ESCRI-SA Project Journey

Phase 1 – Early Investigations and Business Case

A presentation for the ESCRI-SA Knowledge Sharing Reference Group, Meeting 1 – February 6, 2018

In partnership with:

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

The issues in the spotlight….

ABC NEWS LOCATION: Melbourne, Vic Change

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SA power outage: How did it happen?

Updated 29 Sep 2016, 11:39am

South Australia and its 1.7 million residents were left without power on Wednesday evening following severe storms.

So have recent events and a focus on renewable energy created the 'perfect storm' for a state-wide blackout?

First, what happened?

SA Premier Jay Weatherill confirmed two tornados destroyed three elements of critical infrastructure, which led to the power system protecting itself with a shutdown.

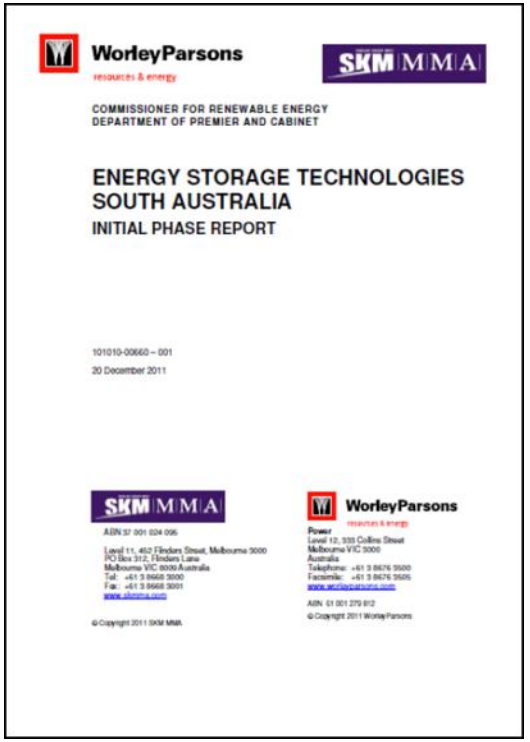
PHOTO: A map on the SA Power Networks website shows outages across South Australia. (SA Power Networks)

RELATED STORY: 'Serious questions' as power cuts leave SA in chaos

Source: ABC

Background to Project

- A SA Government funded study was undertaken in 2011 examining the role of energy storage for renewable integration in the State, which found;
  - A reasonable business case for the use of large scale storage (100s of MWs) such as pumped hydro, potentially compressed air and other concepts including gas transmission line-capacity
  - A potential business case for smaller (<30 MW peak) storage where both a renewable energy generation time shift (“arbitrage”) value could be combined with a network service value



WorleyParsons
resources & energy

SKM MMA

COMMISSIONER FOR RENEWABLE ENERGY
DEPARTMENT OF PREMIER AND CABINET

ENERGY STORAGE TECHNOLOGIES SOUTH AUSTRALIA
INITIAL PHASE REPORT

101010-00660 – 001
20 December 2011

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Related history

- Historically, AGL & ElectraNet had also been undertaking related work:
  - AGL had been investigating the use of the Wattle Point Wind Farm to enable a new large mining load on the Yorke Peninsula, including potential storage
  - ElectraNet examining the integration of renewables into the South Australian system

Photo source: South Australian Government

What is ESCRI-SA?

- Started as a conversation in August 2013 about the smaller energy storage concept (<30MW peak) between WorleyParsons and AGL
- Introduced to ElectraNet who saw the potential to assist renewable energy integration in South Australia, and the “consortium” was born
- Project evolved to demonstrate the business case for such storage, including:
  - The value proposition to renewable generation
  - The commerciality of the concept if combined with transmission network value
  - The ability of storage technology to meet utility and market standards
  - The commercial framework under which such an asset could be owned and operated
  - How such an asset would fit into the Regulatory framework

Historical ESCRI-SA?

Phase 1 – Business Case

- Regulatory environment
- Initial siting
- Functional specification
- Capital estimating
- Technology selection
- Commercial framework
- Market impact & value

Phase 2 – Project Delivery

- Statutory approvals
- Formal procurement
- Finance raising
- Detailed design
- Construction
- Commercial contracts
- Operation of asset

ARP submission for Phase 2

ARENA

Australian Government

Australian Renewable Energy Agency

Phase 1 – Basics

- Targeted revenue from three services;
  - The trading of energy into the NEM, and specifically the time shifting and trading of wind energy within the South Australian NEM Region
  - The provision of network services at transmission level
  - The provision of ancillary services into the NEM
- Technology neutral, but:
  - Sought commercial solutions that can meet utility standards and expectations under a Lump Sum Turn Key (LSTK) Engineering Procurement and Construction (EPC) supply
  - Did not pursue pumped hydro or large scale Compressed Air Energy Storage (due to investment scale and their relatively slow technical response times)
- Resolving basic questions – procurement, standards, safety, approvals etc

Most Energy Storage is New to Markets

- World installed generation capacity in 2015 ≈ 5,500 GW
- World installed energy storage capacity in 2015 ≈ 146 GW[1]

By 2030, EVs could provide a couple of GW of source/sink[2].

Storage type	Technology	Installed Capacity (aprox.)	Capacity in 2018?	
Mechanical	Pumped hydro	142,110 MW	183,000 MW	28%
	Compressed air	435 MW	1564 MW	260%
	Flywheel	920 MW	972 MW	6%
Chemical and electrochemical	Batteries	508 MW	2944 MW	480%
	Flow batteries	19 MW	319 MW	1150%
	Hydrogen	3 MW	20 MW	61%
Electrical	Super-capacitors	21 MW	34 MW	62%
Thermal	Molten Salt	1337 MW	3237 MW	142%
	Other	379 MW	453 MW	20%

[1] All data grid connected, from the US Department of Energy Global Energy Storage Database with data shaded yellow at 8 September 2015 and blue as at 30 Jan 2018. This Exchange is hosted by the Sandia National Laboratories.
[2] Assuming 20% of light vehicle fleet, nominal 10kW charge/discharge and 5-10% of fleet grid connected at one time.

Phase 1 Outcomes

Phase 1 – Business Case

- Regulatory environment
- Initial siting
- Functional specification
- Capital estimating
- Technology selection
- Commercial framework
- Market impact & value

No particular regulation impediment, although some unintended regulatory consequences that are being considered by regulatory authorities

Siting was a complex task, considering multiple services and technologies. A screening methodology was used resulting in 3 sites initially

A mathematical model was built to assess the large arrange of options, and determine a functional algorithm to maximise revenue

A formal RFI was used with 41 national/ international vendors responding – shortlisted to 8 proponents. A wide range of technologies were assessed including Lithium-Ion, AVRLA, various flow batteries, NaS, heat storage and hydrogen

Various commercial frameworks are possible – but for the revenue streams sought, the most effective appears TNSP owned, market leased

Business case was eventually assessed for a 10MW, 20MWh Lithium-Ion battery based at Dalrymple on the Yorke Peninsula

ESCRI Phase 1 – Regulation

- Such an asset is subject to the National Electricity Law and National Electricity Rules
  - There appears no impediment to an energy storage device realising multiple revenue streams
  - Just ***how*** depends very much on what it does, who owns it and how it connects – there is some precedent (pumped hydro), but also complexity, including:
    - The best registration path (market/non-market generator etc.)
    - Consideration of Transmission Use of System (TUOS) charges, Marginal Loss Factors (MLFs), ability or desire to provide market ancillary services (such as FCAS, SRAS or NSCAS)
    - In realising a Network benefit value, the Regulatory Investment Test (RIT-T) process applies and potentially limits trading value, depending on ownership and function – this point currently being looked at by regulatory authorities

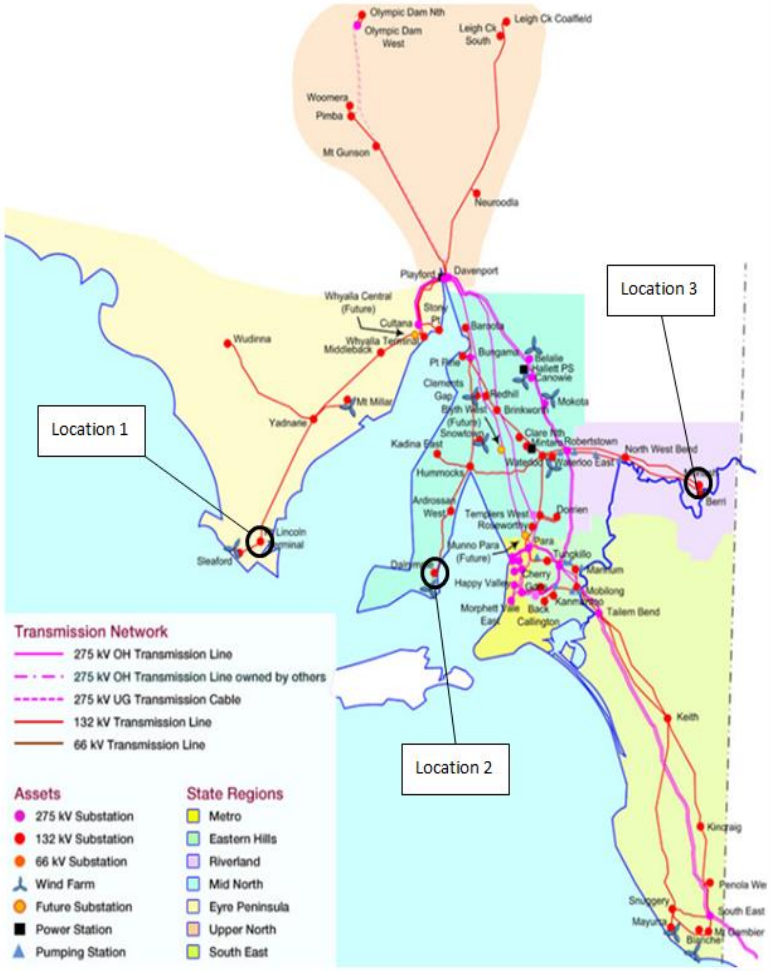
ESCRI Phase 1 – Siting

- Siting aimed to maximise the overall business case for the asset
- Started with broad selection criterion, and slowly rationalised to most valuable/practical
- Two layers of screening to select target sites
- Benefit quantification to try & rationalise selection

Revenue streams considered in final site selection	
Category	Benefit class
Generated Energy Value	1. Energy Trading Value 2. Marginal Loss Factor (MLF) Impact
Network Support (due to reliability constraints)	1. Network Augmentation Capital Deferral 2. Localised Frequency Support 3. Expected Unserved Energy (USE) reduction
Network Support (to increase Market Benefit)	1. Heywood Interconnector Constraint Reduction 2. Murraylink Interconnector Constraint Reduction 3. Local Generator Constraint Reduction 4. Grid Support Cost Reduction 5. System Frequency Support 6. Avoided Wind Farm Frequency and Control Ancillary Service (FCAS) obligation

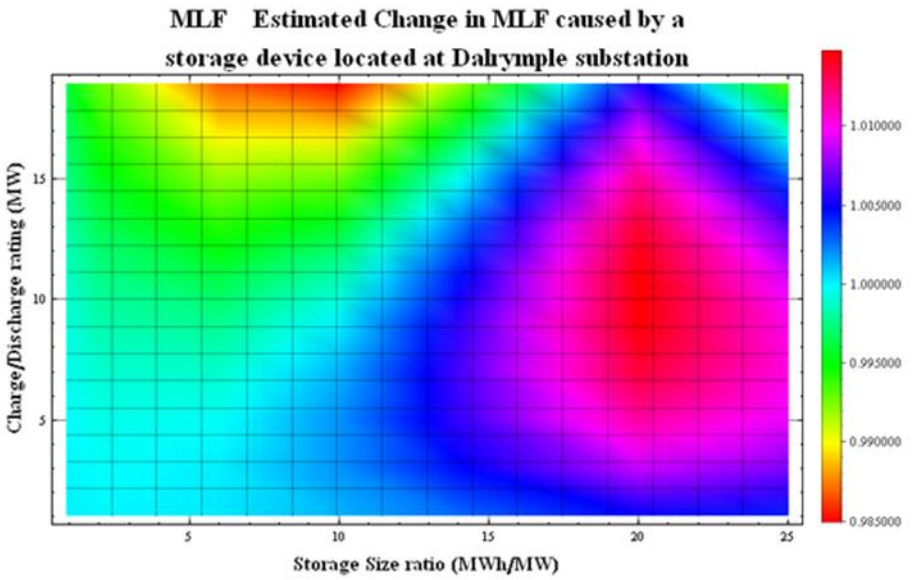
ESCRI Phase 1 – Initial Siting

- Initial siting suggested three locations:
  - Eyre Peninsula
  - Riverland
  - Yorke Peninsula
- Of which three locations were chosen:
  1. Port Lincoln terminal substation
  2. Dalrymple substation
  3. Monash substation
- Ultimately highly iterative process



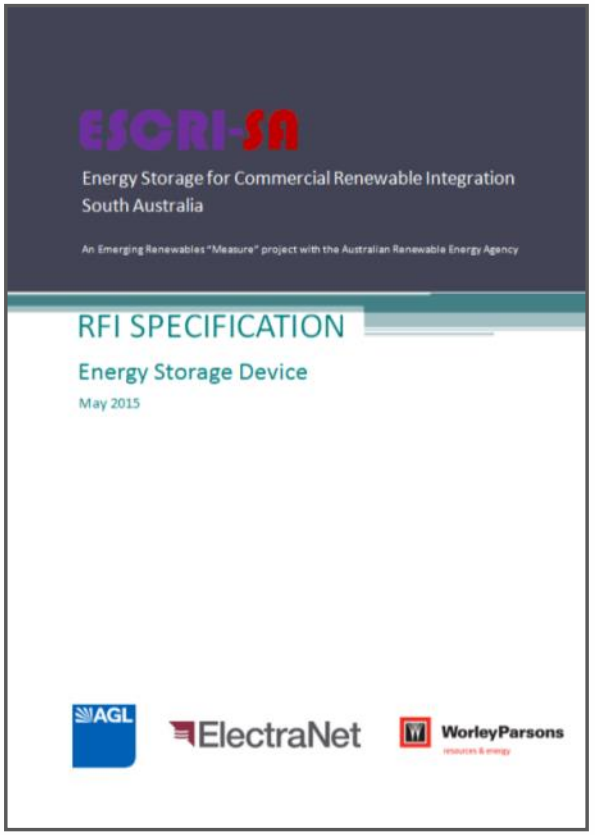
ESCRI Phase 1 – Functional Specification

- A mathematical model of the asset was built, which allowed simulation against financial metrics
- Allowed functional algorithms to be tested and trialled, across 100s of technology and size options
  - Storage parameters can be optimised within technology constraints
  - Various energy time shift algorithms can be tried
  - Differences between sites can be calculated
- Used to determine basic functional Specifications



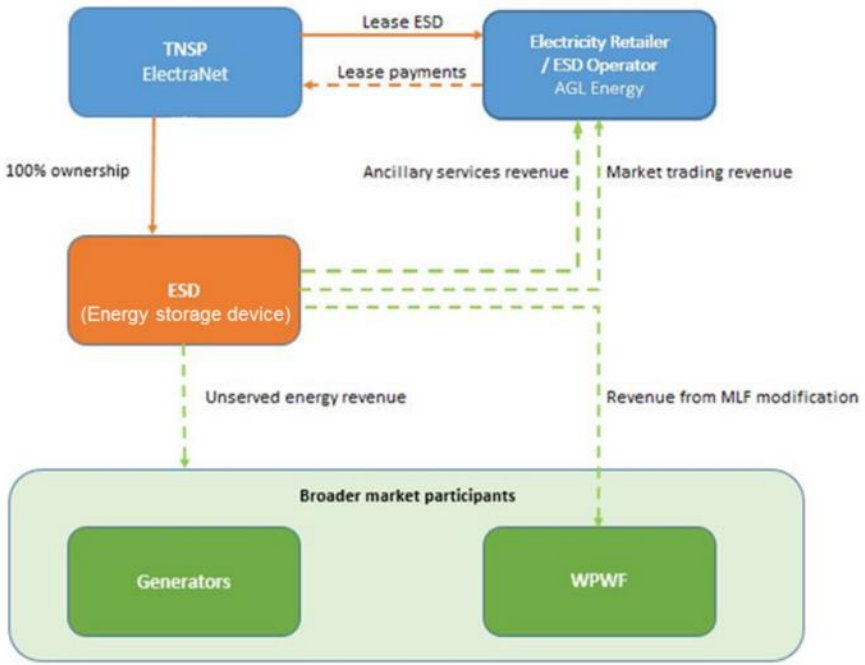
ESCRI Phase 1 – Procurement

- A formal RFI was issued on 11 May 2015 to forty two interested parties (in and outside of Australia);
  - Seeking information on pricing, procurement preferences, technology capability, warranties etc. on LSTK EPC terms
  - Essentially a draft Specification was issued, seeking a storage device between 5-10MWpk & 20–200MWh at typical utility standards
  - Purpose was to short-list for potential Phase 2 tendering and to assist in developing business case
  - Eventually shortlisted to 8 parties
  - Found large variation in prices across a range of battery technologies. Some non-battery options were put forward, but were largely immature technologies and were not short-listed.



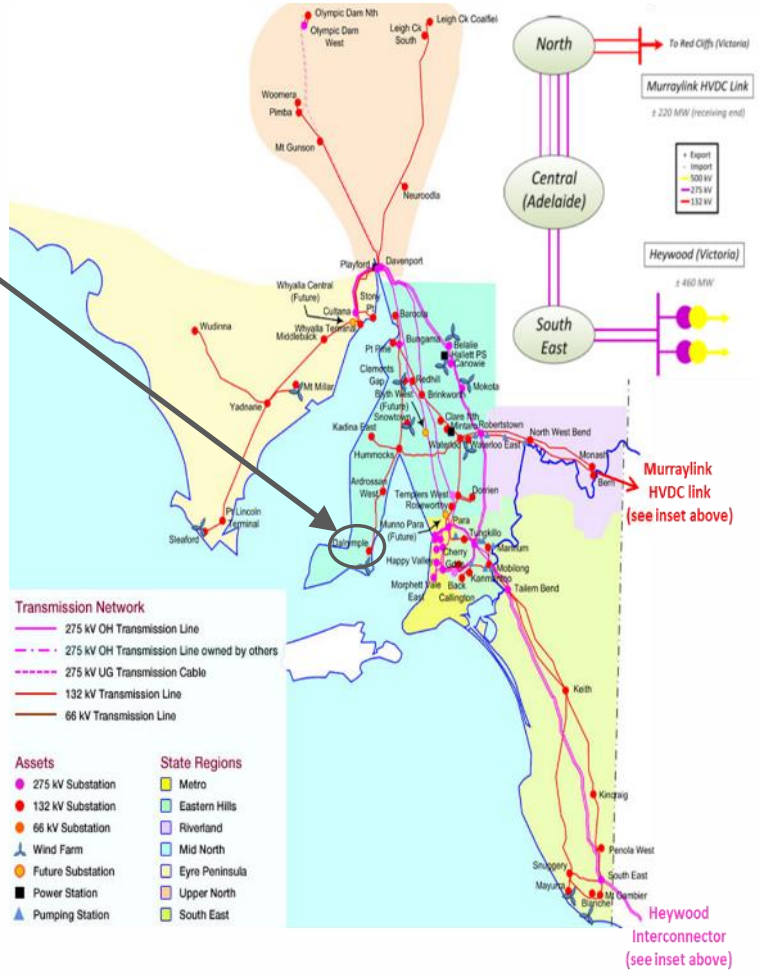
ESCRI Phase 1 – Commercial Framework

- There is a tension between network and energy trading value
- Ownership is critical in determining operation and commercials
  - Could be owned by a TNSP, specialist 3rd party or generator/gen-tailer
  - Functional hierarchy may influence the best owner for such a device – who has dispatch rights and when?
  - Trading could be sold or leased, but if owned by a regulated business there may be a limitation on revenue



ESCRI Phase 1 – Business Case

- Completed business case for a project consisting of a nominal 10MW, 20MWh battery at Dalrymple on the Yorke Peninsula, providing:
  - Islanding services (unserved energy) in parallel with 91MW Wattle Point Wind Farm (WPWF)
  - Energy time shifting (arbitrage)
  - Improvement in MLF to WPWF
  - FCAS services (potentially)
- Basic metrics used;
  - A Lithium-Ion battery
  - 10 year operational lifetime
  - A targeted post tax IRR of 7.5%
  - A COD of June 2017



ESCRI Phase 1 – Financials

Description	NPV[1] ($ 000 real FY16)
Market trading revenue	2,818.3
Revenue from MLF benefit	743.1
Expected unserved energy revenue	2,678.4
Ancillary services revenue (FCAS)	52.0
(A) Total revenue from ESD	**6,291.9**
Opex	(1,634.8)
Capex	(23,429.6)
(B) Total cost of ESD	**(25,064.4)**
Pre-tax NPV (A+B)	**(18,772.5)**
Tax effect	3,970.2
Post-tax NPV	**(14,802.3)**
Proposed ARENA grant	(14,802.3)
Residual funding shortfall	-
Implied IRR (%)	**7.5%**

Business Case Results – Key Financial Figures
Note 1: Net present value based on post tax nominal discount rate of 7.5% and valuation date of 30 June 2016

- Business case was generally poor despite many combinations of inputs considered
- Would need to halve costs and double revenue for a commercial outcome

The business case is given in more detail in the Phase 1 General Project Report available at:

https://arena.gov.au/assets/2016/04/ESCRI-General-Project-Report-Phase-1.pdf

ESCRI – Phase 1 Conclusions

There does not appear to be any particular roadblocks to the development of energy storage in the NEM at transmission level that leverages multiple values and supports renewable energy deployment.

The optimisation of such assets is a complex task as there are multiple technologies to choose from, each with their own capabilities, which impacts on siting, costs and functionality. This will improve with experience, but will likely remain strongly iterative.

The level of experience in Australia with such technologies at utility scale is poor. This includes the procurement and planning paths, social license to operate issues, bankability, deployment and operation. Despite overseas exemplars, suppliers are also inexperienced.

Currently energy storage is too expensive and monetisable revenue opportunities too low to make a project commercial. However, this situation will change as storage decreases in price and as electricity systems change to accept more and more intermittent renewable energy input.

Storage is recognised as a key renewable energy enabler and of all the NEM regions, South Australia is likely to require such services first. Fast acting storage such as batteries have the advantage of leveraging both network and market services, and can be deployed just about anywhere.

It was recommended that a Phase 2 ESCRI-SA demonstration project be supported of nominal 10MW, 20MWh size sited at Dalrymple on the Yorke Peninsula, to begin the process of gaining experience at transmission level and involving both network and market services operating in parallel.

The path to Phase 2?

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- Regulatory environment
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ARP submission in 2017

ARENA

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Thank you

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