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# Voltage Control and Impact of Increasing Harmonics Associated with Power Converters in Wind, Solar and Battery Farms

SC B3 Substations  
PS1 / Q1.3

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# Introduction - South Australia's Transforming Power System

South Australia is a 3 GW scale power system

There are only 2 interconnectors to other states

1 @ AC  $\pm$  650 MW

1 @ DC  $\pm$  200 MW

Summer Load Peaks in the range 2700 – 3200 MW

Winter Load Peaks in the range 2000 – 2400 MW

Minimum system demand 117 MW (solar duck curve)

$\approx$  3100 MW Total synchronous (and falling)

$\approx$  2700 MW Total non-synchronous (more under construction)

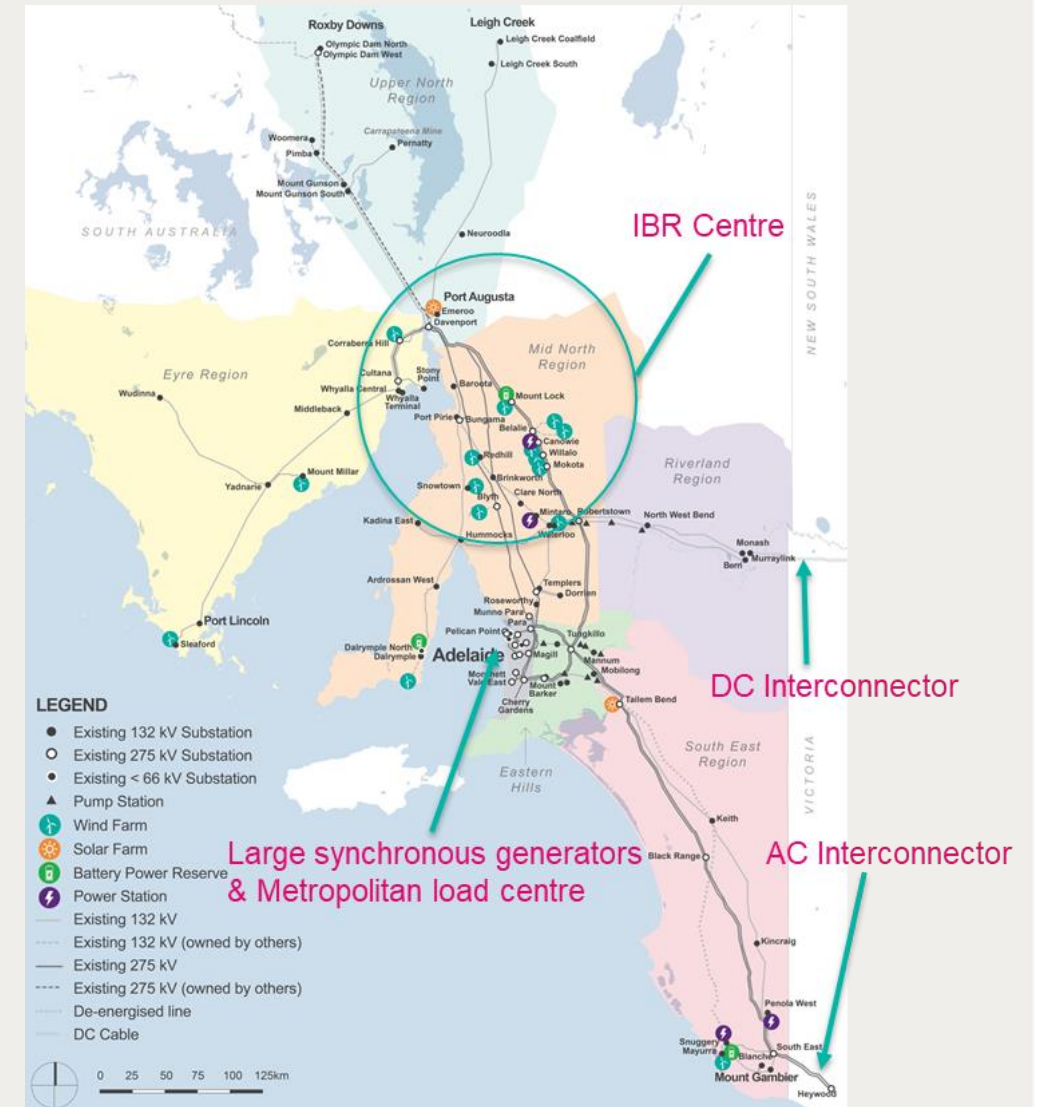
$\approx$  2100 MW wind

$\approx$  400 MW Solar

$\approx$  200 MW Battery

$\approx$  1800 MW Embedded Solar (in distribution system)

$\approx$  68% of electricity is now generated by renewables



# Issues that have emerged as renewables have increased

- High system volts
- Falling system strength
- Embedded Solar PV Shake-off
- Lack of dynamic voltage control to manage rapid changes to voltage & var flows due to changes in renewable generation
- Increasing Harmonic Distortion on the Network
- Ability to accurately measure harmonics
- Renewable generation has to be curtailed to maintain system stability

## *Solar PV Shake Off*

- **Falling system strength:** System disturbances display larger voltage swings across the network
- **Penetration of embedded solar PV** kept steadily increasing - 1800 MW
- **Early generation Solar PV** cannot ride through voltage fluctuations
- As a result, they shutdown or trip

This **shake-off effect** can cause approximately 25% shutdown across the entire network

## *Measuring and Managing System Harmonic Levels*

- Inverters-based generation cause the total harmonic distortion of the network to increase
- At transmission level the total harmonic distortion is not allowed to exceed 3%
- The minimum requirement is to identify harmonic content up to the 50<sup>th</sup> harmonic
- CVTs are typically used in the South Australian transmission network
- CVTs do not correctly identify the harmonic content other than to show that harmonic are present
- Trials have been implemented by installing devices called PQ Sensors and retrofitting to existing CVTs

# Modified CVT to Measure Harmonics

