Darlington Point Energy Storage System

Operations Report #2

Project Name:	Darlington Point Energy Storage System
Contract Number:	2020/ARP05
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Darlington Point Energy Storage System has received funding from ARENA as part of ARENA's Advancing Renewables Program.

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Executive Summary

Edify Energy (Edify) has developed the Darlington Point Energy Storage System (DPESS) which is a 25MW / 50MWh Battery Energy Storage System (BESS) system located adjacent to the 275MW Darlington Point Solar Farm in NSW. DPESS comprises advanced grid forming inverters with the ability to provide system strength services to the NSW electricity network. The performance of the plant is being verified through an agreed Testing Plan. This Testing Plan was developed in consultation with Transgrid and AEMO and includes 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 through further knowledge sharing outputs.

This Operations Report is part of the Knowledge Sharing Deliverables under the ARENA Funding Agreement and is the second of four twice-yearly reports covering the technical and commercial performance of DPESS over the first two years of operation.

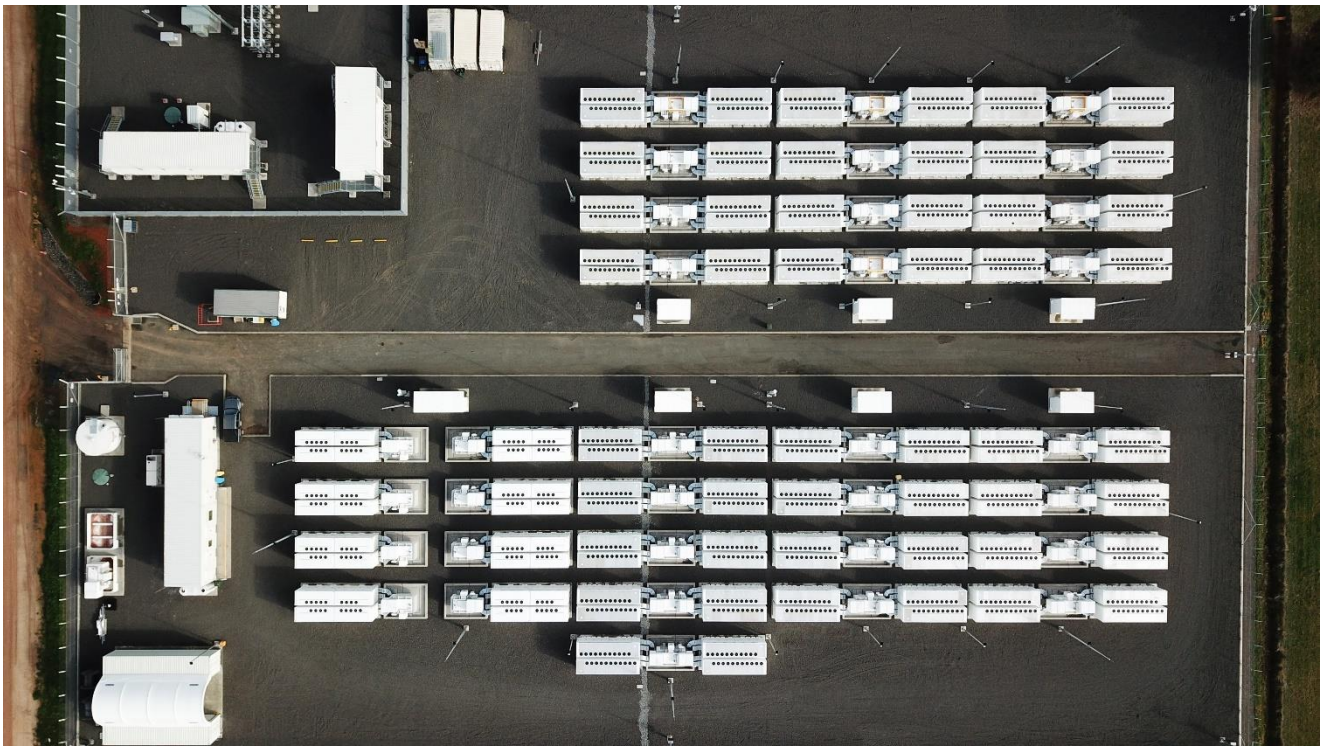
DPESS achieved commercial operations on 29 September 2023. This Operations Report focusses on the second six months of operations from 1 April 2024 to 30 September 2024 and considers:

- Charging behaviour, including participation in various energy markets;
- Technical performance;
- Financial performance;
- Safety and environmental performance; and
- An overview of testing performed as specified in the above Testing Plan.

1 Project details

1.1 Project overview

Edify developed the DPESS project which is 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.

1.2 Project objectives

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.

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 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

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

machines. 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 EnergyAustralia as operators

The revenues of DPESS are wholly captured in a long-term Battery System Services Agreement (BSSA) between DPESS and EnergyAustralia. The BSSA entitles EnergyAustralia to full operational rights over DPESS, as they relate to charge and discharge decisions 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.

The BSSA also provides EnergyAustralia with battery performance, availability and reliability commitments, subject to operational constraints, mainly relating to the implications of cycling frequency on warranted performance.

The battery purchase agreement provides DPESS with performance, availability and reliability commitments from Tesla.

1.4 Project update and status

The project achieved Commercial Operations on 29 September 2023 and has now been in operations for 1 year. The BESS has generally been operating as expected.

2 System strength performance

2.1 Assessment of provision of system strength

The assessment of the provision of system strength will be demonstrated in the wide area network model where the ability to stabilise renewable generation and a comparison to synchronous condensers will be undertaken. This assessment is ongoing and will be reported on in the Flagship Report.

There have been no new network events analysed in the past 12 months.

2.2 Improving stability in southwest New South Wales RIT-T

Following the conclusion of a RIT-T process looking into improving network stability in southwest New South Wales, the Project has recently entered into a contract with Transgrid to improve network stability. The Project is able to do this via the grid forming controls which the project aimed to demonstrate and was specifically preferred to alternative options including synchronous condensers.

The provision of this service is exciting as it is a tangible demonstration of the value of grid forming batteries.

Specifically, the BESS has now become included in one of the most binding constraints in the NEM and when the BESS is available it allows up to 120MW of additional capacity on a constrained section of the Transgrid network between Darlington Point and Wagga Wagga.

The update of the constraint was advised by AEMO in MARKET NOTICE 118323 issued on 19 September 2024.

This will allow for additional solar generation in the southwest of NSW.

3 Technical performance

3.1 Energy throughput and round-trip efficiency

DPESS has exported a total of 7,320 MWh for the 6-month period to September 2024. This is on average 39.93MWh per day relative to the beginning of life storage capacity of 50MWh. This is a cycle rate of lower than 1 cycle per day.

The total imported energy over this same period was 8,561 MWh resulting in a total round-trip efficiency (RTE) of 85%. The total imported energy is slightly higher than the previous 6 months, due to fewer network outages during the period. It is noted that this is an all-inclusive RTE at the point of connection and includes all BoP losses as well as standby losses when the BESS may be idle. RTE is generally tested via a bespoke charge and discharge test which excludes these standby losses resulting in a higher RTE. This test was conducted at the end of Year 1.

Table 1 summarises the charge and discharge cycle outcomes for the 6-month period to September 2024. It is noted that the base case operating profile for the BESS is a single discharge cycle per day. At the beginning of life this was a full 2 hrs per day representing a 8.33% capacity factor with this then reducing through life as energy retention degrades. In year 2 the expected capacity factor for a single cycle per day would be approximately 7.5%. The actual capacity factor has been slightly below this.

The reason the capacity factor is lower in September is due to the planned network outage requested by Transgrid between the 20th and 28th of September. These events had a significant impact on the capacity factor because the assumption for capacity factor calculation is one cycle per day. However, during the outage periods, the site was limited to 0MW, resulting in no generation and a lower capacity factor for those days. On average, the table below shows the BESS discharged less than 1 cycle per day for the 6-month period to September 2024.

Table 1 Charge and discharge cycle summary: April 2024 to September 2024

Parameter	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	6-month period
Charge energy (MWh)	1,550	1,407	1,402	1,652	1,718	833	8,561
Discharge energy (MWh)	1,337	1,188	1,183	1,442	1,463	708	7,320
Discharge capacity factor	7.4%	6.4%	6.6%	7.8%	7.9%	3.9%	6.7%
Total RTE%	86%	84%	84%	87%	85%	85%	85%

Table 2 and Table 3 outlines the BESS' participation the various FCAS markets. The reason for the lower participation in September is due to the planned network outage mentioned above.

Table 2 Percentage of intervals enabled for FCAS: April 2024 to September 2024

Product		Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24
Lower	Regulation	100.00%	100.00%	100.00%	98.21%	97.72%	65.02%
	Delayed	100.00%	100.00%	100.00%	98.19%	97.67%	65.01%
	Slow	100.00%	100.00%	100.00%	98.19%	97.68%	65.01%

Product		Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24
	Fast	100.00%	100.00%	100.00%	98.19%	97.67%	65.01%
	Very Fast	100.00%	100.00%	100.00%	97.86%	97.61%	65.01%
Raise	Regulation	100.00%	100.00%	100.00%	98.22%	97.75%	65.01%
	Delayed	100.00%	100.00%	100.00%	98.19%	97.92%	65.02%
	Slow	100.00%	100.00%	100.00%	98.19%	97.92%	65.02%
	Fast	100.00%	100.00%	100.00%	98.19%	97.92%	65.02%
	Very Fast	100.00%	100.00%	100.00%	98.20%	97.92%	65.02%

Table 3 Average MW enabled for FCAS: April 2024 to September 2024

Product		Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24
Lower	Regulation	9.33	9.05	9.59	9.04	9.35	6.84
	Delayed	4.82	4.47	4.41	4.53	4.84	3.38
	Slow	4.82	4.46	4.40	4.52	4.85	3.39
	Fast	4.81	4.39	4.42	4.52	4.83	3.38
	Very Fast	3.91	3.59	3.71	3.73	4.46	3.14
Raise	Regulation	9.34	9.12	9.61	9.99	9.53	6.30
	Delayed	4.96	4.97	4.97	4.80	4.84	3.46
	Slow	4.98	4.94	4.97	4.79	4.85	3.47
	Fast	4.98	4.96	4.97	4.81	4.84	3.48
	Very Fast	5.38	5.18	5.08	5.13	4.95	3.61

3.2 Energy degradation

The estimated full pack energy of the system has degraded by approximately 7% from the commencement of commercial operation which is line with expectations for lithium-ion batteries. The rate of degradation of lithium-ion batteries decreases over time.

3.3 Availability

The availability for DPESS has been higher than expected, with an average availability of 99.4% over the period. The higher availability during this period compared against the prior 6-month period can be attributed to the resolution of the plant's initial teething issues, which significantly improved operational stability and system performance.

Table 4 Availability: April 2024 to September 2024

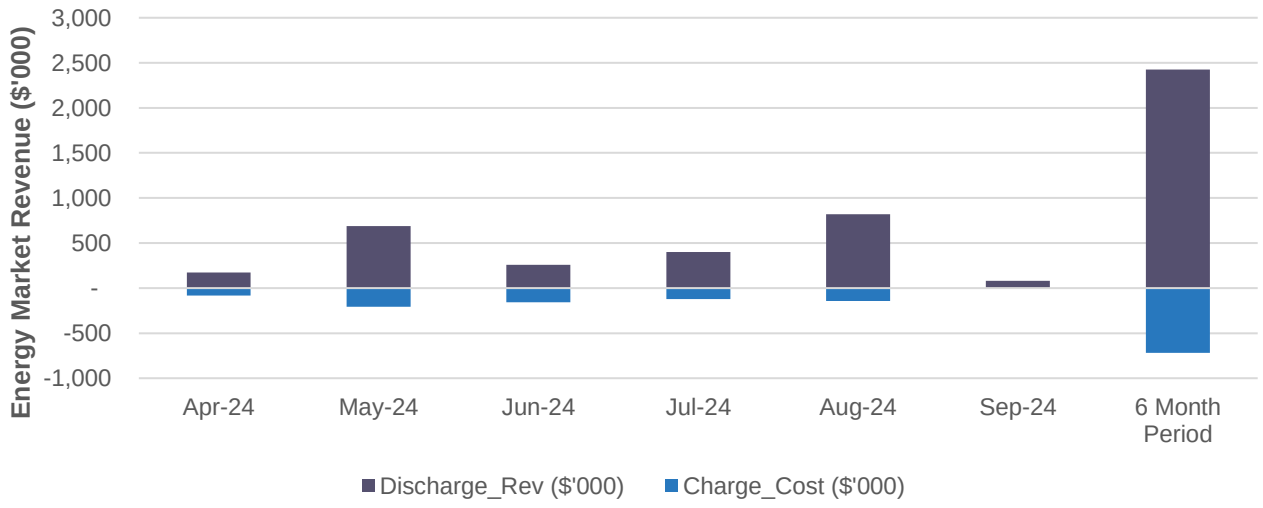
Parameter	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	6-month period
Availability	99.6%	99.4%	99.8%	99.5%	98.5%	99.9%	99.4%

4 Financial performance

As noted earlier, DPESS commenced commercial operations on 29 September 2023. DPESS was registered to provide FCAS services from 20 November 2023 and participation in the new 1s Lower and 1s Raise FCAS (VFFCAS) commenced from 29 February 2024.

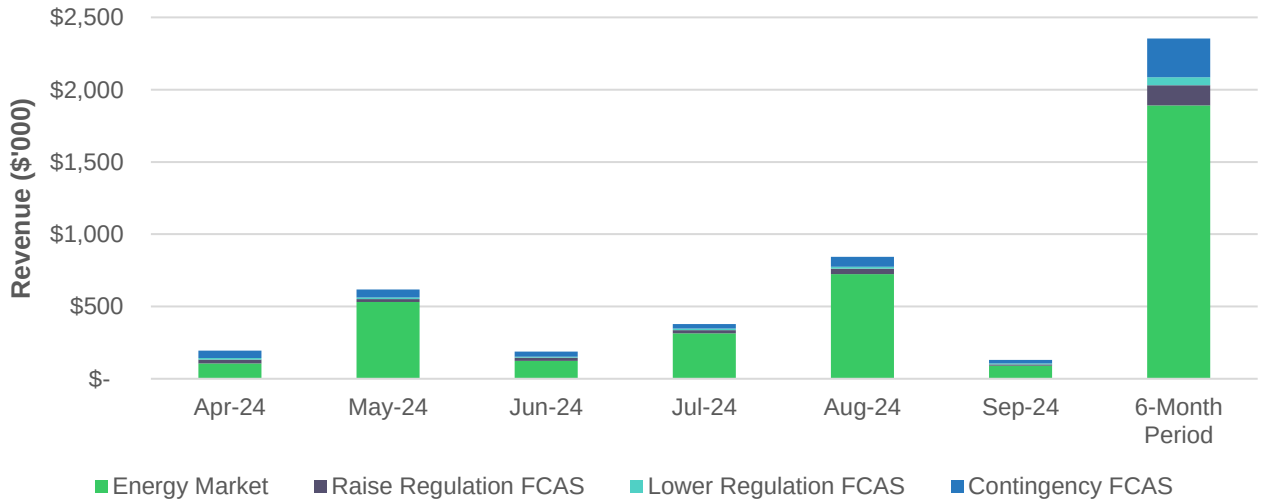
The average discharge price for DPESS between April 2024 and September 2024 was $313.82/MWh, with an average charging price of $79.69/MWh.

Figure 1 Energy Market Revenue and cost per month



The chart (see Figure 2) displays the monthly energy market margins and the value captured from various FCAS markets as they became operational. The contingency markets have significantly boosted the overall revenue across all FCAS segments.

Figure 2 Financial performance of DPESS in different Markets



From an energy market perspective, Figure 3 and Figure 4 outline the average operational profile of DPESS and Figure 5 shows trading interval prices in NSW respectively. As can be expected, DPESS operations have largely mirrored the trends in energy market prices. Typically, it discharges during the morning and evening peak periods when prices are highest and charges during midday when prices are often negative.

Figure 3 DPESS charge MW during the day per month (per 5-minute Trading Interval)

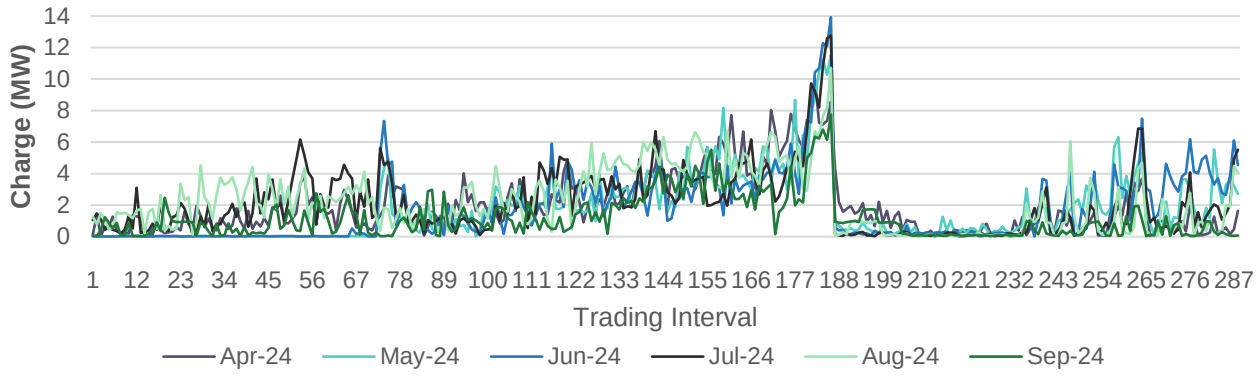


Figure 4 DPESS discharge MW during the day per month (per 5-minute Trading Interval)

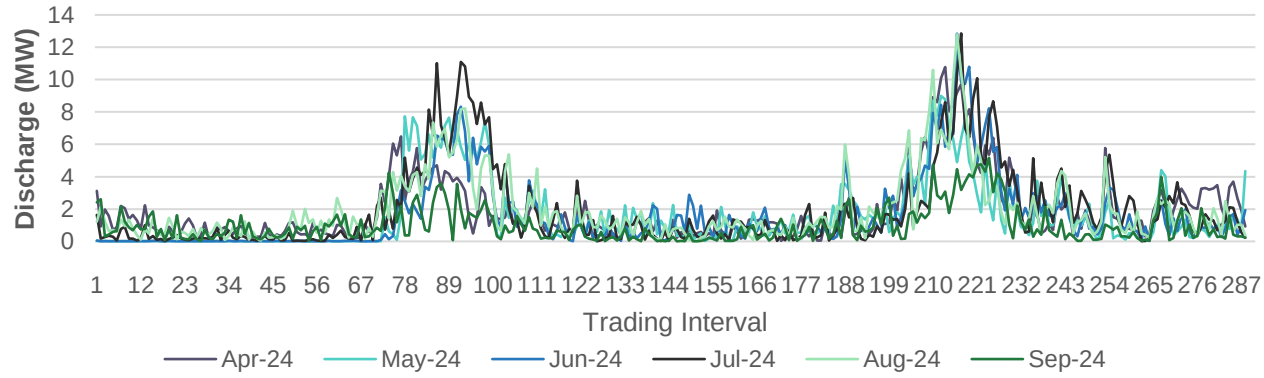
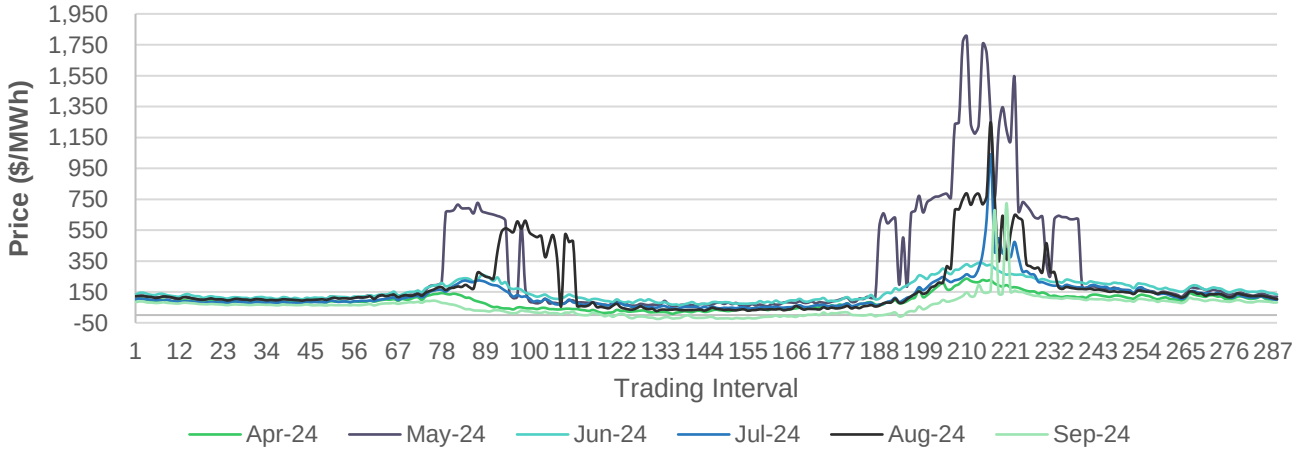


Figure 5 NSW RRP during the day per month (per 5-minute Trading Interval)



5 Safety and environmental performance

The combined Riverina and Darlington Point Energy Storage Systems consists of three individual but co-located BESS units, including DPESS. Over the six-month period ending in September, DPESS recorded no reportable safety or environmental incidents.

The operations and maintenance contractor responsible for oversite of safety on the site has safety procedures in line with good industry practice. This includes ensuring that correct isolations are in place for works to be undertaken and using lock-out procedures to prevent unintended re-energisation. The O&M contractor reviews the work plans of any contractor doing works on the site.

The safety record of the facility reflects the inherent safety architecture aspects of the battery system that includes:

- Individual cell testing prior to module assembly to ensure flawed cells are not introduced into the battery system;
- Battery units are fully sealed to prevent thermal spread and have dedicated management systems that monitor individual cells to ensure they are operated within safe parameters;
- Batteries are contained in weather-proof steel enclosures with monitoring and operation optimised to reduce the risk of cascading failure of pods;
- Compliance with national and international safety standards; and
- Exceedance of standards related to fire safety and propagation resistance to thermal runaway within individual cells.

An external safety audit has been scheduled to be undertaken after the first year of operation. This is to evaluate the effectiveness of the current safety protocols and identify any areas for possible improvement in policies.

6 Glossary of Terms

Acronym	Meaning
AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
ARP	Advancing Renewables Program
BESS	Battery Energy Storage System
BSSA	Battery Storage Services Agreement
DPESS	Darlington Point Energy Storage System
Edify	Edify Energy Pty Ltd and its related entities
FCAS	Frequency Control Ancillary Services
FFR	Fast Frequency Response
NEM	National Electricity Market
O&M	Operations and Maintenance
Project	DPESS
RESS1	Riverina Energy Storage System 1
RESS2	Riverina Energy Storage System 2
RRP	Regional Reference Price
RTE	Round-Trip Efficiency
SCADA	Supervisory Control and Data Acquisition
SOC	State-of-Charge