Smarter homes for distributed energy

Towards home energy management systems that respond to dynamic operating envelopes and unlock distributed energy

February 2022

Authors & acknowledgments

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ARENA

Australian Government

Australian Renewable Energy Agency

Executive summary

THIS STUDY

Energy systems globally are transitioning towards a low-emissions future, and the Australian electricity system is changing as more people install distributed energy resources in their homes.

Within this context, this study aims to assess how residential customers can coordinate their on-site assets through a home energy management system (HEMS). In particular, it looks at the readiness of available HEMS products and services to respond to dynamic rather than static import and export limits – known as *operating envelopes.*

The study fits within a body of work addressing the complexity of implementing dynamic operating envelopes at the customer's point of connection with the electricity distribution network. It is an ARENA-funded study led by strategy consultancy Enea, in support of the Distributed Energy Integration Program (DEIP) Dynamic Operating Envelopes Workstream.

There are four key objectives:

1. Provide an overview of the current state of customer asset orchestration and whether these assets can be coordinated to comply with dynamic operating envelopes (DOEs) specified at the connection point

2. Outline the benefits of orchestrating customer assets and assess the readiness of the HEMS market to orchestrate customer assets to meet DOEs at the connection point

3. Identify the gaps and barriers in terms of capability, market dynamics, and standards and regulations

4. Highlight possible areas for future investigation to progress DOE readiness.

Over the course of the study, Enea consulted with 27 organisations across six main industry stakeholder groups. Insights were gathered from HEMS technology and service providers, distribution network operators, retailers, energy governance organisations, consumer groups and the Australian National University (ANU). Based on the key findings, five areas for future investigation have been outlined to support the continued development of the HEMS market and facilitate the readiness of DOEs.

While the focus of this study is on residential customers and the use of HEMS, some findings from this report may be applicable in commercial and industrial contexts, where customers can also use a customer energy management system (CEMS[1]) to monitor, control, and coordinate their assets.

1 Note that in the case of residential customers, a customer energy management system is more commonly known as a home energy management system, or HEMS.

RENEWABLE ENERGY AT HOME

Distributed energy resources (DER) are small scale units or systems that generate or store electricity, usually located at homes and businesses. They include customer assets such as rooftop solar photovoltaic (PV) systems, battery storage, and electric vehicles (EVs). Other examples of on-site customer assets include appliances such as hot water systems, air conditioners and swimming pool pumps. Residential customers can monitor, control, and coordinate their assets using a home energy management system.

Operating envelopes are the limits placed on the electricity a customer can import or export to the electricity grid. Currently, the customer's operating envelope is determined by their connection agreement with their DNSP. In Australia, these limits tend to *be static* – that is, they are fixed, and often at conservative levels to account for 'worst case scenario' conditions as opposed to the actual network constraints at a given point in time.

Dynamic operating envelopes (DOEs), on the other hand, allow import and export limits to vary over time and location. They more accurately represent the bounds within which an electricity network can safely operate[2] as they consider specific physical and technical limits such as voltage and thermal constraints.

Because of this, DOEs can enable higher levels of energy exports from customers' solar and battery systems when a local network has higher capacity. By ensuring that DER operates within the bounds of the network's capacity, DOEs can increase it's overall hosting capacity of DER.

The use of DER in Australia is growing, with uptake continuing to increase. Implementing DOEs can support the integration of more DER within distribution networks across Australia. Some distribution network service providers (DNSPs) in Australia are already trialling DOEs, with an initial focus on export limits only.

It is within this context that this study was conducted, with a broad aim to understand and assess the technical and commercial readiness of home energy management systems in Australia to meet dynamic operating envelopes.

KEY FINDINGS

OVERVIEW OF THE CURRENT HEMS PRODUCTS AND SERVICES

> HEMS can be a dedicated piece of hardware or embedded in smart DERs

A HEMS is a technology platform through which at least one customer asset can be monitored and controlled. Assets typically orchestrated through a HEMS include solar PV, batteries, EV chargers and home appliances such as hot water systems, air conditioners, and swimming pool pumps. An overview of the behind-the-meter ecosystem is provided in **Figure 1.**

2 ARENA, "Dynamic Operating Envelopes Workstream," September 2021 [Online]. Available: https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/dynamic-operating-envelopes-workstream/

A HEMS can be embedded within smart DERs or installed as dedicated on-site hardware.

All HEMS include a software component, which drives the energy management and performance optimisation of devices. A HEMS can provide purely local control, such as through a smart inverter with embedded energy management capabilities, or it can be managed remotely by a service provider – for example, to enrol the customers' devices into a virtual power plant (VPP).

HEMS are usually paired with a customer interface, accessed through a web portal or app. Monitoring data of customers' energy usage can be accessed, and some functions of the HEMS may be manually controlled through this interface.

Some or all control of a customer's devices through a HEMS may be automated, depending on the services offered by the HEMS and the participation of the home or specific devices in energy and other markets. To allow for these services and market participation, a HEMS can also receive and respond to external signals.

> Customers can choose whether or not to establish an ongoing relationship with a service provider

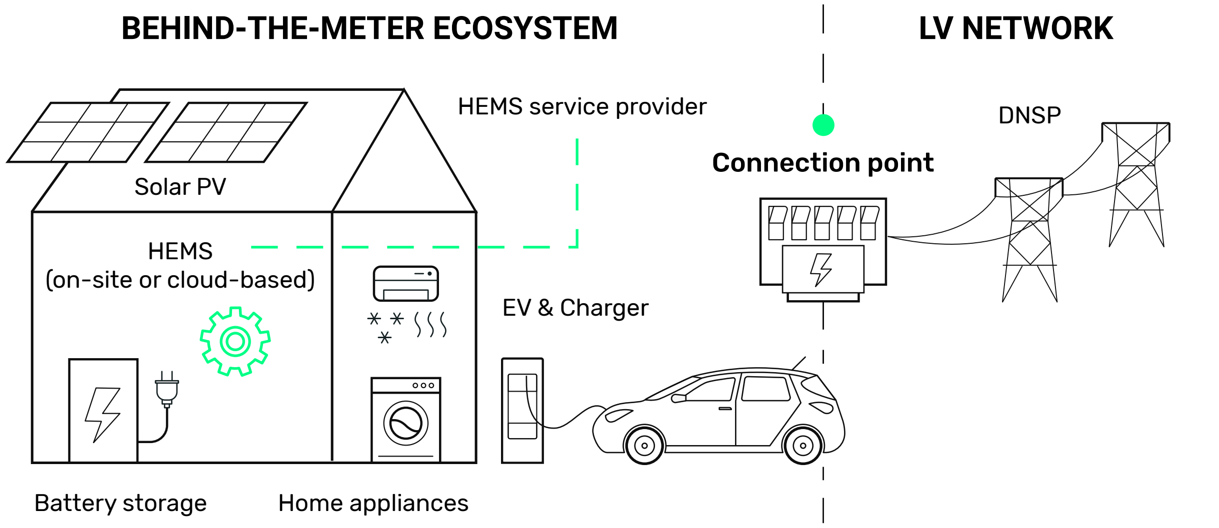
HEMS technology and service providers can have a direct or indirect relationship with customers. A customer may choose to install a HEMS but not to maintain an ongoing relationship with the provider. In this case, the HEMS is set up such that it follows the 'rules' the customer has selected. For example, the HEMS could be set up to optimise self-consumption, without a service provider in control.

Where the customer chooses to have an ongoing relationship with a service provider, typically an aggregator[3], the roles and responsibilities of the provider will vary depending on the agreement established and the business model used. A variety of compensation models are used by service providers as part of their offering to customers in return for control of their devices.

3 An aggregator is a third party that groups and operates many DERs together, to act as a single entity when providing services to the grid. This aggregation of DERs is typically known as a virtual power plant, or VPP.

FIGURE 1

OVERVIEW OF A HOME ENERGY MANAGEMENT SYSTEM



The main models are upfront hardware discounts, reduced (down to zero) retail rates, and fixed and variable rewards.

Some service providers do not directly charge customers in return for the provision of service whilst others operate on a subscription basis. The levels of subscription and fees paid by the customer in return for degrees of service vary – for example, from monitoring and optimisation of customer assets to Frequency Control Ancillary Services (FCAS) market participation as part of a VPP.

> Access to potential value streams is linked to the benefits that a HEMS can unlock

To manage financial risks and maximise value for customers, service providers generally stack as many value streams as possible. Potential value streams that a HEMS can unlock include:

- **Energy bill optimisation –** maximisation of self-consumption and tariff arbitrage (which requires the residential customer to have a cost-reflecive tariff, such as demand charges or Time-of-Use)
- **Energy market participation –** wholesale energy trading and participation in FCAS markets[4], where customers have chosen to join a VPP scheme
- **Provision of network services to DNSPs,** such as peak shaving or voltage management.

4 The Australian Energy Market Operator (AEMO) uses ancillary services to maintain the safety, security, and reliability of the power system. The delivery of ancillary services ensures the key technical characteristics of the system are maintained, with FCAS used to maintain the system frequency. VPPs can participate in contingency FCAS markets, while they are unable, for now, to participate in regulation FCAS markets.

Today, HEMS are typically set up to focus on maximising self-consumption and reducing energy bills.

> HEMS can contribute to a more sustainable, reliable, and affordable power system

A HEMS can unlock a range of financial, energy system, and broader social benefits. For residential customers, financial benefits include energy bill savings and access to additional revenue streams through market participation. Residential customers may also achieve increased autonomy and energy independence. Energy management can result in lowered emissions, through greater utilisation of on-site solar generation.

In addition to the network support services already provided through a HEMS, receiving and responding to DOEs represents an additional capability of a HEMS.

HEMS IN THE CONTEXT OF DOEs

DOEs can be specified directly for individual devices, or at the customer's connection point with the electricity distribution network. To respond to DOEs, a HEMS will need to meet several technical specifications set by DNSPs, as well as commercial and regulatory requirements.

> A single device can be used to receive and respond to a DOE specified at the connection point, with an increased coordination of multiple devices expected

For dynamic operating envelopes specified – or *published* – at the connection point, the total power flows for the customer's site will be required to remain within the published limits. In the near term, it is expected that a single device – for example, a solar PV system managed through a single smart solar inverter – will receive and respond to DOEs published at the connection point. To ensure that the site's net exports comply with the dynamic export limits, it is expected that the solar inverter will balance load with PV production. Where a battery is available as part of the system, the battery can be used to support this balance. As smarter home ecosystems become more developed, the coordination of multiple devices through a HEMS is expected to increase.

> HEMS can be used to receive and respond to DOEs

A major finding of this study was that the HEMS providers consulted do not view receiving and responding to DOEs as a technical challenge, either for the flexible export component in the near term or for flexible imports in the longer term. The capabilities of HEMS to coordinate customer assets for energy bill optimisation and energy market participation (in particular, contingency FCAS) have been successfully demonstrated. As such, HEMS providers consider incorporating the dynamic limits of DOEs a straightforward software programming matter, well within the scope of their technical capabilities.

However, the ability to comply with a DOE for load will depend on which customer assets can be controlled, as not all devices are or will be controllable. HEMS will also need to consider constraints on how customer assets can be coordinated to ensure that the net load at the connection point meets the requirements. For example, if a battery is fully charged, the response is limited in that the battery cannot be further charged to increase consumption. Similarly, further constraints on coordination are likely to be driven by customer needs and preferences.

> The commercial implications of implementing DOEs at scale are mostly unclear

Given that the implementation of DOEs currently remains restricted to trials, the commercial implications of that implementation at scale are mostly unclear. Although some service providers expressed concern that DOEs could impact their ability to stack value streams given the additional constraints that need to be considered, DOEs could also increase the value available to aggregators by providing greater access to the available network capacity.

HEMS providers and retailers also expressed concern around the cost implications of an unstandardised approach to DOEs. Both HEMS providers and retailers expect that integration with each DNSP's platform will result in additional costs if not nationally harmonised.

In addition to concerns around the commercial implications of implementing DOEs, the stakeholders consulted in this study identified several gaps and challenges that are impacting HEMS deployment. In some cases, these gaps and challenges are creating further uncertainty around how the HEMS market might interact with DOEs.

GAPS AND CHALLENGES ALREADY BEING ADDRESSED

Several of the gaps and challenges that were raised by this study's stakeholders are already being investigated, with the view of addressing them. In particular, investigations are underway into the issues relating to DNSP to customer connection point interoperability – including operational requirements for DOEs and regulatory requirements for cyber security. These gaps and challenges are outlined below.

> DNSP to customer connection point interoperability

This study identified the need to further progress DNSP to customer connection point interoperability. This issue, however, is in the process of being addressed through the DER Integration Application Programming Interface (API) Technical Working Group, under the DEIP Interoperability Steering Committee. This national working group is defining a nationally standardised approach to DNSP to connection point interoperability, including approaches for the publishing and communication of DOEs, based on the IEEE 2030.5 standard.

The working group recently produced the first version of the Common Smart Inverter Profile (CSIP-AUS) – the Australian implementation guide of California Rule 21 CSIP[5]. Accordingly, DNSPs' servers and client interfaces (for example, the HEMS interface) will need to be compliant with aspects of this implementation guide. Important operational requirements for DOEs, such as agreed fallback behaviour in the event of a loss of communications or of connectivity, are being defined through the CSIP-AUS.

> Limited regulatory requirements for cyber security

HEMS providers are currently managing cyber security, but national regulatory requirements for cyber security were also raised as a potential gap to be addressed for HEMS and DOE interaction. The Australian Government has proposed various legislative changes in Australia's Cyber Security Strategy 2020[6].
The strategy proposes introducing security and resilience requirements for critical infrastructure entities, such as the energy sector. A dedicated Cyber Working Group has recently been established through the DEIP Interoperability Steering Committee, and is progressing the development of cyber security requirements for DER.

AREAS FOR FUTURE INVESTIGATION

Five areas for future investigation were identified based on the gaps and challenges found in this study. Undertaking work in these areas could support the continued development of the HEMS market in Australia and facilitate the readiness of HEMS to receive and respond to DOEs.

5 DER Integration API Technical Working Group, "Common Smart Inverter Profile - Australia", September 2021. [Online]. Available: https://arena.gov.au/assets/2021/09/common-smart-inverter-profile-australia.pdf

6 Australian Government, "Australia's Cyber Security Strategy 2020", August 2020. [Online] Available: https://www.homeaffairs.gov.au/cyber-security-subsite/files/cyber-security-strategy-2020.pdf

1. Flexible trading relationships could consider the interactions with DOEs

The Energy Security Board (ESB) has proposed two flexible trading models that could enable customers to separate their controllable and uncontrollable resources. The first model introduces a second connection point for flexible loads, and the second model establishes a sub-meter connection point arrangement.

These models could provide customers with access to improved choice, revenue streams, and cost savings via greater access to energy markets. However, possible interactions between these proposed flexible trading relationship models and DOEs remain uncertain. In particular, it is unclear how the DOE would apply in either flexible trading relationship model.

The interaction between flexible trading relationships and DOEs could be further explored by energy governance bodies and governments, in collaboration with the wider energy industry. Findings could inform the choice, design, and implementation of such relationships. If DOEs are not considered, introducing flexible trading relationships and multiple connection points could add to the costs of implementing DOEs. It could also complicate how compliance with DOEs is managed and enforced. On the other hand, if the design and implementation of flexible trading relationships adequately considers DOEs, this will support access to improved choice, revenue, and cost benefits for customers.

2. Explore how to increase the HEMS value proposition for customers

Installing a HEMS can already unlock value for customers today, primarily through energy bill optimisation, energy market participation, and the provision of services to DNSPs. Several service providers highlighted that the provision of further services such as regulation FCAS could be technically feasible, which could increase the revenue streams available to residential customers. Regulatory changes and some technical innovations – for example, telemetry – would first be needed to enable participation in these markets.

Also, energy governance bodies and governments could explore – again through collaboration with the wider energy industry – how to increase the value streams and opportunities available to customers, by removing some of the barriers that prevent a fair two-sided participation.

To expand existing value streams, the following opportunities could be explored:

- Introducing more dynamic pricing – for example, Time-of-Use tariffs, critical peak pricing and real-time pricing – and exploring how stronger price signals could be passed through to customers
- Facilitating greater use of aggregated DERs to provide non-network solutions[7] under the Regulatory Investment Test for Distribution, or RIT-D.

7 Non-network solutions are initiatives that could reduce, defer, or avoid the need for capital investment into network upgrades.

New mechanisms could also be further explored:

- Mandating a control interface in large household appliances such as air conditioners, pool pumps and hot water systems, to allow for control of dispatchable loads
- Enabling household demand to participate in the Wholesale Demand Response mechanism[8], which is currently limited to commercial and industrial customers, or in a future two-sided market
- Enabling aggregated DER to participate in the future essential system services markets[9].

The aforementioned expansion of two-sided and essential system services markets is expected to be explored through the ESB's work on the post-2025 market design.

The roll-out of DOEs could further increase the HEMS value proposition, by unlocking greater hosting capacity and enabling customers to install more DER systems.

3. Investigate the costs and benefits of open device standards

A challenge highlighted by some HEMS providers is the lack of standards for interoperability at the customer asset level. Indeed, there is currently no open device standard or requirement for customer assets in Australia. As a result, there are multiple closed on-site ecosystems operating through proprietary protocols. This can create issues for HEMS providers when integrating with customer assets to optimise energy management.

To address this issue, energy governance bodies and governments could investigate the costs and benefits of introducing either mandatory or voluntary behind-the-meter open device standards.

The investigation could complement the ongoing work into standards such as the development of CSIP-AUS. International standards addressing DER interface interconnection requirements, such as IEEE 1547-2018, could be leveraged as a starting point. This standard requires that one of three specified communication protocols are supported: SunSpec Modbus, DNP3, or IEEE 2030.5. Note that further work on this standard would be required to ensure that coordination is adequately addressed. In addition, HEMS providers and original equipment manufacturers (OEMs) could put forward proposals to support the development of behind-the-meter open device standards, to ensure any future standards meet their needs and preferences.

As part of such an investigation, a regulatory perspective should be considered, to encourage competition within the behind-the-meter ecosystem and to ensure consumers are adequately protected. Such considerations are needed as the *Competition and Consumer Act 2010 (Cth)* does not absolutely prohibit a HEMS gateway or platform from limiting or providing differential access to other devices.

8 The Wholesale Demand Response mechanism in the National Electricity Market (NEM) allows demand side (or consumer) participation in the wholesale electricity market at any time. The mechanism allows consumers to bid and schedule a change, typically a reduction, in electricity consumption in return for payment. The demand response capability of large market loads is classified and aggregated for dispatch by Demand Response Service Providers (DRSPs).

9 The Energy Security Board has identified four essential system services to maintain system security, which market participants could be paid to provide. These services are frequency control, inertia, system strength, and ramping capabilities/operating reserves.

4. Explore the national harmonisation of DOEs

In the absence of standardisation, several different approaches to the definition, publication, communication, and enforcement of DOEs are likely to emerge across DNSPs. This could have cost implications for HEMS providers and, therefore, result in different experiences for consumers.

DNSPs and the wider energy industry have therefore been actively working over the past two years to progress a nationally harmonised approach to DOE standards based on the IEEE 2030.5 standard. A significant level of national consensus has already been achieved through the DER Integration API Working Group, and a first version of a national implementation guide that defines the technical standard and operating protocols has been developed.

To assess whether expanding the harmonisation of DOEs would be beneficial, DEIP could further explore the costs and benefits of a nationally harmonised approach to DOEs. Consideration should also be given to where provisions should be made for DNSPs to develop their own approaches, based on the specific needs of different networks. It is noted, however, that work to address this is already underway as part of various ARENA projects and the DEIP Dynamic Operating Envelopes Workstream.

Where the net benefits of a nationally consistent approach to DOEs are found to outweigh the alternative, energy governance bodies and governments could then consider how this harmonisation of DOEs can be best achieved.

Furthermore, national reporting of DOEs through a central registry could also be introduced. In particular, this could collate information on where provisions have been made for different approaches to DOEs. This would allow market participants and HEMS providers to see the DOE characteristics in each DNSP location at a glance.

5. Consider bespoke regulatory frameworks for compliance with and enforcement of DOEs

Where the responsibility for complying with the DOE might fall in the future – and how compliance will be managed, enforced, and communicated – remains uncertain.

Under the scheme currently envisioned, customers' DOEs are determined by their connection agreements with DNSPs. The customer is therefore the counter party responsible for compliance.

Where the customer has a relationship with a service provider, this third party acts as an agent on behalf of the customer. Whether or not a future arrangement might be introduced under which the service provider becomes the responsible counter party is unknown.

Energy governance bodies and governments could consider developing a bespoke regulatory framework for compliance with and enforcement of DOEs. Within such a framework, the needs and obligations of consumers and the needs of DNSPs to have operating envelopes complied with would need to be balanced with the extent of HEMS control of customers' devices.

Contents

Australian energy market context

Distributed energy resources, or DER, are small scale renewable energy units or systems that generate or store electricity, usually located at homes and businesses. These customer assets include rooftop solar photovoltaic (PV) systems, battery storage, and electric vehicles (EVs). Residential customers can monitor, control, and coordinate their assets using a home energy management system, or HEMS.

The amount of DER in Australia is growing, and uptake is set to continue rising. Customers are increasingly using their on-site assets to generate, consume, store, and manage electricity. This is changing the way distribution networks are managed, as a variety of solutions are deployed to optimise growing DER penetration.

THIS CHAPTER

To provide context for the report findings, this chapter covers some relevant aspects of the current Australian energy market – including the challenges the market faces and processes underway to address these. Specifically, it covers:

1.1 DER integration and the associated challenges

1.2 The broader market context

1.3 The ongoinging work contributing to the development of dynamic operating envelopes

1.1 DER integration and the associated challenges

THE RISE OF DER

Energy systems globally are transitioning towards a low-emissions future. As part of this transition, the electricity sector is becoming increasingly decarbonised and decentralised. Customers are deploying DER, including rooftop solar PV systems, battery storage, electric vehicles, and energy management technologies [1]. These on-site customer assets are being used to generate, consume, store, and manage electricity on-site. Electricity that is not consumed can then be fed back to the electricity grid, creating bi-directional energy flows.

Currently, there are three million rooftop solar PV systems installed on Australian homes and small businesses [2]. This equates to nearly 30 per cent of Australian households. CSIRO forecasts suggest that up to 50 per cent of households could have solar PV installed by 2050. Of these households, it is estimated that up to 60 percent could also have a battery installed [3]. As the uptake of DER continues to rise, so do the opportunities and challenges associated with integrating these resources.

DISTRIBUTION NETWORK CHANGES

Integrating DER into the electricity system changes how distribution network service providers (DNSPs) operate local networks. This includes managing power quality disturbances and balancing bi-directional energy flows.

As part of these changes, a variety of future grid solutions are being deployed to optimise growing DER penetration. These include network augmentation solutions, such as upgrading transformers, and non-network solutions. Examples of non-network solutions include introducing customer demand response programs, deploying community storage, and dynamic operating envelopes.

DYNAMIC OPERATING ENVELOPES TO SUPPORT DER INTEGRATION

Static export limits have been the default for solar PV and battery system exports. These limits have typically been set at 5kW for residential customers. Whilst this has helped DNSPs to maintain a secure and stable grid, these limits can lead to suboptimal economic outcomes [4].

Dynamic operating envelopes (DOEs) support the increased integration of DER[10].

10 DOEs could also be used to help manage system security issues such as minimum demand.

DOEs are flexible upper and lower bounds placed on customers' imports and exports of power. These limits vary over time and location and are a principled allocation of the available DER hosting capacity within a segment of the distribution network [5]. They can be applied on both real and reactive power. This ensures that physical and operational limits of the local network are not breached.

DOEs can be specified – or *published* – at the individual device level or at the customer's connection point with the distribution network [5]. Whilst this study has focused on DOEs that are published to the connection point, device-level operating envelopes are also discussed in this report.

1.2

Broader market context

A number of initiatives are underway to modernise Australia's electricity market design towards unlocking the full potential of renewable energy. Several of these are looking to provide additional opportunities for the deployment and optimised use of DERs.

POST-2025 ELECTRICITY MARKET DESIGN, TO DELIVER A STRONGER AND LOWER EMISSIONS POWER SYSTEM

Work on the development of DOEs, as outlined in section **1.3**, interacts with the Australian Energy Security Board's recommendations for the post-2025 market design [6]. In particular, the Energy Security Board, or ESB, has investigated the concept of flexible trading relationships and proposed two flexible trading models that could enable customers to separate their controllable and uncontrollable resources. The first model introduces a second connection point for flexible loads, whereas the second model establishes a sub-meter connection point arrangement.

New connection point arrangements could enable consumers to engage with more than one energy service provider. This could provide customers with access to improved choice, revenue streams, and cost savings via greater access to the spot and service markets. However, either model could complicate how DOEs are managed in the future. It is unclear how the DOE would apply if there was either a second connection point or a sub-meter connection point arrangement.

As part of the ESB's DER Implementation Plan, within its recommendations for the post-2025 market design, several stages for the introduction of DOEs are set out including a system level use case for DOEs. This would see the Australian Energy Market Operator (AEMO) make system level DOEs available, to manage minimum demand, as a potential next step for the rollout of DOEs. In this instance, the operational security constraint would be defined based on information from AEMO. This would require additional integration with AEMO systems [6]. In the longer term, AEMO could publish minimum load signals through market notices and a system level DOE repository [7].

NEW REGISTRATION CATEGORY FOR AGGREGATORS, TO FACILITATE THE MARKET PARTICIPATION OF SMALL GENERATION AND STORAGE UNITS

Within the ESB's final advice to Energy Ministers, the SGA+ model is proposed. This extends the existing Small Generator Aggregator (SGA) market participant category. The proposed model adds bi-directional flows and participation in FCAS markets into the category [8].

The Australian Energy Market Commission (AEMC) is considering further transforming the SGA category, as part of the *Integrating energy storage systems into the NEM rule change.* The draft rule introduces the Integrated Resource Provider (IRP) as a new participant category. This category would apply to grid-scale storage, hybrid facilities, and DER aggregators. Aggregators registered as IRPs could aggregate generation and load to provide market ancillary services and participate in the wholesale market [9]. This provides greater flexibility in how customers' small generating or integrated resource (load and generation) units can be used to participate in the market.

OTHER MARKET DEVELOPMENTS IMPACTING THE EVOLUTION OF THE HEMS MARKET

The ESB final advice also includes the Scheduled Lite reform, which encourages aggregators to provide visibility of market intentions to AEMO, on an opt-in basis. This reform could make it possible for aggregators to participate in the centralised scheduling and dispatch of generation by AEMO, with lighter telemetry requirements. The introduction of a lighter version of the current Supervisory Control and Data Acquisition (SCADA) requirement would lessen the barriers to entry into central dispatch [8]. How Scheduled Lite would interact with DOEs is yet to be clarified.

Uncertainty around third party access to technical data from customers' electricity meters remains. At the time of writing, the AEMC's ruling on accessing and improving the exchange of this data has not yet been finalised [10]. Without access to this technical data, HEMS providers often install additional metering at the customer's site, since real-time readings of power flow (import and export) information are required for orchestration.

1.3

Ongoing work contributing to the development of DOEs

THE DISTRIBUTED ENERGY INTEGRATION PROGRAM (DEIP)

The Distributed Energy Integration Program (DEIP) is a collaboration of government agencies, market authorities, industry, and consumer associations aimed at maximising the value of customers' DER for all energy users. DEIP is supported by the Australian Renewable Energy Agency (ARENA) [11].

THE DYNAMIC OPERATING ENVELOPES WORKSTREAM

Within DEIP, a dedicated Dynamic Operating Envelopes Workstream has been established [12]. This workstream explores how DOEs could support DER integration and further the energy transition. In collaboration with market participants, it is also identifying opportunities and challenges that arise from the implementation of DOEs.

Based on findings from the workstream's explorations of the issues relating to DOEs, behind-the-meter complexity has been identified as a priority issue. This issue is two-fold, and encompasses:

- The complexities that could arise when multiple parties are physically or financially responsible for power flows at connection points subject to a DOE
- The possible need for a single customer energy management system, or CEMS, with the capability to orchestrate customer assets, to optimally meet the DOE at the connection point.

2

Study overview

THIS CHAPTER

Within the context of these broader market changes, this ARENA-funded study aims to better understand the HEMS options available to residential customers. It also aims to assess how these can be used to receive and respond to DOEs.
This chapter covers:

2.1

Study objectives

This study fits within the body of work to address behind-the-meter complexity and implement dynamic operating envelopes at the connection point. It is an ARENA-funded study led by Enea, in support of the DEIP Dynamic Operating Envelopes Workstream.

It aims to assess the customer asset coordination options available for residential customers through the use of a HEMS. The readiness of these options to respond to DOEs is also assessed. Accordingly, there are four key objectives:

1. Provide an overview of the current state of customer asset orchestration and whether these can be coordinated to comply with DOEs issued at the connection point

2. Outline the benefits of orchestrating customer assets and assess the readiness of the HEMS market to orchestrate customer assets to meet DOEs at the connection point

3. Identify the gaps and barriers in terms of capability, market dynamics, and standards and regulations

4. Highlight possible areas for future investigation to progress DOEs readiness.

While the focus of this study is on residential customers and the use of HEMS, some findings from this report may be applicable in commercial and industrial contexts, where customers can also use a CEMS[11] to monitor, control, and coordinate their on-site assets.

2.2

Study approach

This study was made possible by insights gathered from industry stakeholders, through a wide-ranging consultation process, as well as a research and analysis process.

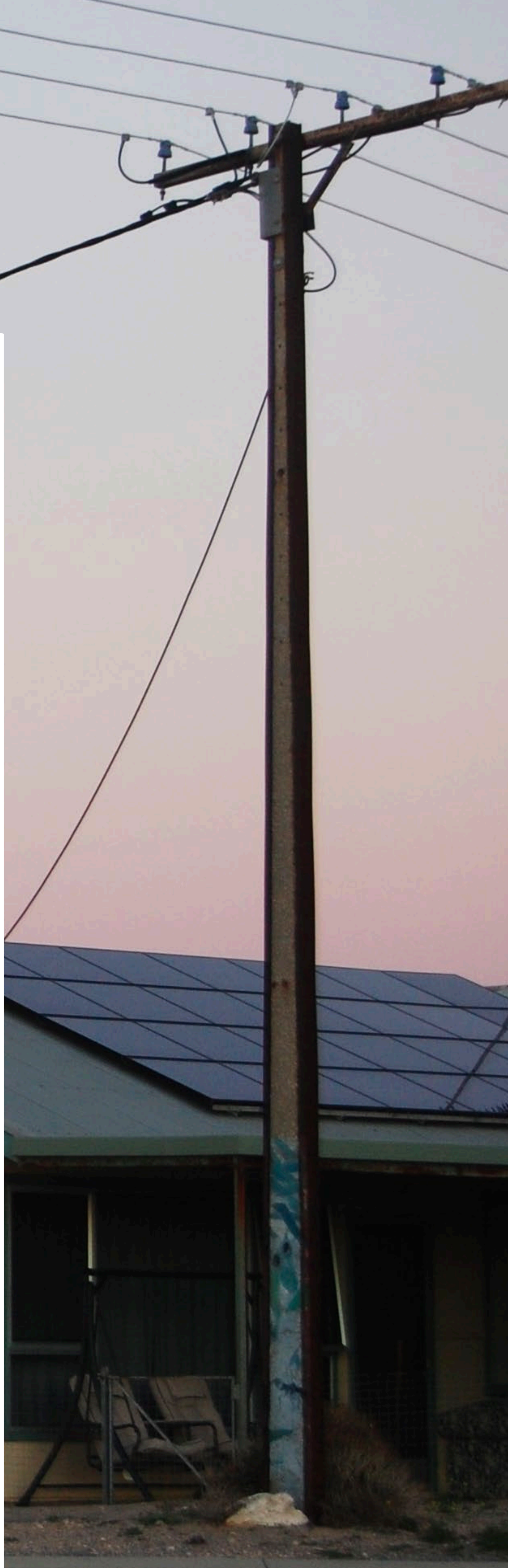
Over the course of the study, Enea consulted with 27 organisations across six main stakeholder groups. HEMS providers, distribution network operators, retailers, energy governance organisations,

11 Note that in the case of residential customers, a customer energy management system is more commonly known as a home energy management system, or HEMS.

consumer groups and the Australian National University were consulted. The complete list of stakeholders consulted is provided in **Appendix 1**.

Stakeholders were consulted through a series of one-on-one and group interviews as well as a workshop with the DEIP Dynamic Operating Envelopes Workstream Steering Committee. During the workshop, the initial findings of this study were presented. This included the segmentation of HEMS offerings and DOE specifications. Areas for further investigation were also refined through the workshop discussion.

Matters relating to consumer protections were further investigated. Legal advice was provided by Allens, with the findings from this analysis included within this report. A summary of the legal analysis is provided in **Appendix 2**.



Home energy management systems

THIS CHAPTER

This chapter outlines the customer asset coordination options available for residential customers through the use of a HEMS and the benefits thereof. Specifically, it covers:

3.1 The current energy management products and services that are available for residential customers

3.2 The broader benefits that can be unlocked through the deployment of HEMS

3.1

Overview of current energy management products and services for residential customers

3.1.1

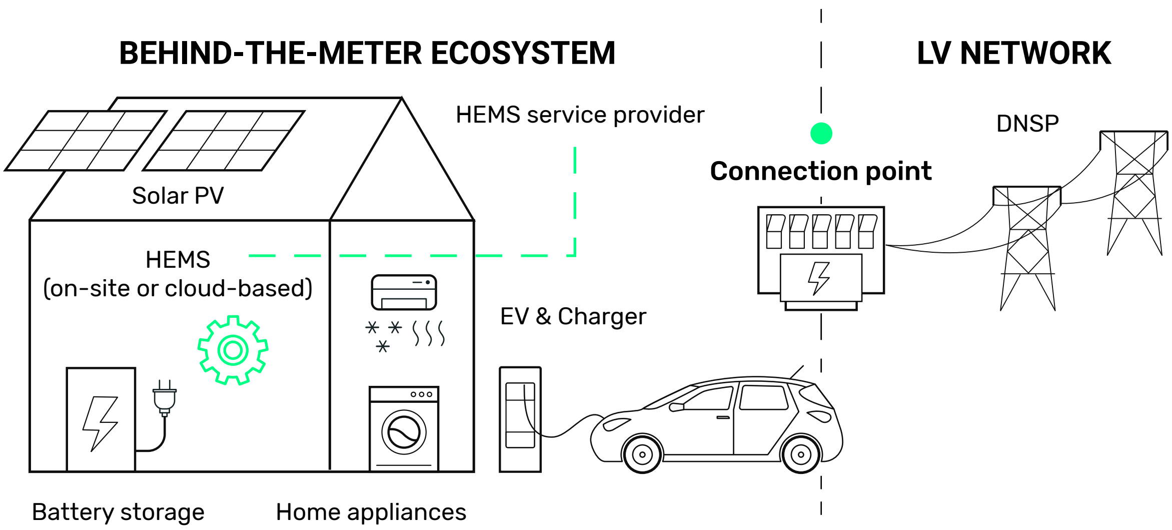
DEFINING A HEMS

A HEMS is a technology platform through which at least one customer asset can be monitored and controlled. Devices typically orchestrated by a HEMS include rooftop solar PV, batteries, and large home appliances such as hot water systems, air conditioners and swimming pool pumps. An overview of the behind-the-meter ecosystem in the residential context is provided in **Figure 2.**

In addition to energy management capabilities, a HEMS can receive and respond to external signals. HEMS can be embedded within smart DER (such as solar or battery inverters) or installed as dedicated on-site hardware. HEMS are usually paired with a customer interface that can be accessed through a web portal or app. Through this interface, customers can monitor their energy usage data and some functions of the HEMS may be manually controlled. The customer's level of control depends on the product, and for those customers with a HEMS managed by a third party, on their agreement with their service provider. Some or all control of devices through a HEMS may be automated, based on the specific services offered through the HEMS and the participation of the home or specific devices in energy and other markets.

FIGURE 2

OVERVIEW OF A HOME ENERGY MANAGEMENT SYSTEM



3.1.2

TECHNICAL OVERVIEW

A HEMS gateway is the interface through which customer assets are managed. This can take one of two configurations – on-site hardware, or embedded energy management capabilities in a smart DER device.

In the first configuration, a HEMS can be installed through a dedicated piece of on-site hardware, generally located at or near the connection point. Examples include SwitchDin's Droplet, Reposit's Smart Controller, and Combined Energy's Gateway.

A more ubiquitous alternative is for a smart DER (such as solar or battery inverters) with embedded – or *native* – energy management system capabilities to function as a gateway device. Devices with built-in energy monitoring and management capabilities include the sonnenBatterie and SolarEdge's Energy Hub inverter. Some smart inverters may already have some of these capabilities, such as the dynamic control of real and reactive power based on local voltage conditions.

ON-SITE OR CLOUD-BASED SOFTWARE ENABLES THE ENERGY MANAGEMENT AND PERFORMANCE OPTIMISATION OF CONTROLLED DEVICES

Beyond driving energy management, the software used in a HEMS is also responsible for managing data flows and communication channels.

EXAMPLE 1 – SWITCHDIN DROPLET (ON-SITE HEMS GATEWAY)

The Droplet is a HEMS for solar PV, battery storage, and controllable loads.

Cost — Approximately $250 (excluding installation)

Capabilities — Local controller providing a smart energy management system, remote control, and improved device management. This includes:

- Control of charging and discharging of battery
- Smart control of whole system (power meter, solar, and battery systems)
- Smart inverter functions including self-consumption, managed import and export, tariff optimisation, demand management, managed grid voltage support, solar curtailment and smoothing, time-based charging management
- Enhanced energy management with optimal control of solar, batteries, and loads
- Microgrid, VPP, and utility demand response management support [13].

Software can be configured to deliver a range of outcomes, from simply controlling devices to optimise energy bills, to providing network services to DNSPs.

In some cases, software is embedded within the hardware to run on-site energy management capabilities. The range of capabilities that are native to a device compared to cloud-based varies by HEMS.

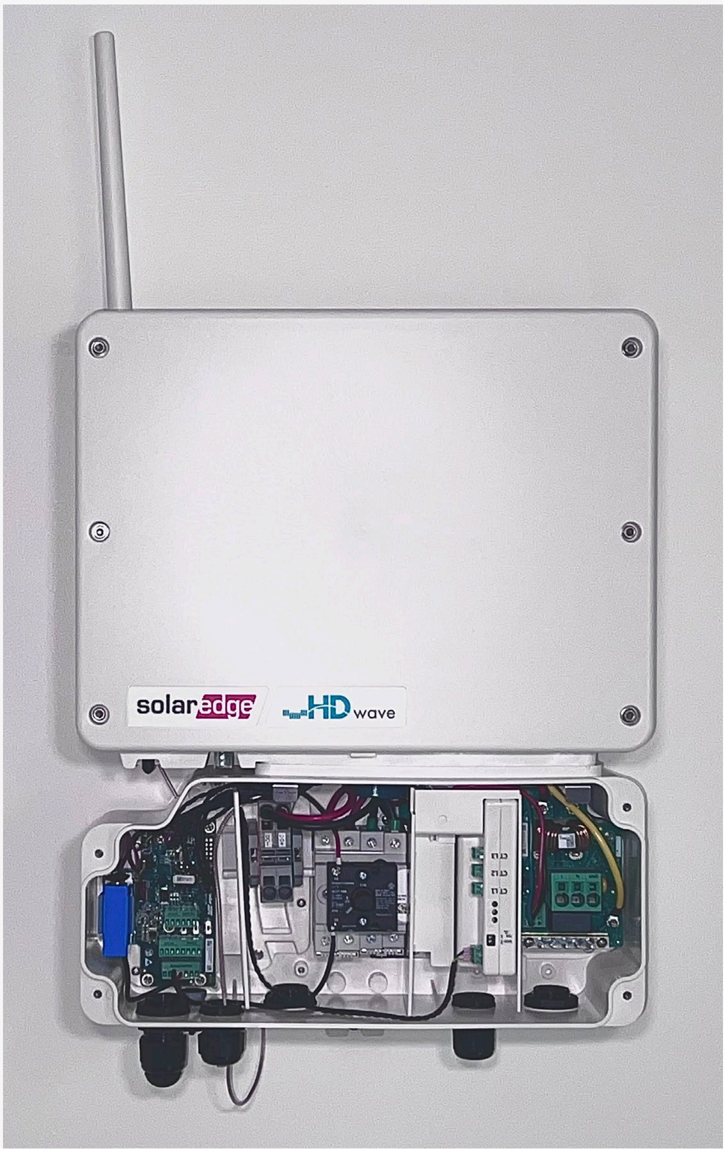
EXAMPLE 2 – SOLAREDGE ENERGY HUB INVERTER (SMART DER WITH EMBEDDED ENERGY MANAGEMENT CAPABILITIES)

The SolarEdge Energy Hub is a smart inverter that provides a single energy management platform for solar PV, battery storage, EV chargers, and home appliances connected to SolarEdge Smart Energy devices.

Cost — Not available

Capabilities — Smart inverter with embedded energy management capabilities, providing a smart energy management system, remote control, and improved device management. This includes:

- Control of charging and discharging of battery
- Real-time reporting
- Ability to schedule energy usage
- Manage a growing range of home appliances connected to SolarEdge Smart Energy devices
- Control EV charging, including remote start and stop charging for EVs and smart scheduling [15].



Other devices have minimal on-site software, with all orchestration performed via cloud-based platforms.

COMMUNICATION CAPABILITIES ENSURE INTERACTIONS BETWEEN CUSTOMER ASSETS

Local communication between the HEMS and on-site customer assets can be wired, wireless, or a combination of both. Establishing local communication links ensures interactions between devices and the control of these assets through a HEMS.

Examples of wired communication technologies include power line communications and wired Ethernet (LAN). Wireless communication network options include Wi-Fi, cellular (for example, 4G and 5G) and Zigbee.

ALTHOUGH OPEN, STANDARDS-BASED PROTOCOLS EXIST, PROPRIETARY PROTOCOLS ARE ALSO USED TO INTEGRATE ON-SITE CUSTOMER ASSETS WITH HEMS

A variety of communication protocols are used to interface and control on-site customer assets. These can be broadly categorised into two types.

The first type consists of open, standards-based protocols and published private protocols for interfacing customer assets. These include SunSpec Modbus, IEEE 2030.5, HTTP, and MQTT. It is important to note, however, that standards-based protocols may still be open to high levels of proprietary interpretation by original equipment manufacturers (OEMs), even within the scope of the standard. This can lead to variation in how a standard is implemented and barriers to device integration with HEMS.

The second type encompasses proprietary protocol layers. By using these, technology providers create closed on-site ecosystems, which presents a challenge for local interfacing and control. This may, in turn, impact a customer's ability to switch HEMS and service providers.

CYBER SECURITY THREATS NEED TO BE MANAGED, AS ADDITIONAL COMMUNICATION LINKS ARE ESTABLISHED WITH THE HEMS

Cyber security is an issue of growing importance, with the use of real-time, two-way communication to manage electricity networks. As interfaces between electricity networks and third parties increase and information is shared between operational and business systems, exposure to cyber security threats is rising [16].

HEMS technology and service providers are actively managing their exposure to these threats. Where HEMS providers supply both commercial and industrial as well as residential customers, the management of cyber security is often driven by the requirements of larger, commercial clients.

One way that HEMS providers are addressing cyber security issues is through compliance with international standards. This includes certification against *ISO/IEC 27001 – Information security management.*

A few of the HEMS technology providers interviewed frequently undergo penetration testing, to verify that security risks are being adequately managed.

Some stakeholders raised concern that hardware with IEEE 2030.5 client software could be easily breached, as the interoperability standards[12] being developed for the Australian energy sector do not provide a comprehensive, end-to-end guide to cyber security. In particular, the guidelines for these standards do not cover the link between an aggregator and customer assets [17]. This absence of minimum requirements for cyber security could lead to consumer protection issues and increase the power system risks in the event of a cyberattack. This may have a negative impact on consumer trust and slow down HEMS deployment.

THE COORDINATION CAPABILITIES OF THE HEMS PRODUCTS AND SERVICES CURRENTLY AVAILABLE HAVE BEEN SUCCESSFULLY DEMONSTRATED

HEMS product and services available in Australia are well developed in terms of their technological readiness. In particular, the capabilities of HEMS to coordinate customer assets for energy bill optimisation and energy market participation have been successfully demonstrated. However, barriers to the integration of on-site customer assets with HEMS still exist. Such barriers are driven by the variation in communication protocols used and the lack of interoperability standards for customer assets.

As standards for third party integration with electricity networks are introduced (such as CSIP-AUS12[12]), the ability of HEMS to comply with these requirements will need to be thoroughly demonstrated across all HEMS products and services. Whilst testing of IEEE 2030.5 implementation in Australia has begun, not all HEMS providers have successfully demonstrated this capability yet. Most HEMS providers interviewed are, however, working towards implementing CSIP-AUS.

Given the technological feasibility of HEMS, which has been demonstrated beyond prototypes, the current state therefore corresponds to a technology readiness level (TRL) of 8[13] – *Actual system completed and qualified through test and demonstration in an operational environment.*

In light of the ongoing changes to the operational environment with the introduction of DOEs, IEEE 2030.5 capabilities need to be successfully proven across all HEMS products to reach TRL 9 – *Actual system proven through successful operations.*

12 Common Smart Inverter Profile (CSIP), SunSpec IEEE 2030.5 (SEP2) and the current version of CSIP-AUS (otherwise known as the Australian implementation guide of California Rule 21 CSIP).

13 The technology readiness scale used by ARENA for renewable energy technologies ranges from *TRL 1 – Basic principles ob-served and reported* to *TRL 9 – Actual system proven through successful operations.* The technology and commercial readiness scales are further detailed in **Appendix 3.**

HORIZON POWER'S ONSLOW DER PROJECT IS DEMONSTRATING HOW CUSTOMERS' DER ASSETS CAN BE ORCHESTRATED TO SUPPORT A HIGHER PENETRATION OF RENEWABLE ENERGY SOURCES.

PROJECT OBJECTIVES AND APPROACH

The Onslow DER project aims to demonstrate a high penetration of renewable energy sources and is set to be Australia's largest microgrid supported by such a high level of DER. To address the safety, reliability and operational challenges associated with renewables, the project is piloting the remote management and orchestration of customers' DER assets. To do this, SwitchDin's utility Droplets are being used as a secure gateway device in 260 households and businesses. PXiSE Energy Solutions is supplying the software for a DER Management System (DERMS). SwitchDin's Droplet is compliant with the international IEEE 2030.5 standard for inverter control, making Horizon Power one of the first utilities in Australia to leverage the 2030.5 client functionality for DER [18].

INNOVATIVE ASPECTS OF THE PROJECT

Horizon Power was constrained by how many rooftop and utility-scale solar PV systems it could connect to the Onslow grid. A high volume of unmanaged, variable solar PV generation across Onslow's houses and businesses increases the potential of grid instability. This could cause power outages and power quality issues for Onslow's residents.

The project is one of the first instances of the use of an end-to-end DER management system in Australia

OUTCOMES OF THE PROJECT

In May 2021, the Onslow microgrid was run on 100 per cent solar and battery power for 80 minutes. 600kW of utility scale solar and 700kW of small scale solar generation serviced the grid, supported by 1MWh of small-scale battery storage installed across Onslow. This achievement demonstrated how the orchestration of DER can support a high degree of grid stability whilst increasing the amount of renewable energy that can be accessed [19].

100 %

SOLAR AND BATTERY POWER FOR 80 MINUTES

700 kW

OF SMALL SCALE SOLAR GENERATION AND 600 kW OF UTILITY SCALE SOLAR

1 MWh

OF SMALL-SCALE BATTERY STORAGE INSTALLED ACROSS ONSLOW

3.1.3

COMMERCIAL OVERVIEW

CUSTOMERS CAN CHOOSE WHETHER OR NOT TO ESTABLISH AN ONGOING RELATIONSHIP WITH A SERVICE PROVIDER

HEMS technology and service providers can have a direct or indirect relationship with customers. A customer may choose to install a HEMS but not to maintain an ongoing relationship with a service provider. In this case, the HEMS is set up such that it follows the 'rules' the customer has selected. For example, the HEMS could be set up to optimise self-consumption, without a service provider in control.

Where a customer chooses to have an ongoing relationship with a service provider, typically an aggregator[14], the roles and responsibilities of the service provider will vary depending on the agreement established and the business models used. This ongoing relationship can typically be:

- **Direct –** a single vertically integrated organisation could supply the HEMS technology and also provide services. Under this arrangement, the HEMS provider might sell their products and services directly to the customer or through a partner, such as an OEM or equipment wholesaler/supplier. Regardless of whether or not a partner is involved, a direct relationship is established between the HEMS provider and the customer. As such, the HEMS provider remains responsible for delivering energy management services to the customer and may also perform other roles including those of a retailer or an aggregator.

14 An aggregator is a third party that groups and operates many DERs together, to act as a single entity when providing services to the grid. This aggregation of DERs is typically known as a virtual power plant, or VPP.

TABLE 1 POSSIBLE RELATIONSHIPS BETWEEN HEMS TECHNOLOGY PROVIDERS AND RESIDENTIAL CUSTOMERS

	NO ONGOING RELATIONSHIP	DIRECT RELATIONSHIP	INDIRECT RELATIONSHIP
Customer agreement	None	Directly with the HEMS technology provider	With an aggregator or retailer (or other third party), who then has an agreement with the HEMS technology provider
Role and responsibility of the HEMS technology provider	No ongoing role or responsibility HEMS set up to follow the 'rules' selected by the customer (such as optimisation of self-consumption)	Provides HEMS technology and energy management services (can include operating a VPP) *Can act as retailer* *Other services depend on the roles performed*	Provides HEMS technology only. Responsibilities will depend on the capabilities of the retailer or aggregator *The HEMS provider may still provide services to the retailer or the aggregator, but not directly to the customer*

- **Indirect –** a separate relationship between the customer and a retailer or aggregator (or other third party) is established. Under such an arrangement, the retailer or aggregator is most commonly in a relationship with a HEMS technology provider, delivering energy management services to the customer through a HEMS. The split of responsibilities will depend on the capabilities of the retailer or aggregator. For example, some retailers may have their own VPP platform that is operated in-house whilst others will outsource the full scope of VPP operations to the HEMS provider. The range of services offered by the HEMS provider through the retailer or aggregator can vary depending on the commercial agreements between the retailer or aggregator and customers.

An overview of these arrangements is provided in **Table 1.**

CUSTOMERS ARE COMPENSATED FOR GIVING HEMS PROVIDERS CONTROL IN DIFFERENT WAYS

A variety of compensation and fee-based subscription models can be used by HEMS providers as part of the offering to customers in return for control of their on-site assets. The main models identified are:

- **Upfront hardware discounts –** discount or rebate offered on the cost of purchasing a HEMS. Note that these draw on government subsidies and rebates.
- **Reduced (down to zero) retail rates –** savings on retail electricity bills. Examples include a “no bills” offer and guaranteed bill savings (either an absolute amount or a relative percentage).
- **Fixed and variable rewards –** financial rewards paid on the amount of energy exported from the customer site (e.g. grid credits). Rewards are based on the level of control and amount of dispatch made available by the customer at certain times.
- **Subscription models –** payment of fees by the customer to the HEMS provider in return for services, on a subscription basis. Levels of subscription and fees payable in return for degrees of service vary (for example, from monitoring and optimisation to market participation).

MOST HEMS PROVIDERS TARGET LARGE RESIDENTIAL ASSETS FOR COORDINATION

Coordinating large residential assets is the focus of most HEMS providers. Priority customer assets include batteries, solar PV, hot water systems, swimming pool pumps, sometimes air conditioners, and potentially EV chargers. The customer assets that can be managed by a single HEMS depend on the capabilities of the system. The scale of integration ranges from only managing solar or battery systems, towards “whole of house” control (noting that not all devices are or will be controllable). The goal of integrating and orchestrating each additional device is to help manage net power flows at the customer connection point more efficiently.

HEMS providers offer coordination under two main configurations, either integrating existing customer assets or selling a bundled HEMS plus DER package. In the first case, HEMS providers integrate with any existing customer assets, to the extent that integration can be achieved (as proprietary communication protocols, or the lack of a control interface, may prevent on-site, local interfacing). The management of some devices, like hot water systems, can be achieved by turning the supply of power on or off. In this case, a control interface is not required at the device.

In the second case, HEMS technology providers sell a bundled package (such as a HEMS plus solar PV and battery system bundle) to residential customers. These providers will only integrate with specified new devices a customer may choose to install. Some existing customer assets may be viewed as non-controllable and will not be integrated into the system, given the costs and/or difficulty of integration.

Some of the assets targeted by HEMS providers (such as hot water systems) have traditionally been managed by DNSPs through controlled load programs. DNSPs have used signals and specific tariffs for these loads, independently from generation considerations. With the emergence of DOEs, the control of these devices could shift from DNSPs to HEMS providers. This change in responsibility could lead to DNSPs generalising their pricing and their offering for dispatchable loads.

ACCESS TO POTENTIAL VALUE STREAMS IS LINKED TO THE BENEFITS THAT A HEMS CAN UNLOCK

To manage financial risks and maximise value for customers, HEMS providers generally stack as many value streams as possible. Potential value streams that a HEMS can unlock, from one to many, include:

Energy bill optimisation

- Maximisation of of total energy use and maximisation of self-consumption. This is commonly the primary, and often largest, focus of product offerings
- Tariff arbitrage. This requires the residential customer to have a cost reflective tariff, such as demand charges or Time-of-Use (ToU)

Energy market participation

- Wholesale energy trading, for solar PV, battery, and EV exports
- Participation in FCAS markets[15], through a VPP operator that is registered as a Market Ancillary Service Provider

Provision of network services to DSNPs

- Examples of services include peak shaving or voltage management
- Note that the provision of these services is not widespread, however it is being trialled and taken up by some DNSPs on a locational basis - for example, at site and feeder level.

The focus of HEMS providers today is to undertake energy bill optimisation on behalf of customers and enable participation in VPPs[16] . Receiving and responding to DOEs represents one future capability of a HEMS, but others are also possible, such as the provision of non-network solutions.

ALTHOUGH AN EARLY LEVEL OF COMMERCIALISATION HAS BEEN ACHIEVED, THE HEMS MARKET REMAINS RELATIVELY NASCENT IN AUSTRALIA

Multiple commercial applications of HEMS in Australia have been deployed, although the market is still emerging and remains relatively immature. Some HEMS applications are still reliant on funding

15 The Australian Energy Market Operator (AEMO) uses ancillary services to maintain the safety, security, and reliability of the power system. The delivery of ancillary services ensures the key technical characteristics of the system are maintained, with FCAS used to maintain the system frequency. VPPs are able to participate in contingency FCAS markets, while they are unable, for now, to participate in regulation FCAS markets.

16 Currently, participation in a VPP enables the provision of FCAS and response to energy market price signals. In the future, VPPs could potentially deliver other services, including DOEs at the aggregated level as well as energy security and reliability services.

through upfront hardware discounts (such as through state government battery or solar system subsidies) and trials to support and demonstrate the commercial viability of deployment. Several of the HEMS offerings available in Australia are also available internationally (commonly in the US and Europe).

Business models are expected to continue evolving in the near to medium term. Thus far, no HEMS providers have successfully scaled up beyond niche markets (especially households with batteries) by both unlocking the available benefits and overcoming the barriers to mass HEMS deployment. These barriers are primarily commercial. Although an early level of commercialisation has been achieved across the HEMS market in Australia, significant barriers to uptake persist (as outlined in section **5**). This corresponds to a Commercial Readiness Index (CRI)[17] Status Summary *Level 3 – Commercial Scale Up.*

17 The CRI is used by ARENA to measure the commercial readiness of renewable energy solutions, and ranges from *CRI 1 – Hypothetical Commercial Proposition* to *CRI 6 – Bankable Asset Class* [41]. The technology and commercial readiness scales are further detailed in **Appendix 3**.

THE CORE4GRID TRIAL IN THE UNITED KINGDOM SOUGHT TO PROVE THE MARKET VIABILITY OF HEMS, ASSESSING HOW WHOLE HOME OPTIMISATION SOLUTIONS CAN LEVERAGE REAL-TIME SMART METER DATA.

PROJECT OBJECTIVES AND APPROACH

The UK Power Networks (network operator for the Southeast and East of England) Core4Grid project trialled the integration of solar PV, EV chargers, hot water systems, and batteries via a HEMS (in this case using geo's Core system). To demonstrate the current market for a flexible future grid, the project aimed to prove the market viability, technological readiness, and customer acceptance of smart HEMS. The trial combined smart meter data with a whole home optimisation solution that leverages the real-time smart meter data, to manage customers' flexible assets across 24 UK homes [20] [21].

INNOVATIVE ASPECTS OF THE PROJECT

The project was the first time that UK Power Networks had trialled coordinating devices to understand how homes can respond to signals from the network, to balance supply and demand through Demand Side Response.

Challenges addressed through the project included testing the extent to which aggregated homes with geo's Core system can provide flexibility, both reliably and at scale, in stressed network areas. Uncertainty around the readiness and affordability of domestic flexible grid technology, and whether net economic benefits are realisable at scale, were also addressed [22].

OUTCOMES OF THE PROJECT

The use of the home optimisation solution enabled participating households to save an average of 49 per cent on their annual energy bills across the Core4Grid trial period [23].

3.2

Broader benefits that can be unlocked through the deployment of HEMS

With HEMS being able to contribute to a more sustainable, reliable, and affordable power system, the deployment of HEMS is expected to provide a range of benefits.

Firstly, at a household level, the benefits from the installation of a HEMS relate largely to financial savings for the householder. At a broader system level, benefits can also be realised by DNSPs, retailers, service providers, and other energy users who may not have a HEMS installed but benefit from more efficient power system operation. HEMS provide a new source of contingency FCAS, with benefits to the energy system.

The broader benefits of HEMS for customers, retailers and DNSPs are detailed in **Table 2.**

TABLE 2

CUSTOMER, RETAILER, AND DNSP BENEFITS UNLOCKED BY HEMS DEPLOYMENT

CUSTOMER	RETAILER	DNSP
Financial and commercial benefits		
Benefits of a HEMS are linked to the value streams accessed, as discussed in section **3.1.3** In some cases, energy management leads to bill certainty	Wholesale cost savings can be realised, through customer load shaping. *This requires the HEMS to know the residential customer's underlying network tariff and wholesale value, which can change over time* Customer engagement and stickiness can increase	Network expenditure can be reduced through DER coordination, by deferring or avoiding network augmentation
Energy system benefits		
Access to increased hosting capacity can be unlocked, which enables more DER at customers' premises	Retailers' ability to manage risks is improved (such as those related to spot market prices and volumes) Demand-side participation can increase	Network utilisation is improved and can be optimised HEMS can be used as a tool to increase hosting capacity (for example by responding to DOEs) Reactive power control can be provided by residential customers
Broader social benefits		
Increased autonomy and energy independence can be achieved Energy management can result in lowered emissions, through greater utilisation of solar generation	Customers can be offered additional value and more compelling retail products	Higher penetration of renewable energy, towards a low emissions electricity grid

Note that whether any or all benefits are realised by the retailer will depend on their retail product arrangement. If the residential customer has established a third party relationship with an aggregator – for example to provide FCAS or retail tariff arbitrage – the benefits to the retailer may be diminished.

A PILOT STUDY IN THE NETHERLANDS FOUND THAT DYNAMIC CHARGE MANAGEMENT FOR EVS USING A HEMS COULD SIGNIFICANTLY REDUCE THE GRID IMPACTS OF CHARGING.

PROJECT OBJECTIVES AND APPROACH

Around 140 Dutch households with battery EVs (BEVs), a home charge point, and a HEMS participated in the pilot study. The pilot study was a collaboration between Enexis Netbeheer (network operator) and Maxem (technology provider), as well as innovation organisations (Enpuls and ElaadNL). Through the study, the role HEMS could play in communicating capacity profiles from a network operator to residential customers was examined. Charge management was operationalised by sending maximum capacity limits from the network operator to the aggregator, who managed the EV charging sessions via the HEMS.

INNOVATIVE ASPECTS OF THE PROJECT

Both static and dynamic limits on EV charging were communicated to different customer groups, to determine the effectiveness of each. For the dynamic signals, the network capacity available for charging was evenly allocated across the charge points that were active (charging a vehicle at that point in time). EV charging was controlled through the HEMS to ensure that total customer load did not exceed capacity on the network. For both the static and dynamic signals, day-ahead network forecasts with the maximum amount of available capacity in the grid at 15-minute increments were sent, to provide the HEMS with foresight to help manage charging profiles. This was done on a rolling basis, every 15 minutes.

OUTCOMES OF THE PROJECT

The trial found that the grid impact of charging EVs can be significantly reduced through dynamic charge management via a HEMS. In the case of dynamic charge management, a 40 per cent reduction in peak load on the LV grid was observed across the one-year trial. The study found that static charge management was not as useful, simply shifting the peak load to a later point in time without reducing the magnitude of the load [24].

15 min

DAY-AHEAD NETWORK FORECASTS FOR DYNAMIC AND STATIC SIGNALS

40 %

REDUCTION IN PEAK LOAD ON THE LV GRID AS A RESULT OF DYNAMIC CHARGE MANAGEMENT

4

HEMS in the context of DOEs

THIS CHAPTER

As part of this study, the readiness of the HEMS market to orchestrate customer assets to meet DOEs at the connection point was assessed. This chapter focuses on that assessment. Specifically, it covers:

4.1 DNSPs' key specifications for DOEs, to be met by HEMS

4.2 The implementation of DOEs at the connection point

4.3 The readiness of HEMS to respond to DOEs

4.1

Key DOE specifications to be met by HEMS

To respond to dynamic operating envelopes issued at the connection point, HEMS will need to meet several technical specifications set by DNSPs, as well as commercial and regulatory requirements. Work to establish a full list of specifications is ongoing, through the DEIP's Dynamic Operating Envelopes Workstream. This section provides an initial overview of the technical, commercial, and regulatory specifications for DOEs.

4.1.1

TECHNICAL SPECIFICATIONS FOR DOEs

PUBLISHING DOEs FOR EACH INDIVIDUAL DEVICE OR AT THE CUSTOMER CONNECTION POINT

DOEs can be specified, or *published,* at a customer's connection point, or directly at the terminal of an individual device, as illustrated in **Figure 3.**

For DOEs specified at the connection point, multiple customer assets may need to be orchestrated. Some DNSPs expect that they may publish both device-level and connection point level operating envelopes, in the near and long term.

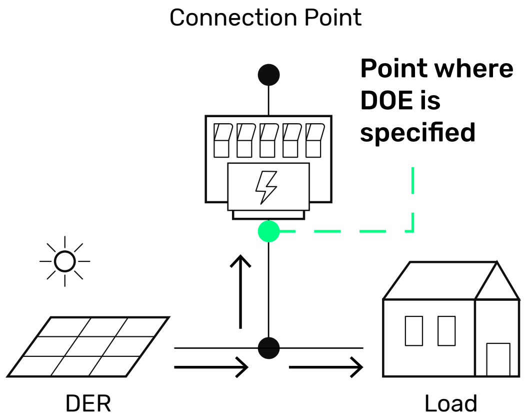
The DNSPs consulted for this study do not expect any significant differences between the two locations (device and connection point) for publishing DOEs. A slight preference towards the connection point approach was expressed by some DNSPs, as modelling of the network and allocating DOEs may be easier at the connection point. Also, specifying DOEs at the connection point is consistent with the use of DOEs to implement dynamic export limits, which is the most immediate use case for DOEs.

With device level DOEs, the customer's decisions around how to respond are limited. Each individual device will need to respond and remain compliant, which could negatively impact the optimisation of a customer's assets. From the DNSP's perspective, device level DOEs could also result in a more complex contractual arrangement.

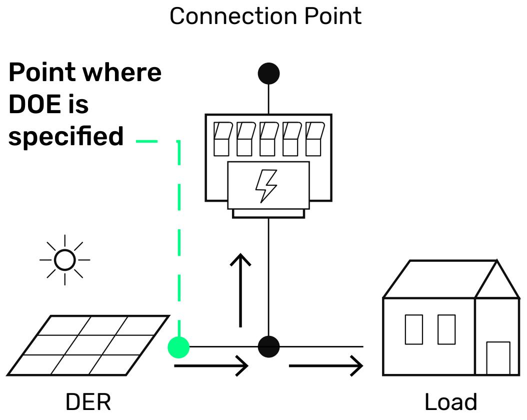
FIGURE 3

SPECIFYING DOEs AT THE CONNECTION POINT OR DIRECT-TO-DEVICE [5]

CONNECTION POINT DOE



DEVICE LEVEL DOE



ESTABLISHING BI-DIRECTIONAL COMMUNICATIONS BETWEEN DNSPS AND THIRD PARTIES

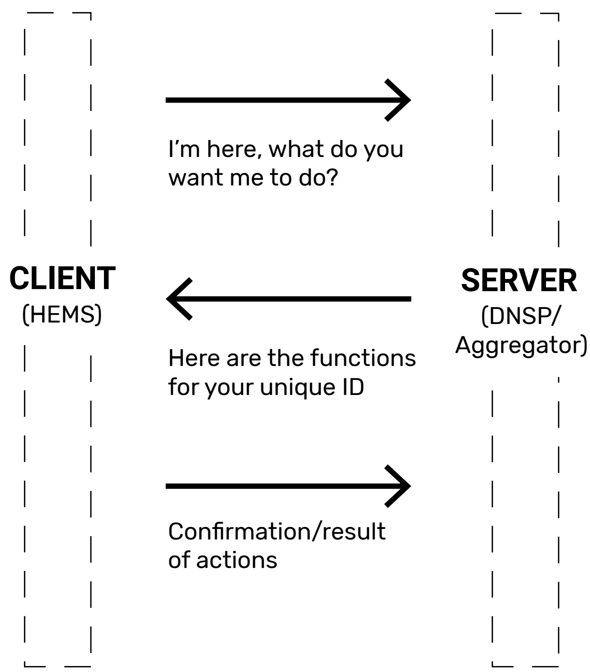
A bi-directional communication channel between the connection point and the DNSP is required to enable two-way flows of data. The residential customer's HEMS must be able to receive a control signal and communicate its operating status back to the DNSP.

In the future, the HEMS will most likely need to be compliant with the IEEE 2030.5 standard as specified in CSIP-AUS, which creates a standardised minimum communication protocol for the interface between DNSPs and third parties. An overview of the communication exchanges that are standardised under IEEE 2030.5 is provided in **Figure 4.**

The level of granularity required is yet to be determined, however a preference towards near real or real-time data and as granular information as possible was expressed by several DNSPs and HEMS providers. Near real or real-time data is needed for HEMS providers to optimise performance and meet network requirements, as well for DNSPs receiving feedback from each connection point.

FIGURE 4

IEEE 2030.5 COMMUNICATION EXCHANGE CONCEPTS [25]



AN INITIAL FIELD TRIAL THAT TESTED THE IMPLEMENTATION OF THE IEEE 2030.5/CSIP NETWORKING COMMUNICATION PROTOCOL IN CALIFORNIA UNCOVERED A LACK OF STANDARDISATION IN THE COMMUNICATIONS USED AT THE DEVICE LEVEL FOR DER.

PROJECT OBJECTIVES AND APPROACH

The SunSpec IEEE 2030.5/ Common Smart Inverter Profile (CSIP) field trial, sponsored by the California Energy Commission, tested the functionality of solar PV and battery storage systems with IEEE 2030.5 compliant smart inverters. The field trial fed into the *Smart Inverter Interoperability Standards and Open Testing Framework to Support High-Penetration Distributed Photovoltaics and Storage* project, which sought to prove the cost-effective deployment of IEEE 2030.5 compliant smart inverters in California.

INNOVATIVE ASPECTS OF THE PROJECT

Through the field trial, opportunities from and barriers to using IEEE 2030.5 as the default protocol for communications between the connection point and the DNSP (as mandated under California's Rule 21) were identified. The trial found that smart inverters with IEEE 2030.5 capabilities can deliver additional value to the grid and increase hosting capacity. IEEE 2030.5 compliant smart inverters also make it possible for DER systems to participate in the wholesale market, unlocking new revenue streams for customers.
The extent of participation will depend on the configuration of a customer's DER system – for example, a solar PV system cannot participate in wholesale demand response, but a solar PV and battery system could.

OUTCOMES OF THE PROJECT

The trial uncovered a lack of standardisation at the DER device level, with different communication interfaces deployed across systems. CSIP, as developed for California, only requires a standardised communication protocol – for example IEEE 2030.5 – for the aggregator (or third party)-to-DNSP link. Since the trial, IEEE 1547 has been mandated under California's Rule 21, in addition to IEEE 2030.5. IEEE 1547 specifies that all DER systems must present at least one standard communication protocol for local communication (SunSpec Modbus, IEEE 2030.5, or DNP3).

Another barrier to DER market participation uncovered through the trial was that customer's wireless networks, such as Wi-Fi, can be unreliable. This resulted in issues with DER connectivity, limiting the reliability of direct DER control.

4.1.2

COMMERCIAL SPECIFICATIONS FOR DOEs

OFFERING BOTH STATIC AND DYNAMIC OPERATING ENVELOPES

The DNSPs consulted in this study suggested it is unlikely that every residential customer will have the ability to meet all the key specifications for DOEs and comply with dynamic limits due to the lack of a compatible HEMS, at least in the short term. As such, some customers will continue to be offered static operating envelopes. As part of the Flexible Exports trial, for example, new solar customers in South Australia can elect to have either a static 1.5kW export limit or a flexible 1.5-10kW constraint if they have a compatible IEEE 2030.5-capable inverter (with embedded energy management capabilities) or on-site HEMS gateway. Note that even under static operating envelopes, some smart inverters may still perform some dynamic control based on local voltage conditions.

4.1.3

REGULATORY REQUIREMENTS FOR DOES

ADJUSTING CONNECTION AGREEMENTS TO INCLUDE PROVISIONS FOR DOEs

Most connection agreements already have provisions for static export limits. Under the scheme currently envisioned, the customers' dynamic operating envelopes are determined by their connection agreements with DNSPs. From the DNSP perspective, considering DOEs in connection agreements is not expected to be complex.

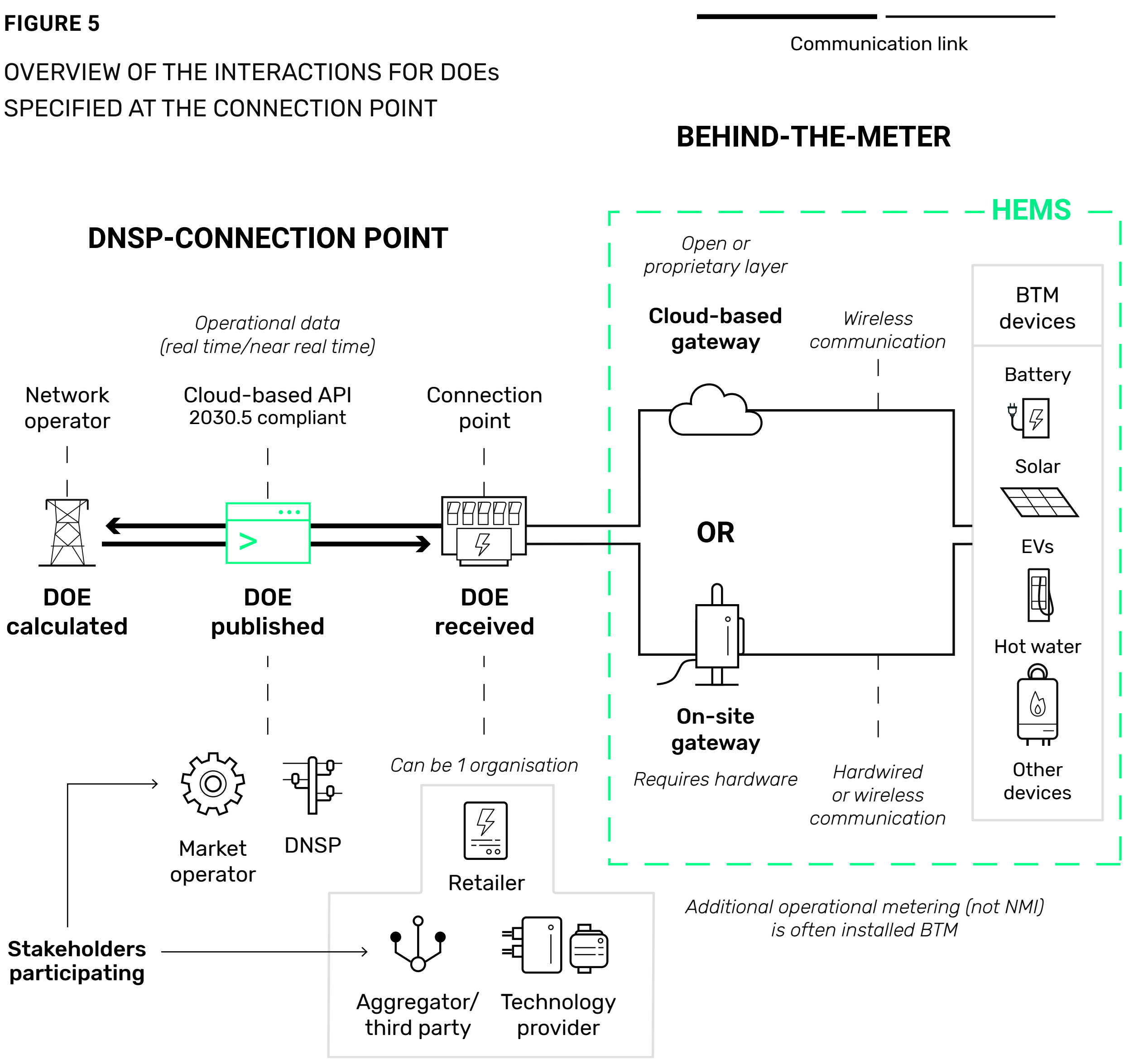
Connection agreements with the customer will need to outline the customer's obligation to meet DOEs. Although this is expected to be a fundamentally straightforward transition, ensuring consumers are educated about the changes and that their perspectives are considered throughout the process will be important. Possible challenges around the obligations to meet DOEs are detailed further in section **5.3**.

4.2

Implementing DOEs at the connection point

FIGURE 5

OVERVIEW OF THE INTERACTIONS FOR DOEs SPECIFIED AT THE CONNECTION POINT

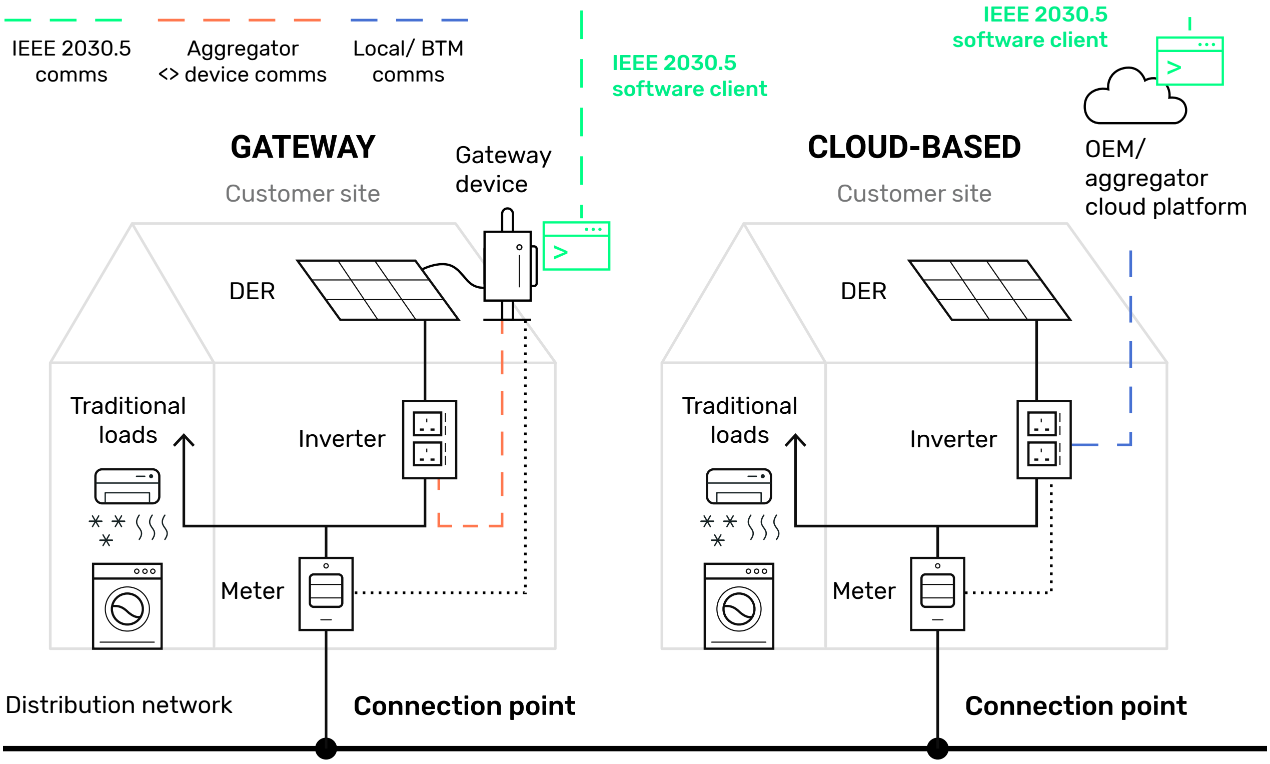


For DOEs specified at the customer connection point, the total behind-the-meter power flows will need to remain within the published limits. In the near term, it is expected that a single device (for example a solar PV system through a smart solar inverter) will receive and respond to operating envelopes published at the connection point.

This configuration facilitates the deployment of DOEs whilst addressing the immediate network challenges posed by customer exports.

FIGURE 6

EXAMPLES OF SINGLE DEVICE MODELS BEING TESTED[18]



Although it is the smart inverter receiving and acting on the DOE, the power flows of the entire site still need to be considered.

The interaction with other devices in the home will increase over time. As smarter home ecosystems develop, multiple devices could be orchestrated to meet these constraints. A HEMS would then be responsible for this orchestration, whether that is through a dedicated on-site gateway or embedded software, as detailed in **Figure 5.**

18 Diagram provided by SA Power Networks, single device models are being tested as part of SA Power Networks and AusNet Services Flexible Exports trial.

4.2.1

SINGLE DEVICE CONFIGURATIONS FOR DOEs AT THE CONNECTION POINT

In the initial phases of implementation, DOEs published at the connection point will likely start with a single device as illustrated in **Figure 6** above (note the figure shows the device models tested in the SA Power Networks and AusNet Services Flexible Exports trial).

Starting with a simple, single device configuration makes it possible to accelerate the availability of connection point DOEs as a network service offering. Thus far, this device has typically been a smart solar inverter or a smart battery inverter with native energy management system capabilities.

SA POWER NETWORKS AND AUSNET SERVICES ARE TRIALLING FLEXIBLE EXPORTS FOR SOLAR PV AND QUANTIFYING THE EXTRA VALUE THESE COULD CREATE FOR CUSTOMERS.

PROJECT OBJECTIVES AND APPROACH

SA Power Networks and AusNet are trialling flexible exports for solar PV by calculating and publishing dynamic export limits at the connection point for solar inverters (as shown in **Figure 8**). The one-year trial began in September 2021 and is expected to involve about 600 customers in South Australia and Victoria. The DNSPs will provide locational and dynamic limit signals at five-minute increments, 24 hours in advance. Note that only the export direction of the operating envelope is being trialled [26].

INNOVATIVE ASPECTS OF THE PROJECT

The trial is testing two configurations for enabling the capabilities necessary to respond to flexible exports. Firstly, solar inverters can be connected to a SwitchDin Droplet, which acts as an on-site gateway device. Secondly, the capabilities can be embedded natively in inverters. Fronius and SMA inverters with native flexible connection capability are expected to become available to participating customers in early 2022.

This project is critical to informing a robust standard, testing and certification process for the application of IEEE 2030.5 in Australia. A lack of end-to-end DER interoperability has been identified through the project, noting that interoperability is not guaranteed by compliance with the CSIP implementation guide [27]. As a result, an accompanying test specification for interoperability is being developed.

OUTCOMES OF THE PROJECT

By demonstrating flexible export limits and building a business case for DNSPs to invest in this capability, the trial could lay the foundations to transition DER customers from static exports to DOEs. The project will quantify the extra value flexible exports can create for solar customers in constrained areas of the network. Pending the outcome of the trial, the distribution networks could offer customers with solar flexible exports as a standard service in the future [28].

5 min

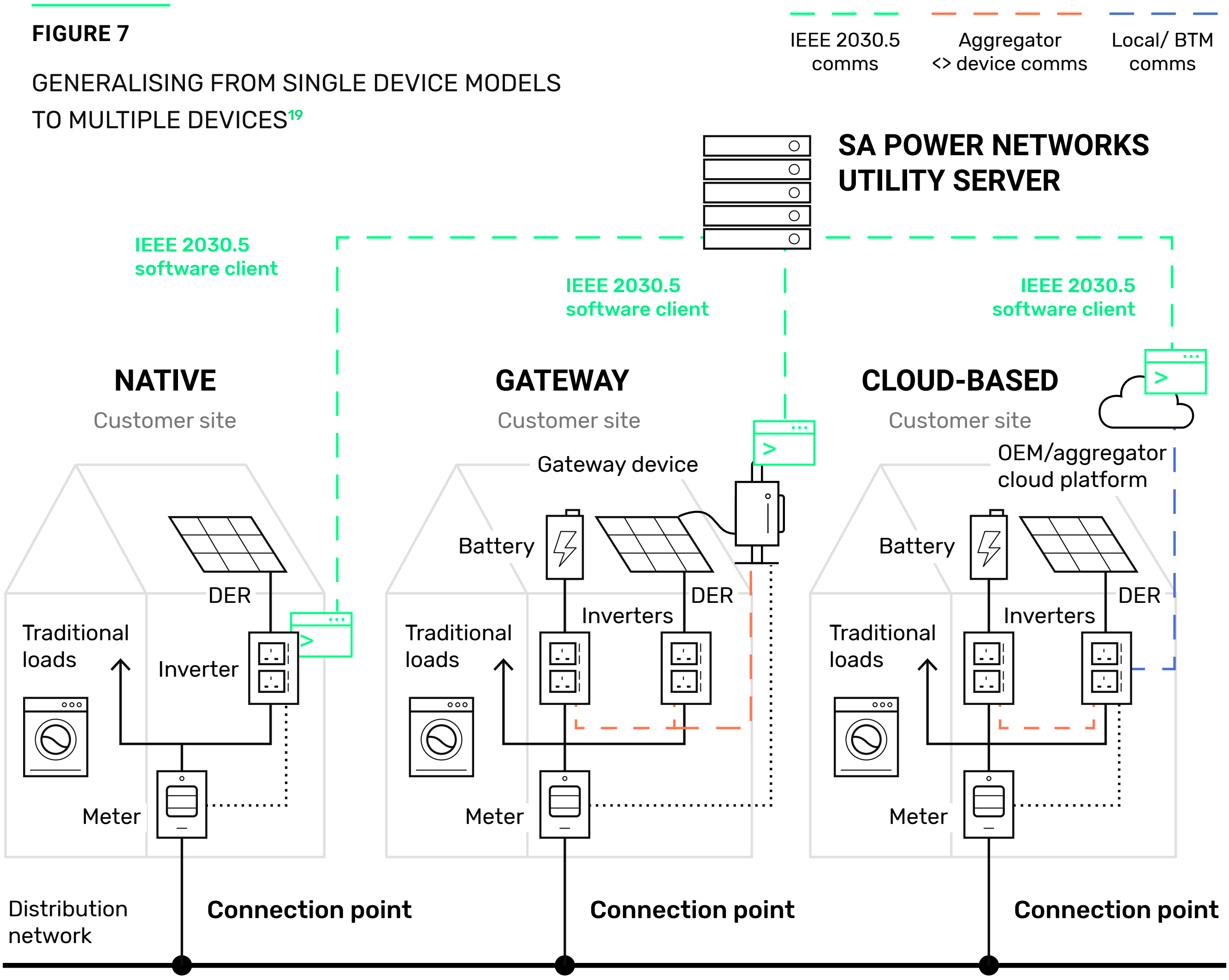
INCREMENTS FOR DYNAMIC LIMIT SIGNALS, 24 HOURS IN ADVANCE

IEEE 2030.5

IMPLEMENTATION IN AUSTRALIA

FIGURE 7

GENERALISING FROM SINGLE DEVICE MODELS TO MULTIPLE DEVICES[19]



4.2.2

COORDINATING MULTIPLE DEVICES TO COMPLY WITH DOEs AT THE CONNECTION POINT

With market evolutions and the development of smarter home ecosystems, integrations with multiple devices will likely evolve simultaneously. This future could see multiple customer assets coordinated through a single HEMS to comply with a DOE published at the connection point.

How this progression from a single device to multiple devices might happen is illustrated in **Figure 7.**

Regardless of the HEMS configuration, local communications between the HEMS and the additional customer assets will need to be established. The differences between the on-site gateway versus cloud-based configurations for HEMS are detailed in section **3.1.2**. Although the coordination of multiple customer assets is not yet happening at scale in the context of DOEs, multiple devices are already being coordinated through a HEMS and in some cases participating in energy markets in Australia.

19 Diagram provided by SA Power Networks.

4.3

Readiness of HEMS to respond to DOEs

Several industry trials are underway in Australia, demonstrating the implementation of DOEs. Key projects include:

- **SA Power Networks Flexible Exports for Solar PV Trial –** the project tests publishing locational and dynamic limit signals to the connection point, for smart inverters. The required flexible export capabilities can either be retrofitted (using an on-site gateway) or embedded within smart inverters. The project is further detailed in section **4.2.1**.
- **Evolve DER Project –** the project aims to demonstrate how the network hosting capacity of DER can be increased by maximising the participation of DER in energy, ancillary and network service markets, within the technical limits of the network. This will be achieved by calculating and publishing DOEs for DER connected to the distribution network. Further details on the project are included within this section.
- **Energy Queensland's Dynamic Operating Envelope Program –** phase 1 of the program focuses on the commercial level, with DOEs implemented across five Energex depots. The project is trialling a two-way communications approach. The management platform used is currently only integrated with solar PV systems, however the management of EVs or battery storage systems could be enabled through this platform [31].
- **Project EDGE –** the multi-year project aims to develop and test the concept of a DER Marketplace, optimally facilitating DER participation in the wholesale markets and the provision of local network services. The project will demonstrate how a DER Marketplace can be achieved within the constraints of the distribution network [32].
- **Project Symphony –** the pilot seeks to trial the coordination of customer DER and selected household appliances through a VPP, to explore how DER integration and orchestration can support network operations [33].
- **Project Edith –** the project aims to demonstrate how more network capacity can be made available by flexibly managing network constraints during peak times. Reposit's smart controller will be used to demonstrate how smart devices can respond to market conditions in real-time, whilst adhering to the local network constraints [34].

THE EVOLVE DER PROJECT IS TRIALLING THE COORDINATION OF DER AND IMPLEMENTATION OF OPERATING ENVELOPES, TO INCREASE NETWORK HOSTING CAPACITY.

PROJECT OBJECTIVES AND APPROACH

The evolve project is led by software developer Zepben in collaboration with industry, academia, and government. The project objectives include demonstrating a system for coordinating DER to optimise network utilisation by publishing DOEs. Developing and integrating working software systems with DNSPs' operational technologies and HEMS providers' DER management platforms are a core focus of the project. Participating DNSPs include Energy Queensland, Essential Energy, Endeavour Energy, and Ausgrid [29].

INNOVATIVE ASPECTS OF THE PROJECT

The business models and product offerings of HEMS providers partnering on the project vary considerably, resulting in diverse technical and operational configurations. As a result, each HEMS provider's experience integrating against the evolve project DOE platforms has been different. This means that a broad range of findings on the integration process have been captured.

OUTCOMES OF THE PROJECT

Although the project is ongoing, some initial findings have been gathered. Significant barriers that slowed down the implementation of IEEE 2030.5 were experienced. These include increased resourcing needs to transition from proprietary approaches to implement open standards and the relative immaturity of the smart DER market. Clear, long-term signals that incentivise HEMS providers to engage in the use of open standards could be beneficial.

Alignment between system capabilities for control and the existing capabilities of HEMS providers varied significantly across partners. Examples of capabilities that support the implementation of DOEs include solar curtailment, battery charge management, and reactive power control. The project found that longer term certainty around the deployment of DOEs would assist HEMS providers to focus their development on the required capabilities [30].

RESPONDING TO DOEs IS NOT A TECHNICAL CHALLENGE

From a technical standpoint, the HEMS providers consulted in this study do not view receiving and responding to DOEs as challenging. Instead, they are confident that HEMS can be used to respond to both the flexible export and flexible load components of DOEs.

However, whilst HEMS providers did not raise any concerns or specific technical challenges that they expect from the implementation of DOEs, it should be noted that not all customer assets are or will be controllable. Responding to the DOEs issued to manage imports from the grid will depend on which customer assets can be controlled. HEMS will also need to consider constraints on how customer assets can be coordinated to ensure that the net load at the connection point meets the requirements. For example, if a battery is fully charged, the response is limited in that the battery cannot be further charged to increase consumption. Similarly, further constraints on coordination are likely to be driven by customers' needs and preferences.

Although significant steps will need to be taken towards ensuring IEEE 2030.5 compliance, HEMS technology and service providers believe they can achieve the integration with DNSPs' interfaces needed to implement DOEs. Some technology providers have already developed IEEE 2030.5 compliant APIs as specified in CSIP, although the CSIP-AUS includes amendments that adapt CSIP to the Australian context. Note that the DEIP Interoperability Steering Committee is supporting the development of CSIP-AUS.

In some cases, HEMS providers are developing the suite of capabilities they expect will be required to comply with DOEs, a position that could offer a future competitive advantage. Specific applications of HEMS, such as the use of HEMS to meet DOEs at the connection point, are currently limited to Australia.

A LACK OF NATIONAL HARMONISATION TO THE IMPLEMENTATION OF DOEs COULD IMPACT THE HEMS MARKET

Stakeholders cited the need for a nationally consistent approach to DOEs across DNSPs, including the communication, publishing, and main technical specifications of DOEs. Concern around the cost implications of an unstandardised approach to DOEs were raised. Both HEMS providers and retailers expect that integration with different DNSPs' platform will result in additional costs.

Given that the implementation of DOEs currently remains restricted to trials, the commercial implications of that implementation at scale are mostly unknown. Although some service providers expressed concern that DOEs could impact their ability to stack revenues, by introducing additional constraints that will need to be considered, DOEs could also increase the value available to aggregators. In particular, DOEs could provide greater access to the available network capacity and enabling more energy to be traded from each customer site, as demonstrated through SA Power Networks' Advanced VPP Grid Integration trial. The trial found that time-varying and locational export limits – set between 5kW and 10kW, as opposed to the previous static limit of 5kW per site – could enable DER to be hosted at higher levels of penetration [35].

5

Gap analysis for HEMS deployment

THIS CHAPTER

This chapter provides an overview of the gaps and challenges identified by the stakeholders consulted in this study. These gaps and challenges are impacting HEMS deployment, and in some cases, creating uncertainty around how the HEMS market might interact with DOEs. Broadly, the gaps and challenges fit across five categories:

5.1 Economics of the HEMS market

5.2 Standardisation and interoperability

5.3 Compliance and enforcement

5.4 Consumer protections

5.5 Consumer awareness and willingness to participate

5.1

Economics of the HEMS market

THE HEMS VALUE PROPOSITION CAN BE RELATIVELY LOW FOR SOME CUSTOMERS

As outlined in the commercial overview in section **3.1.3**, installing a HEMS can already unlock value for residential customers today, primarily through energy bill optimisation, energy market participation, and the provision of services to DNSPs. Nevertheless, the value proposition of HEMS products and services can still be relatively low for some residential customers, due to their current retail tariff arrangements (such as flat tariff rates), the underlying energy market value and high equipment and setup costs.

Several HEMS providers highlighted that the provision of further services, such as regulation FCAS, could be technically feasible. Regulatory changes and some technical innovations – for example, telemetry – would first be needed to enable both participation in these markets. This, combined with the relatively low value proposition for some customers, presents a barrier to the accelerated uptake of HEMS.

5.2

Standardisation and interoperability

WORK ON A NATIONALLY HARMONISED APPROACH TO DOEs IS NOT YET COMPLETE

Stakeholders, in particular HEMS providers, retailers, and energy governance bodies, expect that challenges implementing and complying with DOEs could arise if the approach to DOEs differs significantly across DNSPs. Dimensions of DOEs that could be harmonised include the definition, publication, communication, and enforcement of DOEs.

An inconsistent approach to the publication and communication of DOEs may lead to inefficient and more costly integration of DOEs for HEMS providers. This could slow down the readiness of HEMS to meet DOEs across all Australian jurisdictions, as DOEs are implemented at scale. A lack of national harmonisation could also result in different experiences for customers and lead to inequitable outcomes, depending on the different DNSPs' approaches.

However, the harmonisation of all dimensions might not be in the best interest of the wider energy industry and in particular, customers. There could be some dimensions of DOEs where provisions should be made for DNSPs to develop their own approaches, based on the specific needs of different networks (such as the minimum or maximum thresholds for setting import and export limits). It is not yet clear which factors need to be harmonised and which do not, and there is a need to differentiate between having a common framework and allowing variation in specific settings.

Several of the issues identified in relation to DNSP to connection point interoperability and the operational requirements for DOEs are already being investigated. This includes through collaborations such as the DEIP Interoperability Steering Committee and DER Integration API Technical Working Group, which developed the CSIP-AUS. For example, agreed fallback behaviour in the event of a loss of communications or of connectivity is being defined through CSIP-AUS.

THERE ARE NO REQUIREMENTS THAT PROMOTE OPEN DEVICE STANDARDS

A challenge highlighted by some HEMS providers is the lack of requirements for the implementation of open device standards for customer assets. This can create issues for HEMS providers when integrating with devices to optimise energy management. Where proprietary protocols that are not openly published are used, or where access permissions are denied, HEMS providers are unable to gain an optimal level of local, on-site control. Even where integration with multiple devices is possible, the lack of standardisation could make the integration process costly and time consuming.

Stakeholders highlighted that even where standardised communication protocols are used for on-site communication links, these can be open to a high level of interpretation and different implementations by OEMs. These variations may limit how effective the standard is at achieving intended outcomes such as interoperability.

HEMS providers expressed that a co-optimisation challenge arises if a customer's asset cannot be successfully integrated with a HEMS (either unable to control the device at all or only able to achieve limited control). For example, a HEMS can monitor a battery but might not be able to manage the battery to optimise charge and discharge. As a result, HEMS may automate disconnection (on/off control only), even when the device is technically capable of more sophisticated control. The value that can be unlocked from the battery is therefore reduced.

REGULATORY REQUIREMENTS FOR CYBER SECURITY ARE LIMITED

Adequately managing cyber security presents a growing challenge for HEMS providers and the energy industry more broadly, considering the growing threat posed by cyberattacks. Currently, there are no mandatory minimum requirements for managing cyber security for distributed energy resources in the Australian electricity market.

In the context of HEMS, cyber security threats are related to increasing exchanges between multiple parties and interfaces. As a result, stakeholders such as DNSPs, HEMS providers, or retailers may need to develop new capabilities to manage cyber security across these interfaces.

The Australian Government has proposed legislative changes that could address this gap, in Australia's Cyber Security Strategy 2020 [36]. The strategy proposes introducing security and resilience requirements for critical infrastructure entities, such as the energy sector.

Additional work to develop minimum requirements for managing cyber security and regulatory obligations to strengthen protections is underway. This includes through the DEIP Interoperability Steering Committee, under which a Cyber Working Group has been established. The Cyber Working Group is progressing a DER cyber security technical work plan, with a task to identify the cyber security requirements to support the integration and participation of DER [37].

5.3 Compliance and enforcement

As the implementation of DOEs becomes more widespread, the management and enforcement of compliance may become increasingly important.

AN APPROACH TO DOE COMPLIANCE MANAGEMENT AND ENFORCEMENT HAS NOT YET BEEN DEFINED

Under the scheme currently envisioned, customers' DOEs are determined by their connection agreements with DNSPs. The customer is therefore the counter party responsible for compliance. Where the customer has a relationship with a service provider, this third party acts as an agent on behalf of the customer. Whether an arrangement under which the service provider becomes the responsible counter party might be introduced, in the near or longer term, remains uncertain.

In addition, how compliance with DOEs will be enforced under these different arrangements remains unclear. For example, if the customer's agent becomes the counter party in the future, compliance might be enforced at the site level or potentially at the level of the service provider's portfolio. Some of the DNSPs consulted expect that requiring firm responses to DOEs and enforcing strict compliance will be more important for commercial and industrial customers than for residential customers. If this is the case, then an alternative, more flexible, compliance regime for residential customers could be defined.

Regardless of the compliance regime for residential customers, there will be a need for measurement and verification of customer compliance by DNSPs. At a minimum, this could include mechanisms for testing and certification at the installation stage as well as verifying ongoing performance.

A HIERARCHY OF HEMS RESPONSES TO MARKET SIGNALS AND NETWORK SERVICES THAT TAKES DOEs INTO CONSIDERATION HAS NOT BEEN DEFINED

It is currently unclear how the development of future system security and energy market services – such as essential system services[20] and wholesale demand response – could interact with DOEs. Given this lack of clarity, stakeholders cited the need for a clearly defined hierarchy of responses that takes DOEs into consideration.

In the absence of an established hierarchy, service providers raised concerns that they could face conflicting requirements between the various HEMS responses to market signals and network services. This could pose a significant issue for compliance, in the case that there is a discrepancy between a retailer or aggregator's commitment to market participation at pre-dispatch and the DOE issued to them by the local DNSP. The potential introduction of flexible trading relationships and multiple connection points, and the interactions between the different responses, may further complicate this issue.

Although these interactions have not yet been mapped at scale, most stakeholders expect that DOEs will likely be a 'must run' or 'first response' event. By default, it is expected that DOEs at the device level or connection point will not seek to co-optimise market participation. Rather, they will simply provide local envelopes within which customers and their service providers can participate in markets, in a way that aligns with the incentives presented to them. If this is the case, HEMS providers will need to update their software to prioritise DOE compliance.

20 The Energy Security Board has identified four essential system services to maintain system security, which market participants could be paid to provide. These services are frequency control, inertia, system strength, and ramping capabilities/operating reserves.

5.4

Consumer protections

For the purposes of this study, a review of the electricity regulation and regulations for consumer protections that apply within the NEM jurisdictions was undertaken by legal advisors Allens. This focused on considering how the existing frameworks might apply legally to HEMS products and services.

THE ROLES OF ELECTRICITY REGULATION AND CONSUMER PROTECTION LAWS FOR HEMS ARE UNCLEAR

Stakeholders consulted as part of this study highlighted that it is unclear how the current electricity regulation and other consumer protection laws might apply to HEMS providers and the related products and services offered.

This includes clarifying what the role of the Australian Consumer Law (ACL) for HEMS is in relation to energy law[21].

Consumer protections for HEMS products and services under the ACL are additional to the protections consumers receive for their retail supply of electricity in the NEM. Protections for the retail of electricity are highly prescriptive, in recognition of electricity's status as an essential service. Conversely, customers with HEMS receive the same consumer protections under the ACL that apply to users of other products and services. Voluntary consumer protection frameworks can also apply in some circumstances (such as where the products and services are supported by a government support scheme that requires a HEMS provider to comply with a voluntary framework)[22].

To the extent that HEMS products and services are considered to be an essential service akin to the retail supply of electricity, or where specific competition outcomes are sought as a matter of government policy, there may then be an argument for the development of a more prescriptive, behind-the-meter specific regulatory framework which provides tailored consumer protections.

21 In particular the National Electricity Rules (NER) Part 5A, wherein connection agreement contracts are established, and the National Energy Retail Law (NERL), which governs electricity retailing.

22 For example, suppliers of solar systems are required to be signatories to the Clean Energy Council's Retailer Code of Conduct if they want to participate in Victoria's Solar Homes Program.

THERE IS UNCERTAINTY AROUND WHERE THE RESPONSIBILITY FOR COMPLIANCE WITH DOEs COULD FALL

In the absence of specific contracts or a directly relevant regulatory framework, it is difficult to know where the liability for compliance with a DOE should fall. Under the scheme currently envisioned, customers' DOEs are determined by their connection agreements with DNSPs, as discussed in section **5.3**.

At a high level, the extent of each party's liability for failing to comply with a DOE will be determined by:

- The contracts the parties have entered into with each other and the obligations that each party has undertaken to ensure that a customer's import and export of electricity are within the relevant limits
- The extent to which a regulatory framework (such as the National Electricity Rules or National Energy Retail Rules) may impose obligations on particular parties to ensure a customer's import and export of electricity are within the relevant operating limits, and what the consequences for non-compliance are.

The uncertainty around responsibility for compliance could lead to consumer protection risks, depending on how compliance is managed and enforced. For example, a scenario could eventuate where a consumer unintentionally breaches their DOE because their obligations were not clearly communicated to them, yet they are still penalised for the breach.

Given the relative infancy of the HEMS market, it is difficult to say whether a more prescriptive, behind-the-meter specific consumer protection framework is necessary or appropriate. There is clearly a balance to be had between ensuring that consumers are protected, while also not adding unwarranted regulatory complexity and costs to an already complex and evolving sector of the economy. This may support adopting a wait-and-see approach to deciding whether a behind-the-meter specific consumer protection framework should be developed, what this framework would entail, and who would be responsible for ensuring compliance and enforcement.

Alternatively, non-regulatory or co-regulatory measures could be pursued as an initial step, such as publishing best practice guides or codes, consumer education material, or codes of practice that could be referred to by DNSPs or government DER incentive schemes. A strong understanding of consumer experiences and potential pain points will be important to understand whether further behind-the-meter regulation is justified and what the focus of these regulatory or alternative measures should be.

BARRIERS TO COMPETITION EXIST WITHIN THE BEHIND-THE-METER ECOSYSTEM

Consumer groups and energy governance bodies in particular raised concern that HEMS providers could be preferencing their own proprietary devices over other vendor devices. For example, HEMS providers could only allow access by certain types of devices or treat their own devices preferentially when deciding whether and how to optimise the use of the available network capacity. These behaviours could result in suboptimal outcomes for consumers and there are currently limited consumer protections that address this in practice.

The prohibition on exclusive dealing[23] and the prohibition on the misuse of market power[24] within the *Competition and Consumer Act 2010 (Cth)* are likely to prevent a single dominant vertically integrated HEMS provider using such restrictions to eliminate competition they might otherwise face in supplying devices. This also applies to a single dominant devices supplier similarly limiting competition it faces as a HEMS gateway or platform provider.

These prohibitions do not, however, absolutely prohibit a HEMS gateway or platform from limiting or providing differential access, as they are subject to a lessening of competition test[25]. The lessening of competition test considers a range of factors to determine the likely future state of the market with and without the proposed conduct.

23 Section 47 of the *Competition and Consumer Act 2010 (Cth).*

24 Section 46 of the *Competition and Consumer Act 2010 (Cth).*

25 The substantial lessening of competition test is an economic test that involves considering the likely future state of the market with and without the proposed conduct. As such, the key issue as to whether the prohibitions applied is likely to be whether there is a dominant HEMS provider or device providers which can materially impact on competition in the other market (for HEMS or devices).

CONSUMERS COULD FACE DIFFICULTIES WHEN SWITCHING HEMS PROVIDERS

Stakeholders expressed concern that consumers may become locked into a particular HEMS service or provider, especially where a HEMS uses a proprietary communications framework. In addition to this technical lock in, consumer lock in could also be financial or contractual. If consumer lock in were to become prevalent, this might create uncertainty amongst consumers and could slow down uptake.

It is beyond the scope of this study to assess how a consumer's freedom to switch HEMS providers could be best protected (for example through mandating a standardised, open model for device-to-device communication). However, further exploration into whether the introduction of such protections would be in the best interest of consumers is needed. This is further discussed in section **6**, as part of the area for future investigation into the costs and benefits of open device standards.

5.5 Consumer awareness and willingness to participate

Beyond early adopters, stakeholders perceive consumer awareness of HEMS as being low. Low awareness could also present a challenge for the implementation of DOEs over the longer term, in particular as compliance with DOEs becomes dependent on the coordination of customer assets through a HEMS. HEMS providers will need to build a social licence to automate and control consumers' devices. Another barrier to HEMS deployment could be low levels of consumer trust in the energy sector.

CONSUMER AWARENESS AND UNDERSTANDING OF HEMS IS LOW

Awareness of the HEMS products and services currently available to residential consumers in the market is low. This is primarily due to the small market size of HEMS providers. Consumer groups highlighted the lack of a clear definition outlining what a HEMS is, how it works, and the value it can bring to consumers as a driver of low understanding.

Consumer groups expressed that awareness of the projects trialling DOEs is expected to be low. In addition, the language currently used – DOEs – lacks meaning for customers. This language could change in the future, with some DNSPs considering the use of phrases such as "flexible connections" or "dynamic connections" instead.

SOCIAL LICENCE ISSUES COULD ARISE

In light of the lack of consumer awareness, social licence[26] issues could arise if information is not shared with consumers in a way that is easy to understand and made accessible.

A lack of social licence to automate and control could also prevent the integration of devices with a HEMS. Social licence issues might arise where the impacts of energy management on consumers and their amenity are not clearly defined – for example, clearly communicating when or how devices are going to be controlled. Although stakeholders did not view this as a widespread fear, some consumers may view automation and control of their devices as an overreach by the wider energy industry.

Analysis undertaken by Energy Consumers Australia provides a framework to assist decision-makers to gain and maintain a social licence for DER control [38]. Establishing this social licence could improve consumer acceptance of the coordination of their assets and promote the uptake of HEMS.

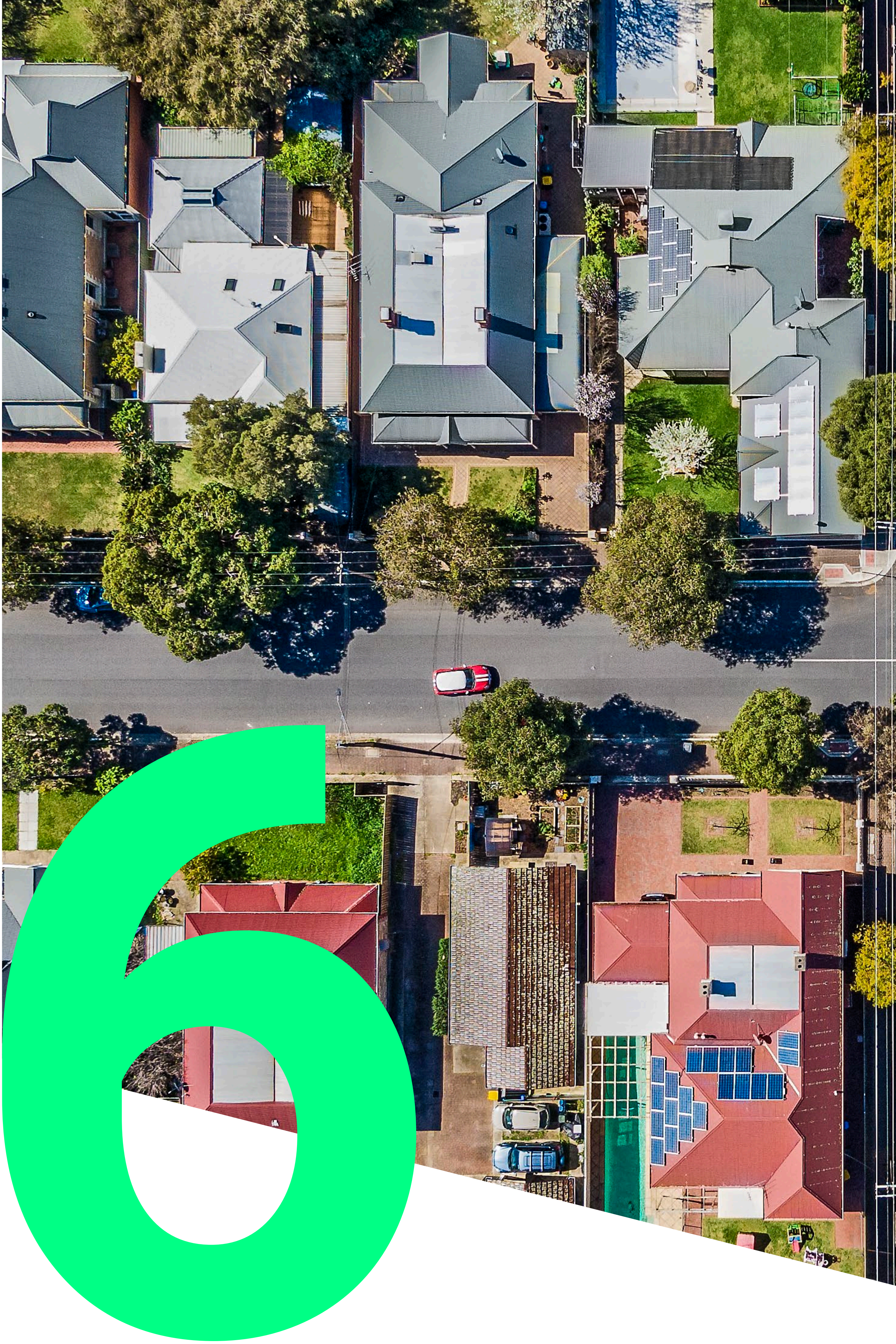
THERE ARE LOW LEVELS OF CONSUMER TRUST IN THE ENERGY INDUSTRY

Consumer groups highlighted that several negative interactions with the energy sector have had a detrimental impact on consumers' overall trust in the energy industry. These include negative experiences with service providers such as solar installers, and regulation changes such as the recent introduction of export charges and how these were reported to consumers.

The 2021 Energy Consumer Sentiment Survey found that just over half (52 per cent) of the survey's respondents trust companies in the electricity sector to do the right thing by their customers and by Australia as a whole [39]. These relatively low levels of trust could present a barrier to the deployment of HEMS and introduction of DOEs at scale.

26 Energy Consumers Australia define social licence, in the context of DER control, as "the permission provided by consumers to government or institutions to control their DER system, above and beyond that required by law".

6



Areas for future investigation

THIS CHAPTER

Five areas for future investigation have been identified, informed by the key findings of this study. Whilst most of these areas could be explored by energy governance bodies and governments, several also call for collaboration across the wider energy industry. The areas for future investigation suggest pathways that could support the continued development of the HEMS market in Australia and facilitate the readiness of HEMS to receive and respond to DOEs.

1 FLEXIBLE TRADING RELATIONSHIPS COULD CONSIDER THE INTERACTIONS WITH DOEs

Possible interactions between the models for flexible trading relationships proposed by the Energy Security Board[27] and DOEs remain uncertain, as detailed in section **1.2.** In particular, it is unclear how the DOE would apply if there was either a second connection point or a sub-meter connection point arrangement.

In collaboration with the wider energy industry, energy governance bodies and governments could further explore the interaction between flexible trading relationships and DOEs. Findings from those investigations could inform the selection, design, and implementation of flexible trading relationships. If DOEs are not considered in the design of flexible trading relationships, introducing flexible trading relationships and multiple connection points could add to the costs of implementing DOEs. They could also complicate the management and enforcement of compliance with DOEs.

If the design and implementation of flexible trading relationships adequately considers DOEs, this could increase the benefits to customers. In particular, flexible trading relationships could provide customers access to improved choice, revenue streams, and cost savings via greater access to the spot and service markets.

2 EXPLORE HOW TO INCREASE THE HEMS VALUE PROPOSITION FOR CUSTOMERS

As noted in section **5.1**, whilst installing a HEMS can already unlock value for residential customers today, HEMS uptake can be limited by a relatively low value proposition for some customers.

Through collaboration with the wider energy industry, energy governance bodies and governments could explore how to increase the value streams and opportunities available to customers, by removing some of the barriers – such as the current telemetry requirements for centralised dispatch – that prevent a fair two-sided participation. Existing value streams that could be expanded include:

- Encouraging more dynamic network pricing pricing – for example, Time-of-Use tariffs, critical peak pricing and real-time pricing – and exploring how stronger price signals could be passed through to customers. In particular, this could enhance the potential value of tariff arbitrage
- Facilitating greater use of aggregated DERs to provide non-network solutions under the Regulatory Investment Test for Distribution, or RIT-D.

27 The Energy Security Board has proposed two models that could enable customers to separate their controllable and uncontrollable resources. The first model introduces a second connection point for flexible loads, whereas the second model establishes a sub-meter connection point arrangement.

New mechanisms that could be further explored include:

- Mandating a control interface in large household appliances such as air conditioners, pool pumps and hot water systems, to allow for the control of dispatchable loads
- Enabling household demand to participate in the Wholesale Demand Response mechanism, which is currently limited to commercial and industrial customers, or a future two-sided market
- Enabling DER to participate in the relevant future essential system services markets, such as two-second FCAS and intertia.

The expansion of two-sided and essential system services markets is expected to be explored through the ESB's work on the post-2025 market design.

The roll-out of DOEs could further support the opportunities provided through a HEMS, by unlocking greater hosting capacity and enabling customers to install more DER systems.

3 INVESTIGATE THE COSTS AND BENEFITS OF OPEN DEVICE STANDARDS

There is currently a lack of standards or requirements for interoperability at the customer asset level in Australia, as noted in section **5.2**.

Energy governance bodies and governments could investigate the costs and benefits, and of introducing either mandatory or voluntary behind-the-meter open device standards. Although the introduction of regulatory requirements for behind-the-meter interoperability could ease the co-optimisation challenge, there is a risk that interoperability requirements might stymie future innovation. In comparison, the current arrangements preserve the choice for HEMS providers to select protocols that best suit the needs of their products and services regardless of whether these are proprietary or not. However, this can in turn limit the integration and optimisation of customer assets in some cases.

This investigation could complement the ongoing work into standards such as the development of CSIP-AUS. International standards addressing DER interface interconnection requirements could be leveraged, such as IEEE 1547-2018. This standard requires that one of three specified communication protocols are supported: SunSpec Modbus, DNP3, or IEEE 2030.5. Some US states have adopted DER interconnection requirements based on IEEE 1547-2018, including California and Hawaii. Further work on this standard would be required to ensure that the coordination of customer assets is adequately addressed.

As an interim option, a voluntary standard could be developed. This would provide a talking point for compliant technology providers and build consumer confidence in the HEMS market. Existing examples of voluntary standards include the New Energy Tech Consumer Code, ENERGY STAR rating, and GreenPower. In addition, HEMS providers and OEMs could put forward proposals to support the development of behind-the-meter open device standards, to ensure their needs and preferences are also met.

Furthermore, a regulatory perspective should be considered as part of this investigation, to encourage competition within the behind-the-meter ecosystem and ensure consumers are adequately protected. Such considerations are needed as the *Competition and Consumer Act 2010 (Cth)* does not absolutely prohibit a HEMS gateway or platform from limiting or providing differential access to other devices, as outlined in section **5.4**.

4 EXPLORE THE NATIONAL HARMONISATION OF DOEs

In the absence of standardisation, several different approaches to the calculation, publication, communication and enforcement of DOEs are likely to emerge across DNSPs. As detailed in section **5.2**, this could have cost implications for HEMS providers and, therefore, result in different experiences for consumers.

DNSPs and the wider energy industry have been actively working over the past two years to progress a nationally harmonised approach to DOE based on the IEEE 2030.5 standard. A significant level of national consensus has already been achieved through the DER Integration API Working Group and a first version of a national implementation guide that defines the technical standard and operating protocols has been developed.

To support this work, DEIP could further explore the costs and benefits of a nationally harmonised approach to DOEs. Consideration should also be given to which dimensions of DOEs could be harmonised versus where provisions should be made for DNSPs to develop their own approaches, based on the specific needs of different networks. Work to address this is already underway, as part of various ARENA projects and the DEIP Dynamic Operating Envelopes Workstream. For example, the standardisation of the following factors could be further investigated:

- Units of measurement for DOE components, such as export, import, kW, KVA

- The standard DOE forecasting period
- API models and communications, for example limiting variations to IEEE 2030.5
- Fallback options for communications
- Reporting of DOE outcomes by DNSPs
- Data sharing, for example the sharing of metering data (by retailers) and DOE information (by DNSPs) through a common data sharing platform or framework.

Where the net benefits of a nationally consistent approach to DOEs are found to outweigh the alternative, energy governance bodies and governments could then consider how this can be best achieved.

Furthermore, national reporting of DOEs through a central registry could also be introduced. In particular, this could collate information on where provisions have been made for different approaches to DOEs. This would allow market participants and HEMS providers to see at a glance the DOE characteristics in each DNSP location.

5 CONSIDER BESPOKE REGULATORY FRAMEWORKS FOR COMPLIANCE WITH AND ENFORCEMENT OF DOEs

As noted in section **5.3**, the customer's operating envelope is determined by their connection agreement with the DNSP. Where the responsibility for complying with the DOE might fall in the future and how compliance is managed, enforced, and communicated, remain uncertain.

Some of the different mechanisms that could be used to support compliance with DOEs include introducing penalties for breaching limits, at either the customer level or the broader portfolio level for aggregators. As outlined in section **5.4**, the extent of each party's liability for failing to comply with a DOE would be determined by the contracts that the parties have entered with each other the extent to which a regulatory framework may impose obligations for compliance.

Energy governance bodies and governments could consider developing a bespoke regulatory framework for compliance with and enforcement of DOEs. This includes exploring any regulatory changes that might be required, to provide a framework that ensures the roles and responsibilities of different parties are appropriate and transparent. Such a framework should include regulatory obligations, identify who obligations should be imposed on, and detail compliance and enforcement mechanisms. Within this framework, the needs and obligations of consumers, the needs of DNSPs to have operating envelopes complied with, and the role of HEMS providers in controlling customers' assets, would all need to be balanced. Such a framework could establish arrangements for informing consumers of their obligations and the consequences for non-compliance.

Glossary of terms

ACL
Australian Consumer Law

AEMC
Australian Energy Market Commission

AEMO
Australian Energy Market Operator

AER
Australian Energy Regulator

API
Application Programming Interface

ARENA
Australian Renewable Energy Agency

BTM
Behind-the-meter

C&I
Commercial and industrial

CEMS
Customer Energy Management Systems. CEMS can be installed at commercial and industrial (C&I) as well as residential premises.

Connection point
The agreed point of electricity supply established with the distribution network

CRI
Commercial Readiness Index. The CRI can be used to measure the commercial readiness of renewable energy solutions.

CSIP
Common Smart Inverter Profile

CSIP-AUS
The Australian Implementation Guide for IEEE 2030.5.

CSIRO
Commonwealth Scientific and Industrial Research Organisation. CSIRO is an Australian Government agency responsible for scientific research.

Customer assets
Devices used by customers to generate, consume, store, and manage electricity on-site. These typically include DER and household appliances and can be either controllable or uncontrollable.

DEIP
Distributed Energy Integration Program

DER
Distributed energy resources. Small-scale, decentralised energy generation or management that is located behind-the-meter. Common examples include rooftop solar PV, batteries, and electric vehicles.

DNSP
Distribution network service provider

DOE
Dynamic operating envelope. DOEs are flexible upper and lower bounds placed on customers' imports and exports of power that vary over time and location based on the hosting capacity of the distribution network.

DR
Demand response

ESB
Energy Security Board

EV
Electric vehicle

FCAS
Frequency Ancillary Control Services

Flexible trading relationships
The two models for flexible trading arrangements, as proposed by the ESB, could enable customers to separate their controllable and uncontrollable resources. This could provide customers with access to improved choice, revenue streams, and cost savings via greater access to the spot and service markets. The first model introduces a second connection point for flexible loads, whereas the second model establishes a sub-meter connection point arrangement.

HEMS
Home energy management system.
A HEMS is a technology platform through which at least one customer asset can be monitored and controlled. Some or all control of devices through a HEMS may be automated, based on the services offered by the HEMS provider and the participation of the home or specific devices in energy and other markets.
In addition to energy management capabilities, a HEMS can receive and respond to external signals.

NEM
National electricity market

Non-network solutions
Solutions that could reduce, defer, or even avoid the need for capital investment into network upgrades. Typically, these initiatives reduce network demand to defer or avoid the network investment.

Non-network solutions can include:
- Direct load control
- Customer demand response
- Embedded generation
- Reactive power and voltage support.

OEM
Original equipment manufacturer

PV
Photovoltaic

RIT-D
Regulatory investment test for distribution. The RIT-D establishes consistent, clear and efficient planning processes for distribution network investments in the NEM.

SCADA
Supervisory Control and Data Acquisition.
A system of software and hardware elements allowing businesses to control processes, monitor, store and process real-time data, and interact with physical devices.

SEP2
SunSpec IEEE 2030.5

SGA
Small Generation Aggregator

ToU
Time-of-Use. ToU tariffs apply different prices for electricity at different times of the day.

TRL
Technology Readiness Level.

VPP
Virtual power plant. VPPs are a cloud-based network of resources (such as DERs and controllable loads) that are coordinated to deliver power system and energy market services.

Appendices

1 LIST OF STAKEHOLDERS

As part of the stakeholder consultation process, 27 organisations across six main industry stakeholder groups were consulted. Insights were gathered from HEMS providers, distribution network operators, retailers, energy governance organisations, consumer groups and a university. The approach taken allowed for a range of viewpoints to be captured across a diverse sample of the wider energy industry.

The purpose of the consultations was to gather information on the current HEMS products and services available and how these might evolve in the future. Insights gathered helped to build a better understanding of the behind-the-meter ecosystem in the residential context. The implementation of DOEs was also explored throughout the consultation process.

TABLE 3

LIST OF ORGANISATIONS THAT PARTICIPATED IN THE STAKEHOLDER CONSULTATION PROCESS

	ORGANISATION	STAKEHOLDER TYPE
1	SA Power Network	DNSP
2	AusNet Services	DNSP
3	Energy Queensland	DNSP
4	Essential Energy	DNSP
5	Energy Networks Australia	National industry body
6	Australian Energy Market Operator (AEMO)	Energy market operator
7	Australian Energy Market Commission (AEMC)	Energy governance body
8	Australian Energy Regulator (AER)	Energy governance body
9	Tesla	Technology and service provider
10	Evergen	Technology and service provider
11	Reposit Power	Technology and service provider
12	Rheem	Technology and service provider
13	Sonnen	Technology and service provider
14	SolarEdge	Technology and service provider
15	SwitchDin	Technology and service provider
16	Wattwatchers	Technology and service provider
17	Origin Energy	Electricity retailer
18	AGL Energy	Electricity retailer
19	Simply Energy	Electricity retailer
20	Powershop	Electricity retailer
21	Pooled Energy	Electricity retailer
22	Energy Consumers Australia	Consumer group
23	Renew (Alternative Technology Association trading as Renew Australia)	Consumer group
24	Uniting Communities	Consumer group
25	Brotherhood of St Laurence	Consumer group
26	St Vincent de Paul Society	Consumer group
27	Australian National University	University

2 SUMMARY OF LEGAL ANALYSIS

Enea carried out a workshop as part of this study, through which four questions that require legal consideration were identified. Legal advice was provided by Allens, around matters relating to consumer protections. Allens have considered each of these questions and provided advice relating to the regulatory frameworks that apply in National Electricity Market (NEM) jurisdictions – other frameworks apply in Western Australia and the Northern Territory.

Set out below is a summary of Allens' findings in relation to each of the questions that were considered.

SUMMARY OF ALLENS' KEY FINDINGS

QUESTION 1: HOW DO CURRENT ELECTRICITY REGULATION AND OTHER CONSUMER PROTECTION LAWS APPLY TO BTM VENDORS AND RELATED PRODUCTS AND SERVICES?

Customers who have BTM products installed at their premises or who provide or receive BTM services are subject to, and receive the benefit of, a range of regulatory frameworks that do not apply to customers who do not have BTM products. These regulatory frameworks include the Australian Consumer Law, economy wide sales and marketing laws, electricity market regulation, electricity safety regulations, non-safety technical regulations, metering regulations, and regulatory frameworks that are voluntarily adopted by BTM vendors or imposed as a condition of government support schemes.

Consumer protections provided to customers in respect of BTM products and services do not displace, and are provided in addition to, the consumer protections that consumers receive in respect of their retail supply of electricity from the National Electricity Market.

The consumer protections that customers receive in respect of the retail supply of electricity are highly prescriptive, in recognition of electricity's status as an essential service. Customers with BTM products and services receive the same consumer protections under the ACL that apply to users of other products and services, although voluntary BTM-specific consumer protection frameworks can apply in some circumstances (such as where the products and services are supported by a government support scheme that requires a supplier to comply with a voluntary framework).

To the extent that BTM products and services are considered to be an 'essential service' akin to the retail supply of electricity, then there may be an argument for the development of a more prescriptive, BTM specific regulatory framework which provides tailored consumer protections. The 'essential-ness' of BTM products and services is not a legal question.

Given the relative infancy of the market for BTM products and services it is difficult to say whether a more prescriptive, BTM specific consumer protection framework is necessary or appropriate. There is clearly a balance to be had between ensuring that consumers are protected, while also not adding unwarranted regulatory complexity and costs to an already complex sector of the economy. These factors may support adopting a wait-and-see approach to deciding whether a BTM specific consumer protection framework should be developed, what this framework would entail, and who would be responsible for ensuring compliance and enforcement. A strong understanding of consumer experiences will be important to understand whether further BTM regulation is justified and what the focus of this regulation should be.

QUESTIONS 2 AND 3: TO WHAT EXTENT WOULD THE DIFFERENT PARTIES BE LIABLE FOR FAILING TO COMPLY WITH A DOE (CEMS PROVIDER/AGGREGATOR, CUSTOMER, RETAILER)? IF COMPLIANCE WITH A DOE FALLS ON THE CONSUMER, HOW IS IT MANAGED, ENFORCED, AND COMMUNICATED?

The extent of a party's liability for failing to comply with a DOE will be determined by the contracts that the party has entered into and the extent to which a regulatory framework may impose obligations on particular parties.

Currently, customers' operating envelopes are determined by their connection agreements with DNSPs. Therefore, in theory, to the extent that a customer failed to keep their import or export of electricity within their operating envelope then the DNSP could be able to make a claim for damages for breach of contract to recover its losses. In practice, it seems unlikely to us that the failure of a single residential premises to operate within their operating envelope would cause a DNSP to suffer a material loss.

To address concerns over DNSP's inability to ensure compliance with DOEs, and assuming that the widespread use of CEMS and BTM devices develops through the use of aggregators, a bespoke regulatory framework could be developed to better balance the needs (and obligations) of consumers, the needs of DNSPs to have operating envelopes complied with, and the role of aggregators in controlling customers' BTM devices. Such a framework could establish arrangements for consumers being informed of their obligations and the consequences for non-compliance.

QUESTION 4: HOW CAN COMPETITION LAW ENSURE A CEMS PROVIDER ISN'T PREFERENCING THEIR GATEWAY OVER OTHER DEVICES?

In summary, the *Competition and Consumer Act 2010 (Cth)* prohibits exclusive dealing and misusing market power which has (in both cases) the purpose, effect or likely effect of substantially lessening competition in a market. The 'substantial lessening of competition test' is an economic test that involves considering the likely future state of the market 'with and without' the proposed conduct.

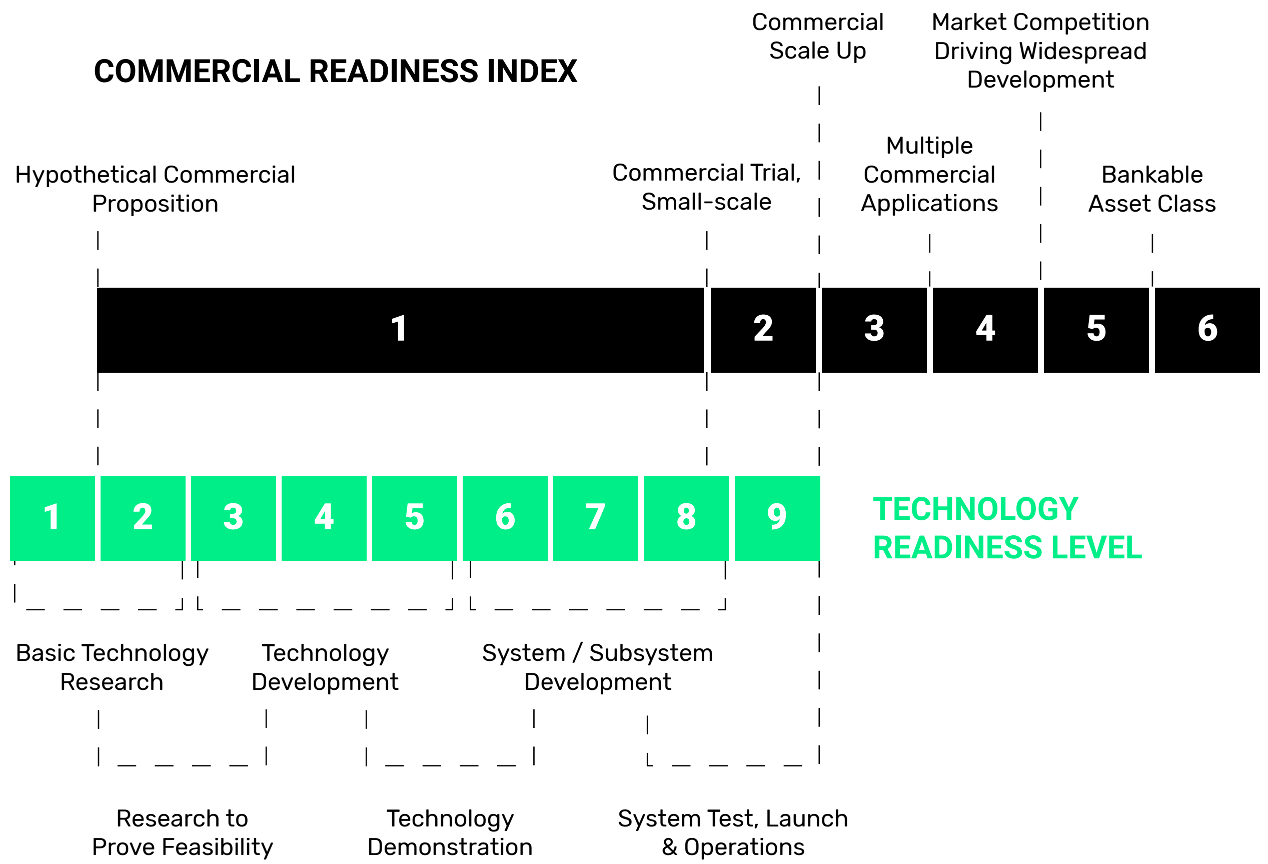
While these prohibitions do not absolutely prohibit a CEMS gateway or platform from limiting access or providing differential access (as they are subject to a lessening of competition test), they would be likely to prevent a single dominant vertically integrated gateway or platform provider using such restrictions to eliminate competition they might otherwise face in supplying BTM devices (or as a BTM provider) or single dominant BTM devices supplier similarly limiting competition it faces as a CEMS gateway or platform provider.

If it was considered important to mandate an open device/technology requirement for CEMS providers, this is likely to be better implemented through specific electricity sector regulatory requirements rather than Australia's generally applicable competition laws, which are intended to regulate commercial dealings in all sectors of the economy.

3 TRL AND CRI SCALES

FIGURE 8

TECHNOLOGY READINESS LEVELS (TRL) IN RELATION
TO COMMERCIAL READINESS INDEX (CRI) [40] [41]



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