Darlington Point Energy Storage System

Lessons Learnt Report #1

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 has developed the Darlington Point Energy Storage System (DPESS) which will be a 25MW / 50MWh large scale battery storage (LSBS) system located adjacent to the 275 MW Darlington Point Solar Farm in NSW. DPESS comprises advanced inverters with the ability to provide system strength services to the NSW electricity network. The performance of the plant will be verified through an agreed Testing Plan. The Testing Plan will be developed in consultation with TransGrid and AEMO and is expected to include a combination of power system studies, commissioning tests, and ongoing performance monitoring. The findings of the Testing Plan and any other key learnings will be disseminated though knowledge sharing outputs.

This first Knowledge Sharing Report is issued at Milestone 2, Delivery of Major Equipment. The report specifically addresses lessons learnt in the connection application process and the approach to design and construction for an advanced inverter plant compared against a traditional grid following plant.

Project Details

Project Overview

Edify Energy has developed the Darlington Point Energy Storage System (DPESS) which will be a 25MW / 50MWh large scale battery storage (LSBS) system located adjacent to the 275 MW Darlington Point Solar Farm in NSW (also developed by Edify Energy). DPESS has been under construction since reaching financial close[1] at the end of May 2023 and is forecast to be operational in Q3 2023.

DPESS connects to TransGrid's 132kV network at Darlington Point Substation and involves the use of advanced inverters set to "grid forming mode" (also known as "virtual machine mode") which is a unique feature that can provide system strength services to the grid.

Project Objectives

DPESS principally aims to demonstrate that an LSBS 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 in future projects.

DPESS aligns with the objectives and desired outcomes of ARENA's Advancing Renewables Program (ARP)[2] 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:

[1] Financial Close is the point in time where a project has become fully funded (by equity funding and/or debt funding) and the key delivery contracts (e.g. the construction and equipment supply contracts) have been executed.
[2] https://arena.gov.au/assets/2017/05/ARENA_ARP_Guidelines_FA_Single_Pages_LORES.pdf

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 update; and
e) increased skills, capacity and knowledge relevant to renewable energy technologies.

LSBS projects using advanced inverters offer several key benefits to the electricity network.

a) **Removes the need for synchronous condensers:** LSBS projects with advanced 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. Therefore, removing the need for such machines significantly reduces the cost and risk profile associated with connecting renewable energy projects in weak grids.
b) **Provides system strength services:** LSBS projects with advanced inverters provide system strength remediation services (i.e. frequency and voltage stabilisation, fast disturbance event response) 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 which such projects can deliver.
c) **Stabilises extreme electricity prices:** LSBS projects help to stabilise extreme electricity prices by discharging their energy during high demand/high price events.

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

LSBS 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 LSBS projects in Australia.

Key Learnings

Lesson Category

Technical/regulatory (connection application process)

Detail

In order to connect a generator to the network, the project proponent must submit a connection application to the relevant Network Service Provider (NSP) and the Australian Energy Market Operator (AEMO). The connection application process is intended to assess whether the proposed project will have any adverse impact to network stability and to agree strict generator performance standards (GPSs) which define the limits within which the generator must operate at all times. The relevant NSP for DPESS is TransGrid.

Edify Energy understands that this was one of the first projects to progress through the grid application process using inverters in grid forming mode which presented some unique challenges in order to agree on suitable performance standards and obtain acceptance of the connection application.

Key lessons learnt

Need for updated performance standards templates

The current GPS templates which are used for LSBS projects are adaptations of GPS templates used for grid-following inverter-based generators, which themselves are adaptations of GPS templates used for conventional thermal generators (e.g. coal generators). As Edify Energy progressed DPESS through the connection application process, it became apparent that these adapted GPS templates are not well suited to assessing advanced grid-forming inverter-based generators and do not capture the performance characteristics of grid forming inverters.

One example experienced during the connection application process for DPESS was rejection of a configuration which provided an optimal grid outcome because the manner in which the outcome was achieved did not meet the norms set by thermal generators. In this example, tuning the plant controller to provider higher inertia increased the rise and settling times beyond the limits allowed by the GPS templates. Modelling indicated that the higher inertia offered would provide improved outcomes for the network in terms of network voltage during and after certain faults.

The opinion of Edify Energy is that greater flexibility should be given to the network engineers at AEMO and the NSP to agree to optimal settings for the network which may be outside the norms.

Education

It was critical to maintain a clear and consistent message on the purpose and differences of the grid forming versus grid following performance to prevent going off on tangents in the review process. At the commencement of the process a briefing was held outlining the core performance differences and future conversations were tied back to this for context.

Direct OEM involvement

Direct involvement of the original equipment manufacturer (OEM) throughout the due diligence process proved beneficial. No-one understands the controller characteristics as well as the OEM and protection of intellectual property often leads to the consultants who are carrying out the network studies not having the full information and understanding which the OEM might have. This makes the involvement of the OEM critical to understanding certain characteristics.

Other

It was important to focus on behaviour differences of advanced inverters in grid forming versus grid following as it related to maximising network benefits vs tuning to automatic or minimum requirements.

It was important to agree generator performance clauses directly impacted by the advanced inverter performance early.

Key outcomes

- 5.3.4A and B letters were issued within 6 months of submission of Connection Application deliverables as defined in the AEMO checklist. This demonstrates that while the generator performance standard template may require adapting in the longer term, it has been possible to connect grid forming inverters.
- Only one major revision of the pack deliverables occurred during the due diligence process which is considered a positive outcome.
- Specific attention was required to the drafting of clause S5.2.5.5 as it relates to grid forming operation.
- The successful outcomes drew upon ongoing works on advanced inverters by both TransGrid as the NSP, and AEMO.

Implications for future projects

Early and regular communication with the NSP and AEMO together with involvement of the OEM were crucial in obtaining timely registration in the Connection Application process. It is noted that each of the involved parties have been drawing upon this and other ongoing works on advanced inverters which should benefit future projects of this type.