The Powerful Neighbours Report

A guide to developing neighbourhood batteries as assets in your community

Powercor AUSTRALIA | Good people in power

Acknowledgments

Powercor would like to thank our partners in this project:

And major funding contributor:

We acknowledge and appreciate the financial support and fellowship offered by the Victorian Government's Neighbourhood Battery Initiative and members of the Department of Environment, Land, Water and Planning team.

We also thank Yarra Energy Foundation's Community Battery Project Manager, Chris Wallin, and Chief Operating Officer, Timothy Shue, for their generous time in sharing insights from the Neighbourhood Battery Initiative they developed over the same 2021-2022 period.

Powercor acknowledges Traditional Owners as the First People of the land and waters where we and our partners operate and pay our respects to Elders past, present and emerging.

It's the neighbour you want

Do you have someone in the neighbourhood who is good to have on your side? The neighbours who get things done, that act to benefit everyone and are generally good to have around? Their power comes from their influence and commitment to the community.

The powerful neighbours that we're talking about in this report offer similar qualities. They're just less likely to invite you for a barbeque.

They are neighbourhood batteries.

Their influence comes from the critical role they can play as our society shifts to greater renewable energy generation and a clean energy future.

Their local commitment is demonstrated by their ability to help whole communities to have highly reliable electricity supplies, keep more locally generated solar energy local, and contribute to energy resilience.

Either way, the necessity for neighbourhood batteries comes from the mismatch between when renewable energy is abundant in the middle of the day and when electricity demand is highest in the late afternoon and evening peak. The challenge is in how to store the energy locally so it can be shared and used by neighbours when it's needed.

This report results from a feasibility study led by electricity distribution network Powercor, and conducted in partnership with CitiPower, United Energy and twelve community-based organisations.

The project, known as the **Electric Avenue Feasibility Study**, was supported by a grant from the Victorian Government's Neighbourhood Battery Initiative in 2021.

In less than 12 months, the partners worked together to investigate the various uses for batteries, the key factors to consider in their location, design and planning, as well as the commercial considerations for not only their cost but also how they may potentially create revenue for communities.

Ultimately, the partners identified a list of preferred battery locations which are at various stages of development as new projects. However, the study also revealed learnings, insights and ideas that may support other communities interested in these new technologies.

The feasibility study has shown how to, in effect, develop neighbourhood batteries to make the most of the benefits they can bring while also ensuring they can be effectively integrated into the fabric of communities.

In this way, they can become valuable community assets. A powerful neighbour that you want to have nearby.

Contents

Publication date

June 2022

> “Battery technology offers great potential benefits for all our customers by supporting power reliability while also providing access to more renewable energy”

Mark Clarke, General Manager Electricity Networks, Powercor

1 A new type of electrical asset

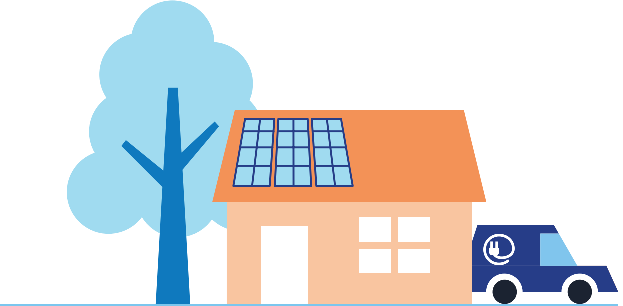
Neighbourhood batteries are new types of electrical assets that have only really started to be introduced in Australia since 2020.

Until now, most attention has been on two opposite ends of the energy storage spectrum.

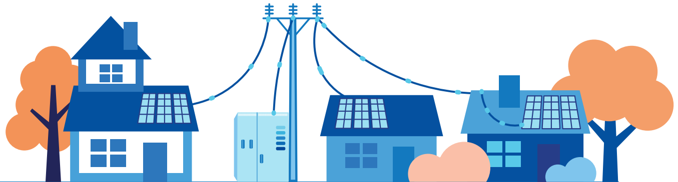
At the large end of the scale are batteries of around 100 megawatts (MW) capacity or more, installed at a high voltage level, often associated with renewable energy generators and capable of supporting large numbers of customers. One example is the 300MW Victoria Big Battery in Geelong which will store enough energy in reserve to power over one million homes for 30 minutes.

At the small end of the scale are household batteries. These are often associated with rooftop solar systems to help customers make the most of the power they are generating for their own use or to provide a level of energy independence.

Essentially, neighbourhood batteries provide a role in between both of these other forms of energy storage. Connected directly to the low voltage electricity distribution network, they provide benefits to a defined local community that is serviced by that part of the network.



Typical home Battery with up to 10kW capacity



Neighbourhood battery 30kW to 5MW capacity

Source: AusNet

Big batteries 100MW capacity +]

How they work

Neighbourhood batteries will charge at times of the day when there is lower electricity demand. There are two main sources for the energy stored. One is the electricity from large scale generators (solar, wind, hydro, gas and coal-fired) that is transported and supplied through distribution networks. The other important source is locally generated energy from rooftop solar systems on homes or buildings when excess power not used by those customers is exported into the distribution network.

Power from the battery can then be discharged and used later in the day when energy demand is high and solar systems are no longer generating. The peak time when most people use power is typically between 3pm and 9pm, Monday to Friday.

Alternatively, the power can also be discharged at times where there is a wholesale energy price opportunity.

Multiple benefit streams

Neighbourhood batteries have the potential to provide social, economic, and technical benefits.

Advantages of neighbourhood batteries

- Support the local distribution network and help to defer expensive infrastructure upgrades. This may enable all consumers to save on bills through lower network charges.
- Support the integration of more solar PV into the electricity network by storing electricity generated by solar systems during the day and discharging it during the evenings when demand is highest. This can enable consumers to generate and consume more renewable energy locally.
- Participate in spot price arbitrage in the wholesale electricity market helping to place downward pressure on electricity prices and provide frequency support services to help maintain the security and reliability of the electricity system.
- In some cases, support customers in remote, outage-prone areas by providing backup power and improving reliability of supply.
- Help to expand consumer access to the benefits of storage through virtual storage models, including providing access to people who may not otherwise be able to install these technologies themselves.

Source: Neighbourhood Battery Initiative, Industry and Community Consultation Report (2022) The State of Victoria, Department of Environment, Land, Water and Planning

One of the key benefits of neighbourhood batteries is that they offer all people within a community the opportunity to participate in the clean energy future whether they have solar panels on their roof or not.

In the transition of the electricity market to more renewable energy and less reliance on fossil fuels, customer take up of rooftop solar is becoming increasingly popular. However, not all customers are able or willing to install their own solar system either due to financial reasons, not having a suitable roof or because they live in apartments or rental properties.

Neighbourhood batteries offer material benefits for all the customers they supply in terms of:

- **High electricity reliability in peak demand periods:**
  when there is a short term need for more power than is typically consumed in the community, for example, on hot summer days when electricity consumption for air conditioning can lead to many times greater demand than average.
- **Lower cost of power supplies:**
  by avoiding or deferring the need for traditional investments or upgrades to electricity poles and wires, all customers benefit from lower future network tariffs as one of the components of their electricity bills.
- **Achieving carbon emissions reduction targets:**
  making available decarbonised, renewable energy at all times of the day to remove concerns that solar and wind power is unavailable when the sun doesn't shine or the wind doesn't blow.

Various project models

Amongst the partners in the Electric Avenue project, the first rollout of neighbourhood batteries occurred in the United Energy network when two power pole-mounted batteries were installed in a trial of the technology in 2020. These batteries in Highett and Black Rock proved so successful, they have now led to a project in which the next generation of pole-top batteries will be rolled out in 40 locations across the Mornington Peninsula and south-east Melbourne suburbs by the end of 2023. These 30 kilowatt (kW) or 66 kilowatt hour (kWh) batteries will collectively, store 1.2MW of power and support an estimated 5,000 households.

CitiPower is a partner in the Yarra Energy Foundation's community battery project through which the first 284kWh battery was unveiled in Fitzroy North in June 2022. The Foundation is an independent, not-for-profit organisation that owns and orchestrates the battery and has plans to develop a network of batteries across inner-urban suburbs of Melbourne. The project's purpose is focused on both environmental outcomes and financial sustainability. The first battery will support an estimated 200 homes by storing locally produced solar and feeding it back for community use during nightly peaks. It is also designed to participate in the wholesale electricity market.

These projects demonstrate just two of the options for how neighbourhood battery projects can be structured. They 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, and the value streams accessed by the battery, depend on who it is owned by and how it is operated.

Some neighbourhood batteries are utilised by energy retailers and aggregators to provide storage services to customers with their own solar generation. This allows these customers to virtually store excess power in the neighbourhood battery for use at another time. Participation in these shared storage schemes can be cheaper, more efficient, and more flexible than purchasing a household battery, avoiding installation and maintenance costs, as well as relocation constraints.

In regional and remote locations, communities are also interested in how batteries can provide back-up power supplies, particularly in light of the risk of power outages caused by extreme or changing weather conditions. This form of neighbourhood battery is associated with more advanced Stand-Alone Power Systems (SAPS) or microgrids. These types of systems were not specifically considered within the Electric Avenue Feasibility Study.

2

Electric Avenue Feasibility Study

In 2021, Powercor received funding from the Victorian Government's Neighbourhood Battery Initiative to lead a feasibility study into community batteries, working with two other distribution networks, CitiPower and United Energy, and 12 councils, community energy and greenhouse alliances.

Electric Avenue Feasibility Study Participants

- Bayside City Council
- Mornington Peninsula Shire
- Manningham City Council
- Eastern Alliance for Greenhouse Action
- City of Melbourne
- Geelong Sustainability
- Southern Otways Sustainable
- Apollo Bay Chamber of Commerce
- Bendigo Sustainability Group
- Hobsons Bay City Council
- Moreland City Council
- Macedon Ranges Sustainability Group.
- Powercor
- CitiPower
- United Energy

Scope

By working with multiple partners, the study aimed to create momentum in developing neighbourhood battery projects. The collaboration sought to define a replicable, systematic process for developing the business case for neighbourhood batteries. At the same time, the study has also:

- further developed the capacity of partner organisations to undertake this form of project
- identified community preferences for stakeholder engagement essential to generating participation or support
- supported the design of network services to provide data essential to project design
- evaluated the proposed value benefits and drivers for battery projects.

Four distinct workstreams were developed under the study as described in table 1.

The critical outcome was to define a list of preferred locations for batteries within the regions represented by the study partners and based on the systematic assessments undertaken. A 'long-list' of 84 potential sites was identified and assessed as part of the study to identify a 'short-list' of 17 preferred sites based on site selection and commercial criteria developed by Powercor and a further 13 sites suggested by partners.

The learnings realised through the study are captured within this report to help inform other potential project proponents about how batteries can best support customers and the community.

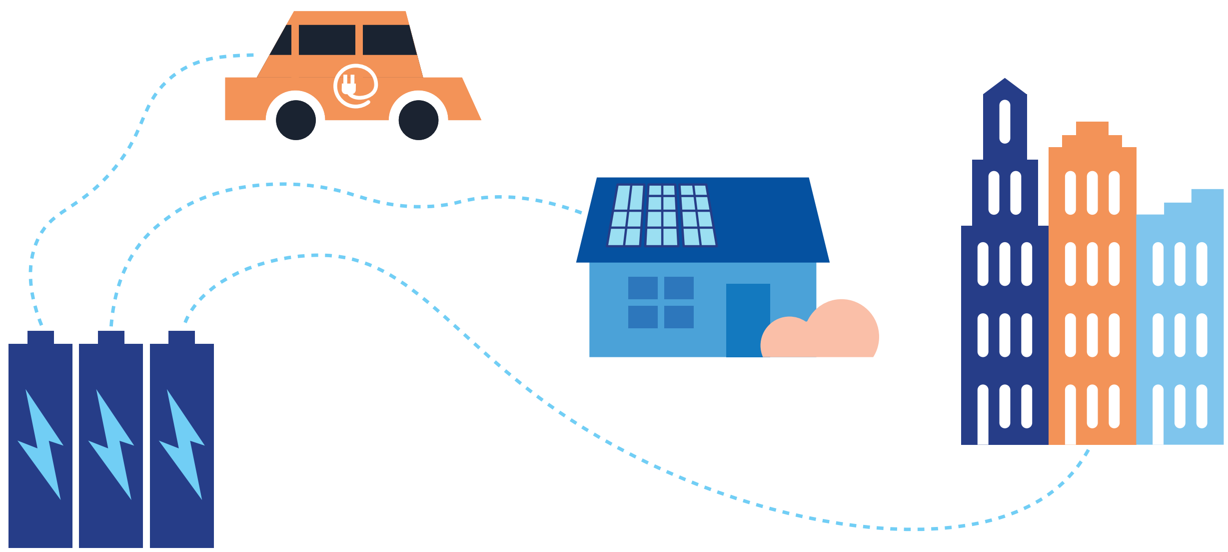


TABLE 1 FOUR FEASIBILITY STUDY WORKSTREAMS

Workstream	Description	Output
Network engagement	Utilising network data to determine where and how to connect batteries to the electricity network taking into consideration: • Substation Demand Constraint • Substation Load Break Circuit Ratings • Solar Penetration • Physical Location Constraints	The development of a 'long list' of potential battery sites subject to further analysis.
Commercial	Undertaking business case studies based on two alternative ownership models (community owned asset or distribution network owned asset) and considering: • Major cost drivers • Potential revenue and value streams • Funding streams	A methodology for each partner to utilise in framing their own project business cases.
Community engagement	Conducting the stakeholder engagement required to support the identification of sites preferred by communities depending on the status of projects being considered.	Standardized selection criteria as a checklist for site assessment. Data and insights that can both support the assessment of preferred battery sites and inform the design of future stakeholder engagement planning.
Approvals	Examining the approval constraints and considerations for battery sites including: • Planning Schemes • Floodway Zones • Environmental Matters • Bushfire Management • European Heritage • Aboriginal Heritage	An Approvals Pathway Guideline to assist with the site selection process.

Use cases

Through initial engagements and surveys with the study partners, it became clear that there were various motivations for their interests in batteries. The most common objectives for the development of a neighbourhood battery in order of priority were:

1. Community-generated interest, for example, with many local governments having undertaken consultation in relation to climate emergency response plans
2. Concerns over climate change
3. Known current network constraints
4. Known electricity reliability issues
5. Energy self-sufficiency
6. Energy resilience.

These were captured into four use case scenarios as each one represented different commercial factors and a different range of benefits for participating communities as shown in table 2.

This insight materially affects the business case for batteries and the feasibility process developed. Where there are no distribution network constraints or benefits relative to Distribution Network Service Provider (DNSP) augmentation investment, there is no opportunity for network investment in the battery under current regulatory frameworks.

In any event, the preference of study partners was for batteries to be community-owned assets.

TABLE 2 BATTERY USE CASES

Use case	Driver / motivation	Benefits
Community initiated works	• Climate change concerns • Environmental concerns • Risk of isolation due to bushfires or extreme weather events	• Emissions reduction objectives • Renewable energy objectives • Energy self-sufficiency objectives • Community resilience objectives
Solar penetration and exports	• Network capacity constraints • Voltage management concerns	• Support increased solar penetration • Support increased installed capacity and export potential • Emissions reduction and renewable energy objectives
Network reliability	• Network constraints • Peak demand reliability risks • Risk of extended power outages due to bushfires or extreme weather events	• Improved network reliability • Improved network resilience to impacts of climate change
Urban residential development	• Network planning for future growth/demand	• Support increased penetration of all forms of distributed energy: solar, batteries, zero emission vehicles (ZEVs), smart home management • Support increased installed capacity and export potential • Emissions reduction and renewable energy objectives

Feasibility assessment

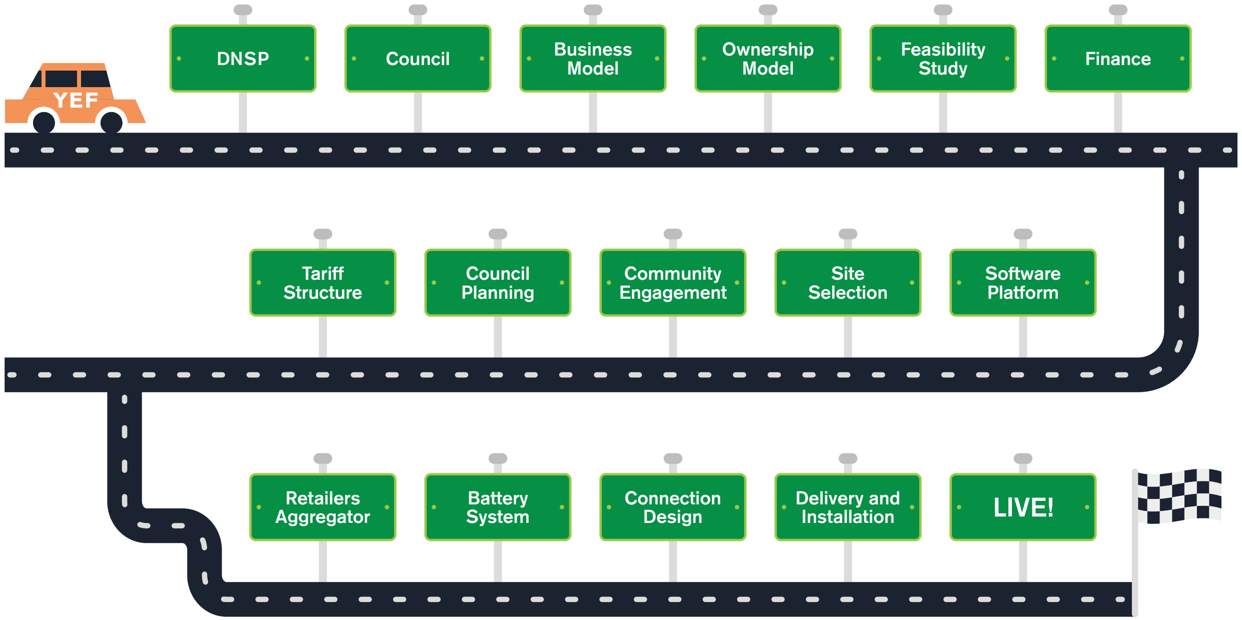
Working in collaboration with all partners, the outcomes of the four workstreams were captured within a model business case template and became the basis of conversations around preferred site selections.

This template is shown in appendix 1 and was designed to be an initial overview only of the foundation objectives, social and commercial considerations, and main risks to inform a project feasibility assessment.

This approach to initial assessment was supported by the experience shared by other battery project case studies. For example, in a presentation to the study partners in October 2021, Chris Wallin, manager of the Yarra Energy Foundation's community battery project discussed the steps they pursued. The full path to project delivery for their Fitzroy North battery commissioned in June 2022 is outlined in illustration 1.

ILLUSTRATION 1 YARRA ENERGY FOUNDATION, YARRA ENERGY STORAGE SOLUTIONS, PROJECT JOURNEY

Project Journey



Adapted from: Yarra Energy Foundation, For a zero carbon future

Within the feasibility study, the 12 partners ranged from organisations which had an interest in batteries but no current project intent to organisations which were well progressed in developing their project models. However, through the work conducted, there were five (5) important learnings that were consistently realised and relevant to all involved.

Feasibility Study — 5 Key Insights and Learnings

1. Know your purpose:

The project needs to be founded on a clear purpose or set of objectives for why the battery is sought. This use case has a material impact on the ownership model and commercial assessment.

2. Embrace communities in the journey:

Community members need to not only be informed and consulted but wholeheartedly embraced in the project if they are to value neighbourhood batteries as a potential customer, investor, neighbour or beneficiary.

3. Financial sustainability is a function of scale:

The high upfront costs associated with battery developments, particularly in relation to control systems and other hardware costs, as well as the mechanics of the wholesale electricity market mean financial sustainability is often best achieved with multiple batteries.

4. With ownership comes great responsibility and cost:

Three alternative ownership models were considered as part of the study with each representing different obligations for who carries the costs and gains the benefits in terms of revenue.

5. The approvals process has just got easier:

The previous lack of established planning processes for neighbourhood batteries has now been addressed by a change in Victorian state planning schemes to enable these developments without additional planning permit approval.

3 Insights and learnings

1. Know your purpose

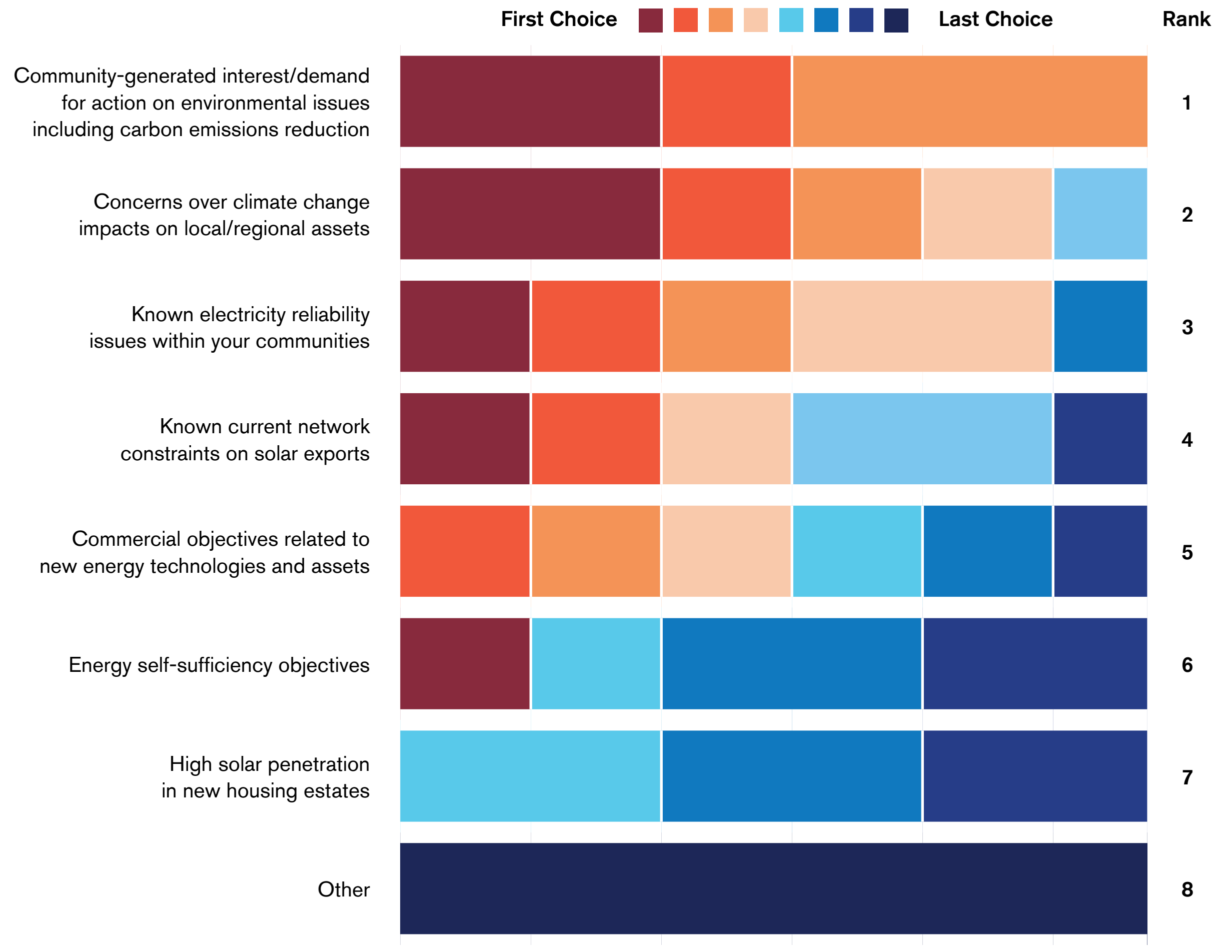
The critical starting point for neighbourhood battery projects is to understand the objectives from an energy, community and commercial perspective.

Questions to consider

- What is your motivation for wanting a neighbourhood battery?
- What are your community's hopes and desires for a neighbourhood battery?
- What are your objectives and how are these prioritised?
- Can you define the scale and timeframe for problems to be overcome or opportunities to be optimised?
- Can you describe the long-term vision for the battery or network of batteries?
- To what extent do you aspire to community ownership, investment or participation?

In the case of Yarra Energy Foundation, the project is described as developing a community battery network owned by an independent, for purpose organisation and intended to promote greater solar penetration within inner city communities. However, from a commercial perspective, they also identified early that in order to be commercially viable, the orchestration of the battery needed to be designed to support market trading in wholesale electricity. Their longer-term goal is to enable community investment in the battery network.

ILLUSTRATION 2 DRIVERS OF INTEREST IN BATTERIES



Feasibility study partners identified climate change related interests as the top two reasons why batteries were being considered for their communities (illustration 2). On this basis, the partners identified government or community as the most likely sources of funds for these projects.

2. Embrace communities in the journey

Community members play multiple roles in neighbourhood battery projects which make them critical stakeholders to the success of the initiatives.

Their interests are as:

1. **Members of the broader community:** These projects are an important proof point of local action and investment to achieve community and local government objectives, particularly in relation to climate change and promoting renewable energy.
2. **Neighbours to the battery:** Unlike other standard electrical infrastructure, ground-mounted neighbourhood batteries have a larger footprint and visible presence. Neighbour acceptance of the location for the battery is therefore essential.
3. **Potential investors or customers:** Depending on the structure of the battery program, community members may be invited to either invest in the battery or participate as a customer of storage as a retail energy service.

A survey amongst study partners questioned the level of awareness of community members regarding neighbourhood batteries. The results varied depending on how advanced the project partners were with their own climate change strategies and battery projects. For 80% of the partners, communities were assessed as having either a low or moderate level of awareness.

The Macedon Ranges Sustainability Group however, reported that recent consultation in support of their ‘MR-BIG’ project found greater than 40% of community members were familiar with neighbourhood battery concepts and 75% were interested in participating in such a project.

EXTRACT

Macedon Ranges Sustainability Group,
MR-BIG Community Engagement Findings Report

The MR-BIG project's community engagement component has found a high degree of enthusiasm for the installation of community batteries within the Macedon Ranges Shire. Community responses have been gathered through a survey, online information session and in-person event.

Key themes identified through this process include:

- Overall enthusiasm for community batteries
- A high preference for equity in renewable energy
- Requests for sensitivity in battery location
- A need for further information on the battery's business model.

Community members saw a community battery as a method to improve equity in renewable energy. This is illustrated in responses to the question on potential benefits of a community battery. The highest-ranking result was "make access to renewable energy equitable for local community". People who already own a household solar battery also placed a strong emphasis on this benefit.

Next most important were 'enable more solar', 'provide blackout backup' and 'make battery storage available'. Grid stabilisation and direct bill savings were seen as lower priorities.

Overall, these findings are supported by consultation for the United Energy pole-top battery program.

Community engagement in relation to the first potential site for these batteries found awareness was generally low. However, once the nature of batteries and their role is explained, community interest and≈support was high. The key value proposition that most people engaged have responded positively to is the opportunity for batteries to absorb excess locally produced solar energy during the day.

The Victorian Government's *Neighbourhood Battery Initiative, Industry and Community Consultation Report (2022)* released during the study period, also advised that battery programs have a well-structured community engagement program. The report indicated projects should be developed with input from the community to best enable their chance of success.

As part of the feasibility study, partners were invited to undertake a survey and participate in a workshop which investigated preferred methods for engaging with communities. In summary, the key outcomes were:

- Webinars, social media campaigns and face-to-face events were the preferred engagement methods
- Community surveys of their awareness and interests were considered important tools for empowering community members
- Information about batteries and community benefit sharing opportunities were considered the key subjects to be communicated, particularly using case studies and simple 'explainer' videos
- Potential concerns around perceived noise and safety issues such as electromagnetic fields, were also considered important to address proactively.

While the International Association of Public Participation, IAP2 Spectrum methodology is recommended as the framework for community engagement planning, some clear principles emerged for how these plans should be executed.

Community engagement principles

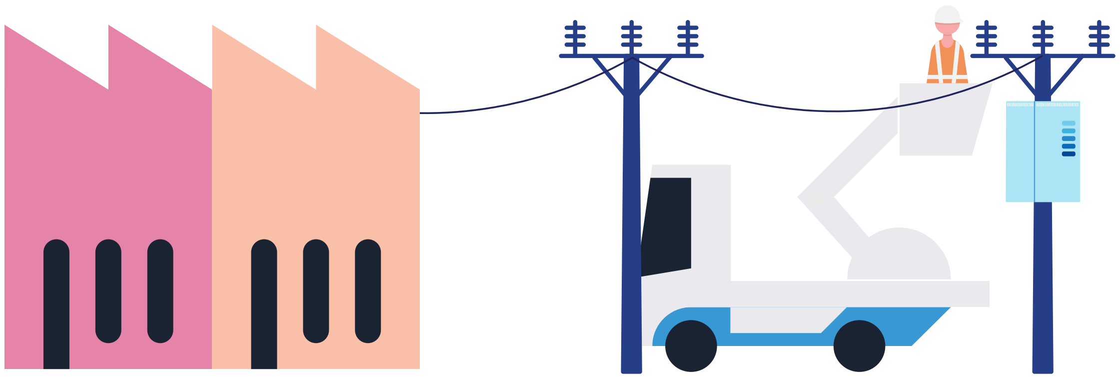
Transparency: Prioritise education and information to raise awareness of the role of batteries and the benefits to communities first before discussing specific locations or sites.

Sensitivity: Clearly identify and anticipate the risks and opportunities associated with the battery and its potential sites from the community members' point of view such as visual amenity. Recognise and respect that some community members have concerns regarding any new form of electrical asset in their community and ensure these concerns can be answered.

Inclusivity: Be clear with community members about how they may influence the design and delivery of their neighbourhood battery. Utilise effective consultation to engage on matters that are negotiable and ensure this feedback is captured within project planning and reported back to the community.

Accessibility: The electricity network and system can be a complex matter to communicate. The simplicity and accessibility of information and opportunities for all community members is therefore important to inspiring acceptance and participation.

Trust: For community members to be confident in the location and operation of a neighbourhood battery, they need to trust the owners and operators will be acting in the best interests of their community. Every point of contact with communities is therefore an opportunity to build this trust through commitments and action.



3. Financial sustainability is a function of scale

A survey of feasibility study partners identified three main commercial objectives for a neighbourhood battery project:

- 58% indicated they wanted to offer community participation in the neighbourhood battery
- 30% reported the goal to cover costs or have a self-funding investment structure
- 10% indicated they were just interested in generating an income stream from the neighbourhood battery.

The survey also identified difficulties associated with securing external funding and revenue sources as well as uncertainty about the relative cost drivers of batteries as the biggest commercial barriers to project delivery. A quarter of study partners expected more than 50% of the total project costs would need to be externally sourced.

Interestingly, around half of the partners indicated a preference for a community-owned neighbourhood battery and 60% were aiming to introduce up to 10 batteries in the community. Two of the study participants were aiming for more than 10.

In response to the partners' information needs and interests, considerable work was undertaken to provide an understanding of the costs and potential revenue streams as well as how these impact on battery project design and business case. A sample cost and revenue overview for a business case is offered in Appendix 2 and 3. The following information (tables 3 and 4) summarises the commercial factors and their implications for the business case.

Some insights arising from this analysis are:

- The major initial capital costs of a battery project are the battery itself and the control systems. If more than one battery is intended to be developed, then the cost of the control system can decrease when spread across the rollout.
- The early engagement of the community's DNSP (such as Powercor, CitiPower or United Energy) is essential to understanding the network implications for battery size and export capacity. These are vital determinants of both cost and revenue drivers. Connection costs can be significant if network augmentation is required for larger batteries.
- The two major potential revenue streams for batteries are Frequency Control Ancillary Services and wholesale energy arbitrage. To access these revenue streams, you will need two key things:
  1. An intermediary: You'll need to engage a licensed Market Participant in the National Electricity Market and their participation will come at a cost such as a commission or fee on energy traded.
  2. Sufficient load: You'll need a minimum of 1MW of electricity to participate in the market. This can be sourced from one battery or aggregated across multiple.

As described in tables 3 and 4, the financial model is influenced by a number of variables including the ownership structure, operating model, battery size, lifespan and targeted revenue streams. All of these factors relate back to the initial purpose of the battery.

Costs will be able to be separated into upfront capital costs (for example the battery costs, connection costs, IT and control system upfront costs) that will be incurred at the start of a project and may be depreciated over time, and ongoing operating costs which may change over the life of the project. The life of the project will be reflective of the battery lifespan.

Income streams will also be able to be differentiated into upfront revenue, for example initial equity investment, grant funding, and ongoing revenue streams. The FCAS and energy arbitrage revenue may be modelled on a yearly basis and should reflect the capacity of the battery and any potential decrease in battery performance over the lifespan.

TABLE 3 COST DRIVERS AND CONSIDERATIONS FOR BUSINESS CASE DEVELOPMENT

Costs	Considerations	Implications
Battery hardware	At the time of producing this document, the cost of batteries in Australia is approximately $AUD 1000/kWh. This is projected to halve by 2030 as battery technology improves and the uptake escalates (World Energy Outlook, 2021). The exact battery costs however, are dependant on the desired use cases, battery size, construction considerations, and other requirements associated with the battery's location and housing.	Initial capital outlay in year one. Ongoing maintenance costs annually subject to advice from the manufacturer.
Control systems and IT	Battery control systems and supporting IT infrastructure are a crucial part of the operation of a neighbourhood battery. Which system is used is dependent on the existing capabilities of the battery owner/operator and could cost as much as the battery itself if not more. The opportunity to spread this cost over multiple batteries in a network can significantly decrease this cost with scale. Considerations should also be made for the need for any additional system integrations required if aggregating energy as part of a National Electricity Market Participant's portfolio.	Initial capital outlay in year one.
Network connection	This reflects the cost of connecting a battery project to the local distribution network. These costs vary based upon site specific dependencies such as proximity to existing network infrastructure, battery sizing and the existing capacity within the local network infrastructure. The larger the battery capacity, or size of the battery in kW/kWh, the more likely that local electricity networks may need to be augmented to enable the additional load.	Initial capital outlay as connection fee year one. Dependent on potential financial contribution by DNSP.
Network tariffs	In order to incentivise the consumption behaviour required to gain the most benefits from neighbourhood batteries, alternative approaches to network tariffs or retail energy plans may be required. It depends on the purpose of the battery. For example, if the aim of the battery is to support local use of exported solar energy, then the preference would be for the battery to charge during the day and then discharge at night. Customers serviced by the battery would need to be encouraged to consume the majority of their energy load in the evening peaks. A trial network tariff based on this approach is available from 1 July 2022 for neighbourhood batteries in CitiPower, Powercor and United Energy network areas. This trial network tariff arrangement is available for non-distributor owned neighbourhood batteries and distributor-owned low voltage neighbourhood batteries.	This can be both a cost and a source of revenue depending on the network tariff arrangements.
Contingencies	Project risk identification and management may reveal additional costs that need to be factored into the business case.	Could be one off or annual costs.

TABLE 4 REVENUE DRIVERS AND IMPLICATIONS FOR BUSINESS CASE DEVELOPMENT

Costs	Considerations	Implications
FCAS market	A Market Participant is required to access this revenue stream, as well as the ability to provide a minimum of 1MW (may be part of an aggregated solution across a network of batteries). The battery location and size will need to allow for optimal battery capacity and operation for market participation with discharging orchestrated through the control system. This will also influence the grid connection process.	Annual revenue Annual commission or fee to the Market Participant
Wholesale energy arbitrage	A Market Participant is required to access this revenue stream, so that the battery can be traded on the wholesale electricity market. The battery location, size and connection will be influenced by the number of customers and size of the load to achieve the desired energy output for trading purposes.	Annual revenue Annual commission or fee to the Market Participant Potential to lease the battery to the retailer or aggregator.
Community or third-party equity or ownership	Community buy-in or relevant capital funding may assist in financing a battery project, however this would typically require a suitable process to distribute the return on investment to the relevant stakeholders. Community member/third party engagement and participation rates may impact the preferred location, as some areas may have a higher or lower interest from the community in co-investing.	Depending on the model • Initial investment income • Annual fee for participation • Dividend or interest payable.
Network support services	These are contestable demand side service opportunities offered by DNSPs. They essentially offer a financial incentive if batteries can respond to network signals to either increase charging or discharge at times when the network needs support. This might include periods of extraordinary peak demand or minimum demand on the networks. To leverage these services, the battery would need to be located in an area where network support services are required. This can be identified through opportunities published by the local DNSP, for example through the Demand Side Engagement Register, or relevant Distribution Annual Planning Reports (DAPR).	Fee subject to competitive tender as offered by the DNSP.

DEFINITION

Frequency Control Ancillary Services (FCAS)

The power system requires that both generation and load are in balance in order to operate safely. If there is a variation in generation without a corresponding variation in load, then the frequency of the power system will deviate which can lead to instability or, at extreme levels, cascading failure and blackouts.

FCAS is a process used by the Australian Energy Market Operator (AEMO) to maintain the frequency of the system within the normal operating band of around 50 cycles per second. Put simply, FCAS provides a fast injection of energy, or fast reduction of energy, to manage supply and demand.

These services are purchased by AEMO to maintain frequency and ensure the stability and reliability of the grid. There are eight markets in the NEM for procuring sufficient FCAS at any given time. Participants must register with AEMO to participate in each distinct FCAS market. Once registered, a service provider can participate in the FCAS market by submitting an appropriate FCAS offer or bid for that service via AEMO's Market Management Systems.

For more information visit: aemo.com.au

4. With ownership comes great responsibility and cost.

As previously indicated, around half of the partners in the feasibility study preferred a community-owned neighbourhood battery. An important insight gained through the study was what this means for both the composition of the team managing the battery and the funding required for its establishment.

Team planning

A survey of partners found they were most likely to provide project management, community engagement and planning approvals resources internally to support the battery project team (illustration 3).

External resources were more likely to be required for technical or specialist functions including technical or engineering advice, financiers, energy retailers or Market Participants. Whether these external resources were already in place was a function of how far advanced the partners were in their developing their battery projects.

The importance of these external roles however, was reflected in the study partners' response to a survey question about the biggest challenges to progressing their targeted projects. The availability of technical information and capability was clearly the top ranking challenge with commercial resources ranked third. Interestingly, challenges associated with the roles and responsibilities assumed internally were also recognised amongst this list (illustration 4).

ILLUSTRATION 3 EXTERNAL RESOURCES IN PLACE VERSUS INTERNAL CAPABILITY

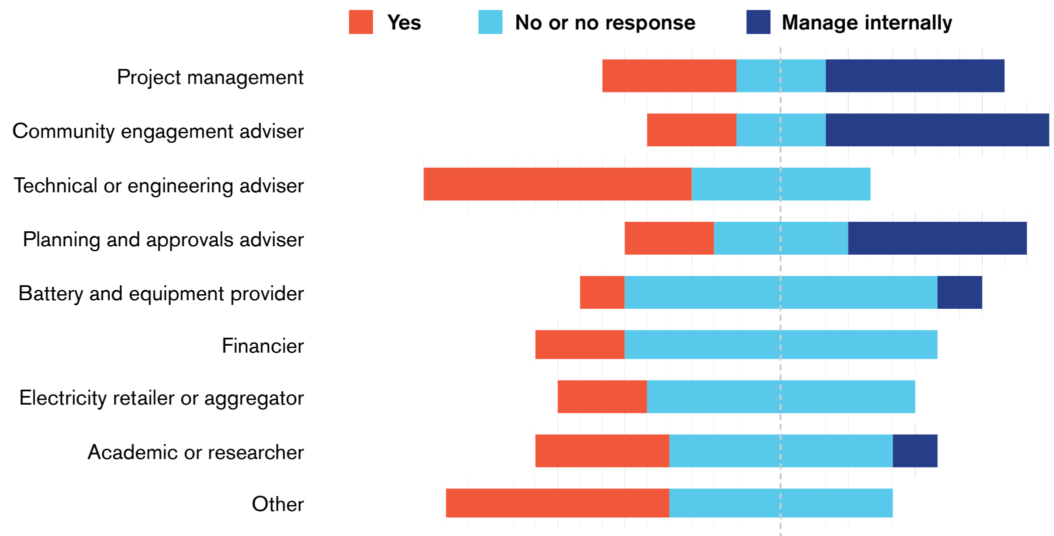
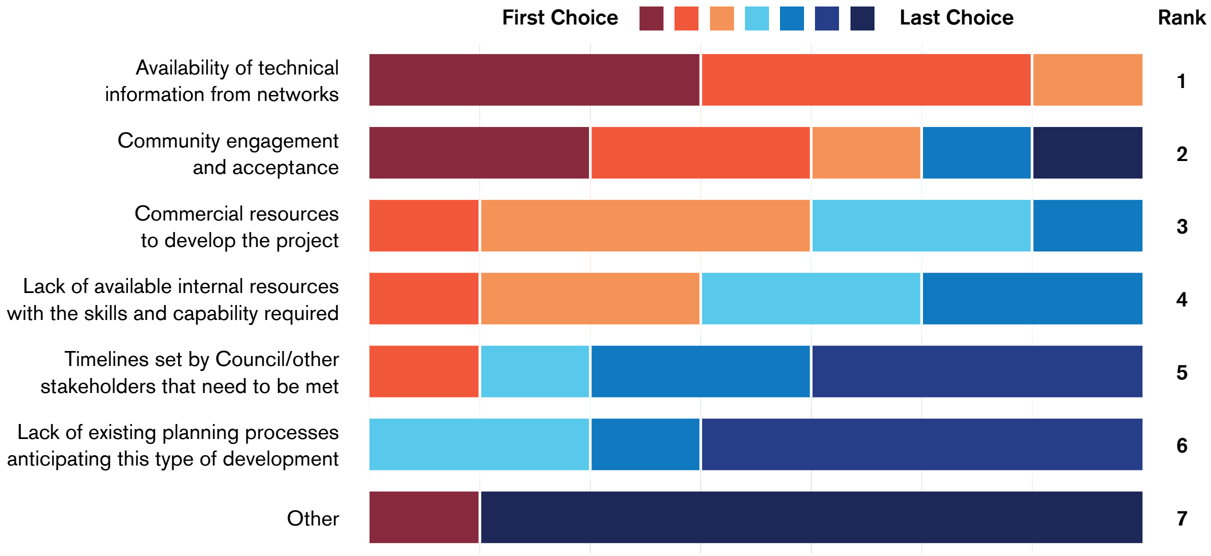


ILLUSTRATION 4 ANTICIPATED CHALLENGES IN PROJECT DEVELOPMENT



The relationship with costs

Three community battery ownership models were identified through the feasibility study. All models allow for the participation of a Market Participant as a critical revenue stream. The main differences between the three models are:

- The primary or priority purpose for the battery
- Which party is responsible for the project's capital outlay and ongoing costs.

The options (outlined in illustrations 5 to 7) are:

1. **DNSP-owned model** – in which network capacity and power reliability are the priorities
2. **Third-party owned model** – in which community objectives are the priorities
3. **Market Participant-owned model** – in which electricity trading outcomes are priorities.

ILLUSTRATION 5 DNSP-OWNED MODEL

Key features:

- DNSP outlays the capital investment on the basis that this investment will represent avoided network augmentation costs.
- DNSP incurs all maintenance and operational costs.
- DNSP ensures the operation of the battery supports the local network requirements, providing benefits to local customers regardless of whether they are a retail customer of the battery or not.
- The network can lease the battery capacity to a Market Participant or energy retailer.
- Network tariffs can be structured based on power being imported into or exported from the battery.
- A retail partner can provide a customer offering and also use the battery to participate in the FCAS and arbitrage markets.
- The customer can buy a retail product provided by a retailer related to the battery.

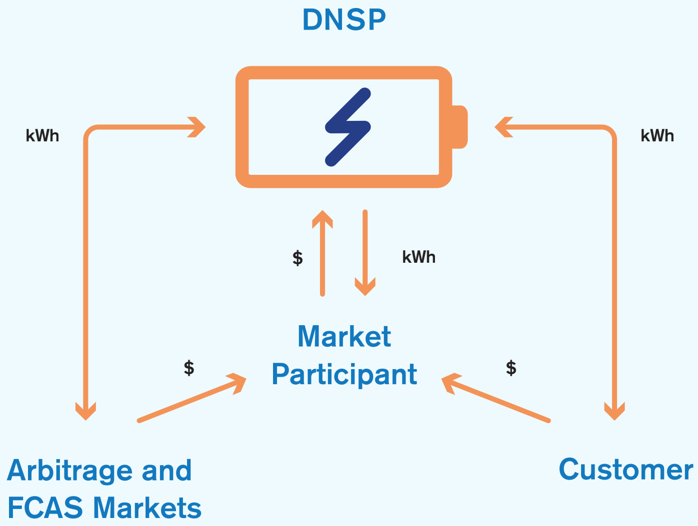


ILLUSTRATION 6 THIRD PARTY-OWNED MODEL

Key features:

- A third party such as a community-based organisation, local government or not-for-profit entity, is the owner and operator of the battery, outlaying the capital investment.
- The third-party incurs all maintenance and operational costs.
- The third-party may operate the battery to respond to requests for network support services.
- Network tariffs can be structured based on power being imported into or exported from the battery.
- The third-party can lease the battery capacity to a Market Participant to participate in FCAS markets and for energy arbitrage.
- The third-party can partner with retailers who may wish to offer customers a product linked to the battery.
- The customer or other third parties can co-invest in the battery.

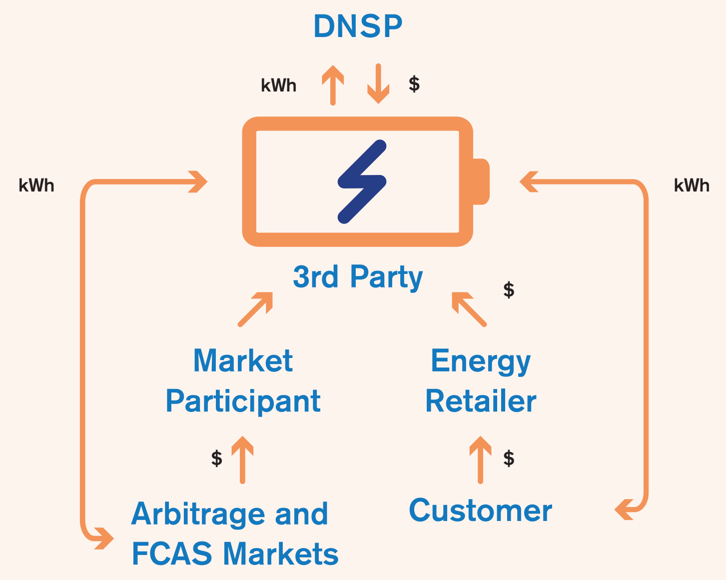
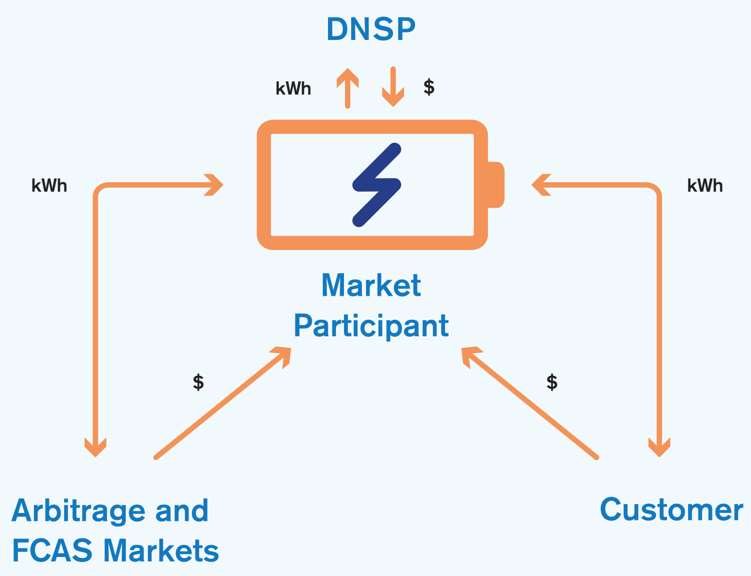


ILLUSTRATION 7 MARKET PARTICIPANT-OWNED MODEL

Key features:

- The Market Participant is the owner and operator of the battery, outlaying the capital investment.
- The Market Participant incurs all maintenance and operational costs.
- Network tariffs can be structured based on power being imported into or exported from the battery.
- The Market Participant may operate the battery in response to requests for network support services.
- The Market Participant trades electricity in the wholesale market.
- The Market Participant can consider providing a virtual battery service to customers.
- Under this model, study partners representing community organisations or local governments, could participate in the battery's development from a stakeholder or approval function perspective, but would not have ownership, control or the potential revenue streams.



5. The approvals pathway just got easier.

Early in the feasibility study, partners identified the lack of existing planning processes for batteries as one of the challenges to progressing these projects. This was explored within the approvals workstream of the study.

This was also researched by one study partner, City of Melbourne, in a dedicated program that explored the potential role that neighbourhood scale batteries can play in achieving zero emissions objectives and sought to understand how local governments can best support their deployment.

The report, *Neighbourhood Batteries: an opportunities assessment for local government (December 2021)* produced by HIP V. HYPE Sustainability, found there is a role for Council in facilitating the deployment of neighbourhood batteries, particularly councils that are setting ambitious targets for their community to move to a zero carbon, 100% renewable energy system.

EXTRACT

City of Melbourne, Neighbourhood Batteries: an opportunities assessment for local government (December 2021), HIP V. HYPE Sustainability

Several key lessons have emerged from this assessment that are highlighted below.

Areas of new or major precinct development offer the best opportunity

One of the more complex barriers to overcome appears to be community engagement and building a social licence to locate the battery (in particular in the right place!).

Greenfield and urban renewal projects, with either a smaller community of stakeholders or an existing multi-stakeholder process therefore offer improved potential for installing neighbourhood batteries. Areas where energy demand can be effectively modelled and planned for – including high solar photovoltaic (PV) penetration, electric vehicle (EV) charging and a mixture of load profiles – allow neighbourhood batteries to be more effectively integrated into the broader plan.

There is a role for council

The most important role is in ensuring that neighbourhood battery projects are optimised for all stakeholders and create genuine shared benefit. This includes stakeholder engagement and alignment, community engagement and enhancing existing statutory and strategic planning roles.

Minor utility installation definition change

In May 2022, the Victorian Government made an amendment to the Victorian Planning Scheme within the *Victorian Planning and Environment Act 1987 (Vic)* to make neighbourhood batteries exempt from any Victorian planning permits.

The Explanatory Report indicates: The amendment supports the efficient delivery of neighbourhood batteries into the electricity distribution network by amending clause 73.03 Land use terms of the *Victoria Planning Provisions* (VPP) and all planning schemes to:

- Include '*a battery connected to a section of the electricity distribution network operating with a nominal voltage not exceeding 66,000 volts*' in the definition of 'minor utility installation'
- Delete '*including battery storage*' in the definition of 'utility installation'.

It recognises that neighbourhood batteries are being installed on the networks to provide solar storage, voltage management and stability services to benefit local communities and businesses. They will operate on the same sections of the network that include powerlines and substations, both of which are defined as minor utility installations and exempt from permit requirements.

The change enables the efficient installation of neighbourhood batteries on the network without the need for a planning permit.

Approvals processes still required

Even with the change in the definition for minor utility installations, neighbourhood battery programs still remain subject to local municipal council requirements and potentially, state legislation related to the site selection process.

Table 5 summarises the potential planning application processes that may need to be considered as part of a neighbourhood battery site assessment. The delivery of effective community consultation is an essential requirement of many of these regulatory approval processes.

These factors were captured in a standardised site selection checklist (appendix 4) to assist in the identification of preferred sites and the management of any associated constraints. This provides a plain English summary of the factors that should be taken into consideration when assessing the suitability or appeal of a proposed battery location. It provides an initial guide to inform further action and studies.

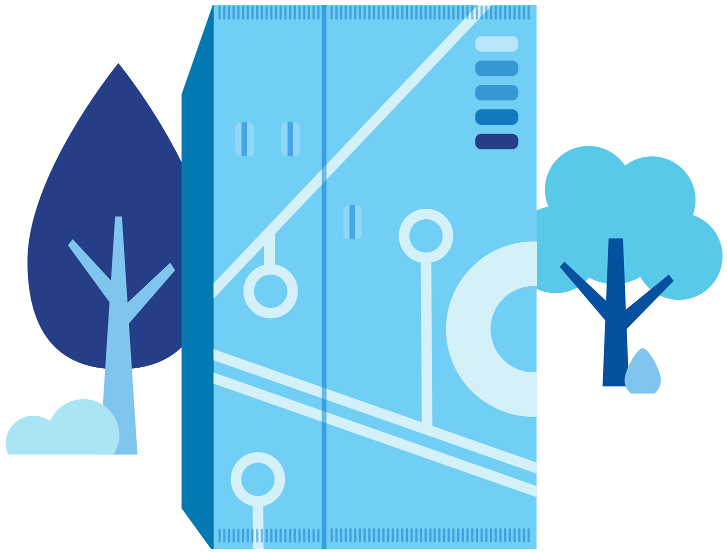


TABLE 5 PLANNING APPLICATION PROCESSES

Assessment	Purpose	Application to neighbourhood batteries
Environmental overlays	Identifying potential impacts to any known or anticipated sites of environmental significance.	• May lead to added controls on the battery. • Lifecycle of the project needs to be defined.
Flood Zones	Apply to land identified as carrying flood flows associated with waterways and open drainage systems including land subject to inundation.	• Most batteries are rated against certain water penetration and are installed on an elevated rigid base such as a concrete footing. • These measures are not intended to protect against the risk of inundation.
Cultural heritage	Protecting Aboriginal Cultural Heritage in Victoria and recognising Aboriginal people as the primary guardians, keepers and knowledge holders of Aboriginal cultural heritage.	• A cultural heritage management plan may be required if the neighbourhood battery site is located in an area of cultural heritage sensitivity.
Native title	Recognition by Australian law that some Indigenous people have rights and interests to their land that come from their traditional laws and customs.	• Needs to be considered as part of a site selection criteria, particularly for sites on Crown Land.
European heritage	Manage places with heritage significance to the local area.	• Depending on the location for the battery, it may require approval from Heritage Victoria to ensure heritage places and objects are not impacted.
Bushfire overlays	Identifies land that may be significantly affected by extreme bushfires.	• Locations in hazardous bushfire risk areas will need to mitigate bushfire risk.
Amenity impacts	Protecting built form, neighbourhood character and liveability.	• The size of the land needed depends on the size of the battery itself as well as other requirements including necessary clearances. • Batteries may emit an audible hum during charging and discharging or there may be noise from a fan as part of the cooling system. • Clearances between a battery and a property typically recommend a minimum of 7.5m depending on the size of the battery and the outcomes of acoustic studies of the noise impacts. • Visual amenity impacts can be managed by vegetation or other screening or painted surfaces.

4 Conclusion

The Electric Avenue Feasibility Study was successful in identifying a large number of potential sites for neighbourhood batteries potentially benefitting multiple communities.

However, the lessons learned by the study partners have also been significant for informing future studies and business cases.

For the final word however, we offer the following recommendation from the City of Melbourne's research into the opportunities for local governments.

This insight regarding the highly contextual nature of neighbourhood batteries summarises well the complexity of planning required to ensure these developments succeed in meeting their environmental, social and commercial objectives.

Not easy to scale or replicate

Neighbourhood battery projects are not easily scalable and the models are not necessarily transferable to new neighbourhoods. They are highly contextual.

The design and implementation of a pilot program depends on the use case (ie are there specific network constraints that are already having an impact that the community and the network want to fix), the business model and ownership structure (ie who is paying and who gets the financial benefits), the public/community amenity impacts (ie is it an eyesore on council land, perceived to be taking up previous open space or can it be accommodated on land owned by the network).

A model for a community battery that is working in Yackandandah in regional Victoria will not translate to inner city Melbourne.

Source: Neighbourhood Batteries: an opportunities assessment for local government (December 2021), HIP V. HYPE Sustainability

Appendix

Appendix 1

SAMPLE BUSINESS CASE TEMPLATE

Battery size and type	
Proposed Location	
Project partner/s	

Overview

Description	Network connection	Project justification				
• Insert Details Here		Financial ✓	Community goals ✓	Local renewable energy goals ✓	Increase network reliability ✓	Address network constraints ✓

Fin./Timing/Risks

Estimated investment

	YEAR 1	YEAR 2	YEAR 3	YEARS 4-10	TOTAL
Annual Cost ($k)					
Funding (eg. ARENA, Council, Govt. grants) ($k)					
Revenue ($k)					
TOTAL INVESTMENT ($k)					

Milestones

Milestones	MM/YY
	MM/YY
	MM/YY
	MM/YY
	MM/YY
	MM/YY

Top 3 risks

Risk	RTG	Risk Mitigant
Risk 1	(green)	• Describe here
Risk 2	(orange)	• Describe here
Risk 3	(red)	• Describe here

Other Factors

Community feedback and access to land	Customer/ reputational/other	Resource consideration
• Insert Details Here	• Insert Details Here	• Insert Details Here

Appendix 2

SAMPLE COST AND REVENUE OVERVIEW

	YEAR 1	YEAR 2	YEAR 3	YEARS 4-10	TOTAL
Annual Cost ($k)					
Battery cost	Initial capital outlay	Ongoing maintenance	Ongoing maintenance		
Project management costs	Project delivery outlay				
Connection cost	Connection fee				
Consulting costs	Consulting outlay				
Land lease	Lease fee	Lease fee	Lease fee		
Other costs					
Funding (eg. ARENA, Council, Govt. grants) ($k)					
Grant 1	Initial grant				
Revenue ($k)					
Customer participation fee	Yearly fee value	Yearly fee value	Yearly fee value		
Energy/FCAS revenue	Yearly revenue	Yearly FCAS revenue	Yearly FCAS revenue		
Other income					
TOTAL INVESTMENT ($k)					

Source: Powercor, 2022.

Appendix 3

SAMPLE FINANCIAL MODEL INPUTS

Inputs	Unit	Value
Battery inputs		
Battery cost	$/kWh	
System size	kW	
System size	kWh	
Battery life	# years	
Operational and Maintenance cost	$/kWh installed capacity	
Ancillary battery cost	$	
IT cost	$	
Annual lease payment	$/kWh	
Network connection cost	$	
Battery round-trip efficiency	%	
Battery yearly decrease in capacity	%	
% battery capacity available for customers	%	
% battery available for FCAS	%	
Number of battery customers	#	
Leased daily battery capacity per customer	kWh	

Inputs	Unit	Value
Revenues		
Discount on distribution tariff (if applicable)	$/kWh	
Battery lease fee - Customer to battery owner	$/day	
Customer battery contribution	$/MW	
Arbitrage revenues		
Arbitrage revenue	$/year	
Regulation FCAS revenue	$/year	
Contingency FCAS revenue	$/year	
WACC	%	
Inflation	%	

Appendix 4
Site Selection Criteria

Background

CitiPower, Powercor and United Energy have partnered with groups representing councils, community energy and greenhouse alliance groups to explore opportunities to utilise neighbourhood batteries as part of the Electric Avenue Feasibility Study.

The study, funded as part of the Victorian Government's Neighbourhood Battery Initiative, will examine the best locations for batteries, considering factors such as community benefits, local power demand and network constraints.

Objective

The criteria detailed in this document are intended to provide a practical and 'plain English' summary of the factors that should be taken into consideration when assessing the suitability or appeal of a proposed battery location.

No criteria ranking has been included as the importance or otherwise of each is dependent on the site in question and a range of other project specific factors.

CRITERIA

	Responsible party or Subject Matter Expert	Criteria	Description	Notes	Standards and further resources
Location	**Council/Local Government (or alternative)**	Land availability	Is there appropriate land available to host the battery? Can the land be leased or sold to the battery owner as is necessary?	Size of land needed depends on the size of the battery itself as well as other requirements including necessary clearances.	
		Accessibility	Does the location offer appropriate accessibility for installation (and removal), servicing and maintenance as well as in case of an emergency such as fire.	In addition to access to the battery itself the ability to reach the site with relevant equipment (e.g. lifting machinery) must be considered.	
		Municipal/land-use zoning	Does the location have a designation or restriction relating to what it can (or cannot) be utilised for?	Most zoning restrictions provide scope for exceptions or exemptions dependent on additional criteria being met or mitigants being deployed.	Planning - Know Your Council
Environmental	**DNSP** **Council/Local Government** **Acoustic Engineers**	Noise	Is there potential for disturbance relating to noise emissions from the battery?	BESS (Battery Energy Storage Solution) units will typically emit an audible hum during the charging and discharging of the battery. They may also emit a constant broadband fan noise, which may be elevated above ambient background noise levels and has the potential to cause disturbance at sensitive use locations. *Powercor has commissioned an acoustic engineer to create a Zoning Matrix to help in assessing noise impacts. (This information will be made available upon completion).*	Applicable legislation is defined within the Environmental Protection Act 2017 as amended by the Environment Protection Amendment Act 2018, including subordinate legislation and any relevant referral and guideline documentation.
	Council/Local Government (or alternative)	Flood/ Inundation risk	Is the location at risk of flooding or inundation?	Consider proximity to waterways including creeks, rivers, and ocean as well as low lying land. Most batteries are rated against certain water penetration and are installed on an elevated rigid base such as a concrete footing. These measures are not intended to protect against the device being submerged or inundated.	DELWP (Department of Environment Land Water & Planning) Flood Warning and Mapping - Water and catchments The Victorian Government website provides a range of interactive mapping tools including MapShareVic which shows information about waterways and floodways.
		Overlays *Environmental, ecological, cultural, heritage considerations etc.*	Are there considerations, restrictions or added stakeholder groups that must be considered relating to one or more applicable overlays?	In many cases an overlay will not immediately prohibit the installation of a battery but introduce added controls, requirements, and oversight throughout the lifecycle of a project.	The Victorian Government website provides a range of interactive mapping tools including VicPlan which shows zoning overlays.

	Responsible party or Subject Matter Expert	Criteria	Description	Notes	Standards and further resources
Community	**Council/Local Government (or alternative)**	Proximity to nearby properties	How close is the site to residential properties or other sensitive locations?	Sensitive locations may include childcare centres, schools, or residences for other vulnerable groups. Required clearances between a battery and a residence or other habitable structure exist but are dependent on the size and type of battery. *A good 'rule of thumb' to begin with is to seek at least 7.5m clearance on all sides.*	The EPA (Environment Protection Authority) has a role in controlling and regulating noise. Their website provides further information - EPA - Noise.
		Visual impact	To what degree does the installation impact the local visual amenity or aesthetic?	Location can be secluded. Battery can be: • Concealed through direct application of paint/colour. • Camouflaged through addition of natural (i.e. trees) or synthetic screening. *Artwork such as a mural or street-art can be commissioned to enhance the visual amenity.*	
	DNSP	Local solar adoption	Are there a high number of local properties which currently have rooftop solar? What is the likelihood of significant growth in solar adoption?	Local solar adoption should be considered as those with solar in direct proximity to the proposed location (i.e. visibility of the battery) and those local residences with solar which may contribute to the need for a battery. *More solar in the area can mean more support for these projects and a greater network need.*	A map of solar installations and further information is available on the Australian PV Institute website.
Network	**DNSP**	Solar export hosting capacity opportunity	Are any local customers with solar prevented from (or restricted in) selling their excess solar back to the grid due to network constraints? Have a high proportion of customers in the area installed solar?	In some cases, a DNSP must prevent or restrict the exporting of solar to maintain a safe and reliable energy supply. In these circumstances the addition of a battery may alleviate the need for such restrictions.	
		Proximity to network/cables	Is the local energy network infrastructure (e.g. cables/conductors) close to the proposed location?	Being closer to electricity network may mean it will be more efficient and less expensive to connect the battery. This will likely also result in less local disturbance during installation.	
		Demand related opportunity	Is there growing demand for electricity on this section of the network?	Installing a battery can create more capacity on the network. This can help in cases of increased housing density or in 'growth corridors.' *This may delay the requirement for a network upgrade to improve capacity.*	More information about demand related opportunities available here.

Assessment

No criteria ranking has been included as the importance or otherwise of each criterion is dependent on the site in question and a range of other project specific factors including but not limited to the chosen ownership structure and commercial model.

Some criteria, such as safety clearances or zoning, have minimum requirements set by standards or legislation. Other criteria such as visual impact are subjective and dependent on perceived impact.

Decision making and dispute resolution

Due to the complexity and diversity of criteria required to be considered when selecting a suitable site, gaining participation and agreement from all relevant parties may be challenging.

To speed up the process and maximise the likelihood of selecting an agreeable site (or sites) a highly collaborative and consultative approach is encouraged.

Such an approach would begin with an assessment of who should be included in the decision-making process to ensure that all relevant areas are considered from an early stage. Discovering that a key person has not been consulted with from the beginning may result in a project being delayed.

Disputes or opposition relating to site choice may occur. To reduce the likelihood and impact of opposition or disputes it is important that the project has strong governance and executive/leadership support, and that the goals and benefits relating to the project are clearly communicated to all stakeholders.

Stakeholders

Site assessment and selection requires input and expertise from a variety of parties across multiple groups. The specific groups and fields of expertise needed is dependent on the project. Each council and project will have a unique group of internal and external stakeholders to consider when selecting a site.

The below is a list of stakeholder groups to consider with when beginning the process.

Council

- Town planning
- Sustainability / Energy
- Zoning / Public Spaces
- Heritage

Public representatives

- Community energy groups
- Representative committees
- Other influencers

Electricity Distribution Network Service Providers

- For example, CitiPower, Powercor, United Energy

External parties

- Traditional Owners
- Community Energy Groups

Recommended approach

A recommended approach to begin assessing criteria may be to use a simple star rating table. Through this process each site and relevant criteria is assessed by the right subject matter expert who provides a score and relevant comments.

Such a table provides a simple visual summary which may form a reference point for further discussion and negotiation between relevant stakeholders.

You may wish to include your own added criteria for consideration. For example, you may include a criterion for *Level of Community and/or Council support*.

SAMPLE CRITERIA CHECKLIST

		Site 1	Sample Site 1	Site 2	Sample Site 2
Category	**Criteria**	**Score**	**Comments**	**Score**	**Comments**
Location	Land availability	★★☆☆☆	Land available in reserve however close to playground	★★★☆☆	Rarely utilized parkland
	Accessibility	★★★☆☆	*Example comments*	★★★☆☆	*Example comments*
	Municipal/land-use zoning	★★★☆☆	*Example comments*	★★★☆☆	*Example comments*
Environmental	Noise	★★★☆☆	*Example comments*	★★★☆☆	*Example comments*
	Flood/Inundation risk	★★★☆☆	*Example comments*	★★★☆☆	*Example comments*
	Overlays	★★★☆☆	*Example comments*	★★★☆☆	*Example comments*
Community	Proximity to nearby properties	★☆☆☆☆	Approx 30 meters from houses and close to playground	★★★☆☆	Approx 60m
	Visual impact	★★☆☆☆	Little opportunity for natural concealment	★★★☆☆	Can be situated behind existing vegetation
	Local solar adoption	★★★☆☆	Good number of local homes with solar	★★★☆☆	Majority of 'near neighbours' have solar
Network	Solar export hosting capacity opportunity	★★★★☆	*Example comments*	★★★☆☆	*Example comments*
	Proximity to network/cables	★★★☆☆	Within 5 meters of cables and in soft soil	★★★☆☆	Site 2 only able to connect to one circuit
	Demand related opportunity	★★★☆☆	*Example comments*	★★★☆☆	*Example comments*
Overall rating		★★★☆☆	Proximity to playground and homes make this the less favourable option	★★★★☆	Located in concealed area while maintaining network benefit

Glossary

Term	Abbreviation	Definition
Arbitrage		This is the practice of taking advantage of a price difference in buying energy at a low price and selling it into the National Electricity Market at a higher price. In the case of batteries, it refers to storing electricity when the price of power is low, and then discharging it at times when wholesale electricity prices are high.
Augmentation		Investment in the distribution network to improve the services offered to customers or improve electricity reliability.
Control systems		Systems that control and coordinate the safe operations of the battery. This includes monitoring the battery, orchestrating when to import or discharge electricity, and optimising the performance of the storage systems. These usually involve advanced telecommunications capabilities linked to distribution network operations.
Distribution network		One of the steps in the energy supply chain, distribution networks take power produced by generators and supplied via high voltage transmission lines, then lower the voltage and transport the power to customer connection points.
Distribution network service provider	**DNSP**	Owners and operators of distribution networks. In Victoria, the DNSP also manages customer meters (mostly smart meters) and provide the meter data to energy retailers. These retailers issue electricity bills directly to customers.
Frequency control ancillary services	**FCAS**	This is a process used by the Australian Energy Market Operator to maintain the frequency of the power system within a normal operating band of around 50 cycles per second. (See a full definition on page 24)
Generators		Major electricity generators that produce large volumes of wholesale energy sold through the National Electricity Market. These include solar and wind farms, hydro, and fossil fuel-fired generators like gas or coal.
High voltage	**HV**	One of the first steps in the electricity supply chain. High voltage transmission networks transport large amounts of electricity from large-scale power generators and over long distances to towns and cities. The electricity is carried at between 220,000 volts and 500,000 volts.
Low voltage network		Low voltage or LV network refers to the distribution network that transports electricity to customer connections. This infrastructure is managed by DNSPs and carries electricity at between 6,600 volts and 66,000 volts. At the customer connection point, the voltage is reduced to 230 volts.
Kilowatt (kW)		A kilowatt is a measure of one thousand watts of electrical power.
Kilowatt hour (kWh)		A kilowatt hour is a unit of measurement of how much energy a device is consuming. For example, 1 kilowatt hour (kWh) is the energy consumed by a 1 kilowatt (kW) electrical appliance operating for one hour.
Market Participant		Registered people or businesses that take part in the electricity markets operated by AEMO. There are various categories of participant but for the purposes of this report, the definition includes Small Generation Aggregators, Market Ancillary Service Providers, Wholesale Electricity Market participants. For more information visit: AEMO | Electricity market participants

Term	Abbreviation	Definition
Megawatt (MW)	MW	A megawatt is a measure of one thousand kilowatts of electrical power.
Microgrids		A self-sufficient energy system that services a defined geographic location or footprint. These usually rely on one or more kinds of distributed energy (like a solar or wind farm) to produce electricity locally and can be disconnected to operate autonomously from the distribution network.
Network capacity		The volume available on the distribution network to transport electricity to a high standard of reliability and power quality.
Network constraints		Parts of the distribution network which have no or limited capacity to: 1. supply additional energy to customers as their energy needs or the number of customers serviced in that area increases (demand related constraint) or 2. absorb and transport electricity sourced from a new connection (such as solar PV) without impacting on network voltage and stability essential to ensure reliability (solar capacity related constraint).
Network connection		A connection point between, in this case, the neighbourhood battery and the distribution network to enable electricity to flow between the two.
Network tariffs		Fixed daily charges that cover the cost of operating, maintaining and managing the distribution network. These charges are fully regulated by the Australian Energy Regulator and set annually. They are often referred to as the 'supply charge' as part of customers' electricity bills.
Peak demand		Periods of electricity demand on the distribution network when customer consumption is highest, typically characterised on a daily or seasonal basis. Weekday peak demand for example, is between 3pm and 9pm Monday to Friday.
Solar photovoltaic (PV)		A type of solar system that converts sunlight into electrical energy. For homes this is often referred to as a rooftop solar system.
Solar exports		Excess power generated from a solar PV system and not used in the home or building, may be exported into the distribution network. Customers can receive a credit for this power in the form of a feed-in-tariff rate.
Stand Alone Power Systems	SAPS	An electricity system to support a location or property where there is no electricity distribution network. Often referred to as 'off-the-grid' as they typically have no connection to a distribution network.
Substation		Part of the electricity distribution network and where voltage levels change from high to low. Electricity typically flows through several substations where voltage goes through a step change at each level.
Tariffs		The cost for each unit of energy consumed by a customer and measured in kilowatts (kW). Options include single rate tariffs, time-of-use tariffs, controlled load tariffs and demand tariffs. These tariffs are offered under energy plans by energy retailers and form a part of electricity bills.
Watts	W	A unit for measuring power. Watts refer to the power of your device. The more powerful a device, the higher the number of watts. For example, a 60W lightbulb is more powerful than a 15W lightbulb.

For further information visit:

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