Mortlake Power Station Battery Project

Lessons Learnt Report No.1
(1 February to 31 May 2024)

Report Reference	**MB1-OE-PJM-RPT-000001**
Version:	**1**
Period End:	**31 May 24**
Date of submission:	**30 May 2024**
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This Project received funding from the Australian Renewable Energy Agency (ARENA) as part of ARENAs Advancing Renewables Program.

Contents

1 Abbreviations

- ARENA - Australian Renewable Energy Agency
- BESS - Battery Energy Storage System
- GFM - Grid Forming Model
- GPS - Generator Performance Standard
- HF - Harmonic Filters
- HV - High Voltage
- kV - Kilo Volt
- OEM - Original Equipment Manufacturer
- Origin - Origin Energy Power Limited
- MPS - Mortlake Power Station
- MW - Megawatt
- MWh - Megawatt hour
- Pty Ltd - Proprietary Limited
- SMA - SMA Solar Technology AG.

2 Executive Summary

This is the first Lessons Learnt Report prepared for Mortlake Battery Energy Storage System (**BESS**) Project (**Project**).

The Project is currently in detail design stage and construction works at Project site are expected to be commenced by mid of July 2024.This Lessons Learnt Report has been prepared to provide information in relation to the Project's development, construction, commissioning and testing.

This Lessons Learnt Report covers the following:

1. The requirement for harmonic filters on the 500kV grid connection side of the BESS development, to cope with grid stability issues rather than directly BESS issues, and

2. Original Equipment Manufacturer's ability to provide a full suite of the necessary technical detail at a sufficiently early stage to allow for timely completion of GPS models associated with connection applications.

3 Project background

The Project is a 300MW/650MWh BESS project being developed by Origin Energy Power Limited (Origin) on land adjacent to Origin's existing gas fired power station located in Mortlake, Victoria.

The Project is being constructed by Fluence Energy Pty Ltd.

The Project received funding from ARENA as part of ARENAs Advancing Renewables Program.

The Project will utilise SMA inverters and will be commissioned with grid-forming functionality enabled. The grid-forming inverters will be tuned to improve system stability in Victoria.

Advanced inverters, also known as grid-forming inverters, enable BESS to provide essential system services traditionally provided by synchronous generation (such as coal or gas) and are expected to play a large role in supporting a future grid capable of operating with 100% instantaneous renewable generation.

The Project will connect into the grid at the existing AusNet 500kV switchyard at Mortlake Power Station via a new substation.

4 Key Learnings

Sr.nr	Category	Lessons learnt title	Details	Implications for future projects
1	Technical	Harmonic Filter	During development of the GPS model it has been determined that the existing condition of the HV Grid at the Mortlake Power Station requires the installation of 500kV harmonic filters (**HF**) to deal with HV grid issues rather than with BESS issues.	The cost and need for HFs on the HV side of generation projects to deal with existing grid performance issues is generally not a recognised issue or need. The cost of grid size HF is magnitudes higher than that of generator side HF and may in some instances significantly affect the economics of a new project and thus its viability.
2	Technical	Model Transparency	Original Equipment Manufacturer's ability to provide a full suite of the necessary technical detail at an early stage to allow for timely completion of GPS models associated with connection applications	Improved efficiency of model tuning process and in the reduction of timeline of preparing acceptable GPS modelling based on Grid forming basis

4.1 Harmonic Filters

Category: Technical

Detail:

During the GPS model development for the Project harmonics were determined to be a connection issue of concern. Initially harmonic filters were modelled on the BESS side of the connection prior to 33kV to 500kV transformation, however this did not resolve the harmonic concerns within the HV Grid. It was thus determined, as the harmonic issues were inherent issues within the existing HV Grid, that harmonic filters were required to be sized on the HV side of the connection to deal directly with the existing HV Grid issues.

Lessons Learnt:

That the existing HV Grid can have unrecognized harmonic issues that are not determined as existing until full GPS modelling is underway. As full GPS modelling does not generally commence until a project has capital expenditure approval and the BESS equipment technology is not determined until capital approval, then there is a significant risk to the project's approved cost, schedule and proposed plot plan due the need to include harmonic filters on the HV Grid connection side of the development. Such risk should be considered for any future developments.

Implications for Future Projects:

The additional cost and schedule impacts of installing harmonic filters on the Grid connection side could make further projects uneconomic to proceed, thereby deaccelerating the transition to more sustainable and renewable energy solutions. A recent study (Management of Harmonic Distortion for Large Renewable Energy Generation) by The University of Wollongong (Australia), funded by ARENA, concluded that "*an approach which is network focused as opposed plant focused will be better able to detect areas where harmonic distortion levels are problematic and also provide more efficient and targeted mitigation*". That study's findings support Origin's experience.

4.2 Model Transparency

Category: Technical

Detail:

Given the relative novelty of grid-forming technology, there is no standardised design norm in the industry. Each inverter Original Equipment Manufacturer (**OEM**) may approach grid-forming capabilities differently and tend to protect their intellectual property by withholding detailed technical information. While a technical memorandum outlining basic Grid Forming Model (GFM) algorithms was provided, unlike a comprehensive technical manual, it lacked sufficient details for modelling activities. For example, the memorandum mentioned two control modes within GFM functionality— inertia mode and droop mode—but did not clarify that these modes are mutually exclusive. This oversight led to initial incorrect assumptions by the modelling engineer and delayed the modelling exercise by approximately a month to identify and then resolve the issue.

Lessons Learnt:

Grid connection modelling is highly specialized and labour-intensive. Each setting update requires at least two weeks for full verification as hundreds of tests must be reviewed against performance standards. Without a clear technical manual being provided by the OEM, the modelling engineer is forced to use trial and error to determine the most suitable settings, which significantly increases both time and cost associated with conducting the modelling.

Implications for Future Projects:

From a developer's perspective, future projects may prefer well-established products to avoid delays caused by uncertainties in grid modelling. This preference might negatively impact market competition for inverters. Alternatively, transparency and maturity of the models need to be prioritised when selecting suppliers.

OEMs should carefully consider the necessity of maintaining such high levels of confidentiality, which might deter potential customers due to the added uncertainty in modelling activities. Market feedback indicates that the competitive edge in the inverter manufacturing industry lies more in the practical know-how than in specific algorithms or control diagrams. Consequently, the lack of transparency in modelling poses a greater concern. It is recommended that OEMs strive to improve transparency to the greatest extent possible.

5 Conclusion

During the reporting period there have been two reportable lessons learnt that deserve knowledge sharing and they both relate to early engagement activities.

Grid forming capability of inverters is a relatively new requirement and is protected technology from the respective OEMs. This creates an environment whereby OEMs will tend to protect the technology rather than openly engage in detailed technical discussions in early phases of GPS modelling. Being aware of the reasons for this constraint will assist proponents in developing strategies to have OEMs release the required technical data necessary to maintain a forward moving path for GPS modelling.

Although the need to filter harmonics within a new generation facility is a recognised risk and/or need that may not be resolved until detail design and securing of major equipment has been well progressed, we have discovered that there may be harmonic issues within the performance of the existing Grid not caused by the new generation facility that require a new project's attention prior to connection approval. The need for a Grid focused resolution of existing Grid harmonic issues rather than a project-by-project resolution has been recognised and recommended by an independent study of this dynamic.

6 Photography and images

Photo of ARENA required sign placed at entrance to MPS