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Lessons Learnt Report No. 2

2020/ARP013 Transgrid Wallgrove Battery

28th of January 2022

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Transgrid

1. Project Details

Project Name	**Wallgrove Grid Battery**
Recipient Name	NSW Electricity Networks Operations Pty Limited (ACN 609 169 959) as trustee for NSW Electricity Networks Operations Trust (ABN 70 250 995 390) trading as Transgrid
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Reporting Period	May 2021 – January 2022

This Project received funding from ARENA as part of ARENA's Advancing Renewables Program.

2. Definitions

AEMO – Australia Energy Market Operator

ARENA – Australian Renewables Energy Agency

BESS – Battery energy storage system

COVID – Coronavirus disease

ESV – Electrical Safety Victoria

FCAS – Frequency control ancillary services

HMI – Human machine interface

NEM – National electricity market

NER – National Electricity Rules

OEM – Original equipment manufacturer

PPC – Power plant controller

PSCAD – Power System Computer Aided Design – software which is used to model the electricity network

RIT-T – Regulatory Investment Test - Transmission

RTAC - Real-time automation controller

TNSP – Transmission network service provider

VBB – Victorian Big Battery

3. Executive Summary

Transgrid is developing the Wallgrove Grid Battery to pilot synthetic inertia services using Battery Energy Storage System (BESS) technology, to maintain frequency stability on the network as well as enable Iberdrola, the contracted market operator, to control dispatch and participate in the FCAS and wholesale energy market for commercial purposes.

Transgrid expects that an inertia gap will be declared in NSW as existing sources of inertia, predominantly coal fired generators, are progressively withdrawn from the market. Large coal fired generators provide spinning mass or kinetic reserve, which supports the frequency stability of the grid. The traditional and proven approach to restore kinetic reserve is to install large rotating devices, such as synchronous condensers, to provide physical inertia to deliver instantaneous support that maintains grid stability. However these units add substantially to the development and maintenance costs of a project.

In preparation for the occurrence of the inertia gap in the NEM, Transgrid is investigating alternate technology solutions to establish technically and commercially viable, lower cost solutions to address the inertia gap.

The Wallgrove Grid Battery will pilot inertia services from a BESS as a network service using both synthetic inertia and Fast Frequency Response services. The project has received funding from both NSW Government and ARENA. Contracts were signed in October 2020 and the project commenced Commercial Operations in December 2021.

The Wallgrove Grid Battery has successfully been constructed, tested and commissioned with only minor defect works outstanding. This lessons learnt report is focussed on the lessons gained through the construction and registration phases of this project along with the development of the commercial models required for a commercially viable pilot project. Specific technical commissioning and operational reports on this project will be shared in the future as part of the Project's Knowledge Sharing Plan.

Lessons learnt covered:

- Cyber security and Tesla automation and control implementation
- Project risk management
- Secondary system design
- Testing and commissioning of new emerging technology
- Connections and registration process

4. Project Overview – Commercial Model

Transgrid is implementing a commercial model which allows the BESS to be used for both network services and market services. Funding has been sourced from both government grants and the regulatory framework to support the network service pilot, as well as a market participant for the market services.

Pilot projects demonstrating new technology for network services can be challenging to implement under the National Electricity Rules prior to a network need being declared or a Regulatory Investment Test for Transmission (RIT-T) being undertaken.

Consequently, the network component of the battery is supported by grant funding. Transgrid expects that this project will demonstrate the ability for BESS to provide inertia network services, and will thus support future BESS providing similar inertia services to be assessed under the regulatory framework, negating the need for support grants.

Even though a BESS has the ability to participate in the energy market, Transgrid being a Transmission Network Service Provider (TNSP) is unable to participate in the market under the current Electricity Transmission Ring-fencing Guidelines. Transgrid has entered into contract with a third party, Iberdrola, enabling them to utilise the BESS for market services while Transgrid utilises the BESS for network services.

At the time of developing this project, all grid-scale BESSs operating in Australia are underpinned by substantial grant funding from state governments and/or ARENA. Securing funding from networks for network services, will be a key factor in underpinning the commerciality of future BESSs. Battery cost reductions, longer asset lives and increasing familiarity with market revenue streams for BESSs are also expected to remove this reliance on grants.

The Wallgrove Grid Battery is reliant on grant funding from both NSW Government and ARENA. The resulting commercial framework and contract structure to fund this battery is therefore complex and took considerable time and resources to finalise. The costs for this project progressively increased through the development journey as all parties gained a better understanding of the capability of the BESS and the roles associated with key stakeholders. Funding was also reduced through the development journey making the final business model quite different from the original concept.

5. Key Learnings

5.1. Lessons Learnt No. 1: Cyber Security and Tesla Automation and control implementation

Category: Technical / Resourcing

Objective: Implement Tesla's Autobidder Solution and Maintenance Remote Connection without compromising Transgrid's Cyber Security integrity.

Detail: The Wallgrove BESS project is a first for Transgrid where Transgrid is the owner of a generation asset as well as being the Transmission Network Service Provider (TNSP). Usually Transgrid provides a point of connection for the customer, and the generation or BESS asset is owned, managed, and operated by a third party.

In the case of the Wallgrove BESS, Transgrid is the TNSP, as well as the asset owner and maintainer. As the TNSP, Transgrid is ineligible to be the market participant of the Wallgrove BESS, thus Iberdrola has been contracted to operate the asset in the National Electricity Market (NEM) under a commercial arrangement.

The BESS asset is comprised of the Tesla Megapack system. Iberdrola uses the proprietary Tesla Autobidder solution to bid and trade market services. This is a first where there are four interfaces for successful operation of the BESS asset. These include Transgrid as the TNSP, Iberdrola as the market participant, Tesla as the operation and bidding system, and AEMO as the market operator.

In order to satisfy Transgrid's cyber security policies and TNSP licence obligations, Transgrid had to develop a solution that would allow for continuous monitoring of Megapack batteries and export of operational and bidding data via the internet to Tesla remote servers without exposing the Transgrid network infrastructure to the risk of a cyberattack. In addition to export of telemetry data, Transgrid also had to develop a process and system to allow Tesla to remotely connect to the Megapack battery system for maintenance and troubleshooting activities, thereby reducing downtime and increasing customer revenue and network stability. This had never been done at Transgrid before, and required the introduction and development of a highly specialised networking hardware and software solution.

Transgrid faced a number of challenges in this work stream during this project construction phase. A lack of specialist skilled personnel, combined with an internal restructure and COVID restrictions during the construction phase all resulted in delays to the system development.

The end result was the successful implementation of networking hardware and software for the integration of the Wallgrove BESS into the existing Transgrid communications network, providing all stakeholders the required information without exposing the NSW Transmission network to additional cyber security risks.

The communications equipment installed to enable the Wallgrove BESS to participate in the market has been designed with sufficient spare capacity to allow the inclusion of future additional Transgrid-owned BESS assets.

The remote maintenance connection protocol, which was de-prioritised during the construction program due to resource limitations, is currently in the process of being designed and implemented, and is estimated to be completed 2 months after the commencement of commercial operation. Whilst this delay has not impacted the commencement of commercial operations of the BESS, it will impact the speed of Tesla's assessment and resolution of issues or outages, as they are required to attend site to conduct system diagnoses, rather than log in remotely.

Many lessons were learnt during this project, including knowledge and awareness of different types of communication technologies, upskilling and retaining of specialist key personnel and integration with BESS infrastructure and technologies.

Implications for other projects: The implications for other TNSPs undertaking this type of project are to assess the additional cyber security system and skilled personnel risks at the project development stage, in order to be fully informed on the requirements during the construction phase.

5.2. Lessons Learnt No. 2: Schedule Impacts of Extreme Weather and COVID-19

Category: Project Management / Construction Management

Objective: Successfully deliver Transgrid's first storage project whilst navigating unprecedented external factors.

The Wallgrove BESS is the first project where Transgrid constructed, tested and successfully commissioned a storage asset and network connection assets, using emerging technology. This was a significant achievement for Transgrid and included a large number of unknowns and associated risks.

There were challenges for Transgrid in developing a specification for a BESS system, developing a project budget and timeline for a new asset type. In order to mitigate project risks, Transgrid utilised its corporate Risk Management Framework and Project Risk Management procedures, along with Transgrid's extensive proven systems and procedures. Despite these systems, the project encountered many unexpected external environmental conditions and risks, which were not fully mitigated by in the commercial framework or project risk processes.

Severe wet weather during the construction phase resulted in utilisation of all of the wet weather contingency in the project and additional wet weather was not an allowable delay in the upstream contract. As part of Transgrid's risk assessment process, a considerable amount of wet weather allowance was allowed for, and although wet weather contingency was exceeded, the project was able to mitigate any further delays by seizing the opportunity of working weekends.

In addition to the unusual weather, onsite construction commenced February 2021, the 2nd year of the COVID pandemic. Initially the project was able to safely manage the COVID controls and restrictions imposed by NSW Health with minimal impact. However, with the occurrence of the Delta outbreak of July 2021, the project also incurred the almost daily changes in rules for construction sites imposed by NSW Health and all non-essential construction in the Greater Sydney area was paused for 3 weeks. All works at Wallgrove BESS were required to cease.

At the same time as the restrictions were lifted, Transgrid received approval for an exemption, and Transgrid, in partnership with its D&C contractor, introduced their own COVID Response Plans and Work Instructions, putting additional controls in place. The introduction of weekly testing for all personnel was one of the additional controls. With all the controls in place the project managed to successfully keep all its work crew safe with none of its team contracting the virus for the duration of construction. Although the impact of the COVID outbreak had a considerable effect on the project timeline and budget, the project was able to minimise the impact incurring a 2 month delay to the project. Ongoing considerations of including additional flexibility in contracting arrangements is recommended as the global situation with COVID continues to develop.

Implications for other projects: Extreme weather and COVID delays should be assessed at the project development stage with a wider range of risk possibilities, and commercially managed in a consistent manner across all contracts.

5.3. Lessons Learnt No. 3: BESS Fire Risks, Mitigation and Management

Category: Project Management / Construction Management

Objective: Review risk management plans and emergency response procedures during the construction phase, following an incident at a similar facility.

In July 2021, Neoen's Victorian Big Battery (VBB) project incurred an incident on 30 July 21, involving a fire which destroyed two Megapack units, resulting in significant adverse media coverage and an approximately 3 month delay to that project's commissioning. The Wallgrove BESS was scheduled to be the next Tesla Megapack project to be commissioned, after the VBB incident.

The most likely root cause of the incident was a leak within the Megapack cooling system that caused a short circuit that led to a fire in an electronic component. This resulted in heating that led to a thermal runaway and fire in an adjacent battery compartment within one Megapack, which spread to an adjacent second Megapack.

This occurrence caused considerable additional technical, safety and risk assurance reviews across Transgrid which added unplanned cost to the project. Transgrid worked closely with Tesla throughout the process to understand and manage the implications of the VBB incident. Electrical Safety Victoria (ESV) completed an independent safety report and were satisfied that the VBB could be re- energised. Transgrid implemented all of the controls that ESV required for VBB. Several joint Tesla-Transgrid lessons learnt workshops were conducted to review documentation from off-site testing. This process included key stakeholders across the business (Lumea, Infrastructure Delivery, Asset Management and Plant Engineering).

The required corrective actions were all implemented prior to energisation and included procedural improvements, firmware upgrades, development of mock thermal runaway response drill, procedure updates for unit inspections and the conduct of commissioning activities. Fire & Rescue NSW's dedicated battery fire response unit was engaged and conducted a site review which resulted in the updating of Transgrid's emergency response plan. An incident media response plan was also developed to ensure appropriate communication with key stakeholders and the public in the event of an incident at Wallgrove. All the learnings from the VBB incident improved Tesla's Megapack safety processes, Transgrid's technical knowledge, preparedness and awareness of site safety and emergency management on site.

Implications for other projects: The VBB incident learnings should be shared across all Tesla Megapack projects, and additional reviews of preparedness and awareness of site safety and emergency management on BESS site should be conducted in conjunction with local emergency services.

5.4. Lessons Learnt No. 4: Secondary System Design

Category: Technical

Objective: Battery Secondary System Integration

Transgrid's project developers faced several challenges in delivering Transgrid's first BESS, including having to define the scope for a type of project that the organisation had never delivered, and engaging the market with limited understanding of the technology and requirements for associated control systems. In the initial scoping phase, little was known about how the Transgrid system would integrate with third parties to successfully implement a BESS.

There were numerous items that were not included as a requirement when engaging the market, and as such the secondary system design integration works were missed from the project scope. Neither Transgrid's nor Tesla's systems allowed for the operational control of the BESS locally at site. Although design had already commenced, this introduced the need for further hardware and automation design. Local integration was required to provide local control and monitoring critical to conduct the hold point testing and maintenance of the Megapack batteries. Without the secondary systems integration Tesla would not be able to locally control the Megapacks, and capture the data required as part of hold point testing. Therefore without the secondary systems integrations, Tesla was unable to successfully commission the Wallgrove BESS.

In order to integrate the Tesla Megapacks to the Transgrid local Human Machine Interface (HMI), a Power Plant Controller (PPC) utilising a Real-time Automation Controller (RTAC) was required to be installed within the Tesla domain. Two were installed for redundancy. The purpose of the RTACs is to integrate the Tesla Megapacks and the Transgrid HMI, providing full functionality for control and status of the batteries. In addition to the requirement for testing and commissioning, the PPC was also required to satisfy additional requirements such as implementing logic to meet the specifications of AEMO's VAR Dispatch Scheduling System, and to meet the requirements of the Instability Monitoring system in accordance with Transgrid's guidelines. The RTACs were integrated within Tesla's environment and connected using new hardware. With the implementation of the secondary system integration, the Wallgrove BESS was able to comply with AEMO and Transgrid specifications, as well as execute hold point testing successfully and allow the market participant Iberdrola to commence commercial operations without delays to the project.

Implications for other projects: One of the key learnings from the Wallgrove BESS is a clearer definition of project scope when engaging the market, and thus minimising risks to increased project costs, and potential project delays.

5.5. Lessons Learnt No. 5: Testing and Commissioning of New Emerging Technology

Category: Technical

Objective: Successfully test and commission a new Grid BESS within New South Wales for the first time.

The Wallgrove Grid Battery is the first battery to undergo commissioning in the Transgrid network. This meant that Transgrid, in its role as the transmission network service provider (TNSP) had to adapt its approach to commissioning to test the new technology.

The commissioning team had to:

- Understand the performance and operation of the battery. Each battery Original Equipment Manufacturer (OEM) has a different product, which means that the TNSP must learn the nuances of each product, in order to determine how to test it. The Wallgrove Grid Battery OEM (Tesla) had to teach the commissioning team about its product in order for the Transgrid team to learn how to test it.
- Ascertain which tests that the TNSP required the proponent to run to assess the performance of the battery to ensure that the battery can meet the agreed Generator/Customer Performance standards and the model overlays.

Transgrid was able to work with AEMO and Electranet (who has experience connecting other Tesla batteries), using ARENA's knowledge sharing processes to gain some insight on the best method for commissioning the battery. Transgrid also learned about how to commission the battery from multiple discussions with the OEM. Using this information, Transgrid was able to develop a commissioning test requirements document that outlined recommended tests for each of the hold point stages during commissioning. AEMO agreed with these requirements, and the OEM, who was performing the commissioning on behalf of the proponent, was able to incorporate this information into their Commissioning Plan.

As there are only a few grid scale batteries connected to the NEM, the OEM had a lot to learn during the technical due diligence and commissioning process stages of the connection. For the Wallgrove Grid Battery, the OEM performed the commissioning tests and prepared the commissioning plan on behalf of the Intermediary (Iberdrola). The OEM had to learn how to provide and amend the PSCAD models submitted as part of the technical due diligence part of the connections process. The OEM learned their obligations under the National Electricity Rules (NER) for commissioning, the commissioning approvals process, and how to prepare Hold Point Testing Reports in accordance with AEMO Guidelines. This process was a steep learning curve for the OEM, AEMO, Iberdrola and Transgrid; and would not have been possible if there had not been regular communication, flexibility and a willingness to cooperate and compromise by all parties.

Another learning curve as part of this process was in relation to readying the Wallgrove Grid Battery for operation as a Frequency Control Ancillary Service (FCAS) provider.

As a TNSP, Transgrid has never had to prepare and test a generator/load to enable it to participate in the FCAS market. Transgrid staff had to research the FCAS requirements to understand what equipment, testing and registration processes would be required for the Wallgrove Grid Battery to be operated by the Intermediary in the FCAS market.

In order to ensure that Transgrid was ready to prepare for FCAS, prior to lodging the connection enquiry for the Wallgrove Grid Battery, Transgrid held discussions with AEMO to understand the technical requirements for participating in the FCAS market, and discussed the equipment, the registration and FCAS testing processes. If Transgrid had not taken these steps, it would not have been able to ready the Wallgrove Grid Battery for operating in the FCAS market prior to the contractual date for commencement of commercial operations by the Intermediary. The project would have been significantly delayed.

One of the key learnings from the Wallgrove Grid Battery project is that Transgrid gained insight into the various pitfalls, delays, risks, and complexities that each of its customers go through as part of the connections process. As well as providing insight on the technical performance on batteries, from being on the other side of the connections process, Transgrid gained insight on where process improvements can be made to improve the connections process. This includes providing “how to” documents, templates and guidance documentation for customers to ensure that the connections process runs more smoothly and efficiently in the future.

Implications for other projects: The implications of Transgrid’s learnings in the testing and commissioning phase of the project are for proponents to allow additional time, resources and expect complexities in the technical assessment of new technologies, although this project has laid the foundations successfully for more efficient approvals.