

Potentials and Limitations for the Grid Integration of Wind Power in the Western Cape

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Actions and cooperation

- Eskom Klipheuwel Wind Energy Demonstration Facility - **3.16 MW**
 - **August 2002 – March 2003** Established V47, V66 & J48
 - Helped to pave way forward and create interest
 - Formal visitors > 3 000 in first 4 years
- 2004-09-06 Renewable Energy Policy of South Africa.
- 2008-03-24 Darling Wind Power **5 MW** by
- 2008-11-15 DME initiative for Renewable Energy
- 2008-12-01 Eskom MTPPP request for generation
- 2009-02-15 Germany GTZ agreement with Western Cape Province D:EADP, co-signed by Eskom
 - Various planned activities
- 2009-03-30 REFIT announcement
- 2009-05-14 Excellent open discussions by 14 developers with Eskom
 - **Foundation is taking shape**

GTZ – D:EADP – Eskom cooperation

- Germany GTZ agreement with Western Cape Province D:EADP
- Eskom participant in agreement
- Cooperation activities
 - 24-25 March 2009 “Grid Integration of Wind Energy” seminar by Dr Markus Pöller, sponsored by GTZ & Western Cape Province D:EADP
 - Invite to Developers, Consultants, Research/Academics, City of Cape Town, Eskom and other role players, e.g. DME & NERSA
 - 26-27 March 2009 Eskom Wind Energy Workshop to create scenarios for:
 - 100 MW case study on sub-transmission network
 - 500 MW case study for integration into 400kV network, incl. 132 kV
 - Regional study of ± 3000 MW on larger main transmission system
 - 2-5 June 2009 Follow up session planned to evaluate feedback
 - July 2009 Complete high level grid scenarios and various technical studies, in cooperation with DigSilent (sponsored by GTZ)



GTZ – D:EADP – Eskom cooperation

- Eskom busy updating and preparing models for PowerFactory V14
- Training and roll-out for PowerFactory V14 scheduled for June 2009
- Specific steady state Loadflow and Fault Level studies per project, based on assumptions
- In support of 50 – 500 – 5 000 MW scenario
 - 50 – How to integrate with existing network
 - 500 – Integration of several sites into new 400 kV substation
 - 5 000 – Influence on larger Western Cape & MTS network
- Voltage stability and dynamic studies to be performed, excluded from current DigSilent study
- Require project site specific details of WTG's, transformer data, etc. for dynamic studies and actual fault level studies.
- Then evaluate further studies to be completed



Renewable Energy Target Setting

- **Western Cape RE Target of 15% to be properly defined and share for electricity to be determined**
- Use of Biomass, Solar Water Heating, Concentrating Solar Power, Photovoltaic, Hydro, **Wind**, Landfill, etc.
- Riaan's assumptions:
 - Expected 2014 electricity usage $\pm 23\,800$ GWh per annum
 - **15% target of electricity only** ~ 3 560 GWh RE required per annum
 - Assume RE for electricity to come from **Wind**
 - **Other RE resources will reduce Wind component**
 - Use capacity factor of **25%**, as higher value is then a bonus
 - Wind Turbine Generator installed capacity required ~ **1 628 MW**
 - Assume regional Maximum Demand to grow to ~ 4 080 MW
 - Then regional grid penetration level of **>40%** could be expected at peak demand
- **Does this wind energy potential exist?**
- **Can it be integrated into the grid?**

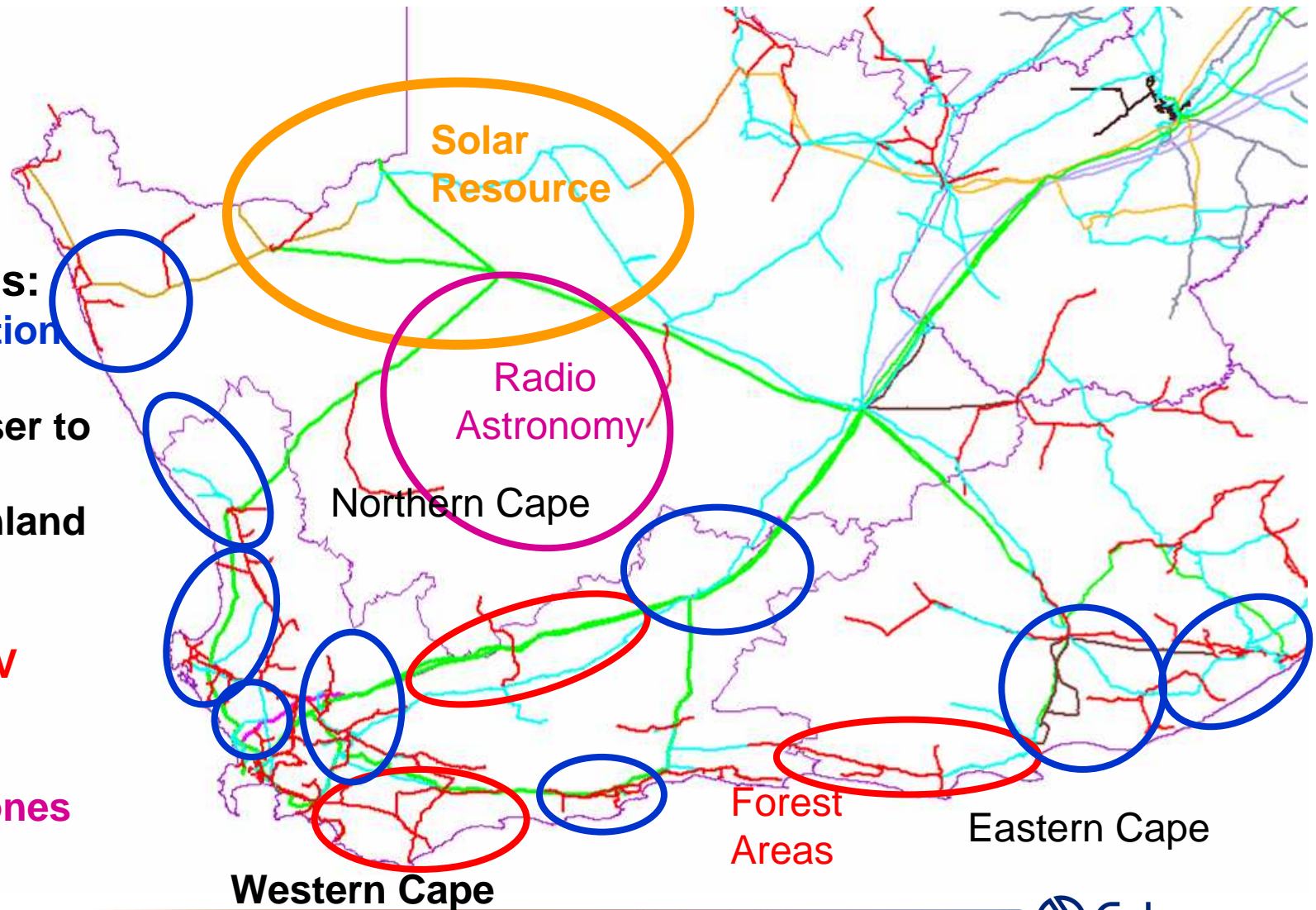


Where is this so called “Grid”?

400 kV
220 kV
132 kV
66 kV

Assumptions:

- Main substation grid areas
- Develop closer to main lines?
- Coastal vs inland winds?
- Some areas around 400 kV grid not well covered
- Exclusion zones



Transfer limitations

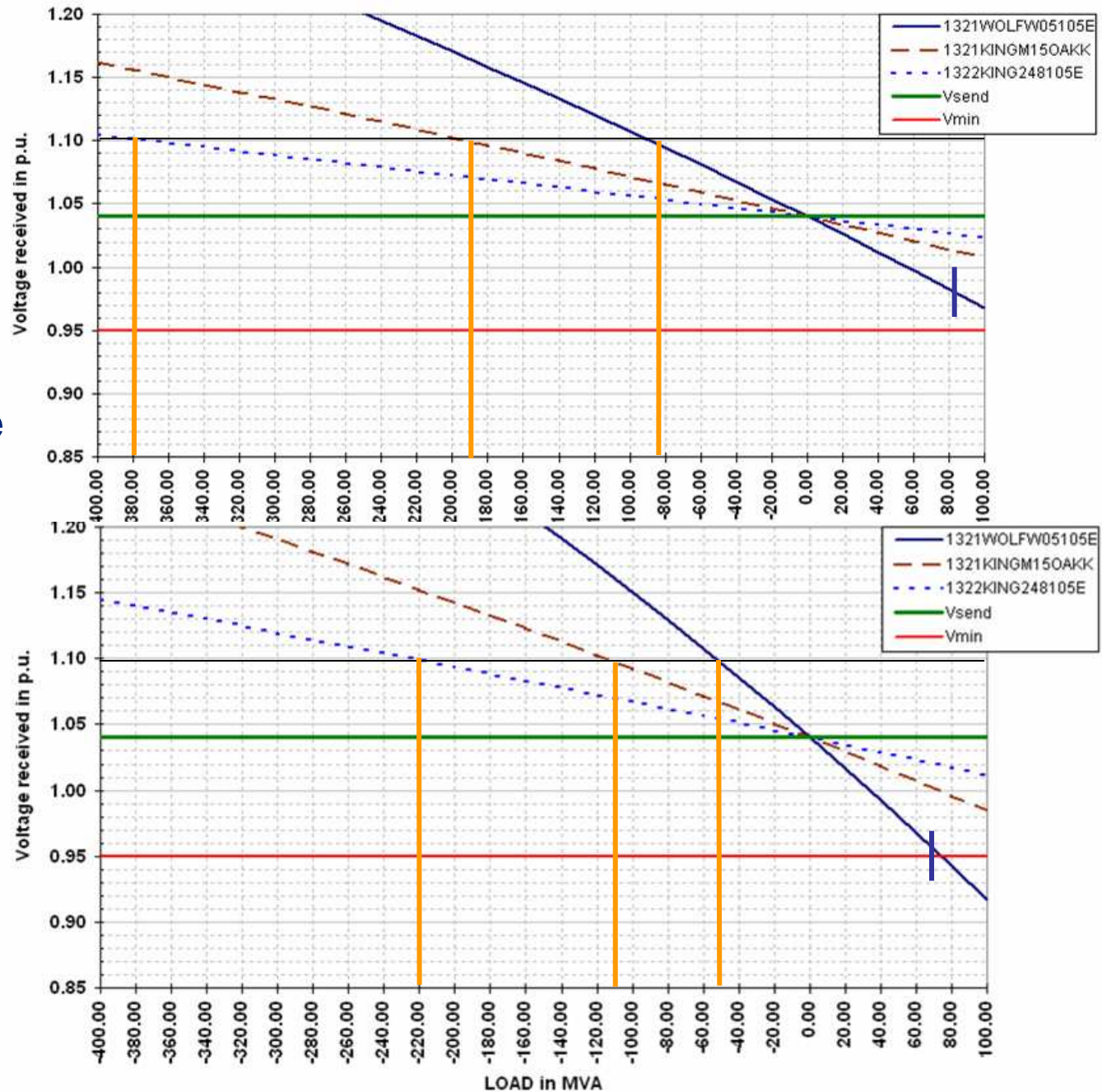
60 km 132 kV line

As line length increase
 Increase in losses
 Voltage changes
 Limit transfer capacity

100 km 132 kV line

Use distances in following slides to help show limitations

VOLTDROP



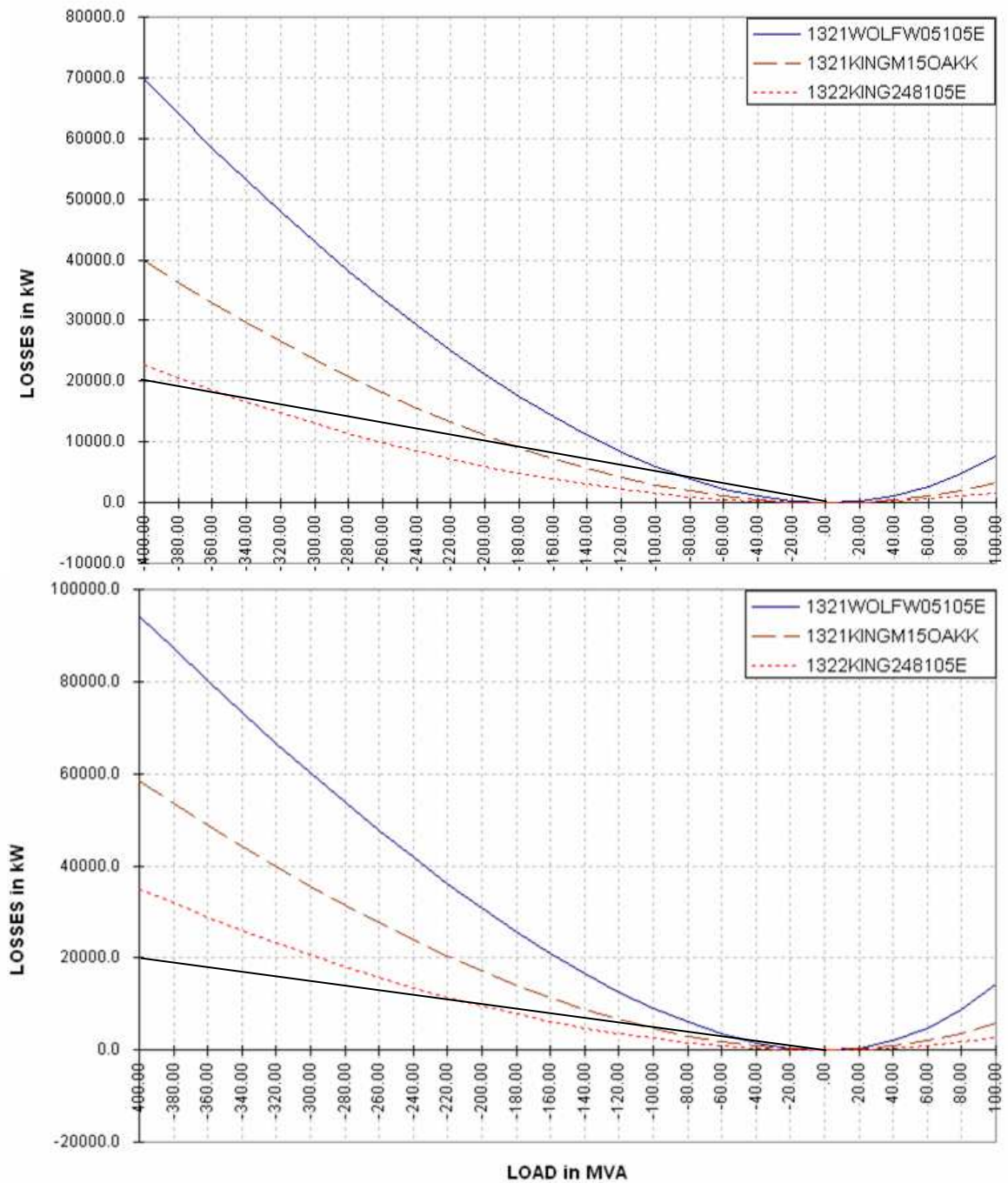


Minimise Losses

Economical loading of line to be determined
Losses limited
~e.g. 5% of peak losses



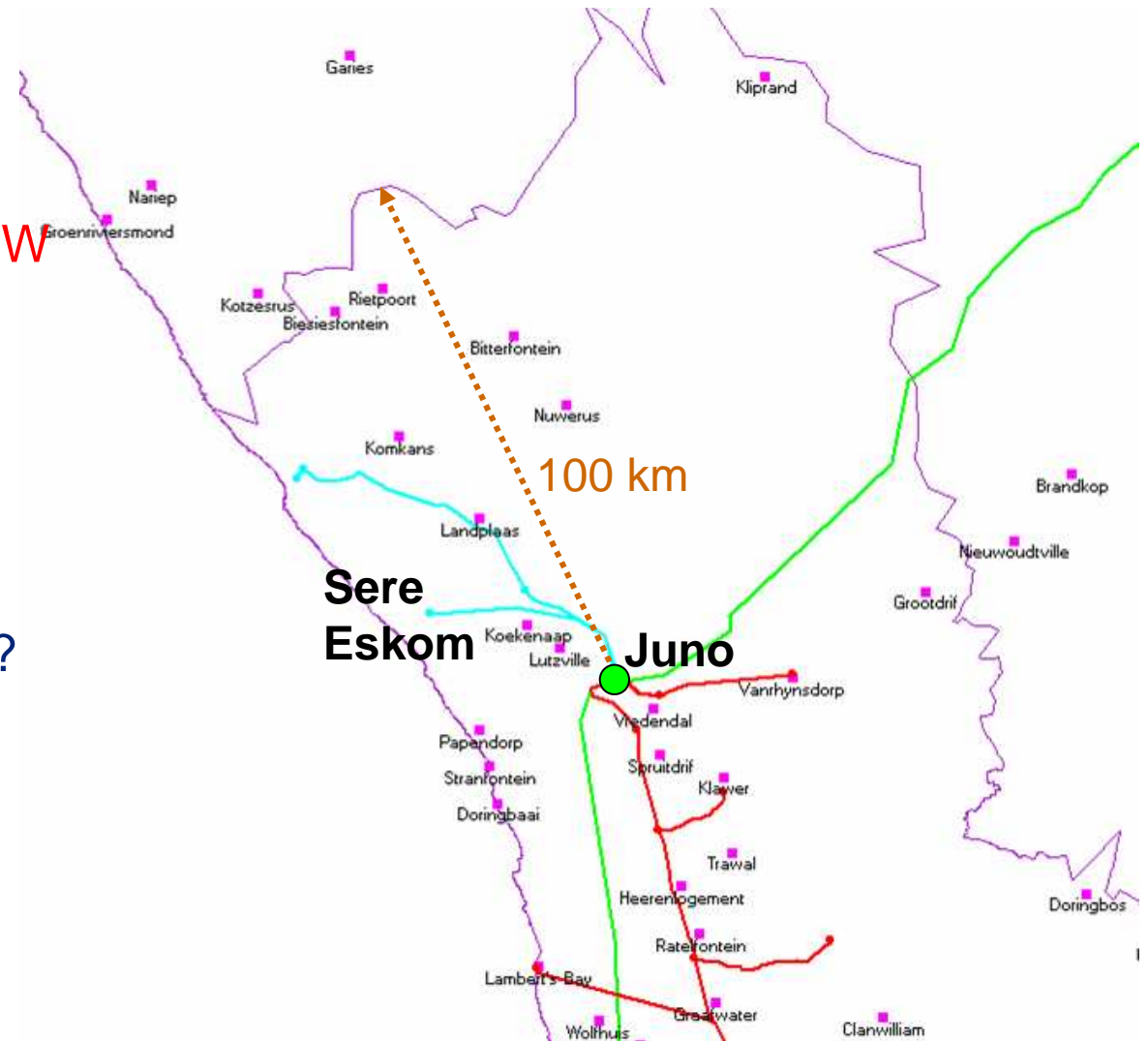
LINE LOSSES



Evaluate area potential e.g. Juno

400 kV
132 kV
66 kV

- Juno 400/132/66 kV
- 2x120 MVA
- Applications: 620 MW
- Potential ideas: 1000 MW
- Existing lines limited
- Will require appropriate 132 kV lines to Juno
- Need to upgrade Juno
 - Allow e.g. 500MVA
 - 3 year lead time ?
- Need to add new MTS ?
 - Minimise losses
 - Ensure system can function properly
 - 4 year lead time ?
- Discuss more detail in break away session



Potential Summary

- Western Cape Province with limited boundary overflow
- **Applications / requests for Grid Connection costs: 3 140 MW**
- **Potential ideas max: 5 918 MW**
- South Africa: 4 200 MW, 10 000 MW
- Western Cape WTG required ~ 1628 MW Western Cape (Riaan's guess)
 - acknowledge not all applications will be implemented by 2014
- Grid integration case studies by June 2009 – how to !
- Grid scenario of <3 000 MW will therefore give good direction for further studies
- **Sufficient interest to meet target**

Regional requirements

- **Environmental Considerations** covered by:
- Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape
 - Towards a Regional Methodology for Wind Energy Site Selection
 - Report 5: Proposed Regional Methodology
- Excellent & detailed Methodology
- *“7.2.2 The issue of cumulative impact is imperative to address and forms an important part of the proposed regional method. Minimum distances between large windfarms are recommended at 30km, with preference being greater than 50km”*
- **Conceptual 25km radius sites clearly overlaps** →
- Minimising cost, sharing & optimisation of grid infrastructure may **require negotiations.**

Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape

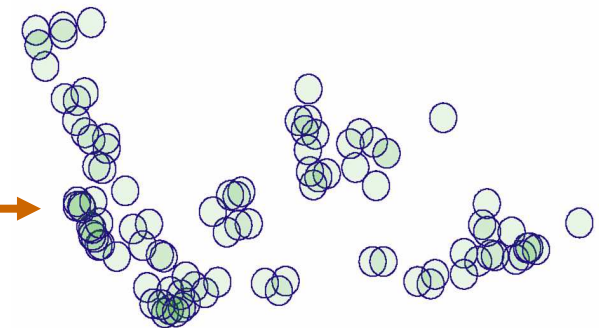


TOWARDS A REGIONAL METHODOLOGY FOR WIND ENERGY SITE SELECTION

REPORT 5: PROPOSED REGIONAL METHODOLOGY



MAY 2006



South African Grid Codes

- The South African Grid Code: The Network Code
 - Focused on large scale generation
 - No specific conditions for renewable energy
- Distribution Network Code, September 2007
 - 8.1 Responsibilities of Embedded Generators to Distributors
 - 8.2 Responsibilities of Distributors to the Embedded Generators
 - Also to be used by Renewable Energy Facilities
- Specify operating requirements
 - Voltage, frequency, protection, earthing,
- Low Voltage Ride Through (LVRT) capability
 - To be considered for larger Wind Energy Facilities
 - Unlikely for units connected to Medium Voltage networks alone

Embedded Generation

- To fulfil Eskom Distribution's obligation under Section 8.2 (4) of the South African Distribution Code: Network Code:
 - “The Distributor shall develop the protection requirement guide for connecting Embedded Generators to the Distribution System to ensure safe and reliable operation of the Distribution System”.
- DST 34-1765: Distribution Standard for the interconnection of Embedded Generation
- Applicable to renewable energy facilities
- Acknowledge further development of standard to cater for:
 - e.g. Wind Energy Facilities
 - Low voltage ride through capability
 - Frequency operating range

Cost of Grid Integration

- The Cost of Transmission for Wind Energy: A Review of Transmission Planning Studies (February 2009):
 - USA review of a sample of 40 detailed transmission studies that have included wind power 2001 – 2008
 - total transmission cost / total amount of incremental generation capacity (wind and non-wind)
 - Majority of studies unit cost of transmission <\$500/kW
 - or roughly 25% of the current \$2,000/kW cost of building a wind project
 - The median cost of transmission from all scenarios in sample is \$300/kW, roughly 15% of wind project cost
 - Aggregate range of transmission costs is from \$0-79/MWh with a median of \$15/MWh and most studies falling below \$25/MWh.
- **Above WTG ave roughly R20 mill/MW ~ Grid ave R3-5 mill/MW**

Recommendations

- Expect major role from SAWEA for guidelines and influence
 - Developers
 - Consultants
 - Industry (OEM Manufacturers, suppliers, etc.)
 - Environmental
 - Utilities (Eskom, Municipalities)
- Grid Integration studies to be completed
- Various Eskom quotes in progress and then project viability to be determined – expect some projects to be delayed?
- Cooperation between developers to minimise grid infrastructure
 - e.g. Share EIA and cost for line routes
- SA Grid codes to be revised to accommodate wind turbine technologies
- Focus on knowledge and skills transfer & Human Capacity

Conclusion

- RE Potential has been identified
 - Mainly Wind
- Plans are being developed with developers
- Limitations can be managed, require sufficient lead times and cooperation
- Depends on REFIT, funding & licensing
- Western Cape RE targets should be met
- Other RE sources not excluded



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- South African Grid Code (all parts). NERSA. August 2005.
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- Grid Code High and Extra High Voltage. E.ON Netz GmbH, Germany. April 2006
- Distribution Code by ESB Networks, CER approved. October 2007
- NRS 048 Electricity Supply – Quality of Supply
- IEC 61400 series standards for wind turbine systems