The Eskom Transmission Development Plan 2019 - 2028

25 October 2018
The Eskom Transmission Development Plan 2019 - 2028

(TDP 2018)

Public Forum

25 October 2018
Keynote address

By: Willy Majola

Group Executive: Transmission (Acting)
Setting-the-scene

Presented by: Mbulelo Kibido

General Manager: Transmission Grid Planning
Desired Outcomes for this Public Forum

• Contextualise the planning timelines relating to the demand forecast and generation patterns

• Share assumptions and results from the Transmission Development Plan 2019 – 2028

• Share information and results relating to the integration of IPPs as per the DOE IPP programs and address future requirements as per the IRP

• Share information on the estimated Transmission Capital Investment Requirements for period 2019 – 2028

• More importantly, to solicit comments and further inputs to improve these plans
The TDP 2018 was formulated to address the following, subject to the Eskom Corporate Plan:

- Attain Grid Code compliance by resolving both substation and line violations
- Determine new network infrastructure requirements to sustain and allow for future demand growth
- Determine new network infrastructure requirements to integrate new generation (Eskom and IPPs)
- Provide detail on the refurbishment requirements of the Transmission network.
Recent Transmission Network Expansion Successes
Significant grid expansion over the last decade: integrated ~11 GW new generation; ~8000 km of new transmission lines, and ~37000 MVA substation capacity
Eskom has committed Capital to enable the integration of successful bidders (Bid Window 1 – 4B, including Small REIPPs) into the National Grid.
Summary of Major Transmission Expansion Projects Completed Recently

Transformation Projects:
1. Rustenburg - Bighorn
2. Polokwane - Tabor
3. Peninsula - Acacia
4. Mpumalanga – Malelane & Komatipoort
5. Tshwane - Thuso
6. Northern Cape - Ferrum
7. KZN – Avon, Incandu, Mersey
8. Upington Substation integration

Kimberley Strengthening
Mercury-Vryburg-Ferrum

Lewensaar: New Traction Substation

Cape Corridor 1st 765kV:
Zeus - Gamma

Upington Substation integration

Cape Corridor 1st 765kV:
Gamma – Sterrekus

Witkop - Tabor
400kV injection

Thuso (Verwoedburg) Substation

Kimberley Strengthening
Mercury-Vryburg-Ferrum

Kusile Integration
1st & 2nd Units

Majuba - Umfolozi
1st 765kV into KZN

East London Strengthening
Eros – Vuyani – Neptune

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.
The Different Plans

**Integrated Resource Plan (IRP)**
- The Department of Energy (Energy Planner) is accountable for the Country Electricity Plan, which is called the Integrated Resource Plan For Electricity (IRP 2016 - draft).
- 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 years 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 Assumptions

Presented by: Ronald Marais
Linkages Between the Various Plans

- Expected demand
- Current capacity and expected projects
- Resource constraints
- Implementation strategy

Adequacy criteria
Determine energy and capacity shortfalls
Policy
Select options
Integrated Resource Plan (IRP)

Disaggregate Demand Spatially
Disaggregate Generation Pattern Spatially
Select robust generation scenarios

Strategic Network Scenario Analysis

20 Year Strategic Grid Plan
20 Year Distribution Master Plan
Connection Applications & Capacity Programmes
Detailed Network Analysis
Distribution Network Development Plans

Adequacy Criteria: Voltage Limits Thermal Rating N-1 Contingency N-2 Contingency

10 Year TDP

Not Eskom Driven
Eskom Driven
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

**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

### Change in Location - Spatial Footprint

<table>
<thead>
<tr>
<th>Current Generation Footprint</th>
<th>Future Generation Potential Footprint</th>
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</thead>
</table>

### Change in Construction 3yr - 5yr Speed of IPP plant rollout

<table>
<thead>
<tr>
<th>Strategic EIAs &amp; Servitudes can enable faster grid development</th>
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</table>

### Transmission Line Project Timeline

<table>
<thead>
<tr>
<th>Phase</th>
<th>Timeframe</th>
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<tr>
<td>1. Strategic Investment in the EIAs &amp; Land acquisition</td>
<td>is critical to meet future IRP connection timeframes</td>
</tr>
<tr>
<td>2. Reducing Tx investment today compounds future Tx Grid roll out leading to high risk of Gx capacity delays</td>
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</table>

**Beyond 2020 Demand Balance significantly changed by dispersed generation in South**

Change of Spatial Footprint into areas with limited Demand requires additional Transmission Capacity

Need to reduce the time to increase grid access by investing in strategic access and corridors servitudes
### Demand Assumptions

**IRP compared to TDP**

#### Demand Forecasts (MW) for the TDP period 2019-2028

**INTEGRATED RESOURCE PLAN 2018**

- **Existing & Committed**
- **IRP4**
- **IRP2**
- **Growth gap line**
- **Existing generation (2020) energy**

**Total Capacity Gap**

- **Decommissioning**
- **Growth**

**Figure 22: Illustration of Capacity and Energy Driver**

<table>
<thead>
<tr>
<th>Year</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
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<td>41.0</td>
<td>41.7</td>
<td>42.3</td>
<td>43.0</td>
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Generation Assumptions
IRP compared to TDP

2018 Base assumptions Generation Comparision of IRP vs TDP

Incease in Generation Comparision of IRP vs TDP between 2019 -2028

Decrease in Generation Comparision of IRP vs TDP between 2019 -2028
TDP Change in Generation Capacity

**Generation 2018 Overview**
- MW 52638

**Change in Gx 2019 - 2028**
- Gx In: 25241
- Gx Out: -3817
- Total: 21424

**Generation 2028 Overview**
- MW 74062

- Conventional: 11886 (47%)
- Renewable: 13355 (53%)
- Import: 1500 (3%)
- Conventional: 75%
- Renewable: 23%
- Import: 2%
visualisation
Change in mix & location

52GW
- Coal 73%
- Pumped storage 5%
- Wind 4%
- PV 3%
- Gas OCGT 6%
- CSP 1%
- Nuclear 4%
- Hydro 1%
- Import 3%

74GW
- Coal 56%
- Wind 13%
- PV 9%
- Pumped storage 4%
- Gas OCGT 9%
- CSP 1%
- Nuclear 3%
- Hydro 1%

Reducing:
- Mpumalanga
- Limpopo

Increasing:
- Western Cape
- Eastern Cape
- Free State

Table:
- Mpumalanga: 52GW, 74GW
- Limpopo: 5968, 3010
- Western Cape: 1935
- Eastern Cape: 1500
- Free State: 4121
- Northern Cape: 5056
- Gauteng: 6863
- KwaZulu-Natal: 3924
- Free State: 4326
- North West: 1115
- Free State: 1500

Overall:
- 29199
- 29337
Questions?
Planning for the Integration of Independent Power Producers (IPPs)

Presented by: Makoanyane Theku
<table>
<thead>
<tr>
<th>Program</th>
<th>No. of Projects</th>
<th>MW Contribution</th>
<th>Current Status</th>
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<td>REIPPPP BW 1</td>
<td>28</td>
<td>1 436</td>
<td>All projects connected</td>
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<tr>
<td>REIPPPP BW 2</td>
<td>19</td>
<td>1 054</td>
<td>All projects connected</td>
</tr>
<tr>
<td>REIPPPP BW 3&amp;3.5</td>
<td>23</td>
<td>1 656</td>
<td>17 projects connected, 4 in execution, 2 awaiting financial close</td>
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<td>REIPPPP BW 4</td>
<td>13</td>
<td>1 121</td>
<td>Projects in financial closure phase</td>
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<tr>
<td>REIPPPP BW 4B</td>
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<td>1 084</td>
<td>Projects in financial closure phase</td>
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<td>Smalls (1-5 MW)</td>
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<td>50</td>
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<td>1 005</td>
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<td>Coal Baseload</td>
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<td>864</td>
<td>Budget quotation phase</td>
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<td><strong>Total</strong></td>
<td><strong>110</strong></td>
<td><strong>8 269</strong></td>
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</table>
Approved IPPs

Renewables
- REIPP1
  - Concentrated Solar Power
  - Onshore Wind
  - Solar Photovoltaic
- REIPP2
  - Concentrated Solar Power
  - Onshore Wind
  - Small Hydro
  - Solar Photovoltaic
- REIPP3
  - Biomass
  - Concentrated Solar Power
  - Landfill Gas
  - Onshore Wind
  - Solar Photovoltaic
- REIPP3.5
- REIPP4
  - Biomass
  - Onshore Wind
  - Photovoltaic Crystalline- Single Axis
  - Small Hydro
- REIPP4b
  - Onshore Wind
  - Photovoltaic Crystalline- Single Axis

Non-renewables
- Coal Baseload
- DoE Peakers

Planned Substations
- Planned Lines
- Existing Substations
- Planned Lines
- Existing Lines

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.
Transmission integration plans for approved IPPs - Recently Commissioned Transmission Infrastructure

**LEGEND**
- Existing Tx Substations
- New Tx Substations (TDP)
- Additional 400/132 kV transformer/s
- 400/132 kV Integration
- New Tx Substations
  - 765 kV line
  - 400 kV line
  - 275 kV line
  - 220 kV line
  - 132 kV line

Recently commissioned transmission infrastructure investment projects for IPP integration
- Mookodi, Helios & Kronos 400/132 kV integration
- Upington 400/132 kV substation integration
- Hydra & Poseidon transformation upgrades
- Aries – Nieuwehoop 400 kV line
- Nieuwehoop – Ferrum 400 kV line
- Nieuwehoop 400/132 kV transformer
- Nieuwehoop – Upington 400 kV line

Planned transmission lines are represented by broken lines
Transmission integration plans for approved IPPs - Ongoing projects to complete connection of the approved projects

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 (BQ phase)
- Khanyisa PS Integration (BQ phase)
Transformer Capacity enhancement for IPP Integration - TDP Period

2018 TDP - REIPP Transmission Substation Capacity Assessment

Megawatts

Substation

2018 TDP - REIPP Transmission Substation Capacity Assessment

Approved REIPP
Capacity expansion 2018 TDP
REIPP
Total Capacity 2018
Transmission integration plans for approved IPPs - Plan for N-1 and the integration of future IPPs (TDP Projects in execution)

LEGEND
- Existing Tx Substations
- New Tx Substations (TDP)
- Additional 400/132kV transformer/s
- 400/132 kV Integration
- New Tx Substations
- 765 kV line
- 400 kV line
- 275 kV line
- 220 kV line
- 132kV line

Planned transmission lines are represented by broken lines

Transmission infrastructure for future IPP projects (Projects in execution)
- Gromis – Oranjemond 220 kV line
- Juno – Gromis 400 kV line
Transmission integration plans for approved IPPs - Plan for N-1 and the integration of future IPPs (TDP Projects – Business case development phase)

**LEGEND**
- Existing Tx Substations
- New Tx Substations (TDP)
- Additional 400/132 kV transformer/s
- 400/132 kV Integration
- New Tx Substations
- 765 kV line
- 400 kV line
- 275 kV line
- 220 kV line
- 132kV line

*Planned transmission lines are represented by broken lines*

**Transmission infrastructure for future IPP projects (Projects in development)**
- Aggeneis – Paulputs 400 kV line (Operated @ 220 kV)
- Aries – Upington 400 kV line
- Aggeneis – Nama – Gromis 400 kV line)
- Aries, Aggeneis and Nama 400 kV integration
Transmission integration plans for future IPPs
Plan for the integration of projected IPPs
(Transmission expansion for future IPPs – Provincial Corridors)

LEGEND
- Existing Tx Substations
- New Tx Substations (TDP)
- Additional 400/132 kV transformer/s
- 400/132 kV Integration
- New Tx Substations
  - 765 kV line
  - 400 kV line
  - 275 kV line
  - 220 kV line
  - 132kV line

Transmission infrastructure for future IPP projects
(Concept phase)
- Aries – Aggeneis 400 kV line
- Paulputts 400kV integration
- Upington – Ferrum 400 kV line
- Upington transformation upgrade
- Gamma – Grassridge 765 kV line
- Poseidon – Grassridge 400 kV line
- Grassridge – Humansdorp 400 kV line

Planned transmission lines are represented by broken lines
Transmission integration plans for future IPPs
- Plan for the integration of projected IPPs
  (Transmission expansion for future IPPs – Major Corridors)

LEGEND
- Existing Tx Substations
- New Tx Substations (TDP)
- Additional 400/132 kV transformer/s
- 400/132 kV Integration
- New Tx Substations
- 765 kV line
- 400 kV line
- 275 kV line
- 220 kV line
- 132kV line

Transmission infrastructure for future IPP projects
(Concept phase)
- Ferrum – Hermes 400 kV strengthening (via Umtu)
- Aries – Hydra 400 kV corridor strengthening (via Kronos MTS)
- Beta – Ferrum 400 kV corridor strengthening

Planned transmission lines are represented by broken lines
Transmission integration plans for future IPPs - Additional SEA Corridors
Questions?
Operational Impact of Renewable Generation

Presented by: Paul Davel
Station Build-up for the Peak Demand day of the week

Thu 18-Oct

MW

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

Landfill Gas
Small Hydro
CSP
PV
Wind
Dispatchable IPPs
Manual Load Reduction
IOS (Excl ILS)
ILS Usage
Pumped Water Actuals
Hydro Water Actuals
Gas Actuals
International Actuals
Nuclear Actuals
Example of Daily Renewable Generation

- Residual Demand (MW)
- Renewables (MW)
- Wind
- PV
- CSP
Example of Daily Renewable Generation

- Residual Demand
- Wind
- PV
- CSP

Residual Load [MW]
Renewables [MW]
This diagram is indicative of the increasing installed capacity but also highlights the magnitude of the variability (particularly from wind).

It is too early to draw any conclusions about seasonal variations. However, some seasonal behaviour can be observed.

Forecasting helps in the short term but not for planning purposes.
High load factors over evening peaks in summer can be observed, dropping during the winter months. A similar behaviour can be observed over all hours in a week, however to a much lesser extent.

This behaviour is consistent, even with the increase in wind generation.
Effect of cold weather on the National Demand – during winter 2018
Effect of cold weather on the National Demand

<table>
<thead>
<tr>
<th>Province</th>
<th>Provincial demand at time of 2017 System Peak</th>
</tr>
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<tbody>
<tr>
<td>Eastern Cape</td>
<td>1584</td>
</tr>
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<td>9506</td>
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<td>KZN</td>
<td>6100</td>
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<td>Limpopo</td>
<td>3011</td>
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<td>Mpumulanga</td>
<td>3852</td>
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<td>North West</td>
<td>3220</td>
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<tr>
<td>Northern Cape</td>
<td>949</td>
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<tr>
<td>Western Cape</td>
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Effect of cold weather on the National Demand

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<tr>
<td>Western Cape</td>
<td>3300</td>
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</table>

COLD (wet) and windy

Pre-frontal WARMER

Cold Front
Effect of cold weather on the National Demand – during winter 2018

- RSA Contracted Demand
- Wind Generation

Impact of cold weather
Effect of high wind generation during low load periods

Curtailment Event: 11 July 2018
Effect of high wind generation during low load periods

Wind Curtailment Event - 11 July 2018

- Estimated Curtailment [MWh]: 947.37
- Peak Curtailment [MW]: 565.2
Summary of Operational Challenges posed by Renewable Generation

• OPERATIONAL CHALLENGES
  • PV drop off before evening peak
  • Unpredictability of wind generation, particularly over system peak
  • Operating regime of CSP, which is not aligned to system requirements
  • “Excessive” wind generation over night minimum, requiring curtailment

• POSSIBLE MITIGATION
  • Installation of large scale storage (pilot projects are presently in execution)
  • Closer alignment of power purchase agreements to system requirements
Questions?
Provincial Development Plans 2019 – 2028
Limpopo Province Profile

- Peak load of 3011 MW: 30th May 2017

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
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<tr>
<td>Base Load</td>
<td>Matimba</td>
<td>3990 MW</td>
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<td>Medupi</td>
<td>2382 MW</td>
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<td>Renewables</td>
<td>Witkop PV</td>
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<td>Soutpan PV</td>
<td>28 MW</td>
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<td></td>
<td>Villa Nora PV</td>
<td>60 MW</td>
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<tr>
<td>Total Installed Generation</td>
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<td>6490 MW</td>
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Completed Projects

- Borutho 400/132kV Substation
- Dwarsberg 132kV Switching Station
Limpopo Province Load Forecast

Electrification, Agriculture, Diamond and Coal Mining
Commercial and light industrial load growth. Platinum and Coal Mining
Electrification, Agriculture and Chrome Mining

* Compound Annual Growth Rate

<table>
<thead>
<tr>
<th>Year</th>
<th>Load (MW)</th>
<th>Lephalale CLN Peak</th>
<th>Polokwane CLN Peak</th>
<th>Phalaborwa CLN Peak</th>
<th>Limpopo Grid Peak</th>
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<td>5896</td>
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TRANSMISSION DEVELOPMENT PLAN
Developments in the Lephalale CLN

- **Medupi Integration:**
  - 2 x Medupi-Ngwedi 400 kV lines

- **Waterberg Generation Integration:**
  - Medupi – Witkop & Borutho – Silimela 400 kV line

- **Borutho 3\(^{rd}\) 500 MVA Transformer**

- **Warmbad 1\(^{st}\) 250 MVA Transformer**

**Matimba Solar PV 60MW**
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 Substation

Tabor Solar PV 28MW
Witkop Solar PV 30MW
Developments in the Phalaborwa CLN

- Manogeng Switching Station & Silimela Substation
- Sekhukhune Substation
- Foskor - Merensky 400 kV Line
- 400 kV at Foskor Substation
- Leseding 3rd 500MVA Transformer
- Acornhoek 3rd 125MVA Transformer
Questions?
Mpumalanga Province
TDP 2019 - 2028
Planning Engineer: Kabir Singh
Presented by: Thamsanqa Ngcoba
Mpumalanga Province Profile

Load

- 2017 Peak load of ~4011 MW

- Mining: 22%
- Community Services: 16%
- Trade: 15%
- Manufacturing: 14%
- Finance: 12%
- Electricity: 12%
- Transport: 7%
- Construction: 3%
- Agriculture: 3%

Generation

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
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<tr>
<td>Camden</td>
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</tr>
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<td>Duvha</td>
<td>2875</td>
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</tr>
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<tr>
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<tr>
<td>Kriel</td>
<td>2850</td>
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<td>Kusile</td>
<td>720</td>
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<tr>
<td>Majuba</td>
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<td>Matla</td>
<td>3450</td>
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<td>Tutuka</td>
<td>3510</td>
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<tr>
<td>Arnot</td>
<td>2232</td>
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</table>

Total Installed Generation 29780
Completed projects

- Gumeni 400/132 kV 500 MVA substation
- Hendrina-Gumeni 400 kV line
- Kusile 400 kV Yard
- Duvha-Minerva Loop-in to Kusile
- Kendal-Apollo Loop-in to Kusile
- Kusile-Zeus
- 2nd Kendal-Zeus
Mpumalanga Load Forecast
2019 - 2028

CAGR* = 2.5%

Residential, commercial and industrial development
Natural load growth, tourism and residential developments
Mining and Heavy Industry

* Compound Annual Growth Rate
# Generation Forecast

## Hendrina

<table>
<thead>
<tr>
<th>Year</th>
<th>Unit</th>
<th>MW</th>
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<tbody>
<tr>
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<td>2020</td>
<td>2</td>
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<tr>
<td>2023</td>
<td>5</td>
<td>185</td>
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Total per station: **1793**

## Grootvlei

<table>
<thead>
<tr>
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<th>Unit</th>
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</thead>
<tbody>
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</tr>
<tr>
<td>2020</td>
<td>2</td>
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<tr>
<td>2023</td>
<td>5</td>
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</table>

Total per station: **1120**

## Komati

<table>
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<th>Year</th>
<th>Unit</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
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<td>114</td>
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<tr>
<td>2020</td>
<td>2</td>
<td>114</td>
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<td>4</td>
<td>91</td>
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<tr>
<td>2023</td>
<td>5</td>
<td>91</td>
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</tbody>
</table>

Total per station: **904**

Total assumed generation reduction: **3817**
TRANSMISSION DEVELOPMENT PLAN
Generation Developments in Mpumalanga

- **Kusile Integration**
  - Kusile – Duvha
  - Kusile – Minerva
  - Kusile – Apollo
  - Kusile – Lulamisa
  - Kusile – Zeus
  - Kendal – Zeus

- **Khanyisa IPP Integration**
Strengthening Developments in Mpumalanga

• Sol B Integration
• Emkhiweni Integration
• Marathon 400 kV Integration
Questions?
Gauteng Province

TDP 2019 - 2028

Presented by: Thamsanqa Ngcoba
Gauteng Province Profile

- Grid peak demand: ~11 GW

- Economic Drivers (Eastern, Central, Northern, Southern, and Western Corridors):
  - Industrial
  - Logistics
  - Commercial
  - Residential

- Generation

<table>
<thead>
<tr>
<th>Type / Owner</th>
<th>Name</th>
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<tbody>
<tr>
<td>City Power</td>
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<tr>
<td>City of Tshwane</td>
<td>Rooiwal / PTA West</td>
</tr>
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</table>
Gauteng Load Forecast

* Compound Annual Growth Rate

<table>
<thead>
<tr>
<th>Year</th>
<th>West Rand</th>
<th>Johannesburg</th>
<th>East Rand</th>
<th>Vaal</th>
<th>Diversified Grid Peak</th>
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<tbody>
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<td>3600</td>
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<td>2028</td>
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<td>4542</td>
<td>4100</td>
<td>2165</td>
<td>15057</td>
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</table>

CAGR* = 3.1%
Developments in the JHB East & South Area

Key Projects

- Mesong Substation
- Sebenza Substation
- Jupiter B integration
- Sisimuka Substation
- Lesokwana Substation
Developments in the Tshwane Area

Key Projects

- Wildebees Integration
- Diphororo Integration
Developments in the JHB North Area

Key Projects

- Kusile-Lulamisa 400kV line
- Apollo-Lepini 2nd 275kV line
- New MTS Sesui 400/88kV
- New MTS Kyalami 400/88kV
- New MTS Donatello 400/88kV
Developments in the West Rand & Vaal Area

Key Projects

- Vaal Strengthening Phase 2
- Soweto Strengthening
- West Rand Strengthening Phase 1 & 2
Questions?
KwaZulu-Natal Province

TDP 2019 - 2028

Presented by: Thokozani Bengani
KwaZulu-Natal Province Profile

Load

Peak load of 6221 MW: 24th July 2017

- 11% Residential
- 26% Industrial/Mining
- 46% Agricultural
- 5% Commercial
- 12% Logistics

Generation

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Output</th>
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<tr>
<td>Peaking</td>
<td>Drakensberg</td>
<td>1000 MW</td>
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<td></td>
<td>Ingula</td>
<td>1330 MW</td>
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<tr>
<td>IPP</td>
<td>Avon IPP</td>
<td>680 MW</td>
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</table>

Total Installed Generation 3010 MW
KwaZulu-Natal Load Forecast

**Demand (MW)**

- **Pinetown**: 3557, 3646, 3736, 3826, 3922, 4014, 4100, 4184, 4242, 4300
- **Empangeni**: 2123, 2206, 2234, 2225, 2237, 2253, 2259, 2270, 2282, 2283
- **Newcastle**: 756, 774, 791, 809, 826, 844, 861, 877, 894, 910
- **Ladysmith**: 258, 262, 266, 369, 375, 380, 384, 390, 395, 401
- **Provincial Peak**: 6412, 6598, 6732, 6925, 7051, 7176, 7285, 7397, 7485, 7562

*Compound Annual Growth Rate (CAGR) = 1.85%*
TRANSMISSION DEVELOPMENT PLAN
KwaZulu-Natal 765 kV Strengthening

Planned Projects:

• Empangeni Integration
• Pinetown Integration

Benefits:

• Creates additional capacity to meet the growth in demand in uMhlathuze, KwaDukuza and Dube Tradeport
• Provides network redundancy
  • Ability to switch off critical circuits for maintenance
400 kV Backbone Strengthening

Planned Projects:

- Ariadne-Venus 2nd 400 kV line
- Ariadne-Eros 2nd 400 kV line
- St Faiths Substation

Benefits:

- Alleviate power transfer shortfalls in Msunduzi, eThekwini & south coast
- Create capacity to meet the growth in demand
- Provide network redundancy
  - Ability to switch off critical circuits for maintenance
Drivers for growth:

- iSimangaliso wetland park eco-tourism
- Agriculture
- Public infrastructure delivery

Planned Projects:

- Northern KZN Strengthening: Phase 1: Normandie – Iphiva 400 kV line and Iphiva Substation integration near Mkuze
- Phase 2: Duma – Iphiva 400 kV line
Drivers for load growth:

- Coal Mining & Ermelo-Richards Bay Coal line

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
Drivers for load growth:

- Dube tradeport development
- eThekwini Metropolitan
- KwaDukuza Municipality

Planned Project:

- Inyaninga Substation Integration

Benefits:

- Caters for the demand growth around the Dube Tradeport
- Frees up capacity on the existing transmission network supplying eTE & iLembe DM
Drivers for load growth:
- SIP 2: Logistic Corridor
- Mixed use developments

Planned Project:
- Shongweni Substation Integration

Benefits:
- Will cater for the demand growth in the eThekwini western region
- Will free up capacity on the existing transmission network supplying eThekwini Electricity & the south coast
Questions?
Free State Province

TDP 2019 - 2028

Presented by: Thokozani Bengani
Free State Province Profile

Peak load of 1524 MW: 17th May 2017

Load

- Agricultural: 9%
- Commercial: 3%
- Industrial/Mining: 50%
- Residential: 29%
- Logistics: 9%

Generation

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Output</th>
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<tbody>
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<td>Lethabo</td>
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<tr>
<td>IPP</td>
<td>Hydro</td>
<td>IPPs</td>
</tr>
<tr>
<td></td>
<td>PV</td>
<td>IPPs</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Voltage

- Existing
  - 765 kV
  - 400 kV
  - 275 kV
- Planned
  - 765 kV
  - 400 kV
  - 275 kV
Sasolburg  
Provincial Peak

**Free State Load Forecast**

- **CAGR**: 2.0%
- **SIP 2, logistics and public infrastructure delivery**
- **Commercial and industrial development**
- **Public infrastructure delivery**

### Demand (MW)

<table>
<thead>
<tr>
<th>Year</th>
<th>Welkom</th>
<th>Sasolburg</th>
<th>Bloemfontein</th>
<th>Provincial Peak</th>
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<td>481</td>
<td>611</td>
<td>1694</td>
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<td>973</td>
<td>488</td>
<td>619</td>
<td>1731</td>
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<td>980</td>
<td>495</td>
<td>635</td>
<td>1762</td>
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<tr>
<td>2022</td>
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<td>845</td>
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<td>1034</td>
<td>604</td>
<td>866</td>
<td>2024</td>
</tr>
</tbody>
</table>

* Compound Annual Growth Rate
Key Developments in Eastern Free State

Drivers for load growth:
- Strategic Integrated Projects 2 (Harrismith Logistics Hub)
- Public infrastructure delivery

Planned Projects:
- Harrismith Strengthening: Extension of Sorata SS (Phase 1 and 2)
Key Developments in Sasolburg

Drivers for load growth:

• Mining activities
• Industrial activities
• Public infrastructure delivery

Planned Project:

• Igesi Substation Integration
Key Developments in Mangaung and Surrounding Regions

Drivers for load growth:
• Solar power generation
• Public infrastructure delivery

Planned Projects:

Bloemfontein Strengthening Phase 2:
• Everest-Merapi 400kV Line (operated @ 275kV)
• Harvard 400/132 kV Substation
• 2 x Beta-Harvard 400kV Lines
Questions?
North West Province

TDP 2019 - 2028

Planning Engineer: Queen Melato

Presented by: Dudu Hadebe
North West Province Profile

Load

- Peak load of 3263MW: 30 May 2017

- 10% Redistributors
- 20% Industrial, Mining and Commercial
- 5% Agriculture
- 5% Commercial
- 60% Residential

Generation

<table>
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<th>Type</th>
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<td>RustMo1 Solar</td>
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<tr>
<td>Total Generation</td>
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</table>
Completed Projects

- Mookodi Substation Integration
- Dinaledi 3rd transformer
- Ngwedi substation integration
North West Province Load Forecast

<table>
<thead>
<tr>
<th>Year</th>
<th>Rustenburg CLN Peak</th>
<th>Carletonville CLN Peak</th>
<th>Provincial Peak</th>
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<tbody>
<tr>
<td>2019</td>
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<td>3315</td>
<td>1387</td>
<td>4651</td>
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</tbody>
</table>

* Compound Annual Growth Rate
## Renewable Energy Projections:

- **Approximately 0.65 GW**
  - (10 year horizon)

- **Mookodi Substation** – **475 MW**
  - Approved 75MW Waterloo Solar Park

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

- **Bighorn Substation** – **100 MW**
NETWORK DEVELOPMENT PLAN
Developments in the Rustenburg CLN

- 2x Medupi – Ngwedi
  400kV lines (1x 765kV design) - near Mogwase

- Bighorn Extension – near Marikana

- Rustenburg
  Reactive
  Compensation (Bighorn, Marang and Dinaledi)
Developments in the Carletonville CLN

- Watershed Strengthening
- Pluto – Mahikeng 400kV line
- Mahikeng substation
Questions?
Northern Cape Province

TDP 2019 – 2028

Presented by: Dudu Hadebe
Northern Cape Province Profile

LOAD

- Peak load of 1077 MW: Feb 2017

27% Commercial
21% Mining
52% Agriculture & Residential

GENERATION

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Output</th>
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<tbody>
<tr>
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<td>Gariep</td>
<td>360 MW</td>
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<tr>
<td>Eskom Total Installed</td>
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<tr>
<td>REIPPPP Projects Installed to date</td>
<td>Wind</td>
<td>590 MW</td>
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<td></td>
<td>PV</td>
<td>667 MW</td>
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<td></td>
<td>CSP</td>
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<td>Hydro</td>
<td>10 MW</td>
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<tr>
<td>REIPPPP Total</td>
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<td>1567 MW</td>
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</table>

- Kokerboom
- Harib
- NamPower

North West
- Mookodi
- Perseus
- Gariep
- Boundary
- Kimberley

Botswana
- Mokadi
- Gariep
- Prieska
- De Aar
- Garona
- Nieuwehoop
- Kronos
- Ferrum
- Lien

Namibia
- Harib
- Kokerboom
- NamPower

South Africa
- Alexander Bay
- Kleinsee
- Nama
- Gromis
- Kappo
- Loeriesfontein
- Victoria West
- Gariep
- Garona
- Nieuwehoop
- Kronos
- Ferrum
- De Aar
- Prieska
- Gariep
- Boundary
- Kimberley

Commercial: 27%
Mining: 21%
Agriculture & Residential: 52%
Completed Projects

- Upington Strengthening
  - Upington Substation 400/132 kV
  - Upington-Nieuwehoop 400 kV line for IPP’s
- Aries – Niewehoop 400 kV line
- Nieuwehoop-Ferrum 400 kV line
- Hydra 400/132 kV transformation for IPP’s
Northern Cape Province Load Forecast

## Load Drivers
- Natural load growth
- Anticipated mining loads in Kimberley

### Compound Annual Growth Rate

\[ \text{CAGR}^* = 4.2\% \]

### Load Forecast

<table>
<thead>
<tr>
<th>Year</th>
<th>Namaqualand CLN</th>
<th>Karoo CLN</th>
<th>Kimberley CLN</th>
<th>Provincial Peak</th>
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<tbody>
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<td>2019</td>
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<td>291</td>
<td>636</td>
<td>1055</td>
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<tr>
<td>2020</td>
<td>169</td>
<td>295</td>
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<td>2021</td>
<td>214</td>
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<td>342</td>
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<td>1593</td>
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</tbody>
</table>

*Compound Annual Growth Rate*
TRANSMISSION DEVELOPMENT PLAN
Developments in the Namaqualand CLN

- Juno-Gromis 400 kV line
- Gromis-Oranjemond 2nd 220 kV line (built at 400 kV)
- Gromis-Nama-Aggeneis 400 kV line
- Aggeneis-Paulputs 2nd 220 kV line (built at 400 kV)
- Aries SVC
- Helios 2nd 500 MVA 400/132 kV Transformer
- Helios 20 MVA 132/66 kV Transformer
Developments in the Karoo CLN

- Ruigtevallei transformer normalisation and transformation
- Gariep Strengthening – derate the 220 kV line to 132 kV
Developments in the Kimberley CLN

- Aries-Upington 400 kV lines
Questions?
Eastern Cape Province

TDP 2019 - 2028

Planning Engineer: Queen Melato

Presented by: Ahmed Hansa
Load Drivers
- Automotive, tourism, agriculture, agro-processing, and ocean economies

Generation
- Port Rex 171 MW
- Dedisa OCGT 372 MW
- RE IPP (Wind & Solar) ~ 1300 MW

Load Served
- Peak Load (10th August 2017): 1716 MW
- Geographic Areas: Nelson Mandela Metro, Buffalo City Metro, and Mthatha
LOAD FORECAST
Eastern Cape Load Forecast

Load (MW)

<table>
<thead>
<tr>
<th>Year</th>
<th>Port Elizabeth</th>
<th>East London</th>
<th>Provincial Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>1136</td>
<td>650</td>
<td>1675</td>
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<td>2020</td>
<td>1164</td>
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<td>2028</td>
<td>1559</td>
<td>980</td>
<td>2387</td>
</tr>
</tbody>
</table>

* Compound Annual Growth Rate

CAGR* = 4%

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

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

0 500 1000 1500 2000 2500 3000

Load (MW)

Port Elizabeth

East London

Provincial Peak

43%
GENERATION FORECAST
Eastern Cape Generation Forecast

Renewables (MW)

<table>
<thead>
<tr>
<th>Year</th>
<th>EL</th>
<th>PE</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>250</td>
<td>1452</td>
<td>1702</td>
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</table>

Gas generation ~ 2000 MW

Generation (MW)

- PV
- Gas
- Wind
- Year Total

PV: 75 75 75 75 75 75 75 75 75 75 75
Gas: 0 335 335 335 335 335 335 335 1335 1335 2067 2067 2067 2067
Wind: 544 823 1020 1020 1020 1650 1850 1850 1950 2250 2750 2850 4450 4550
Year Total: 619 1233 1430 1430 2060 2260 3260 3360 3660 4892 4992 6592 6692

net power exporter
COMPLETED PROJECTS
Completed Projects (2014 – 2017)

- Eros – Vuyani line, Vuyani substation and Vuyani – Neptune line
- Poseidon 500 MVA 400/132 kV transformer
- Grassridge – Dedisa 132 kV line
- ~ 1300 MW RE in the province and 300 MW DOE OCGT generation at Dedisa
NETWORK DEVELOPMENT PLAN
Key projects in the East London CLN

- **400 kV at Pembroke substation:**
  - Neptune – Pembroke 400 kV line
  - Poseidon – Pembroke 400 kV line

- **Delphi substation:**
  - 1st 500 MVA transformer
  - 100 Mvar 400 kV capacitor bank
Key Projects in the PE CLN

- Dedisa and Grassridge
  - 3rd 500 MVA transformers and
  - 100 Mvar 400 kV capacitor banks
- Gamma- Grassridge
  - 1st 765 kV line
Questions?
Western Cape Province

TDP 2019 - 2028

Presented by: Ahmed Hansa
Western Cape Province Profile

Load

- Peak load of 3930 MW: 26th June 2017

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
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<tr>
<td>Base Load</td>
<td>Nuclear Koeberg</td>
<td>1860 MW</td>
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<td>Peaking</td>
<td>Gas Acacia</td>
<td>171 MW</td>
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<td></td>
<td>Ankerlig</td>
<td>1332 MW</td>
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<td></td>
<td>Gourikwa</td>
<td>740 MW</td>
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<td>Pumped Storage</td>
<td>Palmiet</td>
<td>400 MW</td>
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<td>Eskom Renewables</td>
<td>Wind Sere</td>
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<td>Eskom Total</td>
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<td>REIPPPP</td>
<td>PV IPPs</td>
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<td>Wind IPPs</td>
<td>316 MW</td>
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<td>REIPPPP Total</td>
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<td>450 MW</td>
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<tr>
<td>City of Cape Town</td>
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<td>258 MW</td>
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</table>
COMPLETED PROJECTS
1st 765 kV line to the Cape (~1400 km)
132 kV 72 Mvar Capacitor Banks

Bacchus (x2), Proteus (x1) and Aurora (x2) Substations
3rd 500 MVA transformer and FCLRs at Muldersvlei Substation
CHALLENGES
Encroachments on Philippi-Erica Servitude

- 765 kV
- 40m - 50m
- 400 kV
- 21m - 33m

4/4/2012
26/04/2012
17/07/2012
28/06/2013
LOAD FORECAST
Western Cape Load Forecast

CAGR* = 1.4%

Load growth due to the Saldanha Bay IDZ

Natural load growth and residential developments

Residential, commercial and light industrial load growth

<table>
<thead>
<tr>
<th>Year</th>
<th>Peninsula</th>
<th>Outeniqua</th>
<th>West Coast</th>
<th>Provincial Peak</th>
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<td>1011</td>
<td>573</td>
<td>4527</td>
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</table>

* Compound Annual Growth Rate
NETWORK DEVELOPMENT PLAN
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 – Google Earth and Grant Duncan Smith (http://www.subiaco.co.za)

- 58 000 m² platform
- ~6 rugby fields
- 7 000 m³ concrete
- ~70 000 bags of cement
- 170 tons steel
- 1.2 km fencing
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
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
2019 - 2028

Presented by: Atha Scott
Content

• Tx Mandate and Framework
• Asset Replacement Process
• Criteria for Development
• Network Sustainability
• 10 Year Refurbishment Capital Plan
• Asset Condition and Replacement Plan
• Network Status
• Conclusion
South African Grid Code stipulates that Transmission is responsible for the renewal, optimisation, reconfiguration and decommissioning of existing assets to ensure sustainability of the network.

Eskom is supporting an Asset Management approach and alignment to ISO 55000

Transmission Refurbishment deliverables/focus areas:

- Asset Replacement of aging equipment (CTs, VTs, Surge Arresters, H.V. 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.)

Asset Purchases (Production Equipment)

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

- Engineering Asset Appraisal Reports for HV & Secondary Plant Updates
- Asset replacement based on Planned Projects
- TCP
- SAP PM
- Asset Replace Timeline
- Surs / Decommissioned Assets
- FRA
- ERA
- DRA
- CRA
- PCRA
- Location
- Plant Item
- Condition
- Timeline
Refurbishment Plan Development

Criteria for successful development:
- Structured AM approach
- Participation and Buy-in
- Accurate Data
- Accurate Tools for Estimation and Definition

Stakeholders

- Finance
- Planning
- Asset Management
- Performance Management
- Engineering
- Grid
10 Year Asset Renewal Plan Objective

Plan Semi-constrained to reflect bottle necks in the Capital Plan value chain

- Starting point: assets identified based on condition rolled up per bay.
- Rolled up into substation
- Phased using criticality, importance and impact
- Generated projects to cost and enter into plan

TRANSMISSION’S SUBSTATION PLANT CONDITION ASSESSMENT OVERVIEW

<table>
<thead>
<tr>
<th>Equipment</th>
<th>0%</th>
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<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
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<th>80%</th>
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</table>

A - Normal Maintenance (88-100%)
B - Normal Maintenance (71-85%)
C - Maintenance & Monitoring (51-70%)
D - Possible Project/Life Extension (31-50%)
E - Raise Project (0-30%)

TsAME Capex per Category

<table>
<thead>
<tr>
<th>Year</th>
<th>FY15</th>
<th>FY16</th>
<th>FY17</th>
<th>FY18</th>
<th>FY19</th>
<th>FY20</th>
<th>FY21</th>
<th>FY22</th>
<th>FY23</th>
<th>FY24</th>
<th>FY25</th>
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<td>Value</td>
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</tr>
</tbody>
</table>
## Prioritisation and Optimisation

### Criteria matrix
- **Type of Customer and Value to Customer**
- **Network Stability**
- **Likelihood of Load loss (MW)**
- ** Interruption/Restoration of supply**
- **Performance (i.e. without the additional components)**
- **Statutory**
- **Safety and Environmental Improvements**
- **Spares**
- **Type of failure**
- **Cost of maintenance**
- **Prior Refurbishment**
- **Future need**
- **Skill Level**
- **Age**
- **Asset Health Index Score**
- **Technology**

![Prioritisation and Optimisation Diagram]

16 Weighted criteria

Critical projects that could have been missed, are elevated

Prioritisation defined to eliminate sensitivity to interpretation
Statutory Network Requirements

Production Equipment: Maintenance support and Emergency Preparedness Plans

Capital Spares: Supply restoration

N-1 Transformation projects for regulatory compliance

Refurbishment of network: long term sustainability and reliability of the network, covering asset classes: Substations, Transmission lines, Associated general infrastructure

Network Sustainability Framework
Sustainability Key Priorities/Focus areas

- Improvement in Line Performance
- Implementation of Energy and Operational Efficiency Programmes
- Implementable Asset Investment Plan
  - Integration in existing network
  - Optimal outage Management
  - Adequate Project Execution Planning
  - Appropriate Resourcing
- Management of Safety and Environmental requirements
- Ensuring an appropriate level of Strategic and Critical Spares
- Data Management
- Effective EPP’s (Emergency Preparedness Programmes)
Major Spend Categories

Substation type projects FY19-28

- Sub Refurb: 74%
- Sub Protect: 26%
- Sub Breakers: 6%
- Sub Trfr: 6%
- Sub Capbank: 6%
- Sub Provision: 3%
- Sub Reins: 2%
- Sub DC: 2%
- Sub Transformer: 1%
- Sub Control: 1%

Line type projects FY19-28

- Line Reins: 19%
- Line Recond: 14%
- Line Deviations: 14%
- Line Anchors: 12%
- Line Bird Guards: 11%
- Line OPGW: 10%
- Line Tower Rep: 6%
- Line Clearance Violation: 5%
- Line Vandal Proof: 4%
- Line Anti-climbs: 3%
10 Yr Major SS Refurbishments
10 Yr Major SS Refurbishment: KZN
10 Yr Major SS Refurbishment: Gauteng
10 Yr Major SS Refurbishment: Mpumalanga
Asset Condition per Asset Category Based on Baseline Reports
Planned Asset Replacements per Province
10 Year Refurbishment Plan (FY19–28)
Planned Asset Replacements per Category
10 Year Refurbishment Plan (FY19–28)

Planned Assets to be Replaced

- Voltage Transformer: 1155
- Transformer: 104
- Surge Arrester: 2526
- Reactor: 1
- Protection: 1212
- Isolators: 2909
- Current Transformer: 3498
- Circuit Breakers: 898
- Capacitor: 1
Assets Replaced 2010 - 2017

- Western Cape: 1587
- Northern Cape: 1561
- North West: 870
- Mpumalanga: 2440
- Limpopo: 2096
- KwaZulu Natal: 1225
- Gauteng: 2248
- Free State: 891
- Eastern Cape: 798

0 500 1000 1500 2000 2500 3000
# Network Status

<table>
<thead>
<tr>
<th>Tx Asset</th>
<th>Performance and Condition</th>
<th>Focus Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tx Line Assets</td>
<td>Tx Line Assets are approximately <strong>midlife and performance</strong> is trending near target levels with mostly <strong>bird</strong> related faults impacting on performance. The assessment reports indicate that the asset <strong>condition is generally good</strong> with specific types of refurbishments required at present</td>
<td>• Bird Guard projects (Delayed due to Legal case)&lt;br&gt;• Coastal areas tower member and guyed anchor replacements&lt;br&gt;• Line re-insulation &amp; hardware replacements&lt;br&gt;• Clearance violations (non - age related)&lt;br&gt;• Vandalism and Anti-climb</td>
</tr>
<tr>
<td>Breakers</td>
<td>Assessment reports indicate that the asset <strong>performance and condition is generally good</strong> and trending near target levels. There are a number of assets <strong>in poor and very poor</strong> condition and they <strong>are being packed into major substation refurbishment</strong> projects.(systematic replacement approach)</td>
<td>• High risk breakers have been identified and have been prioritized in once-off projects to deal with specific risk.&lt;br&gt;• Failures are managed via spares where stock levels are as per policy and are being successfully maintained at present.</td>
</tr>
<tr>
<td>Protection</td>
<td>Protection assets <strong>performance is generally good</strong> and are trending within target levels</td>
<td>• With the new protection scheme contracts and their associated implementation requirements, we are assessing the implementation strategies inline with the required rate of replacement and develop appropriate solutions.&lt;br&gt;• The Protection Refurbishment is currently a high focus area.</td>
</tr>
</tbody>
</table>
# Network Status

<table>
<thead>
<tr>
<th>Tx Asset</th>
<th>Performance and Condition</th>
<th>Focus Areas</th>
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</thead>
<tbody>
<tr>
<td>Transformers</td>
<td><strong>Transformer performance is trending well</strong> and the asset class is an important focus area.</td>
<td>• High Risk Transformer initiatives are dealing with the exceptions and <strong>poor and very poor units</strong> whilst the substation refurbishments manage the replacement program.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Failures are managed via the <strong>strategic spares policy</strong> which has been successfully implemented and maintained.</td>
</tr>
<tr>
<td>Capacitors</td>
<td>Technical <strong>performance is trending well</strong> and the PCB (Polychlorinated Biphenyls) programs are supporting the replacement of aged units.</td>
<td>• PCB (Polychlorinated Biphenyls) programs</td>
</tr>
<tr>
<td>Reactors</td>
<td>Technical <strong>performance is trending well</strong> and the asset class is managed by the replacement program.</td>
<td>• 7 units have been included in the current 5yr plan.</td>
</tr>
<tr>
<td>Auxiliary Items</td>
<td>CTs technical <strong>performance is trending well</strong>. Spend on this asset class has been prioritized.</td>
<td>• <strong>Priority assets</strong> have been identified for urgent replacement and the balance of assets are to be managed through the replacement program.</td>
</tr>
<tr>
<td></td>
<td>Aux Transformers technical <strong>performance trending near target levels</strong>.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Isolators, surge arrestors, VT’s and Line traps technical <strong>performance is trending near target levels.</strong></td>
<td></td>
</tr>
</tbody>
</table>
Other H&S /Environmental Projects included in Plan

- **Health & Safety**
  - Line clearance corrections
  - Anti theft, anti climbs and vandal proofing
  - Aircraft warning spheres
  - Servitude gates
  - Substation earth-mat reviews
  - Substation security, perimeter fences and lighting and yards stoning

- **Environmental**
  - Bird anti-perching and diverters (line collisions)
  - Polychlorinated Biphenyls (PCB) phase out by 2026
  - Asbestos phase out by 2033
  - Energy efficient lighting and air conditioners
The current 10 year Transmission refurbishment plan is a reflection of 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 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.”
Thank You!

Time for Questions…
RECAP:

Demand Forecast:

<table>
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<tr>
<th>Year</th>
<th>2018 TDP Demand - High (65GW by 2040)</th>
<th>2018 TDP Demand Medium (58GW by 2040)</th>
<th>2018 TDP Demand - Low (50GW by 2040)</th>
<th>KSACS Customer NMD (MW)</th>
<th>Distribution Customer NMD (MW)</th>
<th>Projected Total Customer NMD (MW)</th>
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<td>47802</td>
<td>42987</td>
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<td></td>
<td>44772</td>
</tr>
</tbody>
</table>

Demand Forecasts (MW) for the TDP period 2019-2028

- **2017 TDP Demand (MW) - Transmission High**: 35850, 35850, 35742, 36816, 38245, 39826, 41051, 42415, 43708, 44924, 46255, 47694, 49232, 50864, 52182
- **2010 IRP Demand (MW)**: 42129, 43994, 45786, 47870, 49516, 51233, 52719, 54326, 55734, 57097, 58340, 60150, 61500, 62850, 64200
- **2016 Base Draft IRP Demand (MW)**: 41682, 42702, 43831, 44916, 46130, 47336, 48547, 49656, 51015, 52307, 53561, 54567
- **Actual Peak Demand (MW) *Instantaneous***: 35343, 34695, 35742, 36359
RECAP:

Generation Pattern:

Legend:
- ★ Existing Power Stations (Eskom)
- ▲ New Build
- ○ CCGT Gas 1
- ▲ Renewables (REBID Windows 1 to 4)
  - ▲ Biomass
  - ▲ Concentrated Solar Power
  - ▲ Landfill Gas
  - ▲ Onshore Wind
  - ▲ Small Hydro
  - ▲ Solar Photovoltaic
  - ▲ Solar PV - Single Axis

Generation Allocation For the 2028 Network

- Medupi
- Kusile
- North-East Power Pool
- IPP Coal At Thabametsi and Khanyisa 900 MW
- DOE OCGT 1 & 2

- CCGT - 2196 MW potentially at Dedisa and Ankerlig
- OCGT - 3000 MW potentially at Dedisa and Athene
- 6305 MW of PV generation Across different regions in South Africa
- 1005 MW of CSP generation across the N. Cape
- 9800 MW of Wind generation at different sites and potential sites across the Cape
- Gourikwa
- Ankerlig
- Koeberg
- Drakensberg
- Ingula
## Summary of Transmission Infrastructure Requirements over the TDP Period

### Transmission Assets: National View

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>Power lines (km)</strong></td>
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<tr>
<td>765kV</td>
<td>98</td>
<td>300</td>
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<td>400kV</td>
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<td>132kV</td>
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<td><strong>Total length (km)</strong></td>
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<tr>
<td><strong>Transformers</strong></td>
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<tr>
<td>Number of units</td>
<td>43</td>
<td>72</td>
<td>115</td>
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<tr>
<td>Total capacity (MVA)</td>
<td>16630</td>
<td>29270</td>
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Transmission expansion plan: Transmission lines

2017 vs 2018 TDP - Cumulative transmission line construction planned per year

<table>
<thead>
<tr>
<th>Year</th>
<th>2017 TDP</th>
<th>2018 TDP</th>
<th>Actual Built Cumulated</th>
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<tbody>
<tr>
<td>2010</td>
<td>5239</td>
<td>5239</td>
<td>600</td>
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<td>2011</td>
<td>5800</td>
<td>5714</td>
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<td>9927</td>
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<tr>
<td>2019</td>
<td>11211</td>
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<tr>
<td>2020</td>
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<td>11774</td>
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</table>
Transmission expansion plan: Transformer capacity

2017 vs 2018 TDP Cumulative transformation capacity planned per year (MVA)

<table>
<thead>
<tr>
<th>Year</th>
<th>2017 TDP</th>
<th>2018 TDP</th>
<th>Actual Installed Cumulated</th>
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<tr>
<td>2028</td>
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</tr>
</tbody>
</table>
Major Projects planned in the TDP period

- **Peninsula / Mitchells Plain**
- **West Coast Strengthening**
- **Cape Corridor (2nd 765kV)**
- **Upington Strengthening Ph2**
- **North West / Kimberley Strengthening**
- **Kusile Integration**
- **Kyalami, West Rand**
- **JHB South, East**
- **Lowveld Strengthening**
- **Medupi Integration Ph2**
- **Nzhelele Integration**
- **Tshwane Strengthening**
- **Kusile Integration**
- **Highveld South Secunda**
- **Empangeni Strengthening**
- **Pinetown Strengthening**
- **Bloemfontein Strengthening**
- **East London Strengthening**
- **PE Strengthening**

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.
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, H.V. 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: FY2019-2028

Summary of Transmission Capex Plan (R Million):
FY 2019 - FY 2028

<table>
<thead>
<tr>
<th>Transmission Capex Category</th>
<th>Total: (FY19-28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Expansion</td>
<td>91,217</td>
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<tr>
<td>Refurbishment</td>
<td>14,874</td>
</tr>
<tr>
<td>EIA and Servitudes</td>
<td>2,670</td>
</tr>
<tr>
<td>Production Equipment / other</td>
<td>585</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>109,346</strong></td>
</tr>
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</table>

![Pie chart showing Transmission Capex Plan: FY19 - FY28 (R million)](chart.png)
The total Transmission Capital Plan amounts to R109 billion over the TDP period 2019 – 2028 of which:

- R91.2 billion is required for reliability (N-1) projects, integration of committed generation (Medupi, Kusile, Ingula, IPPs up to Bid Window 4B) and connection of new loads onto the system

- R18 billion is required for EIA and Servitudes, refurbishment and production equipment
Risk to the TDP 2018

- Nersa’s decision on Eskom’s MYPD4 application 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 continues to be a challenge to the TDP roll out.
- The execution ability to accomplish the plan remains a challenge.
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 2018 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?
Thank you