ElectraNet

ESCRI-SA PROJECT SUMMARY REPORT

The Journey to Financial Close

May 2018

In partnership with:

agl

ARENA
Australian Government
Australian Renewable Energy Agency

Advisian
WorleyParsons Group

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

Copyright and Disclaimer

The purpose of this document is to provide a project summary of the ESCRI-SA Battery Energy Storage Project.

ElectraNet makes no representation or warranty as to the accuracy, reliability, completeness or suitability for particular purposes of the information contained within this document. ElectraNet and its employees, agents and consultants shall have no liability (including liability to any person by reason of negligence or negligent misstatement) for any statements, opinions, information or matter expressed or implied arising out of, contained in, or derived from, or for any omissions from, the information in this document, except in so far as liability under any statute cannot be excluded.

Reasonable endeavours have been used to ensure that the information contained in this Report is accurate at the time of writing. However, ElectraNet gives no warranty and accepts no liability for any loss or damage incurred in reliance on this information.

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

Contents

Glossary of Terms

Term	Description
AC	Alternating Current
AER	Australian Energy Regulator
AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
BESS	Battery Energy Storage System
BOA	Battery Operating Agreement
CAM	Cost Allocation Methodology
CB	Circuit Breaker
CFS	Country Fire Service
CPP	Consolidated Power Projects Australia Pty Ltd
CPS	Customer Performance Standards
DC	Direct Current
DPTI	Department of Planning, Transport and Infrastructure
DTT	Direct Transfer Trip
Dvar	Dynamic Voltage Amp Reactive
EOI	Expression of Interest
EPC	Engineering, Procurement and Construction
ESCOSA	Essential Services Commission of South Australia
ESCRI-SA	Energy Storage for Commercial Renewable Integration, South Australia
ESD	Energy Storage Device
FCAS	Frequency Control Ancillary Services
FFR	Fast Frequency Response
GPS	Generator Performance Standards
Hz	Hertz
KSRG	Knowledge Sharing Reference Group
kV	Kilovolts
MW	Megawatts
MWh	Megawatt hours
NCIPAP	Network Capability Incentive Parameter Action Plan
NCC	Network Capability Component
NEM	National Electricity Market
NER	National Electricity Rules
NPV	Net Present Value

O&M	Operation and Maintenance
PSCAD	Power System Computer Aided Design
PSS/E	Power System Simulator for Engineering
Q&A	Questions and Answers
RIT-T	Regulated Investment Test for Transmission
RoCoF	Rate of Change of Frequency
RFT	Request for Tender
R&D	Research and Development
SA	South Australia
SAPN	South Australia Power Networks
SCADA	Supervisory Control And Data Acquisition
SIPS	System Integrity Protection Scheme
SOC	State of Charge
TBIPS	Topology Based Islanding Detection Scheme
TNSP	Transmission Network Service Provider
STPIS	Service Target Performance Incentive Scheme
TUOS	Transmission Use of System
WPWF	Wattle Point Wind Farm
WTG	Wind turbine generators

1. Introduction

This Report covers the journey to financial close of the Energy Storage for Commercial Renewable Integration, South Australia (ESCRI-SA) project (the Project), which is part funded by the Australian Renewable Energy Agency (ARENA).

The Report represents one of the key Knowledge Sharing deliverables required under Milestone 2 of the funding agreement between ElectraNet and ARENA (the Funding Agreement).

The intention of the Report is to describe the journey and lessons learnt in getting the Project to financial close. To do this, the Report is divided into Sections which track the journey of the Project from initial inception through to final investment decision.

Section 2 outlines the key purpose of the Report, the intended audience and any distribution restrictions. This Section also includes links to other Knowledge Sharing information available on the Project, including the on-line Portal.

Section 3 sets the context with reference to Phase 1 of the Project, which was completed in 2015 and examined the business case for the use of energy storage in South Australia. The business case for a storage asset providing energy rather than power-based services was found to be poor. This Section then describes the contemporary issues playing out in the South Australian electricity system, and how, in light of these, the ESCRI-SA Project and the services it provides were changed leading to the Project now being delivered under Phase 2.

Section 4 describes the detailed learnings from the period leading up to financial close. A full timetable of critical events in the Project is then outlined, before covering the important topics of regulatory fit, updated business case, planning approvals, community consultation, commercial arrangements, procurement and evolution of the Project specification and function. Lessons learned round out Section 4.

Section 5 then draws the journey to conclusion and defines the Project at the point of Financial Close, including its objectives, the final ownership model for the asset, the primary services that will be offered and operational methodology to be employed, the primary Contractors employed and their scope of work, the Project timetable and an outline of the interaction expected with key Project stakeholders.

Section 6 provides a small introduction to the role of the members of the Project team and provides links to obtain more information about the Project, and to ask questions of the Project team.

Appendices provide additional supporting material.

2. Document Purpose and Distribution

2.1 Purpose of Document

This document is a public Report issued as part of the Knowledge Sharing commitments of Phase 2 of the ESCRI-SA Project, in accordance with the Funding Agreement. Knowledge Sharing is an integral component of the Project and a requirement of ARENA, who as contributed funding support through its Advancing Renewables Programme.

ESCRI-SA involves the installation of a 30 MW, 8 MWh Battery Energy Storage System (BESS) at Dalrymple on the Yorke Peninsula of South Australia, with Phase 1 of the Project completed in 2015 involving preliminary business case work and Phase 2 the actual procurement, installation, commissioning and operation of the asset.

This Report focuses on the journey taken to reach Project Financial Close, including a summary of the work undertaken in Phase 1 and detail on the approach and resolution of issues required to initiate the actual Project in Phase 2. The Report then focuses on several critical components of this journey which occurred between signing of the Phase 2 Funding Agreement with ARENA, and Funding Agreement Milestone 1, including;

- Regulatory treatment of the Project
- The Project business case
- Environmental (and other) approvals
- Community consultation
- Stakeholder issues and interactions
- BESS performance parameters
- Procurement
- Lessons learnt

Over the course of the Project a wide range of Knowledge Sharing work is being undertaken, including delivery of a range of reports, presentations, meetings and site visits. Access to the full list of Knowledge Sharing resources as well as operational information and data on the ESCRI-SA BESS is available at the Project Portal (www.escri-sa.com.au) described in Section 6.

2.2 Intended Distribution

This document is intended for the public domain and has no distribution restrictions.

3. Context and Project History

ESCRI-SA is a project which began as a concept in 2013 to explore the role of energy storage in a future with more variable renewable energy-based generation within Australia's larger interconnected energy system. This concept evolved into a consortium consisting of ElectraNet, AGL and WorleyParsons (the Consortium[1]), that jointly explored firstly the business case for such an energy storage device (Phase 1), and now the installation of a BESS (Phase 2).

This Section provides the context in which the Project was formulated by considering firstly the work and results of Phase 1. This is then followed by a summary of the key contemporary issues in the South Australian transmission network, which are important in understanding the roles and services that the final ESCRI-SA BESS is targeting and the engineering solution that resulted.

3.1 Overview of Project Phase 1

Phase 1 of the ESCRI-SA Project was initiated through a funding agreement between ARENA and AGL signed in August 2014 and resulted in the delivery of a final public Report as the major Project deliverable in December 2015. This final Phase 1 Report can be found at the following link:

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

Phase 1 was exploratory in nature and examined the role of a non-hydro Energy Storage Device (ESD) within the South Australian transmission system specifically designed to leverage value from the energy market and through both ancillary and network services. A key objective of the work was to demonstrate that such storage adds value to renewable energy integration, with the ESD targeting that outcome as well as additional services to improve its business case.

The work began with a simple assumption that energy storage could provide a range of functions of value in systems with higher variable renewable energy input, including energy arbitrage and other market facing services such as ancillary services, but also network related services such as voltage control and potentially deferral of network augmentation.

Phase 1 was agnostic on the ESD technology, in part to allow very broad thinking to evolve and different solutions to be compared, but also as the likely Phase 2 Project was expected to have poor economics and be, therefore, limited in size – hence, pumped hydro was not considered as previous work in South Australia had suggested a much larger scale asset would be required for this than envisaged.

In Phase 1 it was always intended that a multi-functional asset would be pursued, that is, one which leveraged both market and regulated revenue, and this also favoured technologies that were less geographically limited than pumped hydro.

As an example, batteries and other storage solutions were considered to be simpler to install and even repurpose to another site, which was expected to aid leverage of network related services.

[1] The parties and their roles are described in Section 6 along with a contact for Project enquiries

At the time of Phase 1, Australia had little experience with non-hydro energy storage within its interconnected systems, and the technologies involved were just emerging into the mainstream internationally. This meant that the work had to concentrate on a range of issues across a broad spectrum, including:

- The regulatory environment in which such an asset would operate
- What services it would provide, and how would these be monetised
- Where the asset would be sited
- What energy storage technology was available, its maturity and both supply and operational risks
- Issues around project progression, including planning and environmental approvals
- Procurement of the asset, specifications and contracting terms
- Commercial framework under which the asset would be owned, and outputs traded
- The business case in terms of ESD commercial return, risks and sensitivities

The work was found to be highly iterative, with many combinations and permutations of technology, siting, services and prices. All of these had to fit within the regulatory bounds and commercial constructs that existed. The Consortium employed several techniques to aid final Project selection, all of which are described with outcomes in the Final Report.

Business cases were explored for a wide range of ESD sizes at various locations in the current South Australian region of the market. Unfortunately, it was found that no project could be made Net Present Value (NPV) positive and a decision was made to choose the best performing variation, a 10 MW, 20 MWh ESD sited at the Dalrymple substation on the Yorke Peninsula, as the basis for the detailed business case.

This project option was chosen as it has significant local renewable energy generation (Wattle Point Wind Farm) and appeared to have the most suitable characteristics to leverage value from such ESD sizing. A Lithium-Ion battery was used as the basis of the business case as this showed the best overall metrics.

An important aspect of the Dalrymple option was the revenue sources that could be leveraged, which included market-based products but also significant regulated value, one of which involved the ESD supporting islanded operation together with the Wattle Point Wind Farm following a 132 kV fault on the incoming radial transmission line. Such islanding meant that unserved energy could provide additional benefit to the Project with the ESD and wind farm serving the load until transmission service was restored.

Ultimately, the Dalrymple ESD was found to be significantly NPV negative, requiring approximately a 63% capital contribution (NPV terms) from ARENA to be commercially viable. Simply, while there were many values the asset could provide, of those monetisable under current regulations, there was simply not enough revenue. This was a disappointing result, but the Consortium and ARENA saw value in furthering the Project objectives.

The Consortium continued to review cost and revenue aspects of the Project and to hold discussions with ARENA about the re-examination of the Project considering the unfolding circumstances in South Australia and the National Energy Market (NEM).

For ESCRI-SA Phase 2, the Energy Storage Device (ESD) was renamed the Battery Energy Storage System (BESS) in recognition that Lithium–Ion battery technology had been selected and was likely the long term best solution.

While the Project ultimately evolved to align more with the particular services needed within the South Australian power system, the basic concepts involving siting at Dalrymple and BESS technology remained and became the backbone of the final solution.

3.2 Changes Occurring in the National Energy Market and South Australia

At the time of Phase 1 of the ESCRI-SA Project, it was evident that South Australia had unique issues involving the continued development of variable renewable energy, principally wind and solar photovoltaics. Following completion of Phase 1, these issues continued to evolve and ultimately drove a different approach to the Project, altering the services that the Project would offer and moving the MW/ MWh combination to include a focus on addressing system security.

South Australia has one of the highest renewable energy penetration levels of any interconnected system worldwide. Given recent generation dispatch experience, closure of synchronous coal generation in the State and an increasing reliance on the primary South Australia to Victoria Heywood interconnector, there are system security and market challenges that need to be addressed to support further variable renewable deployment.

One of the most challenging aspects of power system security is the ability to maintain the stability of a system that unexpectedly becomes “AC islanded” from a much larger system. This is most pronounced if there is a deficit of available supply compared to demand in the islanded system.

An example of this is the separation of South Australia from the rest of the National Electricity Market such as occurs if the Heywood interconnector experiences an unplanned outage at a time when it is importing power into South Australia. In the past, sufficient large conventional synchronous generators have been available and operating in South Australia to provide a range of services that assist in managing sudden, unexpected transitions to an islanded system condition and keep the islanded system stable.

This is due to their large spinning inertia, which has the effect of moderating the initial rapid rate of change of frequency (RoCoF) that occurs for the first seconds immediately following an AC separation event. There is presently no market for this service, which has until recently been an inherent characteristic of the power system.

However, with the retirement of synchronous generation in South Australia, particularly coal generation, this inertial response has diminished and this has stretched the ability of the islanded system’s frequency to recover to within the 49 Hz to 51 Hz range within two minutes, as required by the NEM’s Frequency Operating Standard. This is a situation that all regions of the NEM will face as variable renewable energy increases and legacy coal assets retire.

3.3 Changes to ESCRI-SA and the Road to Phase 2

The issues in South Australia around system security changed the Project direction to consider different services, particularly fast frequency response services that were emerging as valuable. This provided a different flavour to the asset, from one focused more on the energy market, to one focused more on system security.

In practice, this process involved an increase in the MW capability of the asset, and a decrease in its energy storage depth (MWh), with a nominal 30 MW/ 8 MWh device finally selected based on several iterations with vendors around price, modelling of monetisable revenues, and with the aim of limiting any ARENA contribution to the final asset while maximising demonstration value.

Within this process the revenue items of the Project changed in terms of services provided, their respective contributions, and the interaction between the parties involved, particularly commercially. The Project lifetime also consolidated to twelve years. This process of defining the core aspects of the Project continued well through financial close decision making and is discussed with final outcomes in Sections 4 and 5.

The final ESCRI-SA Phase 2 Project was presented to ARENA in early 2017 with a conditional Funding Agreement signed for the Project in April 2017 and a final Agreement signed in August 2017. This Agreement included several Milestones, the first of which involved the Project proceeding to Financial Close, with a target date of 30 October 2017. This Financial Close Milestone included the following key deliverables:

- Provision of a financial model reflecting all final contractual arrangements
- Provision of evidence that all authorisations required for the Activity at that point in time have been obtained (i.e. all statutory approvals)
- Executable versions of the following agreements
    - EPC Contract
    - Maintenance Agreement
    - Battery Operating Agreement
- Provision of insurance documentation
- A certified risk management plan

This Report focuses on the period from August 2017 to the end of October 2017 in terms of the journey undertaken to meet this Milestone 1.

4. The Journey to Financial Close, and Lessons Learnt

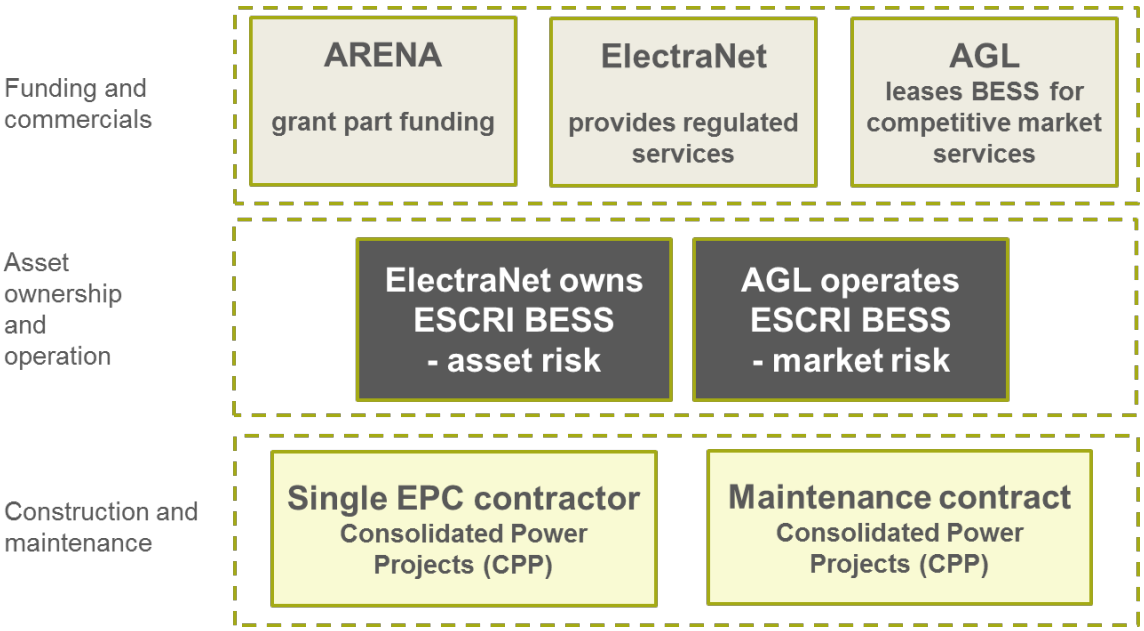
This Section covers the lessons learnt from the process of reaching Financial Close.

4.1 What Financial Close Means for a Battery Storage Project

Financial close on a battery storage project can be summarised from ElectraNet's perspective as achieving the following:

- Certainty of funding sources/ revenue
- A high degree of confidence on cost estimates
- A robust business case to support an investment decision by the asset owner
- Required approvals
- Appropriate risk allocation

The overall commercial arrangements for the Project, including the above aspects are summarised in the following diagram. The subsections that follow address each aspect in turn.



4.1.1 Funding sources/ revenue

The ESCRI-SA BESS business case is dependent on the following three funding sources/ revenue:

- Regulated benefits that underpin a regulated investment
- Unregulated revenue
- ARENA grant funding

To reach the ARENA Financial Close milestone, ElectraNet was required to have in place the following agreements, approvals and documentation:

- Financial model reflecting all final contractual arrangements
- Development approvals
- Community consultation plans
- Engineering Contract Specification (ECS)
- Executable versions to ARENA's satisfaction for the:
  - EPC Contract with the final vendor
  - Maintenance Contract with the final vendor
  - Battery Operating Agreement with AGL
- Certificate of Currency
- Certified Risk Management Plan
- Agreement in place for the regulatory treatment of the BESS from the Australian Energy Regulator (AER)
- Letter of support for the Connection and Registration of the BESS from the Australian Energy Market Operator (AEMO)
- Other Project documentation

ElectraNet engaged closely with the AER to demonstrate the regulated benefits to be delivered by the BESS and to support a portion of the cost of the BESS to be allocated as a regulated investment. The AER had to be assured that the regulated benefits outweigh the cost of the regulated investment. Also, the AER had to be convinced that these regulated benefits will not be eroded by the commercial operation of the BESS.

During the procurement process, AGL refined the benefits from competitive market services based on updated annual available capacity of the BESS over the planned twelve-year operational period. The relevant lease payments and BESS availability were agreed between AGL and ElectraNet.

4.1.2 Cost estimates

ElectraNet followed an extensive procurement process to identify a single EPC contractor that could also maintain the BESS over the twelve-year contract period. Both the capital cost as well as maintenance cost were key factors in identifying the preferred EPC contractor. In addition to the EPC and maintenance costs, ElectraNet estimated additional costs; e.g. connection costs, network studies, registration and knowledge sharing.

4.1.3 Business case

The BESS is the first significant project for ElectraNet that combined a regulated and unregulated investment, but also included a significant ARENA grant. The business case also included aspects such as R&D tax offsets, in-kind contributions and a blended rate of return in recognition of the combined regulated and unregulated investment.

A blended rate marginally higher than the regulated discount rate was used in the final business case. This blended rate satisfied both ARENA as a reasonable rate for the application of Government funds, as well as the ElectraNet Board as a reasonable rate to cover the risk of an unregulated investment.

The basic business case metrics are discussed in Section 4.4.

4.1.4 Required approvals

The Project requested development approval exemption from the SA Government. This request was not granted, and the Project was required to follow normal development approval processes.

4.1.5 Risk allocation

In negotiating the relevant contracts and agreements, the broad principle was followed for ElectraNet to take on the asset risk with AGL wearing the market risk. As part of the Battery Operating Agreement, ElectraNet is guaranteeing a certain level of BESS availability linked with financial penalties should the actual availability be less than the guaranteed value.

To manage this risk, ElectraNet has entered into a twelve-year maintenance agreement with Consolidated Power Projects (CPP), which also includes availability guarantees imposed on CPP – essentially back-to-backing the availability guarantees agreed to with AGL.

4.1.6 ARENA Milestone 1

The Milestone 1 Report required under the Funding Agreement was submitted to ARENA on 30 October 2017, which detailed the status of the Project and included copies of the commercial agreements identified above, approvals and other documentation as required by ARENA as part of the funding agreement.

The Milestone 1 Report was accepted without change indicating that the consortium had achieved Financial Close. The Project was now approved to progress into construction phase and the EPC and maintenance contracts, and battery operating agreement with AGL were executed.

At this time, the Project had in place all the necessary approvals, contracts and funding arrangements in place to commence construction and necessary agreements for commercial operation.

4.2 Chronology of Events (past and estimated future)

The following table provides a breakdown of the basic timetable for various components of the Project, shown in terms of the ARENA funding path, the primary EPC contract, and other significant major Project components.

As this table combines both past and future events, those shaded in grey are indicating estimated time at the point of Financial Close of the Project.

Work stream/ Event	Date
ARENA Funding	
• ARENA Conditional Funding Approval	13 April 2017
• ARENA Funding Agreement Executed	15 August 2017
• Amendment to ARENA Funding Agreement (Funding instalment agreement)	16 October 2017
• ARENA Project Completion Date (following 2 years of operation)	30 September 2020
EPC contract	
• Request for Proposal issued (revised functional specification reflecting updated revenue streams)	30 May 2017
• Request for Tender issued (containing full commercial terms and more detailed functional descriptions)	13 July 2017
• Notice to Proceed - Early works, long lead time items procurement, and design phase	17 August 2017
• EPC contract and Maintenance Service Agreement executed	21 September 2017
• Design work packages progressively completed	October 2017 - December 2017
• Practical Completion	30 April 2018
Battery Operating Agreement executed	21 September 2017
Development Approval received	11 October 2017
Final Investment Decision by ElectraNet Board	October 2017
Complete connection application and a complete market registration application lodged with AEMO	27 April 2018
Undertake Network Studies	September 2017 - March 2018
AEMO to review proposed Generator Performance Standards	March 2018 - April 2018
Energisation of BESS	30 April 2018
Commercial Operation	30 June 2018
BESS commissioning and compliance tests (Completion)	30 June 2018

4.3 Regulatory Treatment

Batteries at transmission level are relatively new in the NEM and as a consequence the regulatory treatment of the Project has presented some challenges. Currently regulatory bodies are still considering the right approach to batteries and how the services they provide are valued and used within the NEM.

In summary, the regulatory treatment for ESCRI-SA is as follows:

- The BESS is 100% owned by ElectraNet
- A proportion of the cost of the BESS is treated as a capital investment relating to prescribed (regulated) transmission services – these prescribed service benefits are estimated in a transparent manner with cost allocation in line with ElectraNet's approved Cost Allocation Methodology (CAM)
- The AER endorsed the amendment of ElectraNet's Network Capability Incentive Parameter Action Plan (NCIPAP) to include the prescribed capital cost component of the ESCRI-SA Project as part of the Network Capability Component (NCC) of the Service Target Performance Incentive Scheme (STPIS)
- The lease payment made by AGL for access to the BESS is treated as non-regulated revenue by ElectraNet – the lease payments will recover the costs of a portion of the BESS that is not used to provide regulated services.
- The remaining capital costs of the Project are being recovered through ARENA grant funding.

This treatment is discussed further in the subsections that follow.

4.3.1 Service classification

The BESS will provide the following prescribed transmission network services, which are described in more detail in Section 5:

- improved connection point reliability in the local network, leading to a reduction in unserved energy
- fast frequency response reducing the number of periods in which the rate of change of frequency (RoCoF) constraint on imports over the Heywood interconnector is binding. This constraint is imposed because of a South Australian Government obligation to maintain expected RoCoF of at or below 3 Hz/s in the event of a non-credible loss of the double circuit Heywood Interconnector.[2] Reducing the periods in which this constraint binds improves transfer capability and reduces generator dispatch costs.

These services directly contribute to the capital expenditure objectives in the National Electricity Rules.

In addition to these prescribed services, the BESS also will provide energy and/or ancillary services on a contestable basis via the wholesale market and the contestable ancillary services market, also described in Section 5. This lowers the costs of the BESS that would need to be recovered from electricity customers via prescribed transmission charges.

ElectraNet will lease operation of the BESS to an unrelated party (AGL) and will play no role in the provision of contestable market services or how the BESS is used to provide those services. This approach is consistent with the current regulatory framework, including the AER's transmission ring-fencing guidelines and the recently updated distribution ring-fencing guidelines.

2 The South Australian Government Gazette, 12 October 2016

AGL is therefore the operator and controller of the BESS and, as such, holds both generator registration under the NER and a generator licence under the SA Electricity Act issued by ESCOSA.

The innovative nature of this Project and its focus on improving network capability is strongly aligned with the purpose and intent of the STPIS NCC.

On 14 July 2017, the AER endorsed the amendment of ElectraNet's NCIPAP under the NCC of the transmission STPIS to include the ESCRI-SA Project. This followed review and acceptance of the Project by AEMO on 6 July 2017.

The economic analysis undertaken in relation to this Project identified the following specific benefits to prescribed customers:

- Reduced unserved energy through improvement in supply reliability to customers supplied from Dalrymple substation (with estimated benefits of $5.3 million)
- Reduced dispatch costs through a reduction in the RoCoF constraint on the Heywood interconnector to benefit customers across the network (with estimated benefits of $8.2 million)

These values were used in the business case described in Section 4.4.1.

Improving the capability of the network in this manner directly targets elements of the transmission system most important to determining spot prices, and at times when users place greatest value on the reliability of the transmission system, consistent with the requirements of the network capability incentive scheme.

As the prescribed capital cost component of this Project ($5.8 million) falls below the $6 million cost threshold relevant for application of the Regulatory Investment Test for Transmission (RIT-T), the level of capital expenditure on this Project is also consistent with the requirements of the NCC.

4.3.2 Cost allocation

ElectraNet is applying its approved CAM to allocate costs between the prescribed services and non-regulated services to be provided by the BESS using a 'direct attribution' approach to allocate the capital costs of the Project to the relevant service categories in the following order:

- Application of full ARENA grant funding (reducing the capital cost);
- Application of other capital cost offsets, including in kind contributions and R&D tax credits (further reducing the capital cost);
- Attribution of the full cost contribution from AGL relating to provision of non-regulated services; and
- Attribution of the remaining capital costs to the provision of prescribed services.

Alternatively, where direct attribution of costs as the preferred method is not possible (which is not the case for the ESCRI-SA Project), the CAM provides for costs to be allocated on a causal basis.

The most appropriate allocator in this case would be the relative benefits to be derived from the provision of the respective prescribed and non-regulated services. This would have resulted in a higher cost allocation to prescribed customers based on the estimated benefits as outlined in Section 4.3.1.

The ongoing operating expenses associated with the BESS will be allocated to the prescribed and non-regulated services in the same proportion as the capital costs under the direct attribution method. The BESS does not trigger the AER's Shared Asset Guideline, as the costs of the asset will be allocated up front between regulated and non-regulated services according to the approved CAM.

The AER endorsed this treatment on 14 July 2017 for the purposes of the BESS Project, while noting this is not considered a precedent for all future projects.

4.3.3 Registration and TUOS charges

At the time of Financial Close there was some uncertainty in the NEM on both the type of registration required under the NER for the BESS, and any resulting Transmission Use of System (TUOS) charges that may apply. These issues were resolved as follows.

TUOS charges

ElectraNet sought an exemption from the AER from TUOS charges being payable for the BESS on the following basis.

AGL is the Registered Participant in relation to the BESS (i.e. AGL is the operator and controller of the BESS) and, as such, AGL is both a Market Generator and a Transmission Customer for the BESS.

The connection agreement between ElectraNet and AGL comprises the following negotiated transmission services:

- shared transmission services of the type described in paragraph (a)(2) of the definition of negotiated transmission service in Chapter 10 of the NER
- a connection service, consisting of both an entry service and an exit service

The connection agreement does not specify an agreed maximum demand in relation to this connection point because the connection agreement will require AGL to only charge the Battery in accordance with the dispatch instructions received from AEMO.

This shared transmission service is not required to meet all the network performance requirements set out in Schedule S5.1 of the Rules. In particular, ElectraNet will not be required to comply with the requirements of clause S5.1.2.2 of Schedule 5.1 of the Rules in relation to the power transfer capability for this connection point when the Battery is charging.

It follows that TUOS will not be payable because:

- the charges for these negotiated transmission services are required to be negotiated in accordance with Part D of Chapter 6A of the Rules and regulated by the relevant connection agreement
- Part J of Chapter 6A of the Rules has no relevance in relation to the services being provided under this connection agreement because none of those services are Prescribed Transmission Services

It also follows that as the BESS is functionally operating as a generator, it would not have firm access rights to the transmission network through jurisdictional reliability standards under the Electricity Transmission Code that require adequate network capacity to be maintained at customer connection points.

The AER accepted the approach of this service being categorised as a negotiated transmission service under the rules and accepted that TUOS will not be payable at this connection point under the rules. However, the AER did not consider this should set a precedent for all future projects.

AGL was appointed and registered as the Generator (in its capacity as Intermediary) to make ElectraNet exempt from the requirement to be registered as a Generator under the NER, in each case pursuant to NER rule 2.9.3.

AGL was registered as the Market Customer for the BESS and connection point.

ESCOSA has separately confirmed with ElectraNet on 12 December 2017 that the reliability standards of the Electricity Transmission Code do not apply to the BESS.

Registration

The BESS was required to be registered as both a Generator and Market Customer under the Rules given the current limitations of AEMO's market systems (scheduled load as well as generator).[3]

It is expected that future changes to the Rules and/or AEMO market systems to facilitate the uptake of batteries, may change this requirement.

4.3.4 Connection to transmission system

The BESS is being physically connected on the 33 kV bus at the Dalrymple substation as the most efficient and reliable connection solution, which is nominally not a transmission voltage. However, this is functionally a connection to the transmission network for all intents and purposes.

With the agreement of SA Power Networks and the AER, AEMO has agreed to progress the connection application as a connection to the transmission network for the purposes of the registration process under the NER.

[3] As outlined under the AEMO 'Guide to Generator Exemptions and Classification of Generating Units' reissued on 7 July 2017.

4.4 Project Business Case

4.4.1 Business case

In Phase 1 of the ESCRI-SA Project, a detailed business case was undertaken for a 10 MW, 20 MWh ESD located at the Dalrymple substation on the Yorke Peninsula. The site was chosen as it has significant local renewable energy generation (Wattle Point Wind Farm) and could provide reliability benefits sited at the end of a radial transmission line.

The asset was defined to leverage revenue across four primary revenue streams, being:

- Market trading essentially through time shifting trading ("arbitrage") and market high events
- An improvement of the Marginal Loss Factor for the Wattle Point Wind Farm
- Improved reliability and reduced Expected Unserved Energy for local customers in the lower Yorke Peninsula – under contingency conditions the Dalrymple substation and downstream load can island, with the ESD expected to cover the islanded load
- Contingency Frequency Control Ancillary Services

An asset with a 10-year operational life starting commercial operations in mid-2017 was targeted. A range of Project sensitivities were also investigated.

The ESD asset was found to be significantly NPV negative. The Project would have required approximately a 63% capital contribution from ARENA or other funding sources to proceed. This amount of ARENA funding was considered excessive and the Consortium was tasked with reducing this funding requirement.

During Phase 2 of the Project, the sizing of the BESS was refined to a 30 MW/ 8 MWh BESS as described in Section 3.3. The Project team identified additional network benefits that provided new revenue streams and the benefits from the existing revenue streams were reviewed and updated. This resulted in revenue streams being:

- Supply of fast frequency response (FFR) to reduce constraints on the Heywood interconnector, resulting in increased flows on the interconnector
- Reduction of Expected Unserved Energy to Dalrymple following loss of supply, involving islanding of the BESS with the local load, the Wattle Point Wind Farm intended to remain in service at reduced output, and local rooftop PV, until grid supply is restored
- Market trading of electricity in the National Electricity Market through the provision of market caps (a market derivative/ insurance product) and Frequency Control Ancillary Services (FCAS) services

The operational life of the BESS was increased by two years to twelve years by increasing the initial installed capacity of the BESS, which was designed to have a specified nameplate capacity available at twelve years, meaning battery degradation was factored in to this lifetime. A twelve-year service maintenance contract was negotiated, to ensure that the BESS had the required technical support for the planned operational life.

The business case was still NPV negative but the required funding from ARENA had substantially reduced from 63% to 40% ($12m). This level of funding was deemed more acceptable by ARENA, with the demonstration value of such a BESS within the NEM the return on these public funds.

The following table demonstrates the basic costs and revenues that were used in the ElectraNet business case for the final decision.

Regulated financials[1]

Benefits to regulated customers exceed costs

Estimated costs and benefits to regulated customers	PV ($m)
Prescribed costs of project (including operating costs)	(6.3)
Benefits of reduced unserved energy	5.3
Benefits of reduced interconnector constraints	8.2
Net benefits to customers	7.2

Capital cost allocation ($m nominal)	Cost allocation[2]
Total capital cost	**30.0**
ARENA grant funding	12.0
Capital cost offsets (in-kind contributions and R&D tax credits)	1.6
Non-regulated component (Battery operator lease)	10.6
Prescribed component	5.8

1. All figures approximate only
2. Direct attribution method applied

4.4.2 Ownership model

In Phase 1 of the Project, a simple ownership structure was conceived where ElectraNet would own the BESS, using the asset for regulated services, and AGL would lease the asset to provide market facing services. There was little detail on this Agreement, and during the Phase 2 negotiations between the parties, significant development was required towards the model outlined in Section 5.3. The technical implications for the asset were also developed to define the Project's Functional Description.

The key challenges during the negotiation process were to agree on risk allocation, annual lease payments and associated availability guarantees. Given the tight timeframes ElectraNet and AGL relied on a good working relationship to progress some of the unclear matters. Some matters were also agreed on in good faith due to the innovative nature of the Project.

4.4.3 Risk management

The risk management plan for the Dalrymple Battery Storage Project was intended to develop and implement a process that would:

- facilitate the identification of Project risks that may affect the Project's ability to reach its objectives
- evaluate the likelihood of occurrence of these risks and potential consequences
- propose and implement mitigation strategies to facilitate either a reduction of the likelihood of occurrence or in the consequences that the risks may have on the Project

As part of the risk management plan, a Risk Register was developed that allows a formal recording and tracking of risks, mitigation and contingency plans. The Risk Register at the time of Financial Close is provided in Appendix A.

The objectives of the risk management approach were to Identify, evaluate, propose and implement mitigative or contingent actions for active risks.

Some of the major Project risks were identified as follows:

- Regulatory treatment
- BESS ability to provide all services committed to
- Delays in achieving generator (BESS) registration
  - NER compliance (GPS / CPS)
  - ESCOSA requirements
  - Office of Technical Regulator requirements
- Development approval timeframes and associated (unknown) requirements; such requirements can cover, but not necessarily be limited to: DPTI requirements (e.g. access roads), Country Fire Services requirements (e.g. fire prevention, containment or extinction)
- Project resources - both before and after contracts execution - may not be available when needed, with impacts for all major Project drivers (technical, quality, costs / variations, time / delays, GPS registration)
- Significant public incident (such as a site fire or localised loss of supply/ generation)
- Challenges with the studies required to simulate BESS operation and support the AEMO registration requirements within the Project timeframes
- Project delivery delays by main EPC contractor

4.5 Environmental (and other) Approvals

ElectraNet unsuccessfully approached the South Australian State Government for an exemption from Development Act for the BESS development at Dalrymple.

It subsequently submitted BESS development approval documentation (Section 49) for assessment for Crown approval in August 2017. The Department of Premier and Cabinet provided support for the Project in accordance with Section 49 of the Development Act 1993. ElectraNet also provided a Certificate of Compliance from the Office of the Technical Regulator for the facility in accordance with the new generator guidelines.

Prior to lodging the Development Application, ElectraNet engaged with stakeholders and adjoining landholders to understand their key issues/ primary concerns (refer Section 4.6). This information, together with internal advice from ElectraNet's land management and environmental specialists, resulted in siting the facility separate from the existing Dalrymple substation to avoid native vegetation clearance and reduce the risk of extended approval timeframes or potentially not obtaining approval.

One representation from an adjoining landowner was received during the public notification period raising concern about land use – did not want the facility built at Dalrymple due to perceived property devaluation, noise and health impacts and bushfire/ fire risk. ElectraNet responded to the State Commission Assessment Panel with supporting information, as had been provided directly to the landowner during consultation. This included provision of fire management plans, confirmation of siting the facility away from nearby dwellings and external colour of the facility to blend with the surrounding environment.

Development approval was granted on 12 October 2017.

Prior to construction commencing, ElectraNet was required to obtain Building Rules Certification in accordance with the Building Code of Australia (BCA). Of particular note in this process was the requirement to obtain endorsement from the SA Country Fire Service's Development Assessment Service. Through this process, ElectraNet sought an *Alternative Solution* to the BCA 2016 Deemed-to-Satisfy Provisions in the form of the Class 8 building being fitted with a fire suppression system and extinguishers and exemption to fire fight with water – no water tank and fire hose reels proposed. This solution was supported.

4.6 Community Consultation

4.6.1 Project communications and community engagement strategy

ElectraNet developed a community consultation plan and initiated consultation/ communication with the local community about the Project. ElectraNet provided responses and, where possible, adapted Project delivery in accordance with feedback received from local community. Based on feedback ElectraNet:

- relocated the BESS facility further north to increase separation distance from nearby dwellings and minimise the removal of trees which resulted in an extended length of underground high voltage cable

- revised the main access route and main road intersection, local to the site, to improve traffic management and to minimise disruption to adjoining land owners

It also engaged with Country Fire Service (CFS), Department of Planning, Transport and Infrastructure (DPTI), Native Vegetation Council, and the local Yorke Peninsula Council. Where possible, Project requirements and delivery approach were adjusted to accommodate the feedback received from these organisations.

4.6.2 Stakeholder issues and interaction log

The following specific issues were raised by stakeholders and addressed during the approvals path for the Project.

Stakeholder	Issue	Mitigation / Response
Adjoining landholder	Concern regarding traffic - use of Antonio Road for construction vehicles and impact of noise, dust on dwellings and condition of road	ElectraNet decision to only use alternative Little Glory Road for all vehicle access both during construction and ongoing operation
Adjoining landholder	Concern regarding land use – does not want facility built at Dalrymple due to perceived property devaluation, noise and health impacts	Specific siting of facility away from dwellings to minimise impacts. Development Application lodged and assessed by State Planning Commission, supported by Yorke Peninsula Council.
	Bushfire and building fire risk	Extensive consultation with SA Country Fire Service regarding building fire safety design. Site and building implemented all conditions and requirements specified by CFS, including 50m vegetation management zone surrounding building. Building Rules Consent obtained, and fire management details provided to State Planning Commission
Department of Planning, Transport and Infrastructure	Upgrade of Yorke Highway / Little Glory Road intersection	Ongoing consultation with DPTI regarding extent of upgrade works required. Concern raised by ElectraNet regarding over-design/ excessive requirements resulting in cost prohibitive works, particularly given lack of maintenance on existing infrastructure and more frequent use of road by non-construction heavy vehicles/ farm machinery.

4.6.3 Community

ElectraNet engaged with the local community through local news articles, public notices, a stall at the Yorke Peninsula Field Days and communication with local neighbours to give them an understanding of the development and operation of the facility and to listen to any feedback they provided.

4.7 BESS Performance Parameters

In Phase 1 of the Project, a high level Functional Specification was written and provided to vendors for initial costing purposes. ElectraNet revised this Specification in Phase 2 by providing more detail on the re-focussed functionality and required duty cycles. This was used as the basis for Request for Proposal assessment and shortlisting of potential EPC contractors prior to the Project reaching Financial Close.

ElectraNet also later developed:

- a Battery Energy Storage System (BESS) Engineering Contract Specification, which provided a more exhaustive scope description, functional requirements and detailed Project delivery requirements. This was used as the basis for the tender assessment (from a technical standpoint) and selection of preferred EPC contractor;
- a telecommunication Engineering Contract Specification - subsequently used for contract award to the preferred telecommunication contractor;
- a Maintenance Service Agreement based on the preferred tenderer's response to the Engineering Contract Specification's requirements for Lifetime Availability and Maintainability
- A detailed control philosophy for operating the BESS to support the implementation of the EPC contractor's detailed design and the development of the Battery Operating Agreement between ElectraNet and AGL

In parallel ElectraNet developed the scope of works for network studies associated with grid connection to allow:

- simulation/ prediction of BESS behaviour under different operating conditions
- development of Generator and Customer Performance Standards

4.8 Procurement & Costs

4.8.1 Tender process

The tender process in Phase 1 of the Project included an Expression of Interest (EOI) to the wider energy storage industry in 2015-16 resulting in a shortlist of 12 potential suppliers, which were included in a select non-binding tender in May 2017. In Phase 2, the 12 offers were reviewed with four suppliers shortlisted based on price and non-price selection criteria assessed by an ElectraNet Buying Team.

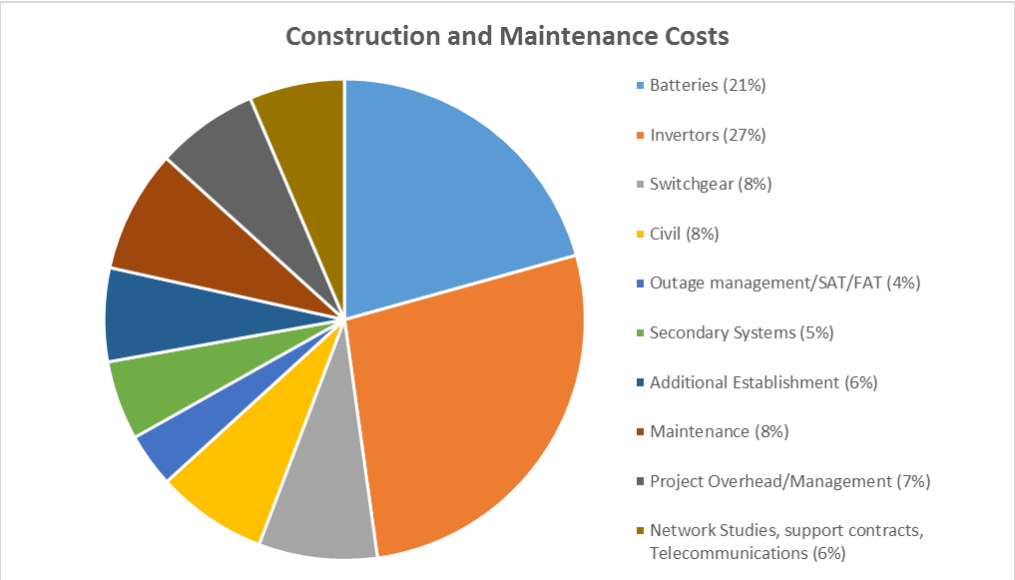
A more comprehensive and binding RFT was issued to the four shortlisted tenderers in mid-July 2017 including the scope of works for the battery facility and twelve-year maintenance requirements. The following selection criteria were established as part of the Buying Team assessment of the final four offers:

- The capacity and commitment to complete and energise the Project as early as possible and/or a target date of 31 December 2017, and otherwise in accordance with ElectraNet's expected programme
- Commercial attractiveness of submission including the whole of life cost structure
- The extent to which a submission demonstrates an understanding of and compliance with the RFT Specifications
- Any additional value provided by the proponent's technical solution and submission which exceeds the RFT Specifications
- The proponent's demonstrated capability to deliver the services required, including relevant experience and provision of suitable referees of similar projects
- Compliance to the terms and conditions of the EPC contract, and terms and conditions of the Maintenance Contract (including in respect of performance and availability guarantees throughout the term), and willingness to align with usual confidentiality privacy, freedom of information and knowledge sharing obligations that may be imposed by a government funding body (including the Australian Renewable Energy Agency) under the terms of any funding arrangements
- Financial standing and stability of the contractor

The Buying Team reviewed tender submissions in accordance with the above selection criteria and recommended that Consolidated Power Projects (CPP) be awarded a design and construct construction contract and a separate twelve-year maintenance agreement.

4.8.2 Total project costs and breakdown

The total construction and maintenance cost of the Project was estimated as $32.0 million, broken down according to the following figure.



4.8.3 Warranties

Warranty for services

The EPC contractor warrants that the Services will:

A) Be performed by the contractor and its personnel that have the necessary experience, skill, knowledge, expertise and competence to undertake the Services and (where appropriate) that hold such licences, permits or registrations or any other authorisations as are required under any State, Territory or Commonwealth legislation or Government regulatory authority to undertake the Services, and who are fit and proper people;

B) be performed in accordance with the contract;

C) be provided with all due care and skill; and

D) conform to any legally applicable standards and legislative requirements and manufacturers guidelines.

Warranty for goods

The EPC contractor warrants:

A) That it will supply goods to the principal manufactured by a third party and do all such things as may be necessary to ensure that such warranties are made available for the benefit of the principal to the extent it is practicable to do so.

B) That clear title in respect of the goods supplied will be passed to the principal on receipt of payment in full and clear funds.

C) Unless otherwise agreed in writing, all goods shall be new.

D) That where the principal expressly makes it known to the contractor the purpose for which the goods are required that the goods shall be fit for that purpose.

E) That where the principal has not expressly or by implication made known to the contractor the purpose for which the goods are required, that the goods shall be fit for the purpose for which the goods would ordinarily be required.

F) That where the goods are to be supplied by description that the goods manufactured will correspond with the description in all respects.

G) That the goods comply with all and any written specification issued by the principal about or in connection with the goods.

H) That the contractor shall supply to the principal, instructions, guidelines, demonstrations, rules and operating manuals relevant to the use of the goods by the principal on or prior to the delivery of the goods to the principal.

I) That the goods, if manufactured by the contractor, shall be manufactured in a manner safe to workers, the general public and the environment, and where not manufactured by the contractor, the contractor shall use its best endeavours to ensure that the manufacturer of those goods complies with this sub-clause.

J) That the goods shall comply with all legislative requirements.

K) That the contractor shall pay all taxes, duties and imposts payable on the manufacture of the goods prior to the transfer of title to the goods to the principal.

4.8.4 Guarantees

The EPC contractor is required to:

- Demonstrate and guarantee that the BESS batteries will not overheat or enter a thermal runaway condition
- Guarantee the maximum useable energy capacity (MWh) and annual availability for each year of the twelve-year operating period. This requirement backs up ElectraNet's obligation under the Battery Operating Agreement with AGL to ensure that the BESS can achieve the Availability Guarantee for the duration of the term
- Guarantee a BESS availability of 96% for each year of operation

4.8.5 Schedule

There was a clear stakeholder expectation to complete the Project as early as possible. To assist with an expedited delivery a single EPC contractor was appointed. Key Project dates are listed in Section 4.2.

4.9 Lessons Learned

4.9.1 Vendor capability

The shortlisted tenderers generally had adequate capability to undertake the design and construction and the associated maintenance services with the following qualifications:

- The expertise in the new technology aspects of BESS were limited to pockets of people within the proponents' teams. It was critical to lock in those key personnel contractually
- The technical solutions offered varied from adapted off-the-shelf to fully customised solutions
- Not all proponents had generator models to suit AEMO requirements
- International tenderers generally lacked demonstrated Australian experience
- Tenderers found the target completion date of 9 months very challenging
- The standard equipment in the balance of plant was well addressed

4.9.2 Technical barriers to deployment

The technical barriers have largely been addressed in getting the Project to financial close.

The key technical challenges included ensuring that the Project meets Generator Performance Standards as part of the connection process, and the implementation of islanding capability with the battery supporting wind and solar generation in meeting local demand when islanded.

ElectraNet has undertaken significant network connection studies and has engaged specialist consultants to assist in determining the effects of the BESS on the local network, wind farm and the transmission network which will be concluded following Financial Close.

Studies include Generator Performance Standards studies, which involve power system simulations using both the PSS/E Power System Simulator and Power System Computer Aided Design (PSCAD) power system modelling software packages (these packages are commonly used in the industry).

4.9.3 Regulatory barriers to deployment

Given the innovative nature of this demonstration Project, ElectraNet engaged early with regulatory bodies to determine an appropriate regulatory treatment. This engagement was quite substantial, but ultimately led to the AER and ESCOSA accepting ElectraNet's proposed regulatory treatment of the BESS under the National Electricity Rules and South Australian Electricity Transmission Code respectively.

However, in accepting the proposed regulatory treatment, the AER did not consider this should necessarily set a precedent for all future projects. More generally, several regulatory treatment issues remain to be resolved for other battery projects.

4.9.4 Preliminary economic modelling

The use of non-firm/ non-binding proposals for preliminary economic modelling is risky especially for new technologies. Future projects should use either binding offers or allow sufficient risk allowance for market modelling of new technologies.

4.9.5 Commercial drivers and business case

Commercial drivers/ Business case and performance requirements for the BESS were not fully understood initially by and between stakeholders, including:

- ARENA
- AGL
- CPP (selected EPC contractor)
- ElectraNet

resulting in continuous review by AGL and ElectraNet to get the Project justified.

Future projects need to:

- Involve finance expertise earlier in the project life to perform financial modelling
- Understand the importance of availability guarantees and factor these into the Engineering Contract Specification. The same applies for energy requirements and auxiliary consumption.
- Focus on the whole of life business case of the BESS not just the construction aspects. In the case of the ESCRI-SA BESS, the maintenance contract is inextricably linked with the business case and directly affects the business case.
- From a contractual negotiation point of view, all contracts need to be negotiated in synchronism, to avoid gaps between contracts and erosion of negotiation power due to various contracts being awarded early without all conditions from other contracts being confirmed.

4.9.6 Team structure

The Project structure was set up to ensure that the right resources were available to enable the Project to be undertaken in an accelerated time frame.

The ESCRI-SA team structure was:

- Executive steering committee
- Responsible Executive Manager directly involved in issue resolution
- Dedicated legal resource
- Project Manager
- Engineering, Procurement, Finance, Land and Regulatory specialists

The higher than normal involvement of Executive management enabled decisions and issue resolution to be dealt quickly and effectively as required.

4.9.7 Contracting and procurement

Ensure all specifications, maintenance requirements and financial arrangements are agreed before Request for Tender process is completed and notification of shortlisting to one contractor is sent to the preferred contractor. This is to ensure competitive tendering pressure and optimal outcomes by preserving negotiating power.

5. Final Project Concept, Delivery & Operational Methodology

The journey undertaken to financial close involved the definition of the Project, Project delivery methodology, constraints in terms of operation and bounds, and the parties involved and how they work together contractually.

The following outlines the final Project concept as envisaged at the time of Financial Close.

5.1 Key Project Objectives

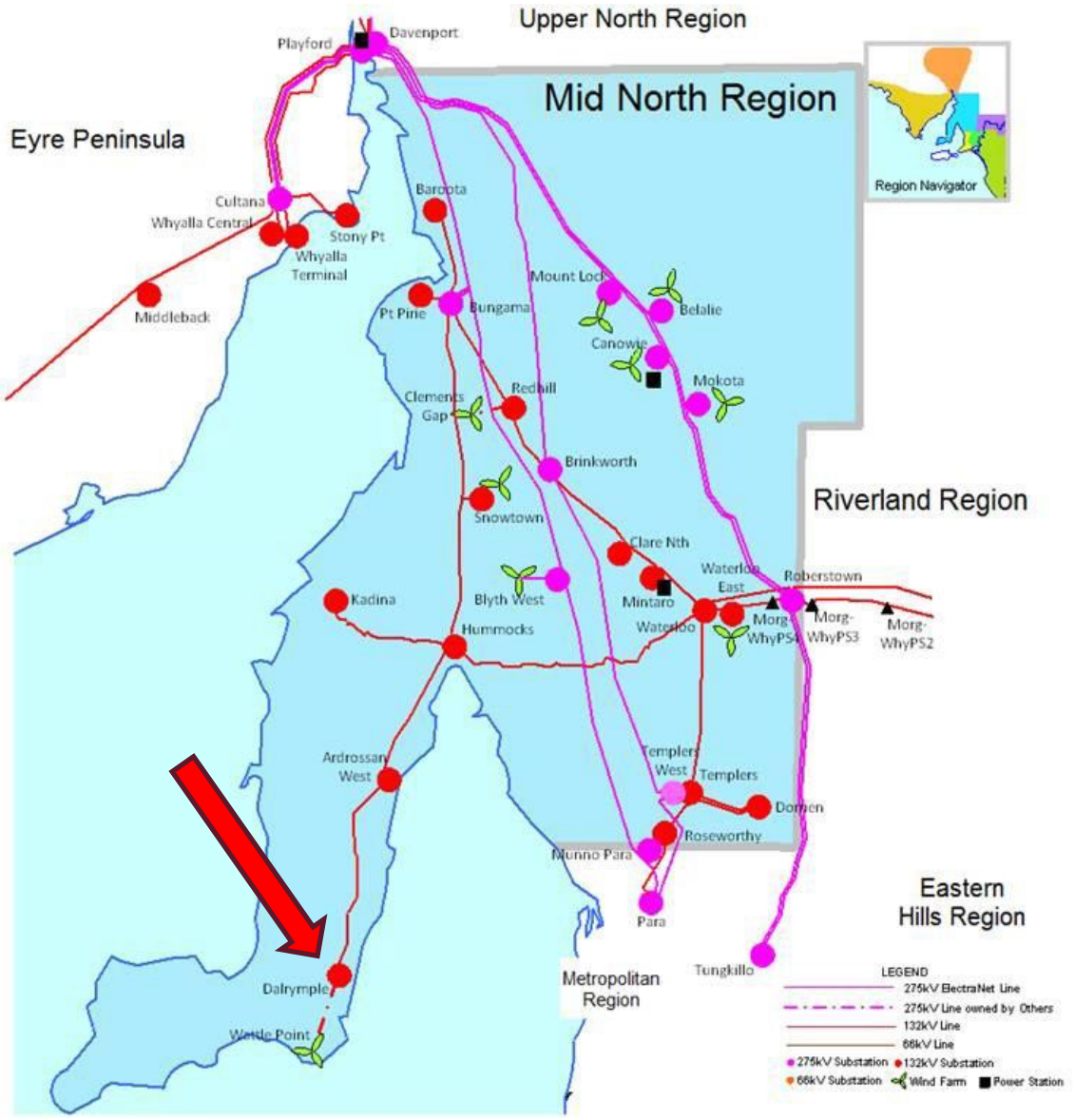
The primary objective of the ESCRI-SA Phase 2 Project is to demonstrate that utility scale energy storage can be a key enabler of large scale intermittent renewable energy on an interconnected power system. This will be done by designing, building and commercially operating a Battery Energy Storage System (BESS) at Dalrymple in South Australia.

The Project is intended, amongst other things, to demonstrate the application of energy storage to providing essential system security services such as fast frequency response (FFR). Such services would enable a higher penetration of renewable energy by allowing more conventional synchronous generation to be displaced by renewable generation while addressing system security risks.

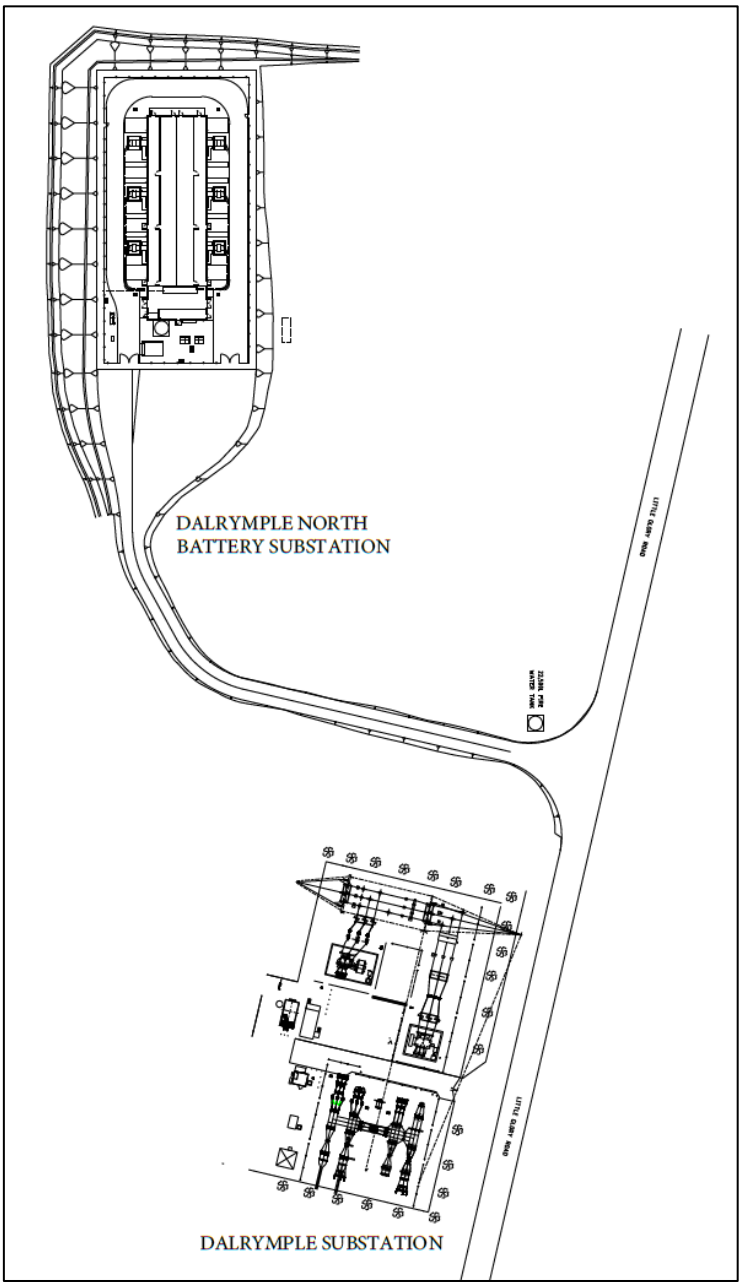
A secondary objective for the Project is to evaluate the operation of a local islanded system where demand is supplied by a local wind farm, with no conventional generation, where regulation services are provided by the BESS. This will lead to learnings that could be applicable at a broader level to a South Australian system with 100% intermittent renewable generation, such as the amount of storage that is needed to manage varying levels of demand and intermittent generation.

5.2 Location

The BESS will be located adjacent to ElectraNet's Dalrymple substation on Yorke Peninsula in South Australia, indicated by the large arrow in the figure below and shown in relation to the transmission system in South Australia.



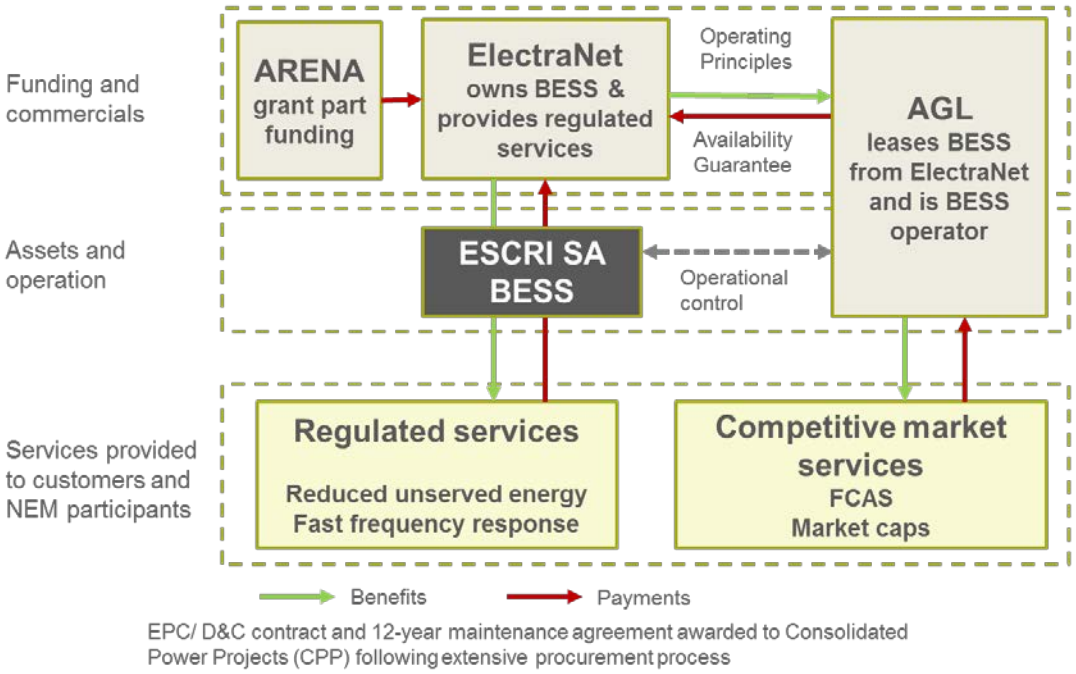
The BESS Project site is adjacent to the existing Dalrymple Substation to which it connects electrically via a 33kV underground cable. The site in relation to the substation is shown in the following figure.



5.3 Ownership & Operations

The figure below shows the funding and commercial model for the BESS over its planned twelve-year operational life.

The BESS will be owned and maintained by ElectraNet, with the operation of the BESS leased to AGL Energy for twelve years. ElectraNet has set up a corresponding contract with Consolidated Power Projects, the primary EPC contractor for maintenance of the BESS for the twelve-year period with an availability guarantee.



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

5.4 Primary Services Provided & BESS Operation

The BESS will provide the following range of primary services:

- Supply of fast frequency response (FFR) to reduce constraints on the Heywood interconnector, resulting in increased flows on the interconnector
- Reduction of expected unserved energy to Dalrymple following loss of supply, involving islanding of the BESS with the local load, the Wattle Point Wind Farm intended to remain in service at reduced output, and local rooftop PV, until grid supply is restored
- Market trading of electricity in the National Electricity Market through the provision of market caps (a market derivative/ insurance product) and Frequency Control Ancillary Services (FCAS) services

These services are described in more detail in the following subsections.

5.4.1 Islanded operation

The BESS will be able to provide islanded grid forming services for the Dalrymple local service area by providing the necessary power system frequency reference and control, and the reactive power necessary to maintain a stable power system voltage.

The power system island will include all loads and rooftop solar PV installations downstream of Dalrymple substation and a portion of Wattle Point Wind Farm.

While in islanded mode, the BESS will provide signals to Wattle Point Wind Farm based on its state of charge to allow the Wattle Point Wind Farm control system to dispatch turbines in order to charge or discharge the BESS as appropriate to maintain generation and demand balance.

5.4.2 Unplanned islanding

A Topology Based Islanding Detection Scheme (TBIPS) provided by ElectraNet and a local on-board vector shift detection scheme will be employed to detect the islanding of the network under unplanned conditions. Once detected, the TBIPS will send the "Island Mode" signal to the BESS.

5.4.3 Planned islanding

Planned islanding will occur when a planned outage of the 132 kV transmission network is required. For such a condition, all the normal processes for planning and co-ordinating such an outage will remain.

Once the planned islanding/ outage is initiated, the BESS will minimise flow across the islanding circuit breakers by controlling output of Wattle Point Wind Farm and then open the relevant circuit breakers.

5.4.4 Resynchronisation of the system

Resynchronisation of the islanded system to the main grid will proceed either automatically or by operator action.

Once voltage is sensed on the other side of the islanding breakers resynchronisation is initiated. Once initiated an automated control system will match the islanded frequency, phase and voltage level with the main system frequency (e.g. via an auto sync relay) by controlling the BESS. Once these parameters are within tolerance the closure of the circuit breaker will be initiated by the control system.

5.4.5 Black start

It is possible that the changeover to an islanded mode could be unsuccessful.

In this event the BESS will be available to black start the island. However, in this circumstance, the Wattle Point Wind Farm would not be connected and would not be able to maintain the charge of the BESS.

This may occur automatically if certain conditions are met or after operator action.

5.4.6 Fast frequency response (FFR)

The BESS will provide fast frequency response, which will result in either:

- Rapid charge of the device or
- Rapid discharge of the device

This will occur in response to a rapid change in power system frequency (RoCoF)[4] measured at the local AC busses of the inverters. This functionality is inherently always active and ready to provide immediate FFR response.

[4] The intent of this service is to mimic the inertial response provided by rotating synchronous generators.

The device will vary its reactive power output accordingly to maintain control of the power system voltage during large and rapidly changing power flows.

The frequency response will be maintained as long as the rate of change in frequency condition is present or the battery becomes either fully charged or discharged.

There are no State of Charge (SOC) limitations in this service.

5.4.7 Network support – System Integrity Protection Scheme (SIPS)[5]

The BESS will provide real power response as part of the SIPS, which will result in either:

- Rapid charge of the device (may be implemented at a later stage) or
- Rapid discharge of the device (expected for the initial stage of the SIPS)

in response to digital signals provided by ElectraNet (via the SIPS scheme)[6].

The BESS will vary its reactive power output accordingly to maintain control of the power system voltage during large and rapidly changing power flows.

The real power response will be maintained until a stop signal is received, or the battery becomes either fully charged or discharged. There are no SOC limitations in this service.

5.4.8 Contingency FCAS[7]

The BESS will provide contingency FCAS, which will result in either:

- Ramped charging of the device or
- Ramped discharging of the device

in response to a change in power system frequency by utilising a primary frequency droop type characteristic[8]. The BESS power response magnitude and duration will also be adjusted (via the secondary control of <1 sec) in accordance with BESS operator FCAS market bids (raise/ lower and duration).

The device will vary its reactive power output accordingly to maintain control of the power system voltage during large and rapidly changing power flows.

---

5 This response is an extension of the FFR response where the SIPS is intended to provide fast action within South Australia to prevent a SA system separation from the NEM

6 The non-credible loss of multiple generating units in South Australia, at times of high import from Victoria into South Australia, can lead to extreme flows on the Heywood interconnector, resulting in a loss of synchronism between South Australia and the rest of the NEM, and a trip of the Heywood Interconnector by protection designed to detect this loss of synchronism. The scheme is designed to rapidly identify conditions that could result in a loss of synchronism and correct those conditions by rapidly injecting power or shedding load in South Australia to ultimately avoid this loss of synchronism.

7 The intent of this service is to mimic the governor and re-dispatch response currently provided by rotating synchronous generators and hence service the 6 second, 1 minute and/or five minute FCAS contingency services.

8 The BESS will only transiently respond to frequency events on the grid (driven by the primary inertial and governor response of the BESS), but the output will soon after be controlled to zero by the secondary control.

The response will be maintained as long as the under frequency or over frequency condition is present and the bid response time or the battery charge reaches any SOC limit.

5.4.9 External set point mode

The BESS will charge or discharge in accordance with external real and reactive power set point signals. Note: The reactive power set point is not relevant if the BESS is in voltage control mode.

The BESS operator (AGL) will use the BESS for cap-trading and/ or arbitrage in this mode and provide the external real and reactive power set point signals.

There are SOC limitations on the cap-trading and/or arbitrage service.

5.4.10 Voltage and reactive power regulation

Regardless of whether the BESS is charging or discharging, it will provide reactive power support to the network in order to inherently maintain and control power system voltage to a set point via a voltage droop characteristic or control the power factor (if the power factor regulation mode is selected). ElectraNet/ AEMO will be able to change the voltage set point via SCADA. The AGL control room will be informed should any voltage set point change be made.

It is envisaged that the BESS will normally be set in voltage control mode.

5.4.11 Power factor regulation

As an alternative to voltage regulation, the BESS can be run in power factor regulation mode. ElectraNet/ AEMO will be able to switch the BESS to power factor control and provide/ change a power factor set point via SCADA.

5.4.12 Fault current support

In the event of a power system fault, the BESS will dispatch reactive power to attempt to maintain the power system voltage.

Although this service is described separately from the voltage regulation service it is delivered by the same physical processes and control system.

5.4.13 Control mode priority

The various control modes will have a priority order as listed in the table below.

Priority based Services		Inherent Services	
		ID	Description of Service
1	**Islanded Operation**	**A**	**Voltage Control** **Frequency Control** **Fault Current Support**
	Grid Connected modes below	**B**	**(Voltage Control** **or** **Power Factor Control)** **Fast Frequency Response** **Fault Current Support**
2	**Network Support - SIPS**		
3	**Contingency FCAS services**		
4	**External set point mode (P & Q)** **(Energy Trading Modes)** **Market Trading**		

5.4.14 Wattle Point Wind Farm (WPWF) interaction

The following provides information on Wattle Point Wind Farm interaction with the BESS both in islanded and grid connected modes.

Voltage control

The reactive power control performed by the BESS control system will not be extended to WPWF, given that WPWF has local voltage/ power factor control facilities. When islanded the BESS will serve as a voltage reference to the loads and WPWF connected via the Dalrymple-WPWF transmission line.

Wind farm control when islanding

The BESS will form the island and become the frequency reference and maintain voltage without any loss of load at Dalrymple.

Four out of five collector groups at WPWF will be tripped on an unplanned transition to island. As all are below the 25 MW instantaneous figure, no single group on its own will exceed the BESS rating.

5.4.15 Wind farm control when islanded

The BESS will provide the following services:

- Voltage Control
- Frequency Control
- Fault Current Support
- WPWF set point control

BESS as primary control

The BESS will reduce the active power limit to WPWF to the aggregate of the SA Power Networks 33 kV load plus 7.5 MW. This also occurs in the event of a planned transition to island.

The limit may be a smaller value if the SOC of the batteries is so high that the ability of the BESS to charge is limited. The ability to charge is defined by a SOC percentage versus wind farm MW output curve.

Wind farm signals

The BESS controller that will interface with the WPWF via the AGL SCADA interface will be receiving measurements of active and reactive power from the WPWF. It will send an active power limit back to WPWF via SCADA. The magnitude of the power limit will depend on the state of the system.

BESS protection

ElectraNet is implementing a fast-acting TBIDS on the protection system level that will open relevant circuit breakers in the Dalrymple substation on detection of islanding upstream from and including Dalrymple.

The BESS will detect an islanding state either from the statuses of the local circuit breakers (and using vector shift arrangement), or receive an input from TBIDS.

In addition to opening of circuit breakers at Dalrymple, the TBIDS will issue direct transfer trip (DTT) commands to WPWF Collector group circuit breakers. Appropriate action will be taken by protective devices on the WPWF side to ensure that there will be no excess generation in the islanded system.

5.4.16 Management of BESS battery charge

State of charge requirements

In the event of a loss of supply to Dalrymple, the BESS will be operated to provide supply demand balance (and voltage and frequency regulation services) for the islanded load and a portion of Wattle Point Wind Farm.

Prior to the islanding event, the BESS will be partially charged so that it has sufficient headroom and floor-room to enable the generation at the wind farm and the local load to be matched as closely as possible after a seamless transfer. These limits/ requirements are shown in the table below.

Level of charge	With wind farm coordination	Without wind farm coordination
Max allowable level of charge for non-regulated Services	X – 0.8 MWh	X
Min allowable level of charge for non-regulated Services	0.8 MWh	4.8 MWh

Availability parameters

The maximum usable energy capacity at beginning of life is 12.6 MWh with the guaranteed maximum usable energy capacity at the end of each year shown in the table below.

Parameter	Target (All figures are at 33 kV connection point)												
Power output	The full system continuous rated power output (30 MW) (bi directional)												
Maximum usable energy capacity	Year	1	2	3	4	5	6	7	8	9	10	11	12
	MWh at end of Year	12.2	11.7	11.3	10.9	10.5	10.2	9.9	9.5	9.2	8.9	8.6	8.3

The guaranteed availability is 96% measured on an annual basis.

Measurement of state of charge

The measurement and indication of the BESS battery charging level is of critical importance. The BESS will provide indication of both the available MWh DC battery charge as well as useable MWh BESS charge at the 33 kV connection point (AC). The 33 kV AC charge values will be calibrated at least annually by comparing the indicated values to actual discharges or tests.

BESS charging rates

An AGL algorithm will provide set points to the BESS so that:

- the BESS is charged at no more than 30 MW for no more than 35 cycles per Contract Year
- the BESS is charged at no more than 7.5 MW for the remainder of cycles in any Contract Year

Cycle counts

A cycle means the discharge of the Facility (whole BESS) of more than 2.4 MWh that passes through a state of charge (SoC) of 2.4 MWh. Cycles are counted in both grid connected and islanded modes.

An annual cycle limit of 250 cycles applies.

Wind farm out of service

AGL shall use its best endeavours, but no longer than 12 hours to ensure the BESS is charged to at least 4.8 MWh from when the wind farm is out of service or otherwise cannot coordinate with the BESS.

5.5 Project Staging

The EPC contract was signed on 21 September 2017 between ElectraNet and CPP for a two stage delivery model of the Dalrymple BESS that aligned with the ARENA Funding Agreement Milestones 2 and 3.

Stage 1 (Milestone 2) Energisation of the Battery Energy Storage System requires that all site works are complete, the BESS can import/ export energy and support local Dalrymple load without WPWF integration achieved. The original target date for this Milestone of 28 February 2018, was amended in agreement with ARENA and achieved on 30 April 2018.

Stage 2 (Milestone 3) Commissioning of the Battery Energy Storage System requires all works to be completed other than integrated operation of the BESS and WPWF under islanded condition. The original target date for this Milestone of 30 April 2018, is currently forecast for 16 June 2018.

5.6 Project Delivery Model

The BESS Project will be delivered using the following major contracts using a lump sum EPC arrangement.

A) Engineer, Procure, Construct contract for the detailed design, construction and commissioning of the facility with the following contractors.

Main contractor

- Consolidated Power Projects Australia Pty Ltd (CPP)

Sub-contractors

- ABB Australia Pty Limited
- Samsung SDI

B) A Battery Operating Agreement (BOA) between ElectraNet and AGL (effectively a Lease) for AGL to operate the BESS to provide competitive market service.

The major work packages required for the Dalrymple BESS deployment include:

a) Engineer, Procure and Construct (EPC) works – covering the design, procurement, delivery, installation, testing and commissioning of the BESS (works awarded to CPP, following a competitive tendering process);

b) Preparation of Generator Performance Standards (GPS) as required for BESS registration and generation licence (works assigned to FortEng following a competitive selection process);

c) Connection of the BESS to 33 kV connection point on the SA Power Networks side of the Dalrymple substation (works undertaken by SA Power Networks for its assets);

d) Establishment of telecommunication infrastructure necessary for the integration of the BESS in the larger ElectraNet telecommunication network, as well as establishment of telecommunication links between the BESS and the Wattle Point Wind Farm (works performed by Telstra – strategic ElectraNet business partner, with the Dalrymple works integrated in larger OneIP telecommunication upgrades performed by ElectraNet in its telecommunication network);

e) Undertaking BESS on-load tests, including islanding and combined operation with Wattle Point Wind Farm.

5.7 Risk Assessment and Treatment

The Risk Register for the Project at Financial Close (31 October 2017) is provided in Appendix 1.

Key stakeholders for the Project delivery and commissioning include the following.

Stakeholder	Stakeholder's Interest	Stakeholder's Expectation
Australian Energy Market Operator (AEMO)	• Regulatory Body • Market operator	• Scope is well defined by the Project team; • Deliverable milestones are met; • Project issues and risks are communicated to in a timely fashion; • Good communication and cooperation with ElectraNet Project team. • Project meets its network support commitments. • Knowledge Sharing Reference Group member
Australian Energy Regulator (AER)	• Regulatory Body	• Prudent investment is observed; • Project meets its network support commitments. • Knowledge Sharing Reference Group member

Stakeholder	Stakeholder's Interest	Stakeholder's Expectation
AGL	• Project Partner • Project Organization, Planning, Delivery and operation • BESS market operator	• Scope is well defined by the Project team; • Deliverables and Project milestones are achieved; • AGL anticipated revenue is achieved; • Planned BESS and Wattle Point interaction (including under islanded condition) is achieved. • Knowledge Sharing Reference Group member
ARENA	• Project Funding partner • Project Organisation, Planning and Delivery • Knowledge Sharing	• Scope is well defined by the Project team • Deliverables and Project milestones are achieved • Project can be used for observing batteries interaction with the network and facilitates integration of renewable resources into the NEM • AGL anticipated revenue is achieved • Planned BESS and Wattle Point interaction (including under islanded condition) is achieved • Knowledge sharing process followed. • Knowledge Sharing Reference Group member
ESCOSA	• Regulatory Body	• Scope is well defined by the Project team; • Open communication and cooperation with ElectraNet and AGL Project team • Generation Performance Standard (GPS) and R2 Compliance testing results • Generation registration
CPP	• Principle construction contractor • Maintenance Service provider	• Scope is well defined by the Project team • Contracts terms and conditions agreed for construction and 12 maintenance programme • Clear line of communication established
ABB	• Construction partner • BESS controller designer and supplier	• Scope is well defined by the Project team • Clear line of communication established
Samsung	• Construction partner • Battery supplier	• Scope is well defined by the Project team • Clear line of communication established
FortEng	• PSS/E and GPS modeller • GPS and R2 compliance tester	• Scope is well defined by the Project team • Clear line of communication established

Stakeholder	Stakeholder's Interest	Stakeholder's Expectation
Electranix	• PSCAD modeller	• Scope is well defined by the Project team • Clear line of communication established
South Australian Power Networks	• Construction Partner	• Scope is well defined by the Project team; • Contracts for works agreed and issued • Clear line of communication established
Neighbours and local community	• Local beneficiary and community interest	• Consulted throughout initial planning, construction and operation phases • Benefits of the Dalrymple Energy Storage System communicated including islanding ability of BESS
Yorke Peninsula Council	• Local Council	• Consulted during initial planning phase and notified about any material deviation to the Development Approval
SA Government	• BESS performance • Project learnings	• Scope is well defined by the Project team; • Open communication and cooperation with ElectraNet and AGL Project team • Knowledge Sharing Reference Group member
Federal Government	• BESS performance • Project learnings	• Managed will ARENA, and consulted during initial planning, approval and construction phases. • Knowledge Sharing Reference Group member
Advisian	• Project Partner • Knowledge Sharing Partner	• Part of Project team • Lead for Knowledge sharing activities
Knowledge Sharing Reference Group (KSRG)	• BESS performance • Project learnings	• Shared Project learning at KSRG meetings, one held during construction, one after commissioning and at meetings held at six monthly intervals for two years post commissioning. • Two technical site visits, one during construction and one after commissioning
Media outlets	• General Project updates • Achievement of Project milestones	• Provided with information relating to the Project via media releases • Responses provided to questions about the Project when requested • When/where appropriate, provided with site access and talent for visual content

6. About the Project Parties & Project Contact Details

ElectraNet	ElectraNet powers people's lives by delivering safe, affordable and reliable solutions to power homes, businesses and the economy. As South Australia's principal Transmission Network Service Provider (TNSP), we are a critical part of the electricity supply chain. We build, own, operate and maintain high-voltage electricity assets, which move energy from traditional and renewable energy generators in South Australia and interstate to large load customers and the lower voltage distribution network. ElectraNet will own and maintain the 30 MW 8 MWh battery, which will provide both regulated network services and competitive market services.
agl	AGL operates the country's largest electricity generation portfolio and is its largest ASX-listed investor in renewable energy. Our diverse power generation portfolio includes base, peaking and intermediate generation plants, spread across traditional thermal generation, natural gas and storage, as well as renewable sources including hydro, wind, landfill gas, solar and biomass. When complete, AGL will operate the battery to provide competitive market services.
Advisian WorleyParsons Group	Advisian is the advisory and specialist consulting arm of WorleyParsons, who have been involved with the ESCRI-SA Project since its inception in 2013. Advisian provided significant input into the technical, procurement and Project management components of Phase 1. In Phase 2, Advisian is the Knowledge Sharing Partner for the Project.

For more information on the Project, please log into the ESCRI-SA Project Portal located at the following address: www.escri-sa.com.au.

This Portal contains a range of information relevant to the Project, including:

- Access to live and historical data from the operational BESS
- Images of the Project construction and operation
- All publicly published Knowledge Sharing material, including key reports, operational updates and presentations
- Information from the ESCRI-SA Knowledge Sharing Reference Group, which has been formed to share information about the Project, to discuss issues relevant to large scale batteries in the NEM, and to inform key stakeholders
- The ability to ask questions of the Project team through an on-line Q&A process

Appendices

Appendix A BESS Project Risk Register (as at Financial Close)

BESS Project Risk Register
Project whole-of-life costs (including O&M components) may exceed initial estimates
Project revenue may be insufficient/ may not cover Project costs
Project resources - both before and after contract execution - may not be available when needed, with impacts for all major Project drivers (technical, quality, costs variations, time delays, GPS registration)
Project may require additional regulatory approvals (e.g. RIT-T)
Delays or inability to achieve generator (BESS) registration - NER compliance (GPS / CPS); - ESCOSA requirements; - Office of Technical Regulator requirements
Regulatory classification of various assets, including confirmation of Connecting Party, connection point, connection assets, transmission network connection point, with direct impact on assets ownership and various associated commercial/ legal agreements
Assignment of works for connection assets (possibly to SAPN) will affect the Project cost and may subject the Project to delays should the connection assets not be ready for operation when BESS would be ready for energisation
BESS operation under islanded conditions
Insufficient or no experience with certain works/ lack of necessary skills (e.g. batteries, inverters)
Project delivery delays by main EPC contractor
Delivery delays by contractor selected to deliver the connection assets
Inability to integrate the Wattle Point Wind Farm to provide seamless transition / operation under islanded conditions
Unclear knowledge sharing requirements by ARENA, with potential time and cost implications (possibly IP/ confidentiality requirements)
Development approval timeframes - if delays would be incurred, that will affect the main EPC contract
Gaps between the EPC contract (and associated performance guarantees by EPC supplier - for the duration of the BESS design life) and the AGL lease contract - with potential financial consequences for ElectraNet
BESS ability to provide all services committed to by ElectraNet

BESS Project Risk Register
Telco infrastructure requirements - for modified/ existing control schemes and interfacing with the Wattle Point Wind Farm
Failure to identify or implement necessary functionality for BESS protection and control schemes/ control philosophy
Delays in finalising commercial agreement with SAPN or inability to finalise commercial agreement with SA Power Networks
Delays or inability to agree changes to the Wattle Point Wind Farm GPS - may affect the ability to prove combined BESS/ Wattle Point Wind Farm operation under islanded conditions
EPC OEM supplier may default after BESS goes into operation
GPS studies - arrangements and resources
Project learnings are considered inadequate or irrelevant
Significant public incident (such as a site fire or localised loss of supply/ generation).
Stringent environmental conditions imposed as conditions for Project site works
Community rejection of the Project
Spillage of chemicals from the batteries either during delivery, installation, commissioning or operation of the BESS
Failure to meet Environmental Conditions of Approvals
Significant Contractual dispute with EPC contractor
Breach of ARENA Funding Agreement
Necessary regulatory approvals not received
Implementation of new technology - the installation of the BESS requires the implementation of a new technology for ElectraNet. The associated design requirements are to some extent unknown for ElectraNet and carry additional risk.
Foreign exchange variations - may affect the value of the equipment to be bought from overseas suppliers
Rock found at BESS site - additional funds may be required for rock removal to allow site establishment
Groundwater may cause delays and extra costs

ElectraNet Pty Limited
PO Box 7096, Hutt Street Post Office
Adelaide, South Australia 5000
P+61 8 8404 7966 or 1800 243 853 (Toll Free)
F+61 8 8404 7956 **W** electranet.com.au
ABN 41 094 482 416 **ACN** 094 482 416