# Demand Management Innovation Allowance Report – 2019

19.02.20

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# 1. Introduction

During the 2019 calendar year, United Energy (UE) undertook the following initiatives funded from the Demand Management Innovation Allowance (DMIA):

a) Commenced the Grid-Side Battery Energy Storage System (BESS) pilot project detailed in this DMIA report and supported the closure of the preceding Virtual Power Plant (VPP) trial.

b) Concluded enhancements to the UE Summer Saver (voluntary residential demand response) program detailed in UE's 2018 DMIA report..

This report and its attachments deliver the annual reporting requirements for work undertaken on these initiatives during 2019 and documents the outcomes and learnings. Further details are presented below.

# 2. Regulatory Requirement and Compliance

The AER, in its Demand Management Innovation Allowance applied to UE for the 2016-2020 regulatory period, sets certain criteria and reporting requirements for expenditure from the DMIA. These are detailed below along with a description of how UE complies with each of these requirements for each project.

## 2.1 Grid-Side Battery Energy Storage Systems Pilot Project

***1. Demand management projects or programs are measures undertaken by a DNSP to meet customer demand by shifting or reducing demand for standard control services through non-network alternatives, or the management of demand in some other way, rather than increasing supply through network augmentation.”***

The LV grid-side BESS pilot aims at shaving the peak demand on the network by charging the battery during low demand periods i.e. overnight or mid-day when solar PV generation is at its maximum and discharging the battery during early evening when the demand on the UE network is at its maximum. LV BESS pilot is an extension to UE’s VPP project which looked at installing solar PV and battery storage behind customer meters and aggregating the VPP units in providing network support.

As part of this pilot, UE will be partnering with retailers to test the potential market benefits that can be derived by installing batteries on the LV network. This could help close the current economic gap between the cost of installing BESS against traditional augmentation.

***“2. Demand management projects or programs may be:***

***(a) broad-based demand management projects or programs—which aim to reduce demand for standard control services across a DNSP’s network, rather than at a specific point on the network. These may be projects targeted at particular network users, such as residential or commercial customers, and may include energy efficiency programs and/or***

***(b) peak demand management projects or programs—which aim to address specific network constraints by reducing demand on the network at the location and time of the constraint.”***

The LV BESS pilot is sought to address specific network constraints by reducing demand on the network at the location and time of the constraint. It is intended to locate such units in areas where there are identified network constraints. In the first instance, this is likely to be in areas where there are significant distribution transformer constraints. Ultimately, the goal is to alleviate constraints higher up in the network such as at the distribution feeder or zone substation level.

***“3. Demand management projects or programs may be innovative, designed to build demand management capability and capacity and explore potentially efficient demand management mechanisms, including but not limited to new or original concepts.”***

LV Grid-Side BESS pilot offers a new solution for a constrained network area, particularly where load growth is low, uncertain or is expected to plateau in future. The ability to provide incremental amounts of capacity through combining renewable generation and storage to meet the demand as it materialises could be economic against a more traditional network solution that provides significant step increases in capacity at higher cost.

As part of this pilot, UE aims to install BESS systems on LV poles to manage the loading on distribution transformers and LV circuits. Installing grid batteries on LV poles is an innovative new approach to manage loading on the LV network. On completion of this pilot, this would be first pole top BESS units installed in Australia.

***“4. Recoverable projects and programs may be tariff or non-tariff based.”***

The LV Grid-Side BESS projects are non-tariff based.

***“5. Costs recovered under the DMIA:***

***(a) must not be recoverable under any other jurisdictional incentive scheme***

***(b) must not be recoverable under any other Commonwealth or State/Territory Government scheme and***

***(c) must not be included in forecast capital or operating expenditure approved in the distribution determination for the regulatory control period under which the DMIS applies, or under any other incentive scheme in that determination."***

Costs recovered under the DMIA for the LV Grid-Side BESS pilot are costs incurred by UE in procuring expert consulting services, equipment and installation services for the project.

In 2019, UE has commenced the design, procurement and construction of Stage 2 of the project, the LV Grid-Side BESS pilot. The first two units have been procured to be installed in the UE network. UE has engaged a contractor to design, build and deliver these units. The first unit will be installed on the UE network in February 2020. In 2019, cost was incurred for the design and procurement of the equipment.

These costs have not been recovered from any other scheme. The costs do not include labour for UE employees' time toward this project. This cost is absorbed by the organisation and is regarded as in-kind contribution towards the project.

***"6. Expenditure under the DMIA can be in the nature of capital or operating expenditure. The AER considers that capex payments made under the DMIA could be treated as capital contributions under clause 6.21.1 of the NER and therefore not rolled into the regulatory asset base (RAB) at the start of the next regulatory control period. However, the AER's decision in that regard will only be made as part of the next distribution determination."***

All costs incurred by UE under the DMIA for the projects are classified as operating expenditure.

# 3. DMIA Reporting

The information contained in this report is suitable for public publication.

The AER requires that a DNSP's annual report must include the following for each project.

## 3.1 Grid-side Battery Energy Storage Systems Pilot Project

***1. The total amount of the DMIA spent in the previous regulatory year, and how this amount has been calculated.***

UE had $654 excl. GST of expenses during the 2019 calendar year on activities associated with the DMIA for VPP trial. This ongoing operational expense (such as sim cards to enable remote control and continuous live monitoring of the systems) was associated with the unit installed at UE Burwood maintenance depot.

In 2019 UE has commenced the LV Grid-Side BESS pilot by engaging a contractor to design and deliver two BESS units to be installed in UE network. A total of $465,434 was incurred against this project for expert design services and in procuring the BESS units. This pilot project is funded from UE capex budget and from DMIA allowance. DMIA will be funding 82.5% of the project cost with the remaining 17.5% coming from UE capex budget. Based on this proportion, in 2019 DMIA will be contributing $384,168 for the LV BESS project.

***2. An explanation of each demand management project or program for which approval is sought, demonstrating compliance against the DMIA criteria in section 3.1.3 with reference to:***

***(a) the nature and scope of each demand management project or program***

Grid-Side BESS pilot looks at expanding UE's learnings from the VPP trial to install grid-side batteries on the LV network. This pilot does not have any solar PV systems installed as part of the project. However, the aim of the pilot is to charge the battery during low demand period i.e. overnight or mid-day when solar PV generation is at its maximum and discharge during peak demand period to manage the loading on UE LV network.

The aggregated BESS units will be used to test the market benefits of LV grid batteries and in future used to manage the loading on upstream assets as more and more battery systems are installed on the LV network.

***(b) the aims and expectations of each demand management project or program***

The objective of the project is to use the BESS system to manage the existing load on the distribution transformer and LV circuit.

Traditional network solutions usually result in sunk capital; the resulting augmented asset cannot be easily recovered and used elsewhere if future demand falls. This project aims to validate or otherwise, the use of grid-side batteries solution on LV networks for the provision of efficient and prudent network augmentation. The solution will be validated if it:

- effectively avoids/defers Capex/Opex requirements in a prudent and efficient manner
- is the most economic outcome when actual costs and benefits are known
- is a technically appropriate solution with appropriate mitigation of any risks.

The objectives of this pilot are to validate LV BESS as a suitable approach for managing augmentation on the UE distribution network with no adverse impacts to network reliability and safety. The LV BESS pilot aims are:

- evaluate the performance of the grid-side BESS as one of UE's range of options available for rectifying sites experiencing overload operating conditions to deliver the benefits of traditional augmentation
- confirm the total cost to supply and install the grid-side BESS (for use in future business case options analysis)
- evaluate the potential of using BESS units in managing the quality of supply and in enabling higher level of solar penetration on distribution networks
- evaluate the grid-side BESS products (build quality, reliability, standard adherence, operational experience, etc.)

- develop the design, specification, construction, maintenance and operations skills needed to manage this potential fleet of new assets
- determine the benefits of using grid-side BESS technology on the UE network including market revenue (for use in future business case options analysis and to inform the business model for LV grid-side storage) by partnering with one or more retailers for the duration of the pilot.

***(c) the process by which each project or program was selected, including the business case for the project and consideration of any alternatives***

This pilot proposes LV BESS as a solution to address peak demand issues in low-voltage feeders and distribution transformers when augmentation costs using traditional solutions are high. It is anticipated that in the future, energy storage would have applications for the entire network as costs continue to fall.

***(d) how each project or program was/is to be implemented***

Stage 1 which is essentially complete consisted of a VPP system comprising 13 installations at residential sites totalling 50kW. Stage 1 was operated over an extended period to test the economics and commercial models and understand the technology's capabilities, limitations and suitability for larger scale deployment.

Stage 2 of this project involves installing grid-side LV storage systems to manage the loading on distribution substation and LV circuits. As part of this project, UE has identified three constrained distribution substations to install the BESS systems. UE has completed the design and procurement of two BESS units. The first BESS units will be installed by February 2020.

***(e) the implementation costs of the project or program***

In April 2018, UE submitted application to the AER to use part of the 2016-2020 DMIA funding to support Stage 2 of the project, LV Grid-Side BESS pilot on capacity constrained part of UE LV network. AER provided indicative approval for the project on May 2018. The proposed stage 2 of the program is estimated to cost $945,000 with DMIA funding $780,000 with the remaining $165,000 coming from UE capex budget by differing the augmentation of the LV network.

***(f) any identifiable benefits that have arisen from the project or program, including any off peak or peak demand reductions.***

UE has identified a number of constrained locations around the UE network where deployment of LV grid-side BESS is able to achieve peak demand reductions economically.

***3. The costs of each demand management project or program:***

***(a) are not recoverable under any other jurisdictional incentive scheme,***

***(b) are not recoverable under any other state or Commonwealth government scheme, and***

***(c) are not included in the forecast capital or operating expenditure approved in the AER's distribution determination for the regulatory control period under which the DMIS applies, or under any other incentive scheme in that determination.***

- Expenditure under DMIA is not eligible for recovery under any other jurisdictional incentive scheme.
- Expenditure under DMIA is not eligible for recovery under any other state or Commonwealth government scheme.
- Expenditure under DMIA has not been approved in the AER's distribution determination for the regulatory control period under which the scheme applies, or under any other incentive scheme in that determination.

***4. An overview of developments in relation to projects or programs completed in previous years of the regulatory control period, and of any results to date.***

Not applicable.

# 4. Grid-Side Battery Energy Storage Systems (BESS) Pilot Project

After successfully completing a successful customer-based Battery Energy Storage System (BESS) Programme for the Australian Renewable Energy Agency (ARENA), United Energy (UE) decided to expand the learnings generated from this programme and those from earlier Virtual Power Plant (VPP) pilots funded by DMIA to trial grid-side BESS solutions on three constrained distribution substations during 2019/2020.

Therefore, in 2019 UE submitted an application with the AER to use part of the 2016-2020 DMIA allowance to support the development of the low voltage (LV) grid-side BESS pilot project.

With rapidly falling BESS prices, UE is planning to explore the use of grid-side controlled-BESS technology as a network support asset, in developing an incremental approach, to address immediate capacity shortfalls and defer traditional network augmentation solutions.

The objective of the pilot is to:

- evaluate the performance of the grid-side BESS as one of UE's range of options available in rectifying sites experiencing overload operating conditions, to deliver the benefits of traditional augmentation
- confirm the total cost to supply and install the grid-side BESS (for use in future business case options analysis)
- evaluate the potential of using BESS units in managing the quality of supply and in enabling higher level of solar photovoltaic (PV) penetration on distribution networks
- evaluate the grid-side BESS products (build quality, reliability, standard adherence, operational experience, etc.)
- develop the design, specification, construction, maintenance and operations skills needed to manage this potential fleet of new assets
- determine the benefits of using grid-side BESS technology on the UE network including market revenue (for use in future business case options analysis and to inform the business model for LV grid-side storage) by partnering with one or more retailers for the duration of the pilot.

On completion of the pilot, it is expected that the grid-side BESS could be taken into consideration as an option in addressing overloaded distribution substations and LV circuits which lead to asset failure and outages where there is potential for it to be economic against traditional network augmentation.

## 4.1 Pilot Need

In 2016-2017, a Canadian distribution company, Toronto Hydro, successfully deployed pole-mount grid-side BESS. It is proposed to build on the learnings from such trials to accelerate the transition of the technology from trials to business-as-usual (BAU) applications of the BESS technology to assist in managing power demand and quality on the distribution network.

The installation at the selected constrained distribution substations was intended to simulate an on-grid BESS installation as closely as possible. The pilot would be used to demonstrate the suitability of a grid-side BESS as an alternative to traditional network augmentation. Successful demonstration would provide UE with confidence to replicate similar solutions as battery prices decline to reduce network investment costs.

The primary objective of this pilot is to investigate and assess the benefits provided through the use of grid-side BESS in balancing peak demand, managing quality of supply, and potential to deliver market benefits for retailers.

The pilot aims to meet the following objectives:

- investigate the value of the LV grid-side BESS compared with network solutions
- test the current state of technology and its ability to scale
- identify risks with the technology in installation and operation
- develop knowledge and capability in leveraging benefits

- quantify the market revenue potential for retailers.

The pilot will be considered successfully delivered, if it satisfies the following criteria:

- identify, test and validate capability of technology for the trialled application
- identify and validate prudency and efficiency of augmentation using this methodology against current methods
- operational success.

This project is currently on the delivery phase and the first unit is expected to be installed on the UE network by the end of February 2020.

The section below details UE's current learnings and outcomes from the BESS pilot project.

## 4.2 Site Selection

An analysis was undertaken on over-loaded pole-mount distribution substations in the UE network for the 2017/2018 summer to identify sites operating above 120% of the cyclic rating (a proxy for the emergency short-time rating) of the distribution substation or LV circuit. As a majority of UE pole-mount distribution substations are between 100kVA to 315kVA, a filter was applied to look at overloaded substations within this range. Working with the suppliers and through UE's internal analysis, it was identified that a BESS of 30kW/75kWh was the optimal size in capacity to suit overloaded distribution substation and a physical size to suit pole mounting on an overhead LV circuit.

After applying the above criteria, 75 suitable sites were identified to trial a BESS solution. These sites were further narrowed down by adding additional filters listed below:

- demand reduction between 20kW and 30kW is required
- the site should not have had work undertaken or planned this year
- PVR[1] for the network augmentation is above 1
- high penetration of solar PV systems

Once the preferred sites were identified based on the above criteria, a site assessment was completed to assess the geographical location and physical suitability for a pole-mount BESS. UE's Customer and Stakeholder Engagement team were then engaged to address criteria that might impact customers or the community. A high-level summary of the findings and the proposed locations to install the BESS units are detailed below.

## 4.3 Pole Selection

*Site #1 (Black Rock)*

The location determined as most preferred was primarily residential with a local small business shopping precinct a block away. As demonstrated in Figure 1, the specific pole is close to the very busy Bluff Road and outside a community psychology centre with a large forecourt between the pole and the building. The site location was part of the Bayside municipality. Bayside City Council has an aspiration of achieving zero carbon emissions from council assets by 2022, therefore it was envisaged that the city council would support projects that could harness existing renewable electricity.

[1] Present Value Ratio (PVR) = (STPIS Cost + OPEX Cost) / Present Value Cost.


**Figure 1: Proposed BESS Installation – Sylvia-Bluff Distribution Substation**

*Site #2 (Highett)*

This site location is purely residential with many properties overlooking the adjacent football field as shown in Figure 2. A new pole was identified to be installed under the existing powerlines and will be located behind an existing tree so as not to disturb the visual amenity of the park. The site location is also part of the Bayside municipality. Similar to the site in Black Rock, it was envisaged that the city council would support projects that could harness existing renewable electricity.


**Figure 2: Proposed BESS Installation – Highett-Nicol Distribution Substation**

*Site #3 (Keysborough)*

This site location is purely 1980's urban expansion residential allotments. The circuit identified to have a battery installed wraps around a single residential block, at one end is a community kindergarten and park and at the other end the eastern side of the same park as shown in Figure 3. The site location is part of the Greater Dandenong municipality.

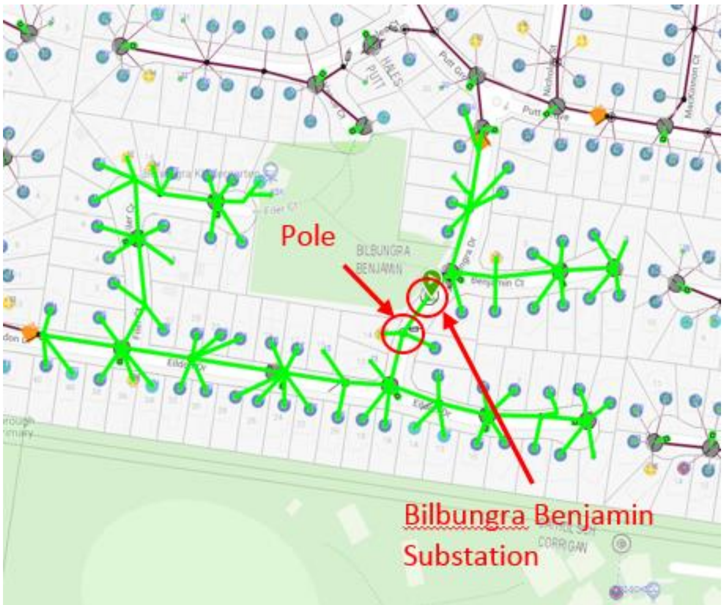


**Figure 3: Proposed BESS Installation – Bilbungra-Benjamin Distribution Substation**

## 4.4 Social and Reputational Risk Assessment

A social and reputational risk assessment (SRA) was performed before the initiation of the BESS pilot project. The SRA was undertaken to:

- identify potential risks to UE reputation as a result of the project
- highlight key considerations to enable smoother project implementation
- provide decision-makers with stakeholder insights to inform decisions about project direction.

As part of this risk assessment, a number social and reputational risks were identified based on the project scope and feedback received about the project's implementation. The summary of the identified risks and mitigation controls are summarised in Table 1.

**Table 1: Social and Reputational Risk Assessment**

| Stakeholder Group | Potential Risks[2] | Risk Rating[3] | Mitigation Measure (Controls) |
|---|---|---|---|
| Residents and local government | Unknown technology causes concern amongst residents and local government causing a delay in the project due to more information required or further consultation to be undertaken. | M | Ensure collateral explains the benefit and the operation of the technology being used. |
| Bayside residents and local government | Changes to visual amenity in a community known for its lifestyle and bayside appeal causes delays in the project as residents lobby to have the batteries moved from their street. | H | Provide city councils with an overview of site location assessment and determination of location. |
| Residents and local government | Perception about location of BESS and electromagnetic field (EMF) on local residents, especially children (if located near playgrounds or parks) causes a delay in project as | H | Ensure collateral address technology perceived issues e.g. EMF. Take EMF measurements. |

[2] If stakeholders are not engaged or engaged effectively.
[3] L: Low, M: Medium, H: High, E: Extreme.

| Stakeholder Group | Potential Risks[2] | Risk Rating[3] | Mitigation Measure (Controls) |
|---|---|---|---|
| | residents lobby to have the batteries moved. | | |
| Residents | Noise from BESS and/or associated air-conditioning units is perceived to be above approved noise limits and causes complaints. | H | Complete day and night ambient noise testing at each location. |
| Residents and Emergency Services | Limited case studies / use of batteries raises concerns about safety. If the battery catches fire and, local fire brigade / emergency services do not understand how to approach and deal with a battery fire at electricity distribution level. | M | Design out any risks as much as practicable. Meet with local emergency services to provide accurate locations and provide them with equipment technical specifications. |
| Residents | Disruption to local electricity supply either during installation of BESS or as a result of BESS failure. | M | Communicate early with impacted residents and promote the potential benefits. |
| State Government and Government agencies | Key stakeholder groups, like ESV, may not support the installation of BESS at distribution level. | L | Meet with key government stakeholders to brief them of the trial. |

## 4.5 Network Use Cases

UE's 300kVA distribution substation called Highett Nichol (one of 2019 pilot sites) had a forecast demand of 29kW above its transformer's cyclic rating for summer 2019/20. This substation also had relatively high solar PV generation creating reverse power flow situations during low load and high PV solar generation periods shown in Figure 4.

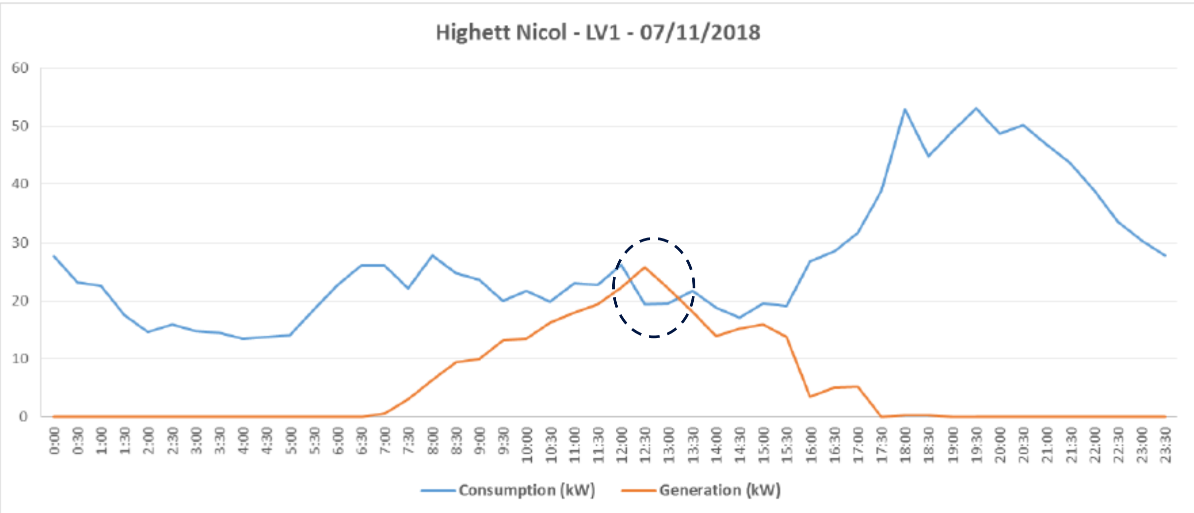


**Figure 4: Reverse Power Flow – Highett Nicol Distribution Substation**

The traditional response to the overload issue would be to augment the network to upgrade the substation to a 500kVA distribution transformer. However, this solution would not solve the reverse power flow and local over-voltages due to high penetration of solar PV penetration and other remedial works would be required.

For the pilot at this substation, UE will be utilising one 30kW/75kWh BESS placed alongside the substation to test and validate the three network use cases:

- discharge the BESS unit during network peak load event to maintain load within the cyclic rating
- charge the BESS unit during peak solar PV generation to avoid reverse power flows and over-voltages

- utilise the smart inverter characteristics to mitigate voltage rises during reverse power and enable higher deployment of distributed energy resources (DER) under the substation.

Besides this, UE will be working with energy retailers to identify potential market benefits from the BESS system detailed in Section 4.6

## 4.6 Energy Retailer Engagement

UE has four energy retailers partnering in the pilot to develop energy retail use cases to enhance the market benefits that could be derived from the BESS units. The energy retailers have identified the following use cases shown in Table 2 as potential sources of market services revenue using grid batteries.

**Table 2: Retailer Use Cases**

| Use Cases | Energy Retailer #1 | Energy Retailer #2 | Energy Retailer #3 | Energy Retailer #4 |
|---|---|---|---|---|
| Energy arbitrage (single daily cycle) | Yes | Yes | Yes | Yes |
| Capture high peak price | – | – | – | Yes |
| Capture negative price | – | – | – | Yes |
| Capture low wholesale price during day | – | – | – | Yes |
| Alternative to hedging | Yes | Yes | Yes | – |
| Frequency control auxiliary services (FCAS) | Yes | – | Yes | – |

It can be seen that each energy retailer has found different ways to derive benefits from leased storage capacity. While energy arbitrage considers the same charge and discharge cycle on weekdays, the other energy retailer use cases involve active monitoring of the wholesale energy price, forecasting irregular events and amending the battery charge and discharge cycle to gain greater market revenues. UE plans to test these energy retailer use cases after installing the BESS units on the distribution network.

Initial high-level estimates of BESS costs and benefits from the use cases are shown in Figure 5.

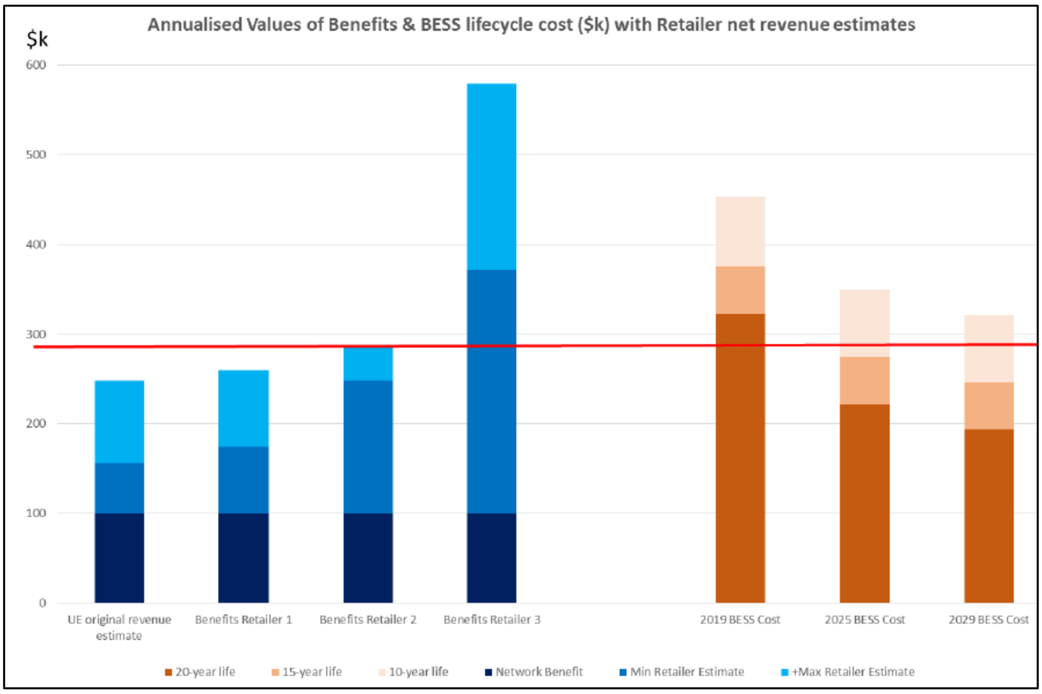


**Figure 5: High-Level BESS Value Stack**

The brown stacked columns represent BESS costs considering multiple replacements over 40 years in order to be comparable against a network augmentation solution. In the same way UE has been able to extend the life of traditional network assets past their design lives with rigorous asset management practises, UE has considered similar possibilities for the BESS. Hence, the value stacks have been developed for different battery life expectancy i.e. 10,15 and 20 years.

The blue stacked columns represents the value stacking of the different benefit streams identified through the initial discussion with the energy retailers. The navy blue stack represents the network benefit quantified by the value of augmentation deferred by undertaking this project. The lighter blue stacks represent the range of market services revenues estimated by the energy retailers using the different use cases they identified. The discrepancy in estimates could be explained by the fact that the first three blue columns were calculated using historical pricing whereas the fourth blue column was estimated considering future electricity pricing. It is clear that there is a large variation in market service benefits which needs to be clarified and validated through the current pilot project.

## 4.7 Technical Specifications

The technical specifications document prepared provides high-level detailing about how BESS providers need to meet UE's business requirements for the grid-side BESS pilot. Below are some of the key business requirements for the BESS system:

- The pole-mount BESS design should enable this type of solution to be applied in any overhead distribution networks
- BESS functionality should include an inverter system with 3-phase, 4 quadrant symmetrical power with associated isolation and safety protection
- Individual BESS unit should have the capability to continuously dispatch minimum 30kW power for at least 2.5 hours to manage the network peak demand
- The BESS system should have the capability to operate in modes which will provide grid support in managing quality of supply and in integrating more distributed energy resources. The BESS system as minimum should be capable of meeting the operating modes specified in AS 4777.2:2015:
    - demand response mode
    - power quality mode
    - volt response mode
    - fixed power factor or reactive response mode
    - power response mode
    - power rate limit.
- Individual BESS units should have the capability to continuously dispatch two times per day a minimum of 30kW for at least 2.5 hours to manage the network peak demand after 10 years of continuous operation (i.e. 7300 cycle number)
- All components of the BESS shall comply with the most recent relevant requirements of the Australia and New Zealand Standards.

## 4.8 Procurement Methodology

Pole top BESS solutions are relatively new technology. As far as UE is aware, there is only one pole top BESS installed globally - Toronto Hydro commissioned a 25kW/16kWh BESS system manufactured by eCamion in 2016. The proposed pilot project would be the first pole top BESS installation in Australia. Based on market research there are currently limited suppliers capable of providing the end to end solution

On 3rd June 2019 a request for proposal was issued to three potential suppliers. A scheduled guarantee performance along with the technical specifications was provided to the suppliers.

UE received proposal from all three potential suppliers. A quantitative and qualitative analysis was conducted as per the evaluation guideline. Each proposals was evaluated against the criteria's listed in Table 3.

**Table 3: Evaluation Criteria**

| Evaluation Criteria | Weighting |
|---|---|
| Pricing | 45% |
| Compliance to technical specifications | 25% |
| Risk and opportunity | 15% |
| Quality of submission | 5% |
| Innovation | 10% |

A team of five was formed to evaluate the response from the suppliers which included both technical and commercial experts. Each individual evaluation team member completed an independent review of the 3 proposals and scored them against the evaluation criteria. Scores were then discussed on Friday 5th July 2019 and the final score was agreed for each criterion.

The results of the qualitative analysis are summarised in Table 4.

**Table 4: Evaluation Outcome**

| Supplier | Score |
|---|---|
| Supplier #1 | 70 |
| Supplier #2 | 59 |
| Supplier #3 | 33 |

Based on the outcome from the evaluation, UE entered into a contract with the preferred supplier to procure, design and build two[4] 30kW/75kWh pole top BESS units on the UE distribution network.

## 4.9 BESS Design

The selected BESS system has 22 battery modules manufactured by Kokam. The battery modules are connected in two strings with each string connecting 11 modules in series. The battery unit is connected to a four quadrant inverter manufactured by Vacon, which converts the direct current (DC) voltage to 290V alternating current (AC) voltage. The inverter is rated for a maximum power output of 30kVA. The output from the inverter is filtered by an LC filter and a 30kVA star-delta transformer is used to tap up the voltage of the system to 415V to connect to UE LV distribution network. The BESS unit also includes a three-phase AMI meter, protection relay and control systems.

The main protective devices inside the BESS enclosure include:

- inter-tie, multi-function, programmable protection relay – SEL-700GT+
- inverter – Vacon NXP00615
- main BESS circuit breaker – ABB XT2N 160 Ekip
- inverter filter 100A circuit fuse
- inverter pre-charge circuit fuse

The functional components of the BESS units are housed in a 2.2m x 1.2m BESS cabinet. The BESS cabinet comes in two halves, inverter half and battery cabinet and will be wrapped around a wooden LV pole as shown in Figure 6. The BESS cabinet is planned to be installed on a 10.2m LV wooden pole. The unit will be mounted 3.6m high from the base and the cabinet will have a total weight of ~1750kg.

[4] It is planned to procure the 3rd BESS unit from a different supplier to expand the learnings from this pilot.

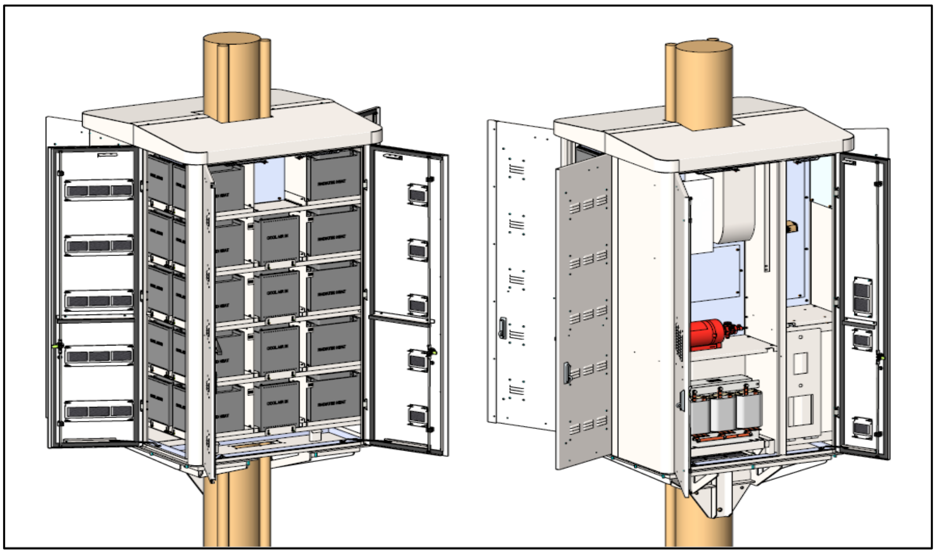

**Figure 6: BESS Installation Design**

## 4.10 Project Learnings To Date

This section explains the current learnings that have been identified during the BESS pilot project

Table 6 lists project management related lessons learnt on this project.

**Table 5: Project Management Lessons Learnt**

| Situation | Action | Recommendations for Future Projects |
|---|---|---|
| Final supplier contract execution was delayed as there was last minute revisions by the supplier to address all the business requirements and technical specifications. | UE worked collaboratively with the supplier to ensure last minute revisions to address the business requirements and technical specifications were accurately captured and formally documented as part of the executed contract. | In future, UE will hold a pre-tender meeting to ensure suppliers understand the expectations documented in the business requirements and technical specifications. |
| The supplier's design was delaying the ordering of some key BESS equipment. | UE worked with the supplier to place orders on key equipment items (i.e., batteries, inverter, cabinet and transformer) as soon as it was practical to do so. | Ensure the timing for design of key equipment is included in the project schedule and aim to order the equipment as soon as it is practical to do so. |
| At the start of the project, there was some uncertainty regarding roles / responsibilities of the various teams involved with the project. | UE established specific project stream meetings to provide clarity of roles / responsibilities as below:<br>• supplier<br>• works practices<br>• communications and control<br>• protection and ITP<br>• steering committee<br>• energy retailers. | Ensure a formal project management plan (PMP) is developed, reviewed and signed off by the key stakeholders at the start of the project. The PMP should include details on how the project will be delivered along with resourcing, budgeting, milestones, roles / responsibilities and delivery methodology. |
| Due to the tight framework for delivering the project, the technical specifications used for the original tender included some requirements that were not fully addressed by the | UE worked collaboratively with the supplier to ensure business requirements were refined and addressed during the design phase of the project. | The general lesson learnt is that the more complete the original specifications are, the less issues present themselves during project |

| Situation | Action | Recommendations for Future Projects |
|---|---|---|
| supplier. Some examples are use of fuses instead of MCB[5]s', clarity around BESS enclosure design, mounting of antenna, etc. | | execution. Ensure adequate time is allocated upfront during the tender negotiation phase to accurately capture the requirements of the technical specifications with the supplier. Ensure the supplier details their quality assurance methodology during the tender stage. |

Table 6 shows project design / operation related lessons learnt on the BESS project.

**Table 6: Design / Operation Lessons Learnt**

| Situation | Action | Recommendations for Future Projects |
|---|---|---|
| The supplier was not keen on implementing a formal design review and approval process. | UE steered the supplier to submit the relevant design (where available) for formal review and approval. | A formal design review and approval process should be included on future projects. |
| The supplier submitted drawings which did not meet UE drawing standards and Australian standards. | UE worked with the supplier to assist in submitting drawings which met UE drawing standards and Australian standards. | UE will hold a pre-tender meeting to ensure Suppliers understand the expectations documented in the business requirements and technical specifications.<br>Ensure the supplier is provided with UE drawing (electrical and mechanical) standards and meets Australian standards applicable to drawings. |
| There were various design aspects associated with the BESS enclosure which had not been addressed by the supplier. | UE worked collaboratively with the supplier to discuss the mounting methodology and agree to install the BESS as two separate enclosures on a mounting platform. Ventilation of the BESS enclosure was discussed with the supplier and it was agreed that 4 new openings would be installed at the base of the enclosure. Inclusion of isolation devices as part of the BESS was discussed and additional requirements identified. | In future, UE to ensure regular safety-in-design workshops are held with the supplier as part of the design review and approval process. |
| Lifecycle, servicing and maintenance requirements were not proactively addressed by the supplier. For example, can fans be accessed in-situ for maintenance purposes? can the fire suppression be isolated by field operators? how | UE worked proactively to ensure the design would allow servicing and maintenance requirements to be addressed. | Ensure lifecycle, servicing and maintenance requirements (replacement/renewal) are identified and discussed early in the project with the supplier. Address requirements as part of the regular safety-in-design |

[5] MCB = Master Circuit Breaker.

| Situation | Action | Recommendations for Future Projects |
| --- | --- | --- |
| has dust mitigation been addressed? does the BESS enclosure allow for water to drain? is the BESS securely fastened to the pole at the top? | | workshops. For example, future design should allow for provision of a work platform on the pole to enable removal and repair of major equipment, ensure the future design allows live battery terminals to be isolated from personnel contact and allows isolation for batteries along with a mechanism to discharge the batteries after isolation. Future design to allow for activation / deactivation of fire suppression system. |
| The single-line diagram (SLD) and protection settings provided by the supplier did not meet the requirements of the UE's Protection team. | UE's Protection team worked collaboratively with the supplier. Collaboration and discussion resulted in the supplier simplifying the protection requirements. | UE to detail the protection requirements to suppliers in the pre-tender meeting: Provision of a SLD; separate protection schematic; inverter settings; a report detailing the control, operation and protection philosophy; provision of all device data sheets; and detailed system/transformer specifications. |

Table 7 shows construction / installation related lessons learnt on the BESS project.

**Table 7: Construction / Installation Lessons Learnt**

| Situation | Action | Recommendations for Future Projects |
| --- | --- | --- |
| The technical specifications did not address certain requirements in depth. For example, cross cabling between the 2 separate BESS enclosures was not specified, door opening mechanism and fixation orientation was not specified. | UE worked collaboratively with the supplier to ensure cables are run to the bottom of the enclosure and then, back up the pole through an additional conduit. UE agreed with the supplier to install fixable doors along with a door stay to mitigate the risk of injury or damage during high wind. | Ensure a formal design review and formal process is implemented along with regular safety-in-design workshops. This would allow the design to progressively identify and address any shortcomings in the technical specification. |
| Due to resource constraints around the December/January period, the service provider was unable to offer adequate resourcing for installation of the BESS units. | UE undertook high-level discussions with the service provider and agreed on resourcing to be arranged for installation of the BESS. | UE to ensure resourcing requirements are identified and addressed early in the project. For example, UE should identify and ensure alternative options are available from a resourcing perspective. |

Table 8 shows work practices related lessons learnt on the BESS project.

**Table 8: Work Practices Lessons Learnt**

| Situation | Action | Recommendations for Future Projects |
|---|---|---|
| There was some uncertainty regarding the height at which the BESS should be mounted. | UE decided to use the same height standard applicable for installation of pole-mount transformers for the BESS units. It was agreed to install the BESS units at a height of 3.6m. This approach was agreed to with the Work Practices team. | Ensure Work Practices team is consulted regarding installation of BESS units at heights and it is compliant with applicable UE standards. |
| The supplier was unsure of the operating procedures to be supplied to UE as part of the BESS Pilot project. | UE has collaboratively worked with the supplier to ensure they provide operational procedures (some of which are as below):<br>• planned/fault conditions<br>• isolation of the BESS during an outage<br>• reconnecting the BESS after an outage.<br>Undertaking in-situ maintenance on the BESS. | In the pre-tender meeting, UE should detail the training requirements for testing, operating and maintenance to the supplier to ensure such requirements are comprehensively addressed. |

Table 9 shows testing practices related lessons learnt on the BESS project.

**Table 9: Testing Lessons Learnt**

| Situation | Action | Recommendations for Future Projects |
|---|---|---|
| The supplier's inspection and testing plan (ITP) did not meet the various testing requirements specified by UE in the technical specifications. | UE worked with the supplier to ensure the testing requirements were addressed to UE requirements. | In a pre-tender meeting, detail the testing requirements to the supplier as below:<br>• noise testing<br>• derating testing at different temperatures<br>• charge and discharge testing at different temperatures<br>• short circuit testing<br>• EMF testing and electromagnetic compatibility (EMC)<br>• mechanical testing of the cabinet<br>• hazards compliance testing<br>• fire suppression testing<br>• over-voltage protection<br>• under-voltage protection<br>• over-temperature protection<br>• low-temperature protection<br>• over-current protection<br>• over-frequency protection<br>• under-frequency protection<br>• voltage imbalance protection<br>• energy capacity test |

| Situation | Action | Recommendations for Future Projects |
|---|---|---|
| | | • round trip efficiency test<br>• response time test<br>• insulation monitoring test<br>• operating modes testing<br>• SCADA[6] and communications testing. |

Table 10 shows testing practices related lessons learnt on the BESS project.

**Table 10: Energy Retailer Engagement Lessons Learnt**

| Situation | Action | Recommendations for Future Projects |
|---|---|---|
| There was uncertainty initially regarding the control of the BESS units when available for energy retailing deployment. Some energy retailers were keen to gain control of the BESS units which presented an unacceptable risk to UE. | UE worked collaboratively with the energy retailers to document the use case scenarios and agreed on retaining control over the BESS units. The energy retailers would supply UE with the use case scenarios for deployment over the duration of the project. | Ensure scope of use case scenarios is well documented and UE expectations of retaining control over the BESS units is communicated to energy retailers early in the project. |

Table 11 shows BESS supplier related lessons learnt on the BESS project.

**Table 11: Supplier Selection Lessons Learnt**

| Situation | Action | Recommendations for Future Projects |
|---|---|---|
| Capability of BESS supplier was a concern for UE based on the quality of documentation received throughout the project. | UE expressed concerns to the supplier through a number of face-to-face meetings. It was stressed to the supplier they work with UE in an open and transparent relationship. | In future, it is recommended the following actions are undertaken:<br>• ensure the BESS supplier is adequately resourced and assumes all responsibility for design, engineering, permitting and installation<br>• perform reference checks on suppliers with other clients<br>• review quality of documentation provided by suppliers on other client projects<br>• UE noted a barrier with the battery supplier, where the supplier was unable to provide appropriate documentation relating to the battery specifications; ensure such aspects are assessed at the pre-tender stage<br>• Ensure UE performs reference checks on the inverter supplier<br>• Ensure the supplier has the ability to partner with other service providers to |

[6] SCADA = Supervisory Control and Data Acquisition.

| Situation | Action | Recommendations for Future Projects |
|---|---|---|
| | | ensure all aspects of delivery are adequately covered and has the ability to scale up for larger volumes. |

In summary, the following key recommendations will be implemented on future projects:

- conduct of a pre-tender meeting to establish UE's technical specifications expectations with suppliers
- ensure a formal design review and approval process is implemented along with regular safety-in-design workshops
- ensure lifecycle strategy, servicing and maintenance requirements are identified and addressed early in the project.

## 4.11 BESS Control System

UE is developing an internal BESS control software to manage the pilot BESS units. All operatory and supervisory control interface software will use the PaDECS RESTful Web-API to manage the BESS units.

The BESS control software developed will take both network and energy retailer commands. The energy retailer commands will be received in .json format. The BESS controller is designed to provide priority for network commands over the energy retailer commands. Both energy retailer and network command will be verified before sending the settings to the BESS controller. Figure 7 below provides a high level design of the proposed control system.

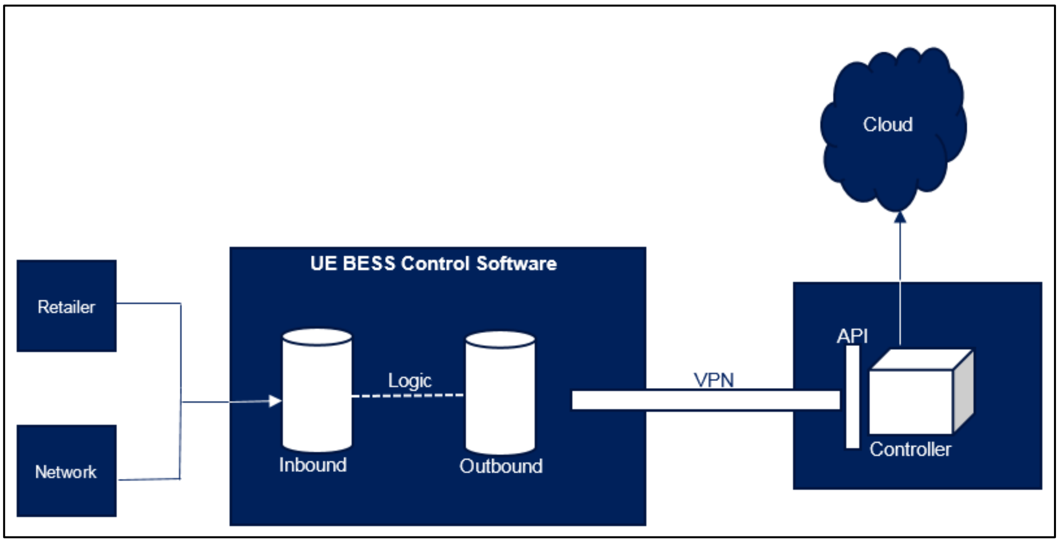


**Figure 7: Proposed BESS Control Design**

## 4.12 Risk Assessment

A risk assessment workshop was conducted with key stakeholders from the business prior to commencing of the BESS pilot project. The purpose of this workshop was to identify key risks associated to this project that could affect UE's reputation, financial, customers and regulatory compliance. In order to manage the identified risks, adequate controls were put in place and the status of these mitigation controls have constantly been monitored and updated throughout the life of the project.