Welcome!

Eskom Transmission Development Plan (TDP) 2020 - 2029 Public Forum

The Eskom Transmission Development Plan (TDP) 2020 - 2029

31 October 2019

Keynote address

By: Segomoco Scheppers
Group Executive: Transmission

Setting-the-scene

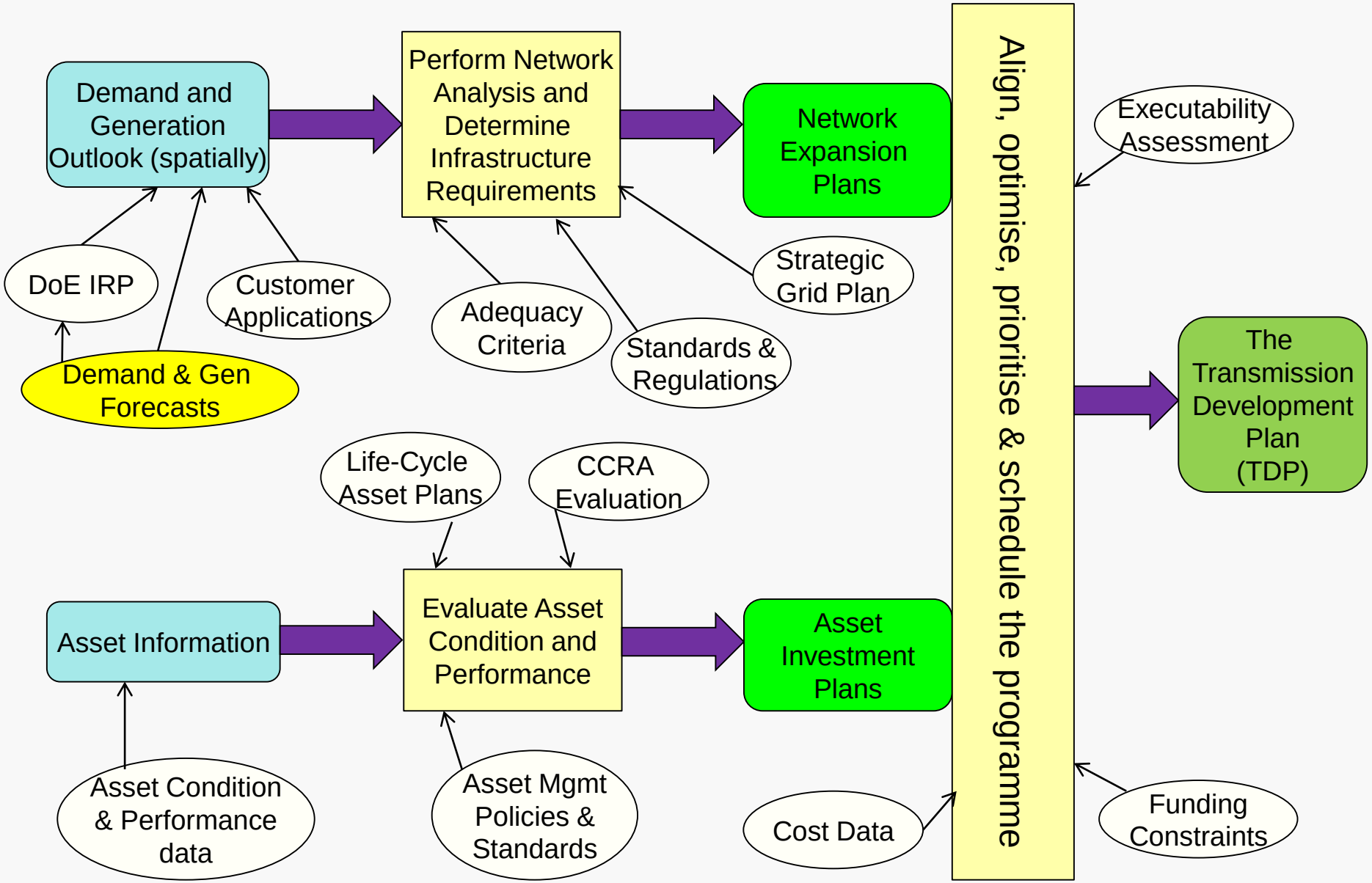
By: Mbulelo Kibido
General Manager: Grid Planning

Overview and purpose of the TDP Public Forum

The objective of the presentation is to:

- Contextualise the planning timelines relating to the demand forecast and generation patterns
- Share assumptions and results from the Transmission Development Plan 2020 – 2029
- Share information and results relating to the integration of IPPs, as per the DoE IPP programmes and address future requirements as per the IRP
- Share information on the estimated Transmission Capital Investment Requirements for the period 2020 – 2029
- More importantly, to solicit comments and inputs to improve on the Transmission Plans

A Simplified Transmission Network Infrastructure Investment Planning Model



Basis of the TDP 2020 - 2029

The TDP 2020 - 2029 was formulated to address the following:

1. Attain Grid Code compliance by resolving both substation and line violations

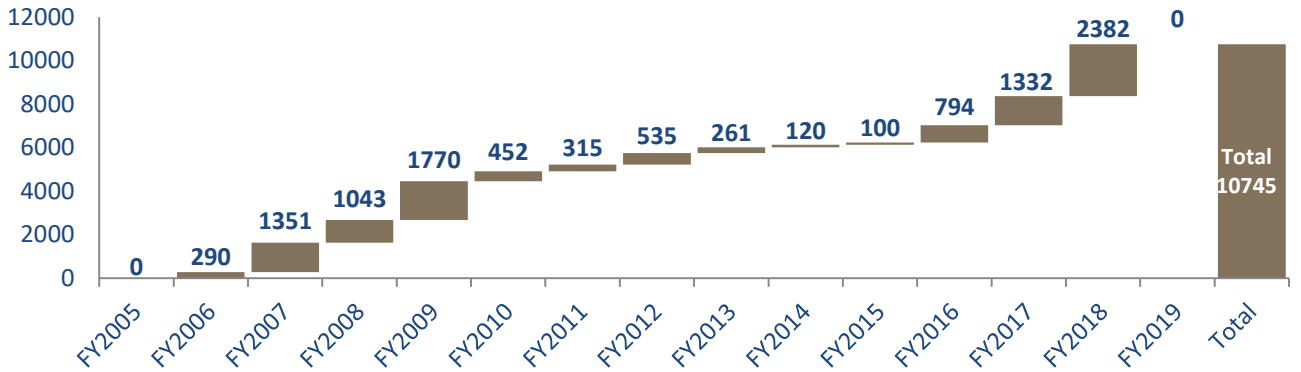
2. Determine new network infrastructure requirements to sustain and allow for future demand growth

3. Determine new network infrastructure requirements to integrate new generation (Eskom and IPPs)

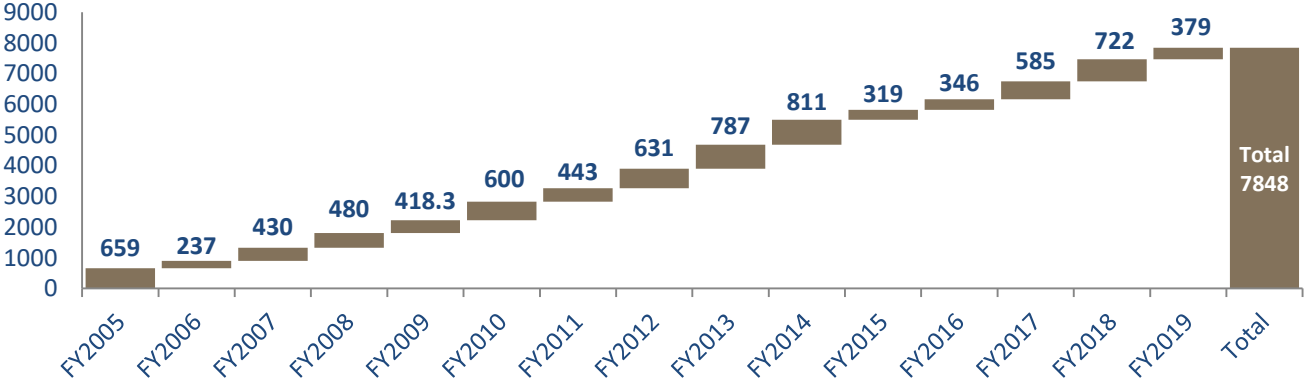
Recent Transmission Network Expansion Successes

To date, a large amount of construction work has been completed, adding ~10.7 GW of generation, ~7 850 km of transmission lines, and ~37.4 GVA substations…

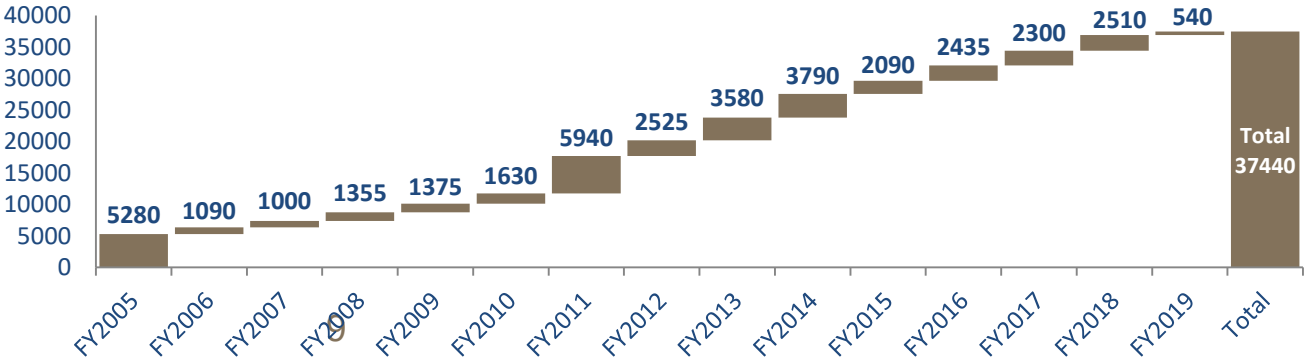
Generation (MW)



Transmission lines (km)



Transmission Substations (MVA)



DOE IPP Programme Overview – 31 July 2019

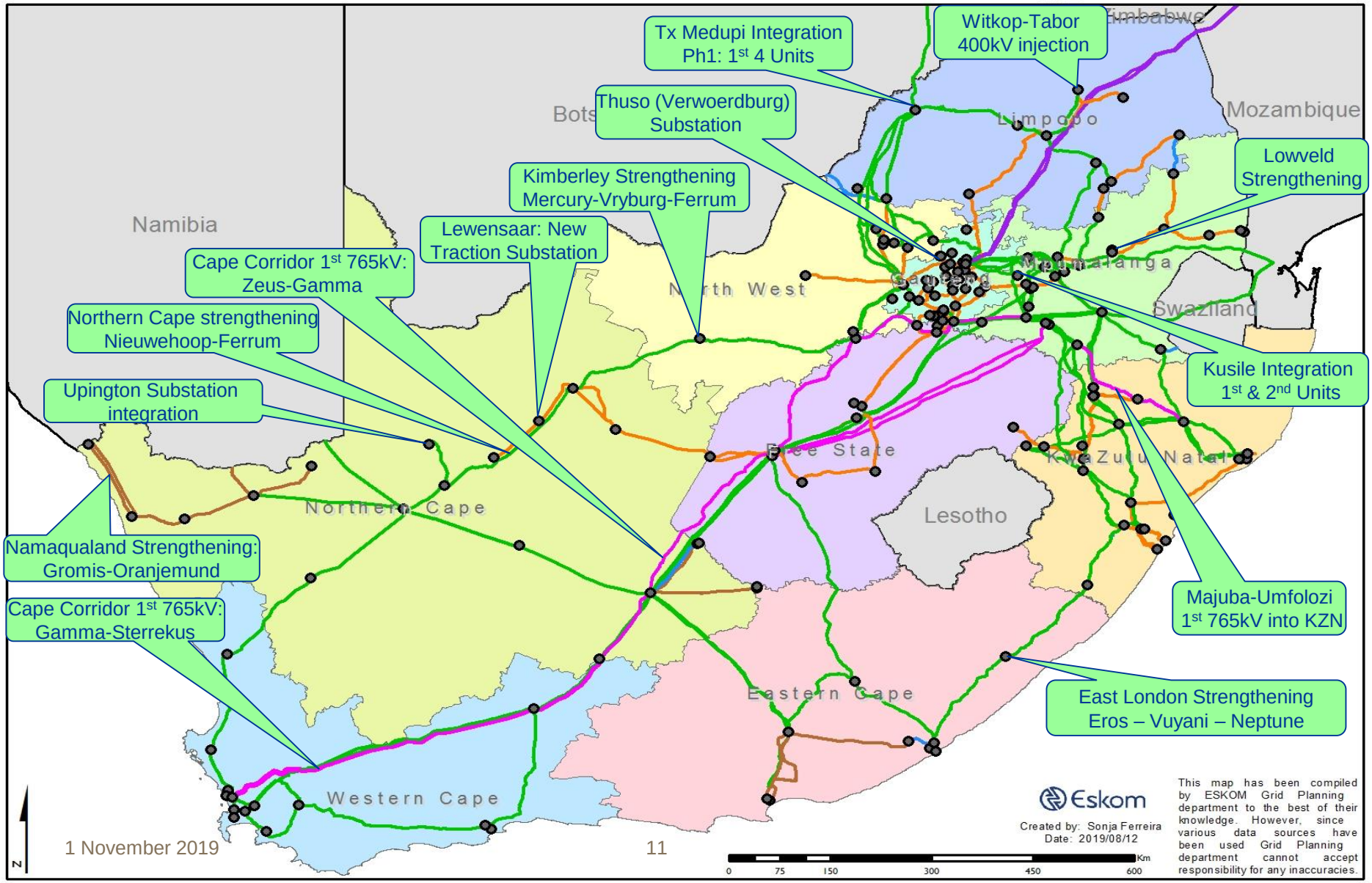
Peakers	REIPP BW1	REIPP BW2	REIPP BW3&3.5	REIPP BW4	REIPP BW4B	Small 1-5	Coal Baseload
2 projects 1200 MW	28 projects 1436 MW	19 projects 1054 MW	23 projects 1656 MW	13 projects 1121 MW	13 projects 1084 MW	20 projects MW TBD	2 projects 864 MW
All projects connected	All projects connected	All projects connected.	20 projects connected, 3 projects in execution phase	Projects in Execution Phase		Projects in Budget Quotation phase	Projects in Budget Quotation phase

8415 MW from 120 individual projects (The capacity for individual Smalls REIPP project TBD)

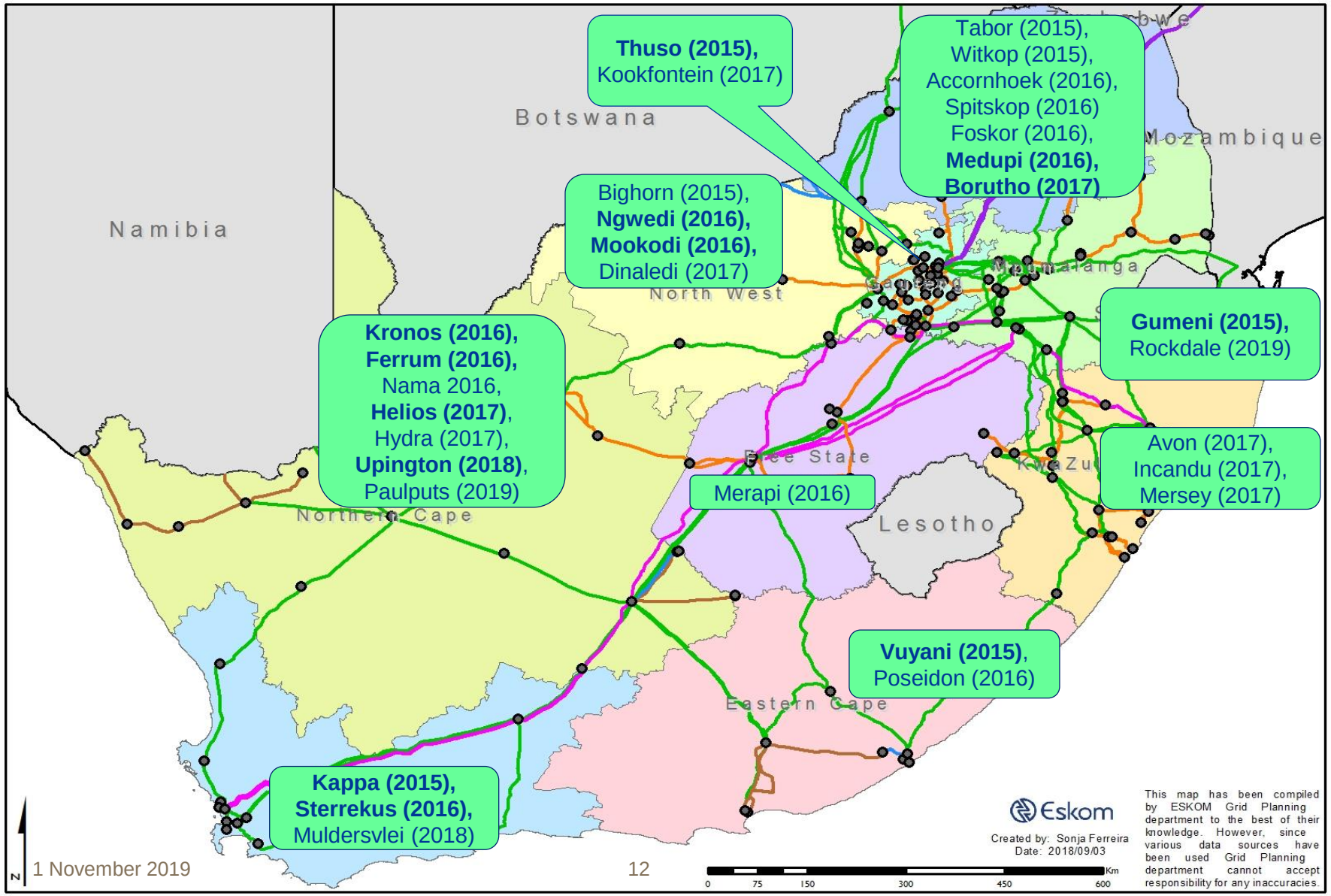
69 projects totalling 5241 MW have been commissioned, of which 4041 MW is from RE Sources

- Eskom has committed Capital Costs to enable the integration of successful bidders (Bid Window 1 – 4B, including Small REIPPs) into the National Grid.
- Grid connection capacity for future REIPP exhausted in some parts of the national grid, particularly in the Northern Cape Province.

Summary of major transmission corridor expansion projects completed recently



Summary of transmission transformation projects completed recently



The Different Plans

Integrated Resource Plan (IRP)

- The Department of Mineral Resources and Energy is accountable for the Country's Electricity Plan, which is the Integrated Resource Plan (IRP)
- The Integrated Resource Plan (IRP) is intended to drive all new generation capacity development
- NERSA licences new generators according to this determination

Strategic Grid Plan (SGP)

- The Strategic Grid Plan formulates long term strategic transmission corridor requirements
- The Plan is based on a range of generation scenarios, and associated strategic network analysis
- 20-year planning horizon, updated every 2 - 3 years

Transmission Development Plan (TDP)

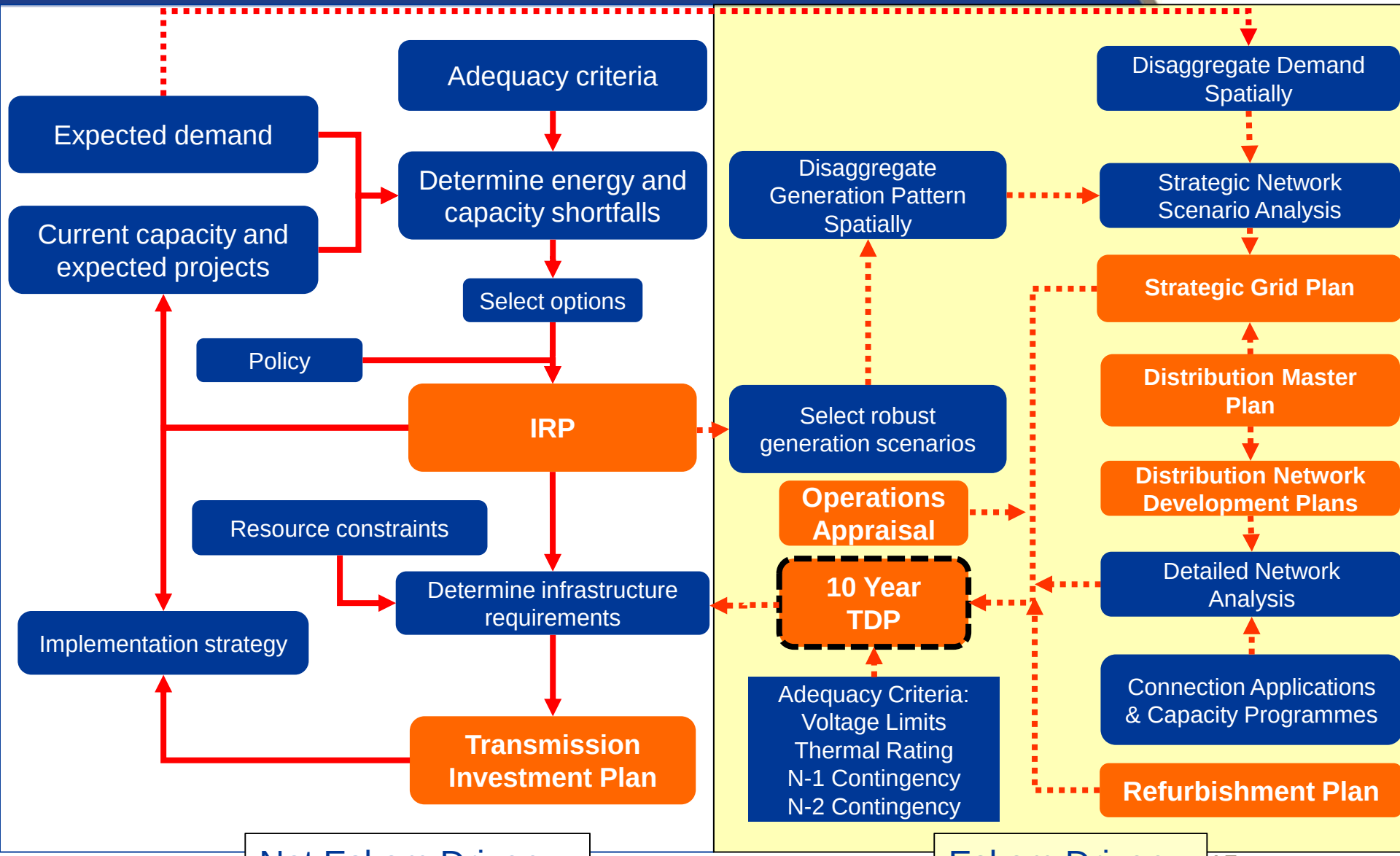
- The Transmission Development Plan (TDP) represents the transmission network infrastructure investment requirements
- 10-year planning horizon, updated annually
- Indicates financial commitments required in the short to medium term

Planning for the South African Integrated Power System

The TDP 2020 - 2029 Generation Assumptions

Presented by: Ronald Marais
Senior Manager: Strategic Grid Planning

Linkages Between the Various Plans



TDP Timelines

License obligation & Grid Code compliance

Open access & Reliability

TDP Ten Year Period

TDP Scenario Assumptions

Strategic Grid Plan

Stakeholder Engagement

Assumptions Generation & Demand

TDP 2020 - 2029

2020----------2025----------2029

1 - 3 | 4 - 6 | 7 - 10

Implementation & Preparation

Detailed studies & Business case

Uncertainty & Readiness

EIA & Servitude to enable, robust and flexible speed of implementation

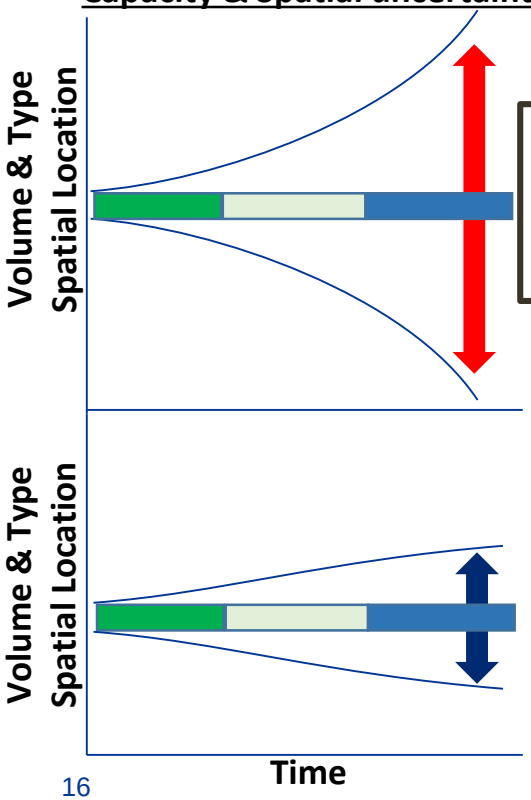
Annual TDP Update

1 - 3 | 4 - 6 | 7 - 10

Review and adjusting uncertainty

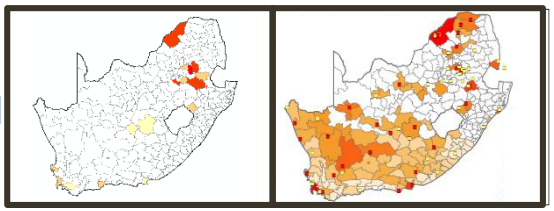
1 - 3 | 4 - 6 | 7 - 10

Capacity & Spatial uncertainty



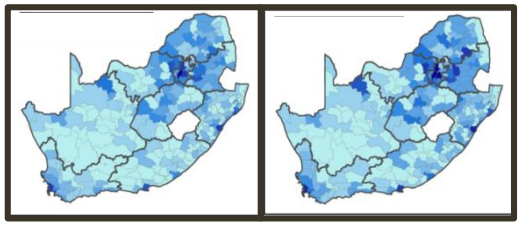
Generation

High spatial and capacity risk



Demand

Low spatial and capacity risk



Planning for the Integration of Independent Power Producers (IPPs)

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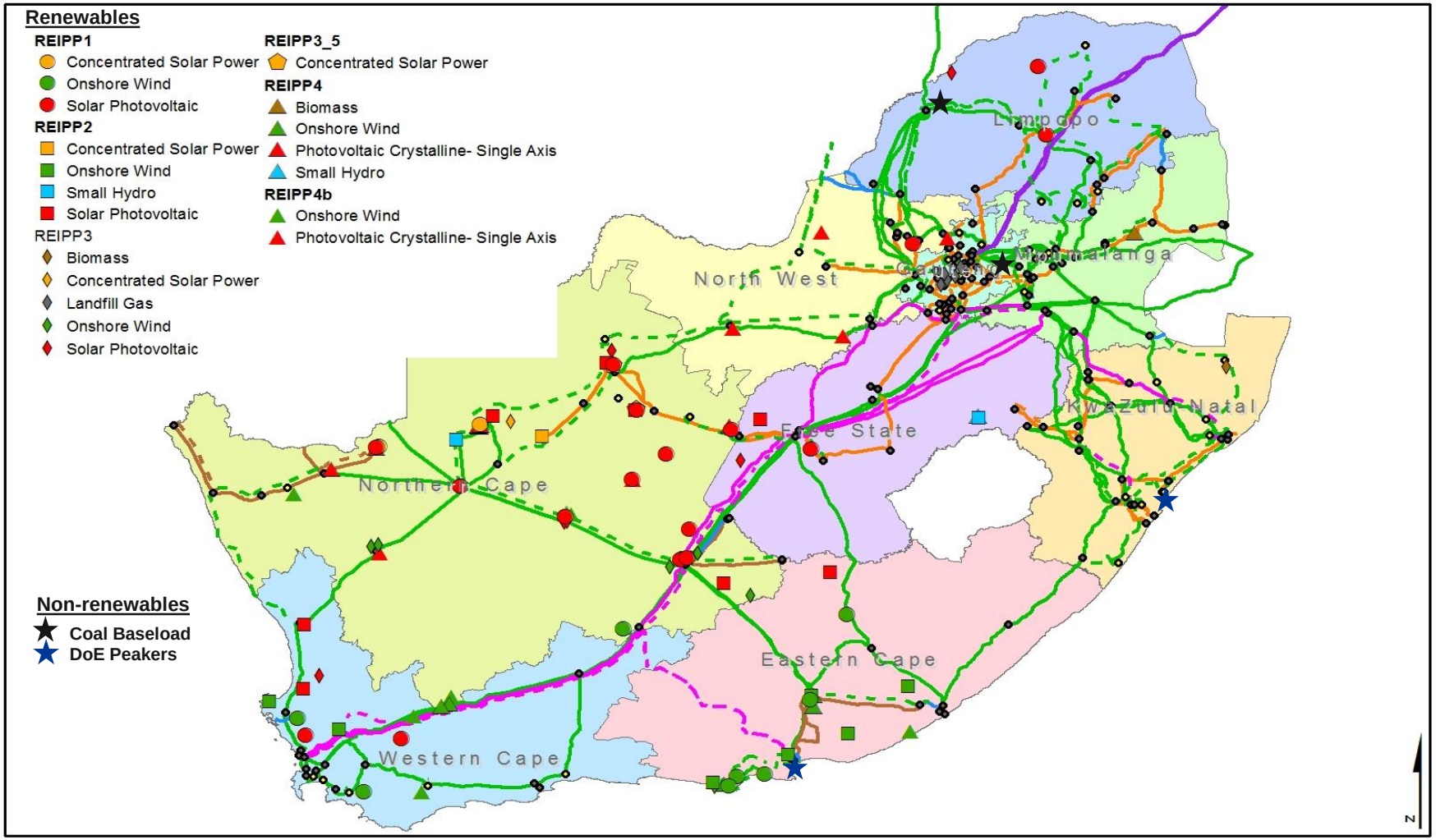
Approved IPPs



Planned Substations
Existing Substations
Planned Lines 132 220 275 400 765
Existing Lines 88 132 220 275 400 533 765

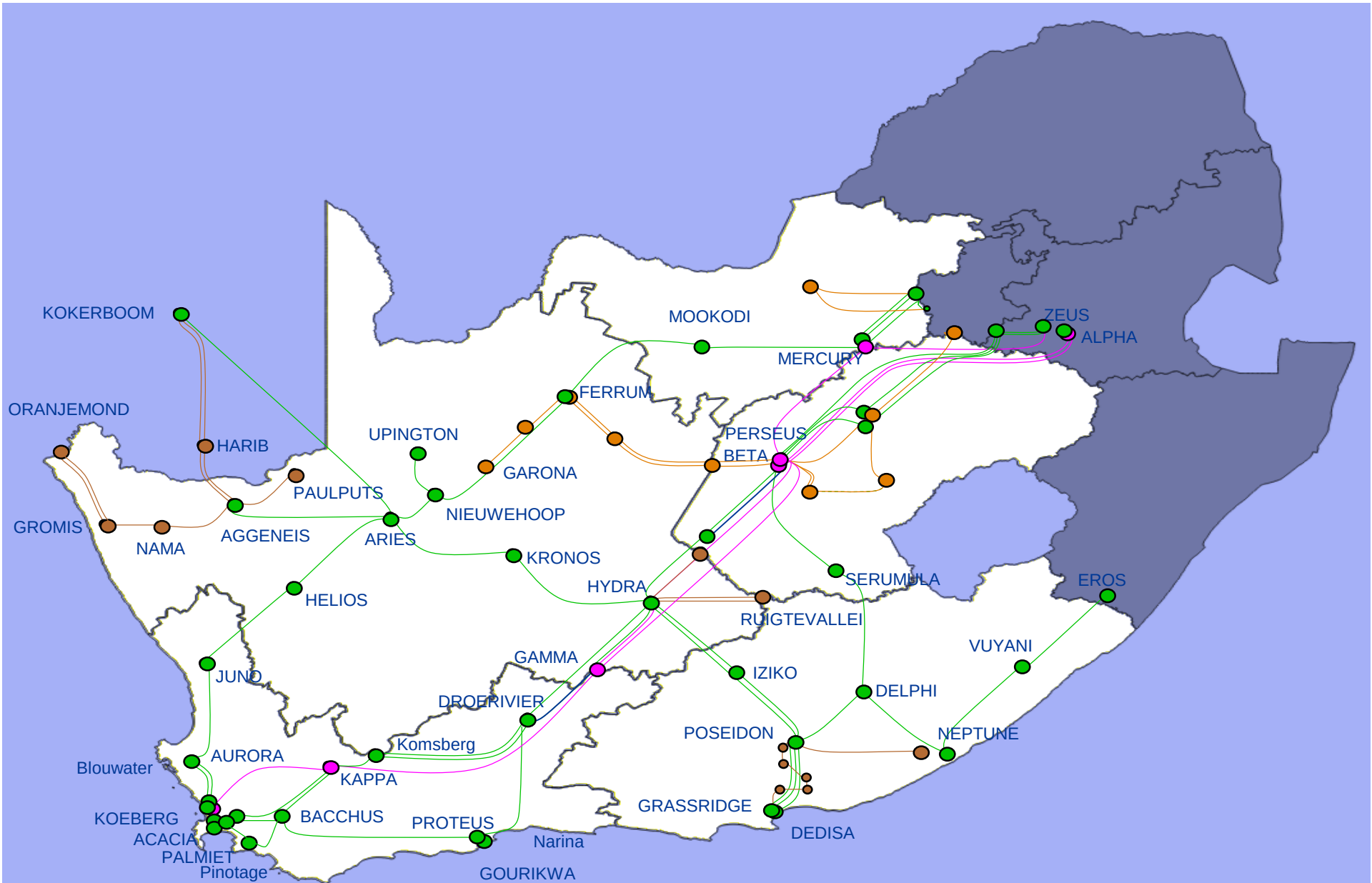
IPPs

Created by: Sonja Ferreira
Date: 2018/09/06

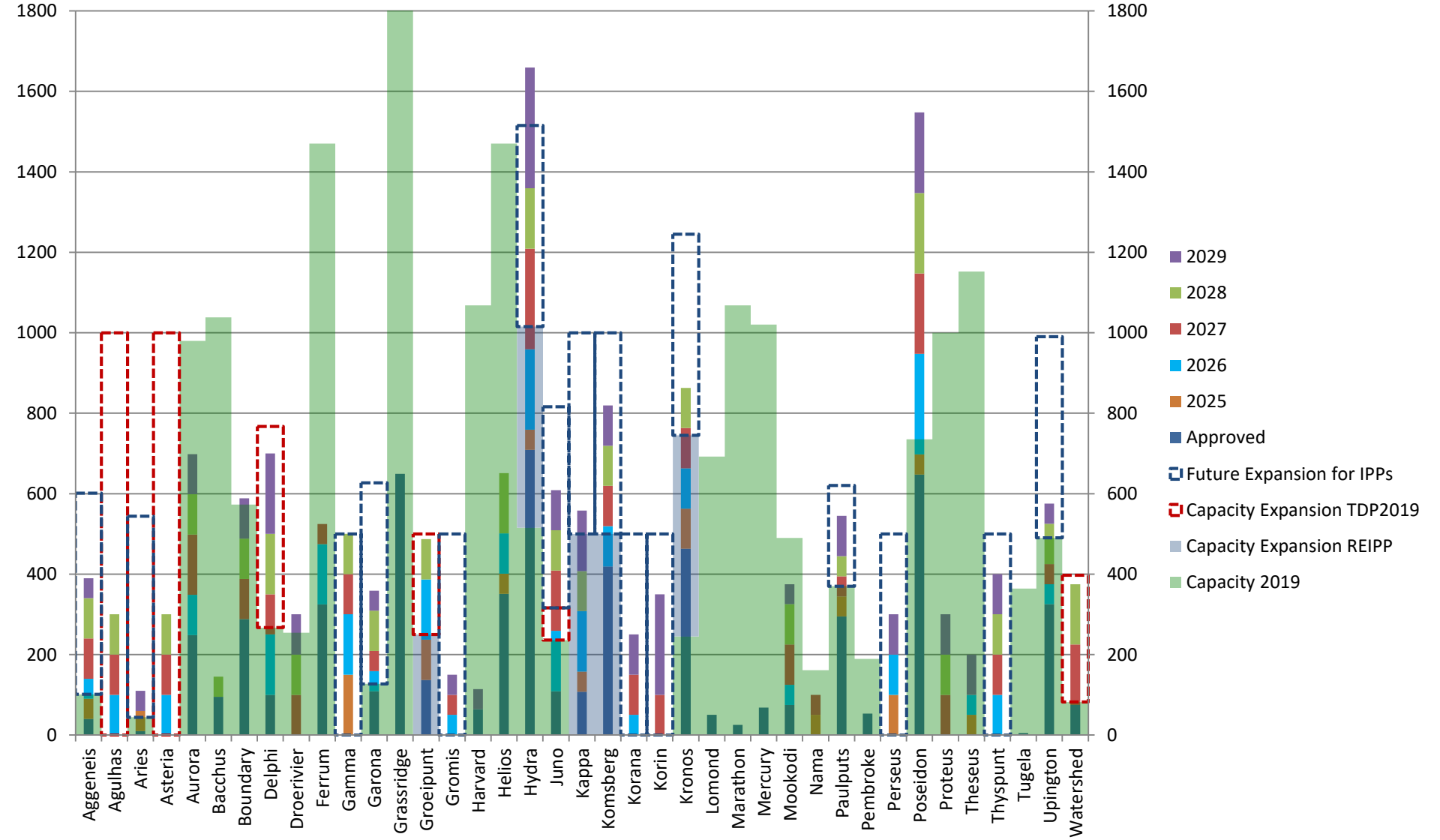
0 90 180 360 540 720 Km

This map has been compiled by ESKOM Grid Planning department to the best of their knowledge. However, since various data sources have been used Grid Planning department cannot accept responsibility for any inaccuracies.

Existing Transmission infrastructure - Overview of the constrained network



Transformer capacity enhancement for IPP Integration - TDP 2020 - 2029



Transmission integration plans for IPPs

Recently commissioned transmission infrastructure investment projects for IPP integration

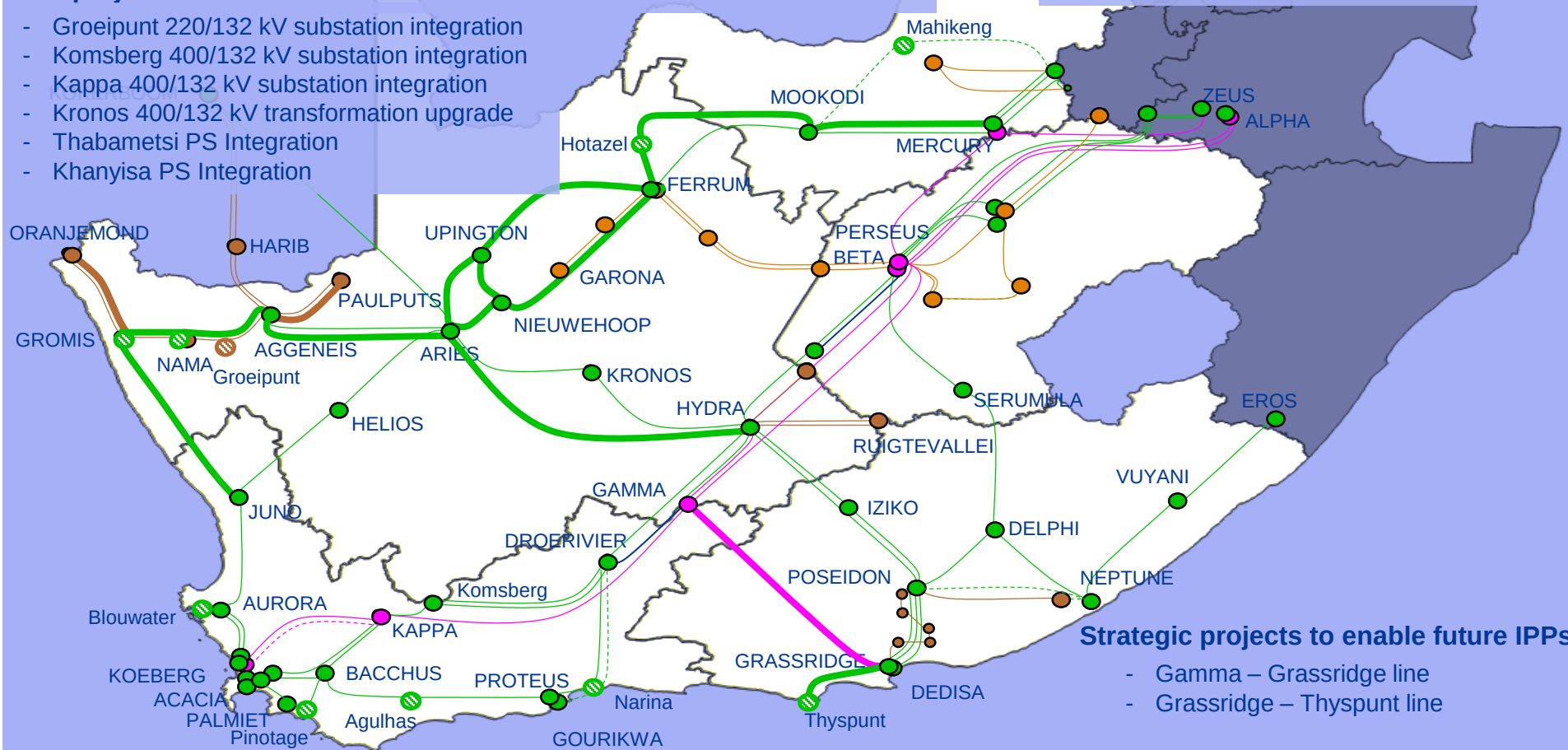
- **400/132 kV integration**: Vuyani, Mookodi, Helios, Ferrum, Kronos, Upington & Nieuwehoop
- **Transformation Upgrade**: Nama, Hydra & Grassridge
- **400 kV lines**: Aries – Niewehoop, Niewehoop – Upington, Niewehoop – Ferrum, Gromis – Oranjemond (Operated at 220 kV)

Transmission infrastructure to complete connection of the approved IPP projects

- Groeipunt 220/132 kV substation integration
- Komsberg 400/132 kV substation integration
- Kappa 400/132 kV substation integration
- Kronos 400/132 kV transformation upgrade
- Thabametsi PS Integration
- Khanyisa PS Integration

TDP projects to enable future IPPs

- Aggeneis – Aries line
- Aries – Hydra line
- Ferrum – Hotazel – Mookodi – Hermes line
- Aries – Upington line
- Aggeneis - Nama - Gromis line
- Aggeneis - Paulputs line
- Ferrum – Upington line



Strategic projects to enable future IPPs

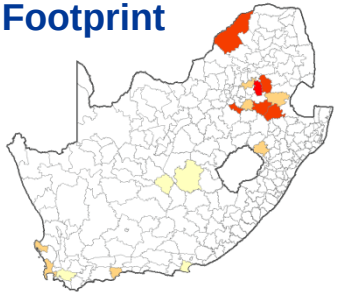
- Gamma – Grassridge line
- Grassridge – Thyspunt line

Tx Strategy to increase Grid Access to meet future needs of the IRP and customers

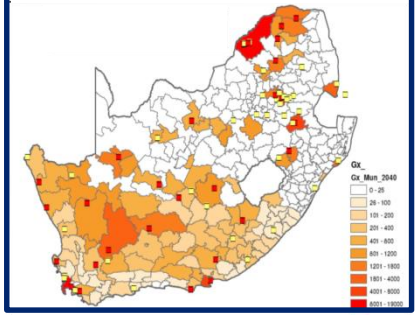
Change in generation diversity has major impact on future Tx Grid

- Grid Access – Increased connection capacity needed in new areas (delivery time > 8yr)
- On Time Connection – Smaller IPP generation plant can be constructed faster (delivery time <5yr)
- Unknown locations - Multiple unspecified IPP sites require market access for best price

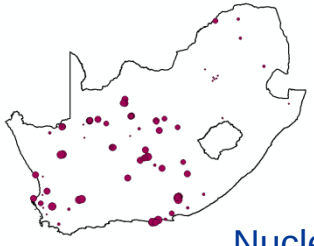
Current Generation Footprint



Future Generation Potential Footprint



Current Eskom Wind, Solar & REIPP 1.2.3.4

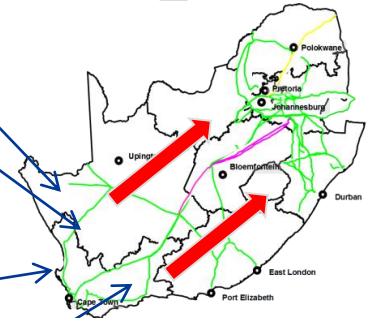


Solar

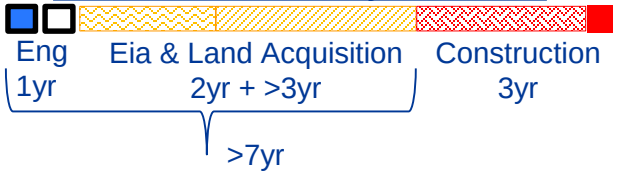
Wind

Gas

Nuclear



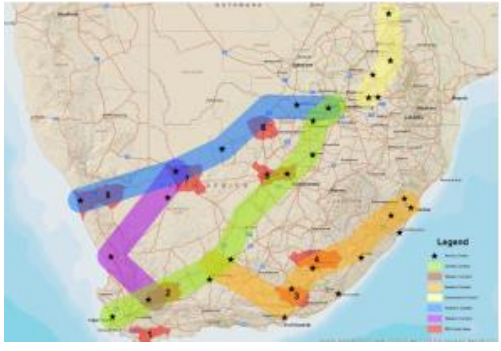
Transmission Line Project Timeline



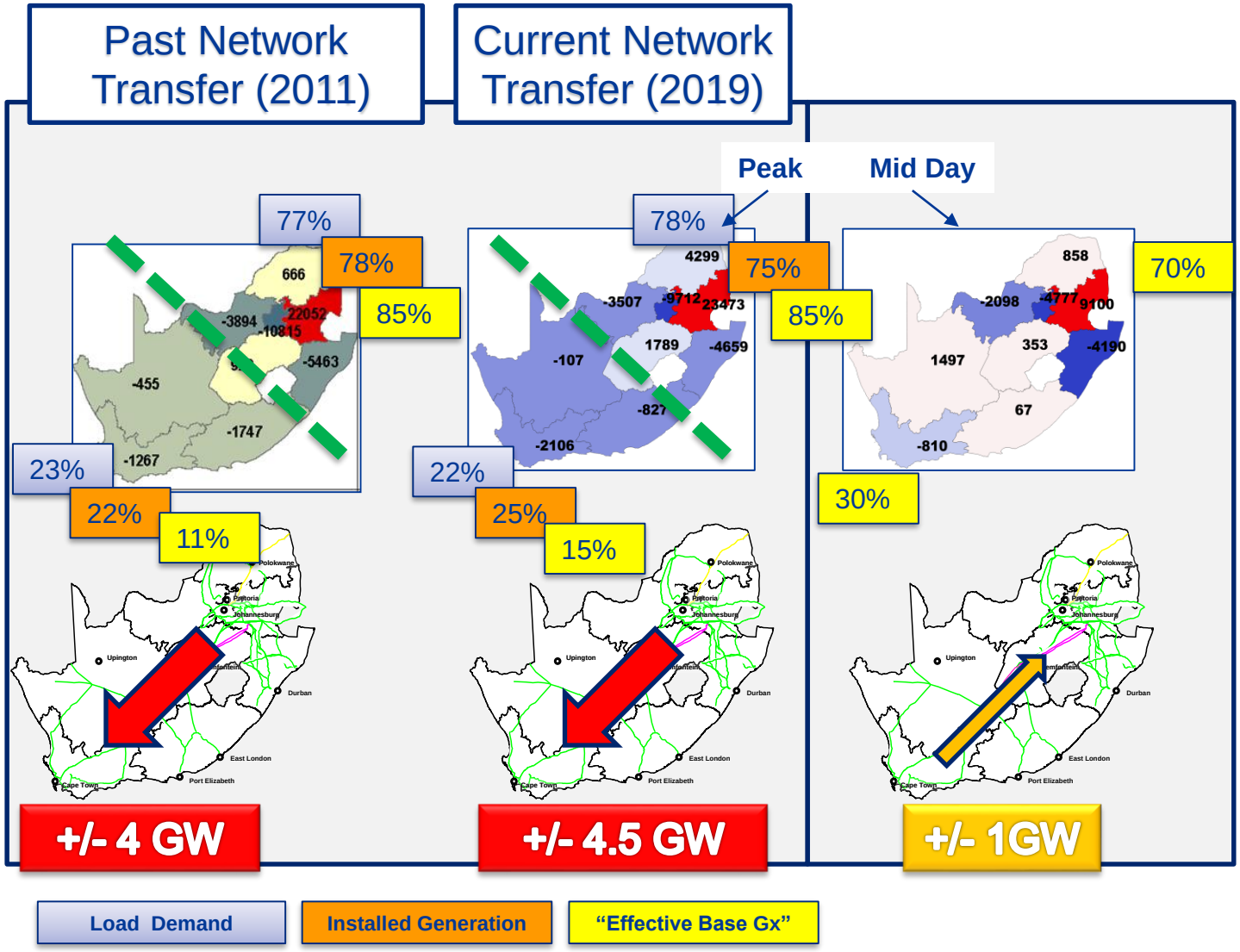
1. Strategic Investment in the EIAs & Land acquisition is critical to meet future IRP connection timeframes

2. Reducing Tx investment today compounds future Tx Grid roll out leading to high risk of Gx capacity delays

SEA Corridors for SIP 10 project



Grid Insights - Flow implications (2019)



2011 Net Flow (Legacy)

- In 2011 generation was predominantly North – South
- Net Flow was 4GW

2019 Net Flow (Transition)

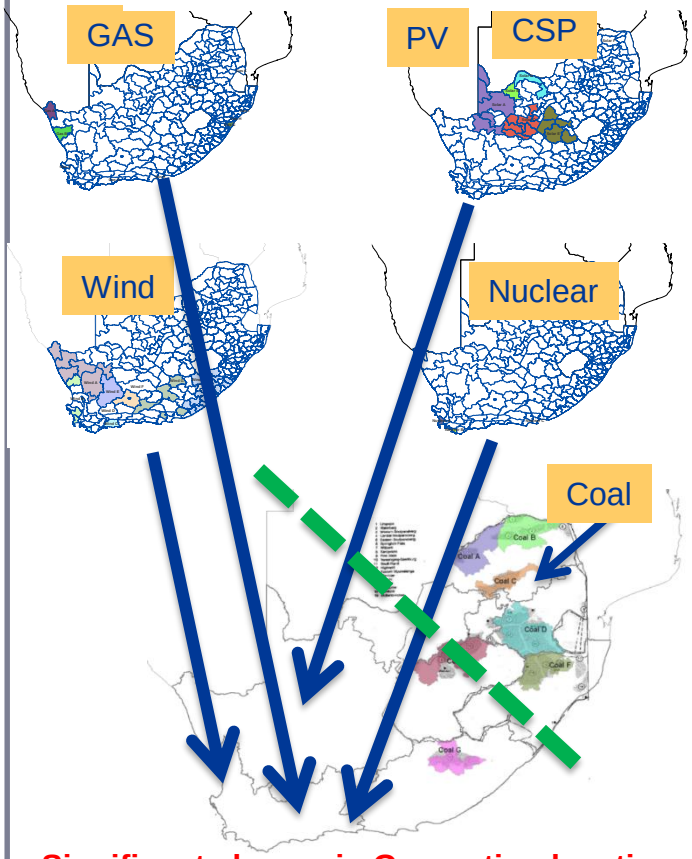
- In 2019 generation pattern is in transition
- There is a net flow of 4.5 GW from North to South in 2019 under Peak Load
- There is a net flow of approx. 1 GW from South to North in 2019 under Midday Load

Grid Insights – Future generation and load

Future Generation & Load Allocation

Generation

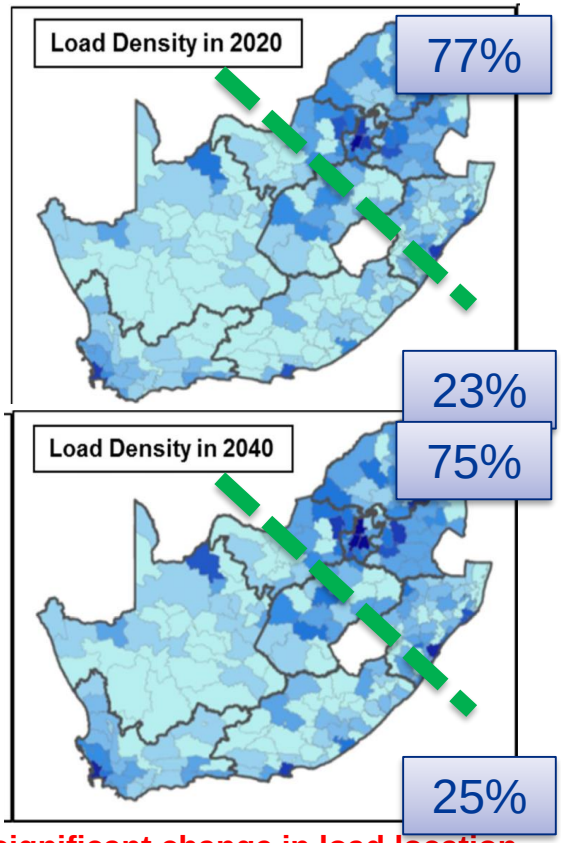
Energy resources for electricity



Significant change in Generation location

Demand

Load Demand for each area for 2020 & 2040



No significant change in load location

Gen Pattern Changing

- North to South Migration
- High Capacity required in the network that is traditionally weak

Dominant Load Areas

- No significant shift in dominant load areas
- Slight growth predicted

TDP Generation Assumptions – Based on IRP 2018

energy
Department:
Energy
REPUBLIC OF SOUTH AFRICA

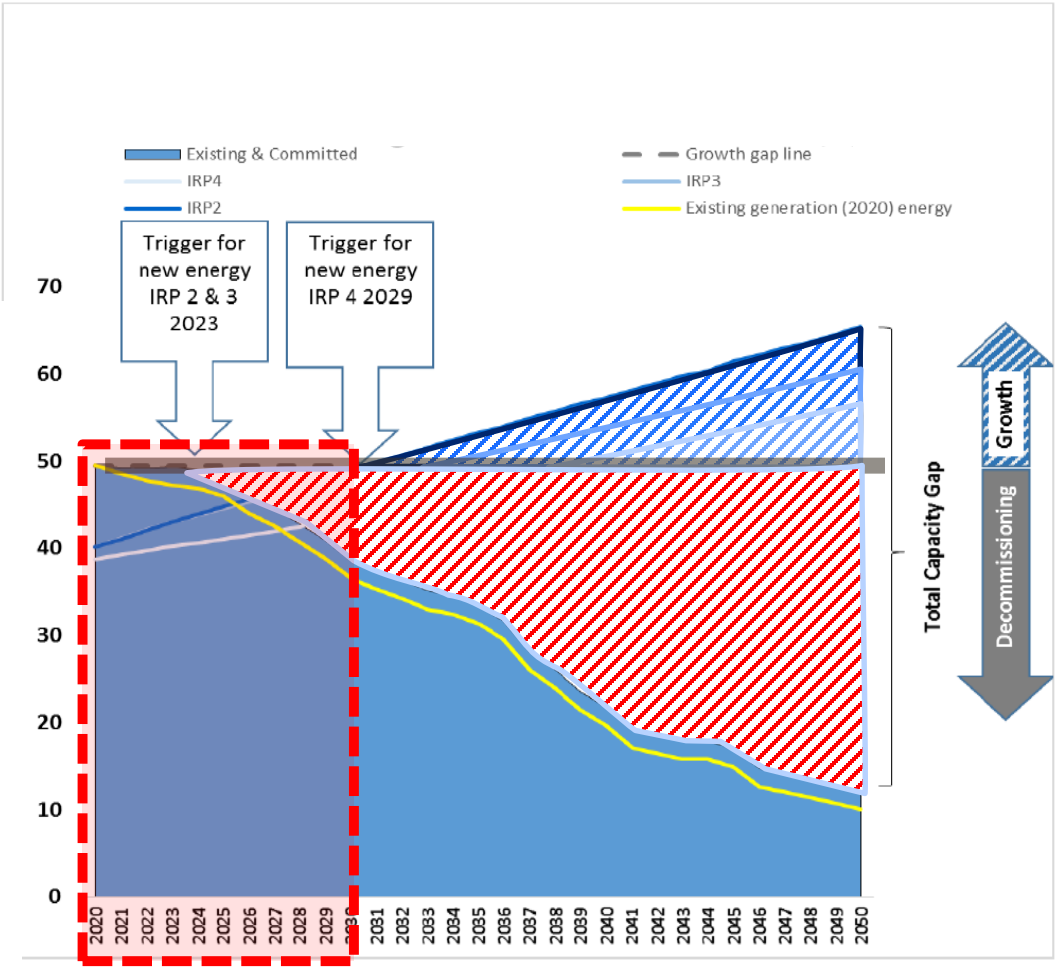
INTEGRATED RESOURCE PLAN 2018

AUGUST 2018

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

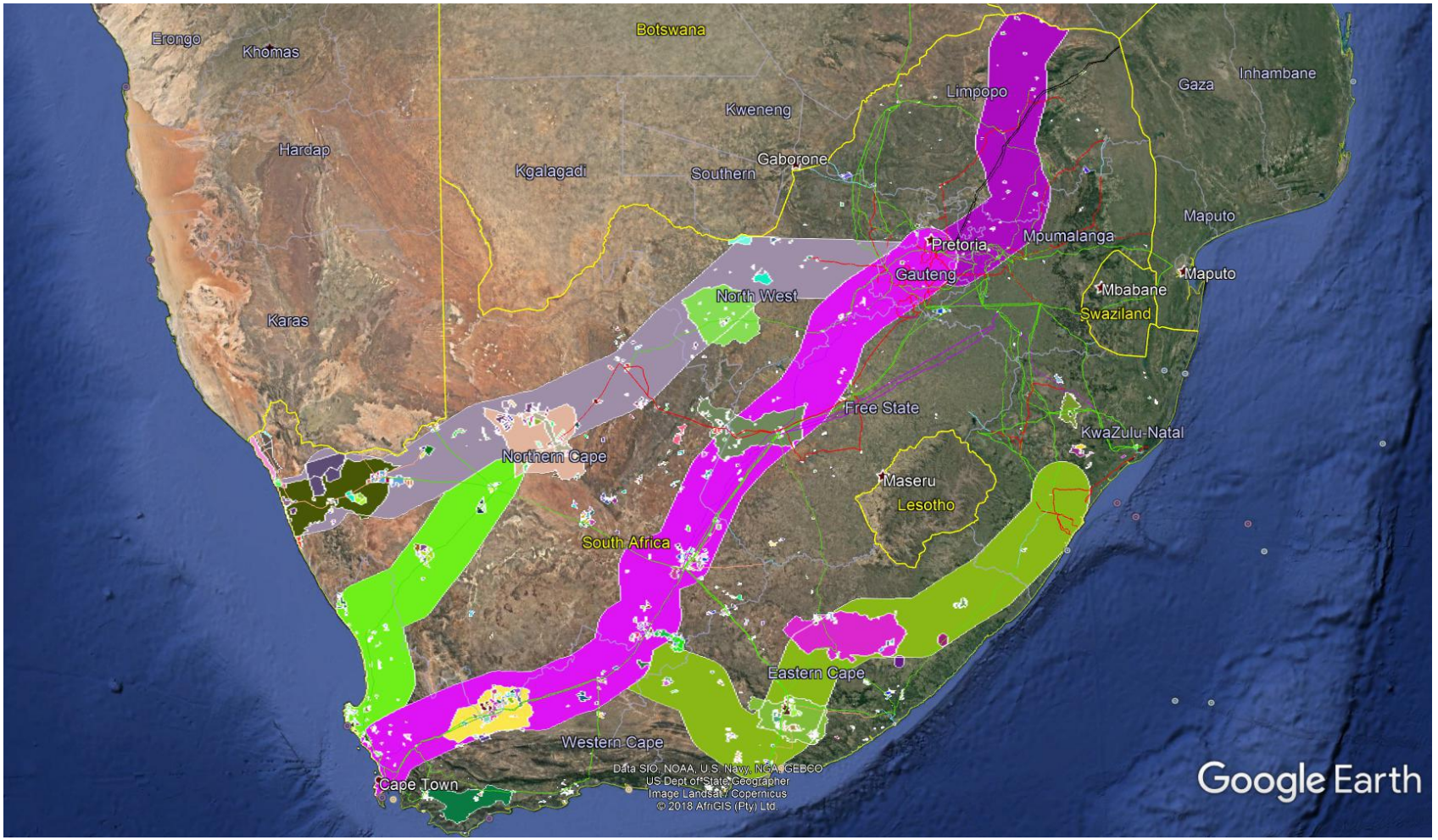
Installed Capacity
Committed / Already Contracted Capacity
New Additional Capacity (IRP Update)

INTEGRATED RESOURCE PLAN 2018



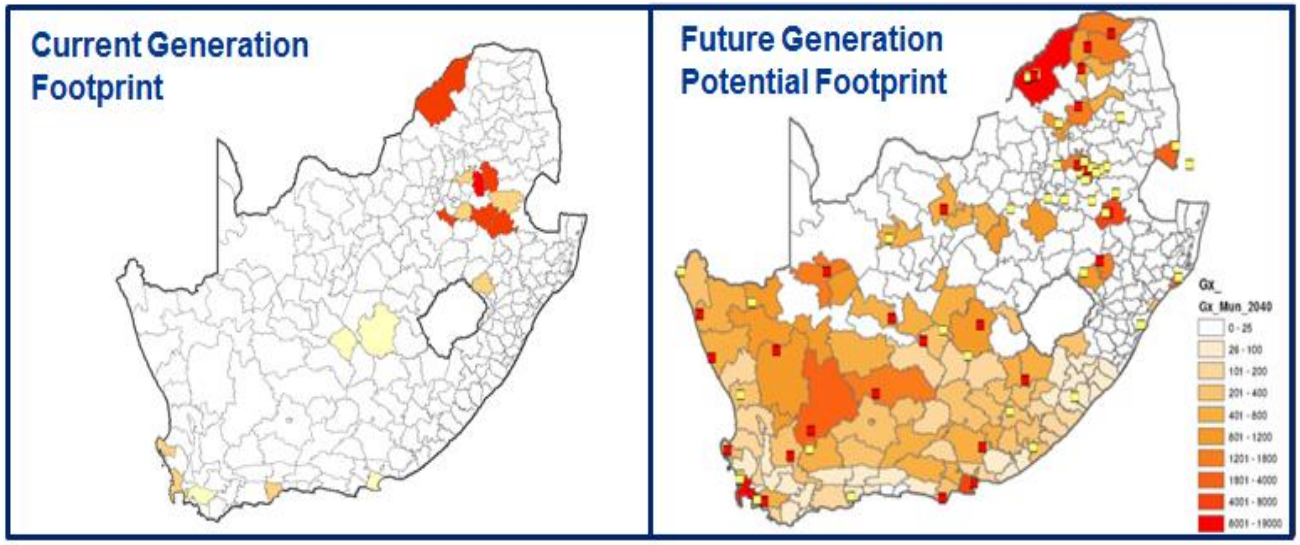
igure 22: Illustration of Capacity and Energy Driver

TDP Generation Assumptions – Spatial location



Expansion drivers and network depletion

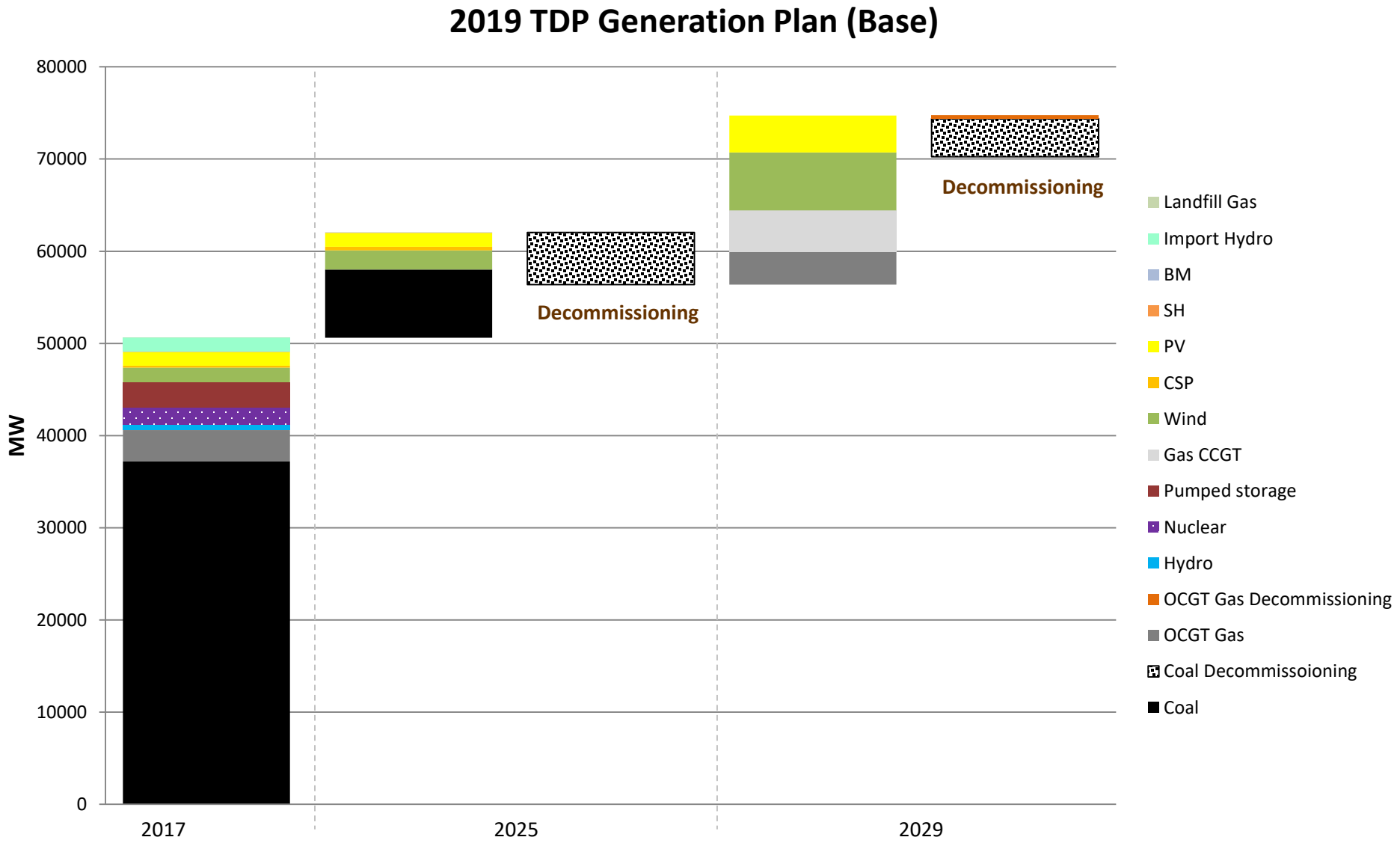
Change in Generation Spatial Footprint



Different generation scenarios indicate that the generation in the southern parts of the country will increase significantly

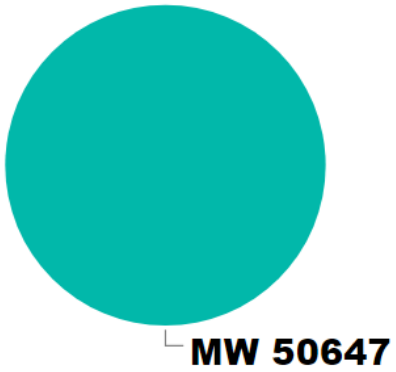
Irrespective of generation scenario

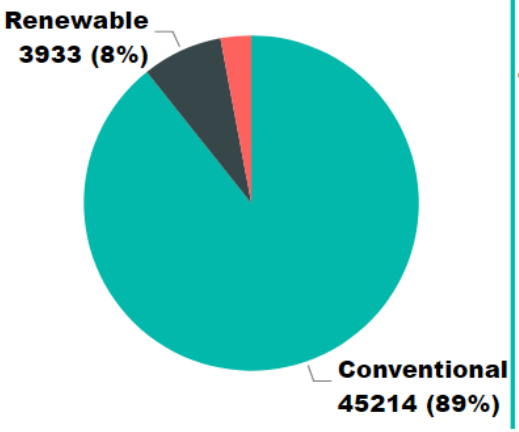
TDP Generation Base Scenario



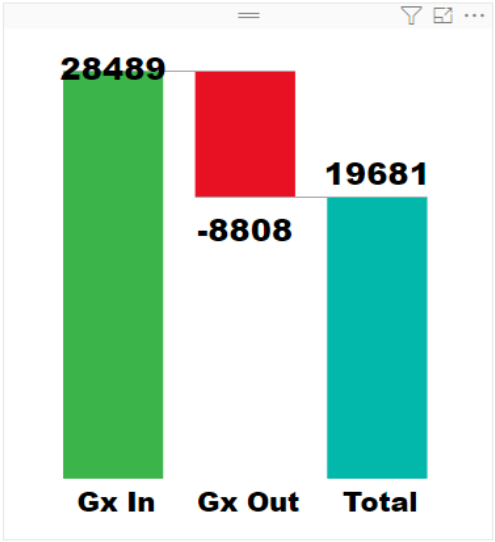
Current TDP 2020 -2029
Assumptions based on 2018 IRP

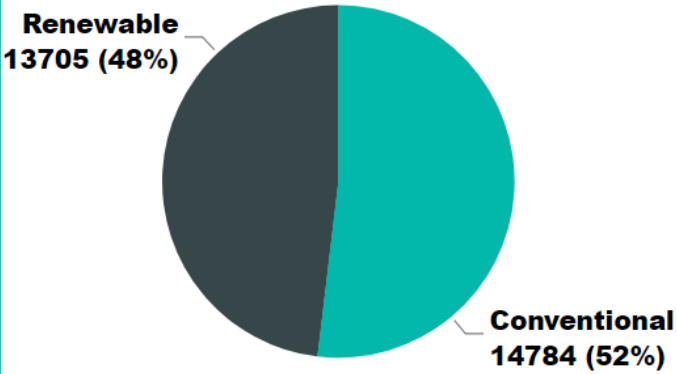
Generation 2019 Overview



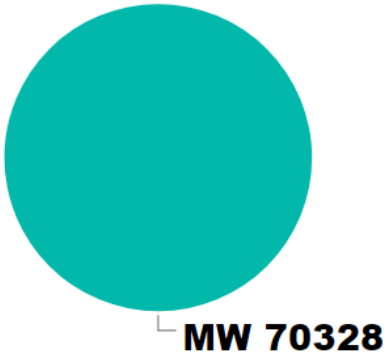


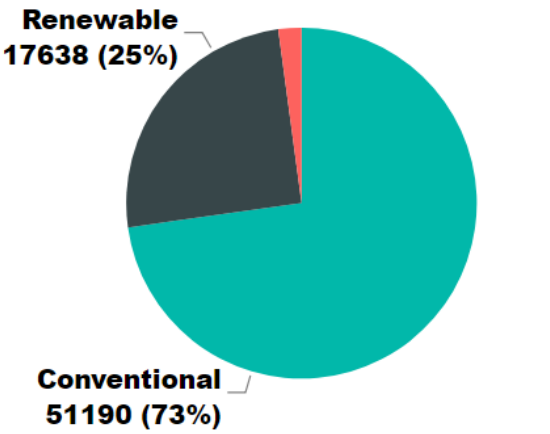
Change in Gx 2019 - 2029



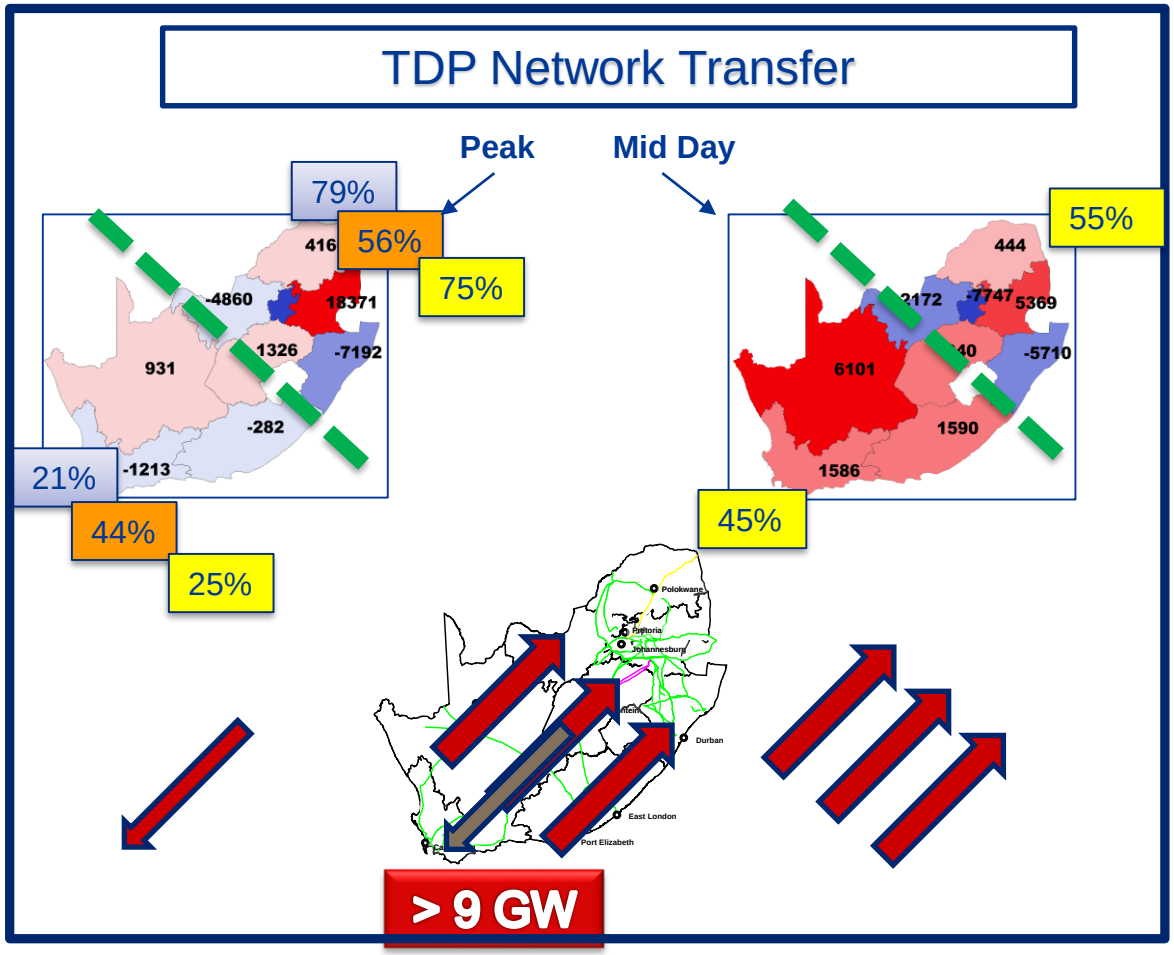


Generation 2029 Overview





Flow implications (2029)

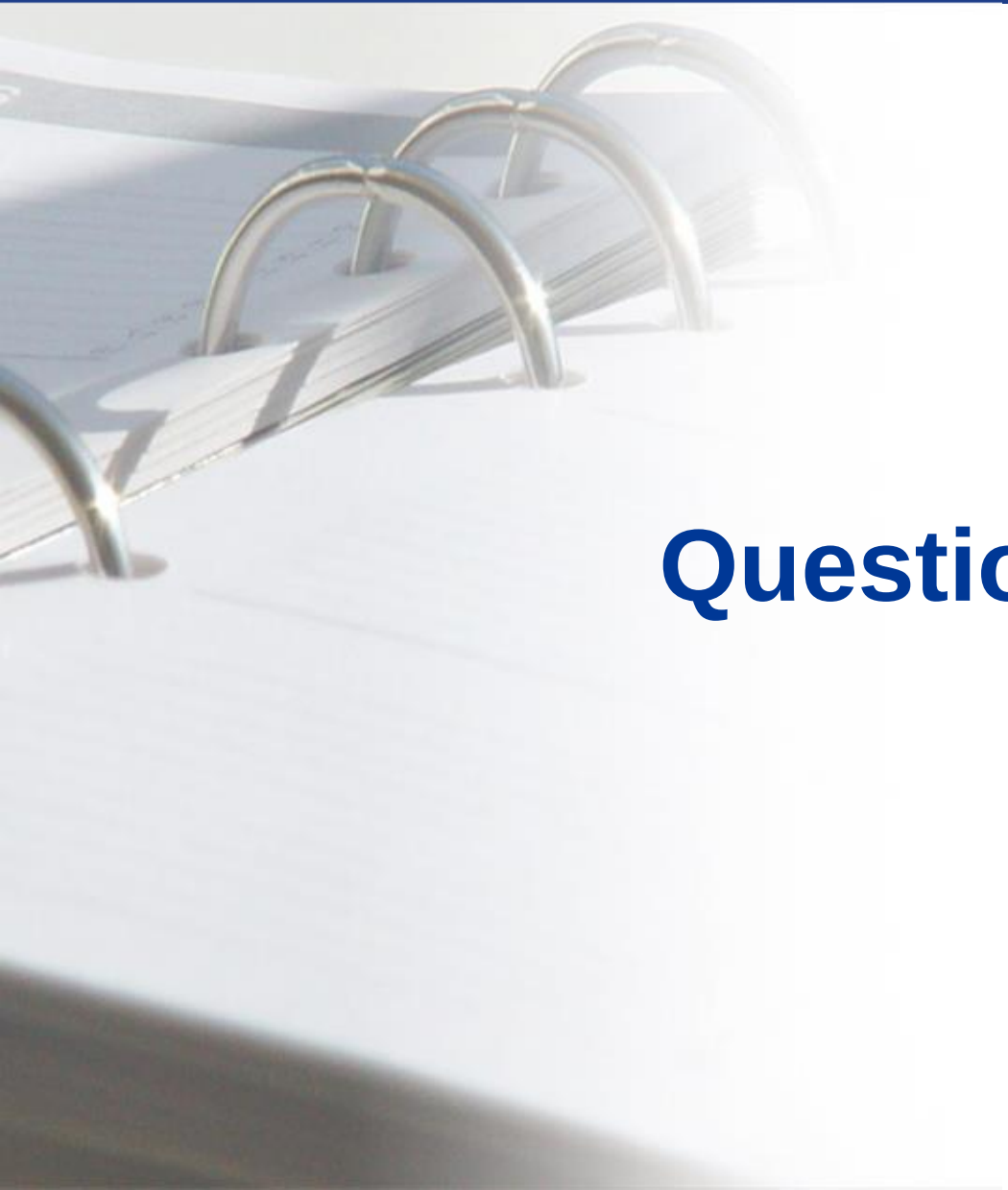


2029 Midday

- The South Network will need to export 9GW Northwards
- The corridor connecting North and South is 4.5GW in Capacity
- The corridor was built over approx. 30years, it will need to be doubled in ten years under capital deferment conditions

2029 Peak Period

- There is a slight North – South flow in 2029 under peak load conditions
- This is due to PV being out and higher load absorbing local generation
- There will be a need to manage voltage as the network will be very lightly loaded



Questions?

The TDP 2020 - 2029 Demand Forecast

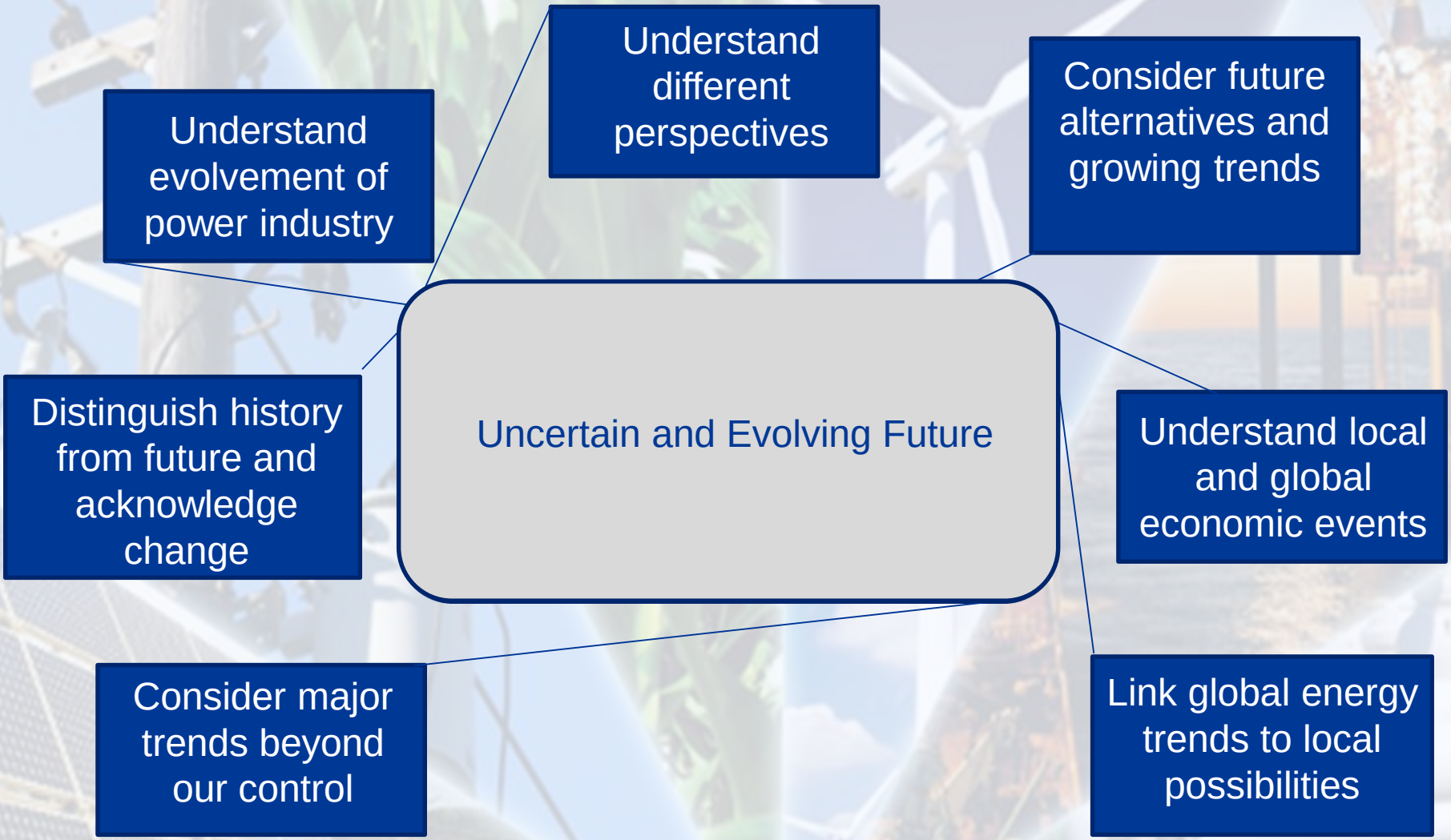
Presented by: Jana Breedt
Chief Advisor: Demand Forecasting

Presentation Overview

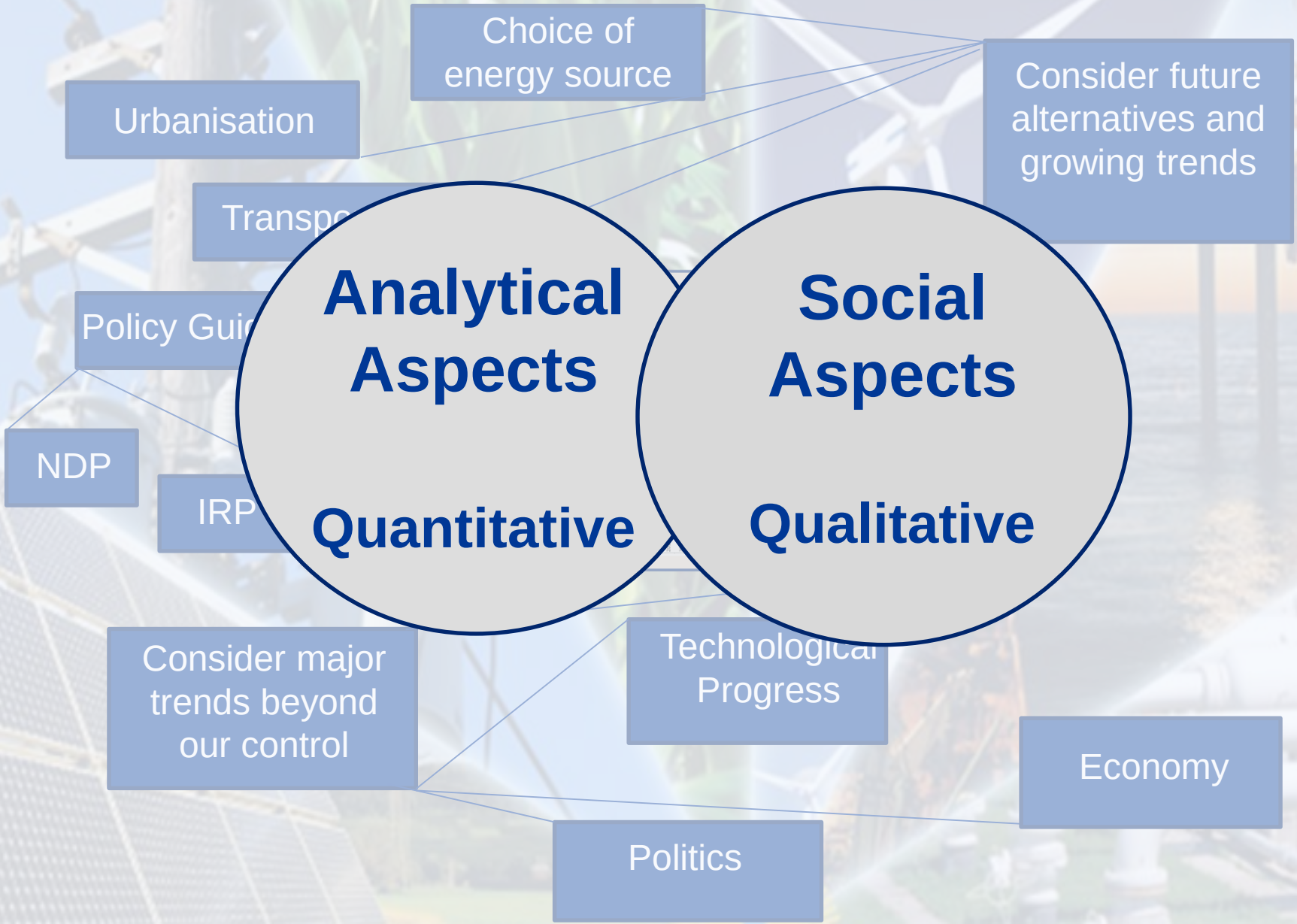
The purpose of the Transmission demand forecast is
to provide an overview of the national grid electricity demand in
South Africa that serves as input to the
Eskom Transmission Development Plan

The presentation outlines
the base of the Eskom demand forecast methodology,
components used to model the demand forecast and
the national forecast scenarios

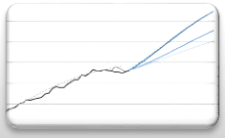
Eskom Transmission demand forecast methodology



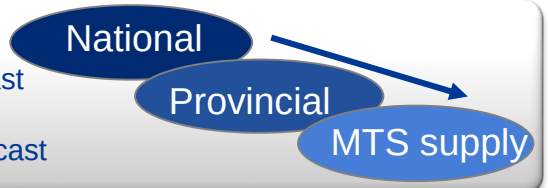
Eskom Transmission demand forecast methodology



Transmission forecast process & components



Top down Forecasting



- Compiling of information into Transmission forecast
- Formulation of forecast assumptions
- Double S-Curve Methodology used to model forecast

Base Demand Analysis

- Gathering of actual demand figures
- Network topology updates
- Research on technological advancement and its influence on forecast

Market Intelligence

- Sectorial information data gathering and analysis
- Indicative & Budget Quotes; Macro Economics; Developments and Investment monitoring
- Answer **What, Where, How much, When**

Mathematical Model

- Forecast assumptions and formulation
- Transshipment model used for nodal balancing of horizontal integrated supply chain
- Balance top down forecast scenarios: National – Provincial – Transmission Node (MTS)

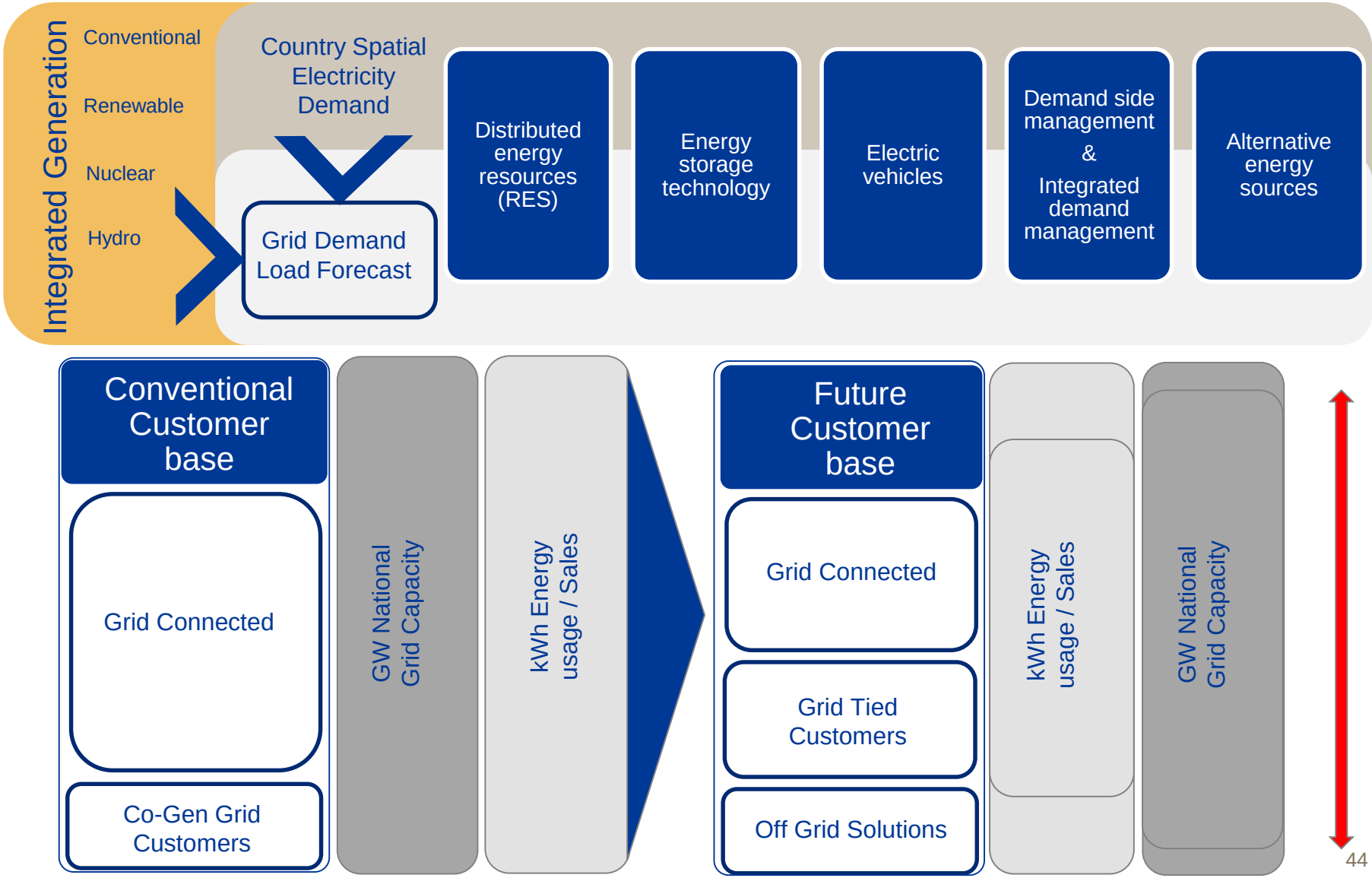
Validation & Alignment

- Validating forecast with external forecasts (Macro Economics, GDP, IRP, NDP,CSIR)
- Quarterly Combine Forecasting Forum (CFF) alignment and sharing interaction
- Alignment of forecasts internal to Eskom (CFF, Transmission/Distribution bottom up)

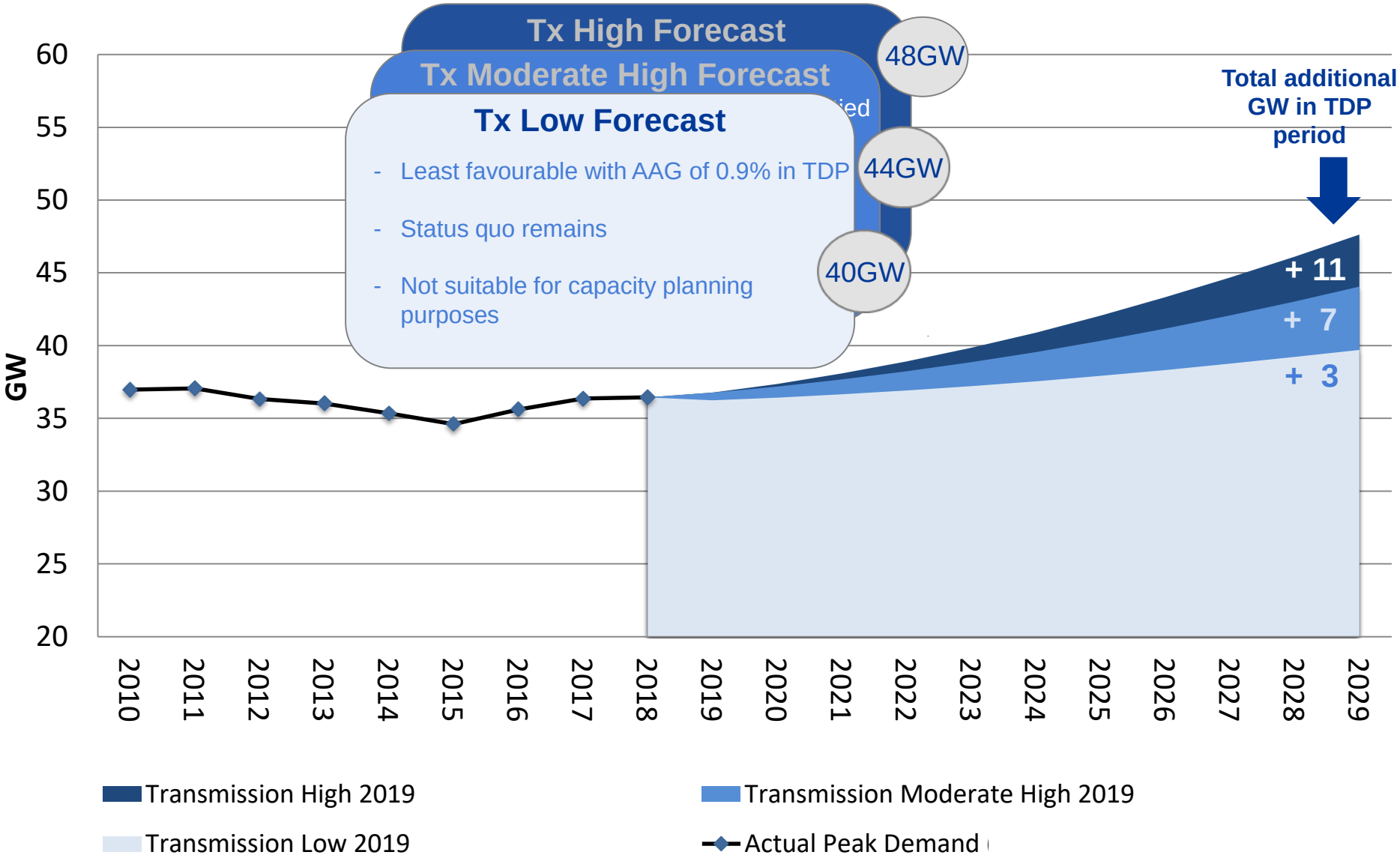
Implementation of Forecast

- Input to TDP Planning
- Accuracy Tracking

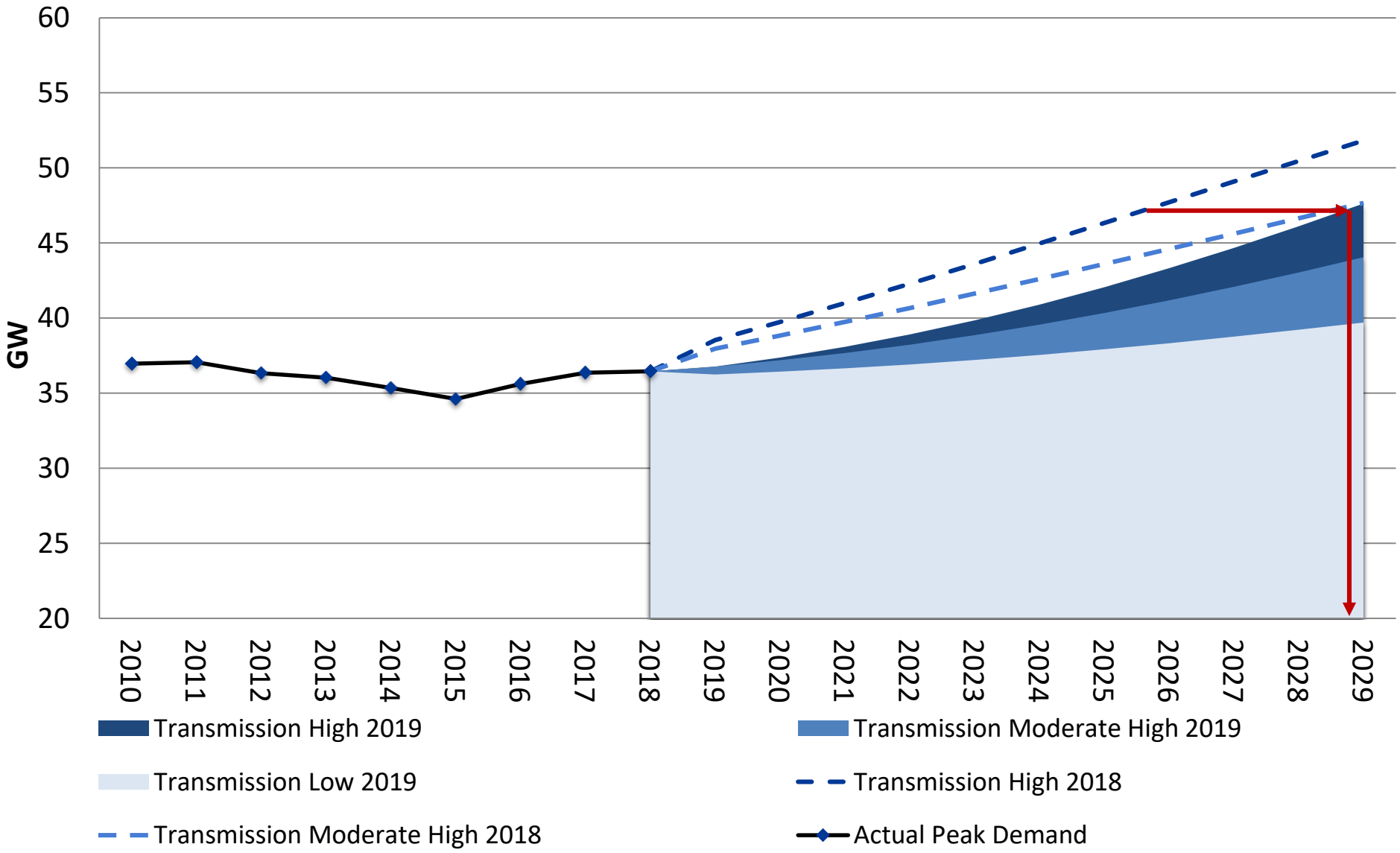
An evolving power sector and change in forecast landscape



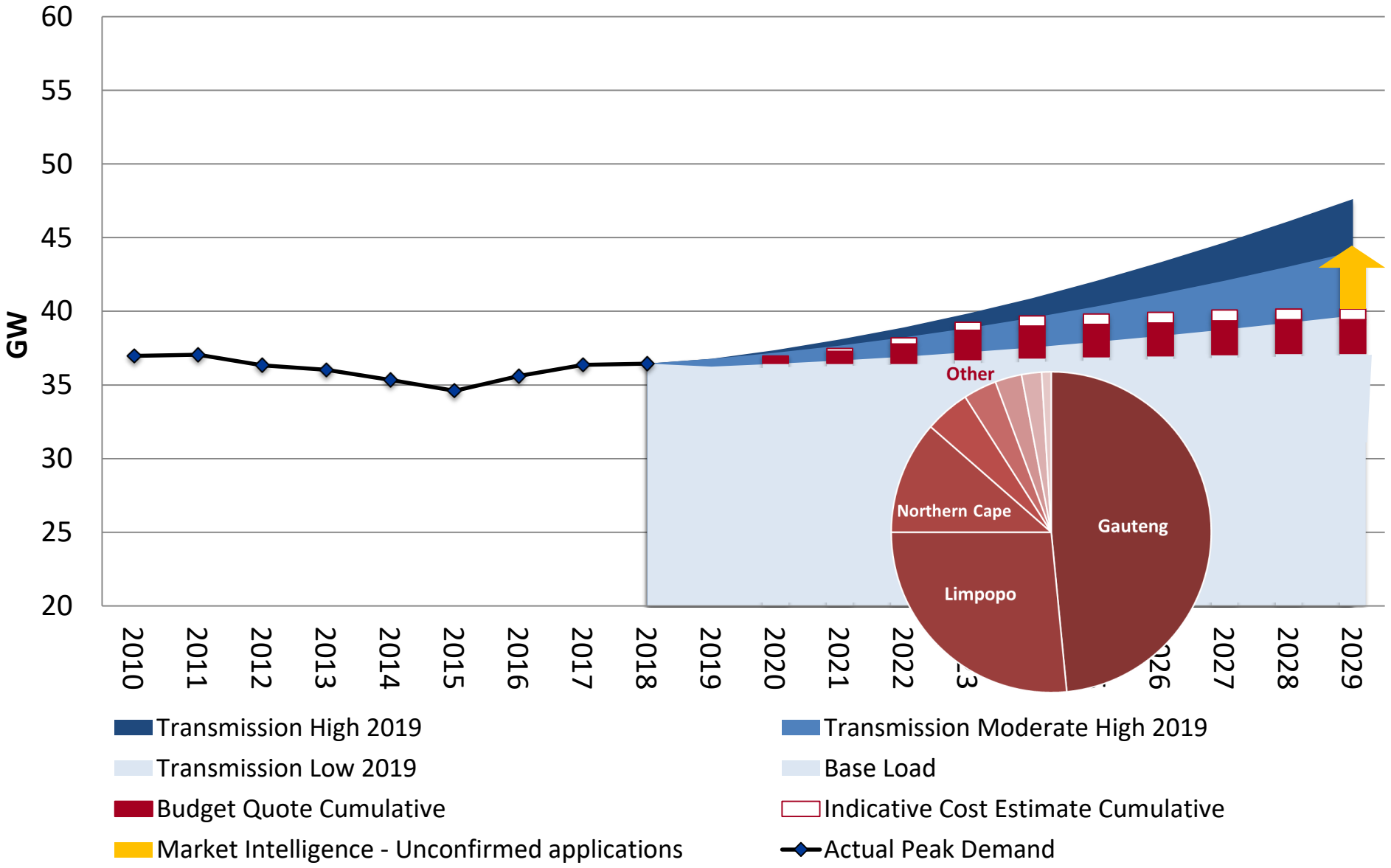
Transmission national demand forecast 2020 – 2029



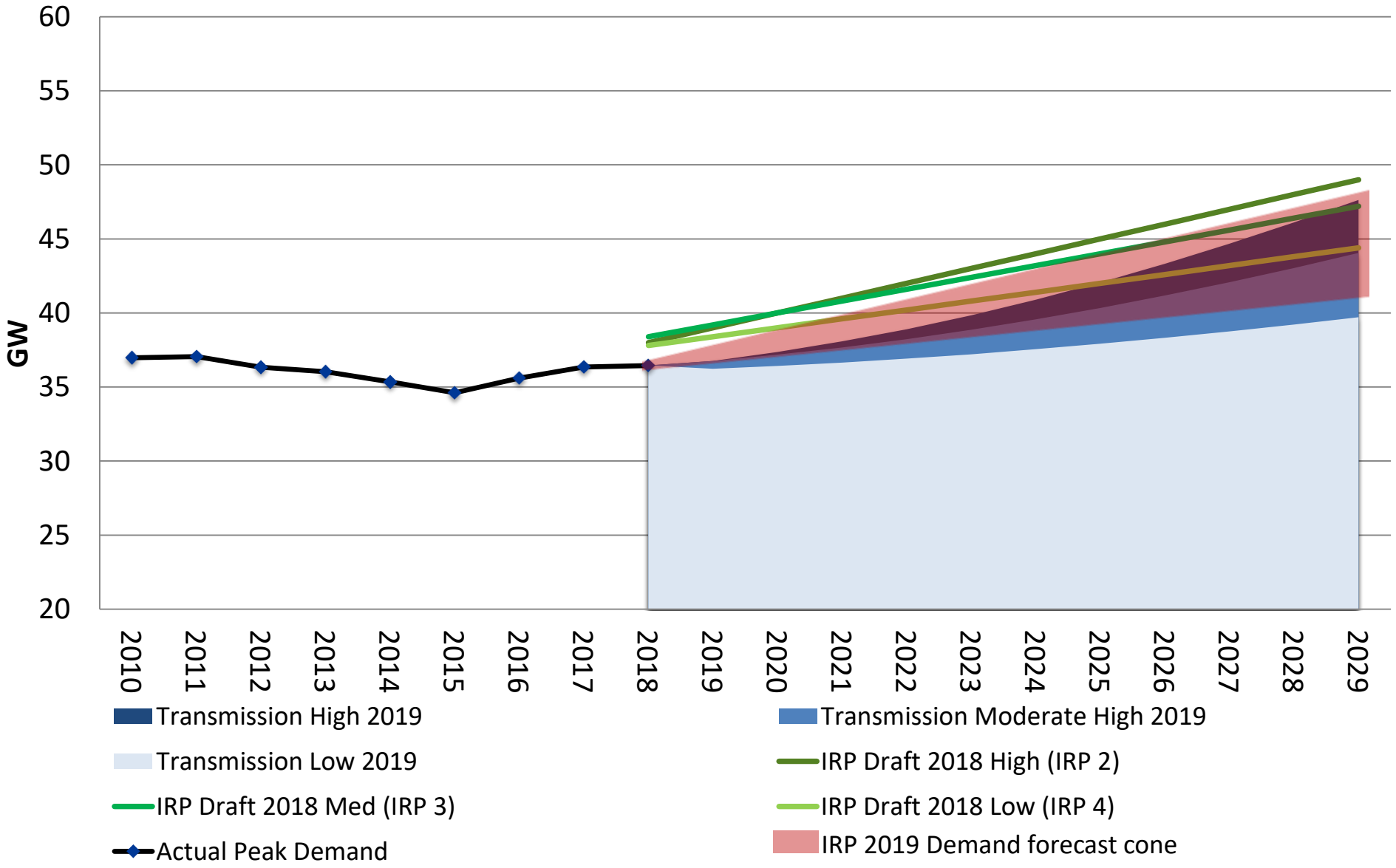
Change in Transmission demand forecast from 2018



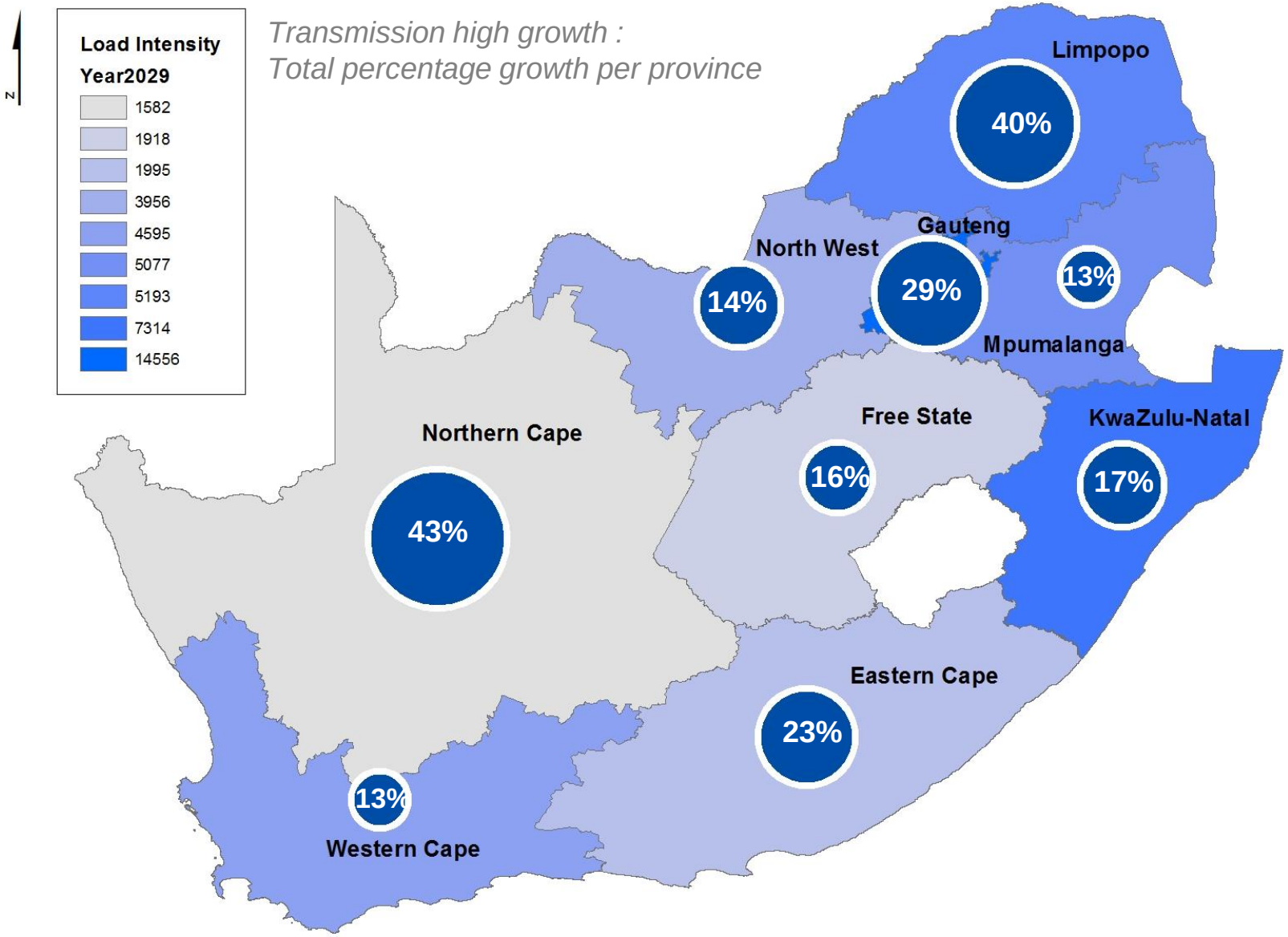
Customer applications and market intelligence comparison



Integrated Resource Plan (IRP) demand forecast validation



Key growth areas for TDP period 2020-2029



Collaboration between role players

Eskom

energy
Department:
Energy
REPUBLIC OF SOUTH AFRICA

CSIR
our future through

SEZs IN SOUTH AFRICA

Investors

Decision makers

Metros

Collaboration allows us to know more than we are capable of knowing by ourselves
~ Paul Solarz

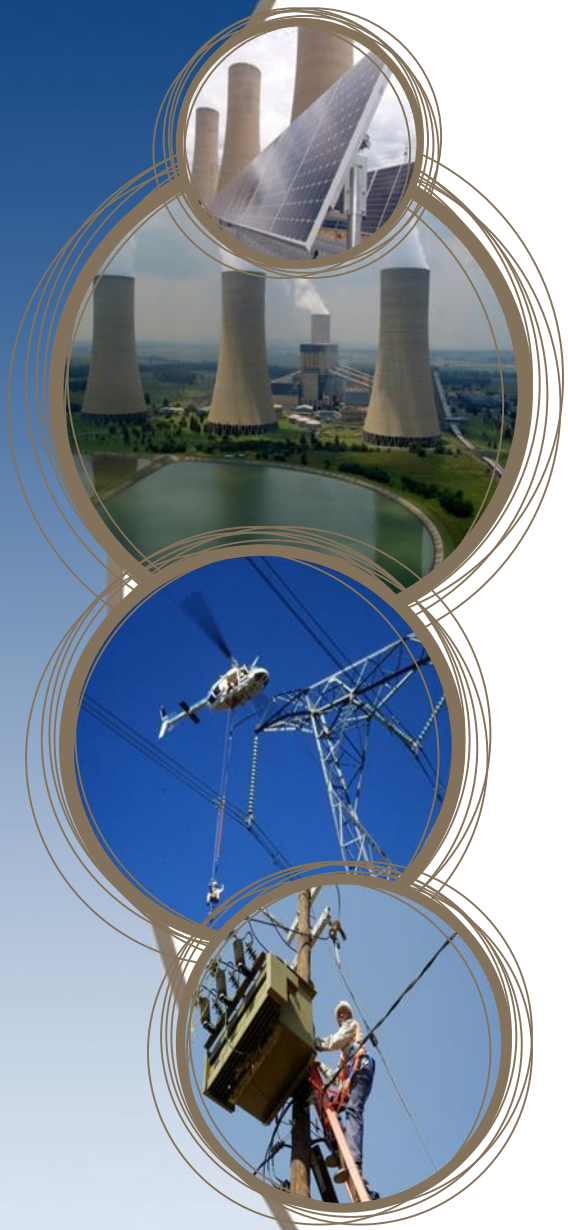
dube tradeport

Eskom
Combined Forecasting Forum

cigre
For power system expertise

Customers
Technology Experts
Developers

Questions?



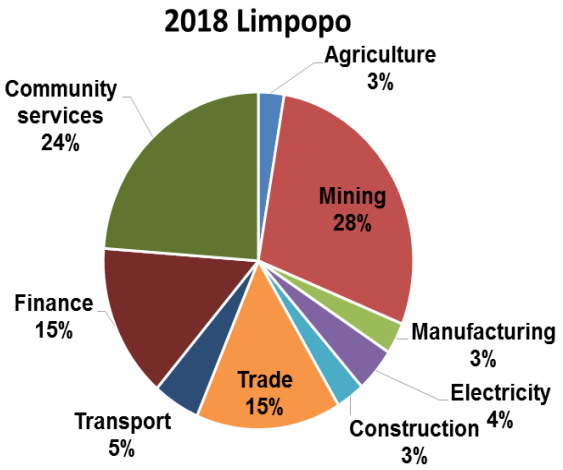
Provincial Development Plans 2020 – 2029

Limpopo Province
TDP 2020 - 2029

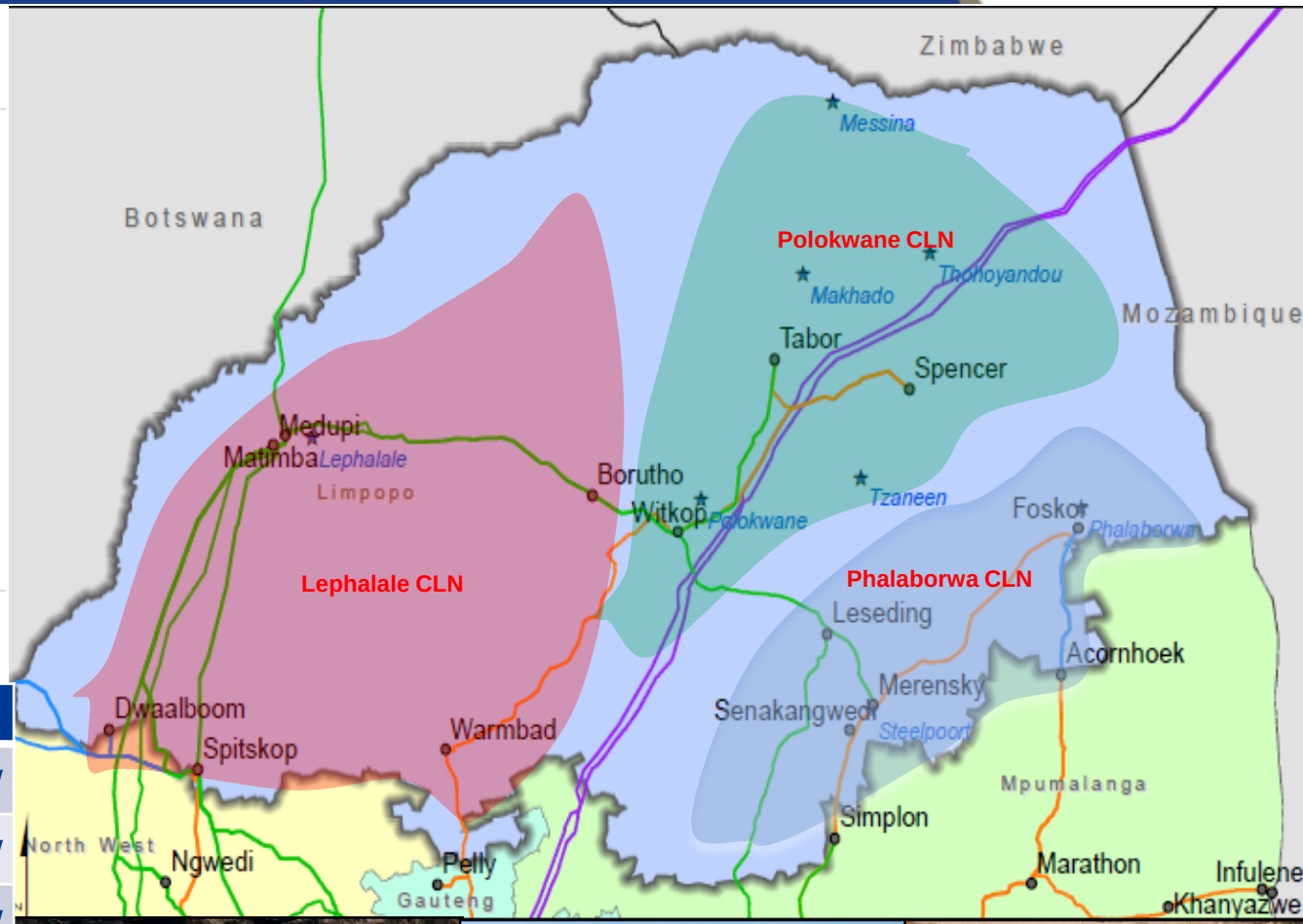
Presented by: Caroleen Naidoo
Chief Engineer

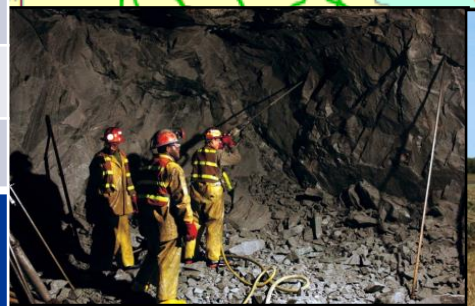
Limpopo Province Profile

Peak load of 3011 MW



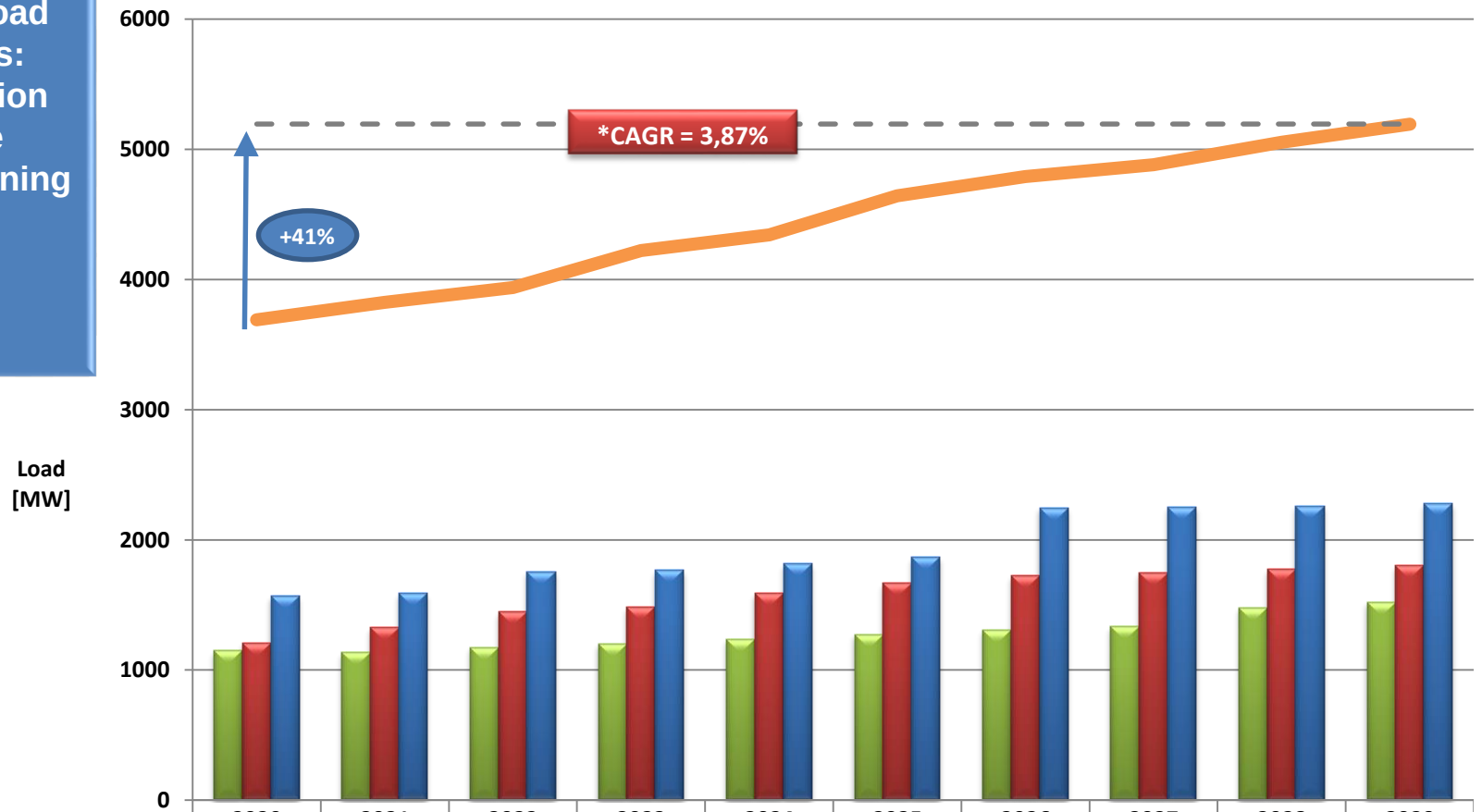
Type	Name	Output
Base Load	Matimba	3990 MW
	Medupi	2382 MW
Renewables	Witkop PV	30 MW
	Soutpan PV	28 MW
	Villa Nora PV	60 MW
Total Installed Generation		6490 MW





Limpopo Province Load Forecast (2020 – 2029)

Phalaborwa Load Growth Drivers:
- Electrification
- Agriculture
- Chrome Mining

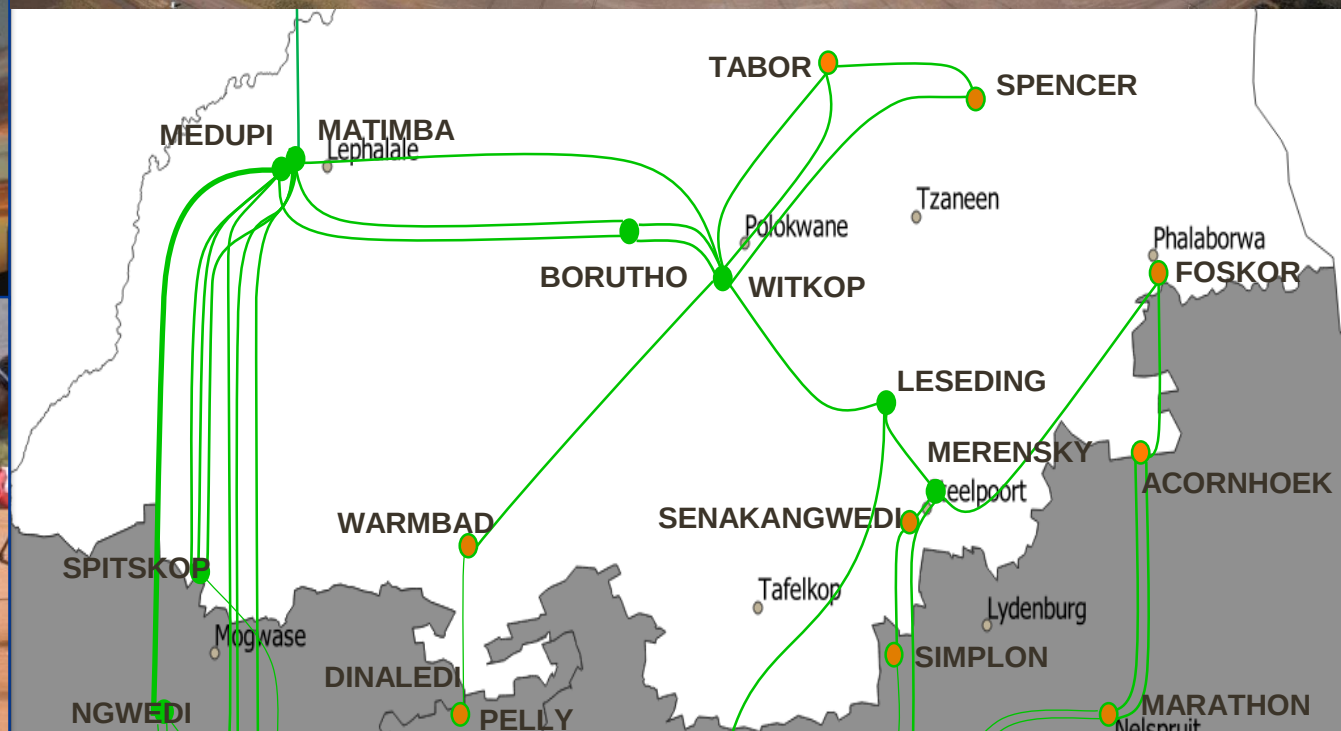


	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Polokwane CLN Peak	1148	1136	1173	1203	1238	1273	1309	1335	1480	1523
Lephalale CLN Peak	1210	1324	1446	1485	1591	1665	1724	1750	1773	1804
Phalaborwa CLN Peak	1570	1588	1756	1770	1817	1866	2246	2253	2260	2278
Provincial Peak	3690	3824	3938	4221	4342	4643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

* Compound Annual Growth Rate

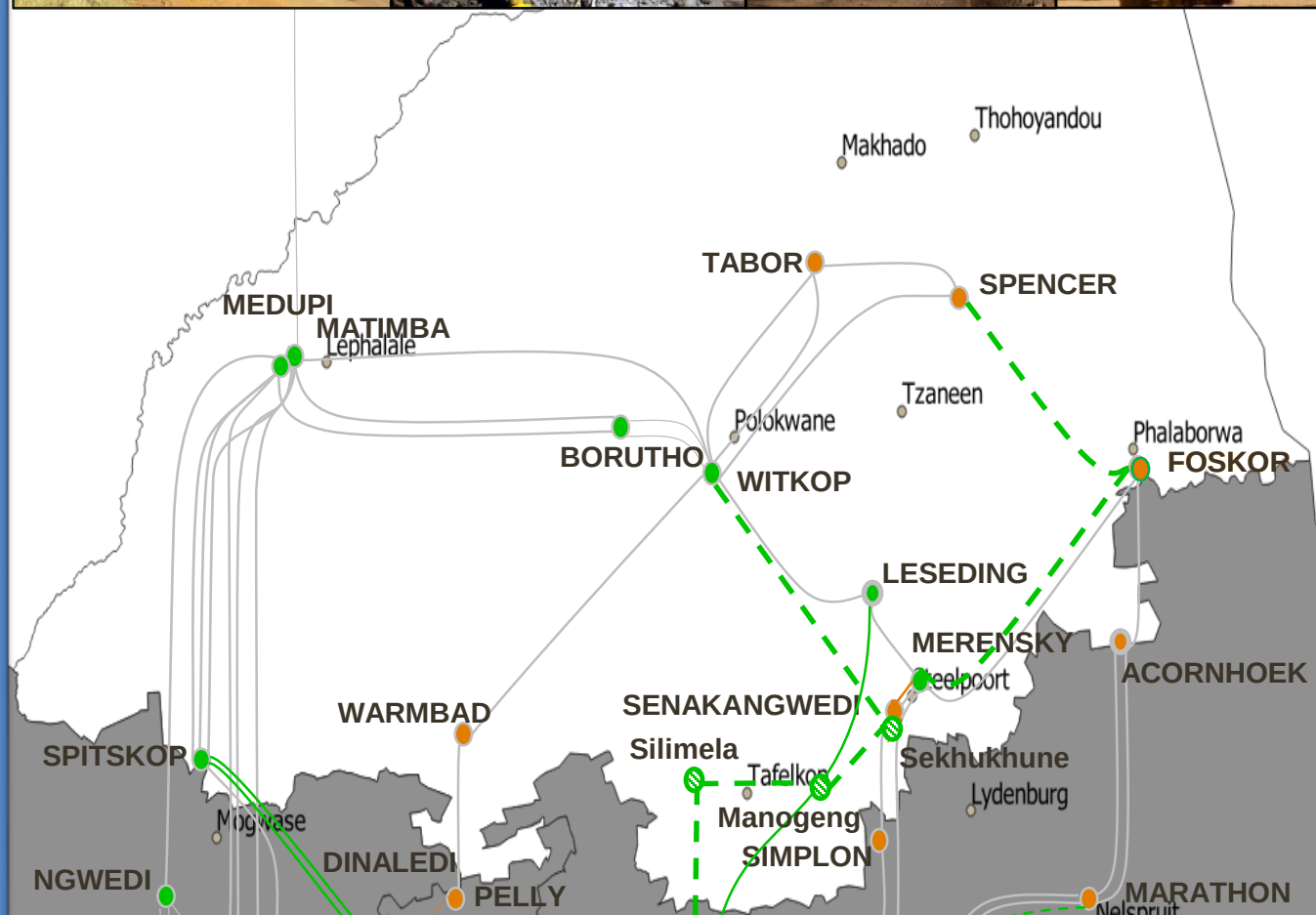
Completed projects and existing network

Medupi-Ngwedi 400 kV line 1 part of the Medupi Integration was commissioned in September 2019



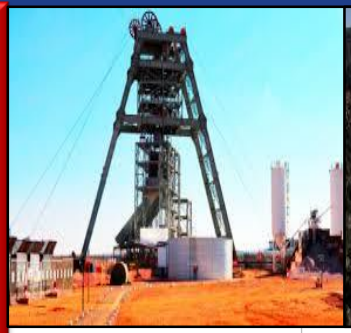
Developments in the Phalaborwa CLN

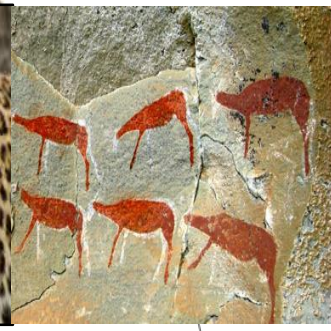
- Manogeng Switching Station and Silimela Substation
- Sekhukhune Substation
- 400 kV at Foskor Substation
- Merensky-Foskor-Spencer 400 kV line
- Leseding 3rd 500 MVA Transformer
- Acornhoek 3rd 125 MVA Transformer

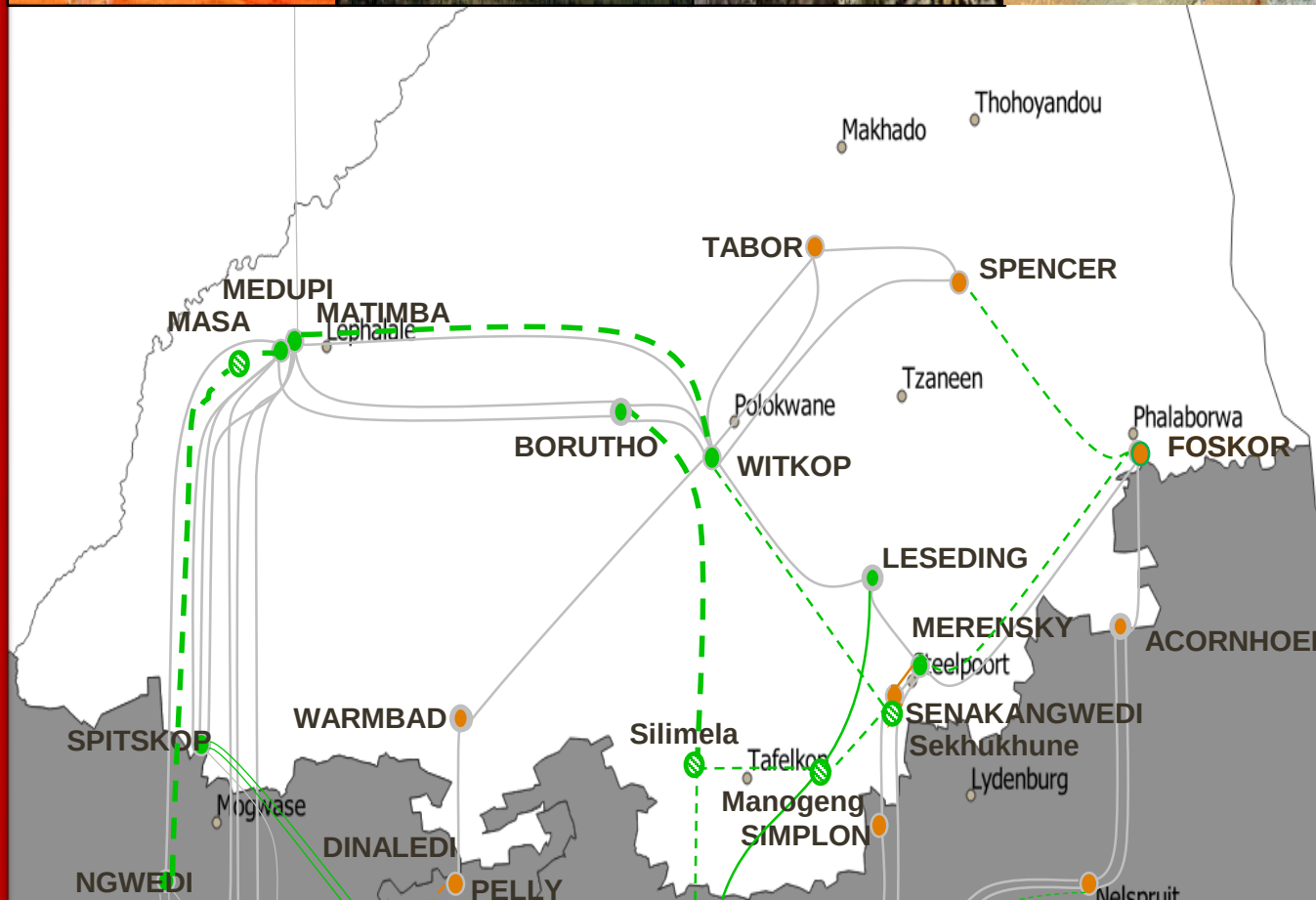


Developments in the Lephalale CLN

- **Medupi Integration: Medupi-Ngwedi 400 kV line 2**
- **Waterberg Generation Integration: Medupi-Witkop and Borutho-Silimela 400 kV line**
- **Borutho 3rd 500 MVA Transformer**
- **Warmbad 1st 250 MVA Transformer**

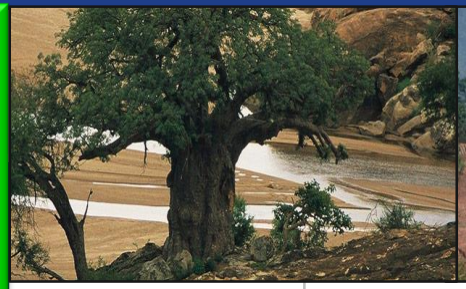
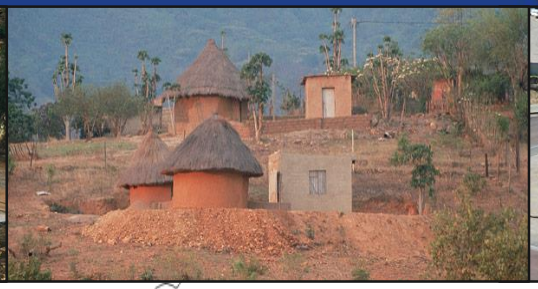


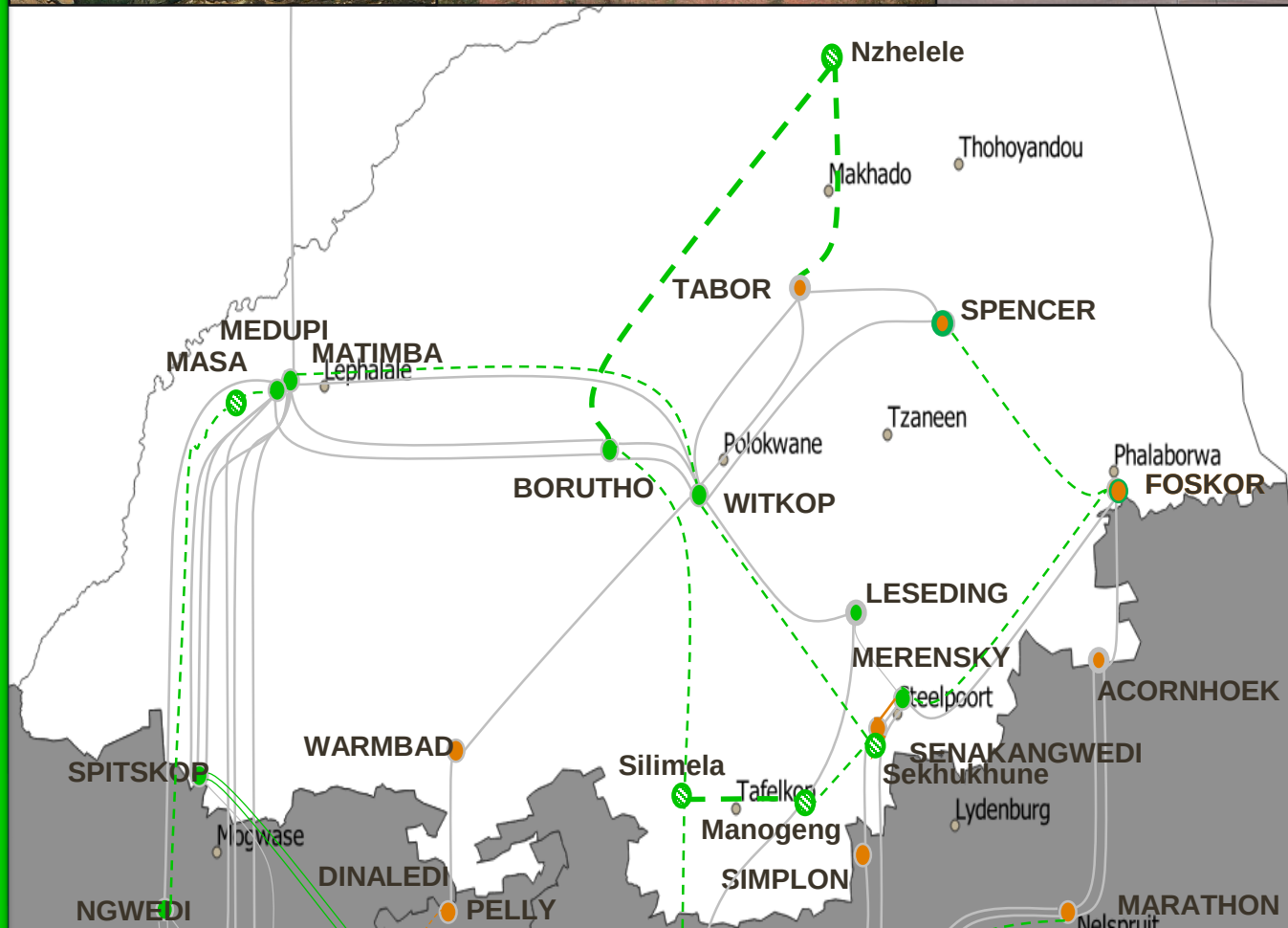





Developments in the Polokwane CLN

- **Nzhelele 400/132 kV Substation**
- **400 kV at Spencer Substation**
- **2 x 36 Mvar Capacitor Banks at Tabor and Spencer Substations**

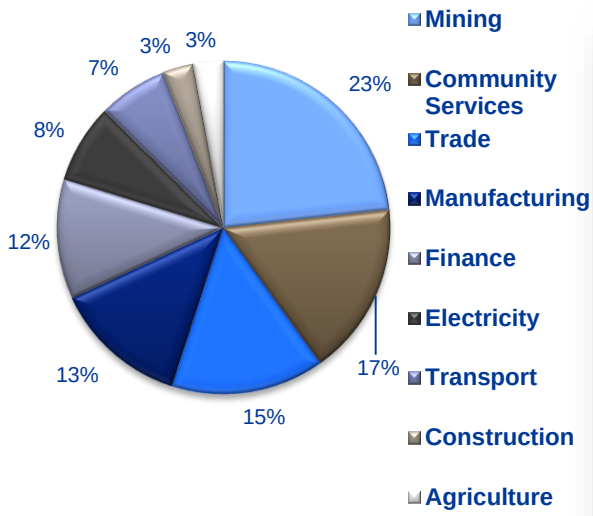
Questions?

Mpumalanga Province
TDP 2020 - 2029

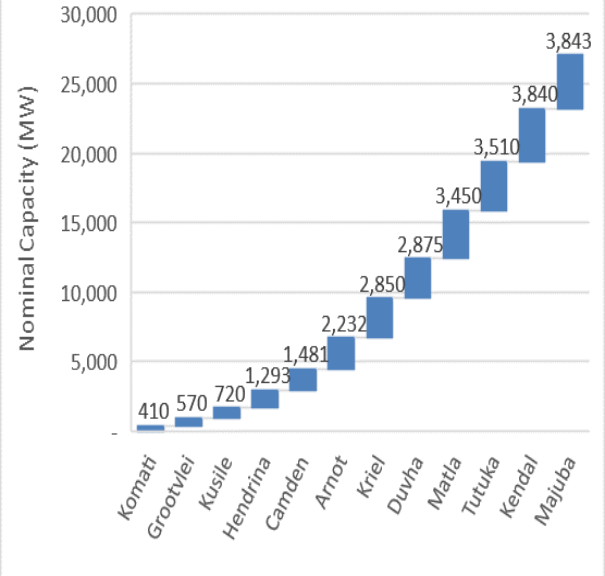
Presented by: Kabir Singh
Chief Engineer

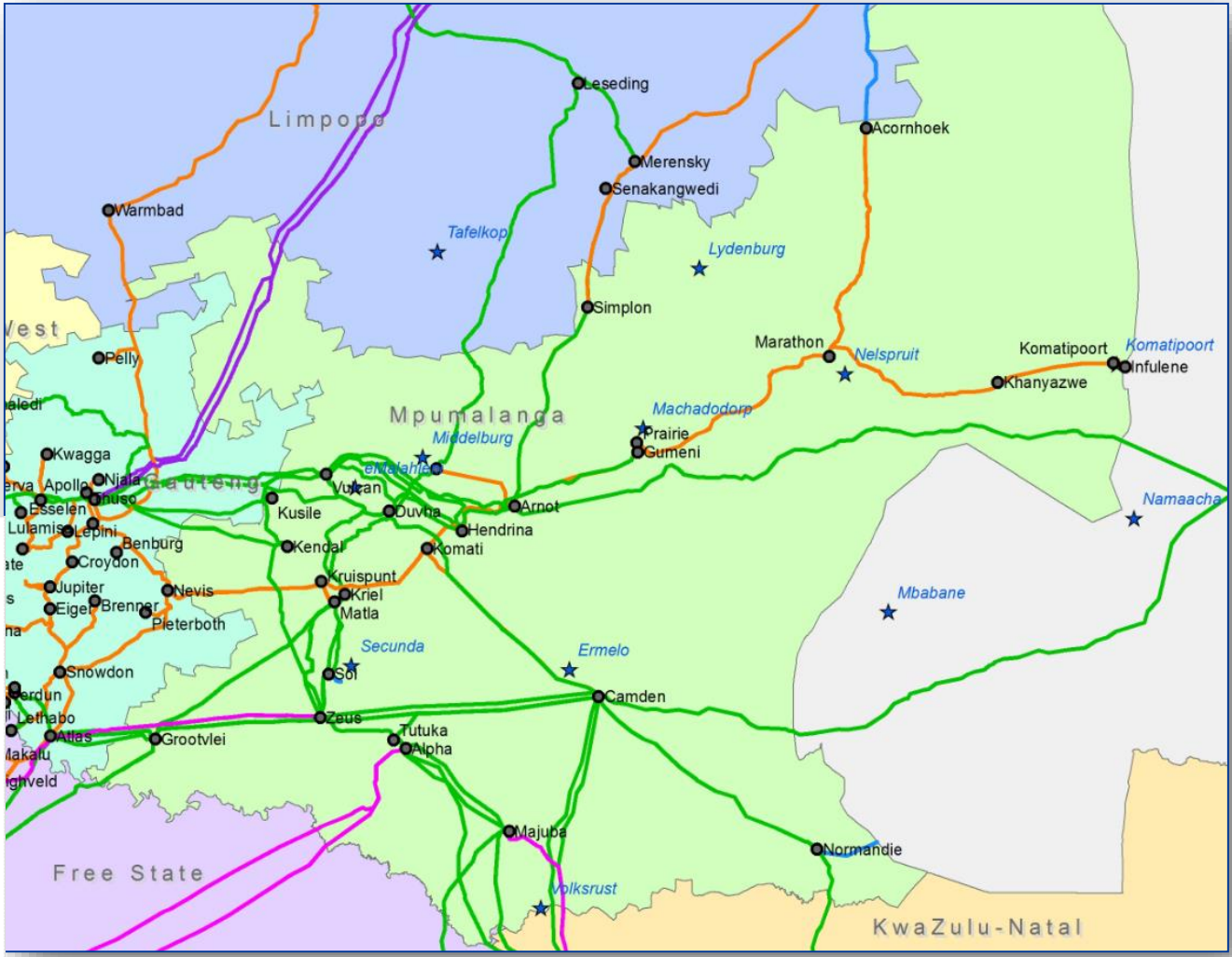
Mpumalanga province profile

Load of ~ 4.3 GW



Generation capacity of ~27 GW





Completed projects for grid reliability

Sol 5th 400/132 kV 500 MVA transformer

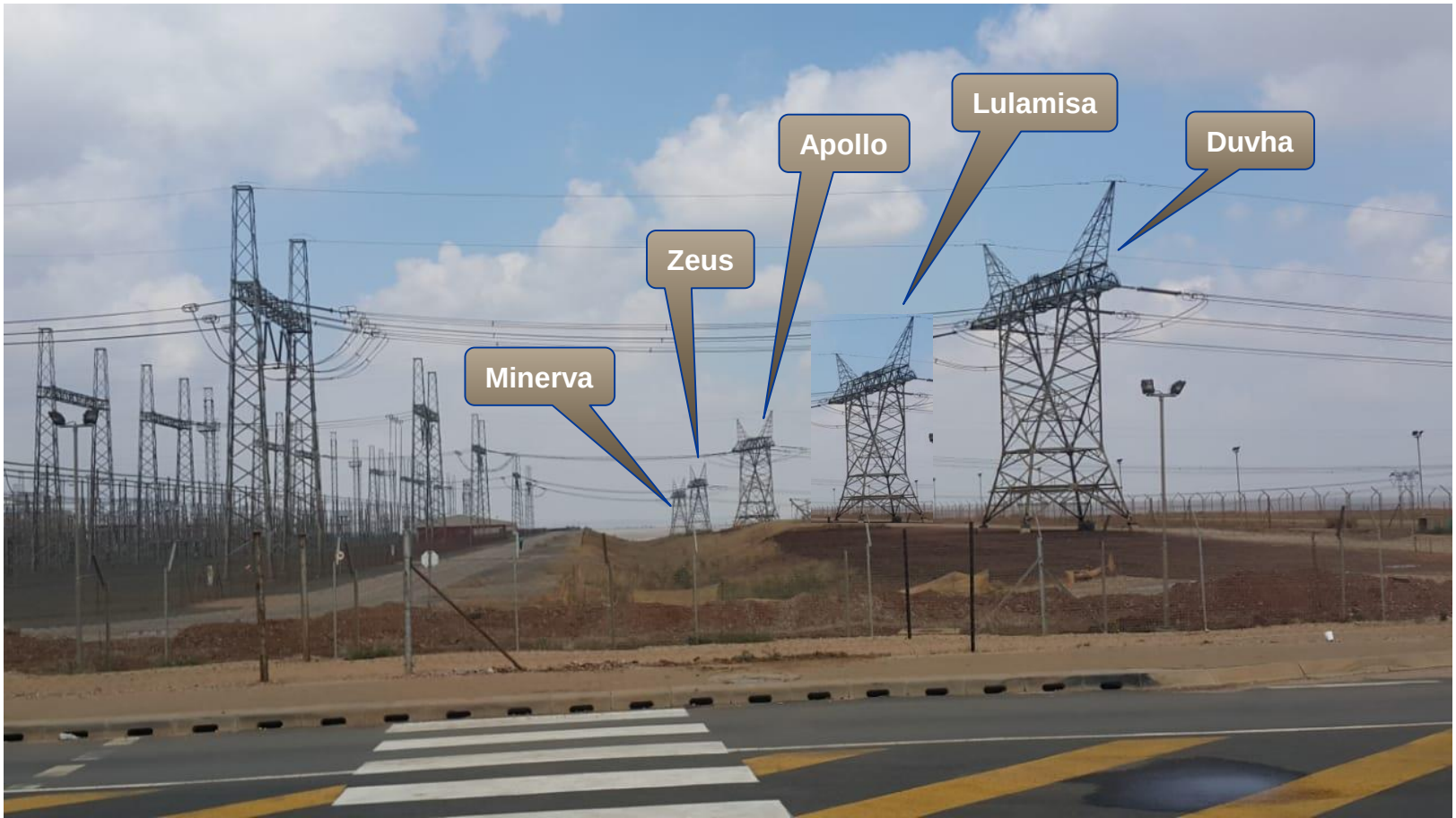
- For executability of:
  - The fault level mitigation-FCLR's
  - Refurbishment and upgrade of terminal equipment
- To be redeployed to the new Wonderkrag S/S

Normandie 2nd 400/132 kV 250 MVA transformer

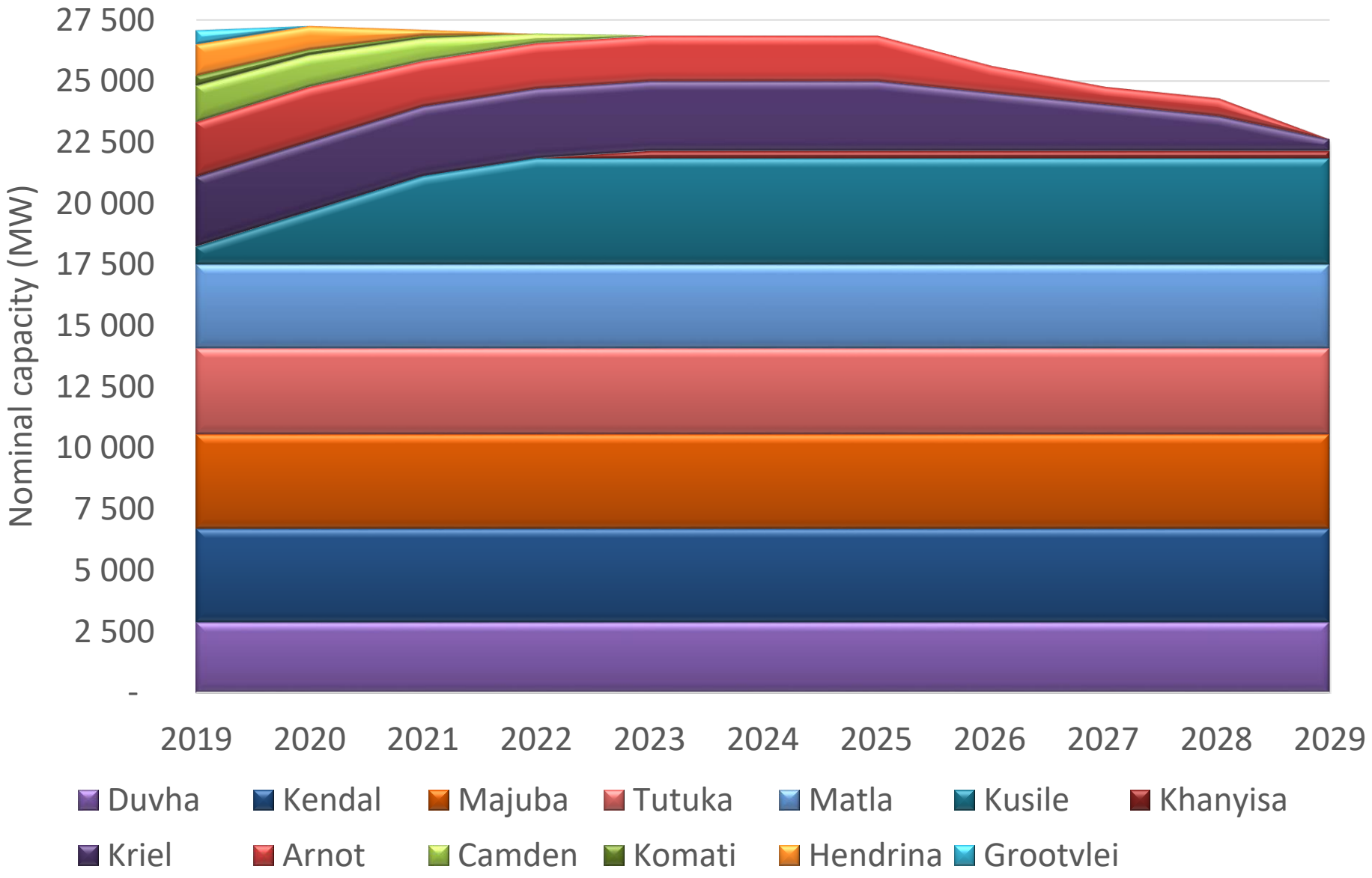
- N-1 requirement
- Improved reliability of supply to Swaziland

Completed projects of the Kusile transmission integration

- Kusile 400 kV Yard
- Kendal-Apollo loop-in to Kusile
- Kusile-Zeus 400 kV line
- 2nd Kendal-Zeus 400 kV line
- Loop the Kendal-Duvha line to form Kendal-Arnot
- Loop the Duvha-Kendal line to form Duvha-Vulcan 2
- Duvha-Minerva loop-in to Kusile
- Sol-Camden 400 kV line 1 & 2 (Zeus bypass)

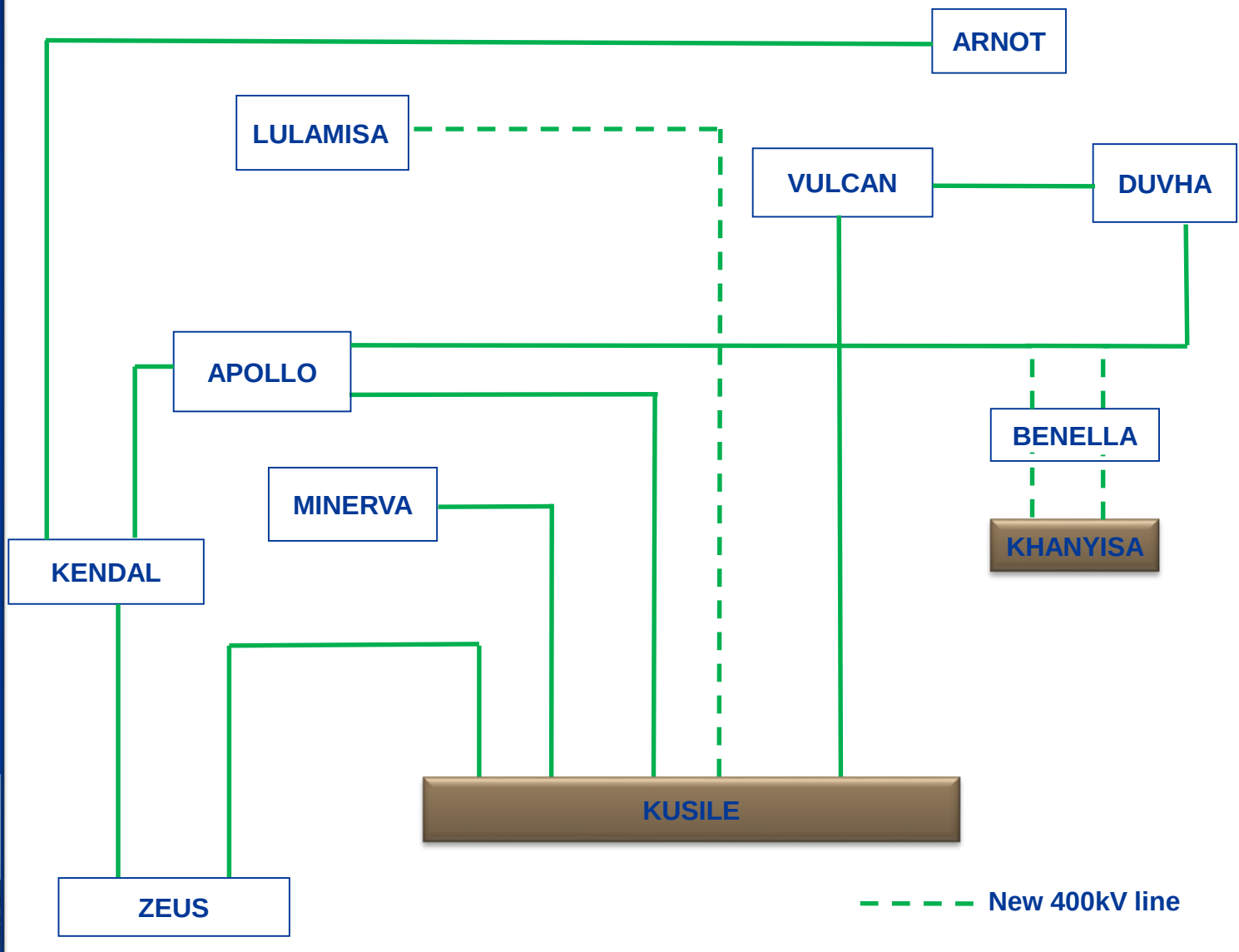


Mpumalanga generation forecast 2020 - 2029

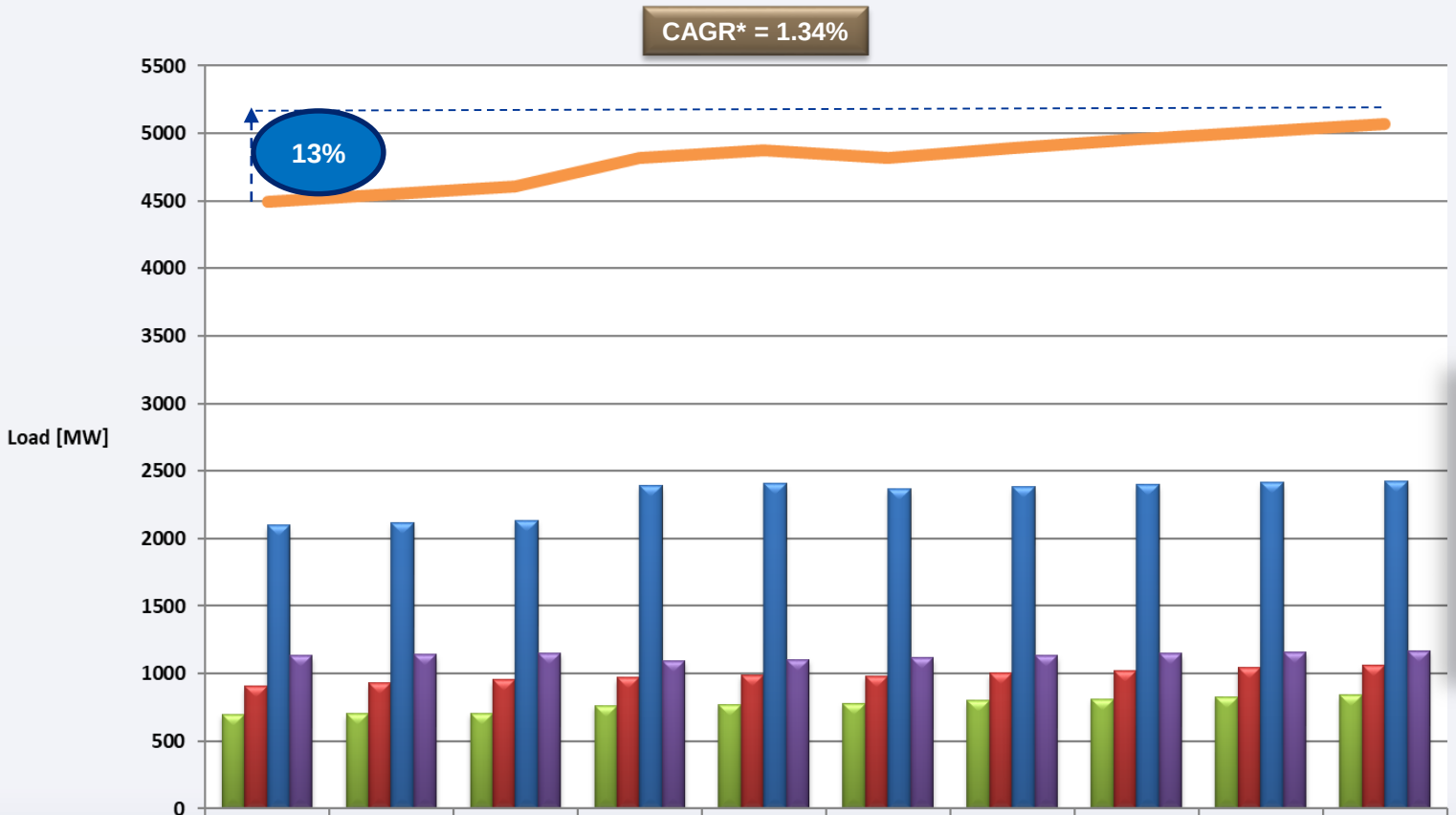


Generation Developments in Mpumalanga

- **Kusile Integration**
  - Kusile – Duvha
  - Kusile – Minerva
  - Kusile – Apollo
  - Kusile – Zeus
  - Kendal – Zeus
  - **Kusile – Lulamisa**
- **Khanyisa IPP Integration**
  - **Duvha-Apollo 400 kV loop-in to Benella Sw/S**



Mpumalanga Load Forecast 2020 - 2029



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

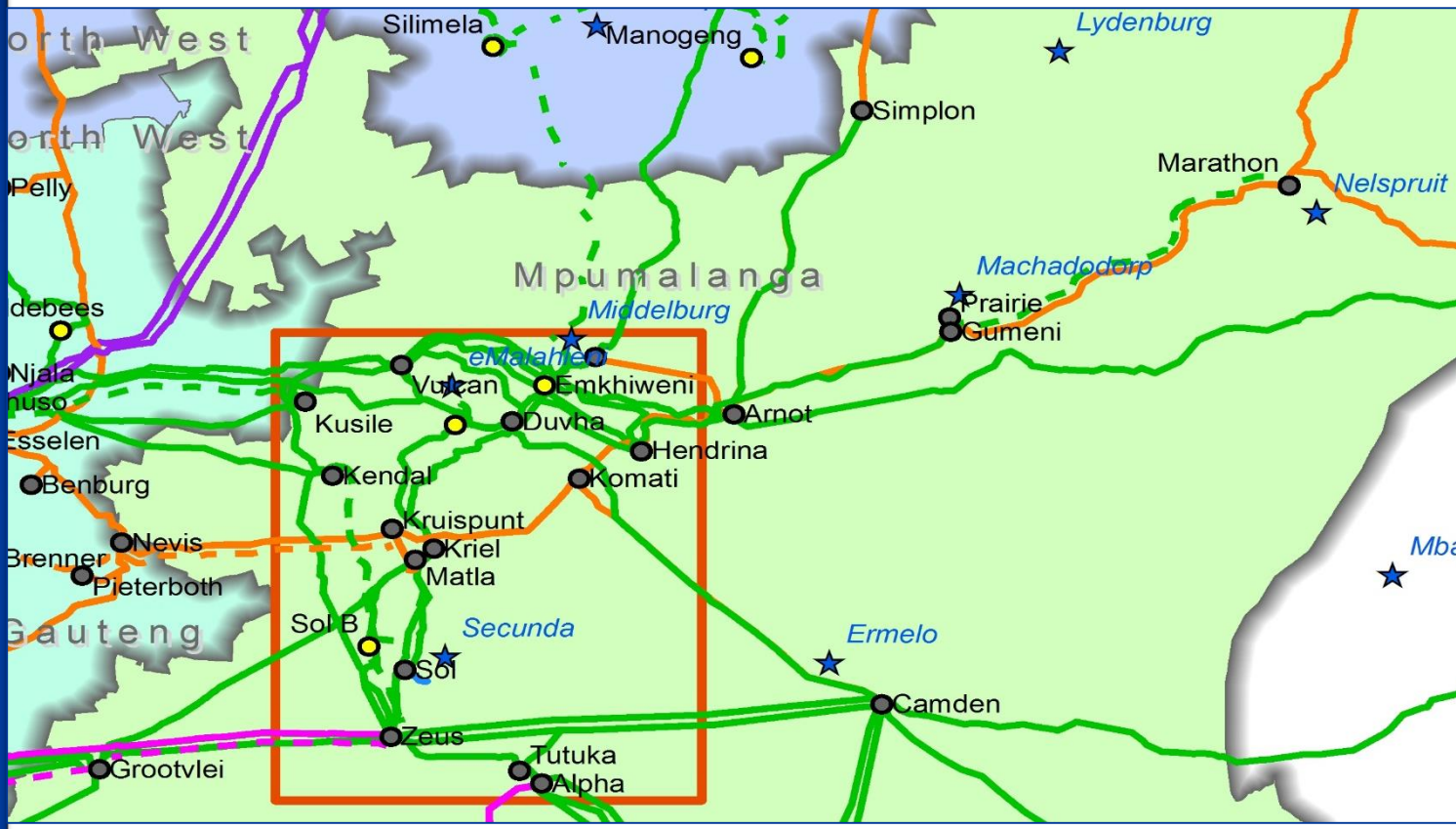
Key Growth Drivers

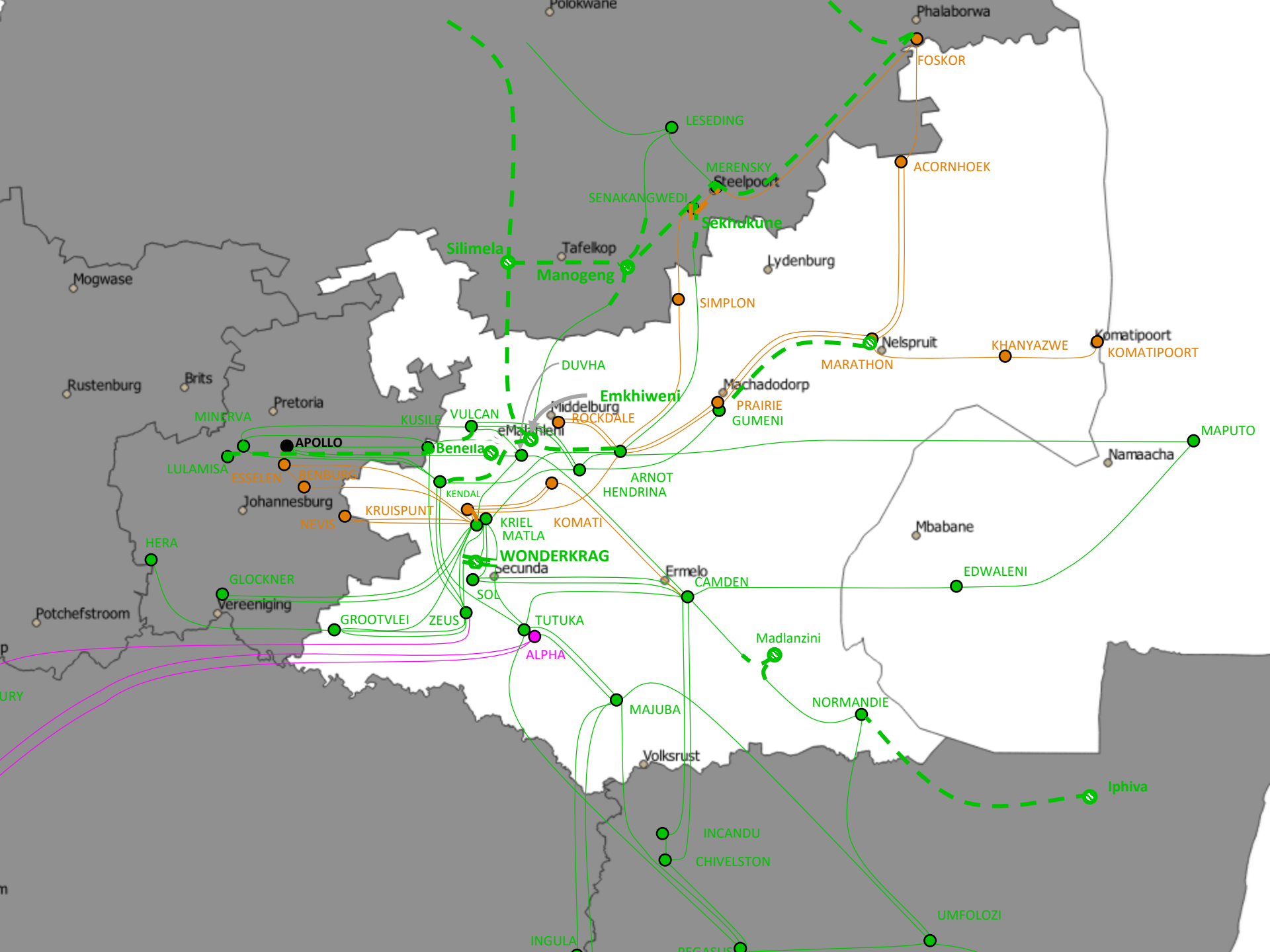
- Residential
- Commercial
- Tourism
- Mining
- Industrial development

* Compound Annual Growth Rate

Strengthening developments in Mpumalanga

- **Wonderkrag integration**
  - N-1 compliance
  - Safety compliance
  - Creating spare capacity
  - Fault level mitigation
- **Emkhiweni integration**
  - N-1 Compliance
  - Safety related to burning grounds
  - Creating spare capacity
- **Marathon 400 kV integration**
  - N-1 compliance
  - Creating spare capacity
  - Increased cross-border transfer capability




Polokwane
Phalaborwa
FOSKOR
LESEDING
MERENSKY
Steelpoort
ACORNHOEK
SENAKANGWEDI
Sekhukune
Silimela
Tafelkop
Manogeng
Lydenburg
Mogwase
SIMPLON
Nelspruit
KHANYAZWE
Komatipoort
KOMATIPOORT
MARATHON
DUVHA
Emkhiweni
Machadodorp
PRAIRIE
GUMENI
Middelburg
ROCKDALE
Rustenburg
Brits
Pretoria
MINERVA
KUSILE
VULCAN
eMalahleni
APOLLO
Beneila
MAPUTO
Namaacha
LULAMISA
ESSELEN
BENBURG
ARNOT
HENDRINA
KENDAL
Johannesburg
KRUISPUNT
NEVIS
KRIEL
MATLA
KOMATI
Mbabane
HERA
WONDERKRAG
Secunda
Ermelo
CAMDEN
EDWALENI
GLOCKNER
Vereeniging
SOL
Potchefstroom
GROOTVLEI
ZEUS
TUTUKA
Madlanzini
ALPHA
MAJUBA
NORMANDIE
Volksrust
Iphiva
INCANDU
CHIVELSTON
UMFOLOZI
INGULA

Questions?

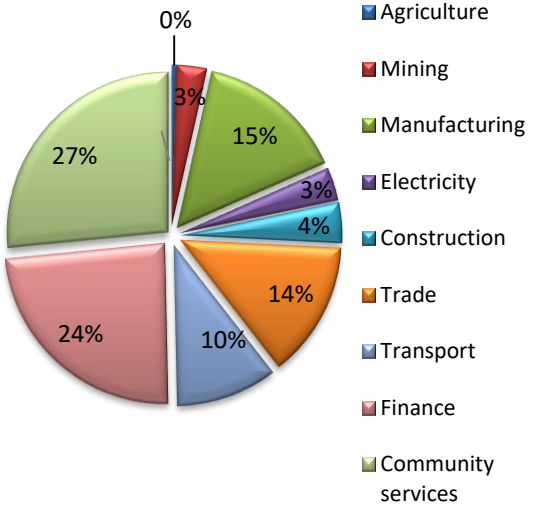
Gauteng Province
TDP 2020 - 2029

Presented by: Thamsanqa Ngcoba
Chief Technologist

Gauteng Province Profile

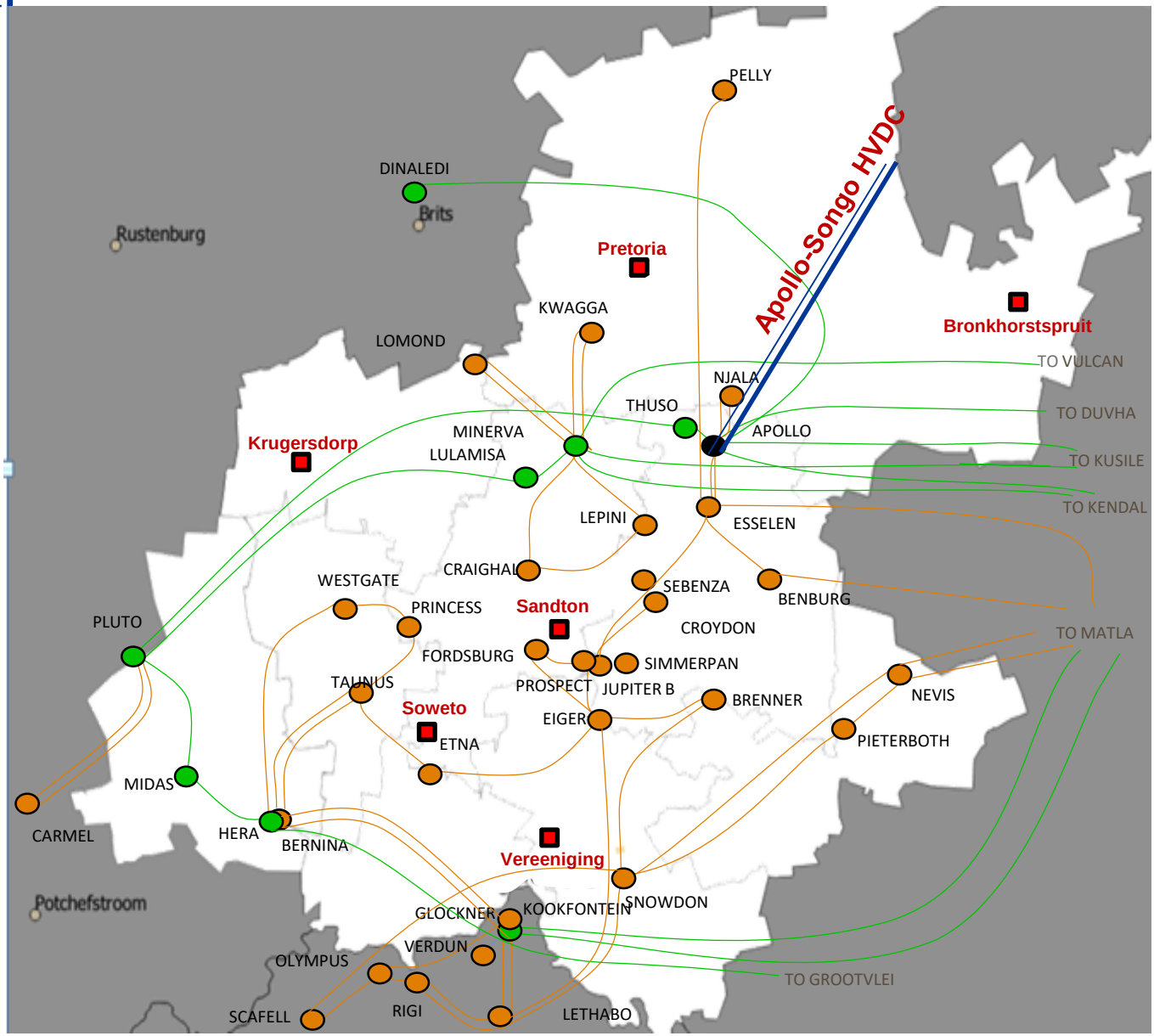
Load

- **Grid peak demand: ~11000 MW**



Generation

Type / Owner	Name
City Power	Kelvin
City of Tshwane	Rooiwal and PTA West



Gauteng projects in execution

Benburg Ext. 3rd 250 MVA 275/132 kV Transformer

- Supports network reliability in the East Rand

Gauteng projects in execution

Sisimuka 88 kV Busbar

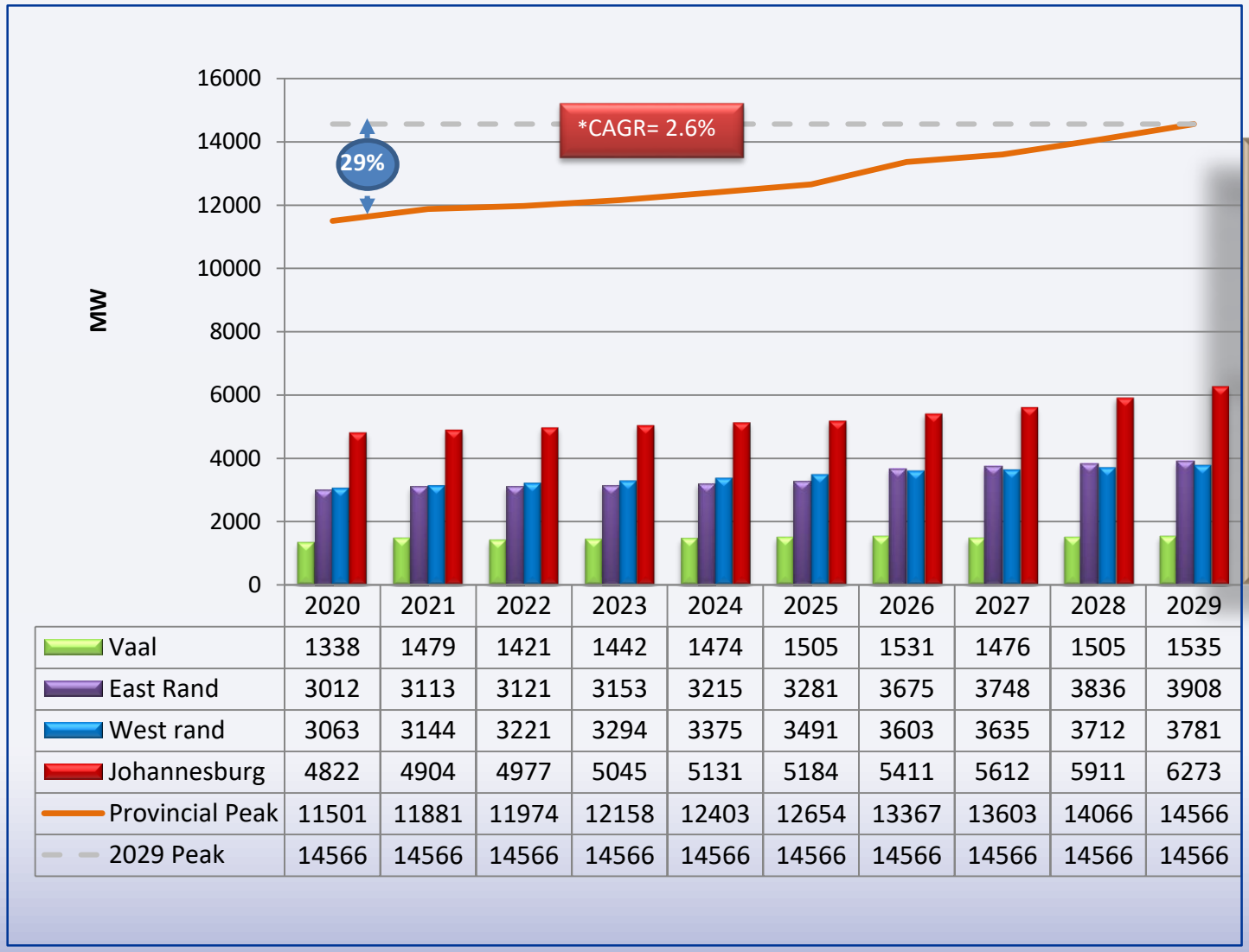
- 1st Phase of converting Simmerpan to a 275/88 kV Substation
- Supplies growth in the Germiston area

Gauteng Projects in execution

Lepini Ext. 275 kV 2 x 150 MVar Capacitors

- Supports the Minerva-Lepini-Craighall 275 kV ring, which supplies the northern suburbs
-

Gauteng Load Forecast



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

Growth drivers:
- **Residential,**
- **Commercial, and**
- **Light industrial**

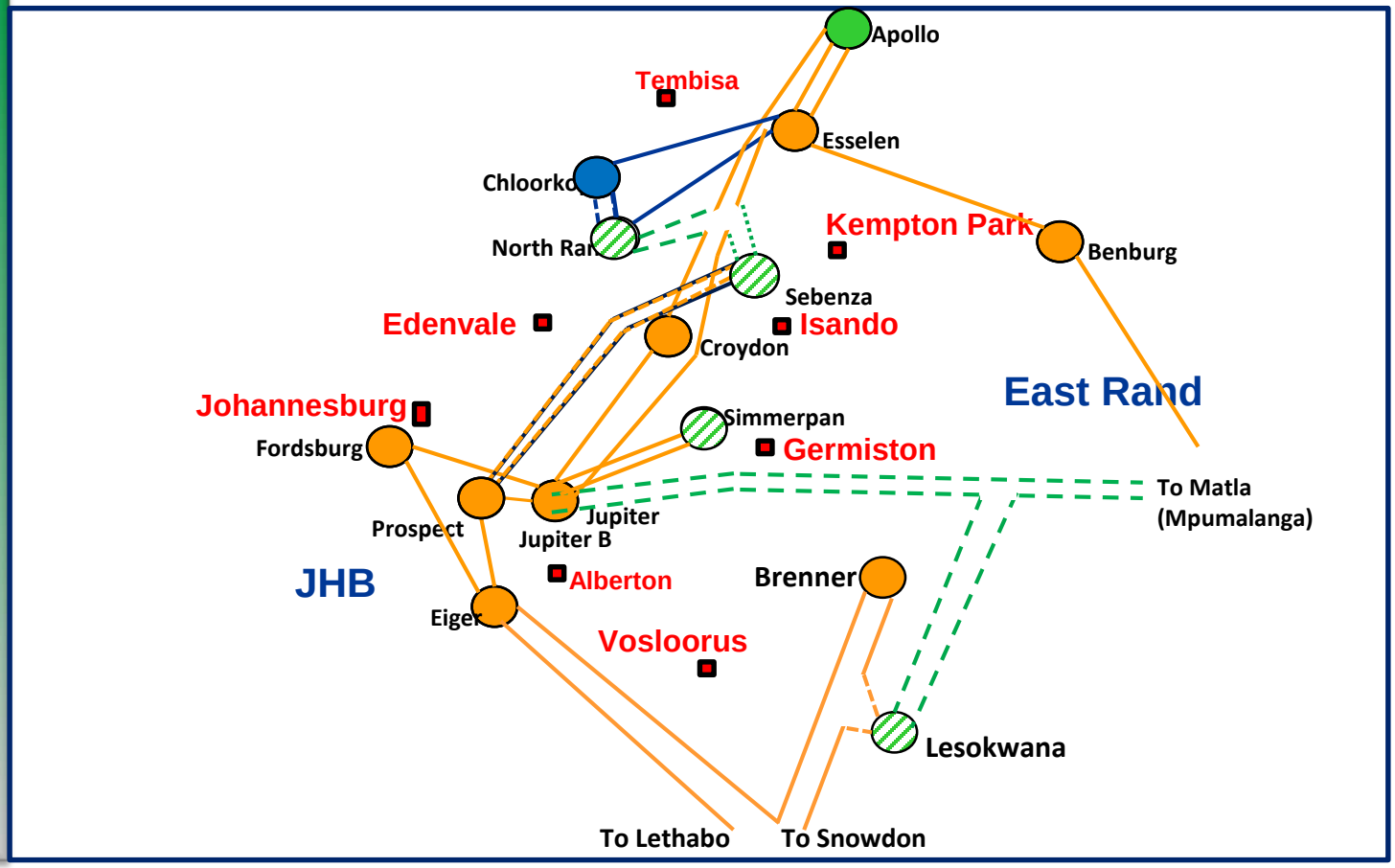
Growth nodes:
- **Northern suburbs**
- **West Rand**
- **East Rand**
- **Tshwane**

***Compound Annual Growth Rate**

Developments in the JHB East and South Area

Key Projects:

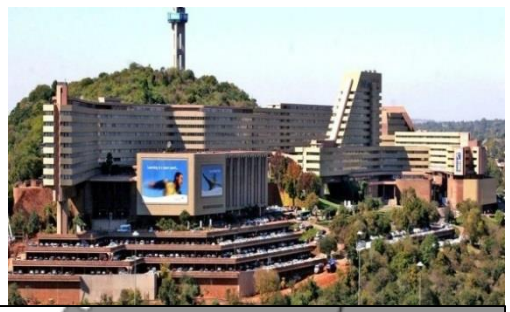
- Mesong Substation
- Jupiter B integration
- Sisimuka Substation
- Lesokwana Substation

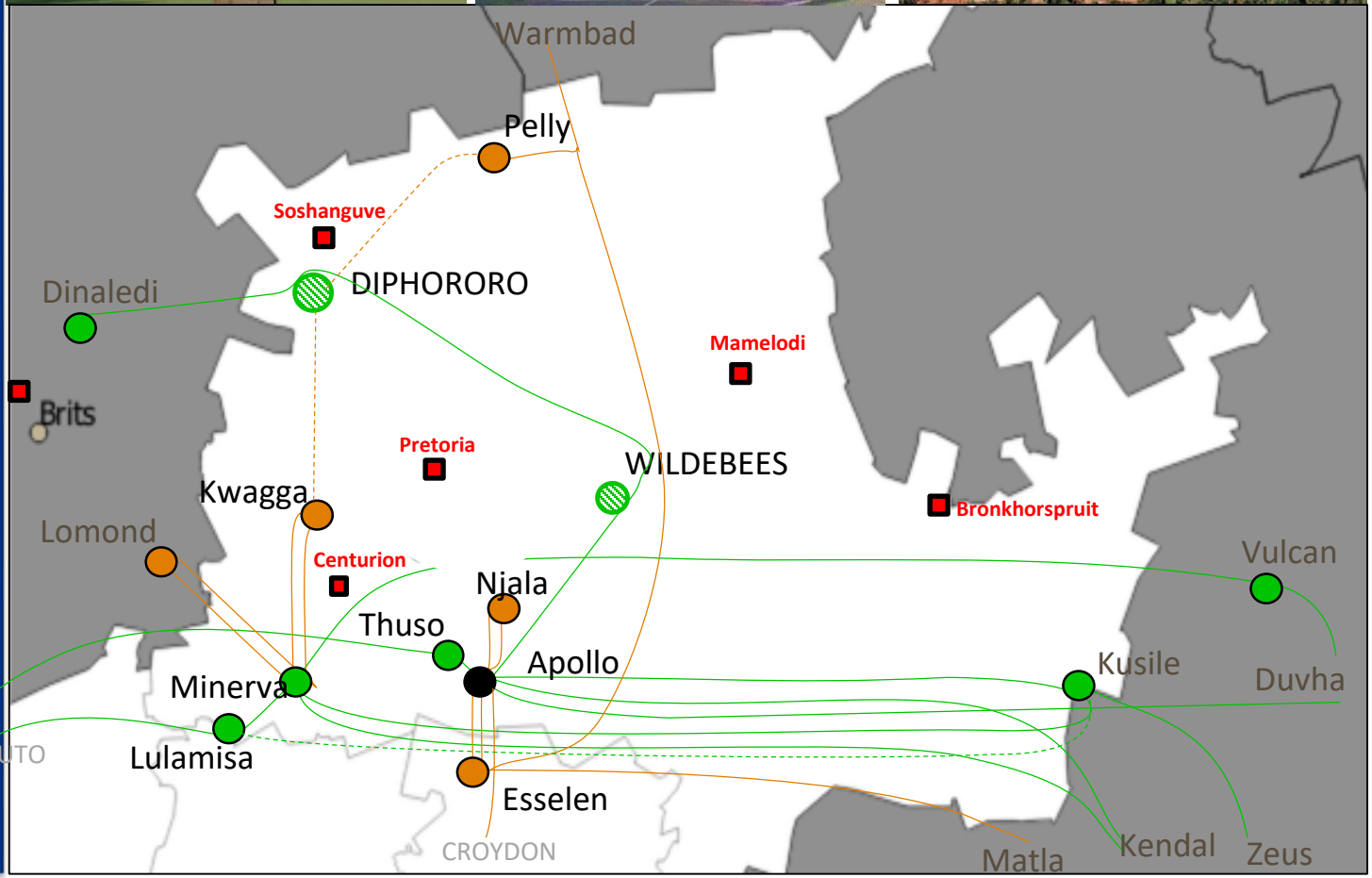


Developments in the Tshwane Area

Key Projects:

- **Wildebees integration**
- **Diphororo Phase 1**
- **Diphororo Phase 2**

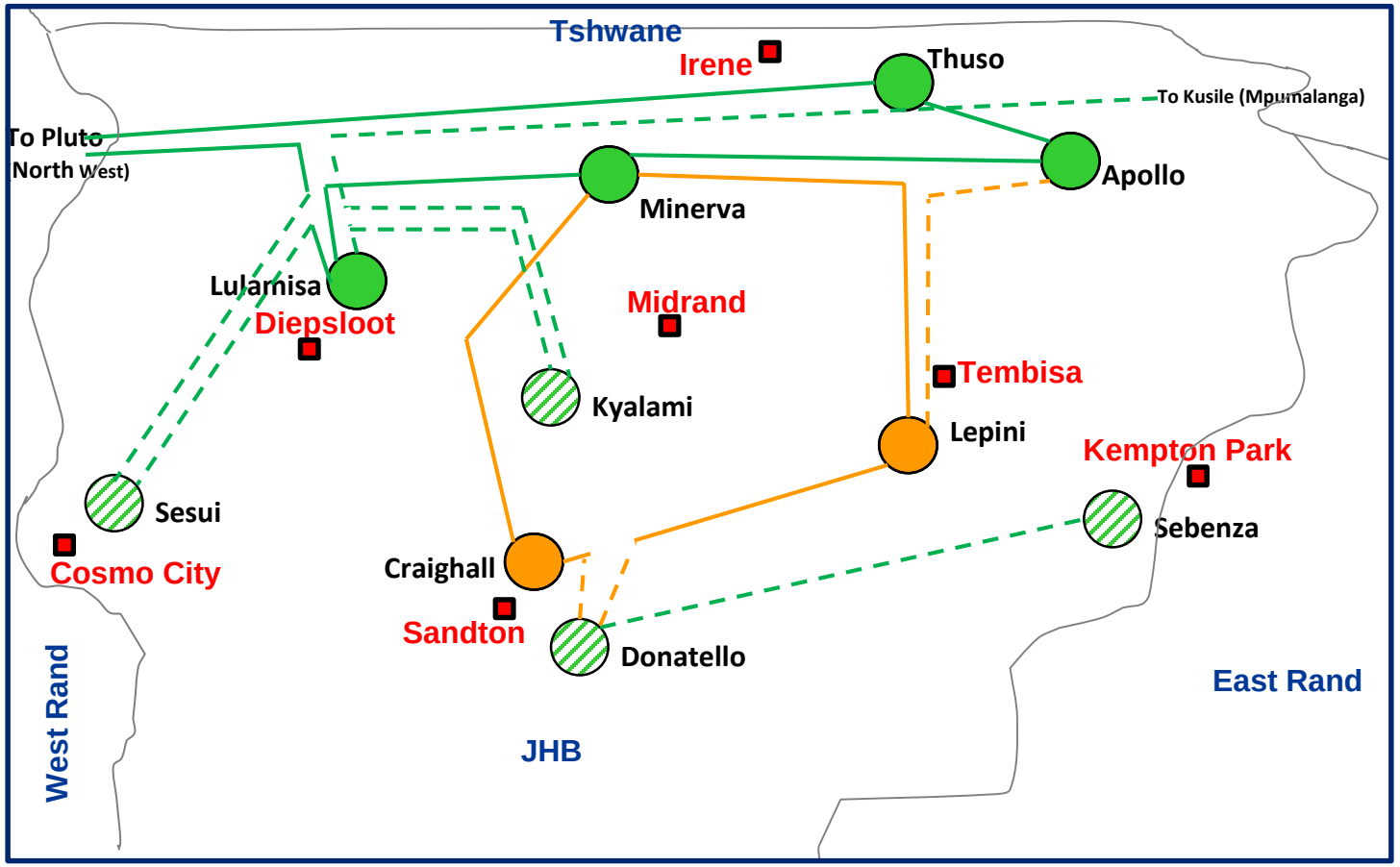




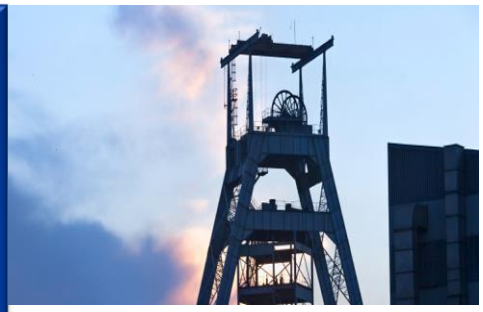
Developments in the JHB North Area

Key Projects:

- Kusile-Lulamisa 400 kV line
- Apollo-Lepini 2nd 275 kV line
- New MTS Sesui 400/88 kV
- New MTS Kyalami 400/88 kV
- New MTS Donatello 400/88 kV

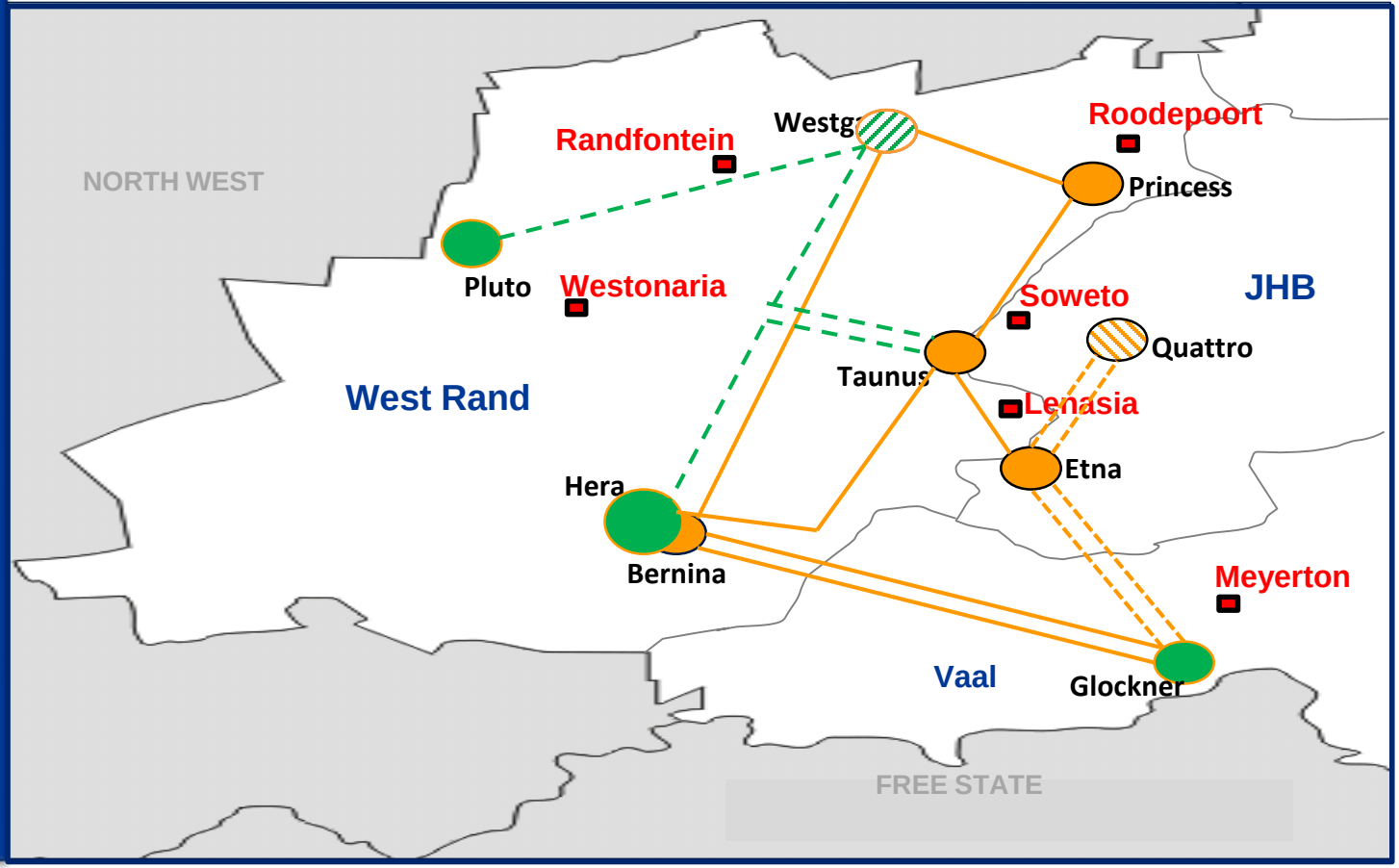


Developments in the West Rand and Vaal Area



Key Projects:

- **Vaal Strengthening Phase 2**
- **Soweto Strengthening**
- **West rand Strengthening Phase 1 and 2**



Questions?

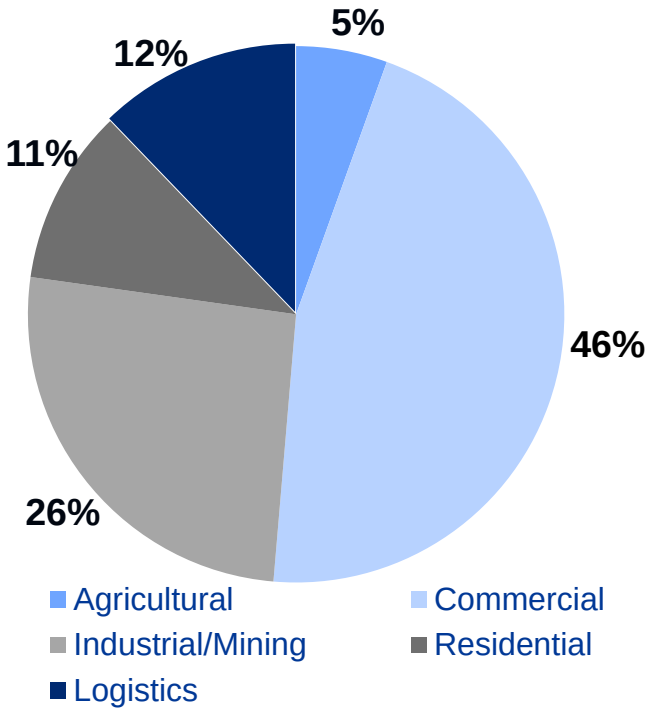
KwaZulu-Natal Province
TDP 2020 - 2029

Presented by: Thokozani Bengani
Chief Engineer

KwaZulu-Natal Province Profile

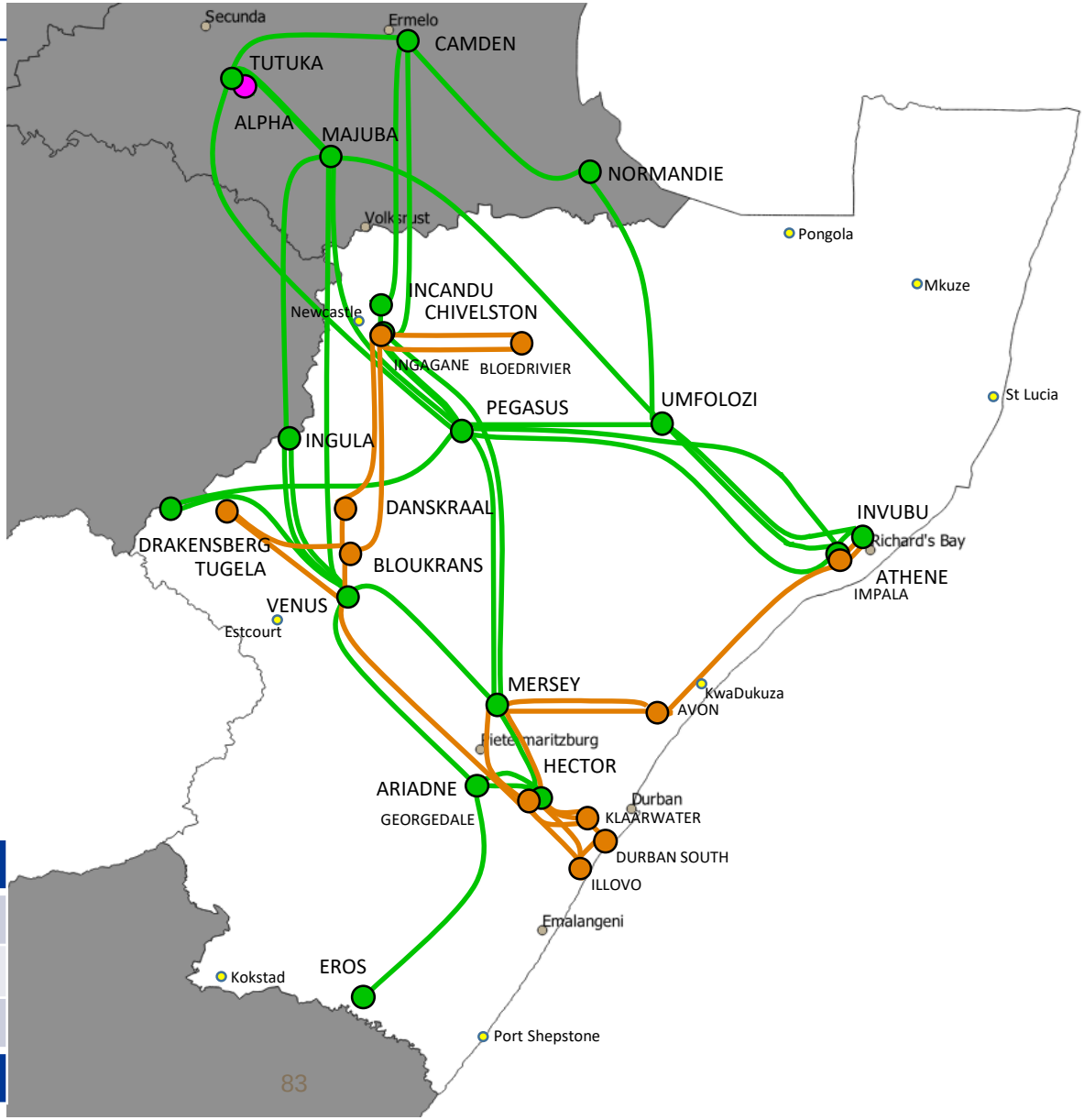
Load

Peak load of 5900 MW: 02 Aug 2018

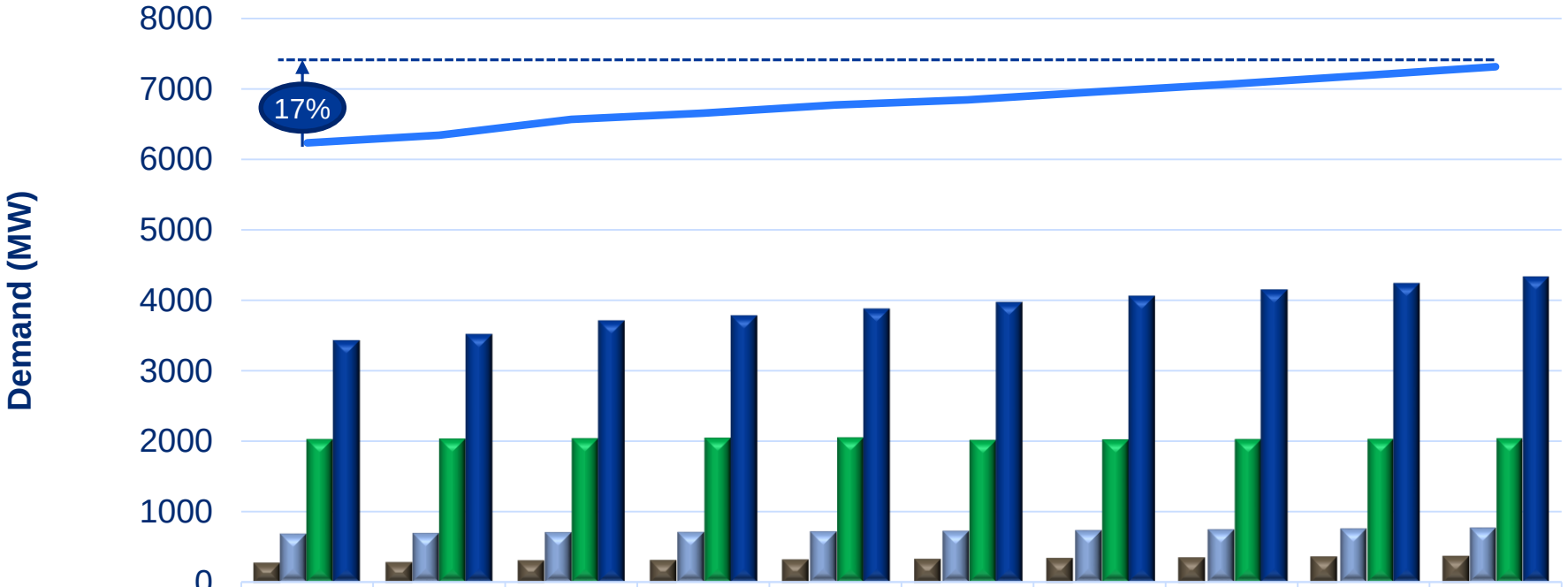


Generation

Type		Name	Output
Peaking	Pumped Storage	Drakensberg	1000 MW
		Ingula	1330 MW
IPP	Gas	Avon IPP	680 MW
Total Installed Generation			3010 MW



KwaZulu-Natal Load Forecast



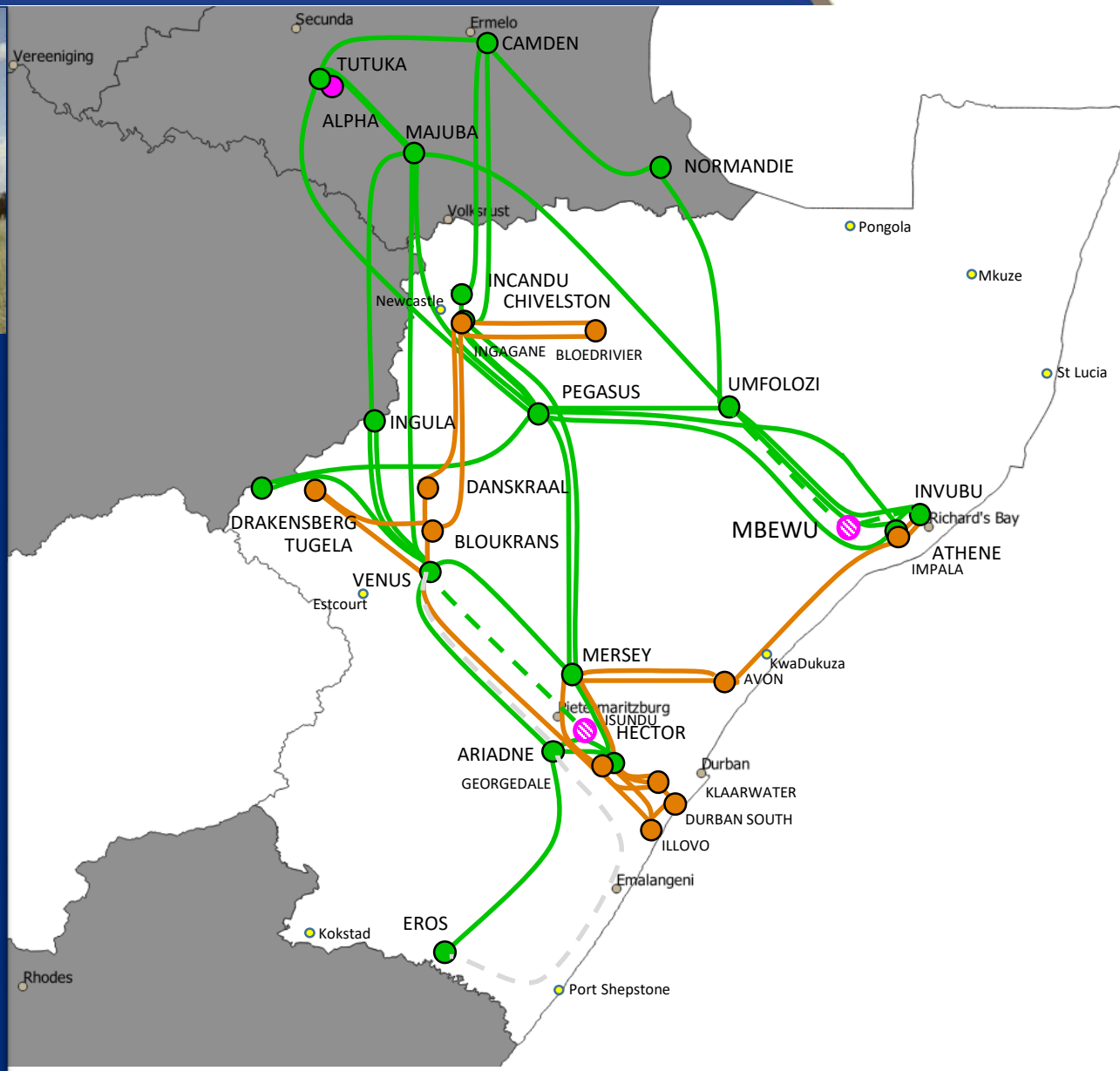
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Ladysmith	277	283	305	310	320	328	339	348	358	369
Newcastle	680	689	699	703	711	720	728	739	752	764
Empangeni	2031	2036	2041	2048	2052	2017	2026	2031	2034	2042
Pinetown	3432	3521	3711	3783	3879	3971	4062	4148	4241	4336
Grid Peak	6237	6345	6569	6655	6771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

Years

Growth drivers in the province:
Commercial, Light industrial, Residential, Tourism and Universal access to electricity

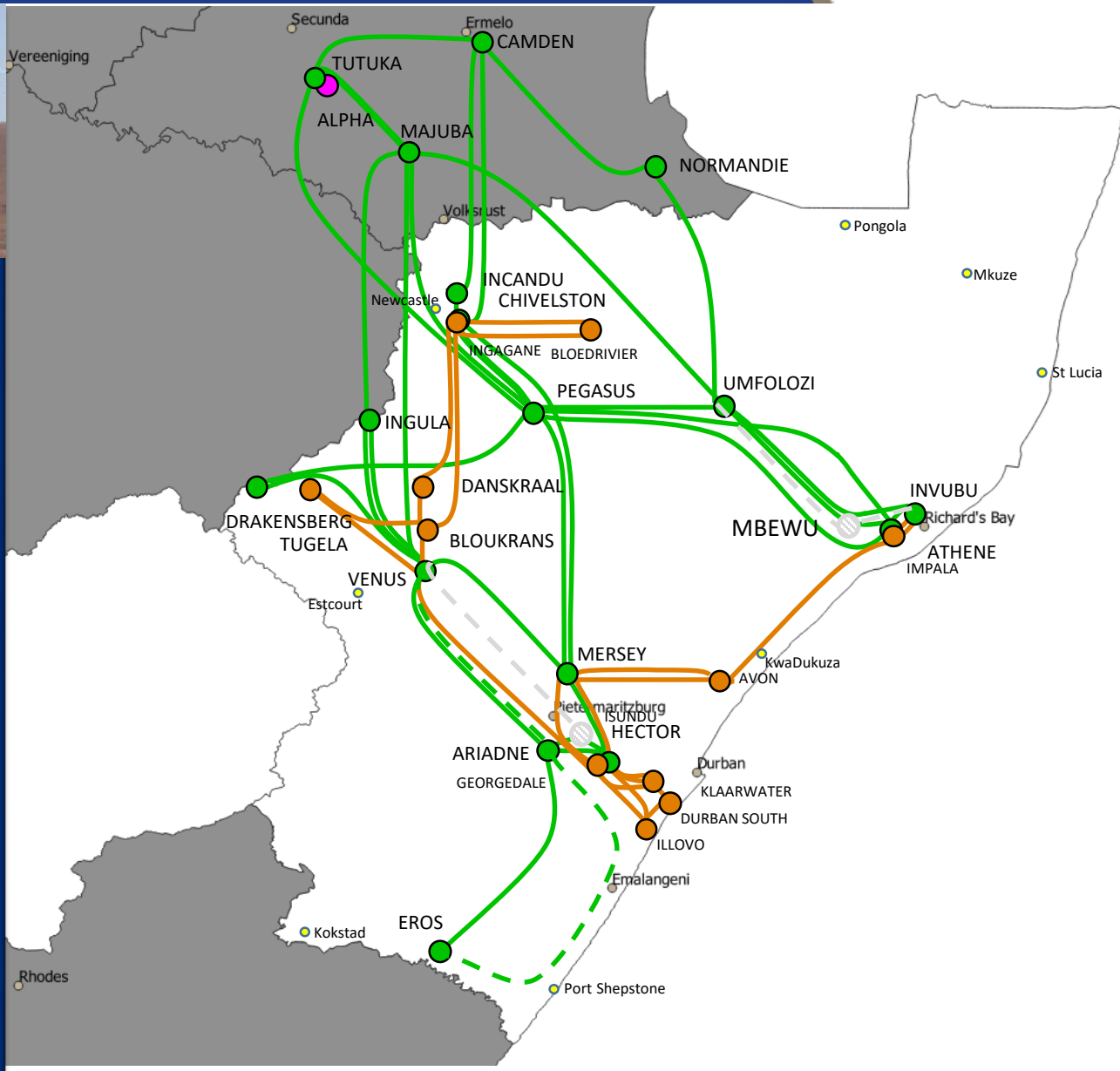
KwaZulu-Natal 765 kV Strengthening

- **Benefit**
  - Will create additional capacity to meet the growth in demand in uMhlathuze, RBIDZ, KwaDukuza and Dube Tradeport
  - Will provide network redundancy
    - Ability to switch off critical circuits for maintenance
- **Planned Projects:**
  - Empangeni Integration
  - Pinetown Integration



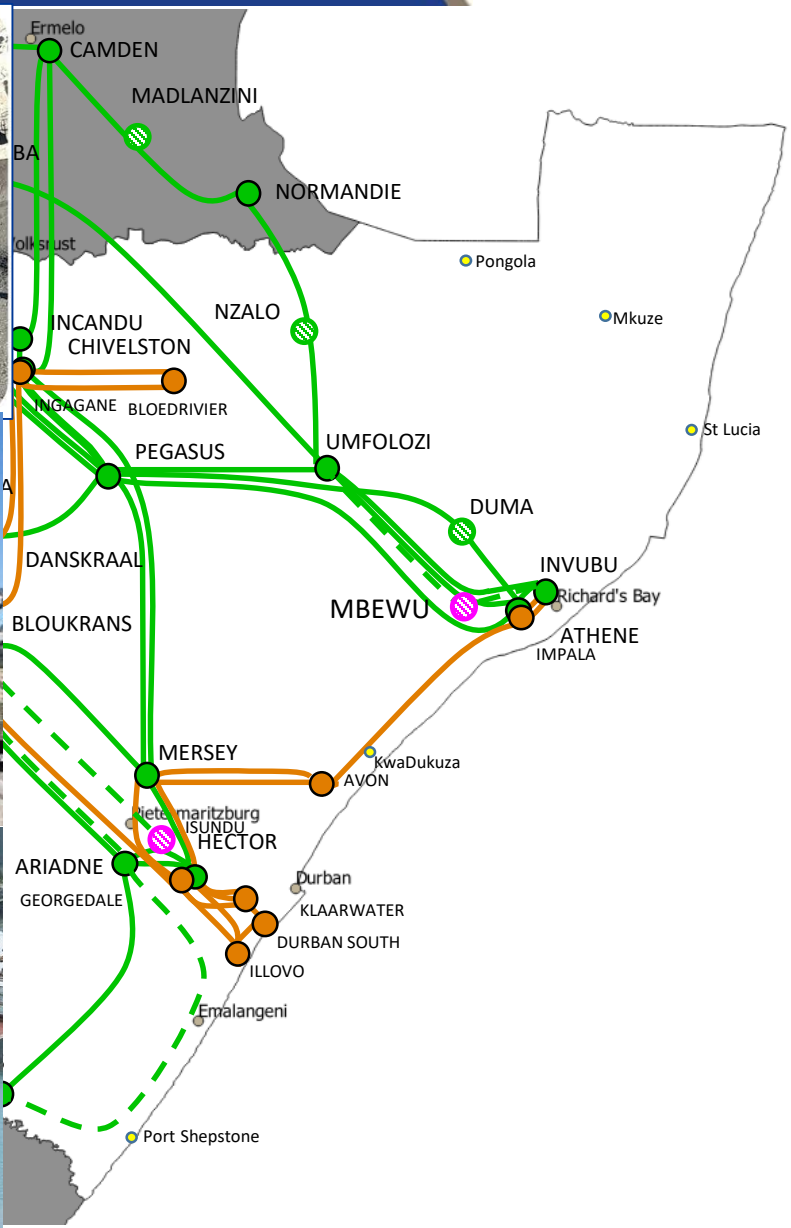
400 kV Backbone Strengthening

- **Benefits:**
  - Will alleviate power transfer shortfalls in Msunduzi, eThekwini and south coast
  - Will create capacity to meet the growth in demand
  - Will provide network redundancy
    - Ability to switch off critical circuits for maintenance
- **Planned Project:**
  - Ariadne-Venus 2nd 400 kV line
  - Ariadne-Eros 2nd 400 kV line



Ermelo-Richards Bay freight rail upgrade

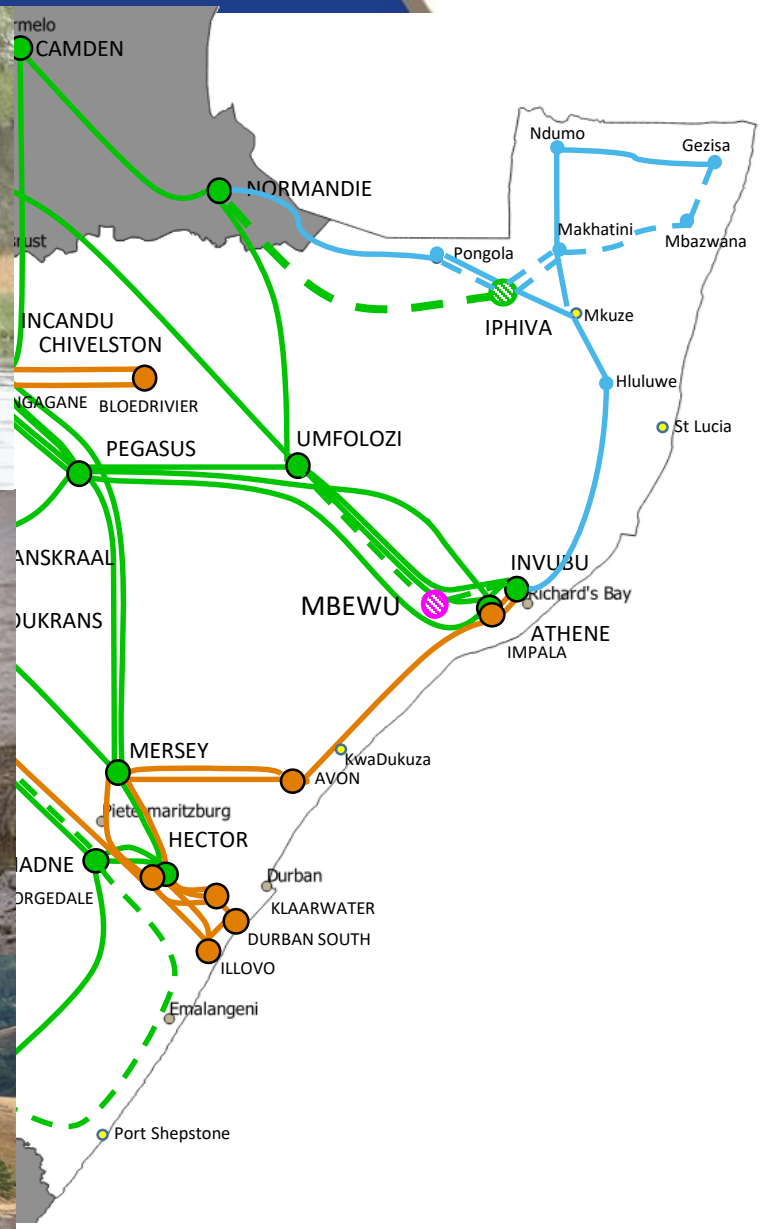
- **Drivers for load growth:**
  - Mining and Exports
- **Planned Projects:**
  - Madlanzini Substation loop into Camden-Normandie 400 kV line
  - Nzalo Substation loop into Normandie-Umfolozi 400 kV line
  - Duma Substation loop into Pegasus-Athene 400 kV line



Jozini and Umhlabuyalingana Municipalities

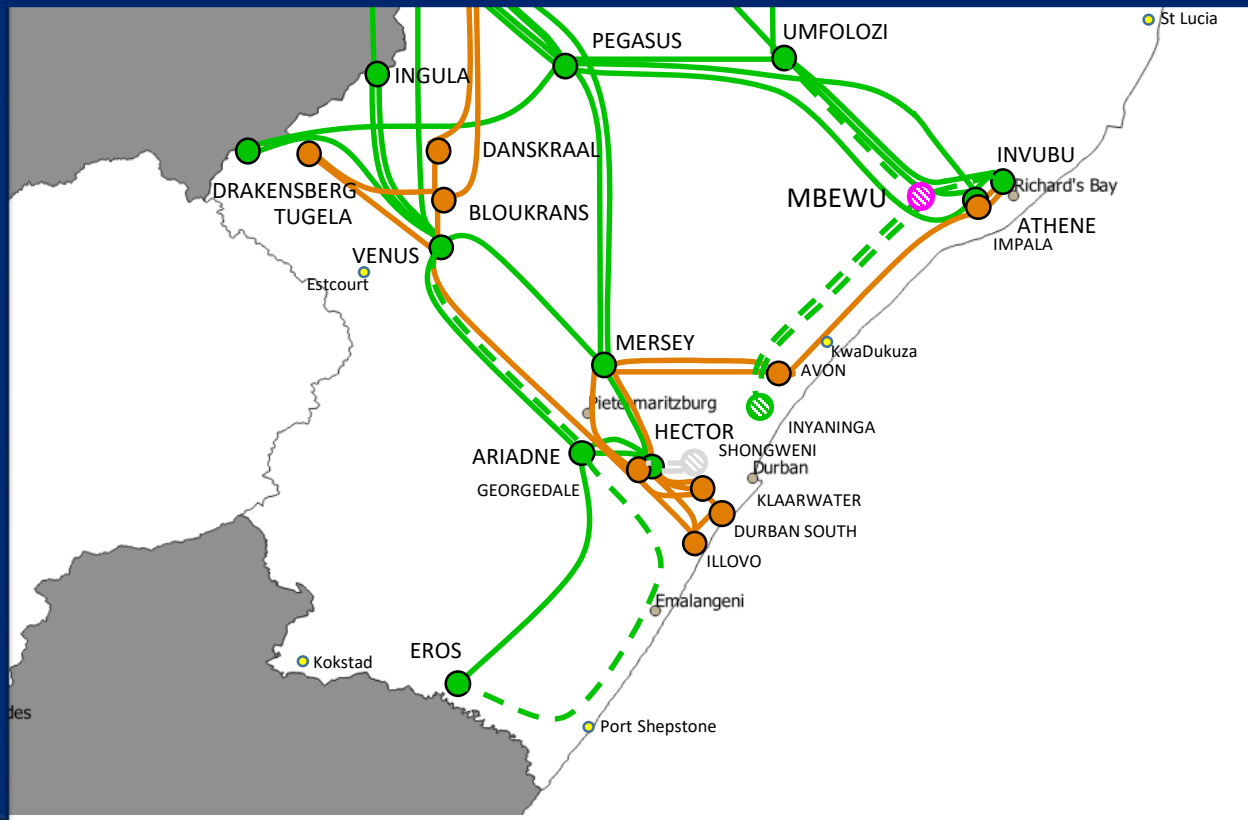
- **Drivers for growth:**
  - iSimangaliso wetland park eco-tourism
  - Agriculture
  - Universal access to electricity

- **Planned Project:**
  - Northern KZN Strengthening: Phase 1: Normandie-Iphiva 400 kV line and integration of Iphiva Substation near Mkuze



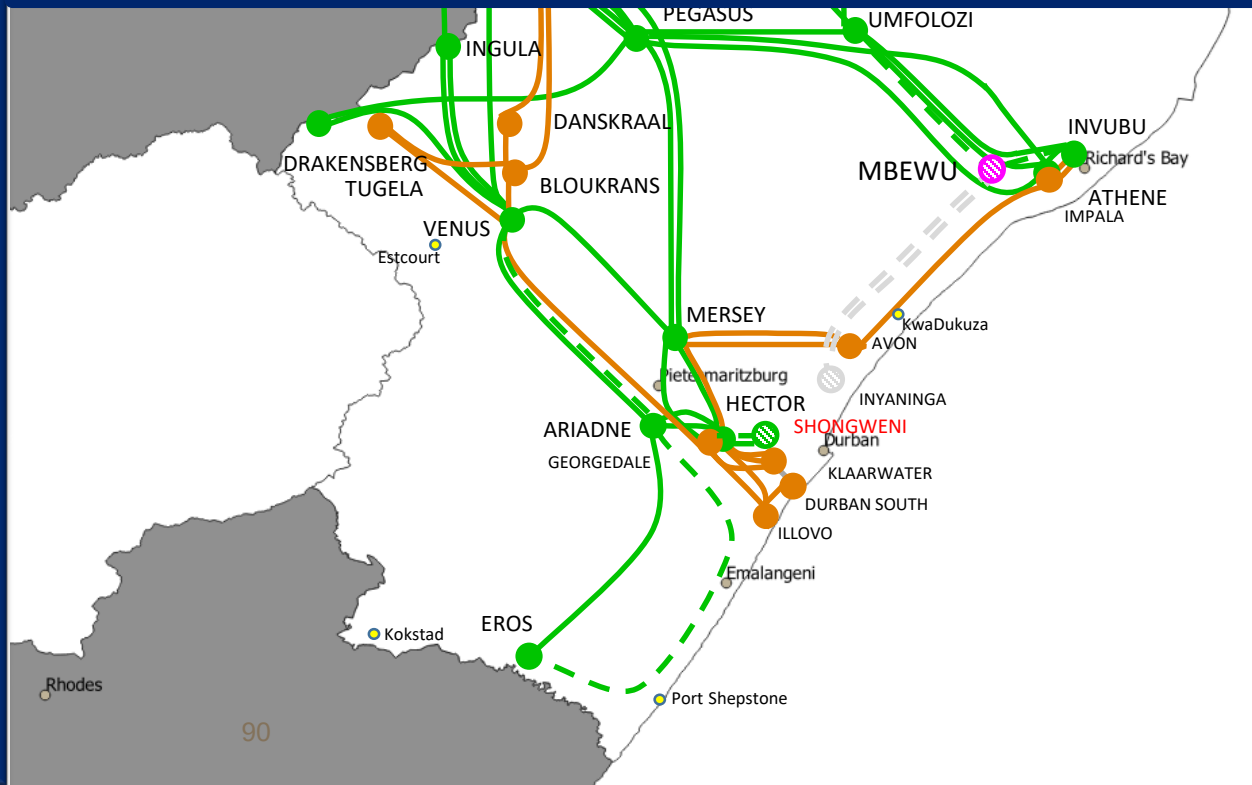
Dube Tradeport – Durban Aerotropolis

- **Drivers for load growth:**
  - Dube Tradeport development
  - eThekwini Metropolitan
  - KwaDukuza Municipality
- **Planned Project:**
  - Integration of Inyaninga Substation
- **Benefits:**
  - Will cater for the demand growth around the Dube Tradeport
  - Will free up capacity on the existing transmission network supplying eTE and iLembe DM



eThekwini Western Region

- **Drivers for load growth:**
  - Durban-Gauteng Logistics Corridor
  - Mixed use developments
- **Planned Project:**
  - Integration of Shongweni Substation
- **Benefits:**
  - Will cater for the demand growth in the western region
  - Will free up capacity on the existing transmission network supplying eTE and the south coast



Questions?

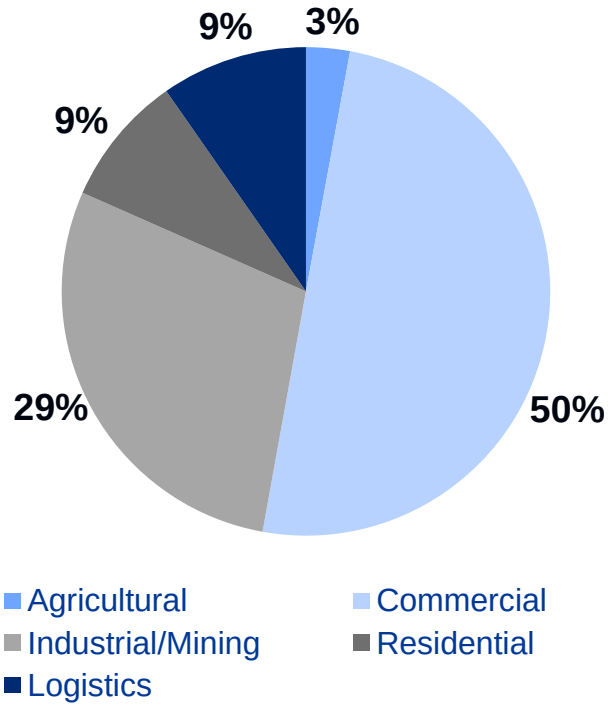
Free State Province
TDP 2020 - 2029

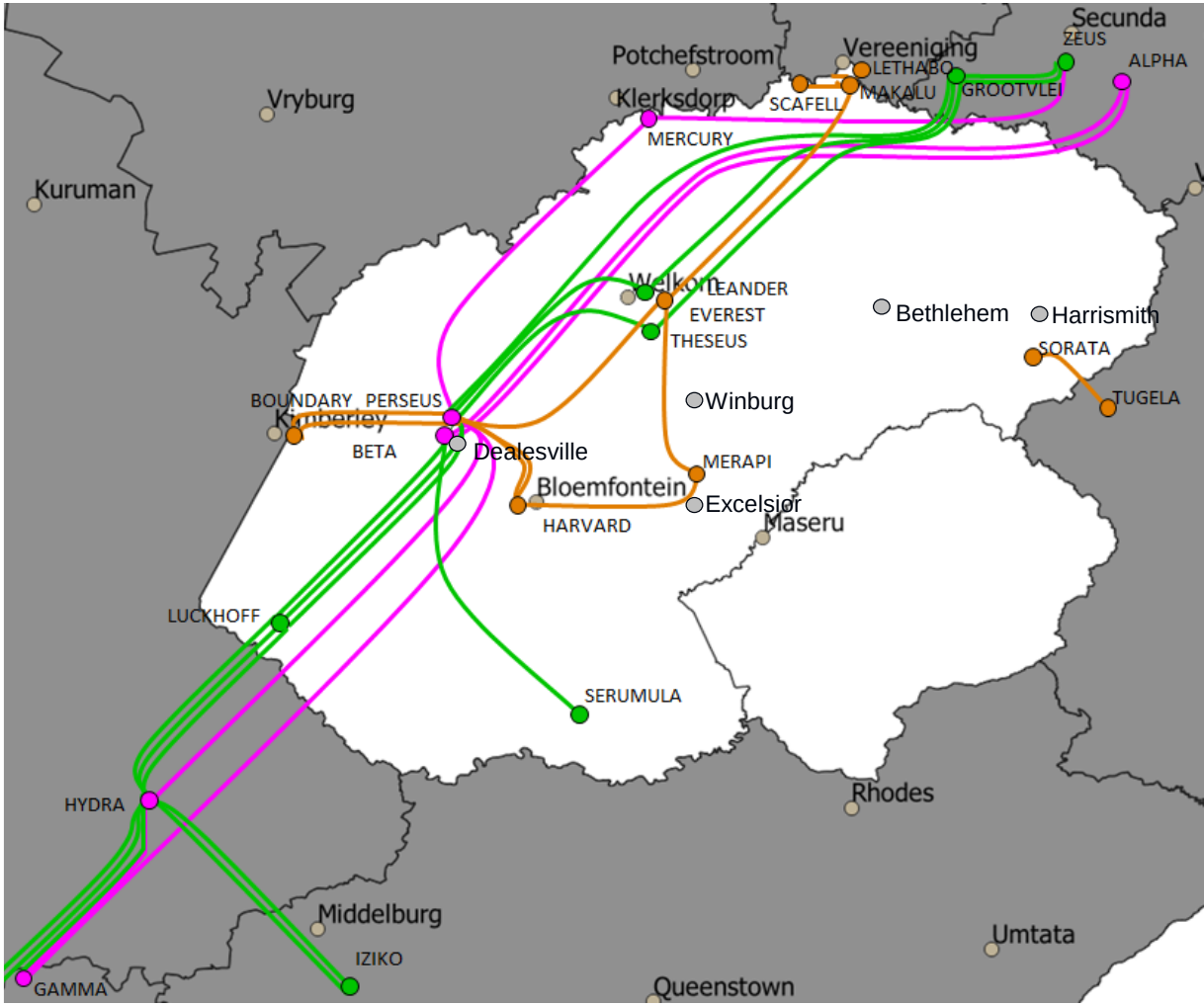
Presented by: Thokozani Bengani
Chief Engineer

Free State Province Profile

Load

Peak load of 1650 MW: 21th July 2018

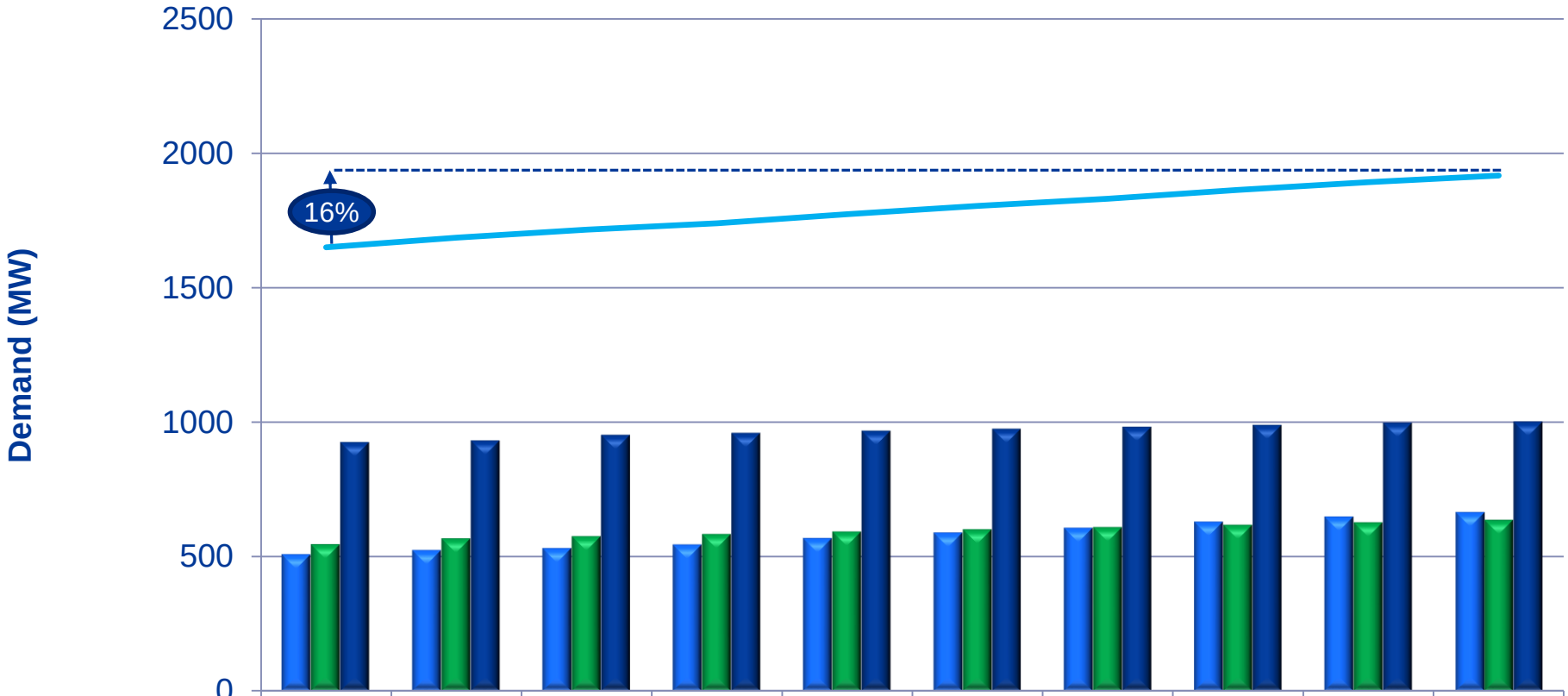




Generation

Type		Name	Output
Base	Coal	Lethabo	3558 MW
IPP	Hydro	IPPs	4.4 MW
	PV	IPPs	199 MW
Total Installed Generation			**3761 MW**

Free State Load Forecast



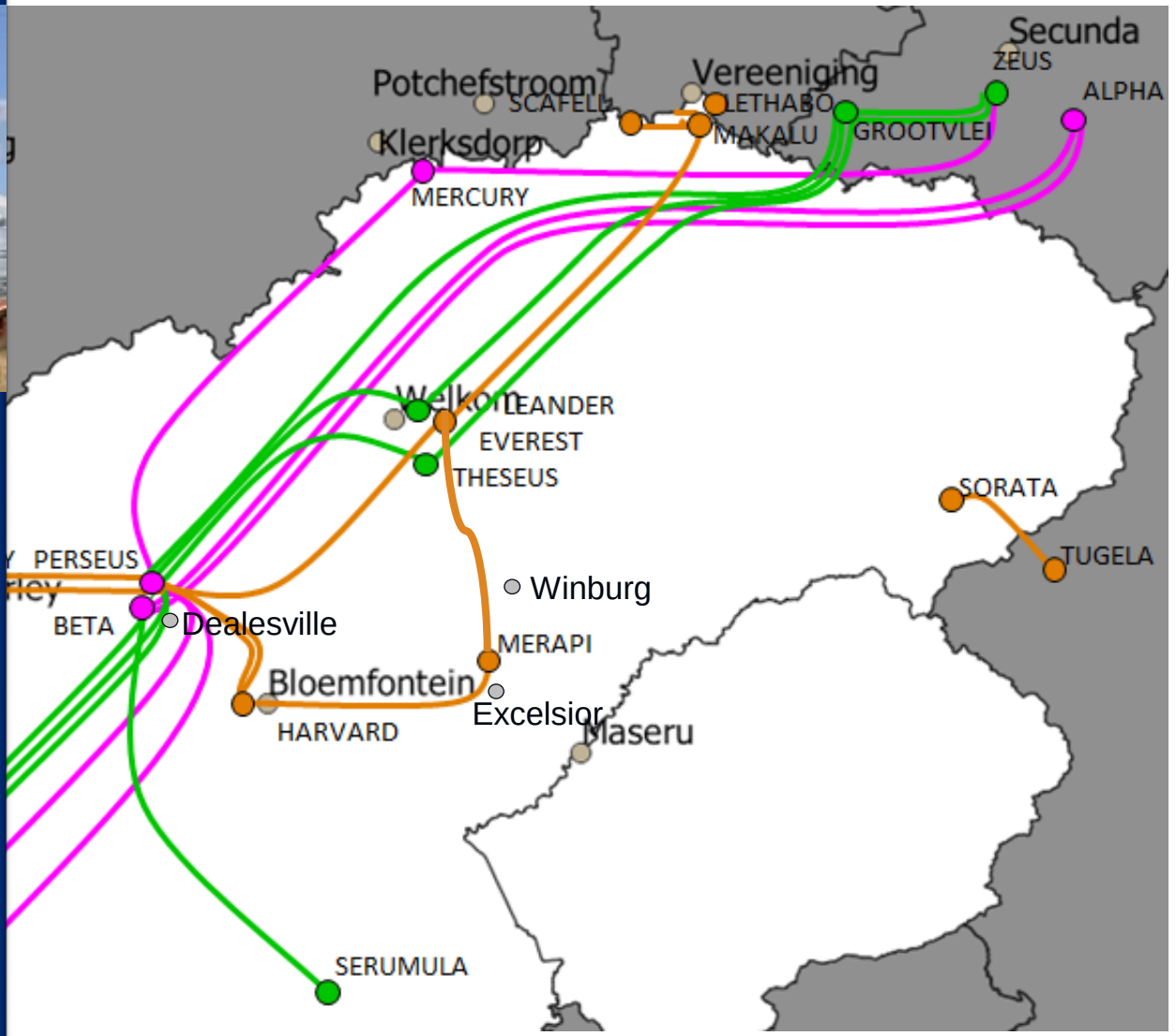
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Bloemfontein	508	524	530	544	567	588	605	628	646	663
Sasolburg	545	566	574	583	592	600	609	617	626	635
Welkom	925	932	953	960	967	975	982	990	998	1002
Grid Peak	1650	1686	1716	1740	1774	1804	1831	1864	1893	1918

Year

Growth drivers in the province:
Commercial, Light industrial, Logistics & Universal access to electricity

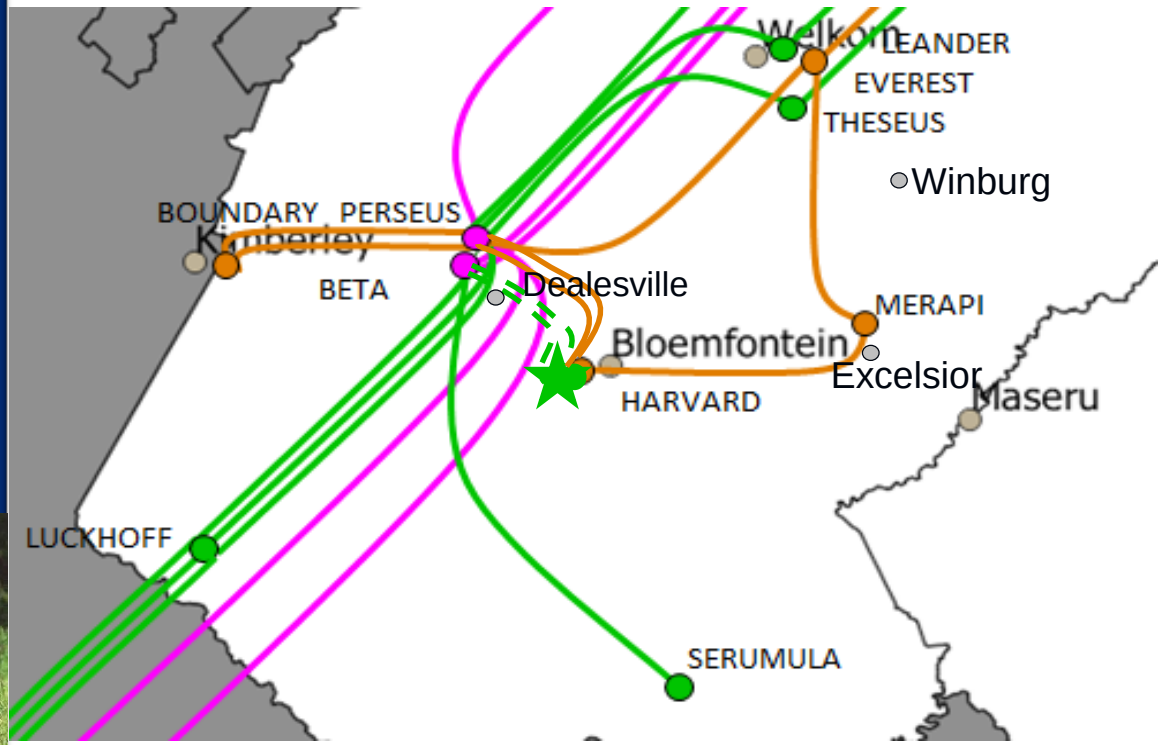
Everest-Merapi 400 kV line, operated at 275 kV

- **Benefits**
  - Increased network capacity to meet the growth in demand
  - Alternative transmission supply to Excelsior, Winburg and surrounding areas



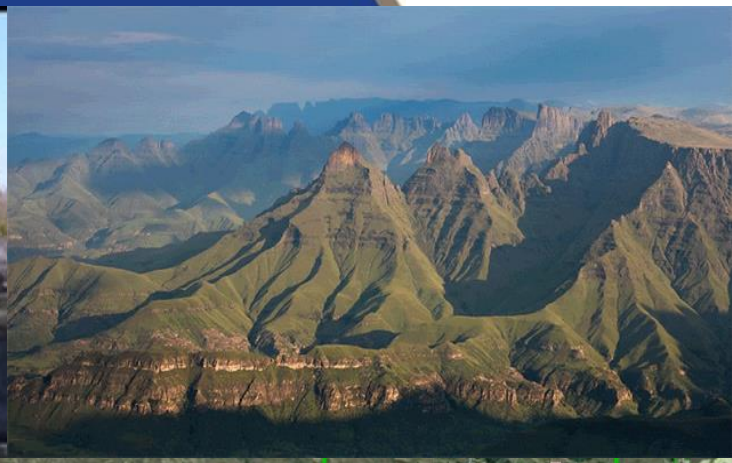
Key Developments in Mangaung and Surrounding Regions

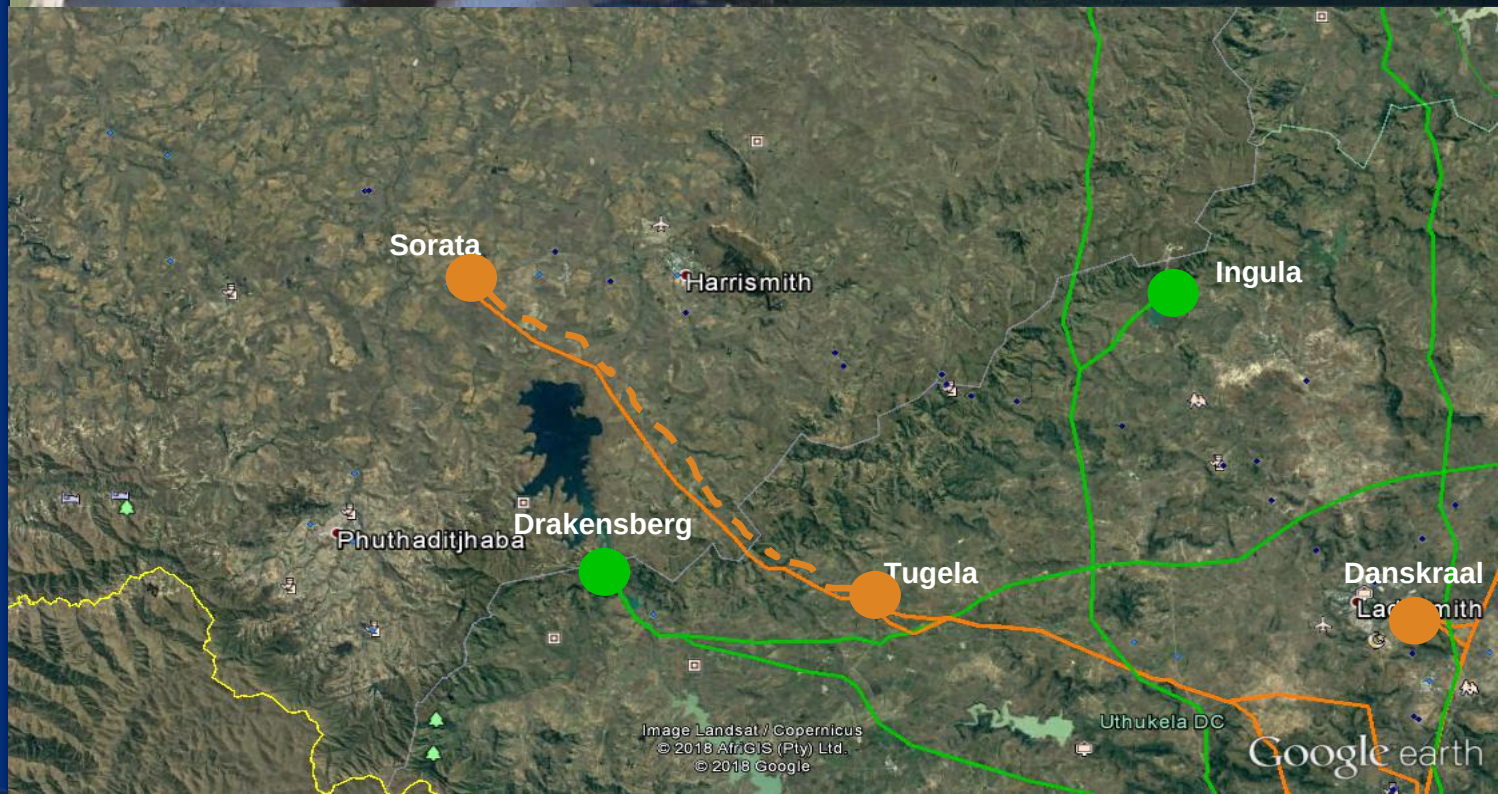
- **Drivers for load growth:**
  - Solar power generation
  - Universal access to electricity
- **Planned Project:**
  - Bloemfontein Strengthening Phase 2
  - Harvard 400/132 kV Substation
  - 2 x Beta-Harvard 400 kV lines



Key Developments in Eastern Free State

- **Drivers for load growth:**
  - Harrismith Logistics Hub
  - Universal access to electricity
- **Planned Project:**
  - Harrismith Strengthening: Extension of Sorata Substation (Phase 1 and 2)





Key Developments in Sasolburg

- **Drivers for load growth:**
  - Mining
  - Industrial activities
  - Universal access to electricity
- **Planned Project:**
  - Integration of Igesi Substation

Questions?

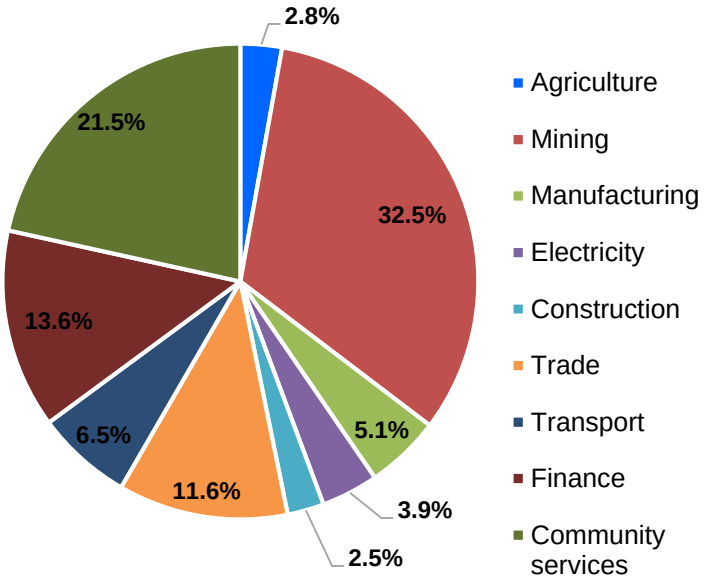
North-West Province
TDP 2020 - 2029

Presented by: Queen Melato
Chief Engineer

North-West Province Profile

Load

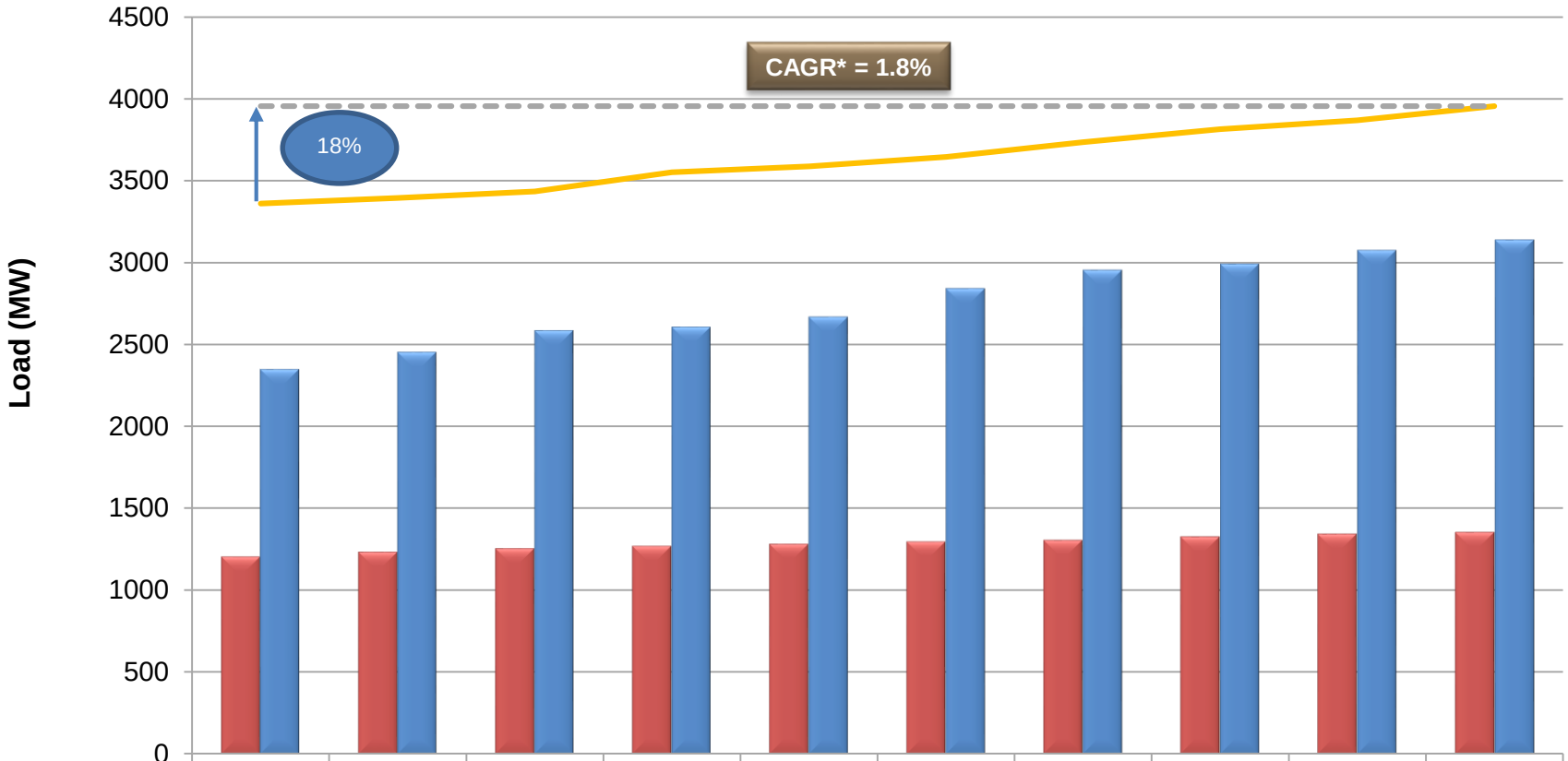
- **Peak load 3263 MW**



Generation

Type		Name	Output
Renewable Energy	PV	RustMo1 Solar	7MW
Total Generation			**7MW**

North-West Province Load Forecast



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

*** Compound Annual Growth Rate**

Renewable Energy in North-West Province

Renewable Energy Projections:

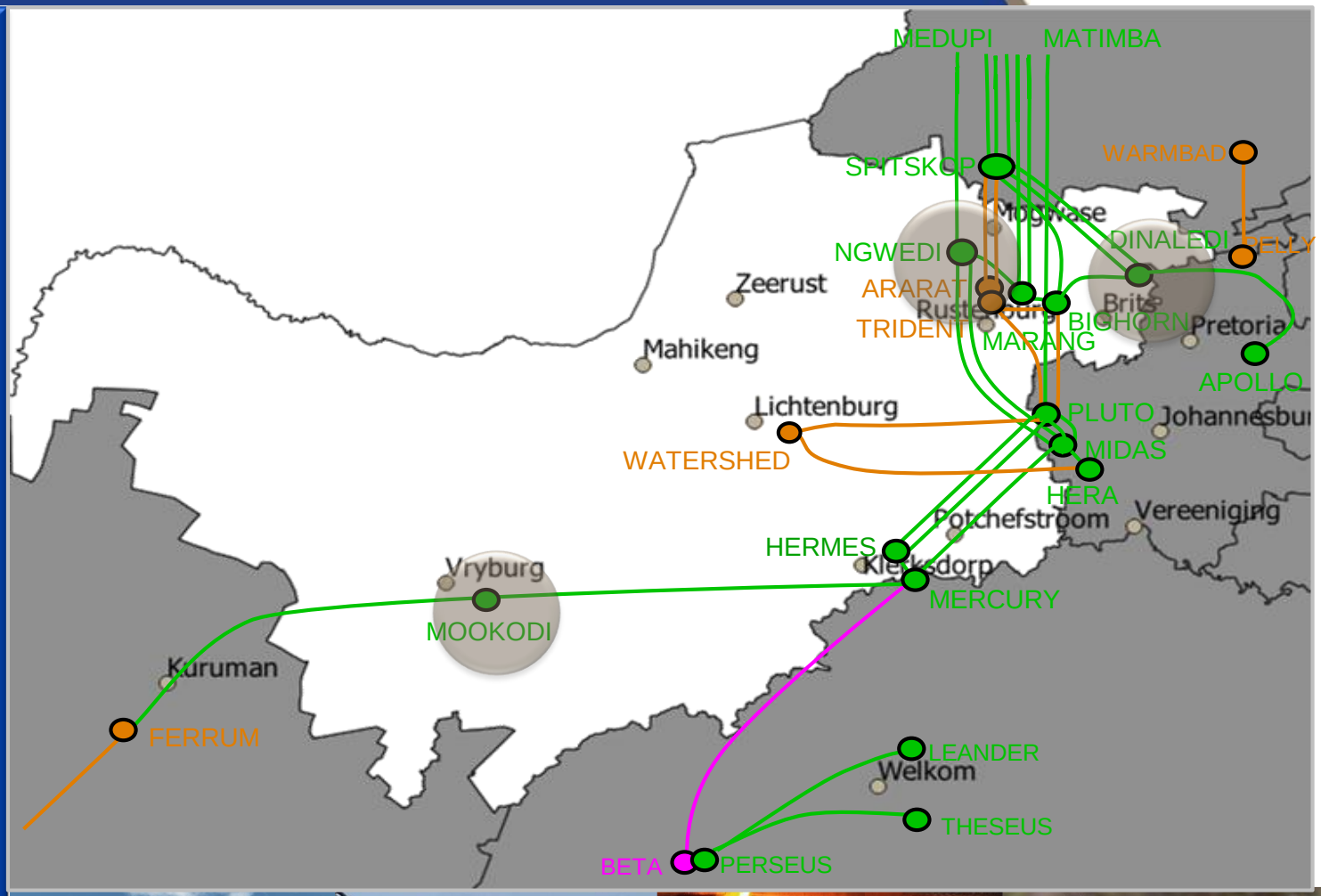
- **Approximately 0.75 GW**
  (10 year horizon)

- Mookodi Substation - **375 MW**
  - Approved 75 MW Waterloo Solar Park

- Watershed Substation - **375 MW**
  - Approved 75 MW Zeerust Solar Park

Completed Projects

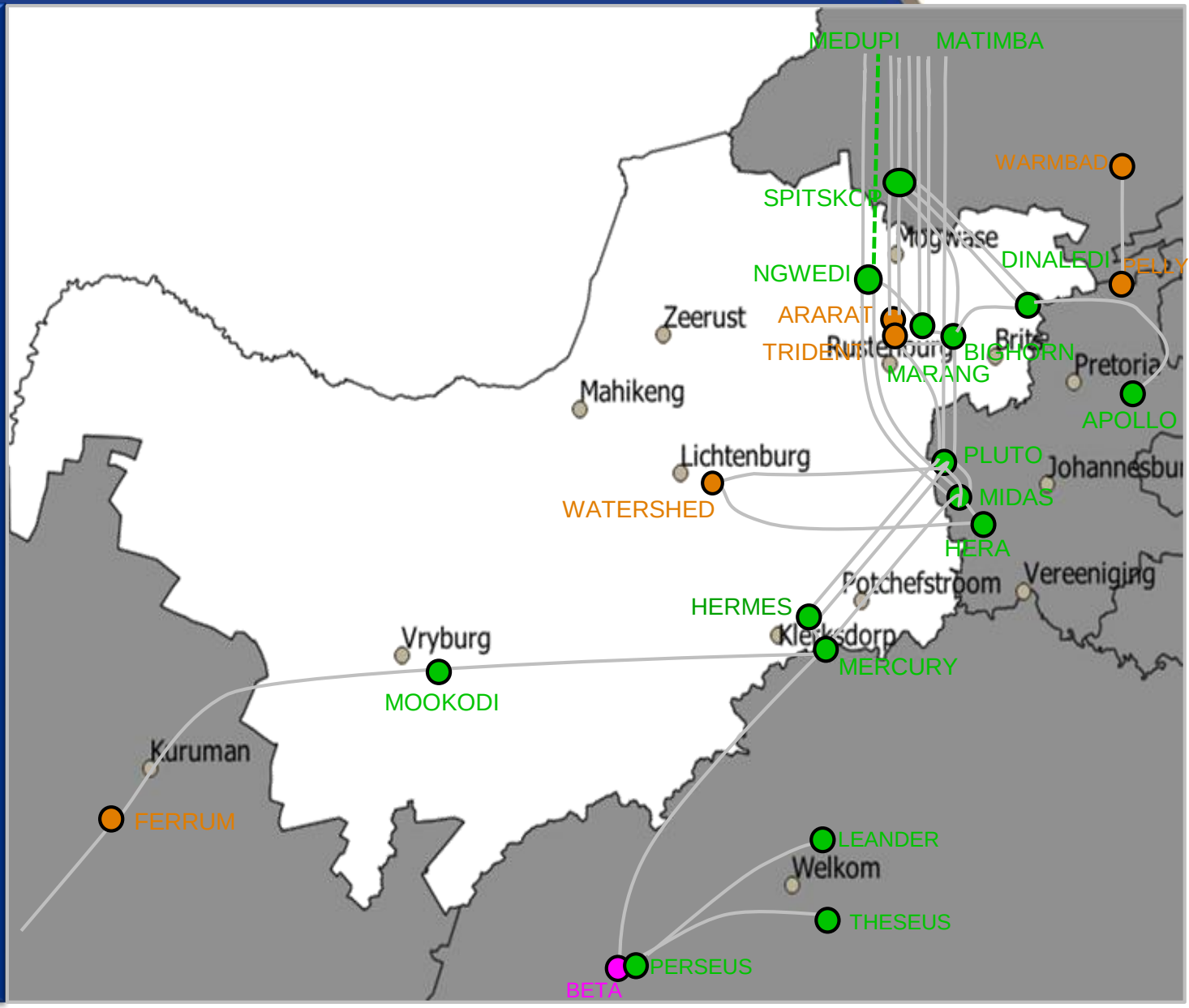
- **Mookodi Substation Integration**
- **Dinaledi 3rd transformer**
- **Ngwedi Substation integration**
- **Medupi-Ngwedi 400 kV line 1**





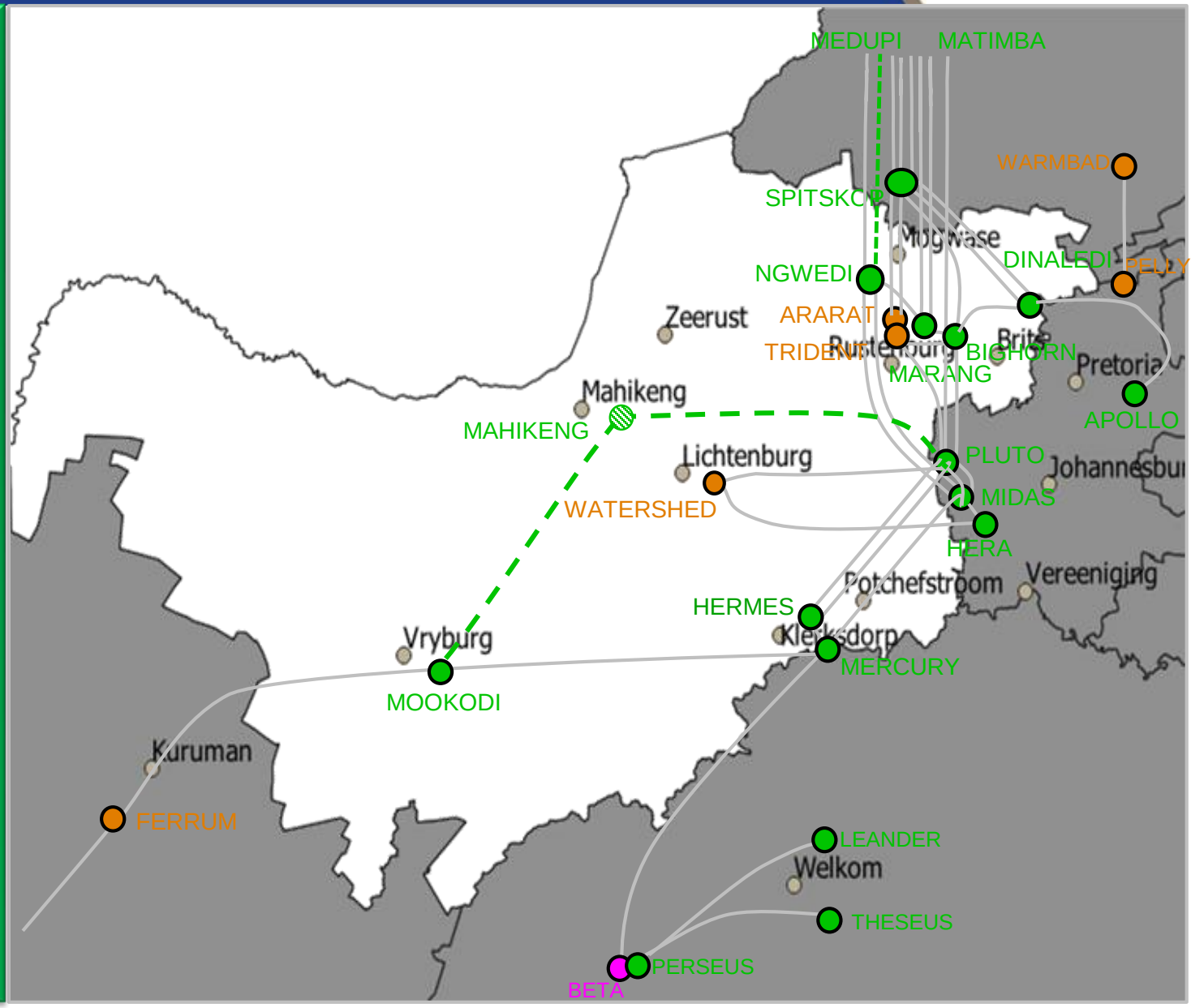

Developments in the Rustenburg CLN

- **Medupi-Ngwedi 400 kV line 2 (765 kV design)**
- **Bighorn Extension**
- **Rustenburg Reactive Compensation (Bighorn, Marang and Dinaledi)**



Developments in the Carletonville CLN

- **Watershed Strengthening**
- **Pluto-Mahikeng 400 kV line**
- **Mahikeng Substation**
- **Mookodi-Mahikeng 400 kV line**

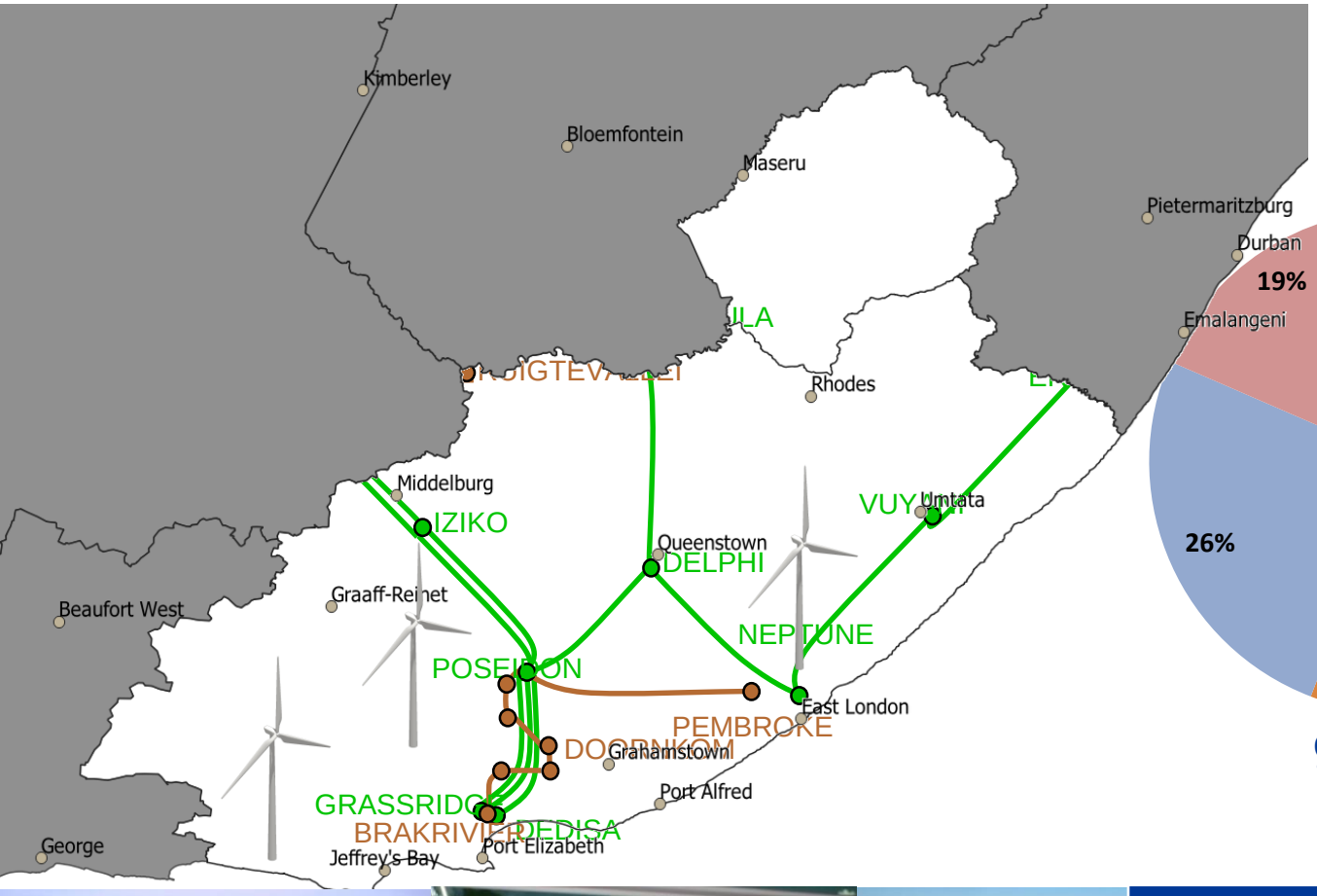


Questions?

Eastern Cape Province
TDP 2020 - 2029

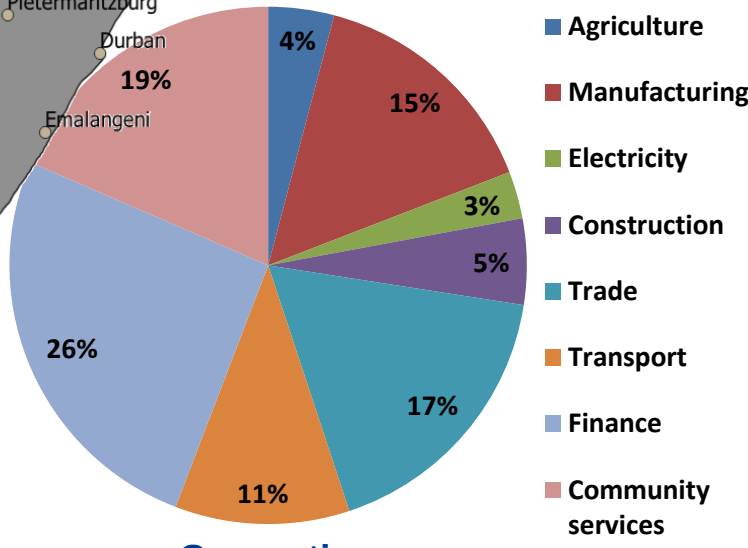
Presented by: Queen Melato
Chief Engineer

Eastern Cape Province Profile

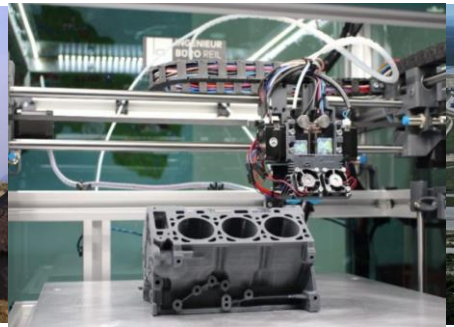


Load

Recorded Peak 1716 MW



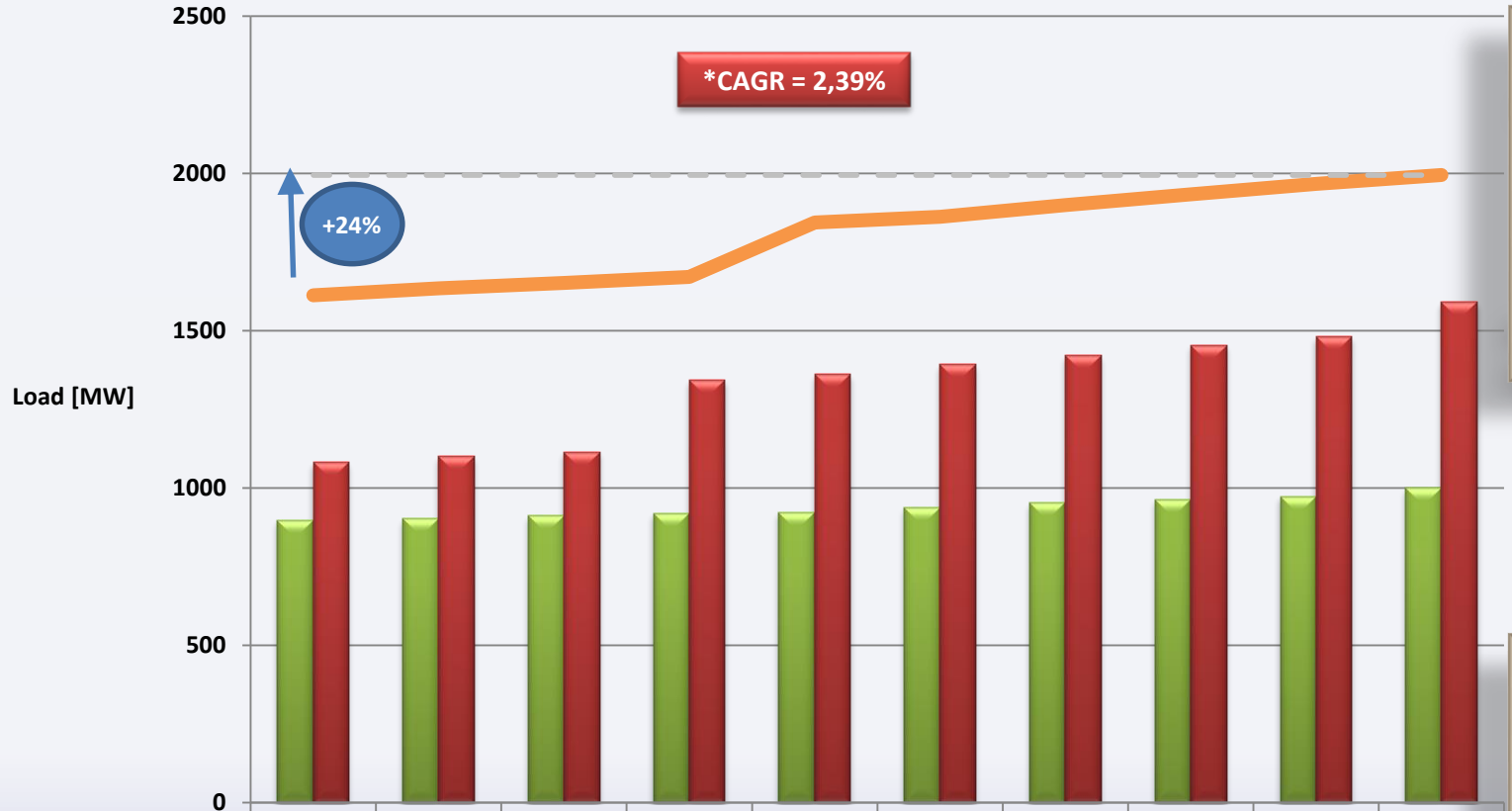
Generation



Type		Name	Output
Peaking	Gas	Port Rex	171 MW
		Dedisa	372 MW
RE IPP	Wind & Solar	All	~1083 MW
Total Installed Generation			**~1843 MW**

Eastern Cape Load Forecast 2020 - 2029

Eastern Cape Load Forecast



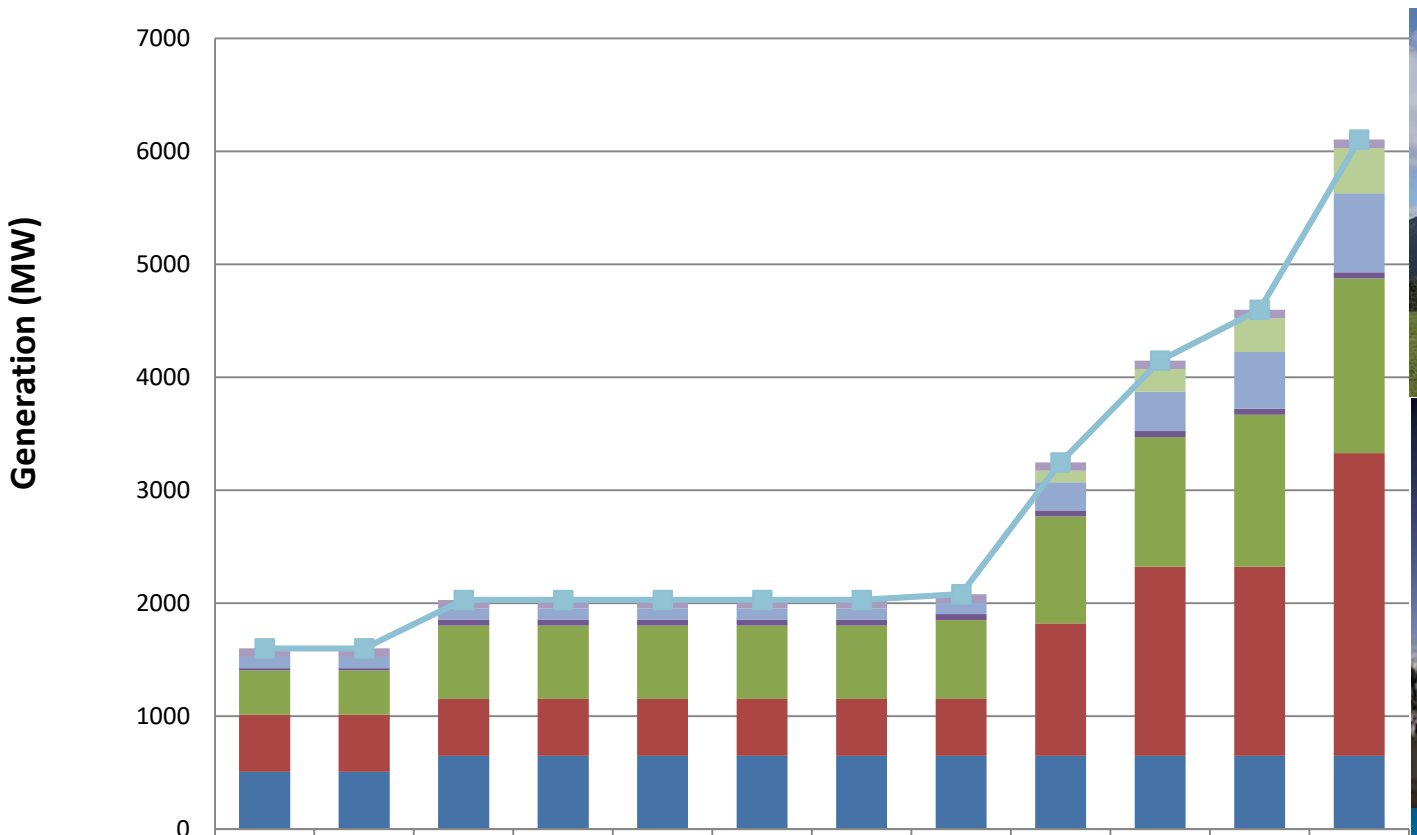
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
East London	898	903	912	920	924	939	953	964	973	1000
Port Elizabeth	1083	1100	1116	1343	1362	1393	1422	1453	1480	1590
Grid Peak	1613	1634	1652	1671	1844	1862	1899	1933	1967	1995
2029 Peak	1995	1995	1995	1995	1995	1995	1995	1995	1995	1995

Electrification Construction – Commercial Growth Agriculture, Forestry and Agro-Processing East London IDZ

Coega IDZ's – Petro/ Ferrochrome Smelter(s) Manufacturing – Auto Industry - Exports

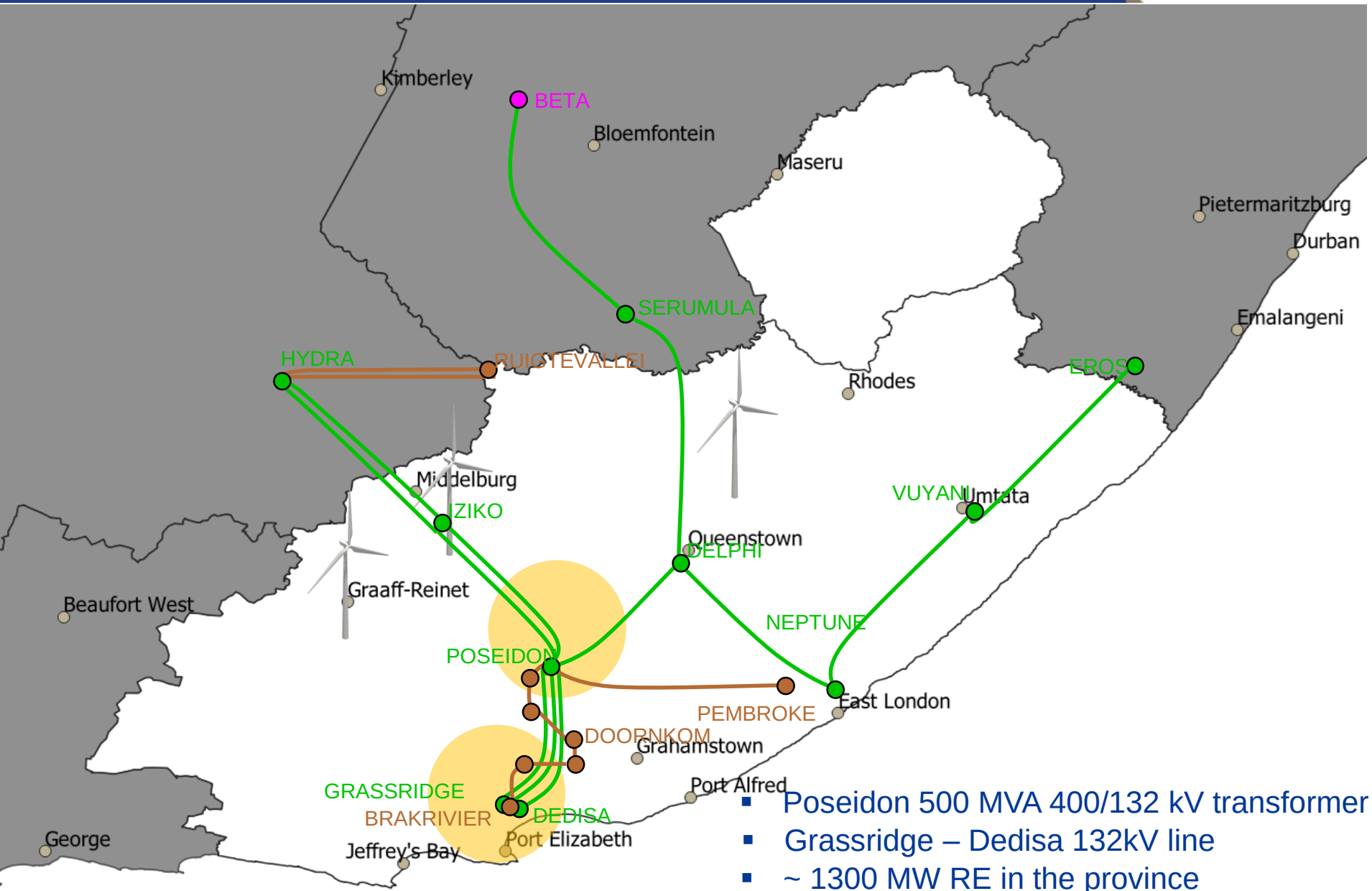
* Compound Annual Growth Rate

Eastern Cape Generation Forecast



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Ruigtevallei	75	75	75	75	75	75	75	75	75	75	75	75
Thuyspunt	0	0	0	0	0	0	0	0	100	200	300	400
Delphi	100	100	100	100	100	100	100	100	250	350	500	700
Pembroke	21	21	54	54	54	54	54	54	54	54	54	54
Poseidon	390	390	646	646	646	646	646	696	946	1146	1346	1546
Dedisa	506	506	506	506	506	506	506	506	1173	1675	1675	2680
Grassridge	509	509	649	649	649	649	649	649	649	649	649	649
Year Total	1601	1601	2030	2030	2030	2030	2030	2080	3247	4149	4599	6104

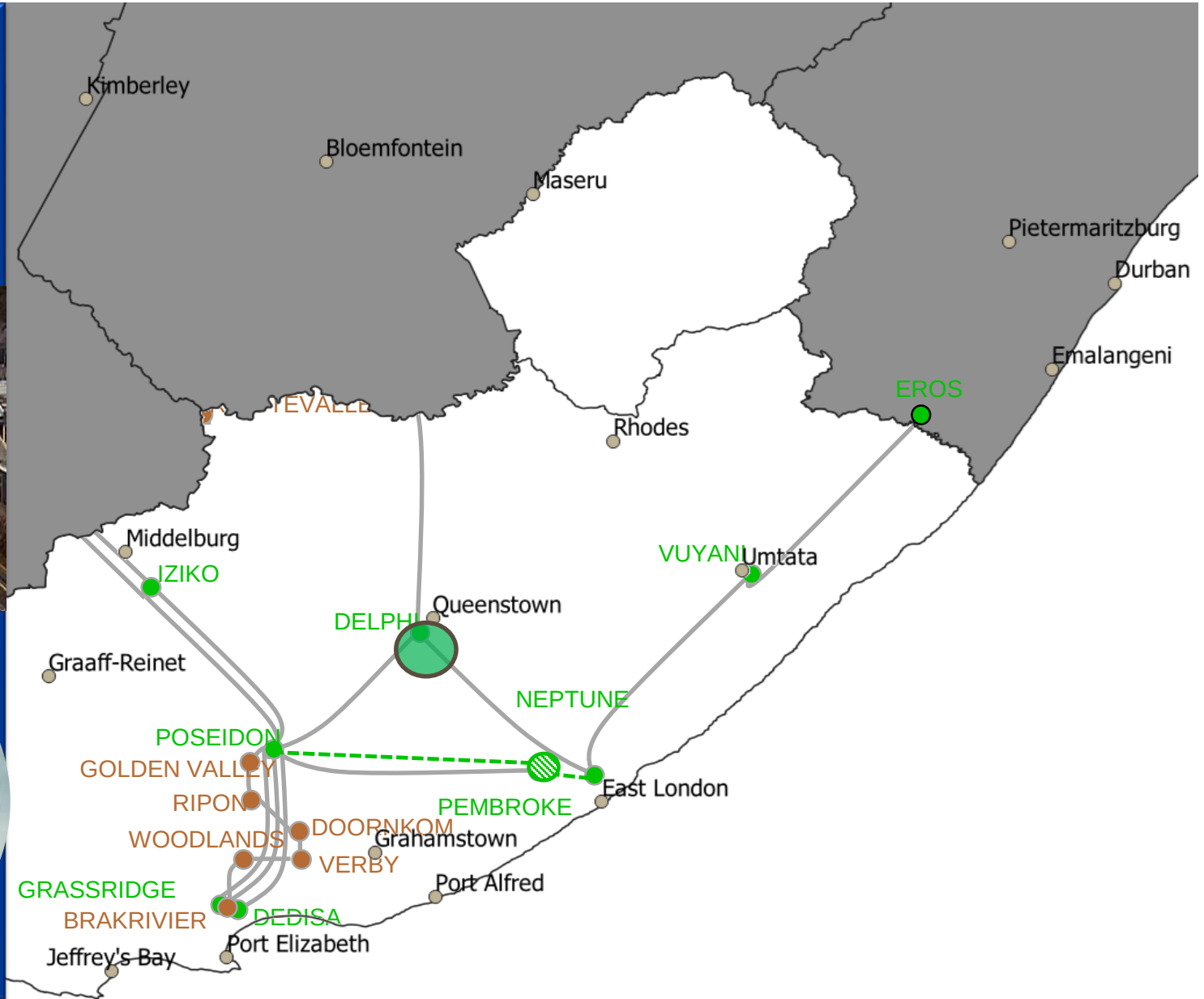
Developments and completed projects (2016 – 2018)



- Poseidon 500 MVA 400/132 kV transformer
- Grassridge – Dedisa 132kV line
- ~ 1300 MW RE in the province

Key projects in the East London area

- **Pembroke 400 kV Integration**
- **Delphi 1st 500 MVA Transformer**



Key Projects in the Port Elizabeth CLN

- **Dedisa 3rd 500 MVA Transformer**
- **Grassridge 3rd 500 MVA Transformer**
- **Gamma-Grassridge 1st 765 kV line**
- **Thyspunt Wind**

Kimberley
BETA
Bloemfontein
Maseru
Pietermaritzburg
Durban
SERUMULA
Emalangeni
HYDRA
RUIGTEVALLEI
EROS
Rhodes
GAMMA
Middelburg
VUYANI
Umtata
IZIKO
Queenstown
DELPHI
Graaff-Reinet
NEPTUNE
POSEIDON
East London
GRASSRIDGE
Grahamstown
Port Alfred
DEDISA
Thyspunt
Port Elizabeth
Jeffrey's Bay

Questions?

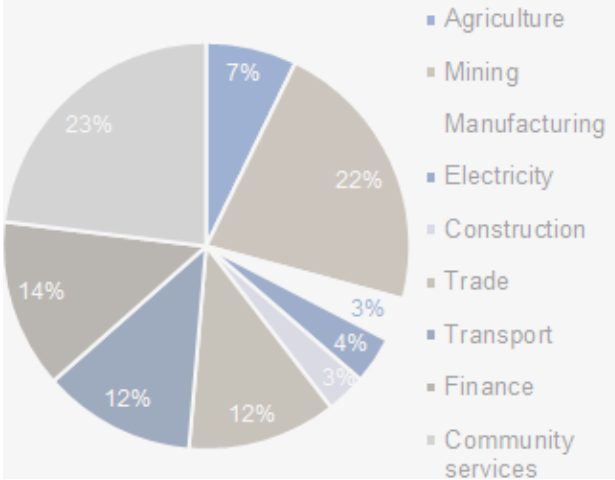
Northern Cape Province
TDP 2020 - 2029

Presented by: Ahmed Hansa
Chief Engineer

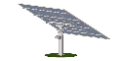
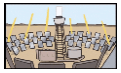
Northern Cape Province Profile

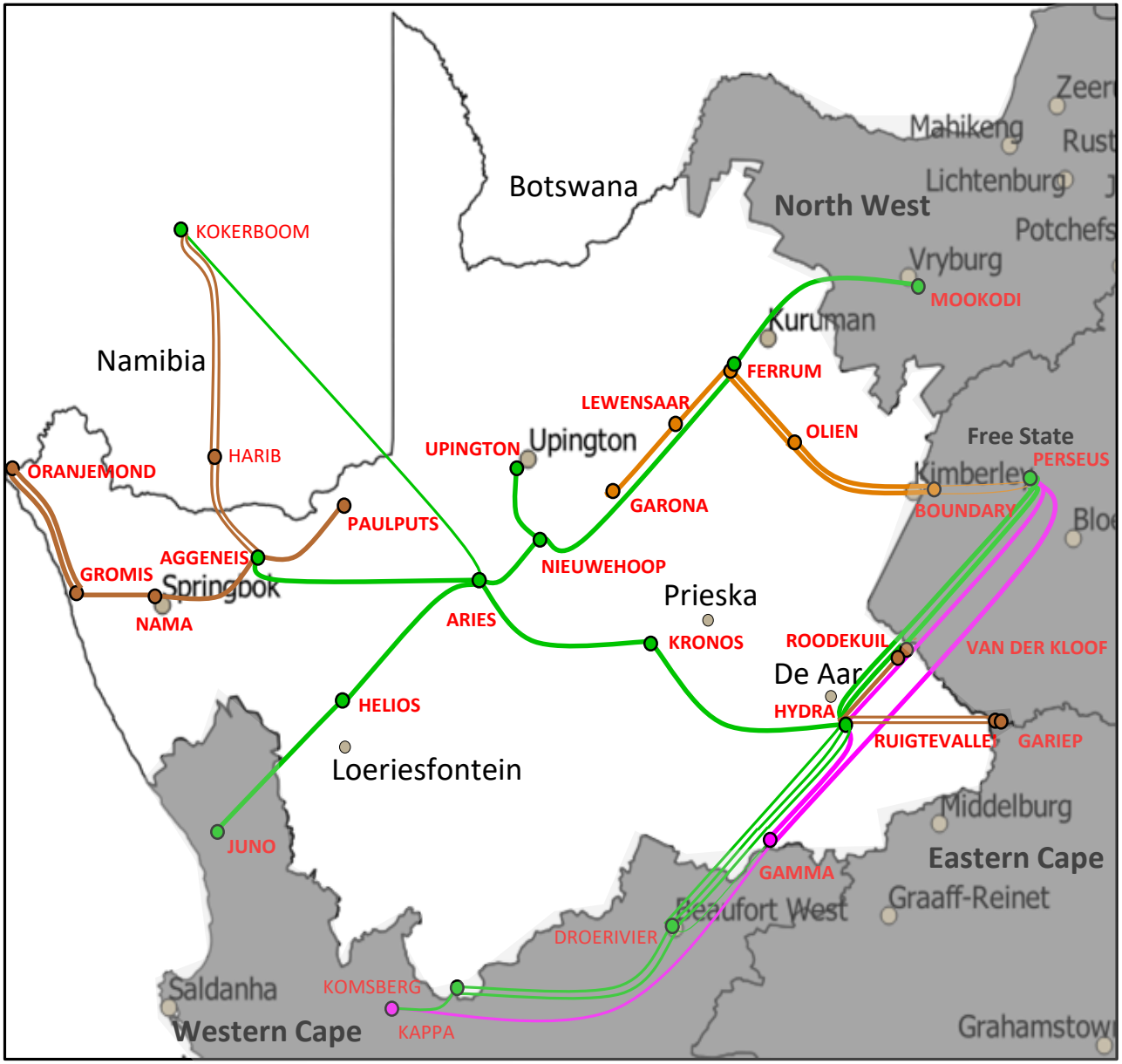
LOAD

- Peak load of ~1100 MW in 2018



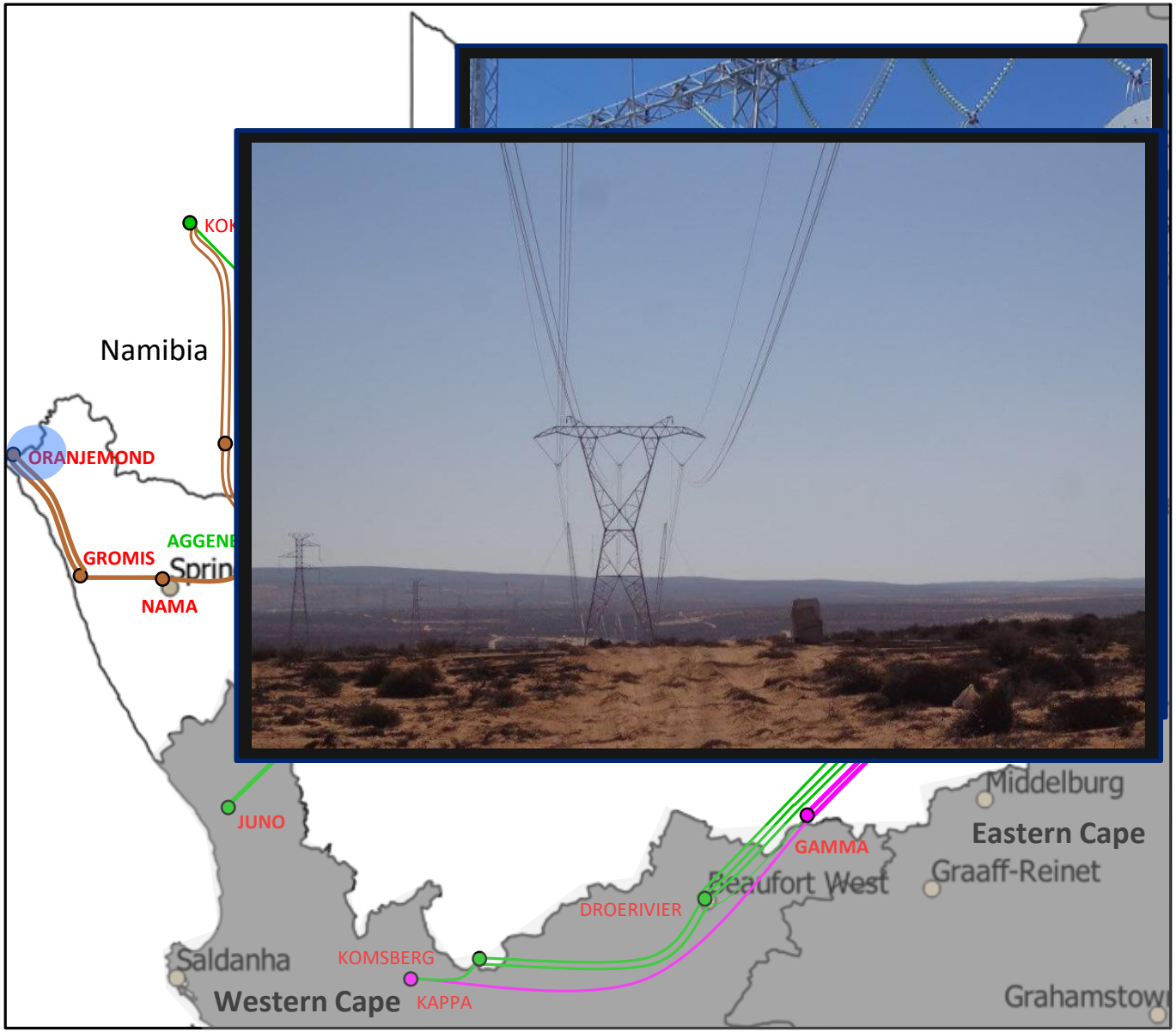
GENERATION

	Van der Kloof	240 MW
	Gariep	340 MW
	Eskom Total	**600 MW**
	PV	1083 MW
	CSP	600 MW
	Wind	665 MW
	Small Hydro	10 MW
	REIPP Total	**2358 MW**

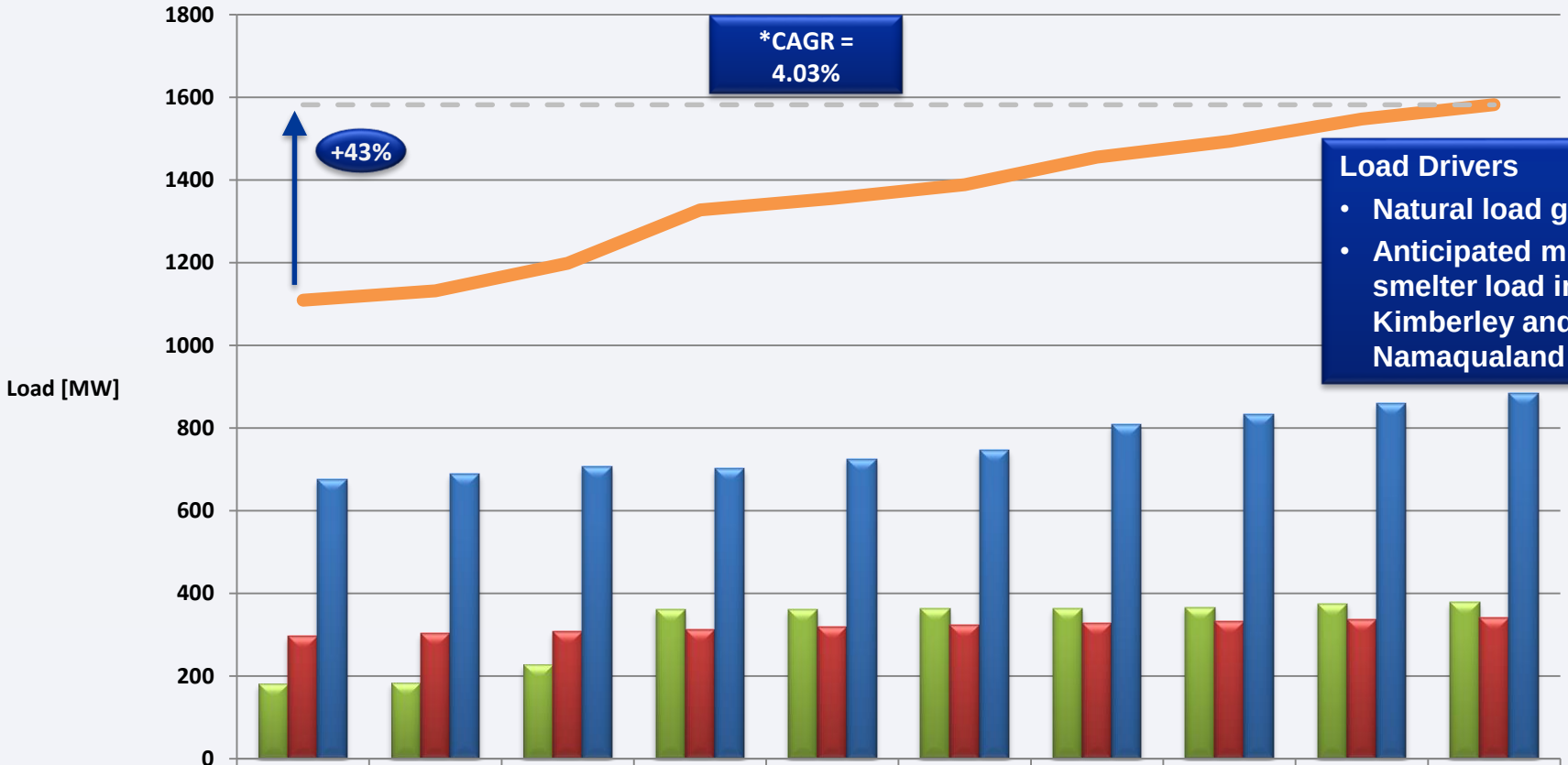


Completed Projects

- **Gromis-Oranjemond 2nd 220 kV line (built at 400 kV)**
- **Paulputs 2nd transformer 250 MVA 220/132 kV**



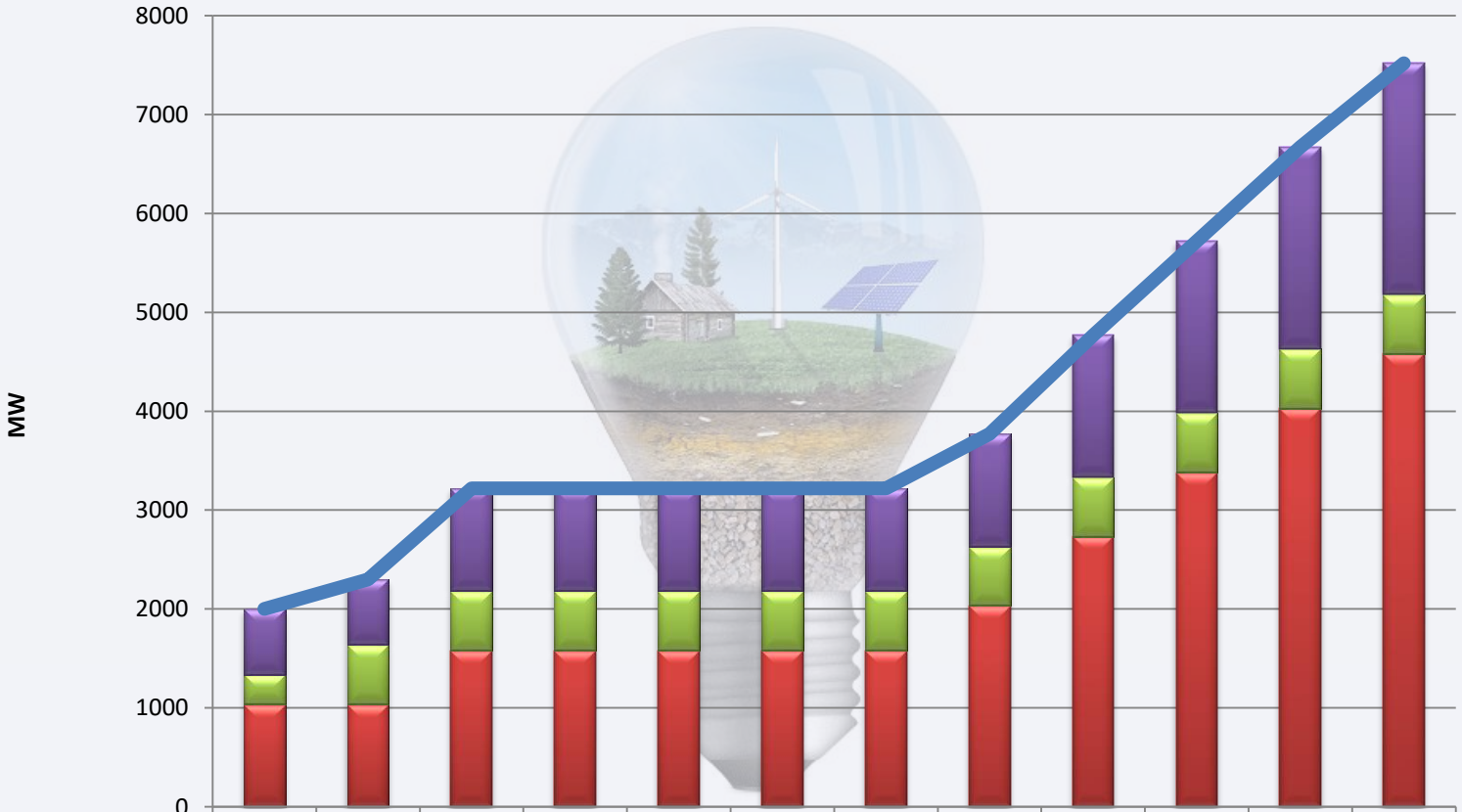
Northern Cape Province Load Forecast



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

* Compound Annual Growth Rate

Northern Cape Province Renewable Energy Generation Forecast

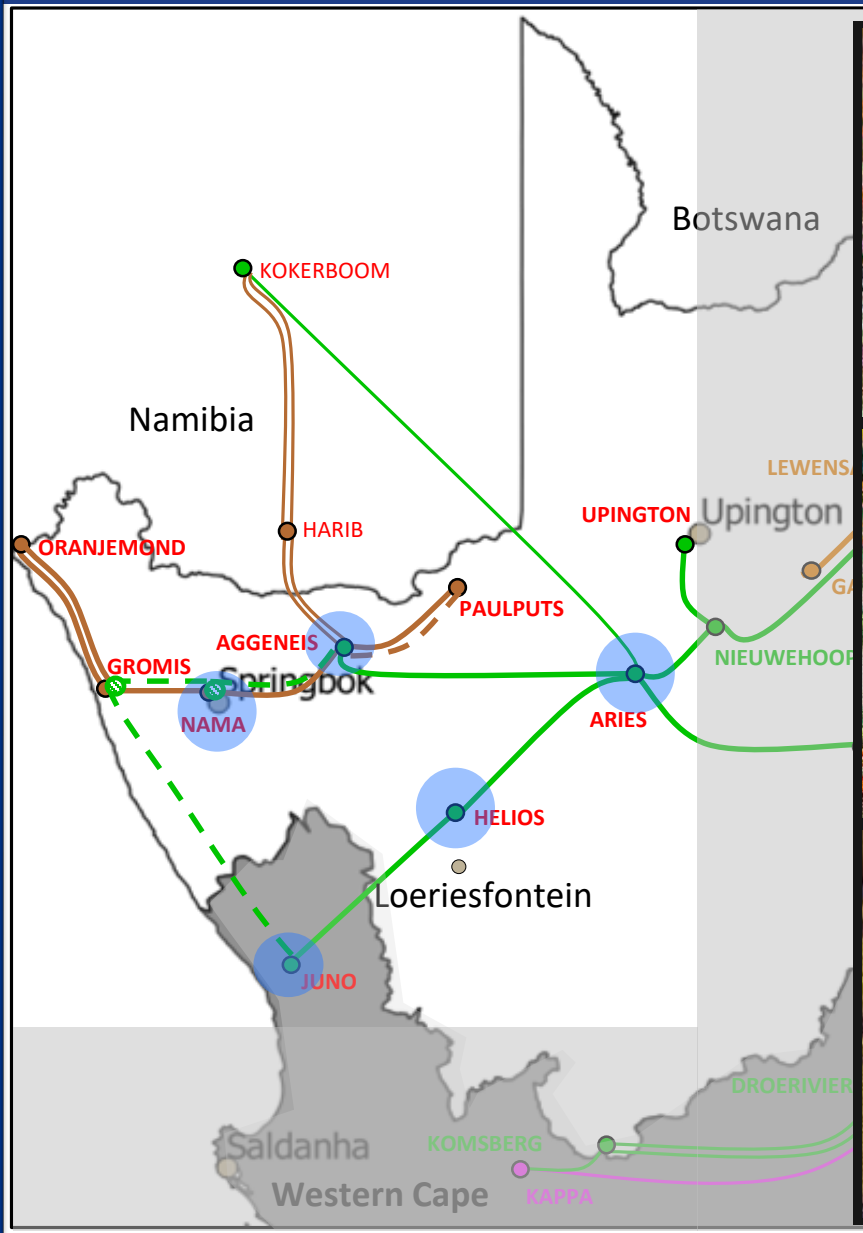


	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Wind	665	665	1040	1040	1040	1040	1040	1140	1440	1740	2040	2340
CSP	300	600	600	600	600	600	600	600	600	600	600	600
PV	1035	1035	1580	1580	1580	1580	1580	2030	2730	3380	4030	4580
Cumulative Total	2000	2300	3219	3219	3219	3219	3219	3769	4769	5719	6669	7519

Transmission Development Plan

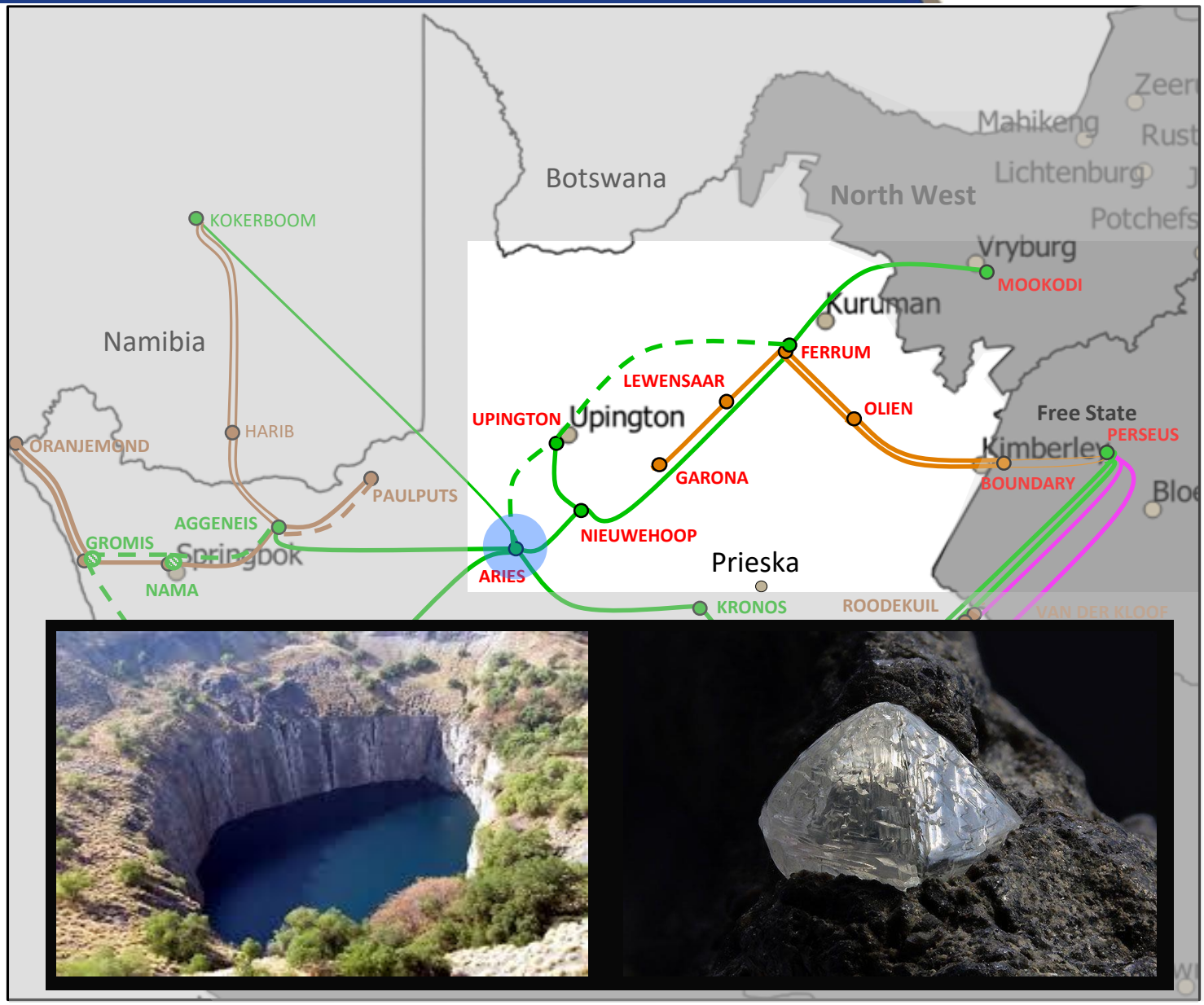
Developments in the Namaqualand CLN

- **Juno-Gromis 400 kV line and Gromis 500 MVA 400/220 kV transformer**
- **Nama 20 MVA 66/22 kV transformer**
- **Aries SVC device**
- **Helios 20 MVA 132/66 kV transformer**
- **Gromis-Nama-Aggeneis 400 kV line**
- **Aggeneis-Paulputs 2nd 220 kV line (built at 400 kV)**



Developments in the Kimberley CLN

- **Aries-Upington 400 kV line**
- **Upington-Ferrum 400 kV line**



Developments in the Karoo CLN

- **Ruigtevallei 10 MVA 132/22 kV transformer**
- **Derate Hydra-Ruigtevallei 220 kV line to 132 kV**
- **Hydra-Roodekuil 132 kV line strengthening**

Questions?

Western Cape Province
TDP 2020 - 2029

Presented by: Ahmed Hansa
Chief Engineer

Western Cape Province Profile

Transmission Network

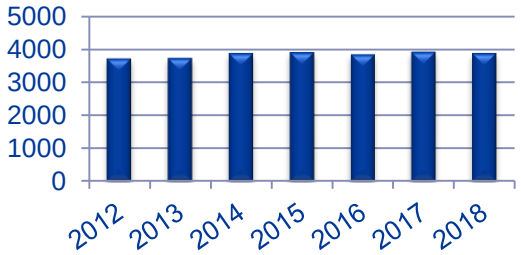
- 400 kV: 2 783 km
- 765 kV: 546 km

- 12 Substations
- 44 Transformers
- 14 045 MVA (installed)
- 5 470 MVA (firm)

CLNs

- Outeniqua
- Peninsula
- West Coast

Load



- Peak load of 3890 MW on 28th May 2018

- Reduction in industrial demand, for example, Mossgas
- Introduction of small scale embedded generation (SSEG)
- Warmer winters
- Household energy efficiency through energy efficient appliances, CFL / LED lighting and solar geysers

Existing generating facilities in the Western Cape

Eskom Power Stations		
Acacia	19	171 MW
Ankerlig	21	1 327 MW
Gourikwa	22	740 MW
Koeberg	5	1 830 MW
Sere	23	100 MW
Palmiet	18	400 MW
Total		**4 568 MW**

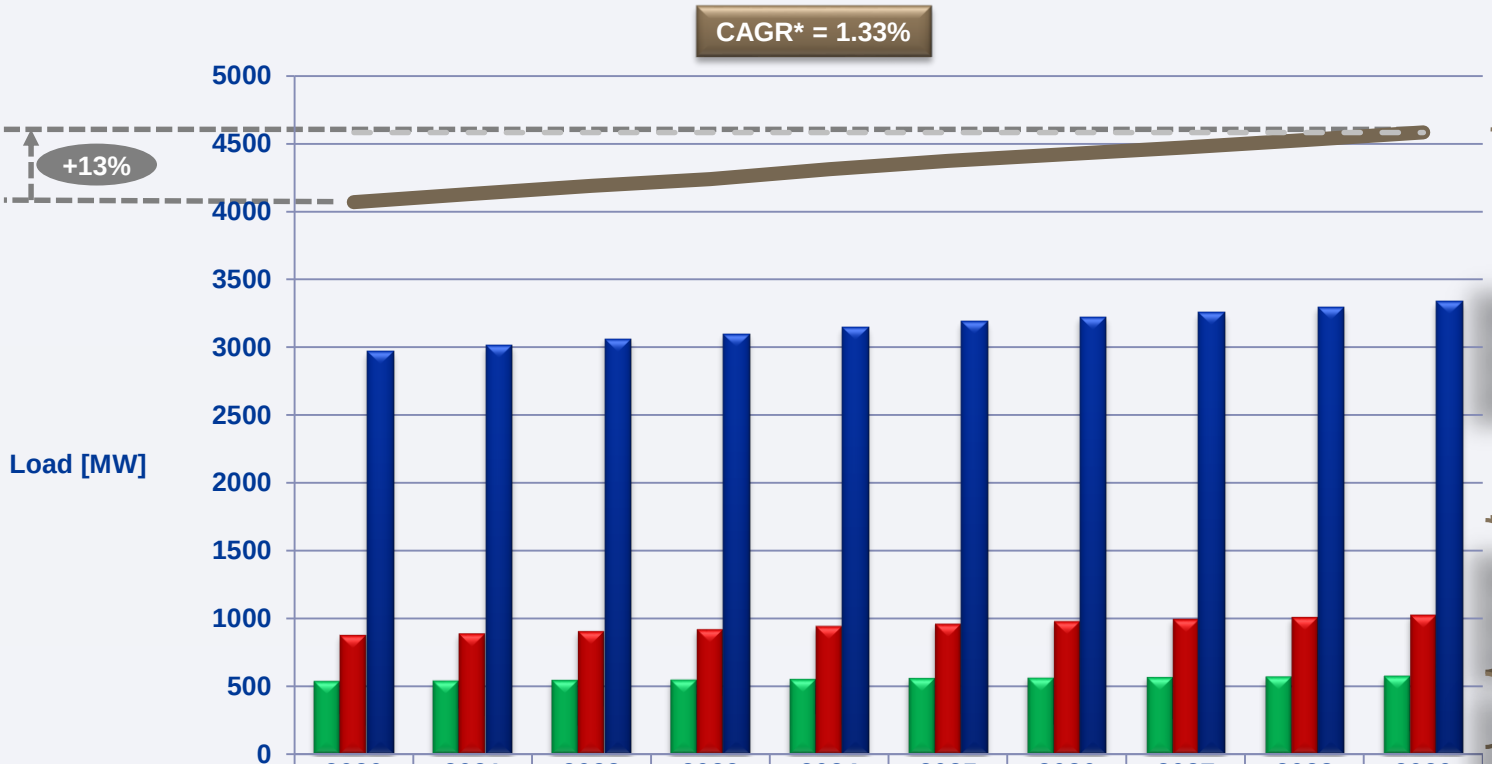
RE IPPs		
PV		134 MW
Wind		316 MW
Total		**450 MW**

City of Cape Town	
Total*	**258 MW**

*excludes small scale embedded generation (SSEG)

Load Forecast

Western Cape Load Forecast



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

Residential, commercial and light industrial load growth

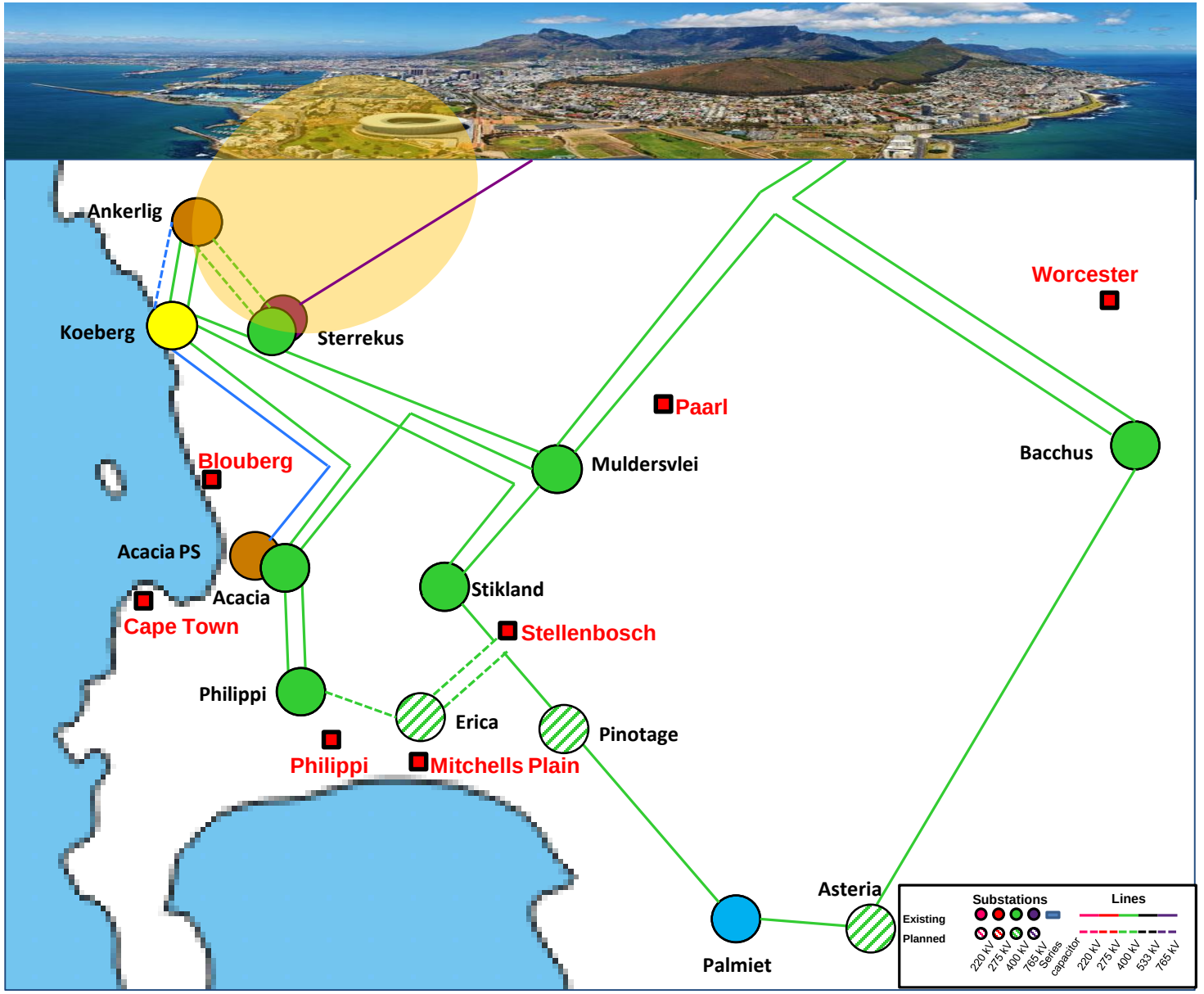
Natural load growth and residential developments

Load growth due to the Saldanha Bay IDZ

* Compound Annual Growth Rate

Developments in the Peninsula CLN

- Ankerlig-Sterrekus 1st and 2nd 400 kV lines
- Relocate Koeberg offsite supply to Ankerlig
- Koeberg-Acacia 2nd 400 kV line
- Erica Substation
- Pinotage Substation

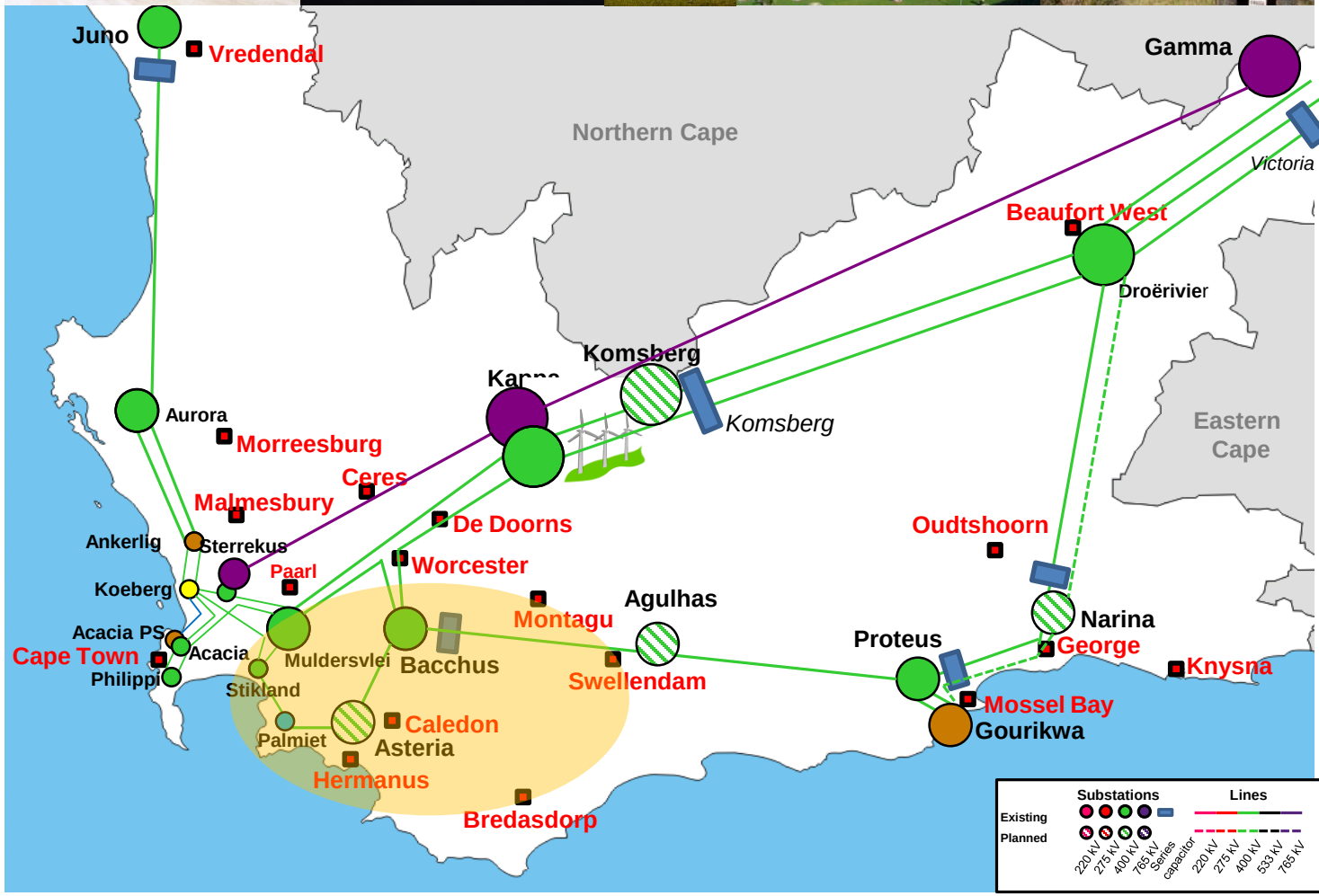


Pinotage Substation – under construction

Photo Credits –Grant Duncan Smith (http://www.subiaco.co.za)

Developments in the Outeniqua CLN

- Asteria Substation
- Agulhas Substation
- Kappa 400/132 kV transformation
- Komsberg 400/132 kV Substation
- Narina Substation
- Gourikwa-Narina-Droërivier 400 kV line – Strategic EIA



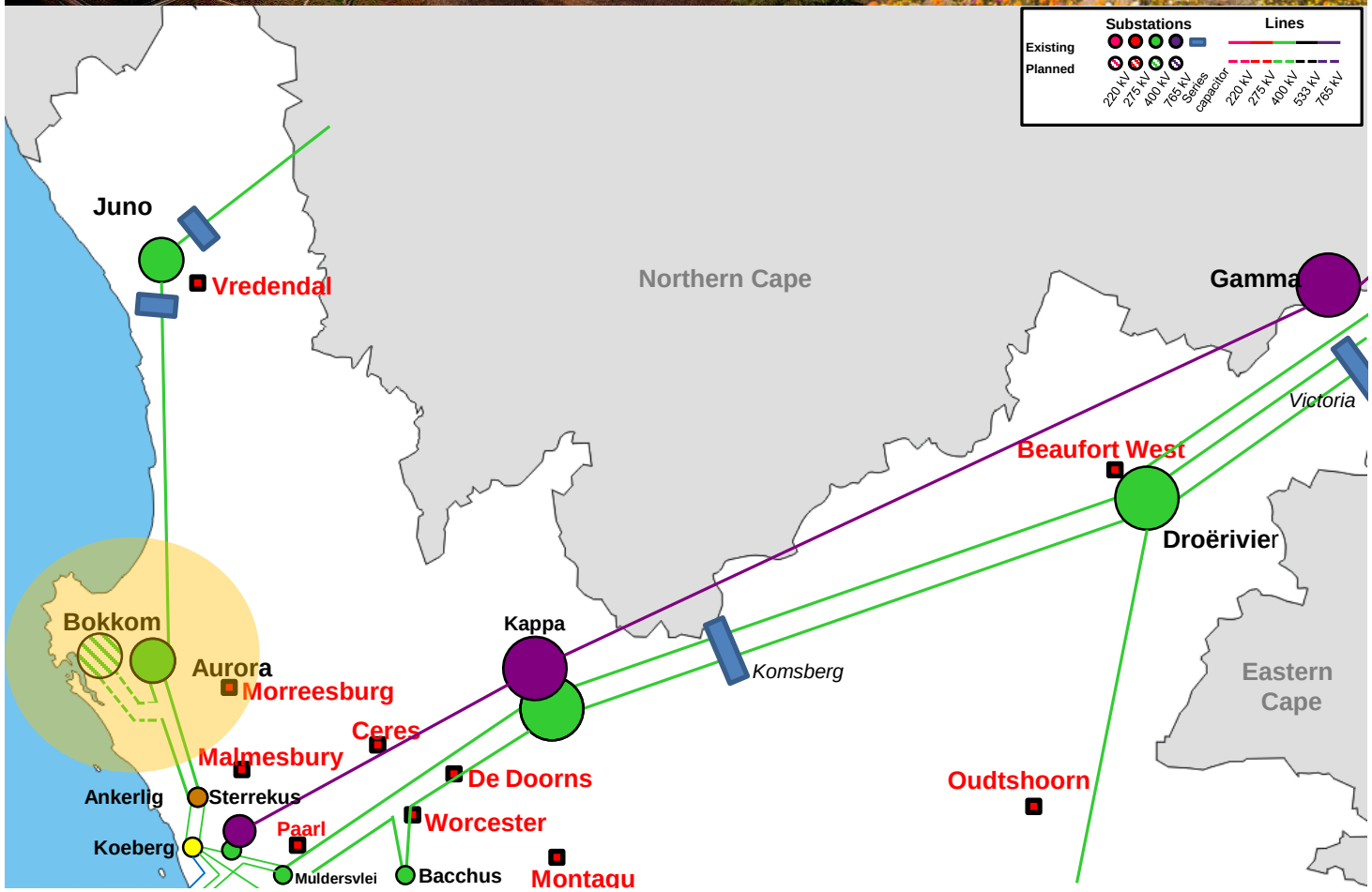
Komsberg Substation – under construction

(Photo Credits –Armien Edwards)

Developments in the West Coast CLN

- Aurora transformation upgrade
- Bokkom Substation (Phase 1)
- Juno transformation upgrade
- PCB series cap phase out plan





Questions?

Eskom Transmission Refurbishment Plan 2020 - 2029

By: Atha Scott
Senior Manager: Asset Investment Planning

Presentation Overview

The purpose of this presentation is to provide an overview of Transmission asset replacement planning and sustainability requirement to ensure the renewal and optimisation of our existing assets as well as the stability of the network.

Contents

- Asset Management Framework
- Transmission Network Refurbishment Plan (TNRP) Development
- Transmission System Sustainability
- Asset Condition Assessment
- Grid Refurbishment Plans
- Conclusion

Transmission Asset Management Framework

Regulatory, Stakeholder and Legal requirements

Transmission Operational Plan

Eskom Asset Management Policy

Performance and Condition monitoring

Asset Management Framework
ISO 55001

Asset Creation

Transmission Refurbishment Standard

Transmission Refurbishment Investment Prioritisation Procedure

Asset :
- **Specifications**
- **Standards**
- **Procedures**
- **Manuals**

Operations Requirements

Maintenance Processes and Procedures

Asset Life Cycle Plan

Asset Condition Monitoring

Performance Monitoring

Transmission Asset Base (HV Plant, Secondary Plant, Lines)

CREATE
- -Transmission Development Plan

OPERATE & MAINTAIN
- -Transmission Operational Plan
- -Transmission Maintenance Plan

RENEW / REPLACE
- - Transmission Refurbishment Plan
- -Transmission Sustainability Plan

Transmission Refurbishment Plan

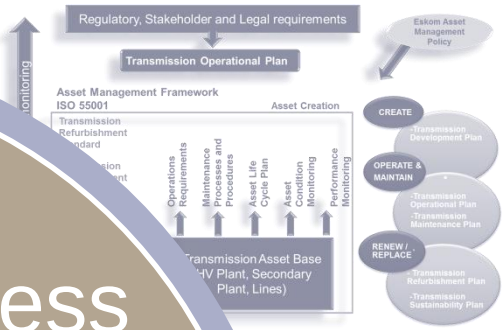
- Sustainability Plan
- 10 Year Refurbishment Plan
- Project Evaluation and Prioritisation

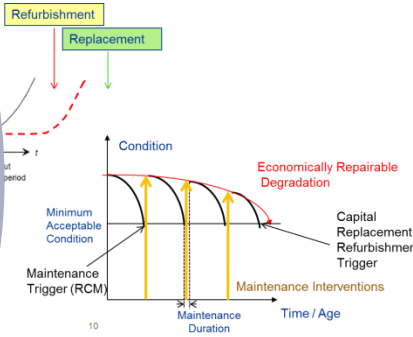
Planning

- **Condition**
- **Criticality**
- **Performance**
- **Risk**

Process

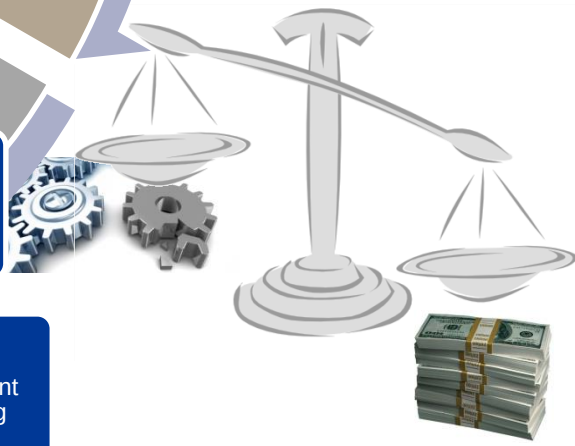
Balance between Reliability, Cost and Income





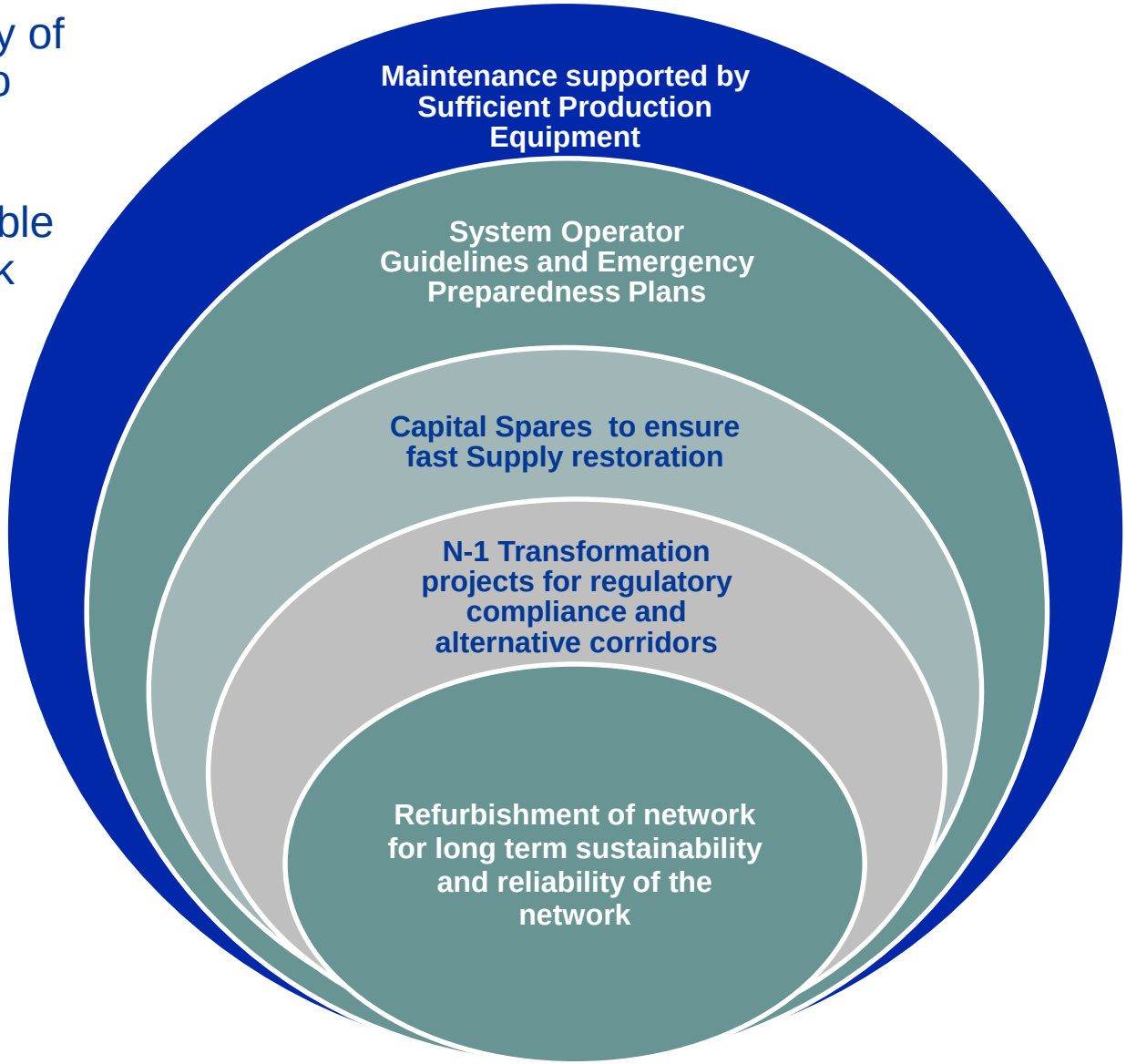
Assessment

- Technology Appraisal Reports and LCMP (Strategy)
- Grid Operation and Maintenance
- Performance Management
- Asset Health Assessment Index
- Asset Investment Planning



Network Sustainability Framework

To maintain continuity of supply, compliance to Statutory Network requirements and support of a sustainable Transmission network

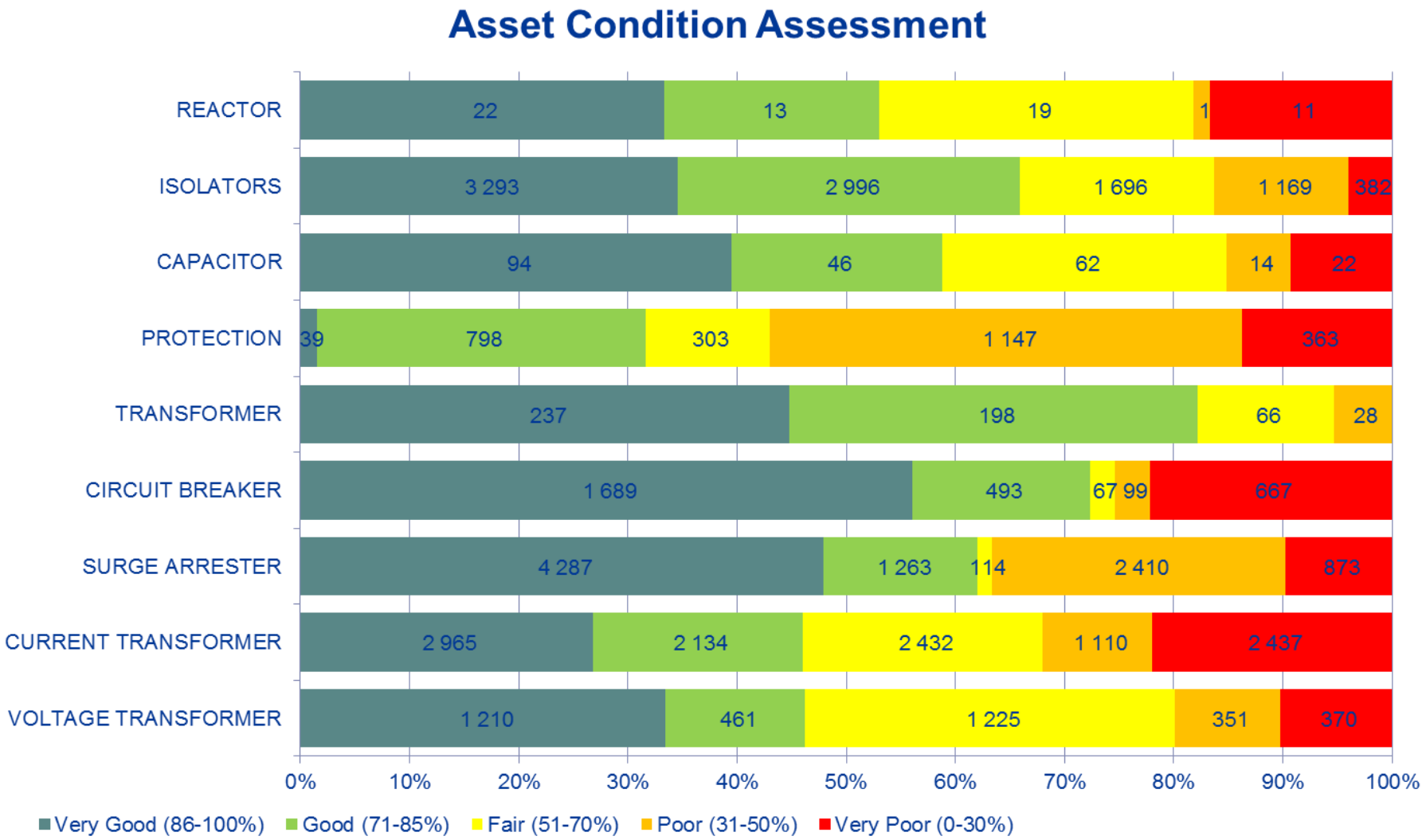


Key Focus Areas in Sustainability

1. **Sustain** existing good performing areas
   - ✓ Maintenance Plan Execution
   - ✓ Enhanced Human Performance
2. **Refurbishment -** replacement of high risk plant
3. **Improve**
   - ✓ Line and Equipment Performance
   - ✓ Plant Availability
   - ✓ Restoration response
4. **Manage** operational risks effectively
   - ✓ Outage scheduling, planning, management of obsolete equipment and execution risk management
5. **Effective** inspections, condition assessment & defect risk analysis and defects management

Ageing assets and potential declining plant health may impact future system performance. An active replacement strategy is utilised to manage performance and to avoid an extensive end of life asset replacement and plant failures.

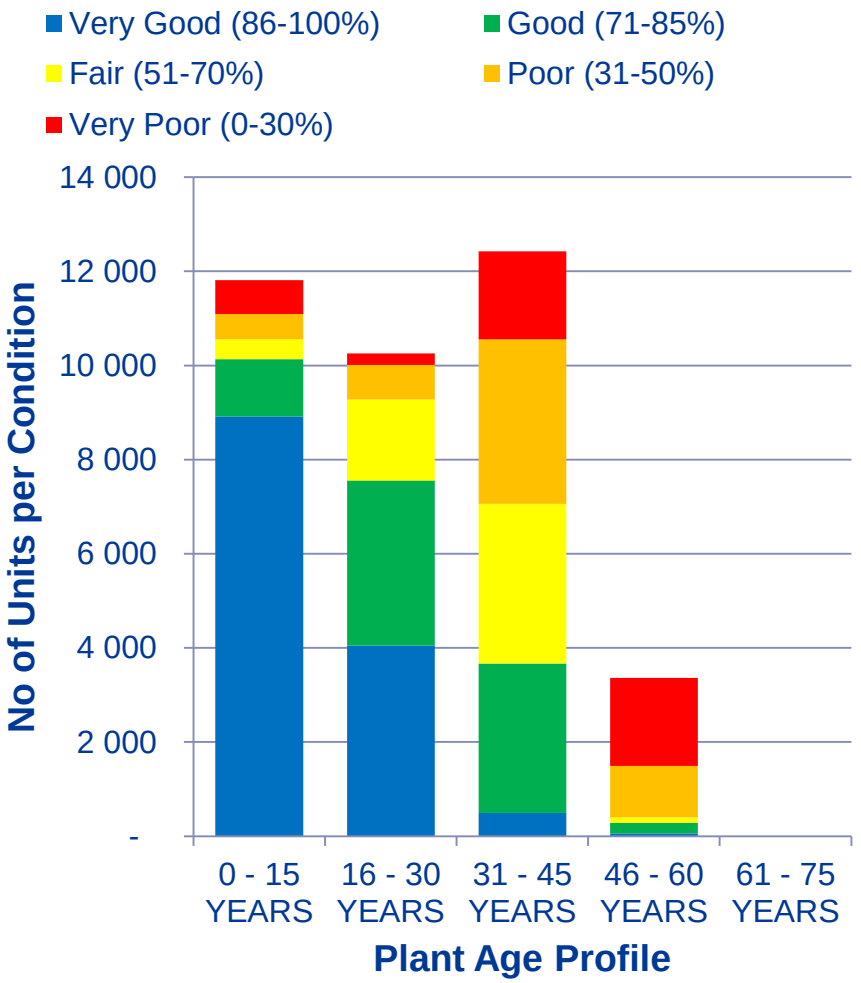
Asset Condition Assessment – Main asset classes



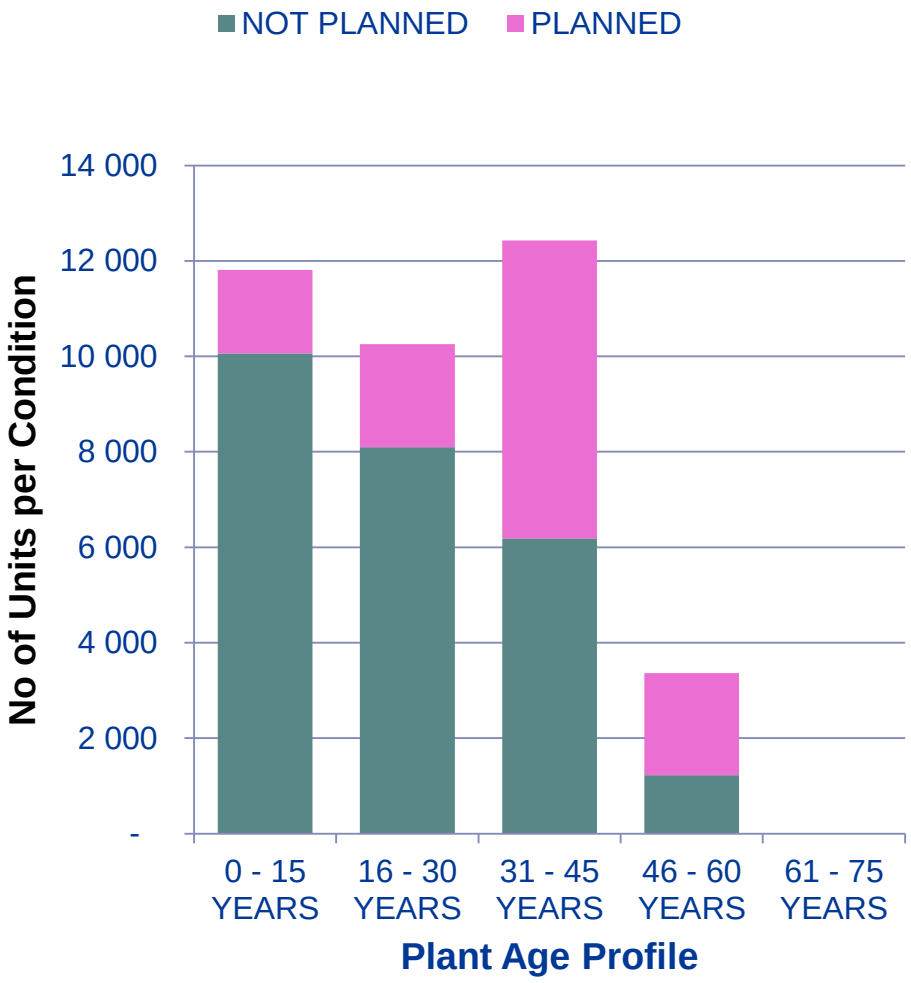
National View

Asset Condition Assessment and Plan

Plant Age & Condition Profile



Planned for Replacement



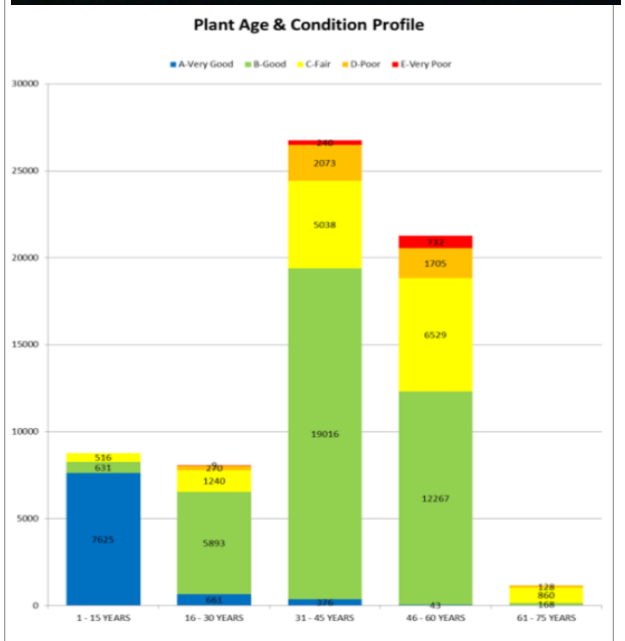
Replacement Strategies for high impact and value assets

- The Transformer asset strategy is a combination of:
  - replacement of high risk units,
  - synergies with substation refurbishments
  - risk mitigation covered by sufficient levels of strategic spares and effective contingency plans in place for un-firm stations.
  - Technology improvements
- Replacement of high risk circuit breakers that have become unreliable and/or exhibit poor performance are expedited via equipment specific projects.
- Protection asset replacement criteria is based on equipment failure rate, performance, functional importance and age.
- Incorporate identified assets into substation refurbishment projects
- Life extension interventions and maintenance programs are to be implemented on the balance of assets not catered for on the current refurbishment plan to mitigate the risk of failure.
- The spares holding levels are aligned with prevailing network failure rates and capital constraints impacting on the implementation of the refurbishment plan.

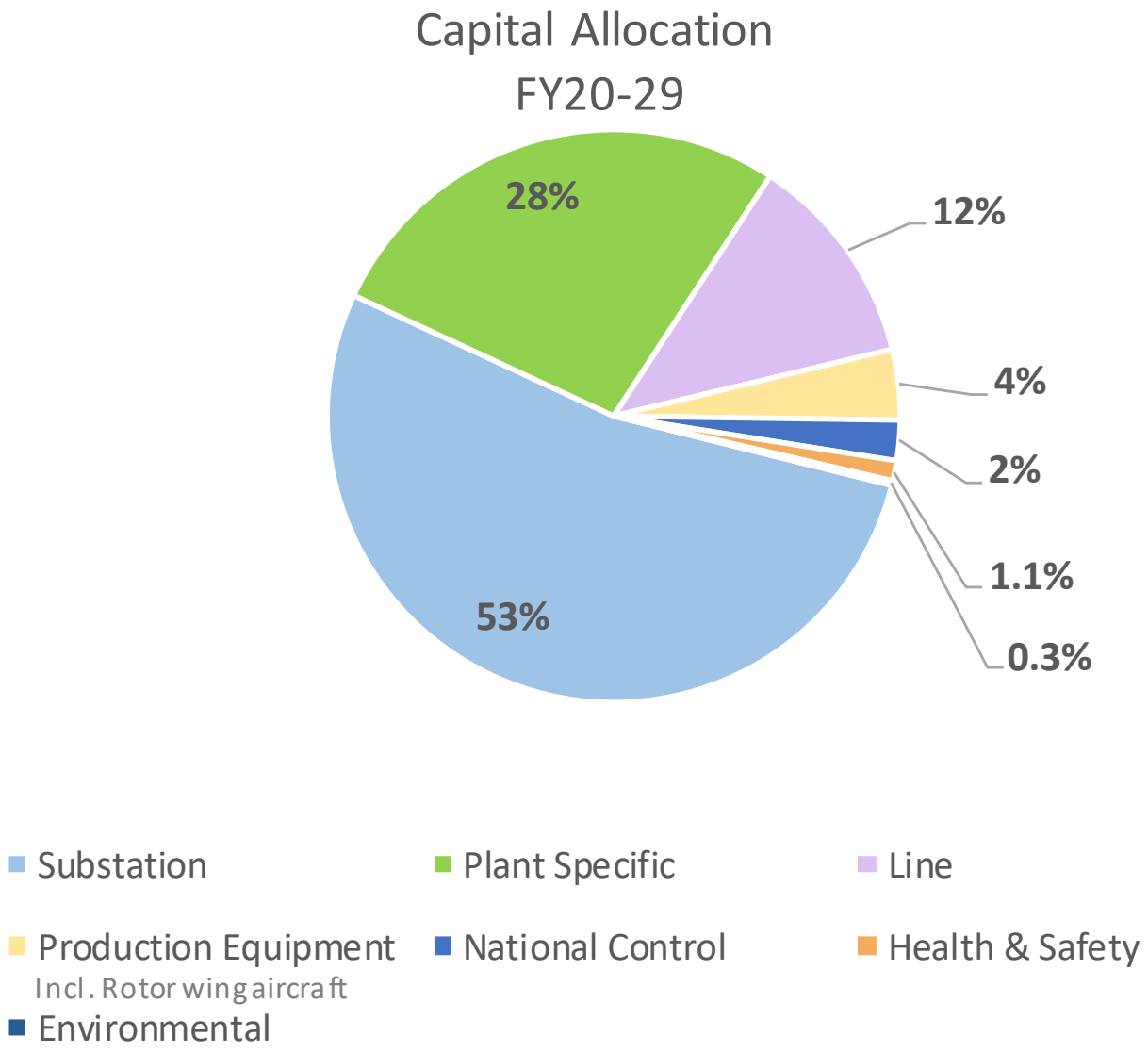
Overhead Lines Refurbishment Strategy

Lines Asset Strategy (installed asset base of 32 721km) entails:

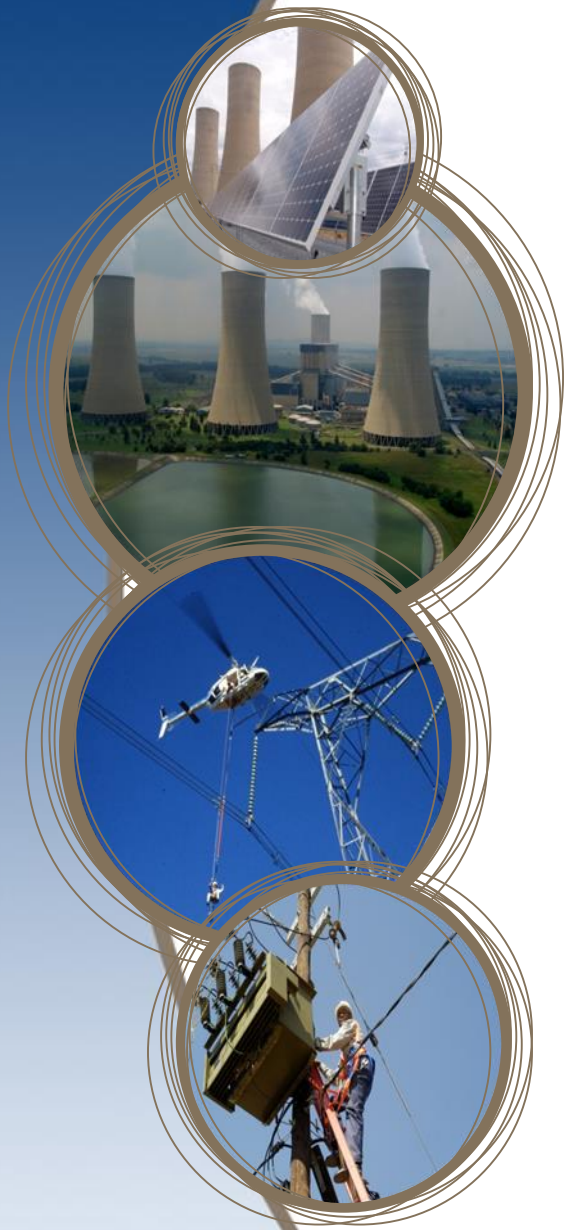
- Transmission Overhead Lines are **heavily influenced by the environment that they operate in** and their performance and condition is susceptible to the elements. Although they are mechanical structures, they are not affected by wear and tear as much as the substation equipment and thus have a much higher longevity than that of substation equipment.
- A rigorous maintenance program is followed. From detailed inspections, periodic maintenance addresses the identified defects, to restore the line to the initial design specification.
- Design parameters have changed **to cater for climate and technology changes**. Past design and construction practices have resulted in limitations and these are rectified through a refurbishment program. Refurbishment program includes:
  - Replacement of insulators
  - Corroded steel lattice members
  - Bare guy-anchor links
  - Conductor and hardware.



Capital Allocation within the Refurbishment Plan



Grid Refurbishment Plans

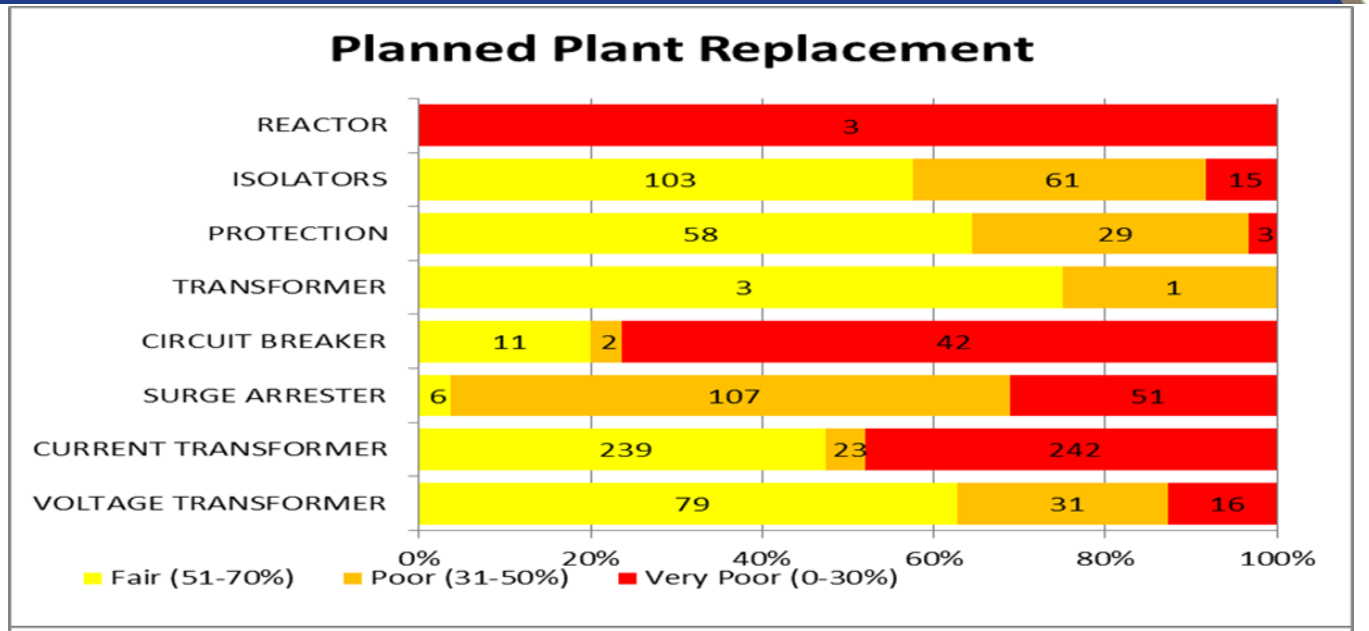


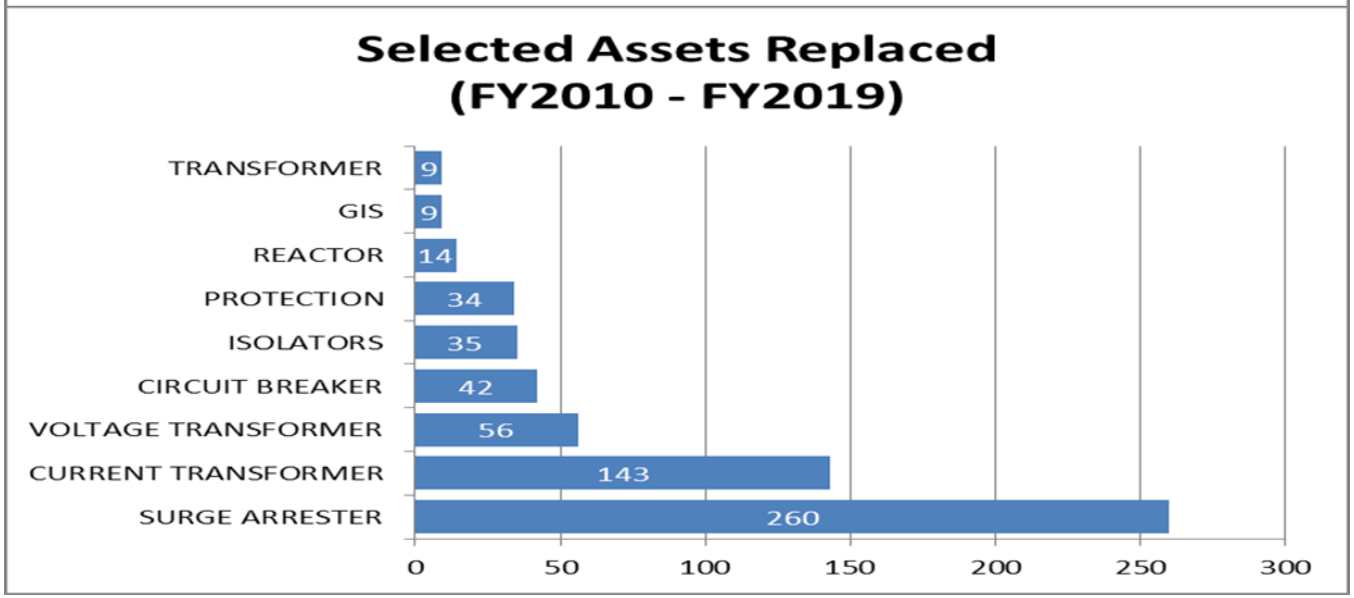
Western Cape Province

2020 – 2029 TNRP

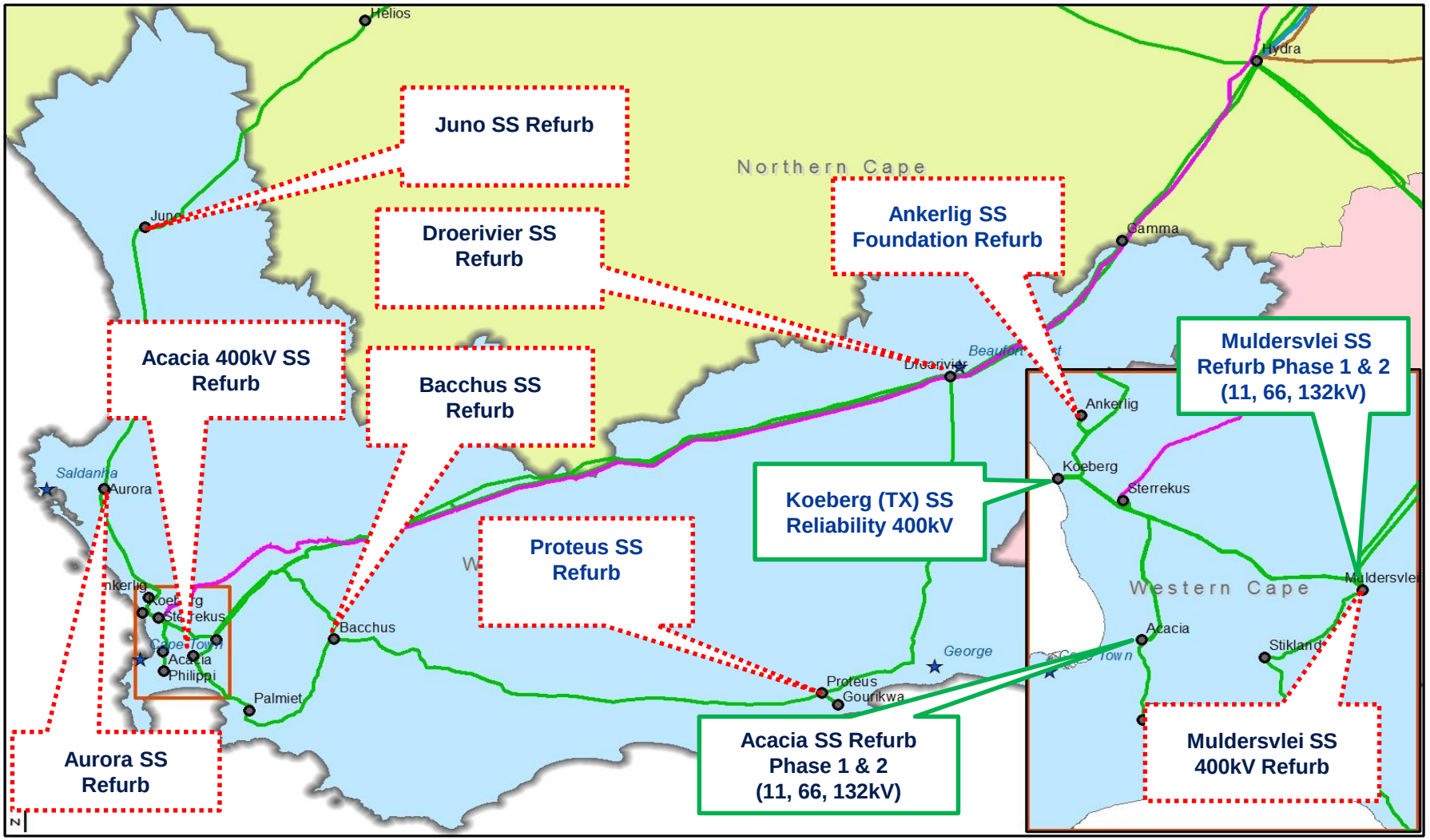
Presented by Jimmy Khoza

Western Cape Province: Asset Replacement Profile



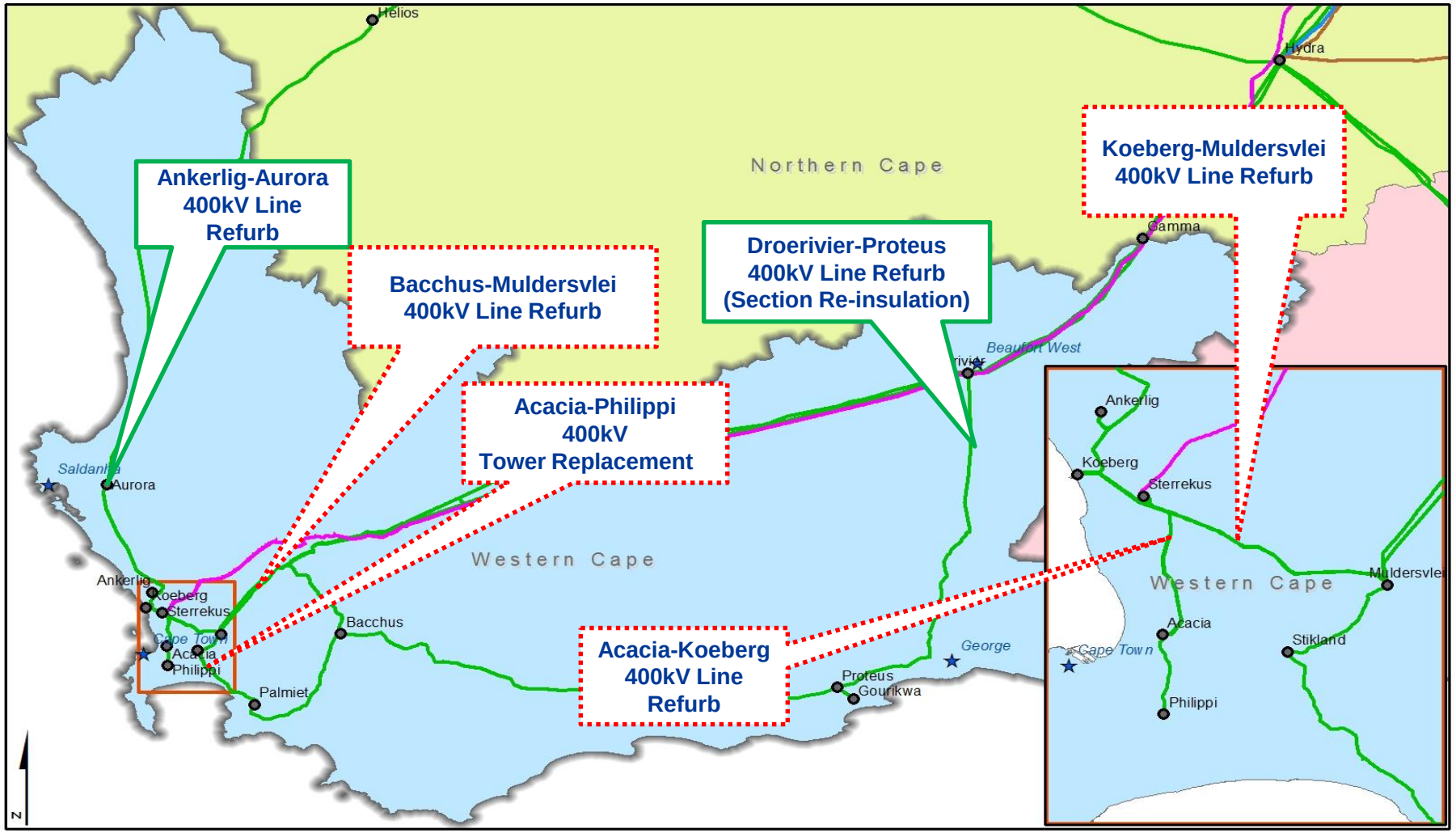


Major Substation Refurbishment per MTS



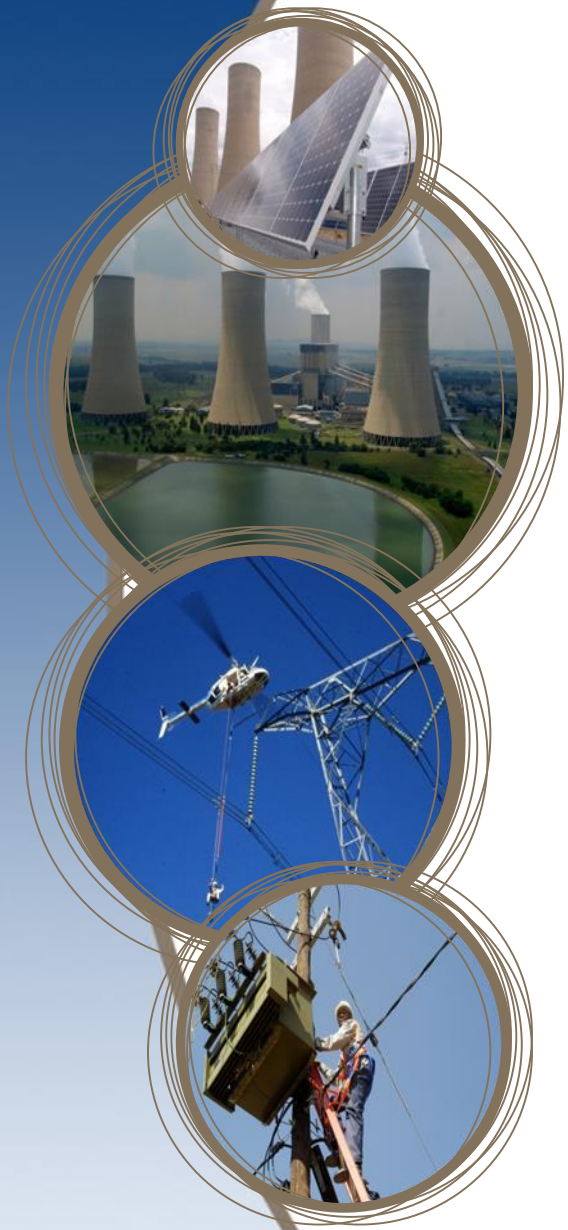
This map has been compiled by ESKOM Grid Planning department to the best of their knowledge. However, since various data sources have been used Grid Planning department cannot accept responsibility for any inaccuracies.

Major Lines Refurbishment



Asset Classes planned for Replacement

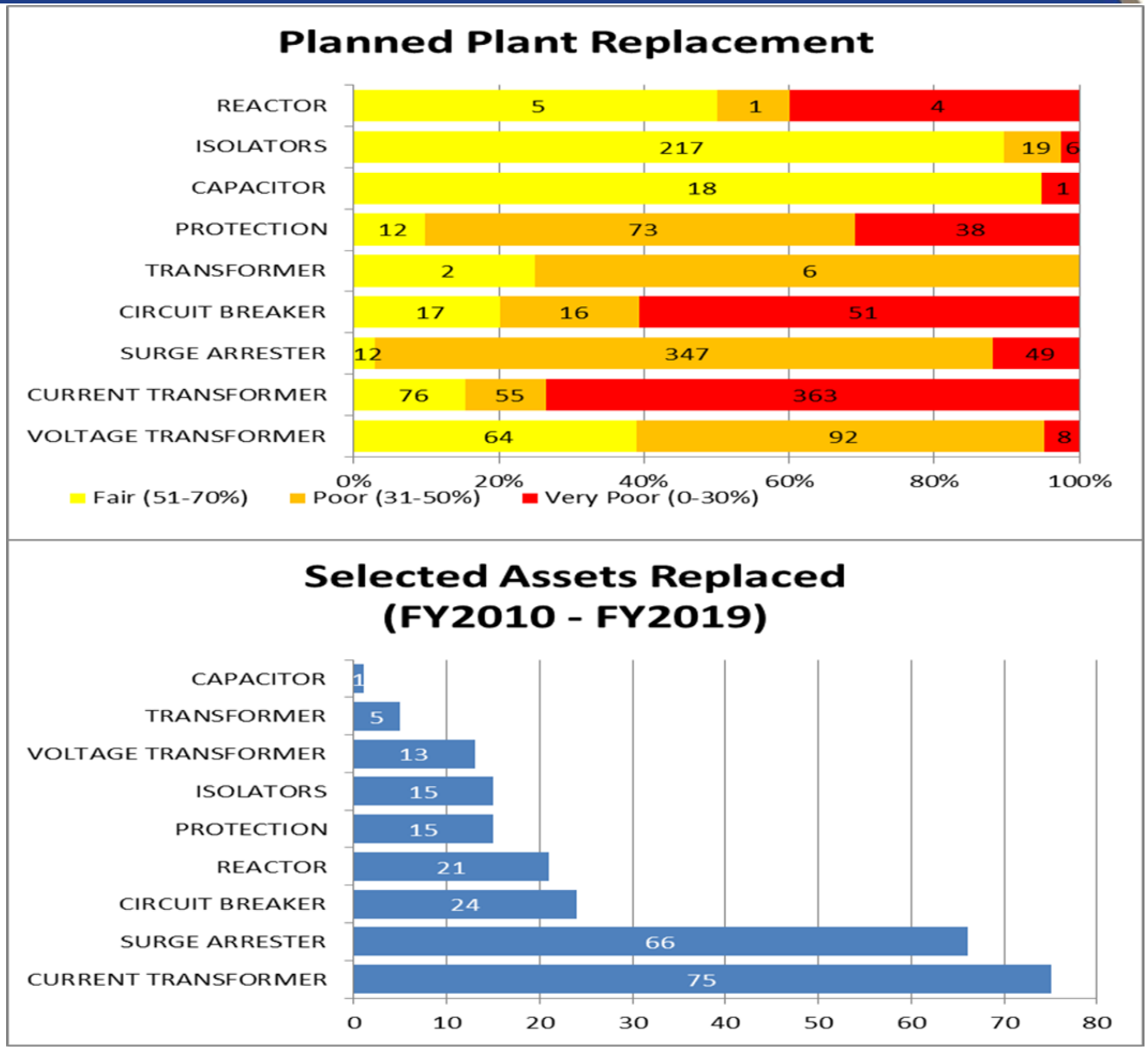
Number of Assets Planned for Replacement				
Asset Category	MYPD 4	FY23-FY25	> 6 YRS	Total
CAPACITOR	0	4	0	4
CIRCUIT BREAKER	25	65	3	93
CURRENT TRANSFORMER	77	230	4	311
ISOLATORS	95	223	10	328
PROTECTION	34	89	12	135
REACTOR	1	4	0	5
SURGE ARRESTER	84	111	12	207
TRANSFORMER	9	2	3	14
VOLTAGE TRANSFORMER	31	54	5	90



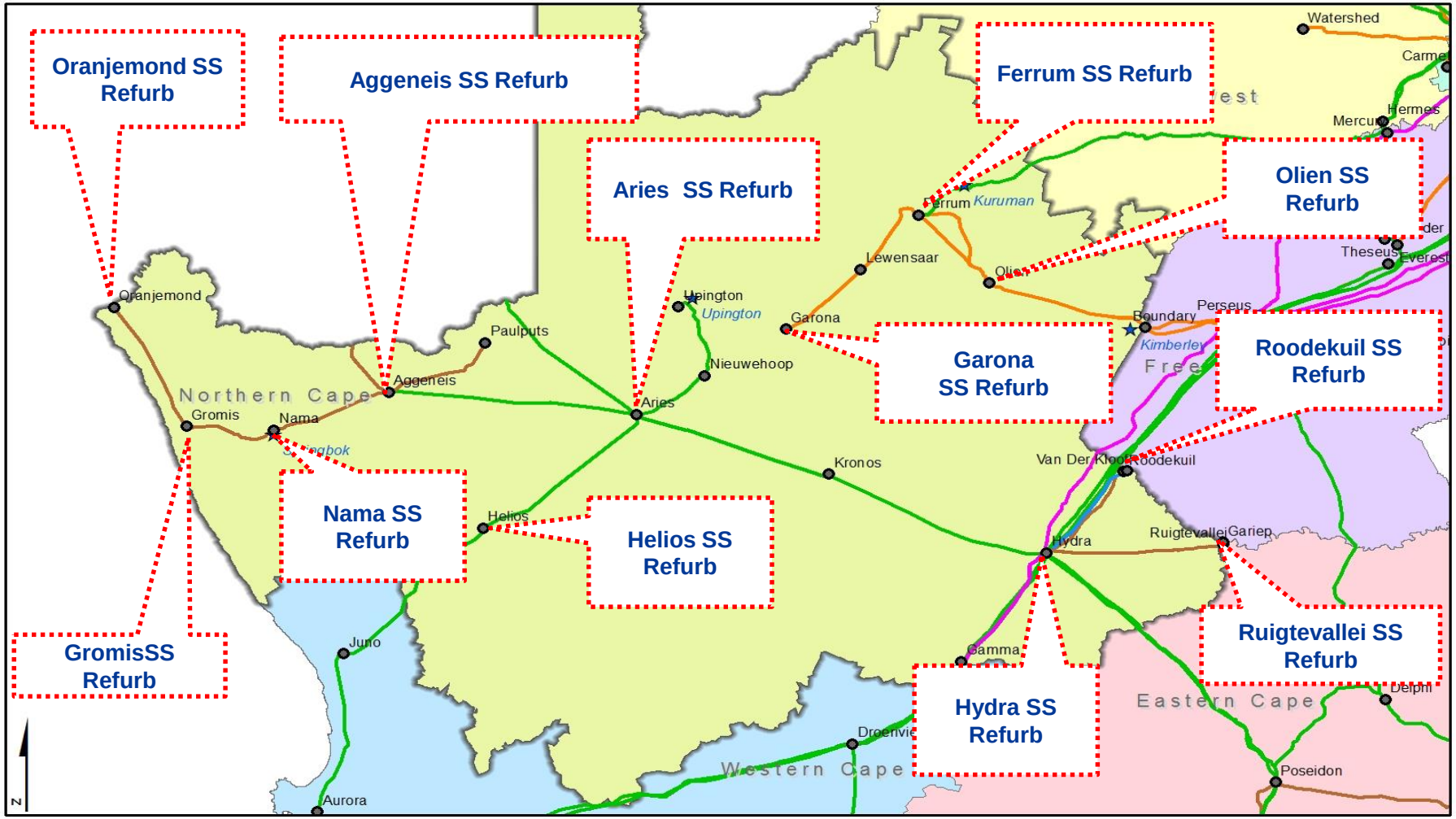
Northern Cape Province

2020 – 2029 TNRP

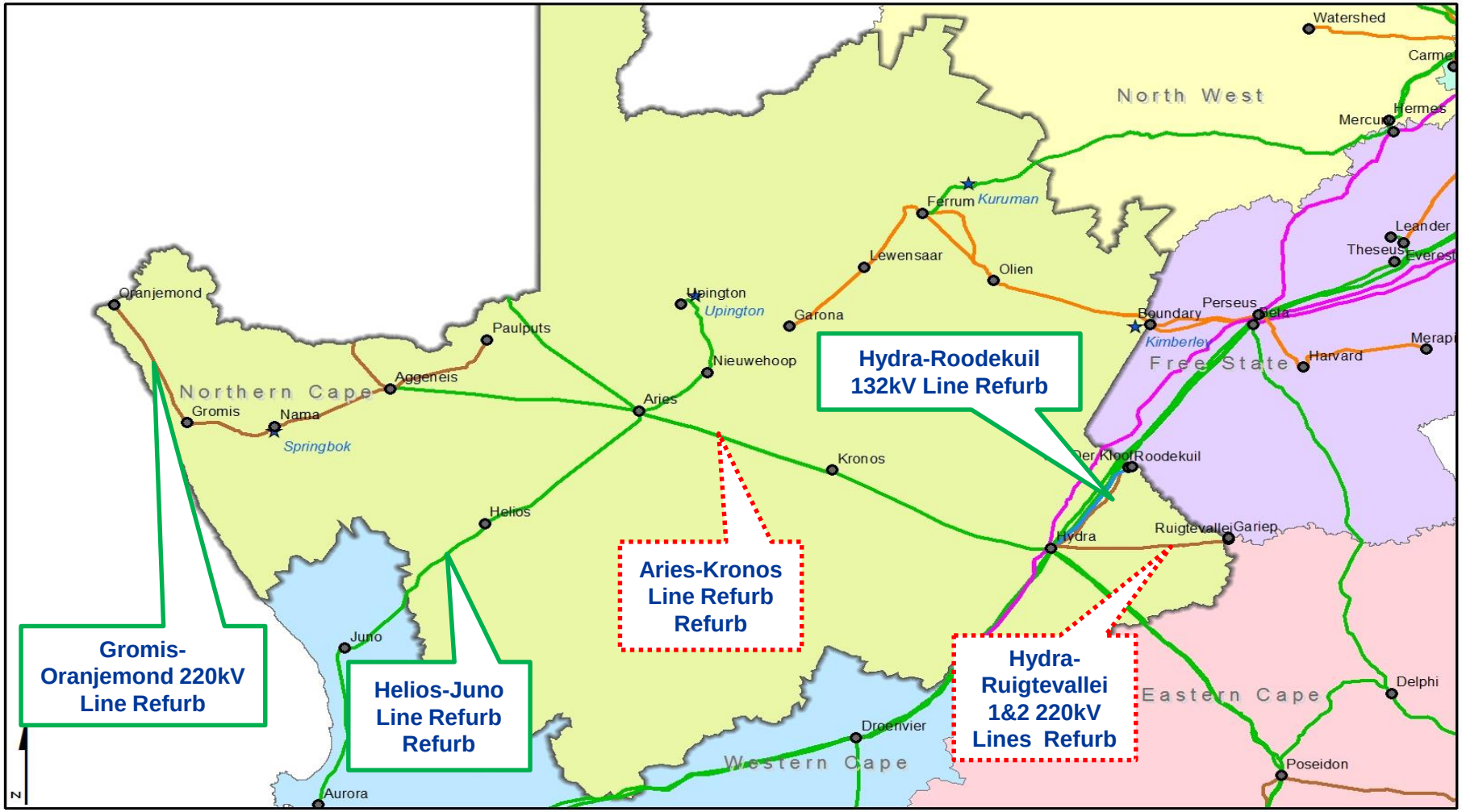
Northern Cape Province: Asset Replacement Profile



Major Substation Refurbishment per MTS



Major Lines Refurbishment



Existing Substations Existing Lines
Towns
132 220 275 400 765

Northern Cape

Created by: Sonja Ferreira
Date: 2019/05/28

0 50 100 200 300 400 Km

This map has been compiled by ESKOM Grid Planning department to the best of their knowledge. However, since various data sourceshave been used Grid Planning department cannot accept responsibility for any inaccuracies.

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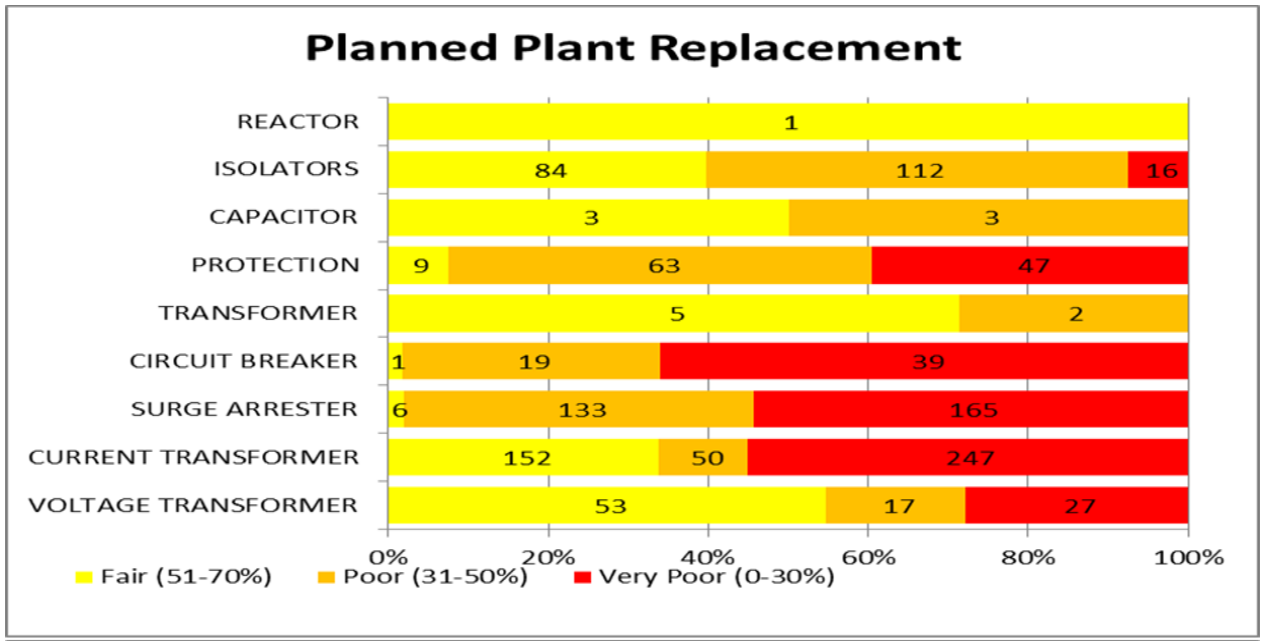
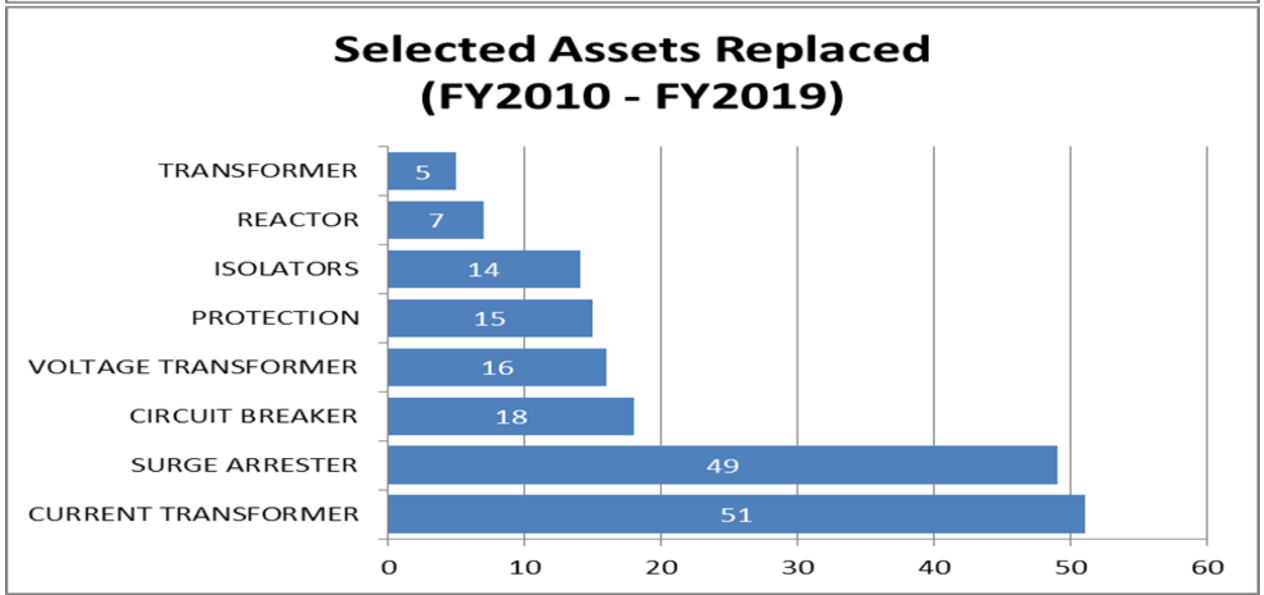
Eastern Cape Province South Grid

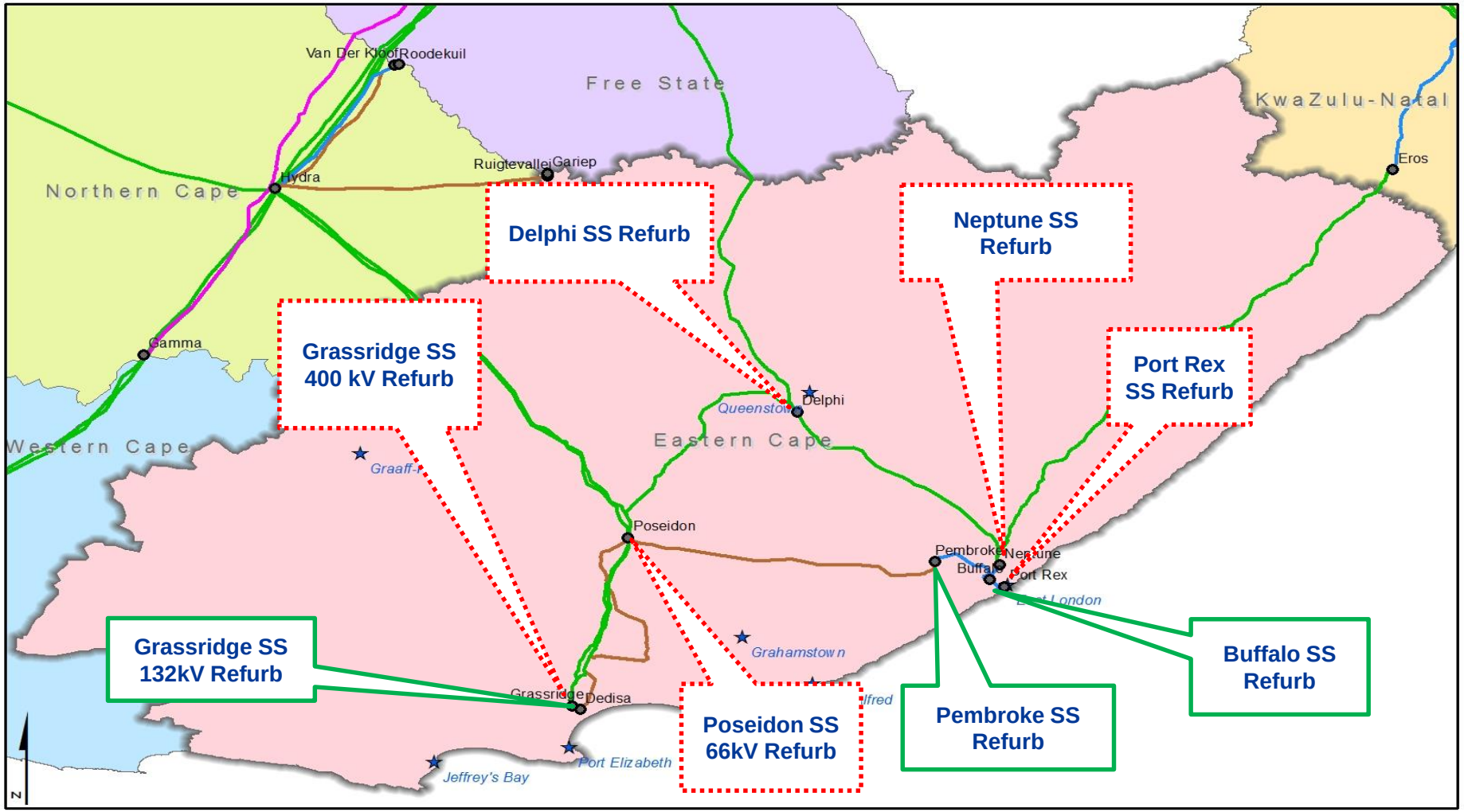
2020 – 2029 TNRP

Eastern Cape Province: Asset Replacement Profile





Major Substation Refurbishment per MTS



Existing Substations Existing Lines
Towns
132 220 275 400 765

Eskom

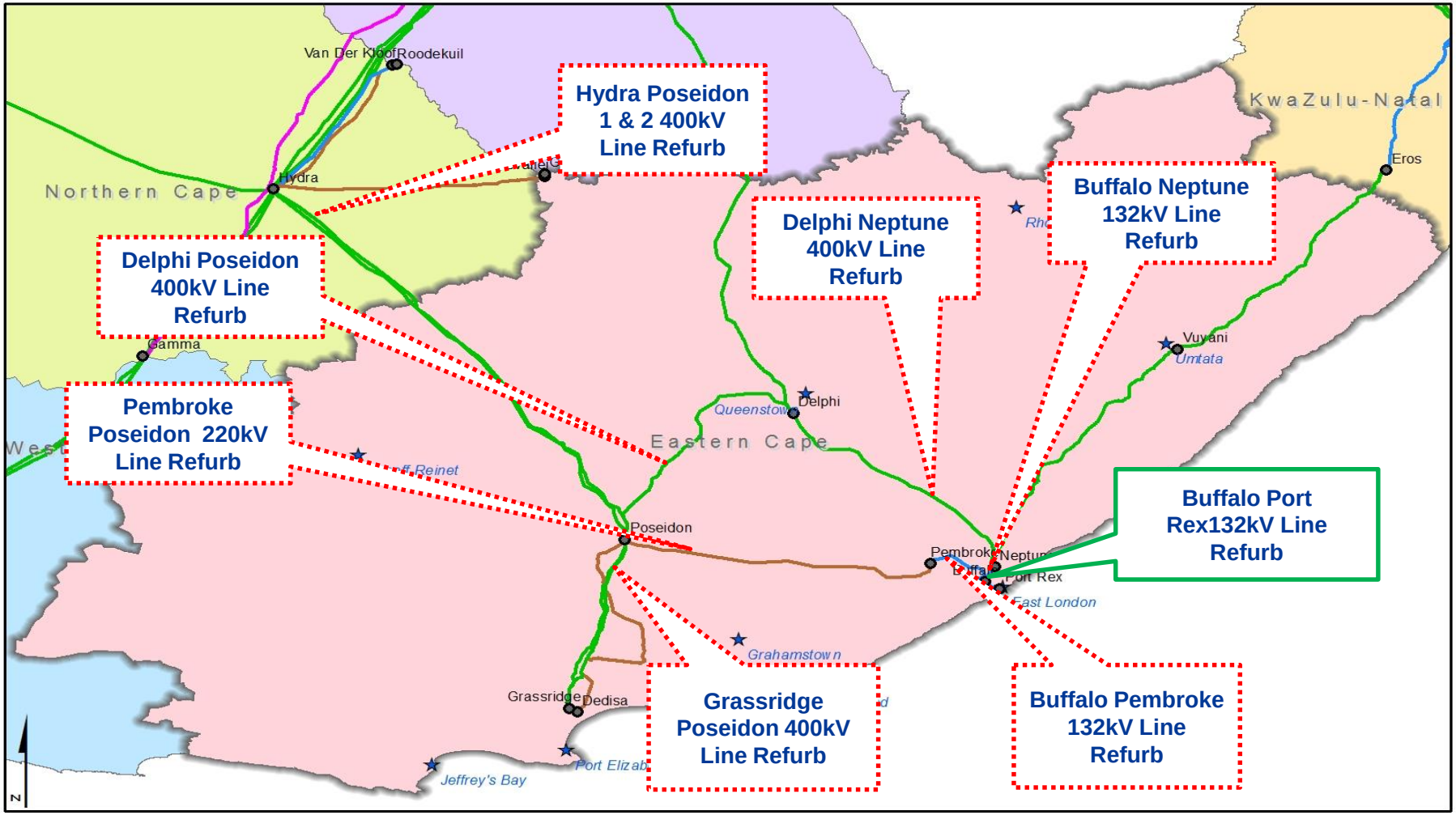
Eastern Cape

Created by: Sonja Ferreira
Date: 2019/05/28

0 30 60 120 180 240 Km

This map has been compiled by ESKOM Grid Planning department to the best of their knowledge. However, since various data sources have been used Grid Planning department cannot accept responsibility for any inaccuracies.

Major Lines Refurbishment



Existing Substations Existing Lines
Towns
132 220 275 400 765

Eastern Cape

Created by: Sonja Ferreira
Date: 2019/05/28

0 30 60 120 180 240 Km

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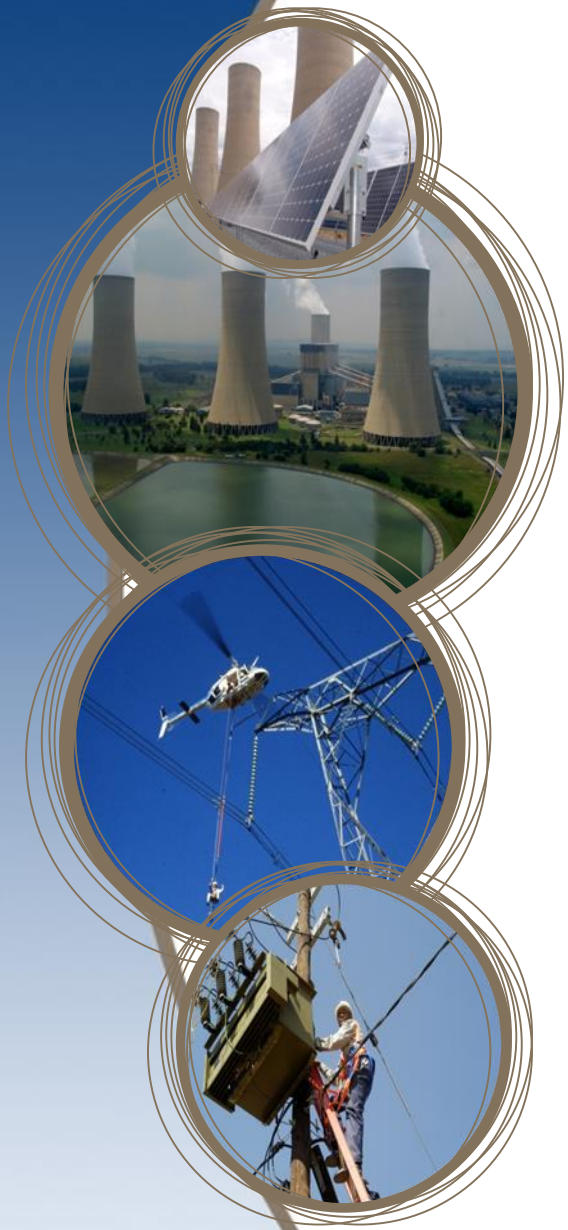
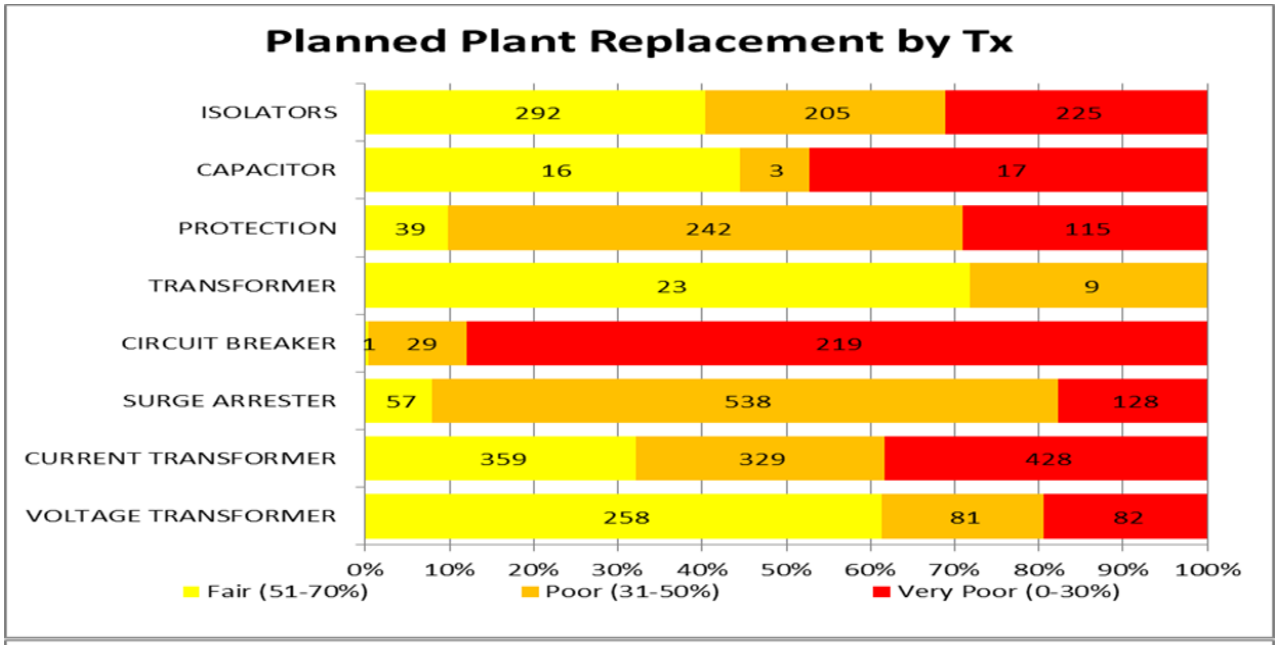


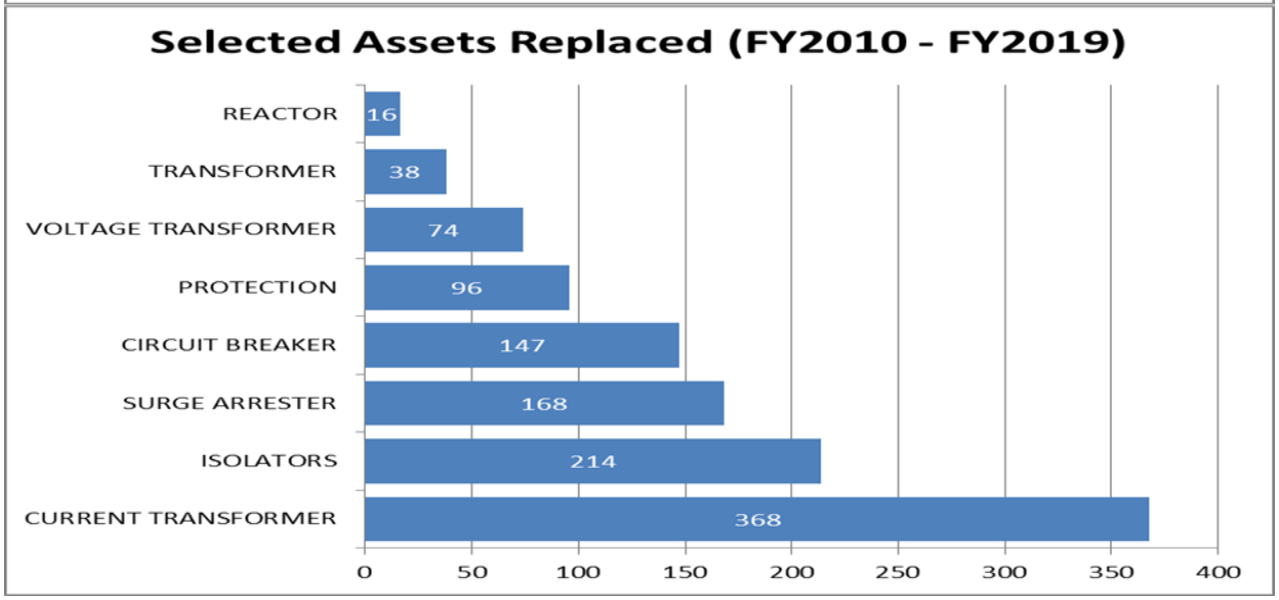
Gauteng Province

2020 – 2029 TNRP

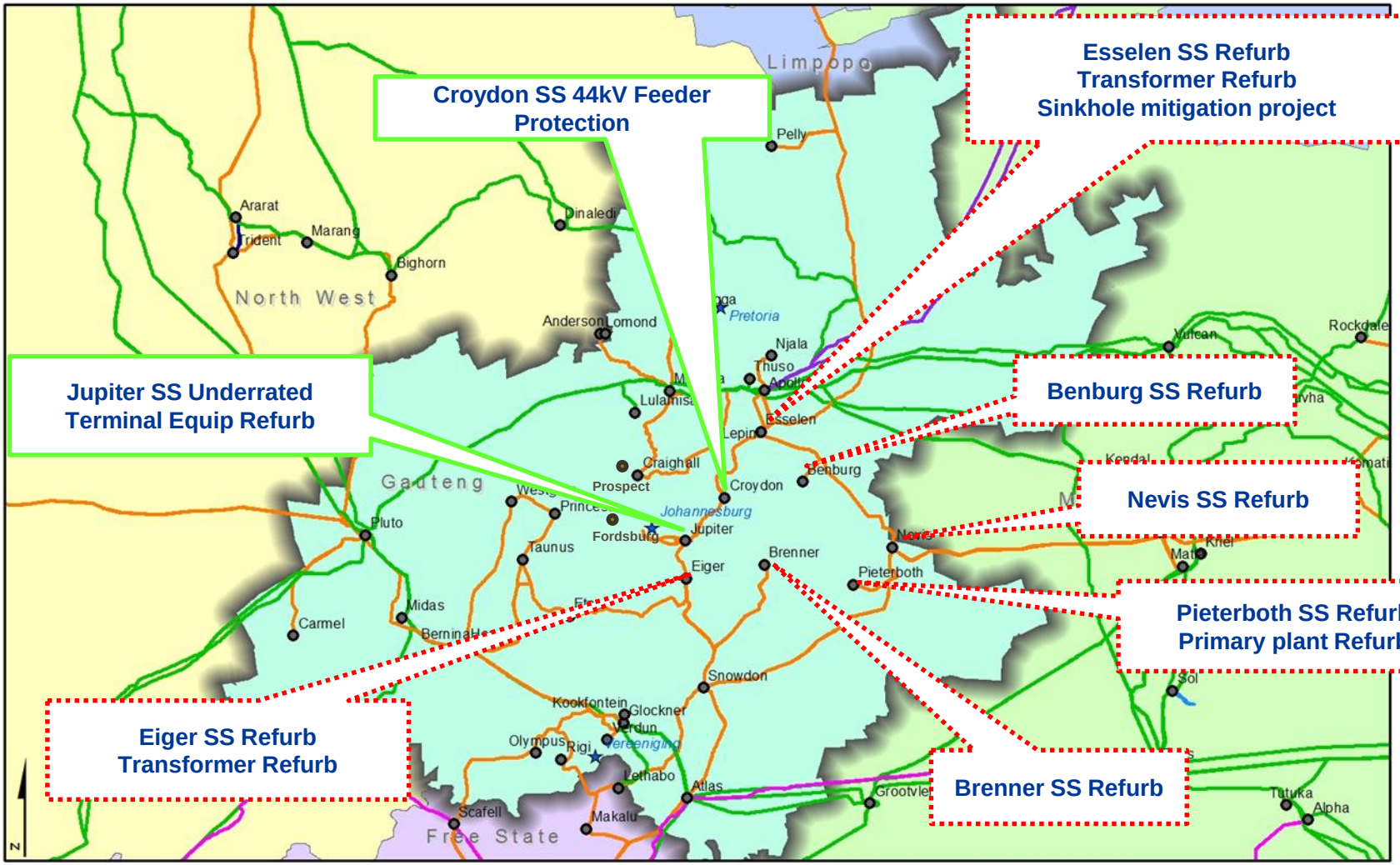
Presented by Mini Palamootil

Gauteng Province: Asset Replacement Profile

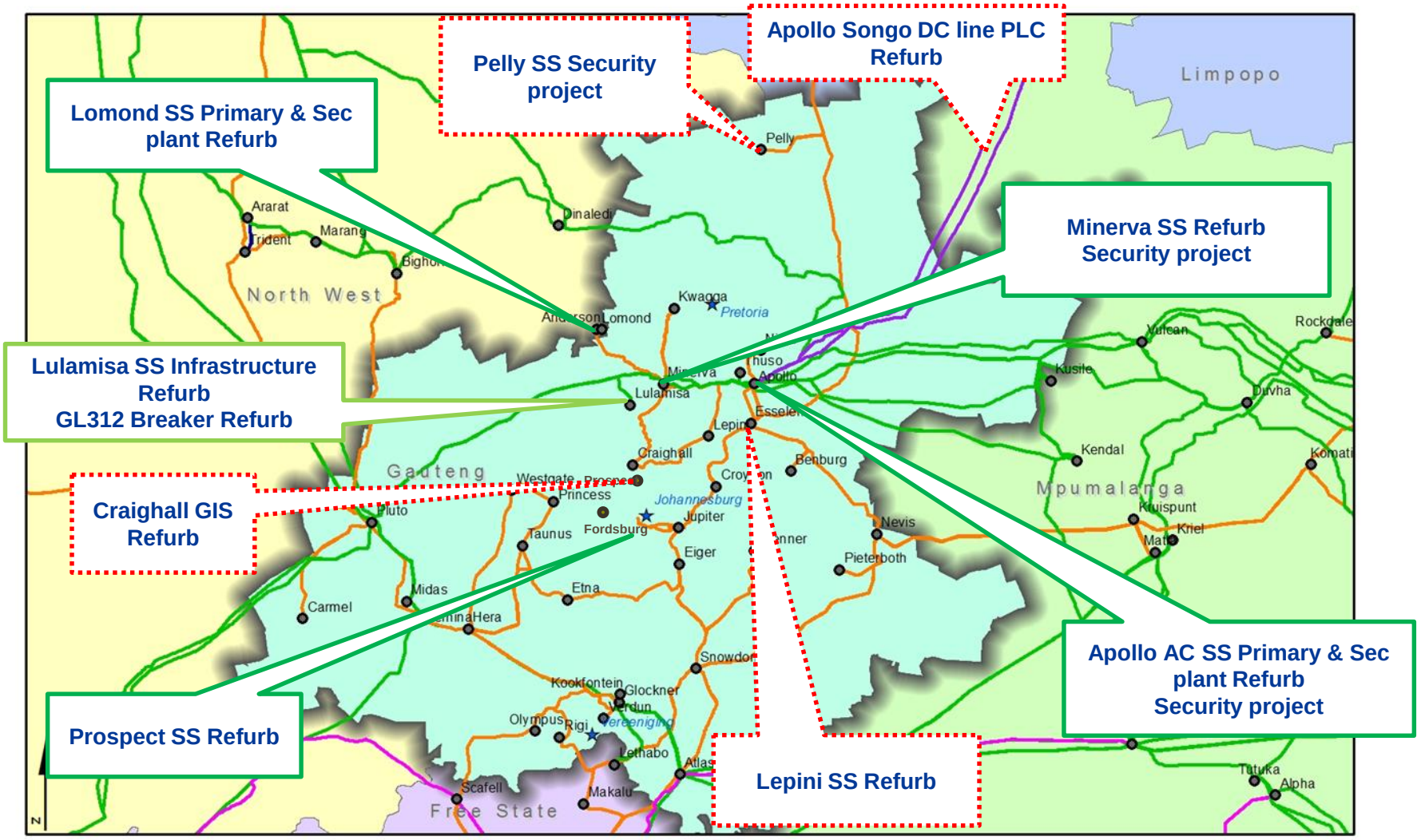




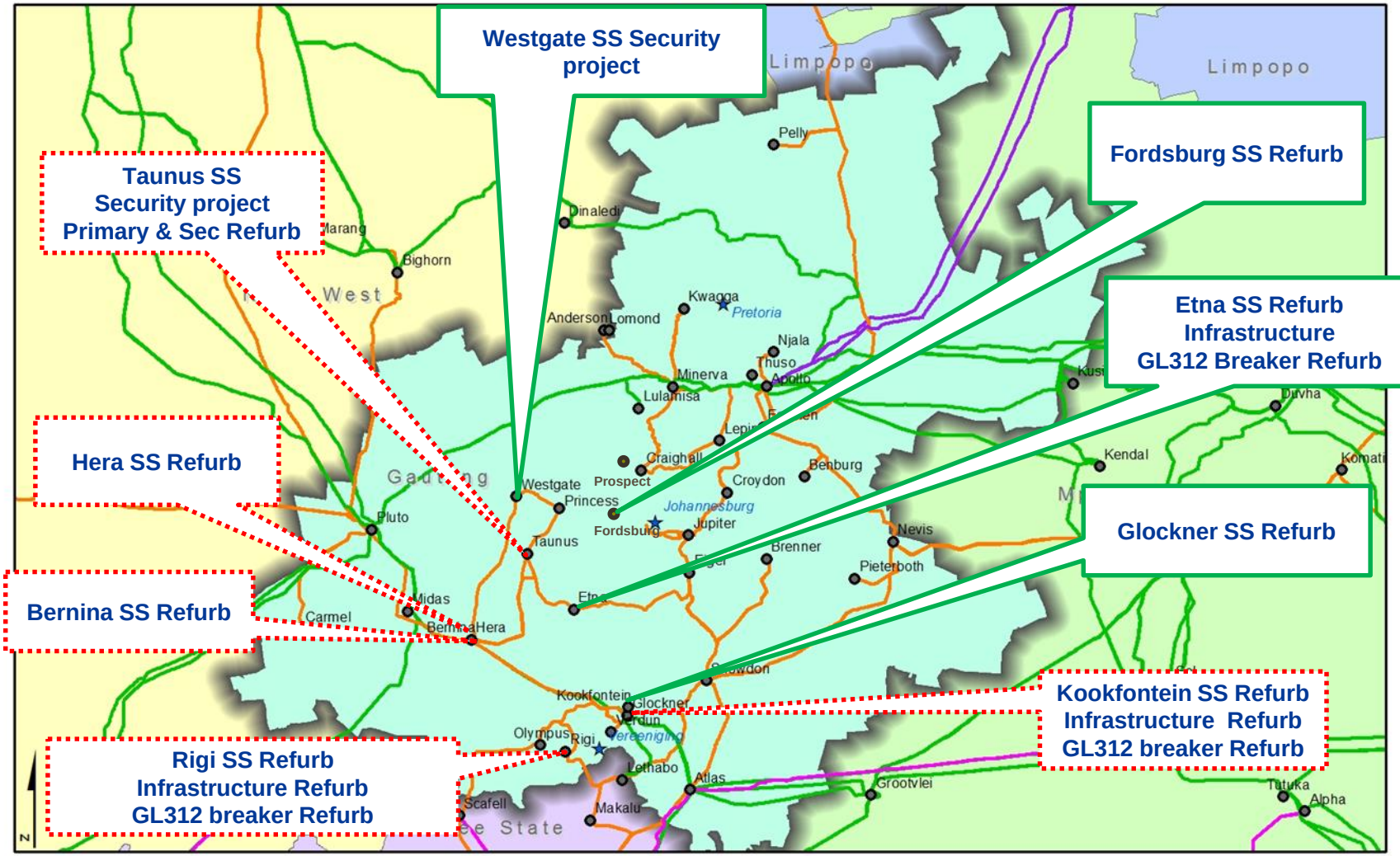
Major Substation Refurbishment MTS
East Rand CLN



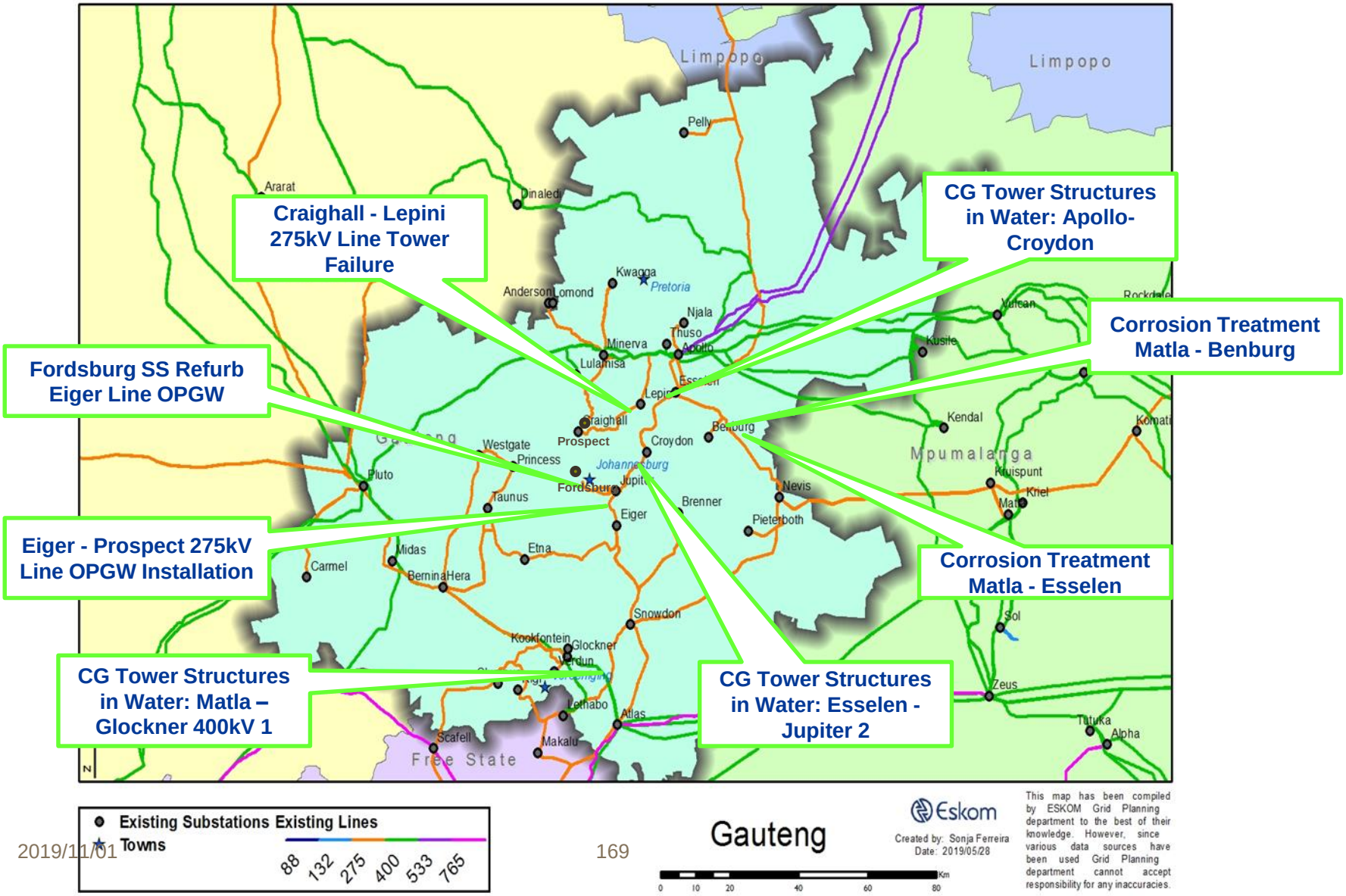
Major Substation Refurbishment per MTS JHB CLN



Major Substation Refurbishment per MTS
Vaal CLN & West Rand CLN

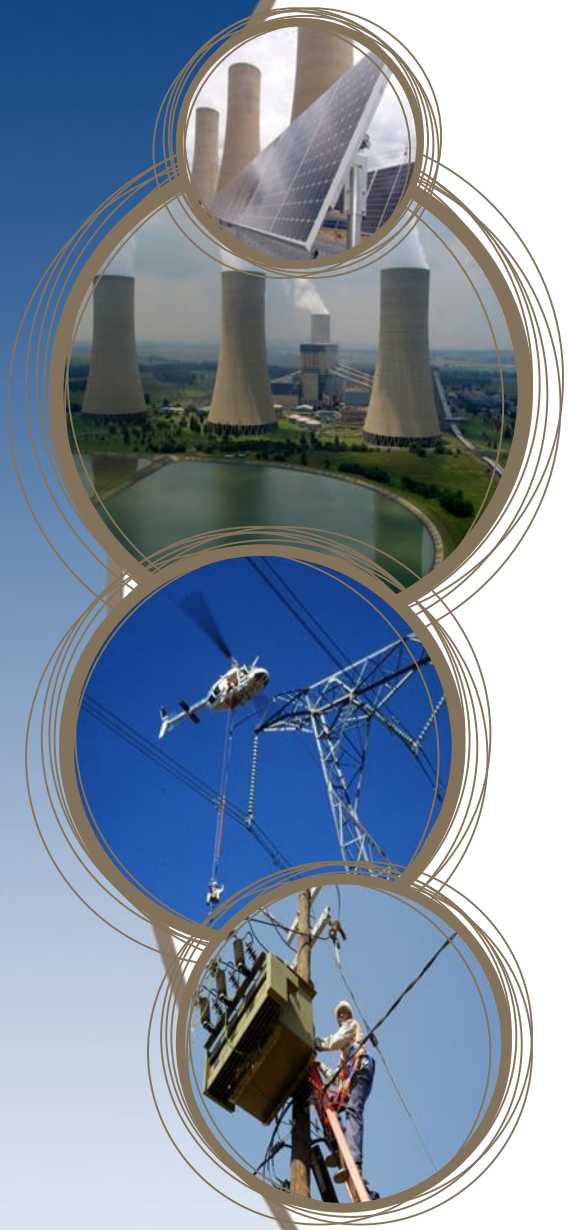


Major Lines Refurbishment



Assets Planned for Replacement per category

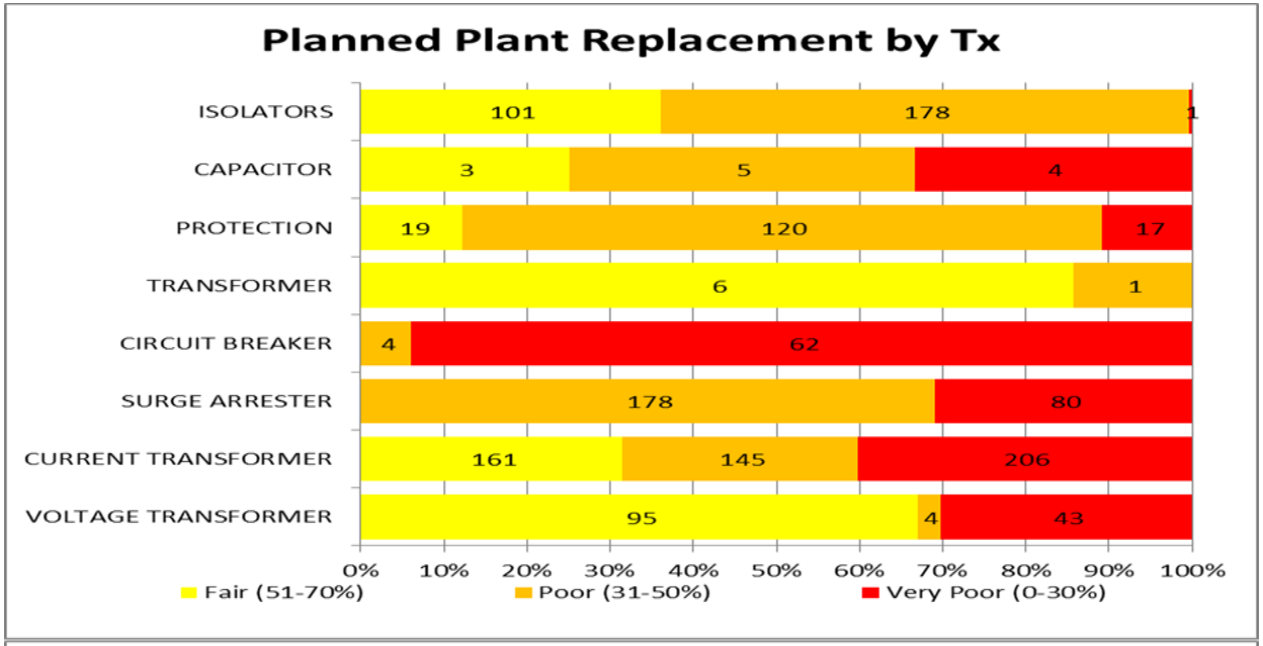
Number of Assets Planned for Replacement				
Asset Category	MYPD 4	FY23-FY25	> 6 YRS	Total
CAPACITOR	5	0	8	13
CIRCUIT BREAKER	34	12	130	176
CURRENT TRANSFORMER	152	36	582	770
GIS	0	0	132	132
ISOLATORS	120	32	490	642
PROTECTION	52	11	178	241
REACTOR	0	0	3	3
SURGE ARRESTER	57	36	437	530
TRANSFORMER	0	0	5	5
VOLTAGE TRANSFORMER	77	18	225	320

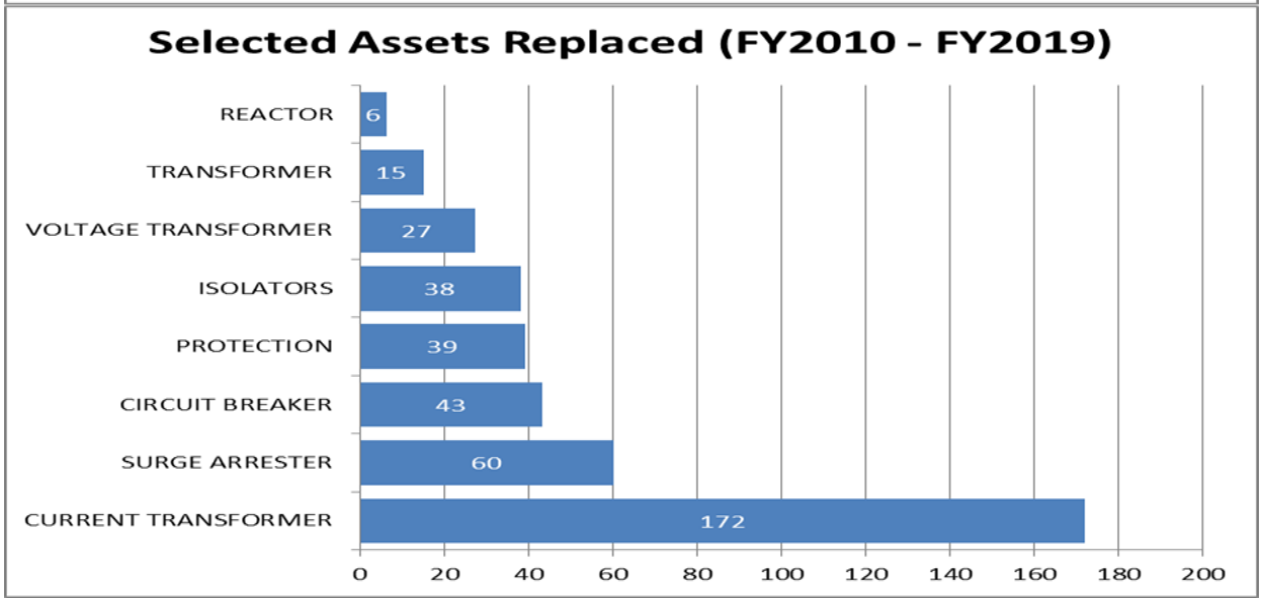


North West Province

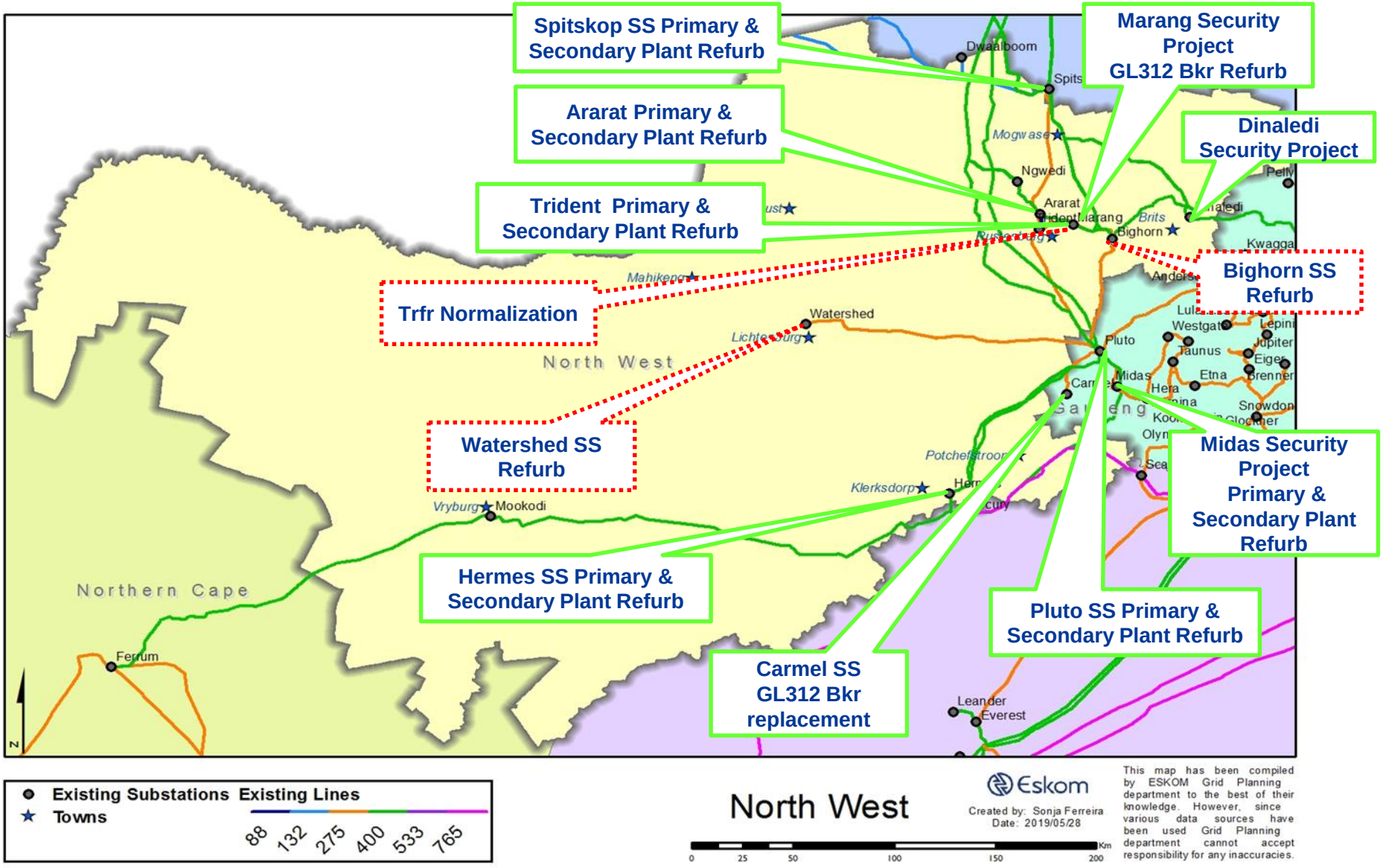
2020 – 2029 TNRP

North West Province: Asset Replacement Profile

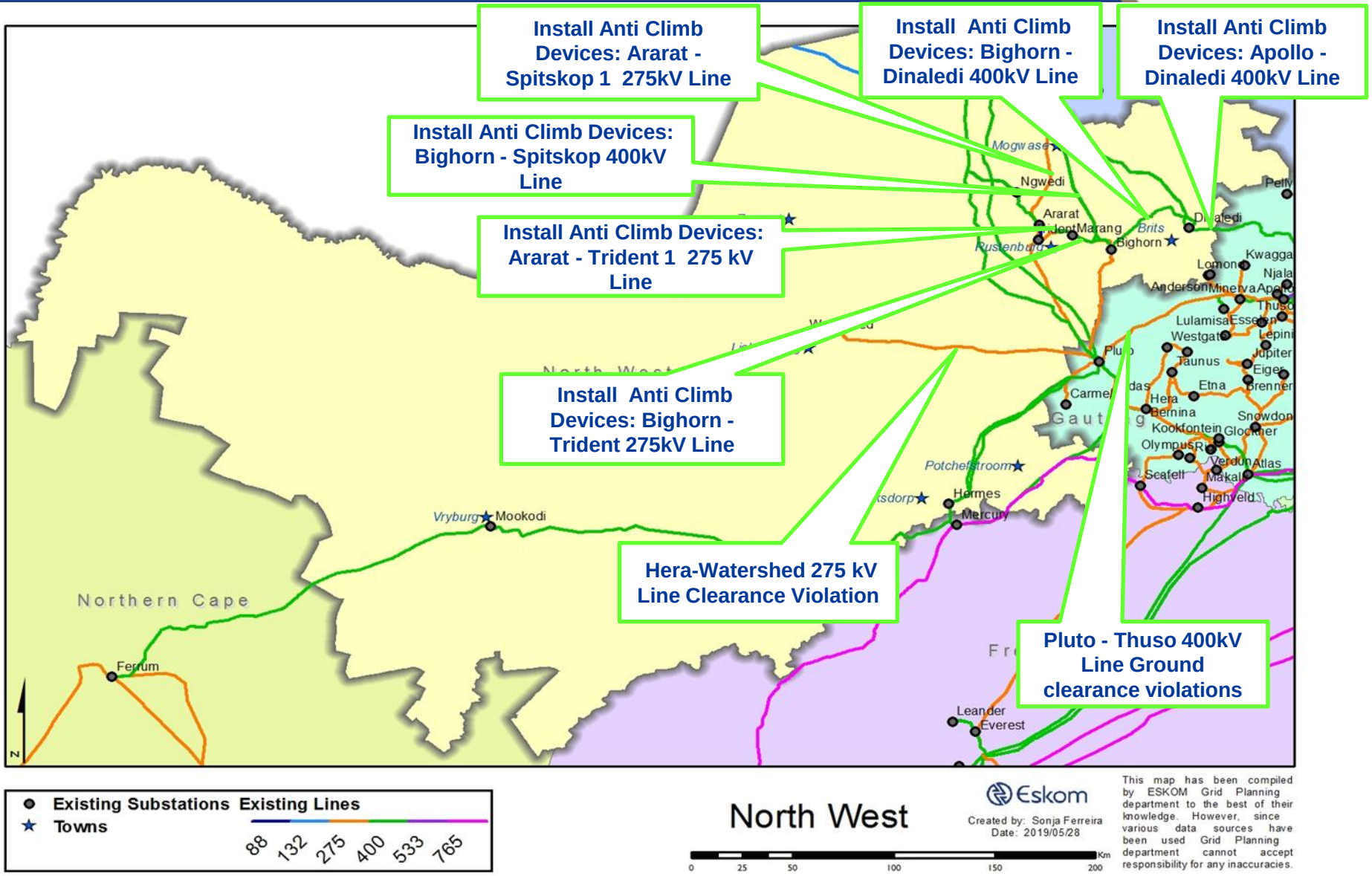




NW: Major Substation Refurbishment Projects



Major Lines Refurbishment



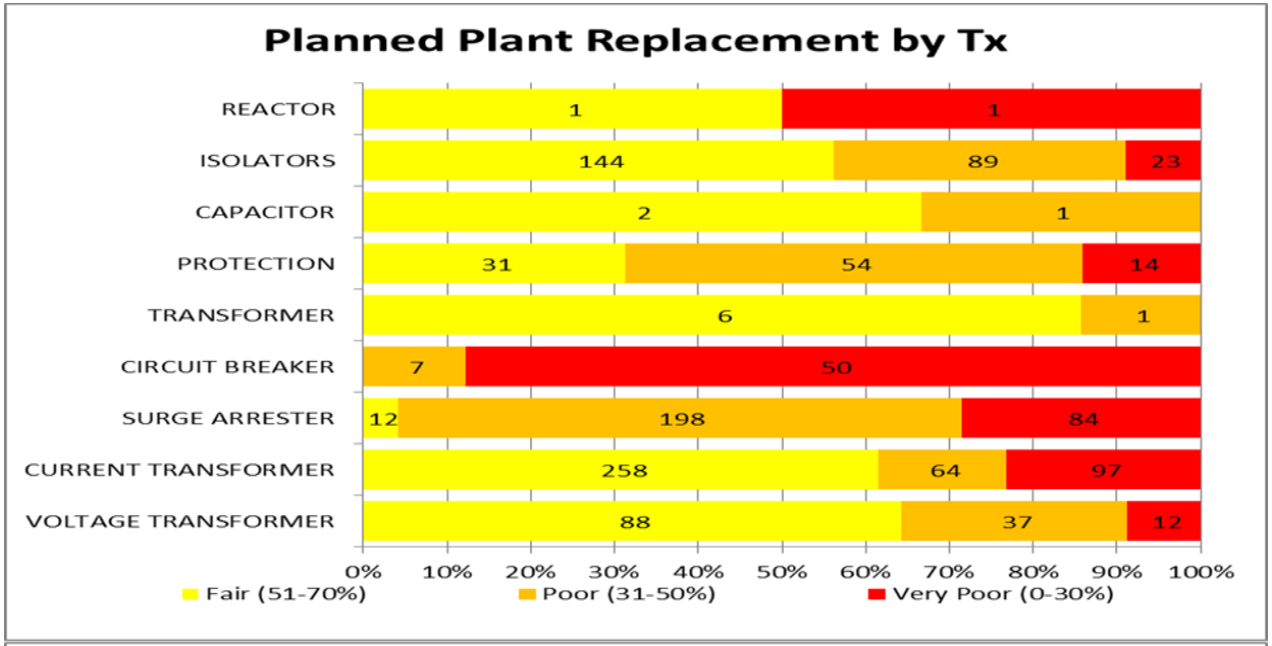
Assets Planned for Replacement per category

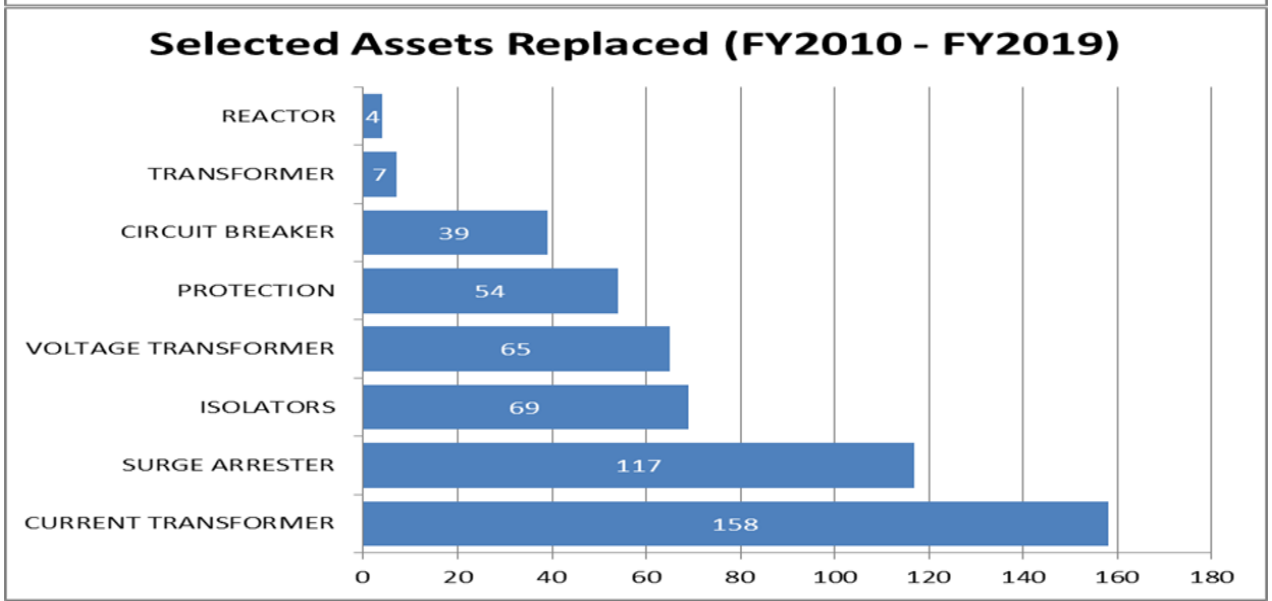
Number of Assets Planned for Replacement				
Asset Category	MYPD 4	FY23-FY25	> 6 YRS	Total
CAPACITOR	7	0	0	7
CIRCUIT BREAKER	6	10	12	28
CURRENT TRANSFORMER	18	35	36	89
ISOLATORS	15	31	47	93
PROTECTION	6	10	18	34
SURGE ARRESTER	0	36	38	74
VOLTAGE TRANSFORMER	3	12	13	28

Limpopo Province

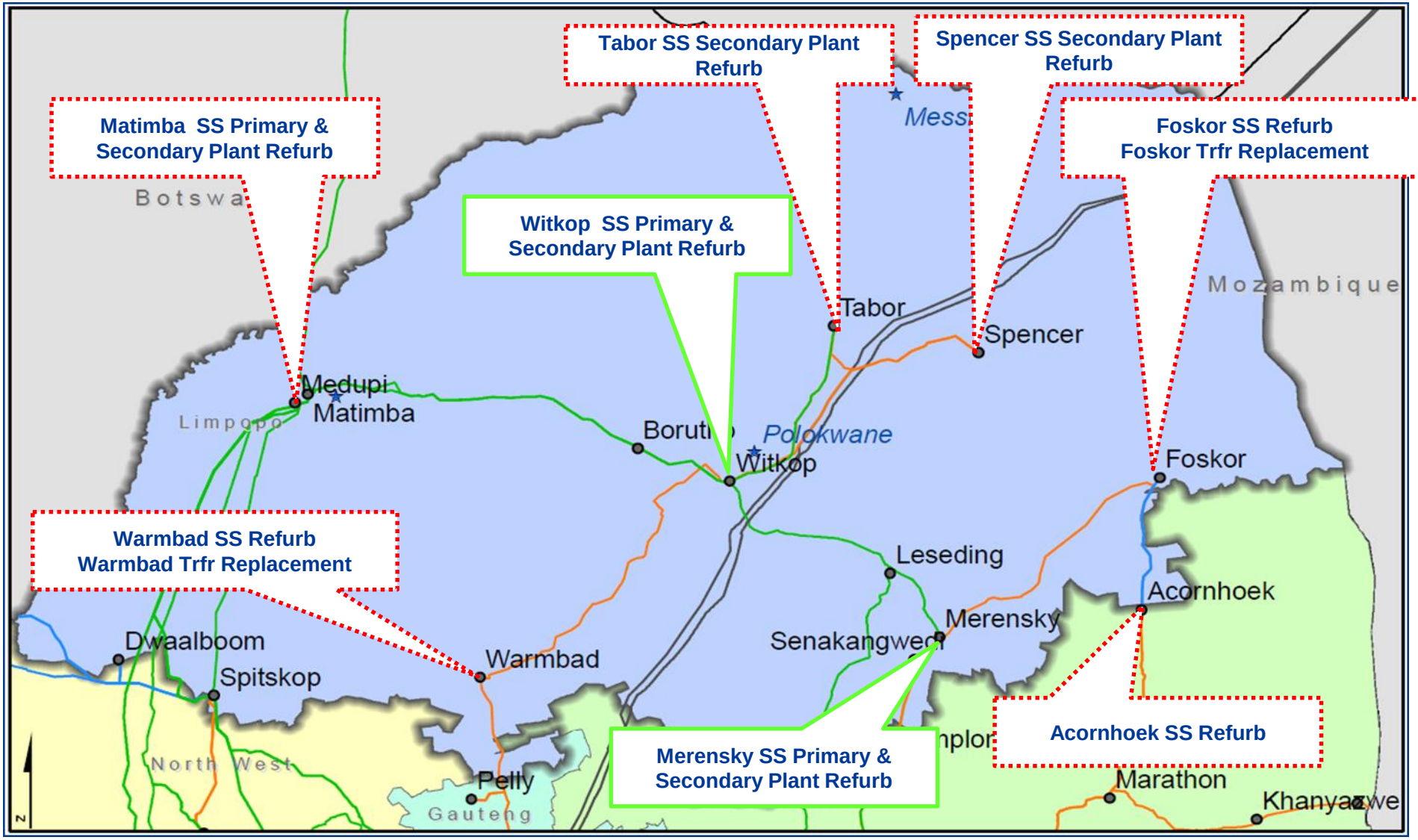
2020 – 2029 TNRP

Limpopo Province: Asset Replacement Profile

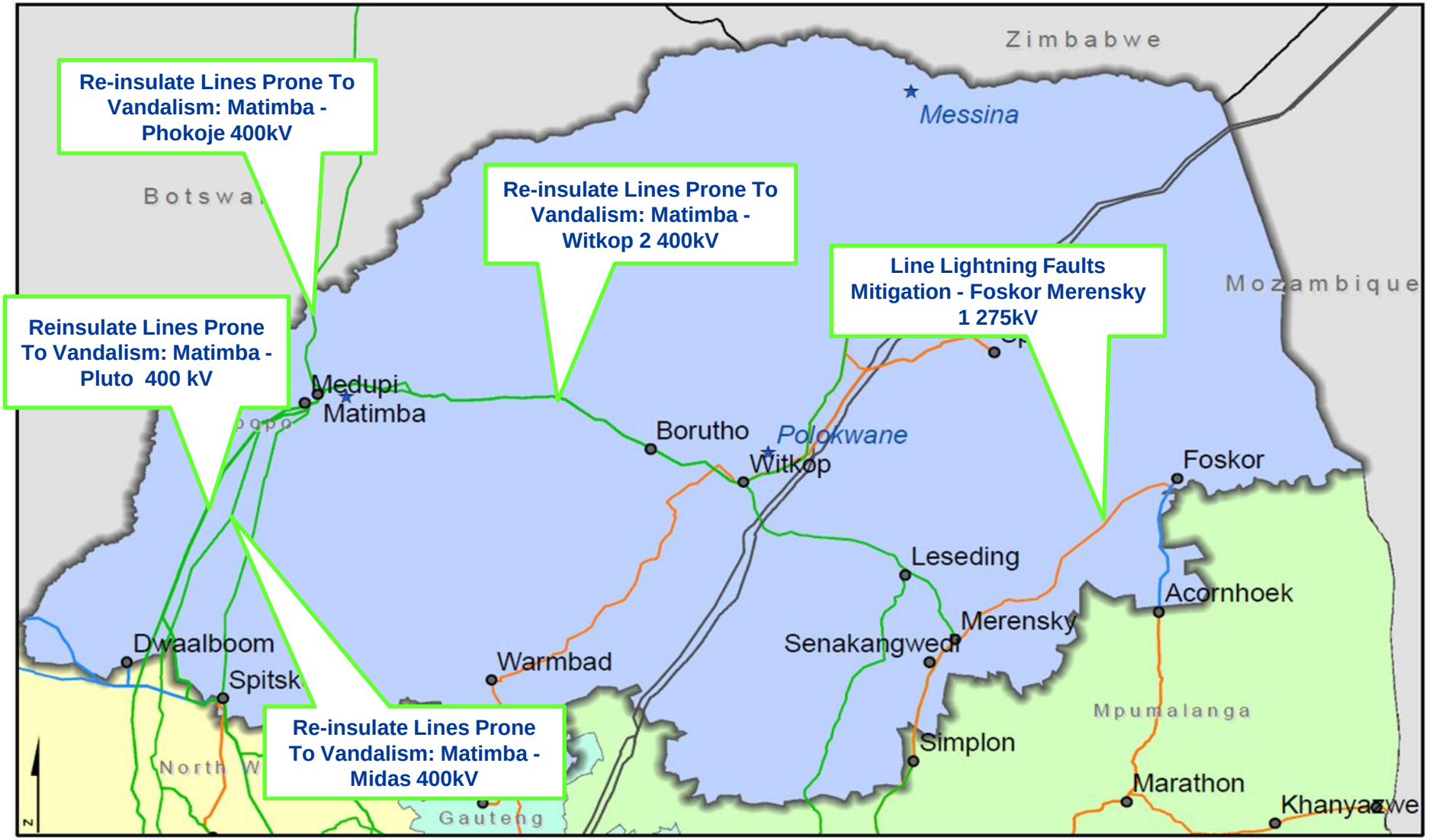




Major Refurbishment per MTS

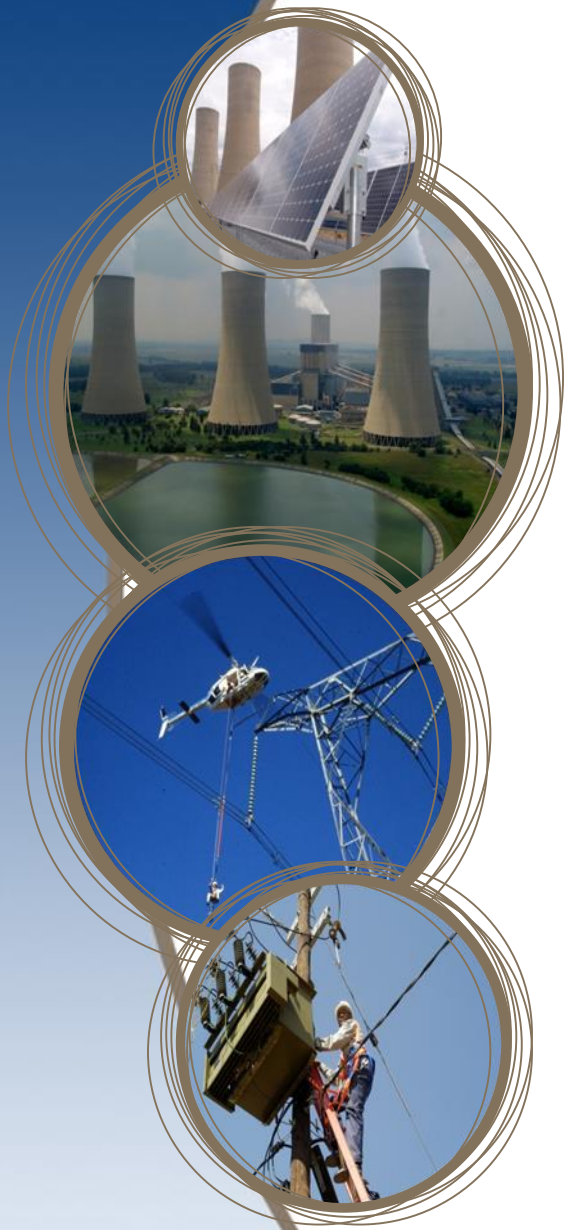


Major Lines Refurbishment



Planned Assets for Replacement per category

Number of Assets Planned for Replacement				
Asset Category	MYPD 4	FY23-FY25	> 6 YRS	Total
CAPACITOR	3	2	0	5
CIRCUIT BREAKER	3	14	34	51
CURRENT TRANSFORMER	9	33	141	183
ISOLATORS	8	57	121	186
PROTECTION	3	9	23	35
SURGE ARRESTER	0	65	105	170
VOLTAGE TRANSFORMER	0	27	62	89

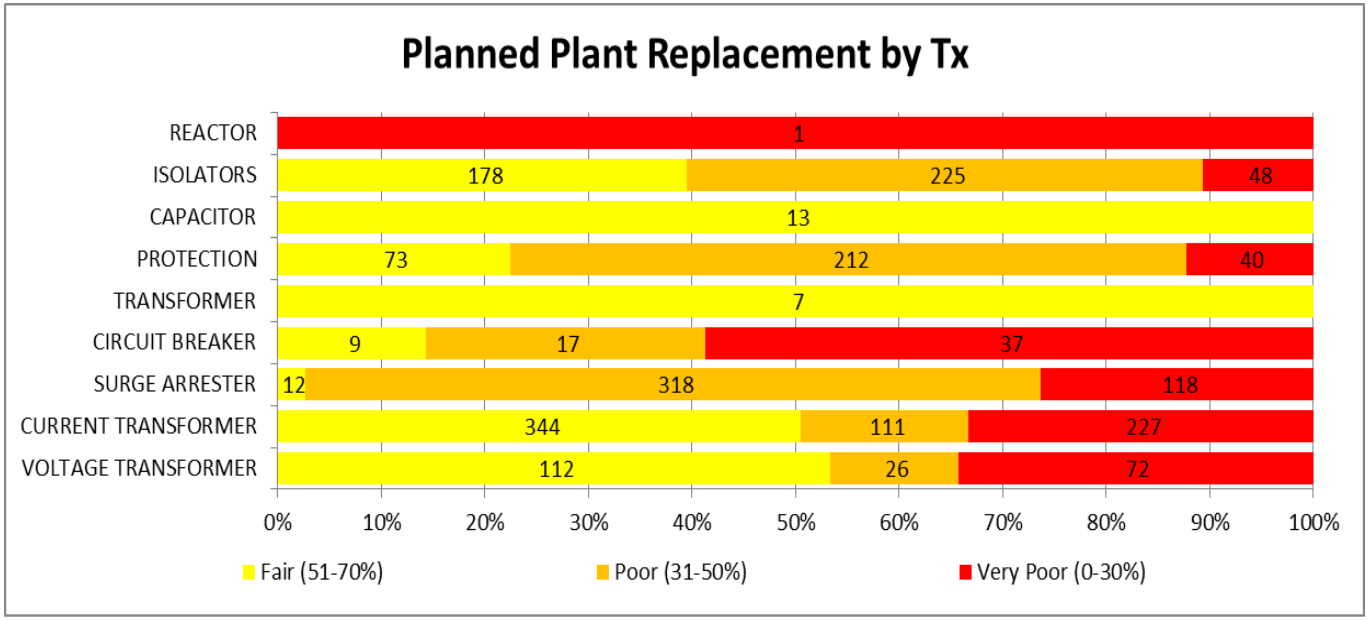


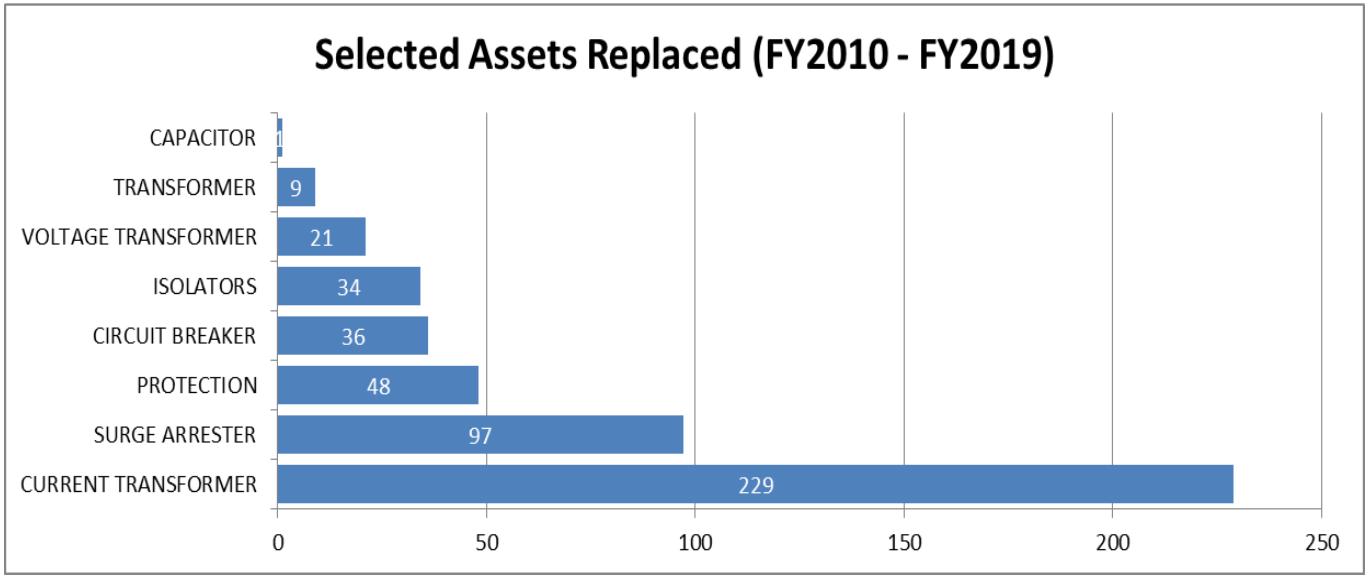
KwaZulu- Natal Province

2020 – 2029 TNRP

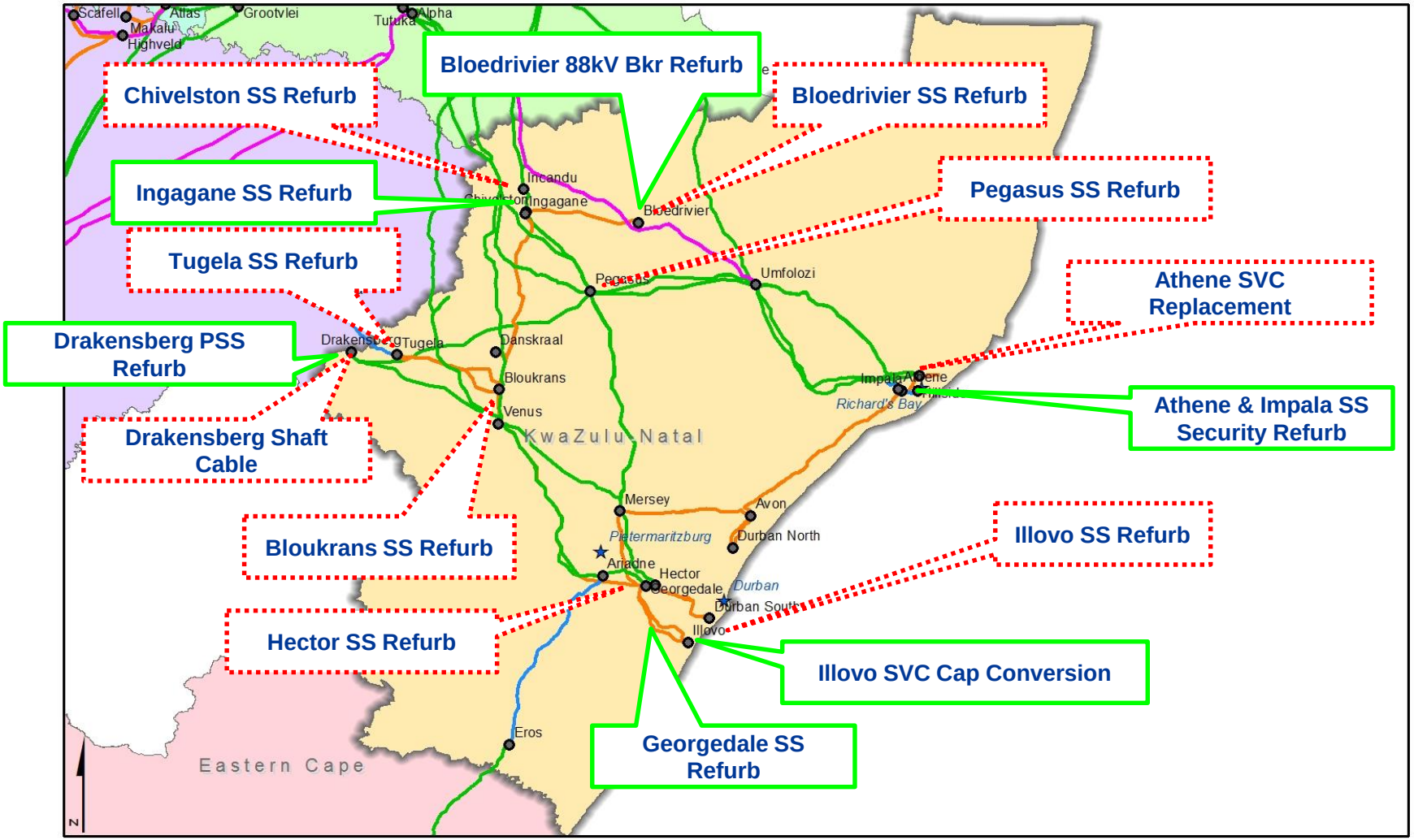
Presented by Jorge Correia

KwaZulu-Natal Province: Asset Replacement Profile

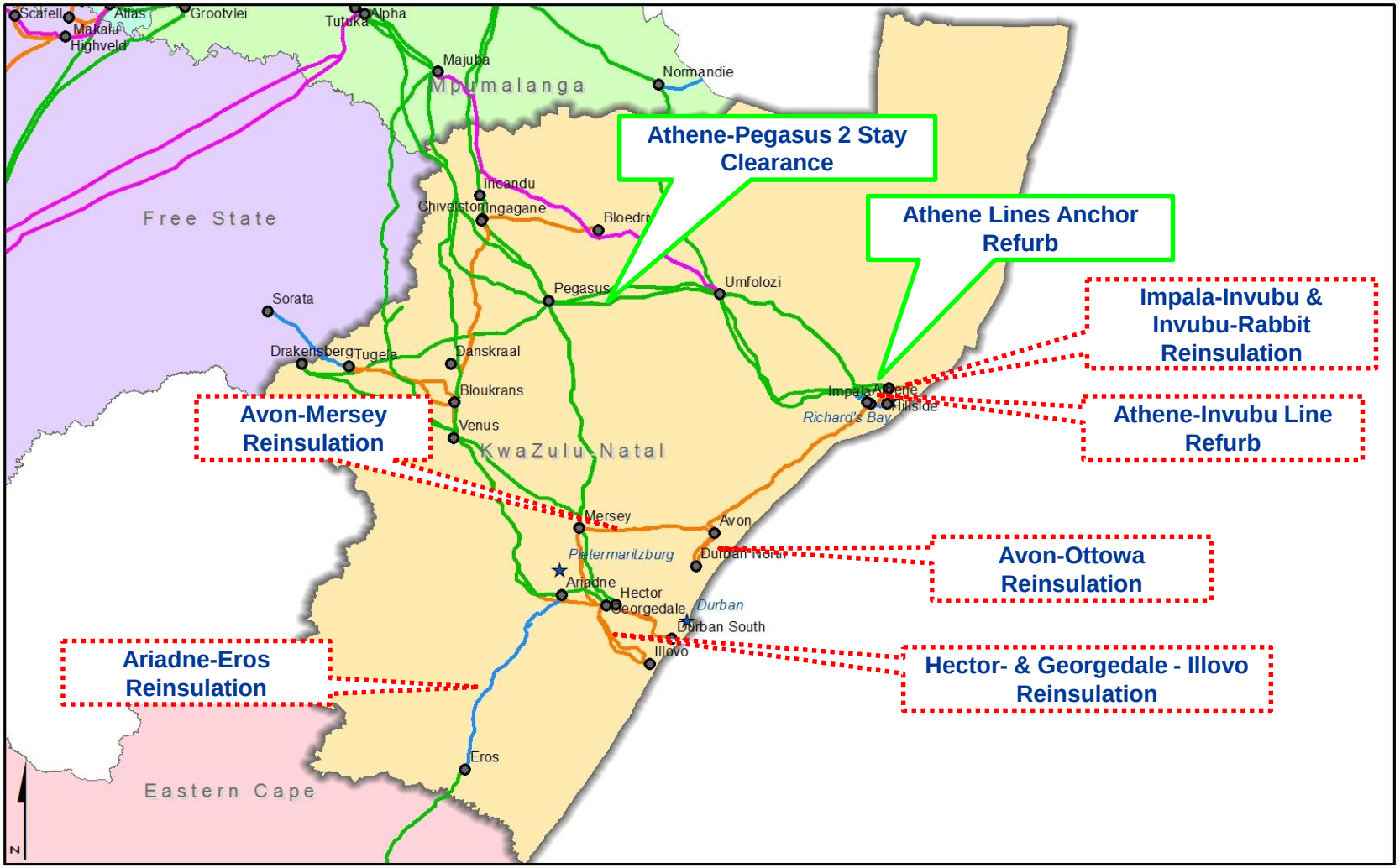




Major Substation Refurbishment per MTS



Major Lines Refurbishment



Existing Substations Existing Lines
Towns
132 275 400 765

KwaZulu-Natal

Created by: Sonja Ferreira
Date: 2019/05/28

0 30 60 120 180 240 Km

This map has been compiled by ESKOM Grid Planning department to the best of their knowledge. However, since various data sources have been used Grid Planning department cannot accept responsibility for any inaccuracies.

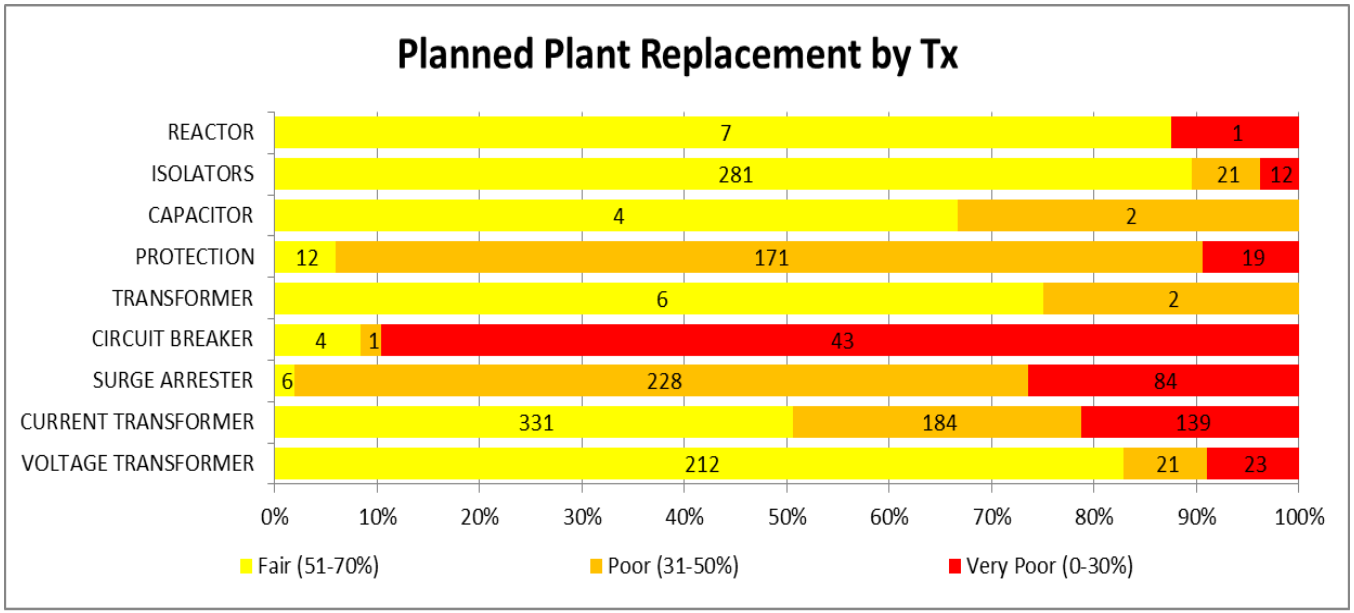
Asset Classes to be replaced

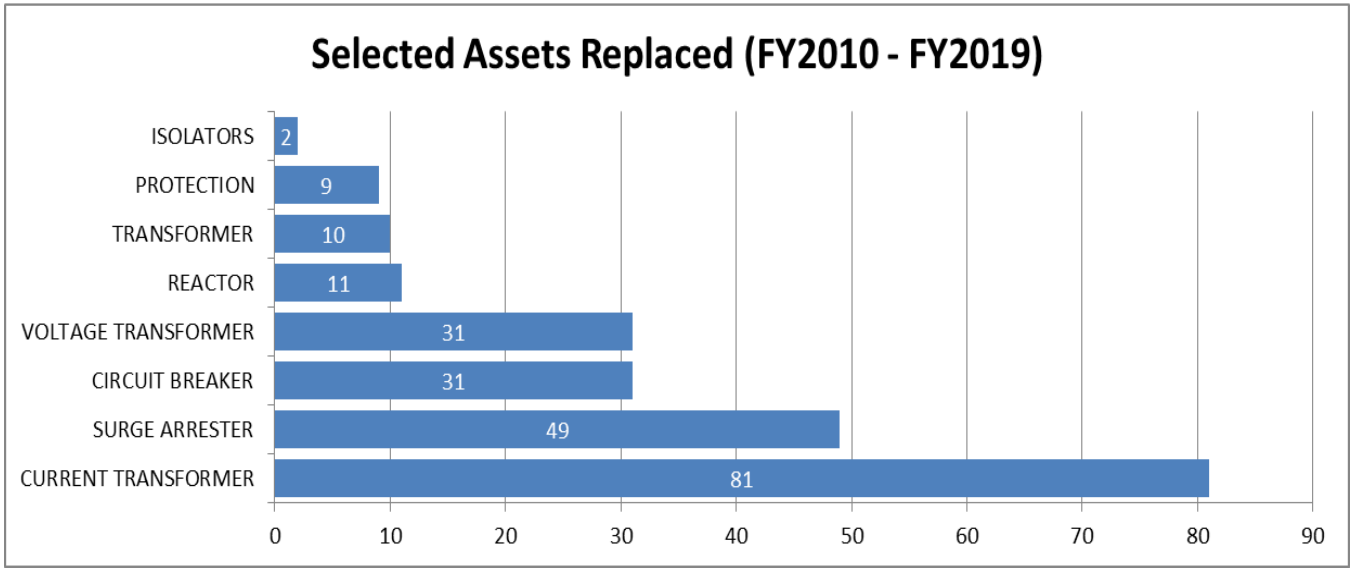
Number of Assets Planned for Replacement				
Asset Category	MYPD 4	FY23-FY25	> 6 YRS	Total
CAPACITOR	0	0	1	1
CIRCUIT BREAKER	10	15	43	68
CONTROL	0	3	4	7
CURRENT TRANSFORMER	96	87	114	297
DC & STANDBY	0	18	51	69
GIS	0	6	0	6
ISOLATORS	55	84	165	304
METERING	0	4	4	8
PROTECTION	8	37	91	136
QUALITY OF SUPPLY	0	1	2	3
REACTOR	1	3	0	4
SURGE ARRESTER	90	60	225	375
TELECOMMUNICATIONS	8	24	31	63
TRANSFORMER	7	11	12	30
VOLTAGE TRANSFORMER	12	39	47	98

Free State Province

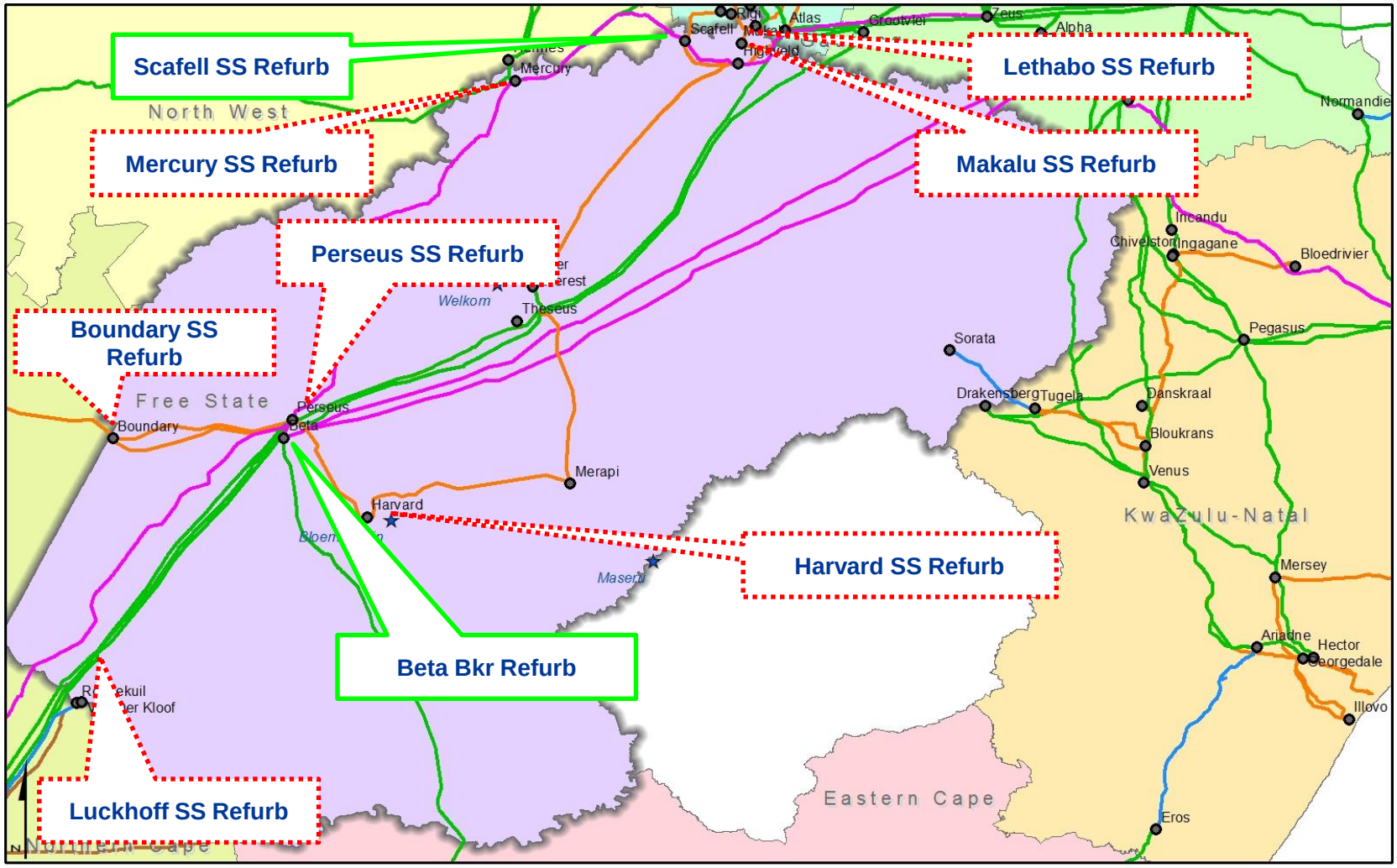
2020 – 2029 TNRP

Free State Province: Asset Replacement Profile





Major Substation Refurbishment per MTS



Existing Substations Existing Lines
Towns
132 220 275 400 765

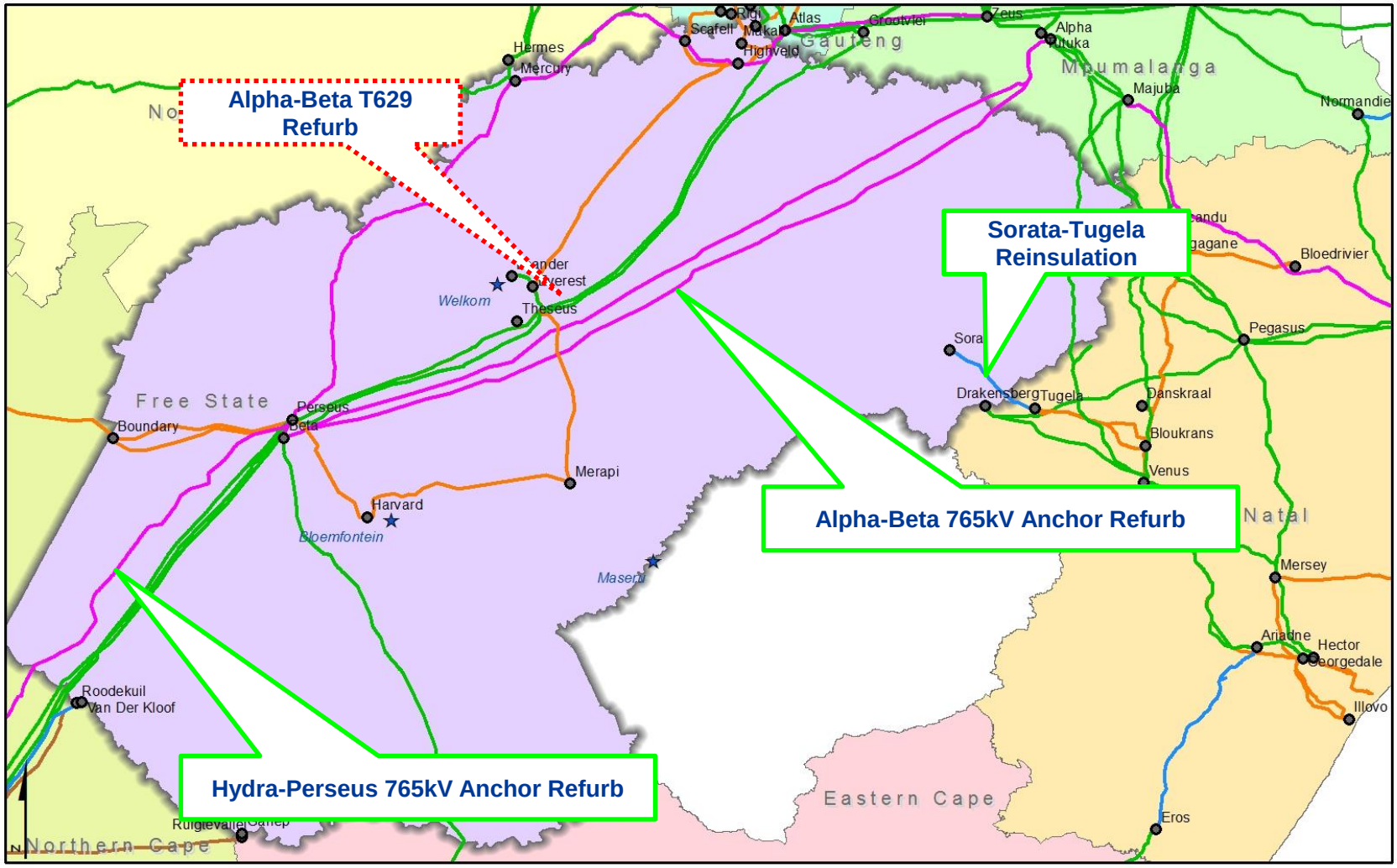
Free State

Eskom
Created by: Sonja Ferreira
Date: 2019/05/28

0 25 50 100 150 200 Km

This map has been compiled by ESKOM Grid Planning department to the best of their knowledge. However, since various data sources have been used Grid Planning department cannot accept responsibility for any inaccuracies.

Major Line Refurbishment



This map has been compiled by ESKOM Grid Planning department to the best of their knowledge. However, since various data sources have been used Grid Planning department cannot accept responsibility for any inaccuracies.

Asset Classes to be replaced

Number of Assets Planned for Replacement				
Asset Category	MYPD 4	FY23-FY25	> 6 YRS	Total
CAPACITOR	0	0	2	2
CIRCUIT BREAKER	2	11	31	44
CURRENT TRANSFORMER	165	48	86	299
DC & STANDBY	0	8	0	8
ISOLATORS	9	89	128	226
METERING	0	0	8	8
PROTECTION	5	42	53	100
REACTOR	0	0	1	1
SURGE ARRESTER	15	66	137	218
TELECOMMUNICATIONS	4	11	14	29
TRANSFORMER	2	0	2	4
VOLTAGE TRANSFORMER	6	76	25	107

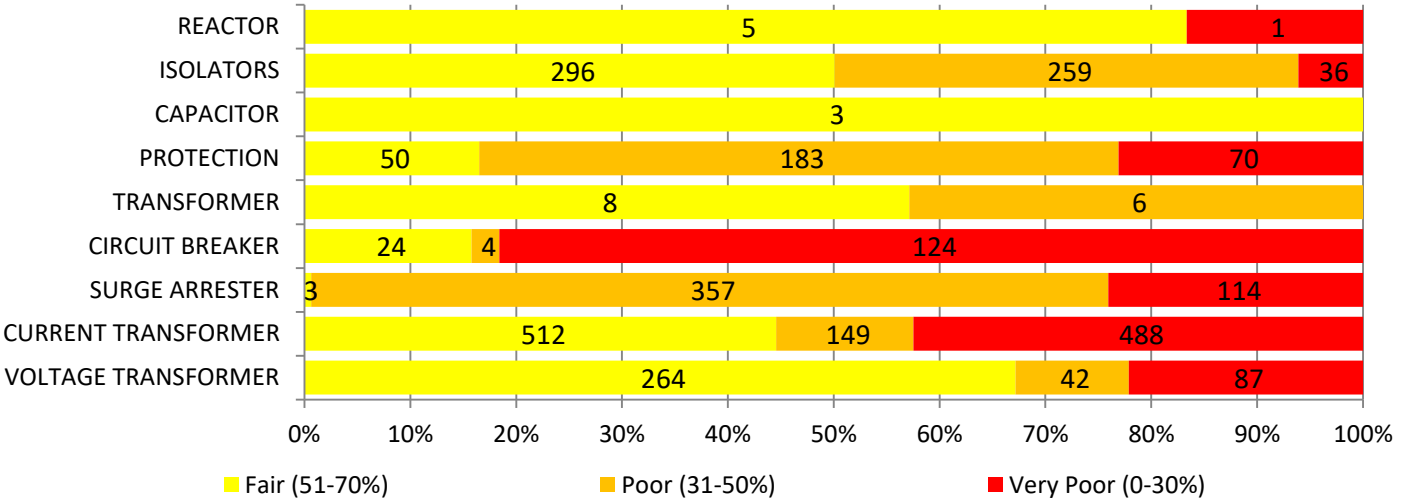
Mpumalanga Province

2020 – 2029 TNRP

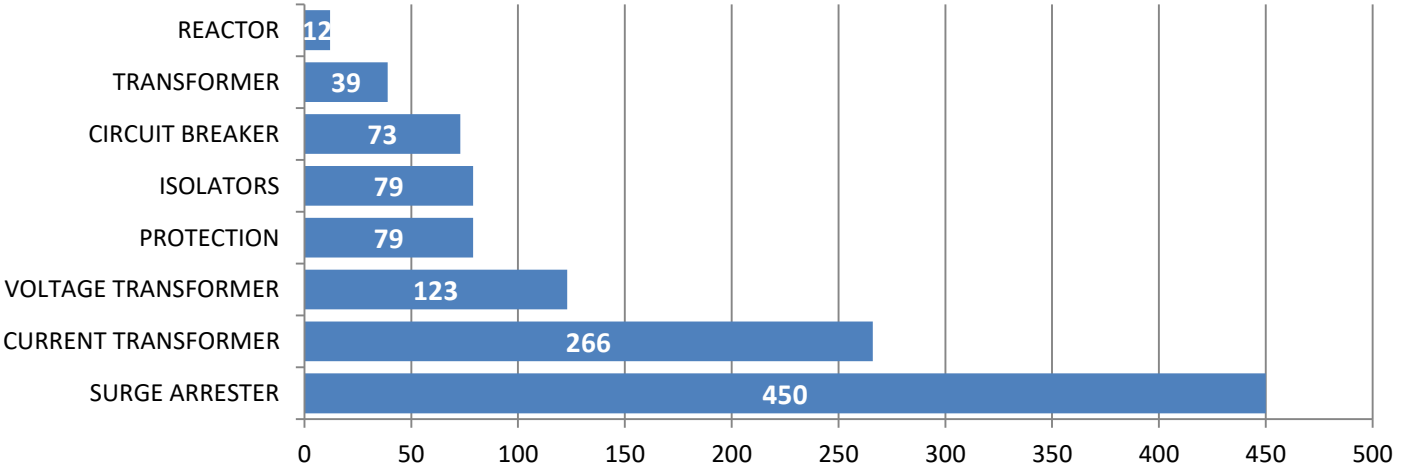
Presented by Calvin Govindasamy

Mpumalanga Province: Asset Replacement Profile

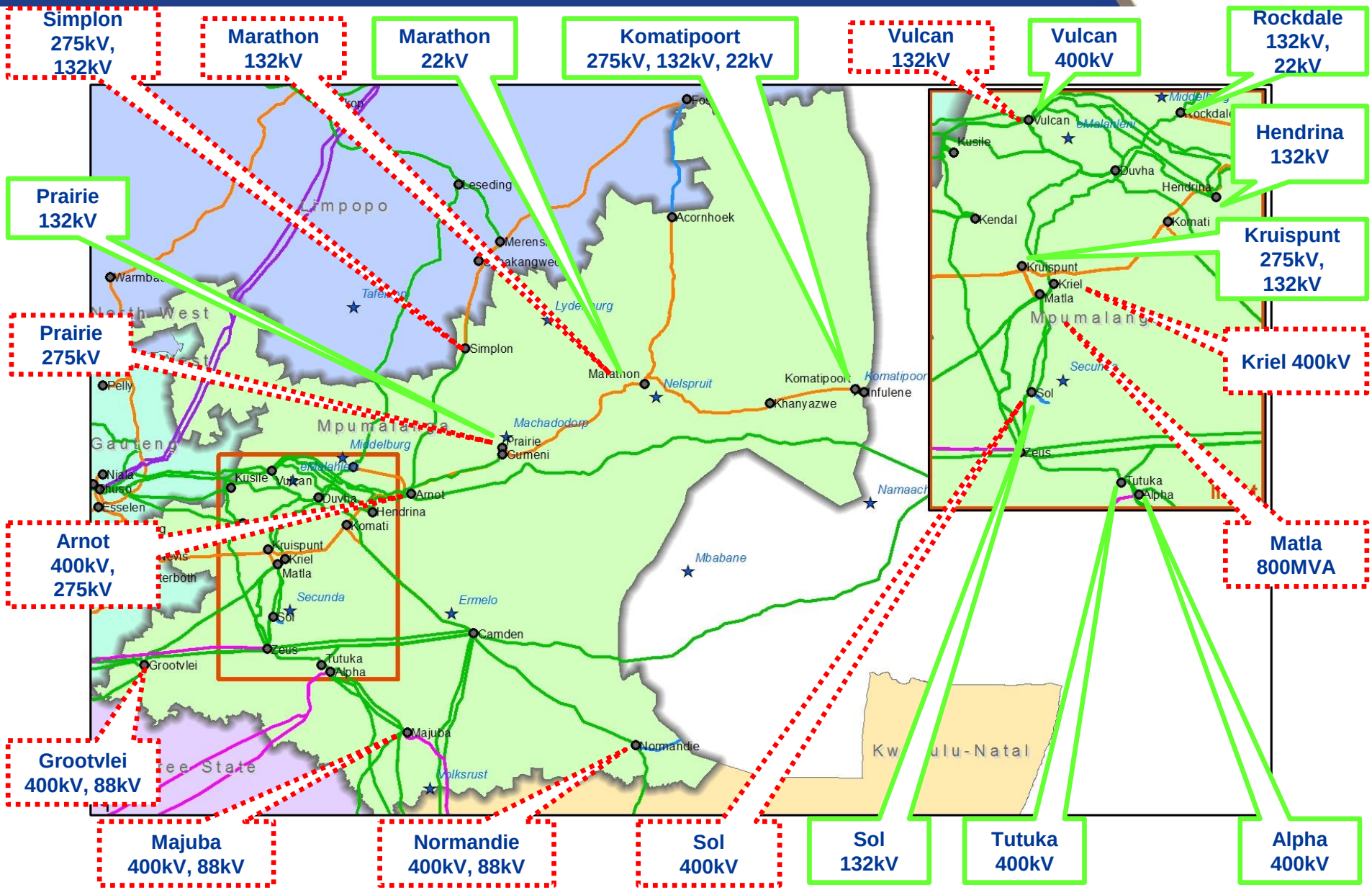
Planned Plant Replacement



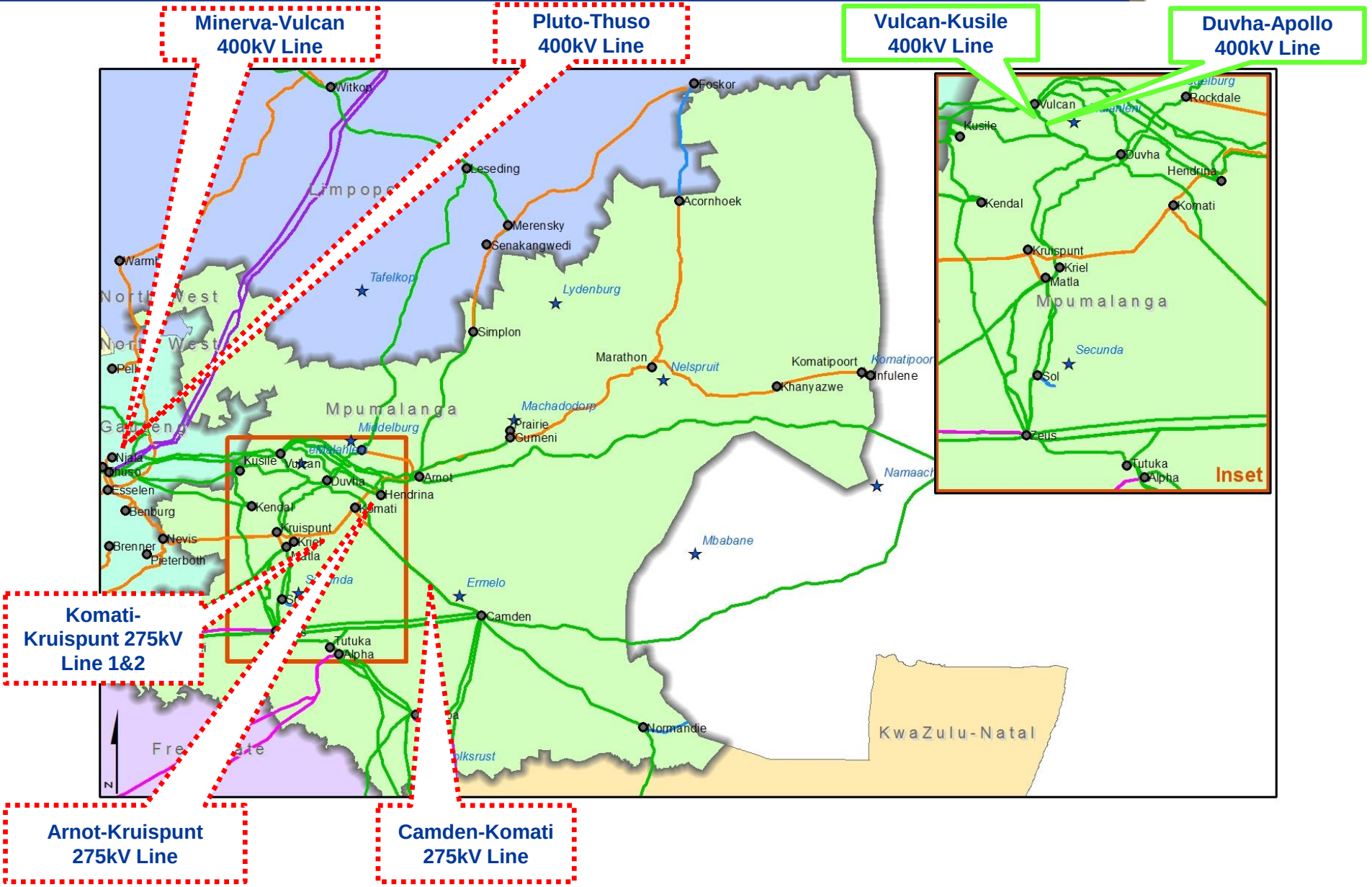
Selected Assets Replaced (FY2010 - FY2019)



MP: Major Substation Refurbishment Projects



MP: Major Line Refurbishment Projects



Mpumalanga: Number of Assets Planned for Replacement per category

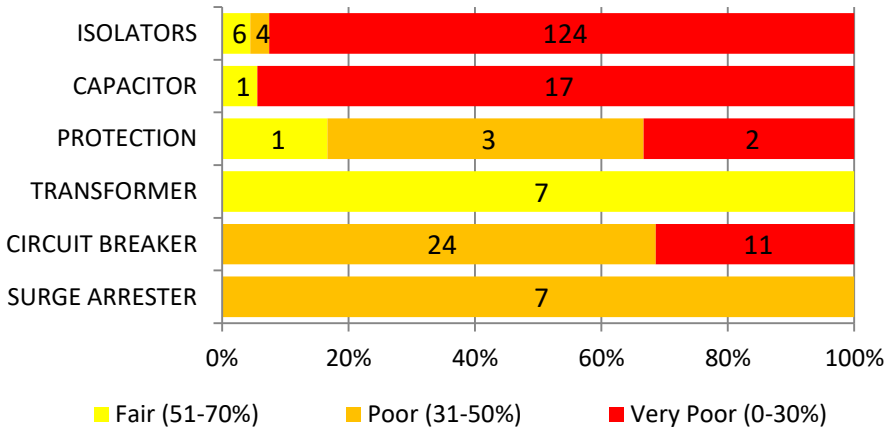
Asset Category	MYPD 4	FY23-FY25	> 6 YRS	Total
CAPACITOR	0	0	2	2
CIRCUIT BREAKER	59	26	81	166
CURRENT TRANSFORMER	236	90	425	751
ISOLATORS	202	111	345	658
PROTECTION	66	39	128	233
SURGE ARRESTER	140	137	297	574
TELECOMMUNICATIONS	33	0	3	36
TRANSFORMER	2	2	2	6
VOLTAGE TRANSFORMER	93	51	158	302

Apollo HVDC Converter Station

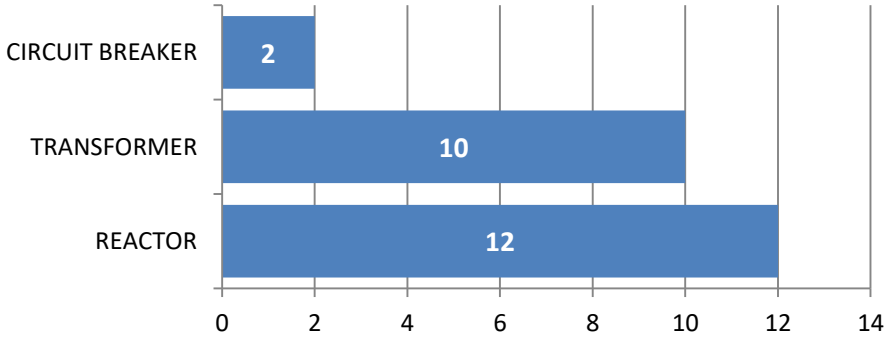
2020 – 2029 TNRP

Apollo HVDC: Assets Planned for Replacement

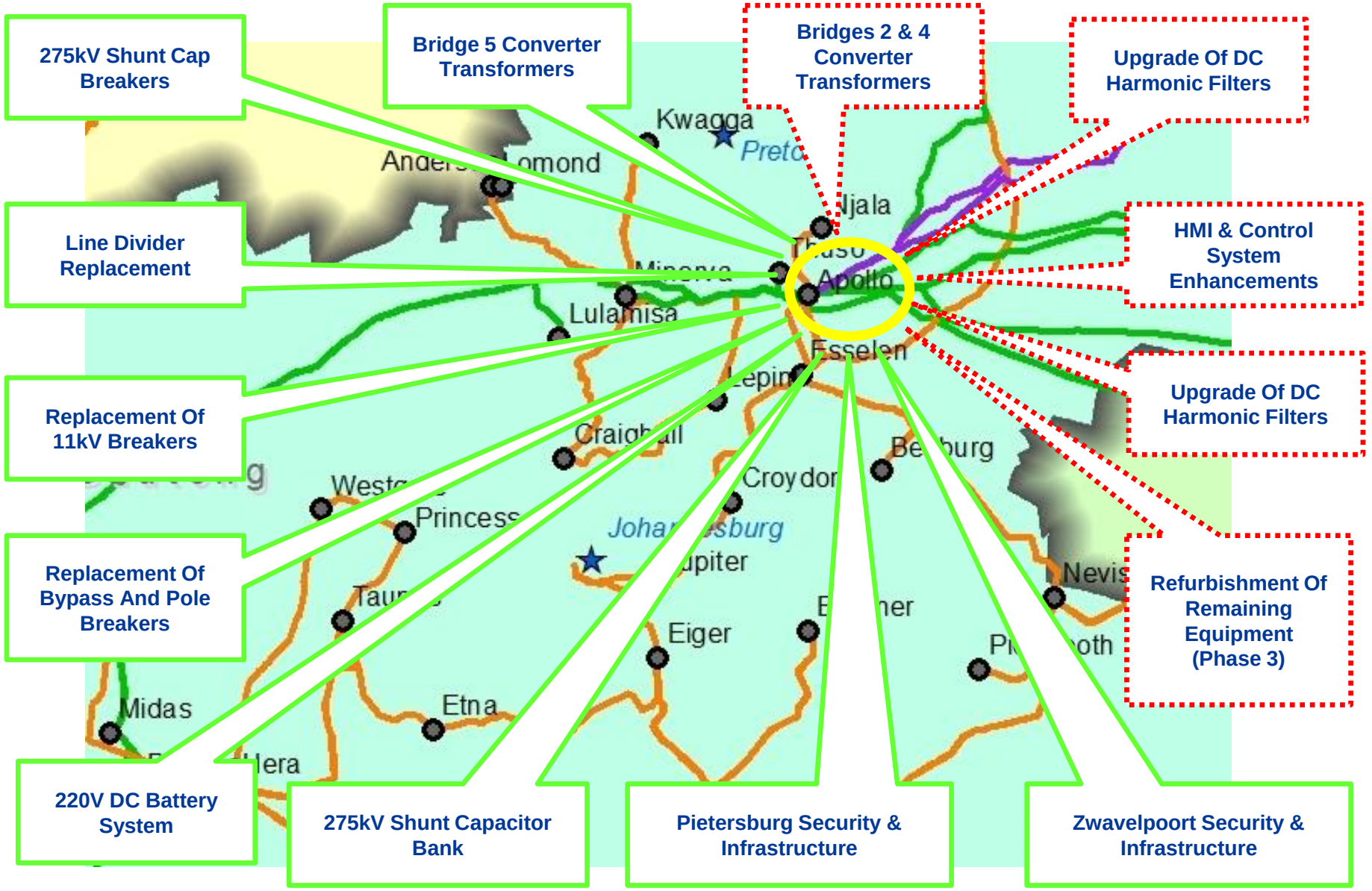
Planned Plant Replacement by Tx



Selected Assets Replaced (FY2010 - FY2019)



Gauteng Province (Apollo HVDC)



Apollo HVDC: Assets Planned for Replacement

Number of Assets Planned for Replacement				
Asset Category	MYPD 4	FY23-FY25	> 6 YRS	Total
CAPACITOR	2	2	0	4
CIRCUIT BREAKER	44	0	0	44
CURRENT TRANSFORMER	0	0	0	0
DC & STANDBY	4	0	0	4
HIGH VOLTAGE DC	2	0	0	2
ISOLATORS	0	115	0	115
PROTECTION	0	4	0	4
SURGE ARRESTER	0	8	0	8
TRANSFORMER	3	3	3	9

Conclusion

- Transmission has a robust planning process to determine asset replacement requirements, which is aligned to Asset Management principles.
- The current 10 year Transmission refurbishment plan is a good reflection of the needs of the network since it is based on asset condition assessments, asset criticality and network risks.
- The prioritisation process that was employed in developing the portfolio of projects for the 10 year refurbishment plan, embodies the requirements and stipulations of the Grid Code. The plan is flexible enough to accommodate emerging operational risks and current requirements in addition to the planned asset replacement program.
- The plan supports two key strategic imperatives of Eskom Holdings:
  - "Ensure the reliability and availability of power capacity to support South Africa's economic growth ambitions."
  - "Continue capturing efficiencies in operating and capital costs to achieve a sustainable tariff path for the economy."
- Opportunities are pursued to enhance the current plan and secure resources to expedite the Refurbishment Plan.


Thank you

Transformer Refurbishment Strategy

Condition Assessment

- The end of life of transformers and reactors (or estimation) are defined by certain condition criteria which are calibrated into an asset health appraisal.
- The criteria used for the assessment evaluated the transformer/reactor:
  - insulation condition,
  - electrical condition,
  - auxiliary components and
  - the dissolved gas analysis of the insulating oil.
- This condition information (asset health appraisal) forms the basis for the equipment operation, maintenance and refurbishment strategies.

Maintenance

- Maintenance is based on the Manufacturer manuals, asset health appraisal, as well as Transmission procedures defined by Transmission Engineering

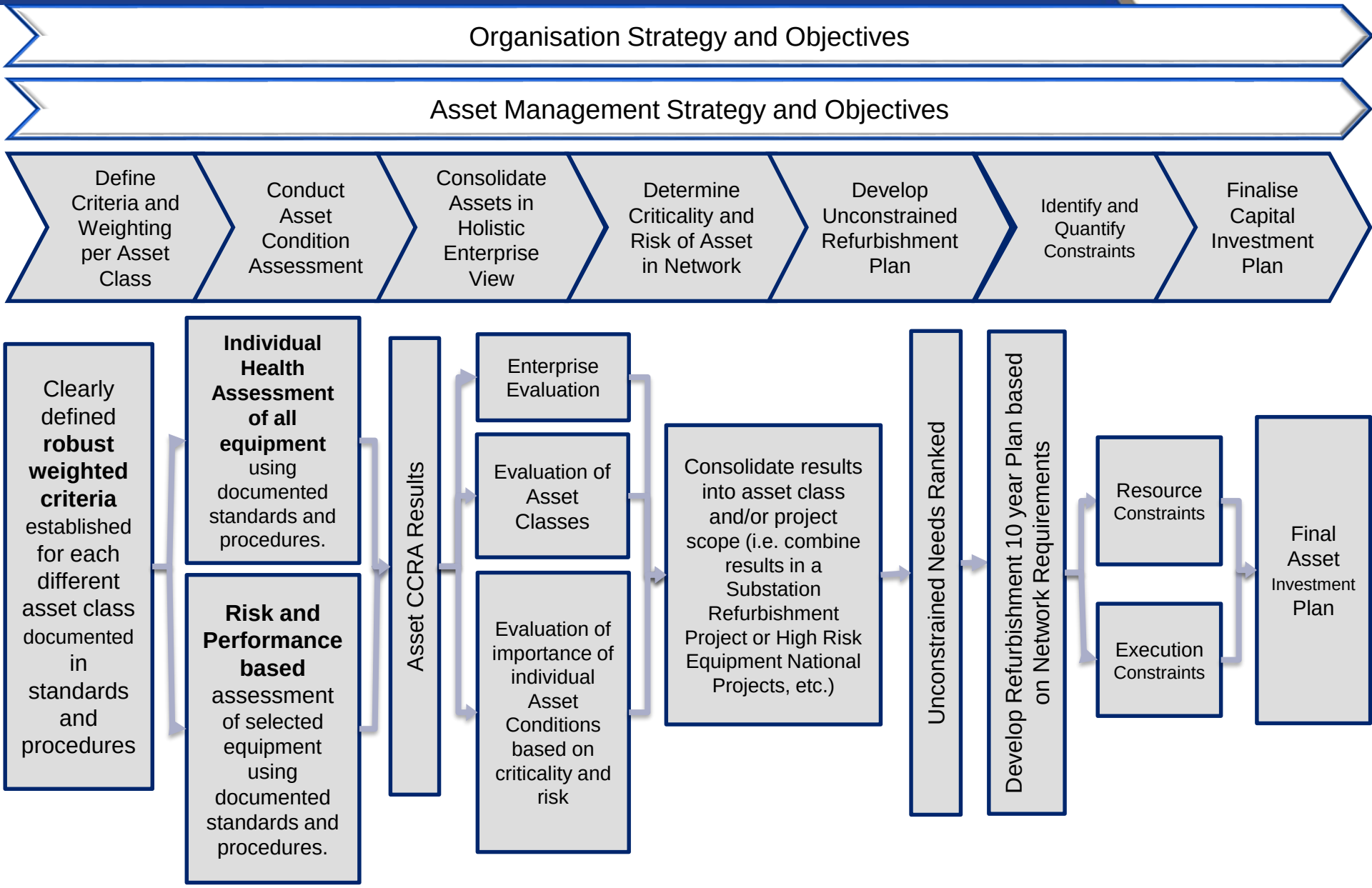
Asset Replacement

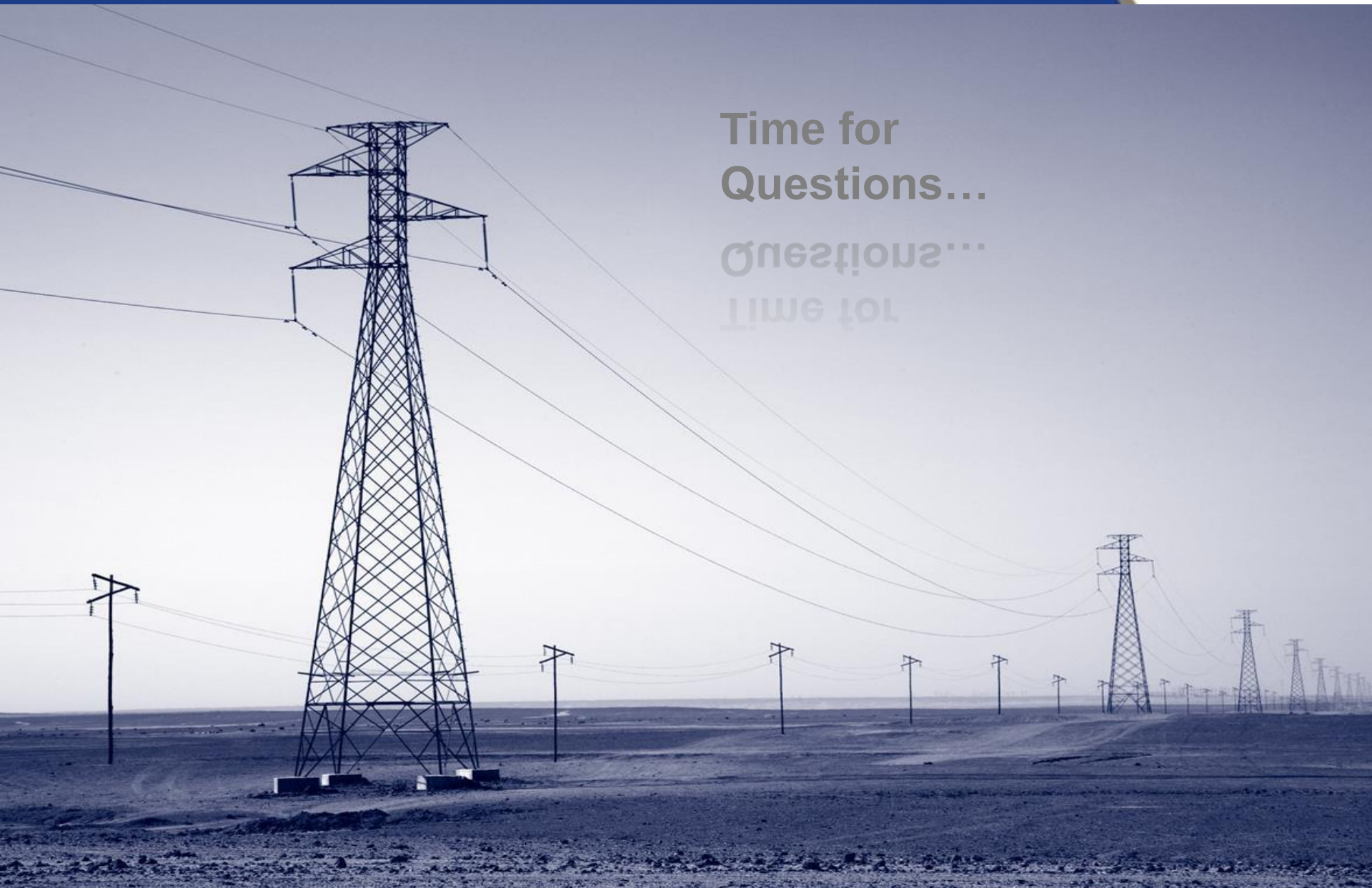
- Assets are replaced when they have reached the economic end of life or technical end of life, whichever comes first. Economic end of life brings risk to the customers into the decision which is the least economic criterion in the Grid Code.
- The least economic criterion warrants the replacement of assets when customer interruption costs, CIC (R/kwh) > costs to Eskom
- Optimising the capital budget involves prioritising and considering the best combination of refurbishment projects to reduce overall risk to customers and the network, given the financial constraints.

$$CIC > \frac{\text{Annualised Capex costs + Life cycle costs of new asset – Maintenance costs of old asset}}{\text{probability of failure x load lost x duration}}$$

- the probability of failure is a function of the condition of the asset

Transmission Network Refurbishment Plan Development Process



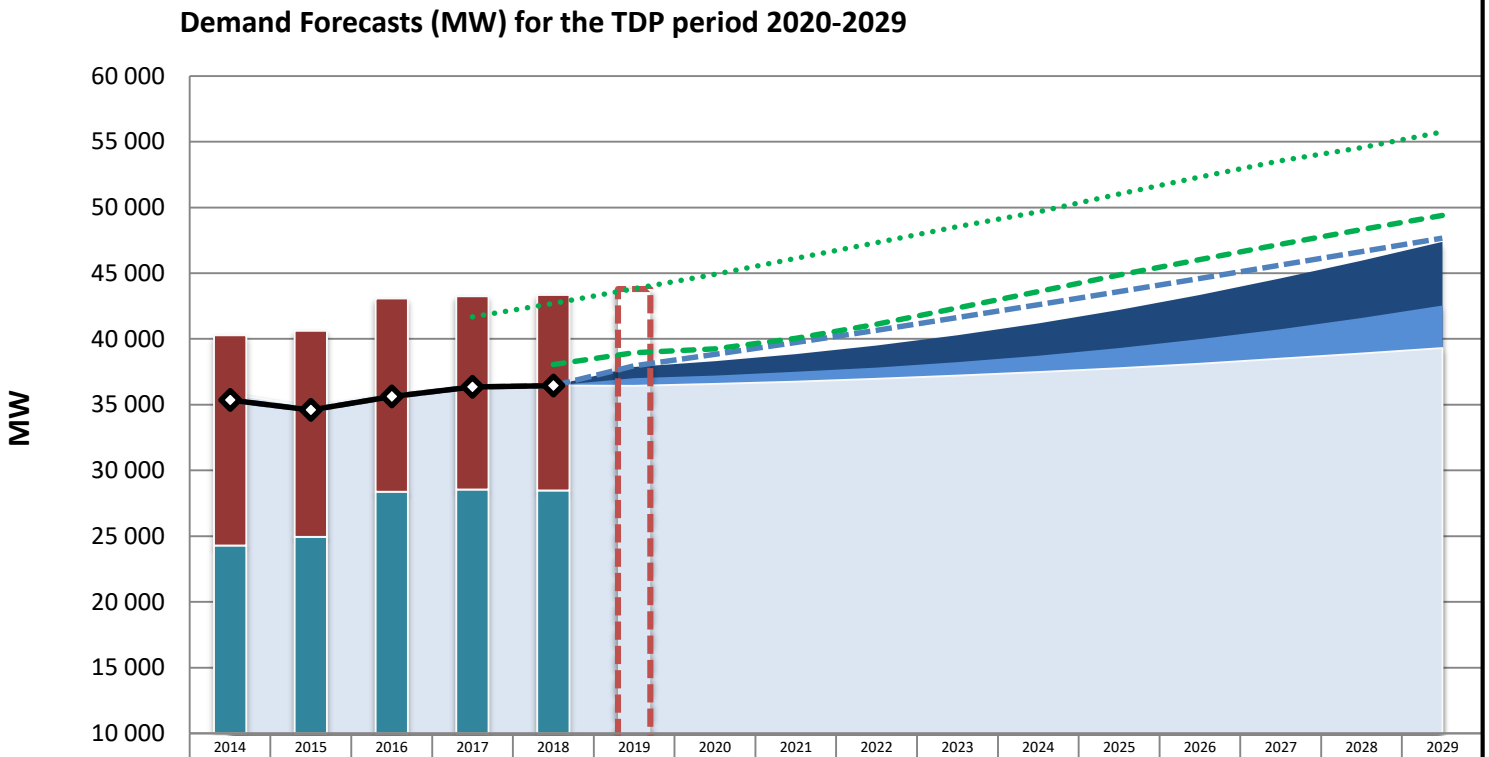

Time for
Questions…

Transmission Development Plan 2020 – 2029

Summary and Capex Analysis

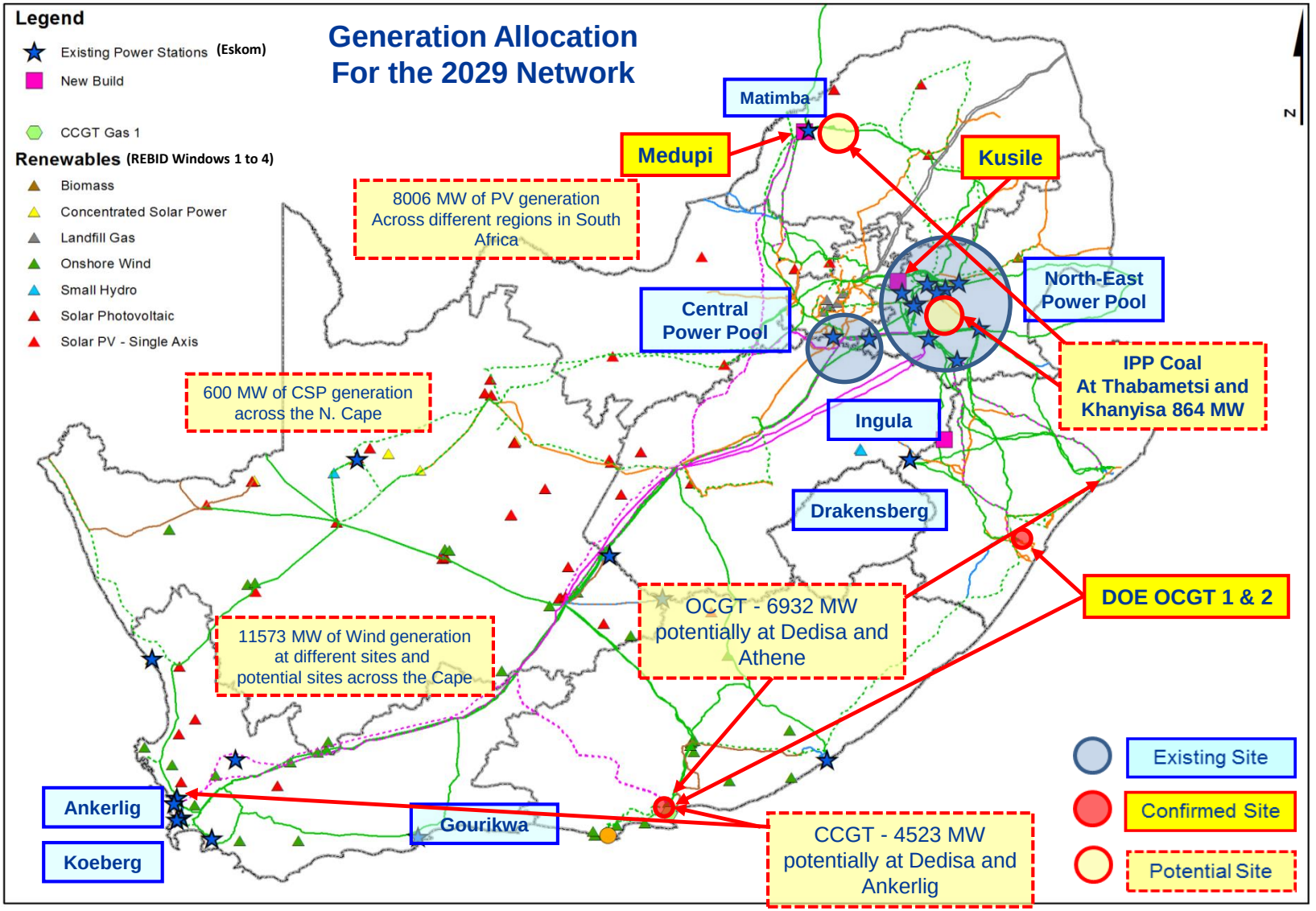
By: Makoanyane Theku
Manager: Infrastructure Planning Support

Recap: Transmission demand forecast and comparisons



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

Recap: Assumed Generation Pattern for the TDP 2019

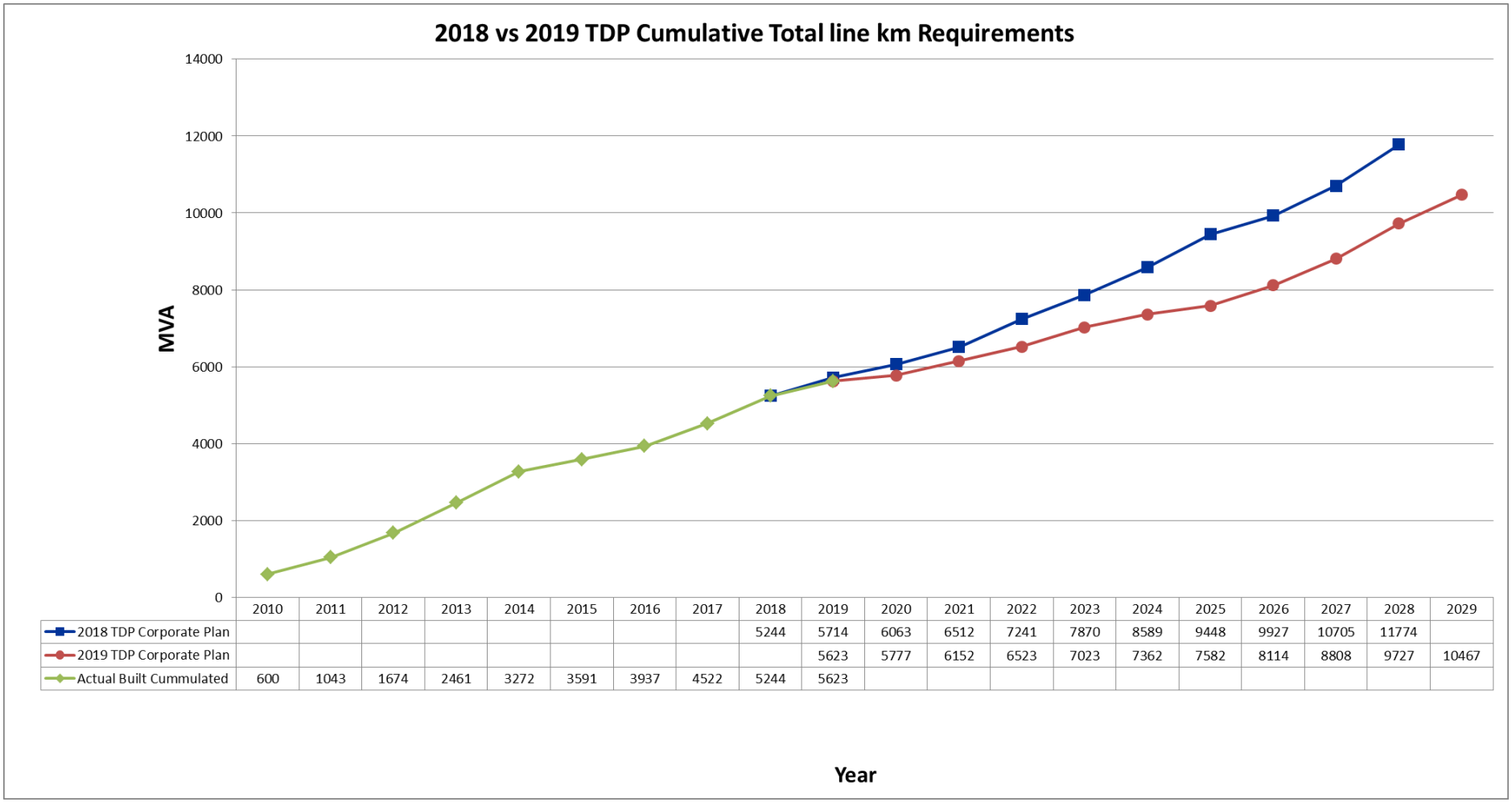


Summary of Transmission infrastructure requirements over the TDP Period

2019 TDP Plan

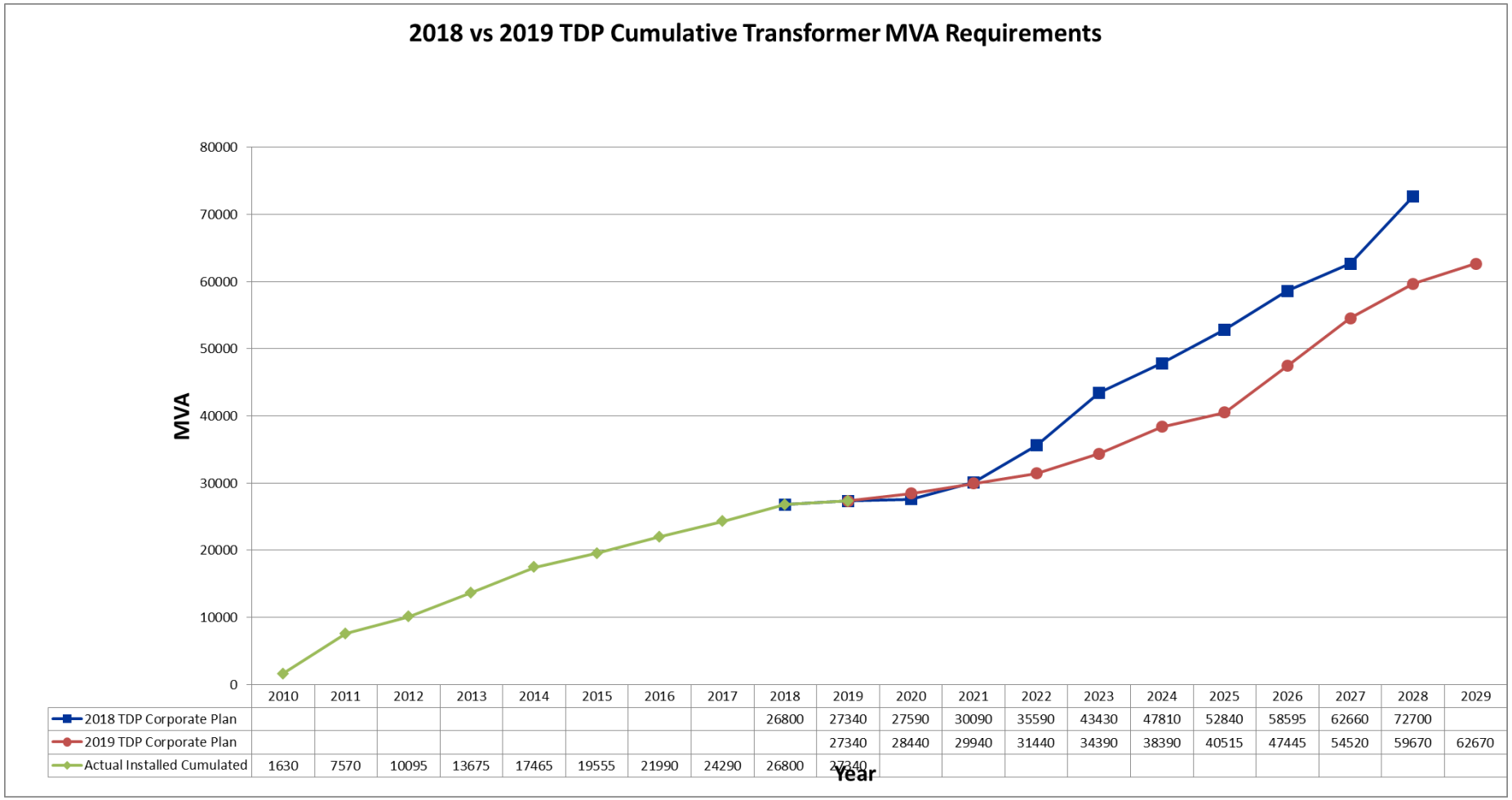
Transmission Assets: National View	New Assets expected in 2020 - 2024	New Assets expected in 2024 - 2029	Total New Assets
Power lines (km)			
765 kV	178	190	368
400 kV	1389	2793	4182
≤275 kV	172	122	294
Total length (km)	1739	3105	4844
Transformers			
Number of units	29	58	87
Total capacity (MVA)	11050	24280	35330

Transmission expansion plan: Transmission lines



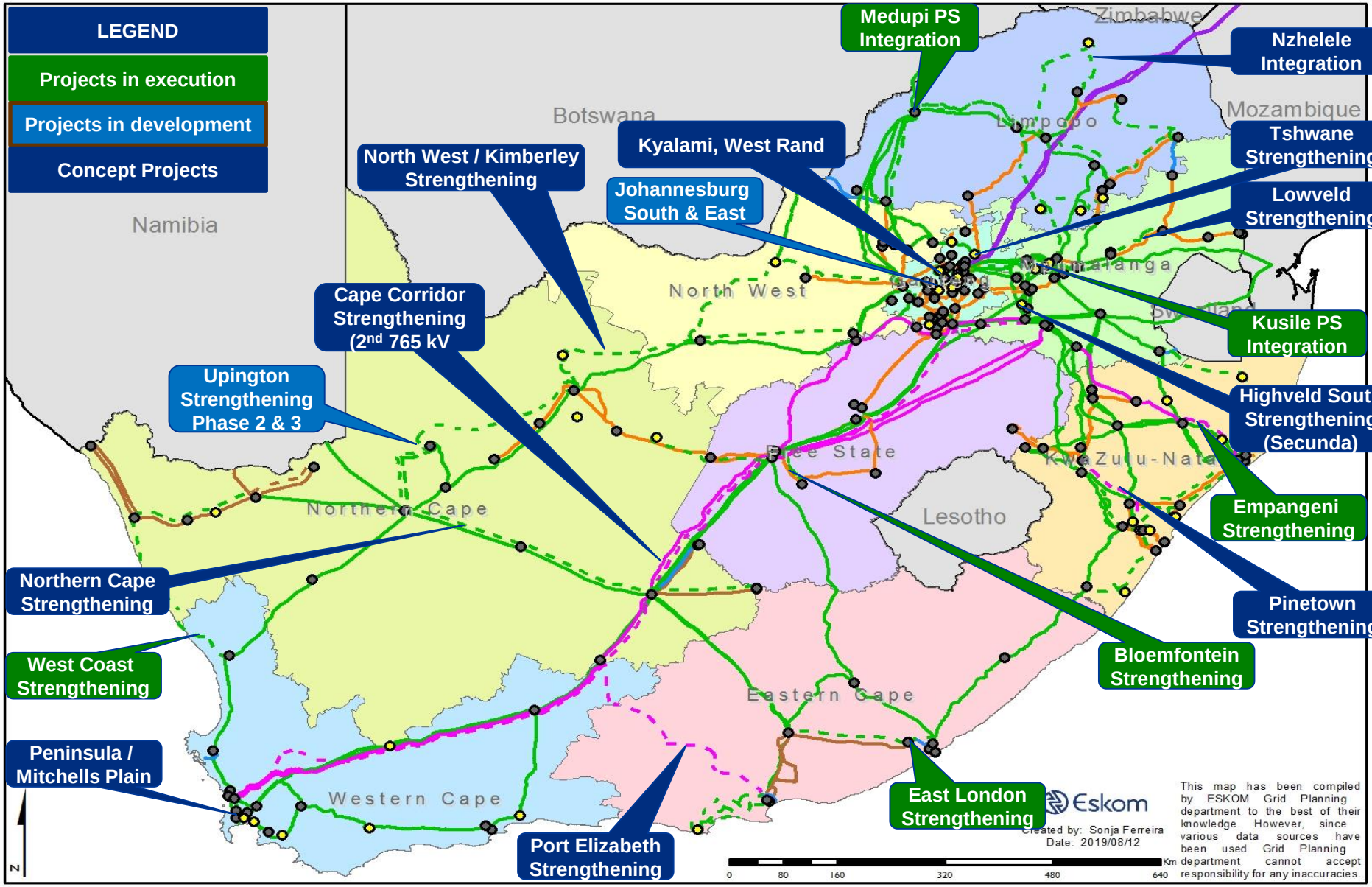
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
2018 TDP Corporate Plan									5244	5714	6063	6512	7241	7870	8589	9448	9927	10705	11774	
2019 TDP Corporate Plan										5623	5777	6152	6523	7023	7362	7582	8114	8808	9727	10467
Actual Built Cummulated	600	1043	1674	2461	3272	3591	3937	4522	5244	5623										

Transmission expansion plan: Transformer capacity



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
2018 TDP Corporate Plan									26800	27340	27590	30090	35590	43430	47810	52840	58595	62660	72700	
2019 TDP Corporate Plan										27340	28440	29940	31440	34390	38390	40515	47445	54520	59670	62670
Actual Installed Cumulated	1630	7570	10095	13675	17465	19555	21990	24290	26800	27340										

Major Projects planned in the TDP period



Transmission Capital Expenditure Drivers

1. **Capacity Expansion and Network Strengthening:**
   - Connection of new and anticipated customer loads and generation
   - N-1 reliability investments
   - Mitigation of fault-level exceedances (existing and anticipated)
   - Resolution of quality of supply excursions
   - Securing of servitudes and environmental authorisations
   - Compliance (Regulatory, OHSAct, Environmental etc.)

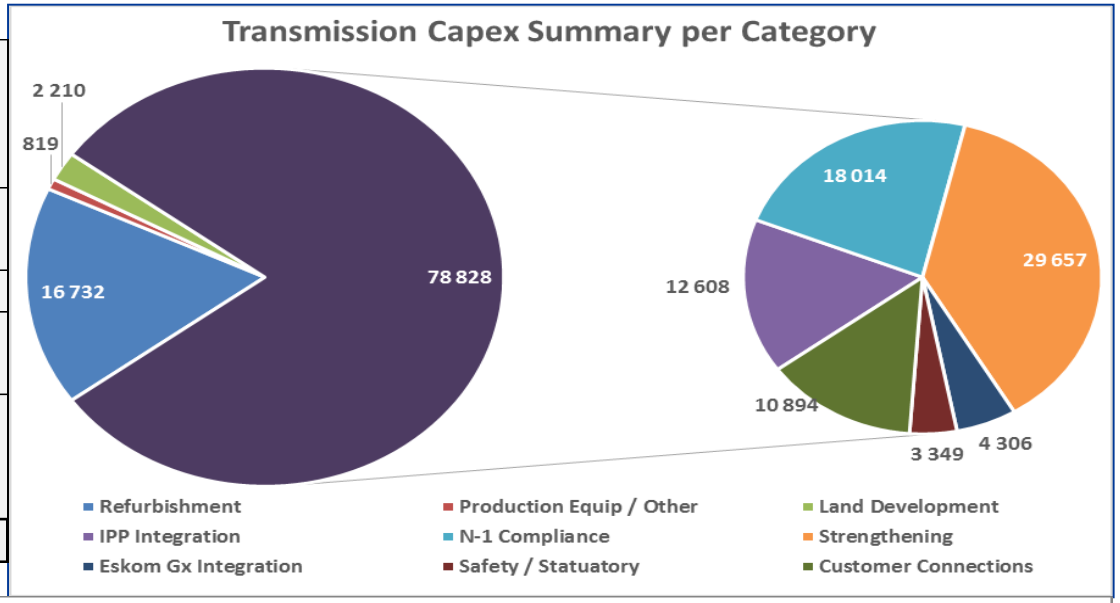
2. **Refurbishment** (i.e. Extension of life of existing assets):
   - Refurbishment of aging equipment (CTs, VTs, Surge Arresters, HV Circuit Breakers and Power Transformers)
   - Replacement of substation batteries and electronic components for protection and control systems, corroded conductors etc. (these not repairable)
   - Targeted asset performance improvements (lines and substation equipment)
   - Physical security improvements and surveillance and monitoring at our key assets and sites
   - Strategic and operational spares holding (to reduce SML<1 and MI risk)
   - Compliance (Regulatory, OHSAct, NKP Act, Environmental etc.)

3. **Asset Purchases:**
   - Specialised equipment for: live-line work; fault location systems, and online condition monitoring, etc.

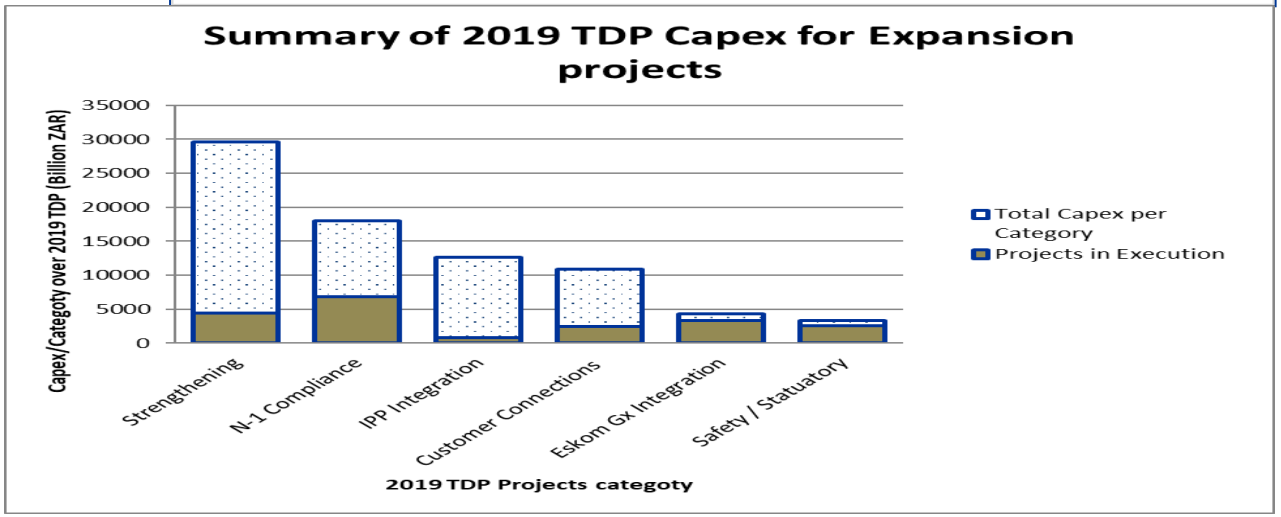
Transmission 10-year CAPEX Plan: FY2020 - 2029

Summary of Transmission Capex Plan (R Million) FY 2020 - 2029

Transmission Capex Category	Total: (FY19-28)
Capacity Expansion	78 878
Refurbishment	16 732
EIA and Servitudes	2 210
Production Equipment / other	819
	98 639



~R21bn of Capex is for projects in execution



Capex observations

The total Transmission Capital Plan amounts to R98.6 billion over the TDP period 2020 – 2029 of which:

- R79 billion is required for reliability (N-1) projects, integration of committed generation (Medupi, Kusile, IPPs) and connection of new loads and generation onto the system
- R20 billion is required for EIA and servitudes, refurbishment and production equipment

Risk to the TDP 2019

- Decision on Eskom's future MYPD applications may impact execution of the Transmission Development Plan
- The liquidity position of Eskom may impact the execution of the Transmission Development Plan
- The location of future IPPs may also impact the roll-out of new network reinforcements
- The time taken to acquire servitudes remains a challenge to the TDP roll out

Conclusions

- The demand forecast in the TDP assumptions compares favourably with all the forecasts (IRP and Eskom) and is therefore prudent
- The generation forecast assumptions will be sufficient to allow the 2019 TDP to meet the requirements of the IRP (Draft), and where necessary, sensitivity studies will be done to meet extreme conditions or stress test various scenarios
- We are confident that projects currently in construction will be completed in time
- We will continue engaging with our stakeholders to enable network access in anticipation of the Country's future demand and generation needs
- Investments in the Transmission infrastructure is a crucial enabler for economic growth and development

Questions?

Impacts of the IRP 2019

Presented by: Ronald Marais
Senior Manager: Strategic Grid Planning

Grid Insights - Network Capacity

Generation Connection Capacity Assessment 2022

Round 5 - Interest

Round 1 – 4B
(Low Hanging Fruits)

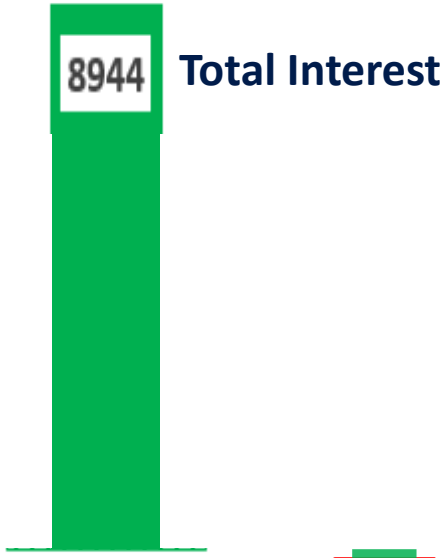
GCCA 2022 4B

beyond 4B→BW5 interest (expedited round)

Impact of the New IRP 2019 vs IRP 2018 Draft (referred to as IRP2018)

Available Capacity vs BW5 Interest

GCCA shows there is Capacity in FS, LP, MP and NW, but little interest for Round 5

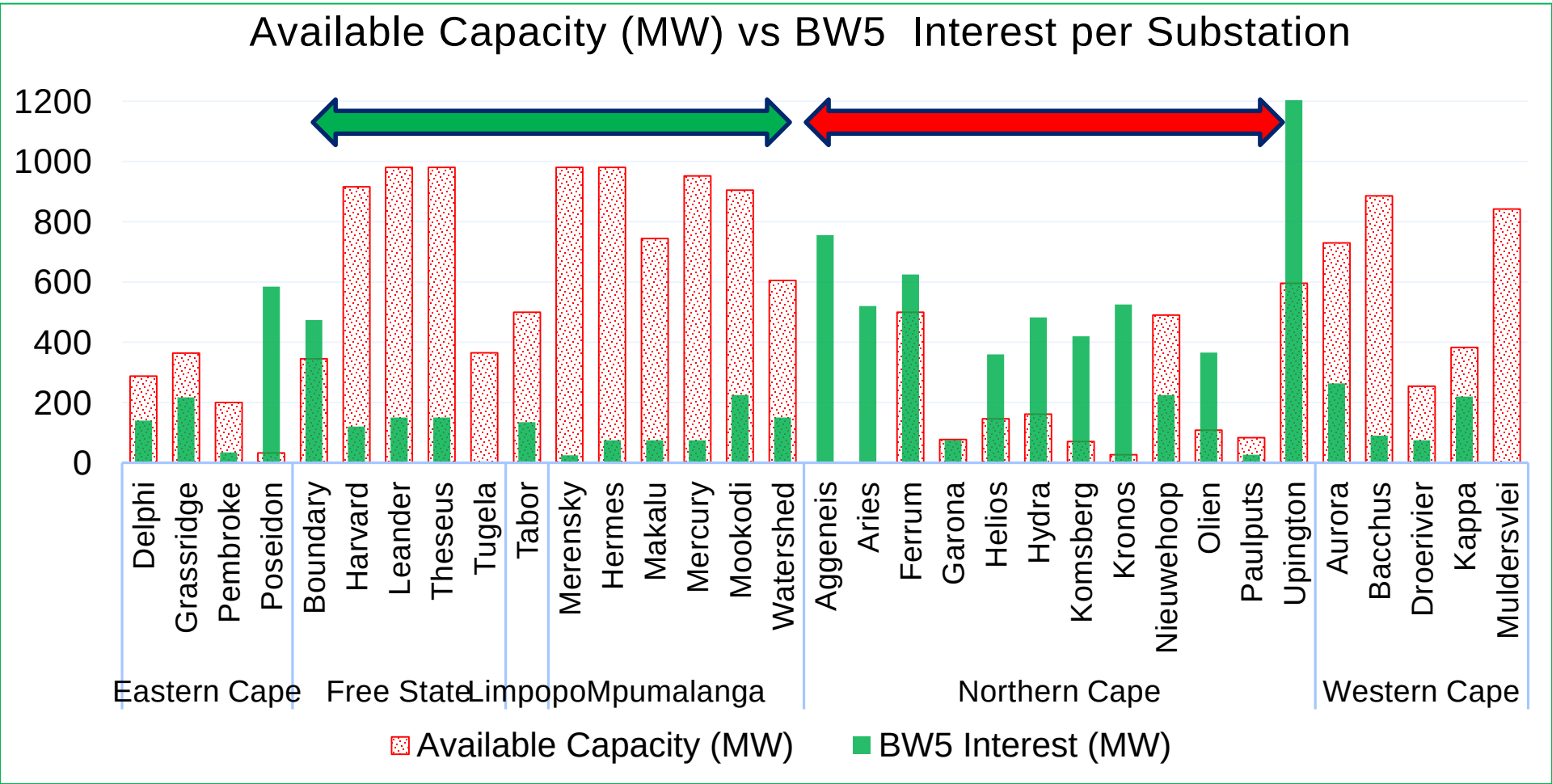


	Eastern Cape	Free State	Limpopo	Mpumalanga	North West	Northern Cape	Western Cape
Available Capacity	885	3586	500	980	4186	2260	3095
BW5 Interest	977	898	135	25	600	5656	653

Available Capacity BW5 Interest

Available Capacity vs BW5 Interest

- Interest in RE generation is inverse to network availability
- Capacity will have to be increased in deficit areas or generation must follow capacity



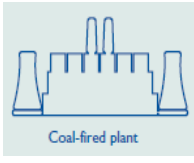
IRP 2019

2030

Eskom

IRP 2019

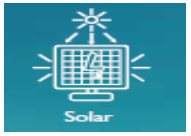
Gazetted in October 2019

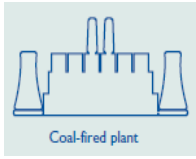
Type		MW	
Hydro		2500	0
CSP		300	0
PV		6814	330
Wind		15762	6300
Storage		2088	2088
Gas & Diesel		3000	5100
Nuclear		0	0
Coal		7232	500

IRP 2019 Impact

2029

	IRP2019	IRP2018	Change
Hydro	0	0	0
CSP	300	300	0
PV	5814	5484	330
Wind	14162	7862	6300
Storage	2088	0	2088
Gas & Diesel	3000	8100	5100
Nuclear	0	0	0
Coal	7232	6732	500



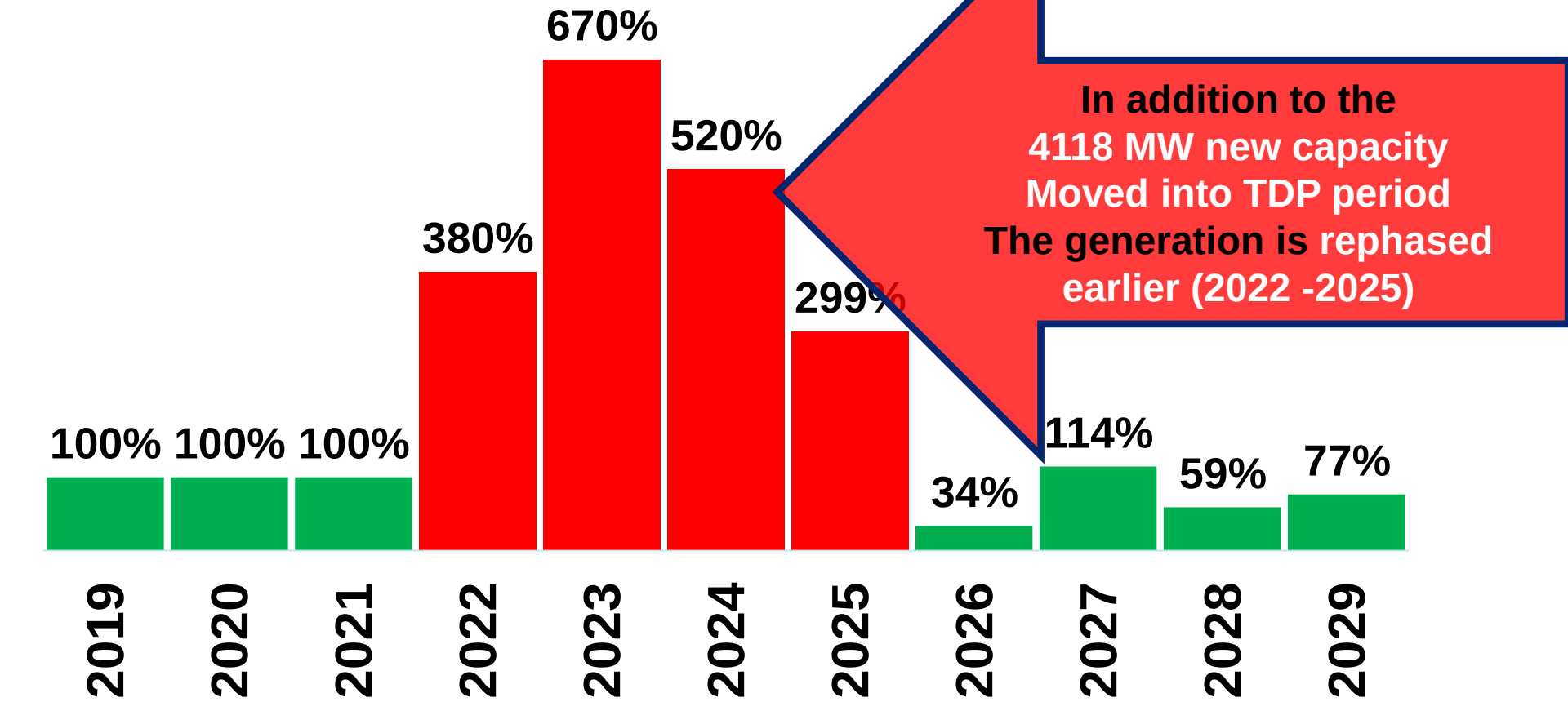


4118

4118MW Increase in capacity within the TDP period

IRP 2019 vs IRP 2018 Draft
% Change in capacity to be installed per year

100% - capacity installed remains the same in IRP 2019 vs IRP 2018
>100% - increase in capacity
<100% - decrease in capacity

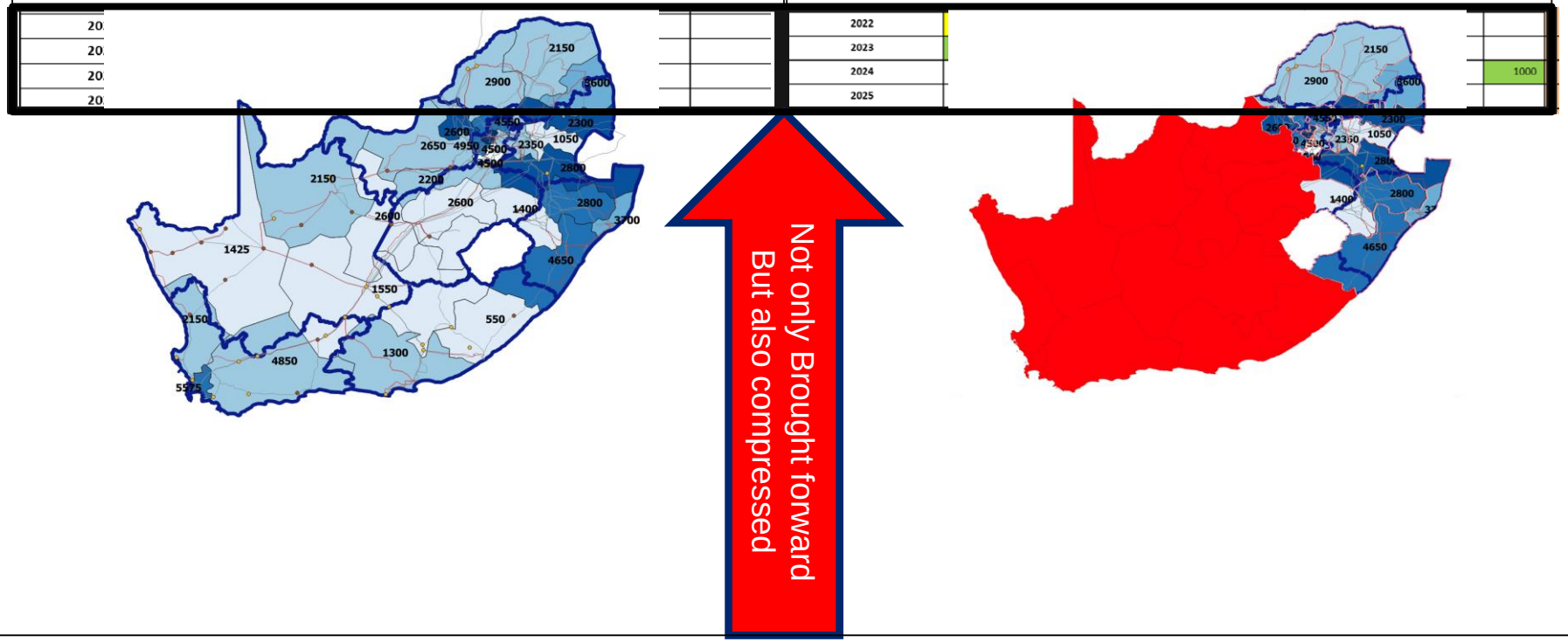


New capacity and rephasing will require acceleration of TDP projects and local substation strengthening.

IRP 2019 vs IRP 2018
Impact by 2025 - New Pressure on Grid Capacity

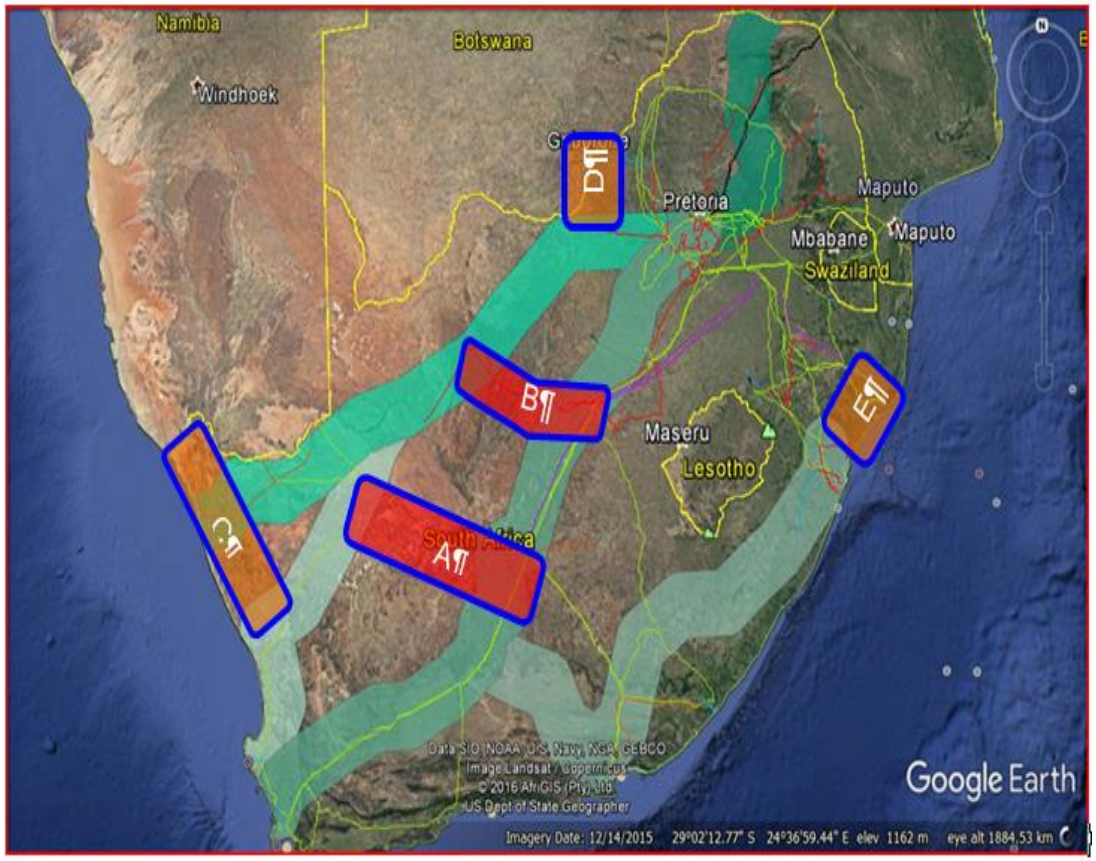
Additional 9.793 GW to be installed by 2025

1.87 GW	11.66 GW

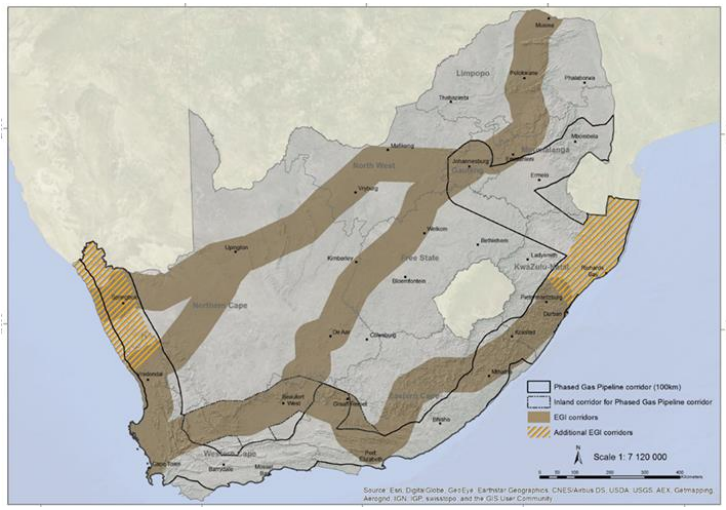


Developing new Tx capacity in this time frame will be challenging. Most likely existing Tx capacity to be exploited first and local substation strengthening.

Additional Corridor Requirements & Strategic Servitudes required



- Previous strategic studies indicated a need to supplement the corridors
- Gas corridor (SEA) studies will supplement electricity corridors and the request has been included in the study



Summary

4118 MW new capacity included in the TDP window

Rephasing of capacity into the period 2022 – 2025

9793 MW increase of capacity between 2022 – 2025

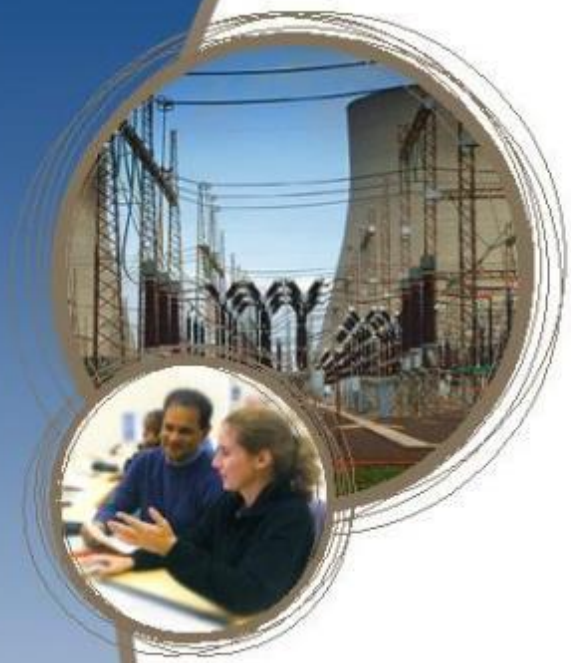
New capacity and rephasing will require acceleration of existing TDP projects, development of new corridors and substation strengthening.

Developing new Tx capacity in this time will be challenging from a servitude, EIA and capital perspective.

Most likely existing Tx capacity will need to be capitalized first.

Co-ordination of wind and solar locations will be important not to sterilize technology capacity integration

Streamlining the process and co-operation/partnership from RE association, DOE, IPP Office etc will be key to the success of the implementation of the IRP 2019



Thank you