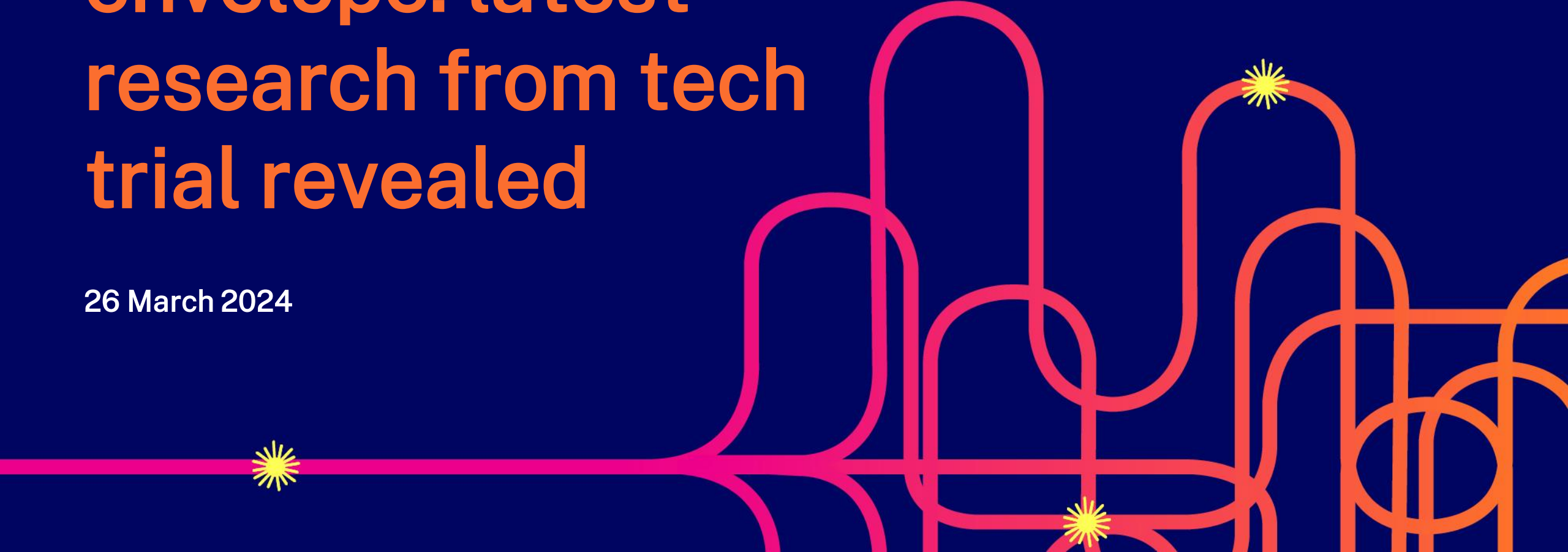


Pushing the envelope: latest research from tech trial revealed

26 March 2024



Agenda

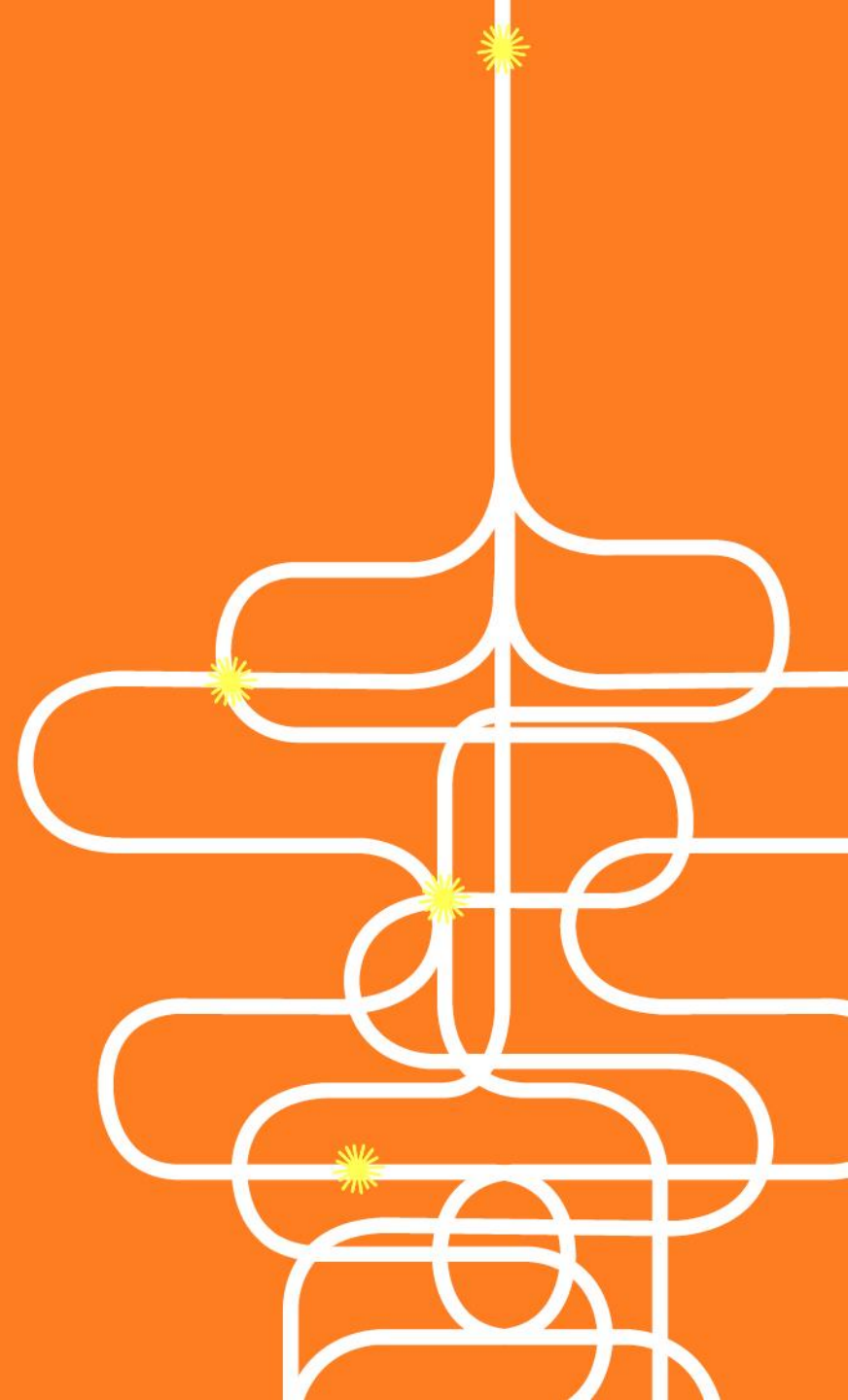
- **Industry perspective** by Salman Stevenson, Evoenergy
- **Project Converge overview**, by Laura Jones, ANU Battery Storage and Grid Integration Program
- **Technical findings**, by Dan Gordon, ANU Battery Storage and Grid Integration Program
- **Social research findings** by Pip Watson, ANU Battery Storage and Grid Integration Program
- **Q&A** moderated by Laura Jones, ANU Battery Storage and Grid Integration Program

CONVERGE



Industry perspective

Salman Stevenson
Evoenergy



Currently the electricity industry is going through an energy revolution. Traditional energy models of generation have been turned on their heads with the advent of CER (Customer Energy Resources).

This means that now we must balance a network with energy flows going in multiple directions.

To accommodate these changes we have several options which include:

- Traditional augmentation of the network i.e. building more poles, transformers and wires.
- More novel augmentation methods like installing OLTC's, STATCOM's.
- Strict measures of implementing static export limits and the ability to disconnect inverters (backstop methodology) when necessary.
- Non-network solutions such as Dynamic Operating Envelopes (DOEs) and Shaped Operating Envelopes (SOEs).



1

Poles, Transformer & Wires



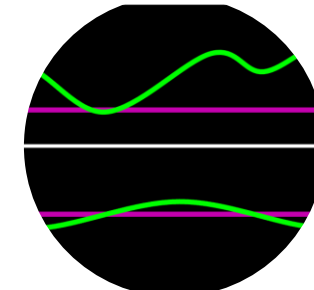
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OLTC, STATCOMS



3

Static export limits, Backstop Measures

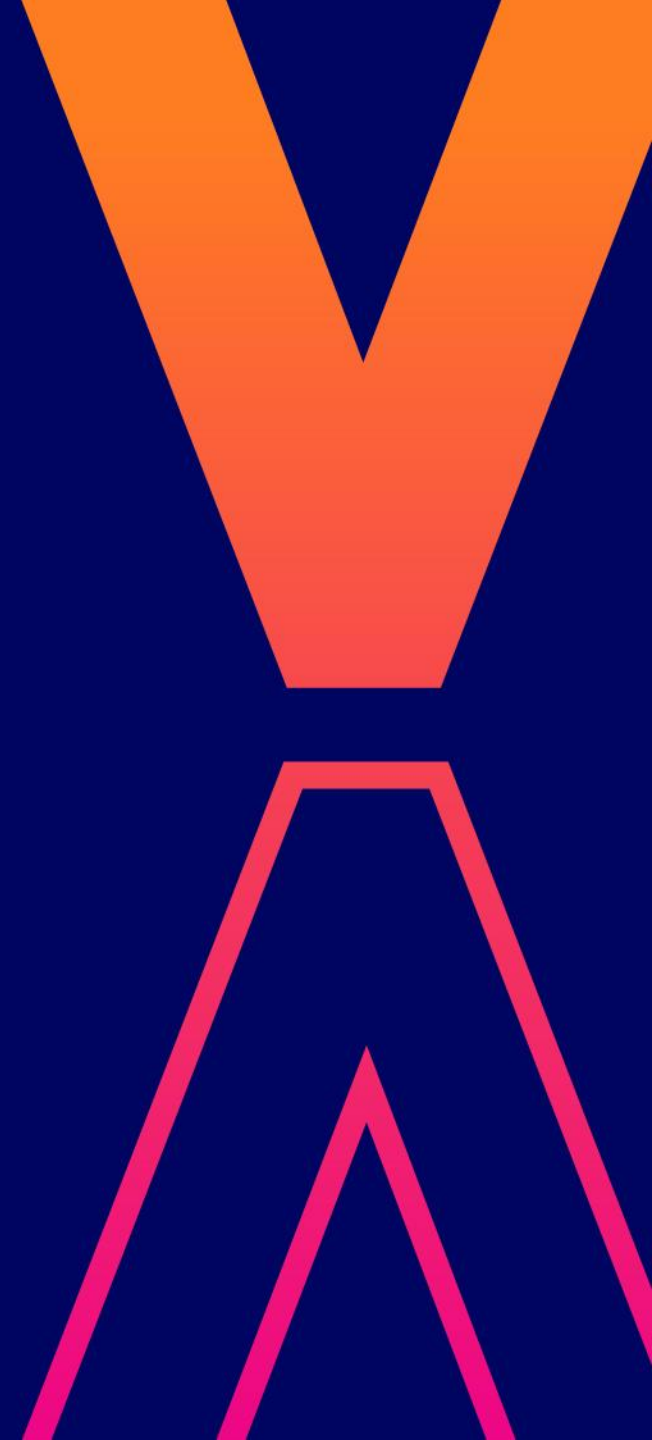


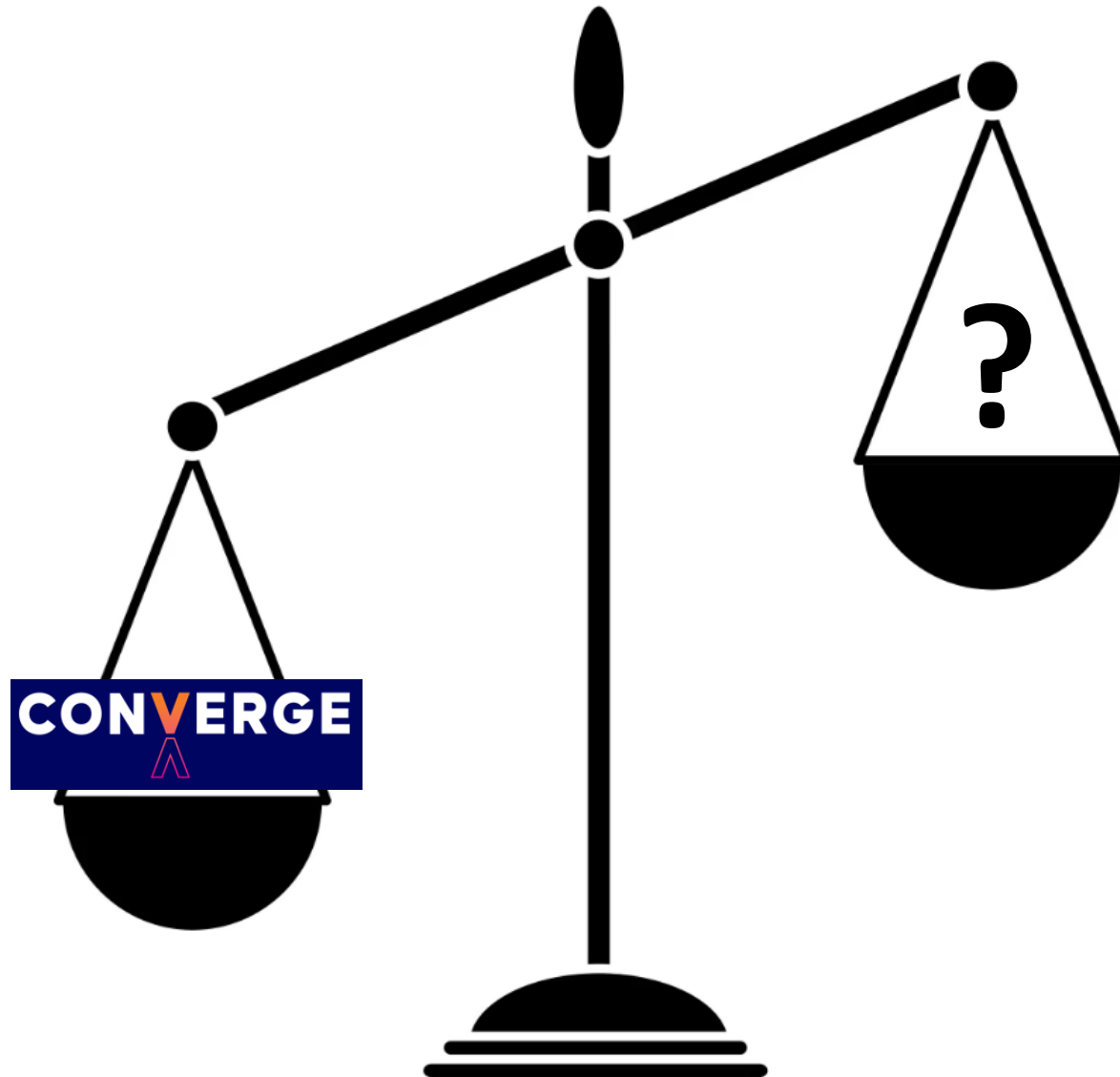
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Non-network Solutions such as Operating Envelopes

Why Converge?

CONVERGE

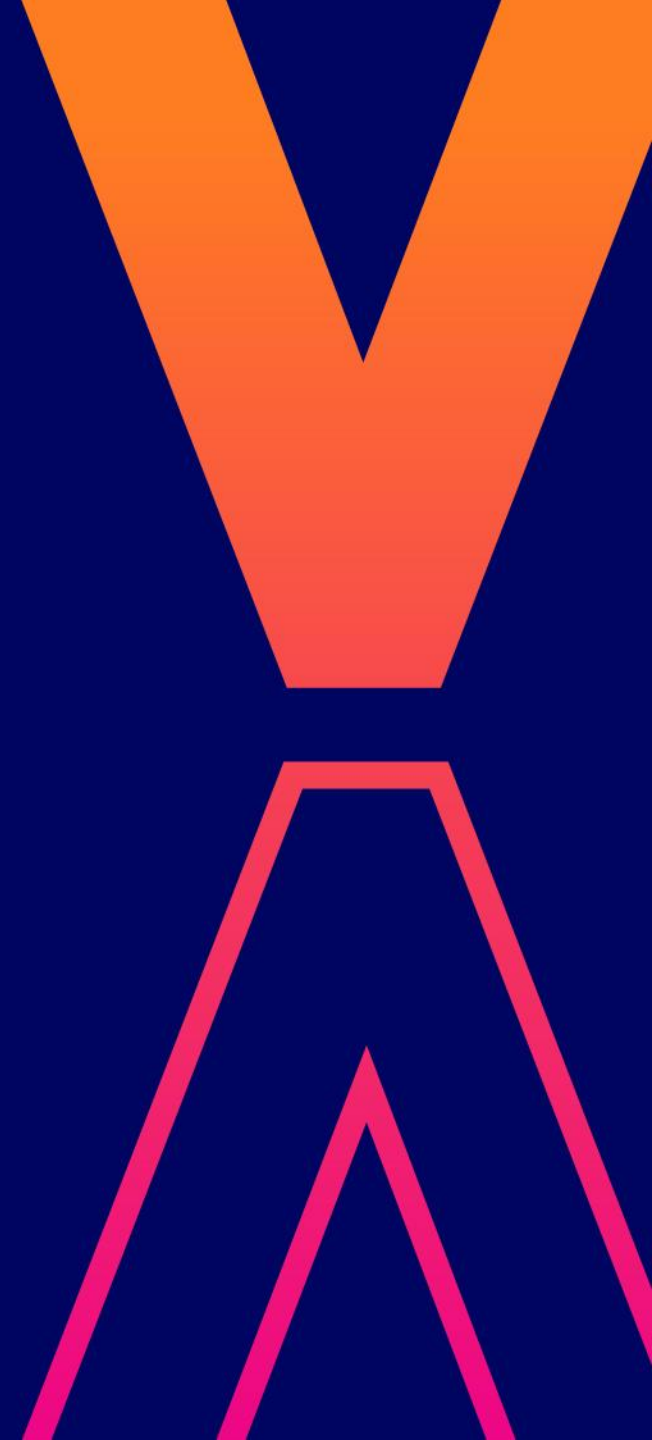


Why Converge?

- Operating Envelopes are the most cost-effective non-network solution.
- We can build upon the successes of the 'Evolve' project.
- Allows for the development of tools and it helps us to learn.

What is
interesting?

CONVERGE

What is interesting?

TOOLS

We have obtained many tools required for building operating envelopes including Utility Servers and Real Time RIT-D tools.



RELATIONSHIPS

We have built further relationships with aggregators, industry partners and customers necessary for making Operating Envelopes happen.



TECHNICAL & SOCIAL LEARNINGS

We have learnt the required technical parameters for SOEs and gained an invaluable understanding of intermediary and customer requirements going forward.

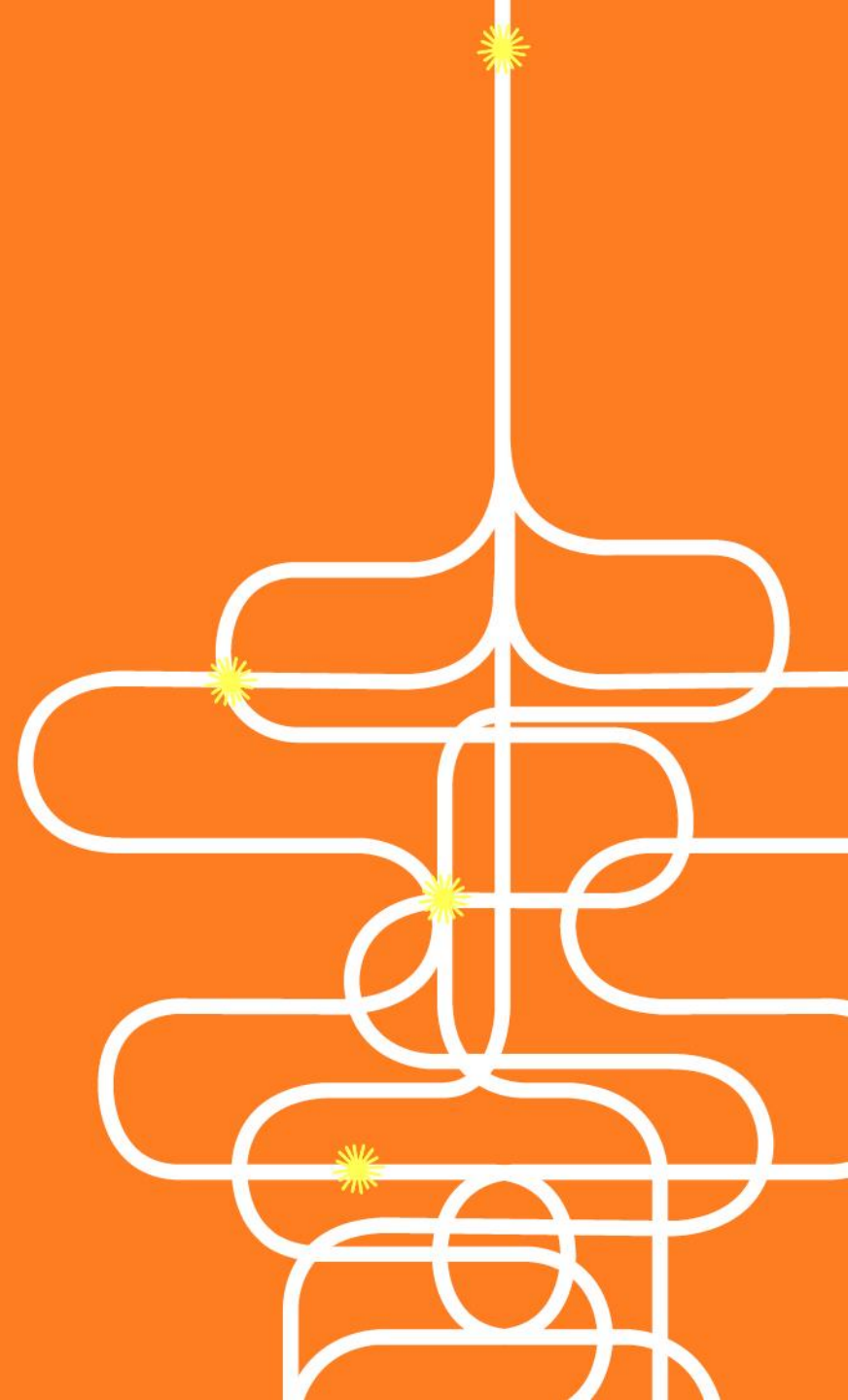


OPERATIONAL LEARNINGS

To make operating envelopes we must build the ecosystem and not just the solution. This includes dramatic improvement in network visibility, education of all stakeholders and recommendations for regulatory reform

Project overview

Laura Jones
Battery Storage and Grid Integration Program
ANU



Converge in a snapshot

- A new approach to integrating Consumer Energy Resources
- 1001 ACT-based consumer batteries involved in the trial
- Research - technical and social by the Australian National University
- Industry participation by Evoenergy and aggregators Reposit and Evergen

Many thanks to our funding body, **ARENA** and our partners, **ACT Government** and ACT-based technology company **Zepben**.

Why Shaped Operating Envelopes?

Optimal DER Scheduling for Frequency Stability

Study Report

Prepared by

University of Tasmania

Evan Franklin, Kazi Alam, Ruhul Amin, Michael Negnevitsky

Australian National University

Paul Scott, José Iria, Dan Gordon, Ahmad Attarha, Sylvie Thiebaut

February 2022

www.utas.edu.au

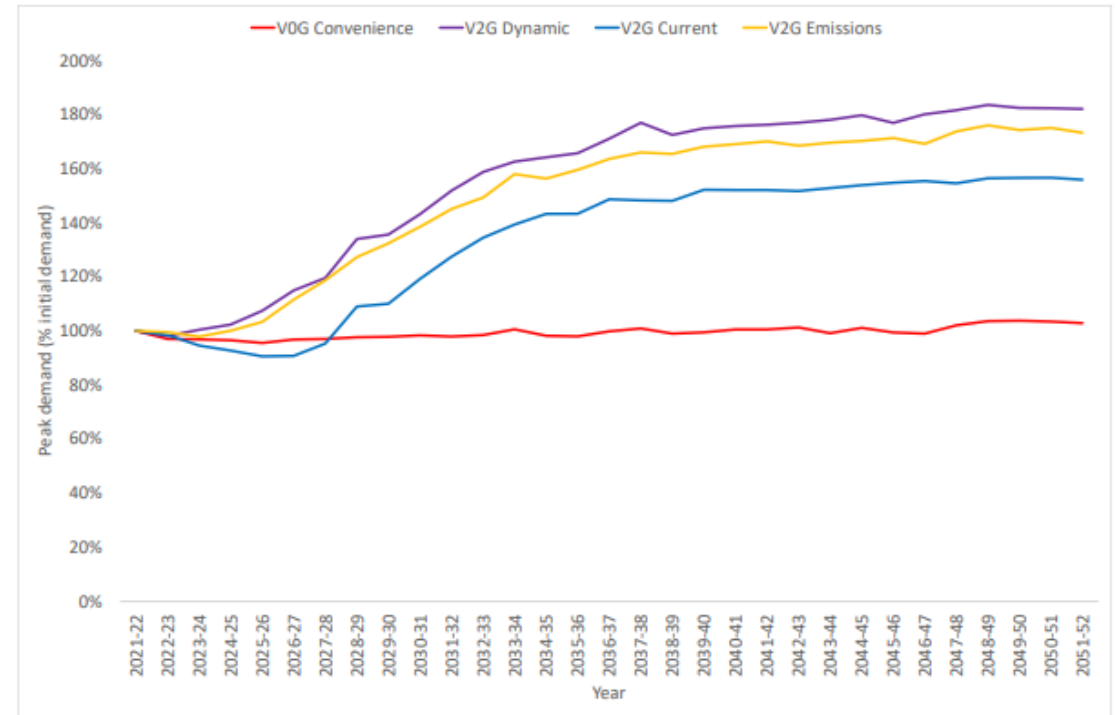
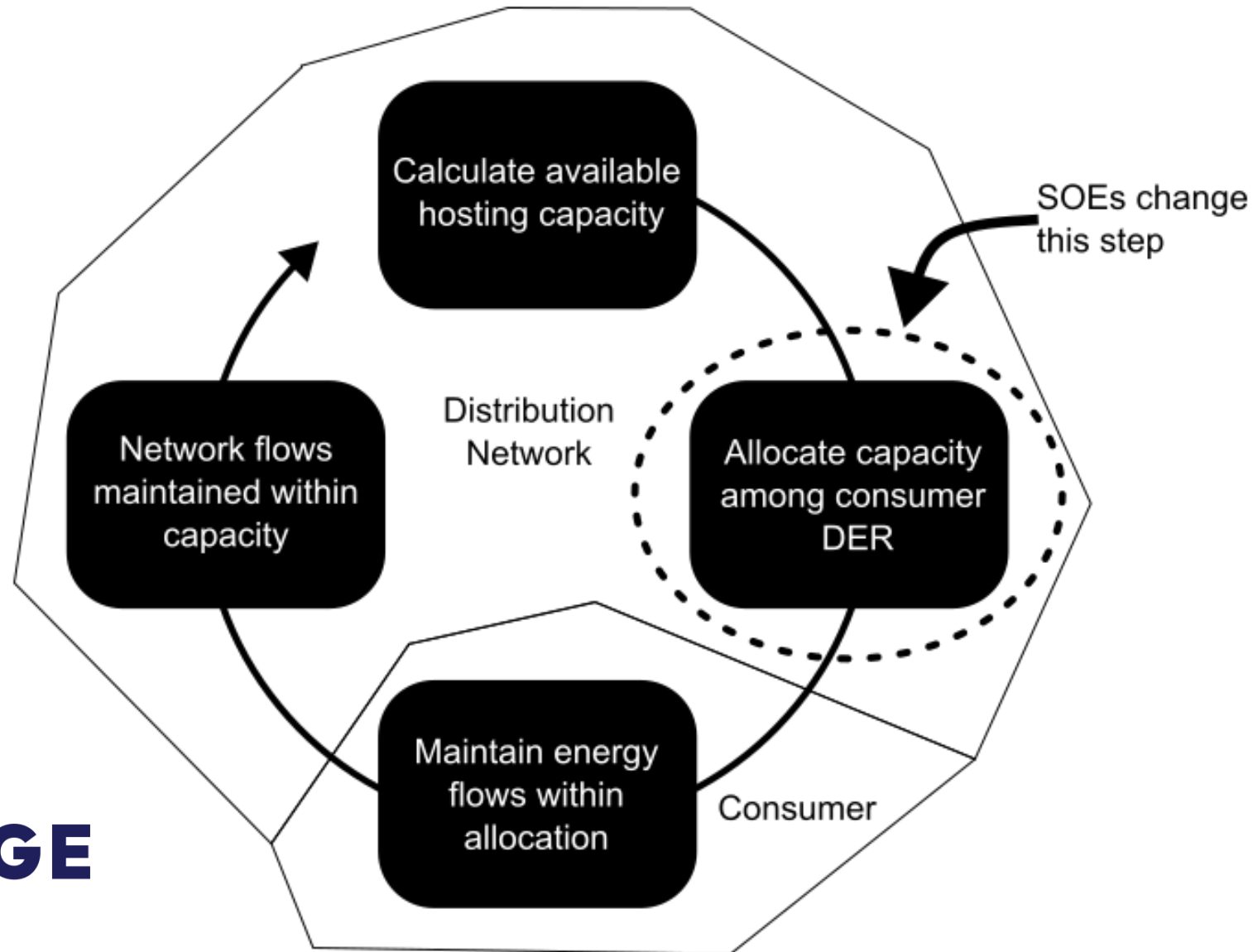


Figure 26 Peak demand forecast: bidirectional charging, office. V2G creates large coincident peaks for offices too, Particularly for emissions optimisation

What are Shaped Operating Envelopes?

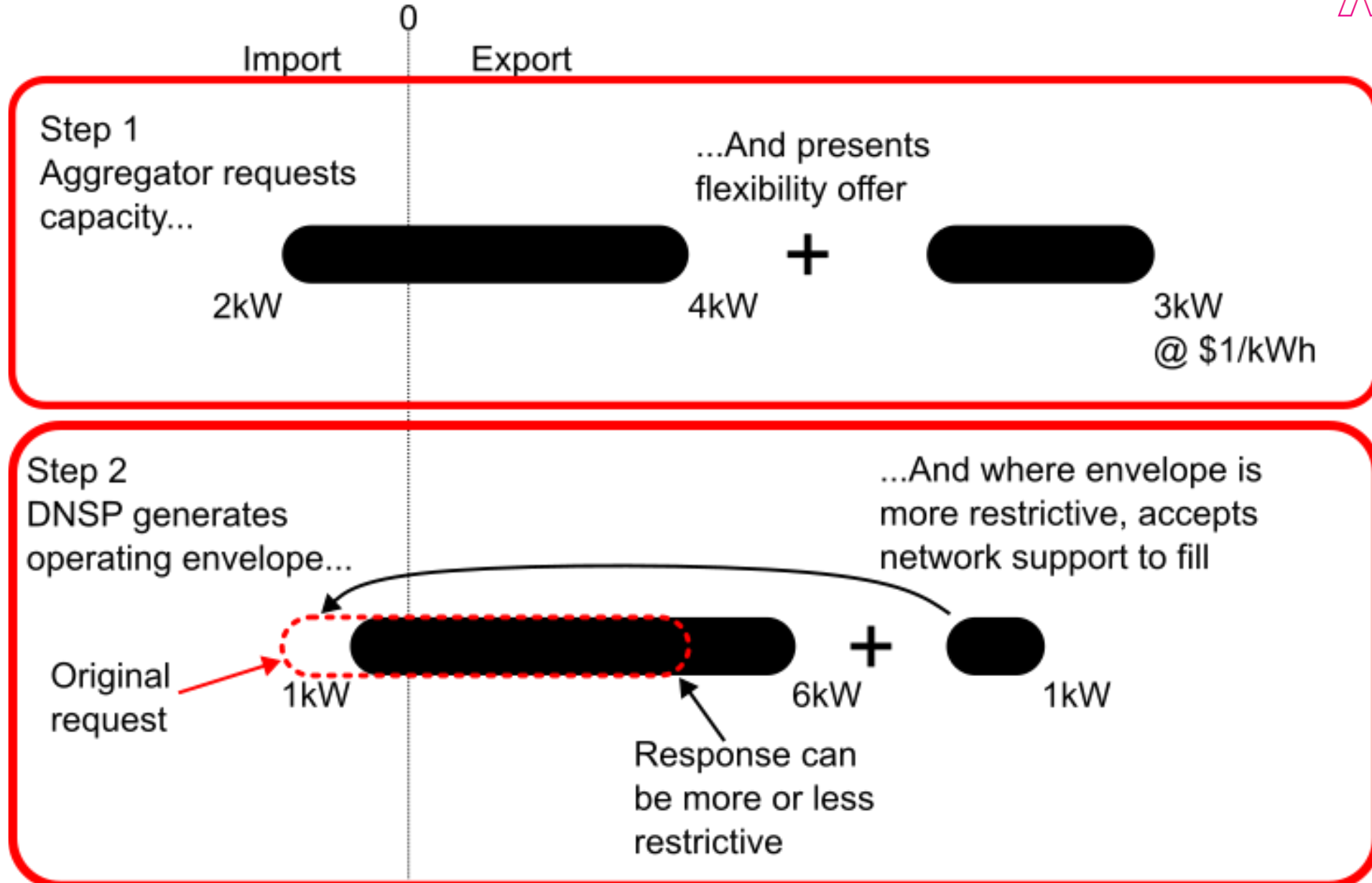


But why?

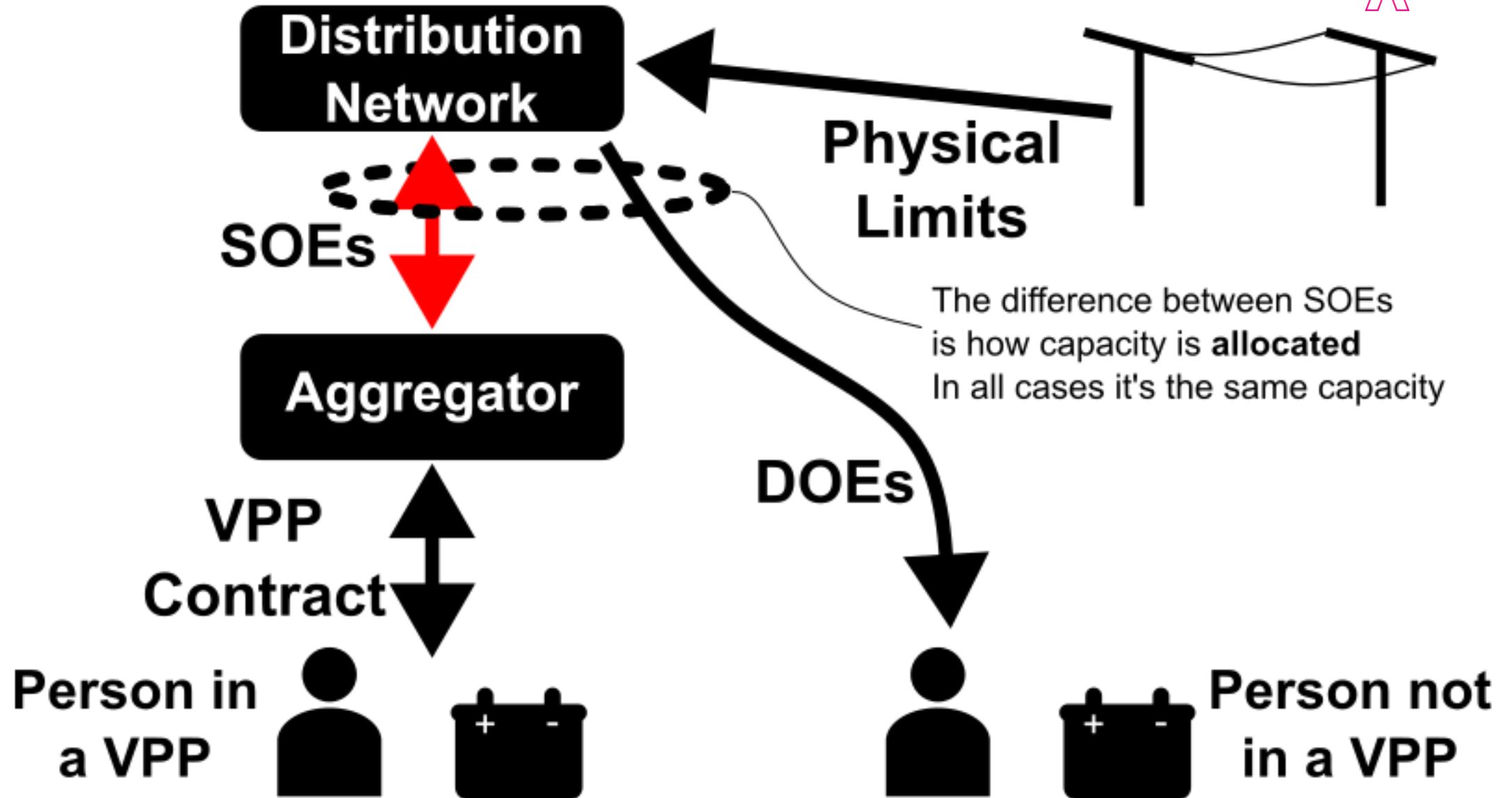


*Maybe... we can allocate capacity better
if we ask aggregators how much they
want first?*

How do they work?



Where do they fit?

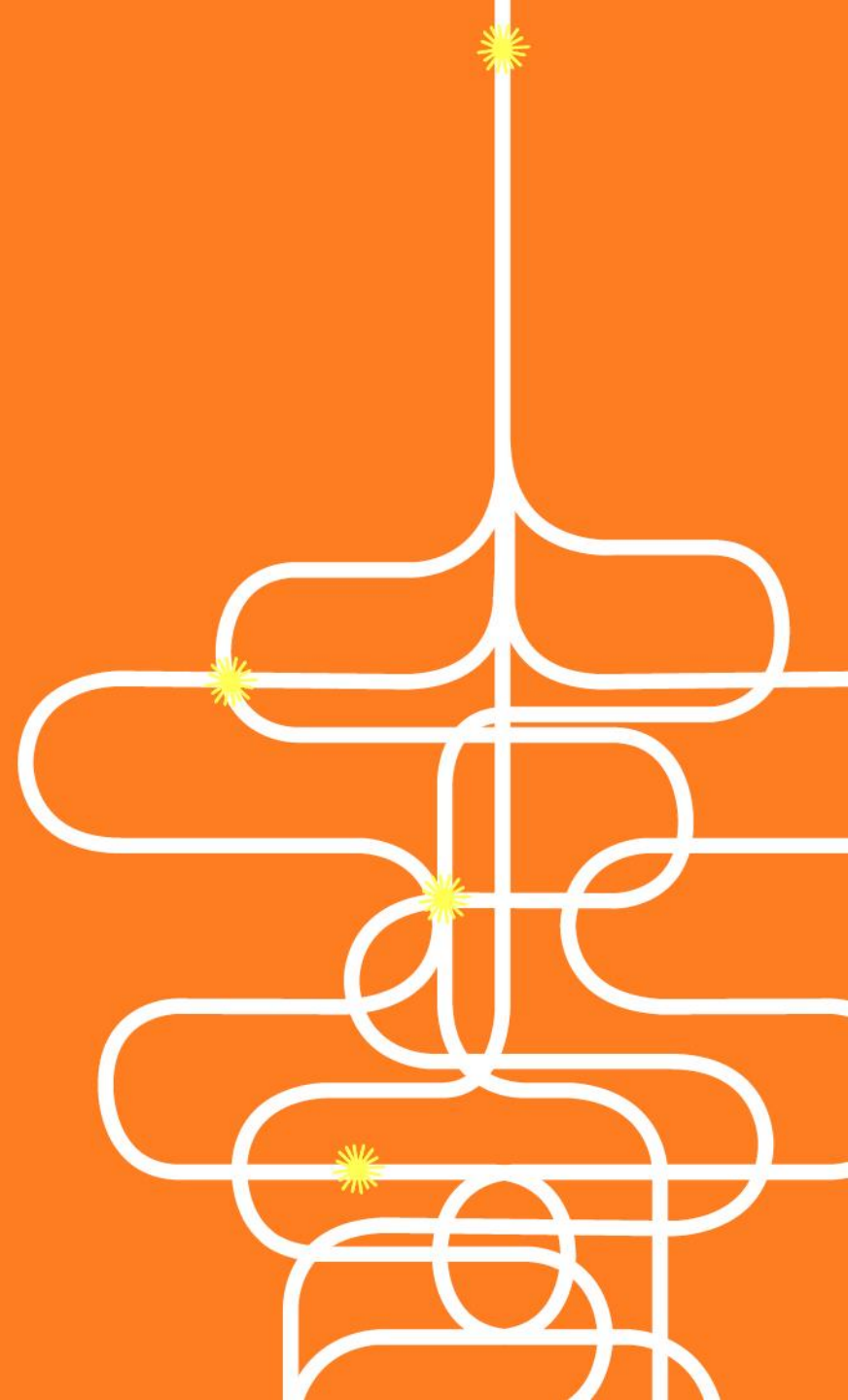


Myth busting, expectations, and assumptions

- Self-consumption
- Expectations on how aggregators bid vs how they actually bid

Technical research

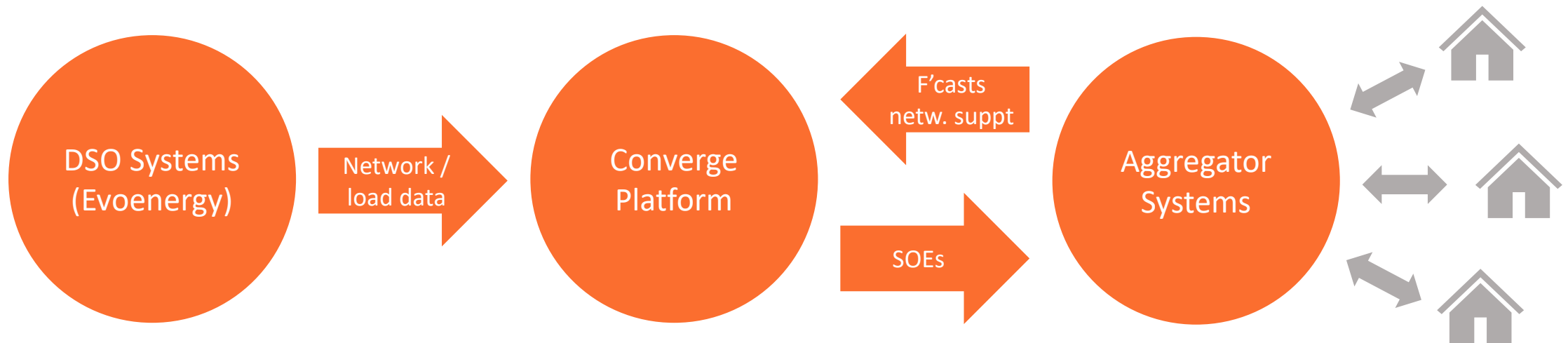
Dan Gordon
Battery Storage and Grid Integration Program
ANU



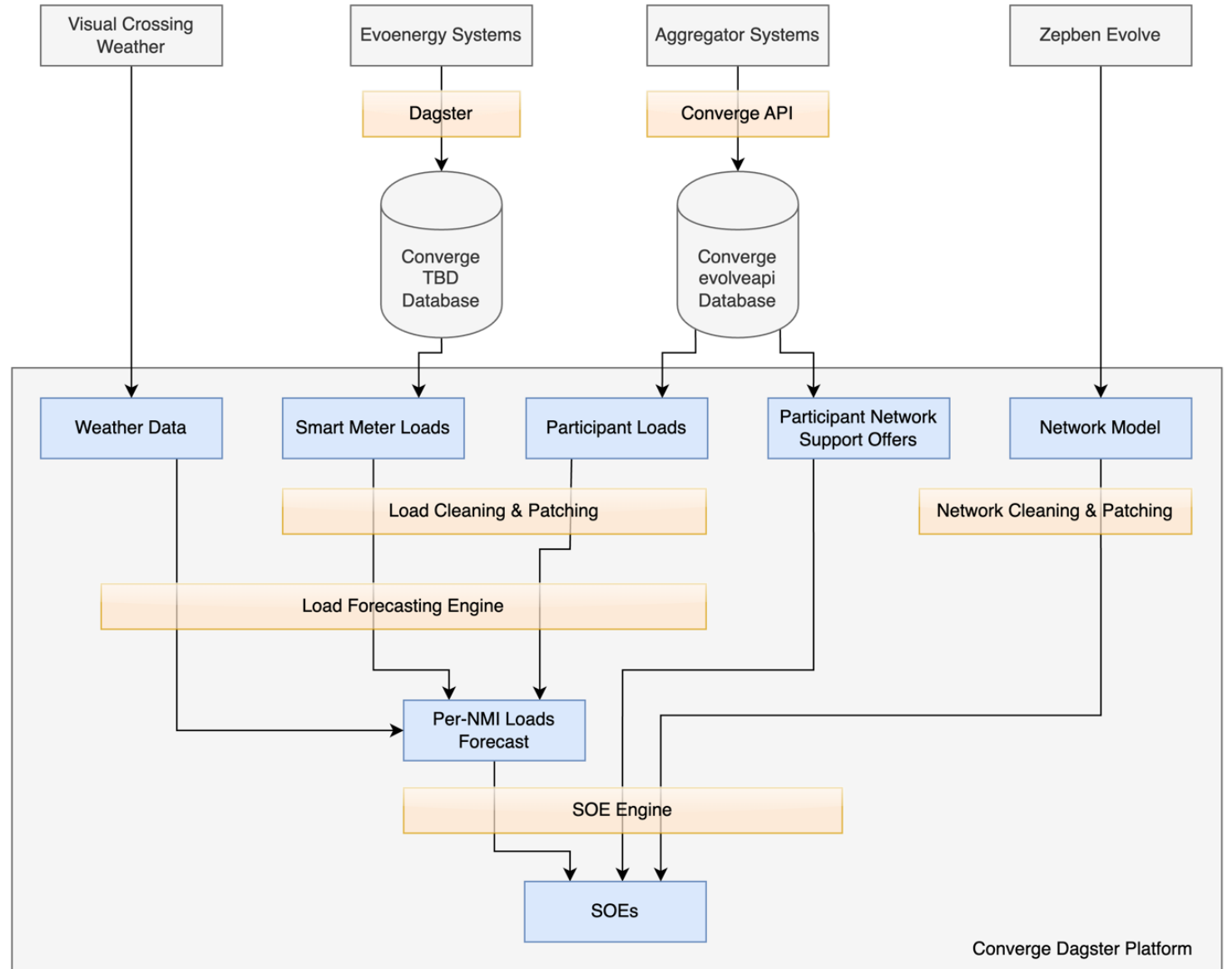
Converge platform



The SOE concept, as implemented in Project Converge, was an automated exchange of data between **aggregators** and an **SOE platform**, with additional information coming from the **distribution system operator (DSO)**



Implementation



DOEs and SOEs

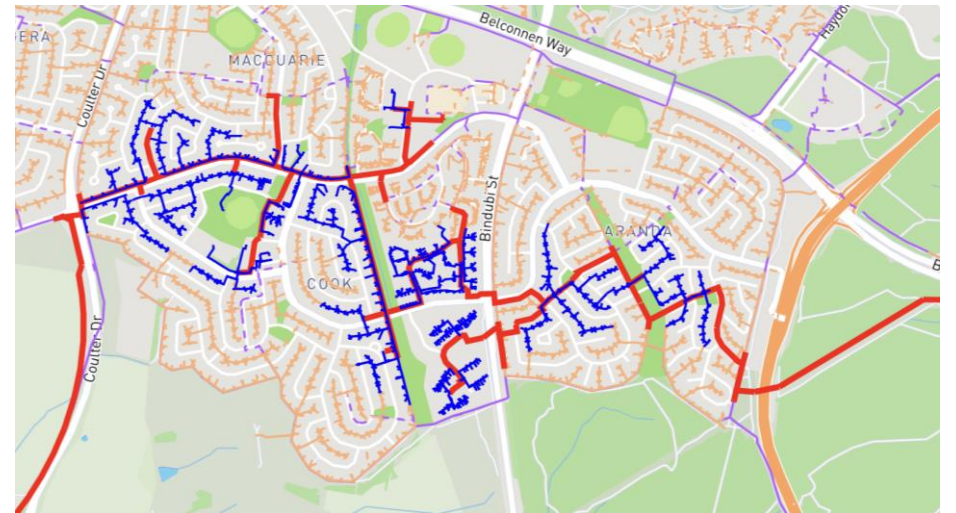
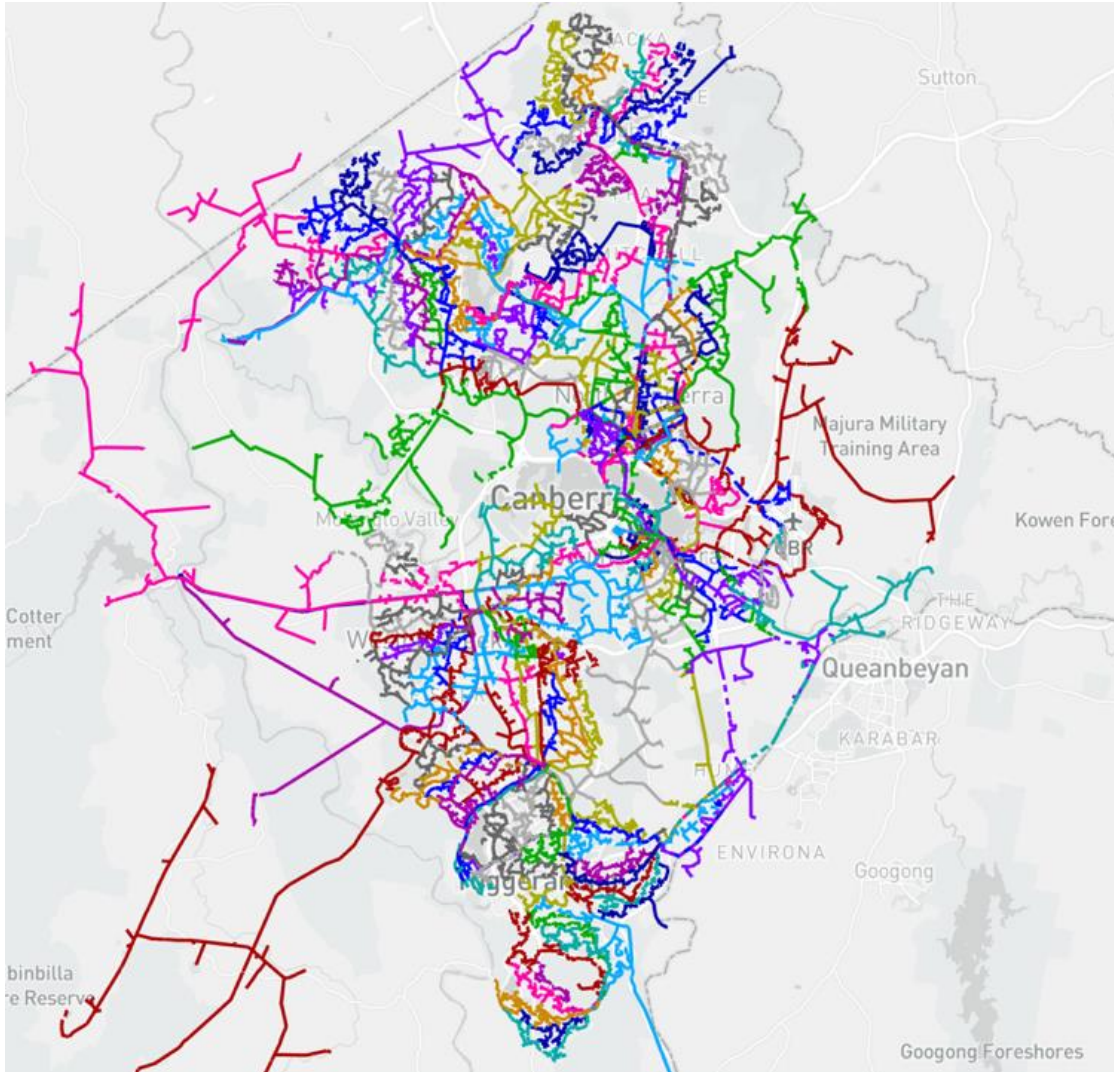


A **Dynamic Operating Envelope (DOE)** is a restriction on the consumption or generation of participants that can vary in time or depending on the local network conditions. DOEs are normally calculated to ensure that network constraints are obeyed.

A ***Shaped Operating Envelope (SOE)*** is a DOE that maximises the *value* (market / personal utility / social) of allowing the participant more flexibility in their consumption or generation.

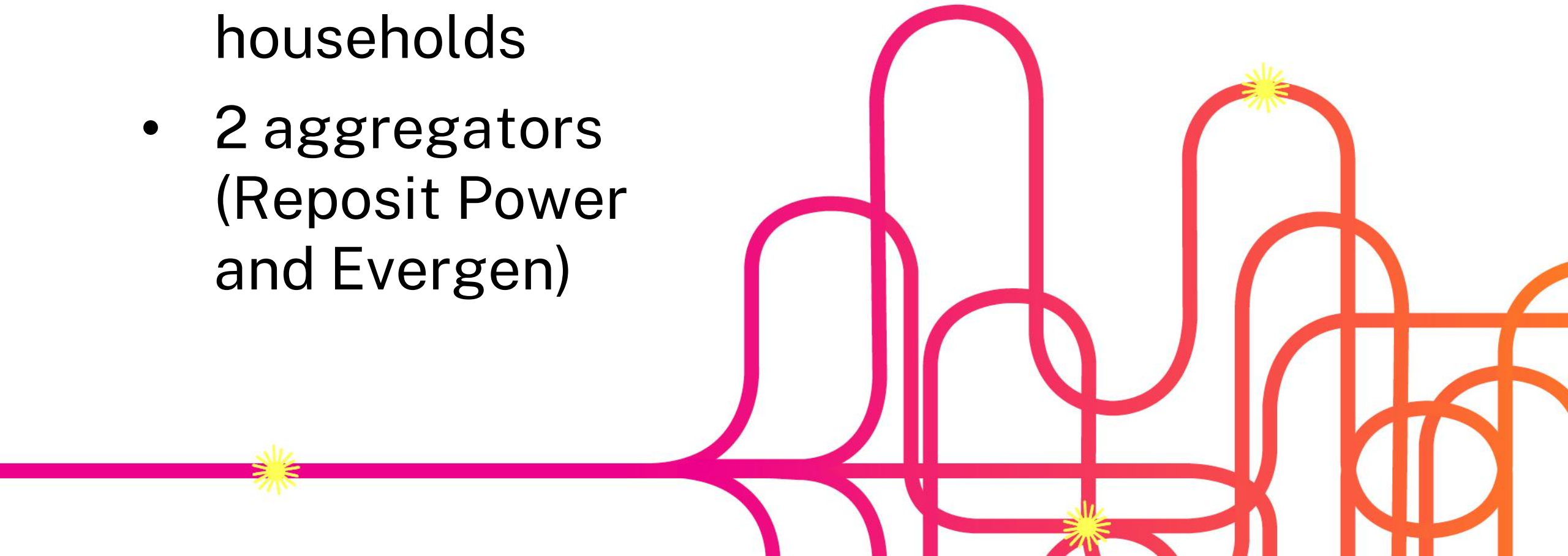
Network Modelling

- 241 MV/LV feeders in Evo's ACT network
- Made available via Zepben's Energy Workbench (EWB) platform



Aggregators and customers

- 1001 participating households
- 2 aggregators (Reposit Power and Evergen)



Testing and trials

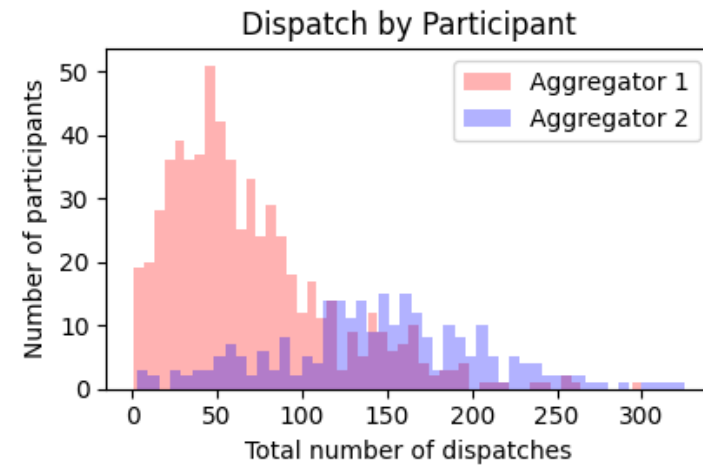
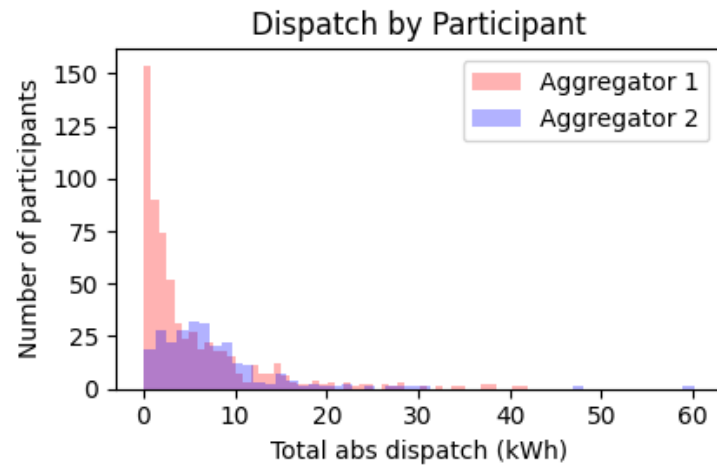
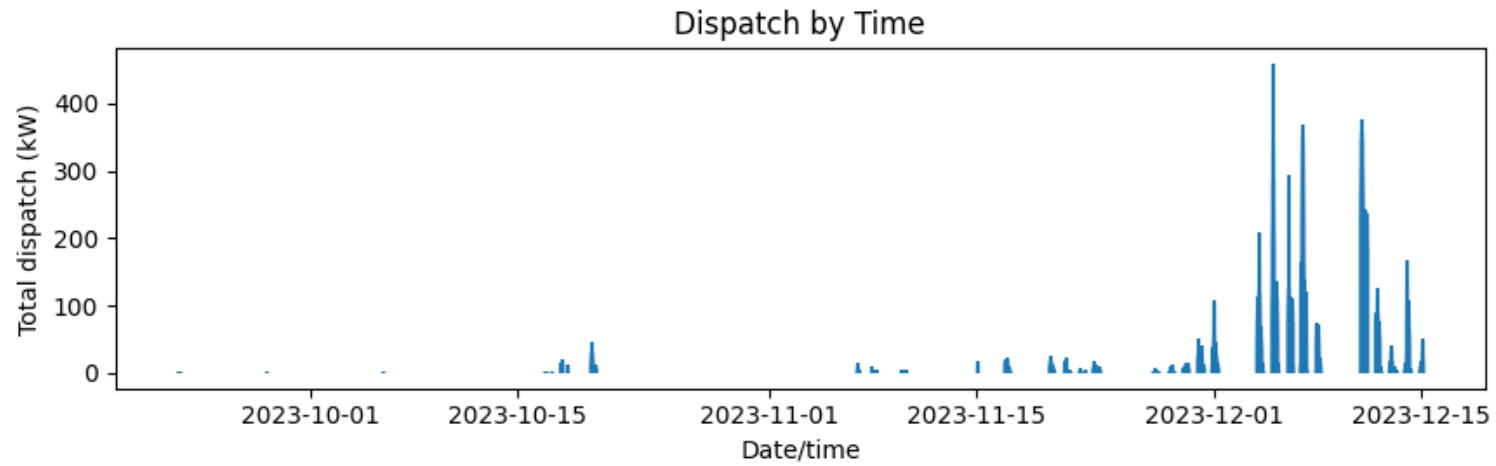


Live testing: October 2023

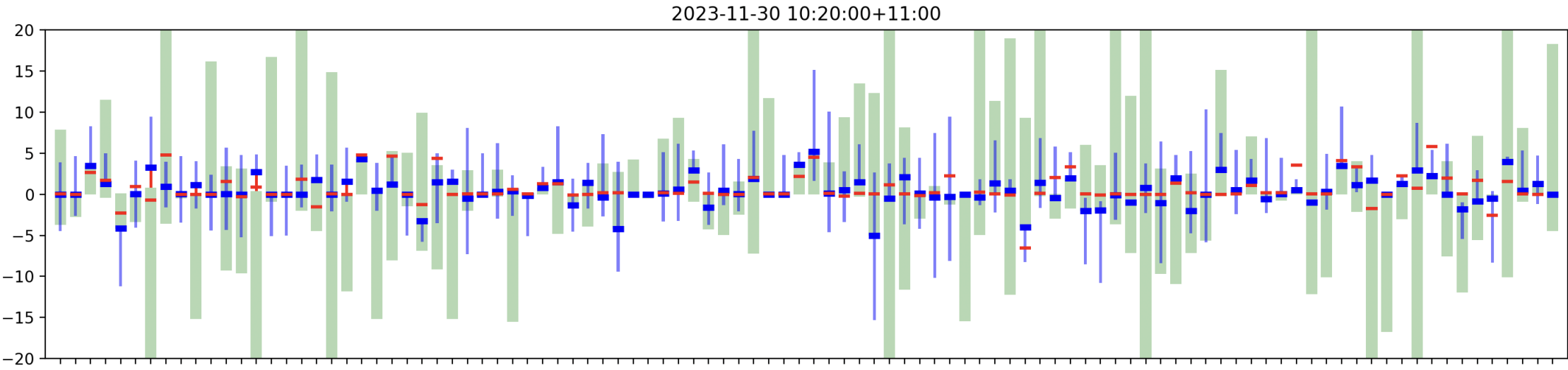
Trials: November and December 2023

5 feeders, each containing between 7 and 23 Converge participants

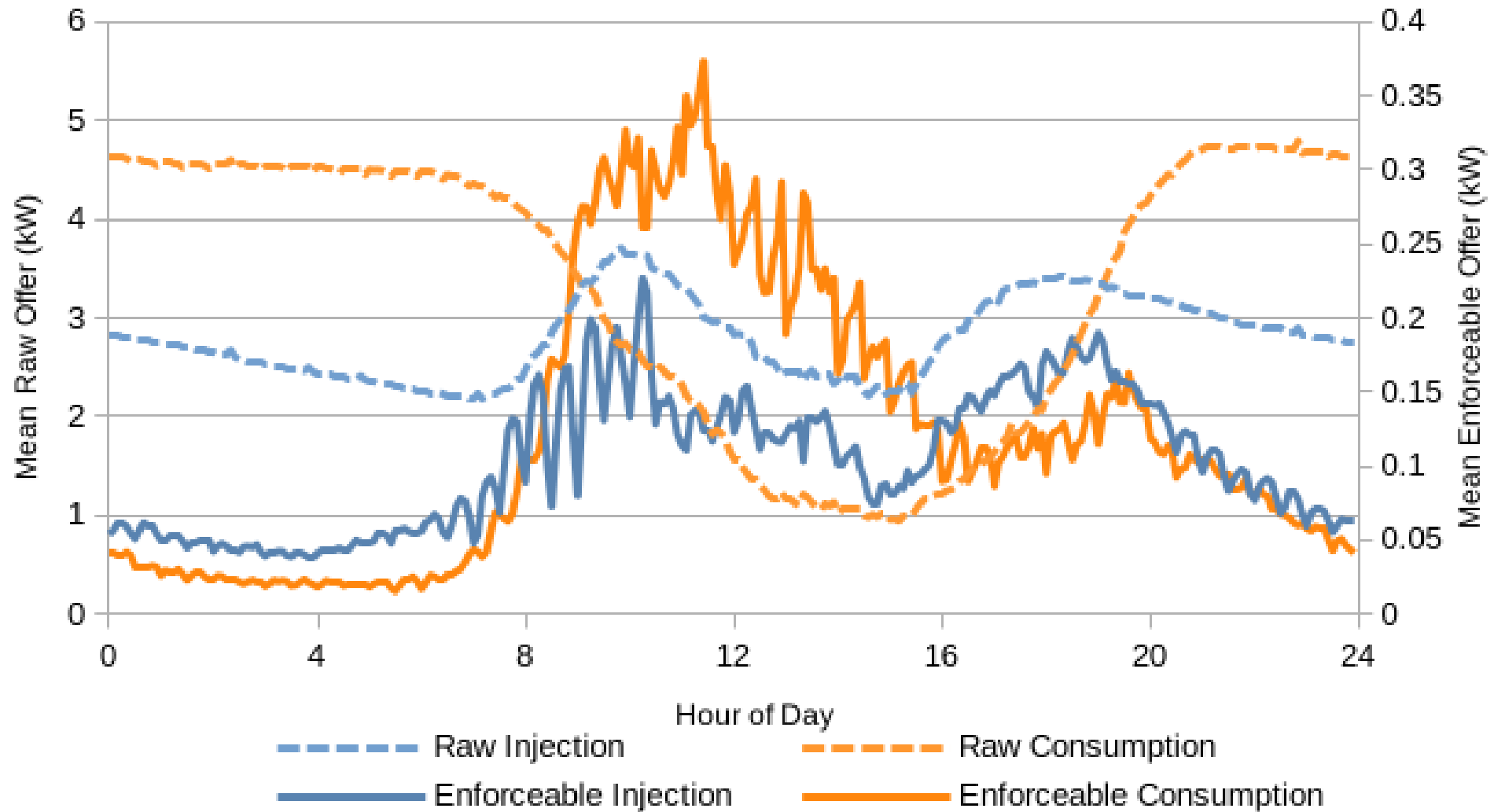
- **Trial 1:** test voltage limits by creating artificially tight limits to induce network support response. 5 feeders simultaneously.
- **Trial 2:** test thermal limits by creating artificially tight limits to induce network support response. 5 feeders simultaneously.
- **Trial 3:** test SOEs with greater DER penetration by artificially mapping *all* participants to single feeders (one feeder at a time).



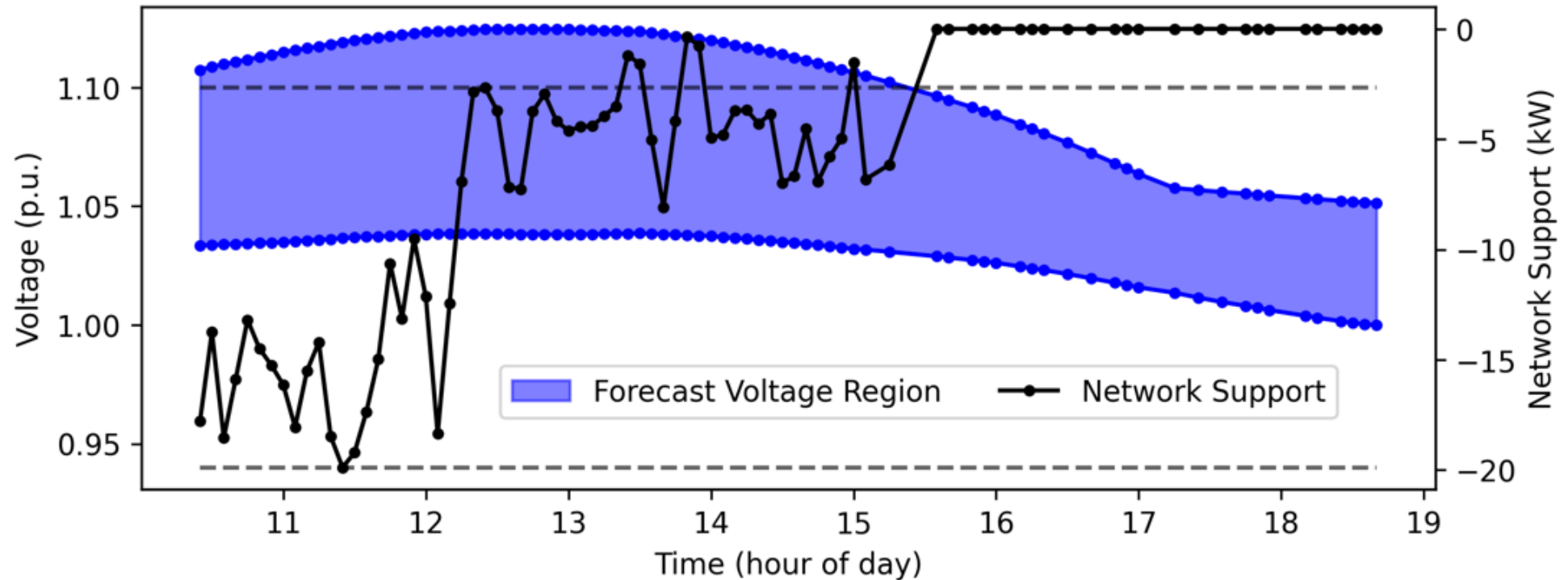
Envelopes: high DER concentration



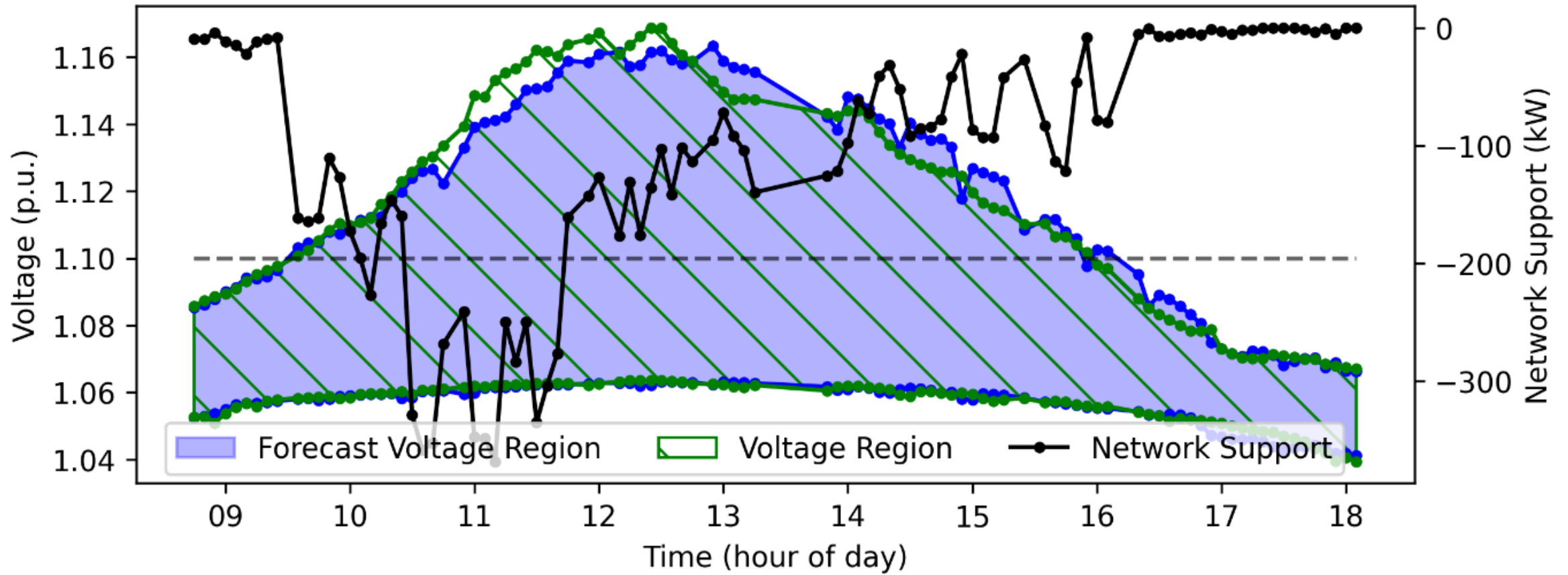
Trial results: network support availability



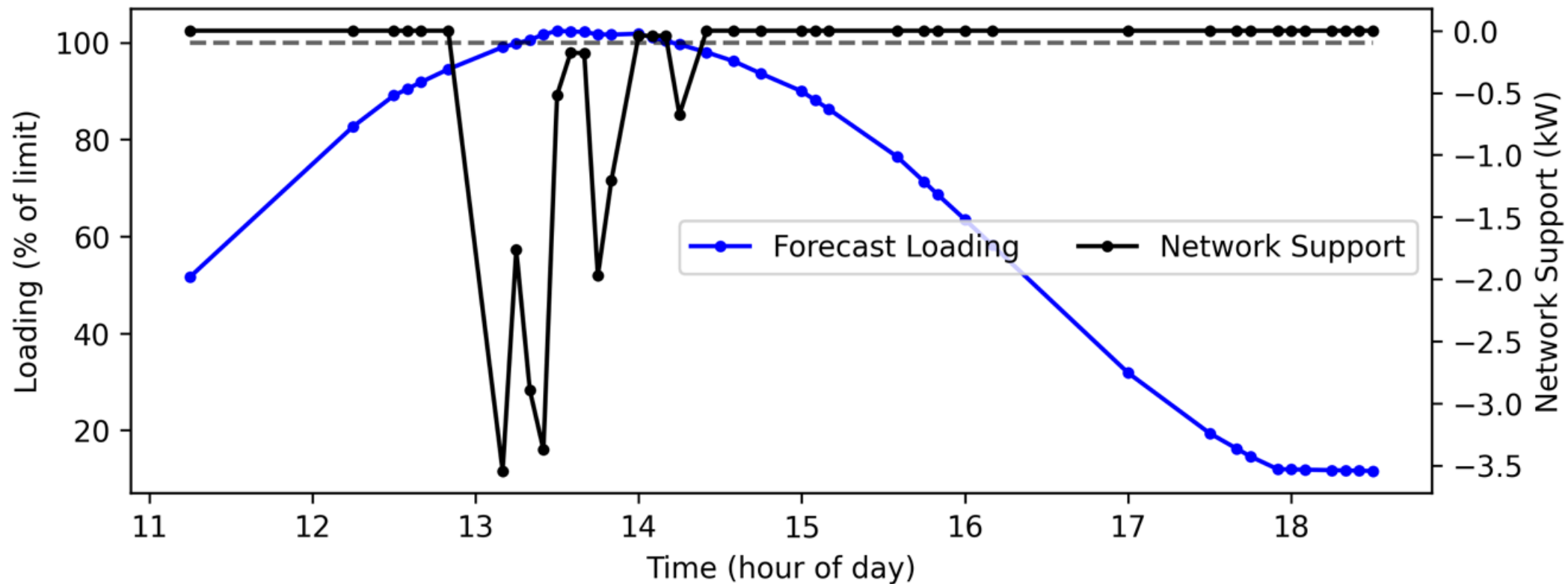
Trials results: response to voltage violations



Trials results: response to voltage violations



Trials results: response to thermal violations



Offline simulations

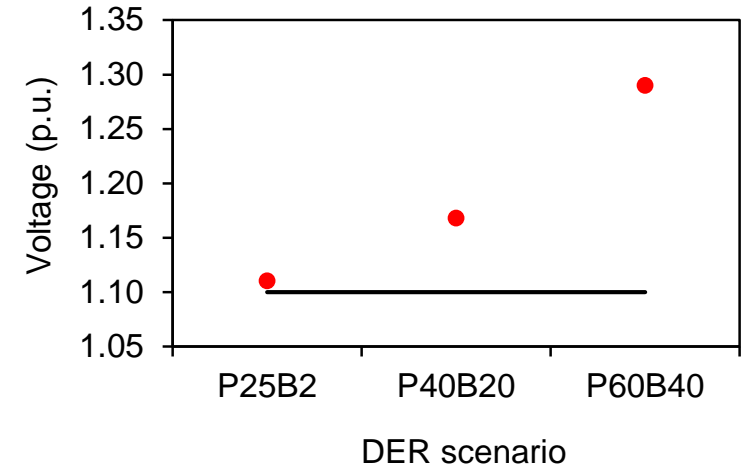
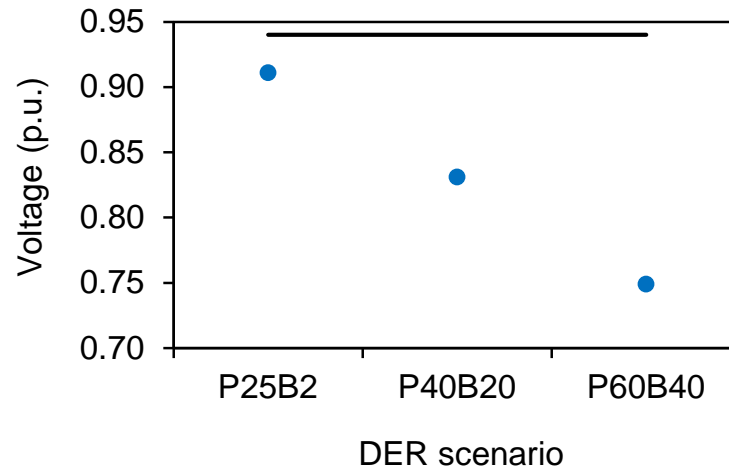
Compare SOEs to

- Fixed Operating Envelopes (FOEs)
- Dynamic Operating Envelopes (DOEs)

Consider various scenarios for PV and battery network penetration:

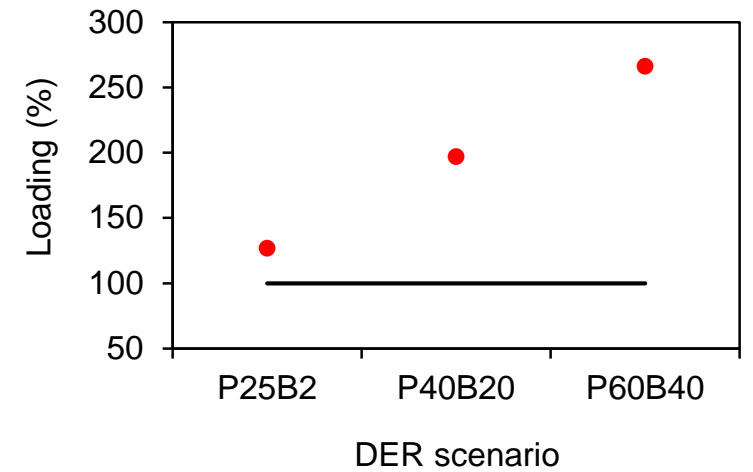
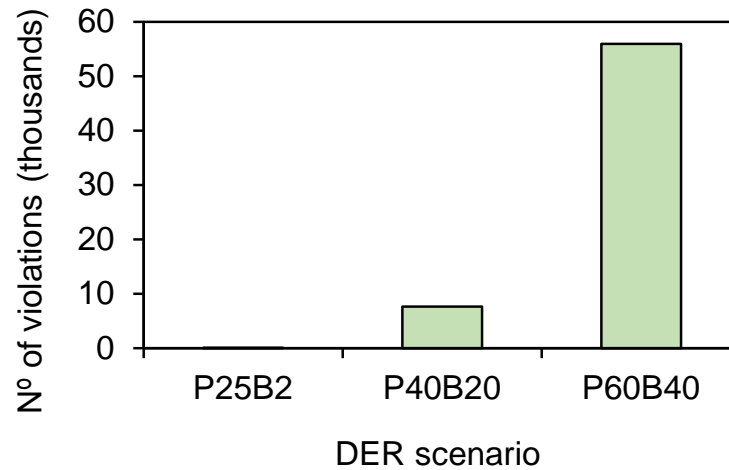
- Current DER: 25% PV / 2% battery
- Medium DER: 40% PV / 20% battery
- High DER: 60% PV / 40% battery

Offline simulations: FOE violations



— Lower limit ● Min voltage

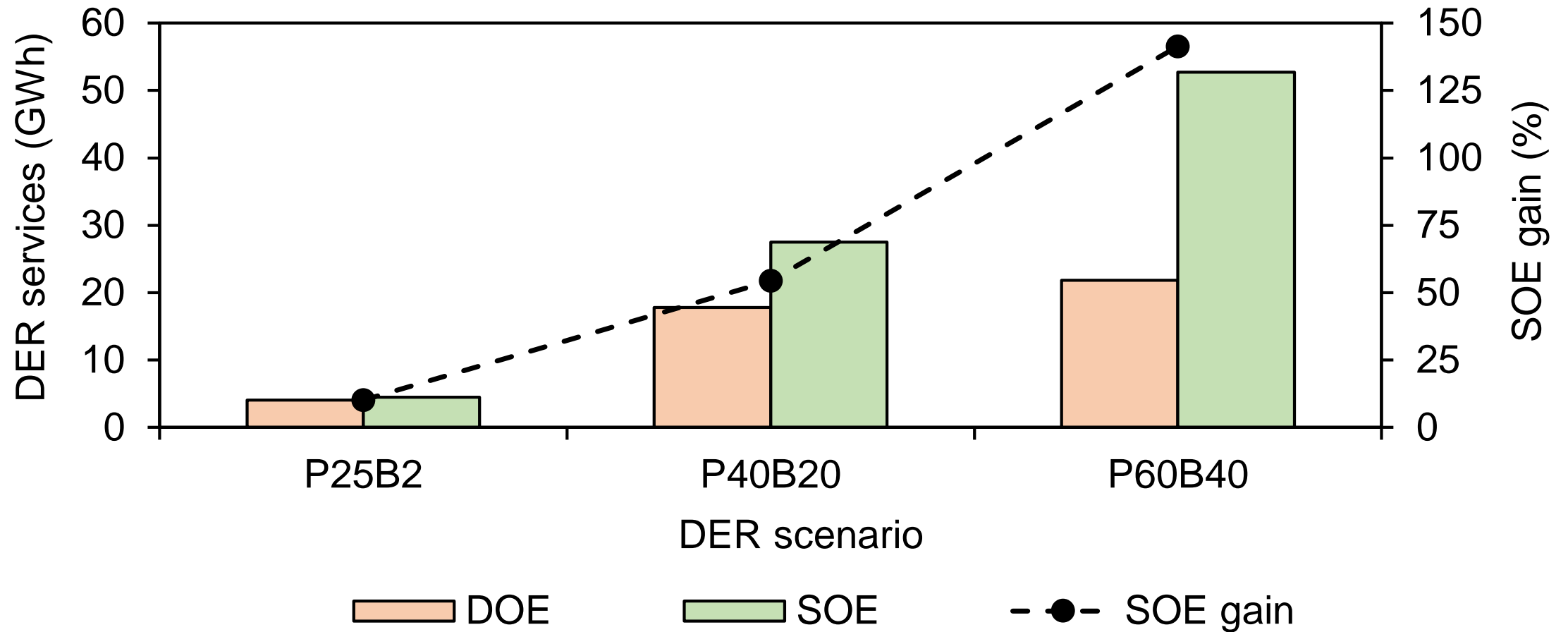
— Upper limit ● Max voltage



■ Transformer overloads

— Limit ● Max overload

SOEs vs DOEs: unlocked DER capacity

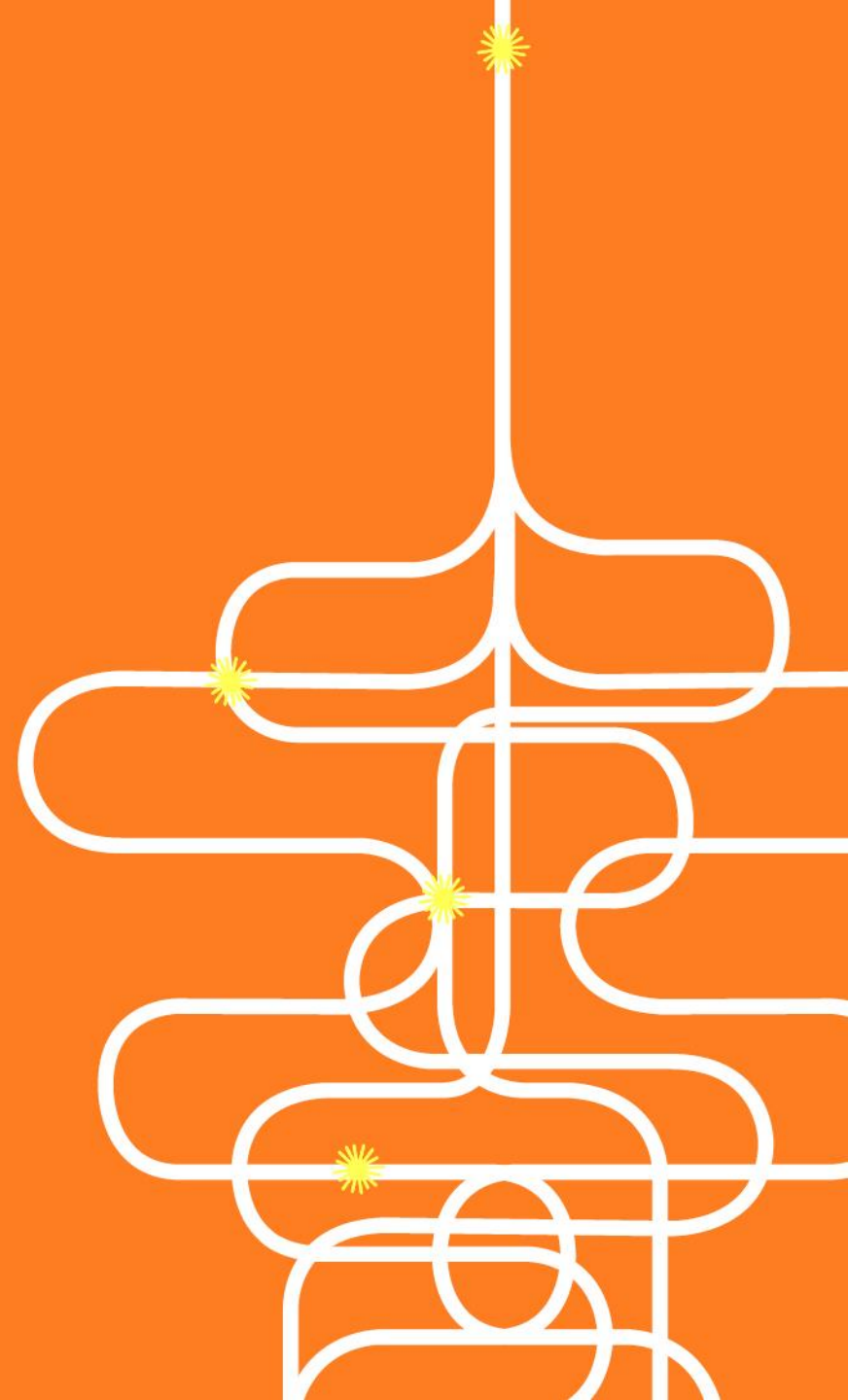


Social research

Pip Watson

Battery Storage and Grid Integration Program

ANU



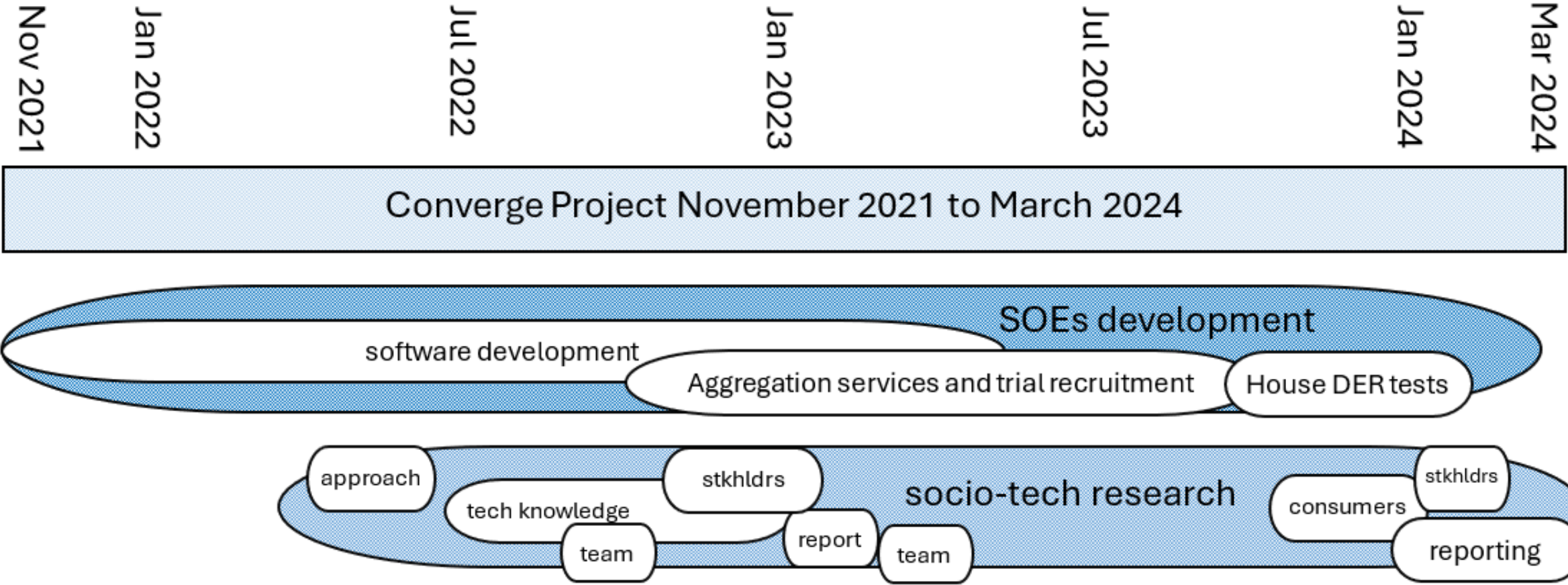
Underlying propositions for approach



- All technologies require people to apply/engage with them.
- This is a trial of an emerging technology, currently being developed in a protected 'niche'.
- Stakeholders of the energy system – intermediaries – move tech from niche to scaled (and to business as usual).
- Including energy consumers - those who experience the tech, and those who do not - is key.
- We used iterative (stepped), emergent process and built understanding in layers, capturing different perspectives and over time.

Socio-technical; Strategic Niche Management; Intermediaries

Stepped social research approach



Participants



Group	Participant description	Participation
Converge design/development team members	Researchers and innovators in our inter-organisational team (energy industry)	Team meetings regular and 2 focus groups, 12 for each focus group.
Intermediaries – professional stakeholders	Key stakeholders - energy system expertise, work with operating envelopes, energy innovation, energy consumers and related. Diversity of backgrounds and organisations.	Interviews - 20 people, 17 organisations, 18 interviews, late 2022. Workshop -14 people (mostly previously interviewee) after household consults Feb 2024.
Battery-owning householders - some taking part in Converge trial	Longer term battery-owning householders in Australian Capital Territory (ACT), customers of aggregators (involved in trial). Some involved with Converge trial, others not.	Interviews online -10 interviews, 12 people. Some took part in trial. Some chose not to. A \$50 grocery voucher thank you.
Diverse household energy users	A mix of people from around ACT. Not involved with the tests/trials. Mix of have DER and do not have DER.	Workshops – 3 held, with 25 participants overall. A \$50 grocery voucher thank you.

Findings - social research

On responses to SOEs, participation with SOE trials, on roles and responsibilities and systems needs, conditions with which people would engage the DER with grid integrated systems.

A selection for today:

What did stakeholders and householders think?

Complexity and communications

Values and drivers

Intermediary roles

SOE features - feature of a product, a product or products?

Scaling and implementation and what is next?

What did stakeholders + householders think?

People generally positive about SOE intentions and features. Householders with aggregators didn't really notice the trials much. With caveats and cautions. Including they wanted more understanding.

Positioning SOEs in the broader energy system. SOES are part of a suite of solutions alongside DOEs (not competing as achieving a different end). SOE features overlapped with some other solutions and some similar factors included in some DOE calculations.

Complexity and communications

SOEs are complex and developing, so descriptions develop too. Finding ways to communicate is needed.

The importance of trust – the right level of detail in communications build trust. Complexity makes this a task. Industry and consumers are on a maturity journey.

Industry actors need to collaborate and cooperate & decide who should communicate with consumers so it's not confusing.

*'My gut feel is that we have made **this market so complex and so complicated** and the costs of regulation and the costs of all the intermediaries between the producers of energy and the consumers of energy, we've got now so many different layers in between, **getting to a point where you will never be able to explain this to consumers adequately so that they can make appropriate financial decisions for themselves.**' (26.11.23 workshop)*

Values and drivers

Top 4 emphasis-wise: social equity; environmental stewardship; self-consumption; affordability.

No solar wastage; let's share in our local area; energy efficiency. Happy to generate income with excess via aggregation services. Who should benefit? The energy system as a collective good.

Value exchange. More than price and incentives, but these are part of decisions.

*"This is what society's about, **making sure that you do help out**, so electricity demand should be no different from making sure people don't starve or sleep on the street. If you can help out you should be able to help out."*
(Householder interview, 24/11/23)

Intermediary roles

Aggregators are primary intermediaries. Who decides on allocation? Aggregators may decide - as SOEs runs through them and alongside their own algorithms. Do SOEs become hidden? Or proprietary? Or is it standard process everywhere?

Important roles for many - industry experts, installers, battery companies, consumer advocates, regulators and more. Need further skill development on grid integration and operating envelope real time technologies.

Underlying is real pressure on networks, who are drivers of DOE and SOE innovation.

SOE - features, a product or products?

SOEs as a concept and a product have value that overlaps with processes elsewhere. SOEs nest with DOEs and potentially other solution paths for electricity capacity management and DER grid integration. There are multiple features of SOEs - understanding features helps understand what SOEs offer whom and scaling possibilities.

Perhaps if just in standard products it is completely hidden? Or the features are able to be applied in different ways? Do they work differently with smaller and larger products? Older or newer systems? How do they interact with different network infrastructure?

What is next? Scaling?

More questions: Understanding value of various SOE features and how they nest with other solutions? What will SOEs look like as a product? Will SOEs become one decision in a string of aggregation decisions? Will householders even notice them? What are the impacts on equity? Who is responsible for deciding allocation? Do aggregators want the responsibility? How to align self- consumption and market priorities? How will the complexity be communicated effectively?

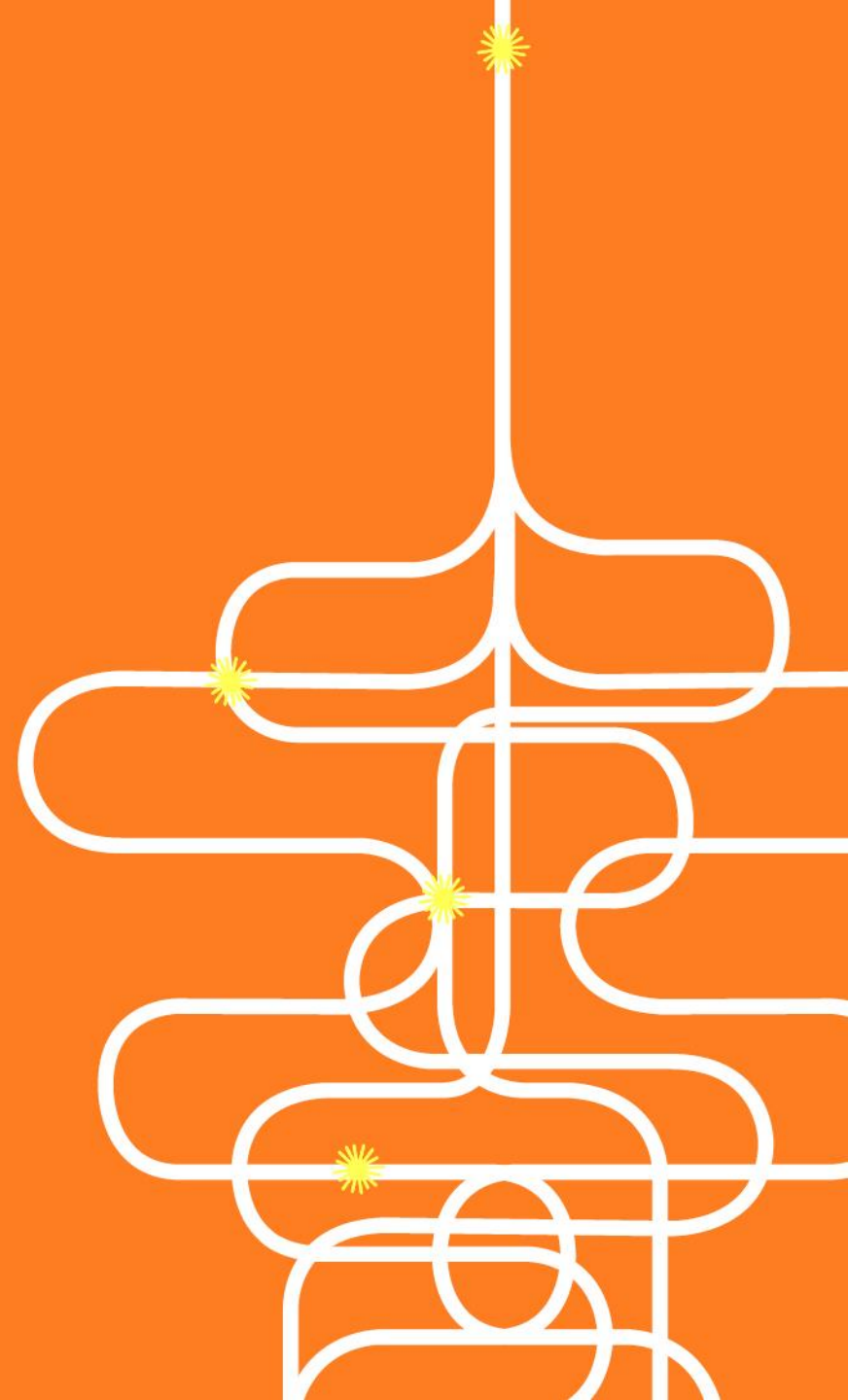
People spoke about their principles confidently – they know what they would like in grid integration technologies. How do we design with these principles moving forward?

Conclusions

Laura Jones

Battery Storage and Grid Integration Program

ANU



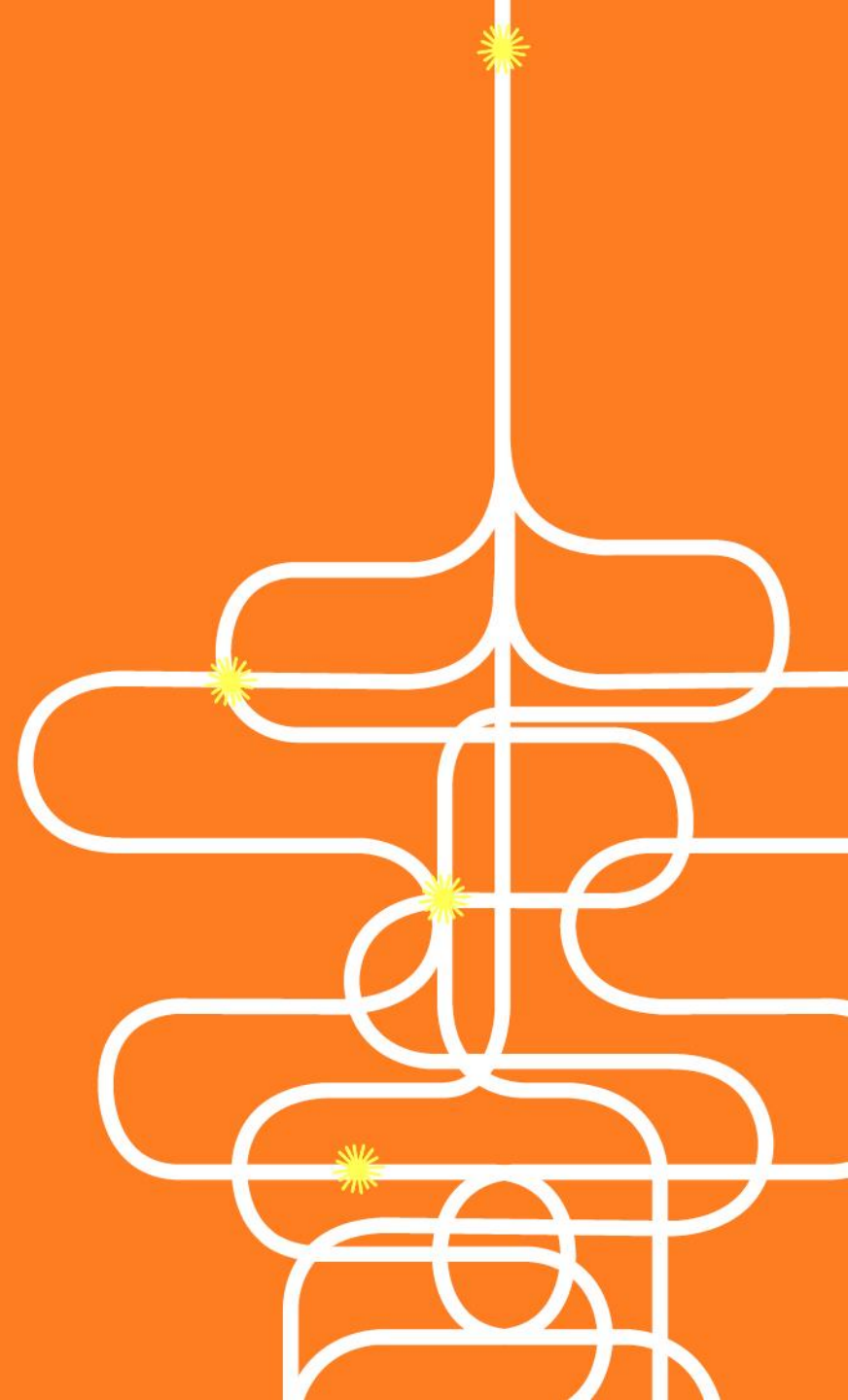
Conclusions and next steps



- Future conditions where SOEs might be used, ie as part of a Virtual Power Plant.
- Evoenergy will be using the learnings and tools gained from Project Converge in the next iteration of Operating Envelopes with full implementation in the next revenue reset period.
- Greater network visibility is crucial. Evoenergy has justification now to go to the Regulator to ask for more funds for network visibility.
- Interrogating the features and identify and firm the value of the product opportunity - how it overlap with others.
- Social equity – progress understanding of impacts.
- Importance of the role of intermediaries – regulatory reform?
- Final reports coming soon to ARENA website. Existing reports can be found here: bsgip.com/research/converge

Q&A

Moderated by Laura Jones
Battery Storage and Grid Integration Program
ANU



Thank you.

