Evaluating and tracking impacts of neighbourhood batteries

Neighbourhood Battery Initiative

Battery Storage and Grid Integration Program

An initiative of The Australian National University

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Energy, Environment and Climate Action

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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.

Images

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Executive summary

This report presents the ANU neighbourhood battery impact framework. This framework was primarily developed for government organisations, to guide the evaluation of government-funded neighbourhood battery projects and programs.

In Australia, significant government funding for neighbourhood battery projects in recent years presents an opportunity to develop business models that not only stack up economically (currently a challenge), but also deliver on broader policy targets to decarbonise the economy while keeping energy affordable. Early and ongoing evaluation of projects is essential for achieving this and also for guiding the policy settings that support best outcomes. Evaluation can also inform government decision-making around the role neighbourhood batteries could play in the broader energy transition, particularly in comparison to alternative options including household batteries and electric vehicle battery storage.

The framework considers a comprehensive range of social, economic, environmental and network impacts relevant to neighbourhood batteries. This evaluation framework can support the successful roll-out of neighbourhood batteries, by providing a way to assess projects and the sector more broadly. Communicating risks and benefits to the public is an important step for building trust and collective decision-making about future public investment.

Impact assessment for neighbourhood batteries

Neighbourhood (or community) batteries are a promising new form of mid-scale energy storage (100-1,000kWh), potentially offering numerous benefits compared to alternative forms of energy storage in terms of supporting electrification of suburbs and enabling more rooftop solar.

As with all new technologies, though, the potential benefits and impacts can be both positive and negative. For example, the battery could do a great job of soaking up excess neighbourhood rooftop solar but could also increase peak distribution network load through charging at suboptimal times. Similarly, whilst a neighbourhood battery project could excite community engagement in the clean energy transition, if the benefits and risks are not clearly communicated, it could also exacerbate public distrust about the energy transition and the key institutions responsible for delivering the transition.[1]

Assessing impacts is important to select appropriate solutions, ensure that positive impacts are delivered, and manage risks and unintended effects. Impact assessment, a key form of accountability, is needed for social acceptance, which, in turn, is critical for technology and infrastructure roll-outs, with examples from around the globe of opposition from local communities to renewable energy projects.[2,3]

Over time we've learnt that impact assessments are best done if they:

- support affected peoples, proponents and regulatory agencies
- increase understanding of potential change and capacities to respond to change
- seek to avoid and mitigate negative impacts and to enhance positive benefits across the life cycle of developments, and
- emphasise enhancing the lives of vulnerable and disadvantaged people.[4]

At all stages, assessments need to involve community engagement, in order to understand impacts as they unfold in local contexts and to assess technologies in relation to local needs and requirements.[5]

Evaluation is particularly important for neighbourhood batteries because:

a) they are sited close to where people live, and can thus be expected to have distinctive social impacts, both positive and negative

b) they are part of a broader transition happening with rooftop solar and electrification, and their impacts will influence this process and its outcomes

c) Most of the batteries being rolled out from 2022 onwards are majority government funded.

Previous research has found that the public's excitement about this technology is focused on the notion of community batteries – assets that enable energy sharing and local benefit.[1] While there have been other experiments with collective energy assets, such as solar and wind farms, community batteries are distinctive in their close connection to where people live and the likelihood that they will be in urban areas, as well as in regional locations.

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Specific challenges associated with evaluating neighbourhood batteries include:

Scale

Neighbourhood batteries are intensely local in terms of context, so assessment of impacts, particularly social ones, may be critical to the success, acceptability and social embedding of batteries in neighbourhoods.

Diversity and complexity of models

The social, network and environmental impacts will be strongly influenced by both the context and the particular objectives and models that are implemented locally.

For example, differences between projects in overloaded networks with high rooftop solar penetration versus those with minimal rooftop solar penetration. Or one neighbourhood's particular focus on using a neighbourhood battery for improving resilience due to their frequent experience with blackouts versus another's focus on reducing energy costs.

Specific opportunities associated with evaluating neighbourhood batteries include:

New and distinctive social contributions

Neighbourhood batteries could contribute to energy equity, collective governance, energy practices, community development and placemaking, and local climate action. While these social aspects are challenging to quantify, they are important. Things that can be easily counted (e.g. battery revenue) are not always the things that count the most to people (e.g. transparency and decarbonisation).

Sector-wide assessment

Looking at the impact of neighbourhood battery projects as a whole and the role they can play in the energy transition in Australia. This overarching type of assessment can be used to understand and capitalise on the positive social impacts that may arise from this technology and how they vary across settings. We suggest:

1) Assessments of available battery technology to determine the ones that comply best with environmental and social indicators.
2) Evaluate as early as possible existing projects – selecting ones that are as different from each other as possible, to determine their social, economic and technical benefits.
3) Assessment of available ownership and operational models to determine the ones that result in the best outcomes for the public.


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The ANU neighbourhood battery impact framework

Table 1: Overview of the ANU neighbourhood battery impact framework

SUSTAINABLE ENERGY TRANSITION	• Decarbonisation and integration of community energy resources • Trust and participation • Security, stability and resilience • Safety and lifecycle impacts • Accountability
SOUND GOVERNANCE AND SOCIAL ACCEPTANCE	• Trusted project governance and accountability • Benefits without burdens • Engagement and consultation • Ethical data governance • Evaluation and learning
ECONOMIC IMPACTS	• Project viability • Economic benefits

Table 1 provides an overview of the ANU neighbourhood battery impact framework and Table 2 (next page) gives a detailed list of the indicators for each category including tools and methods to guide the evaluation of each indicator. The methods are divided into the 'light version', designed for post-delivery project assessments, and the 'full version' designed for more in-depth independent evaluations. Supporting documentation for this framework is also presented as part of the Neighbourhood Battery Knowledge Hub under Evaluate Your Model. The framework has been split into three main categories:

1) sustainable energy transition
2) sound governance and social acceptance, and
3) economic impacts.

Sustainable energy transition

This category reflects the fact that energy system technologies like neighbourhood batteries can contribute directly to reducing emissions, but can also help to transform physical, regulatory and cultural systems to better support sustainability. For example, neighbourhood batteries could raise awareness about the energy transition and about decisions and practices at a household level that could support the transition. They could empower people to take action to address climate change, through their interaction with the battery and through other decisions and actions. Indicators like decarbonisation, efficiency, resiliency, and life cycle impacts will all be important.

Sound governance and social acceptance

This category recognises that good governance is an essential element of project success. There is now very good evidence from projects that neglect of good governance (e.g. appropriate community engagement or a data breach) will slow down, or even stop projects altogether.[6]

Sound governance is also critical to trust in the project proponents and the project. Such trust, and the perception that a development process and outcome is fair, have consistently been linked to acceptance and positive impacts for energy projects.[7] In Australia, research has revealed that desire for control over Consumer Energy Resources (CER) is strongly linked to a perception that the energy sector has not decarbonised the electricity system fast enough.[8,9]

Householders desire direct control over their energy use and their CER in part because they do not trust incumbents and in some cases, the digital infrastructure, to make decisions on their behalf.[10] Issues of trust and of control are likely to be very significant in whether neighbourhood batteries come to be understood by the community as a better alternative to home batteries.[11]

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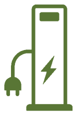
Economic impacts

This category focuses on transparency, accountability, equity and community consultation. Given the ongoing challenges of balancing costs and revenues, and uncertainty in relation to energy markets and the monetisation of network services, economic assessment will remain challenging and dynamic. This includes quantifying economic flow-on benefits like energy bill savings for energy users or downward pressure on energy prices. In this context, we highlight the importance of ongoing transparency and accountability of neighbourhood battery projects. The fairness and equity of financial benefit sharing will be a key criterion for social acceptance of projects.

In general, evaluations should be designed in the context of the particular project or sectoral issue, and the specific setting and objectives. Thus, this framework is not intended as a prescriptive framework or checklist but as a starting point to identify the most important and relevant impacts. There may be additional impacts identified and some of the impacts in the table may not be relevant to some projects.

Table 2: Detailed overview of the ANU neighbourhood battery impact framework

CATEGORY	EVALUATION MEASURE	QUESTIONS	INDICATORS	METHODS LIGHT	METHODS FULL	INFOR-MATION SOURCES
SUSTAINABLE ENERGY TRANSITION 	Decarbonisation and integration of community energy resources	• Is the battery performing solar soaking? • Is the battery performing demand management? • Is the battery contributing to improving network solar hosting capacity?	• Zero emissions charging (off wasted or excess solar energy). • Battery discharging during peak demand. • Battery has increased solar hosting capacity in the local network.	• Estimate marginal emissions intensity of battery's charging - see Appendix A. • Shaved daily peak load - see Appendix B.	• Marginal emissions intensity of battery's charging - see Appendix A. • Self-solar consumption rate and the self-sufficiency rate - see Appendix B.	Battery meter, distribution transformer meter, battery manager, community, marginal emissions data.
	Trust and participation	• Has the project empowered community members to participate in transition, including other climate action? • Does the project give people trust and confidence in energy transition? • Has the project led to changes in energy practices?	• Community members are more active in transition and climate action. • Community members have greater trust and confidence in the energy system. • The project has stimulated improved practices.	• Testimonies, surveys, social media discussion.	• Interviews, focus groups, surveys, ethnographic work.	• Community.

CATEGORY	EVALUATION MEASURE	QUESTIONS	INDICATORS	METHODS LIGHT	METHODS FULL	INFOR-MATION SOURCES
SUSTAINABLE ENERGY TRANSITION	Security, stability and resilience	• Is the battery contributing to improving voltage stabilisation? • How does the battery behave before, during and after contingency events? • Has/can the battery contribute/d to the resilience of the local energy system, including in times of crisis (e.g. bushfires, floods, heatwaves)? • Are the battery's response times appropriate for services required?	• The project has delivered benefits without detriment to the stability of the network. • The project has enabled a more resilient local energy system.	• Daily peak load. • Battery charging/ discharging behaviour.	• Voltage measurements across the LV network where the battery is connected. • Response rate of battery to provide all services required including contingency services. • Battery performance in an outage, if set up to provide back-up power i.e. is island-able.	• NSP, battery dashboard.

CATEGORY	EVALUATION MEASURE	QUESTIONS	INDICATORS	METHODS LIGHT	METHODS FULL	INFOR-MATION SOURCES
SUSTAINABLE ENERGY TRANSITION	Safety and lifecycle impacts	• Is the battery optimally cycled? e.g. only charging within a 10% and 90% State of Charge (SOC) • Has the project minimised environmental and social impacts of the manufacture, installation, running and recycling/disposal of the battery? • Has the battery complied with standards and certifications for environmental impact? • Has the battery complied with safety standards and certifications and put in place measures to monitor and maintain safety? • Are these impacts and actions transparently communicated to all stakeholders?	• Plans and policies exist and are enacted to minimise impacts in purchase, installation, running and end-of-life. • Battery State of Health (SoH). • Safety and lifecycle impacts are accounted for in reporting to stakeholders including community.	• Plans and policies, evidence of implementation and evidence of communication. • Monitoring battery's SoH over its life-span using the battery's dashboard (should display current SoH).	• Plans and policies, evidence of implementation and evidence of communication. • Analysis of battery SoH to ensure consistent with that expected of a battery of its age. If not consistent, investigation of battery's cycling patterns and operation.	• Project team, partners, battery dashboard.
	Accountability	• Is it easy for people to understand the different types of impacts from neighbourhood batteries? • Does tracing the costs and benefits require significant resources from a regulator?	• The project has delivered benefits without overburdening the regulatory systems.	• Review of regulatory activity required in existing documentation.	• Interviews with key stakeholders.	• Regulators, project proponents, the general public.

CATEGORY	EVALUATION MEASURE	QUESTIONS	INDICATORS	METHODS LIGHT	METHODS FULL	INFOR-MATION SOURCES
SOUND GOVERNANCE AND SOCIAL ACCEPTANCE	Trusted project governance and accountability	• Is the project run by an organisation trusted to make fair and competent decisions? • Is there clarity and transparency re goals, values, business model, decision-making, procedures and financials? • Is there transparency and accountability in the operation of the battery and distribution of benefits? • Has this project made good use of available time and resources?	• There is trust in the project proponent. • Project governance processes exist and are implemented. • Project is on time and budget.	• Testimonies, feedback forms, surveys. • Project documents.	• Document analysis, process observation. • Interviews.	• Website, project team, advisory group members, partners, community.
	Benefits without burdens	• Has the project provided community benefits, without unacceptable burdens or risks? • Are benefits and burdens distributed equitably? • Has the project contributed to community wellbeing and development?	• The community accept that benefits outweigh burdens and risks. • Benefits and burdens are distributed equitably and fairly. • Community wellbeing has improved, community assets and/or capacity have increased.	• Testimonies, feedback forms, surveys. • Number of community assets pre and post battery project commence-ment.	• Interviews. • Evaluation of impact of new community assets (i.e. those installed post battery project).	• Website, project team, advisory group members, partners, community.

CATEGORY	EVALUATION MEASURE	QUESTIONS	INDICATORS	METHODS LIGHT	METHODS FULL	INFOR-MATION SOURCES
SOUND GOVERNANCE AND SOCIAL ACCEPTANCE	Engagement and consultation	• Has the project engaged with the community, including opportunities to influence decisions by people who will be affected? • Has community input influenced the project and has this been communicated? • Has the project enabled participation of diverse community members? • Have experiences of participation been positive, including access to information and dispute resolution?	• A good practice engagement plan has been developed and implemented. • Engagement has been effective, inclusive and has influenced the project. • Participants reflect the diversity of the community. • Participation has been positive, underpinned by due process.	• Project documents, engagement plans, reports. • Evidence of engagement and input. • Gather stats on diversity. • Participant satisfaction surveys, testimonials.	• Document analysis, observation, interviews, focus groups, stats on diversity, surveys.	• Project team, partners, community.
	Ethical data governance	• Are there security and privacy provisions in the use of data?	• Provisions exist and are used.	• Project documents, external party policies. • Testimonies, info re problems.	• Project documents, external party policies. • Assessment of policies in practise, against standards.	• Project team, partners, customers.

CATEGORY	EVALUATION MEASURE	QUESTIONS	INDICATORS	METHODS LIGHT	METHODS FULL	INFOR-MATION SOURCES
SOUND GOVERNANCE AND SOCIAL ACCEPTANCE	Evaluation and learning	• Has the project been evaluated for accountability, improvement and learning? • Have lessons been shared?	• Evaluation has been conducted and results are publicly available. • Lessons have been shared.	• Surveys, feedback forms.	• Evaluation plan and report. • Interviews, focus groups, surveys.	• Project team, wider NB community.
ECONOMIC IMPACTS	Project viability	• Does the project have a viable business model, sustainable for the life of the project? • Has the model addressed risks and uncertainties? Is the model scalable?	• The project has a viable, sustainable business model. • The model addresses risks, uncertainties and scale.	• Non-negative Net Present Value (NPV) for the project (approximated using neighbourhood battery NPV calculator). • No major risks with a moderate to high likelihood (determined using neighbourhood battery risk assessment template).	Before operation: • Project CAPEX and OPEX quotes. • Optimised battery operation revenue modelling (historical and forecasted prices). During operation: • Project CAPEX and OPEX actuals. • Battery's actual versus forecasted revenue.	• Project proponents, DNSP commun-ications, community members, local and national businesses, neighbourhood battery feasibility studies, historical NEM data, battery operation software.

CATEGORY	EVALUATION MEASURE	QUESTIONS	INDICATORS	METHODS LIGHT	METHODS FULL	INFOR-MATION SOURCES
ECONOMIC IMPACTS	Economic benefits	• Do the economic benefits of the project flow to energy users, including in bill reductions? • Is the distribution of economic benefits equitable? Has the project reduced inequity and energy poverty in the community? • Do economic benefits from the project flow to supporting the energy network, such as through infrastructure investment? • Do economic benefits flow to the community as a whole, leading to local economic development?	• A fair proportion of returns and benefits flow to participants/ energy users. • Community members judge decisions and benefit sharing to be fair. Non-solar owners and poorer community members are better off. • The project has led to local energy network improvements/ upgrades that benefit all energy users. • The project has led to economic benefits for the community.	• Energy bill credits (or other financial reward provided by battery operator/ owner). • Review of community investments and funding. • Network upgrades.	• Full cost benefit assessment of the battery project. • Number of new household solar installations since operation of neighbourhood battery project, system-wide improvements.	• Energy bill credits, accounts and expenditure, surveys, interviews, hosting capacity calculations (see Appendix B).

Appendices

A: Detailed assessment of environmental impacts

See: bsgip.com/kbtopic/environmental-goals-impacts/.

To ensure that the battery has a net negative impact on emissions, you will need to account for the emissions associated across the four stages of the battery's lifetime: material and parts production, battery manufacturing, battery operation and battery end-of-life. These can be summarised as embedded emissions and operational emissions, with the main source of emissions associated with neighbourhood batteries coming from its operation. In the above section of the Neighbourhood Battery Knowledge Hub, we share the light and full version for estimating or calculating the operational emissions of a neighbourhood battery. Estimates for the embedded emissions of a lithium-ion battery, currently the main neighbourhood battery technology, are also provided.

B: Detailed assessment of network impacts

See bsgip.com/kbtopic/network-goals-impacts/.

There are three main areas that a neighbourhood battery may impact the distribution network: solar hosting capacity, local energy management, and voltage impacts. Network impacts can be investigated with both modelling as well as evaluation of real-life trials, as explained in the 'Performing calculations' page within the link above. In all assessments of network impacts, it is important to keep in mind, and use as a base case of comparison, alternate ways in which these network impacts could have been resolved. For example, how much better is the neighbourhood battery increasing hosting capacity compared to how it could have been increased from upgrading the distribution transformer?

C: Literature review: Evaluating the impacts of energy technologies

See bsgip.com/knowledge-hub/evaluating-the-impacts-of-energy-technologies/

Here we have provided a literature review on evaluation for assessing the impact of energy technologies. It was written to provide context for evaluators or project proponents of neighbourhood battery projects to help them understand the importance and history of evaluating such technologies.

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References

1. Ransan-Cooper, H. *Stakeholder views on the potential role of community scale storage in Australia*. https://arena.gov.au/assets/2020/08/stakeholder-views-on-community-scale-storage-in-australia.pdf (2020).
2. Devine-Wright, P. *et al*. A conceptual framework for understanding the social acceptance of energy infrastructure: Insights from energy storage. *Energy Policy* **107**, 27–31 (2017).
3. Assefa, G. & Frostell, B. Social sustainability and social acceptance in technology assessment: A case study of energy technologies. *Technol*. Soc. **29**, 63–78 (2007).
4. Esteves, A. M., Franks, D. & Vanclay, F. Social impact assessment: the state of the art. *Impact Assess. Proj. Apprais.* 30, 34–42 (2012).
5. Lizana, J., Barrios-Padura, ÿngela, Molina-Huelva, M. & Chacartegui, R. Multi-criteria assessment for the effective decision management in residential energy retrofitting. *Energy Build*. 129, 284–307 (2016).
6. Next generation engagement: Setting a research agenda for community engagement in Australia's infrastructure sector - Bice - 2019 - Australian Journal of Public Administration - Wiley Online Library. https://onlinelibrary-wiley-com.virtual.anu.edu.au/doi/full/10.1111/1467-8500.12381.
7. Boudet, H. S. Public perceptions of and responses to new energy technologies. *Nat. Energy* **4**, 446–455 (2019).
8. Nicholls, L., Arcari, P., Glover, A., Martin, R. & Strengers, Y. *Engaging households towards the future grid: experiences, expectations and emerging trends*. www.energyconsumersaustralia.com.au (2019).
9. Temby, H. & Ransan-Cooper, H. 'We want it to work': understanding household experiences with new energy technologies in Australia. https://www.ewov.com.au/reports/voices (2021).
10. Ransan-Cooper, H., Lovell, H., Watson, P., Harwood, A. & Hann, V. Frustration, confusion and excitement: Mixed emotional responses to new household solar-battery systems in Australia. *Energy Res. Soc. Sci.* **70**, 101656 (2020).
11. Milchram, C., Künneke, R., Doorn, N., van de Kaa, G. & Hillerbrand, R. Designing for justice in electricity systems: A comparison of smart grid experiments in the Netherlands. *Energy Policy* **147**, 111720 (2020).

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