Broken Hill Battery Energy Storage System

Lessons Learnt Report #1

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The purpose of this document is to provide details on the lessons learnt during the System Strength Modelling of the Broken Hill Battery Energy Storage Project.

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Australian Government
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Acronyms and Abbreviations

Acronym/abbreviation	Definition
AEMO	Australian Energy Market Operator
AGL	Australian Gas Light Company
ARENA	Australian Renewable Energy Agency
BESS	Battery Energy System
BHBESS	Broken Hill Battery Energy Storage System
DF	Damping Factor
DPE	Department of Planning and Environment
EMT	Electromagnetic Transients
FRT	Fault Ride Through
FRNSW	Fire and Rescue New South Wales
GPS	Generator performance Standards
HiL	Hardware in the Loop
Hz	Hertz
IC	Inertia Constant
I/O	Input / Output
IP	Intellectual Property
IBR	Inverter Based Resources
kV	Kilovolt
km	Kilometre
MWh	Megawatt hour
MW	Megawatts
NEM	National Electricity Market

Acronym/abbreviation	Definition
NER	National Electricity Rules
OEM	Original Equipment Manufacturer
p.u.	Per Unit
POC	Point of Connection
PPC	Power Point Controller
PFR	Primary Frequency Response
PI	Proportional Integral
RoCoF	Rate of Change of Frequency
SCR	Short Circuit Ratio
SMIB	Single Machine Infinite Bus
SVC	Static Var Compensator
TRC	Transient Reactive Current
TNSP	Transmission Network Service Provider
UNSW	University of New South Wales
VBB	Victorian Big Battery

Executive Summary

Broken Hill Battery Energy Storage System (BESS), developed by AGL is a 50MW/ 50MWh large scale battery storage system located 200m from Transgrid's Broken Hill substation in New South Wales.

The performance of the plant will be verified through an agreed Testing Plan. The Testing Plan will be developed in consultation with Transgrid and AEMO and is expected to include a combination of power system studies, commissioning tests, and ongoing performance monitoring. The findings of the Testing Plan and any other key learnings will be disseminated though knowledge sharing outputs in the form of knowledge sharing reports.

This report specifically addresses lessons learnt in the connection application process of the Broken Hill Battery Energy Storage System and the approach to design and construction for a grid-forming inverter plant compared to traditional grid-following plants.

1. Project Details

1.1. Project Overview

There has been apprehension across the National Electricity Market (NEM) about how the changing nature of generating plant from traditional rotating machines to inverter-based resources may alter the dynamic behaviour of the grid.

System Strength is a term used to describe how impervious the voltage is to alteration of the 50Hz sinusoidal waveform. Large rotating generators are able to dominate the local voltage and subsume aberrant waveforms. The previous generation of inverters have been current source inverters which have filtering to supress the inherent higher order harmonics but otherwise, are not intended to optimise the voltage waveform.

In 2016, an outage of the Buronga to Redcliffs 220kV line resulted in Broken Hill being at the end of a single 700km circuit and electrically remote from stronger part of the grid. In this weak grid environment, sub-synchronous oscillations of around 7Hz between the Broken Hill solar farm and the SVCs at the Broken Hill substation reached a magnitude of 4.5% of the fundamental frequency.

Uncertainty of what the implications were of sub-synchronous oscillations in electrically remote locations led Australian Energy market operator (AEMO) to limit generation from solar farms in the "Western Murray" area including Broken Hill for many months. Many studies and physical tests were performed on the Western Murray region with the issue eventually being resolved by relaxing Generator Performance Standards (GPS) with less aggressive settings for the solar farm inverters in that area. A BESS is not necessary at Broken Hill to address any current sub-standard performance. The area is however still an extreme example of a weak part of the grid, and an ideal location to investigate the potential for a voltage source/grid forming inverter to mitigate sub-synchronous oscillations.

ARENA has supported a proposal to evaluate the potential for a battery with a voltage source inverter emulating the characteristics of synchronous generator to mitigate the effects of low system strength. As a consequence, a 50MW battery with a Grid-Forming inverter is being constructed at Broken Hill.

1.2. Project Objectives

The project objectives are to evaluate the ability of a Grid-Forming battery to provide system strength characteristics by:

- Computer modelling of the behaviour of a Grid-Forming inverter in an area of weak system strength such as Broken Hill.
- Studying the behaviour of the Grid-Forming inverter on a real-time test bench.
- Monitoring the behaviour of the Grid-Forming inverter when installed at Broken Hill.
- Confirming that a Grid -Forming inverter can both avoid contributing to the symptoms of poor system strength and potentially compensate for non-grid forming inverters.
- Identifying obstacles to connecting Grid-Forming inverters to the NEM.

2. Lessons learnt

2.1. Modelling and Testing conducted

The following are the lessons learnt from the modelling and testing phase.

2.1.1. Need for Updated processes and tests

As AGL progressed through the connection application process for the Broken Hill Battery Energy Storage System, it became clear that current processes and tests were not suitable for assessing advanced grid-forming inverter-based resources (IBRs) and their impact on grids. Existing processes are primarily geared towards traditional/conventional generator technologies (e.g. thermal) and tests have been defined accordingly. These tests have been adapted to include IBRs at a time when IBR penetration to the grid was low, rather than being built up for IBR-dominated grids.

New processes and tests need to be defined and agreed in order to consider recent issues related to the integration of IBRs. One example experienced during the connection application process was the demonstration of system strength capabilities (e.g., damping of oscillations and fault current contribution) of the Broken Hill Battery Energy Storage System.

Real-time digital simulation testing offers additional features compared to conventional offline EMT simulations. By including hardware-in-the-loop (HiL) testing, it is possible to validate the performance of actual controllers, protection relays, or even power electronics converters. In the case of the Broken Hill Battery Energy Storage System, the grid and power electronics converters were simulated in the real-time EMT simulator while the actual controller was interfaced via analogue/digital I/Os. This enabled testing of the grid-forming control hardware, its capabilities and its positive impact on the grid.

When considering future higher penetration of IBRs, additional tests should also support the evaluation of site-specific capabilities of a grid-forming IBR. Emerging analysis such as impedance-based methods can help to:

- study the dynamic interaction between the grid and IBRs,

- analyse control interactions among IBRs,
- investigate the damping of local and wide-area oscillation modes,
- evaluate the wide frequency range response of the IBR and the grid.

To assess the overall stability of the grid in the long-term and not only when commissioning the new project, the connection application process should also include tests evaluating future scenarios.

2.1.2. Network Modelling and Quality of Models and Information

During feasibility studies, including the demonstration of system strength capabilities, there were numerous unresolved questions regarding the modelling approach and data sources. The primary ones were:

a) **Model and data availability:** Access to models and data may be limited, restricted (owned by third parties), or even completely unavailable. Furthermore, this information may not be current, affecting the model's quality and, consequently, the obtained results and conclusions.

b) **Equivalent network model:** Traditionally, single-machine-infinite-bus (SMIB) equivalent models were considered adequate for testing the performance of a new generator connection. However, as the generation pool diversifies and new grid issues emerge, broader areas need to be modelled in detail.

To address these challenges, several meetings were held to agree on modelling assumptions and data. Additionally, a Working Group, including AEMO and Transgrid, was established to further validate the methodology, assumptions, models, results, and conclusions. In particular, related to aforementioned points **a)** and **b)**:

- Confidential agreements were signed in order to gain access to certain information. Adaptations were made to improve the quality of the models and reflect ongoing changes in the grid.
- Detailed models were adapted and expanded to create power system models equivalent to those used by AEMO when assessing connection applications. Furthermore, real-time EMT digital simulators were considered as the modelling and simulation platform mainly

because of their capability to perform HiL testing, allowing to expand and cross validate results when integrating the actual Original Equipment Manufacturer (OEM) controller.

2.2. Early Education on New Technologies

At the commencement of the project, multiple briefings were held to set the main specifications of grid-forming (GFM) inverters, their capabilities, and their main differences to grid-following (GFL) inverters. Future discussions on the Broken Hill Battery Energy Storage System were tied back to these meetings for context.

During this process, it was identified that the operation of an inverter in GFM mode enables it to actively participate in voltage and frequency regulation, providing necessary grid-supporting services in response to changes in the external grid. Additional functionalities and services that can be provided by GFM inverters include provision of synthetic inertia, mitigation of sub-synchronous oscillations, enhancement of system strength as well as increased hosting capacity of renewable generation.

Power-synchronization loops are used in GFM inverters to generate an internal voltage phasor, while GFL inverters rely on phase-locked loops (PLLs) to passively synchronize with the external grid. This key difference allows GFM inverters to flexibly switch between grid-connected or standalone modes and provide voltage references to facilitate the integration of other GFL inverters.

Reaching consensus on the definition and the main characteristics of a grid-forming inverter is crucial for facilitating the future integration of IBRs. This understanding will inform and aid industry dialogue on the topic. Furthermore, similar discussions should be held in order to educate the industry on any other new or emerging technology.

2.3. Grid Connection Approval Process

After submitting the application package, AEMO and Transgrid provided initial feedback on the package. Following several rounds of discussions, particularly focusing on plant performance during Fault Ride-Through (FRT) and frequency disturbance events, certain changes were implemented to enhance the plant's responses and ensure compliance with GPS requirements.

These changes included modifying the location of the power point controller (PPC) fault ride through (FRT) measurement, retuning virtual inertia and damping factor parameters, which resulted in improved plant responses. To facilitate the acceptance and approval of the connection application, meetings were held between AGL/Aurecon/OEM and the teams from AEMO and Transgrid. These meetings aimed to address the questions raised in the project issues tracker and provide explanations regarding inverter response in specific circumstances.

It was observed that conducting weekly meetings with AEMO and Transgrid proved beneficial for all parties involved, as it facilitated a better understanding of the project's progress. Additionally, the engagement between the OEM and Transgrid, as well as AEMO, demonstrated that establishing appropriate channels of communication could expedite the overall process.

Further, having biweekly meetings with the OEM to monitor the progress of resolving model issues has been beneficial in addressing any model-related issues discovered during standard grid connection studies or due diligence studies conducted by AEMO and Transgrid. During these meetings, all the identified model issues would be discussed, and the progress made on each issue would be reviewed. The team members from AEMO, Transgrid, and the OEM would provide their feedback on each issue and work collaboratively to find resolutions.

These meetings serve multiple purposes. Firstly, they ensure that all model issues are being actively addressed and progress is being made towards resolving them. Secondly, they provide a platform for discussing and sharing feedback on each specific issue. This collaborative approach helps in finding effective solutions and streamlining the resolution process. Furthermore, having these regular meetings helps in prioritizing the model issues. By discussing and evaluating each issue collectively, the team can identify which issues require immediate attention and should be addressed first. This ensures that everyone involved is aware of the priorities and can focus their efforts accordingly. Overall, the biweekly meetings with the OEM serve as a valuable mechanism to track the progress of resolving model issues, gather feedback from all team members, and prioritize the resolution of these issues.

To submit the connection application and obtain the necessary documents such as the 5.3.4A letter and R1 package[1] for generator registration, it is crucial for the proponent to acquire critical documents outlined in various checklists and guidelines published by AEMO. These documents include the connection application checklist, R1 submission checklist, power system mode guidelines, communication failure guidelines, and dynamic model acceptance guidelines.

Since many of these documents are related to the OEM, it is recommended to request the OEM to provide them in advance or as soon as possible, preferably before submitting the connection application package. By obtaining these documents from the OEM beforehand, it can help expedite the connection application process and avoid unnecessary queries from AEMO and Transgrid regarding the availability of these documents. It is important to note that certain documents, such as functional block diagrams and source codes, may be confidential in nature. In such cases, they should be submitted directly to AEMO following the prescribed procedures and guidelines.

By proactively obtaining the required documents from the OEM and ensuring their timely submission, the connection application process can be streamlined, minimizing delays, and facilitating smoother communication with AEMO and Transgrid. This highlights the importance of effective communication and collaboration between all parties involved. Establishing appropriate channels of communication and ensuring the timely sharing of relevant information can facilitate a smoother and more efficient evaluation process.

2.4. Grid-Forming Inverter Restricted IP Resources

Grid-Forming Inverter core intellectual property (IP) resources such as the functional block diagrams, which provide essential information about how the inverter works, are not available to AGL or Aurecon. Additionally, there is no direct channel of communication between AGL / Aurecon and the vendor, which further complicates the situation. As a result, AGL has to rely on feedback from Transgrid regarding any issues, and there may be restrictions on sharing certain information due to intellectual property (IP) concerns.

[1] The 5.3.4A letter (offer to connect) and the R1 model package are in accordance with and defined under the National Electricity Rules.

It is crucial to note that functional block diagrams are essential for conducting due diligence by Transgrid and AEMO. In hindsight, it would have been advisable to ensure that these diagrams were made available to AEMO and Transgrid in a timely manner, providing them with the necessary information required for their assessments.

This highlights the importance of effective communication and collaboration between all parties involved. Establishing appropriate channels of communication and ensuring the timely sharing of relevant information can facilitate a smoother and more efficient evaluation process.

2.4.1. OEM Engagement

Direct involvement of the OEM throughout the due diligence process was proved beneficial. Arrangements for protection of intellectual property limit access to information and understanding of controller characteristics, specifically when referring to emerging technologies such as grid-forming converters. Since OEMs have a comprehensive understanding of the controller, their involvement is critical to assisting proponents and the industry in comprehending the technology, facilitating the access to control's firmware to perform additional tests, and easing the integration of grid-forming inverters to the grid.

2.5. Low SCR Network and Virtual Inertia Impacts

To further examine the impacts of damping factor (DF) and virtual inertia constant (IC), AGL and Aurecon performed a sensitivity analysis with three combinations of DF and IC settings and an additional case with disabling virtual inertia capability in a low SCR network and applied frequency disturbance tests.

It was determined that an IC of 0.1 and DF of 12 showed the most stable voltage response across the range of frequency disturbance tests applied. A key summary of the related lesson learnt is given in Table 1 below, with the key learning being that a higher inertia constant (ie. more megawatts injected into system) is not necessarily good for weak grid condition as it would lead to depressed voltage levels resulting in fault ride through.

Table 1 IC and DF Setting Sensitivity Analysis Summary

Number	Option	Comments	Pros and Cons
1	Existing virtual inertia settings IC = 2.5 DF = 62	4Hz/s RoCoF results in approximately 1pu active power swing. Under SCR = 2 conditions, this causes voltage rise/drop, and subsequent FRT entry and/or re-striking	Aggressive virtual inertia response causes voltage stability issue under low fault level conditions. Transgrid wishes to prioritise voltage control over virtual inertia response and as such this is not a desirable option.
2	Minimised virtual inertia settings: IC = 0.1 DF = 12	4Hz/s RoCoF results in a negligible overshoot on primary frequency response (PFR) value. Observed FRT re-strike on 47Hz PminQmin scenario only.	Acceptable, stable performance in SMIB for all but 47Hz PminQmin scenario. Sufficiently small virtual inertia to maximise voltage control capability. Higher inertia is generally advantageous for resisting the rate of change of frequency (ROCOF) in a network. However, in networks with lower system strength, increasing inertia is observed to induce greater voltage swings during frequency change tests. This effect can potentially trigger or retrigger Fault Ride-Through (FRT) conditions, thereby introducing voltage instability problems into the network. Consequently, there is an inherent trade-off between inertia response and voltage stability. Smaller virtual inertia values are relatively less likely to result in significant voltage swings during frequency change events.
3	Disabled virtual inertia – direct P control: Kp = 5 Ti = 1 Tb = 0	Response is materially the same as minimised virtual inertia settings (option 3).	Acceptable, stable performance in SMIB for all but 47Hz PminQmin scenario. Materially the same performance as Minimised virtual inertia settings. However, the preference is to not disable virtual inertia so that opportunities for any further

			learning on this performance characteristic aren't missed. This is because UNSW study work is indicating that virtual inertia and damping factor capability of BHBESS response can potentially assist in damping the voltage oscillations in the Broken Hill area.
4	Reduced virtual inertia settings: IC = 0.5 DF = 20	4Hz/s RoCoF results in approximately 20MW overshoot on PFR response value. Observed FRT re-strike on 47Hz and 48Hz PminQmin scenario.	The virtual inertia response appears acceptable for all but PminQmin operating conditions. However, this is not considered a preference as the active power response profile and PoC voltage still move significantly.

2.6. Grid-Forming and Grid-Following Mode Switching

Inverters are designed to operate in grid-forming mode until the inverter terminal voltage exceeds the specified Fault Ride Through (FRT) thresholds, such as a voltage drop below 85% or exceeding 120%. During grid-forming mode, if the terminal voltage drops due to a network fault or voltage disturbance, it does not trigger the transient reactive current (TRC) support, which is a characteristic of grid-following mode. Controlling the reactive current injection during faults is essential to comply with the National Electricity Rules (NER) requirements stated in clause S5.2.5.5.

Recent changes to the NER rules have provided some relaxation in the reactive current response to network disturbances. This opens the possibility of implementing the BHBESS with grid-forming fault ride through functionality. The previous rules were prescriptive on the requirement for reactive current injection during a fault which is difficult for a voltage source inverter. The relaxation of the reactive current requirement now removes that impediment for grid forming/voltage source inverters.[2]

[2] The current NER rules are mostly designed for grid-following inverters. At the time of their development, grid-forming inverters were not prevalent in the Australian market. As the industry matures, and there is more awareness of the capabilities of grid-forming inverters, it is expected that

However, there are two critical areas that may require further work to facilitate this implementation. Firstly, the settling times for reactive current response need to be optimized to ensure efficient and effective operation during faults. This involves minimizing the time it takes for the reactive current to reach a stable state after a disturbance.

Secondly, the stability of the inverter's response to unbalanced faults is another important consideration. Unbalanced faults introduce phase jumps and asymmetries in the system, which can affect the stability of the reactive current control. Further work is needed to address these stability concerns and ensure reliable operation during unbalanced fault conditions. By addressing these critical areas of reactive current settling times and unbalanced fault stability, it becomes possible to enhance the grid-forming fault ride through functionality of the BHBESS, in line with the recent NER rule changes.

2.7. Grid-forming performance for Shallow faults

During shallow faults, where voltage events like undervoltage or overvoltage remain within predefined thresholds, the inverter operates in grid-forming mode without triggering transient reactive current (TRC) support, which is typical of grid-following mode. This leads to a different response compared to the response during TRC, as the control properties specific to grid forming mode come into play.

In the case of shallow balanced faults (fault condition involving all three phases or a three-phase to ground fault)[3], no control loop is active in the inverter to regulate the output current in response to sudden changes in voltage magnitude and phase jumps. However, the Plant Power Controller (PPC) remains active during shallow faults and sends active power (P) and reactive power (Q) commands to the inverter to regulate the voltage and frequency deviations observed at the Point of Connection (POC).

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recent rule changes might be beneficial in supporting Battery Energy Storage Systems (BESS) in Grid-Forming Mode (GFM) at all times.

[3] A "balanced fault" refers to a fault condition involving all three phases or a three-phase to ground fault, while an "unbalanced fault" encompasses fault scenarios such as two-phase faults, two-phase to ground faults, and one-phase to ground faults.

On the other hand, the response of inverter control to unbalanced faults (e.g. two-phase faults, two-phase to ground faults, and one-phase to ground faults) is more complex and differs from the analysis conducted for balanced faults. Unbalanced faults lead to varying phase voltages, and the introduction of negative sequence voltage introduces its own dynamics into the voltage control process. As a result, the control error experienced by the frequency and voltage controllers is expected to be slightly worse compared to balanced faults.

It is important to consider these factors when analysing the behaviour of the inverter during shallow faults, as the control response and performance can vary based on the fault type and system conditions.

2.8. Power Plant Controller coordination with Inverters

Grid-forming inverters are designed to control both voltage and frequency, like synchronous generators, while grid-following inverters typically control active and reactive power or current. The power plant controllers (PPC) are typically designed to send active and reactive power commands to the inverters, following grid-following control logic. However, for the Broken Hill Battery Energy Storage System (BHBESS), which requires grid-forming capabilities with voltage and frequency references, an additional layer of control is necessary. This additional control layer is responsible for converting the active and reactive power commands from the PPC into usable voltage and frequency commands for the grid-forming inverter.

Essentially, this additional control layer ensures that the PPC's active and reactive power commands are translated into appropriate voltage and frequency references that allow the BHBESS to operate as a grid-forming resource. It bridges the gap between the power-based control commands and the voltage and frequency control required for grid-forming operation. By incorporating this additional layer of control, the BHBESS can effectively convert the PPC's power commands into voltage and frequency commands, enabling it to function as a grid-forming inverter and contribute to the overall stability and reliability of the grid.

During a fault event when the inverter switches to grid-following mode, the additional layers responsible for frequency and voltage control are disabled. Those layers are active in grid forming mode and the inverter operates according to the transient reactive current (TRC) logic to manage reactive and active current. In this mode, the inverter no longer listens to the power plant controller (PPC) commands, and the commands from the PPC are frozen shortly after the fault is cleared, typically within a few hundred milliseconds. It is important to note that in grid-following mode, the inverter does not have the virtual inertia and proportional integral (PI) controller control loops that are present in a grid-forming inverter. These control loops are an additional layer of control that require tuning and coordination in grid-forming applications. The virtual inertia control loop emulates the behaviour of synchronous generators by providing a response similar to the inertia present in conventional power plants. This control loop helps stabilize the grid frequency during disturbances. The PI controller is responsible for regulating the voltage and reactive power exchange with the grid. In grid-following inverters, these control loops are not present, and their absence means that additional efforts are required to ensure proper tuning and coordination of the control parameters. This is necessary to maintain stable and reliable operation of the inverter in grid-following mode, especially during fault events.

3. Planning Approvals

3.1. Consultation with stakeholders

As per the project's development consent, consultation with specific stakeholders was mandated for the development of project management plans, including:

- Traffic Management Plan (Transport for NSW and Broken Hill City Council)
- Biodiversity Management Plan (Biodiversity Conservation Division of DPE)
- Soil and Water Management Plan (DPE Water)
- Fire Safety Study (Fire and Rescue NSW and the NSW Rural Fire Service)
- Emergency Plan (Fire and Rescue NSW and the NSW Rural Fire Service)

Throughout the required consultation process, it proved challenging to establish contact with some of these stakeholders. Additionally, certain plans needed approval from the Planning Secretary before commencing construction, necessitating escalation to DPE Energy Assessments to ensure effective consultation.

In projects where consultation is a condition of approval, it is recommended to allocate additional time in the project schedule for the development and approval of the required management plans.

Moreover, direct engagement of referral agencies by the regulator can significantly aid proponents in obtaining the necessary approvals within a shorter timeframe.

3.2. Fire Safety Study

In the case of the Broken Hill Battery project, the Fire Safety Study underwent a lengthy approval process, resulting in modifications to the development consent condition on two occasions. However, a third modification was refused by DPE as it deemed the decision for the Fire Safety Study to be too close to warrant an amendment. This had a direct impact on the project's costs and schedule. The Fire Safety Study was initially submitted for approval in August 2022 but was not accepted by Fire and Rescue New South Wales (FRNSW) until mid-May 2023. The process involved multiple reviews and updates of the document.

The extended duration of the process was attributed to FRNSW's development of technical guidance during the development of the Broken Hill BESS Fire Safety Study. FRNSW released a draft technical note on "large-scale external lithium-ion battery energy storage systems – Fire safety study considerations" in December 2021. The Tesla Victorian Big Battery (VBB) Thermal Event (Fire) that occurred on 30th July 2021 during the early commissioning stage of the Battery Energy Storage System (BESS) coupled with incidents overseas, highlighted the potential of a fire event in BESS facilities and the requirement for different firefighting requirements than a typical fire for BESS facilities. It also exposed the absence of an Australian Standard or Legislative Guidance specifically addressing risk assessment for large-scale battery facilities, highlighting the necessity for more rigorous approval processes for such developments. However, each Fire Authority has yet to clearly define the assessment criteria, leaving the requirements open-ended and causing difficulty in adequately addressing or understanding what is needed.

4. Regulatory Challenges

Until a rule change was implemented on 20 April 2023, an asynchronous generator was required to provide reactive current in addition to its pre-disturbance level of at least 2% of its maximum continuous current for each 1% change in *voltage* at the *connection point.*

This obligation was particularly challenging for voltage source (grid -forming) batteries.

This rule was relaxed on 20 April 2023 from 2% of its maximum continuous current to “greater than 0% of the *maximum continuous current.”* This change has removed an unnecessary regulatory challenge that was previously imposed on grid-forming batteries.

5. Associated Parties and Project Contact Details

agl	Proudly Australian for more than 185 years, AGL operates Australia's largest private electricity generation portfolio within the National Electricity Market, comprising coal and gas-fired generation, renewable energy sources such as wind, hydro and solar, batteries and other firming technology, and gas production and storage assets. We are building on our history as one of Australia's leading private investors in renewable energy to now lead the business of transition to a low emission, affordable and smart energy future in line with the goals of our Climate Transition Action Plan. AGL owns and maintains the 50MW / 100MWh battery, which provides both regulated network services and competitive market services.
Australian Government Australian Renewable Energy Agency ARENA	ARENA is the Australian Renewable Energy Agency and supports improvements in the competitiveness of renewable energy and enabling technologies, increase the supply of renewable energy in Australia, and to facilitate the achievement of Australia's greenhouse gas emissions targets by providing financial assistance and sharing knowledge to accelerate innovation that benefits all Australians. ARENA is partially funding this project as part of ARENA's Advancing Renewables Program.
aurecon	Aurecon Group Pty. Ltd. is an engineering, management, design, planning, project management, consulting and advisory company based in Australia. Aurecon is undertaking the power system network modelling for this Project.
UNSW SYDNEY	The University of New South Wales (UNSW) is a public research university based in Sydney, New South Wales, Australia. UNSW, in conjunction with AGL is undertaking the power system studies and the simulations for this Project.

FLUENCE A Siemens and AES Company	Fluence Energy brings proven energy storage products and services, and digital applications for renewables and storage to support the modernization of our energy networks. Fluence Energy is the Engineering, Procurement and Construction (EPC) Contractor for this project.
Advisian Worley Group	Advisian Pty. Ltd. is the advisory and specialist consulting arm of Worley Pty. Ltd. Advisian is the Knowledge Sharing Partner for the Project.

For more information on the Project, please log into the Broken Hill BESS Project Portal located at the following address: https://www.agl.com.au/about-agl/how-we-source-energy/broken-hill-battery-energy-storage-system?zcf97o=vlx3ap

The portal contains the ability to ask questions of the project team. It also contains relevant information including:

- Construction update of the Broken Hill BESS
- Planning and environmental approvals

All publicly published Knowledge Sharing material, including key reports, operational updates, presentations and access to live and historical data from the operational BESS will be uploaded progressively as they are made available.