The Eskom Transmission Development Plan
2018 to 2027
(TDP 2017)

Public Forum

19 October 2017
Keynote address and setting-the-scene

Presented by: Thava Govender
Group Executive: Transmission
Acting Group Executive: Risk and Sustainability
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 2018 – 2027
- Share information and results relating to the integration of RE as per the DOE IPP programmes and address future requirements as per the IRP
- Share information on the estimated Transmission Capital Investment Requirements for period 2018 – 2027
- Solicit comments and inputs from stakeholders on the Transmission plans for improvements
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
- Horizon date is 20 years
- Updated every 2 - 3 years

Transmission Development Plan (TDP)
- The Transmission Development Plan (TDP) represents the transmission network infrastructure investment requirements
- The TDP covers a 10 year window
- Updated annually
- Indicates financial commitments required in the short to medium term
Basis of the TDP 2017

The TDP 2017 was formulated to address the following:

• Attain Grid Code compliance by resolving both substation and line deviations

• 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)
Recent Achievements
To date, a large amount of construction work has been completed, adding \( \sim 8.363 \) MW, \( \sim 6.799 \) km of transmission network, and \( \sim 33.59 \) GVA sub-stations…
Major Transmission Projects commissioned in the last 5 years

Transformation Projects for:
(N-1) Reliability
1. Rustenburg - Bighorn
2. Polokwane - Tabor
3. Peninsula – Acacia
4. Lowveld - Malelane
5. Tshwane – Verwoedburg
6. Northern Cape – Ferrum
7. KZN – Avon, Incandu, Mersey

Kimberley Strengthening
Mercury-Vryburg-Ferrum

Lewensaar: New Traction Substation

Cape Corridor 1st 765kV:
Zeus - Gamma

Cape Corridor 1st 765kV:
Gamma – Sterrekus

Witkop - Tabor
400kV injection

Lowveld
Strengthening
(Hendrina – Prairie)

Lowveld Capacity Increase: Malelane & Komatipoort

Tx Kusile Integration

Thuso (Verwoedburg) Substation

Majuba - Umfolozi
1st 765kV into KZN

East London Strengthening
Eros – Vuyani – Neptune

TDP2018-2027

Substations Planned Lines Existing Lines

- Existing
- Planned

33 220 275 400 765

132 220 275 400 500 765

Created by: Siobhan Ferreira
Date: 20170621

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.
### REIPP Programme Overview – end August 2017

#### BW1
- 28 proj. / 1436 MW
- All projects connected

#### BW2
- 19 proj. / 1054 MW
- All projects connected

#### BW 3 & 3.5
- 23 proj. / 1656 MW
- 14 projects connected, 8 in execution, 1 CSP prj. in BW 3.5 awaiting financial close

#### BW 4
- 13 proj. / 1121 MW
- Projects in budget quotation phase

#### BW 4B
- 13 proj. / 1084 MW

#### Small 1-5
- 10 proj. / 50 MW

#### Grid Capacity Exhausted ("Low Hanging Fruit")
- Significant investment required in grid capacity to meet future DoE procurement programmes.

<table>
<thead>
<tr>
<th>Total Projects</th>
<th>Total MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>106</td>
<td>6401 MW</td>
</tr>
</tbody>
</table>

Eskom has committed capital to enable the integration of successful bidders (Bid Window 1 – 4B, including Smalls) into the National Grid.

- R2.4bn Capital
- R1.3bn Capital

#### 61 projects connected ~ 3 520 MW
Salient facts concerning future IPP integration:

- Much of the capacity in high interest areas is depleted
- Extensive network development will be required to enable integration of future IPPs
- EIA, Servitude requirements, licensing requirements and efficient project execution are critical for future IPP integration

Distribution of approved IPP projects to date:

**Total approved capacity: 8 269 MW**

- **Wind**: 3382.57 MW (36 Projects)
- **PV**: 2435.53 MW (53 Projects)
- **CSP**: 500 MW (6 Projects)
- **Gas**: 1022.5 MW (7 Projects)
- **Hydro**: 14.7 MW (2 Projects)
- **Biomass**: 51 MW (4 Projects)
- **Coal**: 863.5 MW (2 Projects)
- **Gas**: 1022.5 MW (7 Projects)
- **Hydro**: 14.7 MW (2 Projects)
- **Biomass**: 51 MW (4 Projects)
- **Coal**: 863.5 MW (2 Projects)

Status to date:

- **3 520 MW** of REIPP, commissioned and in commercial operation
- **1 004.5 MW** of DoE Peakers commissioned and in commercial operation

**Total IPP Generation in commercial operation: 4 524.5 MW**
Planning for the South African Integrated Power System

The TDP Assumptions

Presented by: Ronald Marais
The different plans

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Linkages between the various plans

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

Determine energy and capacity shortfalls
- Policy
- Select options

Integrated Resource Plan (IRP)

Adequacy criteria

Disaggregate Demand Spatially

Disaggregate Generation Pattern Spatially

20 Year Strategic Grid Plan

Select robust generation scenarios

20 Year Distribution Master Plan

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

Connection Applications & Capacity Programmes

Detailed Network Analysis

Distribution Network Development Plans

External Process

Transmission Investment Plan

Eskom Process
TDP Timelines

- **Licence obligation & Grid Code compliance**
- **Open access & Reliability**
- **TDP Ten Year Period**
- **TDP Scenario Assumptions**

**TDP 2018 - 2027**

- **2018---------2022---------2027**
- **1 - 3 4 - 6 7 - 10**

Implementation & Preparation
Detailed studies & Business case
Uncertainty & Readiness

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

**Assumptions Generation & Demand**

**Capacity & Spatial uncertainty**

**Volume & Type**
Spatial Location

**TDP Timelines & Preparation**

- **Volume & Type**
- **Spatial Location**

**Annual**
**TDP Update**

- **1 - 3 4 - 6 7 - 10**

Review and adjusting uncertainty

**Generation**
High spatial and capacity risk

**Demand**
Low spatial and capacity risk

EIA & Servitude to enable, robust and flexible speed of implementation
Assumed Transmission Capacity Forecast and Comparisons

Capacity Forecast (MW)

Upward movement NMD

Change in load growth results in timing shift

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</table>
Demand Growth – RSA 2018 vs 2027

South Africa Load Overview

Legend:
- 1004.798282 - 2000.000000
- 2000.000001 - 3000.000000
- 3000.000001 - 4000.000000
- 4000.000001 - 5000.000000
- 5000.000001 - 6000.000000
- 6000.000001 - 7000.000000
- 7000.000001 - 8000.000000
- 8000.000001 - 13000.000000
- 13000.000001 - 16000.000000

2018

2027
TDP Generation Base Scenario

2017----2022----2027

Existing | New Build | Future | Total
---|---|---|---
Eskom | 44.1 | 7.9 | 14.5 | -4.2 | 74.6
IPP incl. Peakers | 4.2 | - | - | - | -
IPP (Up to BW 4B) | - | - | - | - | -
Build | - | - | - | - | -
Planned Gx Reduction | - | - | - | - | -
Conventional / Variable

Existing Generation Mix

48.3 GW

Dispatchable 48.3 GW

Variable 48.3 GW

Existing Generation Mix

Existing Generation Mix

48.3 GW

Dispatchable 48.3 GW

Variable 48.3 GW

Future Generation Mix

74 GW

Dispatchable 74 GW

Variable 74 GW

Future Generation Mix

Future Generation Mix

74 GW

Dispatchable 74 GW

Variable 74 GW
However, there is uncertainty in terms of:
- Where is the location?
- What is the size?
- What is the type?
The new Generation Pool drives significant new Transmission Infrastructure over long distances.
Strategic investment in EIAs & Land acquisition is critical to meet future IRP connection timeframes.

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

Current Eskom Wind, Solar & REIPP 1,2,3,4 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 > 8yrs)
- On Time Connection – Smaller IPP generation plant can be constructed faster (delivery time <5yrs)
- Unknown locations - Multiple unspecified IPP sites require market access for best price

Change in Location - Spatial Footprint

Current Generation Footprint

Future Generation Potential Footprint

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

Strategic EIAs & Servitudes can enable faster grid development

Transmission Line Project Timeline
- Eng 1yr
- EIA & Land Acquisition 2yr + >3yr
- Construction 3yr

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 rollout leading to high risk of Gx capacity delays.

Beyond 2020 Demand Balance significantly changed by dispersed generation in South

Significantly More transmission corridors and grid access required

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
Assumed Generation Pattern for the TDP 2017

Future Generation Mix

74 GW

- CCGT
- Coal
- OCGT
- Nuclear
- Pumped storage
- Hydro
- CSP
- Other
- PV
- Wind

- Dispatchable
- Variable

59.16%
15.39%

4300 MW of PV and 650 MW of CSP allocated at potential sites across the N. Cape, Polokwane and N West Provinces

5700 MW of Wind generation allocated at potential sites across the W Cape, E Cape and N Cape

4000 MW of Nuclear generation

5700 MW of Wind generation allocated at potential sites across the W Cape, E Cape and N Cape

1000 MW of OCGT

59.16%
15.39%

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1000 MW of OCGT
Questions?
Planning for the South African Renewable Energy IPP Integration

Presented by: Makoanyane Theku
# Independent Power Producer (IPP) integration

Status to-date (end August 2017)

<table>
<thead>
<tr>
<th>Program</th>
<th>No. of Projects</th>
<th>MW Contribution</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>REIPPPP BW 1</td>
<td>28</td>
<td>1 436</td>
<td>All projects connected</td>
</tr>
<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>14 projects connected, 8 in execution, 1 project in BW 3.5 awaiting financial close</td>
</tr>
<tr>
<td>REIPPPP BW 4</td>
<td>13</td>
<td>1 121</td>
<td>Budget quotation phase</td>
</tr>
<tr>
<td>REIPPPP BW 4B</td>
<td>13</td>
<td>1 084</td>
<td>Budget quotation phase</td>
</tr>
<tr>
<td>Smalls (1-5 MW)</td>
<td>10</td>
<td>50</td>
<td>Budget quotation phase</td>
</tr>
<tr>
<td>DoE Peakers</td>
<td>2</td>
<td>1 004.5</td>
<td>All projects connected</td>
</tr>
<tr>
<td>Coal Baseload</td>
<td>2</td>
<td>863.5</td>
<td>Budget quotation phase</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>110</strong></td>
<td><strong>8 269</strong></td>
<td></td>
</tr>
</tbody>
</table>
Successful Bidders: REIPP Bid Window 1 - 4B
Grid enablement for IPP integration in the medium to long term (2018 – 2027)*

- Most of the available grid capacity will be exhausted beyond BW 4B
- TDP assumption for IPP programmes beyond REIPP BW 3.5 are shown below:

<table>
<thead>
<tr>
<th>IPP Bid window / Projects</th>
<th>Total allocated / Assumed capacity (MW)</th>
<th>Total cost estimates for Infrastructure requirements included in the 2018 – 2017 TDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>REIPPPP BW 4 &amp; 4B</td>
<td>2205</td>
<td>✓</td>
</tr>
<tr>
<td>Coal Baseload (Khanyisa and Thabametsi)</td>
<td>900</td>
<td>✓</td>
</tr>
<tr>
<td>New OCGT / CCGT generation Dedisa and Athene Substations</td>
<td>3732</td>
<td>✓</td>
</tr>
<tr>
<td>Future REIPP (Solar PV)</td>
<td>3500</td>
<td></td>
</tr>
<tr>
<td>Future REIPP (wind)</td>
<td>4400</td>
<td>✓</td>
</tr>
<tr>
<td>Future REIPP (CSP)</td>
<td>450</td>
<td></td>
</tr>
</tbody>
</table>

* Assumptions as per the IRP Baseline Plan
Transmission Connection Requirements:
Future DoE RE Programme (Wind, CSP, PV)
Issues to Consider

- Servitude and EIA restrictions
- Lead times:
  - Long Tx lines: 6 - 8 years
  - Large Power stations: 8 - 10 years
  - Distributed IPP plants: 2 - 5 years
- Use all appropriate proven technology available:
  - HVDC, EHV AC, HVDC conversions of existing AC lines, multiple circuit AC lines
  - Transmission technology choice must be compatible with strategic power system development plan

RE Grid Access issues

- IPP developments tend to be in close proximity of Eskom substations. This sometimes restricts access to other RE IPP participants due to limited power line corridors through IPP properties.
- Subsequent to REBID 1 - 4 there is limited spare capacity on the Distribution networks and in some cases, Transmission networks.
- Due to uncertainty of allocation of Preferred IPP Bidders, quotations are issued on an individual basis i.e. no other application is considered in the quotation. This potentially raises / reduce the cost of connection per quotation.
• The Grid Enablement team was established (under the auspices of Eskom and DoE IPP Office). The following grid enablement initiatives are in progress:
  • Conduct joint Distribution & Transmission infrastructure masterplan to enable future IPP integration. (Complete)
  • Identify strategic development corridors to enable speedy integration of future IPP (Complete)
  • Investment approval for EIA, servitude acquisition and required licenses (Pending)
  • Align the timetables of the IPP programme to the timetables of the grid plans (Pending)
## IPP Connection Framework

**Basis for enabling future IPP programmes**

<table>
<thead>
<tr>
<th>Assumptions setting</th>
<th>Review &amp; Refine</th>
<th>RFP</th>
<th>Bids Subm.</th>
<th>Pref. Bids</th>
<th>Fin. Close</th>
<th>Const.</th>
<th>CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements Capture</td>
<td>Concept Analysis</td>
<td>GCCA</td>
<td>CEL</td>
<td>Final review</td>
<td>BQ</td>
<td>Const.</td>
<td>CO</td>
</tr>
</tbody>
</table>

### Stakeholders engagement
- Formulate Assumptions
- Risk Analysis
  - Define controls and mitigations

### Produce Integration Master Plan
- Determine Grid connection requirements and costs

### Requirements Capture
- Refine & prioritize Planning requirements

### Concept Analysis
- Development
  - EIA
  - Acquisition
  - Licenses
  - Design (Prelim)

### IPP connection feasibility assessment
- Refine connection SOW
- Costing

### Optimisation of the connection SOW
- Detailed design
- Specialized studies
- Governance approvals
- Costing

### Execution
- Testing
- Review / Evaluate
- Improve
Total RE generation capacity assumption per substation (2017 TDP period) IRP Baseline Plan aligned

- Solar Photovoltaic (Solar PV)
- Wind Energy
- Concentrated Solar Power (CSP)
TDP plans for IPP Integration

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

Planned transmission lines are represented by dotted lines.

**2020+ IPP integration plans: Strategic**

- Replacing existing 275kV infrastructure
- Additional 275kV infrastructure
  - Bayonne 275kV 400/132kV integration
  - Additional 275kV 400/132kV integration
  - OCGT Integration (Richards Bay)

**Lowest level of Confidence**
- Unconfirmed IPP location, timing & scope
- Some of the key development enabling activities have not started / in initial phase

---

- Oranjemond
- Gronis
- Nama
- Aggeneis
- Aries
- Kronos
- Hydra
- Betta
- Nieuwhoop
- Ferrum
- Upington
- Paulputs
- Nieuwhoop
- Helios
- Juno
- Aurora
- Kappa
- Komsberg
- Proteus
- Grassridge
- Neptune
- Vuyani
- Delphi
- Poseidon
- Neptone
- Muldersvlei
Main corridor EA / servitude requirements supplementary to the SEA (Proposed modification)
Conclusion

• Grid Enablement team feedback:
  
  • Provided valuable insights and skills, which has enriched the infrastructure development process
  
  • Engagements are paramount in improving process effectiveness, quality of input assumption, connection criteria fundamentals as well as continually improving plans as necessary.

• Potential opportunities for future initiatives
  
  • Optimize integration process between DOE IPP and Eskom network development plan by:
    
    • Recommending IPP procurement programme towards areas where network capacity is available.
    
    • Target specific geographic areas for IPP projects to optimize on timelines for readiness of the grid infrastructure
Questions?
Provincial Plans
TDP 2018 – 2027
North-West Province

Presented by: Queen Melato (Planning Engineer)
North-West Province Profile

Load

- Peak load of 3171MW: 16 Nov 2015

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

Generation

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<tr>
<th>Type</th>
<th>Name</th>
<th>Output</th>
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<tr>
<td>Base Load Coal</td>
<td>Matimba</td>
<td>3360 MW</td>
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<tr>
<td>Base Load Coal</td>
<td>Medupi</td>
<td>1588 MW</td>
</tr>
<tr>
<td>Renewable Energy PV</td>
<td>RustMo1</td>
<td>7 MW</td>
</tr>
<tr>
<td>Renewable Energy Solar</td>
<td>Solar</td>
<td>7 MW</td>
</tr>
</tbody>
</table>

Total 4955 MW

Approved REIPPPP Projects PV 225 MW

REIPPPP Total 225 MW
Achievements in the Platinum Province
Unlocked capacity for electrification and industrial activities.

Created capacity for connection of RE plants in and around Vryburg.
• Unlocked capacity for mining, industrial activities and tourism.
Load Forecast
## North-West Province Load Forecast

### CAGR* = 3.6%

### Load Breakdown:
- **Rustenburg load**: mining, residential and commercial
- **Carletonville load**: electrification, commercial, residential and natural load growth
- **North West @ TOSP**

### Load Forecast (MW):

<table>
<thead>
<tr>
<th>Year</th>
<th>Rustenburg</th>
<th>Carletonville</th>
<th>North West @ TOSP</th>
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<tbody>
<tr>
<td>2017</td>
<td>2013</td>
<td>1225</td>
<td>3043</td>
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<tr>
<td>2018</td>
<td>2302</td>
<td>1336</td>
<td>3120</td>
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<td>2019</td>
<td>2270</td>
<td>1451</td>
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<td>2526</td>
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<tr>
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<td>2716</td>
<td>1883</td>
<td>3941</td>
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</table>

* Compound Annual Growth Rate
Generation Forecast
Renewable Energy in North-West Province

RE Projections (10 year):

• Approximately 0.55 GW

• Mookodi Substation: 475 MW

• Watershed Substation: 75 MW
Developments in the Rustenburg CLN

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

- Ngwedi substation - around Sun City

- Marang Extension - next to Rustenburg Municipality

- Bighorn Extension – near Marikana

- Dinaledi 3rd Transformer in Madibeng / Brits
Developments in the Carletonville CLN

- Pluto-Mahikeng 400kV line
- Mahikeng substation
- Mookodi-Mahikeng 400kV lines
- Hermes-Mookodi 400kV line
- Mookodi-Hotazel 400kV line

2028
1883MW

2018
1225MW

2023
1587MW

Graph showing development timeline.
Limpopo Province Profile

- **Peak load of 2960 MW**: 19 October 2015

- **Redistributors**
  - Industrial, Mining and Commercial
  - Agriculture
  - Electrification, Residential and Prepaid

---

**Type | Name | Output**
--- | --- | ---
**Base Load** | Coal | Matimba 3990 MW
| | Medupi 1692 MW
**Renewables** | Photovoltaic | Witkop 30 MW
| | Soutpan 28 MW
| | Villa Nora 60 MW
**Eskom Total** | 5800 MW
**Approved REIPPPP Projects** | PV | 118 MW
| Coal (Future) | 600 MW
**REIPPPP Total** | 118 MW
Achievements
• Borutho 400kV Integration
• Foskor 3rd 250MVA Transformation
• Acornhoek Transformation Upgrade
• Spitskop Transformation Upgrade
• Dwarsberg 132kV Switching Station
• Medupi Transmission Integration
Load Forecast
Limpopo Province Load Forecast

<table>
<thead>
<tr>
<th>Year</th>
<th>Polokwane</th>
<th>Lephalale</th>
<th>Phalaborwa</th>
<th>Limpopo Grid Peak</th>
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<tr>
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<td>1991</td>
<td>2113</td>
<td>4204</td>
<td>6600</td>
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</table>

Residential, Electrification, Agriculture and Chrome Mining commercial and light industrial load growth. Platinum and Coal Mining

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

Residential, Electrification, Agriculture and Chrome Mining
Developments in the Polokwane CLN

- **Nzhelele 400kV Integration**
  - Nzhelele 400/132kV substation (1st and 2nd 250MVA)
  - Tabor-Nzhelele 400kV line
  - Borutho-Nzhelele 1st 400kV line

- **Limpopo East Corridor Strengthening**
  - Spencer 400/132kV Transformation (1st 400MVA 400/132kV Transformer)
  - Foskor-Spencer 1st 400kV line (110km)

- **Install Capacitor Banks at:**
  - Tabor MTS
  - Spencer MTS
  - Nzhelele MTS

---

<table>
<thead>
<tr>
<th>Year</th>
<th>MW</th>
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<tbody>
<tr>
<td>2020</td>
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<tr>
<td></td>
<td>1991</td>
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30MW Witkop Solar PV
28MW Tabor Solar PV

---

Witkop, Tabor, Spencer, Foskor, Limpopo, Map of Polokwane CLN area.
Developments in the Lephalale CLN

- Medupi Transmission Integration
- Waterberg Generation Integration at 400kV
- Borutho 3rd 500MVA 400/132kV transformer

2027
2113 MW

60MW Matimba Solar PV
Developments in the Phalaborwa CLN

- Highveld North-West and Lowveld North Reinforcement-Phase 2
  - Silimela 400/132kV substation
  - Manogeng Switching Station
- Tubatse Strengthening Scheme Phase 1
  - Senakangwedi B MTS) 400/275kV Substation (1st 800MVA 400/275 kV transformer)
- Foskor & Acornhoek 275/132kV Transformation Upgrades
  - Foskor-Merensky 2nd 275kV Line (400kV)
  - Limpopo East Corridor Strengthening Tabor MTS
  - Foskor-Spencer 1st 400kV Line

- 2017
  - 1484 MW

- 2020
  - 2583 MW

- 2027
  - 4204 MW
Mpumalanga Province

Planning Engineer: Kabir Singh

Presented by: Thamsanqa Ngcobo
Mpumalanga Province Profile

Sector Breakdown
- 2016 Peak load of 3934 MW
- Generation Capacity of ~30 GW

<table>
<thead>
<tr>
<th>Power Station</th>
<th>Capacity</th>
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<tbody>
<tr>
<td>1 Arnot</td>
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<tr>
<td>2 Camden</td>
<td>1520</td>
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<tr>
<td>3 Duvha</td>
<td>3600</td>
</tr>
<tr>
<td>4 Grootvlei</td>
<td>1200</td>
</tr>
<tr>
<td>5 Hendrina</td>
<td>1900</td>
</tr>
<tr>
<td>6 Kendal</td>
<td>4400</td>
</tr>
<tr>
<td>7 Kriel</td>
<td>3000</td>
</tr>
<tr>
<td>8 Komati</td>
<td>1000</td>
</tr>
<tr>
<td>9 Majuba</td>
<td>4000</td>
</tr>
<tr>
<td>10 Matla</td>
<td>3720</td>
</tr>
<tr>
<td>11 Tutuka</td>
<td>3600</td>
</tr>
</tbody>
</table>
Achievements
Completed projects

- Gumeni 400/132 kV 500 MVA substation
- Hendrina-Gumeni 400 kV line
- Kusile 400 kV HV Yard
- Minerva - Duvha and Kendal – Apollo 400 kV lines loop in and out
Load Forecast
Mpumalanga Load Forecast 2018 - 2027

- **Witbank @ Grid Peak**: 1292, 1312, 1324, 1333, 1351, 1364, 1175, 1179, 1185, 1189, 1194
- **Middelburg @ Grid Peak**: 1020, 1084, 1144, 1168, 1219, 1276, 1462, 1485, 1505, 1539, 1621
- **Lowveld @ Grid Peak**: 956, 992, 1017, 853, 883, 912, 1009, 1027, 1007, 1024, 1042
- **Highveld South @ Grid Peak**: 1680, 1723, 1729, 1739, 1750, 1760, 2236, 2171, 2179, 2186, 2194
- **Mpumalanga @ Grid Peak**: 4056, 4173, 4249, 4175, 4257, 4337, 4788, 4774, 4788, 4835, 4915

* **CAGR** = 2.0%

**Growth Drivers**
- Residential, commercial and industrial development
- Natural load growth, tourism and residential developments
- Mining and Heavy Industry

* **Compound Annual Growth Rate**
Generation Forecast
## Generation Forecast

### Commissioning schedule

<table>
<thead>
<tr>
<th>Station</th>
<th>Kusile</th>
<th>Khanyisa IPP</th>
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<td>Unit</td>
<td>MW</td>
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<td>2019</td>
<td>2</td>
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<td>5</td>
<td>722</td>
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<tr>
<td>2023</td>
<td>6</td>
<td>722</td>
</tr>
</tbody>
</table>
Developments in Witbank

- Kusile Integration
  - Kusile-Duvha 400kV line
  - Kusile-Minerva 400kV line
  - Kusile-Apollo 400kV line
  - Kusile-Lulamisa 400kV line
  - Kusile-Zeus 400kV line
  - Kendal-Zeus 400kV line
Developments in Witbank and Middelburg

- Khanyisa IPP
  - Kusile-Vulcan 400kV LILO
- Emkhiweni Integration
  - Arnot-Vulcan 400kV LILO
  - Emkhiweni-Silimela 400kV line
Developments in Highveld South

- Mulalo (Sol B) Integration
- Kriel-Zeus 400kV LILO
- Kriel-Tutuka 400kV LILO
Developments in the Lowveld CLN

- Marathon 400kV Integration
- Marathon 1st 500 MVA 400/132 kV transformer
- Marathon-Gumeni 400 kV line
Gauteng Province

Presented by: Thamsanqa Ngcobo (Planning Engineer)
Load
- Peak load of 9,885 MW: 28th July 2016

Generation
- Kelvin Power Station (in Johannesburg) and Rooiwal Power Station (in Tshwane) are some of the Independent Power Producers (IPPs) that lie within the defined Gauteng grid area. There is also potential Biomass IPPs in the region.

- The primary sources of power are Cahora Bassa, Lethabo, Matla, Kendal, Duvha, Grootvlei and Matimba power stations.
Load Forecast
Gauteng Load Forecast

Gauteng Province Load Forecast

**Natural load growth:**
- residential developments
- commercial and light industrial load growth

* Compound Annual Growth Rate

<table>
<thead>
<tr>
<th>Year</th>
<th>VAAL GRID PEAK</th>
<th>WEST RAND GRID PEAK</th>
<th>EAST RAND GRID PEAK</th>
<th>JHB GRID PEAK</th>
<th>GAUTENG TOSP</th>
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<td>1682</td>
<td>4173</td>
<td>4937</td>
<td>5596</td>
<td>14925</td>
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</table>
Major Developments
Hazeldean Node Development (East Capital): The Hazeldean Consortium master plan includes a mall, hospitals, educational facilities, residential, retail, hospitality and tourism components.
Developments in the Tshwane CLN

- Tshwane Reinforcement – Wildebees integration
- Tshwane Reinforcement – Diphororo Phase 1
- Tshwane Reinforcement – Diphororo Phase 2

![Map showing developments in the Tshwane CLN](image)

Bar chart showing projected power generation increase from 2017 to 2027.

- 2017: 2258 MW
- 2027: 3304 MW

Locations: Jhb (Joburg), East Rand, Centurion, Pelly, Kwagga, Tshwane, Pelly, Wildebees, Mamelodi, Bronkhorstspruit, To Dinaledi MTS (North West), Njala, Thuso, Apollo, Minerva, Lomond, Soshanguve, Diphororo, Pretoria, Tshwane.
Lufhereng and Syferfontein Development – Mixed housing developments planned in the Soweto area. (>60 000 housing units envisaged)
Developments in the JHB North CLN

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

2017 1527 MW → 2027 2294 MW
Developments in the West Rand and Vaal CLN

- Vaal Strengthening Phase 2
- Soweto Strengthening
- West Rand Strengthening Phase 1

2017: 3729 MW → 2027: 5709 MW
Zendai Modderfontein (Mixed Development)
- 30 000 Housing units, commercial and light industry envisaged
- Potential 200 000 jobs

Linbro Park (Mixed Development)
- 20 000 Housing units, commercial and light industry envisaged
- Alexandra Township re-blocking
Developments in the JHB East and South CLN

- City Power integration
- Mesong integration
- Sebenza integration
- Jupiter B integration
- Sisimuka integration
Developments in the JHB East and South CLN

- City Power integration
- Mesong integration
- Sebenza integration
- Jupiter B integration
- Sisimuka integration
- Lesokwana Integration

2017: 4423 MW
2027: 6324 MW

Map showing various locations and connections within the JHB East and South CLN.
KwaZulu-Natal Province

Presented by: Thokozani Bengani (Planning Engineer)
KwaZulu-Natal Province

**Generation**
- Power supply into the province is mainly from Mpumalanga Province power pool
- Drakensberg Pumped Storage with 1000 MW installed capacity
- Ingula Pumped Storage with 1330 MW installed capacity
- Avon OCGT with 680 MW installed capacity

**Geographical area**
- Newcastle, Ladysmith, Drakensberg, Pietermaritzburg, Pinetown, Port Shepstone, Amanzimtoti, Durban, KwaDukuza, Empangeni, Richards Bay, St Lucia, Hluhluwe and Ermelo

**Economic Activity**
- Redistributors, Commercial, Mining, Industrial, Residential, Agricultural, Traction
Achievements
Avon, Mersey and Incandu 3rd Transformers

1 x 500 MVA & 2 x 250 MVA transformers were installed in KZN in 2016, adding a total of 1000 MVA of capacity to the system.
Load Forecast
KwaZulu-Natal Load Forecast

<table>
<thead>
<tr>
<th>Year</th>
<th>Pinetown (GP)</th>
<th>Empangeni (GP)</th>
<th>Newcastle (GP)</th>
<th>Ladysmith (GP)</th>
<th>TOSP</th>
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<td>773</td>
<td>322</td>
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CAGR* = 1.87%

* Compound Annual Growth Rate
Network Development Plan
Key Developments in Empangeni, Ulundi, Vryheid and Newcastle

- Drivers for load growth:
  - Coal Mining and Ermelo-Richards Bay Coal line
  - Industrial activities
  - Public infrastructure delivery

- Planned Project:
  - 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

These substations will reinforce the Ermelo-Richards Bay coal link.
Key Developments in Northern KZN

- Growth Drivers:
  - iSimangaliso wetland park eco-tourism
  - Agriculture
  - Public infrastructure delivery

- Planned Project:
  - Northern KZN Strengthening:
    - Phase 1: Normandie-Iphiva 400 kV line and integration of Iphiva Substation near Mkuze
    - Phase 2: Duma-Iphiva 400 kV line
KwaZulu-Natal 765 kV Strengthening

- **Purpose:**
  - To create sufficient capacity to meet the growth in demand
  - Also provide opportunities to switch off critical circuits for maintenance

- **KZN 765 kV Strengthening Planned Projects:**
  - Empangeni Integration
  - Pinetown Integration
Key Developments in Pinetown CLN

- Drivers for load growth:
  - eThekwini Metropolitan:
    - Shongweni development
    - Cornubia development
    - Dube tradeport development
    - Old airport dig-out
  - South Coast:
    - Commercial and tourism
    - Public infrastructure delivery

- Planned Project:
  - Venus- Ariadne 2nd 400 kV line
  - eThekwini Strengthening
    - Integration of Inyaninga SS
    - Integration of Shongweni SS
  - South Coast Strengthening:
    - Ariadne-Eros 400 kV line and integration of St Faiths SS
Free State Province

Presented by: Thokozani Bengani (Planning Engineer)
Free State Province Profile

Generation
- Power supply into the province is mainly from Mpumalanga Province power pool and Lethabo Power Station 3558 MW
- There is a potential for renewable energy generation
- Solar PV commissioned 124 MW

Geographical area
- Harrismith, Bloemfontein, Botshabelo, Welkom, Sasolburg, Kroonstad, Parys, Phuthaditjhaba and Bethlehem

Economic Activity
- Redistributors, Mining, Commercial, Industrial, Residential, Agriculture and Traction
Load Forecast
Free State Load Forecast

SIP 2, logistics and public infrastructure delivery

Commercial and industrial development

Primary driver is public infrastructure delivery

Load (MW)

- 500 1,000 1,500 2,000 2,500

2,017 2,018 2,019 2,020 2,021 2,022 2,023 2,024 2,025 2,026 2,027

Welkom (GP) 869 945 952 973 980 988 996 1,003 1,011 1,019 1,023

Sasolburg (GP) 450 463 481 488 495 503 510 517 524 532 541

Bloemfontein (GP) 578 593 611 619 635 662 689 699 710 727 748

TOSP 1,831 1,931 1,973 2,008 2,037 2,079 2,119 2,143 2,168 2,199 2,232

* 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 Project:
  - Harrismith Strengthening: Extension of Sorata Substation (Phase 1 and 2)

Welkom CLN:

<table>
<thead>
<tr>
<th>Year</th>
<th>MW</th>
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<tr>
<td>2021</td>
<td>980</td>
</tr>
<tr>
<td>2027</td>
<td>1023</td>
</tr>
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</table>

LESOTHO
Key Developments in Sasolburg

- Drivers for load growth:
  - Mining activities
  - Industrial activities
  - Public infrastructure delivery

- Planned Project:
  - Integration of Igesi Substation

Sasolburg CLN:
- 2027: 541 MW
Key Developments in Mangaung and surrounding regions

- Drivers growth:
  - Public infrastructure delivery
  - Solar power generation
- Planned Project: Bloemfontein Strengthening:
  - Everest-Merapi 400 kV Line
  - Harvard 400/132 kV Substation
  - 2 x Beta-Harvard 400 kV Lines

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity (MW)</th>
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<tbody>
<tr>
<td>2017</td>
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<td>635</td>
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<tr>
<td>2027</td>
<td>748</td>
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Venus – Ariadne – Eros 400 kV Line Route
Northern Cape Province

Planning Engineer: Jamila Kombe
Presented by: Ahmed Hansa
Northern Cape Province Profile

**LOAD**
- Peak load of 728 MW: Feb 2016

**GENERATION**

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Output</th>
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<tr>
<td>Peaking</td>
<td>Van Der Kloof</td>
<td>240 MW</td>
</tr>
<tr>
<td></td>
<td>Gariep</td>
<td>360 MW</td>
</tr>
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<td>Eskom Total</td>
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<tr>
<td>REIPPPP Projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td></td>
<td>150 MW</td>
</tr>
<tr>
<td>PV</td>
<td></td>
<td>950 MW</td>
</tr>
<tr>
<td>CSP</td>
<td></td>
<td>200 MW</td>
</tr>
<tr>
<td>Hydro</td>
<td></td>
<td>10 MW</td>
</tr>
<tr>
<td>REIPPPP Total</td>
<td></td>
<td>1310 MW</td>
</tr>
</tbody>
</table>
Load Forecast
Load Forecast

CAGR* = 3.68%

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

Namaqualand CLN @ Provincial Peak
- 2018: 103.4
- 2027: 149.7

Karoo CLN @ Provincial Peak
- 2018: 197.9
- 2027: 248.1

West Coast CLN @ Provincial Peak
- 2018: 13.72
- 2027: 14.51

Kimberley CLN @ Provincial Peak
- 2018: 774.7
- 2027: 1098.2

Northern Cape Province (Area Max)/Province
- 2018: 1089.7
- 2027: 1510.5

Northern Cape Province (MSD)
- 2018: 974.7
- 2027: 1351.4

* Compound Annual Growth Rate
Generation Forecast
Generation Forecast

NC Renewable Generation

<table>
<thead>
<tr>
<th>Year</th>
<th>NC RG Cumulative</th>
<th>NC RG Cumulative</th>
<th>NC Load forecast Provincial Peak</th>
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</thead>
<tbody>
<tr>
<td>2015</td>
<td>685</td>
<td></td>
<td>891</td>
</tr>
<tr>
<td>2016</td>
<td>1070</td>
<td></td>
<td>883</td>
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<tr>
<td>2017</td>
<td>2094</td>
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<td>2018</td>
<td>2384</td>
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<td>1090</td>
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<td>2025</td>
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</tr>
<tr>
<td>2027</td>
<td>9264</td>
<td></td>
<td>1510</td>
</tr>
</tbody>
</table>
Achievements
Achievements

**Aries - Nieuwehoop 400 kV line**

Kronos 400/132 kV transformation for load which also facilitated:
- Prieska 75 MW PV
- Sonnidex 75 MW PV

Helios 400/132 kV transformation for:
- Loeriesfontein 140 MW wind farm
- Khobab 140 MW wind farm

Paulputs transformation for load which also facilitated:
- Kaxu 100 MW CSP
- Xina 100 MW CSP
- Konkoonsies 9.7 MW PV
- Neusberg Hydro Electric 10 MW
Network Development Plan
Developments in the West Coast CLN

- Further transformation at Helios for load

• 2027 14.5 MW

- Western Cape
Developments in the Namaqualand CLN

- Juno-Gromis-Oranjemond 400 kV line
- Gromis-Nama-Aggeneis 400 kV line
- Aggeneis-Paulputs 2nd 220 kV line
- Aries FACTS Device

Bar graph showing increasing MW capacity over years:

- 2018: 103 MW
- 2022: 137 MW
- 2027: 150 MW

Map showing key locations and connections in NAMIBIA.
Developments in the Karoo CLN

- Hydra transformation
- Ruigtevallei transformer normalisation and transformation
- Gariep Strengthening
Developments in the Kimberley CLN

- Upington Substation and Upington-Nieuwehoop 400 kV line
- Nieuwehoop-Ferrum 400kV line
- Ferrum-Mookodi 400 kV line via Hotazel
Western Cape Province

Presented by: Ahmed Hansa (Planning Engineer)
Western Cape Province Profile

Load
- Peak load of 3850 MW: 26th July 2016

Generation

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Load</td>
<td>Koeberg</td>
<td>1860 MW</td>
</tr>
<tr>
<td></td>
<td>Acacia</td>
<td>171 MW</td>
</tr>
<tr>
<td></td>
<td>Ankerlig</td>
<td>1332 MW</td>
</tr>
<tr>
<td></td>
<td>Gourikwa</td>
<td>740 MW</td>
</tr>
<tr>
<td>Peaking</td>
<td>Acacia</td>
<td>171 MW</td>
</tr>
<tr>
<td></td>
<td>Ankerlig</td>
<td>1332 MW</td>
</tr>
<tr>
<td></td>
<td>Gourikwa</td>
<td>740 MW</td>
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<tr>
<td>Pumped Storage</td>
<td>Palmiet</td>
<td>400 MW</td>
</tr>
<tr>
<td>Eskom Renewables</td>
<td>Wind</td>
<td>105 MW</td>
</tr>
<tr>
<td>Eskom Total</td>
<td></td>
<td>4608 MW</td>
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<tr>
<td>REIPP PPP</td>
<td>PV IPPs</td>
<td>134 MW</td>
</tr>
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<td></td>
<td>Wind IPPs</td>
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<td>REIPP PPP Total</td>
<td></td>
<td>450 MW</td>
</tr>
<tr>
<td>City of Cape Town Total</td>
<td></td>
<td>258 MW</td>
</tr>
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</table>
Cape Corridor

- Comprises of 400 kV and 765 kV lines originating from Zeus Substation and Alpha Substation in Mpumalanga to Hydra Substation in the Northern Cape.

- It then extends into the Western Cape Province.

Cape Corridor 765 kV Progress

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

See Inset 1
Achievements
Kappa-Sterrekus 765 kV line

Route Challenges:
- Tower construction by means of Gin pole and helicopter
- Longest 765 kV span in South Africa – 1290 m
- Terrain inaccessible for vehicles and cranes
- Steep side slopes
Load Forecast
Western Cape Load Forecast

**Western Cape Load Forecast**

MW

<table>
<thead>
<tr>
<th></th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peninsula</strong></td>
<td>2715</td>
<td>2791</td>
<td>2830</td>
<td>2871</td>
<td>2910</td>
<td>2971</td>
<td>3015</td>
<td>3050</td>
<td>3084</td>
<td>3118</td>
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<tr>
<td><strong>Southern Cape</strong></td>
<td>752</td>
<td>763</td>
<td>775</td>
<td>788</td>
<td>800</td>
<td>812</td>
<td>824</td>
<td>836</td>
<td>851</td>
<td>864</td>
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<tr>
<td><strong>West Coast</strong></td>
<td>498</td>
<td>520</td>
<td>529</td>
<td>532</td>
<td>536</td>
<td>539</td>
<td>542</td>
<td>550</td>
<td>553</td>
<td>556</td>
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<tr>
<td><strong>TOSP</strong></td>
<td>3876</td>
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<td>4222</td>
<td>4279</td>
<td>4332</td>
<td>4382</td>
<td>4431</td>
</tr>
</tbody>
</table>

*C Compound Annual Growth Rate*
Developments in the Peninsula CLN

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

2027
3300 MW
Pinotage Substation – Under construction
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
- PCB series cap phase out plan

2027
990 MW

Substations
Lines

Existing
Planned

Cape Town
Bredasdorp
Hermanus
Gourikwa

Narina
Vredendal
Morreesburg
Malmesbury
Ceres

Asteria
Kappa
Komsberg

Beaufort West
Droërivier
Oudtshoorn
Mossel Bay
Knysna

George
Knysna

Acacia PS
Sterrekus
Koeberg
Paarl

Montagu
Worcester
Agulhas

Acacia
Mulgrew
Acacia PS
Sterrekus
Koeberg
Paarl

Saasveld
Caledon

Hermanus
Bredasdorp

Asteria

2018
860 MW
2022
920 MW
Developments in the West Coast CLN

- Aurora transformation upgrade
- Bokkom Substation
- Juno transformation upgrade
- PCB series cap phase out plan
Construction of a second 765 kV link from Zeus to Sterrekus in order to ensure adequate transfer capacity into the Cape

- Zeus-Perseus 765 kV line
- Perseus-Gamma 2nd 765 kV line
- Gamma-Kappa 2nd 765 kV line
- Kappa-Sterrekus 2nd 765 kV line
Eastern Cape Province

Planning Engineer: Caswell Ndlhovu

Presented by: Ahmed Hansa
**General**
- EC Population ~ 6.7 million
- 3rd most populous province
- ~ 8% of total South African GDP
- 4th largest contributor to GDP
- **Major Industries**
  - Automotive, tourism, agriculture, agro-processing, ocean economies

**Generation in Eastern Cape**
- Port Rex 171 MW
- Dedisa OCGT 372 MW
- RE IPP (Wind & Solar) ~ 1060 MW

**Load Served**
- Peak Load demand (2016) 1472 MW
- Geographic Areas: Nelson Mandela Metro, Buffalo City Metro, Mthatha
Load Forecast
Drivers - East London
- Electrification
- Construction – Commercial Growth
- Agriculture, Forestry and Agro-Processing
- East London IDZ

Drivers – Port Elizabeth
- Coega IDZs – Petro/ Ferrochrome Smelter(s)
- Manufacturing, Auto Industry, Exports

Eastern Cape Load Forecast

<table>
<thead>
<tr>
<th>Year</th>
<th>East London Peak (MW)</th>
<th>Port Elizabeth Peak (MW)</th>
<th>Eastern Cape @ TOSP (MW)</th>
<th>Eastern Cape Grid Peak (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>687</td>
<td>879</td>
<td>1300</td>
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<tr>
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<td>2027</td>
<td>867</td>
<td>1190</td>
<td>1630</td>
<td>1896</td>
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</table>
Generation Forecast
Eastern Cape Generation Forecast

Renewables (MW)

<table>
<thead>
<tr>
<th>Year Total</th>
<th>EL</th>
<th>PE</th>
<th>Total</th>
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<tbody>
<tr>
<td>2015</td>
<td>250</td>
<td></td>
<td>250</td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td>1428</td>
<td>1452</td>
</tr>
<tr>
<td>2017</td>
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<td>2018</td>
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<td>3806</td>
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<tr>
<td>2027</td>
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<td>5406</td>
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</tbody>
</table>

- **PV**: 0, 0, 70, 70, 70, 70, 70, 70, 70, 70, 70, 70, 70, 70
- **Nuclear**: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1600
- **Wind**: 470, 556, 1003, 1260, 1432, 1632, 1632, 1632, 1632, 1632, 1632, 1632, 1632, 1632

**Gas generation ~ 2000 MW**

**Thyspunt Nuclear, depends on government approval and IRP ~ 1600 MW**

**Net power exporter**
Achievements
- Eros-Vuyani line, Vuyani substation and Vuyani – Neptune line
- Poseidon 500 MVA 400/132 kV transformer
- ~ 1060 MW RE in the province and DOE OCGT generation at Dedisa
Network Development Plan
Key projects in the East London area

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

- **3rd 120 MVA transformer and 100 Mvar 400 kV capacitor bank at Delphi substation**

**2027**

867 MW

- Neptune
- Pembroke
- Delphi
- Eros
- Queenstown
- Mthatha
- Vuyani
- East London
- Graaff-Reinet
- Port Elizabeth
- Dedisa
- Grassridge
- Port Alfred
- Grahamstown
Key projects in the Port Elizabeth area

- 3rd 500MVA transformers and 100 Mvar 400 kV capacitor banks at Dedisa and Grassridge
- Thyspunt nuclear and 1.7 GW gas-to-power generation integration
- Gamma-Grassridge 1st and 2nd 765 kV lines
Transmission Refurbishment Plan 2018 - 2027

Presented by: Atha Scott
The South African Grid Code stipulates that the Transmission company is responsible for the renewal, optimisation, reconfiguration and decommissioning of existing assets to ensure sustainability of the network.

The development of the Transmission refurbishment plan is premised on an asset management (AM) framework.

The asset management approach involves asset condition assessment and asset risk assessment, to support the compilation of refurbishment plans.

The AM approach seeks to sustain a reliable and quality of supply, by managing the delicate balance between; network performance, network risks and capital constraints.
Clearly defined robust weighted criteria established for each different asset class documented in standards and procedures.

Individual Health Assessment of all equipment using documented standards and procedures.

Risk based or condition based assessment of selected equipment using documented standards and procedures.

Asset Health Results

Group results into asset class and/or project scope

Asset Hierarchy Mapping

Tx
Province
Substation
Bay
Equipment

Enterprise Evaluation

Evaluation of Asset Classes

Evaluation of importance of individual Asset Conditions based on criticality and risk

Unconstraint Needs Ranked

Unsolicited injections

Resource Constraints

Execution Constraints

Revised Plan

Final Asset Management Plan

Unconstraint Plan

Constraints

Final Investment Plan

Asset Management Strategy and Objectives

Organisation Strategy and Objectives

Development of TDP 2018 - 2027 (Asset Refurbishment Framework)
Refurbishment Portfolio Focus Areas

• **Development Mandate:**
  • Capital Spares: Supply restoration
  • Production Equipment: Maintenance support
  • Customer Connections: Secure revenue base
  • N-1 Transformation projects for regulatory compliance
  • Statutory network requirements
  • Refurbishment of network: long term sustainability and reliability of the network, covering asset classes in the following disciplines:
    • Substations
    • Transmission lines
    • Telecommunications
    • Associated general infrastructure
## Transmission Substations’ Refurbishment Requirements (Needs)

### Transmission’s Substation Plant Condition Assessment Overview

<table>
<thead>
<tr>
<th>Component</th>
<th>Normal Maintenance (86-100%)</th>
<th>Normal Maintenance (71-85%)</th>
<th>Maintenance &amp; Monitoring (51-70%)</th>
<th>Possible Project/Life Extension (31-50%)</th>
<th>Project (0-30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Transformer</td>
<td>1413</td>
<td>515</td>
<td>1340</td>
<td>410</td>
<td>418</td>
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<tr>
<td>Transformer</td>
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<td>251</td>
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<td>Surge Arrester</td>
<td>3218</td>
<td>530</td>
<td>413</td>
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<td>Reactor</td>
<td>22</td>
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<td>Protection</td>
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<td>Isolators</td>
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<td>3356</td>
<td>1886</td>
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<td>Current Transformer</td>
<td>3000</td>
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<td>374</td>
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<td>2597</td>
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<tr>
<td>Circuit Breaker</td>
<td>2034</td>
<td>638</td>
<td>123</td>
<td>60</td>
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<td>Capacitor</td>
<td>12</td>
<td>30</td>
<td>34</td>
<td>13</td>
<td>5</td>
</tr>
</tbody>
</table>

Legend:
- A - Normal Maintenance (86-100%)
- B - Normal Maintenance (71-85%)
- C - Maintenance & Monitoring (51-70%)
- D - Possible Project/Life Extension (31-50%)
- E - Project (0-30%)
The 10 year asset renewal plan formulation process

- 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

Plan Semi-constrained to reflect bottle necks in the Capital Plan value chain
## Project Prioritisation Matrix (Snapshot)

**Update Constraint Score**

<table>
<thead>
<tr>
<th>ITEM_NAME</th>
<th>STAGE GATE</th>
<th>Score</th>
<th>Ø Type of Customer and Value to Customer</th>
<th>Ø Network Stability</th>
<th>Ø Likelihood of Load loss (MW)</th>
<th>Ø Performance (i.e. not supply, without the additional components)</th>
<th>Ø Statutory</th>
<th>Ø Safety and Environmental Improvements</th>
<th>Ø Spaces</th>
<th>Ø Type of failure</th>
<th>Ø Cost of maintenance</th>
<th>Ø Prior Refurbishment</th>
<th>Ø Future need</th>
<th>Ø Skill Level</th>
<th>Ø Age</th>
<th>Ø Asset Health Index</th>
<th>Ø Score</th>
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<tbody>
<tr>
<td>Kriel HV Yard Refurb</td>
<td>PCRA</td>
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<td>Sprektskop 2 X 500 MVA 132kV Transformer Upgrade(Era)</td>
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<td>Apollo CS: Breakers 11kV Replacement</td>
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<td>Sprektskop 2 X 500 MVA 132kV Transformer Upgrade(Era)</td>
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</tbody>
</table>

Critical projects previously never stood out and had not been started

16 Weighted criteria

Prioritisation defined to eliminate sensitivity to interpretation
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.**
Questions?
TDP 2018 – 2027
Summary and Capex Analysis

Presented by: Leslie Naidoo
Network Planning: The role of Transmission Planning

Transmission network is required to transport the electricity to Distribution and Large Customers.

Existing and new Generation capacity projects as per the IRP.

Transmission Planning ensures adequate long term network development plans are augmented to ensure the reliability and security of the power system.

Distribution connections, existing and new loads Customers.
Summary of transmission infrastructure requirements over the TDP period

Corporate Plan aligned 2017 TDP Plan

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<tr>
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<tr>
<td>Power lines (km)</td>
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<tr>
<td>765 kV</td>
<td>98</td>
<td>350</td>
<td>448</td>
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<tr>
<td>400 kV</td>
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<td>275 kV</td>
<td>33</td>
<td>211</td>
<td>244</td>
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<tr>
<td>Total length (km)</td>
<td>2539</td>
<td>4126</td>
<td>6665</td>
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<tr>
<td>Transformers</td>
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<tr>
<td>Number of units</td>
<td>44</td>
<td>51</td>
<td>95</td>
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<tr>
<td>Total capacity (MVA)</td>
<td>16390</td>
<td>25045</td>
<td>41435</td>
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Planned transmission lines

2016 vs 2017 TDP Cumulative Total Line km Requirements

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<tr>
<td>Actual Built Cumulated</td>
<td>600</td>
<td>1043</td>
<td>1674</td>
<td>2461</td>
<td>3272</td>
<td>3591</td>
<td>3937</td>
<td>4522</td>
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<td>2016 TDP Corporate Plan</td>
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<td>4522</td>
<td>5327</td>
<td>6275</td>
<td>6671</td>
<td>6797</td>
<td>6908</td>
<td>7197</td>
<td>8026</td>
<td>8810</td>
<td>9403</td>
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<tr>
<td>2017 TDP Corporate Plan</td>
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<td></td>
<td>4522</td>
<td>5199</td>
<td>5790</td>
<td>6184</td>
<td>6681</td>
<td>7061</td>
<td>7860</td>
<td>8310</td>
<td>8755</td>
<td>10251</td>
<td>11187</td>
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</table>
Planned transformer capacity

![Graph showing cumulative transformer MVA requirements from 2010 to 2027. The graph compares actual installed cumulated MVA, 2016 TDP Corporate Plan, and 2017 TDP Corporate Plan. The values are given in MVA for each year.](image-url)
Major projects planned for in the TDP period

1. Medupi Integration Ph2
2. Nzhelele Integration
3. Tshwane Strengthening
4. Kusile Integration
5. Lowveld Strengthening
6. Highveld South Secunda
7. Empangeni Strengthening
8. Pinetown Strengthening
9. Bloemfontein Strengthening
10. East London Strengthening
11. PE Strengthening
12. Peninsula / Mitchells Plain
13. Cape Corridor 2nd 765kV
14. North West / Kimberley Strengthening
15. Upington Strengthening
16. JHB South, East
17. Kyalami, West Rand
18. West Coast Strengthening
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)
   - Securing of Servitutes 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)
   - Targeted Asset Performance Improvements (lines and substation equipment)
   - 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.
Age profile of transmission assets
Transmission 10-year Capex Plan: FY 2018 – 2027

Summary of Transmission Capex Plan (R Million):
FY 2018 - FY 2027

<table>
<thead>
<tr>
<th></th>
<th>Total:</th>
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<tbody>
<tr>
<td></td>
<td>(FY18-27)</td>
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<tr>
<td>Capital Expansion (1)</td>
<td>119,151</td>
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<td>Capital Expansion for IPPs (2)</td>
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<tr>
<td>Refurbishment</td>
<td>23,442</td>
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<tr>
<td>Capital Spares</td>
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<td>Telecoms</td>
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<td>Production Equipment</td>
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<td>Land &amp; Rights</td>
<td>5,157</td>
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<td><strong>174,496</strong></td>
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</tbody>
</table>

Notes:
1) Capital Expansion: reliability projects (N-1), network strengthening for load growth, integration of generation (Medupi, Kusile, Ingula, IPPs up to Bid Window 3.5)
2) Capital Expansion for IPPs - to integrate IPPs beyond Bid Window 3.5 (Renewables, gas, new coal)
Transmission 10-year Capex Plan: FY 2018 – 2027

Transmission Capex Plan: 2018 - 2027
(R Million)

- Capital Expansion: 119,151
  - 74,965
  - 22,189
  - 9,663
  - 7,631
  - 4,703

- Refurbishment: 5,157
- Capital Spares: 3,938
- Land Development: 2,914
- N-1 Compliance: 23,442
- Eskom Gx Integration: 1,537
- Customer Connections: 1,537

- Production Equipment
- Telecoms
- IPP Integration
- Strengthening
- Safety / Statuatory
Capital Expansion Analysis:

TDP 2018 - 2027

<table>
<thead>
<tr>
<th>Implementation &amp; Preparation</th>
<th>Detailed studies &amp; Business case</th>
<th>Uncertainty &amp; Readiness</th>
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<td>1 – 3</td>
<td>4 - 6</td>
<td>7 - 10</td>
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Capital Expansion Analysis:

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<th>Phase</th>
<th>Capex Requirements per Phase</th>
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<td>FY18-FY20</td>
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<td>FY21-FY23</td>
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<tr>
<td>FY24-FY27</td>
<td><img src="image" alt="Capex Requirements" /></td>
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</table>
The total Transmission Capital Plan amounts to R174 billion over the TDP period 2018 – 2027 of which:

- R119 billion is required for reliability (N-1) projects, integration of committed generation (Medupi, Kusile, Ingula, IPPs up to Bid Window 4) and connection of new load onto the system.

- R18 billion is required to integrate new IPPs (ie. RE, gas, coal) beyond Bid Window 4 of the DoE’s IPP program.
The liquidity position of Eskom may impact the execution of the Transmission Development Plan.

The IPP programme may also trigger extensive network reinforcements.

The time taken to acquire servitudes continues be 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 2017 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