Public Project Knowledge Sharing Report & Project Commissioning Report

Darlington Point Energy Storage System

Project Name:	Darlington Point Energy Storage System
Contract Number:	2020/ARP05
Contact Name:	Sam Hill
Date:	30 October 2025

Darlington Point Energy Storage System has received funding from the Australian Renewable Energy Agency (ARENA) as part of ARENA's Advancing Renewables Program and from the NSW Government, Emerging Energy Program (EEP).

The views expressed herein are not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein.

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Executive Summary

Darlington Point Energy Storage System (DPESS) is a 25MW / 50MWh Battery Energy Storage System (BESS) located adjacent to the 275MW Darlington Point Solar Farm in the Riverina region of NSW. DPESS connects to Transgrid's 132kV network at Darlington Point Substation.

This Public Project Knowledge Sharing Report represents one of the Knowledge Sharing deliverables under the Funding Agreements with ARENA (under the Advanced Renewables Program) and NSW Government (under the Emerging Energy Program).

This report covers the pathway from project inception to completion of the BESS, covering development, construction and commissioning learnings, including the following:

- General project information;
- Overview of project objectives;
- Description of the journey to financial close; and
- Description of construction and commissioning activities, and lessons learned.

1 Introduction

1.1 Project Overview

Edify developed the Darlington Point Energy Storage System (DPESS or the Project), a 25MW / 50MWh BESS located adjacent to the 275MW Darlington Point Solar Farm in NSW (also developed by Edify). DPESS commenced construction in July 2022, completed construction in May 2023 and began commercial operations in September 2023.

DPESS connects to Transgrid's 132kV network at Darlington Point Substation and has advanced inverters set to 'grid forming mode' (also known as 'virtual machine mode'), which can provide system strength services to the grid.

DPESS was developed and constructed concurrently with two other battery energy storage projects – the Riverina Energy Storage System 1 (RESS1) and Riverina Energy Storage System 2 (RESS2). RESS1 is a 60MW / 120MWh BESS while RESS2 is a 65MW / 130MWh BESS, both of which are similar in technology type to DPESS.

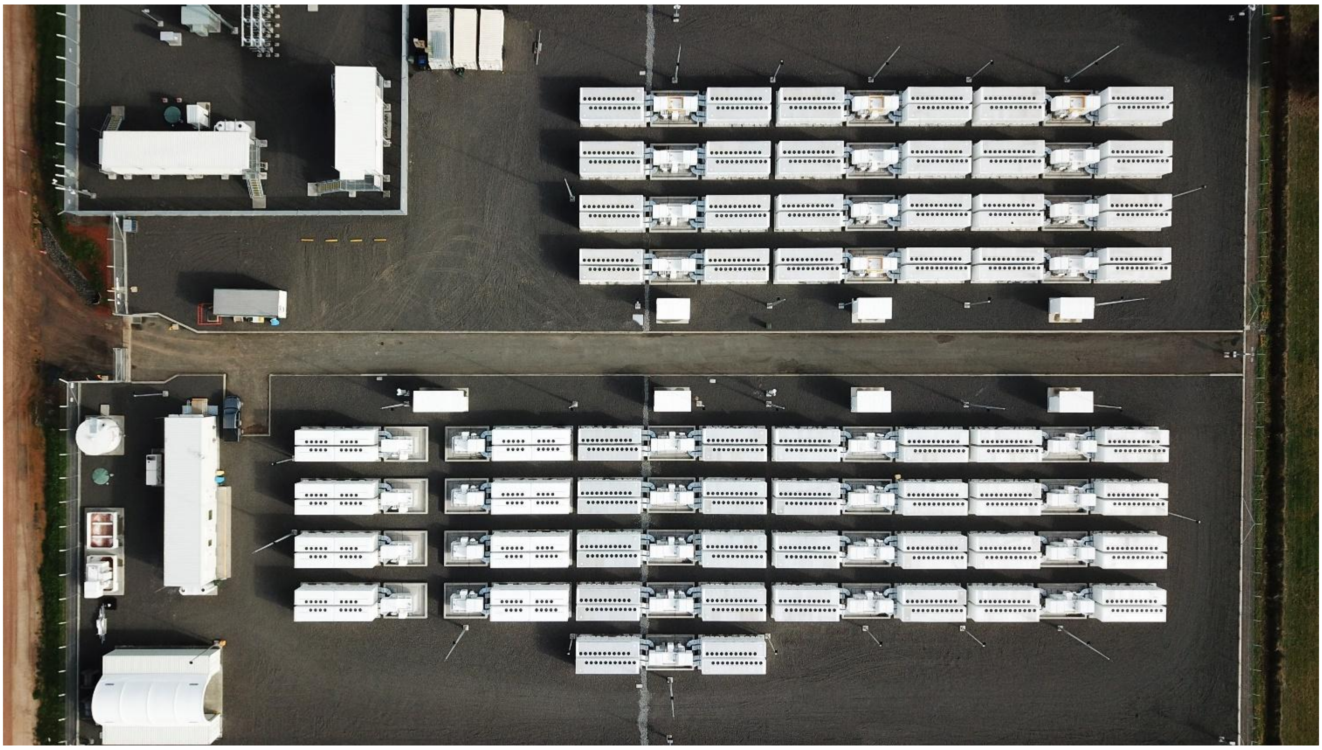

Figure 1 Aerial view of DPESS, RESS1 and RESS2

These three projects have been constructed as a single facility within the same compound and share common infrastructure such as the O&M building and maintenance facility. Each of the projects is a separately registered bidirectional unit (BDU) within the NEM and each has a separate connection point at 33kV within the Transgrid-owned Riverina BESS substation. To facilitate this connection arrangement the Project had to establish a Designated Network Asset (DNA) between the 132kV Darlington Point Substation and the points of connection of the three projects.

Figure 2 DPESS, RESS1 and RESS2

DPESS principally aims to demonstrate that a BESS with advanced inverters can reduce the cost of connecting variable renewable energy projects to weak grids by offsetting (fully or partially) the need for synchronous condensers (or other reactive plant) in future projects.

1.2 Alignment with ARENA's Advancing Renewables Program

DPESS aligns with the objectives and desired outcomes of ARENA's Advancing Renewables Program (ARP)[1] as successful completion of DPESS will contribute to technical, regulatory and commercial outcomes that are of high priority for ARENA. DPESS will contribute to all five of the ARP objectives and outcomes, which are:

a) reduction in the cost of renewable energy;
b) increase in the value delivered by renewable energy;
c) improvement in technology readiness and commercial readiness of renewable energy technologies;
d) reduction in or removal of barriers to renewable energy uptake; and
e) increased skills, capacity and knowledge relevant to renewable energy technologies.

BESS projects using advanced grid forming inverters offer several key benefits to the electricity network, as follows:

a) **Provide system strength services and reduce the need for synchronous condensers**: BESS projects with advanced grid forming inverters provide system strength (i.e. frequency and voltage stabilisation, fast disturbance event response, etc.) with much faster response times than other energy storage or generation technologies. These services can allow nearby renewable energy projects to operate with fewer constraints or without constraints to their output, increasing the value of these projects and improving the utilisation of the network. By providing these services, BESS projects with

[1] https://arena.gov.au/assets/2017/05/ARENA_ARP_Guidelines_FA_Single_Pages_LORES.pdf

advanced grid forming inverters can remove the need for synchronous condensers or other measures to be installed with renewable energy projects. Synchronous condensers are complex and expensive machines with long procurement lead times. Therefore, removing the need for such machines significantly reduces the cost and risk profile associated with connecting renewable energy projects in weak grids.

b) **Multi-use technology**: BESS projects with grid forming inverters can also provide all the beneficial services that have been observed and well reported from other BESS projects (such as charging during periods of low demand / price, dispatching into high demand / volatile price periods and providing market ancillary services) making them a multi-use market and technical service technology, in contrast to single purpose technologies such as synchronous condensers.

These benefits combine to support the further commercialisation of BESS and advanced grid forming inverter technology, further development of renewable energy projects and increased economic, environmental and social benefits to Australian consumers.

BESS technology is relatively new and as such there are significant learnings from every project. Key learnings to date from DPESS are detailed in the following section. These learnings are already being applied to other renewable energy and BESS projects in Australia.

1.3 Alignment with the Emerging Energy Program

The Project is being supported by the NSW Government's Emerging Energy Program. The objectives for the Project under this program include:

a) the Project will enhance system reliability and security in NSW by operating in the wholesale energy and frequency control ancillary services markets in the National Electricity Market (NEM);
b) the Project will promote diversification of electricity supply in the NSW region of the NEM by deploying a lithium-ion battery system that is dispatchable and capable of firming variable renewable energy generation;
c) the Project will reduce greenhouse gas emissions in NSW and maintain an emissions intensity of 0.476t $CO2$-e / MWh;
d) the Project will charge from the co-located solar farm; and
e) the delivery of the Knowledge Sharing Plan will provide value to NSW and the NEM by demonstrating the benefits of using advanced inverter capabilities as well as detailing regulatory and financial learnings.

2 Project Information

2.1 Technical Characteristics and Developments

DPESS is a 25MW / 50MWh (2 hour) lithium-ion battery facility based on the Tesla Megapack 2XL units.

Technical characteristic	Description
Nominal capacity	25MW / 50 MWh (2 hours)
Actual Connection Date	The project achieved Commercial Operations on 29 September 2023
Generator Type	Battery Energy Storage (classified as a bidirectional unit (BDU) within the NEM
NMI	NTTTW0ZS50
Battery units	16 x Tesla Megapack 2XL, 2.40 MVA per unit
Inverters	Inverters are integral to the Tesla Megapack 2XL unit
Voltages	DC voltage: 480V High voltage: 33kV
Balance of plant	8 x 4.8MVA 33/0.48/0.48kV MV unit transformers ABB SafePlus GIS RMU Switchgear

2.1.1 Battery Cells

The battery cells employed in the Megapack 2XL are Lithium Iron Phosphate (LFP) type batteries which are a type of lithium-ion battery that uses iron phosphate as the cathode material. LFP batteries are used in the majority of stationary storage applications due to their low cost, consistent lifetime performance and higher resistance to thermal runaway when compared to other lithium-ion battery chemistries. LFP batteries offer a good balance of safety, longevity, and cost-effectiveness. Several battery cells are connected together into battery modules.

2.1.2 Power Conversion

Tesla Megapacks vary from most other suppliers of stationary energy storage systems in that the inverters are of a much lower power level and are integrated into the battery modules (up to 24 per Megapack container). The inverters convert the battery-side DC energy to and from AC energy at 480V and each connect to a common AC bus within the Megapack providing a common 480V AC output.

Most alternative battery systems connect an entire shipping container of batteries at DC level and use a large power converter to convert to AC power.

2.1.3 Auxiliary Supply

The Megapacks internally supply all auxiliary power demands in the Megapack from the internal 480V AC bus. This means that no separate external auxiliary supply is required and allows Megapacks to self-supply auxiliary power where this is required.

This differs from most other stationary storage suppliers where a separate auxiliary supply to the battery container is required.

2.1.4 Control Systems

The overall plant control consists of three main control levels as follows:

1. **Gateway Level**
   The gateway level control is the highest level of control of the power plant. The plant consists of dual redundant gateways as they are critical to the control of the plant. The gateway controller performs the following key functions:
   - receives dispatch information form AEMO including Automatic Generator Control (AGC) setpoints and energy and FCAS enablement;
   - interprets the dispatch commands and converts these to setpoints actionable by the site controller;
   - communicates with the TNSP and AEMO for network controlled voltage control setpoints and modes;
   - provides SCADA points to TNSP and AEMO; and
   - hosts the human-machine interface (HMI) for operator control of the Project.
2. **Site Controller**
   Tesla standard site controller which performs the following functions:
   - receives setpoint and mode change information from the gateway controller as a result of remote signals from AEMO / TNSP or local commands from the HMI by the operators;
   - provides the overall plant control of the facility;
   - monitors the actual output of the plant via the control meter; and
   - adjusts control signals sent to the Megapack level controllers for both active power and reactive power.
3. **Megapack Controllers**
   The Megapacks contain controllers which control the output of the Megapack and include the actual control of the inverters within the Megapack.

2.2 Project Layout and Arrangement

The project layout with a description of the key features is shown below in Figure 3. Each battery container feeds power to a medium voltage (MV) transformer (either two or four battery containers per transformer), which increases the voltage to 33kV. Between four and five MV transformers then feed to a single ring main unit (RMU) which contains switching and protection devices. The main feeder cables then feed power from each RMU to the Transgrid switchroom.

The Transgrid switchroom contains switching, protection and metering devices. Power is fed from the switchroom to the main high voltage (HV) transformer, which further increases the voltage to 132kV to match the local electrical network voltage.

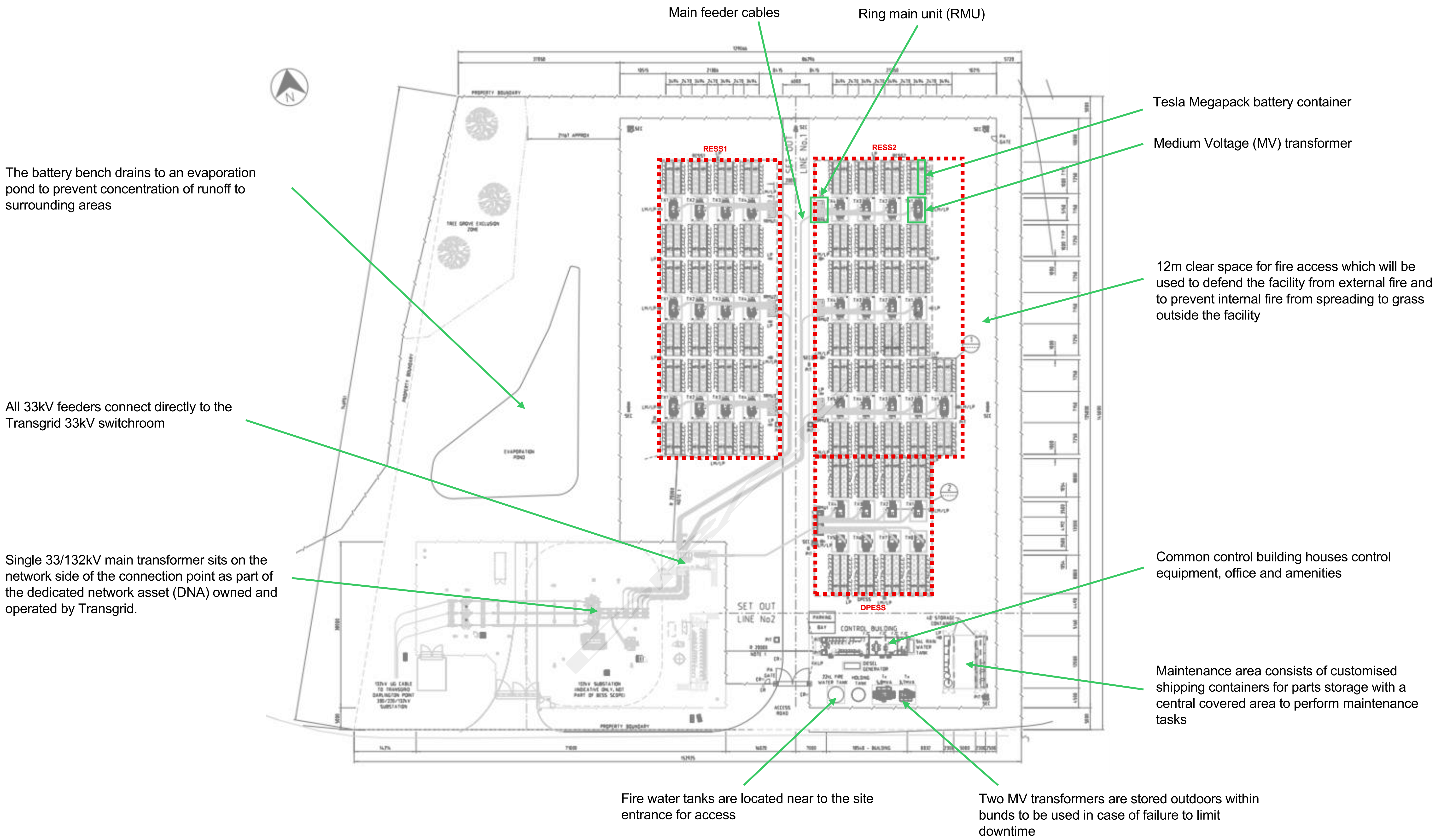

Figure 3 Project Layout

2.3 Project Delivery Model

A turnkey EPC contract model was adopted for this project. Tesla was selected as the principal contractor with responsibility for the supply of the battery system components and design, procurement and construction of the balance of plant.

Tesla worked with Consolidated Power Projects (CPP) as their main balance of plant contractor for the works.

Transgrid was appointed to build, own and operate the DNA which in this instance includes the 33kV substation. This substation is located on the same site as the BESS. Through negotiations with Transgrid, Edify was able to ensure that CPP was also appointed as the main construction contractor by Transgrid for the substation. This was critical as it allowed CPP to manage the site initially as a single site – CPP was able to design a common bench and drainage system for the entire site and to construct the bench and earth grid together which would have otherwise introduced complex interfaces to co-ordinate.

Key lessons learnt about the construction and development model include:

- The turnkey EPC delivery model is often favoured as it is seen by the industry to minimise interface risk compared to a split contract model which, while typically costing less to the project owner, introduces the risk and complexity associated with the coordination of multiple suppliers / contractors. However, for much of the project (up until the commissioning phase), the project was largely controlled by CPP and the project owner interfaced significantly with CPP during this phase. The key learning was that the interface risks involved in a split contract model would be manageable for future projects. Edify has taken this learning and moved to a split procurement model on future projects such as the Koorangie Energy Storage System where a separate BOP contract was awarded for the battery and conversion system including commissioning and grid testing.
- The arrangement to have CPP complete both the Transgrid and BESS scope was critical to the success of the project. The project had very limited space for construction facilities and laydown areas – it would not have been practical to have separate contractors established on the site. This model also reduced the complexity of design interfaces which occurred seamlessly due to the same design team being responsible for both (albeit with Transgrid review of the substation scope).

2.4 Project Partners

The following table outlines the project partners enabling delivery of DPESS:

Project Partner	Project Role
Sustainable Australian Real Asset Company Pty Limited (with a minority position held by Edify Energy)	Project Sponsor
Edify Energy Pty Ltd	Construction Manager
Tesla Motors	EPC Contractor
EnergyAustralia	Offtaker

2.5 Business Model and Offtake Agreements

2.5.1 Battery System Services Agreement

The market revenues of DPESS are wholly captured in a long-term Battery Storage Services Agreement (BSSA) between DPESS and EnergyAustralia. The BSSA entitles EnergyAustralia to full operational rights over DPESS to direct charge and discharge operations in both energy and FCAS markets. Accordingly, EnergyAustralia is the beneficiary of all market-linked revenues from DPESS, which it receives in exchange for making fixed payments to DPESS. This business model provides a long-term stable revenue stream for the project rather than being subject to the volatility of the NEM.

The BSSA also provides EnergyAustralia with battery performance, availability and reliability commitments. These commitments are subject to operational constraints which mainly relate to the implications of cycling frequency on warranted performance. The battery purchase agreement with Tesla provides DPESS with performance, availability and reliability commitments from Tesla to manage these upstream obligations.

2.5.2 Network Support Agreement

DPESS recently entered in a Network Support Agreement (NSA) with Transgrid under which it provides network stability services. The ability to provide these services is due to the grid forming nature of the BESS.

The origins of this agreement commenced with a Project Specification Consultation Report entitled *Improving stability in south-western NSW* which Transgrid published in July 2020 under the Regulatory Investment Test for Transmission (RIT-T) framework. In this they identified that the power system in south-western NSW had seen a significant growth in renewable connections as part of the wider energy market transition to renewables. This included approximately 560MW of renewable generation connected at the time and a further 800MW expected to connect in the near future. The report identified that the only way of managing the risk in the immediate term was to constrain generation in south-western NSW, such that AEMO implemented constraint equations which resulted in the main 330kV line between Darlington Point and Wagga Wagga (Line 63) being operated well below its thermal capacity due to stability concerns.

The underlying concern that system studies highlighted was that the 132kV system in south-western NSW would experience significant stability issues following the tripping of Line 63. Transgrid investigated a number of options to alleviate the constraint which initially included new transmission lines as well as a new static synchronous compensator (STATCOM) at Darlington Point. Transgrid initially discounted batteries as they noted they would need to be coupled with a STATCOM and so would always be more expensive than a STATCOM alone to provide the same benefit.

Edify proposed that Transgrid could contract the services of a non-network battery which could otherwise earn revenue from the energy market, meaning the cost of the network services could be as competitive as a STATCOM together with transmission upgrades.

While the battery was not able to fully alleviate the constraint up to the thermal limit of the transmission line, it was able to increase the permitted flow by over one third of the previous limit and was assessed to be the preferred solution in terms of cost-benefit to consumers.

DPESS executed the Network Support Agreement with Transgrid in July 2024 which requires the facility to regulate the voltage by automatically and continuously responding to disturbances. The services contracted under the NSA are all additional to the existing services contracted under the BSSA.

2.6 Knowledge sharing activities to date

The following public knowledge sharing reports have previously been prepared by Edify and issued by ARENA:

- Lessons Learnt Report #1 - https://arena.gov.au/knowledge-bank/darlington-point-energy-storage-system-lessons-learnt-report-1/
- Lessons Learnt Report #2 - https://arena.gov.au/knowledge-bank/edify-energy-darlington-point-energy-storage-system-lessons-learnt-report/
- Operations Report #1 - https://arena.gov.au/knowledge-bank/edify-energy-darlington-point-energy-storage-system-operations-report-1/
- Operations Report #2 - https://arena.gov.au/knowledge-bank/edify-energy-darlington-point-energy-storage-system-operations-report-2/
- Operations Report #3 - https://arena.gov.au/knowledge-bank/edify-energy-darlington-point-energy-storage-system-operations-report-3/

Under the ARENA and EEP Funding Agreements, the following milestones have been completed:

- Milestone 1 – Notice to Proceed
- Milestone 2 – Delivery of Major Equipment
- Milestone 3 – Completion and Connection of Project
- Milestone 4 – Commercial Operations (ARENA only)

Lessons Learnt Report #1 was issued 20 March 2023 to coincide with Milestone 2 – Delivery of Major Equipment. The report covered lessons learnt in the connection application process. The key learning was that early and regular communication with the NSP and AEMO together with OEM involvement were crucial in obtaining timely registration in the connection application process.

Lessons Learnt Report #2 was issued at ARENA Funding Agreement Milestone 4 Commercial Operations Commenced (no equivalent milestone under the EEP Funding Agreement) addressing lessons learnt in the registration, testing and commissioning process and the approach for an advanced grid forming inverter plant compared to a traditional grid following plant. The key lessons are outlined below:

- While there are specific nuances and challenges to the connection of grid forming inverters in each of the connection application, registration and commissioning and testing phases, the overall process and timeline for these stages is similar to grid following technologies.
- Similar to grid following technologies, the connection process becomes easier with precedence of similar projects in terms of both the formation of appropriate GPS clauses and the familiarity and confidence in power system models of the grid forming inverter controls. The biggest risk to the initial timeframes relates to the additional time in the due diligence process for parties to become familiar with new models.
- The grid forming controls have created no observable difference from a market and trading perspective for the BESS.

Since the Commercial Operations milestone was reached in September 2023, Operations Reports have been published at six-monthly intervals covering technical and commercial performance including discussion of items relating to system strength performance and charging behaviour for the respective periods.

3 Reaching Financial Close

3.1 Grid connection process

The grid connection process in the NEM involves several stages with AEMO and Network Service Providers (NSPs) playing key roles in each. The process is governed by the National Electricity Rules and aims to ensure a reliable and secure electricity supply.

Key elements of the connection process include:

- Detailed power system models (in PSS®E and PSCAD format) are required to be submitted to the TNSP and AEMO along with detailed connection studies to demonstrate that the plant is able to be connected to the network without any adverse impact on the network;
- The project must propose and negotiate Generator Performance Standards (GPS) and must demonstrate compliance via power system modelling;
- AEMO and the TNSP will undertake additional modelling assessments in their wide area network model to assess stability where there is insufficient system strength; and
- In parallel to the assessment of the project's impact on the network and negotiation of the GPS, it is required to negotiate with the TNSP to facilitate the physical connection to the network.

The connection process for DPESS was novel and delivered learnings outlined in the following sections.

3.1.1 First Connection Application for Grid Forming Inverter Generator

We understand that the Project represented the first connection application which Transgrid and AEMO assessed for grid forming inverters. While some earlier generators transitioned existing plants to grid forming, DPESS was the first to navigate the initial connection process as grid forming in NSW.

This did make the connection process more complicated due to there being a level of uncertainty and the need for engagement and consultation in the decision-making process in the negotiation.

Fundamentally the connection process for grid forming projects is identical to grid following projects and largely the same minimum standards for the GPS apply. The main point of discussion for the GPS was finding the ideal tuning of the generator while still meeting the negotiated standards of the GPS. We found that the reactive current rise and settling times were challenging due to the following reasons:

- For shallow network faults the reactive current settling times were found to be long and if these cases were used to assess GPS compliance, it was difficult to meet the automatic access standards unless the grid forming controls were materially restricted or tuned out. This was not the case for deep network faults where the settling times were generally within the automatic access standards.
- Tuning out the grid forming controls was overall detrimental to the network stability, while in the fault scenarios where the settling times were non-compliant there was an immaterial impact on the network, which Edify considered not to be the intention of GPS clauses.

Transgrid and AEMO are generally bound by the negotiating principles which mandate that where a plant can be tuned to meet automatic access standards, it should do so in preference to negotiating access standards. Ultimately, we were able to agree on a means for specifying and assessing the GPS which allowed for the grid forming controls to be applied in a best for network approach. However, there was concern that the decision-making process would delay and ultimately become a risk to the Project.

While this negotiation exercise initially focused on a specific GPS clause, we believe its value was much broader. The key benefits were realised through:

- **Knowledge Building:** the Project gave power systems engineers from the consultant (DIgSILENT), Transgrid, and AEMO the chance to work on a real-world project involving grid-forming inverter tuning and performance. This hands-on experience is highly valuable, as these organisations now have internal personnel with practical expertise to draw on for future projects.
- **Precedent Setting:** the collaboration helped establish a precedent for decision-making within these organisations, providing a useful reference point for similar projects in the future.

3.1.2 Three Parallel Connections

Another challenge of the Project was that rather than being connected and operated as a single generator, the Project had three separate connections and GPSs. While there was potential for Transgrid to consider this as three entirely separate connection applications they instead were pragmatic and considered this as a single connection application with three units, albeit each with slightly different capacities.

The approach to modelling was as follows:

- A single performance model was developed by Edify containing all three generators and including the Transgrid DNA which was not part of existing network models;
- Performance was assessed at the network level and at the point of connection of each generator to allow for GPS compliance assessment;
- A number of grid event scenarios were modelled to ensure suitable performance:

  – the majority of scenarios assumed all three generators were operating in parallel to assess the worst case (which was also the most likely operating case); and
  – a smaller subset of scenarios where only a single generator was operating.

This was a key learning of the Project where there was previously uncertainty about how we could progress the simultaneous applications for three generators.

3.2 Regulatory treatment

3.2.1 Designated Network Asset

A key aspect of the regulatory treatment of this project was that it established a DNA to facilitate the connection of three projects in an efficient network arrangement.

Due to the way the Project was contracted, it was a requirement for each of the three BESSs to have a separate point of metering and settlement with AEMO (not only separate dispatch which can be achieved with AEMOs new hybrid registration approach) but to otherwise have a shared 33/132kV transformer and only a single 132kV connection into the existing Darlington Point Substation.

The way to achieve this was to make use of a new classification of network assets (a DNA) which was created via a rule change which was finally determined on 8 July 2021. The rule allowed for the proponent to opt in to the small common network to be a DNA under which it is considered part of the Transmission Network and so is operated by the TNSP.

This was the first application of the new rules in Australia, with the application process starting prior to the rule even coming into effect. This was initially a challenge as it took some time for key parties to assess the new rules and prepare suitable agreement templates.

We consider that this project was an immediate success of the rule change as prior to this, the project would have had to construct three new 132kV bays at the Darlington Point Substation and three separate 33/132kV transformers to achieve the desired outcome. The application of a DNA resulted in a much more efficient use of network infrastructure.

The DNA now exists under a special access regime which means that while there is potential for future connections, the capacity of the founding generators is maintained as they have funded the network.

This benefit of the Project is that now there are established frameworks for developing these smaller DNAs.

3.2.2 Introduction of Bidirectional Unit Registration Category

DPESS was initially registered in early 2023 as both a Scheduled Generator and Scheduled Load (with two NMIs) which was the prevailing arrangement for battery energy storage systems registered in the NEM.

AEMO has subsequently created a new bi-directional unit (BDU) classification and required that all grid-scale BESSs registered before 3 June 2024 be transitioned to it by 3 March 2025. This has subsequently been completed and introduced a number of changes as follows:

- Single dispatch unit;
- Single NMI; and
- Single bid submission with the introduction of 20 price bands compared to the previous 10 for each unit.

Overall, the transition was well managed and seamless from an operational perspective.

3.3 Procurement

3.3.1 Strategy

As previously discussed, Edify's procurement approach to the Project was to seek a turnkey EPC contract for the supply and construction of the BESS facility. This approach was preferred for the following reasons:

- Removes any interface risk between the BESS and the balance of the plant which can exist in design, delivery and timing and commissioning and testing responsibilities;
- Ensures that the key performance characteristics for the BESS (energy storage capacity and round-trip efficiency) could be measured and guaranteed at the point of connection;
- Offers a single point of responsibility.

One key difference this approach introduced was that due to the battery system cost being a very high proportion of the overall cost of the project (where liquidated damages paid for underperformance are typically somewhat proportional to the contract price), it is high risk for a balance of plant contractor to enter into an EPC contract. It was therefore decided that the nominated battery system OEM would be best placed to take the lead contractor role. This was not a natural role which the battery OEMs wanted to perform or necessarily had the skills to perform.

Through execution of the Project however, a key learning on the contracting strategy was that the interface between the BESS and balance of plant was far simpler and cleaner than envisaged and that for subsequent projects, a split contract model would be preferred.

3.3.2 Supplier Selection

Inverters

The inverters were one of the first equipment choices made for the Project. This was partly because the Project would be using grid forming inverters and so choosing a supplier who was sufficiently advanced in the development of their grid forming controls and models was critical. Inverters are also always a key consideration for grid connected projects in Australia as they need to be selected prior to commencing the connection studies which occurs some time prior to receiving a connection agreement. There were three inverter suppliers which we considered were sufficiently advanced at the time to be considered for selection – one of these was Tesla who supply an integrated solution with inverter and battery systems while the others were inverter suppliers only.

BESS
The key considerations for the BESS supply were performance characteristics (round trip efficiency and storage capacity degradation) as well as fire safety and the overall cost to the Project. BESS suppliers typically provide 20-year warranties for the BESS and so they become a key partner for the life of the Project. As such, their ability to deliver and support on a long-term basis is of critical importance to the success of the Project.

Ultimately Tesla was selected as the supplier of the integrated BESS and inverter solutions, and also played the role of EPC contractor for the Project. Tesla subcontracted the balance of plant design and construction to Consolidated Power Projects (CPP).

Ultimately this decision came down to the following key factors:

- Ability to deliver in the shortest timeframe compared to other solutions where the lead-time of the inverters resulted in longer overall project schedule;
- Readiness of grid forming controls and models;
- High level of technical support in country;
- Experience in testing and commissioning in the NEM;
- Highly integrated product which represented a lower risk solution with fewer design and installation interfaces; and
- Ability to provide long term operation and maintenance services.

3.3.3 Local Availability of Components

There were no local manufacturers or suppliers who could supply the main BESS or inverter systems and as such this was not a key factor in the supplier selection.

Local suppliers were considered for the MV transformers, where there are two local manufacturers (Wilsons Transformer Company and Tyree Transformers) who have strong capability in this area. Ultimately the MV transformers were supplied from overseas by Hitachi. However, Wilsons Transformer Company provided the 33/132kV main step-up transformer which ultimately formed part of the DNA owned by Transgrid.

3.3.4 Changes in Cost of Components

During the tender and negotiation process there was a high degree of volatility in the pricing for BESS systems. The cost of BESS systems is highly dependent on the raw materials of which lithium carbonate is a major contributor.

The project signed the EPC contract in late 2022 with a Q1 2023 commencement date. Prior to November 2022, battery grade lithium carbonate prices had not exceeded 150,000 Chinese yuan. However, in late 2022 and early 2023 there was a material spike to prices of more than 400,000 Chinese yuan. As such the project suffered a late and unexpected increase in the BESS supply price due to this spike in raw input costs. Management of these risks will be a key consideration for future projects.

3.4 Key commercial considerations and securing finance

The project was project financed as is typical in the renewables industry, where lenders typically take a conservative view of projects. Key considerations for the project in securing finance were as follows:

- **Contracted revenues**
  The revenue of BESS projects in the NEM over the long term is highly uncertain due to the rapidly changing nature of the generation of mix as we undertake the energy transition. As such lenders place high value on contracted revenues from high quality counterparties. DPESS entered into a BESS tolling

arrangement with EnergyAustralia which provides the project with fixed revenue over the term of the agreement. This was a key reason that the project was able to be debt financed.

- **Reputable technology provider**
  With BESS projects still an emerging area at the time of financing, a high degree of due diligence was undertaken on the technology being deployed. This included aspects such as:

  – Capability and track record of the product and supplier;
  – Fire risk;
  – Ability to secure operational insurances covering fire risk; and
  – Existence of robust performance warranties to cover unexpected drops in the performance.

- **Use of grid forming inverters**
  There was significant consideration given by lenders to the risks to the project schedule and performance due to the use of grid forming inverters. Key questions which were asked included:

  – Risk of commissioning delay due to the use of grid forming inverters – our assessment of this risk was that this was, if anything, derisking the project due to the dynamic performance being beneficial to the network rather than increasing risk of stability and therefore presented a lower risk of issues being discovered in commissioning.
  – The operational impact of using grid forming inverters including the need to maintain minimum reserve capacity and risk of high energy use due to providing grid support such as inertia. The operational impact of using grid forming inverters is very low and there is no need to retain any headroom above what is typically maintained due to operational reasons.

3.5 Community consultation

Edify already had a high level of support in the local community off the back of the successful construction of the Darlington Point Solar Farm. Following best practice, Edify held a Community Information Forum where the community was invited to attend the local Sports Club to meet the EPC contractor, understand the project schedule, voice concerns and learn about opportunities for employment and procurement.

Date: Tuesday 22nd March 2022

Time: 6 – 8pm

Place: Darlington Point Sports Club

The positive relationship was further strengthened through ongoing and visible engagement within the community. Given the small size of Darlington Point, engagement was primarily achieved through a consistent local presence, interacting with residents at local businesses, attending events, and fostering open, informal communication.

The Darlington Point BESS project page on Edify's website provided detailed information about the project, including all EIS and Statutory Approvals and approved plans for:

- Accommodation and Employment Strategy
- Biodiversity Management Plan
- Construction Environment Management Plan
- Emergency Management Plan
- Traffic Management Plan
- Chance Finds Protocol

- Final Layout Drawing

Throughout construction, a dedicated email address was available for community feedback and enquires, via the website project page.

The community was highly engaged and realised the economic benefits and opportunities that the projects were bringing to the local community.

Working closely with local community groups, service providers and Murrumbidgee Council, Edify identified a number of community benefit programs to support, which includes:

- Donation of tools to the Darlington Point Rural Fire Service
- Sponsorship of the Riverina Classic fishing event in the local area
- Council contributions which were used to fund a number of public facility upgrades in the local area
    - Darlington Point Sports Precinct Facility building upgrade
    - Darlington Point Sports Precinct Score Board replacement
    - Darlington Point Pool PVC Solar Panel Solar System
    - Darlington Point Pool blanket installation
    - Lions Park upgrade and footpaths

To mark commercial operations of the BESS and celebrate the First Nations Wiradjuri people, local artist Jayden McLachlan was commission to produce an artwork which illustrates the importance of caring for country.

There were no disputes with the local community with regards to the Project which required management.

4 Construction and Commissioning Activities

4.1 Overview of activities

Activity	Description
Bulk Earthworks	The battery system was built on an elevated engineered bench to ensure that the BESS is a suitable height above the maximum flood level. The first stage of construction was the earthworks phase where the existing ground was stripped and imported fill was placed to build up the bench for the battery facility to be constructed on. The bulk earthworks also included the construction of swale drains surrounding the BESS and the retention pond which was included to slow water runoff to prevent erosion from the BESS area runoff. Estimated workforce = 10
Detailed Civils	The detailed civils package involved the construction of the foundations on which the primary equipment was placed. Concrete foundations were cast in place requiring excavation of the foundation then erection of formwork and placement of reinforcement before concrete was poured. This stage also included the placement of conduits which were buried and cast into the foundations for later installation of cables. The detailed civils package also included the installation and construction of drainage structures used to capture and drain water from the bench area. Estimated workforce = 30
Main Equipment Installation	This phase involved the delivery, unloading and installation of the main equipment comprising the Megapacks (battery systems), MV transformers and RMUs. The deliveries were staged such that the equipment was lifted in a single lift from the delivery truck to the foundation without the need for intermediate storage. Careful consideration was required in the layout to allow for this to occur and planning for the crane setup and delivery vehicle access was critical. In this case we were able to obtain crane setup positions so that up to 12 Megapacks could be delivered and lifted to foundation from a single crane setup position which allowed for a full day of deliveries and for the crane position to be adjusted once per day. There were a number of batches of deliveries, so this phase overlapped with the electrical installation. This stage also included the delivery and installation of a prefabricated control building which was delivered and lifted onto the foundations. Estimated workforce = 12

Electrical Installation	This phase involved the installation of electrical cables between each Megapack, MV transformers, RMU and to the point of connection as well as auxiliary power and communication cables. Cables were pulled, cut to size and then stripped back to allow for the connection of appropriate end connectors before they were finally terminated to the appropriate equipment. In many cases there were multiple parallel cable runs to achieve the current requirements which made this the most labour-intensive stage of the works. Terminated cables needed to be appropriately secured as they were installed. Estimated workforce = 40
Commissioning	The commissioning phase of the project included the final checks of the installation then functional testing of individual systems before the whole plant was back-energised from the grid for the R2 (grid connection) testing process. This included all communications and SCADA point testing and protection testing. Estimated workforce = 10

4.2 Project Delivery Team

The Project Delivery Team was structured to ensure effective management, coordination, and execution of all project phases. The team comprised the following core functions:

- **Project Management and Controls**
  This function encompassed overall project leadership, procurement, and scheduling activities. The team consisted of five full-time professionals, each holding an engineering degree, who were dedicated exclusively to the successful delivery of the Project.

- **Engineering**
  The Engineering team comprised approximately 25 engineers who contributed over a four-month period. Team members were drawn from various consultancies and specialist disciplines, with several concurrently supporting multiple projects. This structure provided access to a broad range of technical expertise and ensured a high standard of engineering input across all disciplines.

- **Construction Management**
  The Construction Management function consisted of a site-based team of approximately five personnel, with staffing levels adjusted in line with project stage and activity requirements. Key roles included the Site Manager, HSSE Manager, Civil Site Engineer, and two Electrical Supervisors. This team was responsible for overseeing all on-site activities and ensuring compliance with safety, quality, and schedule objectives.

- **Commissioning Management**
  The Commissioning team comprised five full-time personnel, including a Commissioning Manager, two Commissioning Engineers (Electrical), and two Electrical Operators. The team ensured all systems were safely tested, commissioned, and handed over in accordance with project specifications and operational requirements.

All members of the project delivery and construction teams were locally based within Australia. No expatriate resources were engaged beyond their existing roles within the organisation.

Overall, the Project Delivery Team performed effectively, and no material issues were identified in relation to team performance, capability, or structure.

4.3 Grid connection and commissioning activities

4.3.1 Registration

Prior to energising and testing a generation system it is necessary to obtain registration from AEMO. In the case of DPESS there were multiple parties involved in the registration process.

EnergyAustralia is the registered participant acting as the intermediary for DPESS Pty Ltd, the Owner/Operator of the BESS. EnergyAustralia is the Financially Responsible Market Participant (FRMP) who submit market offers and settle all power transferred at the point of connection. EnergyAustralia therefore took the overall lead on the registration process.

Edify (working on behalf of the project entity) was responsible for providing technical details in relation to the registration including:

- The R1 connection studies and modelling package, which was a refresh of the R0 connection application updated for any changes resulting from the detailed design. This package was required to be reviewed in detail by the TNSP and AEMO prior to sign-off and was one of the last milestones to occur prior to release into testing.
- Organising for the SCADA control path to be commissioned and tested.
- Obtaining metering installation details which in turn were provided by Transgrid as the metering services provider.
- Providing other plant technical information.

Tesla as the EPC contractor were required to:

- Ensure that the SCADA signals were being provided to AEMO prior to registration and to complete point to point testing.
- Ensure that the protection systems were in operation and had been tested prior to registration.
- Provide ‘clearance to energise certificates’ for the BESS.

Overall, the registration process involved a number of different workstreams, where it was critical to ensure that all parties were completing the necessary requirements in a timely manner. Edify achieved this by using a dedicated grid connection responsibility matrix which outlined everyone’s responsibilities to obtain registration.

The Project also made use of a temporary exemption (notifiable exemption) from registration which could be used to energise the facility prior to connecting any inverters. This temporary exemption was useful when the due diligence of the R1 modelling was still ongoing but all other requirements of registration had been achieved. Note however, AEMO does not allow ‘hold point’ testing to occur under notifiable exemptions.

4.3.2 Commissioning and Testing

Following energisation, the Project went through a typical hold point testing program. Key learnings from this process were as follows:

- The approach of the TNSP and AEMO to attend the test and witness in real time was critical as it often allowed them to give permission for testing to proceed to the next stage based on there being no stability concerns while the details of the test outcomes were considered later.
- Any issues which were encountered in testing were able to be addressed at a later stage if they did not present a risk to the network in continuing other tests.

- The testing of grid forming inverters followed the same process for grid following and may be slightly easier due to responses being generally less likely to cause stability issues.

4.4 Risk and safety management

Risk management for a large-scale battery project focuses on identifying what could go wrong, understanding how likely those events are, and planning how to prevent or minimise their impact. The process starts by mapping out potential risks across all areas. These may be technical issues like battery faults, construction delays, supply chain problems, financial pressures, or safety incidents. Each risk is then assessed for how likely it is to occur and how severe its consequences would be, allowing the team to prioritise those that matter most.

Once the key risks are known, the project team develops strategies and actions to manage them. These may include using proven technology to avoid failures, designing in measures to reduce safety and environmental hazards, or taking out insurance to manage financial risk. Each risk has a clear owner responsible for monitoring it, and the risk register (a central record) is reviewed and updated as the project moves from design through to construction and finally into operation. In essence, risk management ensures the team is always thinking ahead, preparing for “what ifs,” and keeping the project safe, reliable, and financially sound.

A safety in design process was undertaken during which the design is scrutinised by experienced parties and assessed against a series of key words which are designed to trigger focused evaluation of each part of the design. These key words include gravitational hazards, fire/explosion, access and clearances, ergonomics, flood levels etc. The safety in design process is undertaken at various stages and addresses hazards that may arise during both construction and operational phases of the project.

A number of risk registers were developed at different stages of the project. This included the following:

- project development risk register developed and implemented by Edify which focused on risks applicable through the development process;
- design risk register which was developed through the safety in design process; and
- construction risk register managed by Tesla with ongoing contributions and close monitoring from Edify.

Key topics covered by the risk registers includes the following:

- working at heights;
- equipment failures;
- performing hot works;
- on-site vehicle movements and equipment clearances;
- works near electrically live equipment including lock-out/tag-out procedures;
- lifting and manual handling;
- heavy vehicle movements to/from site and on-site;
- local road use;
- loading and unloading;
- suspended loads;
- confined spaces;
- vehicle refuelling;
- driving to/from site;
- fatigue management;
- drugs and alcohol;
- excavations;
- bushfire;

- dangerous plants and animals;
- working outdoors (e.g. sun exposure, dehydration);
- use of mobile phones;
- waste management and hazardous waste;
- erosion and sediment control;
- civil earthworks;
- concrete pouring;
- contagious illnesses and COVID-19;
- site security; and
- inclement weather.

A safety management plan was developed which clearly set out the identified risks and agreed measures.

All of the documents were live throughout the design, construction and commissioning phases, meaning that ongoing reviews were undertaken and content was updated as appropriate as the project progressed and risks evolved.

The process was overall very successful, with safety risks appropriately managed and no material safety or environmental incidents occurring.

4.5 Environmental (and other) approvals

The Project was assessed and approved as a state significant development by the NSW Department of Planning and Environment (DPE). This occurred in parallel to the approval of the Darlington Point Solar Farm, which was considered the first stage of the approved project while the BESS was the second stage.

Due to changes in technology between the original approval and the Project's construction, a modification application was required to confirm the final layout and technology and also to assess a revised route of grid connection based on the final connection arrangement.

One key challenge for the Project in regard to the approvals was fulfilling the pre-construction conditions of the development approval. One of the pre-conditions to construction was obtaining endorsement of a fire safety study by DPE who in turn referred the plan to Fire Rescue NSW. While the Project was not the first large scale BESS in NSW, it was the first large scale BESS which Fire Rescue NSW had been consulted on and so the approval of the fire safety study took longer than expected. This was a key learning in regard to the need for early engagement with fire safety authorities in the relevant states. Ultimately we were able to partly mitigate this risk by agreeing that this condition could be delayed until the batteries were energised which allowed the Project to proceed while the fire safety study was revised and endorsed. There were no changes required to the layout of fire protection as a result of the studies.

5 Operational Experience

The Project has published the following public operational reports which provide details about the operational performance of the Project since commencement of operations. These are available on the ARENA website at the following locations:

- https://arena.gov.au/knowledge-bank/edify-energy-darlington-point-energy-storage-system-operations-report-1/
- https://arena.gov.au/knowledge-bank/edify-energy-darlington-point-energy-storage-system-operations-report-2/
- https://arena.gov.au/knowledge-bank/edify-energy-darlington-point-energy-storage-system-operations-report-3/

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Appendix A Glossary of Terms

Acronym	Meaning
AEMO	Australian Energy Market Operator
AGC	Automatic Generator Control
ARENA	Australian Renewable Energy Agency
ARP	Advancing Renewables Program
BESS	Battery Energy Storage System
BDU	Bidirectional Unit
BSSA	Battery Storage Services Agreement
CPP	Consolidated Power Projects Australia Pty Ltd
DNA	Designated Network Asset
DPESS	Darlington Point Energy Storage System
EEP	Emerging Energy Program (NSW Government)
Edify	Edify Energy Pty Ltd and its related entities
EPC	Engineering, Procurement and Construction
FCAS	Frequency Control Ancillary Services
FFR	Fast Frequency Response
FRMP	Financially Responsible Market Participant
GPS	Generator Performance Standards
GFL	Grid Following
GFM	Grid Forming
LFP	Lithium Iron Phosphate
NEM	National Electricity Market
NER	National Electricity Rules
NMI	National Metering Identifier
NSA	Network Support Agreement
NSP	Network Service Provider
O&M	Operations and Maintenance
PPC	Power Plant Controller

Project	DPESS
PSCAD	Power Systems Computer Aided Design
PSSE	Power System Simulator for Engineering
RES	Collectively, RESS1, RESS2 and DPESS
RESS1	Riverina Energy Storage System 1
RESS2	Riverina Energy Storage System 2
PFR	Primary Frequency Response
RIT-T	Regulatory Investment Test for Transmission
ROCOF	Rate of Change of Frequency
RRP	Regional Reference Price
RTE	Round-Trip Efficiency
SCADA	Supervisory Control and Data Acquisition
SOC	State-of-Charge
STATCOM	Static Synchronous Compensator
Syncon	Synchronous Condenser
TNSP	Transmission Network Service Provider