





Assessment of Potential Security Risks due to High Levels of Wind Generation in South Australia

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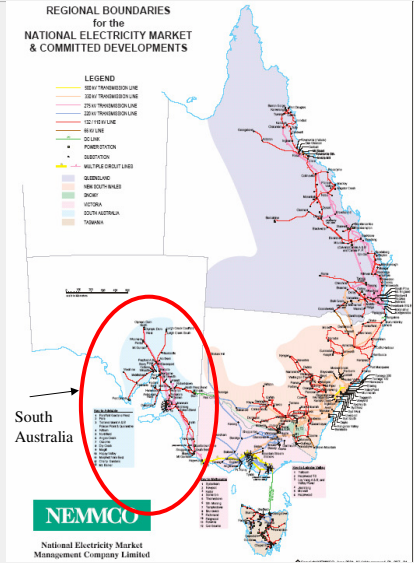
The Australian Transmission System - Overview


Overview:

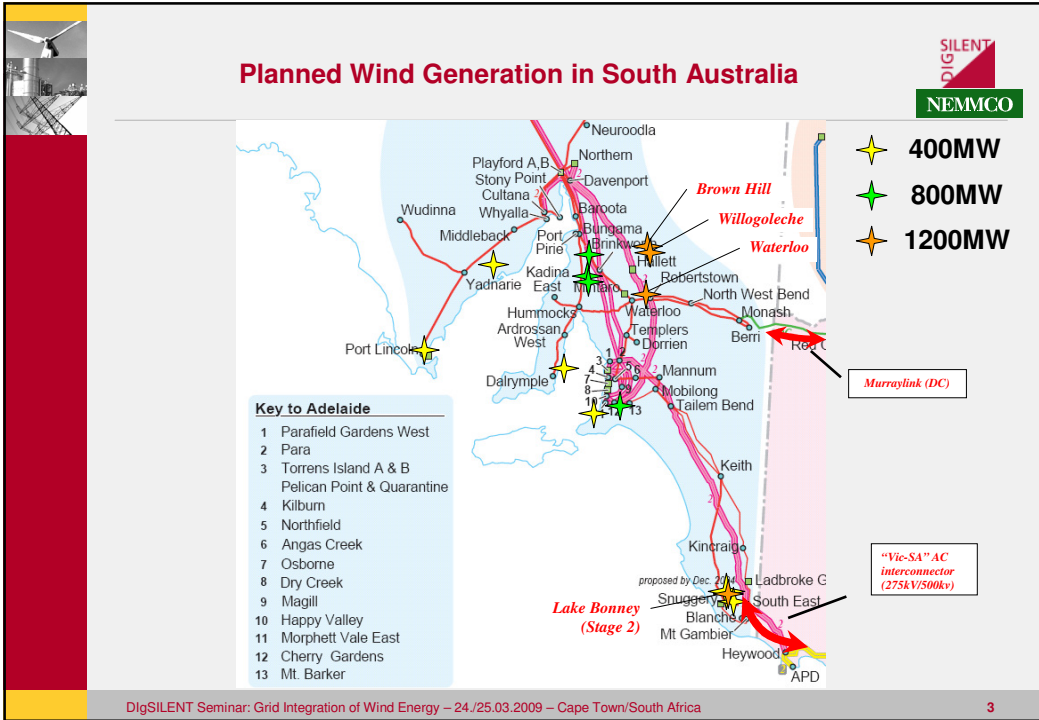
- Four states synchronously connected:
 - Queensland (QLD)
 - New South Wales (NSW)
 - Victoria (VIC)
 - South Australia (SA)

- Strong/Weak Load
 - Australia: 30 000 MW/13 000 MW
 - SA: 3 000MW/1 000MW

- SA Interconnector:
 - Thermal Limit: 460MW
 - Export Limit: 300MW




National Electricity Market Management Company Limited



Scenarios

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Wind Generation:

- **0MW** wind generation -> reference scenario (e.g. no wind)
- **400MW** wind generation -> „short-term“, end of 2005
- **800MW** wind generation -> „medium-term“, mid of 2006
- **1200MW** wind generation -> „longer-term“, existing license applications

Operational Scenarios:

- High-load, high SA-import
- High-load, high SA-export
- Low-load, high SA-import
- Low-load, high SA-export

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Purpose and Scope of Study

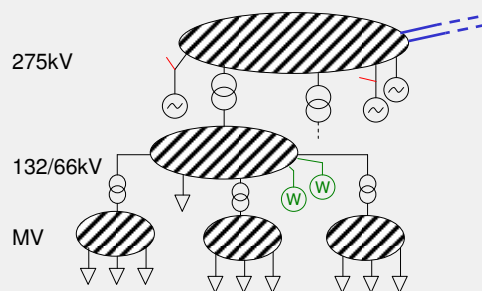


Impact of wind generation in SA on critical stability issues in the Australian transmission system:


- Transient stability constrained export limits SA->VIC
- Voltage stability constrained import limits VIC -> SA
- Frequency rate of change in case of loss of interconnector
- Transient stability constrained export limits outside SA
- Damping of inter-area oscillations




Scenarios – Assumptions



- Substitution of conventional generation in SA according to priority-list
- Minimum conventional generator dispatch: 500-600MW
- No additional spinning reserve considered for backing up intermittency -> wind variations assumed to be compensated by interconnector flow (and evt. Murray Link)
- Murray Link dispatch: 0MW in all cases (but connected -> voltage support)
- No network upgrades considered.




Modelling




- Full „four-state“ model of the NEM-system for short-term dynamics (approx. 1700 bus bars, 200 generators with AVR and PSS)
- Dynamic models of all wind farms, including electrical control, shaft-dynamics, pitch control, fault-ride-through strategies etc.
- Simulation software:

DIGSILENT *PowerFactory*

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Study Results



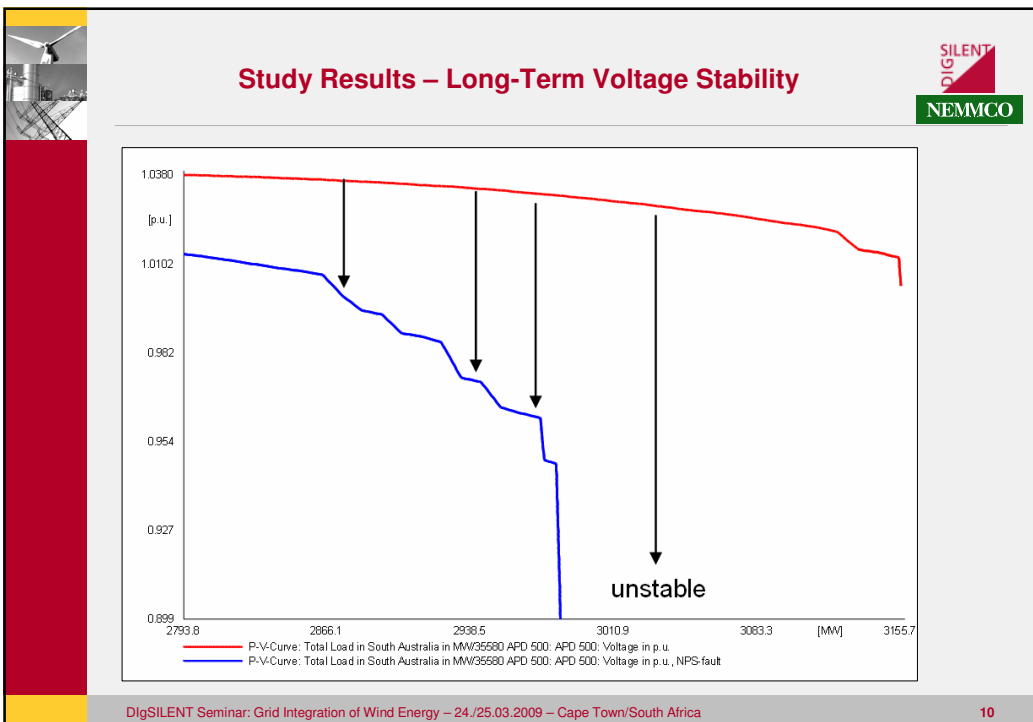
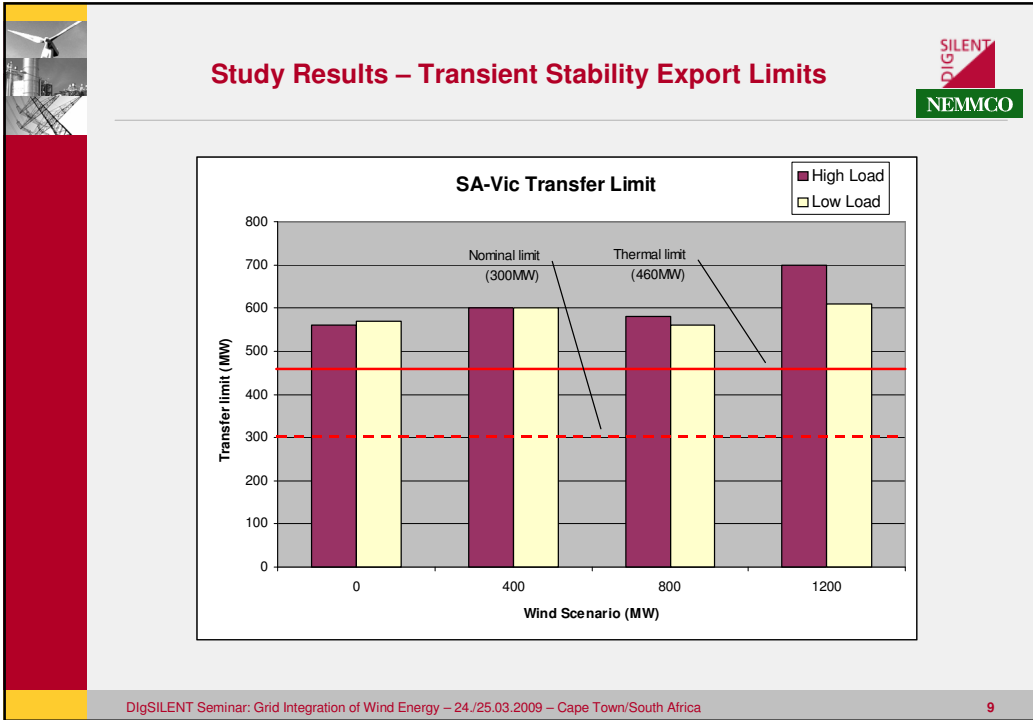
Regional ability to support high wind penetration:

| | |
|----------------------------------|-------------|
| Wind generation: | 1200MW |
| Minimum conventional generation: | 500MW |
| Low-Load: | 1000MW |
| Losses: | about 100MW |
| | |
| Export: | 600MW |

-> Exceeds capacity of AC-interconnector

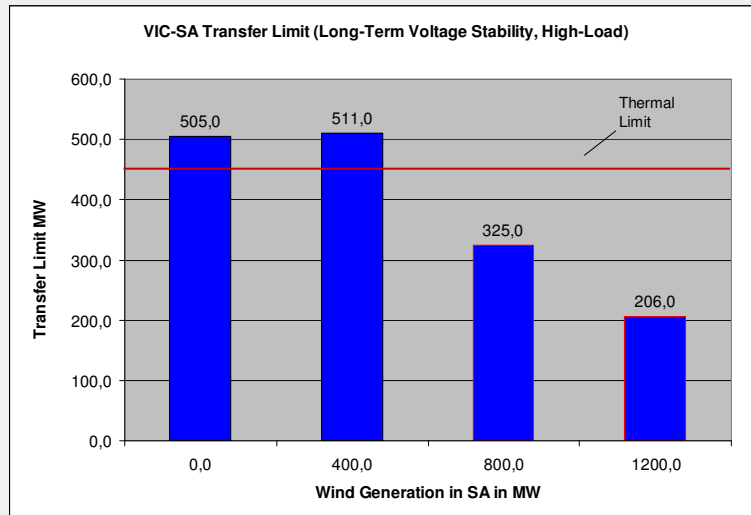
- Interconnector upgrade required
- Murray link dispatch
- Limitation of wind generation during high-wind/low-load hours

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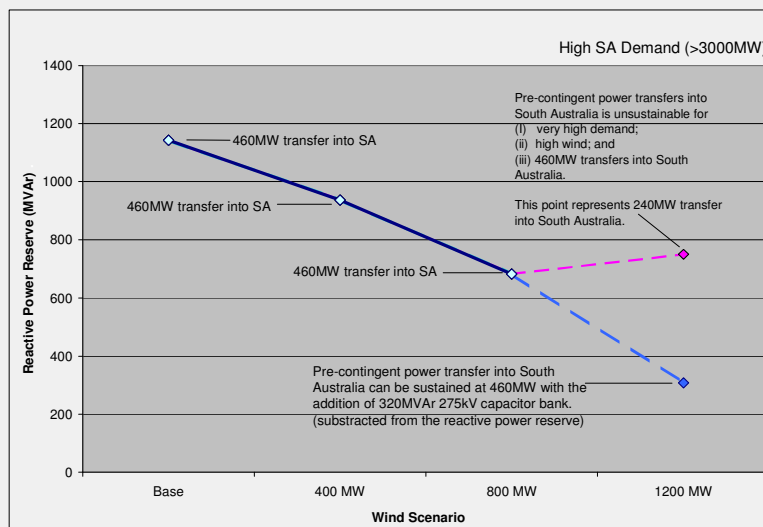




Study Results – Long-Term Voltage Stability

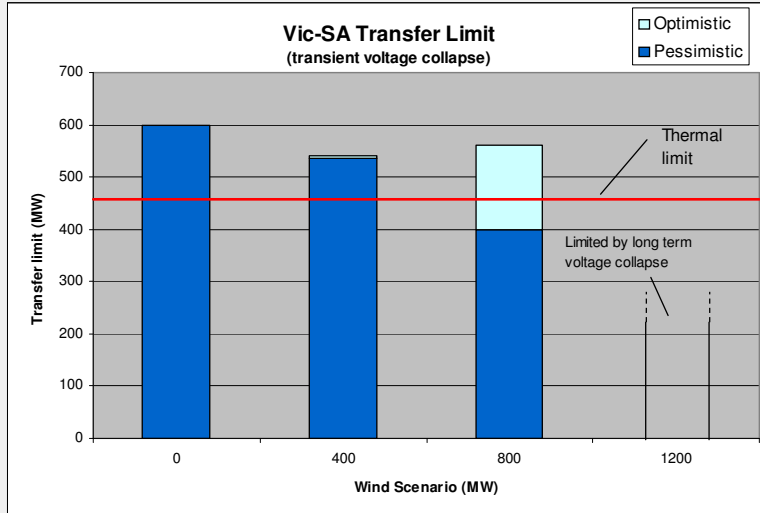


Study Results – Long-Term Voltage Stability

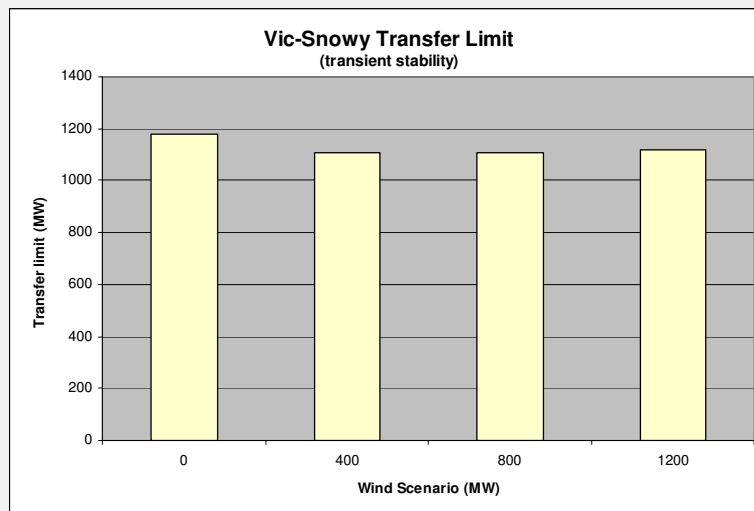


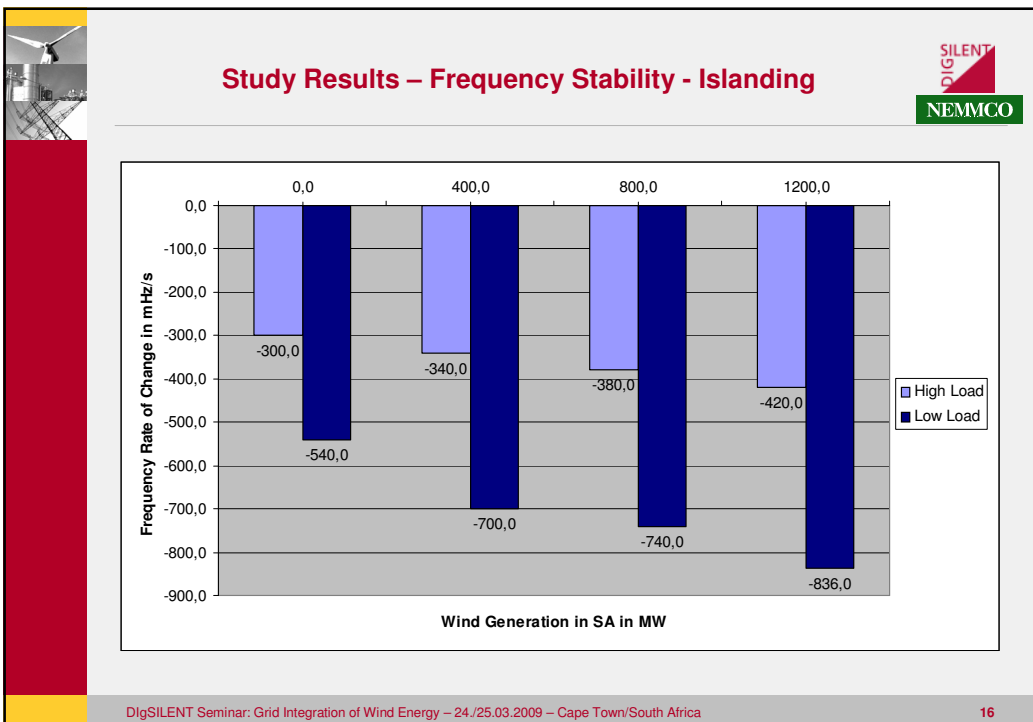
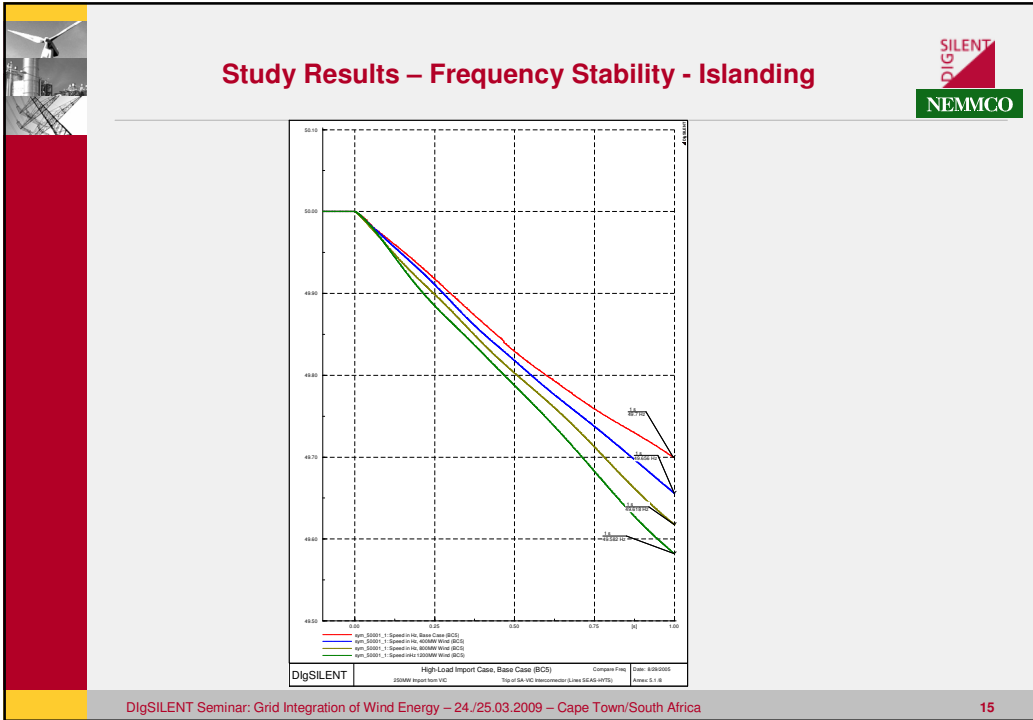


Study-Results – Short-Term Voltage Stability



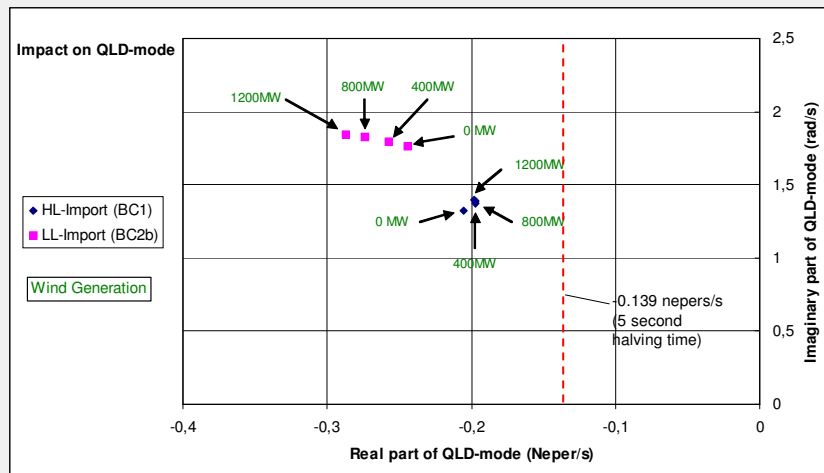
Study-Results: Impact on Export Limits outside SA








Study-Results: Impact on QNI-Mode




Conclusions

Regional Ability:

- Sufficient in all cases, except from 1200MW wind – case:
 - Interconnector upgrade required
 - Murray Link dispatch investigated
 - Limitation of wind generation during high-wind/low-load hours




Conclusions




Impact on SA-VIC power transfers:

- Increased transient stability export limits
- Reduced voltage stability import limits (short and long term)
 - Additional reactive power compensation in Adelaide area required (SVC, SynCon -> must be at 275kV-level!)
 - Increased minimum conventional generation in SA
 - Active power reduction of wind farms under low voltage conditions must be avoided.

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Conclusions



- No considerable impact on transfer limits outside SA detected.
- Increased frequency rate of decline in case of sudden SA-islanding
 - Further analysis considering governors and impact on load shedding required.
 - Evt. additional spinning reserve in SA required (constraint equation)
 - Possible frequency support of Murray-Link (to be investigated)
- No considerable impact on QNI-mode found
 - Impact on other modes still to be analysed.

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Conclusions



No stability impact was found that would question the feasibility of planned wind generation in SA.

Additional constraint equations or minor network upgrades can solve the identified problems.