

ESCRI-SA

Battery energy storage - Lessons learned

Energy Networks 2018

Sydney, 6 June 2018

In partnership with:



Advisian
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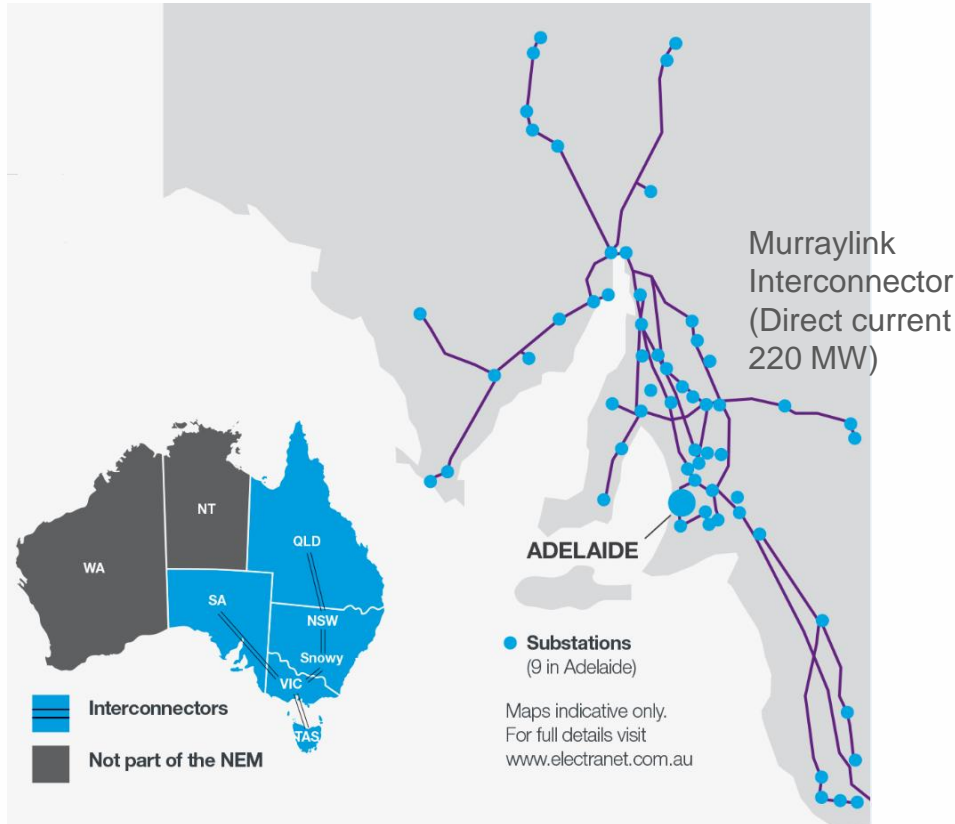
This activity received funding from ARENA as part of ARENA's Advancing Renewables Programme

Presentation outline

- > South Australian power system context
- > ESCRI-SA project
 - Background
 - Project overview
 - Status update
- > Lessons learned/ challenges

About ElectraNet

Owner and operator of South Australia's transmission network



Heywood Interconnector (currently 600 MW)

NEM – National Electricity Market

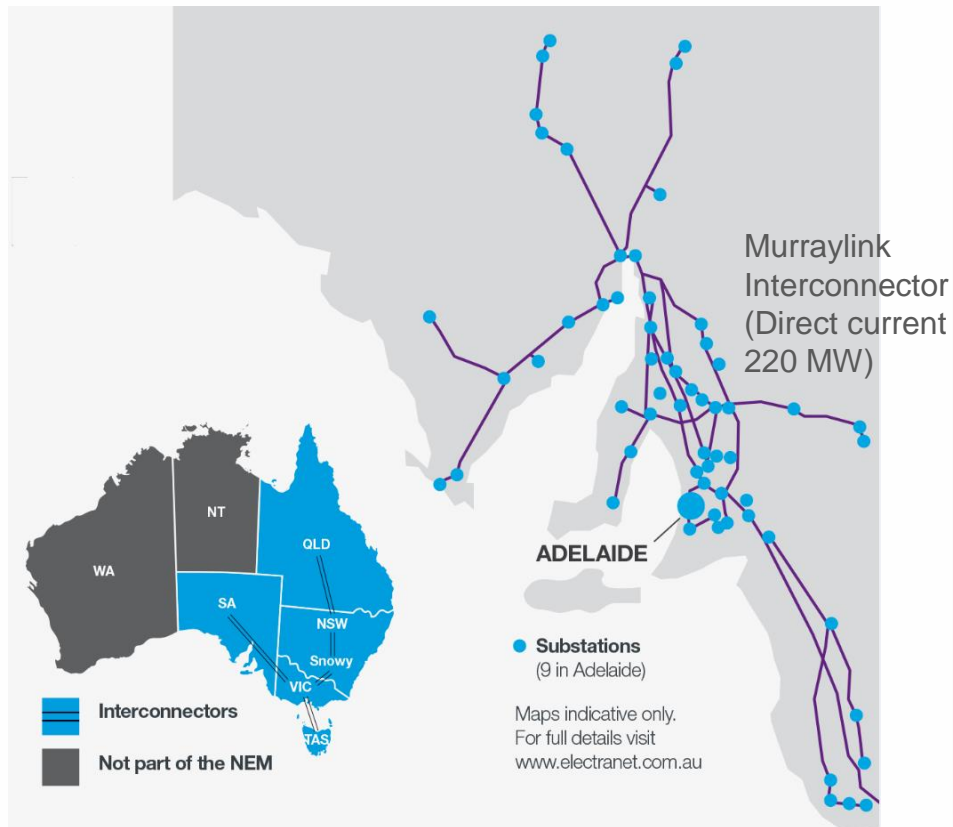
AEMO – Australian Energy Market Operator

- > Connecting customers and moving power over long distances
- > Private company with 3 major shareholders (State Grid Corporation of China, YTL Power and Hastings Funds Management)
- > Total regulated assets of \$2.5 billion
- > Network covers area of over 200,000 square kilometers
- > 91 high voltage substations
- > 5,600 circuit km of high voltage transmission lines and cables
- > 13,700 transmission towers

South Australian power system context

South Australian system overview

South Australia (SA) is at the forefront of energy transformation



Heywood Interconnector (currently 600 MW)

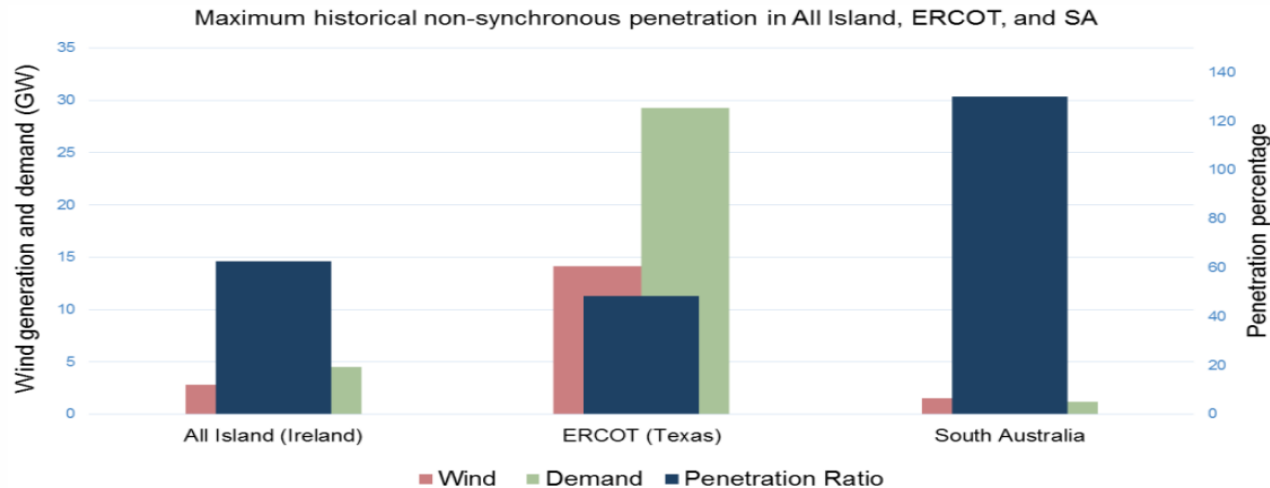
NEM – National Electricity Market

AEMO – Australian Energy Market Operator

- > Abundant high quality renewable energy resources with leading wind and solar penetration levels compared to demand
- > Last coal fired power station closed 2016
- > Reliance on gas generation and impact of higher gas prices
- > Recent SA separation and load shedding events have led to heightened concerns about power system security
- > New measures have been introduced by AEMO and the SA Government to manage power system security
- > Ongoing policy drivers to lower carbon emissions, new technology and customer choice are driving energy transformation

SA renewable energy integration

The challenges seen in SA in relation to minimum levels of synchronous generation are a first in any large scale power system in the world...



Source: AEMO, South Australian System Strength Assessment, September 2017

- > SA is unique compared with other major systems with high levels of wind:
 - Denmark** – has many interconnections with neighbouring countries
 - Ireland** – restricts non-synchronous generation to 55% penetration levels
 - Germany** – has many interconnections with neighbouring countries
 - Texas** – has low levels of wind relative to system demand

ESCRI-SA project background

Energy Storage for Commercial Renewable Integration –
South Australia

Project development history

ESCRI-SA Phase 1 – Business Case exploration

**November 2014 to
December 2015**

Examined regulatory, commercial, technology and technical issues and publicly reported results – Business case for a 10 MW, 20 MWh battery was poor



ESCRI-SA Phase 2 – Expression of Interest for delivery phase

**March to July
2016**

30 MW, 8 MWh battery for targeting fast frequency response, but unable to monetise – Benefits included increased Heywood Interconnector import capability, reduced unserved energy, and market price cap trading. Business case improved



ESCRI-SA Phase 2 – Full Application for delivery phase

**January to
March 2017**

Same 30 MW, 8 MWh battery but with fast frequency response system security benefit monetised (reducing Heywood Interconnector import constraints) and ancillary services revenue (FCAS) added. ARENA grant funding of up to \$12m required.

Project scope and objectives

Scope: Nominal 30 MW, 8 MWh (after 12 years) lithium-ion battery energy storage system (BESS)

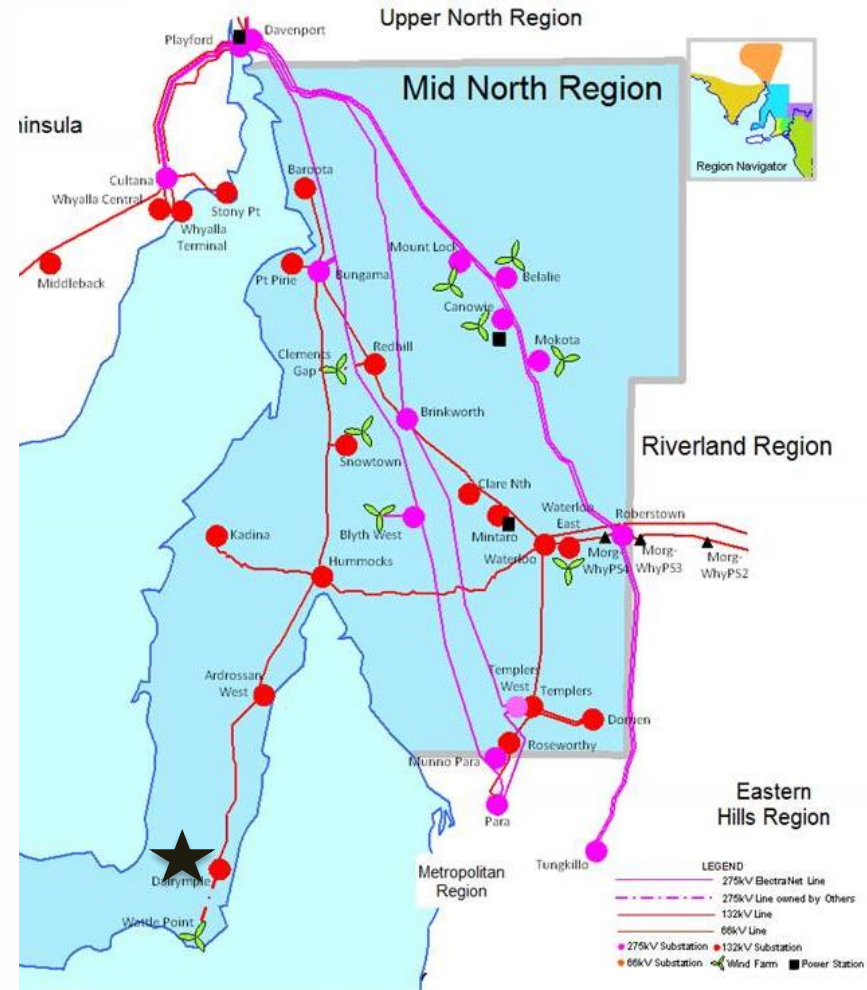
- > Demonstrate that grid scale battery storage can effectively provide network reliability and security services alongside competitive energy market services
- > Demonstrate network ownership of battery storage and appropriate commercial separation of the provision of regulated services and competitive market services
- > Demonstrate islanded operation with 100% renewable generation following transmission outages

Location

Site selected to maximise value from BESS

- > Connection at 33 kV at Dalrymple substation on Yorke Peninsula
- > Opportunity to reduce expected unserved energy under islanding conditions (max demand is about 8 MW but on average need about 3 MW for 2 hours)
- > Close to the 91 MW Wattle Point Wind Farm (AGL operates) – provides opportunity for BESS to support islanded operation with the wind farm and 2 MW of local rooftop solar, following network outages

BESS – Battery Energy Storage System



ESCRI-SA project overview

www.escr-sa.com.au

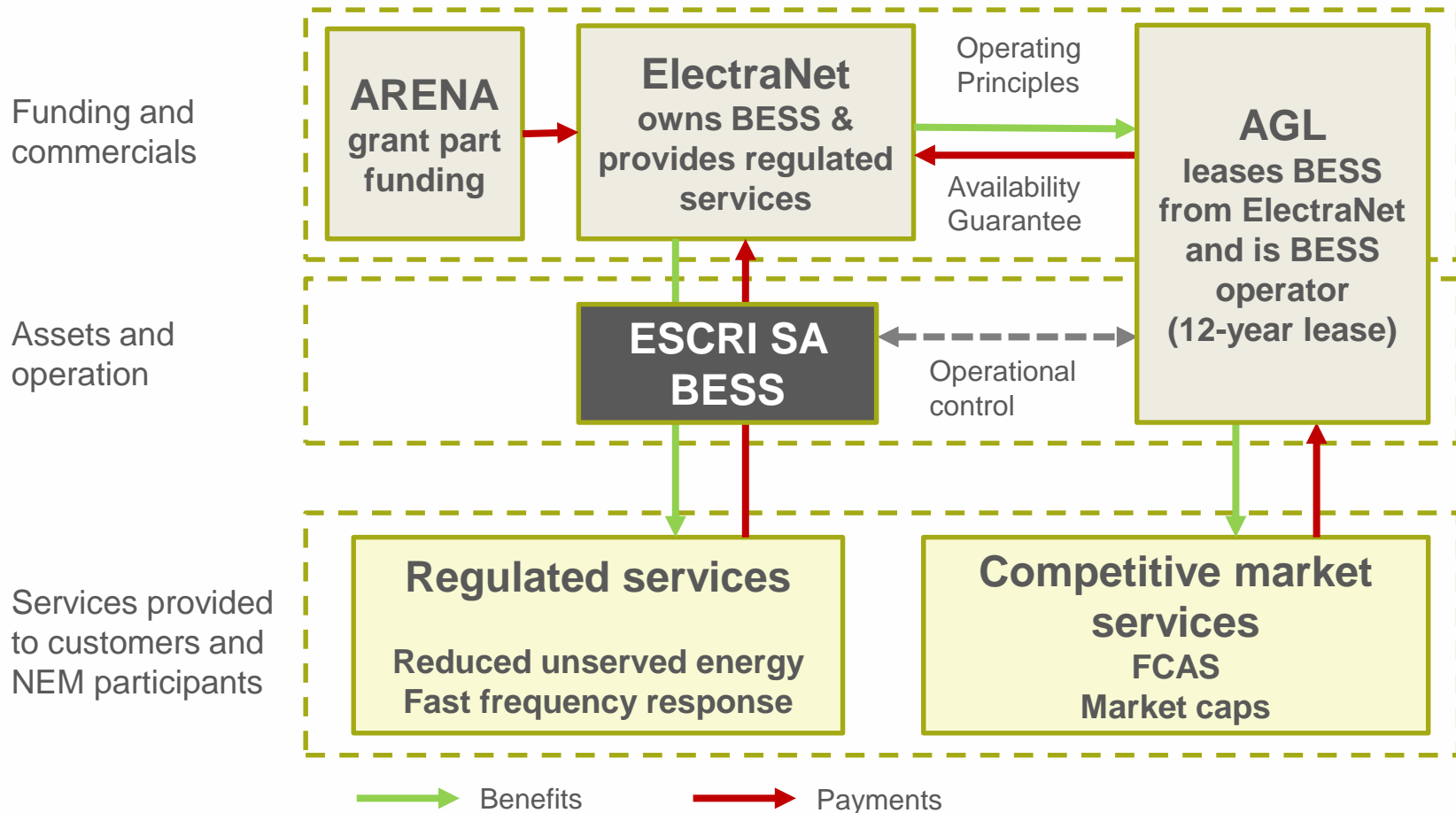
BESS provides a range of services

Benefits used (in **bold** below) in business case depend on specific application

Component	Service / Benefit	BESS	ESCRI-SA application
Energy	Cap trading	✓	Market service
	Energy time shifting	✓	AGL may use
	Energy security	✓	Not applicable
Network reliability / support	USE reduction	✓	Regulated service
	Capital deferral	✓	Not applicable
	Voltage & reactive control	✓	Especially in island operation
Frequency control	Short term spinning reserve	✓	Not applicable
	FCAS	✓	Market service
	Fast Frequency Response	✓	Regulated service
Safety	Fault level	✓	Island operation
	Black start	✓	Island operation

Commercial arrangements

Providing both regulated and competitive market services

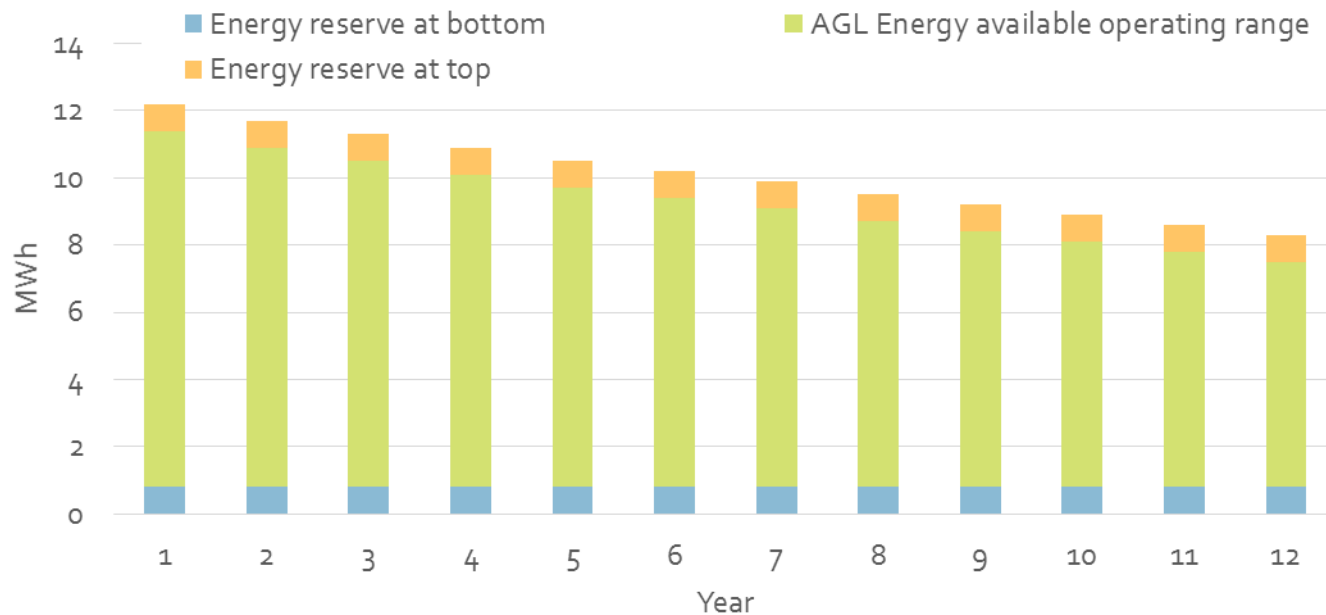


EPC/ D&C contract and 12-year maintenance agreement awarded to Consolidated Power Projects (CPP) following extensive procurement process

Operating principles

Battery Operating Agreement prioritises and protects regulated services

Level of charge at 33kV for non-regulated services	With Windfarm coordination	Without Windfarm coordination
Max allowable level of charge	X – 0.8 MWh	X
Min allowable level of charge	0.8 MWh	4.8 MWh



Islanded operation

ESCRI-SA BESS manages transition and then controls the island

> Islanding detection

- Topology-based Islanding Detection Scheme (IDS)
- Anti-islanding protection to disconnect BESS under certain conditions

> Transitioning to an island

- Disconnect 80% of Wattle Point wind farm (operated by AGL)

> Islanded operation with BESS as island grid master control:

- Voltage and frequency reference
- Wind farm generation dispatch – to manage BESS charge level
- Fault current provision & distribution protection
- Black start (if required)

ESCRI-SA status update

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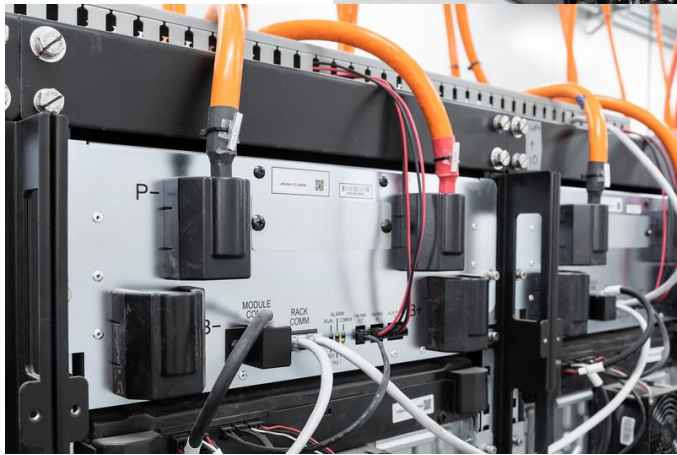
ESCRI-SA BESS – Dalrymple North



Project milestones

Key deliverable	Date
Financial close and contract award	21 Sep 2017
Energisation of BESS	30 Apr 2018
AEMO registration of BESS	5 June 2018
Commissioning and handover of operation to AGL Energy	Jun-Jul 2018
ARENA reporting and knowledge sharing period ends (two years)	May 2020

Batteries



Inverters



Transformers



Lessons learned & Challenges

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Lessons learned/ challenges

- > Each battery project appears to have its own set of unique challenges and some learnings are quite project specific
- > Learnings/ challenges have included...
 - demonstration project with an aggressive timeline
 - regulatory treatment
 - obtaining equipment models and evaluation of Generator Performance Standards (GPS)
 - clarifying AEMO registration and metering requirements
 - improving understanding of performance parameters
 - islanding challenges

Regulatory treatment

- > Acceptance of a service based approach to regulation
- > Create a new battery registration category under the National Electricity Rules that picks up relevant generation registration and charging/ discharging requirements so AEMO can manage constraints in market systems
- > Current requirement to register as a scheduled load as well as a scheduled generator raises TUOS implications, jurisdictional licensing obligations etc.
- > AER approved cost allocation approach, but AER suggested further work is required to develop a more general cost allocation approach for assets providing both regulated and competitive energy market services

Modelling and GPS

- > Developing compliant models for equipment introduced for the first time in the NEM is complex and time consuming
- > Start process early, engage early and regularly with all participants, including AEMO
- > The requirements of the grid forming mode (seamless islanding) formed the fundamental basis of development – this in some instances constrained grid connected modes, e.g. speed of response

Licensing and Registration

- > Remember jurisdictional requirements (these vary by state)
- > National Grid Metering requirements
- > Managing around set schedules:
 - ESCOSA board requires one month to review before granting a license
 - AEMO registration committee
 - Review of commissioning test plan
- > Early engagement and good collaboration went a long way!

Performance parameters

- > Inconsistent understanding of the FCAS technical functionality and market requirements between the OEM (ABB) and BESS operator (AGL), in particular Contingency FCAS
- > Overload capability
- > Standby losses
- > Battery life and cycle counts:
 - Impact of charging rates
 - Battery rest period requirements
 - Improve definition of a cycle

Islanding challenges

- > Islanding detection and anti-islanding protection
- > Wattle Point wind farm integration (AGL as operator)
- > Transformer inrush currents
- > Rooftop PV resulting in minimum demand
- > Distribution network protection
- > Distribution network Voltage Change Over scheme

ESCRI-SA BESS – Dalrymple North



Questions?

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Thank you

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