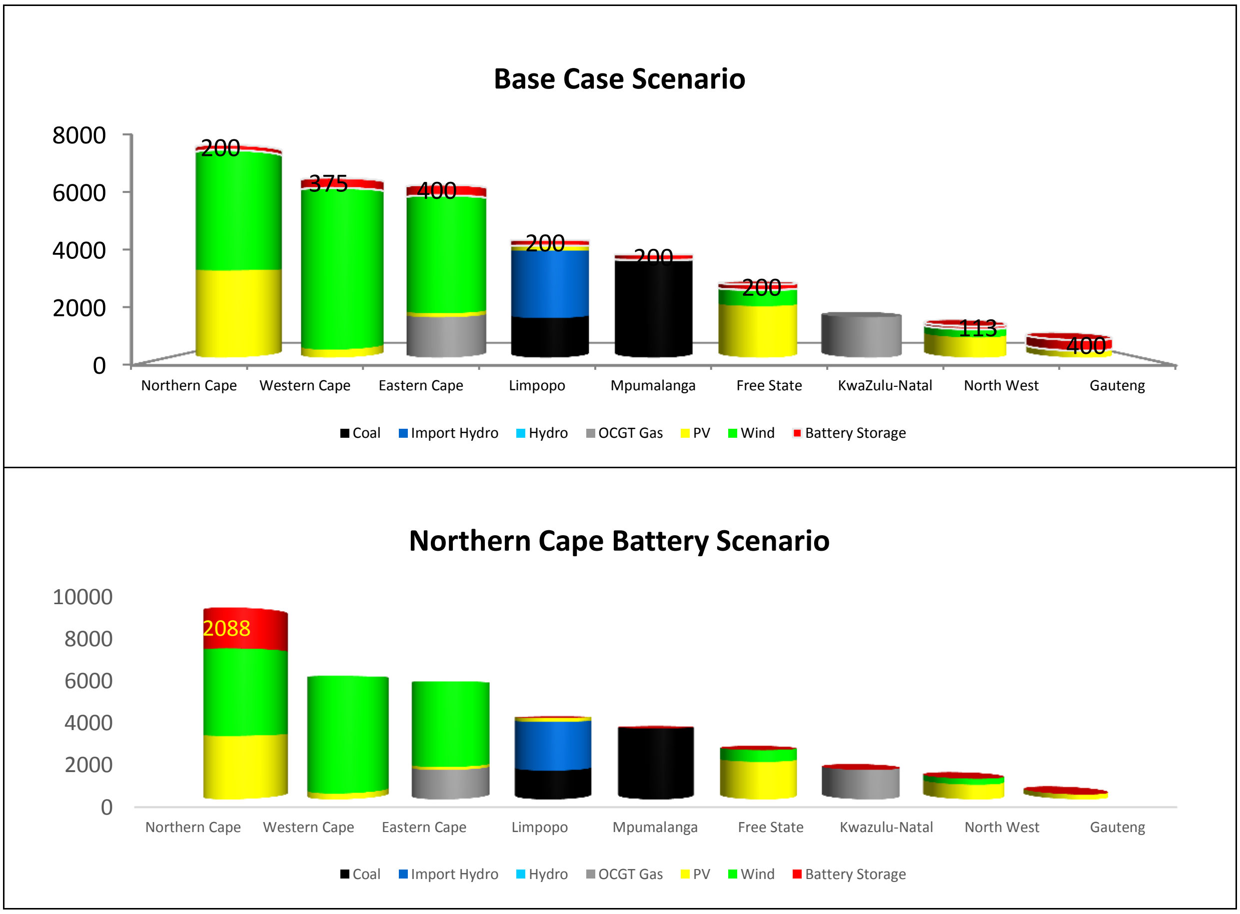


Figure 2-10: Northern Cape battery scenario compared to the base case scenario

3 DEMAND FORECAST

The purpose of the transmission demand forecast is for capacity planning of the transmission networks. The transmission demand forecast continuously needs to align with the aspirations of South Africa's National Development Plan (NDP) and the IRP to facilitate the economic growth of the country. The NDP stipulates a vision to create adequate energy infrastructure to stimulate a steady economic growth for South Africa. It further encourages diversification in energy generation sources and developing technologies to enable sustainable capacity building. The IRP was updated and gazetted in October 2019. The IRP demand forecast is used as a guideline forecast in formulating the transmission demand forecast.

3.1 ASSUMPTIONS

The following principle assumptions are made on demand growth potential in the country:

- Transmission responsibilities will stay similar to the current operations within the Eskom structure, irrespective of the pending restructuring.
- Eskom remains a going concern as the main utility for South Africa.
- Construction of additional generation capacity remains on target and is implemented on time.
- There is a reasonable recovery on the energy availability factor (EAF).
- Socio-political environment will stabilise or improve in the medium to long term.

3.2 DEMAND DRIVERS

In South Africa, the demand is highly focused on consumer behaviour in residential (both electrification and redistributor environments), investment policies in industrial sectors, and the electricity price structures. Population statistics and economic behaviour is continuously monitored to relate it to the forecast. In line with global trends, the NDP has stipulated that an ongoing increase in urbanisation will stimulate electrification and urban developments that will increase electricity demand. The NDP estimates that approximately 70% of the country's population will be relocating to city centres. The total population growth for the TDP period up to 2031 is estimated at 14% as published by Global Insight forecast in the third quarter of 2020.

Urbanisation and an increase in technological innovation are driving densification of already populated areas as well as further development. Exponential growth in this regard can be seen in Gauteng, KwaZulu-Natal and Western Cape. These provinces, with their city centres of Johannesburg and Pretoria, eThekwini and Cape Town respectively, have been declared as the fastest growing city regions with large implication on infrastructure development and electricity demand. Technological evolution has brought forward the need for energy-intensive data centres and telecoms infrastructure. This is seen to be a significant demand driver within the near future and TDP period.

South Africa has an abundance of mineral-rich areas. Limpopo and North West, as well as the Northern Cape, still show significant interest in mining and beneficiation of minerals in the manufacturing sectors. The Northern Cape houses more than 80% of the world's ferromanganese reserves. Therefore, it poses high potential for mining and manufacturing to add additional demand in the future. Coal, uranium, and platinum sources are posing an increase in demand over Limpopo, as the mining operations migrate from North West's platinum resources towards the mineral-rich northern areas of the country.

Globalisation has affected the overall supply chain regarding the mining and manufacturing sectors, and export of raw materials has increased with more competitive commodity processing offers from external countries. This has impaired the potential demand growth for manufacturing products such as steel and other local manufacturing opportunities. Saldanha Steel has lowered their notified maximum demand as their plant was shut down. Like their predecessor, Highveld Steel, in the northern parts of the country, also reduced and closed down their steel production in the past five years.

A significant drive towards climate change is also contributing to new sources of electricity demands. The introduction of charge stations for electric vehicles, hydrogen fuelling, and increase in energy efficiency can lead to an increase in production capacity at manufacturing facilities.

Demand drivers can be gathered from customer applications as another important input to validate statistical growth patterns from the past and enhance growth possibilities into the future. Customer connection applications and scanning of market intelligence and governmental investment declarations and growth initiatives, such as the special economic zone programmes and strategic investment projects, are used to quantify future potential demands in the various regions of South Africa.

A spatial view per province can be seen in Figure 3-1. The blue circles indicate customer applications (indicative cost estimates (ICEs) and budget quote applications (BQs)) and the grey circles represent load growth possibilities identified by market intelligence gathered from official sources.

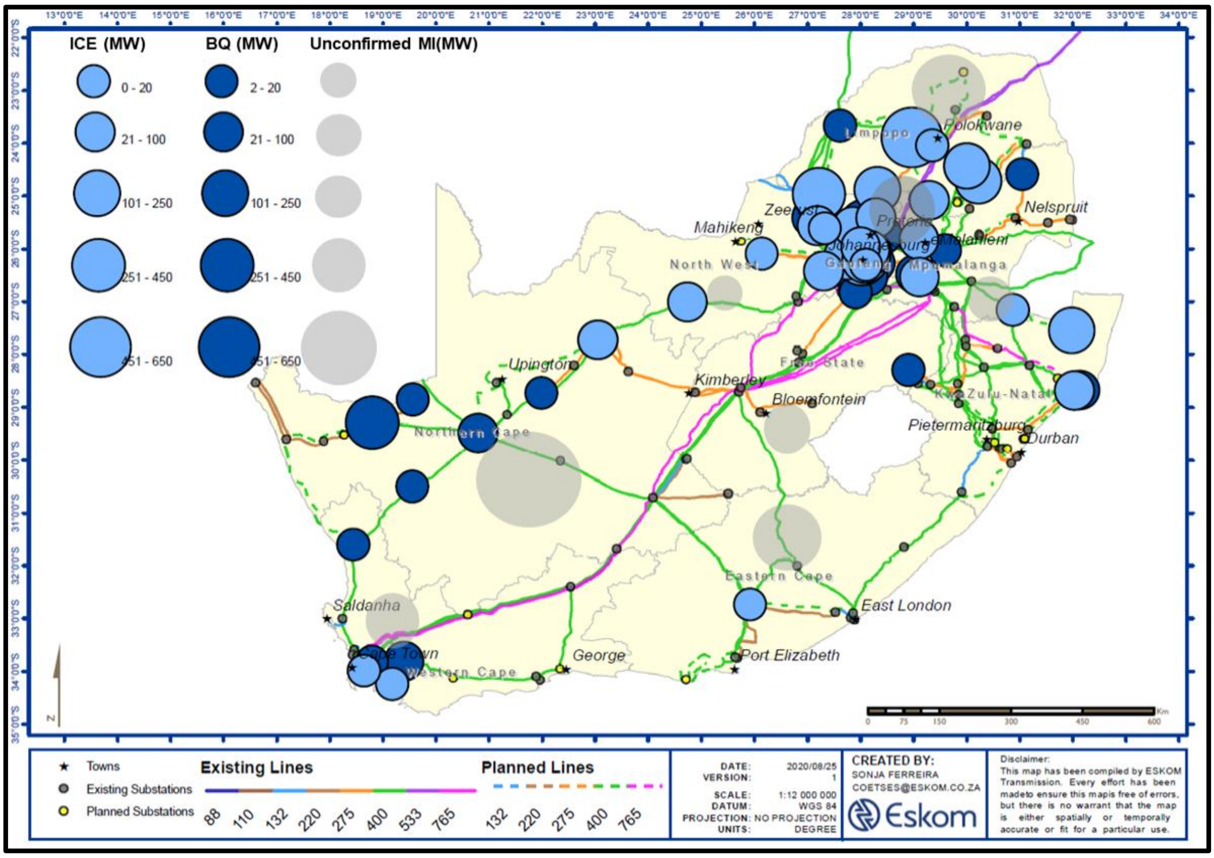


Figure 3-1: Processed customer applications and market intelligence data

This is already an indication that if only the applications are considered, demand growth is inevitable and that electricity is a pivotal point in catalysing growth.

3.3 METHODOLOGY

Policy guidelines are conformed to and in line with Grid Code requirements to deliver an annual transmission forecast. The forecast methodology is focused on scenario planning by looking at different perspectives of the future. A double S-curve methodology, combined with quantitative and qualitative techniques, is used to produce the national forecast scenarios. The scenarios are tested against external forecasts such as the IRP and also aligned with Eskom Distribution forecasts.

The demand forecast is based on the collaborated modelling of both quantitative and qualitative techniques. Quantitative analysis is done on actual data received from in-house metering systems, customer quotations processes, and economic forecasts from service providers. Qualitative analysis is conducted using scenario exploration and using external market information sourced from assigned platforms, such as Fitch Solutions and Econometrix. Continuous scanning and monitoring of market information are further used to forecast possible future demand. Such projections are subject to market influences and contingent upon matters outside the demand forecasters' control and therefore may not be realised in the future. Historical demand growth patterns are no guarantee of future performance. Availability of generation supply is closely correlated with demand growth in the country and will have a significant influence on future demand realisation. The forecast is continuously monitored closely, and any financial decisions should be based on sensitivity analysis encompassing all relevant and most recent information sets.

3.4 NATIONAL FORECAST

Four distinct national scenarios were created, each with its own set of assumptions.

3.4.1 HIGH SCENARIO – "FLY HIGH AND ENABLE"

The high scenario is based on assumptions that take South Africa to being a developed country as specified by the NDP and, therefore, indicates optimistic growth figures. The high scenario is in line with projected GDP growth of 3.5% average year-on-year growth expected for the TDP period 2021 to 2030. 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. Average annual growth in demand over the TDP period is estimated at 2.8%. From 2022 onwards, the generation of Ingula, Medupi, and Kusile power stations will be increasingly available to the system, and it is assumed that the combination of other potential generation sources will become available as well in order to meet the future demand to enable economic growth for the country. This scenario leads to a nominal capacity forecast of 46 GW by the end of the TDP period and 65 GW in 2040.

3.4.2 Moderate High Scenario – "Fly With Caution, Enable and Collaborate with Off-Grid Solutions"

The moderate-high scenario is based on an explorative approach where the growth trend experienced in the past is simulated into the future. This scenario is still in line with the NDP requirements of a 65 GW target. This scenario foresees the return of main industries in South Africa, however, at a slower, steady pace. An average year-on-year demand growth of 2% is expected, and it is forecasted that the load will reach 42 GW by the end of the TDP period, 57 GW by 2040, and 65 GW by 2050.

3.4.3 Medium (Energy Efficient) Scenario – "Sharing the Energy Supply Market"

The medium (energy efficient) scenario is where there is an increase in uptake on alternative energy generation associated with an increase in energy efficiency. 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 as provided by the country's power utility. This scenario leads to a nominal capacity forecast of 40 GW by the end of the TDP period, with a final forecasted value of 47 GW in 2040.

3.4.4 Low Scenario - "Losing Market Share in the Industry, Lagging Economy"

The low scenario is based on assumptions that there will be a continued suppressed development rate in the country, and most of the industries will not return to their original status. This is a pessimistic view with a year-on-year growth rate of 0.6% and relates to the low economic growth of below 1% in GDP. This forecast leads to 35 GW towards the end of the TDP period and 38 GW in 2040.

Figure 3-2 describes the four Transmission demand forecast scenarios. The scenarios are depicted in a four-quadrant matrix indicating the relation of each scenario regarding grid connectivity vs energy efficiency and technological innovation.

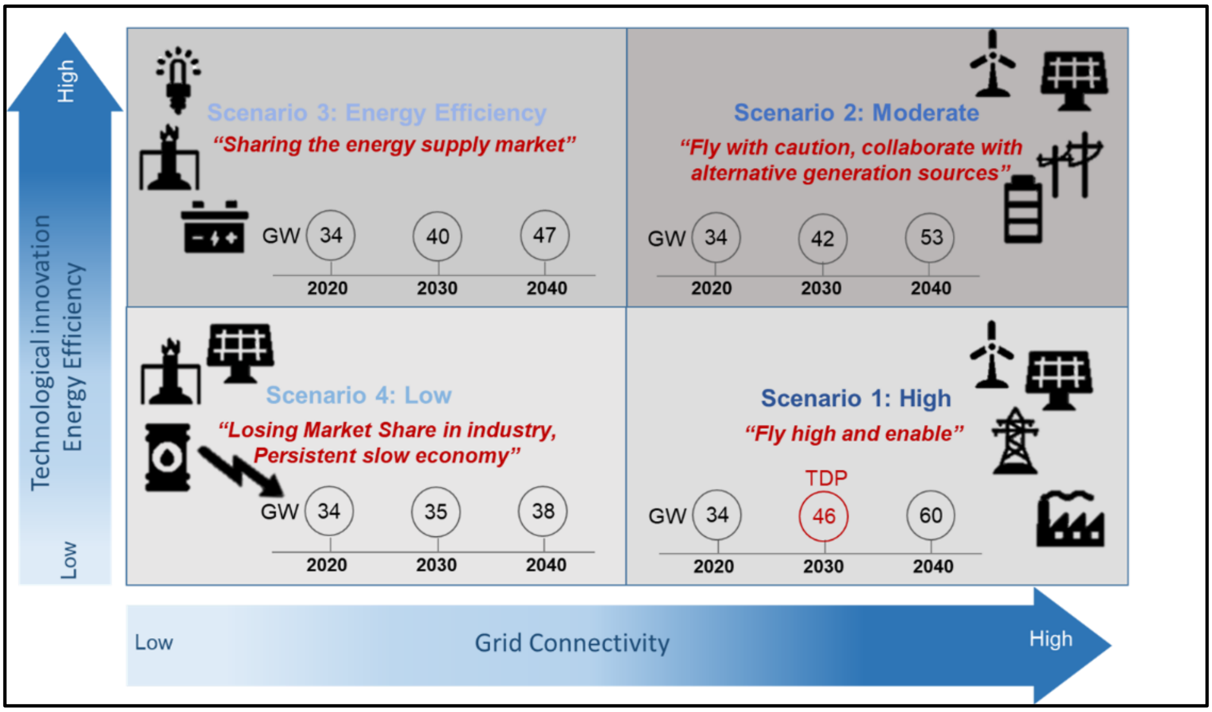
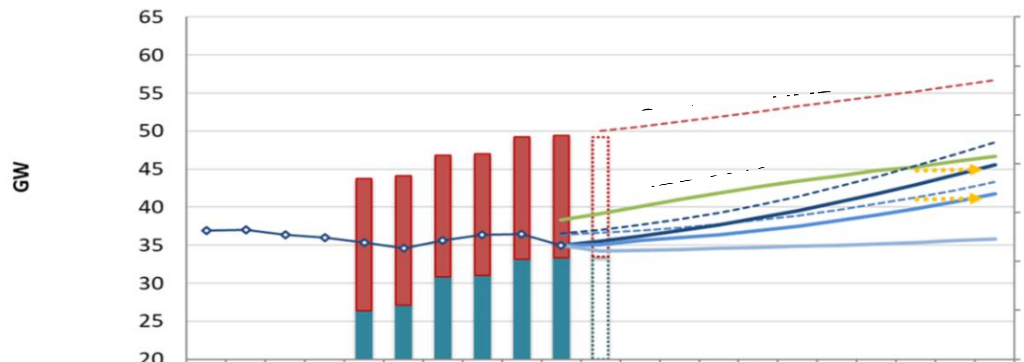


Figure 3-2: Summary of Transmission demand forecast scenarios

3.5 COMPARISON OF FORECASTS

Figure 3-3 shows the transmission demand forecast (2019 and 2020) vs the IRP 2019 demand forecast and the actual customer notified maximum demand (NMD) forecast. Only three of the four transmission forecast scenarios are displayed as the second and third scenarios are closely related within the TDP period.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
KSACS Customer NMD (GW)					17	17	16	16	16	16	16										
Distribution Customer NMD (GW)					26	27	31	31	33	33	33										
2019 IRP HLI Demand (GW)										38	39	40	41	42	43	43	44	45	45	46	47
2019 Tx Moderate High										36	37	37	37	38	38	39	40	40	41	42	43
2020 Tx High										35	36	36	37	38	39	40	41	42	43	44	46
2020 Tx Moderate High										35	35	36	36	36	37	38	38	39	40	41	42
2020 Tx Low										35	34	34	34	35	35	35	35	35	35	36	36
2019 Tx High										37	37	38	38	39	40	41	43	44	45	47	49
Actual Peak Demand (GW) *	37	37	36	36	35	35	36	36	36	35											
Customer Growth Projection at 1,3%											50	51	51	52	53	53	54	55	55	56	57

Instantaneous Peak Demand

Figure 3-3: Comparison of the forecast with IRP 2019 forecast and NMD forecast

The IRP 2019 forecast includes other electricity sources used in South Africa and therefore has a slightly higher start-off point than all of the Transmission demand forecast scenarios.

From the notified maximum demands, it is observed that the Distribution customers' NMD is still growing at an average annual growth rate of more than 1.3%. However, there is a decrease in the Transmission key customers' NMD mainly due to large customers, such as Saldanha Steel, that have shut down or are in the process of winding down operations.

There is a decrease of 4% from the 2019 forecasted values to the actual peak demand as indicated by the dotted lines. This is mainly due to a major slowdown in economic growth and severe load shedding throughout 2019 due to capacity constraints and planned maintenance on generation plants. The IRP 2019 forecast and the Transmission high scenario merge at the end of the TDP period. It is therefore recommended that the high scenario be adopted for planning at a national level and the moderate-high scenario will be used for detailed substation planning.

3.6 PROVINCIAL FORECAST

The Transmission national forecast is disaggregated into the demand forecast per province, per customer load network (CLN) and transmission substation. Figure 3-4 shows the load density and growth prospects per province. It indicates the change in growth prospects from the 2019 TDP to 2020 TDP forecast and subsequent growths per province for high and moderate-high scenarios. Details of the provincial forecasts can be found in Chapter 7, PROVINCIAL DEVELOPMENT PLANS.

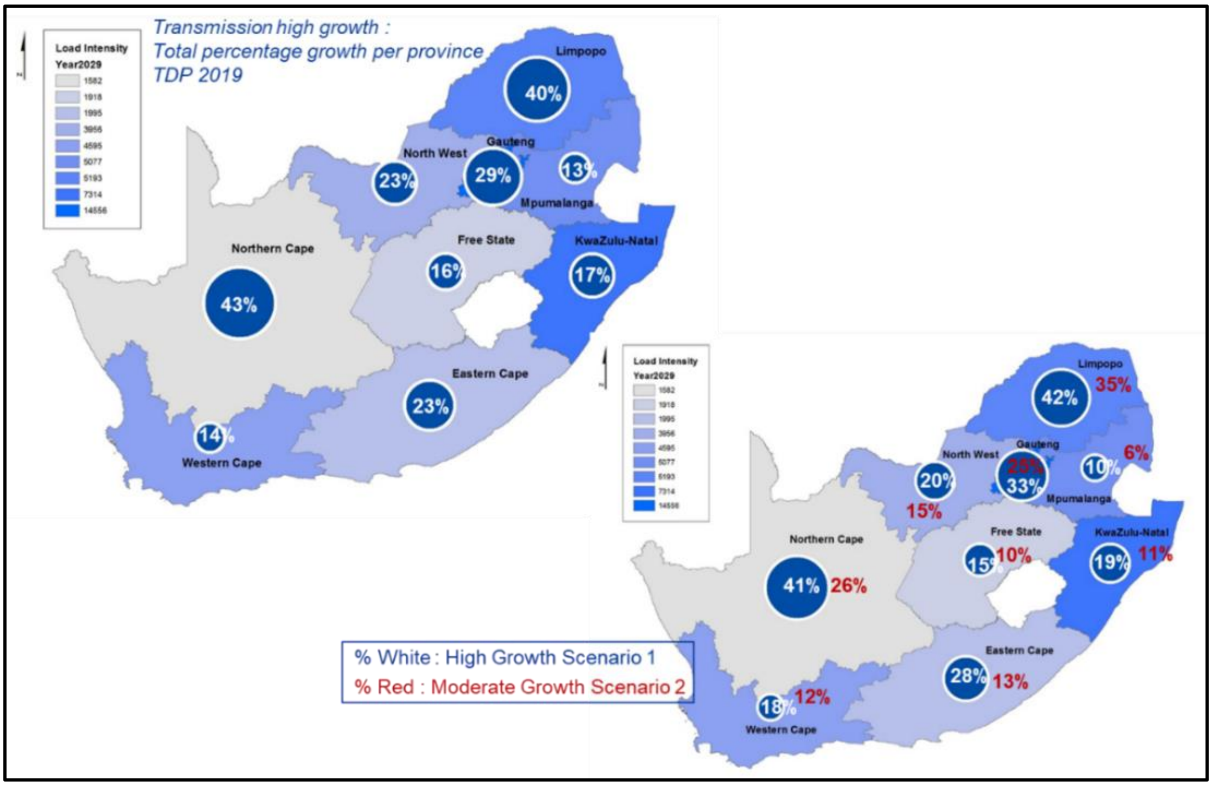


Figure 3-4: Provincial demand forecasts

3.7 IMPACT OF COVID-19 PANDEMIC AND ECONOMIC OUTLOOK

In this year's forecast cycle, a major disrupter was the worldwide COVID-19 pandemic and a double downgrade in the financial status of South Africa by two major financial institutions. COVID-19 has caused tremendous disruption throughout the world economy. The further downturn on the South African GDP is expected due to the economic effects of the lockdown implemented by government.

The short-term effect of the COVID-19 pandemic has led to a further decline in growth projections for the world and South African economy alike. GDP forecasts started at -2% and soon deteriorated to as bad as -10 % for 2020, with slow recovery in 2021 to 0.9% and 2%.

Figure 3-5 shows the national forecast from three renowned econometric forecast companies used by Transmission. All of these forecasts indicate a high likelihood of a fast recovery. This is similar to the outlook of most worldwide countries.

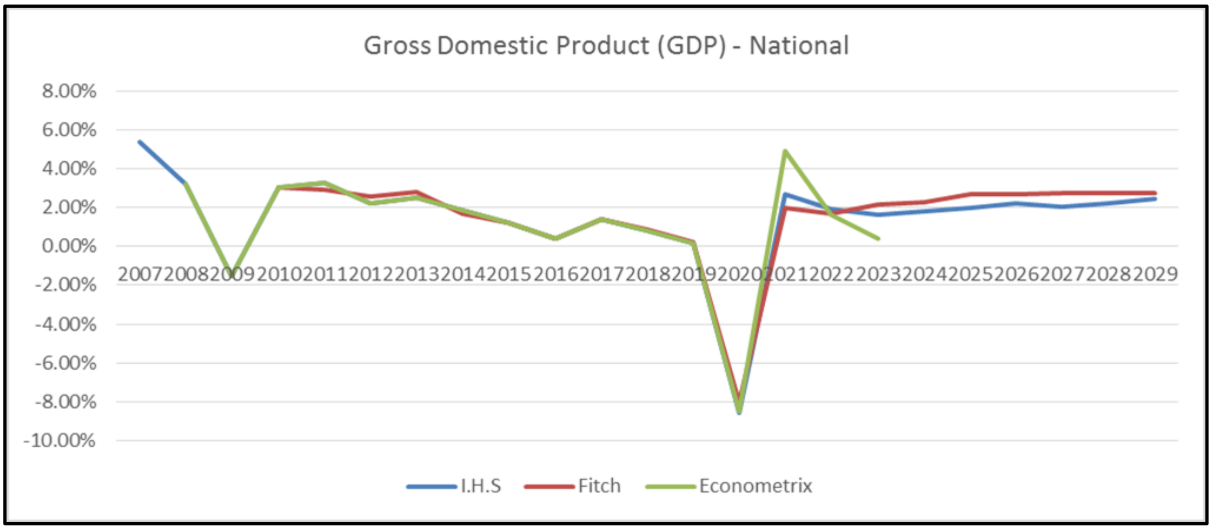
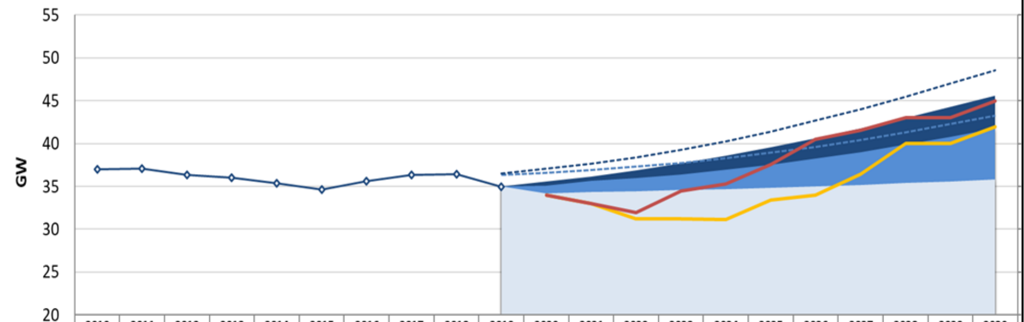


Figure 3-5: GDP projections for South Africa (August 2020)

Figure 3-6 below shows two forecast scenarios when taking COVID-19 economic repercussions into account in the short to medium term. COVID-19 Scenario 1 expects a fast recovery and predicts that the forecast will decline for the following two years and then start to regain momentum towards the original enabling environment of demand growth fuelled by sufficient electricity generation and transmission investment. This scenario leads to a nominal capacity forecast of 45 GW by the end of the TDP period.

COVID-19 Scenario 2 assumes a slower return of industry with a more severe knock to South Africa's economy, which will see a downward trend in demand that only regains momentum around 2024/25. This scenario leads to a nominal capacity forecast of 42 GW by the end of the TDP period.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
2020 Tx High										35	36	36	37	38	39	40	41	42	43	44	46
2020 Tx Moderate High										35	35	36	36	36	37	38	38	39	40	41	42
2020 Tx Low										35	34	34	34	35	35	35	35	35	35	36	36
2019 Tx Moderate High										36	37	37	37	38	38	39	40	40	41	42	43
2019 Tx High										37	37	38	38	39	40	41	43	44	45	47	49
Actual Peak Demand (GW) *	37	37	36	36	35	35	36	36	36	35											
Covid Scenario 2											34	33	31	31	31	33	34	36	40	40	42
Covid Scenario 1											34	33	32	34	35	38	40	42	43	43	45

Figure 3-6: Transmission demand COVID-19 scenarios overlaid on TDP scenarios

It is recommended that the preferred high forecast scenario is still adopted with sensitivity analysis done using the moderate-high forecast in those areas, especially where the impact on commercial, industrial, and mining sectors is significant.

Due to the harsh economic circumstances, capital constraints also have to be taken into account when making strategic investment decisions. The long-term effects are still under investigation and will have to be closely tracked and monitored to establish the exact impact on the future forecasts.

4 COMPLETED PROJECTS

A summary of transmission expansion projects completed since publication of the previous TDP in 2019 is shown in Table 4-1. The project lists exclude all the dedicated components of the projects resulting from the customer connection applications received.

Table 4-1: List of completed transmission expansion projects since October 2019

Province	Project name	Substation
Eastern Cape	Nxuba IPP Integration	Poseidon
	Golden Valley IPP Integration	Poseidon
Limpopo	Dwarsberg Strengthening: 132 kV Switching Station	Dwarsberg
North West	Waterloo IPP Integration	Mookodi
Northern Cape	Konkoonsies II IPP Integration	Paulputs
	Aggeneis Orlight IPP Integration	Aggeneis
	Kangnas IPP Integration	Aggeneis
	Sirius IPP Integration	Upington
Western Cape	Perdekraal East 110 MW Wind Farm Integration	Kappa

The Dwarsberg Strengthening project now provides additional reliability to Distribution customers as well as the Botswana Power Corporation (BPC). All of the IPP integration projects listed above facilitated the integration of over 700 MW of RE generation onto the national grid.

5 CUSTOMER APPLICATIONS

Table 5-1 outlines the number of ICEs and budget quotations processed by Transmission during the 2019/20 financial year (April 2019 to March 2020). These were as a result of applications for grid connections to the transmission network. The identities of individual applicants are not reported on, to protect the confidentiality of the parties involved.

The number of connection applications received was 96, which was marginally lower than the 2018/19 financial year of 114.

Table 5-1: Connection applications received and accepted in the FY2019/2020

Quotation type	Indicative cost estimates		Budget quotations	
	Received	Accepted	Received	Accepted
Generation	48	0	4	0
Load	36	9	8	1
Total	84	9	12	1

6 NATIONAL OVERVIEW

Significant lengths of new transmission lines and associated substations and substation equipment are being added to the system. These additions are mainly due to the major 765 kV network reinforcements required for the supply to the Cape and KwaZulu-Natal, 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 country’s major load centres. 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 future generation 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 indicates 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 in the Grid Code. Further transformation capacity is also required at several substations to enable the integration of RE generation into the transmission network.

Shunt capacitors are required to support the network under contingency conditions to ensure that the required voltage levels are maintained and defer more expensive network strengthening, such as additional transmission lines. Maintaining of voltages at desired levels also improves system efficiency by reducing network losses. Additional shunt reactors and line reactors are required due to the length of the 765 kV and the 400 kV transmission lines that will be constructed over this period. They are needed to enable the safe and secure operation of the system and to prevent overvoltage during light loading conditions and line switching operations.

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

The map in Figure 6-1 shows a high-level view of the major TDP scheme projects. The relative location of the new transmission lines and associated transmission substations is indicated schematically in the figure.

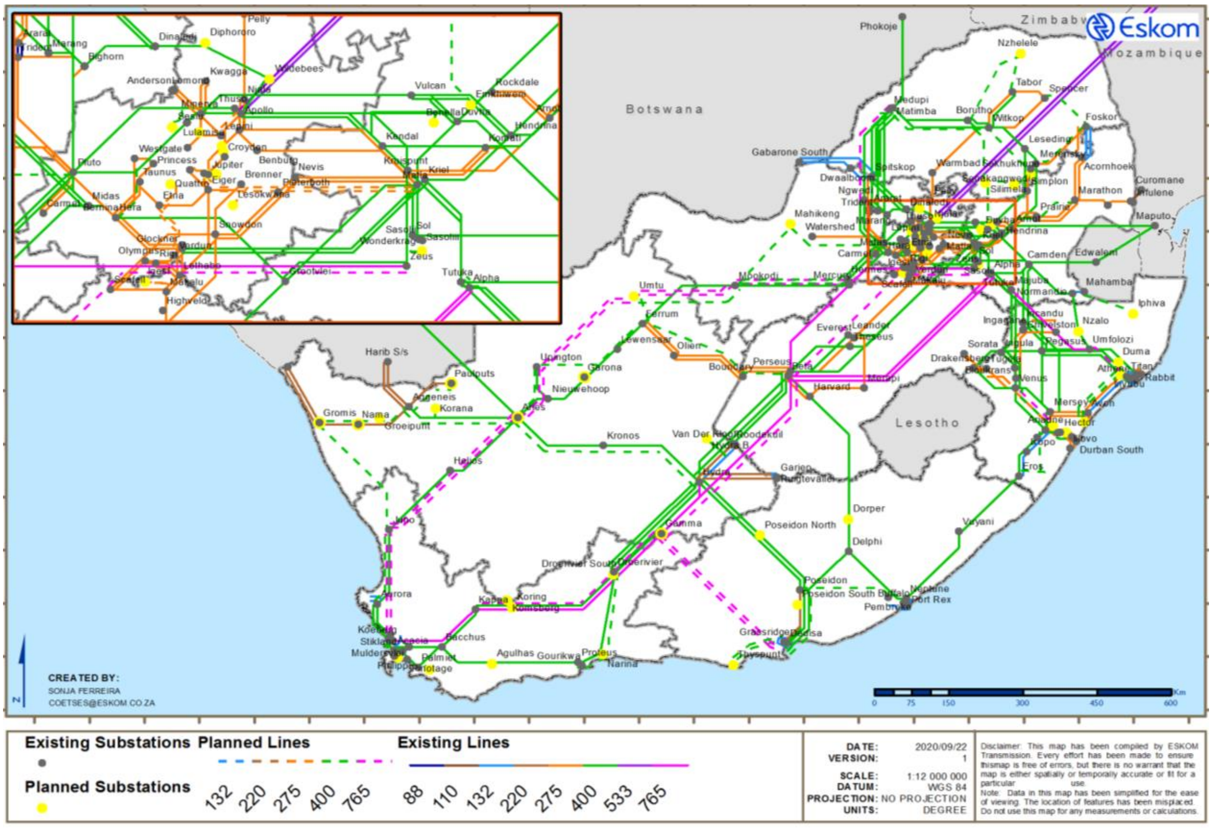


Figure 6-1: High-level overview of the major TDP scheme projects

The major new assets that have either been approved or are planned to be added to the TS over the next 10 years are summarised in Table 6-1 to Table 6-4. For the most part, this excludes the assets associated with the alternative generation and future IPP projects.

Table 6-1: Planned transformers for TDP period

Transformer type	2021-2025		2026-2030	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
125 MVA 275/132/22 kV	2	250	-	-
160 MVA 132/66/22 kV	-	-	1	160
160 MVA 400/88/22 kV	3	480	-	-
20 MVA 132/6,6 kV	-	-	1	20
2 000 MVA 765/400/33 kV	-	-	3	6 000
250 MVA 275/132/22 kV	2	500	-	-
250 MVA 400/132/22 kV	2	500	2	500
315 MVA 275/88/22 kV	3	945	3	945
315 MVA 400/88/22 kV	-	-	2	630
400 MVA 400/275/22 kV	-	-	1	400
500 MVA 275/132/22 kV	3	1 500	1	500
500 MVA 400/132/22 kV	29	14 500	46	23 000
800 MVA 400/275/22 kV	-	-	1	800
20 MVA 66/22 kV	1	20	-	-
160 MVA 132/66 kV	-	-	1	160
315 MVA 400/220/22 kV	1	315	-	-
Grand total	**46**	**19 010**	**62**	**33 115**

Table 6-2: Planned overhead lines for TDP period

Line voltage	2021-2025	2026-2030
	Total length (km)	Total length (km)
275 kV	29	43
400 kV	3 188	3 008
765 kV	306	1 682
Grand total	**3 523**	**4 733**

Table 6-3: Planned capacitor banks for TDP period

Capacitor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	4	400	-	-
40 Mvar 132 kV	2	80	2	80
48 Mvar 88 kV	-	-	26	1 248
72 Mvar 132 kV	-	-	19	1 368
400 Mvar 400 kV	-	-	1	400
Grand total	**6**	**480**	**48**	**3 096**

Table 6-4: Planned reactors for TDP period

Reactor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	14	1 400	10	1 000
400 Mvar 765 kV	-	-	7	2 800
Grand total	**14**	**1 400**	**17**	**3 800**

7 PROVINCIAL DEVELOPMENT PLANS

7.1 EASTERN CAPE

Eastern Cape is South Africa's second-largest province by landmass and is located on the county's south-eastern coast. The capital city of Eastern Cape is Bhisho, and 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 Eastern Cape's urban areas. The 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 desirable wind energy sources, the Eastern Cape has attracted a significant share of the RE projects procured to date. It is also expected that the majority of future generation from wind energy will be located in this province.

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 number of in-feeds into East London consists of three 400 kV lines and a single 220 kV line to Bhisho. The current transmission network is shown in Figure 7-1

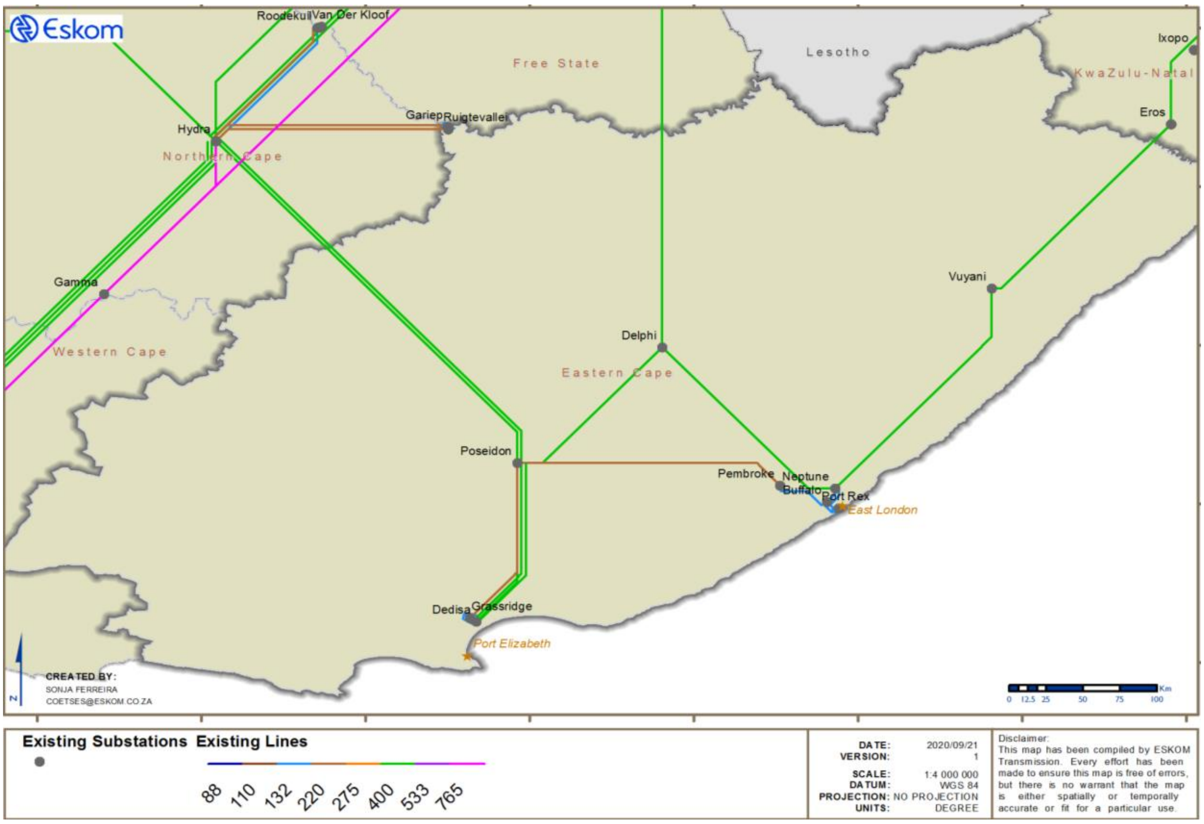


Figure 7-1: Current Eastern Cape transmission network

7.1.1 Generation

Historically, the Eastern Cape did not have a huge amount of local generation. 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, which is located on the provincial border of Northern Cape 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. In recent times, the national power deficit has resulted in these peaking plant power stations generating outside the typical peak periods.

The total approved capacity in the Eastern Cape since the introduction of renewable energy independent power producers (REIPP) in the province amounts to 1 596 MW. The composition is shown in Table 7-1 below.

Table 7-1: Approved projects in the Eastern Cape under the REIPPPP

Programme and bid window	Wind (MW)	PV (MW)	Grand total (MW)
IPP RE 1	485	0	485
IPP RE 2	414	70	484
IPP RE 3	197	0	197
IPP RE 4	397	0	397
IPP RE 4B	33	0	33
Grand total	**1 526**	**70**	**1 596**

7.1.2 Load Forecast

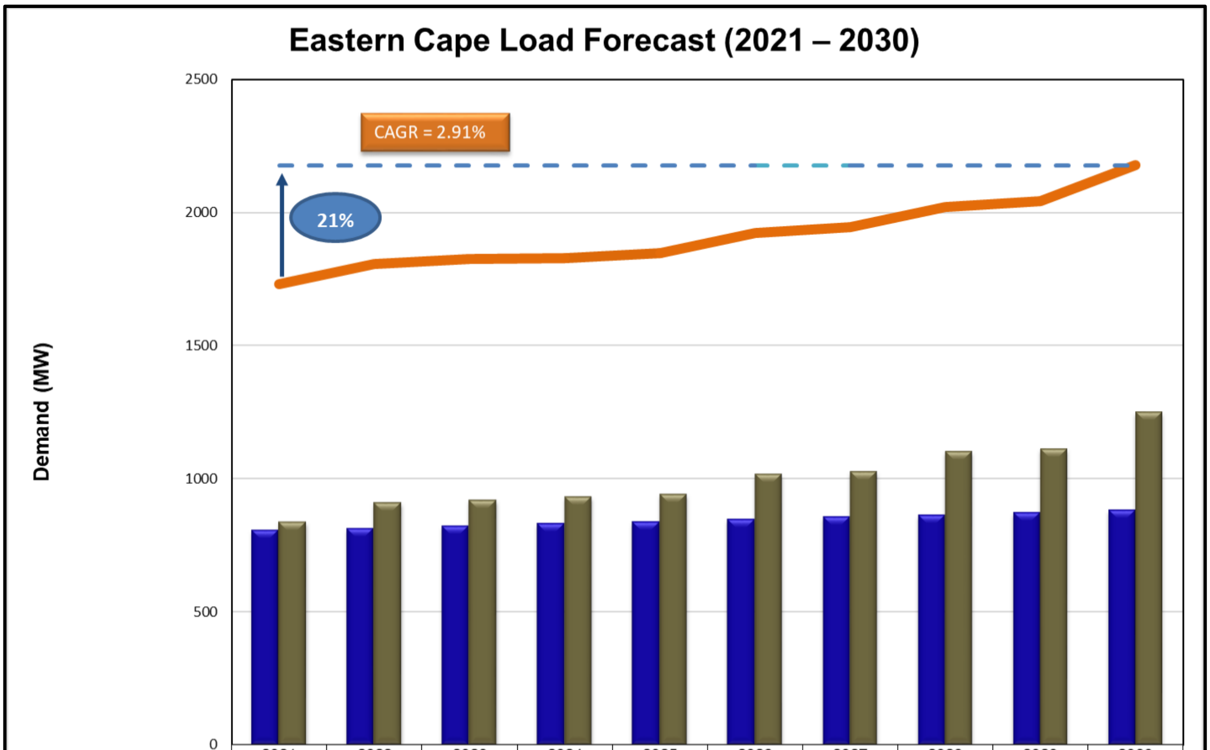
The provincial load for the Eastern Cape peaked at around 1 700 MW in 2019, and it is expected to increase to about 2 177 MW by 2030. The province’s major economic drivers are the manufacturing sector, construction, the renewable IPP sector, and supporting industries. The rate of load growth has reduced 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, commercial and residential developments.

There is a high potential for developments in the Nelson Mandela Bay Metro in the port of Ngqura, popularly known as Coega. As a result, the peak demand for electricity in the Port

Elizabeth area is forecasted to increase from 827 MW to about 1 250 MW in the next 10 years. The bulk of the expected load increase in the CLN is attributable to the industrial development at Coega.

The East London CLN has a mixture of rural and urban loads. Most of the rural electrification is anticipated in the northern parts of East London CLN, in and around the Mthatha area. The Vuyani Substation and associated 400 kV supply lines are expected to unlock future electrification in the Mthatha area. Vuyani Substation's capacity also has the potential to support and unlock capacity for the electrification in the area.

The load forecast for the Eastern Cape is shown in Figure 7-2.



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
East London CLN	805	813	821	829	838	846	854	863	872	880
Port Elizabeth CLN	836	910	920	930	941	1015	1026	1100	1111	1250
Grid Peak	1732	1808	1827	1828	1847	1924	1944	2021	2042	2177
2030 Peak	2177	2177	2177	2177	2177	2177	2177	2177	2177	2177

Figure 7-2: Eastern Cape load forecast

7.1.3 PLANNED PROJECTS

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

7.1.3.1 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 and building the Neptune-Pembroke 400 kV line and installing the first 400/132 kV 500 MVA transformer. The Greater East London Strengthening Phase 4 will introduce the second 400 kV corridor into Pembroke; construction of the Poseidon-Pembroke 400 kV line and installing the second 500 MVA 400/132 kV transformer.

Southern Grid Strengthening Phase 3 and 4

Southern Grid Strengthening Phase 3 entails introducing 765 kV into the Eastern Cape by means of the first Gamma-Grassridge 765 kV line. The Southern Grid Strengthening Phase 4 introduces the second Gamma-Grassridge 765 kV line.

7.1.3.2 New Substations

The low voltages under network contingencies at Pembroke Substation and the underlying network will necessitate the introduction of 400 kV at Pembroke Substation near King William's Town.

7.1.3.3 New Lines

Pembroke experiences low voltages with the loss of the 220 kV line from Poseidon. A 400 kV injection from Neptune (that is, Neptune-Pembroke 400 kV line) is required to support the 220 kV line from Poseidon. A Poseidon-Pembroke 400 kV line will further strengthen the East London CLN network and assist with the evacuation of generation in the Port Elizabeth CLN.

7.1.3.4 Reactive Power Compensation

There are no reactive power compensation projects (capacitor banks and/or SVCs) planned for the Eastern Cape within the TDP period.

7.1.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period 2021 to 2030.

Table 7-2: Eastern Cape– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Greater EL Phase 3	• Neptune-Pembroke 400 kV line	2022
	• Pembroke first 400/132 kV 500 MVA transformer	2022
	• Pembroke first 132/66kV 160 MVA transformer	2022
Grassridge third 500 MVA 400/132 kV transformer	• Grassridge third 500 MVA 400/132 kV transformer	2023
Dedisa third 500 MVA 400/132 kV transformer	• Dedisa third 500 MVA 400/132 kV transformer	2026
Greater EL Phase 4	• Poseidon-Pembroke 400 kV line	2028
	• Pembroke second 400/132 kV 500 MVA transformer	2028
	• Pembroke second 132/66 kV 160 MVA transformer	2028
Southern Grid Strengthening Phase 3	• First Gamma-Grassridge 765 kV line	2028
Poseidon 80 MVA 132/66 kV transformer	• Poseidon 80 MVA 132/66 kV transformer	TBA
Port Elizabeth Substation Integration	• Port Elizabeth Substation Integration	Deferred

7.1.3.6 Projects for Future Independent Power Producers

The following transmission network strengthening projects will be required to enable the connection of the IPPs located in the province within the current TDP period based on the generation assumptions:

- Dorper 400/132 kV substation between Beta and Delphi
- Introduction of 765 kV at Grassridge Substation
- Poseidon South 400/132 kV Substation between Grassridge and Poseidon
- Thyspunt 400/132 kV Substation
- Poseidon North 400/132 kV Substation at Iziko Series Capacitor Station

The envisaged generation growth in the Port Elizabeth CLN in 2028 will result in undervoltages at Pembroke Substation with some circuits out of service. The construction of Poseidon-Pembroke 400 kV line is expected to have increased generation evacuation through the Vuyani-Eros 400 kV line. The East London CLN will result in low voltage at Pembroke, Neptune, and Vuyani substations under certain network contingencies. Shunt compensation projects that entail the installation of 100 Mvar capacitor banks at 400 kV will be implemented for voltage support at the following substations:

- Pembroke;
- Neptune; and
- Vuyani.

The following strengthening projects are required to facilitate future IPP integration for the period 2021 to 2030.

Table 7-3: Eastern Cape – projects required to facilitate IPP integration

TDP scheme	Project name	Required CO year
Poseidon North 400/132 kV	• Poseidon North new 400/132 kV Substation at Iziko Series Capacitor Station	2029
Poseidon South 400/132 kV	• Poseidon South 400/132 kV and loop-in between Grassridge and Poseidon	2029
Thyspunt 400/132 kV Substation and 400 kV lines	• Thyspunt new 400/132 kV Substation and 400 kV lines	2029
Dorper 400/132 kV Substation	• Dorper new 400/132 kV Substation and loop-in between Beta and Delphi	2029
East London voltage support: 100 Mvar Shunt Cap Banks at Pembroke, Neptune, and Vuyani	• 100 Mvar Shunt Cap Banks at Pembroke, Neptune, and Vuyani	2029
Southern Grid Strengthening Phase 4	• Second Gamma-Grassridge 765 kV line	2030

7.1.3.7 Projects for Alternative Generation Scenario

There has been interest shown in the integration of generation from natural gas close to Coega Industrial Development Zone (IDZ), amounting to approximately 3 000 MW. The proposed plan includes the assessment to determine the impact on the transmission network within Eastern Cape if all the proposed 3 000 MW gas located in Port Elizabeth is connected by 2030. The following additional transmission network strengthening projects will be required to enable the evacuation of the gas generation from the province:

- Establish a new Coega 400 kV HV yard with 400 kV busbar
- Coega-Grassridge 400 kV line
- 2 x Coega-Dedisa 400 kV lines
- Coega-Poseidon 400 kV line
- Gamma-Grassridge 765 kV line 1 & 2 in 2028 and 2030 respectively
- Grassridge Substation 132 kV fault current limiting reactors

7.1.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-3 below.

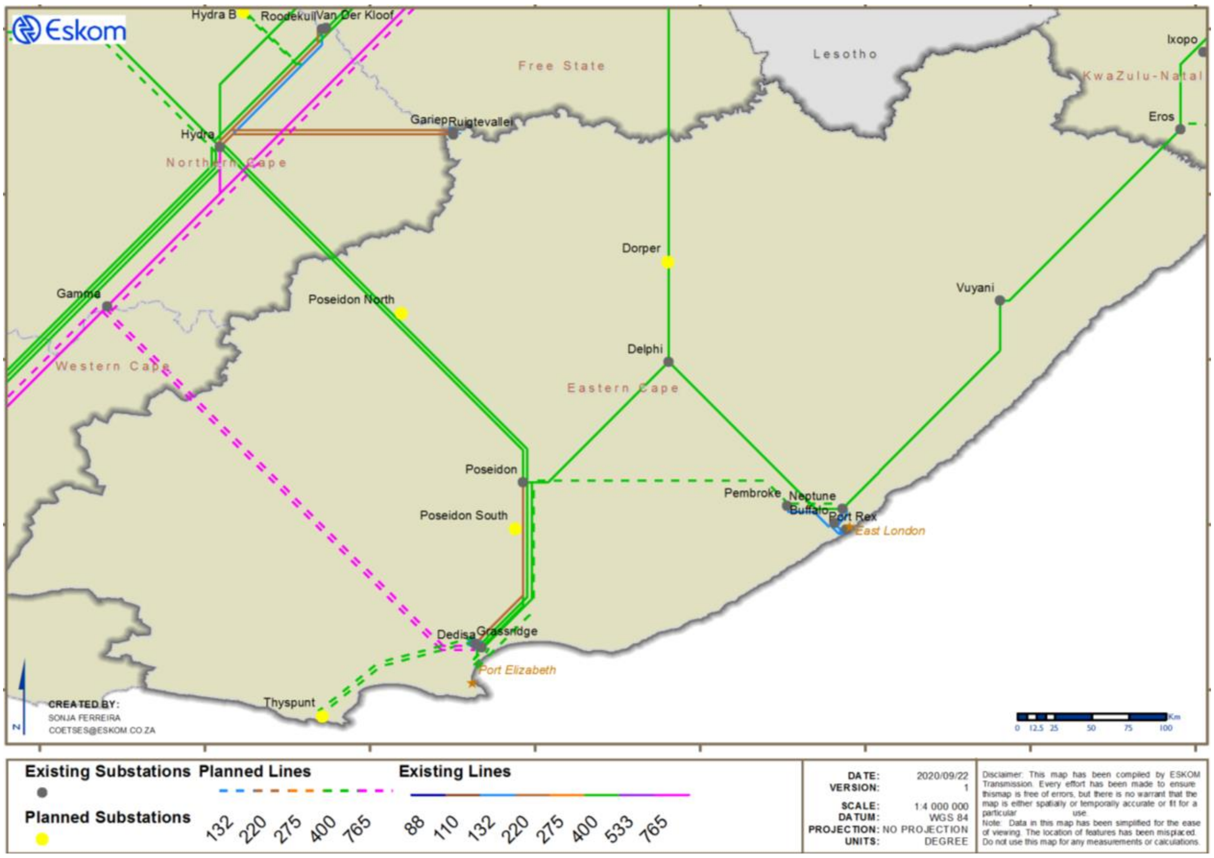


Figure 7-3: Future Eastern Cape transmission network

A summary of all new major assets planned for this province is provided in Table 7-4 to Table 7-6. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-4: Planned transformers for the Eastern Cape

Transformer type	2021-2025		2026-2030	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
160 MVA 132/66/22 kV	-	-	1	160
20 MVA 132/6,6 kV	-	-	1	20
2000 MVA 765/400/33 kV	-	-	2	4 000
500 MVA 400/132/22 kV	-	-	10	5 000
160 MVA 132/66 kV	-	-	1	160
Grand total	**-**	**-**	**15**	**9 340**

Table 7-5: Planned overhead lines for the Eastern Cape

Line voltage	2021-2025	2026-2030
	Total length (km)	Total length (km)
400 kV	20	395
765 kV	-	702
Grand total	**20**	**1 097**

Table 7-6: Planned reactors for the Eastern Cape

Reactor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	-	-	1	100
400 Mvar 765 kV	-	-	3	1200
Grand total	**-**	**-**	**4**	**1300**

7.2 FREE STATE

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

Important road and rail links traverse the province, including two of the busiest national highways, the N1 (Cape Town-Johannesburg) and the N3 (Durban-Johannesburg). There are plans to leverage this advantage by creating 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 province has a number of development plans including several 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 7-4. The 765 kV network is primarily used to transmit power through the province to the Cape.

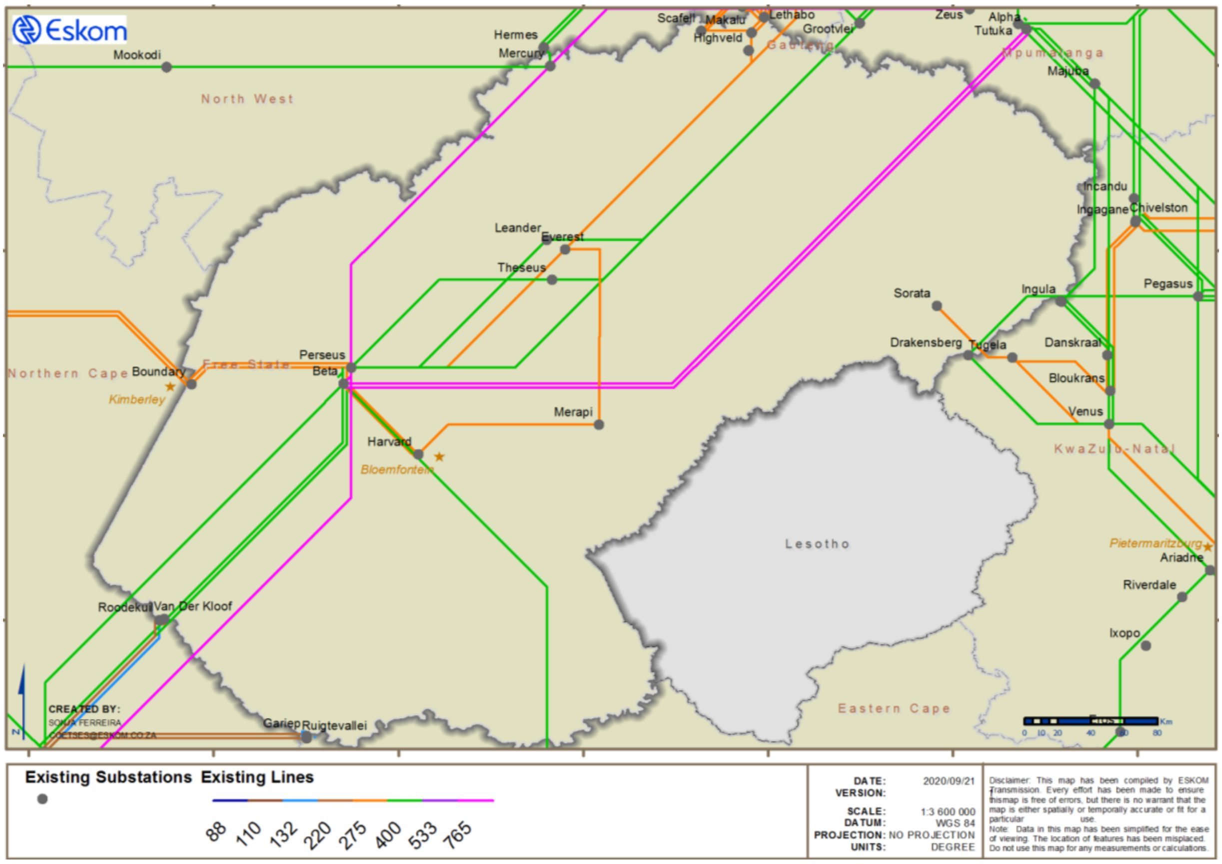


Figure 7-4: Current Free State transmission network

7.2.1 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.

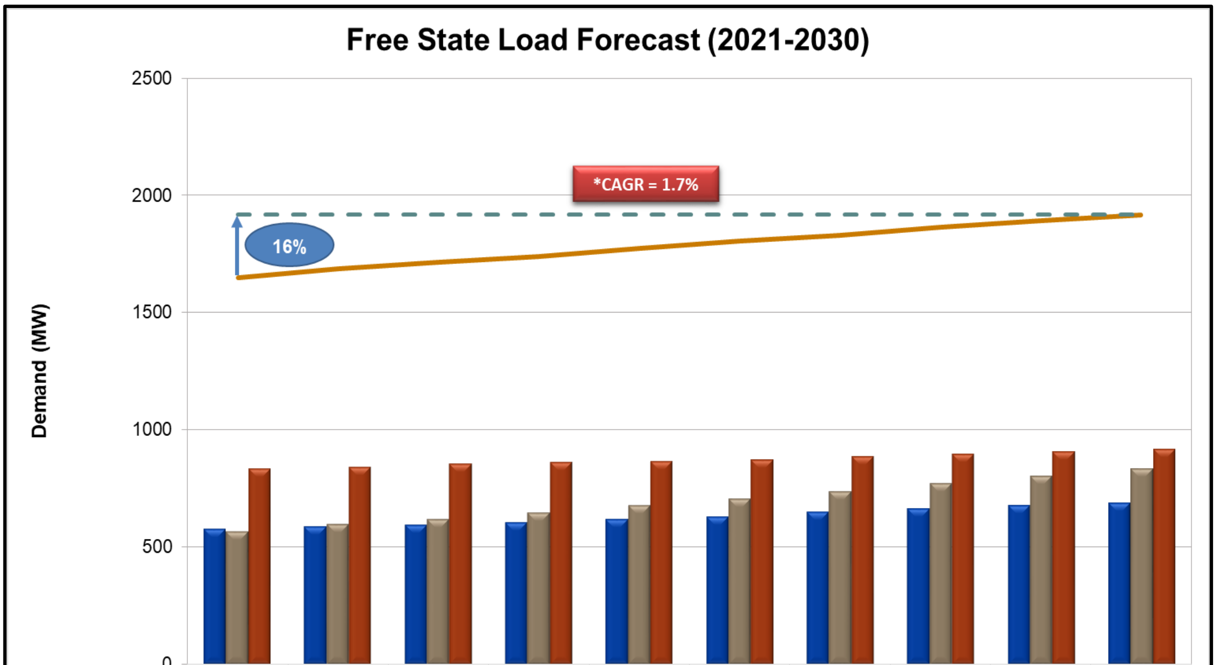
IPPs have shown interest in solar generation in the province, especially in its western parts. Approximately 203 MW of IPPs (PV and small hydroelectric plants) have been integrated into the grid since the inception of the REIPPPP. The current composition of the RE in the Free State is 199 MW PV plants and 4.4 MW hydroelectric plants. The composition is shown in Table 7-7.

Table 7-7: Approved projects in the Free State under the REIPPPP

Programme and bid window	Small hydro (MW)	PV (MW)	Grand total (MW)
IPP RE 1	0	64	64
IPP RE 2	4.4	60	64.4
IPP RE 3	0	75	75
IPP RE 4	0	0	0
IPP RE 4B	0	0	0
Grand total	**4.4**	**199**	**203.4**

7.2.2 Load Forecast

The Free State's economic mix is predominantly comprised of mining, commercial customers, and residential customers. The provincial load peaked at around 1 499 MW in 2019, and it is forecasted to grow steadily at approximately 1.7% annually, from 1 650 MW in 2021 to 1 918 MW by 2030. The Free State comprises three CLNs, namely Sasolburg, Bloemfontein, and Welkom. The Welkom CLN consumed approximately 41.3% of the load. Sasolburg and Bloemfontein CLNs make up the remaining 58.7% of the demand in the province. The highest provincial load growth is expected in the Sasolburg CLN. The load forecast for the Free State is shown in Figure 7-5.



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Bloemfontein	574	585	593	603	616	627	650	663	676	686
Sasolburg	564	595	618	645	676	705	734	771	801	834
Welkom	832	839	852	860	863	870	885	895	906	915
Grid Peak	1650	1686	1716	1740	1774	1804	1831	1864	1893	1918
2030 Peak	1918	1918	1918	1918	1918	1918	1918	1918	1918	1918

Figure 7-5: Free State load forecast

7.2.3 Planned Projects

7.2.3.1 Major Schemes

The major projects for the Free State mainly involve overlaying the existing 275 kV networks with 400 kV networks to increase the power transfers into the respective load centres.

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.

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 implementation of each stage will depend on demand growth (generation and/or load) and strengthening requirements in the Bloemfontein CLN.

Harrismith Strengthening Phase 1

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

Sorata Substation Strengthening

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

Makalu Substation Strengthening

This project involves establishing Igesi 275/88 kV Substation and looping into one of the Lethabo-Makalu 275 kV lines to create Lethabo-Igesi and Igesi-Makalu 275 kV lines.

7.2.3.2 New Substations

Igesi 275/88 kV Substation will be established in the province to deload Makalu Substation. It will also assist to reduce the network fault levels around Makalu Substation.

7.2.3.3 New Lines

A second Sorata-Tugela 275 kV line (built at 400 kV and operated at 275 kV) will be constructed as part of the Sorata Substation Strengthening.

7.2.3.4 Reactive Power Compensation

There are no reactive power compensation projects (capacitor banks and/or SVCs) planned for the Free State within the TDP period.

7.2.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period 2021 to 2030.

Table 7-8: Free State– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Bloemfontein Strengthening Phase 1B	• Construct Everest-Merapi 400 kV line (operated at 275 kV)	2020
Bloemfontein Strengthening Phase 2A	• Construct 2 x Beta-Harvard 400 kV lines • Install 2 x 500 MVA 400/132 kV transformers at Harvard Substation	2034
Harrismith Strengthening Phase 1	• Install first 275/132 kV 250 MVA transformer at Sorata Substation and operate Tugela-Sorata at 275 kV	2020
Makalu Strengthening	• Establish 2 x 315 MVA 275/88 kV Igesi Substation • Loop-in one of Lethabo-Makalu 275 kV lines into Igesi Substation	2025
Sorata Substation Strengthening	• Recycle Groenkop-Tugela 132 kV line 1 and construct Sorata-Tugela 400 kV line (operated at 275 kV) • Install second 275/132 kV 250 MVA transformer at Sorata Substation	2029

7.2.3.6 Projects for Future Independent Power Producers

A 500 MVA 400/132 kV substation near Dealesville will be required to enable the connection of the IPPs located in the province within the current TDP period based on the generation assumptions.

Table 7-9: Free State - projects required to facilitate IPP integration

Project name	Required CO year
500 MVA 400/132 kV substation near Dealesville	December 2020

7.2.3.7 Projects for Alternative Generation Scenario

There is no alternative generation scenario identified for the Free State.

7.2.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-6 below.

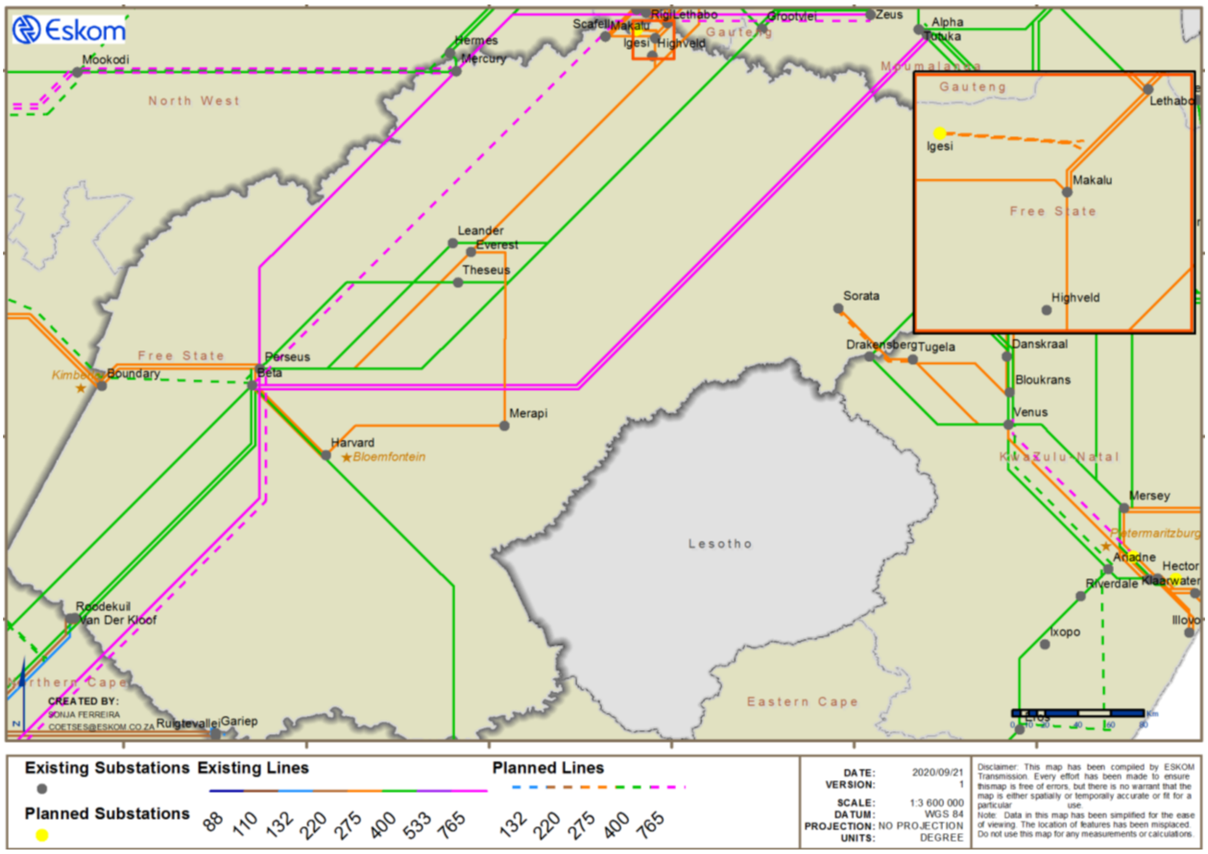


Figure 7-6: Future Free State transmission network

A summary of all new major assets planned for this province is provided in Table 7-10 to Table 7-12. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-10: Planned transformers for the Free State

Transformer type	2021-2025		2026-2030	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
250 MVA 400/132/22 kV	-	-	1	250
315 MVA 275/88/22 kV	2	630	-	-
500 MVA 275/132/22 kV	1	500	-	-
500 MVA 400/132/22 kV	-	-	4	2 000
Grand total	**3**	**1 130**	**5**	**2 250**

Table 7-11: Planned Overhead Lines for the Free State

Line voltage	2021-2025	2026-2030
	Total length (km)	Total length (km)
275 kV	14	-
400 kV	2	309
Grand total	**16**	**309**

Table 7-12: Planned reactors for the Free State

Reactor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	-	-	1	100
Grand total	**-**	**-**	**1**	**100**

7.3 GAUTENG

Gauteng is located on the north-eastern part of South Africa. Despite it being the smallest province in the country, it is the economic hub of the country, a gateway to Africa, and the most populous province in South Africa. The capital of the province is Johannesburg. The economic mix in the province comprises the residential sector, gold mines, commercial and service customers, as well as industrial, technology and logistics customers. Redistributors (metros and municipalities) account for about 75% of electricity consumption in the province.

The main transmission infeed network into Gauteng is predominantly operated at 400 kV. However, most of the local transmission stations within the province are supplied and interconnected via 275 kV lines and only a handful of substations run at 400 kV. The subtransmission system is run and interconnected through the 132 kV and 88 kV underlying distribution networks. The current transmission network is shown in Figure 7-7.

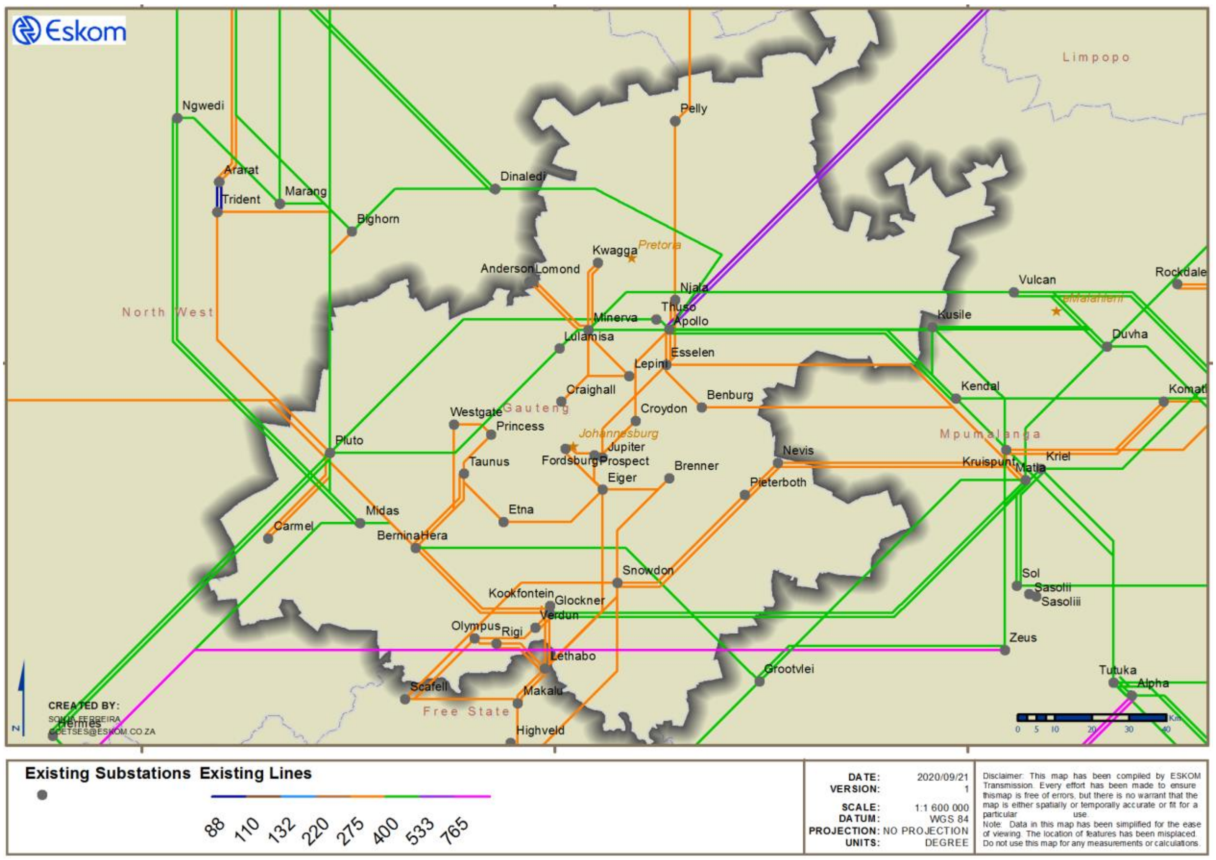


Figure 7-7: Current Gauteng transmission network

7.3.1 GENERATION

There are no Eskom power stations that lie within the defined Gauteng Grid; small municipal power stations include Kelvin and Rooiwal power stations. Most of the electricity consumed within Gauteng is sourced from power stations in the neighbouring grids via 400 kV transmission lines and via the 533 kV Direct Current (DC) Cahora Bassa line from Mozambique. The primary sources of power are obtained from the following power stations:

- Cahora Bassa (through Apollo Converter Station) via 533 kV DC lines
- Duvha Power Station via 400 kV lines
- Grootvlei Power Station via 400 kV lines
- Kendal Power Station via 400 kV lines
- Kusile Power Station via 400 kV lines
- Lethabo Power Station via 275 kV lines
- Matimba Power Station via 400 kV lines
- Matla Power Station via 400 kV lines
- Medupi Power Station via 400 kV lines

Lethabo Power Station, although situated within the Free State Grid, supplies a large percentage of the reactive power requirements of Gauteng. Due to high fault levels, Lethabo Power Station is operated split when five or more units are in service to prevent exceeding the rupturing capacity of equipment on the 275 kV busbar. The major injections of reactive power in Gauteng are from Matla Power Station, Midas 400 kV via the Hera 400/275 kV transformers and Apollo.

The REIPPPP has provided a platform for the private sector to invest in renewable energy that would be connected to the South African power grid. The total number of installed IPPs, including capacity in Gauteng, is shown in Table 7-13. These are already embedded in the municipal and Eskom distribution network. There are no significant IPPs planned for the Gauteng Grid for the foreseeable future.

Table 7-13: IPPs integrated in Gauteng

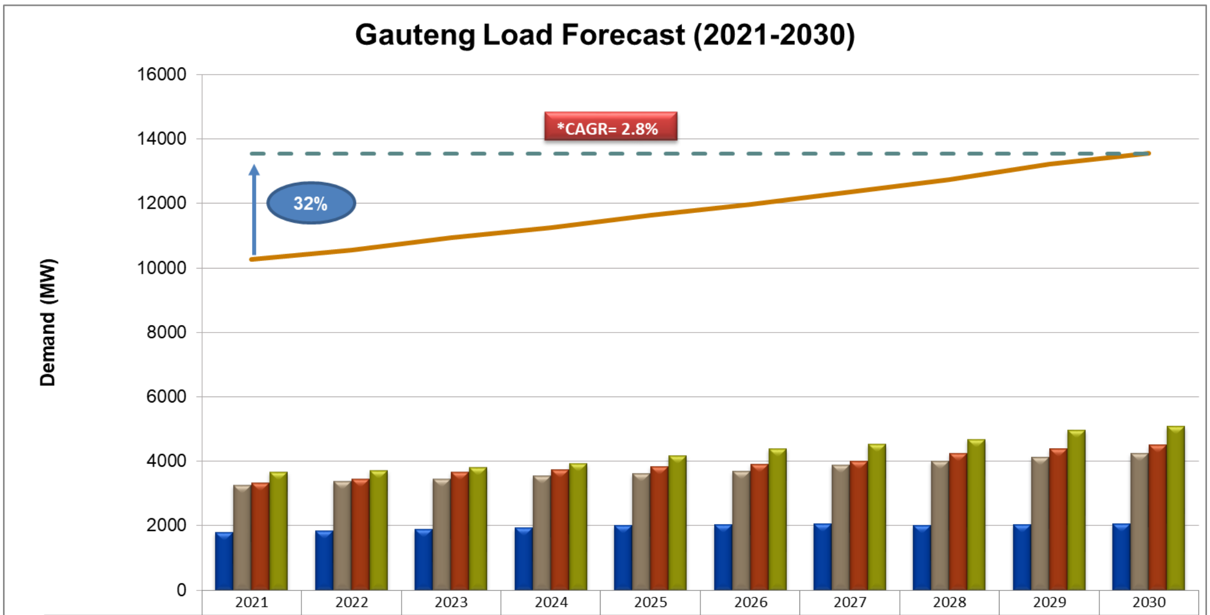
Date commissioned	Technology	POC	Capacity (MW)
April 2015	Biomass	Munic	3
April 2015	Biomass	Munic	2.28
Dec 2017	Biomass	Munic	6
2018	Biomass	Eskom Distribution	4
2018	Biomass	Eskom Distribution	1.4
Total capacity			**16.68**

7.3.2 Load Forecast

Gauteng is the economic hub of South Africa and contributes significantly to the financial, manufacturing, transport, technology, and telecommunications sectors, among others. The province currently contributes above 30% to the total TS peak load.

The economic mix in the province comprises residential customer, gold mines, commercial and services customers, logistics, technology, and industrial customers. The provincial electricity demand peaked at about 9 845 MW in 2019 and is forecasted to grow steadily at about 2.8% annually, from 10 276 MW in 2021 to 13 550 MW by 2030.

The Gauteng Grid comprises four CLNs, namely East Rand, Johannesburg, Vaal, and West Rand. The Johannesburg CLN has the highest load growth forecast, followed by the West Rand and East Rand CLNs. The highest provincial load growth is expected in the Johannesburg and West Rand CLN due to commercial and residential developments. The Vaal CLN has the lowest growth outlook in the province. The load forecast for Gauteng is shown in Figure 7-8.



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Vaal	1795	1857	1905	1962	2017	2046	2068	2011	2040	2077
West Rand	3269	3382	3466	3569	3638	3710	3906	4025	4138	4266
Johannesburg	3354	3467	3673	3748	3840	3927	4018	4255	4409	4511
East Rand	3671	3719	3826	3950	4187	4395	4535	4685	4974	5087
Provincial Peak	10276	10561	10940	11245	11630	11966	12348	12730	13227	13550
2030 Peak	13550	13550	13550	13550	13550	13550	13550	13550	13550	13550

Figure 7-8: Gauteng load forecast

7.3.3 PLANNED PROJECTS

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

7.3.3.1 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 support future loads in the CLN. Two 150 Mvar 275 kV capacitor banks have recently been installed at Lepini Substation and is expected to be in commercial operation by 2021. This will be followed by the construction of the Apollo-Lepini 275 kV line to increase capacity. This line is expected to be commissioned in 2026.

Vaal Strengthening

The scheme entails the construction of 2 x Glockner-Etna 400 kV lines (Vaal Strengthening Phase 2) to deload the overloaded Hera Substation and lines in the West Rand CLN. Phase 1 is complete, and load can now be shifted under contingency from the Hera 400/275 kV transformers onto the Glockner 400/275 kV corridor via the Glockner-Bernina 275 kV lines. Completion of Phase 2 is expected in 2022. The new lines will be energised at 275 kV until the requirement for 400 kV operation at Etna Substation is established in the future.

Simmerpan 275 kV Integration

Simmerpan Strengthening addresses unfirm transformation at Jupiter Substation (due to load increases in the Germiston South) and the future unfirm capacity at Croydon Substation (due to growth in the Germiston North area). The scope of work includes establishing a 275 kV transmission substation adjacent to the Simmerpan Distribution Substation and installing 1 x 315 MVA 275/88 kV transformer (Phase 1B).

The name of the new substation will be Sisimuka. The substation will be energised from the planned Jupiter B Substation via one of the existing Jupiter-Simmerpan 275 kV lines (currently energised at 88 kV). Completion of this phase is expected in the next five years. The second 275/88 kV transformer and the second Jupiter-Sisimuka 275 kV line are only required outside the TDP period. In future, the substation will be extended further to accommodate 2 x 250 MVA 275/132 kV transformers, subject to load growth in the Croydon 132 kV network (Germiston North).

Soweto Strengthening

The focus of this scheme is to ensure Grid Code compliance for Taunus and Fordsburg substations and address the expected thermal constraints in the Soweto distribution network. The scope of work includes establishing the new Quattro Substation, which will cater for 4 x 315 MVA 275/88 kV transformers belonging to City Power and 2 x 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.

Johannesburg East Strengthening

This scheme addresses network constraints in the East Rand and the Johannesburg South CLN. Sebenza 275/88 kV Substation (400/88 kV construction) that City Power has commissioned, deloads Prospect Substation and creates more capacity in the East Rand. The planned construction of two Matla-Jupiter B 400 kV lines will result in increased transfer limits in the East Rand CLN. The planned Mesong (previously North Rand) Substation will be integrated through the loop-in and loop-out of the existing Apollo-Croydon 275 kV line. This solution can be developed faster than the Apollo-North Rand corridor due to environmental and land acquisition challenges.

Westgate 400 kV Integration

This scheme addresses thermal constraints in the West Rand CLN. The project entails establishing a 400 kV overlay at Westgate Substation by installing 1 x 500 MVA 400/132 kV transformer at Westgate, energised via the proposed Hera-Westgate 400 kV line (West Rand Phase 1). The first 13 km of the Hera-Westgate line will be double-circuit, with the second circuit in the double-circuit section dedicated for the Pluto-Westgate line (Phase 2B). The Pluto-Westgate 400 kV line and the second Westgate 400/132 kV transformer will be required within about four years of completing the above projects but falls outside the TDP period.

Tshwane Reinforcement

The Tshwane reinforcement projects address unfirm substations due to load increases in the Tshwane growth node. A new 400/132 kV Diphororo Substation will be built just outside Soshanguve and will be equipped with 2 x 500 400/132 kV transformers. This is expected in the next five years to cater for load growth in the Garankuwa and Soshanguve areas. Further, a new Wildebees 400/132 kV Substation will be built in the Mmamelodi area to cater for the expected load growth in the Pretoria East area. Expected completion is in the next five years; the project is at concept phase (due to substation site location revision on advice by the City of Tshwane).

7.3.3.2 New Substations

The following new substations will be established in the Gauteng transmission network during this TDP period to address load growth and reliability:

- Diphororo 400/132 kV Substation in Pretoria North area
- Kyalami 400/132 kV Substation in the Johannesburg North area
- Lesokwana 275/88 kV Substation in the Ekurhuleni area
- Mesong 275/132 kV Substation in the Modderfontein area
- Quattro 275/132 kV Substation in the Soweto area
- Sesiu 400/88 kV Substation in the Cosmo City area
- Sisimuka 275/ 88 kV Substation in the Germiston area
- Wildebees 400/132 kV Substation in PTA East
- Jupiter B 275 kV Switching Station in Germiston

7.3.3.3 New Lines

- The 2 x Glockner-Etna 400 kV lines (operated at 275 kV until 400 kV operation is established at Etna Substation) will deload overloaded lines in the Vaal and West Rand CLN. They will also marginally deload the 2 x 800 MVA 400/275 kV transformers at Hera Substation.
- The Apollo-Lepini 400 kV line (operated at 275 kV) will increase capacity in the Johannesburg North area.
- The 2 x Quattro-Etna 400 kV lines (operated at 275 kV) will address expected thermal constraints in the Soweto distribution network.
- The 2 x Matla-Jupiter B 400 kV lines (operated at 275 kV) will increase transfer limits in the East Rand CLN.
- The Hera-Westgate 400 kV line will address thermal constraints in the West Rand CLN.

7.3.3.4 Reactive Power Compensation

The following reactive power compensation is planned in Gauteng, as shown in Table 7-14 below.

Table 7-14: Planned reactive power compensation in Gauteng

Substation	Voltage (kV)	Size (Mvar)
Brenner	88	2 x 48
Diphororo	400	1 x 100
Lepini	275	2 x 150
Princess	88	1 x 48
Quattro	132	1 x 72
Taunus	132	1 x 72
Westgate	132	1 x 72
Wildebees	400	1 x 100

7.3.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period 2021 to 2030:

Table 7-15: Gauteng– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Vaal Strengthening Phase 2	• Glockner-Etna first and second 400 kV line (operated at 275 kV)	2022
Brenner Strengthening Phase 1	• Brenner 2 x 88 kV 48 Mvar capacitors	2029
Tshwane Metro – Diphororo Phase 1	• Diphororo 400/132 kV Substation Integration	2025
Tshwane Metro – Wildebees Phase 1	• Wildebees 400/132 kV Substation Integration	2025
Tshwane Metro: Thuso third transformer	• Thuso 400/132 kV Substation (third 250 MVA transformer)	2027
Etna Strengthening: third transformer	• Etna 275/88 kV Substation (third 315 MVA transformer)	2026
Soweto Phase 1: Quattro 275/88 kV	• Quattro 275/88 kV Substation Integration	2025
Soweto Phase 2: Quattro 275/132 kV	• Quattro 275/132 kV Substation Integration	2028
West Rand Strengthening Phase 1	• Westgate 400/132 kV Substation Integration	2029
West Rand Strengthening Phase 2A: Capacitors	• 1 x 72 Mvar Cap Banks at Westgate 132 kV • 1 x 72 Mvar Cap Bank at Taunus 132 kV	2027

TDP scheme	Project name	Expected CO year
	• 1 x 72 Mvar Cap at Quattro 132 kV • 1 x 48 Mvar Cap at Princess 88 kV	
JHB North Phase 2	• JHB North: Apollo-Lepini first 400 kV line (operated @ 275 kV)	2026
Simmerpan Phase 1B	• Sisimuka 275/88 kV Substation Integration	2025
JHB North: Sesiu Integration	• Sesiu 400/88 kV Substation Integration	2028
JHB East: Mesong Integration	• JHB East: Mesong 275/132 kV Integration	2027
JHB East: Jupiter B integration	• Jupiter B 275 kV Switching Station • Matla-Jupiter B first and second 400 kV lines • Jupiter B 275 kV Loop-ins (Prospect-Sebenza 1 and 2, Jupiter-Prospect 1, Jupiter-Fordsburg 1)	2030
JHB North: Kyalami Substation	• Kyalami 400/132 kV Substation Integration	2030
Brenner Phase 2: Lesokwana Substation	• Lesokwana 275/88 kV Substation Integration	2029

7.3.3.6 Projects for Future Independent Power Producers

The future planned IPPs do not have sufficient capacity to impact the transmission network. Therefore, there are no additional transmission projects required to enable the future connection of the IPPs in Gauteng.

7.3.3.7 Projects for Alternative Generation Scenario

There is no alternative generation scenario identified for Gauteng.

7.3.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-9 below.

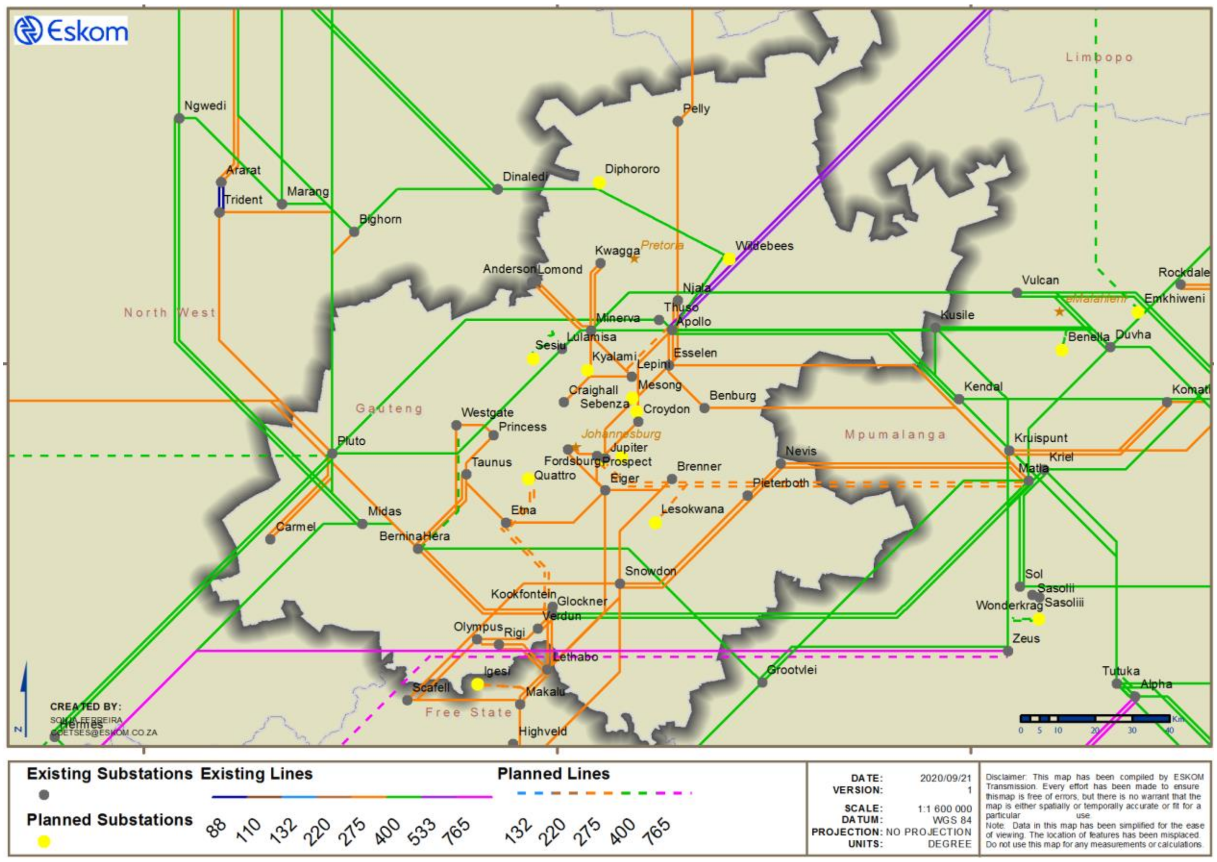


Figure 7-9: Future Gauteng transmission network

A summary of all new major assets planned for this province is provided in Table 7-16 to Table 7-18. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-16: Planned transformers for Gauteng

Transformer type	2021-2025		2026-2030	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
160 MVA 400/88/22 kV	1	160	-	-
250 MVA 400/132/22 kV	-	-	1	250
315 MVA 275/88/22 kV	1	315	1	315
500 MVA 275/132/22 kV	2	1 000	-	-
500 MVA 400/132/22 kV	3	1 500	8	4 000
Grand total	**7**	**2 975**	**10**	**4 565**

Table 7-17: Planned overhead lines for Gauteng

Line voltage	2021-2025	2026-2030
	Total length (km)	Total length (km)
275 kV	10	28
400 kV	131	74
Grand total	**141**	**102**

Table 7-18: Planned capacitor banks for Gauteng

Capacitor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	2	200		
48 Mvar 88 kV			2	96
72 Mvar 132 kV			4	288
Grand total	**2**	**200**	**6**	**384**

7.4 KWAZULU-NATAL

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 neighbouring countries. The province has also established the Dube Tradeport as an air logistics platform to promote access to global trade and tourist nodes between these two seaports. 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 and clustering potential.

The main transmission supply network to KwaZulu-Natal is predominantly connected at 400 kV, with the local transmission stations predominantly connected at 275 kV. The current transmission network is shown in Figure 7-10.

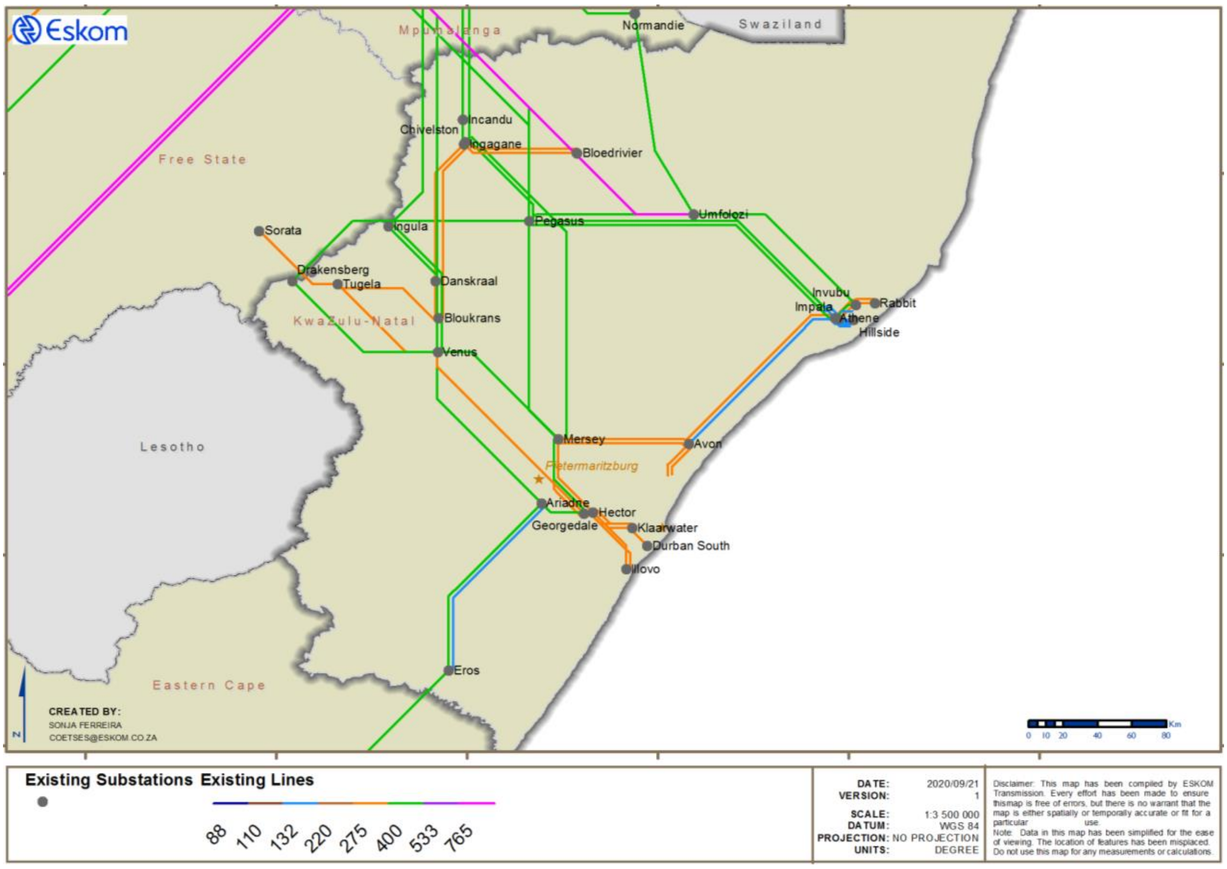


Figure 7-10: Current KwaZulu-Natal transmission network

7.4.1 Generation

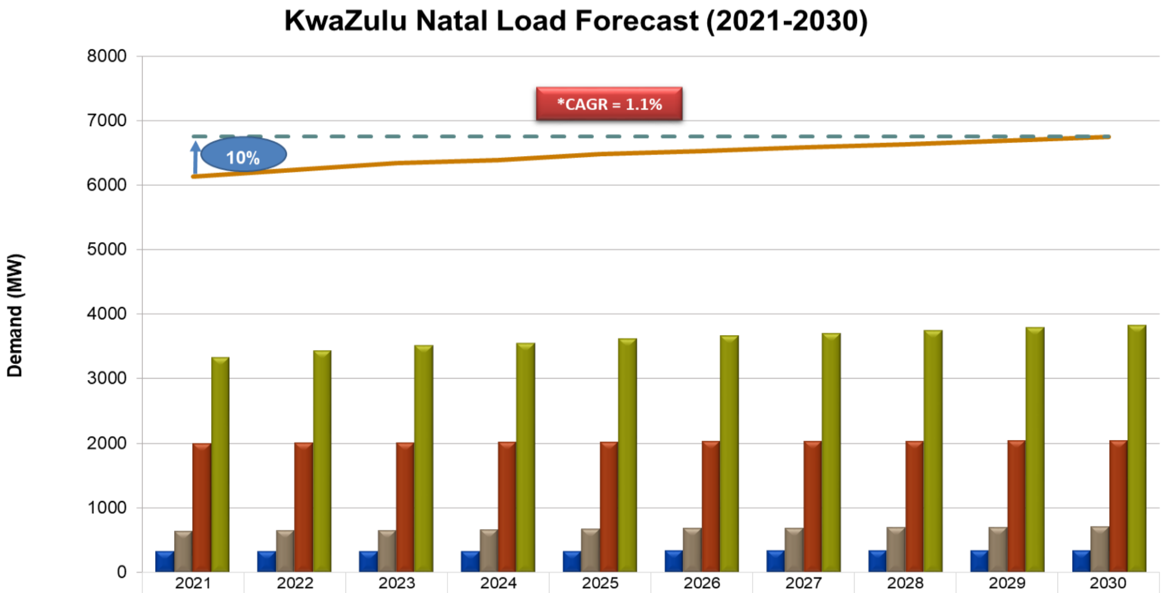
Most of the electricity consumed in KwaZulu-Natal is sourced from the power stations in Mpumalanga via 400 kV transmission lines.

There are three peaking plants in the province consisting of a gas plant and two pumped storages. These comprise Avon OCGT, and the Drakensberg and Ingula pumped storage stations. Avon OCGT has a generating capacity of 680 MW. Drakensberg and Ingula pumped storage stations have generating capacities of 1 000 MW and 1 333 MW, respectively.

7.4.2 Load Forecast

The economic mix in KwaZulu-Natal comprises redistributors, commercial customers, and industrial customers. The provincial electricity demand peaked at around 6 100 MW in 2019 and is forecasted to grow steadily at about 1.8% annually, from 6 134 MW in 2021 to 6 749 MW by 2030.

The KwaZulu-Natal Grid comprises four CLNs, namely Empangeni, Ladysmith, Newcastle, and Pinetown. The Empangeni and Pinetown CLNs are the two main load centres in the province, consuming approximately 31% and 53% of the load, respectively. Ladysmith and Newcastle CLNs make up the remaining 16% of the demand in the province. The highest provincial load growth is expected in the Pinetown and Empangeni CLNs due to industrial, commercial, and residential developments. The load forecast for KwaZulu-Natal is shown in Figure 7-11.



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ladysmith	325	327	329	331	333	335	336	338	340	342
Newcastle	644	651	659	667	676	685	692	698	706	712
Empangeni	2002	2008	2013	2019	2024	2030	2035	2041	2046	2052
Pinetown	3338	3434	3519	3551	3630	3670	3710	3750	3793	3838
Grid Peak	6134	6241	6338	6384	6477	6531	6583	6636	6692	6749
2030 Peak	6749	6749	6749	6749	6749	6749	6749	6749	6749	6749

Figure 7-11: KwaZulu-Natal load forecast

7.4.3 Planned Projects

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

7.4.3.1 Major Schemes

The major TDP schemes planned in KwaZulu-Natal are as follows:

KZN 765 kV Strengthening: Empangeni Integration

This project entails the construction of Mbewu-Umfolozi 765 kV line and the establishment of Mbewu 765/400 kV Substation near Empangeni. Initially, the planned Mbewu–Umfolozi 765 kV line will be operated at 400 kV, and only the 400 kV yard will be established at Mbewu Substation. Mbewu Substation will be integrated into the 400 kV network by looping in the Athene-Umfolozi and Invubu-Umfolozi 400 kV lines and the new Invubu-Mbewu 400 kV line. The introduction of 765 kV will depend on demand growth (generation and/or load) in the province.

eThekwini Electricity Network Strengthening

This project involves establishing Inyaninga 2 x 500 MVA 400/132 kV Substation near King Shaka International Airport. The planned substation will be supplied by two Inyaninga-Mbewu 400 kV lines. This substation will deload the Mersey-Avon 275 kV system and supply the Dube Tradeport Development.

NKZN Strengthening: Iphiva 400/132 kV Substation

This project involves establishing 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. The two 400 kV lines will be executed in various stages. Each stage's implementation will depend on demand growth (generation and/or load) and network strengthening requirements.

7.4.3.2 New Substations

The following new substations will be established in KwaZulu-Natal during this TDP period to address load growth and reliability:

- Iphiva 400/132 kV Substation near Mkuze town
- Inyaninga 400/132 kV Substation near King Shaka Airport in Durban
- Mbewu 400 kV Switching Station near Empangeni town

7.4.3.3 New Lines

- Ariadne-Venus second 400 kV line involves dismantling an existing Georgedale-Venus 275 kV line and constructing a second Ariadne-Venus 400 kV line. Construction of the line is underway.
- Ariadne-Eros second 400 kV line involves constructing a 400/132 kV multi-circuit line between Ariadne Substation and Eros Substation. The 400 kV circuit will extend 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 underway.
- Umfolozi-Mbewu 765 kV line (operated at 400 kV)
- Invubu-Mbewu 400 kV line
- Normandie-Iphiva 400 kV line
- Inyaninga-Mbewu 2 x 400 kV lines

7.4.3.4 Reactive Power Compensation

Within KwaZulu-Natal, there are plans to:

- Refurbish the Athene Static Var Compensator (SVC).
- Decommission the Illovo SVC and configure the SVC’s 100 Mvar capacitor bank as a permanent capacitor bank.

7.4.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period 2021 to 2030:

Table 7-19: KwaZulu-Natal– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Ariadne-Venus 400 kV Line 2	• Construct Ariadne-Venus 400 kV line 2 by recycling Georgedale-Venus 275 kV line 2)	2021
South Coast Strengthening	• Construct Ariadne-Eros 400 kV line 2	2025
Transnet Freight Rail Upgrade	• Madlanzini 1 x 160 MVA 400/88 kV Substation	2026-2029
	• Loop-in Camden-Normandie 400 kV line 1	
	• Nzalo 1 x 160 MVA 400/88 kV Substation	
	• Loop-in Normandie-Umfolozi 400 kV line 1	
	• Duma 1 x 160 MVA 400/88 kV Substation	
	• Loop-in Pegasus-Athene 1 400 kV line 1	
KZN 765 kV Strengthening - Empangeni Integration	• Mbewu 400 kV Switching Station	2028
	• Loop-in Athene-Umfolozi 400 kV line 1 and Invubu-Umfolozi 400 kV line 1 into Mbewu Substation	
	• Construct Umfolozi-Mbewu 765 kV line (extension of Majuba-Umfolozi 765 kV line 1), operate at 400 kV	
	• Construct Invubu-Mbewu 400 kV line 2	
NKZN Strengthening Phase 1	• Establish 1 x 500 MVA 400/132 kV Iphiva Substation	2031
	• Construct Normandie-Iphiva 400 kV line 1	
eThekwini Electricity Network Strengthening	• Establish 2 x 500 MVA 400/132 kV Inyaninga Substation	2030
	• Construct Inyaninga-Mbewu 400 kV lines 1 and 2	

7.4.3.6 Projects for Future Independent Power Producers

The future planned IPPs do not have sufficient capacity to impact the transmission network. Therefore, there are no additional transmission projects required to enable the future connection of the IPPs in KwaZulu-Natal.

7.4.3.7 Projects for Alternative Generation Scenario

Richards Bay is one of the potential sites identified for the planned gas-to-power programme in accordance with the IRP 2019. The envisaged allocation for Richards Bay ranges between 2 000 MW and 3 000 MW. Transmission integration options were studied to determine the transmission network expansion required to integrate the planned gas plant facility if Richards Bay is announced as the preferred site. The assessment assumes that KwaZulu-Natal gas generation could be between 2 000 MW and 3 000 MW. The following additional transmission network strengthening projects will be required to enable the evacuation of the additional generation into the transmission grid:

- Establishment of a 400 kV substation at the gas plant facility
- Construction of 4 x 400 kV lines from the gas plant to loop into the Athene-Invubu and Athene-Umfolozi 400 kV lines

7.4.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-12 below.

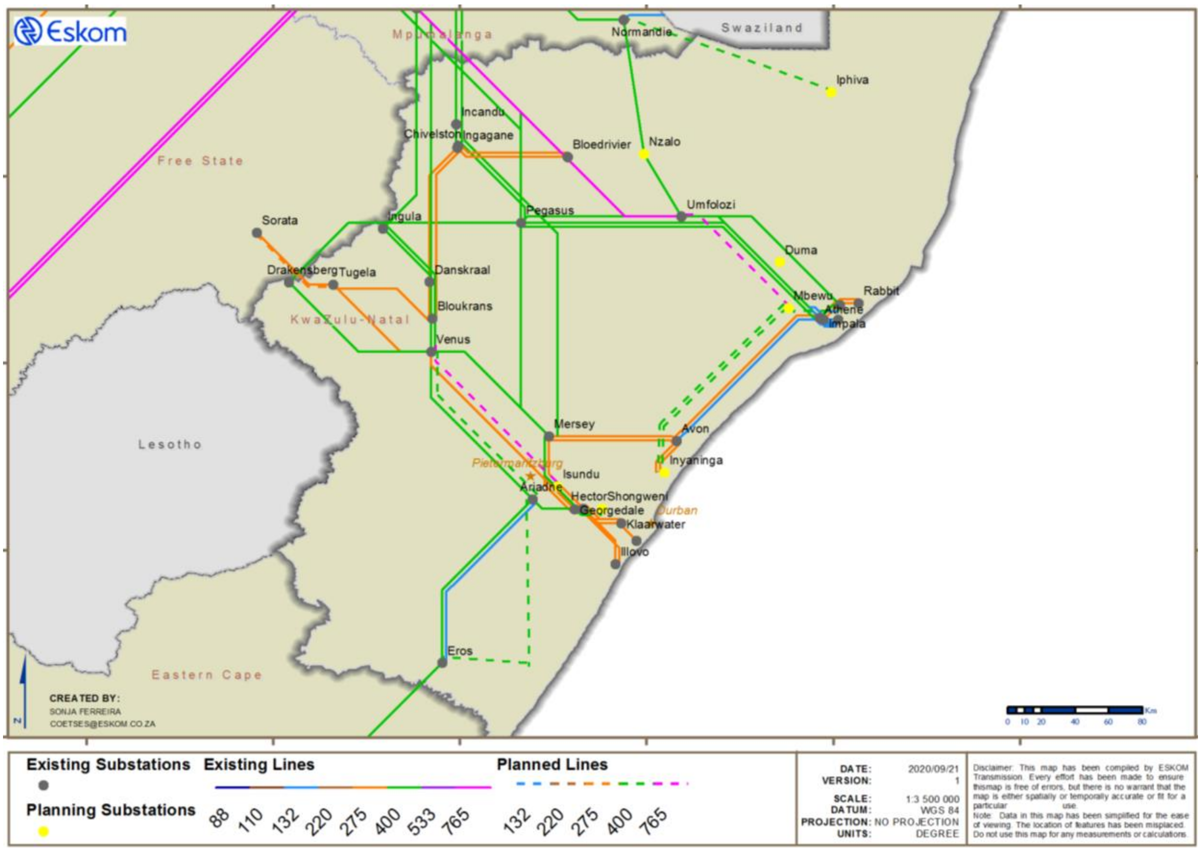


Figure 7-12: Future KwaZulu-Natal transmission network

A summary of all new major assets planned for this province is provided in Table 7-20 to Table 7-21. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-20: Planned transformers for KwaZulu-Natal

Transformer type	2021-2025		2026-2030	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
500 MVA 400/132/22 kV	-	-	5	2 500
Grand total	**-**	**-**	**5**	**2 500**

Table 7-21: Planned overhead lines for KwaZulu-Natal

Line voltage	2021-2025	2026-2030
	Total length (km)	Total length (km)
400 kV	298	534
765 kV	0	60
Grand total	**298**	**594**

7.5 LIMPOPO

Limpopo is situated on northernmost part of South Africa and is named after the mighty Limpopo River that runs through it. Limpopo is the fifth-largest province in South Africa and shares international borders with Botswana, Mozambique and Zimbabwe. The capital city of the province is Polokwane.

The provincial economy is mainly driven by mining, exporting of primary products, and importing of manufactured goods. Limpopo is the “bread and fruit basket” of South Africa, producing up to 60% of all fruit, vegetables, maize meal, wheat, and cotton. Major international mining operations contribute to 20% of Limpopo's economy, making mining one of the primary drivers of economic activity in the province. Limpopo’s diverse mining activities include diamonds, iron ore, coal, copper, platinum, and chrome.

The province’s transmission network comprises 400 kV and 275 kV and is interconnected via the 132 kV underlying distribution network. The current transmission network is shown in Figure 7-13.

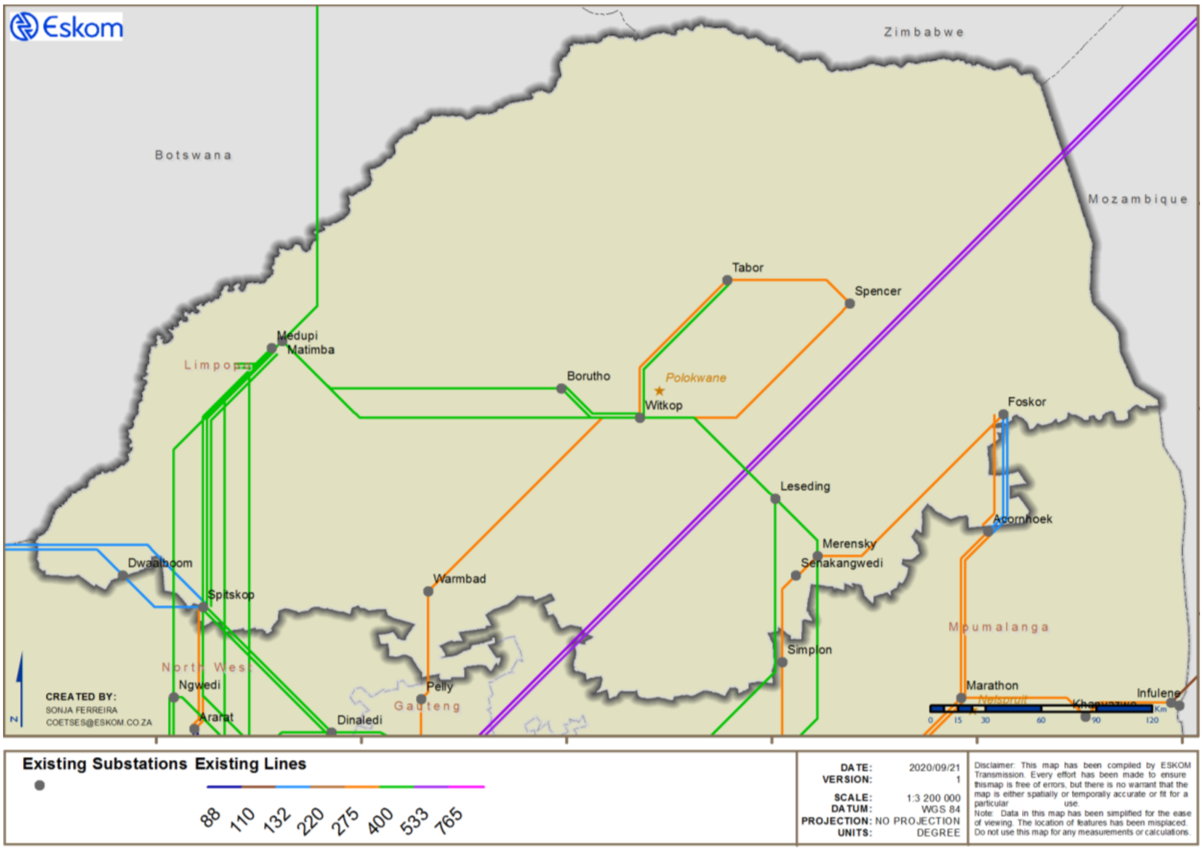


Figure 7-13: Current Limpopo transmission network

7.5.1 GENERATION

The baseload generation in Limpopo is located in the coal mining town of Lephalale, which has rich coal reserves. There are two coal-fired power stations located in this area, namely Medupi and Matimba power stations. On completion of Medupi, these two power stations will provide almost 8.5 GW of generation to the South African grid.

Matimba Power Station, named after the Tsonga word for "power", is one of the largest direct dry-cooled power stations in the world, with 6 x 665 MW turbo-generator units. Matimba was commissioned in 1989 and is designed to generate 3 990 MW of power. The adjacent Grootegeluk colliery has sufficient coal reserves to guarantee Matimba a minimum lifespan of 35 years, extending it to a possible 50 years at 2 100 tons of coal per hour.

Medupi Power Station, named after the Sepedi word meaning “gentle rain”, will be one of the largest coal-fired plants and the largest dry-cooled power station in the world. It will be 25% larger than Matimba Power Station in terms of operation, design, and dimensions. The power station has a generating capacity of 4 356 MW (6 x 726 MW units).

Thabametsi Power Station will be the first IPP coal-fired power station in the country. Thabametsi Power Station is forecasted to have a nominal generating capacity of 600 MW (2 x 300 MW units) on completion.

The REIPPPP has provided a platform for the private sector to invest in RE connected to the South African power grid. The total approved capacity in Limpopo since the inception of the programme amounts to 118 MW. The composition is shown in Table 7-22.

Table 7-22: Approved projects in Limpopo under the REIPPPP

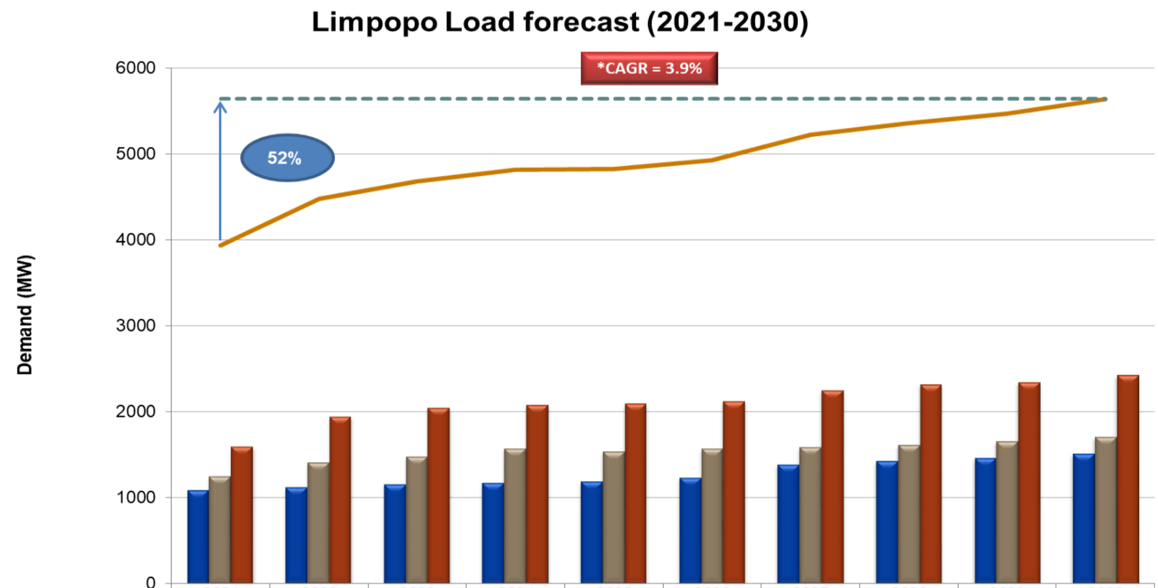
Programme and bid window	Name of project	Type	Capacity (MW)	Transmission substation
IPP RE 1	Tabor PV Plant	PV	28	Tabor 132 kV
	Witkop PV Plant	PV	30	Witkop 132 kV
IPP RE 3	Matimba PV Plant	PV	60	Matimba 132 kV

7.5.2 Load Forecast

The 2019 peak load for the province was 2 899 MW. There is a decrease of 112 MW when compared to the peak demand of 3 011 MW that was experienced for the year 2018.

The province consists of three CLN, namely Lephalale, Polokwane, and Phalaborwa. The Lephalale CLN is expected to have a steady growth rate of 4.5%. This can be attributed to heavy and light industry and commercial and residential developments as spin-offs. Mining activities are also expected in the areas of Lephalale CLN. Polokwane CLN is expected to experience a load growth at 2.3%. The Phalaborwa CLN is expected to have a growth rate of 3.7%. This can be attributed to an increase in mining activities and possible smelting operations near Leseding Substation over the next 10 years.

The load forecast for Limpopo is shown in Figure 7-4.



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Polokwane CLN	1092	1123	1156	1172	1189	1229	1385	1432	1462	1515
Lephalale CLN	1246	1407	1479	1568	1542	1571	1593	1615	1660	1705
Phalaborwa CLN	1597	1946	2048	2079	2100	2126	2247	2318	2347	2426
Provincial Peak	3936	4476	4682	4819	4831	4926	5225	5364	5469	5646
2030 Peak	5646	5646	5646	5646	5646	5646	5646	5646	5646	5646

Figure 7-14: Limpopo load forecast

7.5.3 PLANNED PROJECTS

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

7.5.3.1 Major Schemes

The major schemes for the province consist of establishing a 765 kV network (operated at 400 kV), integration of the Medupi Power Station, and extension of the 400 kV and 275 kV networks, which entails installation of additional transformers at existing and new substations.

The major TDP schemes planned in Limpopo are as follows:

Medupi Transmission Integration (400 kV and 765 kV)

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

Waterberg Generation 400 kV Stability Enhancement

The following projects are required due to future planned generation projects around the Waterberg area. These projects were raised to ensure that the power stations in the area remain transiently stable.

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

Nzhelele 400 kV Integration

The integration of 400 kV into Nzhelele is required to deload Tabor and Spencer substations and to enable load growth in the northern parts of Limpopo. 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

These projects will resolve transformation constraints and supply future load growth around Spencer and Foskor substations for the next 20 years. In addition, this scheme will introduce

400 kV corridors between Spencer, Foskor, and Merensky substations, resulting in higher transfer limits and savings in losses on the Limpopo transmission network.

Silimela Substation

A new transmission substation will be introduced next to the existing Wolwekraal Distribution Substation to resolve network constraints in the Mapoch and Kwaggafontein areas. In addition, the substation will supply the long-term future load growth expected in the south-western part of the Phalaborwa CLN and deload Simplon Substation.

Sekhukhune Substation

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

7.5.3.2 New Substations

The following new substations will be established in Limpopo to address current and future load growth in the network:

- Nzhelele 400/132 kV Substation
- Silimela 400/132 kV Substation
- Sekhukhune 400/275/132 kV Substation

Some of the new substations have been renamed as indicated in Table 7-23:

Table 7-23: Limpopo substation name changes

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

7.5.3.3 New Lines

The following new lines will be established in the network as part of the Medupi integration requirements, to ensure transient stability of the generation in the area, to connect new substations and to alleviate network constraints:

- Medupi-Witkop 400 kV line
- Medupi-Borutho 400 kV line
- Borutho to Silimela 400 kV line
- Borutho-Nzhelele 400 kV line
- Manogeng-Sekhukhune 400 kV line
- Sekhukhune-Senakangwedi 275 kV line
- Manogeng-Silimela 400 kV line
- Witkop-Sekhukhune 400 kV line
- Tabor-Nzhelele 400 kV line
- Foskor-Merensky second 275 kV Line (built at 400 kV specification)
- Foskor-Spencer 400 kV line

7.5.3.4 Reactive Power Compensation

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

- 2 x 36 Mvar 132 kV capacitor banks at Tabor Substation
- 2 x 36 Mvar 132 kV capacitor at Spencer Substation

7.5.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period 2021 to 2030:

Table 7-24: Limpopo– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Medupi Transmission Integration	• Medupi-Ngwedi first 765 kV line (Energised at 400 kV)	2020
	• Medupi-Borutho 400 kV line	
Waterberg Generation 400 kV Stability Enhancement	• Medupi-Witkop first 400 kV line	2020
	• Borutho-Silimela first 400 kV line	2029
Highveld North-West and Lowveld North Reinforcement Phase 2	• Silimela 400/132 kV Substation	2022
	• Manogeng 400 kV Switching Station	
	• Loop-in Duvha-Leseding 400 kV line into Manogeng Switching Station	
	• Manogeng-Silimela 400 kV line	
Highveld North-West and Lowveld North Reinforcement Phase 1	• Emkhiweni-Silimela 400 kV line	2029
Sekhukhune Integration Phase 1	• Sekhukhune 400/275/132 kV Substation (1 x 800 MVA 400/275 kV transformer and 2 x 500 MVA 400/132 kV transformers)	2029
	• Loop-in Arnot-Merensky 400 kV into Sekhukhune Substation	
	• Manogeng-Sekhukhune first 400 kV line	
	• Sekhukhune-Senakangwedi first 275 kV line	
Sekhukhune Integration Phase 2	• Witkop-Sekhukhune first 400 kV line	2030
Nzhelele 400 kV Integration	• Nzhelele 400/132 kV Substation (2 x 500 MVA 400/132 kV transformers)	2029
	• Tabor-Nzhelele 400 kV line	
	• Borutho-Nzhelele first 400 kV line	
Foskor and Acornhoek 275/132 kV Transformation Upgrades	• Foskor-Merensky second 275 kV line (built at 400 kV specification)	2031
Limpopo East Corridor Strengthening	• Establish 400 kV busbars at Spencer Substation and Foskor Substation	2031
	• Foskor first 400 MVA 400/275 kV transformer	

TDP scheme	Project name	Expected CO year
	• Spencer first 500 MVA 400/132 kV transformer	
	• Foskor-Spencer first 400 kV line (110km)	
	• Merensky-Foskor second 275 kV line change-over to 400 kV line	
Polokwane Reactive Power Compensation	• Spencer 2 x 36 Mvar capacitor banks	2026
	• Tabor 2 x 36 Mvar capacitor banks	
Warmbad Transformation Upgrade	• Warmbad first 250 MVA 275/132 kV transformer	2026
Leseding Transformation Upgrade	• Leseding third 500 MVA 400/132 kV transformer	2026
Acornhoek Transformation Upgrade	• Acornhoek third 125 MVA 400/132 kV transformer	2026
Borutho Transformation Upgrade	• Borutho third 500 MVA 400/132 kV transformer	2026

7.5.3.6 Projects for Future Independent Power Producers

The future planned IPPs do not have sufficient capacity to impact the transmission network. Therefore, there are no additional transmission projects required to enable the future connection of the IPPs in Limpopo.

7.5.3.7 Projects for Alternative Generation Scenario

There is no alternative generation scenario identified for Limpopo.

7.5.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-15 below.

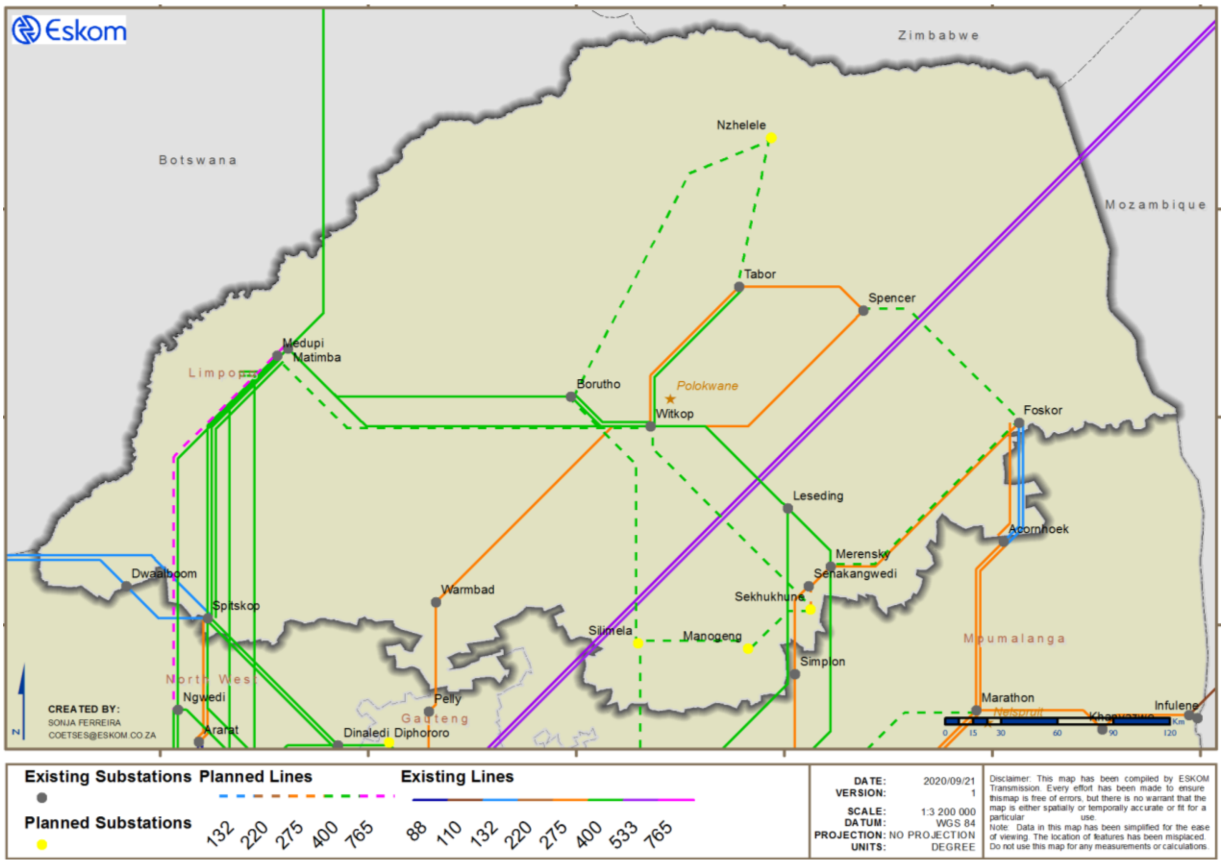


Figure 7-15: Future Limpopo transmission network

A summary of all new major assets planned for this province is provided in Table 7-25 to Table 7-28. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-25: Planned transformers for Limpopo

Transformer type	2021-2025		2026-2030	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
125 MVA 275/132/22 kV	2	250	-	-
250 MVA 275/132/22 kV	2	500	-	-
400 MVA 400/275/22 kV	-	-	1	400
500 MVA 400/132/22 kV	1	500	7	3 500
800 MVA 400/275/22 kV	-	-	1	800
Grand total	**5**	**1 250**	**9**	**4 700**

Table 7-26: Planned overhead lines for Limpopo

Line voltage	2021-2025	2026-2030
	Total length (km)	Total length (km)
275 kV	-	15
400 kV	214	595
765 kV	76	0
Grand total	**290**	**610**

Table 7-27: Planned capacitor banks for Limpopo

Capacitor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
40 Mvar 132 kV	2	80	2	80
Grand total	**2**	**80**	**2**	**80**

Table 7-28: Planned reactors for Limpopo

Reactor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	4	400	3	300
Grand total	**4**	**400**	**3**	**300**

7.6 MPUMALANGA

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, Sudwala Caves, and Blyde River Canyon.

The transmission grid in Mpumalanga is comprised 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. Table 7-16 represents the current transmission network in Mpumalanga.

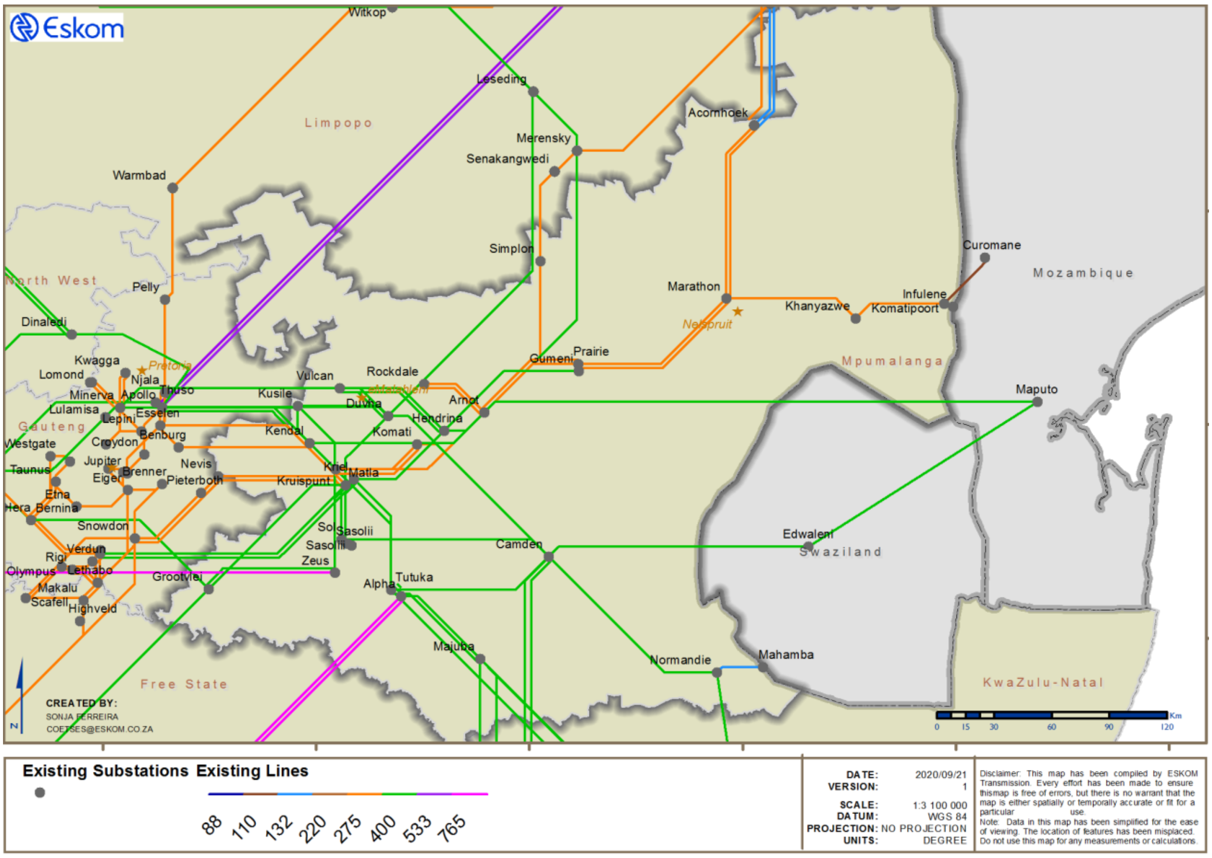


Figure 7-16: Current Mpumalanga transmission network

7.6.1 GENERATION

Mpumalanga is considered the generation hub of South Africa's electricity network due to the concentration of power stations in this region and their proximity to the large load centres. Currently, 12 of 14 Eskom coal-fired power stations, namely Arnot, Camden, Duvha, Grootvlei, Hendrina, Kendal, Komati, Kriel, Matla, Majuba, and Tutuka are located in Mpumalanga. This includes one of the two Eskom power stations currently under construction, namely, Kusile Power Station.

The total capacity of Kusile Power Station on completion is expected to be 5 076 MW. Table 7-29 details the programme for the Kusile units becoming commercially available.

Table 7-29: Kusile Power Station schedule

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

The only remaining transmission project for integration of Kusile Power Station is the Kusile-Lulamisa 400 kV line. This project was delayed due to servitude acquisition challenges and is required before Unit 5 is commissioned.

Hendrina, Grootvlei, and Komati power stations are close to reaching the end of their economic life.

Table 7-30 shows the Eskom power station units that are assumed to be decommissioned within the TDP period. Approximately 8.7 GW of capacity is assumed to be removed from the Mpumalanga generation pool over the next 10 years.

Table 7-30: Ageing generators decommissioning schedule

Power station	2021	2022	2023	2026	2027	2028	2029	2030	Total per station
Arnot	350			700	350		700		**2 100**
Camden	375	540	380						**1 295**
Grootvlei	380	190							**570**
Hendrina	375	533	190						**1 098**
Komati	114	82							**196**
Kriel				475	475	475	950	475	**2 850**
Matla								575	**575**
Total per annum	**1 594**	**1 345**	**570**	**1 175**	**825**	**475**	**1 650**	**1 050**	**8 684**

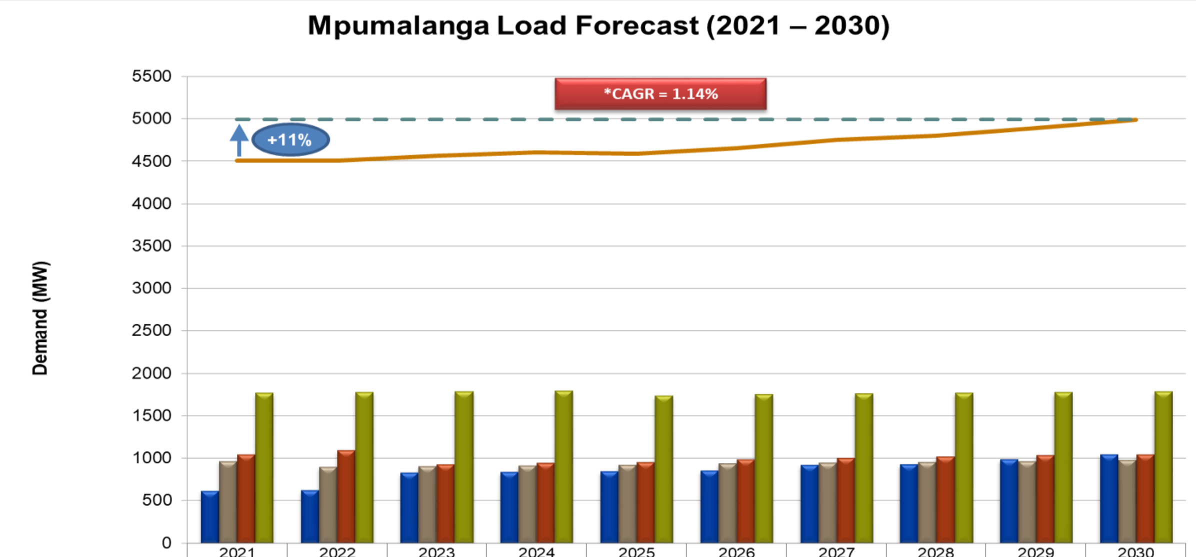
7.6.2 Load Forecast

Load growth is expected in the province due to development in the commercial, electrification, and industrial sectors. The future load mix is not expected to differ from the existing one, mainly comprised of redistributors, mining, commercial, and industrial customers. The cumulative average growth rate within the TDP period is estimated at 1.14% per annum, from 4 508 MW (at provincial peak) in 2021 to 4 990 MW in 2030.

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

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

The load forecast for Mpumalanga is shown in Figure 7-17.



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Middelburg	611	618	822	831	842	853	914	925	982	1042
Lowveld	961	896	906	916	925	938	948	957	967	978
Witbank	1038	1084	923	937	951	980	995	1010	1026	1042
Highveld South	1762	1770	1777	1785	1736	1745	1754	1763	1772	1780
Provincial Peak	4508	4505	4565	4607	4591	4656	4754	4800	4894	4990
2030 Peak	4990	4990	4990	4990	4990	4990	4990	4990	4990	4990

Figure 7-17: Mpumalanga load forecast

7.6.3 PLANNED PROJECTS

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

7.6.3.1 Major Schemes

The major TDP schemes planned in Mpumalanga are as follows:

Emkhiweni 400/132 kV Integration

This scheme entails establishing 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 2 x 500 MVA transformers and turn-ins from the existing Arnot-Kendal 400 kV line. This project is currently in the development phase and 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 Province is at an advanced stage and is expected to be completed before the Emkhiweni integration.

Wonderkrag 400/132 kV Integration

This scheme entails establishing 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 comprise 4 x 500 MVA transformers as well as a fifth standby transformer. This project is currently in the execution 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 (first 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.

7.6.3.2 New Substations

Additional 400/132 kV substations will be established due to load growth, to remain Grid Code compliant and to create additional capacity:

- Emkhiweni 400/132 kV Substation will address both Vulcan and Rockdale unfirm transformations and improve safe working conditions over burning grounds. It will also address the n-1 line firmness to the future Silimela Substation.
- Wonderkrag 400/132 kV Substation will address the unfirm transformation and high fault levels at Sol Substation.

7.6.3.3 New Lines

- Emkhiweni-Silimela 400 kV line
- Emkhiweni 400 kV turn-ins
- Benella 400 kV turn-ins
- Kusile-Lulamisa first 400 kV line
- Gumeni-Marathon 400 kV line

7.6.3.4 Reactive Power Compensation

There are no reactive power compensation projects (capacitor banks and/or SVCs) planned for Mpumalanga for this TDP period. However, Eskom Distribution plans to add some compensation in the Lowveld network to improve voltages under contingency. However, these projects have since been deferred.

7.6.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period 2021 to 2030:

Table 7-31: Mpumalanga– summary of projects and timelines

TDP scheme	Project name	Expected CO date
Highveld North-West and Lowveld North Reinforcement – Phase 1	• Turn in Kendal-Arnot 400 kV line into Emkhiweni 400/132 kV Substation	2027
	• Emkhiweni 400/132 kV Substation	
	• Emkhiweni-Silimela 400 kV line	2027
Highveld South Reinforcement	• 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	2023
	• Turn in Duvha-Apollo 400 kV line into Benella Switching Station	
Kusile Integration Phase 2: Lulamisa	• Kusile-Lulamisa first 400 kV line	2023
Kusile Integration Phase 3A: 400 kV Duvha Bypass	• Kusile 400 kV bypass Duvha (to form Kusile-Vulcan 400 kV line)	2021
Lowveld Strengthening Phase 2B	• Gumeni-Marathon 400 kV line	2027
	• Marathon 400/132 kV Substation	
Mpumalanga Underrated Equipment Upgrade (MURE)	• Upgrade underrated equipment at Vulcan, Rockdale, Hendrina, Kruispunt, Komati, Zeus, Arnot, Tutuka, Alpha, Majuba, and Matla • Install Matla FCLRs	2026

7.6.3.6 Projects for Future Independent Power Producers

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 2023. This project involves the establishment of Benella Switching Station to integrate the Khanyisa Power Station.

The future planned IPPs do not have sufficient capacity to impact the transmission network. Therefore, there are no major upstream transmission projects required to enable the future connection of the IPPs in Mpumalanga.

7.6.3.7 Projects for Alternative Generation Scenario

There is no alternative generation scenario identified for Mpumalanga.

7.6.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-18 below.

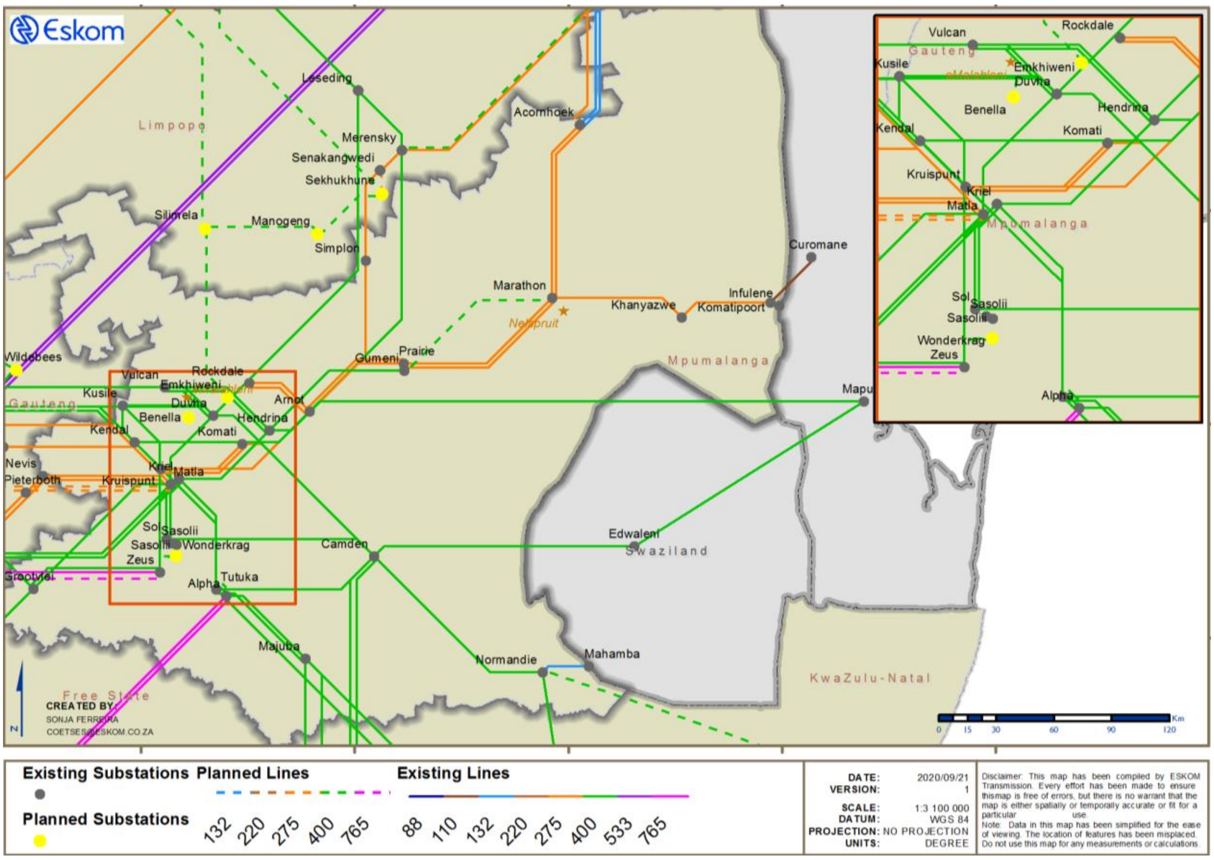


Figure 7-18: Future Mpumalanga transmission network

A summary of all new major assets planned for this province is provided in Table 7-32 to Table 7-33. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-32: Planned transformers for Mpumalanga

Transformer type	2021-2025		2026-2030	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
315 MVA 275/88/22 kV	-	-	2	630
500 MVA 275/132/22 kV	-	-	1	500
500 MVA 400/132/22 kV	5	2 500	2	1 000
Grand total	**5**	**2 500**	**5**	**2 130**

Table 7-33: Planned overhead lines for Mpumalanga

Line voltage	2021-2025	2026-2030
	Total length (km)	Total length (km)
400 kV	579	406
Grand total	**579**	**406**

7.7 NORTHERN CAPE

Northern Cape is situated in the western 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. The majority of the economic activity is concentrated in Kimberly and Upington, 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 solar radiation and for that reason has attracted the most solar PV and CSP projects of all the provinces in South Africa. Furthermore, the increased interest in mining operations in the Namaqualand and Kimberley areas is expected to increase electricity 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 220 kV network supported by the 400 kV backbone from Aries. The existing transmission network is shown in Figure 7-19.

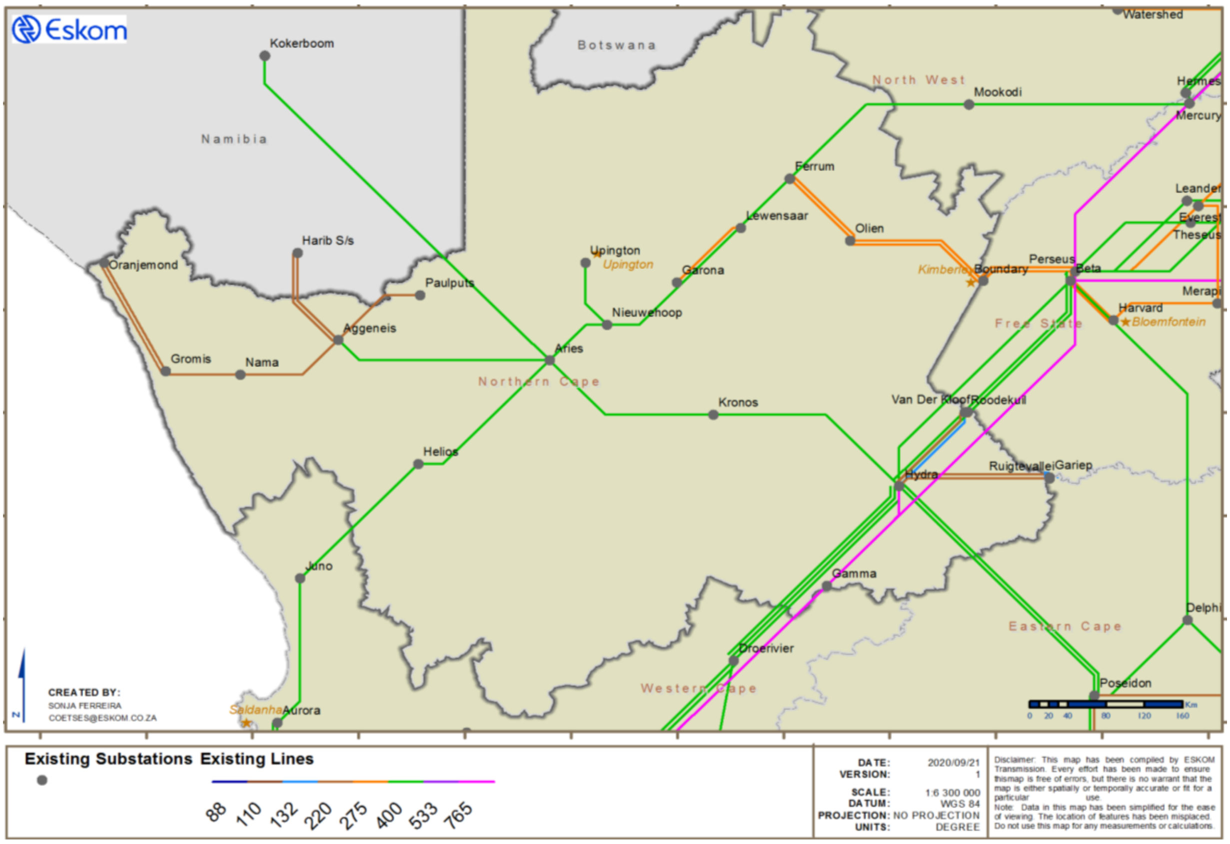


Figure 7-19: Current Northern Cape transmission network

7.7.1 Generation

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

Gariep is located on the border of Eastern Cape, Free State, and Northern Cape and falls within the border of Eastern Cape. Gariep has a generating capacity of 360 MW with four units rated at 90 MW each, evacuating its power directly onto the Hydra 220 kV busbar via the two Hydra-Ruigtevallei 220 kV lines in the Northern Cape.

The REIPPPP has provided a platform for the private sector to invest in RE connected to the South African power grid.

The Northern Cape climate has made it a popular province for RE with photovoltaic (PV), CSP, wind generation, and small hydro integrated into the grid via the REIPPPP rounds held by the DMRE. In the Northern Cape, thus far, around 3 150 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 48% PV, 33% Wind, and 19% CSP. A summary of the approved projects in the Northern Cape under the REIPPPP are indicated in Table 7-34: Summary of approved projects in Northern Cape under the REIPPPP.

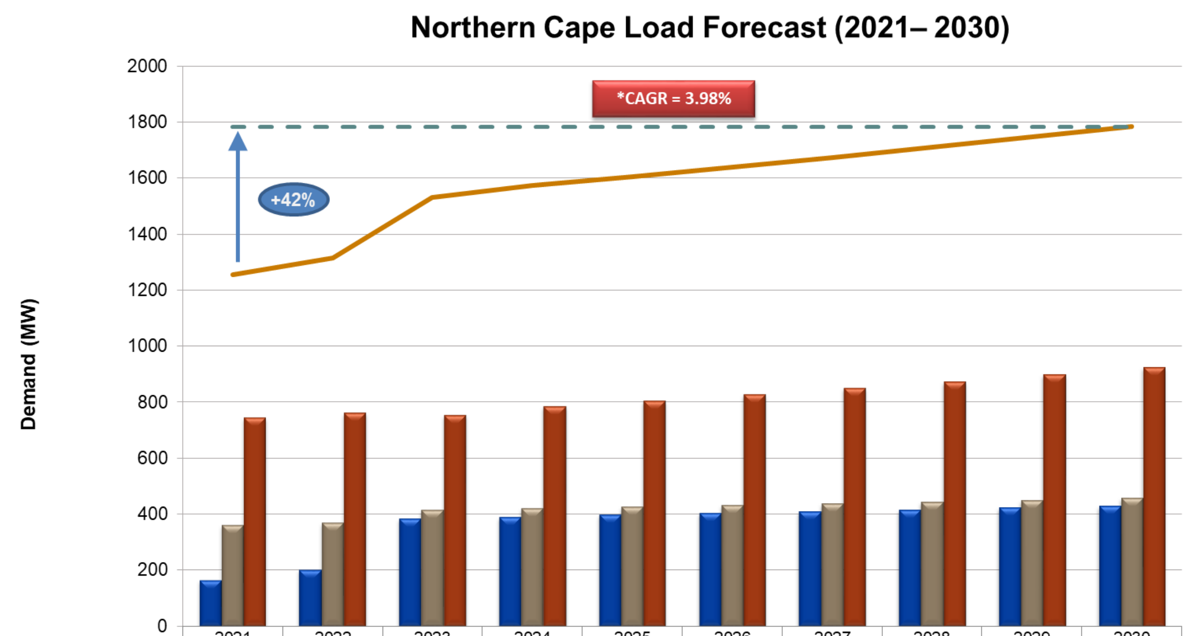
Table 7-34: Summary of approved projects in Northern Cape under the REIPPPP

Programme and bid window	CSP (MW)	Wind (MW)	PV (MW)	Small hydro (MW)	Grand total (MW)
IPP RE 1	150	73	462		685
IPP RE 2	50		270	10	330
IPP RE 3	200	591	225		1 016
IPP RE 3.5	200				200
IPP RE 4			415		415
RE IPP 4B		375	130		505
Grand total	**600**	**1 039**	**1 502**	**10**	**3 151**

7.7.2 Load Forecast

The provincial load peaked at around 1 255 MW over the last year, and it is expected to increase to about 1 784 MW by 2030.

The Northern Cape comprises three CLNs, namely Kimberley, Karoo, and Namaqualand. Kimberley CLN is the main load centre consuming more than half of the load in the province. The anticipated mining in the Namaqualand CLN along with possible smelter operations associated with these mines explains the hike in demand in 2023. The forecast for the remaining CLNs shows a natural load growth. The load forecast for the Northern Cape is shown in Figure 7-20.



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Namaqualand	165	202	385	391	397	403	410	417	424	430
Karoo	362	370	415	421	427	433	439	445	451	457
Kimberley	747	763	753	785	807	828	851	875	899	924
Provincial Peak	1255	1315	1530	1573	1606	1639	1675	1711	1748	1784
2030 Peak	1784	1784	1784	1784	1784	1784	1784	1784	1784	1784

Figure 7-20: Northern Cape load forecast

7.7.3 PLANNED PROJECTS

The traditionally weak radial transmission network, forecasted demand, and the high potential for the development of generation from RE sources makes the Northern Cape a key centre for network development activities within this planning horizon. As such, several projects and schemes that aim to address the long-term requirements of the province have been initiated in order to accommodate the forecasted load and new generation.

7.7.3.1 Major Schemes

The major TDP schemes planned in the Northern Cape are as follows:

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-Oranjemund 220 kV line (constructed at 400 kV). The Gromis–Oranjemund 220 kV line has been completed and energised in 2018.

Kimberley Strengthening Phase 3

This strengthening entails the construction of Umtu (Hotazel) 400/132 kV Substation along with the Hermes (later Selemo)-Mookodi, Mookodi-Umtu and Umtu-Ferrum 400 kV lines, which are to cater for the increasing load in the area. Distribution has indicated that the demand in the area has not materialised as anticipated, thus resulting in the deferment in establishment of Umtu 400/132 kV Substation. However, the 400 kV corridor will be reprioritised to enable the evacuation of renewable power out of the province.

Kimberley Strengthening Phase 4

This is a strategic project to support the forecasted load growth. However, the Ferrum-Beta 400 kV corridor will also be required to be phased in earlier to assist with integrating and evacuating the renewable generation potential in the area.

Upington Strengthening

The integration includes the phased construction of an Aries-Upington 400 kV line, an Upington-Ferrum 400 kV line and 400/132 kV 500 MVA transformation at Upington.

7.7.3.2 New Substations

The following new substations are planned in the Northern Cape for the current TDP period:

- Groeipunt 220/132 kV Substation about 10 km from Nama Substation. The substation was commissioned in 2020.

7.7.3.3 New Lines

- Juno-Gromis 400 kV line
- Aggeneis-Paulputs 400 kV line – Initial plans were to operate the line at 220 kV. However, due to the large demand for renewable generation in the vicinity there may be a requirement to operate the line at 400 kV from the onset.
- Ferrum-Upington 400 kV line

7.7.3.4 Reactive Power Compensation

Additional reactive compensation will be installed at Aries Substation, that is, an Aries 400 kV dynamic device (-150 Mvar to +250 Mvar) to assist with dynamic voltage control as part of the Northern Cape Reinforcement project.

7.7.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period 2021 to 2030:

Table 7-35: Northern Cape– summary of projects and timelines

TDP scheme	Project name	Expected CO year
Gariep Network Strengthening	• Ruigtevallei-Hydra derate 220kV line to 132 kV	2022
	• Ruigtevallei 132 kV Feeder Bay to Dreunberg	2022
Western and Northern Cape Series Caps decommissioning	• Decommission Hydra Series Cap	2022
Nama MTS Transformers Upgrade	• Nama 66/22 kV 20 MVA Transformer	2023
Oranjemund Shunt Cap	• Decommission 15 Mvar 66 kV Shunt Cap	2023
Northern Cape Reinforcement	• Aries dynamic device	2023
Hydra-Roodekuil Strengthening	• Rebuild Hydra-Roodekuil 132 kV line	2023
Upington Strengthening	• Upington second 500 MVA 400/132 kV transformer	2023
Namaqualand Strengthening	• Juno-Gromis first 400 kV line	2024
	• Gromis 400/220 kV transformation	2024
Northern Cape Voltage Unbalance	• Northern Cape line transposition	2025
Northern Cape Transformation	• Helios 1 x 20MVA 132/66 kV Transformer	2025
Upington Strengthening	• Ferrum-Upington first 400 kV line	2026
Aggeneis-Paulputs 400 kV line	• Aggeneis-Paulputs 400 kV line	2026
Ruigtevallei Transformer Normalisation and Strengthening	• Ruigtevallei 1 x 10 MVA 132/22 kV Transformer	2030
Kimberley Strengthening Phase 3	• Umtu (Hotazel) 400/132 kV Substation (first and second 500 MVA 400/132 kV transformers)	Deferred
	• Umtu (Hotazel) Ext 132 kV 1st 36 Mvar Capacitor	Deferred
Kimberley Strengthening Phase 4	• Establish Ulco and Manganore Substations and Beta-Ulco-Manganore-Ferrum 400 kV line	Deferred
	• Olien 400 kV Strengthening	Deferred

7.7.3.6 Projects for Future Independent Power Producers

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.

The following transmission network strengthening projects will be required to enable the connection of the future IPPs located in the province within the current TDP period based on the generation assumptions.

Table 7-36: Northern Cape - projects required to facilitate IPP integration

TDP scheme	Project name
Kronos IPP Transformation Phase 2	Kronos second 400/132 kV transformer (500 MVA)
Gamma Strengthening	Gamma first 500 MVA 400/132 kV transformation (loop-in and out of Hydra-Droërivier 400 kV line)
Aggeneis Strengthening Phase 1 (IPP)	Aggeneis first 500 MVA 400/132 kV transformation
Groeipunt 400/132 kV Transformation	Groeipunt 500 MVA 400/132 kV Transformer
	Aggeneis-Groeipunt 400 kV line
Hydra-Aries second 400 kV Corridor	Hydra-Kronos second 400 kV line
	Kronos-Aries second 400 kV line
Boundary Transformation Strengthening	Boundary third 500 MVA 275/132 kV transformer
Hydra B 400/132 kV Substation	New Hydra B 400/132kV Substation (loop-in loop-out of the Hydra-Perseus 400 kV line)
Garona Strengthening Phase 2	Garona MTS first 500 MVA 400/132 kV transformation (loop-in and out of Nieuwehoop-Ferrum 400 kV line)
Nama IPP Transformation	Nama 400/132 kV transformation
Gromis-Nama-Groeipunt 400 kV line	Nama-Gromis 400 kV line
	Groeipunt-Nama 400 kV line

TDP scheme	Project name
Aries Strengthening Phase 1	Aries first 500 MVA 400/132 kV transformation
Paulputs third Transformer	Paulputs 400/132 kV 500 MVA Transformer
Upington Strengthening	Aries-Upington first 400 kV line
Gamma Strengthening Phase 2	Gamma second 500 MVA 400/132 kV transformer
Kimberley Strengthening Phase 3 (Ferrum-Mookodi-Hermes Corridor)	Ferrum-Mookodi (Vryburg) second 400 kV line (via Umtu)
	Hermes (later Selemo)–Mookodi (Vryburg) first 400 kV line
Korana 400/132 kV Substation	New Korana 400/132 kV Substation (loop-in loop-out of Aries-Aggeneis 400 kV line)
Aries-Aggeneis second 400 kV Corridor	New Aries-Aggeneis 400 kV line
Kimberley Strengthening Phase 4 (Ferrum-Beta Corridor)	Establish Ferrum-Beta 400 kV line
Hydra B Strengthening Phase 2	Hydra B second 500 MVA 400/132kV Transformer
	Loop-in loop-out the second Hydra-Perseus 400 kV line at Hydra B
Kronos IPP Transformation Phase 3	Kronos third 500 MVA 400/132 kV transformer
Helios Strengthening Phase 2	Helios second 500 MVA 400/132 kV transformer
Gamma 765/400kV transformation	Gamma 2000 MVA 765/400 kV Transformer
Cape Corridor Phase 4	Second Gamma-Perseus 765 kV line
	Perseus-Zeus 765 kV line
Cape Corridor Phase 5A	Phase 1 (Operated at 400kV): • First Aries-Upington 765 kV line • First Upington-Umtu (Hotazel) 765 kV line • First Umtu (Hotazel)-Mookodi 765 kV • First Mookodi-Mercury 765 kV line
Gromis IPP Transformation	Gromis first 400/132 kV 500 MVA transformation
Hydra B Strengthening Phase 3	Hydra B third 500MVA 400/132 kV transformer
Kimberly Strengthening Phase 4 (Boundary 400 kV Strengthening)	Boundary 400/132kV transformation (loop-in loop-out of the Ferrum-Beta 400 kV line)
Upington Strengthening	Upington third 500 MVA 400/132 kV transformer

7.7.3.7 Projects for Alternative Generation Scenario

A scenario of an additional 2 GW of battery energy storage capacity in the Kimberley CLN was considered. It is proposed that the battery energy storage systems (BESS) should operate in charging mode during times of maximum renewable generation output in the Northern Cape. This will avoid putting the transmission corridors exporting power out of the Northern Cape under strain. It is further recommended that large-scale BESS in the Northern Cape should not discharge more than 40% of their installed capacity when RE plants in the vicinity are operating at or near their maximum outputs.

Over and above additional transformation required at the substations proposed for the large-scale BESS integration, the minimum strengthening requirements for the Northern Cape alternative generation scenario are highlighted below. The projects will also assist with the evacuation of surplus generation from the Western Cape.

Table 7-37: Northern Cape required projects for alternative generation scenario

TDP scheme	Project name
Kimberley Strengthening Phase 4 (Boundary 400 kV Strengthening Phase 2)	Boundary-Beta second 400 kV line
400 kV Northern Ring Reactive Power Compensation	Umtu 2 x 100 Mvar Shunt Compensation
Cape Corridor Phase 5B	Aries 765/400 kV Extension (first 2 000 MVA transformer)
	Bypass Upington, operate Aries-Umtu first 765 kV line
	Bypass Mookodi, operate Umtu-Mercury first 765 kV line
Cape Corridor Phase 6 (Northern Cape)	Aries second 2000 MVA 765 /400 kV transformer
	Aries-Umtu second 765 kV line
	Umtu-Mercury second 765 kV line
	Install series compensation on the Umtu-Mercury 765 kV lines
	Zeus third 2000 MVA 765/400 kV transformer
	Hydra second 2 000 MVA 765/400 kV transformer

7.7.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-6 below.

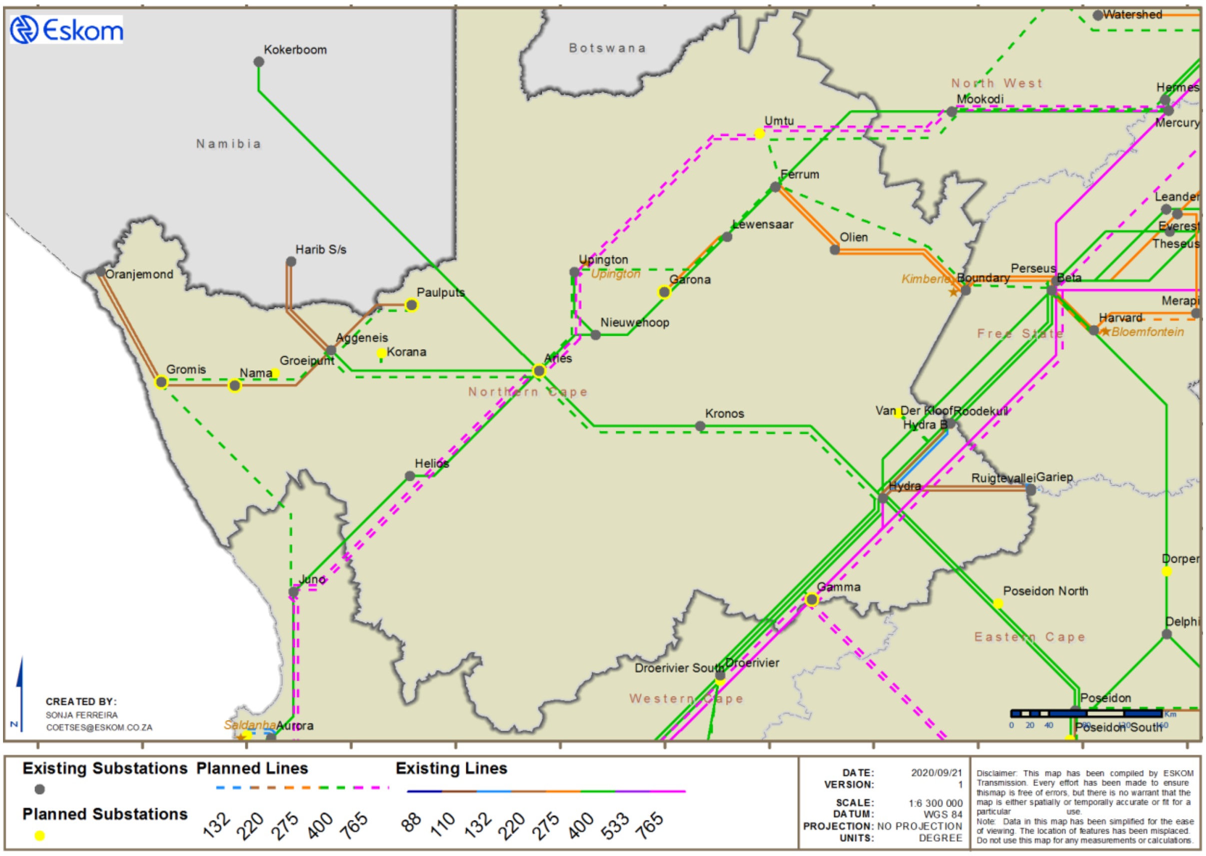


Figure 7-21: Future Northern Cape transmission network

A summary of all new major assets planned for this province is provided in Table 7-38 to Table 7-41. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-38: Planned transformers for the Northern Cape

Transformer type	2021-2025		2026-2030	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
2 000 MVA 765/400/33 kV	-	-	1	2 000
500 MVA 400/132/22 kV	9	4 500	8	4 000
20 MVA 66/22 kV	1	20	-	-
315 MVA 400/220/22 kV	1	315	-	-
Grand total	**11**	**4 835**	**9**	**6 000**

Table 7-39: Planned overhead lines for the Northern Cape

Line voltage	2021-2025	2026-2030
	Total length (km)	Total length (km)
400 kV	1 584	385
765 kV	-	500
Grand total	**1 584**	**885**

Table 7-40: Planned capacitor banks for the Northern Cape

Capacitor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
400 Mvar 400 kV	-	-	1	400
Grand total	**-**	**-**	**1**	**400**

Table 7-41: Planned reactors for the Northern Cape

Reactor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	9	900	2	200
400 Mvar 765 kV	-	-	3	1 200
Grand total	**9**	**900**	**5**	**1 400**

7.8 NORTH WEST

The North West, also known as the platinum province, is a neighbour to Botswana and shares borders with the Free State, Northern Cape, Limpopo and Gauteng. Its capital is Mahikeng.

The province is enriched with various mineral resources, such as gold, uranium, platinum, diamonds, dimension stone, fertile and vast agriculture soil, a strong manufacturing sector, and plentiful opportunities in RE and agro-processing. The North West is a key ferrochrome producer and is home to some of the largest platinum mines and refineries.

In addition, both tourism activities and investment opportunities thrive in the province, boasting, among others, internationally renowned tourism hubs. These include the Big Five Pilanesberg National Park, located in the crater of an extinct volcano, the Madikwe Game Reserves, Sun City Entertainment and Golf complex, the Taung Skull Heritage Site, and the ever-popular Hartebeespoort Dam.

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, sunflowers, tobacco, cotton, and citrus fruits.

The transmission network consists of a highly interconnected 400 kV network with an underlying 275 kV network. The current North West transmission network is shown in Figure 7-22.

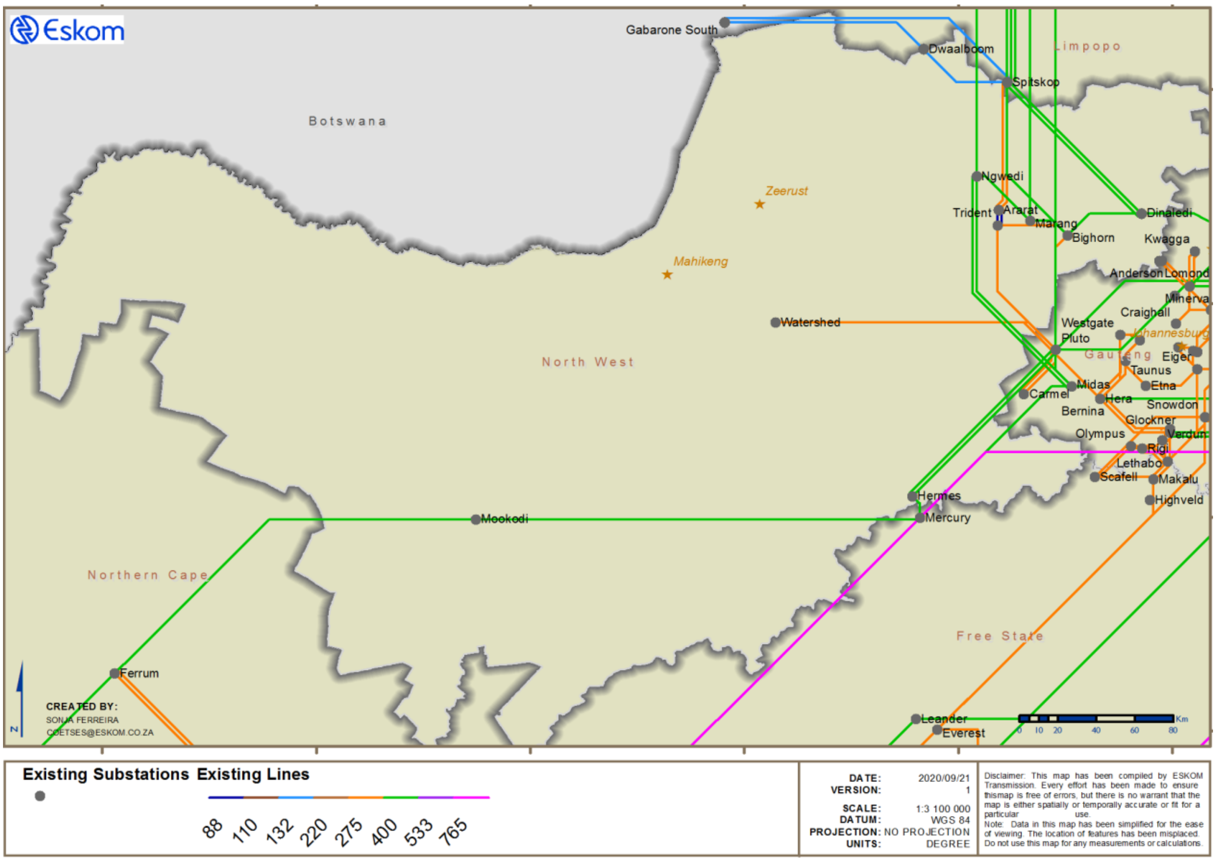


Figure 7-22: Current North West transmission network

7.8.1 GENERATION

There are no power stations located in North West. All the power consumed within this province is sourced from power stations in Limpopo and Mpumalanga. With the complete integration of the Medupi Power Station, most of the province's power will be supplied from Limpopo.

The REIPPPP has provided a platform for the private sector to invest in RE connected to the South African power grid. Thus far, in the North West, around 275 MW of RE plants are committed for integration to the power grid from Rounds 1 to 4B, and 100% of these plants are PV. The approved projects within the REIPPP programme are summarised in Table 7-42 below.

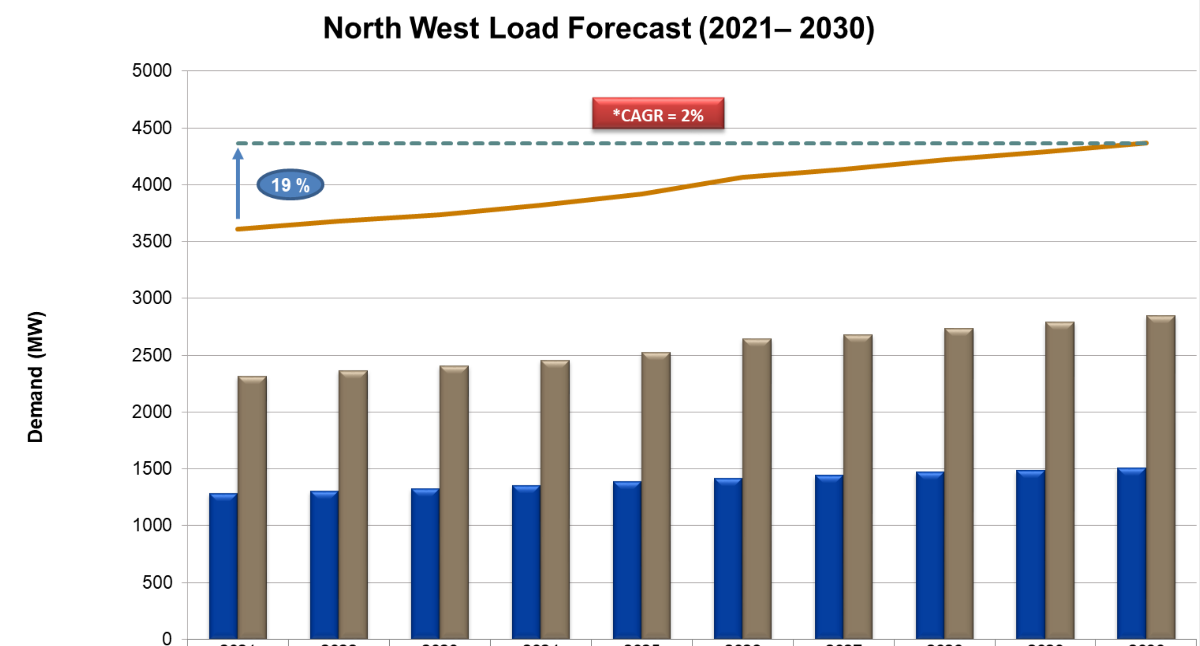
Table 7-42: Approved projects in North West under the REIPPPP

Programme and bid window	PV (MW)	Grand total (MW)
IPP RE 1	7	7
RE IPP 4B	268	268
Grand total	**275**	**275**

7.8.2 LOAD FORECAST

The mainstay of North West's economy is mining, which generates more than half of the province's GDP. There is an abundance of livestock farming and game ranches and crop-growing regions that yield a variety of produce. The provincial economy is also driven by the entertainment and the casino complex at Sun City and the Lost City.

This province comprises of two CLNs, namely Rustenburg and Carletonville. Rustenburg CLN consumes approximately 65% of the load, with Carletonville CLN making up the remaining 35% of the demand. The electricity demand peaked at around 3 263 MW in 2019, with the load within the province projected to grow steadily at about 1.92% annually to reach 4 400 MW by 2030. The load forecast is shown in Figure 7-23**.**



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Carletonville	1288	1308	1326	1359	1389	1419	1450	1475	1492	1509
Rustenburg	2319	2369	2408	2461	2529	2645	2683	2742	2795	2855
Provincial Peak	3608	3677	3734	3820	3918	4064	4134	4218	4287	4364
2030 Peak	4364	4364	4364	4364	4364	4364	4364	4364	4364	4364

Figure 7-23: North West load forecast

7.8.3 Planned Projects

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

7.8.3.1 Major Schemes

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

Rustenburg Strengthening Phase 1

The scheme refers to the extension of Bighorn Substation with the installation of 2 x 500 MVA 400/132 kV transformers. Major customers will be supplied at 132 kV, deloading the existing 275/88 kV transformers.

Rustenburg Strengthening Phase 2

Rustenburg Strengthening Phase 2 refers to the extension of Marang Substation, which will also introduce a 132 kV voltage level at the substation. The distribution network will be upgraded from 88 kV to 132 kV in conjunction with introducing a 132 kV line at Marang Substation. Due to the slump in the platinum sector at Rustenburg, this project has been deferred to outside of the TDP period.

Rustenburg Strengthening Phase 3

The scheme is expected to address low voltages in the Rustenburg CLN under contingencies by installing shunt capacitors at Marang, Bighorn, and Dinaledi substations. This will also improve the voltage profile and provide reactive power support in the Rustenburg CLN.

Watershed Strengthening

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

Watershed (Backbone) Strengthening Phase 3

The current constraints at Watershed Substation are capacity shortages and poor voltage regulation, emanating from the N-1 of 275 kV in-feeds to Watershed Substation. To address this network constraint, load will be shifted from Watershed Substation to both the Mookodi and Ngwedi substations. Furthermore, a new Mahikeng Substation, designed at 400/132 kV but operated at 400/88 kV, is planned approximately 60 km west of Watershed Substation. The substation in-feeds will comprise of the construction of the Pluto-Mahikeng 180 km 400 kV line and the Mookodi-Mahikeng 160 km 400 kV line.

7.8.3.2 New Substations

To address load growth around Mahikeng and improve reliability on the network, Mahikeng 400/132 kV Substation will be established in North West. It will also provide a possible strategic connection corridor to the SADC region through Botswana as the first point of entry.

7.8.3.3 New Lines

- The Medupi-Ngwedi first 765 kV line (energised at 400 kV) near Mogwase will provide the required level of reliability to fully evacuate the power from the Waterberg generation pool to North West.
- Pluto-Mahikeng 400 kV line
- Mookodi-Mahikeng 400 kV line

7.8.3.4 Reactive Power Compensation

Additional shunt capacitors are planned at the following locations:

- Watershed 88 kV 1 x 30 Mvar and 132 kV 2 x 30 Mvar;
- Bighorn 132 kV 2 x 72 Mvar and 88 kV 3 x 48 Mvar;
- Marang 88 kV 5 x 48 Mvar; and
- Dinaledi 132 kV 3 x 72 Mvar.

7.8.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period 2021 to 2030:

Table 7-43: North West – summary of projects and timelines

TDP scheme	Project name	Expected CO year
Watershed Strengthening	• Watershed Substation 132 kV reactive power compensation (2 x 30 Mvar capacitors) • Watershed Substation 88 kV reactive power compensation (1 x 30 Mvar capacitors) • Watershed 275/132 kV Substation 250 MVA 275/132 kV transformer	2021
Watershed (Backbone) Strengthening Phase 3	• Pluto-Mahikeng 400 kV line • Mahikeng first 315 MVA 400/88 kV transformer	2028
	• Mookodi-Mahikeng 400 kV line, and • Mahikeng second 315 MVA 400/88 kV transformer	2030
Kimberley Strengthening Phase 3	• Hermes-Mookodi (Vryburg) first 400 kV line	2031
Rustenburg Strengthening Phase 1	• Bighorn 2 x 500 MVA 400/132 kV transformer	2030
Rustenburg Strengthening Phase 2	• Marang Extension 2 x 500 MVA 400/132 kV Substation	Deferred
Rustenburg Strengthening Phase 3	• Bighorn Reactive Compensation (2 x 72 Mvar 132 kV and 3 x 48 Mvar 88 kV shunt capacitors) • Marang Reactive Compensation (5 x 48 Mvar 88 kV shunt capacitors) • Dinaledi Reactive Compensation (3 x 72 Mvar 132 kV shunt capacitors)	2028
Medupi Integration Phase 2A: Mogwase	• Ngwedi 2 x 500 MVA 400/132 kV Substation • Ngwedi 400 kV loop-in (Matimba-Midas and Mara-Midas 400 kV lines) • Medupi-Ngwedi first 400 kV line	Commissioned

TDP scheme	Project name	Expected CO year
	• Medupi-Ngwedi first 765 kV line (energised at 400 kV)	2021
Trident-Ararat 2 x 88 kV lines capacity uprate	• Trident-Ararat 2 x 88 kV lines capacity uprate	2023

7.8.3.6 Projects for Future Independent Power Producers

The following transmission network strengthening projects will be required to enable the connection of the IPPs located in the province within the current TDP period based on the generation assumptions:

Table 7-44: North West – projects required to facilitate IPP integration

Project name	Required CO year
Mookodi 1 x 500 MVA 400/132 kV transformer	2025

7.8.3.7 Projects for Alternative Generation Scenario

There is no alternative generation scenario identified for the North West.

7.8.3.8 Provincial Summary

The future transmission network for the province is shown in Figure 7-24 below. It is expected that the complete integration of Medupi Power Station will further enhance the major power corridors into Rustenburg and extend into the Carletonville supply zones.

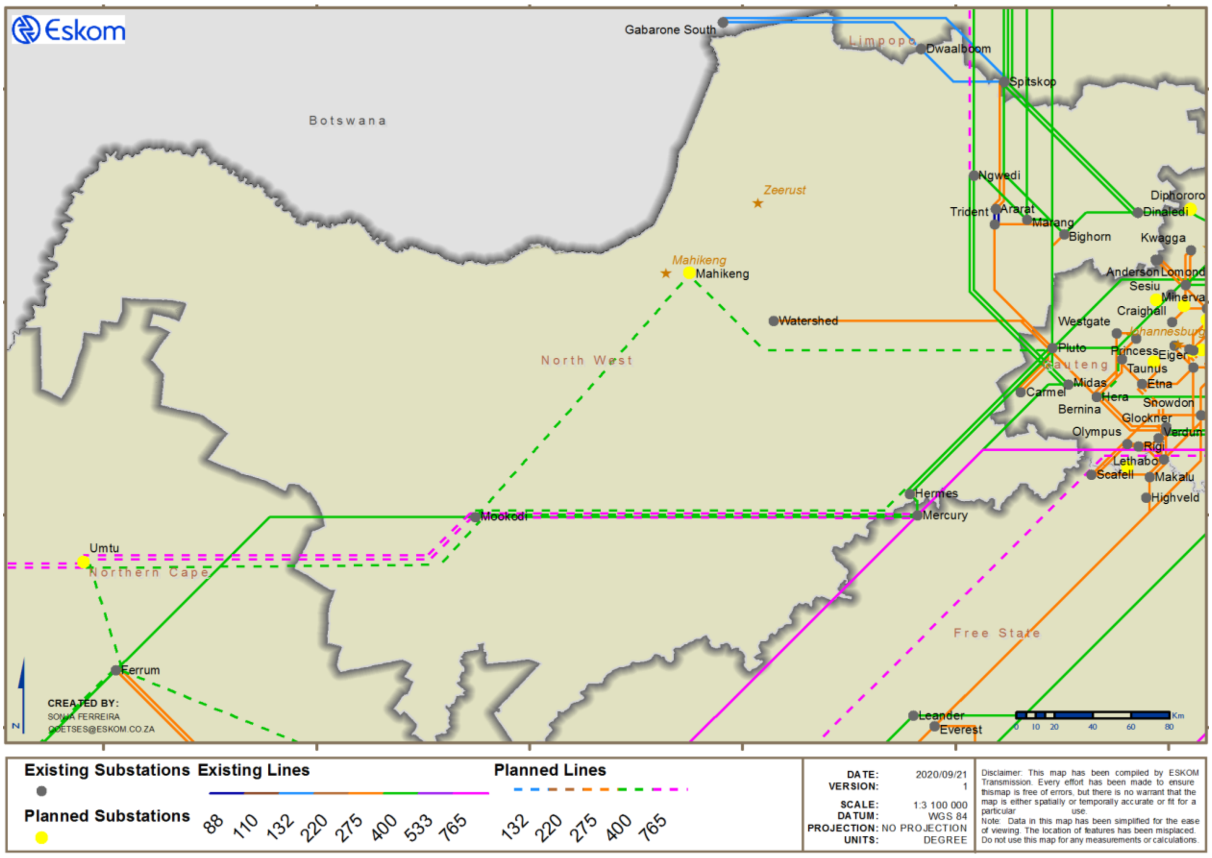


Figure 7-24: Future North West transmission network

A summary of all new major assets planned for this province is provided in Table 7-45 to Table 7-48. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-45: Planned transformers for the North West

Transformer type	2021-2025		2026-2030	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
160 MVA 400/88/22 kV	2	320	-	-
315 MVA 400/88/22 kV	-	-	2	630
500 MVA 400/132/22 kV	3	1 500	2	1 000
Grand total	**5**	**1 820**	**4**	**1 630**

Table 7-46: Planned overhead lines for the North West

Line voltage	2021-2025	2026-2030
	Total length (km)	Total length (km)
400 kV	243	310
765 kV	-	250
Grand total	**243**	**560**

Table 7-47: Planned capacitor banks for the North West

Capacitor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
48 Mvar 88 kV	-	-	24	1 152
72 Mvar 132 kV	-	-	15	1 080
Grand total	**-**	**-**	**39**	**2 232**

Table 7-48: Planned reactors for the North West

Reactor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	1	100	3	300
Grand total	**1**	**100**	**3**	**300**

7.9 WESTERN CAPE

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

Cape Town

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

The Western Cape transmission network consists mostly of 400 kV lines. It stretches over 550 km from Gamma Substation (near Victoria West) to Philippi Substation (near Mitchells Plain). The current transmission network is shown in Figure 7-25.

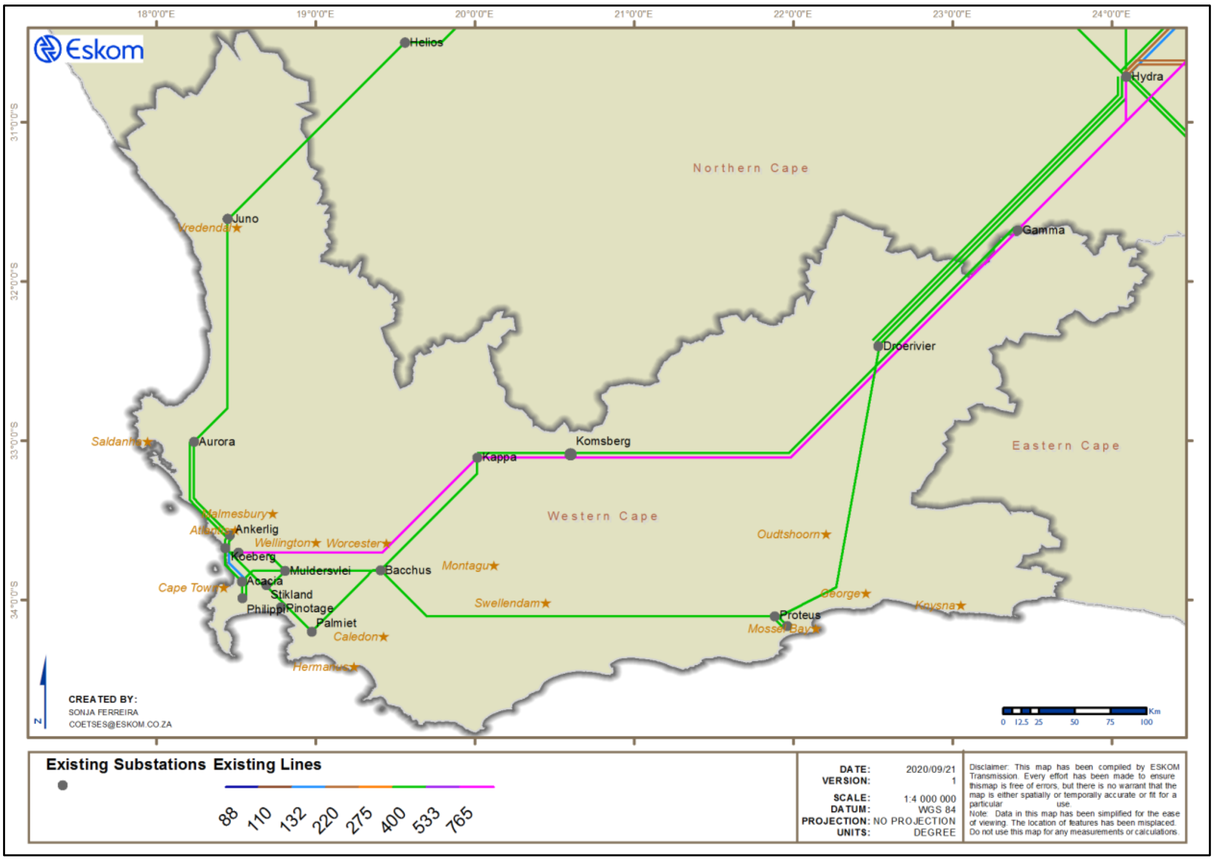


Figure 7-25: Current Western Cape transmission network

7.9.1 GENERATION

Koeberg Power Station is the only base load power station situated locally in the Western Cape. There are also four Eskom peaking plants in the Western Cape, consisting of pumped-storage and gas turbine generation, which help to meet the demand in the Western Cape and the national grid during generation shortages. These comprise the Palmiet Pumped-Storage Station, Ankerlig, and Gourikwa OCGT stations and the Acacia Gas Turbine Station. There are also three City of Cape Town (CoCT)-owned peaking plants in Cape Town, which help to manage the CoCT demand. These are the Steenbras Pumped-Storage Station and the Athlone and Roggebaai Gas Turbine Stations. The Western Cape has also benefited from RE generation due to its climate and proximity to the 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 1 860 MW (sent-out). The two units are rated at 970 MW each.

Koeberg Power Station

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 in accordance with the National Nuclear Regulator licencing requirement.

Ankerlig and Gourikwa Power Stations

The 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 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.

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

Steenbras Pumped-Storage Scheme

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

Steenbras Pumped-Storage Scheme is a CoCT generating facility. It consists of 4 x 45 MW units and is integrated into the 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 periods as they use 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 completed in February 2003 and has a capacity of 3.16 MW comprising three wind turbines (660 kW, 1.75 MW, and 750 kW). It is located around 50 km north of Cape Town in Durbanville.

Since the commercial operation of the facility, the plant has reached the end of its useful life, and Eskom 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 (that is, 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.

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.

Sere Wind Farm

Renewable Energy Independent Power Producers

The 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 in accordance with Table 7-50.

Table 7-49: Commissioned projects in the Western Cape under the REIPPPP

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

Touwsrivier CPV

Gouda Wind Facility

The integration of the projects for Rounds 4 and 4B will lead to additional Transmission infrastructure as summarised in Table 7-50.

Table 7-50: Approved projects in the Western Cape under the REIPPPP 4 and 4B

<table>
<tr><th>Bid window</th><th>Name of project</th><th>Type</th><th>Capacity (MW)</th><th>Transmission strengthening</th></tr>
<tr><td rowspan="2">4</td><td>Karusa Wind Farm</td><td rowspan="3">Wind</td><td>140</td><td rowspan="3">Establish Komsberg 400/132 kV 1 x 500 MVA Substation</td></tr>
<tr><td>Roggeveld</td><td>140</td></tr>
<tr><td rowspan="3">4B</td><td>Soetwater Wind Farm</td><td>139</td></tr>
<tr><td>Excelsior Wind</td><td rowspan="2">Wind</td><td>32</td><td>132 kV feeder bay at Bacchus Substation</td></tr>
<tr><td>Perdekraal East</td><td>107</td><td>Kappa Substation extension 400/132 kV
1 x 500 MVA transformer</td></tr>
</table>

7.9.2 LOAD FORECAST

The Western Cape GDP is the third-highest contribution to the country's total at around 15% and has one of the fastest growing economies in the country. The provincial load peaked at around 3 900 MW in 2019, and it is expected to increase to about 4 500 MW by 2030.

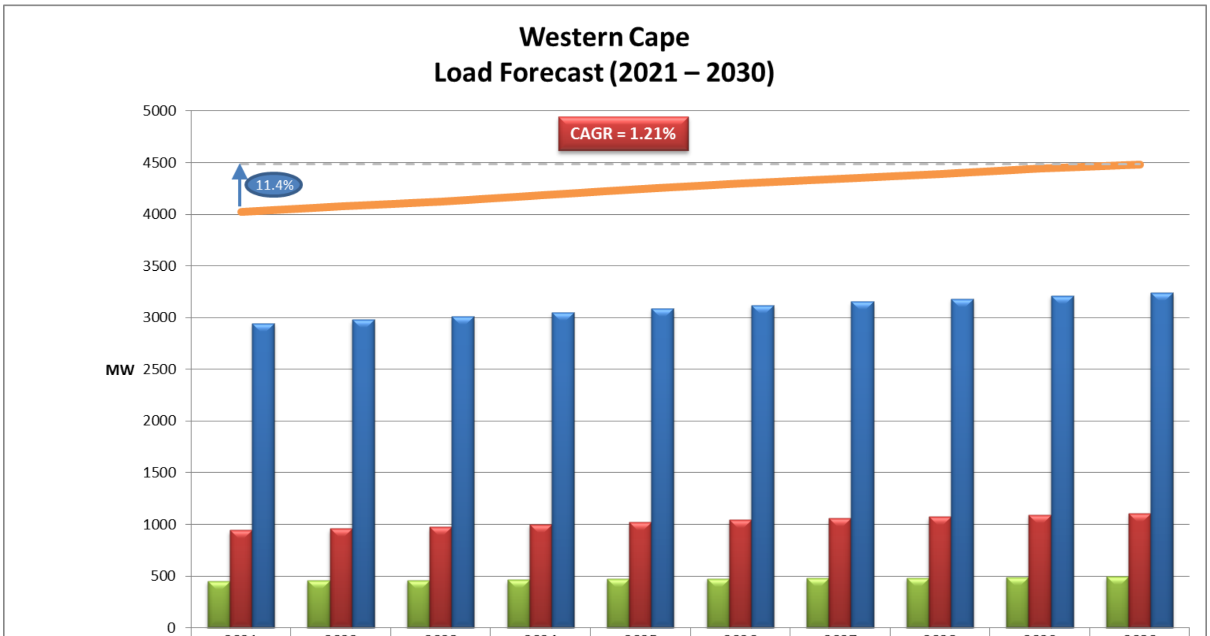
The Western Cape comprises three CLNs, namely Peninsula, Outeniqua, and West Coast. The Peninsula CLN is the main load centre in the province, consuming approximately 67% of the load. Outeniqua and West Coast CLNs make up the remaining 33% of the demand in the province.

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, 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 to import gas.

The load is forecasted to grow from ~4 000 MW in 2021 to ~4 500 MW in 2030. This translates to ~500 MW (11%) over the next 10 years, with a compound annual growth rate (CAGR) of 1.21%. The load forecast is shown in Figure 7-27.



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
West Coast	452	455	459	463	472	476	479	484	490	495
Outeniqua	943	959	975	1003	1019	1042	1059	1075	1095	1107
Peninsula	2947	2982	3016	3050	3088	3123	3155	3184	3213	3241
Provincial Peak	4023	4074	4123	4183	4241	4297	4346	4392	4441	4484
2030 Peak	4484	4484	4484	4484	4484	4484	4484	4484	4484	4484

Figure 7-26: Load forecast for the Western Cape

7.9.3 PLANNED PROJECTS

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

Local strengthening is planned across the province, mainly comprising new 400/132 kV substations. Additional 400 kV line infrastructure is also required, primarily to integrate these substations and assist with power evacuation from the existing power stations. Further strengthening of the recently completed 765 kV Cape Corridor is also envisaged.

7.9.3.1 Major Schemes

Cape Corridor Phase 4: Second Zeus-Sterrekus 765 kV line

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

The Cape Corridor comprises high-voltage 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 OCGT power stations in the Western Cape assist this corridor during the peak. However, the planned duty cycle for the OCGTs and associated fuel costs of running these generators, especially when one Koeberg unit is off for refuelling, may not be able to cater for the growth.

Therefore, the Cape Corridor has been strengthened with the first 765 kV line comprising the following sections that were constructed and energised over more than 10 years:

- Zeus-Mercury and Mercury-Perseus in December 2012
- Hydra-Perseus in July 2013
- Perseus-Gamma and Hydra-Gamma in February 2014
- Gamma-Kappa in April 2015
- Kappa-Sterrekus in December 2016

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 constructing a second 765 kV line.

7.9.3.2 New Substations

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 (which was commissioned in July 2020)
- Asteria Substation in the Houhoek area
- Erica Substation in the Mitchell's Plain area

Pinotage Substation

In the Outeniqua CLN, load growth in the residential, tourism, and agricultural sectors will compel 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 require the following developments:

- Construction of Komsberg 400 /132 kV Substation
- Introduction of 132 kV at Kappa Substation

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

7.9.3.3 New Lines

The Ankerlig-Sterrekus double-circuit 400 kV line, 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 second Koeberg-Acacia 400 kV line, currently operated at 132 kV, must also be energised at 400 kV. 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 to ensure that servitudes are acquired timeously to cater for additional gas generation projects that 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.

7.9.3.4 Reactive Power Compensation

To improve power transfer and system stability, series compensation has been used extensively in the network. Such installations exist throughout the Western Cape. However, some of the 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”. The Juno 1 and Juno 2 series capacitors were decommissioned in December 2017, the Helios series capacitor was decommissioned in January 2019, and the Victoria 1 and 2 and Hydra series capacitors were decommissioned in October 2020.

The Bacchus series capacitor will be bypassed by integrating the planned Agulhas Substation (near Swellendam) and the Proteus series capacitor will be bypassed with the integration of the planned Narina Substation (near George).

There are no additional reactive power compensation projects (capacitor banks and/or SVCs) planned for the Western Cape for the period 2021 to 2030.

7.9.3.5 Network Strengthening Projects

The following strengthening projects are planned for the period 2021 to 2030:

Table 7-51: Western Cape– summary of projects and timelines

TDP scheme	Project name	Expected CO year
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	2022
Komsberg Substation	• Komsberg 400/132 kV Substation (first 500 MVA transformer) • Loop-in and out Droërivier-Kappa 2 400 kV line	2021
Kappa Substation extension	• Kappa ext. 400/132 kV (first 500 MVA transformer)	2020
Ankerlig-Sterrekus first and second 400 kV lines	• Ankerlig-Sterrekus first and second 400 kV lines	2021
Koeberg 400 kV busbar reconfiguration and transformers upgrade	• Koeberg 400/132 kV GIS substation (first and second 400/132 kV 250 MVA transformers) • Reroute existing Koeberg 400 kV and 132 kV lines to the new substation	2024
Juno Substation transformation upgrade	• Replace the 2 x 40 MVA 132/66 kV units with 2 x 80 MVA units	2024
	• Install an additional 20 MVA 66/22 kV unit with the existing 10 MVA unit	
Second Koeberg-Acacia 400 kV line	• Second Koeberg-Acacia 400 kV line	2026
Erica Substation	• Erica Substation (1st and 2nd 400/132 kV 500 MVA transformers) • Philippi-Erica 400 kV line	2027
	• Loop-in and out Pinotage-Stikland 400 kV line	2028
Philippi Substation extension	• Establish 400 kV busbar • Install third 400/132 kV 500 MVA transformer as a hot standby	2023
Agulhas Substation	• Agulhas Substation (first and second 400/132 kV 500 MVA transformers) • Loop-in and out Bacchus-Proteus 400 kV line • Bypass Bacchus series capacitor bank	2028
Saldanha Bay Network Strengthening (Phase 1)	• At Aurora Substation, replace one of the existing 400/132 kV 250 MVA units with a 500 MVA unit as part of the refurbishment	2024
	• Strategically acquire a substation site in the Saldanha Bay area.	2026

TDP scheme	Project name	Expected CO year
	• Construct 2 x 400 kV lines (operated at 132 kV) from Aurora Substation to the new Distribution Blouwater (Anyskop) Substation	
Saldanha Bay Network Strengthening (Phase 2)	• Bokkom Substation (first and second 400/132 kV 500 MVA transformers) • Loop-in Ankerlig-Aurora 1 400 kV line	Deferred
Asteria Substation	• Asteria Substation (first and second 400/132 kV 500 MVA transformers) • Loop-in and out Palmiet-Bacchus 400 kV line	2026
Narina Substation	• Narina Substation (first and second 400/132 kV 500 MVA transformers) • Loop-in and out Droërivier-Proteus 400 kV line • Bypass Proteus series capacitor bank	2030
Cape Corridor Phase 3b: Series compensation on the 765 kV lines between Perseus and Kappa	• Series compensation on the 765 kV lines between Perseus and Kappa	Deferred
Cape Corridor phase 4: second Zeus-Sterrekus 765 kV line	• Zeus-Perseus first 765 kV line • Series compensation at Zeus and Perseus • Perseus-Gamma second 765 kV line	Deferred
	• Gamma-Kappa second 765 kV line	Deferred
	• Kappa-Sterrekus second 765 kV line • Loop-in and out Koeberg-Stikland 400 kV line into Sterrekus • Sterrekus Substation second 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
Windmill Transmission Substation	• Windmill 400/132 kV Substation (first and second 500 MVA transformers) • Loop-in and out Bacchus-Muldersvlei 400 kV line	Deferred
Stikland third 400/132 kV 500 MVA transformer	• Install third 400/132 kV 500 MVA transformer and FCLRs	Deferred
Pinotage third 400/132 kV transformer	• Install third 400/132 kV transformer at Pinotage Substation	Pre-concept

7.9.3.6 Projects for Future IPPs

There are two designated RE development zones in the Western Cape, namely Overberg and Komsberg. These have been identified as areas with high potential for RE generation and were gazetted as such in February 2016. The Western Cape is, therefore, a prime location for wind generation as well as for some PV generation.

As a result of this, the following generation assumptions were conceived for renewable generation in the Western Cape by 2030:

- ~7 000 MW of RE generation (in addition to what has already been commissioned or given preferred bidder status)
- 400 MW of battery storage

This results in the Western Cape becoming a net exporter of generation, with as much as 7 GW of excess generation during peak load.

The Transmission infrastructure required to integrate this renewable generation in the Western Cape is:

- Additional 400/132 kV transformers at existing and planned substations, that is, Droërivier, Juno, Kappa, and Komsberg.
- Establishment of Koring Substation between Droërivier and Komsberg substations by turning in the Droërivier-Komsberg 1 400 kV line.
- Establishment of a new substation 60 km south of Droërivier Substation by turning in the Droërivier-Proteus 1 400 kV line.

Additional infrastructure over and above this will be required to evacuate the excess power from the Western Cape. This will be in the form of 765 kV and 400 kV lines to deliver the power to the load centres in the central and eastern parts of the country. For the most part, the line routes lie within the recently gazetted electricity grid infrastructure (EGI) corridors.

A third and fourth 765 kV line to the Western Cape originating from Mercury Substation to Sterrekus Substation will need to be established. The backbone strengthening can be summarised as follows:

- 2 x Mercury-Sterrekus 765 kV lines with series compensation between Umtu Substation and Mercury Substation
- 765/400 kV transformation at Juno, Aries, and Umtu substations

- Additional 765/400 kV transformation at Zeus, Hydra, and Sterrekus substations

The projects required for the integration of future IPPs is summarised in Table 7-52.

Table 7-52: Western Cape – projects required to facilitate IPP integration

Scheme	Project name
Droërivier third 400/132 kV transformer	• Install third 400/132 kV 500 MVA transformer at Droërivier Substation
Kappa second 400/132 kV transformer	• Install second 400/132 kV 500 MVA transformer at Kappa Substation
Komsberg second and third 400/132 kV transformers	• Install second and third 400/132 kV 500 MVA transformers at Komsberg Substation
Koring Substation	• Koring 400/132 kV Substation (first 500 MVA transformer) • Loop-in and out Droërivier-Komsberg 1 400 kV line
Droërivier B Substation	• Droërivier B 400/132 kV Substation (first 500 MVA transformer) • Loop-in and out Droërivier-Proteus 1 400 kV line
Cape Corridor Phase 5: third 765 kV line	• Mercury-Mookodi first 765 kV line • Mookodi-Umtu first 765 kV line • Umtu-Aries first 765 kV line • Umtu ext. 765/400 kV (first 2000 MVA transformer)
	• Aries-Juno first 765 kV line • Juno-Sterrekus first 765 kV line • Aries ext. 765/400 kV (first 2000 MVA transformer) • Juno ext. 765/400 kV • (first 2 000 MVA transformer)
Cape Corridor Phase 6: fourth 765 kV line	• Zeus Substation third 765/400 kV 2 000 MVA transformer
	• Hydra Substation second 765/400 kV 2 000 MVA transformer
	• Mercury-Mookodi second 765 kV line • Mookodi-Umtu second 765 kV line • Umtu-Aries second 765 kV line • Umtu Substation second 765/400 kV 2000 MVA transformer • Install 50% series compensation on Mercury-Mookodi and Mookodi-Umtu 765 kV lines

Scheme	Project name
	• Aries-Juno second 765 kV line • Juno-Sterrekus second 765 kV line • Aries Substation second 765/400 kV 2 000 MVA transformer • Juno Substation second 765/400 kV 2 000 MVA transformer • Sterrekus Substation third 765/400 kV 2 000 MVA transformer

7.9.3.7 Projects for Alternative Generation Scenario

A gas-to-power programme has been initiated by the DMRE to achieve a total of up to 3 000 MW of capacity from gas-fired power generation facilities within the vicinity of Coega (Ngqura), Richards Bay, and Saldanha Bay.

The integration for up to 1 GW of gas generation in Saldanha Bay connects the gas power station to the future Bokkom Substation at 400 kV. To increase the capacity to 3 GW, the following additional infrastructure will be required:

- Turn in of the second Aurora-Ankerlig 400 kV line
- 1 x 400 kV line to Sterrekus
- Second Aurora-Juno 400 kV line

7.9.3.8 Provincial Summary

The future Western Cape transmission network is shown in Figure 7-28.

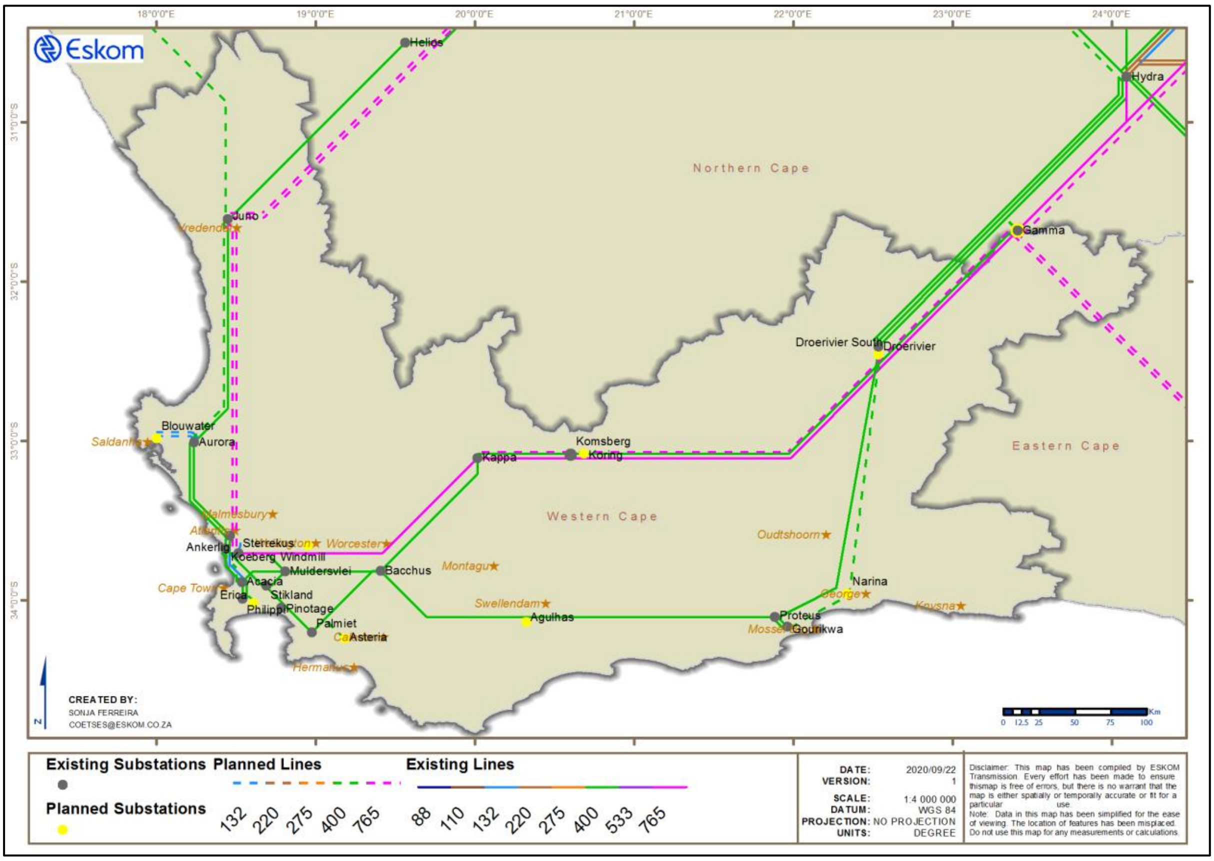


Figure 7-27: Future Western Cape transmission network

A summary of all new major assets planned for this province is provided in Table 7-53 to Table 7-55. This excludes the assets associated with the alternative generation and future IPP projects.

Table 7-53: Planned transformers for the Western Cape

Transformer type	2021-2025		2026-2030	
	Quantity	Total capacity (MVA)	Quantity	Total capacity (MVA)
250 MVA 400/132/22 kV	2	500	-	-
500 MVA 400/132/22 kV	8	4 000	-	-
Grand total	**10**	**4 500**	**-**	**-**

Table 7-54: Planned overhead lines for the Western Cape

Line voltage	2021-2025	2026-2030
	Total length (km)	Total length (km)
275 kV	5	0
400 kV	117	0
765 kV	230	170
Grand total	**352**	**170**

Table 7-55: Planned capacitor banks for the Western Cape

Capacitor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
100 Mvar 400 kV	-	-	2	200
Grand total	**-**	**-**	**2**	**200**

Table 7-56: Planned reactors for the Western Cape

Reactor type	2021-2025		2026-2030	
	Quantity	Total capacity (Mvar)	Quantity	Total capacity (Mvar)
400 Mvar 765 kV	-	-	1	400
Grand total	**-**	**-**	**1**	**400**

8 CAPITAL EXPENDITURE PLAN

The total capital expenditure for Transmission amounts to approximately R 118 billion and is summarised in Table 8-1.

Almost R90 billion is required for capacity expansion projects to address the following:

- The increase in generation capacity of ~30 GW in the next 10 years, mainly in areas with limited network capacity, will require a significant amount of investments in transmission networks to connect and develop new corridors and substations to dispatch the power to the load centres.
- Completion of the integration of the Medupi and Kusile power stations as well as the Bid Window 4 and 4B IPPs, resolve network reliability constraints (N-1), the connection of customers, ensure safety and regulatory compliances are met, and sustain the network for future growth and the acquisition of servitudes.

Further to the above, an amount of R27 billion in capital expenditure is required for:

- Refurbishments that address the life extension of existing assets to ensure network sustainability;
- Production equipment;
- Refurbishment of ageing telecommunications infrastructure; and
- Strategic spares for emergency works.

Table 8-1: Capital expenditure per category of projects for FY2021 to FY2030

Transmission capex categories	R million
Capacity expansion:	86 979
IRP2019 – integration of RE	*22 695*
Network Strengthening	*64 284*
Refurbishment	18 803
Production equipment	674
EIA and servitude	3 107
Telecoms	4 015
Strategic spares	4 173
Total	**117 751**

9 CONCLUSION

The major change from the TDP 2019 to this revision of the TDP is associated with the assumptions on the future generation capacity for the country. Whereas the TDP 2019 was based the draft IRP 2018, the TDP 2020 was informed by the IRP 2019 that was gazetted in November 2019. The fundamental difference is that the IRP 2019 proposes an accelerated new generation capacity programme where 9.8 GW of new capacity is proposed for integration to the system by 2025 followed by some 17 GW of generation capacity by 2030. A significant amount of this new capacity is from RE resources in areas with limited network capacity.

Apart from the expedited new generation capacity expectations in accordance with the IRP 2019, the development plans for the TDP 2020 remain aligned to that of the TDP 2019 regarding the plans for the integration of IPPs from Bid Windows 4 and 4B of the REIPPPP, network reliability enhancements, new demand growth, safety, and regulatory network strengthening requirements.

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 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 utilisation of strategic spares, the use of capacitors in the short term for voltage support, and 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 significantly affect 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 processes and funding constraints.

10 ACKNOWLEDGEMENTS

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This document and the public forum presentation are available for download via the Eskom website.

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