Integrating Embedded Generation into distribution networks

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Outline

• Context of Embedded Generation (EG) in South Africa
• Technical impacts of EG grid connection
• Eskom initiatives to support EG grid connection
• Conclusion
Context of EG in South Africa

• Growing need for Renewable Energy, including government’s target of 10 000 GWh energy to be produced from renewable energy sources by 2013

• Pilot national co-generation project and medium term power purchase programmes (PNCP and MTPPP)

• Renewable energy feed-in tariff (REFIT)
Technical impacts using a simple grid

Customer voltages
Must be between 90% and 110%

132 kV

HV source (generation, transmission and sub-transmission)

HV/MV transformer, with MV busbar voltage control

Distribution MV/LV transformer

MV voltage drop

11 kV

LV voltage drop

11kV/420V Fixed tap
Peak load

Grid

132 kV

OLTC

11 kV

5% voltage drop

5MW

105%

5% boost

100% voltage drop

10% voltage drop

100kW

90%
Low load

Grid

132 kV

OLTC

11 kV

105%

500kW

10% of peak load

0.5% voltage drop

104.5%

0.5% voltage drop

108%

5% boost

1% voltage drop

109%

10kW

108%

Distance (km)

Voltage (%)

110
107.5
105
102.5
100
97.5
95
92.5
90

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14 - 17 MARCH 2011 | CAPE TOWN, SOUTH AFRICA
Voltage profiles with no generation

- **Low load**: 1% rise limit
- **Peak load**: 15% drop limit

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**Graph Details**

- **Y-axis**: Voltage (%)
  - Range: 90 to 110
- **X-axis**: Distance (km)
- **Lines**:
  - Blue line for peak load
  - Green line for low load

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**Voltage Values**

- **Peak load**:
  - 109 at 10.5 km
  - 104.5 at 20 km
  - 90 at 30 km
- **Low load**:
  - 105 at 0 km
  - 108 at 10.5 km
Peak load with generation

Grid
132 kV
OLTC

11 kV

3% voltage drop

105%

3MW

70kW

3.5% voltage drop

102%

5% boost

103.5%

105%

Distance (km)

0

95

100

105

110

102

96.5

103.5
Low load with generation

- Grid
- 132 kV
- OLTC
- 11 kW

105%

1.5% voltage rise

1.5MW

11 kV

2% voltage rise

112.5%

5% boost

20kW

114.5%

106.5%

1% voltage rise

105%

106.5%

107.5%

108.5%

109.5%

110.5%

111.5%

112.5%

113.5%

114.5%

Distance (km)
Voltage profiles with generation

Network can absorb significantly less power than it can supply
EG can also affect

• Fault levels
• Thermal loadings
• Stability
• Protection
• Power quality

Detailed network analysis is required to assess the grid connection
Example Smart Grid solutions

- Intelligent distributed voltage control and protection

Ancillary Services
- Voltage control
- Frequency control
- Dip compensation
- Power conditioning
- Islanding
- Storage

Grid

132 kV

OLTC

11 kV

Feeder

OLTC MV/LV Transformers

Fault current limiting

2MW

Micro Grids

Demand Response

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Gaps identified for EG connection

• Lack of EG Experience
• Existing networks not designed to accommodate EG
• Data availability
• Billing systems and tariff structures
• Short timeframes
• Operating and maintenance
Initiatives to support grid connection

1) Technical guidelines and standards for planning and design
2) Grid connection assessment of individual applications
3) Industry collaboration
4) Proactive transmission network connection capacity assessment
Eskom technical guidelines & standards

Eskom has established three working groups (WG) focusing on the connection of renewables to the grid:

- Embedded Generation Distribution Network Planning WG
- Transmission Grid Planning renewable WG
- Eskom Research renewable energy WG
## Eskom Dx standards and guidelines

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Eskom Dx interconnection standard

- Boundaries of accountability
- Embedded Generation requirements
- Network connection points
- Synchronizing requirements
- Frequency requirements
- Network interfacing
- Protection, metering, telecontrol, DC
Eskom Grid connection application

The Generation Connection Application form can be found at www.eskom.co.za under the following sub-section headings:
“About Electricity / Tariffs and Charges / Embedded Generators”
Initial assessment tools

Developed excel based tools for quick analysis of:

- MV voltage rise
- Short circuit fault levels
- Short circuit ratio

Provides the network planner with a high level Indication of likely grid integration capacity
Industry collaboration

• Grid interconnection of small scale embedded generation (NRS 097 series)
• Spatial data on EG resource potential
• Linkages with international organizations such as CIGRE-C6, IEEE, IET and EPRI
• Training: e-learning (training program with learning material in a web-based format)
• Inputs to RSA Grid Code
• Liaison with SABS on wind turbine standards i.e. IEC 614000 series
Proactive transmission network connection assessment (GCCA)

- To determine transmission grid ability to absorb renewable generation at various transmission substations
- First phase focused on the Northern, Western and Eastern Cape areas
- High level estimate of the potential connection capacity for the transmission network
- Confined to steady state analysis
- Being extended to include dynamic studies and national coverage
Results of GCCA

System N-1 Generation Capacity per Zone

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<th>Area</th>
<th>Level 1</th>
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<tr>
<td>Western Cape Zone</td>
<td>2,988 MW</td>
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<tr>
<td>Eastern Cape Zone</td>
<td>1,042 MW</td>
</tr>
<tr>
<td>Northern Cape Zone</td>
<td>129 MW</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>4,159 MW</strong></td>
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Access to GCCA report

Request for a GCCA-2012 document must be submitted as follows:

- Go to Eskom website
  www.eskom.co.za
- Go to the following sub-sections:
  “Media room/Publications” to find the “GCCA Report” option
- Complete the details as requested and submit to the email address
- Organisation / Entity will be entered in database
- Copies can be either sent electronically or posted (CD or book)
- Only one copy per organisation / entity
Conclusion

• With the REFIT and other EG drivers, South African utilities are expected to receive increasing numbers of applications for EG grid access

• The integration of EG needs to be done in a coordinated manner

• Technical standards and skills need to be developed, leveraging off international work

• South Africa is committed to the integration of renewable generation to the grid as per the initiatives discussed
Thank you

• For any additional information, please do not hesitate to contact us.

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