Australian National University

Battery Storage and Grid Integration Program

An initiative of The Australian National University

Submission on residential electrification

Battery Storage and Grid Integration Program, ANU

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BSGIP Submission to Senate Economics References Committee inquiry into residential electrification

The Battery Storage and Grid Integration Program (BSGIP) at the Australian National University (ANU) is grateful for the opportunity to contribute to the Senate Economics References Committee inquiry into residential electrification. This is an important and central issue as Australia transitions towards a renewable, distributed energy system, driven by the need to rapidly achieve economy-wide decarbonisation.

BSGIP is a multi-disciplinary, industry-focused, research, development and demonstration Program based at ANU. We take a holistic, socio-techno-economic approach to our work in the energy system. In this context, our submission provides insights and evidence from all three perspectives that we believe will create an energy future that better serves all Australians, in the context of three themes:

1. Household and community perspectives
2. Complex challenges in residential electrification
3. Addressing macro-barriers to residential electrification

1. Household and community perspectives

New energy technologies are poised to radically transform the Australian energy sector. Australia leads the world in the per capita adoption of rooftop solar and batteries while electric vehicles, virtual power plants and microgrids continue to grow in popularity. These technologies mean that households and small businesses are no longer only consumers of energy but now can also generate, store and export energy as well. This represents the most significant transformation of our Australian energy system to date.

There is increasing interest among Australians in taking greater control over their personal use of energy through smart appliances and systems, and in the production of renewable forms of energy such as rooftop solar. Reasons for this include the high cost of energy and strong environmental values.

While the uptake in new energy technologies has the potential to empower households and lead to improved financial and environmental outcomes, these new technologies are evolving faster than consumer protection frameworks. This could expose households to increased and unfamiliar risks and reduce the take up – and therefore the benefits – of new energy technology adoption.

It is critical that households and communities are considered and consulted in the transition, and their perspectives incorporated. Three recent BSGIP research projects provide evidence of consumer energy experiences, the values they bring to the energy system, and how care practices are critical to a decentralized energy system. These projects are summarized below, and BSGIP would be happy to provide further briefings to the Committee if desired.

These three studies provide evidence that energy users have many values that influence decision-making related to their energy use, and drive their investments in new energy technologies. However, regulatory decisions and rule changes in the electricity market have highlighted how everyday energy user values may not be incorporated into energy sector decisions. These regulatory decisions impact what energy users can do by setting the way they must interact with the energy system.

An inclusive energy system requires change from within the energy system that goes beyond its engagement with the public. It requires a fundamental shift from techno-economic regulation to socio-techno-economic (or integrated) regulation. We encourage the Committee to undertake a thorough socio-techno-economic analysis to fully capture the opportunities that residential electrification may facilitate.

New Energy VOICES (Victorian energy and water Ombudsman Investigation of Consumer Experiences):[1]

In 2020 and 2021 BSGIP spoke with 92 householders, businesses and industry experts about their experiences with new energy products and services for the New Energy VOICES study. The findings of BSGIP's research included:

Motivation: Consumers had a high degree of '**transition awareness**'. All households were motivated by pro-environmental attitudes to some extent. Other key motivations included financial expectations, a desire for greater self-sufficiency and resilience, community mindedness, enthusiasm for technology, and comfort.

Information: Consumers felt there is a **lack of leadership from government and industry**, with some technology providers failing to provide adequate information to users. Many consumers turn to community groups and peers for experiential information.

Experience: Retailers, installers and dealers have a central role in determining whether householders' experiences with new energy products and services are positive. **Good providers take the time to understand householders' needs,** and help them to navigate complex technological choices. Post-installation roles such as handover and after sales support are also critical.

Emerging business models and reforms: Householders have a range of concerns around new energy technology, generally driven by a **feeling that the energy sector's motivations are not in line with their own**. Issues raised include data privacy, and scepticism that third-party control would be in their best interests. Householders felt a desire to control aspects of their energy use and technologies – which they saw as conflicting with third party automation and control.

[1] Hugo Temby and Dr Hedda Ransan-Cooper (BSGIP), 'We want it to work': understanding household experiences with new energy technologies in Australia. https://www.ewov.com.au/uploads/main/Reports/Other-reports/EWOV-VOICES-report.pdf

Customer Focused Network Management:[2]

This research, generously funded by Energy Consumers Australia, investigated how consumers should be involved in major reforms. It analysed how the industry could manage future energy needs from the point of view of customers. It explored customer expectations around how much capacity should be available, how it should be shared, and what decision-making frameworks are appropriate for networks to apply as they manage the network.

Key themes from the consumer interactions in this project included:

- Appropriate consumer engagement models during energy system decision making processes; and
- How consumers would like the energy system to respond to their needs.

Using these two findings, BSGIP was able to define how consumers would prefer to engage. Consumers desire a voice in decision making, but still see experts as appropriately leading these processes. They indicated that experts need to be more responsive to consumers' values and asked for this to occur earlier in decision making processes. This means that consumer engagement processes need to evolve. Consumers should be consulted earlier, using tools such as value sensitive design to explore what is important to consumers. This creates a space which focusses on consumers' expectations rather than proposed solutions to industry-defined problems.

Who cares? How care practices uphold the decentralised energy order:[3]

This analysis exposed how invisible care practices underpin householders' material engagement with the energy system, and that they are also inextricably entangled with making a decentralised energy system work in practice.

The research revealed that decentralised energy is enabled and made workable by the peoples' care for the future, and their ability to take responsibility and action. It particularly highlighted the impacts on those excluded from care-giving and -receiving, how these gaps hamper the flow of care, and ways existing gender relations are reinforced by, and reinforce, these gaps and exclusions.

Policymakers can recognise the importance, but also the limitations, of bureaucratic and market care in the energy system, and the need for policies and projects to recognise, support, and empower diverse abilities and care practices. This could be achieved through meaningful co-creation of policies, rules and processes. Energy businesses and intermediaries are encouraged to go beyond a transactional approach to installing technologies.

[2] Laura Jones, Brenda Martin and Dr Phillipa Watson (BSGIP), Customer focussed distribution network management project final report. https://bsgip.com/wp-content/uploads/2023/06/Final-report.pdf

[3] Dr Kathryn Lucas-Healey, Dr Hedda Ransan-Cooper, Hugo Temby, and Dr Wendy Russell (BSGIP). Who cares? How care practices uphold the decentralised energy order. Buildings and Cities, 3(1), p.448–463, 2022. https://journal-buildingscities.org/articles/10.5334/bc.219

2. Complex challenges in residential electrification

One element in a successful global energy transition will be ensuring significant consumer participation through the uptake of distributed energy resources (DER). These assets are also called consumer energy resources (CER). Examples of these assets include rooftop solar PV, household battery storage, and electric vehicles (EVs). One commonly discussed obstruction for further uptake by consumers is the cost and complexity of acquiring and benefitting from these technologies.

BSGIP has been working to address barriers to electrification by developing and advocating for more just, accessible, and equitable system and market participation models for DER.[4] These models aim to explicitly consider and manage the need for complexity with accessibility, consumer value drivers, and contextual factors that may challenge uptake. Consumers must be able to afford and benefit from consumer energy resources and accelerate decarbonisation without becoming experts in the complex energy system.

The difficulty that Australian energy consumers experience is well-documented, including in the Australian Energy Regulator's *Towards Energy Equity* strategy[5]. Recent policy developments have sought to unlock the capabilities of consumer energy resources to provide value to all consumers. However, there are risks that by increasing complexity, these approaches could actually lead to a reduction in consumer engagement. Mechanisms must be developed that allow consumers to engage with the energy market simply and easily, without compromising flexibility.

There are many opportunities to improve consumer engagement and distribute the economic value of consumer energy resources to all energy consumers, but opportunities also go well beyond the economic. Through regulatory changes such as metering innovation, a portion of these assets could be coordinated to provide the specific benefits the consumer wants, while allowing others to operate based on their own control or algorithms.

There could also be benefits for shared-living or strata arrangements – supporting individual consumers in a household to engage with their own preferred trader for their specific assets (EV supply equipment being a clear example) without impacting on the other occupants, or reducing the technical complexity associated with EV charging on dedicated car-park circuits in apartment buildings. In particular, support is needed to develop solutions that prioritise renters, apartment dwellers and other groups who are repeatedly and increasingly left behind in times of technological change.

There is enormous potential for Australia's world-leading fleet of consumer energy resources to contribute to decarbonising our energy system, improve its efficient use, and create benefit for consumers. Simplifying participation in the electricity market will open up the opportunity for householders to benefit from decarbonisation and support vulnerable households to share in this transition equitably.

Apartment buildings

A particularly complex decarbonisation challenge is multi-dwelling (apartment) buildings and strata arrangements. These buildings pose unique challenges of multi-ownership, a mix of owner-occupiers and

[4] See for example https://bsgip.com/wp-content/uploads/2023/08/Meter-Unbundling-final-report.pdf
[5] https://www.aer.gov.au/retail-markets/guidelines-reviews/towards-energy-equity-a-strategy-for-an-inclusive-energy-market

renters, a mix of private and common energy usage, relatively small land area to occupant ratio affecting ability to install DER infrastructure, and embedded energy networks (including regulation).

Electrification of apartment buildings also poses unique integration questions, particularly in accommodating EV chargers, economically viable hot water and heating options, and co-ordination and control of demand augmented by various forms of energy storage. Without sophisticated modelling, design, and planning, these systems could be very expensive and challenging to operate. Integrating the energy systems in the building together and into the grid can provide value stacking outcomes that would not be realised if these systems were to operate in isolation. Basing this integration and optimisation in rigorous modelling and research will ensure the forecast benefits are realised.

BSGIP is working to determine the technical feasibility of deploying a large amount of DER and electrified assets in an apartment building, co-ordinated and optimised to minimise energy flows to and from the grid so as to realise these benefits. This work will apply BSGIP's unique socio-techno-economic modelling and scenario-based approach to determine the feasibility and optimal design elements for a low emissions, electric apartment building. In parallel we will design, test and implement enabling capabilities for DER integration, and test scenarios that could deliver economic benefits to the building owners and tenants. We would be happy to continue to engage with the Committee on this project.

Renters

In considering electrification support for renters, the power imbalance between tenants and landlords must be clearly understood and planned for. BSGIP's *Meter unbundling conceptual analysis* report[6] showed that this power imbalance has the potential to enable financial drivers for landlords to behave in ways that do not benefit tenants, for example maximising energy export to the grid from rooftop solar.

Currently, rental properties are considerably less likely to have rooftop solar installed than owner-occupied homes.[7] There are a variety of reasons for this, but the complexity of such an arrangement – and potential to exacerbate existing inequalities – are likely leading. In order to avoid perverse situations that might incentivise landlords to encourage tenant energy consumption, it could be worth considering detaching any returns from rooftop solar to landlords from tenant energy consumption patterns.

Community solar farms are an alternative way to enable solar access for renters and apartment dwellers, without installing solar panels on their home. These initiatives could be extended to include solar canopies on community playgrounds and communal spaces to enable solar generation located close to people's homes, and also provide shade in summer.

Energy Efficiency

Energy efficiency initiatives can increase the comfort of people's homes, and support health and wellbeing.[8] In raising energy efficiency it is important to consider households who currently do not use enough energy to stay healthy – homes with poor thermal comfort with lower income occupants are likely

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[6] Laura Jones, Tim Moore and Michael Thomas (BSGIP). Meter unbundling conceptual analysis: final report. June 2023. https://bsgip.com/research/meter-unbundling-conceptual-analysis/

[7] Mara Hammerle, Lee V. White, Bjorn Sturmberg. Solar for renters: Investigating investor perspectives of barriers and policies. Energy Policy, March 2023. https://www.sciencedirect.com/science/article/pii/S0301421523000022

[8] A capture of benefits from Australian projects can be found in Acil Allen, 2017, Report to Energy Consumers Australia Multiple Impacts Framework: an Assessment Framework, October, for Energy Consumers Australia. https://energyconsumersaustralia.com.au/wp-content/uploads/Multiple-Impacts-Framework.pdf .
A capture of specific benefits of one of the projects in the Acil report are covered in - Rooney, M., Watson, P., Watson, S., 2016 Get Bill Smart Detailed Study Report, Sustainable living Tasmanian and University of Tasmania, June. https://apo.org.au/node/319556

to have this issue. For low income households, housing envelope improvements and other efficiencies are achievable and worthwhile, but these households would benefit from infrastructure upgrades without receiving the message to be more efficient with energy use. Expectations on behaviour change and the ability to retrofit need to align with the capacity people have to effect change.

An innovative emerging efficiency initiative is to ensure coordinated generation, storage and consumption of energy occurs as much as possible within the building. Producing, storing and consuming energy locally is more efficient, can offset the need for infrastructure upgrades, and contributes to supporting the increased penetration of variable renewable energy generation into our electricity grid. Energy storage can take the form of stationary batteries, as well as smart heat pump hot water systems as thermal batteries (heating and storing water soaking up excess solar generation). These solutions are modular and scalable, meaning they can be implemented in single households, apartment or commercial buildings, or larger precincts.

A successful building retrofitting campaign would need to address individual issues faced by individuals, families and communities within these buildings. For example, private renters and people living on lower incomes have traditionally had the most difficulty retrofitting new energy technologies and infrastructures into their homes. Consideration particularly needs to be given as to how to support these people.

Other areas to increase focus could include non-technical and smaller solutions with outsized impacts, such as reminders, timers, or curtains. These can help with ensuring efficient use of dryers, dishwashers and washing machines, as well as space heating and cooling.

3. Addressing macro-barriers to residential electrification

As households are electrified, we need to ensure that these assets work together effectively. At BSGIP we call this grid integration, referring to the control, optimisation, coordination, and orchestration techniques needed to bring these disparate devices together to deliver energy reliability, security, and resilience.

These new integration capabilities encompass new systems, new algorithms, and even new technical standards, an often forgotten but vitally important contributor to beneficial integration outcomes.

DER integration

Increased uptake of rooftop solar PV has required electricity distribution networks to manage congestion on the electricity grid at certain times of each day and of each year. EV charging and electrification of gas appliances could further challenge existing distribution network capacity. That is, increasing electrification could cause increased load and congestion on the grid and lead to an extensive need to 'reinforce' the network by building out more distribution network infrastructure.

A lower-cost solution currently being tested and deployed nationally by distribution networks allows network capacity to be dynamically managed, which will reduce or eliminate the need for expensive new infrastructure to be built. These new capabilities are implemented through a technology called dynamic operating envelopes (DOEs).[9] By design, DOE processes can be fully automated and are thus invisible to

[9] On the calculation and use of dynamic operating envelopes, BSGIP. 2020. https://arena.gov.au/assets/2020/09/on-the-calculation-and-use-of-dynamic-operating-envelopes.pdf ; Dynamic Operating Envelopes Working Group: Outcomes Report. By the Distributed Energy Integration Program (DEIP) Dynamic Operating Envelopes Working Group. March 2022. https://arena.gov.au/assets/2022/03/dynamic-operating-envelope-working-group-outcomes-report.pdf ; M. Mahmoodi, L. Blackhall, S. M. N. R.A., A. Attarha, B.

energy users, as they work to support significantly increased uptake of household DER including solar PV, residential battery storage, and electric vehicles. BSGIP is a partner in a suite of projects across Australia implementing dynamic operating envelopes to operationally realise the benefits of these approaches.[10]

Beyond DOEs, there is also the potential for creating financial incentives for managing network capacity. In this context, BSGIP is working with key distribution network partners to develop a pricing engine that facilitates customer participation in network services markets.

More sophisticated optimisation and control of assets with a larger energy demand is particularly useful for some types of technologies such as electric vehicles, where demand can often be shifted with lower impact on consumers. Additional solutions such as time of use pricing and accessible information can help consumers shift practices to better align use of other devices to periods where there is excess generation capacity and network capability, without the need for complex and expensive automation technology.

Ultimately, the electrification process will necessitate an increased focus on operating and optimising our electricity infrastructure and assets to ensure they meet the needs and expectations of the community at the same time as reducing the cost of transitioning to a purely electric economy.

Enhancing interoperability by supporting open standards

There is now a strong evidence base for the need to prepare electricity grids for household electrification, so that consumer energy resources can be an asset to support the grid rather than simply creating new loads. A clear finding from BSGIP's work on grid integration is that a good outcome will require the right standards, processes, and value mechanisms to be in place, and that this important issue should not be left solely to market mechanisms.

Standards to support the integration and interoperability of household electrification assets are a particularly critical area of focus. Contemporary methods of managing these assets often use walled-garden approaches that reduce interoperability and make it difficult (or impossible) for technology providers to orchestrate disparate resources to the consumer's benefit. Supporting the development and implementation of approaches based on open standards will better enable consumers to engage with the energy system, while also enhancing consumer choice and improving competition among technology providers.

BSGIP has been supporting the development of relevant standards and policy through our leadership of, and contribution to, various streams of the ARENA Distributed Energy Integration Program (DEIP)[11] initiative. We work with the initiative broadly, in addition to specific work on the Interoperability Steering Committee (ISC),[12] which is chaired by the Head of BSGIP. A greater focus by government to support the development of relevant standards through these processes would be welcome.

Weise and A. Bhardwaj, "DER Capacity Assessment of Active Distribution Systems Using Dynamic Operating Envelopes," in IEEE Transactions on Smart Grid, doi: 10.1109/TSG.2023.3313550.

[10] See https://bsgip.com/research/evolve/; https://bsgip.com/research/edith/; https://bsgip.com/research/converge/

[11] https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/

[12] https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/interoperability-steering-committee/

Contact

Thank you again for the opportunity to provide input into this inquiry. If you would like to discuss any of our comments in this submission, please feel welcome to contact Alix Ziebell, BSGIP Engagement and Impact Lead, by email at [redacted]

Further information:

- Battery Storage and Grid Integration Program[13] – for information on our mission, work and people
- DEIP Interoperability Steering Committee[14] – for information on the work of the ARENA Interoperability Steering Committee (chaired by BSGIP) to enable the interoperable integration of DER
- Projects evolve, Symphony and Converge[15] – software and social science exploring the grid participation of distributed energy resources
- Sans Limites[16]– an automated, public tool that aims to improve customer understanding of costs and benefits of acquiring DER assets, and how these benefits arise
- Meter unbundling conceptual analysis[17] – exploring ways novel metering arrangements can be evaluated as a vehicle to increase household electrification, reduce consumer energy costs, and genuinely improve household experience of their energy supply.
- New energy VOICEs (Victorian energy and water Ombudsman Investigation of Consumer Experiences)[18] – exploring household experiences with energy technology.
- Customer-focused network management[19] - how incorporating the values of energy users can improve how energy networks make decisions.

[13] www.bsgip.com
[14] https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/interoperability-steering-committee/
[15] https://bsgip.com/research/evolve/ ; https://www.westernpower.com.au/our-energy-evolution/projects-and-trials/project-symphony/ ; https://bsgip.com/research/converge/
[16] https://bsgip.com/research/sans-limites/
[17] https://bsgip.com/research/meter-unbundling-conceptual-analysis/
[18] https://bsgip.com/research/new-energy-voices-victorian-ombudsman-investigation-of-consumer-experiences/
[19] https://bsgip.com/research/customer-focused-network-management/

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