

Social science report 1: intermediary insights on dynamic and shaped operating envelopes

Interim project insights

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CON**V****ERGE**


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Executive summary

This report provides an initial opportunity to outline insights shared by stakeholders (or intermediaries) working in the area of distributed energy resources (DER), in relation to the emerging application of dynamic operating envelopes (DOEs), and possible opportunities for 'shaped' operating envelopes (SOEs) in Australia. Social research is being conducted as part of Project Converge as SOEs are being developed, to progress understanding of social aspects of DOEs in their early days of application and SOEs as a concept for future application. There is currently little social research undertaken on DOE or SOE solutions. From a wealth of insights shared by intermediaries through interviews and a Converge team meeting, this first report relates intermediary opinions of DOEs and SOEs and implications about intermediary roles related to operating envelopes as they scale. After first providing some background explanation about DOEs and SOEs, this initial report finds that:

- DOEs are generally well supported as an approach and are anticipated to be increasingly rolled out around Australia. Caveats were shared about DOE application, including a warning that simpler approaches should be used where appropriate first.
- Multiple trials and application of flexible exports in South Australia are currently gradually generating insights into DOEs.
- SOEs are relatively unknown but intermediaries see there is a need to think through solutions in the space that SOEs are in. The intent of SOEs to co-optimize to better utilise available capacity where needed (on top of DOEs) and also to consider the position and involvement of more actors (not just network needs alone) was seen as positive. The SOE solution itself needs to be better detailed for intermediaries before they can make an accurate assessment of the solution's worth from their positions in the energy system.
- DOEs and SOEs require specialised understanding and the intermediaries working in this space are currently a relatively small group of people. The roles, knowledge and skills needed in Australia as DOEs (and perhaps later SOEs) are applied and scaled are greatly varied. All intermediaries involved will need to have specialist understanding of DOEs. Targeted support looks necessary to support the growth of DOE specialised intermediaries at scale, so that DOEs can then be scaled.
- While intermediaries involved with DOEs understand their decisions greatly impact consumers and householders who are involved, there is some speculation that the technical DOE and SOE solutions may not be noticed that much by consumers at all. The next stage of this research will explore how much householders notice and their experience and impacts from DOEs.

Overall, the insights shared so far in this report from intermediary interviews and Converge team discussions indicate DOEs and their scaled application are likely to be well supported. Intermediaries indicated that while they needed more information to assess SOEs, they recognised SOEs are seeking to solve problems that need attention. Other projects are also exploring aspects of the problem space that the SOE solution focuses on. Further intermediary insights, such as views on customer needs, equity and fairness and critical needs for scaling of DOE are available in the insights from interviews and will be reported in future publications.

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Introduction

This report provides an initial opportunity to outline insights shared by stakeholders (otherwise called intermediaries) about emerging dynamic operating envelopes (DOEs), and possible opportunities for ‘shaped’ operating envelopes (SOEs) in Australia. The contributing intermediaries are people who work in, observe, plan, design and engineer distributed energy resources (DER)/customer energy resources (CER) and related systems in Australia. This is the first social research report of two for the Converge Project and focuses on intermediary opinions about DOEs and SOEs, and intermediary roles needed to progress DOEs.

Dynamic operating envelopes (DOEs), which are time-sensitive upper and lower bounds for energy flows on a network (or areas of a network), are emerging and being applied as a response to challenges of peak electricity demand and peak solar exports on electricity networks. DOEs are a relatively popular emerging approach (or solution) and have gained significant attention in Australia. Multiple networks (in multiple states) are currently developing elements of the DOE solution to help their networks. Shaped operating envelope solutions are a further layer of response to current energy supply challenges that are anticipated to work in concert with DOEs to further utilise network capacity and to account for other actors, such as aggregators and customers, in operating envelope calculations. SOEs are currently in research and development. (Further background on these concepts can be found in the body of the report.)

Social research is being conducted as part of Project Converge alongside the development of SOEs in order to develop insight into various social aspects of both emerging DOE application and SOEs as a solution for future application. Focusing on the social implications of DER-system approaches, in this instance dynamic and shaped operating envelopes, is useful because it provides understanding of the opinions, critical social influences and the necessary social systems features that will be needed to realise effective and equitable DOEs, and potentially SOEs, at scale in Australia. This report and the social research being conducted, sits with only a small number of other current publications and investigations that looks from a social lens at DOEs (for example ARENA 2020, DEIP 2022, Newton et al 2022). This report is therefore contributing to a relatively early conversation about social aspects of operating envelope solutions in Australia. By providing insights through this report, we intend to contribute in a small way to a living conversation that is underway and evolving, with the end goal of supporting smart and fair next steps in the operating envelopes journey in Australia.

This report focuses on insights collated from stakeholders, hereafter called intermediaries, about DOEs and SOEs and their place in the current and near future DER electricity transitions occurring around Australia. The term intermediaries is used because it indicates people who have a function or purpose in a given system, and in this instance also indicates they are acting in relation to an innovation in the process of becoming more mainstream (following use of the term in innovation literature, for example Kivimaa et al 2018). Twenty intermediaries who work with DER and DOEs in Australia contributed to insights through 18 interviews and team Converge intermediaries contributed insights through team discussions. Interviews were conducted over the last quarter of 2022 and Converge team insights were shared at group discussions over the last half of 2022 and into early 2023. The intermediaries’ interviewed provide important perspectives, covering roles across various organisations and with insight

into organisational, governance, system, technical and social (including customer) aspects of DER and operating envelope transitions for Australia. Altogether the insights collated so far provide accounts from expert tactic experience gained from working with DER, DOEs and their application in context; and provides us with helpful indicators about what to consider as DER, DOEs and SOEs are progressed.

Insights shared by interviewees were extensive with significant depth and technical detail provided and only a proportion of what they shared is reported here. Further insights from these interviews will be shared in the final report (and via other knowledge sharing pathways), alongside insights gathered from consumers via further research to be undertaken later in 2023.

This report proceeds by:

- First providing background, including explanations of context and key terms;
- Then describing the methods used for this stage of intermediary research; and,
- Finally provides and explores a selection of insights intermediaries shared.

The selection of insights shared in this report focuses on opinions intermediaries hold about DOEs and SOEs and intermediary roles and related support needed in a DER-with-DOE energy future.

Background: intentions, DOE and SOEs, and why intermediaries

This section provides background to the report by stating the social research intention, describing the challenge that project Converge is responding to, outlining dynamic operating envelopes, proving a work-in-progress explanation of shaped operating envelopes, and explaining the value of engaging with intermediaries that are involved in the DER-with-DOEs energy transition.

Defining DOEs and SOEs and why they are being developed is important here in order to contextualise the insights shared later in the report. Neither DOEs or SOEs are commonly known or understood concepts. DOEs are relatively new and in early stages of implementation and SOEs are completely new with testing planned with householders via the Converge Project in 2023.

Overarching social research intention

The overarching aim of Project Converge is to develop and test a new orchestration approach to further support the use of distributed energy resources on constrained networks through a 'shaped operating envelope' (SOE) solution. Envisaged as a complimentary approach that can work with dynamic operating envelopes (DOEs), SOEs are intended to support Distribution Network Service Providers (DNSPs) network orchestration efforts, assist with congestion management, and support DER being bid into energy markets.

The social science research that is part of Project Converge is contributing to two questions underlying Converge:

- 1) What are the potential issues associated with SOE implementation and scaling?
- 2) What are the implementation issues associated with householder - energy system interface through DER market design?

The main objective of the social science study is *to understand the views of key stakeholders on the design, implementation and operation of capabilities deployed through the Converge project.*

This social research is therefore exploring, over two reports, implementation and scaling considerations from intermediary and householder perspectives of DER, DOE and SOE integration into the energy system. This report focuses on considerations raised by experienced intermediaries or stakeholders involved in DER and the current electricity supply transitions that are underway. The second report will build on this report and will include insights from householders who have DER, including a battery, at home.

Intermediaries in this instance are stakeholders/actors from the Australian energy system and Converge team members. All intermediaries engaged for this report have experience with DER, the emerging two-way electricity system in Australia and/or emerging DOEs which are currently being planned and applied.

The growing challenge

There is increasing congestion in electricity distribution networks in Australia that is arising from substantial uptake of solar and other distributed energy resources (DER), increasing electrification of services, and greater participation of DER in electricity markets. DER can assist to alleviate congestion on the electricity network and contribute to a competitive wholesale and ancillary services market if there is both dynamic assessment of constraints and opportunities and dynamic management of DER assets over time.

The level of congestion a network can manage is ultimately defined by the physical constraints of the network, most importantly thermal limits of the wires and specified voltage ranges. Exceeding thermal limits can damage network infrastructure. Network 'operating envelopes' are set by DNSPs to ensure that load and congestion do not exceed the capacity of networks and therefore do not lead to damage of physical network infrastructure.

Currently DNSPs mainly use 'static' operating envelopes to help manage their networks. Static envelopes are determined ahead of time to cover an identified worst-case scenario. Static operating envelopes can take into account local network dynamics and can also place more stringent static limits in areas of networks that have been identified as having existing voltage issues. However, static operating envelopes tend to be DNSP wide or have a large geographic area; and they also currently tend to have a zero-export limit. A static limit may be used, for example, when someone is applying to connect a new generating asset (i.e. solar) to the network. Static envelopes do not account for fluctuations of demand over time, nuanced activity of individual DER assets, or the potential of DER to help the network in particular locations where or when it is needed. ARENA states that 'currently, in most cases, operating

envelopes are fixed at conservative levels regardless of the capacity of the network because they are static and need to account for ‘worst case scenario’ conditions’ (ARENA 2022).

DOEs in response to the challenge

Dynamic operating envelopes (DOEs) are being developed, tested and applied to networks to better engage with DER and the dynamics they create on networks, and to better support other network constraints, such as voltage limits in areas of the network where it is of concern. Dynamic operating envelope algorithms were developed through a previous project – Evolve (ARENA 2019a, Battery Storage and Grid Integration Program 2022).

Dynamic operating envelopes as defined by ARENA are operating envelopes ‘where import and export limits can vary over time and location’ (ARENA 2022). Effectively DOEs are enacted digitally via communication technology platforms and act as a mechanism for allocating available capacity in a dynamic way. As with static operating envelopes, DOEs are set to maintain quality of supply within the parameters of the physical grid. In contrast to static operating envelopes (that are often calculated for longer periods of time and with less information) DOEs can assess capacity and needs on the network in increments of minutes and relatively close to a network congestion event of concern. DOEs are applied via software platforms that work in a relatively fine-grained way calculating constraints according to the time of day, and the particular loads and congestion on different parts of a network. Therefore, DOEs can factor in minute by minute, hourly, daily, weekly and seasonal energy load and congestion patterns. This allows for much more accurate operating envelopes on networks, leading to improved use of existing network capacity. ARENA explain the benefits of DOEs as enabling ‘higher levels of energy exports from customers’ solar and battery systems by allowing higher export limits when there is more hosting capacity on the local network’ (ibid.) It is early days for DOE application, but they are being looked to as a solution that will be widely deployed, with current testing occurring in various projects and programs across Australia. Indeed, effort put into the Dynamic Operating Envelopes Working Group suggests there is significant interest in DOEs as a solution (DEIP 2022 a and b).

As defined by Project Evolve, and therefore now Project Converge, there are some limitations to dynamic allocation of capacity via DOEs, in particular:

- DOEs do not consider relative ‘value’ of the DER that capacity is allocated to and do not yet necessarily consider what might be in the best interest of DER owners or consider or maintain flexibility for customers. For example, PV systems can be allocated capacity during negative price events (and this can be difficult for retailers who still have to pay during these negative price events).
- DOEs do not allow for (factor in) DER as network support, where DER could be dispatched to increase available network capacity or as a network service.

Additionally, it is likely that as operating envelopes are calculated ahead of time there can be inefficient allocation of capacity (where network capacity is not fully utilised) and capacity thought to be available might not be when the time comes, leading to some customers being unnecessarily constrained.

Various networks are already applying aspects of DOEs to trials or pilots and DOEs are anticipated to be gradually applied across Australia as people connect new solar and inverter technology at their homes (or upgrade their systems). DOEs are currently only developed for exports from households to the grid (DEIP 2022b). Export DOEs have been focussed on initially to address the critical issues resulting from high solar exports in some Australian states. Import envelopes have been recognised as having a greater impact to customers, as import envelopes may impact the use of essential appliances such as space heating. As such, further work is required to understand an appropriate model for import envelopes.

SOEs to work with and build on DOEs

Shaped Operating Envelopes (SOEs), currently under development in this project (Converge), are a co-optimising orchestration solution designed and anticipated to directly build on and work alongside the DOE solution developed through Project Evolve and the Frequency scheduling for FCAS project with (ARENA 2019b).

SOEs contribute further to operating envelope solutions by making more effective use of existing network capacity and DER, while considering ways to optimise benefits for all parties involved (networks, aggregators, DER owners and energy users). SOE further calculates DER flow and DER opportunity to that ensure multiple parties' interests and needs are met, alongside those of the network and wholesale market; there is maximised support for use of renewable energy (as DER); and customers are rewarded for maximising renewable energy on the grid. As SOEs are about further management and involvement in two-way energy flows, it is anticipated that SOEs will be adopted by customers, or by agents on behalf of customers, that wish to engage in a more detailed way with DER two-way flows and with the market. Therefore SOEs are not currently anticipated to be applied to all DER over time. This is in contrast to DOEs, which are anticipated to be applied to a broader customer base over time as new solar is installed.

SOEs use a principles-based approach and build on DOE interfaces, technology and processes to produce a more detailed two-way energy sharing solution. SOE techniques support further utilisation of DER within the safe working capacity of the electricity grid, effectively better sharing capacity in and between networks and across the whole grid. They factor in what aggregators would like to offer the network, available capacity in local areas of the network, DER support available for local areas of the network, and market prices that make it attractive for aggregators and DER owners to provide network support via DER. Therefore, SOEs can support:

- Aggregators and customers to better use their existing DER generation in a more detailed way, while ensuring they receive market value for assisting the network;
- DNSPs to better utilise their own network capacity; and
- Greater efficiencies in the wholesale and ancillary markets and broader decarbonisation objectives.

In Converge DOEs are being shaped or reshaped (ie, enhanced) through SOEs to incorporate market participation and network support consideration, with corresponding payments for action from customers' assets, and this is being demonstrated with aggregator involvement. The processes include considering aggregators' ideal set of bids (these don't have to be in the

operating envelope limits to begin with). The operating envelope then factors these in. The aggregator sends these bids with cost of activities considered in cost related bands. SOEs are therefore about extra information and extra factors in the decisions – ensuring that intentions and desires of aggregators and customers are factored in so that operations better tailor to what is needed, wanted and available and so there is no waste of potential capacity.

Additionally, the nodal breaking up of customer contributions also allows further understanding of who is doing and offering what on the network in more detail. This can provide a better sense of what part of the network the renewable energy / network services would be coming from.

Principles used for allocation are:

- Select the most competitive;
- Justify providing the services through a process similar to a regulatory test for distribution (RIT-D) – by following values to ensure that the activities will be in the best interest of the market (bring benefit to the market).

An example might be where SOEs assist or let aggregators who have groups of customers work more fairly with that group and distribute opportunities more effectively and/or more fairly, with the point of view of the aggregator and the householder included in the decisions made by the operating platforms.

Having SOEs build on DOE standards and interfaces is anticipated to make implementation of SOEs easier and is one of the reasons this particular solution is being pursued and tested. Among cost and infrastructure benefits, it enables multiple aggregators in the same space. Some customers (energy users) and areas of networks will only need DOEs to function well, while others, for example customers who want to participate more with their DER on the network, will benefit from SOEs.

Ultimately it is anticipated that DOEs and SOEs used together will substantively reduce the need for physical upgrades of networks for capacity purposes and through this will assist to keep electricity costs as low as possible.

Please also refer to technical reports that are published, or are being published, on the Project Converge ARENA Knowledge sharing page (ARENA 2019). The explanations and definitions provided above are still somewhat fluid and are further explored in the insights section below.

Intermediaries as part of operating envelope transitions

Using a transitions type of lens in this research, DOEs and SOEs are being examined as innovations in what can be called a ‘strategic niche’ (which is a term used in innovation theory and literature) and also potentially as solutions that will move into more mainstream use in Australia. Transitions theories provide a framework for thinking about how and why practices occur and how they can be scaled (or not) (Lovel 2022). Transitions can be studied at ‘meso’-level of socio-technical systems (as opposed to ‘macro’-level (e.g. changing the nature of capitalism) or the ‘micro’-level (e.g. changing individual choices). There are different theories for considering socio-technical transitions, depending on what type/scale of transition is of interest. Innovation theory and strategic niche theory investigate innovative opportunities to

assess if they can be scaled for common use (becoming part of more mainstream ways of doing things) (Schot and Geels 2008). DOEs and SOEs fit well into this concept.

There are reasons why policies to encourage niches might appeal to governments more than sector-wide regulatory changes, in particular because niches are aligned with prevailing competition principles and are less likely to threaten powerful interests embedded within the existing socio-technical system(s). But niches are still messy and examples of their implementation reveal they can still be rolled out in an adhoc, nonstrategic and political ways (Moore 2018).

Understanding intermediaries is a useful step towards understanding how the innovation transitions are proceeding and what will likely be needed in the future to support a continued transition. Intermediaries are human actors who have a function or purpose in any given system, and as such are key actors of the system with important roles. The social research for this project uses the concepts of intermediaries as developed through transitions and innovation research, where intermediaries are seen as brokers and catalysts who can have a range of functions in any system or innovation niche (for example Kivimaa et al 2018). Intermediaries are recognised as those who play key role in whether or not a niche technology becomes mainstreamed (or part of the regime) (Özden-Schilling, 2023).

Empirical studies indicate that intermediary actors aggregate learning from individual projects and translate best practice, resources, standards and global visions to influence the formation of new projects and the selection environment. They are important for providing niches with momentum and credibility towards the mainstream. Other research has revealed the importance of established actors to adopt intermediary roles to advance transitions, and this will be very much the case for DOEs and SOEs. Working with transitions theory levels, intermediaries can be described as working and influencing at micro, meso or macro scales – or ‘systemic’, on a regime or system level, in an innovative strategic niche (growing an innovation), process based where they assist with day-to-day process, or a user of a system. that is, intermediaries working and influence from the lived day to day experience of the system up close through to the system at abstracted, strategic and legislative levels.

At the systematic level an intermediary might mediate between multiple actors and interests of the system, for example, be a facilitator. They can often be seen as relatively neutral but can also have an interest in stimulating transitions. ARENA is an example of a ‘systemic’ intermediary who has a particular focus to encourage renewable energy. There are also other types of intermediaries relevant to DOE and SOE innovation and implementation and it is these intermediaries who were consulted for the report and for this social research more generally.

Often intermediaries have tacit knowledge of the phenomenon they are involved with – a form of expert knowledge that is often unrecorded. Their expertise has developed in large part as they are part of the system or phenomenon, learning about and observing the system for a long period of time. The way that intermediaries see DOE and SOE solutions and their understanding of both how the sector and energy users may react to and interact with these solutions; and the sector’s capacity to embed these solutions are critical aspects of developing, testing and implementing these solutions.

The intermediaries we engage with are experts, observers and designers from networks, government and non-government agencies and commercial enterprises. In further detail:

- Network intermediaries provide us with technical design expertise and system thinking, sharing expert views about networks, technicalities, relevant trials, and associated design and future planning. Their contributions provide a form of technical systems level perspective.
- Intermediaries from relevant government and quasi-government agencies provide us with insight into regulatory processes and undertakings related to operations of distribution systems (DSO). They have awareness of, and observe, the electricity system as a whole, and consider multiple stakeholder perspectives. They support the testing and trialling of new solutions and prepare and maintain regulatory and standards systems. These are also likely system level thinking intermediaries.
- Expert commentators view innovations from an interested or specialised onlooker position, often with interest in the consumer perspective. These sources can be seen as relatively trustworthy because they are not invested in a solution and consider various angles. Commentators likely observe people and happenings from outside the system - and they can have understanding of both the system and the users of the system.
- Technical and systems service providers provide technical insight into the application of technical solutions. As the technical solution providers they can offer detail that other intermediaries may not provide. They may also provide installation insights – whether it be from the perspective of organisations, or householders. These actors often sit inside the innovation/solution environment (and its systems) and are often critical design and development actors.
- Aggregators and retailers provide insight into commercial realities and regularly also have a customer perspective. They often sit in organisations that are in between a customer or client or householder and the other organisations involved in rolling out and managing and innovations and solutions. In this instance they are regularly involved with orchestrating DER.

Socio-technical transitions research is based in social research traditions, where bias is seen as a key and normal part of peoples' points of views. While in transitions theory intermediaries can be described as non-biased, we take a social research perspective and view all intermediary actors as biased, seeing issues through their own lens or perspective and from their own context. Intermediaries may, for example, prefer the familiarity of their own solutions or context, or be influenced by potential gains toward their solutions or their preferences. Intermediary positions and expertise are nonetheless extremely helpful in understanding otherwise uncaptured insights and to provide a picture of innovation spaces and the potential for innovations to move to mainstream use. To ensure some balance in the social research discussions we therefore consult intermediaries from multiple contexts and who take different perspectives.

Methods

A transdisciplinary multi method approach is being used to conduct the social research for this project, and therefore for this first report. Transdisciplinary and multi method approaches assist with socio-technical and real-life transitions studies as they remove abstract disciplinary bounds that can distort understanding of the nature of the whole, complex (social and technical) phenomena being investigated; and they capture multiple angles and facets for consideration. In social research such as this, human actor knowledge is valued as data and insight is viewed as being able to be captured through discourse and engagement with people. Each person is assumed to have their own view and their own situational bias – this is seen as normal and the discursive information provided as nevertheless valuable. Multi-methods and capturing multiple views assists to understand phenomena from different perspectives and map key intermediary actor positions, and also mitigates perspective biases.

This research is also taking an iterative, emergent approach to knowledge development, meaning researchers learn along the way through layers of research and investigation. This is especially helpful for complex phenomenon such as energy transitions and studies of specialised and complex solutions such as DOEs and SOEs. The technical innovations create unique social phenomenon and researchers need to layer their understanding of social and technical interactions as they progress. Iterative emergent approaches allow for adjustments in the research trajectory as research progresses as what is been learnt along the way may indicate that an altered inquiry path will be needed to meet overall objectives.

The main insights used in this interim report come from 18 interviews held with 20 intermediaries between September and December 2023; and team conversations with the Converge Project team.

Interviews with intermediaries were online, were up to 60 minutes in length, and used a semi structured question approach to explore and discuss DOEs and SOEs and related context. These interviews were approved by the by the Australian National University's human ethics process (protocol number 2022/2/337), which follows national ethical guidelines for research. Informed consent was sought for interviews. Interviewees were purposively recruited via known networks and contacts. People with knowledge of DOE were sought.

The planned questions were broadly followed, but the content of discussion focused in on particular areas of the topics that interviewees felt needed to be discussed. The interviewees were the experts and as such, their emphasis was important. Additionally, interviewees were encouraged to add information they thought was relevant and that questions may not have covered. Interviews sought understanding in areas such as:

- Interviewee work roles related to DER and DOE;
- Understanding of DOEs;
- Opinions about DOEs currently and in application;
- Opinions about SOEs as a concept;
- Application, and scaling of DOEs and SOEs;
- Gaps in social systems and industry processes at the moment that might hinder DOE and SOE application;

- Any assumptions we have made in relation to DOEs and SOEs;
- Related social concerns and opportunities including relating to equity and fairness; and
- Whether DOEs and SOEs could in any way link with community energy action.

DOEs were an important part of the discussions because they have been relatively broadly discussed in intermediary DER energy communities and they are also currently being implemented in various forms around Australia. DOE discussion therefore provided a useful base in interview discussions and supported discussion about SOEs and evolving operating envelopes in general. SOE concepts were less familiar to most interviewees and therefore discussions about SOEs were more speculative.

Originally 16 interviews were planned, but anticipation of a slower response rate to invites and seeking to cover key stakeholder groups led to 18 interviews being conducted. The interviewees provided insight into multiple positions and vantage points in the DER and energy transitions social ecology. They played key roles in various organisations related to energy transitions, DER and DOEs; and often had decision making or important observational power in their roles. In the interview discussions some topics got to the point of what is called 'saturation', which means they were covered reasonably well and similar points were raised in different interviews repeatedly. This indicates that for certain topics covered, 18 was an appropriate number of interviews. For other topics, however, saturation of discussion was not reached. More time in interviews may have assisted to better cover some topics. The lack of saturation also indicates that these are complicated issues and further stakeholder views would be needed to further understand the issues explored. Nevertheless, the interview group is a large stakeholder group from 17 different organisations and so covered the discussion reasonably well.

Intermediaries interviewed were:

- market body and Australian oversight organisations - 4 people in 4 interviews (various organisations and various roles)
- DNSPs - 7 people in 7 interviews (systems and future networks planners and business and marketing roles, 6 different organisations)
- experts and commentators - 4 people in 3 interviews (different roles and organisations)
- aggregations and aggregation software and technology services - 5 people in 4 interviews (different organisations with different business models)

Topics and areas that could be further covered in future interviews includes aggregation services and aggregator opinions, energy observer and commentator opinions, DOE and SOE interactions with consumers, energy justice and fairness. Additionally as DOES are new, some people were still working out how they will be involved with DOEs. This likely means that further research with the same people on the same or similar topics may capture notable evolutions of opinions over time.

Converge team conversations have occurred in team meetings and through an online team focus group, held in August 2022. Two further face to face and online team focus groups are planned for 2023. In team meetings, discussions vary and are mostly focused on issues that

need to be reported to progress the project. The August 2022 focus group was held so that the team could revisit basic definitions and assumptions being made in the SOE design process. As with interviews, the team focus group discussion had guiding topics, but focused on specifics that the team felt were important to consider. Insights were mainly technical and assisted social researchers to ensure their research was relevant and on track, and provided a space for in-depth team conversation.

Interviews and the team focus group were transcribed using auto text identification and then were read through and corrected to ensure the text represented the discussions closely. All text was then analysed using qualitative coding software (NVIVO in this instance). The text was thematically coded for content, meaning and for implications. (Any comment can hold information that is useful as a content descriptor, because it implies a meaning, or because it has potential implications.)

For reporting we aim to use codes or pseudonyms and a generic description of the role the interviewee holds. These are techniques used to de-identify interview contributions as in this research we are keeping participants anonymous. However, in this report, there was a possibility that quotes and identifiers could still identify so here we elected to remove all role titles from quotes as well. Interview participants were also emailed the same draft version of this report sent to ARENA for review so they could check the use of quotes and the reporting of findings. No adjustments were requested to quotes or findings by participants.

Researcher position

It is useful in social research to state the position of the social researchers so readers are aware of how they interact with the wider project. In this instance, the social research is being conducted from inside the Project Converge team. Dr Hedda Ransan-Cooper planned the social research and approach (methods), Dr Phillipa Watson is conducting the majority of the ongoing research and refining methods as required, and Andrew Fraser is providing project oversight, and technical and contextual guidance.

Drs Watson and Ransan-Cooper are employed at ANU through the same ARENA grant the designers and developers of the SOE solution are employed through. Andrew Fraser is a project manager in the SOE team and comes from a long career in network innovation. Watson and Ransan-Cooper are also part of a broader transdisciplinary socio-technical research group that have worked on multiple other energy transition projects.

Watson and Ransan-Cooper's work is focused on socially based implications of technical energy transitions. They often use socially under-pinned, qualitative methods and engage with emergent learnings from applied projects to progress scaling and wider application of energy innovations in society. Both are motivated to ensure that applied tests and pilots learn about what social systems need to be in place so that energy users (consumers, householders, small business, community groups and more) needs are met; and so feasible, smart, inclusive, and ethical solutions are developed.

Initial social insights – opinions of DOEs and SOEs and intermediary roles

This section outlines the first round of broad findings from intermediary interviews and from Converge team discussion. Implications underlying these interviews are also related here. These early findings provide indications, from various relevant perspectives, of where Australian operating envelope development, application and critique is now, where it is likely headed and what aspects of DOE and SOE development and application need further consideration and action. This section steps through findings in the sub sections:

1. Intermediary opinions about DOES and SOEs – provides indicative opinions from intermediary interviews about DOEs and SOEs and their potential to support DER energy transitions.
2. Intermediary roles and what is needed – explores what intermediaries may be required in the DER-with-DOE energy future, including at scale, and the likely support needed to get this workforce and social system support functioning at scale.

The intermediary insights related in this report were chosen out of a wider and very rich data set either because they aligned with areas mapped as important in the ARENA knowledge sharing deliverables for this report; and/or they are key considerations. Further insights are available in the data and are anticipated to be reported in the final social science report for Converge. Critically, insights from intermediaries about consumers are available and are planned to be published in the future alongside the household interview data that will be gathered in a later stage of the Converge project.

Intermediary opinions about DOEs and SOEs

Intermediaries were asked to provide their definitions, opinions and thoughts about DOE and SOE solution paths. This section relates the opinions stakeholders/intermediaries had about DOEs and SOEs in relation to application and outlines a range of the themes/concerns and caveats raised as we spoke about DOEs and SOEs.

Points raised about DOEs and SOEs have been separated out into different sub-sections. Commentaries are included about whether the concepts were known and understood (with some mention of where they are occurring), whether the concepts were generally supported, and what considerations and critiques intermediaries mentioned.

Opinions on DOEs

Knowledge of the DOE concept

Understanding of the concept of DOEs and their possible applications was consistent across the group of people interviewed. As previously stated, this group of intermediaries were chosen for their involvement in and/or observation of DER and DOEs. This meant that their understanding of DOEs was anticipated. Interviewee DOE knowledge was generally fairly detailed. Explanation of DOEs tended to be relatively consistent as well. These responses all indicate that although DOEs are comparatively new in the energy transition, they are part of

the awareness of at least a notable cohort of specialist intermediaries involved in the transition.

There were some interesting points raised in relation to how DOEs were defined. Three notable definition-related points raised were about whether DOEs were export only or import based as well, the specificity of definitions available and in use so far, and the underlying principles that should drive DOE application on networks.

Whether DOEs were for export from solar at homes only or for energy import from the grid too was reported as having been discussed during the clearly pivotal discussions and report writing in the Distributed Energy Integration Program (DEIP) process (undertaken in Australia with invited stakeholders over the last number of years). During the recent DEIP process interviewees reported there had been a decision to just focus on operating envelopes in relation to exports only. This decision was related in DEIP reports (for example DEIP 2022a and 2022b) where DOEs are clearly described as currently for export only. In most interviews, while people recognised the current focus on exports, as a group they thought DOEs should be considered for imports as well, and that imports were likely to be considered in the future. Interviewees were able to describe the technical reasons why imports are just as important a consideration as exports. Export DOEs were seen as partial DOEs. Defining a DOE versus a partial DOE and where a partial (eg flexible export) DOE stopped and a complete DOE begins was unclear to some participants. Others had a pretty clear idea of how DOEs could be broken up into parts.

DOEs were not always seen as well-defined enough and interviewees did not necessarily think DOE information provided clear guidance or made sense of the potential impacts or implications of DOE application.

'I don't have a sense of how dynamic the dynamic operating envelope is. You know is it changing on an hourly basis? Is it changing on a seasonal basis? I don't know and I'm in the industry. So again how does a consumer understand what that is? And how do they understand how they get the best out of their system if they're not using an aggregator? If they're just trying to connect to... solar panels and send it to the grid?' (interview on 10.10.22)

Value wise, interviewees explained that DOEs were being applied to a common resource, that they allowed more use of renewable energy on the network and that people's choice and freedom within the necessary constraints needed recognition in the way DOEs were applied. For example:

'The dynamic operating envelope is an upper and a lower limit. So an export, an additional load limit allocated to a customer to freely use without any further coordination required. So it is to be used, and it comes on top of the, it doesn't include their current essential loads that they already have. It's only meant to operate on flexible energy appliances like solar battery ev chargers and it's not meant to include washing machines, televisions and lighting, right. ... a safe value range that is being allocated to each customer individually and basically being owned by the

customer individually to be used freely at that time. And they can choose to operate anywhere within that interval. And ... they can choose to operate anywhere within that interval safely without having to even tell, ..., without further coordination and verification with the network operator.’ (interview on 12.10.22)

And,

‘I’ve expressed before we see it as an extension of our network connection agreement. And so we should be trying to provide them that capacity, as much capacity as we can, in the most efficient way we can. And so to the extent that a customer pays the same for access to network capacity, then we think, we think that they should enjoy the same level of service that other customers around them are.’ (interview on 17.10.22)

Interviewees - specialists in the know - were incredibly generous with technical explanations and they worked to share these with the interviewer (Watson) - in a language that was accessible to a non-DER specialist. It was clear that there was an awareness that DOE information had to be explained; an explanatory bridge was needed to ensure non-specialists could also understand what was planned; and all interviewees understood that DOEs were being applied in society and therefore had to be explained so laypeople could understand and engage. A number of technical specialists spoke about spending time working out how to communicate about DOEs and related changes that were coming; and about working on using plainer and more intuitive language. Notably, significant professional effort was being put into working out how to bring DOEs from their current technically specific explanations to more accessible interpretations by interviewees.

Was DOE as a solution supported?

There was a high level of support for DOEs, particularly because of the current pressures on networks around Australia (as related in the background section of this report) and in relation to meeting renewable targets and climate change mitigation efforts. Overall interviewees commented that DOEs were seen as a much better option for energy users on the grid than static envelopes. Static envelopes already exist in certain constrained networks and are likely to continue to be applied elsewhere if DOEs, or partial DOEs, or alternatives to DOEs are not applied soon. DOEs were seen as likely to become increasingly mainstream and to offer better use of renewable energy that was on networks (than current setups on networks allowed). DOEs were seen to have the potential to help people use the network as much as they wanted within current physical network limits, without impacting on others (a focused comment on this is in an interview from 10.10.22) - and this shift was seen as a positive step. Additionally, that DOE could be applied across the network and was not DER-type specific was important, as was the potential transparency of DOEs.

There was also recognition that flexible exports are being supported as a clear starting point that stakeholders (often networks) are confident about in the current context. Flexible exports are seen as an important first step in a progression of DOE related changes. Starting with flexible exports and moving onto more DOE (or DOE-like) features will assist in moving from passive DER installations, which cause pressure on networks, but can’t be managed or

anticipated easily, to managed installations that are able to be managed and anticipated within the bounds of the network capacity (eg, interview on 13.10.22).

One interviewee explained the overall benefits were positive for both flexible exports and DOEs:

'What it should give you is greater opportunity over the entire period, say over if you think about the period as being a year, you should in that year be able to expect, export much more than you can with a static limit.' (interview on 10.10.22)

Caveats and other considerations were raised in relation to DOEs, which are listed below in this section. Assumptions underpinning DOEs and the need to be aware of these were discussed as well. Due to time and space limitations assumptions have been left out of this report, but will likely be in future publications.

Examples of Application

There was concern about when DOEs would come in, or be applied. DOEs were reported as being needed relatively quickly – intermediaries could see the pressure on the network and the energy supply system from emerging climate change requirements, needs for more renewables, and need for related policy development, among other pressures (interview on 18.10.22 provides an example of this sentiment).

Various testing and application of DOEs, or partial DOEs was mentioned, and these examples included:

- Both research of DOE acceptance and application of 'dynamic export limits' or 'flexible exports' (described as kind of 'half a DOE' in interviews), in South Australia by South Australian Power Networks and other government agencies.
- Testing and plans for larger scale application of aspects of DOEs in Queensland over the coming few years.
- Consideration of application of DOE type solutions in the Northern territory in the coming years. One intermediary advised this would likely be a little behind Queensland's DOE application.
- Current testing of DOEs through the Project Symphony pilot in Greater Perth, Western Australia WA.
- Current testing of DOEs (and some aspects of SOEs also being considered) in Project Edge, in various locations.
- Multiple organisations, for example Jemena, United Energy, TasNetworks and Evoenergy, are also doing some related research on DOEs and managed EV charging.

Considerations raised

Important considerations and caveats were discussed in relation to DOEs and approval of DOEs in each interview. Interviewees thought significant further consideration was needed including in relation to technical retrofitting, social considerations, strategic timing of rolling out DOEs, the details of how DOEs should connect at the home, and more. The list of issues mentioned was long and a list is included here to further describe key considerations:

- Developing standards and standardisation of application was seen as important. While there was recognition that too much prescription could be a problem, there was also clarity that standards were very much needed. Australia's Common Smart Inverter Profile (CSIP-AUS) IEEE 2030.5 standard is a recent standard for DER that was repeatedly provided in interviews as an important new standard that would support the application of DOE solutions. One interviewee explained that the communications standard was more important than the algorithms being used, because while the algorithms could be finessed over time, the communications standard needed to be well established and stable to provide a frame for setting up DOE systems. Standards were also seen as a way of supporting national consistency in application, which interviewees saw as critically needed if Australia is to convince technology companies to provide the technology needed. Australia is seen as a small market for technology and therefore national scale influence was seen to be needed to encourage tech companies to make alterations to their technologies to accommodate DOEs.
- Related to national scale standards concerns, interviewees were concerned about the different solutions appearing in different states. They felt it was critical to work for DOE solutions that could work across the states and therefore scale and provide a consistent playing field on which to build various skills and technologies.
- Further regulation and policy was also seen to be needed. There were questions still about how incentives would be structured, which is mentioned further below. In relation to this, if there aren't affective incentives as motivators, then interviewees could see that operating envelopes might be mandated, and this was a contentious point for some.
- Looking past DER solar export management to other opportunities such as supporting upper sides of exports, collective (peer to peer) energy exchanges and supporting consumer choice within the limits is important.
- Considering DOEs as a starting point for coordinating customer energy flows, not as the final solution, was mentioned as a meta strategy that needs to be employed.
- Considering DOE influences in relation to social equity was mentioned repeatedly. There was concern that while some very early analysis had been done on impacts of certain algorithms, the social impacts of applying DOEs has had very little attention overall. By interviewees specialised in consumer considerations this area is seen as having large gaps in relation to DOEs. Related to this, implied in many discussions about equality were concerning indications that Australia would create significant infrastructure inequality through the roll out of flexible exports and DOEs, because of the expensive infrastructure needed to join in to (connect to) DOEs.
- There was also concern about DOEs being used as a 'throttling mechanism' over and above their intended basic function of maintaining a safe working envelope on the grid. In other words, there was concern that DOEs could be used as an alternative to a network service. For example, if overvoltage is a problem for a network, then some networks might adjust the DOE to solve the overvoltage. But this was seen as overstepping roles and responsibilities and unfairly taking away an asset owner's right to be paid for DER services that assist with what is effectively a network problem. It was argued that service for the network provided by energy user DERs should be

procured as a service by the network, otherwise it is unethical and unfair (interview on 3.10.22).

- The dance between export and import aspects of DOEs needs further resolution. Currently there is disagreement on what aspects of exports and imports can be applied in a DOE. While interviewees all indicated they understood there are benefits to both import and export DOE functions, they reported having observed organisations taking positions on whether both import and exports should be included. There was some confusion as to why this debate had led to such definite action (excluding imports from consideration) in the DEIP report.
- Currently DOEs appear to be based on worst case scenarios due to high levels unpredictability in energy use, and this leads to the smallest amount possible being allocated in the DOEs. So even though DOEs are better than static envelopes, in many cases they are not utilising the actual capacity of the network involved (for eg interview from 12.10.22).
- DOEs can be DER and appliance ‘agnostic’ to some extent when the DOEs are calculated at a NMI level - this was seen as a positive feature by interviewees. However, connecting anywhere other than NMIs can limit the opportunity/facility that each appliance can provide. Alongside some connection issues with some appliances, the way DOEs are measured and registered, and where they connect with an end user's technologies can affect the ability of some appliances to help with reducing need for export to the grid. When batteries are connected via inverters, for example, there can be lost opportunities to use energy behind the meter. So in setting DOE policy and when implementing DOEs there needs to be understanding of how DOEs (could or do) interact with other technologies and the impact of these interactions.
- Other alternative approaches need more consideration alongside DOEs, including further work with assessing pricing and tariffs and how they can help with operating envelopes and managing concerning export levels (alternatives will be listed in future publications). There were multiple people who suggested that alternatives to DOEs could hold off the need for DOEs for a reasonable length of time. Additionally, DOEs were seen as part of a suite of solutions that were needed for the current and future energy transitions that are needed in Australia, rather than a stand alone solution.
- Related to pricing and tariffs, there were questions from interviewees about what remuneration might help to maintain safe operating envelopes. With or without DOEs, remuneration and valuing energy users services is recognised as important. Interviewees said more work is needed to understand where remuneration is fair and needed.
- Caution was advised in relation to focusing on DOEs and related solutions as only market based solutions, or introducing competition where it wasn't needed, or just focusing on a competition solution only. An interviewee compared European attempts to make operating envelopes purely market driven and warned that this could force energy users to participate in a single market, which would destroy other DOE related opportunities, such as sharing of energy between people with DER technology and

those without (interview on 12.10.22). Related concepts to this are further described in the SOEs section below.

- Flexible export constraints and DOEs are being applied (and being planned to be applied) as new and replacement solar is installed. Interviewees felt DOEs would need to expand to existing DER installations over time to have a reasonable effect, but currently DOEs cannot be applied to older technology.
- Management of DOEs may be difficult where data about what is happening (electrically) on the network is needed. This data is currently often incomplete or unavailable. Additionally, intermediaries have become aware through their involvement in various trials that technology is not always doing what it was expected or calculated to do. So data is needed to understand what is and is not happening after DOEs are applied in real end user environments.
- Retailers appear to have less interest and control of DOE technology design and what is coming in terms of DOE application. Networks were repeatedly noted as driving DOEs and other related solutions and also as seeing these solutions primarily from their own network point of view.
- While DOEs could be widespread, there were cautions shared about needing to tailor DOEs to apply to specific geographic locations and to different networks, as these different environments created very different constraints on the networks and impacts on end users. Urban networks often have different issues to regional networks due to the population density and distance of lines, for example, which would then affect what solutions should be prioritised for peak exports and peak load management.
- How permanent DOEs for a dwelling or location were, was questioned. There is currently no clarity around whether abodes and their users could come on or off DOEs and whether, if someone moved house, the new owners must inherit the DOE status of solar, for example.
- Aspects of SOEs were also seen to be possibly already being planned into DOEs. More on this is noted below in the SOE section.
- Incentives to encourage customers were seen to be important. Interviewees pondered how DOE solutions created value for customers. Studies done on DOE value have found there is value for householders, for example, because households avoid the strict curtailment of static envelopes. One interviewee explained - 'The energy market is a financial market and consumers are hit in the hip pocket. That's what we've got to keep in mind when we are talking about this, th[ey] don't care about how the electrons are flowing backwards and forwards. What do I pay for my energy and how do I get the best out of it?' (interview on 19.10.22)
- DOEs will become more and more relevant over time with less solar export curtailment needed early on, but likely more needed as more EVs are being charged. So reasons to have a DOE may change over time and the impetus of avoiding curtailment is likely to grow over time.

- The pathway to DOE application at scale around Australia will need to appeal to users and be gradual so users can come along with, and develop understanding of, the changes.
- End users and end prosumers will need to have DOEs and the current constraints on the networks explained well before they will be able to come on board.
- An interviewee pointed out that there were ethical considerations to work through. They mentioned personal data and how it is being shared for DOEs. Various data could be shared about a house/premises and how it is used, which raises ethical concerns. Ethically based concerns also underpin other issues mentioned above, such as assessing whether end users are assisting with networks services, such as balancing overvoltage.
- Interviewees indicated a need to move onto thinking about application at scale and that practical thinking and application will be needed for this scaling of DOEs.

Opinions on SOEs

As stated above, shaped operating envelope (SOE) solutions are currently being explored through Converge in order to establish ways to co-optimize energy flows and to consider benefits for multiple parties. Interviewees provided helpful discussion on SOEs and key points they shared are summarised below in the following sub sections.

Knowledge of the concept and particulars

The term and concept of SOEs is relatively new and not well known. Unlike DOE, it has not yet been examined by a wider specialised intermediary community. It is currently a term used by the Converge design team to describe their solution. In the interviews some people had been connected with the earlier DOE exploration in Project Evolve or the development stages of Project Converge and were therefore conversant with the idea of the space SOEs are looking to fill. Most of the interviewees had not had this Converge connection and so were speaking about their thoughts on SOEs after a brief introduction to the concept (that happened via the email correspondence about the interview and briefly during the interview). The SOE concept shared with interviewees was necessarily a work in progress, as the project was still defining and developing the SOE solution, and there had not yet been any community assessment of the term or the solution path. The term ‘shaped’ actually misled a few people as they considered SOEs, which indicated the word was unlikely to provide an intuitive guide to the features of SOEs.

SOEs as a concept were also compared to, and related back to, what Europe coined flexibility markets, which are processes that look for flexible opportunities and process them through the energy market (for eg, European Commission 2023).

Moving from DOE to SOE in people’s minds was confusing and it felt there was an unclear boundary between the two. One interviewee realised as the SOE definition was read that they had assumed SOE activity that was looking at considering further parties – like consumers and aggregators – was part of the DOE definition (interview on 29.9.22). ‘Why do half a job once you are doing it?’ they asked. Some interviewees indicated the DOE definitions could potentially stretch to cover some or much of what SOEs are looking to include. Indeed, some

people reported that some DOE explorations are looking to consider and/or include some SOE activities described. Inclusion of SOEs into DOEs relates back to discussion reported above about there being spectrums or gradations of DOEs and DOEs really having a potentially broad area of activity.

Critically, there was discussion about how SOE activity potentially sat in a grey or even contentious area of responsibility that was possibly ethically and principally beyond where the realm of network responsibility and control stopped. This conversation suggested that roles and responsibilities relating to SOE functions and co-optimising may need to be defined alongside SOEs and SOE functions as they are developed.

A Converge team quote helps position current SOE research and how it fits in with other co-optimising explorations:

'so we've gone from sort of static to dynamic [and] the industry broadly is comfortable moving towards the DOEs, but then recognises that there's a space beyond that where there's still the need to go further in terms of, ... co optimising, I think its a fuzzy space for me. I think it's not clear ... how that could be done. And that's really the problem, the specific problem niche that Converge is in, [project] Edge is in and to some extent project [project] Edith with Ausgrid is in.' (Converge team discussion on 16.8.22)

So SOEs as a concept sat in a contested and unresolved space and presenting the definition was useful to expose SOEs as a placeholder in what is potentially still a relatively liminal space.

SOEs were seen as aligning with capacity optimisation. One interviewee, after reading and synthesising the description, saw SOE as a natural progression of DOE:

'SOE then in that sense is probably a more advanced version of DOEs. Where it could be used is potentially in areas of high DER penetration. Where the network needs to do, ...be a bit more hands on in managing it. So you get a system level benefit because there's a third party managing it rather than just a fairly elementary you know [DOE] across the area.' (interview on 28.9.22)

Was this solution generally supported?

There was support for the SOE concept and awareness that SOEs could cover functions that DOEs did not. However, stakeholders were interested to hear more detail before making a full assessment. Overall there was a sentiment that if SOEs helped to use resources in a smarter way and would acknowledge the actors involved, interviewees were interested to hear more.

'If shaped operating envelopes mean that more parties can be involved and more parties can have benefits out of it, and this is consumers plus retailers plus aggregators, then I think that might actually increase its chances of success.' (interview on 28.9.22)

Many saw SOEs as a later step to be considered as networks became more constrained. Some thought SOEs should be considered as part of the job/task alongside DOEs, as DOEs were

developed. And a couple of interviewees reminded us about ensuring we looked at the whole picture and solve with the simplest solutions first, suggesting that perhaps both DOEs and SOEs could be delayed if simpler options could be successfully applied first.

Having more parties considered and to have further ability to create efficient use of network capacity were both attractive features. Having consumers and aggregators have more input or consideration was thought a useful approach, with multiple interviewees commenting on the strength of influence of networks in all DOE solutions and how networks can problematically be focused on to the detriment of other parties. Having the ability to better use capacity because of the better information and understanding of intentions of various parties was also seen to have great potential. Understanding more about availability of energy and capacity to export and import could offer significant efficiencies. Additionally, because it can be difficult to forecast individual behaviour, SOEs were seen to be potentially positive as they would be able to assist with the less predictable aspects of energy use that could limit DOE based operating envelopes, reducing allowable capacity (eg interview 1.10.22).

Interviewees felt SOEs would likely be for situations where end users or prosumers wanted to be more involved with energy trade and would therefore be most of interest to a proportion, not to all, consumers. This is also the expectation of the Converge team. Interviewees felt however that the need for SOEs might increase over time.

There was also support for other solutions that covered elements of the SOE solution. Notably other projects are also trialling variations on the SOE approach in their projects, and in doing so indicate that those projects also support some form of solution in the area that SOEs are in.

Considerations raised

Considerations and concerns were raised in relation to SOEs as a solution path. Interviewees thought significant further consideration was needed as SOEs were designed and developed. Extra complexity, extra data flows and working out who was responsible in the SOE space were all considered big issues.

Issues shared included:

- Intuitive concerns from some interviewees about the higher levels of complexity involved moving from static to dynamic to shaped operating envelopes. Some interviewees reminded us to not to overlook simpler techniques, start with simple strategies where possible and not overcomplicate things.
- However, SOEs were also seen as something that may be able to manage the increasing complexity at hand. Increases of price responsive smart devices and the complexity of these were seen as something that may trigger more need for SOEs. Increasing EV loads were also seen as something that might trigger the need for activity in the SOE solution space due to the significant need to further co-ordinate charging that comes with increases in EV use, and the individual nature of the charging involved.

- Increasing complexity equalled increasing data needs for interviewees. In relation to this, the Converge team felt SOEs are a practical approach to co-optimising challenges at hand because they didn't need perfect data sets and could engage to get a good enough solution. A Converge team member explained: 'Co-optimised is sort of the ultimate, you know, the most efficient technical solution, but it's actually really hard to compute from a data...point of view. We can compute an OP, an optimal power flow, and come up with the best solution to dispatch everything. The problem is actually how do you get all the data together to be able to do that that computation.' The Converge team 'recognises through our experience collectively over many projects that that's really hard to do. So we're taking a step back from that for a solution that is much easier to implement and still might get 80 to 90% of the efficient results for that solution. So ... shaped operating envelopes is a practical end game and will deliver enough benefits that we don't need to go to that ultimate fully co-optimised solution' (focus group on 16.8.22). Project Edge is working on this data challenge with their network management solutions as well.
- Because of the nature of what SOEs are doing it was unclear who would have responsibility and who would be involved. There was concern that SOEs might not actually be something for networks to manage, despite SOEs possibly being linked with DOEs. Networks, it was indicated, could overstep their reach and mandate if not careful when applying SOEs. An interviewee explained 'you have networks kind of doing their very best job to set the limit. Then retailers, aggregators, service providers, whoever else is working with the customer around that limit to create value for the customer and for everybody else. And SOE sounds like something where that's the network entering into that space. And on the face of it - it's like, hang on, have we now got networks, not just wanting to set the limit, but want[ing] to do the active management and support to shape it, which really isn't their role?' (interview on 4.10.22).
- Following on from the point above, some DOE platforms may be able to accommodate SOE functions, but aforementioned concerns about ownership, who managed SOEs and whether networks should or should not be involved overlaid practical discussions about the platforms. There are gaps in understanding about who would oversee, check and develop SOEs. Some people suggested SOEs traversed organisations and responsibilities and went way outside of network remit and others indicated SOEs would possibly sit with networks for reliability and security. People asked for further thought on what drivers are involved and therefore who should be responsible for SOEs and consequently what roles each sort of organisation should take. Caution was advised around making sure motives, drivers and impacts of both DOEs and SOEs were clarified and understood broadly. Working out the benefits and what is required of all actors involved mattered greatly.
- Social equity implications of SOEs were entirely unclear and need further analysis. 'a fundamental issue [of DOEs] is who would participate and the cost to participate. And SOEs as well. I think you'll need to... aggregate all of the assets behind that meter need to be to be working in concert for SOEs to work effectively.' (interview on 19.10.22)
- SOE solutions may take us closer to actual effective optimisation of loads and capacity on networks. This led to one interviewee suggesting that planning SOEs need to consider how more efficient use of capacity may negatively impact our networks. It is unclear as yet whether networks can physically cope with the long-term effects of

being highly optimised. For example, can the transformers take near capacity loads for long periods? Currently they have times when they are not fully loaded, and they cool during those time periods.

Overall intermediary positions on DOE and SOE solutions

Fundamentally the strategy and philosophy that underpin DOEs and SOEs of improving use and capacity of networks, with recognition of key actors involved, was seen as a positive by interviewees. It was in the particulars of application interviewees' opinions differed, including in relation to principles around who was responsible for what and how each entity should be allowed to engage. People were more aligned in the responses they provided about DOEs than about SOEs, conceivably mainly because DOE solutions are further progressed. There was recognition that DOEs themselves were not the end of the journey and that there is need for solutions in the space where SOEs sit. For example, one interviewee said:

'Absolutely the only way forward longer term because you know people are gonna keep sticking solar panels on their roofs. And we just basically either make that, discourage it, or overbuild the network incredibly, or do this.' interview 29.9.22

The Converge team were clear with their reasons for working in this space:

So we've had to adapt, and we can adapt in an efficient and cost-effective way, or we can adapt in an expensive way, so the most, one of the solutions for the most cost-effective ways, is implementing DOES and SOEs and that's why we're working very hard on that problem.' (team focus group 16.8.22)

While generally supportive, there was a clear argument from most interviewees that we need an overarching strategy and a coordinating effort to ensure these solution paths are developed into what is needed, and are successful. Additionally, many interviewees suggested the entire DOE and SOE journey needed oversight from a monitoring entity. A critical part of being strategic is understanding how and when customers are prepared to be involved and also what DOE and SOE actions will be fair for Australian energy users connected to networks as a whole. Consumer involvement and concepts of equity and fairness will be examined in future social research on this project.

Intermediary roles and what is needed

Intermediaries in the current innovation niche

As stated earlier, intermediaries and their various influences are a critical element of innovation processes as they are the people who act to bring about change. Intermediaries currently taking part in the energy transitions underway, and in particular those stepping through designing, assessing and bringing about change related to DER management and DOEs have a range of expertise and roles.

The majority of intermediary activity on DOE testing, planning and application and SOE design and planning is clearly currently focussed in the professional realm. Consumer interaction

with DOEs and assessment of consumer responses, appears to currently be via a handful of key consumer advocate organisations. There is some evidence of intermittent input by energy consumers to specific network and retail projects via often confidential consumer reference or advisory groups, but otherwise there is very little apparent activity from community groups or individuals in relation to DOEs. In SA there is some further connection with consumers as they make choices about going on a flexible export agreement (rather than staying on a static agreement) as they install solar at their houses. There has also been some one-off consultation via surveys about DOEs in South Australia (related to flexible export planning) and likely also in other states. Consumer engagement with SOEs and SOE-like functions will begin via current projects – Converge, Edge and Edith. SOEs will likely progress via the same social systems and application avenues as DOEs have, unless deliberate extra consumer consultation is sought.

Professional intermediaries involved with DER, DOEs and early SOE concepts are located in various organisations in a wide array of areas, including in:

- Distributed network service providers DNSPs,
- Retailers and aggregators,
- Technical product and service providers to organisations (including DER and aggregation services),
- Technical product and service providers to consumers (including installers and HEMs),
- Australian governance oversight and development (including for markets, systems, and regulation),
- Renewable energy facilitators (including funding organisations),
- Researchers and developers of innovative solutions (multi-disciplinary),
- Peak body associations,
- Community advocacy organisations, and
- Energy system observers and commentators.

Professional stakeholder interviews were conducted with intermediary (stakeholders) from a cross section of these intermediary areas. The people interviewed provided a way to better understand the context within which dynamic and shaped operating envelopes are being developed. They were also people with tacit knowledge of the topic, which is often unpublished (and when published can be confidential, or hard to pinpoint in industry literature without direction). The interviews were not enough to reach saturation of discussion on the topic of DOEs or SOEs, even after adding further interviews and extra interviewees. Not reaching saturation of the topic was expected however as this topic is extremely complex and is currently only lightly researched from a social perspective.

Notably, it is clear from speaking with people in a range of these various areas that current knowledge of operating envelopes is specialised and is held by only one to a few people in each organisation. Networks may have more knowledge within their broader teams about operating envelopes (than other organisations) because they are working at scale with static operating envelopes already. Despite this, it is currently unlikely that DOE knowledge is spread past system or innovation teams at networks. Additionally much in-depth specialist

knowledge about DOE and SOE style solutions is currently held in small multi-organisational, multi-disciplinary project and trial teams that specialise in developing and testing innovative technology. These teams do disseminate insights via reports and presentations, but there are no systemic or scaled education programs as yet stemming from these groups to transfer in-depth, how-to knowledge.

This all indicates that the people currently available and knowledgeable enough to speak about DOEs, and then to also postulate about SOEs, are from a small group nationally. Intermediary communities with knowledge of DOE and SOE style systems and solutions will need to expand substantially to service any scaled application of non-static operating envelopes solutions.

The converge team – an example of exploratory innovation activity

The Converge project team is an example of a small, multi-organisation, multi-disciplinary innovation team. The team are themselves intermediaries as they are encouraging niche innovation and development and are using it to process a possible new solutions for operating envelopes.

The team includes specialists in multiple technical areas, including in batteries, computer programming, network innovation, industry innovation, customer engagement and social research. Innovation takes time and thought and significant engagement with the industry and various organisations, so there are multiple full time equivalent (FTE) roles involved. A university, a network, an IT innovation company, and aggregation service organisations are involved. The network provides project and customer oversight and access to critical data. The university are involved with the platform design and testing, social research and project management. The IT innovation company are involved with the platform development. The particular people involved from each organisation are engaged because they have specialised skills and experience with DER energy transitions. Many have extensive experience with applied DER trials in the community and with householders, which means they have an extra layer of specialisation. Their background experiences are relatively uncommon and bridge disciplinary bounds, so they are highly valued contributors who would be difficult to replace. This team are provided here as an example of the rich skills and connections that need to be generated to work on niche innovation projects like Converge. Larger innovation teams have even larger scale challenges with gathering appropriately skilled staff and then keeping them for what are often long term projects.

Intermediaries needed and scale

Interviewees spoke about the need to move on from tests to practical applied, at scale, solutions for DOEs and also aspects of SOEs. This narrative about needing to scale approaches is familiar to most of us working in or observing DER-DOE applications. There are implications in the push for scaled application in relation to intermediaries and their roles. Intermediaries will have to scale, and in a practical way, alongside other scaling of DOEs and SOEs. The small numbers currently in the know about DOEs are therefore concerning.

Intermediaries in many specialised roles will be needed in larger numbers as DOE and SOE innovation for DER support progresses. Years of training and years of crystalizing expertise

through rich experiences underpins the intelligent engagement of many intermediaries. The topic matter for DOEs and SOEs is complicated, and engagement with it requires an array of skills, not always found together in jobs or acquired through current training avenues. For example (and these are simple examples), intermediaries who are engineers may need experience in innovation processes, contracts, extensive regulatory knowledge and customer engagement. Installers may need to build their IT skills, delve into operating envelopes, acquire new knowledge about new technology, install new workplace health and safety equipment and engage even further with customers. It is highly likely therefore that upskilling will take time. It is highly unlikely that upskilling of specialist intermediaries can happen at the pace required without significant support and intervention by government and funding bodies.

An installer interviewed provided an indication of the regular upskilling required at the scale to keep consumer installations going. This microcosm was a valuable example that indicated what is likely needed to scale intermediary activity in the limited time available.

Additionally, it is clear that innovators will still be needed to work alongside as practical scaled application of DOEs, and likely SOEs, occurs. While acknowledging the absolute importance of scaling activities and the need to put efforts into this, this relatively complex and specialised space will still require DOE and SOE innovation. If our innovators are assisting to scale intermediary groups by sharing skills (through formal or informal education), we may not have enough specialised people to work on everything required.

Critical roles heard about and observed during interviews and through observation as part of the Converge team (and through observation of previous project teams looking at DER) are listed in Table 1. This is effectively a first cut list of roles and skill areas that may be required – invariably there will be important roles missed in this first attempt at a list. These are being listed to outline the extent and the range of roles and skills that will be required as DOEs scale.

Table 1 Critical Roles and Capability required for DOEs at scale

Area	Examples of organisations involved	Examples of roles, skills and specialities needed. All need specialist knowledge of DER, DOE, and SOE.
Distributed network service providers DNSPs	Electricity Networks around Australia	Systems engineers, customer engagement specialists, future network strategists planners and experimenters, business specialists/strategists, regulation specialists, project managers, cyber security, market operations.

Area	Examples of organisations involved	Examples of roles, skills and specialities needed. All need specialist knowledge of DER, DOE, and SOE.
Retailers and aggregators	VPP service providers, and electricity retailers around Australia	Tariff and pricing specialists, overall value assessment (economists / accountants), regulation specialists, customer engagement, business specialists/strategists, product specialists, regulation specialists, project managers, market operations.
Technical product and service providers to organisations (including DER and aggregation services)	DER aggregation technology providers, DER IT systems providers.	Technical product developers-owners-maintainers, overall value assessment (economists / accountants), regulation specialists, customer engagement, business specialists / strategists, regulation specialists, project managers, cyber security.
Technical product and service providers to consumers (including installers and HEMs)	Solar and renewable energy installation companies, electricians and more.	Technical product knowledge, business management, customer engagement and education, regulation and work place health and safety oversight, trainers for installers, IT knowledge and/or training and/or support.
Australian governance oversight and development (including for markets, systems, and regulation)	Electricity supply regulation and market organisations – AEMC, AER, AEMO Energy oversight organisation – ESB State Ombudsmen	Monitors of innovation communities and monitors of new tech and system application at scale, regulation developers, consumer and stakeholder engagement specialists. compliance and checks of systems pricing, technology.
Renewable energy facilitators (including fundings organisations)	Renewable energy innovation funding bodies including ARENA.	Monitors of innovation communities and monitors of new tech and system application at scale, technical system specialists, political relationships engagement, regulation oversight, consumer and stakeholder engagement

Area	Examples of organisations involved	Examples of roles, skills and specialities needed. All need specialist knowledge of DER, DOE, and SOE.
		specialists, project development and monitoring, knowledge sharing.
Researchers and developers - innovation	Universities, think tanks, innovation consultancies, social research consultancies.	Research specialists – in technical (battery, power systems, electrical) design, business, social, economic, science. Applied research skills, commercialisation abilities, knowledge dissemination.
Peak body associations	PV associations, EV associations, Solar groups.	Regulatory and commercial activity oversight, member engagement oversight, business systems knowledge.
Community advocacy organisations, and	Council of social services, energy advocacy organisations, Energy Consumers Australia	Regulatory and commercial activity oversight, member engagement oversight, business, funding application knowledge, consumer engagement, knowledge dissemination, advocacy abilities.
Energy system observers and commentators.	Renewable magazines, technology associations, academics as observers.	Technical product knowledge, consumer engagement, communication skills/knowledge dissemination, advocacy abilities.

For all roles and skills needed, intermediaries would need to have reasonable comprehension of operating envelopes and dynamic operating envelopes. Responses from interviewees reiterated the need to understand the DER and DOE activity, knowledge-spaces and broader contexts before taking part in this space. Information provision and sharing for all parties involved was requested by multiple interviewees – so information exchange is sought. The highly specific and technical dynamic operating envelopes and the potential complexity of shaped operating envelopes suggests that strategic attention will be needed in regard to information dissemination and communication in this area.

A useful example of regular supportive communication was provided in an interview as a useful undertaking. This example highlighted how information in relation to DOE application from networks to installers was really important as installations occurred. Successful information flows in this instance between networks and installers led to better interactions and success with customers and with installations (interview on 3.10.22).

The need for growth of workforces, specialist upskilling and significant information flows suggests that targeted and extensive effort is needed in the DER-DOE (and maybe SOE) space if scaled activity is to occur.

Further data is available on critical gaps that need addressing as DOEs further scale. This will be addressed in future publications.

Intermediary impact on consumers, including householders

Intermediary activity has been observed to affect consumers who are involved in energy supply innovation. Most, or arguably all, decisions made have some effect down the line on consumers. As DER-DOE activity scales, intermediary activity will invariably further impacts consumers in multiple ways. Interviewees indicated in general that they are aware of and concerned about their and other intermediaries' impact on consumers. Each decision made about technology, pricing, communications strategies and more affects the experience of consumers, and this can be in positive or negative ways. Trust of consumers is intricately related to the impacts they feel and awareness of intermediaries about their impact on householders is reassuring.

Some technical design aspects of DOEs and SOEs, interviewees and the Converge team believed, may not be noticeable to consumers (in this case householders). Whether or not technical functions of DOEs and SOEs will be noticed will be ascertained in the coming householder research for Converge and reported in the second and final social report for this project. Moving back from the technical function of algorithms that are part of DOEs and SOEs, it is highly likely that other aspects of systems supporting DOEs and SOE implementation will be noticeable to consumers. Emerging and final findings of previous and ongoing trials and pilots confirm the numerous ways that DER and DOE solutions can be experienced by householders. It is clear from these projects that impacts and reactions of householders can be easily underestimated before innovations teams interact with them. Experiences of consumers may include reactions to:

- Early communications and information about the technology, trial, pilot or application,
- Type and content of contracts,
- Technology choices and installation locations,
- Installation processes,
- Ongoing processes involved,
- Noises from the technologies,
- Ongoing costs or benefits,
- Ongoing incentives, and
- Overall narrative of the activity (eg it could be valuable to a consumer for certain reasons).

Conclusion

This report provided an initial opportunity to outline insights shared by intermediaries working with some connection to dynamic operating envelopes, and also about possible opportunities for 'shaped' operating envelopes in Australia. This report is part of the Converge project and is looking at both dynamic and shaped operating envelopes because there is currently little social research undertaken on either of these concepts.

From interviews with intermediaries where a rich wealth of insights were shared, this first report has reported that :

- DOEs are generally well supported as an approach, with caveats and with a warning to undertake to use simple approaches first wherever possible.
- Multiple trials and application of flexible exports in South Australia are currently gradually generating insights into DOEs.
- SOEs are relatively unknown but intermediaries see there is a need to think through solutions in the space that SOEs are in – that is the space where we try to be even more efficient with network capacity and also consider the involvement of more actors (not just network needs alone).
- DOEs and SOEs require specialised understanding and there is a relatively small group of people working in this area. The roles, knowledge and skills need to include specialist understanding of DER, DOEs and their application and will need to be spread across varied organisations and systems.
- While intermediaries involved with DOE understand their decisions greatly impact consumers and householders who are involved, there is some speculation that the technical solutions may not be noticed that much by consumers at all. The next stage of this research will explore this further.

Overall the insights so far shared from intermediary interviews indicate a likely supported space for DOEs and a viable working space for SOEs as they are considered and developed. Further insights, such as intermediary insights about customers and related equity and fairness and critical needs for scaling of DOE will be reported in the next report.

Definitions and acronyms

ACT – Australian Capital Territory

AEMO – Australian Energy Market operator

AER - Australian Energy Regulator

ARENA – Australian Renewable Energy Agency

DEIP - Distribute Energy Integration Program

DER – Distributed energy resources. Distributed energy resources (DER) describes to assets or systems that generate renewable energy systems from separate, distributed locations. They can be located on private, commercial or public property. DER includes solar generation at homes, electric vehicles and batteries. Further explanation can be found at [Distributed energy resources - Australian Renewable Energy Agency \(ARENA\)](#) .

DNSP – Distributed network service providers

DOE – Dynamic operating envelopes. ‘Operating envelopes are the limits that an electricity customer can import and export to the electricity grid. These limits are agreed between networks, customers and the AER as part of the customer connection or regulatory process. Currently, in most cases, operating envelopes are fixed at conservative levels regardless of the capacity of the network because they are static and need to account for ‘worst case scenario’ conditions. Dynamic operating envelopes are where import and export limits can vary over time and location. Dynamic rather than fixed export limits could enable higher levels of energy exports from customers’ solar and battery systems by allowing higher export limits when there is more hosting capacity on the local network.’ ([Dynamic Operating Envelopes Workstream - Australian Renewable Energy Agency \(ARENA\)](#))

DSO – Distribution systems operators/operations

HEMs - Home energy management systems.

Intermediaries - human actors who have a function or purpose in any given system, and as such are critical actors of the system and can act as catalysts for change.

NMI – National Meter Identifier. A number that identifies a specific meter on networks/grids in Australia.

SOE - Shaped operating envelope

VPP - Virtual power plants - are clusters of energy sources working together via coordination platforms and systems, to provide energy supply (most often to an electricity network). They can include multiple (and many) energy sources and do not need to have energy sources located together. These varied energy sources are often called DER.

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