American Superconductor

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How the Lake Bonney Wind Farm Met ESCOSA's, NEMMCO's, and ElectraNet's Rigorous Interconnecting Requirements

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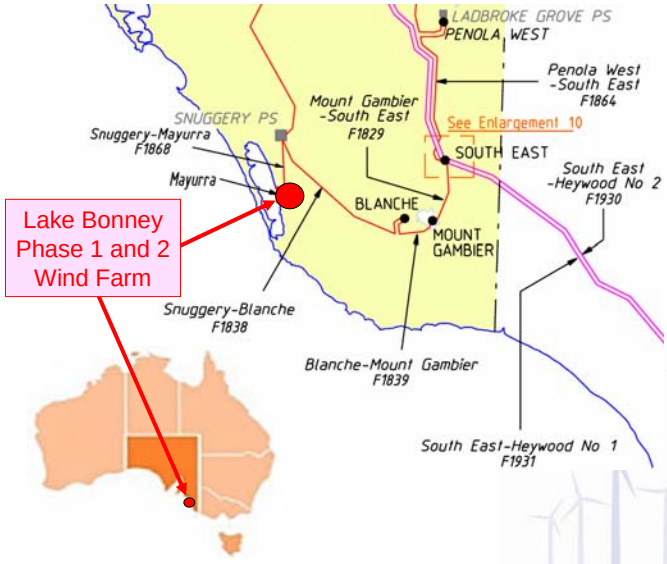
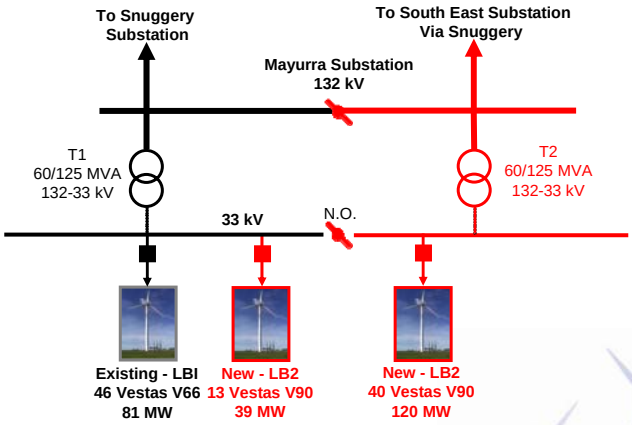
South Australia Transmission Grid and Lake Bonney Wind Farm



Lake Bonney 1 and 2 Wind Farms (240 MW total)



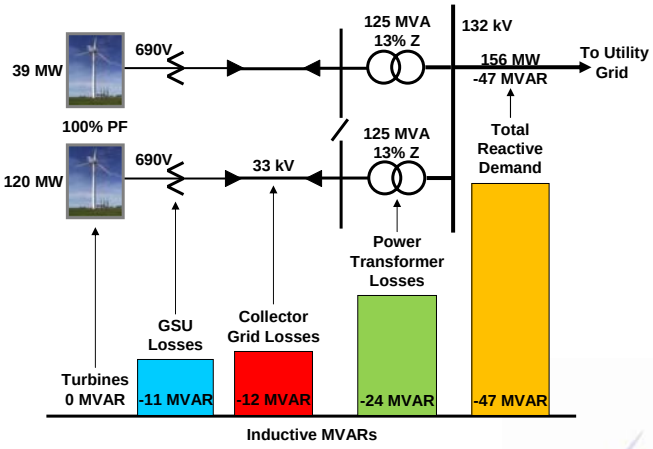
Lake Bonney 1 had no reactive compensation equipment installed.

ESCOSA - Wind Interconnection Requirements

- Capable of +/-93% PF at high side of power transformer at full generation.
- Half of PF correction capability shall be dynamic.
- Reactive output proportional to generation level.
- Regulate transmission system voltage.
- Avoid tripping wind farm for nearby transmission grid faults and high voltage (LVRT, HVRT).
- Restore transmission system post fault voltage to a minimum of 90%.

Requirements can be met primarily by installing dynamic and static reactive resources.

LB2 159 MW Wind Farm - Sources of Reactive Losses at Full Generation



Bottom Line - Add 47 MVAR to the capacitive reactive compensation target value.

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Lake Bonney 2 Reactive Compensation Requirements at Full Generation

Target Requirements	Capacitive	Inductive	
• +/-93% PF at 132 kV	63	63	
• Include reactive losses			
- GSU transformer	12	-12	**47 MVAR**
- 33 kV collector grid	11	-11	
- 132-33 kV transformers	24	-24	
Total Reactive Required	110	16	
50% Dynamic	**55**	**8**	
50% Non-dynamic	55	8	

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Lake Bonney 2 Reactive Compensation Resources at Full Generation

Resources	Capacitive	Inductive
• Dynamic VARs (reqmt. is	+55 Cap	-8 Ind)
- Generator VARs	0	0
- D-VAR® System (24 x 2.67 O.L.)	64	-64
• Dynamic + Static VARs		
- Generator(+98/-96%PF)	32	-46
- D-VAR System (24 MVAR)	24	-24
- Capacitors (4 x 13.5)	54	0
Total Dynamic + Static	110	-70

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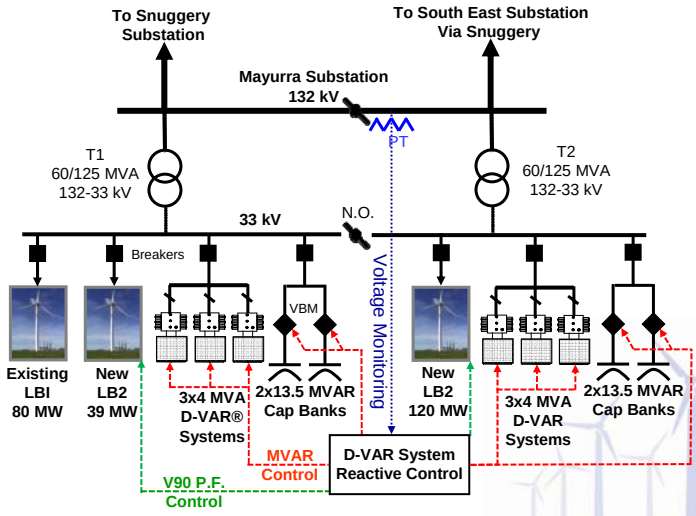
Lake Bonney 1 and 2 Wind Farms and AMSC's D-VAR® Solution



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D-VAR® System Basics

What are **D-VAR®** Units?

- **D**ynamic **VAR**s… Fully Integrated STATCOMs with proprietary 2.67 times the continuous rating (Overload).
- Instantaneously injects precise amounts of reactive power into a network.
- Can be *seamlessly* integrated with static shunt devices as part of a larger solution.
- Can control the PF of a wind farm's wind turbine generators.

No Trailers

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Innovative Approaches to Addressing Wind Interconnection Requirements

- Use D-VAR® overload capability to address transient reactive requirements – during both low and high voltage events
- Use slower speed power factor correction capacitors to address post fault voltage issues
- Use turbine variable power factor (PF) output capability to meet PF requirements

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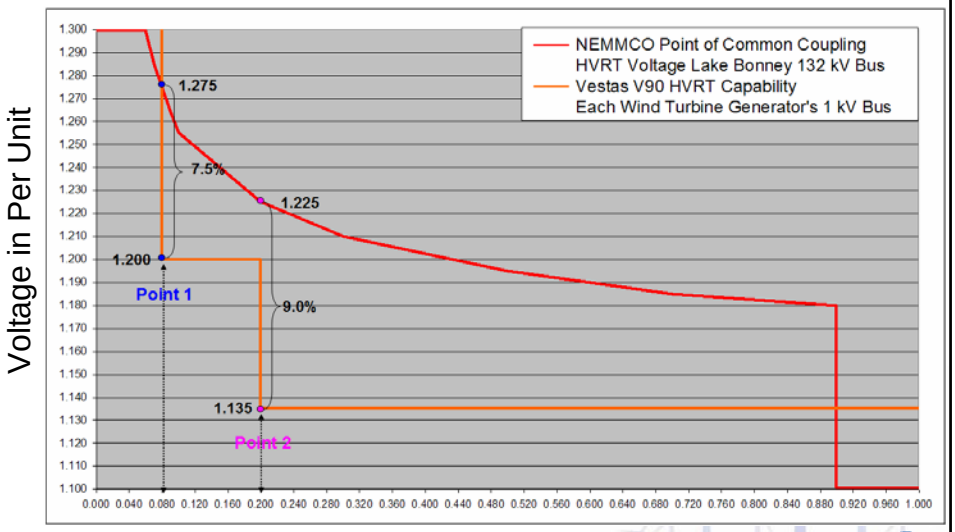
High Voltage Ride Through PCC and WTG Capability



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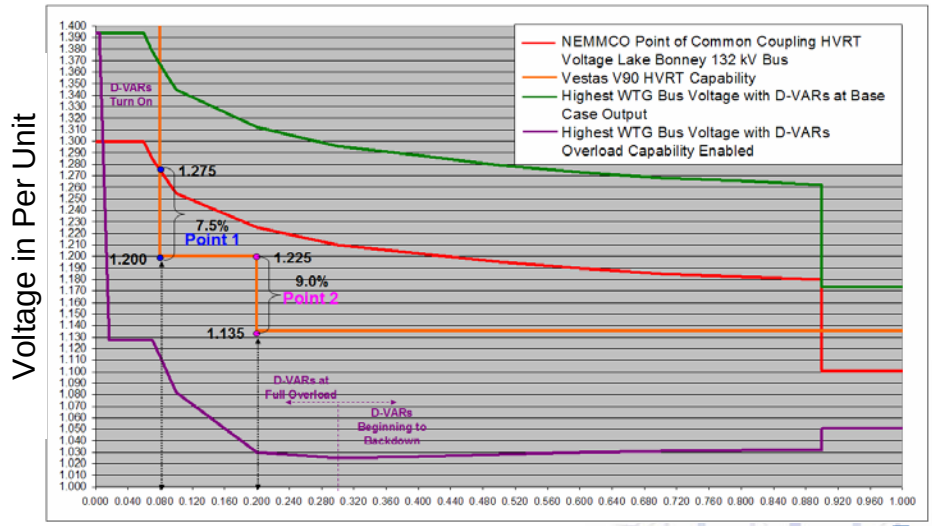
Method of How HVRT Analysis Was Conducted

Analysis of the Impact of the D-VAR® Systems on the Highest WTG Voltage



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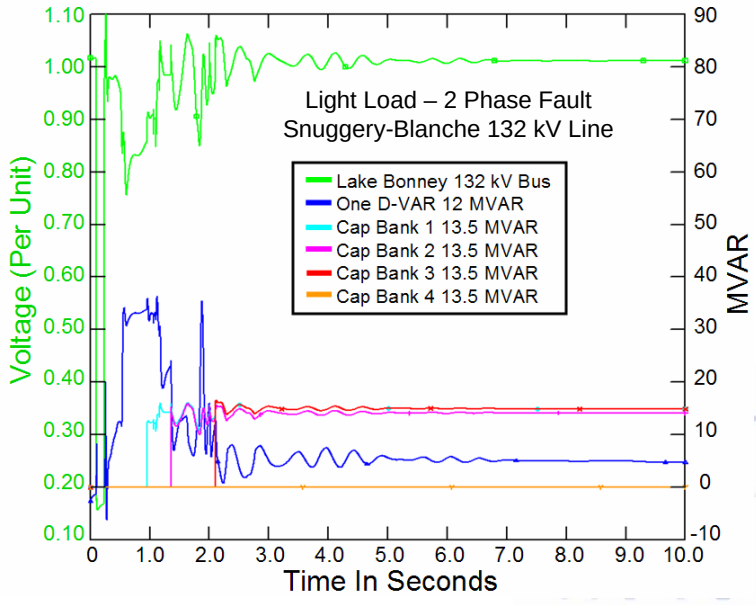
Post Fault Voltage Recovery Simulation Showing Innovative Solution Results



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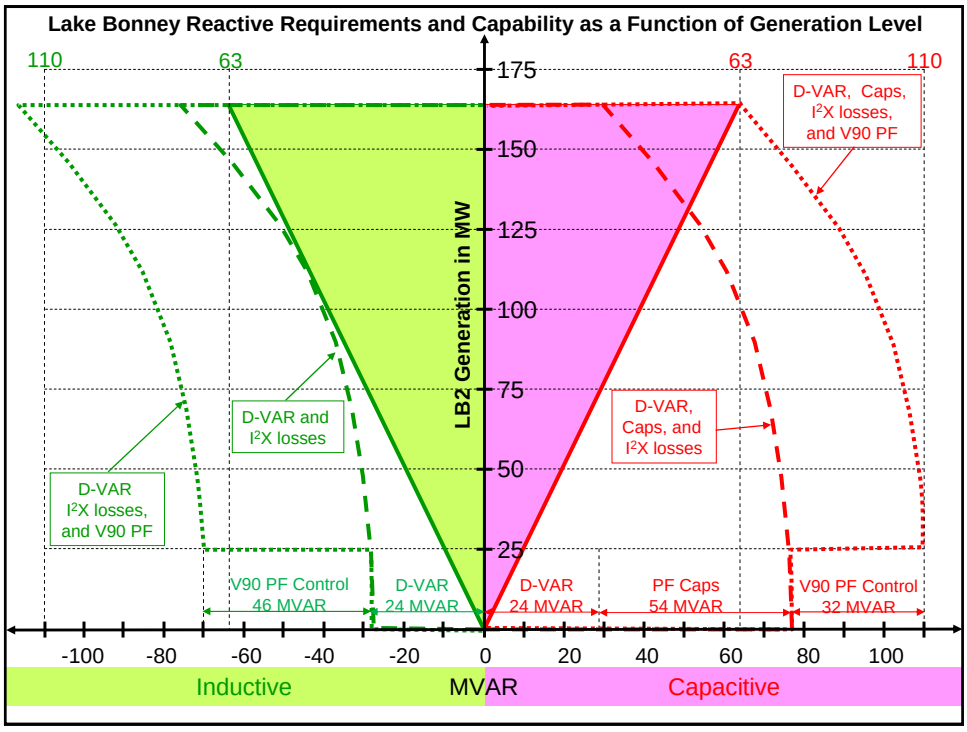

Lake Bonney 2
Reactive Compensation Summary

- LVRT met with improved turbine capability.
- D-VAR® system met all other dynamic and static interconnection requirements.
- Innovative D-VAR system approach minimizes interconnection investment requirements.
  - D-VAR unit's overload capability used to meet post fault voltage and HVRT requirements.
  - D-VAR system's switches caps and controls variable turbine PF capability to achieve PF and voltage regulation targets.

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Recent AMSC D-VAR® System Installations in Asia

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Questions?

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