



Australian Government
Australian Renewable
Energy Agency

ARENA

ARENA INSIGHTS FORUM

SESSION SUMMARIES
& KEY POINTS

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ARENA INSIGHTS

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Introduction

In 2018 ARENA's Knowledge Sharing Team began the Insights Forum, bringing together projects and industry stakeholders to share insights from ARENA-funded projects and to discuss trends across the renewable energy industry. The Forum is a free, invitation-only event that deep dives into technical topics that link to broader challenges and opportunities affecting the renewable energy industry.

The Insights Forum aims to share knowledge from ARENA projects and initiatives in a unique environment focusing on details, insight & opportunities (real lessons without the sales pitch).



The theme of this Insights Forum was “*Storage for the energy transition*”, which covered a range of topics including: the role of batteries in providing system security to the electricity grid; the need for long-duration energy storage to ensure reliable energy delivery; how storage will affect the electricity market dynamics; and the contribution of thermal energy storage for decarbonising process heat. A group of over 30 delegates also participated on a pre-event site visit to the Wallgrove battery on 25 March.

Plenary session and keynote address

OVERVIEW AND SPEAKERS:

The plenary session kicked off with a Welcome to Country given by Gadigal Elder Uncle Allen Murray.

This was followed by a speech from ARENA's CEO Darren Miller, who emphasized the commitment and focus of ARENA to the storage sector. Darren pointed out the importance of social license and challenges such as supply chain and unfitted market model, highlighting the need for regulatory intervention to overcome those challenges. Darren also welcomed the delegates and noted the importance of their input on how to make these storage technologies successful and on how ARENA can provide support.



Next, Alex Campbell, Director of Policy and Partnerships at the Long-duration Energy Storage (LDES) Council, gave the keynote address. Alex provided a global overview of the industry, including an increasing need for LDES with increasing renewables penetration and an expected significant decrease in the cost of the technologies over the next decade. Industrial heat was highlighted as an important use of LDES, a sector that could be electrified by 2030. Alex also presented some changes in policy framework that are happening around the world, pointing out the need for further policy reform as well as market incentives to accelerate the deployment of the LDES technologies.



Session 1: Technologies for Electricity storage

OVERVIEW AND PARTICIPANTS:

This session focused on the technological innovations in storage to provide system security to the electricity grid. The presentations included the following topics:

- › Diana Tulip and Nigel Hicks (Neoen): Innovations in grid forming batteries to provide system inertia and transmission protection.
- › Sam Hill (Edify): Innovations in grid forming batteries to provide system strength.
- › Jeff Renaud (Relectrify): Introduction to battery management system that eliminates the need for inverter.

In addition to the presenters, the panel discussion included Elicia Cantelo (ARENA) as the facilitator, Chris Mock (AEMO) and Jesse Steinfield (Transgrid).



KEY TAKEAWAYS:

- › 100% instantaneous renewables can only be achieved once system services, such as system strength, are decoupled from traditional synchronous generators.
- › Grid forming batteries are now being used in high renewables areas, such as southwest NSW and Kerang in Victoria, to increase the hosting capacity on the grid and alleviate security constraints.
- › Although the synthetic inertia provided by grid-forming batteries behaves close to mechanical inertia provided by traditional generators, there are some differences. Inverters need to have headroom to provide an inertial response, therefore the response is limited by the capacity available. The headroom is not a limitation for provision of system strength.
- › The provision of system strength from grid-forming batteries is becoming increasingly accepted by AEMO and the transmission network service providers (TNSPs). This is an efficient solution as system strength can be provided by the battery irrespective of whether it is charging, discharging or idle and it does not require oversizing of inverters.
- › In addition to inertia and system strength, further exploration is needed to understand the response of these technologies to large system disturbances and system restart.
- › It is likely that synchronous condensers (syncons) will be part of the mix of technologies providing system security. Whilst grid-forming batteries can provide fault current, it requires oversizing which may be less cost effective than syncons. Syncons will also play an important role in the next years whilst the understanding of grid-forming batteries improves. Next steps require engagement to understand the optimal mix of system security solutions.
- › Providing market signals to Original Equipment Manufacturers (OEMs) is key to bringing new technologies to the market.
- › Cell level control of batteries, such as presented by Relectrify, can create an alternate current (AC) sine wave, eliminating the need for an inverter. In addition, as the “weak” cell can be bypassed, second-life and B-grade batteries can be used to create A-grade systems. A 1MW demonstration is expected in 2025 to prove that the technology can be used at grid scale, including provision of system security services.

Session 2: Long-duration storage technologies

OVERVIEW AND PARTICIPANTS:

This session focused on understanding the role of long-duration storage technologies in providing grid resilience. The presentations included the following topics:

- › Kira Rundell (RayGen): Concentrated Solar Thermal couple with energy-storage.
- › Conan Jones (Redflow): Zinc-Bromine flow battery for long-duration storage.
- › David Edwards (Horizon Power): Long-Duration energy storage pilot projects using new battery technologies.

In addition to the presenters, the panel discussion included Dr Tania Benedetti (ARENA) as the facilitator, Naureen Alam (AGL) and Alex Campbell (LDES council).



KEY TAKEAWAYS:

- › There is a direct correlation between duration and renewables penetration, California has recently published a study on the depth of storage needed to get to 100% renewables, Great Britain has also done some research in this area.
- › LDES is a different proposition from shorter duration Lithium-ion batteries. Australian market is very focused on Lithium-ion batteries, requiring tenders that LDES cannot achieve. Education and maturity need to evolve in the market to understand the differences and the need for both short- and long-duration.
- › Markets that incentivise LDES are currently limited to requiring utilities to procure LDES. Established markets in this area are yet to be seen with some learnings from Great Britain and the EU likely to be forthcoming for Australia.
- › Microgrids have been experiencing challenges with increasing renewables ahead of others. Once renewables surpass 80% in remote communities and islands, the capex becomes prohibitive. These challenges breed innovation and it is expected that as the LDES technology advances, it will become cheaper and more attractive than diesel and gas.
- › Microgrids currently heavily rely on gas and diesel to ensure reliability. Horizon power, with 38 microgrids and over 70 standalone power systems, performed a techno-economic analysis and selected vanadium-redox flow battery, zinc-bromide flow battery and sodium-sulphur battery storage for remote microgrid trials as alternatives to gas and diesel.
- › RayGen's technology presents flexibility in how electricity is managed: running the chiller from the solar photovoltaics (PV) modules or from the grid (load), exporting solar PV to the grid (inverter-based power), using the turbine to export to the grid (synchronous power) or storing energy (thermal pit storage). RayGen's value proposition is either as a green peaker in the national electricity markets (NEM) or green baseload, particularly to microgrids and standalone power systems.
- › Redflow's Zinc-bromine flow battery presents key benefits such as availability of source materials, flat charging, predictable discharge characteristics and the ability to get to 100% depth of discharge. It can also be used with grid-forming inverters. Redflow's battery operates optimally between 4-12 hours discharge and can operate with operational tradeoffs at shorter (2h) and longer (12hr to 20hr+) durations.

Session 3a: Participation of storage in electricity markets

OVERVIEW AND PARTICIPANTS:

This session focused on discussions about how storage can affect the electricity market dynamics. The presentations included the following topics:

- › Chris Barrett (Lumea): Overview of participation of the Wallgrove battery in the electricity and in the frequency control ancillary service (FCAS) markets.
- › Guillaume Roger (Monash University): Energy arbitrage dynamics in a storage dominated grid.
- › Stefan Trüeck (Macquarie University): Effect of batteries on FCAS markets.

In addition to the presenters, the panel discussion included Greg Williams (ARENA) as the facilitator and Neil Lessen (AEMC).



KEY TAKEAWAYS:

- › When large enough, storage can have market power in both buying and selling. Storage units can be used to enhance demand, which is a real concern/risk that asset owners could use to influence prices to their benefit. This brings implications to market design, including necessary competition policy to prevent risk of collusion.
- › For large storage assets, intraday trading strategy is roughly proportional to demand, which means the quantity of energy bought is based on estimated demand for the following period.
- › The Wallgrove battery operations show that the battery rarely goes below 15-20MW (out of 50MW) state of charge. This is required to maintain capacity for the synthetic inertia trial, but generally this buffer is maintained for potential of market cap events.
- › Data shows that batteries, especially the larger ones, have substantially increased FCAS competition in the market, which has significantly lowered prices due to other players having to reduce their prices to compete. However, there is risk of flip, where batteries increase FCAS prices with increasing market power. If FCAS becomes a revenue source only for batteries, then markets signals will be necessary to diversify the sources, likely including demand response, in the future.
- › The Wallgrove battery is a price-setter for both 1-second FCAS markets. Its revenue is currently around 1/3 energy arbitrage, and the remaining is distributed among various forms of FCAS. From 2022 to 2023, the revenue shifted from regulation to contingency FCAS, particularly with introduction of the new 1-second market.
- › FCAS market saturation may stall deployment of new batteries. However, there is still room for new investments.
- › LDES is not particularly expected to be important for ancillary market due to potential higher revenue opportunities in arbitrage.
- › Having one large storage instead of several small storage can result in nasty behavior and the market is more efficient with many small batteries. However, cost efficiencies & associated balance of plant considerations are majorly improved with larger storage.
- › Other suggested market changes are: to stop subsidizing solar and instead make battery subsidies; and implementing locational marginal pricing to have storage correctly located.

Session 3b: Thermal storage for process heat

OVERVIEW AND PARTICIPANTS:

This session focused on exploring the role of thermal energy storage (TES) on industrial decarbonization. The presentations included the following topics:

- › Alexander Post (MGA): Technical and economic viability of the thermal block energy storage technology.
- › Paul Matuschka (Mars): Thermal storage in pet food operations.
- › Jenny Selway (Heavy Industry Low-carbon Transition Cooperative Research Centre - HILT CRC): Overview of projects in decarbonization of industrial heat using storage.

In addition to the presenters, the panel discussion included Peter Haenke (ARENA) as the facilitator, Sreeraj Balachandran (Rio Tinto), Byron Ross (Graphite Energy) and Tom Geiser (Rondo Energy).



KEY TAKEAWAYS:

- › TES appears to be the most cost-effective means for securing continuous heat supply from renewable energy sources. MGA Thermal provided a comparative analysis of their levelized cost of heat, revealing that they already can provide better economics than traditional heat sources, especially at scale. Mars Australia shared the cost modelling showing that solar PV and TES can be a viable power-to-heat decarbonisation pathway. HILT-CRC shared the results from ANU research it has supported, which affirmed that TES when paired with renewable generation was cost-competitive.
- › Rapid scale-up of TES research and deployment is required as the maturity of heat decarbonisation is significantly lower than that of electricity generation. Mars outlined that while many organisations can begin decarbonisation via demand reduction through efficiency gains, full heat decarbonisation will likely require TES. MGA Thermal shared the experience of scaling their technology from research stage to commercialisation, and the competitive advantage arising from their materials science expertise. They also reflected on the challenges and risks that accompany the scale-up journey, including lessons gleaned from their recent facility overheat event. Their experience has affirmed the importance of conducting trials in-house rather than at a customer site and highlighted the importance of robust management of change protocols internally.
- › Site integration considerations are challenging but essential. Given that moving heat is prohibitively expensive (in Mars' estimation, the cost to move steam 1 km is over A\$1 million), heat must be generated or stored on-site. HILT-CRC affirmed this is a key consideration for them and focus their funding on application-led TES development such as within the Bayer process to decarbonise alumina production. MGA also noted the importance of tailoring solutions to the end-user's heat needs, which has led them to pursue expanding their already significant heat range (150-650°C) to even higher temperatures.
- › There is need for collaboration and knowledge-sharing within the sector, and for more supportive policy frameworks. In particular, TES solutions could be supported through the introduction of network flexibility providing access to spare real time capacity, electrification tariffs, exemption of demand charges, grant and incentives programs, and support with complex technical modelling and technology considerations.
- › Views differ as to the outlook for TES beyond industrial process heat, indicating that individual company strategies will likely differ.

Further information is available at
arena.gov.au

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