



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

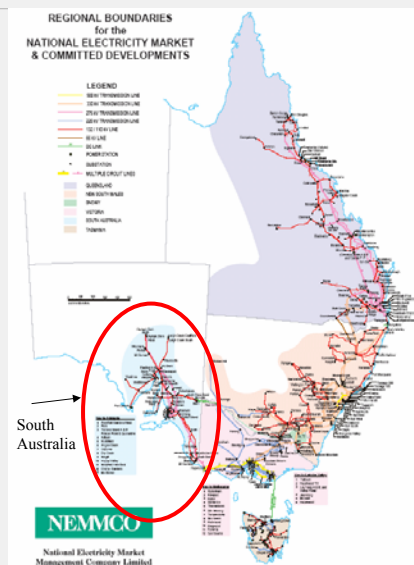
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The Australian Transmission System - Overview

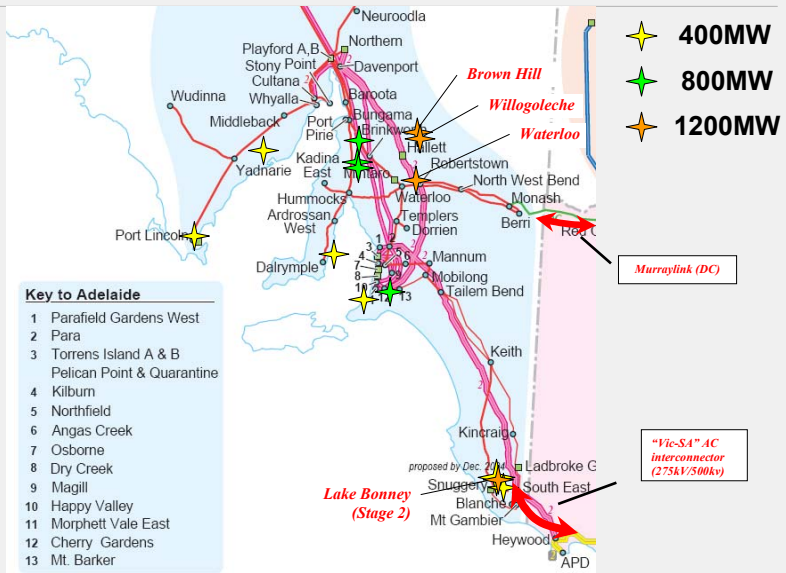
Overview:

- 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





Planned Wind Generation in South Australia



Scenarios



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



Purpose and Scope of Study

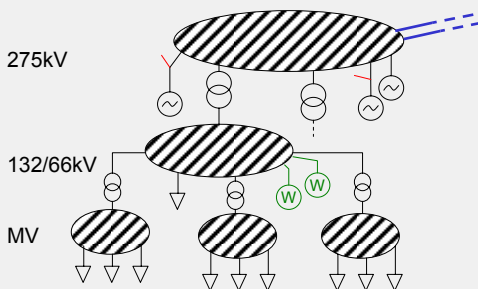


Impact of wind generation in SA on critical stability issues in the Australian transmission system:

- 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*



Study Results



Regional ability to support high wind penetration:

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

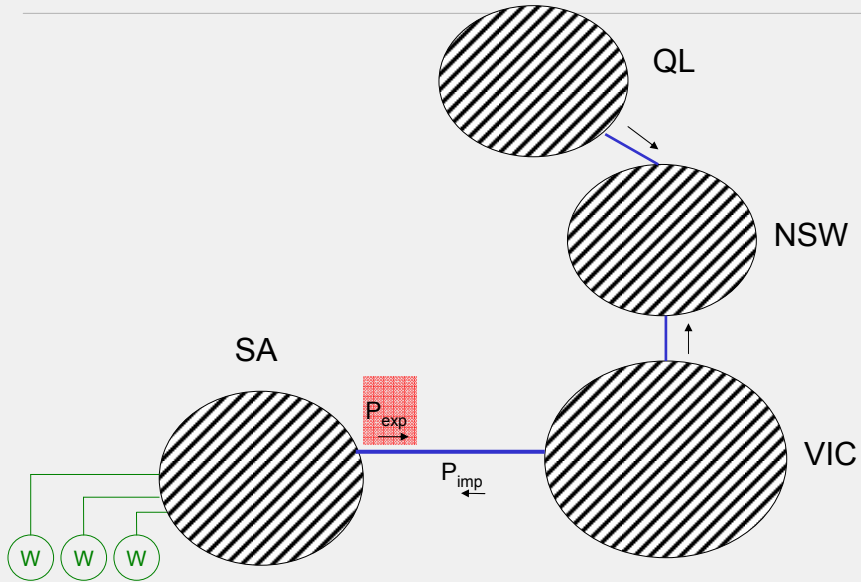
Export: 600MW

-> Exceeds capacity of AC-interconnector

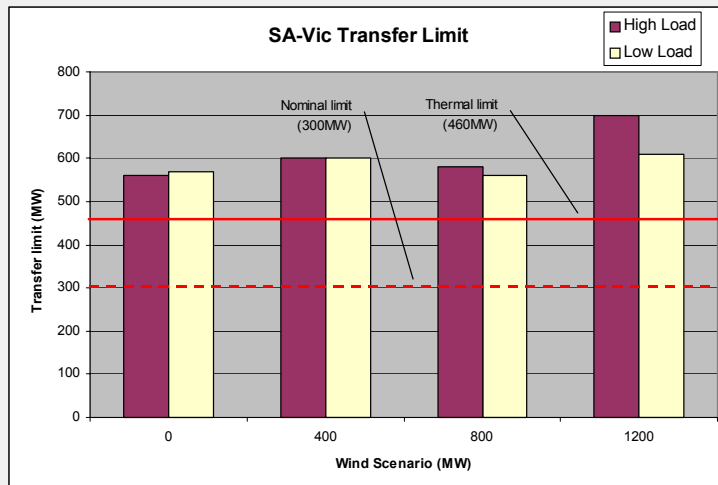
- Interconnector upgrade required
- Murray link dispatch
- Limitation of wind generation during high-wind/low-load hours



Wind Generator Impact on Inter-Regional Transfer Limits

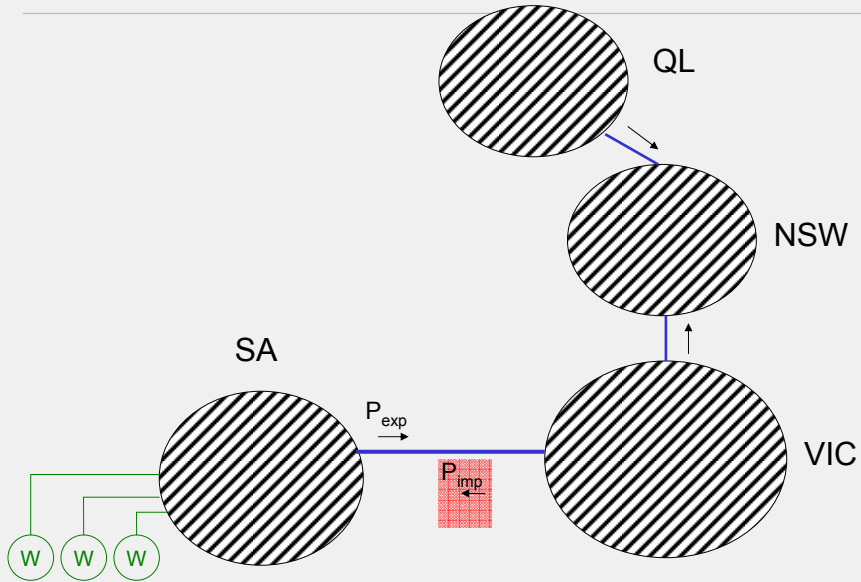


Study Results – Transient Stability Export Limits

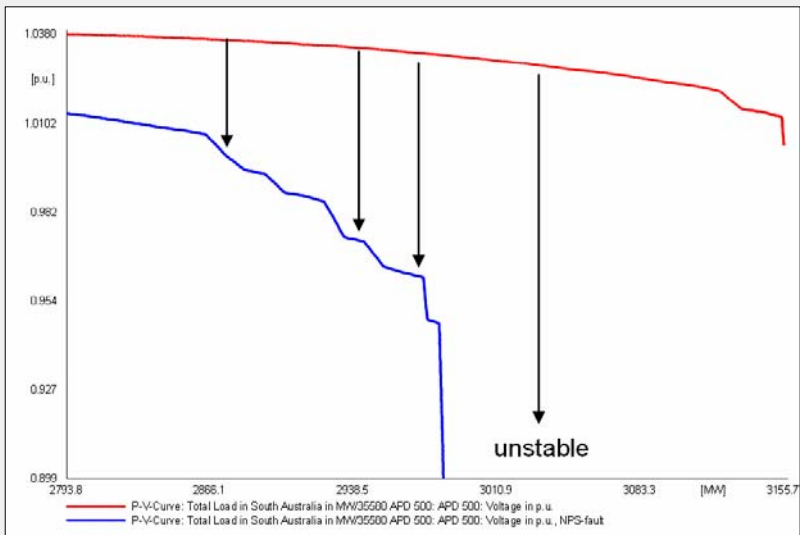




Wind Generator Impact on Inter-Regional Transfer Limits

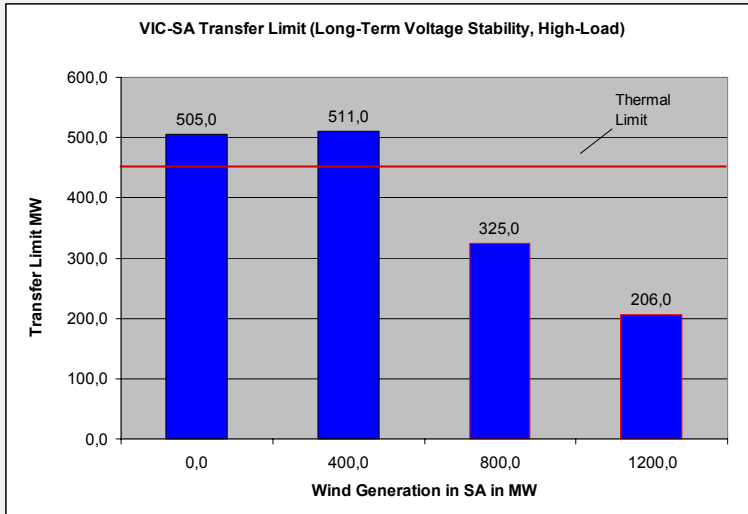


Study Results – Long-Term Voltage Stability

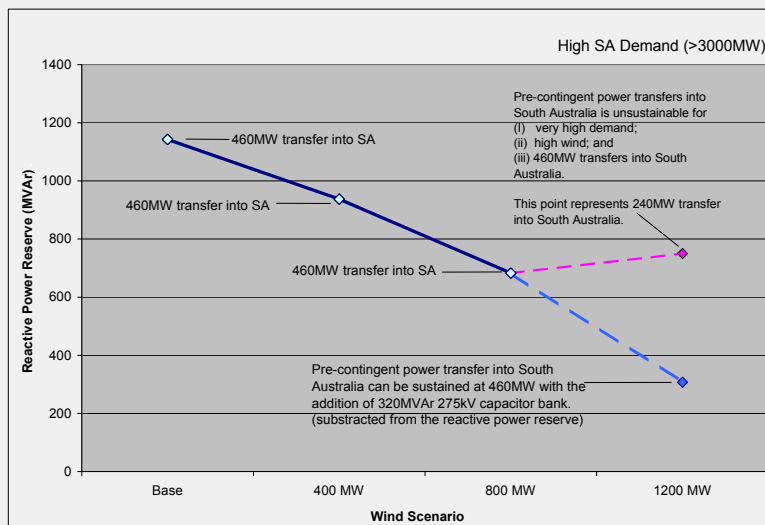




Study Results – Long-Term Voltage Stability

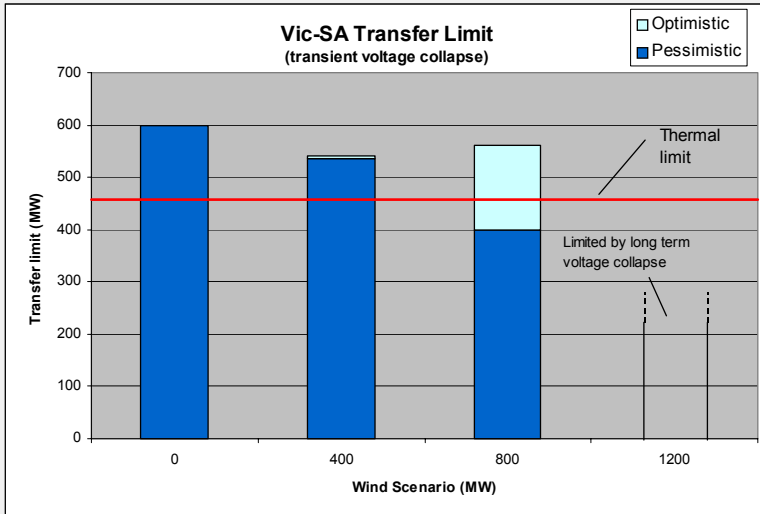


Study Results – Long-Term Voltage Stability

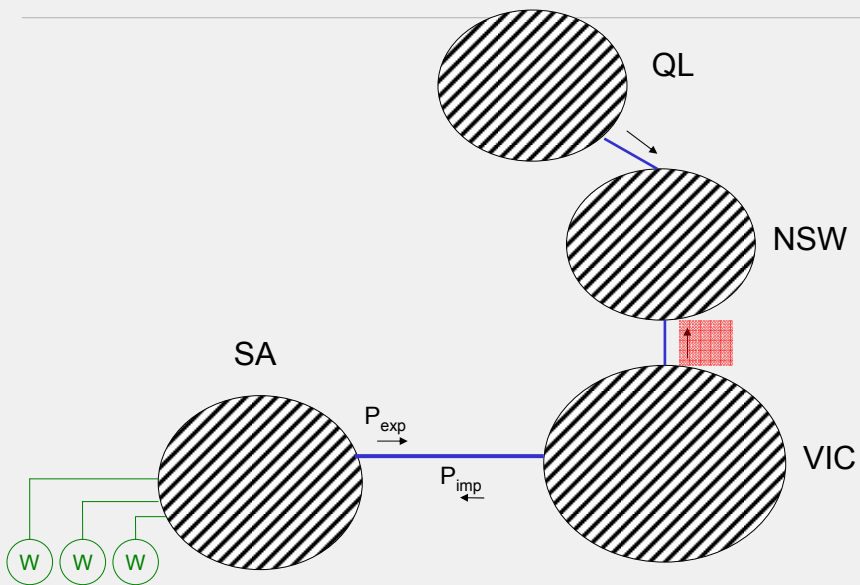




Study-Results – Short-Term Voltage Stability

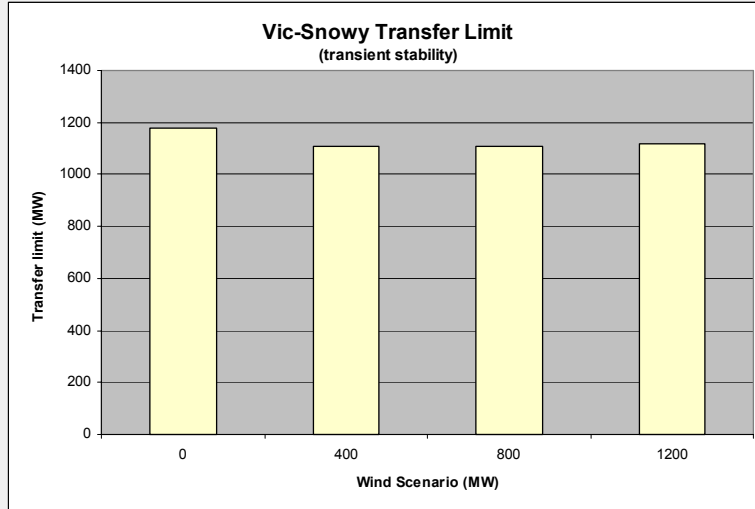


Wind Generator Impact on Inter-Regional Transfer Limits

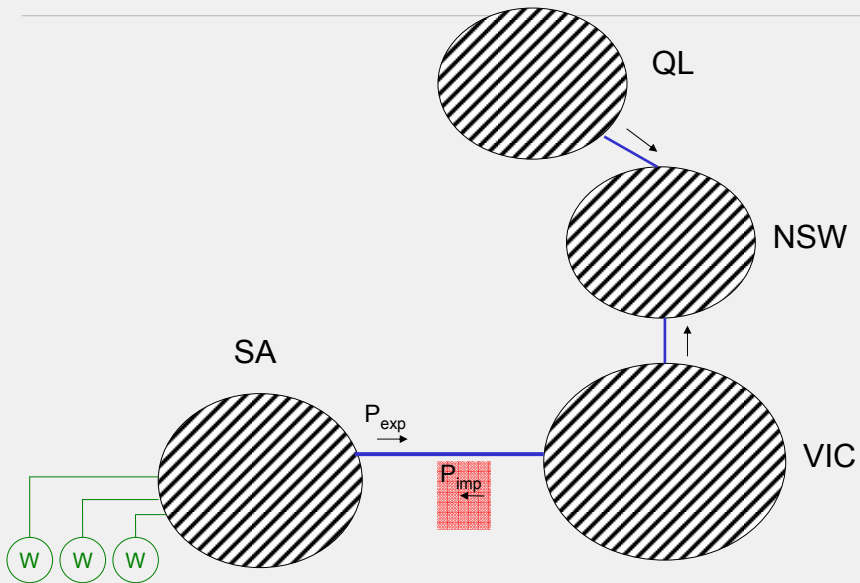




Study-Results: Impact on Export Limits outside SA

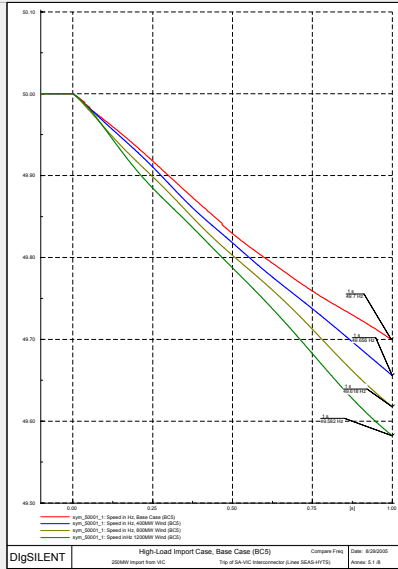


Wind Generator Impact on Inter-Regional Transfer Limits

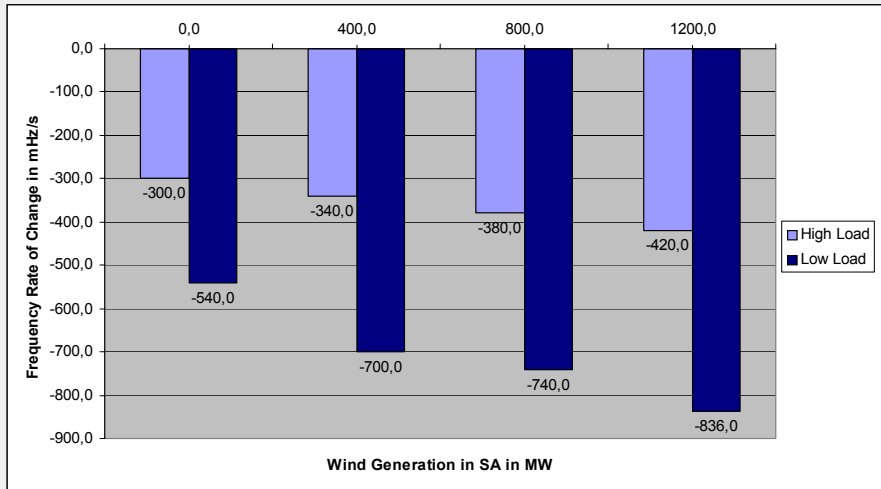




Study Results – Frequency Stability - Islanding

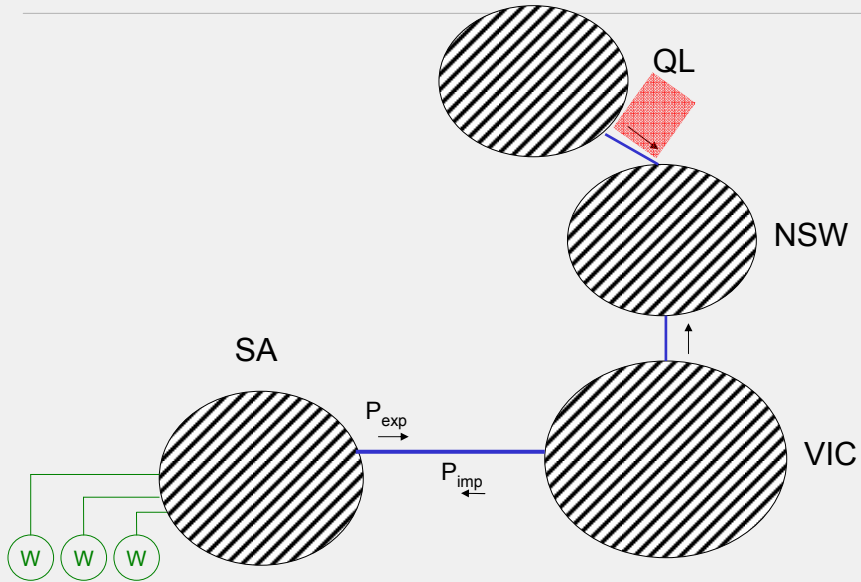


Study Results – Frequency Stability - Islanding

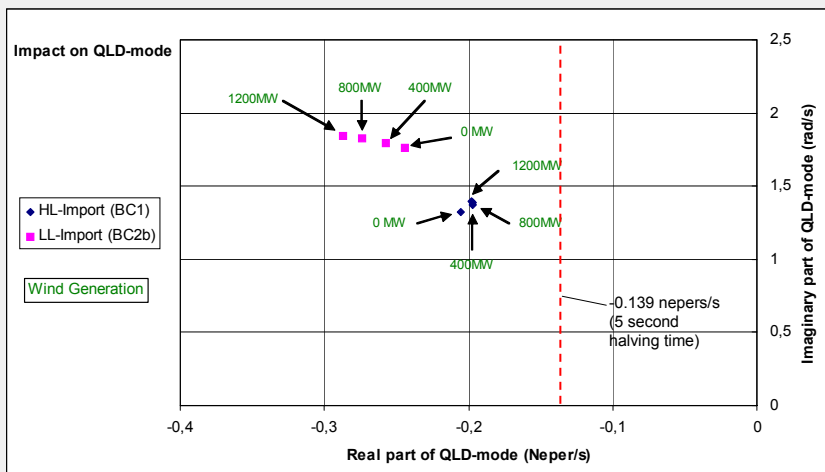




Wind Generator Impact on Inter-Regional Transfer Limits



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.



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.



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.