GEELONG SUSTAINABILITY

Neighbourhood Battery Feasibility Study

Geelong Sustainability

A feasibility study for Community Batteries in the City of Greater Geelong region conducted by Geelong Sustainability.

Revision History

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Disclaimer

All financial figures provided in this document are estimates only. Great care has been taken to source accurate information, but actual costs may vary.

Confidentiality

This document contains confidential information. All reasonable precautions should be taken to maintain confidentiality, to prevent unauthorised access to the document and the disclosure of the material contained in this document.

Acknowledgement

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

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1. Executive Summary

The purpose of this study was to explore and identify the feasibility of installing Neighbourhood Batteries in the City of Greater Geelong region. In particular Geelong Sustainability was interested in how the installation of neighbourhood batteries could store and retrieve community solar generation would further reduce Geelong's reliance on fossil fuel-based electricity and help the community achieve its 100% renewable energy targets.

This project aimed to develop feasible neighbourhood battery business models that will address issues associated with decentralised storage (grid constraints, cost, reliability, equitable access, and community benefit etc.) while identifying how a not-for-profit community organisation could successfully support neighbourhood batteries in the Geelong region.

Image 1. Western Power PowerBank Battery Source: DELWP Victorian NBI Consultation Paper

The key objectives for the project was to evaluate potential business models and assess viable paths to neighbourhood battery deployment. There are a number of challenges and barriers to establishing neighbourhood batteries that our feasibility study aims to address, including:

- Physical Location
- Engagement with Stakeholders
- Financial Viability
- Business Models for Community Benefit
- Technical Complexity

In doing so Geelong Sustainability wanted to ensure that community benefits were maintained at the forefront of the project. With a key outcome to demonstrate how the community benefits and aspirations can be balanced against the needs of other stakeholders.

Geelong Sustainability also set out to address the following throughout the study:

- Grid connection constraints - 30% of new solar PV connections are zero or limited export

- Costs associated with upgrading the distribution grid to support the installation of more residential and commercial solar PV
- Assisting customers who do not have solar to source locally generated renewable energy
- Cost inefficiencies between decentralised Behind-the-Meter BESS and centralised In-Front-of-the-Meter BESS
- Grid reliability, peak demand and power quality issues
- Need for firming of intermittent renewable energy supply.
- Network charges, particularly the adoption of Time of Use Tariffs.

This report provides a summary of the process, findings and key recommendations that Geelong Sustainability found through the study. The work undertaken during the study included liaising with a range of interested partners and the broader community to help define the various options to be studied, modelling across a range of alternatives to try and identify a technical solution that would be acceptable commercially and presenting those findings to the community through a webinar.

Through the initial preliminary work and literature review and then when liaising with industry specialists and the general community, the various issues around Neighbourhood Batteries became more apparent. As the study progressed, those from Geelong Sustainability involved developed their thinking considerably on the issues and potentially the changes/adaptations that would help with the development of Distributed Storage.

The general community expectations of a shared Neighbourhood Battery (IFTM) are quite different to the reality of AEMO regulatory, metering and billing requirements. AEMO requires a Grid Participant, typically an Energy Retailer, to be involved to access the NEM and the revenue options available.

Grid Tariffs are also clearly an issue for Neighbourhood Batteries, not so much for charging, although a reduction would always be welcomed, but rather for customers to be charged Time of Use (TOU) Tariffs to access electricity generated by their own Solar PV systems and stored locally.

Geelong Sustainability firmly believes that Distributed Storage will support the ongoing rollout of Distributed Generation and that changes to the regulatory requirements in conjunction with changes to the financial incentives for PV and adoption of more incentives for storage would be very beneficial in the long term.

Geelong Sustainability was able to determine that current battery and installation costs are still very high and the economics are marginal, if not poor. It is possible to suggest that future battery developments offer the prospect of major reductions in storage costs. Coupled with changes to regulatory and commercial approaches, such cost reductions would help with the installation of large numbers of Neighbourhood Battery installations.

Through the study, what was also uncovered was the huge complexity of commercial, regulatory and technical requirements for developing, installing and operating IFTM Neighbourhood Batteries. What became clearer, as the study progressed, was the lack of alignment between the potential applications for IFTM Neighbourhood Batteries and the available revenue streams that would be required to fund the investment and ongoing operations. Such misalignment was brought about by the requirement to abide by the current regulatory and commercial operations on the NEM, as well as technical issues with metering electricity flows.

Currently, what the study has shown is that the markets for IFTM BESS applications do not suit the type of community organisation that Geelong Sustainability is set up to be. However, with Government support, there are opportunities to help the community directly with a combination of PV Generation and Storage and that Geelong Sustainability would be very keen to work in identifying those opportunities in the Greater Geelong region.

2. Key Terms

AC	Alternating Current
AEMO	Australian Energy Market Operator
BTM	Behind-the-meter
CAPEX	Capital Expenditure
DNSP	Distribution Network Service Provider
BESS	Battery Energy Storage System
DC	Direct Current
DR	Demand Response
EMS	Energy Management System
Energy Units	kW- Instantaneous electricity output of an array is typically measured in kW kWh- A measure of electricity over time. A 1 kW output running for one house is equivalent to 1 kWh. kWp- Refers to the peak output rating of the PV installation
FCAS	Frequency Control Ancillary Services
FiT	Feed in Tariff- Revenue from PV generation exported to the grid
GREAT	Geelong Renewable Energy Action Taskforce
IFTM	In-front-of-the-meter
Inverter	Device to convert DC current (PV panels, batteries) to AC current (Normal grid operating standard)
Irradiance	Level of solar energy impinging on a PV panel, affected by cloud and latitude
ITP	IT Power (Australia) Pty Ltd
kW	Kilowatt, unit of power
kWh	Kilowatt-hour, unit of energy (1 kW generated/used for 1 hour)
kWp	Kilowatt-peak, unit of power for PV panels tested at STC
LCOE	Levelised Cost of Electricity
LGC	Large Scale Generating Certificate

Load Shifting	Providing storage such that PV generation during the day can be stored and released when there is demand
Mismatch	Proportion of Energy Generated that is actually consumed by a customer
NEM	National Electricity Market- Eastern States and SA
NREL	National Renewable Energy Laboratories (USA)
NUoS	Network Use of Service
O&M	Operations and Maintenance
Off-peak	Typically 11pm to 7am and weekends
Opex	Operational Expenditure
Peak	7am to 11pm Monday to Friday
Photovoltaic (PV)	Type of Chemical effect that turns light energy into electrical energy. Used i panels to generate electricity
PPA	Power Purchase Agreement
STC	Small Scale-scale Technology Certificates
VPP	Virtual Power Plant

Table 1. Key Terms used in Neighbourhood Battery Feasibility Study

Image 2. Graphic design representation of a typical Neighbourhood Battery location on a nature strip.

3. Introduction

Geelong Sustainability has been funded by the Victorian Government's Department of Environment, Land Water and Planning (DELWP) to determine the feasibility of establishing a series of Neighbourhood Batteries located across the Greater Geelong region. Neighbourhood Batteries have the potential to provide distributed storage for renewable energy generated on the rooftops of the region, but also grid services to support the local DNSP Powercor.

Geelong Sustainability worked with DELWP and various industry bodies, Battery Electric Storage System (BESS) specialists and project partners to identify potential commercial models and physical sites where a Neighbourhood Battery would be helpful in supporting the grid and the uptake of renewable generation.

What Geelong Sustainability initially envisaged was that a 1MW+ Neighbourhood Battery or Bank of Batteries has the potential to provide shared community benefits for households, businesses and address network constraints, enabling further Solar PV to be installed in the region.

Geelong Sustainability developed a number of business cases initially looking at potential "In Front of the Meter" (IFTM) installations including a high voltage connected BESS, a Low voltage connected BESS and a Low Voltage connected BESS with considerable connected solar at a shopping centre.

"Behind the Meter '' (BTM) alternatives were also modelled, as Geelong Sustainability has experience in this area, they are commonly used in the region and would provide a relevant reality check to the IFTM scenarios. Both BTM business cases studied included connected Solar PV.

For all Business Cases relevant data was obtained and modelling was undertaken by the project Consultant of the various options to determine what would be the most feasible.

This report shows how Geelong Sustainability has investigated the various scope, design, social licence, permit, installation, commissioning and operations issues associated with the technology across a range of sites and storage capacities.

4. Background

4.1. Purpose of Geelong Sustainability

Geelong Sustainability is a dynamic non-partisan, not-for-profit, community association and registered charity. Our vision is for people and our planet to thrive within sustainable limits. Our mission is to empower people to regenerate and protect the planet. To achieve this, we deliver projects that are focused on four strategic priorities - Climate Change, Renewable Energy, the Circular Economy and Sustainable Cities. Some of our many community focussed initiatives can be found on our website www.geelongsustainability.org.au.

The installation of Neighbourhood Batteries to store and retrieve community solar generation could further Geelong Sustainability's ambitions to accelerate the uptake of affordable, reliable renewable energy and reduce Geelong's reliance on fossil fuel based electricity and help the community achieve its 100% renewable energy targets.

Geelong Sustainability is very keen to support the Energy Transition away from fossil fuels to renewable sources and storage is a key part of that mix. It is clear that the variability of renewable generation requires storage and we were keen to look at how Distributed storage could be developed in the Geelong region.

Key priorities for the study were as follows:

1. Alleviate electricity grid constraints and allow more solar to be connected to the grid

2. Identify the value stack of Neighbourhood Batteries

3. Demonstrate how the community benefits

4. Enable shared battery access

Ultimately the intent was to provide a clear feasibility report that will provide the basis for a full business case to justify the development and implementation of Neighbourhood Battery facilities in the Geelong region.

Geelong Sustainability was also concerned with a relatively high number of new Solar PV customers who were not able to receive a full export approval to the grid from the local DNSP - Powercor. This figure was up to 30% from data obtained during the 2021 Geelong Community Solar Program bulk-buy. Such limited access to the grid was driven mainly by the constrained existing capacity of the Low Voltage grid and the huge amount of Solar PV already coming on to that grid during the day.

4.2. The Energy Transition and Electrification of Society

Geelong Sustainability understands that moving away from fossil fuels (gas and petrol) as houses shift to electrifying cooking, heating, hot water and Electric Vehicles will increase the loads (Double) on the grid[1].

The variability of renewable generation (wind and solar) requires that if it is to become a major part of the energy supply, the generation needs to be collected and stored in order to be available when required. This is a particular problem in the colder months.

The rollout of rooftop solar PV to date is impacting adversely grid voltages in the Greater Geelong area. Powercor is in the process of improving the grid (poles, wires and transformers), however, Geelong Sustainability (GS) has seen many applications recently for PV installations to still be approved, but with limited or no export capacity back to the grid.

The PV generation from rooftop installations that could not be exported to the grid would be a waste of valuable generation and an impediment to the rollout of more rooftop solar. There is a clear need to ensure that generation is not wasted and local storage could be a solution.

There are a range of challenges to installing Neighbourhood Batteries including finding suitable sites and locating systems close to grid infrastructure to minimise cable runs and disruptions. Community support, acceptance of the need for such installations and social licence are also very important aspects.

Image 3. Graphic design image of possible location of Neighbourhood Battery at a supermarket

[1] *AEMO 2022 Integrated System Plan numbers*

4.3. Distributed Storage

The importance of Distributed (Battery) storage

Distributed storage has been identified as an important part of our energy future due to the huge increase in Distributed Renewable Generation (mainly rooftop Solar PV) across the country. To help move towards a zero emissions future, Geelong Sustainability is keen to support more ways to generate, store and share renewable energy generation.

The energy grid is facing some considerable challenges with overall capacity and also time of day congestion. Unfortunately, the variability of renewable energy means that there is a typical mismatch between generation and consumption. During the day, excess rooftop Solar PV is being exported to the grid in vast amounts - this is causing voltage problems at the Distribution Transformer level.

The other issue with demand on the grid is that during the evening peak, when the sun has set and people are getting home and start using more energy as they cook, turn on A/C or heating, etc., then the grid can become overloaded. The expectation is that demand on the grid will only increase as people move away from gas and start purchasing electric vehicles.

What is a Neighbourhood Battery?

Neighbourhood batteries (or community batteries) are an energy storage model that have the potential to provide multiple benefits to consumers, communities and the electricity system. Neighbourhood-scale batteries are bigger than household solar batteries. Typical household solar batteries have a power capacity up to about 10 kilowatts (kW), while neighbourhood-scale batteries range from 100 kW to five megawatts (MW).

Typically, neighbourhood batteries are connected 'in front of the meter' to the electricity distribution network, rather than 'behind the meter' like household batteries. A neighbourhood battery would usually be located close to where electricity is being both consumed by homes and generated from rooftop solar.

Neighbourhood batteries can be owned by electricity distribution businesses or third parties such as community energy groups, electricity retailers, aggregators and private investors. The potential benefits a neighbourhood battery can provide, who benefits, and the value streams accessed depend on who the equipment is owned by and how it is operated.'[2]

Image 4. Ausgrid Community Battery NSW. Source: DELWP Victorian NBI Consultation Paper

[2] Neighbourhood Battery Initiative (energy.vic.gov.au)

In Front of the Meter and Behind the Meter installations

The terminology "Behind the Meter" (BTM) and "In Front of the Meter" (IFTM) refer to the location of the PV generation facility or BESS relative to the customer and the grid. For equipment that is installed on the grid, this would normally be termed "In Front of The Meter".

As shown below in figure 1 Neighbourhood Batteries are typically installed In Front of the Meter. The battery would charge and discharge through the grid and as such are liable for grid charges (tariffs). In order to be able to operate, an IFTM BESS would need to be controlled by a Grid Participant (Energy Retailer), enabling access to the grid to charge and discharge to.

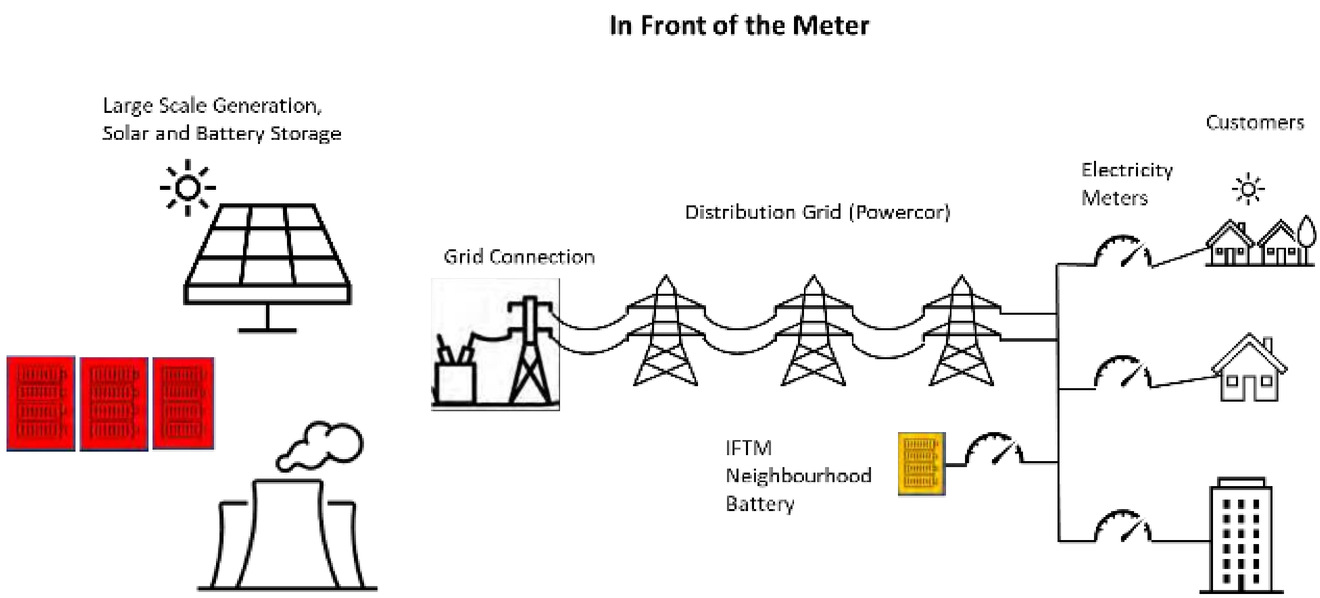

Figure 1 : In Front of the Meter Scenario

"Behind the Meter" Solar PV and BESS installations shown in Figure 2 are normally located on the customer's premises, either on the roof or on any adjacent spare land and are linked to the site switchboard. These types of PV arrays can be up to 2 MW in size, but are usually less than 100 kW to take advantage of the STC rate where Govt rebates are paid up front.

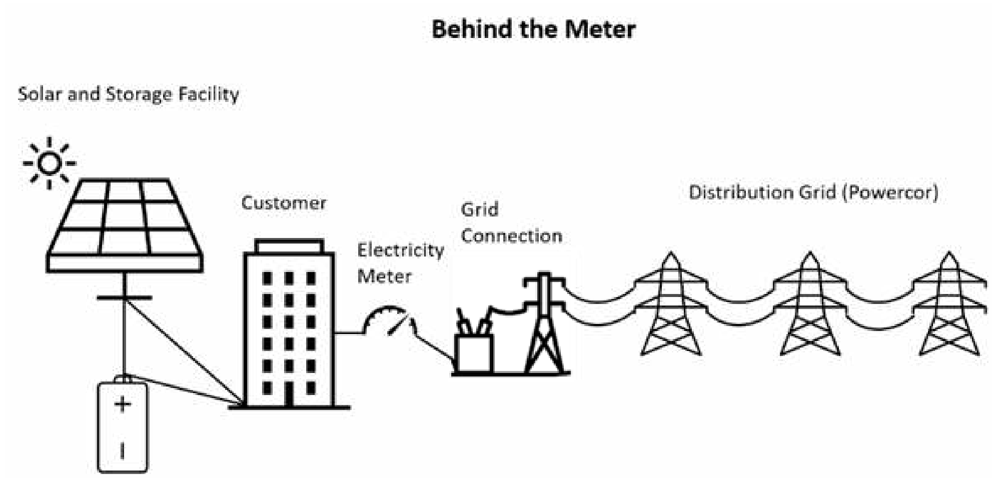

Figure 2 : Behind the Meter Scenario

Generation from BTM PV facilities will offset electricity normally sourced through the grid and will not be liable for Network or other related charges applied to grid sourced power. Excess generation will be exported to the grid and if the PV array is smaller than - 100 kW a Feed in Tariff (FiT) will apply in Victoria.

If a BESS system is also installed with a PV installation, the BESS could be charged from any excess generation and then discharged when the energy was required. The normal residential PV (and battery) installation is a “Behind the Meter” type.

Technical Aspects of a Battery

Lithium-ion batteries are overwhelmingly the dominant energy storage technology deployed in stationary storage applications in both the residential and commercial sectors in Australia. They currently have high energy density, higher efficiency, and longer lifespans than alternative energy storage technologies and hence this report considers only lithium-ion BESS products.[3] BESS type systems are made up of thousands of cylindrical batteries arranged in Battery Racks.

Image 5. Inner layout of a BESS type system

[3] *ITP report, LI-Ion preferred technology*

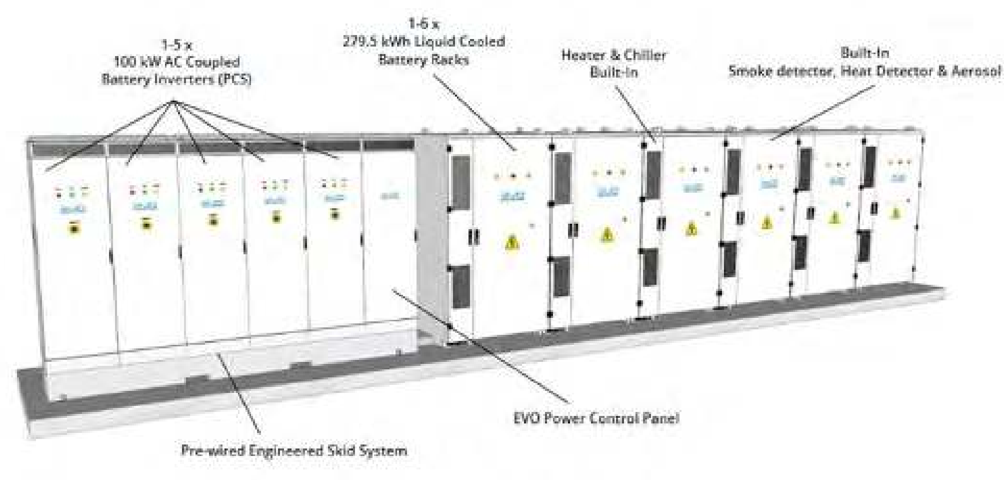

Figure 3. Mid Size Battery Installation showing Major Components Source: EVO Power.

Generally the larger the battery the cheaper - as fixed costs in installation can be amortised over a larger size.

Output capacity is also a factor, if the Inverter capacity is the same size as the battery storage capacity then the cells will be more expensive, as compared to a battery with a relatively lower output capacity. However, the intended use for the battery will impact the design, for example being set up for FCAS markets is an issue of inverter capacity/output, rather than storage capacity. Having a HV connection will add cost, but provide cheaper tariffs.

Expected lifetime of battery

The expected lifetime of a Li-ion battery is quite long but impacted on how the battery is used. If the battery is used on a basis where all of the capacity (100%) is cycled continuously, then the life of the battery may be only 3000 cycles (10 years) or so. This cycling capacity is termed Depth of Discharge.

If the battery is cycled between 20% and 80% of capacity, then the expected life could be much longer. The management of the state of charge on an active basis could provide meaningful extension to the effective battery lie.

Short Term Storage

Generally Neighbourhood Batteries are for short term storage, no more than a few hours, as distinct from long term storage (hydro) which could provide power for days if not weeks.

Location and Size

One of the key issues to resolve relates to the size of the battery based on the technical requirements for a particular application and then how to locate that battery in the streetscape or local available sites.

Medium size batteries can be quite large and Image 6 below shows the 2 MWh capacity battery at Deakin's facility in Waurn Ponds. For comparison's sake, each battery enclosure (1 MWH) is about the size of a 40 ft container or a large bus.[4]

Image 6. 2 MWh Battery Installation at Deakin University Waurn Ponds

In order to keep installation costs to a minimum, cabling from the BESS to the grid connection should be as short as possible. So potential sites to locate a BESS adjacent to the O/H (Over Head) grid are ideal.

What is the potential role of a Neighbourhood Battery?

In the local context Geelong Sustainability identified a number of areas in which a Neighbourhood Battery would provide benefit:

- Support the grid and particularly help to stabilise Grid voltages during excess PV export. This may help to allow more rooftop PV systems to be installed.
- Support the grid to offset infrastructure upgrades - potentially reducing or avoiding increases to Network Tariffs.
- Participate in FCAS markets to help stabilise grid frequency.
- Participate in arbitrage markets - charge when wholesale prices are low and discharge when prices are high.

4.4. Distribution and Transmission Tariffs

The poles and wires that historically have brought electricity from the large generators in the State are broken into two subsets - Transmission (typically 66 kV and above) and Distribution (22 kV and below, as well as the LV 415 V network).

In Victoria these assets are owned, developed and maintained by AusNet for the Transmission sector and for the Distribution sector are split across five Distribution Network Service Providers (DNSP) - Powercor, AusNet, Citipower, United Energy and Jemena.

[4] BYD Energy Storage Solutions Website

These companies apply a regulated and agreed set of charges to pay for the systems and these are known as Transmission Use of System (TUOS) and Distribution Use of System (DUOS). The two combined make up the Network Use of System (NUOS) charges typically shown on an electricity bill.
(TUOS + DUOS = NUOS)

These tariffs are negotiated with the Victorian Government under the oversight of AEMO on a 5 year basis and typically include a usage rate based on the amount of electricity supplied, as well as a Demand Charge based on the costs to provide the electricity connection. As customer connections get larger, the costs decrease, with HV connections considerably cheaper than residential connections.

What is interesting is that DNSPs are trying to discourage demand on the grid during peak times. These peak times for residential connections are changing, with residential Time of Use (TOU) tariffs applied between 3 pm and 9 pm in the evening. Neighbourhood Batteries located on the Network IFTM are fitted with a meter and are liable for these tariffs.

4.5. Grid Participant

For an IFTM Neighbourhood Battery to be able to access FCAS and Arbitrage markets, the operator and equipment need to be registered as “Grid Participants”. AEMO provides a range of Grid Participant classes for those whose businesses operate directly on the NEM.[5] In order to be able to access FCAS Contingency markets - a minimum of 1 MW BESS energy capacity is required and the facility would need to be registered and operated by a Grid Participant.

As FCAS contracts are available in 1 MW blocks (AEMO), a Grid Participant would need at least 5 off 240 kW output Neighbourhood Batteries to be installed in order to provide FCAS services.

Due to the current regulatory and commercial market requirements, Geelong Sustainability was not keen on becoming a “Grid Participant” in order to access the NEM, nor provide retail services to Geelong customers or to operate a BESS. To carry out those roles Geelong Sustainability’s preference would be to partner with an Energy Retailer such as Tango Energy. The Energy Retailer would have access to the NEM, a trading capacity in FCAS markets and be able to provide an arbitrage capability. (Charge the Battery when prices were low and Discharge when prices were high)

[5] *https://aemo.com.au/en/learn/market-participants/electricity-market-participants*

5. Project Partners

Geelong Sustainability brought together a number of key stakeholders including community members, DELWP, Tango Energy (electricity retailer), Powercor (DNSP) and the City of Greater Geelong.
ITP Renewables and EVO Power were able to provide expert support in relation to the technology.

Department of Environment Land Water and Planning (DELWP)

DELWP is the funding body for this feasibility study and actively helped guide and support the study providing high level input when required and appropriate. The Victorian Government's DELWP has provided $3 million into the Neighbourhood Battery Initiative (NBI) to fund pilots and demonstrations of a range of neighbourhood scale battery ownership and operational models, in order to unlock the role that the technology can play in Victoria's transitioning electricity system.

DELWP's aim with these feasibility studies was to:

- support understanding of the full range of benefits that neighbourhood scale batteries can provide;
- help to overcome barriers to the deployment of neighbourhood scale batteries;
- inform regulatory reform;
- determine which methods of neighbourhood scale battery deployment provide the most benefits for the Victorian electricity system; and
- support the decarbonisation of Victoria's electricity system to tackle climate change

www.delwp.vic.gov.au

Powercor
Powercor is the Distribution Network Service Provider (DNSP) for the Geelong region. United/CitiPower/Powercor is Victoria's largest electricity supplier, delivering electricity to over 1.1 million residential households and commercial customers across Victoria.

www.powercor.com.au

Powercor provided access to technical and functional information where permitted to do so to help identify battery locations. Powercor also supported technical analysis in providing peer reviews and guidance. Powercor input for the feasibility of "local use" network tariff trials has been important to understand community use arrangements. Powercor understands the importance of battery storage and the large challenges facing the distribution grid. Powercor has been very supportive of the feasibility study and provided access to network data and technical analysis.

Tango Energy

Tango Energy is the retail arm of Pacific Hydro. It launched in 2012 to "meet Aussie's demands for low cost, simple energy plans with a clean conscience". Tango's growing customer numbers create demand that enables Pacific Hydro to invest in new renewable energy projects throughout Australia. With customer service headquarters in Geelong, Tango's growth has created a major boost for local jobs and a big vote of confidence for local businesses in the region.

www.tangoenergy.com

City of Greater Geelong

City of Greater Geelong (CoGG) is the Local Government Authority for the Greater Geelong region. CoGG participated in the project through its 'Cleantech Innovations Geelong' initiative. Cleantech Innovations is a partnership between the Victorian Government, the Geelong Manufacturing Council and CoGG. The Cleantech Innovations vision is "to establish Geelong as a Centre of Excellence for cleantech in Australia, by attracting investment, creating jobs and building skills". The program has been operating since 2014, delivering positive economic growth and sustainability outcomes for Greater Geelong.
www.geelongaustralia.com.au

The City of Greater Geelong supported this project by providing us with information or advice throughout the study when required.

ITP Renewables

ITP Renewables (ITP) are specialist consultants in renewable energy engineering, strategic and policy advisory, and energy sector analytics.

ITP has been involved with a number of medium scale BESS installations across Australia and was contracted to perform the technical and commercial examination of the proposed sites and suggested business models. ITP worked to undertake a technical examination of potential locations for the neighbourhood batteries, optimal sizing at given locations, and a commercial and regulatory feasibility review.

www.itpau.com.au

BESS Providers

EVO Power is a well established Australian company who have been building BESS systems in Bayswater, Victoria. They have extensive experience in building medium sized BESS for both BTM and connected directly to the NEM and were very supportive of the NBI study. EVO Power worked with ITP to provide relevant pricing information, Battery configuration and sizing, as well as installation and maintenance requirements.

www.evopower.com.au

6. Process for the Feasibility Study

Geelong Sustainability began work on the Feasibility Study in November of 2021. The process Geelong Sustainability took for the feasibility study was as follows:

1. Feasibility study grant application
2. Key stakeholders
3. Literature review and research
4. Business Model Identification
5. Site selection and technical model identification
6. Consultant Scope of Work and Technical Study
7. Community Engagement
8. Key Recommendation Development & Project Reporting

6.1. Feasibility Study Grant

Geelong Sustainability was successful with their grant application with DELWP to conduct this feasibility study as part of the Neighbourhood Battery Initiative. The study was to be broken up into 5 Milestones with various deliverables required for each milestone.

Across the 9 months of the study, regular meetings were held with all of the Key Stakeholders, particularly DELWP and Powercor, to update on progress and receive feedback on the work done to date.

6.2. Key Stakeholders

Geelong Sustainability engaged with a number of key stakeholders in order to complete the study , including Powercor as the local DNSP, City of Greater Geelong as the local municipal authority and Tango Energy as a Geelong based Energy Retailer (refer to *5. Project Partners* for further detail).

An experienced renewable energy technical consultant was required and ITP Energy was chosen to undertake the technical and commercial scoping and modelling for the study. (The specifics of the process to choose a consultant are detailed later in the report).

6.3. Literature Review and Research

The project manager reviewed literature on Neighbourhood Batteries and explored existing Neighbourhood Batteries models and studies. There is considerable material available to help understand potential applications, installation practice and operating models. This information was very useful in scoping out the project initially. Refer to Section 12. for links to the List of References.

6.4. Business Model Identification

Geelong Sustainability looked at a range of options in order to identify a technical and commercial solution that could meet the varying needs of the Community, Government and the Electricity Utilities.

For study balance it was considered appropriate to look at both IFTM and BTM models as such a comparison would provide a reasonable counterpoint and Geelong Sustainability had been involved with the rollout of residential batteries through its Bulk Buy programs.

6.5. Site Selection and Technical Model Identification

One of the key issues identified during the study was how to locate Neighbourhood Batteries in neighbourhoods.

Geelong Sustainability was of the opinion that the region would require a large number of BESS installed to support the amount of local Rooftop PV. On that basis it was understood that it would be best to focus more broadly on a generic model identification that could be used for multiple sites and create a feasibility based on those models to support general viability. The project manager conducted a preliminary analysis to identify potential locations with those assumptions in mind.

Some of the considerations for locating BESS systems in communities are outlined in the Table 2 below.

Category	Criteria
Network	Grid Connection - How far away and what type? Current or Proposed Future Demand Battery Size Transformer Capacity / Limit Solar PV Penetration or Potential
Location	Availability of a Suitable site Technical Access - Installation and Maintenance Civil / Geotechnical Site Lines Size
Community	Proximity to Private Property Local Social Licence / Acceptance Visual Amenity
Local Environment	Noise (Cooling Fans) Flood Risk Cultural, Environmental, Heritage issues, Native Vegetation

Table 2. Considerations for locating a BESS system in the community

One option that was of particular interest was to locate the BESS on nature strips adjacent to existing Overhead Power Lines. The nature strips were the responsibility of the City of Greater Geelong who advised that there were systems and approaches in place for installing roadside equipment as can be seen from the photo below on Anakie Rd.

Image 7. Anakie Rd, Bell Post Hill

Geelong Sustainability was of the opinion that these types of installations were possible with the correct design approach including protection bollards, pedestrian and maintenance access and appropriate alignments of Kerb and Channel.

Image 8. Graphic design image of Neighbourhood Battery possible location

Care needs to be taken to ensure safety aspects such as line of sight for drivers are not obscured, so alignment with existing infrastructure would be beneficial.

Drainage would also be an issue to consider to ensure equipment wasn't inundated.

6.6. Consultant Scope of Work and Technical Study

The major part of the NBI study was to make an appraisal of the technical and commercial aspects of a BESS installation in the Greater Geelong region. A Technical Consultant with the necessary experience in the field and the sophisticated modelling capability to handle the range of inputs and outputs would be required to undertake that work.

Geelong Sustainability determined a list of 7 suitably qualified consultants that would be able to undertake the assessment and modelling. A detailed scope of works to provide guidance for the technical and commercial feasibility work was developed and was sent out to the list of consultants.

The scope included the following:

- Technical examination of proposed sites.
- Development of a 'value stack' for a neighbourhood battery.
- Review commercial models for realising Neighbourhood Battery opportunities.
- Provides GS with an economic analysis of Neighbourhood Battery feasibility.
- Provided GS with a final report on their findings.

All of the consultants provided proposals for the project and Geelong Sustainability went through an extensive review process to determine a suitable candidate partner. ITP Energy was appointed to undertake the study and were able to provide excellent support to help Geelong Sustainability in the study.

Refer to Appendix 1. Consultant Technical Feasibility Report - ITP Renewables.

6.7. Community Engagement

As part of the study we conducted a Community Engagement process with the community of City of Greater Geelong to gather feedback about the community's interests, concerns and understanding of Neighbourhood Batteries, which consisted of an online survey and an information webinar. We referred to Neighbourhood Batteries as 'Community Batteries' when engaging the community.

The online survey was live from 17th June until 13th July 2022 and was shared through various advertising mediums as well as the survey being available on Geelong Sustainability Group's website. Our online survey was filled out by 955 participants with 746 completed the entire survey, giving us great insight into the community's feelings and thoughts in regards to Community Batteries.

The purpose of the community engagement activities were to:

- Better understand the expectations that the community has.
- Deepen our knowledge of what drives the community's interest and the barriers they experience.
- Identify the gaps in information and education.

- Understand the concerns participants have about Community Batteries.
- Gather information on the willingness of the community to make changes in order to participate in a Community Battery.

Community input and perspective was important in informing the considerations required when exploring Community Batteries. The survey gave the community this opportunity.

We also ran an online webinar to share with the community the results from the feasibility study and to further share education and information about Community Batteries. The Community Battery webinar was run online on Tuesday 12th July 7pm-8pm with 242 participants registering for the event. The event was an opportunity for community members to hear about the feasibility study and to have their questions answered by the project manager live. There was also the opportunity for the participants to watch the recording back at a later date and they were all sent a recording and the webinar was also embedded in our website on our Community Battery section.

Refer to Appendix 2 & 3 for a detailed report of Community Engagement results.

6.8. Project Reporting & Key Recommendation Development

Throughout the project Geelong Sustainability reported to DELWP on a regular basis, including providing a range of deliverables over 5 milestones.

Geelong Sustainability was grateful for the ongoing support and interest from DELWP. The meetings enabled a two way communication on issues and findings to help with the project and the recommendations derived.

Through the project, and as the participants learnt more about the various inputs and requirements around Neighbourhood Batteries, thinking has changed considerably. This is somewhat reflected in the development of this final report. Report writing has taken some time and involved a number of meetings to revise and develop the key points and recommendations.

The recommendations are based on what has been studied and learnt from the process and reflect the current environment. Geelong Sustainability will be keen to keep abreast of future developments.

7. Complexity of Neighbourhood Batteries

As the Geelong Sustainability NBI study progressed, the range of regulatory considerations, commercial and operational aspects, technical requirements and the very strong Community interest became apparent.

The Figure 4 represents the complexity of considerations and issues that need to be addressed in scoping and developing a Neighbourhood Battery installation.

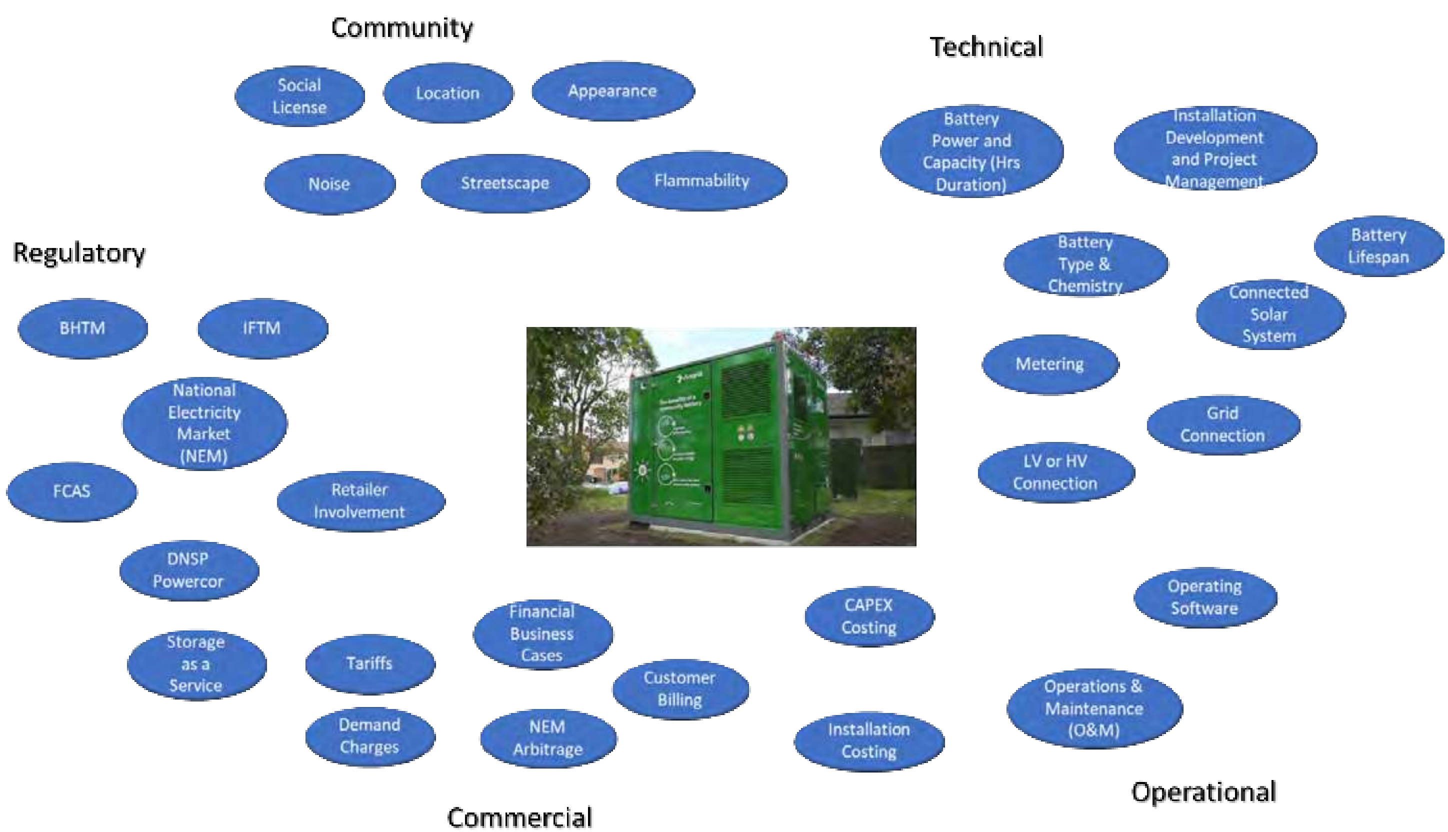

Figure 4. Mind map of the complexities and considerations for Neighbourhood Batteries

7.1. Regulatory Considerations

Much of the attention on Regulatory Requirements was driven by the emphasis on In Front of the Meter installations and the need to comply with operating on the broader grid.

AEMO Requirements

AEMO requires a Customer Registration (Market Ancillary Service Provider) to be able to access both FCAS and Arbitrage Energy markets. Geelong Sustainability would need to engage an Energy retailer such as Tango Energy to operate in these markets. That would have the impact of having to share the income derived from those activities.

DNSP Requirements

The DNSP (Powercor) requires that the Neighbourhood Battery comply with its connection rules , as well as tariff charges.

The DNSPs such as Powercor are now adopting Time of Use tariffs and are charging peak rates between 3 pm and 9 pm, 7 days a week. These rates are considerably higher than off-peak with the intention of trying to move people away from using electricity from the grid in this period.

Permits and Approvals

Recent changes from DELWP have meant that previous Planning requirements are now waived for Neighbourhood battery installations. However, there may be site specific requirements, including traffic and vegetation restrictions that will need to be addressed.

Geelong Sustainability worked with a local Town Planning advisory company The Planning Professionals who were able to advise on considerations in line with Council requirements for locating Neighbourhood Batteries on Nature Strips. Any proposed installation will require City of Greater Geelong review.

There clearly needs to be consideration for regulatory changes to support the installation of Neighbourhood Batteries, but as these changes are still being developed at both the State and Federal level, it is not clear what the impact will be.

7.2. Commercial Considerations

Potential Revenue Streams

As mentioned previously the revenue streams for the various battery types are varied and hard to define.

For BTM installations the calculations are fairly straight forward and are based on:

1. demand on site,
2. the outputs of the Solar PV arrays and
3. the capacity of the battery to “time shift” the generation to meet demand and offset supply from the grid.

These values are relatively easily calculated, CAPEX for each element is relatively easily known and a reliable financial business case can be developed.

For IFTM installations, the revenue streams are not quite as straightforward. DELWP has suggested the following revenue streams for modelling the commercial viability of potential IFTM installations:

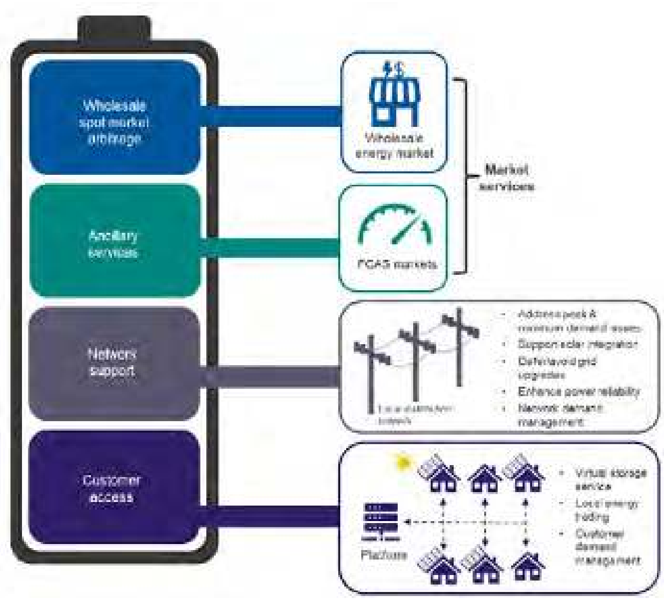

Figure 5. Revenue streams for Neighbourhood Batteries Source - DELWP Victorian NBI Consultation Paper

Geelong Sustainability worked with the various partners to determine NEM and Retail pricing, FCAS valuations and usage data for each site.

NEM and Retail Pricing (Arbitrage)

Tango Energy and ITP internal sources were able to provide data based on Victorian data for the 5 years 2016 - 2020. It is hard to determine whether this historical data will be relevant in future years where market volatility is expected to increase.

FCAS

Of the eight markets available to support AEMO Generation Control, Neighbourhood Batteries are typically configured to only access 4 of the Contingency Services markets. FCAS prices have been high in recent years, but as more large and medium scale BESS begin operating in the market, prices are expected to fall.

Network Support

Unfortunately, Powercor was not able to provide any data for revenue from potential Network Support activities for this study. It was not possible to identify the actual grid benefits, postponing grid upgrades for example, that Powercor would gain from the installation of Neighbourhood Batteries. Unfortunately, estimates could not be made on the value for the commercial model of Network Support benefits for IFTM Neighbourhood batteries.

So for this study ITP carried out modelling looking at **Arbitrage and Contingency FCAS revenue** only based on historical data.

Distribution Tariffs

The range of Tariffs that a Neighbourhood Battery would be charged when located IFTM was based on Powercor published rates as shown below in figure 6.

Neighbourhood Battery - Powercor Tariffs (NUOS)											
(Source - Powercor - 2021-22 Pricing Proposal - June 2021)											
In Front of the Meter Neighbourhood Battery Installations											
				2022/23				2023/24			
Low Voltage	Tariff Code	Peak Times	Fixed Charges	Demand Charges		Usage Rates		Demand Charges		Usage Rates	
				Dec/Mar	Apr/Nov	Peak	Off Peak	Dec/Mar	Apr/Nov	Peak	Off Peak
Small and Medium Voltage (Maximum Demand < 120 kVA)	NDM	10 am - 6 pm workdays	$3.2877 / day	$17.77 /kW/mth	$8.00 /kW/mth	5.76 c/kWh	5.76 c/kWh	$18.27 /kW/mth	$8.22 /kW/mth	5.93 c/kWh	5.93 c/kWh
				Jan - Dec	Dec - Mar			Jan - Dec	Dec - Mar		
Large Low Voltage (Maximum Demand > 120 kVA)	LLV1	7 am - 7 pm workdays		$9.75 /kVA/mth	$13.89/kVA/mth	4.02 c/kWh	2.81 c/kWh	$10.02/kVA/mth	$14.28/kVA/mth	4.14 c/kWh	2.89 c/kWh
High Voltage											
				Jan - Dec	Dec - Mar			Jan - Dec	Dec - Mar		
High Voltage Connection	HV1	7 am - 7 pm workdays		$5.83/kVA/mth	$9.99/kVA/mth	2.33 c/kWh	1.51 c /kWh	$6.00/kVA/mth	$10.27/kVA/mth	2.4 c/kWh	1.55 c /kWh
Residential Tariffs											
In Front of the Meter Neighbourhood Battery Installations											
				2022/23				2023/24			
Low Voltage	Tariff Code	Peak Times	Fixed Charges	Demand Charges		Usage Rates		Demand Charges		Usage Rates	
				Dec/Mar	Apr/Nov	Peak	Off Peak	Dec/Mar	Apr/Nov	Peak	Off Peak
Residential Single Rate	D1		$0.3835 / day			8.20 c/kWh	8.20 c/kWh			8.43 c/kWh	8.43 c/kWh
Residential ToU(Default) 3 Ph, PV, Battery, EV charger, and new connections	PRTOU	3 pm - 9 pm all days	$0.3835 / day			15.96 c/kWh	3.98 c/kWh			16.41 c/kWh	4.10 c/kWh
Residential Demand	DD	3 pm - 9 pm work days	$0.3835 / day	$11.18 /kW/mth	$3.41 /kW/mth	4.63 c/kWh	4.63 c/kWh	$11.50 /kW/mth	$3.51 /kW/mth	4.76 c/kWh	4.76 c/kWh

Figure 6. Neighbourhood Battery Powercor Tariffs and Residential Tariffs. Source: Powercor 2021-2022 Pricing Proposal

During the study it became clear that Powercor were keen to have BESS located IFTM on the LV Network, but to have an output of the BESS no larger than 240 kVA. To that goal Powercor updated rates as per below. Figure 7.

Non-distributor owned community battery

Retailers of a non-distributor owned community battery will incur the following network charges which exclude GST. There are no other network charges although metering charges may apply.

Time band	Fixed (cents/day)	Import rate (cents/kWh)	Export rate (cents/kWh)
10am – 3pm	45	-1.5	0
4pm – 9pm		25	-1.0
All other times		0	0

A positive rate is a charge, and a negative rate is a rebate

Figure 7. Proposed Distribution Tariff rates for IFTM connected BESS below 240 kVA .Source - Powercor Factsheet: Community Battery Trial Tariffs

Clearly Powercor were keen to have the Neighbourhood Battery operate to support the LV Grid and soak up excess Solar PV during the day. These Tariffs for small LV connected BESS were the only financial instruments available to support the Business Cases for IFTM Business Cases being studied.

Of particular concern to Geelong Sustainability, there were no incentives to reduce tariffs for customers drawing power from a Neighbourhood Battery.

Residential and BTM applications

Geelong Sustainability believes that one of the key ways to ensure that renewables do not impact the grid is to store any excess distributed generation (Rooftop PV) at the source of that generation, typically Behind the Meter (BTM), rather than exported. There would be further benefits to the grid in reducing demand by providing for Peak Time consumption supplied from that Distributed Storage.

Unfortunately, it was not possible to quantify the benefits to the grid from this approach in the study. The cost-benefit analysis undertaken by ITP was based only on the arbitrage calculations from the consumer's perspective, not the benefit to the overall grid and local DNSP.

Customer Access to Shared Community Storage or “Storage as a Service”

One of the original hopes for Neighbourhood Batteries is that the installations would provide a more cost effective solution to store excess PV generation from the community and then provide that stored energy back when it was required. ITP was asked to look at this Business Model and their response is part of their consultant’s report. Their commentary is that a “Storage as a Service” model would probably have similar economics to an IFTM LV BESS.

What was determined for this study is that such an option was not clear, as technical and commercial requirements, as well as customer acceptance, were impossible to determine.

Technically, the capability of metering systems to be able to collate real time energy transfers to and from a battery was not available. For the battery to respond to real time requirements by customers for energy was also difficult.

Commercially, a retailer would need to be involved and enable processes to account for energy flows from the NEM and from the battery. It was not clear that the community would be prepared to change retailers to access the battery.

The other issue would be Network Tariffs at peak times would impact the cost benefit of shared community storage.

7.3. Operational Considerations

Owner and Operator Roles
For Geelong Sustainability to be involved with an IFTM Neighbourhood Battery, it would be important to determine how the roles and responsibilities of the developer/owner and the operator are agreed.

One key issue would be setting the operational parameters that ensured the life of the battery was not compromised by heavy cycling of the battery capacity. Also, agreement on proportions of battery capacity to each of the revenue streams may be an issue.

Operations and Maintenance
Similarly to above, how a battery would be operated and maintained will be an important aspect to ensure that battery exceeds the life expectancy. Keeping within manufacturer recommended parameters will be very important.

Access to Data and Software Interfaces
Data and performance of the battery will be important information going forward as the technology develops.

7.4. Technical Considerations

There are a whole range of technical issues that would need to be considered in developing a Neighbourhood Battery including the following. (To cover all of these issues in detail is not possible in terms of this report.)

- Battery Power and Capacity (Inverter Power and Storage Capacity - kW/kWh)
- Battery Type and Chemistry
- Lifespan
- Degradation
- Cost and availability of batteries (Delivery Times)
- Grid Connection (HV, LV)
- Solar PV Connection
- Metering
- Site Access

7.5. Community Considerations

For Neighbourhood Batteries located in the community on streets and in parks it is very important that Community expectations are allowed for, particularly if a large number of batteries will be installed over time.

Finding a location to site a battery is a major concern and one Geelong Sustainability found to be very difficult. The suggested sites that Powercor provided were not located with available vacant land close.

If one option is to try and use the road reserve in neighbourhoods aligned with existing power infrastructure, then the issue of Social Licence is also quite a risk.

Some of the issues would include:

Location & Social Licence
This aspect is a clear issue with battery size requirements having a clear impact on where and how a BESS can be located.

Appearance and Melding with the Streetscape
How the battery is configured and protected in terms of vehicle impact and equipment vandalism is important, complicated by fitting in with the location - Park, DNSP reserve or streetscape. Battery size of course will also be an issue that may impact potential locations.

Noise
When the batteries are working and potentially getting hot, fan noise may emanate from the enclosure. Dependent on treatment and location - additional controls may be required to ensure that the community is not affected.

Flammability
Grid infrastructure fires, especially oil filled transformers are a known issue. Batteries are also known to catch fire, but some chemistries are more susceptible than others. Correct choice of battery chemistry with fire suppression technologies, as well as fault alarm communications should ensure that any safety concerns are addressed.

8. Development of Business Models and Potential Sites

In order to determine exactly what types of BESS and installation should be studied, Geelong Sustainability was initially guided by the suggestions from DELWP, Powercor and Tango Energy on appropriate sites to locate a Neighbourhood Battery.

Geelong Sustainability was also keen to take a broad, generic approach that would provide a commercial, operational and regulatory basis for the group to understand how the technology could be rolled out on a large scale and how the Group could be further involved.

Preliminary work had shown how the distribution and transmission tariff structure could have quite a large impact on the economics of a BESS located IFTM. High Voltage (HV) connected installations generally are considerably cheaper to operate on the grid than Low Voltage connected systems.

The Grid voltage problems[6] identified as impacting the rollout of rooftop Solar PV systems were on the Low Voltage side of the distribution transformer. LV connected BESS installations offered the potential to help solve these issues.

Geelong Sustainability was also keen to understand the impact of larger distributed PV systems connected directly with Distributed Storage, both for IFTM and BTM applications.

As a general reality check and for comparison purposes, Geelong Sustainability included BTM Residential Storage with rooftop PV as part of the study, as well as a BTM commercial site, Geelong YMCA Newtown Stadium, which included a 60kW PV array.

The image in Figure 8. shows the various potential BESS connection points to various parts of the grid in line with the Business Models as outlined.

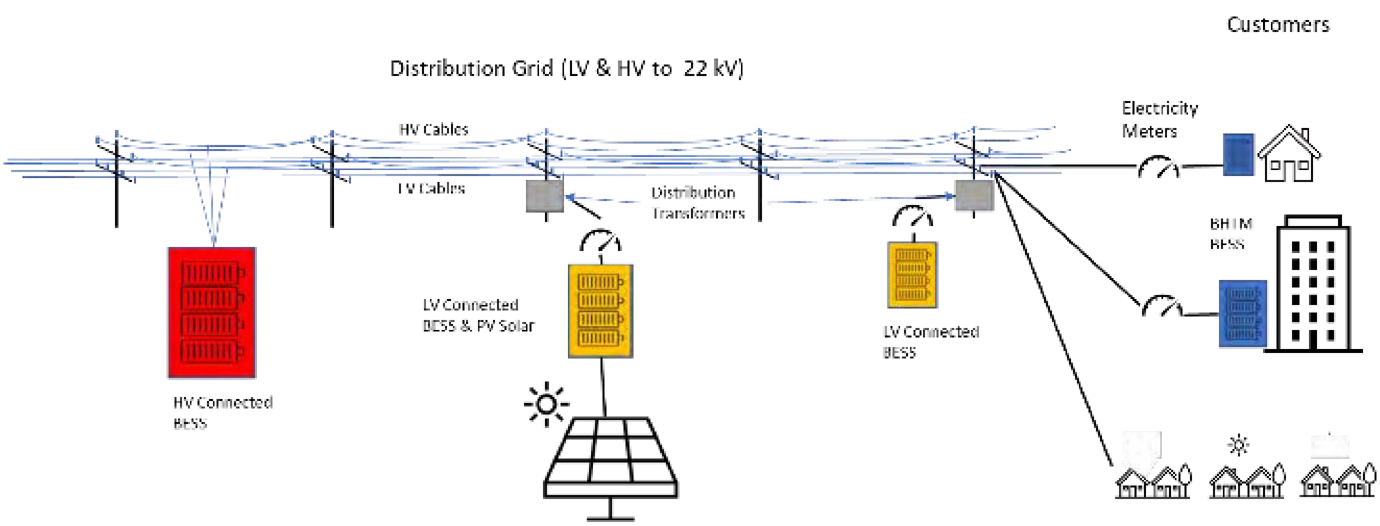

Figure 8 : Schematic of Distribution Grid showing potential BESS connection points

6 *DAPR 2020 Powercor Distribution Annual Planning Report*

The generic approach needed to allow for the requirement for 1 MW blocks of battery inverter power capacity to be available to access FCAS markets and to be large enough to gain energy retailer involvement. Therefore, the outputs of the modelling will need to be replicated in order for the inverter output to meet the 1 MW capacity requirement. For example a 240 kW / 500 kWh BESS would need to be replicated 5 times to total the minimum 1 MW required.

Powercor was very supportive of Geelong Sustainability's efforts and provided details on 18 distribution transformer sites in the Greater Geelong area, including the Bellarine, as potential locations for Neighbourhood batteries.

Image 9. Typical Powercor Pole mounted transformer in the Geelong Region

As can be seen from Image 9 above, all of the sites included HV (22 kV) and LV Overhead lines for possible connection points. From the initial 18 sites, and after extensive site visits, the following three sites in Table 3 were chosen for each IFTM application. Bell Post Plaza was selected based on size and location, East Geelong on the number of Solar customers and Newtown on location.

Distribution Substation	Number of residential customers	Number of solar customers	Installed PV capacity (kW)	Transformer capacity (kVA)	Type of Installation
Newtown	116	20	90.47	315	LV BESS
Bell Post Plaza	180	24	89.13	1500	LV BESS & Solar PV
East Geelong	227	35	138.69	315	HV BESS

Table 3. Selected IFTM Sites from Powercor Suggestions

8.1. Business Model Scenarios

Scenario 1. LV Connected BESS IFTM

Newtown

This Powercor suggested site was considered as ideal for an LV connected BESS located on the nature strip. The site had a reasonable number of customers with about 17% having rooftop Solar PV.

The roadway would allow for adaptations to suit the installation of a BESS including protection bollards and realignment of the Kerb and Channel. Sightlines would not be affected and the installation would be well away from site access driveways and the front of properties.

Image 10. Graph design image of possible location of battery in the community

Scenario 2. LV Connected BESS and DC Coupled Solar PV IFTM

Bell Post Hill (Bell Post Plaza Shopping Centre)

The largest site suggested by Powercor to review was for a Shopping Centre in the North of Geelong. The facility included a large substation of 1500 kVA that had recently been upgraded. The Substation also fed a number of homes in the immediate neighbourhood, of which many had Solar PV.

Each Shop in the centre was fed independently through a switchboard and individually metered, so the suggested BESS and coupled 200 kW PV system facility would be connected IFTM. The PV system generation would be able to augment the grid, particularly during the day when the Centres demand was expected to be high.

Image 11. Ariel image of North Geelong shopping centre with proposed PV array.

Image 12. Graph design image of possible location of battery at a shopping centre

Scenario 3. HV Connected BESS IFTM

East Geelong

The site in East Geelong suggested by Powercor had the largest number of customers in the sample list provided, so was considered as potentially suitable for an HV connected BESS.

The proportion of customers with rooftop PV in the neighbourhood was approximately 15%.

Image 13. Distribution Transformer

Image 14. LV Distribution Switchboard

There was no suitable land close to the 22 kV HV line, but it was thought that a nature strip installation with changes to the roadway may be possible, depending on the size of the required BESS.

Scenario 4. LV Connected BESS with PV BTM

Geelong YMCA Newtown Stadium

Geelong Sustainability recently installed a 60 kW (DC) Solar PV system at the Geelong YMCA as part of its community work in the region. The centre provides sporting and social activities across the day and into the evening and one of the major costs is energy.

The Powercor Grid connection approval for the Solar PV system was based on zero export from the site, so the adoption of a battery would enable generation during the day to be stored and used in the evening.

The installation of a battery would help with energy costs and potentially reduce demand on the grid during evening peak periods.

Image 15. Satellite image of Geelong YMCA

Scenario 5. Residential BESS

As part of the basis for the NBI study was the grid problems caused by excess generation from the many residential PV systems, a reality check seemed to be appropriate to also model a Residential BESS for comparison. Geelong Sustainability relied on ITP to provide the demand, system and operating parameters for a typical residential installation. (It is not clear if the numbers used by ITP reflect a typical Solar PV household in the region.)

Scenario 6. Community Storage - Storage as a Service (SaaS)

There has been great interest from the Community for Neighbourhood Batteries on the basis of shared community storage. ITP was requested to look at the technical and commercial options for this concept "Storage as a Service". ITP suggested that, dependent on gaining approval from Powercor and an adequate allocation of battery capacity being available, the analysis would be the same as Scenario 1 and provide results that are similar. This is explained well in the ITP report. Refer to Appendix 1. Consultant Technical Feasibility Report - ITP Renewables.

8.2. Technical Study Consultant Report

ITP Renewables were asked to look at the various Business Cases as outlined in section 8.1 of this report. A detailed technical report was produced which includes a comprehensive technical and commercial review of the various issues and provides modelling using the data provided and their proprietary software.

Overall ITP found that the various scenarios provided only a “marginal or poor” investment return without subsidy. However, in light of expectations of major cost reductions in time, some insights can be gathered from the data which can suggest future opportunities.

A summary of the technical study report findings is contained in the following sections. Refer to Appendix 1. Consultant Technical Feasibility Report - ITP Renewables.

8.2.1. In Front of The Meter Applications

Through the study a range of sites and battery configurations was modelled. For comparison’s sake, Simple Payback was used as a metric to show what is the best option for IFTM batteries. What became clear is that the larger the battery, the better the economics.

To maximise FCAS revenue ITP used BESS with similar energy (inverter) to capacity (storage) ratios. These batteries are typically more expensive than similar storage capacity BESS with smaller inverter output.

As explained in the section on Grid Participants, the revenue available from IFTM Neighbourhood Batteries would need to be split between Geelong Sustainability as the developer and owner of the BESS and Tango Energy as the operator. (At this stage it is not possible to provide guidance on what the acceptable level of return would be for the parties involved.)

As the results based on Simple Payback are not good, for revenue to be diluted further by a split is not supportive of the IFTM business models.

Table 4 below shows a summary of the various proposed Business IFTM Models and three BESS sizes for each model that ITP were able to assess for their report.

Scenario	PV Capacity (kWdc)	BESS Power (kW)	BESS Energy (kWh)	Capex	Opex p.a	2016-2020 Net Energy Revenue [1] p.a	2016-2020 FCAS Contingency Revenue p.a	NUoS Charges [2] p.a	Simple Payback (years)
Scenario 1. LV BESS	*0*	*240*	*500*	*$626k*	*$17,300*	*$14,200*	*$46,600*	*-$355*	*14.4*
Scenario 1. LV BESS	*0*	*240*	*750*	*$803k*	*$19,000*	*$19,200*	*$45,300*	*-$868*	*17.7*
Scenario 1. LV BESS	*0*	*200*	*250*	*$417k*	*$15,200*	*$6,470*	*$39,500*	*$199*	*13.6*
Scenario 2. LV PV + BESS	*200*	*1,500*	*1,500*	*$2.16m*	*$32,600*	*$47,100*	*$299,000*	*$10,700*	*6.9*
Scenario 2. LV PV + BESS	*200*	*1,000*	*1,000*	*$1.57m*	*$26,700*	*$37,800*	*$199,000*	*$1,270*	*7.5*
Scenario 2. LV PV + BESS	*200*	*500*	*500*	*$981k*	*$20,800*	*$28,200*	*$99,900*	*$593*	*9.1*
Scenario 3. HV BESS	*0*	*2,000*	*2,000*	*$3.23m*	*$43,300*	*$41,000*	*$396,000*	*$2,220*	*8.2*
Scenario 3. HV BESS	*0*	*1.500*	*1,500*	*$2.66m*	*$37,600*	*$30,800*	*$297,000*	*$1,670*	*9.2*
Scenario 3. HV BESS	*0*	*1,000*	*1,000*	*$2.08m*	*$31,800*	*$20,500*	*$198,000*	*$1,110*	*11.1*

Table 4. Proposed models ITP modelled. Source: ITP report.

[1] This is net revenue, accounting for NUoS energy charges payable, as well as the net revenue derived from trading on the NEM

[2] This is inclusive of network energy costs, which are also captured in the energy revenue column

The modelling for IFTM installations shows some interesting outcomes:

- The best option was for Scenario 2. - an LV connected BESS with a large DC coupled Solar PV system. This conceptually makes sense as Solar PV is quite competitive and network tariffs would be avoided when charging the battery.
- The results for Scenario 3. were also interesting. The modelling clearly shows that as battery size increases - the economics get better. What was also interesting is that tariffs for an HV connected BESS were not that high. Although Powercor was very helpful with supportive tariffs for LV connected batteries below 240 kVA, the overall economic benefits of size outweighed that support.
- The results for Scenario 1. were disappointing, as the expectation was that the proposed special Powercor tariffs would have helped more with LV BESS viability.
- ITP's report found that the economics for a larger battery will always be better than smaller batteries. Further a 1 MW BESS will be a better solution when compared to a multiple of smaller batteries to total the 1 MW requirement to meet AEMO NEM trading requirements. However, the opportunity to site such large batteries in Community settings will be difficult.
- One of the key issues is of course physical size and as an example - a 2 MWH HV connected battery has been recently installed at Deakin University in Waurn Ponds. Those batteries were about the size of 2 off 40 ft containers, so quite large and difficult to place in a neighbourhood.
- As far as this study is concerned the installation of Neighbourhood Batteries in line with the requirements of DNSPs (Powercor) and no greater than 240 kVA in output are not considered viable. They are just too small and expensive to install.
- In all the scenarios that ITP modelled, FCAS was the predominant revenue source, however, the long term FCAS revenue prices are forecast to decline (ITP Report), as more large scale batteries are commissioned on the NEM. The competitiveness of Neighbourhood Batteries against larger Utility scale batteries will be very difficult.

8.2.2. Behind the Meter Applications

Scenario 4. Geelong YMCA

Geelong Sustainability was involved in installing a 60 kW PV system at the Geelong YMCA in 2021 that helped to reduce the energy requirements for the centre. The system was allocated a “zero export” grid connection approval by Powercor, which meant that any energy generated by the PV system and not used by the YMCA, would be lost. A BESS installation would help capture that excess generation.

Scenario 4	Peak Imports (kWh/yr)	Off-Peak Imports (kWh/yr)	Total Imports (kWh/yr)	Electricity Bill ($/yr)
60kWp PV, no BESS	*20,175*	*14,314*	*34,489*	*$13,193*
60kWp PV, 50kW/125kWh BESS (smart control)	*2,872*	*15,369*	*18,241*	*$5,536*

Table 5. Community Centre BTM BESS modelling results

Scenario 4	Capex ($)	Bill Saving ($/yr)	Simple Payback (years)
Base Case: 60kWp PV, no BESS			
+50/125kWh BESS (smart control)	*$132,000*	*$7,657*	*17.3*

Table 6. Community Centre BTM BESS financial results

One of the issues with the modelling was data was only available from a period that included Covid lockdowns, so is not a true representation of normal operations.

The results with a BESS installed are interesting in that the data shows that the imports from the grid overall were halved, and at peak times by approximately 85%. Clearly the BESS is helping the on-site generation to provide power when required. One of the issues with PV only installations is that during intermittent cloudy days, there will be times when the PV system is producing more than the site can use and times, when cloud is passing over, when the site will need to draw from the grid as the PV will not be available. Batteries would help considerably with this type of issue.

It is interesting that even with Covid constraints on usage, the numbers for the Community Centre are not that different to the modelling for Powercor’s preferred smaller IFTM installation. Further, there would be quite definite benefits to the community for a BESS to be installed. A subsidised BESS would bring real benefits to the community and help the running costs for the centre.

Scenario 5. Residential Modelling

Geelong Sustainability has been involved with residential PV and Battery installations in the Greater Geelong area over many years and three bulk buy programs. There was a natural fit to understand if there were any synergies between that work and the deployment of Distributed Storage, particularly Residential Batteries.

ITP looked at this as an option to provide a comparison and reality check against larger Neighbourhood Batteries. They chose to model a profile of a 5 KW PV system with a 5 kW/10kWH BESS and an average daily load of 13.4 kWh based on an average of 3000 Victorian homes.

Scenario 5	Capex ($)	Bill Savings ($/yr)	Simple Payback (years)
Base Case: no PV, no BESS			
+5kWp PV	*$5,000*	*$422*	*11.8*
+5kWp PV, 10kWp BESS (smart control)	*$17,500*	*$931*	*18.8*
+5kWp PV, 10kWp BESS (smart control)	*$17,500*	*$952*	*18.4*
Base Case: 5kWp PV, no BESS			
+10kWh BESS (simple control)	*$12,500*	*$509*	*24.6*
+10kWh BESS (smart control)	*$12,500*	*$530*	*23.6*

Table 7. Scenario 5 Financial Results

Scenario 5	Peak Imports (kWh/yr)	Off-Peak Imports (kWh/yr)	Total Imports	Exports	Electricity Bill ($/yr)
No PV, no BESS	*1,206*	*3,685*	*4,891*	*0*	*$1,592*
5kWp PV, no BESS	*822*	*2,117*	*2,939*	*4,805*	*$1,170*
5kWp PV, 10kWh BESS (simple control)	*96*	*765*	*860*	*2,359*	*$661*
5kWp PV, 10kWh BESS (smart control)	*3*	*873*	*876*	*2,360*	*$640*

Table 8. Scenario 5 Modelling Results

The results were not encouraging for either PV or a BESS, but that may be partly to the Load modelled being only 13.4 kWh per day. What is interesting is that demand from the grid during Peak times was reduced considerably.

Scenario 6. Community Storage - Storage as a Service

ITP concluded in their report that technically and commercially this option would be similar to Scenario 1.

The Financial results are poor for Scenario 1 and do not include the revenue split that would be required between Geelong Sustainability as the battery developer and owner and Tango as the operator.

8.2.3. Technical Study Report Conclusions

The work that ITP carried out was rigorous and broad, looking at a range of options to try and find the commercial “sweet spot” within a range of variables including NEM pricing, Solar PV generation, FCAS pricing, typical electricity throughput for generic sites, tariffs, as well as mid size battery Capex and operation costs.

It was found that the business cases with present battery costs are not encouraging. However, the work did provide insights into what could make sense going forward in order to roll out more distributed storage and what would work for the Community, this is discussed further in Section 9.

9. Challenges and Risks Identified

Geelong Sustainability set out to understand the technical and particularly the commercial drivers that impact the rollout of Distributed Storage.

What was identified was a number of mismatches between what type of operating business model was proposed and what the actual benefits that were being sought from a particular type of Neighbourhood Battery installation.

9.1. Challenges

Based on work carried out during the early stages of the study, Geelong Sustainability was very keen to understand the Commercial viability of the installation of Neighbourhood Batteries - as that would underpin any decision to make the necessary investments.

Commercial

From a Commercial perspective the following barriers became more apparent as the study progressed:

Capital Expenditure to install the batteries -

- During the study period battery costs that were initially too high increased further by approximately 30%.
- Design and Connection Costs were too high
- Installation costs were too high
- Markets are only accessible via association with a retailer. Profit share between Geelong Sustainability and a retailer could be an issue.

Regulatory Costs - Requires a minimum investment of $2M+ in order to install the 1 MW output required by AEMO to access the NEM, Arbitrage and FCAS markets. (For smaller LV connected batteries (< 240 kVA) that Powercor was supportive of, the required investment would be $2 - $3M.)

Project Return - The requirement to include a market participant in order to be able to access those markets further stressed the commercial viability of the returns available from a BESS.

Revenue Uncertainty - The variability of future FCAS and Arbitrage revenues were recognised as major issues. Further allocating capacity within the battery for each market could impact the overall benefits that could be derived, particularly for the community.

Table 9 below sets out the range of commercial drivers and incentives that impact the various types of distributed storage. The mismatch between installation type and community/customer expectation is shown.

Installation Type	Network Tariffs	Revenue FCAS	Revenue Arbitrage	Revenue Network Support	Solar PV Incentive	Support Real Time Customer Demand
IFTM LV BESS	*Yes*	*Yes (> 1MVA)*	*Yes*	*Potentially*	*No*	*No*
IFTM LV BESS & Solar PV	*Yes*	*Yes (> 1MVA)*	*Yes*	*Potentially*	*No*	*No*
IFTM HV BESS	*Yes*	*Yes (> 1MVA)*	*Yes*		*No*	*No*
BTM LV BESS & Solar PV	*No*	*No*	*Yes & PV*	*No*	*Yes*	*Yes*
BTM Residential BESS & Solar PV	*No*	*No*	*Software Dependent*	*No*	*Yes*	*Yes*

Table 9. Commercial drivers that impact the various types of distributed storage

Resourcing the Development and Installation of Neighbourhood Batteries
The resources that Geelong Sustainability would need to make available in order to provide the necessary Development through to Operations activities for a Neighbourhood Battery are probably beyond the current capabilities of the Group.

Community Benefits
It was not clear how the Community Benefits that Geelong Sustainability initially set out to achieve could be realised. Specifically, it was not clear how the installation of a Neighbourhood Battery would reduce electricity costs for the community directly and how that would be communicated.

That only larger batteries were economically viable definitely did not align with the need to provide smaller storage on the LV network in order to act as a “Solar Sponge” and support rooftop Solar PV.

Given that, determining the Commercial viability is difficult and further complicated currently by rising battery costs. When Geelong Sustainability started this project, the base assumption was that over time battery costs would be falling and that new technologies would help. The other issue to consider is delivery, in recent discussion with suppliers a 2 year time frame from placement of order has been suggested. So these projects are probably not going to happen quickly.

Government Incentives
Government subsidies at State and Federal levels support rooftop PV, providing distributed generation and contributing to grid congestion issues, but there are really not enough subsidies in place to support distributed storage to offset the incentivised PV generation.

9.2. Commercial Risks

Geelong Sustainability has identified the following as key concerns for the Group with involvement in Neighbourhood Batteries.

Financial models based on historical vs forecast FCAS and Arbitrage revenue valuations
The work done in the current study was undertaken using historical data, although recent market NEM volatility has reinforced that future expectations of revenue could be very different from what would be assumed in a business case.

Market Changes
The transition underway in the Electricity sector is huge and it is not possible to predict how changes may impact the operations of a Neighbourhood battery.

Regulatory Changes
Changes to the Regulatory regime may impact the operations of the battery.

Technology Changes
Newer technology may supersede the current Neighbourhood Battery types.

Installation Costs
Budget blow outs could be quite a problem for a relatively small organisation like Geelong Sustainability.

Social Licence and Reputational Risk
Any community issues with Neighbourhood Battery installations may impact the other activities the group is undertaking in the region.

Operating Costs
A key issue could be the differentials between charging and discharging in the NEM, as well as general operations may not be enough to cover the financial requirements. Further, the available income to cover the BESS CAPEX and OPEX may not be sufficient for both a Retailer and Geelong Sustainability to achieve their respective financial expectations.

Grid Connection & Commissioning Issues
Potential for delays and problems with Commissioning and Grid Connection could delay the project and increase costs.

Damages for non-availability of the storage service
Care would be necessary to ensure any contractual arrangements entered into include limited damages.

Project Development and Management capability
GS having adequate expertise to oversee the work of various consultants and contractors engaged in the development, design, permitting, procurement, installation and commissioning of a Neighbourhood Battery IFTM.

10. Recommendations

The following are the key recommendations and suggestions that Geelong Sustainability would make for this report:

10.1. Recommendations for State Government

1. Subsidise Battery Energy Storage Systems until market pricing reaches an acceptable business case

Currently in the market we are seeing the price of batteries increasing, information from suppliers suggest that BESS prices have jumped by 30 - 40%. These more recent numbers were used in the ITP modelling.

With the huge increase in battery production around the world, the hope is that prices will begin to reverse and drop considerably. However, for the overall cost of projects to drop, there should also be attention to reducing development and connections costs. Further, standardising and modularising installation methods would help to reduce those costs as well.

If Battery CAPEX could be reduced by at least 50%, then project viability could increase considerably for both IFTM and BTM applications.

Experience with PV installations over the last 10 ~ 12 years have shown that module prices have decreased, but so have the rest of the components (Balance of System) and services required to build a PV facility. In general actual installation experience helps to identify opportunities to reduce overall costs and this would be the case for Neighbourhood Batteries as well.

Geelong Sustainability would encourage Governments to subsidise BESS installations and support the industry and community to learn and adapt how best to utilise the technology.

2. Neighbourhood batteries should not rely solely on arbitrage and ancillary market services
There is already considerable investment by major players in the industry to build large scale batteries for FCAS and Arbitrage markets. It is not clear that these markets are viable longer term for Neighbourhood Battery business models and don't seem to align with the issues that need to be addressed.

As overall volumes of renewable energy on the grid increase, large variations for wholesale pricing during the day to peak times in the evening, may become more frequent. These market changes may force the adoption of more Utility Scale Storage, particularly as equipment and installation prices come down and as utilities and related companies work within the marketplace.

For this reason the recommendation would be that Neighbourhood Batteries will potentially be at a competitive disadvantage should they rely solely on Arbitrage and FCAS markets on the NEM for revenue longer term. Consideration is needed in identifying more options for the income value stack for Neighbourhood Batteries. Alternative income streams may require regulation changes as outlined below.

3. DELWP needs to consider the following with respect to IFTM batteries:

1. There seems to be a clear mismatch between the markets and revenue streams (FCAS & Arbitrage) that are available for the installation of an IFTM Neighbourhood Battery and the benefit expectations of the wider community, as well as the DNSPs.
2. For a realistic community focused Neighbourhood Battery - consideration needs to be given on Regulation changes to allow community benefits to be realised by insulating these types of localised storage installations from the broader market forces on the NEM.
3. For IFTM Neighbourhood Batteries the following recommendations would improve the commercial business cases:
    a. Regulation change for NEM requirements. Particularly the requirements for a Grid Participant and revenue from the NEM - FCAS and Arbitrage.
    b. Tariff structure that reflects the localised movement of energy.
    c. Technology for metering and real time Battery Management Systems that would support the separation of the localised system from the NEM.
    d. Support to help reduce battery prices and installation costs - for example further grants.

4. Change renewable energy incentives to support Distributed storage

The current regulations provide a level of incentive with the current feed-in-tariff (FiT) regime for rooftop PV systems below 100 kW DC to export to the grid. The Government should consider replacing the current FiT with a benefit for installing Distributed Storage. This would help keep excess generation off the grid and reduce consumption during peak times.

Alternatively, Governments could potentially provide a solution in reconfiguring the incentives to install distributed PV generation (STCs and FiTs) to also support distributed storage.

For LV grid support and congestion and given the increases in expected volumes as the community electrifies, it probably makes sense for the DNSPs to make the investment decisions on how best to upgrade the local grid based on an overall economic assessment. DNSPs should be able to make the best decisions on the right technical and commercial solutions to support the grid infrastructure.

5. DELWP should consider how to ensure Distributed Storage is also provided with Distributed Generation

DELWP in conjunction with National bodies should consider how to provide incentives to install BESS whenever PV is installed. Potentially, it could also provide incentives for the installation of storage for existing rooftop PV systems.

10.2. Recommendations for Geelong Sustainability

1. Geelong Sustainability should focus on core capabilities

Geelong Sustainability is fortunate to have a large membership base and a core management group with extensive experience in supporting environmental initiatives. The group has shown success in working with the broader community in the Greater Geelong region and other similar organisations in the South West.

Geelong Sustainability has run a number of community funded PV installations, as well as supporting Bulk Buy programs for rooftop PV and battery installations.

The Group believes that continuing to support these types of programs, as well as adding its voice on issues that impact the broader community, are the most appropriate roles moving forward.

2. Geelong Sustainability should investigate the Opportunity for larger scale batteries installed in conjunction with large Solar PV arrays located Behind the Meter at community centres

Geelong Sustainability found that large batteries in conjunction with large PV arrays could provide the benefit of more generation and the capacity to provide that electricity when it was required. Support from the Government for these types of installations at Community Centres could enable community benefit, aligned with reducing grid usage.

Geelong Sustainability would be happy to work with DELWP on identifying and supporting these types of opportunity, including the current Geelong YMCA.

11. Conclusion

Geelong Sustainability supports the move to greater electrification across the community. As part of these changes, there is an expectation that Distributed Storage will be required to support the increase in mandated Renewable Generation.

At the start of the Neighbourhood Battery Initiative study Geelong Sustainability set out to address the following:

- Grid connection constraints - 30% of new solar PV connections are zero or limited export
- Costs associated with upgrading the distribution grid to support the installation of more residential and commercial solar PV
- Assisting customers who do not have solar to source locally generated renewable energy
- Cost inefficiencies between decentralised Behind-the-Meter BESS and centralised In-Front-of-the-Meter BESS
- Grid reliability, peak demand and power quality issues
- Need for firming of intermittent renewable energy supply.
- Network charges, particularly the adoption of Time of Use Tariffs.

Through this feasibility study Geelong Sustainability was able to determine that In-Front of the Meter BESS project economics are marginal, if not poor. With current battery and installation costs the simple payback periods ranged from 8 to 18 years across all modelled scenarios. As BESS technologies mature and become more widespread it is expected that battery costs will reduce in the future, however in the short term for Neighbourhood Battery projects to be feasible they would require subsidy in the form of grants or preferential tariffs in order to be commercially viable.

The study also highlighted the huge complexity of commercial, regulatory and technical requirements for developing, installing and operating IFTM Neighbourhood Batteries. Whilst not entirely insurmountable, the complexity associated with Neighbourhood Batteries and associated challenges and commercial risks (outlined in this report) are beyond the risk appetite that Geelong Sustainability, a small not-for-profit organisation, would be willing to bear.

There seems to be a clear mismatch between the community expectations of the benefits of Neighbourhood Batteries with the reality of operating on the NEM. Geelong Sustainability was not able to find the community benefits that were hoped for. The regulatory and commercial landscape for BESS installation and operations, particularly for customers to access shared community storage, was found to be not viable.

Further, Geelong Sustainability was not able to identify how the operations and the revenue streams of FCAS and Arbitrage on the NEM would have the hoped for impact at the local level. Further, Powercor was not able to advise, in financial terms, the Network benefits of installing a BESS on the LV grid.

Ultimately, Geelong Sustainability has determined that IFTM BESS projects are not suitable for it to pursue, this is due to three main factors. 1.) Marginal commercial viability, 2.) High complexity and associated risks, and 3.) The inability to demonstrate the intended community benefits.

A number of recommendations have been made in this report that would improve above mentioned challenges and improve the outlook for Neighbourhood Battery projects in the future.

The study has also helped to identify future project directions for Geelong Sustainability that focused on supporting the uptake of Behind-the-Meter Battery Storage through community engagement, education and residential bulk-buy programs, as well as investigating the development of larger scale BTM batteries installed in conjunction with large Solar PV arrays at community facilities. This approach is more aligned with Geelong Sustainability's risk appetite and current capabilities, it also achieves many of the community benefits GS had initially set out to achieve.

12. References

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14. Harnessing Victoria's Distributed Energy Resources, Victorian Government 2022
15. Voltage Management in Distribution Networks Consultation paper - DELWP, 2022
16. New Energy Technologies - Sector Strategy - Victorian Government, 2016

13. Appendices

Appendix 1

Consultant Technical Feasibility Report - ITP Renewables (Confidential)

Appendix 2

Community Engagement Report

Appendix 3

Full Survey Results for Community Engagement