ACCELERATING CONSUMER ENERGY IN AUSTRALIA

Building Consumer trust and resilience in the energy network

nexa ADVISORY

SolarCitizens

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About Nexa Advisory

Nexa is a 'for purpose' advisory firm. Our unwavering focus is accelerating the clean energy transition in a way that provides secure, reliable, and affordable power for consumers of all types.

Nexa Advisory is a team of experienced specialists in the energy market, policy and regulation design, stakeholder engagement, and advocacy. We work with public and private clients including renewable energy developers, investors and climate impact philanthropists to help them get Australia's clean energy transition done.

Nexa Advisory stands at the nexus of the energy sector's complex web of stakeholders. We support and direct their dialogue so as to remove the roadblocks to the transition.

We have a track record in policy creation, advocacy, political risk assessment, and project delivery. We are holistic in our approach and deliver solutions with people in mind, and commercial intent.

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About Solar Citizens

Solar Citizens is an independent, community-based organisation working to protect and grow renewable energy and transport in Australia.

Solar Citizens represents the millions of Australian households who are powering their lives with the sun, and the vast majority of Australians who support the transition to renewable energy and clean transport.

Acknowledgments

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Executive Summary

Australia's transition to clean energy is crucial for meeting climate goals, enhancing energy security, supply reliability, and reducing costs. Customer-owned energy resources (CER), especially rooftop solar photovoltaic (PV) and batteries, already plays a significant role in our energy mix and have huge potential to support and even accelerate the transition. However, until recently, the policy focus has been directed at large-scale renewable energy infrastructure.

At their November 2023 meeting, energy ministers identified accelerating adoption and integration of CER as a key priority.[1]

Nexa Advisory was commissioned by **Solar Citizens** to conduct research into the primary barriers to the widespread adoption of CER in Australia. This research involved engaging key solar retailers, inverter manufacturers, and industry organisations receiving services from Distributed Network Service Providers (DNSPs or Networks) across the National Electricity Market (NEM).

This report focusses on the barriers associated with distribution networks and outlines the necessary changes to address them. It is crucial to recognise that failure to address these issues will exacerbate technical integration challenges as CERs aggregate impact on the power system grows.

The barriers can be categorised into two groups: barriers to consumer take up of CER and barriers to effective integration of CER into the power system.

Summary of key findings

- Consumers investing in CER, particularly rooftop solar PV and batteries, are driving the transition to a clean electricity system.
- CER installations are expected to continue growing, with rooftop solar PV increasingly paired with batteries
- With appropriate incentives, CER market participation and 'demand response' from non-CER users has the potential to lower overall system costs.
- With supportive charging incentives, the adoption of electric vehicles (EVs) would further utilise excess rooftop solar PV generation and reduce integration challenges.
- Load duration curve analyses indicate that minimum demand is only an issue during infrequent instances of power system stress, such as interconnector loss, and even then, only for a small fraction of that time.
- DNSPs spend less than 1% of their total capital and operational expenditure to manage rooftop solar PV export.
- DNSPs give limted attention to mitigating the operational impacts of exported rooftop solar generation through encouraging consumer responsiveness.
- Concerns have arisen regarding the anti-competitive behaviours of regulated monopoly networks in competitive areas of the power markets, particularly concerning community batteries and large-scale batteries aimed at grid support.
- **Key issues highlighted by stakeholders during our research:**
  - **A lack of national consistency to connections** leads to inefficiencies and complexity, differing processing times, and gives DNSPs full control.
  - **Network tariff reforms are too slow** and the current model favours network service providers' cost recovery over incentivising behavioural changes.
  - **Lack of network data transparency** is impeding network development and thus the energy transition.
  - **Rooftop solar is being constrained** by inconsistent and conservative and approaches to export management.
  - **Ringfencing and competitive neutrality** would curtail the inappropriate market power being exerted by DNSPs.

Summary of recommendations

Nexa Advisory is calling on federal and state energy ministers to support the following recommendations. They are intended as a call to action to address obstacles of consumer take up of CER and barriers to effective integration of CER into the power system.

Reccommendation	Federal and State Energy Ministers to:
Governance of consumer energy technology standards	• Direct the Department of Climate Change, Energy, and the Environment and Water (DCCEEW) to immediately establish a technical reference group to review existing and proposed technical standards at both jurisdictional and national levels related to the deployment of CER. • Establish a dedicated standards taskforce for the jurisdictional electricity regulators to facilitate consistent application of technical requirements.
Clearly defined roles for market governance bodies	• Clearly define the roles and responsibilities related to CER of all industry bodies including the AEMC, AEMO, AER and the Clean Energy Regulator (CER).
Support the development of market-led services	• Direct AEMO and networks to establish market service criteria for a market-driven response to Minimum System Load (MSL) and/or Distributed PV Curtailment (DPVC) market notices. • Prioritise drafting a rule change proposal by AEMO to enable a market-led response from distribution-connected CER for addressing minimum system load, if deemed necessary.

Addressing electricity network tariff barriers and capex bias	• Task DCCEEW and the AEMC with evaluating the regulatory framework for electricity networks, with a particular focus on capex bias. The framework should emphasise allocation of funds to achieve outcomes (regardless of opex or capex) and incentivise DNSPs to explore non-network solutions that create flexible service markets through consumer side services.
	    • Revise electricity distribution network tariff design: re-examine the recent rule change (ERC0311) permitting DNSPs to impose export tariffs. This must ensure electricity retailers provide transparency and options to customers.
	    • Ensure that Networks develop optional tailored tariffs, preferably dynamic, to facilitate customer-led CER responsiveness (export reduction) or load activation, such as EV charging, during minimum system load events.
	• Task the CER Working Group and DCCEEW, in collaboration with the AEMC, to establish a tariff reform work stream such as the annual Electricity Networks Economic Regulatory Framework (ENERF) review, and seek to provide immediate recommendations on tariff design, informed by ongoing DNSP trials, focussed on consumer-centric technologies and services such as community energy initiatives and battery solutions, solar rooftop PV, electric vehicle charging, demand participation and behind-the-meter batteries.

Reccommendation	Federal and State Energy Ministers to:
Enforce ring-fencing of regulated monopoly businesses	• Direct the AER to protect the benefits of the ring-fencing guidelines and uphold these arrangements. The AER must ensure Ring-fencing guidelines are updated without delay to enhance their robustness in terms of level and manner of separation required in overseeing between regulated and unregulated activities compliance.
Data transparency	• Prioritise access to accurate meter and network data to unlock opportunities for transparency in network constraints, allowing customers and their agents to understand limitations on further DER deployment. • Mandate free public access to DNSP network operations data, including voltage for regulated electricity networks. This should be enforced through jurisdictional licencing bodies as a licence condition. **Direct the AER to:** • Establish open access to network data by the end of 2024 by making it a regulated requirement for all network service providers. • Immediately initiate a review into the DAPR template to ensure its suitability as a guide for future network and non-network investment across all levels in the distribution system. This review should encompass an annual digitisation roadmap and visibility of estimated costs of network upgrades.

Context

Australia's transition to clean energy is crucial to meeting its climate goals, while also enhancing energy security, ensuring supply reliability, and alleviating cost of living pressures now and in the future.

To date, efforts have primarily focused on expanding large-scale renewable energy generation, storage, and transmission infrastructure to facilitate Australia's energy transition, overlooking with the vast potential offered by customer-owned or consumer energy resources (CER[2]), despite their already significant role in our energy mix. Notably, rooftop solar photovoltaic (PV) generated 11.2 per cent of our energy in 2023[3], making it the second-largest contributor of renewable energy generation last year.

Harnessing CER as a source of power will accelerate our energy transition, providing consumers with immediate reductions in their energy bills and bringing benefits to the wider community, including:

- Reductions in wholesale energy prices - the Australian Energy Regulator (AER) references rooftop solar as beneficial to all Australians, not only those who install CER[4].
- Support for the power system during transition – CER, particularly rooftop solar PV coupled with batteries, can help bridge the gap in generation requirements while large-scale electricity infrastructure projects are being developed.
- Solution to the 'minimum demand problem' - Electric vehicles (EVs) and their charging infrastructure can play a significant role in addressing periods of excess rooftop solar PV generation, alongside batteries and the management of solar PV.

This report focusses on the barriers to CER deployment associated with electricity Distribution Network Service Providers (DNSPS, "Networks") and outlines the necessary changes to address them. It is crucial to recognise that failure to address these issues will exacerbate technical integration challenges as CER's aggregate impact on the power system grows.

The barriers can be categorised into two groups: barriers to consumer take up of CER and barriers to effective integration of CER into the power system.

Uptake of rooftop solar PV and batteries- a key contributor to Australia's energy transition

Australia leads globally in rooftop solar PV installations, with over one-third of homes nationwide having installed rooftop panels[5].

Installation rates range from 46% in Queensland to 20% in Tasmania[6]. Australians are drawn to rooftop solar PV because of the energy cost savings (78%), reduced dependence on electricity from the grid (48%), energy efficiency (43%) and environmental protection (39%[7]). To date, Australians have installed 254,500 behind-the-meter battery systems, 57,000 battery installations in 2023 alone[8].

This desire for energy independence reflects a lack of trust in the energy sector, as indicated by declining trust ratings in surveys[9].

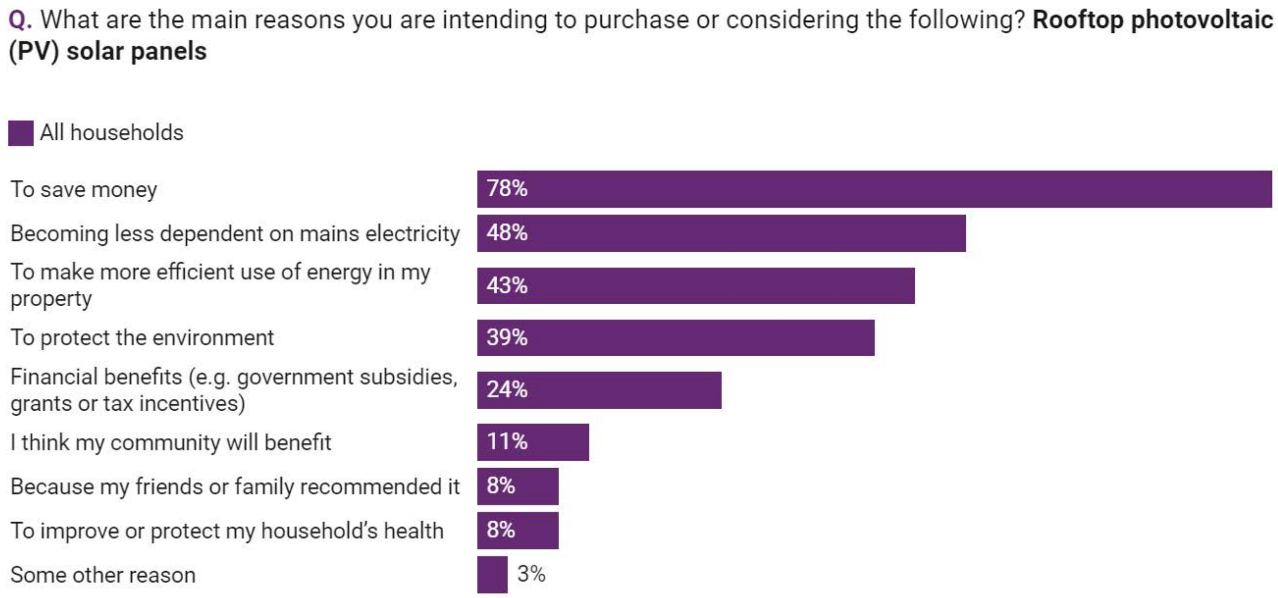


Figure 1: Consumers' reasons for investing in rooftop solar PV

Rooftop solar PV already provides Australia broad system benefits by lowering wholesale electricity prices and reducing the carbon emissions intensity of the power system[10]. Consumers investing in CER, particularly rooftop solar PV and batteries, are driving the transition to a clean electricity system.

With appropriate incentives, CER market participation and 'demand response' from non-CER users, has the potential to lower overall system costs[11].

CER installations are expected to continue growing[12], with rooftop solar PV increasingly paired with batteries[13]. Integrating batteries into homes or businesses with rooftop solar PV helps absorb excess generation, addressing technical integration challenges, as is currently the focus of several Australian Energy Market Operator (AEMO[14,15]) activities. Encouraging the adoption of EVs through supporting charging incentives will further utilise excess rooftop solar PV generation, reducing integration challenges and lowering overall system costs.

Most of the time CER isn't a concern

One of the key challenges posed by high levels of CER is what is termed 'minimum demand'. This occurs when local rooftop solar PV generation meets a region's electricity demand, reducing reliance on large-scale generators and the wholesale electricity market managed by AEMO. To maintain adequate essential power system services like inertia and frequency response for secure operation, AEMO must reserve a minimum energy demand level in each region[16]. This ensures service providers, typically coal-fired power stations, can participate in the energy-only market.

Networks and AEMO consider rooftop solar PV export as a key power system security issue. However, load duration curve analyses reveal that minimum demand is only an issue during rare instances of power system stress, such as interconnector loss, which limits state-to-state electricity flows, or in isolated systems. Even then, it is only an issue for a small portion of that time. For instance, in Queensland, rooftop solar PV export (minimum demand) is not problematic during normal operation and is only a concern for 3.5% of the time during serious power system events. In South Australia, rooftop solar PV leads to minimum demand issues only 2% of the time under normal operation and 9% of the time when the system is 'islanded'. Over 90 % of the time, even when power systems are under stress, the export from rooftop solar PV presents few challenges to the network or the system.

Please see Appendix A for more details export controls and minimum demand management.

Networks spend less than 1% of their total capital and operational expenditure to manage rooftop solar PV export (see Figure 2). In 2023, expenditure on export (opex and capex[17]) accounted for 0 to 3.3% of total network spending, averaging 0.94%[18].

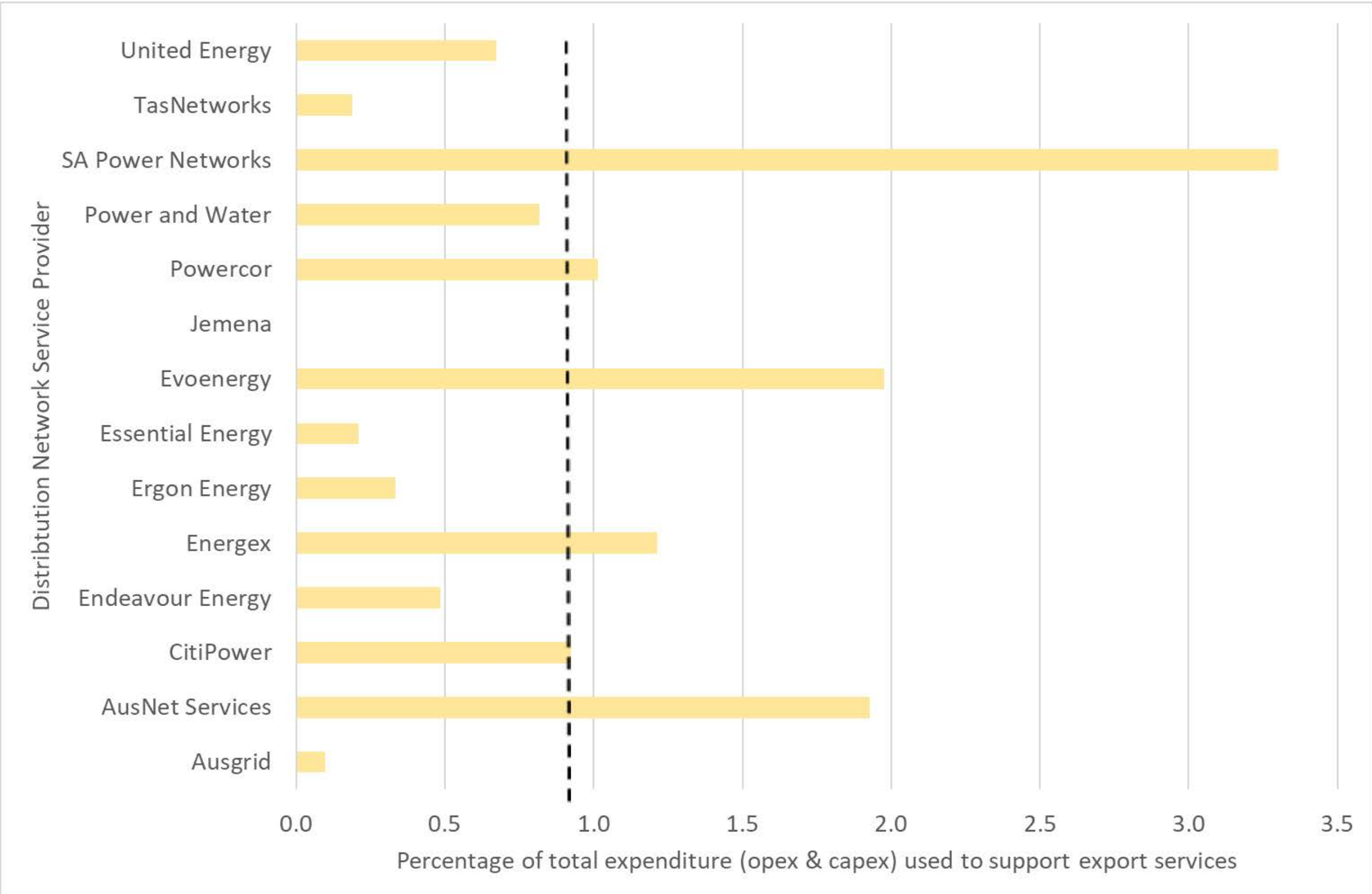


Figure 2: Network expenditure on export as a proportion of total expenditure (vertical dashed line is the average)

Instead, regulatory and technical approaches are being used to minimise and control rooftop solar PV export. There is little focus on ways that the impacts of exported energy on network operation could be alleviated while benefiting all consumers, with or without solar PV, by using EVs, stationary batteries and other high demand appliances.

AEMO has engaged state governments directly, rather than through the standard consultation processes[19] to address mitigation measures for managing minimum demand in each region.

AEMO's 2020 study on the South Australian power system suggested various mitigation options, including "solar soak" tariffs, yet the final recommendation was to shed generation by disconnecting rooftop solar PV[20]. SA Power Networks invested in technology to allow it to increase network voltage, which forces rooftop solar PV inverters to disconnect, halting export and requiring customers to buy electricity from the market rather than using their own rooftop solar PV (in self-consumption mode). Generation shedding was utilised during islanding events from the NEM in March 2021 and November 2022[21], the latter event costing South Australians $5 million collectively[22].

Despite AEMO introducing Minimum System Load (MSL) and Distributed PV Curtailment (DPVC) market notices, neither AEMO nor the networks have actively supported the development of market-led services to reduce exports and increase demand in response to these notices.

The emergency backstop is activated when AEMO issues a MSL 3 (level 3) or DPVC 3[23] notices. Earlier notices (levels 1 and 2) could utilise a market-led response, such as compensating EVs for charging, or incentivising rooftop top solar PV to cease export but these market-led approaches are not supported by AEMO or the Networks.

Please see Appendix A for more details.

Distribution network transformation

Our energy system was originally designed for one-way energy flow from centralised power stations to passive consumers. Consumer adoption of renewable energy production gives rise to two-way energy flows – from grid to consumer and vice versa. As such, there are aspects of our power distribution networks, including system specifications and regulatory frameworks, which require adjustments to allow the seamless integration of CER and optimal consumer investment in these technologies.

Historically, the market bodies and network operators have mainly focused on resolving technical integration issues of CER. AEMO, in particular, has sought to manage and control CER impact through mechanisms like emergency backstops. In doing so, the opportunities available to manage some of the issues by incentivising consumer behaviour have been neglected.

It is also true that the traditional business models of networks and retailers are disrupted by CER. As such, the industry has often resorted to regulatory measures to mitigate integration issues, instead of embracing CER and engaging with consumers to increase its uptake.

The above perspectives mean that reform has focused on complex rule change processes that often involve burdensome consultations. This has alienated consumers and their representatives from the regulatory process, leading to decisions by market bodies that do not consider the long-term consumer interests and perpetuate industry-centric perspectives.

That said, while regulations have not fully adapted to capitalise on CER opportunities in the energy transition, some progress has recently been made. Following Nexa Advisory's report, Putting the Power in People's Hands[24], published in October 2023, energy ministers committed to prioritising CER in November 2023 and requested the development of a taskforce and roadmap[25]. Additionally, in April 2024, the Federal Government released the National Energy Performance Strategy[26], which integrates efficiency, flexible demand, and performance into a unified plan.

Network flexibility and innovation is needed to bridge the electrification gap in our energy transition. To ensure our regulatory frameworks align with the evolving electricity system, a paradigm shift is still needed to move from viewing CER as a problem. This report aims to offer alternative pathways which have the potential to make CER part of the solution to our energy challenges.

The current slow pace of market reforms poses a threat to the transition

Over the past decade various reviews, such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Energy Networks Australia (ENA) roadmap[27], AEMO assessments[28], and the Energy Security Board (ESB) workstream have examined CER integration. However, few actual changes have been implemented.

Of the changes that have occurred, such as the Access and Pricing rule change[30], many penalise CER or primarily benefit industry[31]. Additionally, changes like emergency backstops, export tariffs, and technical obligations on grid-connected assets have been made with minimal consumer consultation and have not resulted in meaningful consumer-centric outcomes.

Benchmarking DNSP performance in accommodating CER

Nexa Advisory conducted interviews, surveys and extensive desktop research to identify key impediments to accelerating rooftop solar PV adoption in Australia. This involved engaging top solar retailers, inverter manufacturers, and industry organisations receiving services from DNSPs across the National Electricity Market (NEM).

Original Equipment Manufacturers (OEMs) were asked to rank the primary challenges impacting their business and customers. The main concerns highlighted by the interviewed OEMs can be summarised as follows:

Network tariff reforms: There is a gap between what consumers pay for electricity and what they are reimbursed for exporting power, this is exacerbated by slow network tariff reforms. The current model favours network service providers' cost recovery over incentivising behavioural changes, leading to customers being penalised for solar exports while also experiencing curtailment due to ineffective price signals.

National consistency for connections: The lack of national consistency in rooftop solar PV connection processes across DNSPs results in inefficiencies, complexity, and varying processing times. It also grants DNSPs full control, limiting the ability for installers or OEMs to engage on the feasibility of more cost-effective solutions. This 'black box' approach is also emerging for other CER technologies such batteries and EV chargers.

Provision of network data: DNSPs hold vast amounts of data that could enhance network optimisation, yet they do not share this information. Transparency in this area would enable third parties to pinpoint locations where solutions like batteries, EV charging solutions or demand-side responses could address network constraints.

Constrained rooftop solar: There are inconsistencies in how DNSPs treat and accommodate rooftop solar PV, leading to differences in export limits, system size constraints and approaches to export management. However, there is a prevalent bias towards conservatism, command and control, and network capex.

Ringfencing and competitive neutrality: DNSPs are contesting ringfencing regulations that would allow third parties to enter the power system, and thus prevent DNSPs from leveraging their natural monopoly.

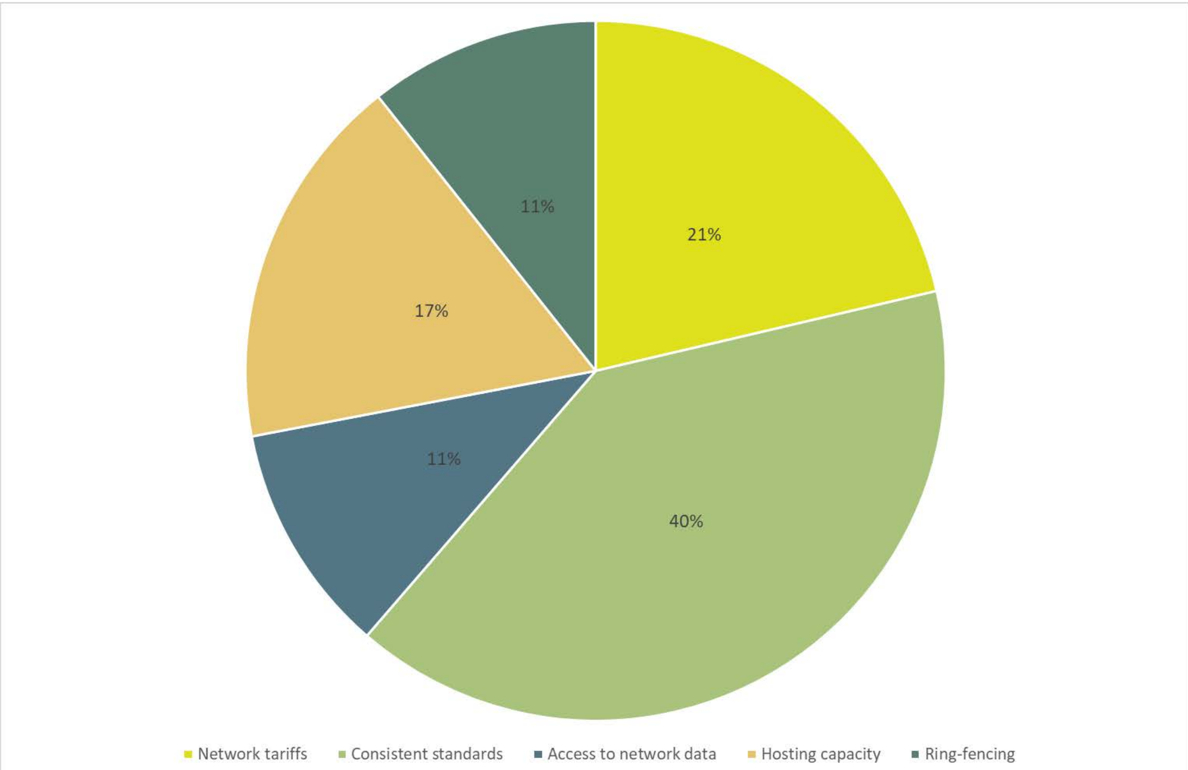


Figure 3: Key Network issues raised in interviews and surveys with CER providers

Key priorities for reform

Overall, the inconsistent application of standards, outdated network tariff structures, and data transparency issues were ranked as the primary barriers hindering the uptake of rooftop solar PV, battery, and future CER technology.

These barriers are further explored in the subsequent sections, with associated recommendations for action by energy ministers.

Inconsistent application of standards

Networks typically adhere to standards like AS4777.2(2020) to ensure that inverter-connected CER comply with national requirements. However, the application of these standards varies between networks.

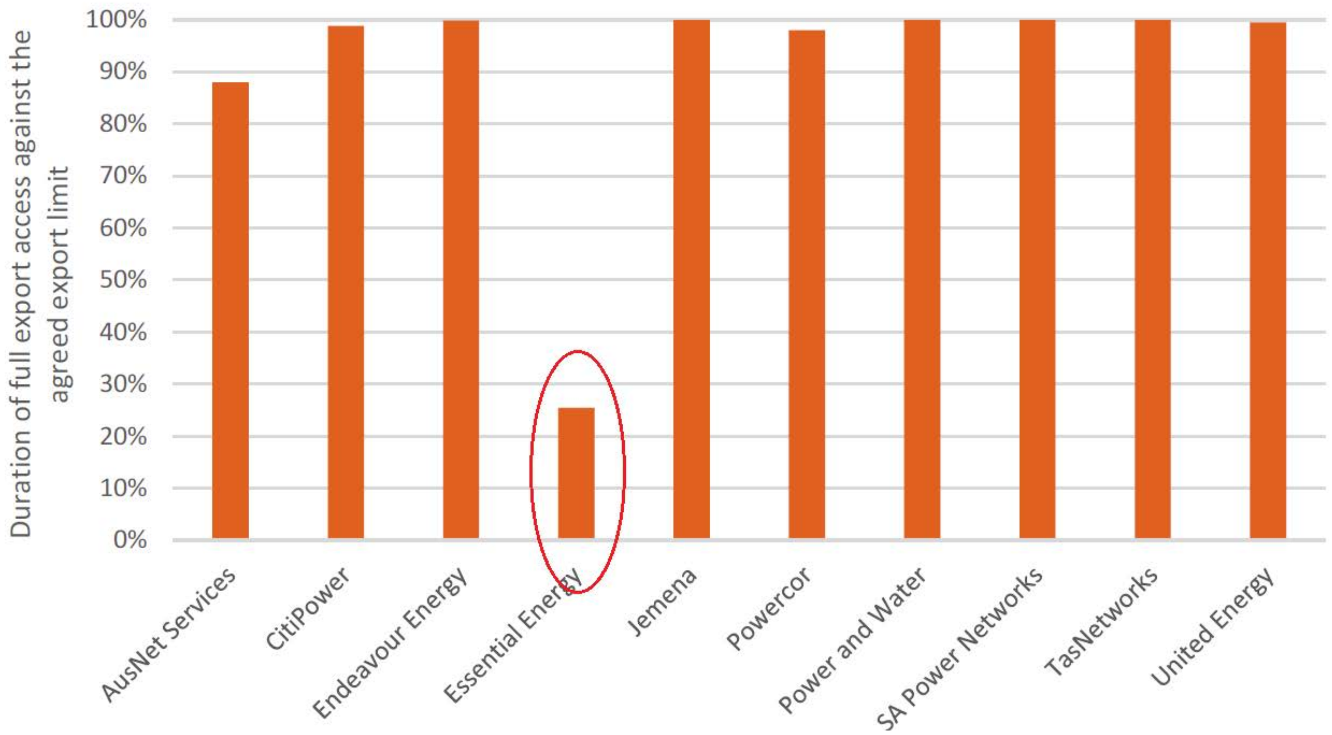


Figure 4: Export access versus agreed export limit, showing how Essential Energy's different treatment of inverters results in different outcomes for customers[32]

For example, Essential Energy reduces export access when voltage exceeds 240V, while other DNSPs do so when voltage exceeds 253V[33]. This discrepancy stems from different interpretations of AS4777.2(2020) requiring a small reduction in real power output at 240V for volt-ampere reactive (VAR) curtailment, but a large reduction in real power output at 253V for volt-watt curtailment[34].

Ausgrid, Energex, and Ergon Energy did not provide data to the Australian Energy Regulator (AER) on this metric, despite all three networks proposing to levy export tariffs on CER.

CASE STUDY - Approach to the Emergency Backstop

In four states spanning ten different networks, an emergency backstop mechanism has been implemented. This mechanism is activated when AEMO issues a Distributed PV Contingency Level 3 (DPVC3) market notice, requiring networks to curtail the export of rooftop solar PV. This has resulted in different mechanisms. In South Australia and Victoria, the networks have implemented the Common Smart Inverter Profile Australia (CSIP-Aus), while in Queensland the network has required all new installations to adopt Audio Frequency Load Control (AFLC – more commonly known as "ripple control") via a third-party box that has to be purchased and installed in addition to the solar PV panels and inverter. The CSIP-Aus standard was effectively an Australian Renewable Energy Agency (ARENA) Distributed Energy Integration Program (DEIP) guideline document developed by Networks. The CSIP-Aus standard was never consulted on via Standards Australia or Australian Energy Market Commission (AEMC), nor did it involve broader industry consultation.

The burden on OEMs to implement these diverse standards across the various jurisdictions results in significant costs, which are ultimately passed on to consumers.

South Australia

All rooftop solar PV installations after 28 September 2020[35] must be CSIP-Aus compliant[36] (based on IEEE 2030.5). This compliance allows the network to communicate directly with rooftop solar PV inverters for shutdown purposes. This renders the majority of current legacy PV installations non-compliant, as they cannot be remotely disabled. To ensure sufficient rooftop solar PV is disconnected, the Network must rely on increasing the voltage to force disconnection, which prevents self-consumption. All new rooftop solar PV installations after 1 July 2023 must have a fixed static export limit of 1.5 kW or a flexible connection to allow the network to control the output of the inverter up to a maximum export of 10 kW[37].

Victoria

All rooftop solar PV inverters installed after 1 July 2024 must be CSIP-Aus compliant[38]. Similar to South Australia, this allows the network to remotely turn off inverters for system security, when instructed to do so by AEMO. Although implemented via three utility servers (as opposed to one in South Australia), they are manufactured by two different vendors and have varying structured requirements.

In addition to implementing a backstop mechanism, they have a comprehensive flexible exports mechanism used solely to set an export threshold during emergencies. This entails OEMs receiving a power threshold setting every 5 minutes for a single DNSP, despite the function potentially changing only for a few hours once a year. This imposes a huge cost burden on OEMs from both a data and infrastructure perspective, without any consumer benefit.

Queensland

All inverters will eventually be required to adhere to the CSIP-Aus standard for flexible connections, enabling the network to control rooftop PV export and Smart Energy Profile (SEP) 2.0 for batteries. This means that compliance standards for battery imports will differ from rooftop solar PV. All new installations from 6 February 2023 require a Generation Signalling Device (GSD) to be connected to inverters to allow for network-controlled shutdowns, particularly during islanding events[39]. GSD uses "ripple control" and is not reliant on the internet or mobile networks for communication. However, installing the GSD requires additional communication wiring expertise for installers. Even if inverters comply with CSIP-Aus, the GSD will remain necessary for the emergency backstop in Queensland, requiring specific installer skills for rooftop solar PV installations. In addition, this mechanism is a blunt solution as it shuts down the inverter entirely rather than solely the export component, shifting consumer load onto the network, preventing self-consumption.

Approach to EV charging

Queensland has adopted a unique approach to EV charging. However, some EV charger requirements are not supported by industry standards and available technologies.

For instance, the requirement for a 20-amp charger conflicts with the international standard of 32 amps. This means charging equipment available in Australia is unusable in Queensland[40].

In addition, like rooftop solar PV inverters, Queensland networks mandate EV chargers to be equipped with a GSD or comply with the CSIP-Aus. However, currently available EV chargers do not meet these standards.

As a result, new EV owners wishing to install a charging unit must do so without the network's awareness, as meeting these requirements requires additional equipment that adds complexity and cost to the installation. It also means there is a risk of the EV not being charged when expected due to network intervention.

EVs offer a demand-side solution to rooftop solar PV export. Owners should be incentivised to charge them during peak solar export periods through a solar soaker tariff, rather than requiring the purchase of a Network Control Device (NCD), which is currently the only approved option despite the unavailability of compliant chargers. Solar soaking would also serve as a valuable incentive for increased battery deployment in Queensland.

Reccommendation	Federal and State Energy Ministers to:

clearly defined roles for market governance bodies	• Clearly define the roles and responsibilities related to CER of all industry bodies including the AEMC, AEMO, AER, the Clean Energy Regulator (CER) and Standards Australia and any jurisdictional regulatory bodies.
	  • Thoughtful consideration and open consultation of eligibility for creating new technical standard/requirement.
	  • Coordination on the development of any technical requirements, prioritising national consistency.
	  • A hierarchical structure for the development of technical requirements/standards to ensure clear understanding and management of both the development and implementation process.
	  • Guidance to enhance data and reporting on installation compliance, beyond solely relying on electrical inspectors.

Support the development of market-led services	• Direct AEMO and networks to establish market service criteria for a market-driven response to Minimum System Load (MSL) and/or Distributed PV Curtailment (DPVC) market notices. • Prioritise drafting a rule change proposal by AEMO to enable a market-led response from distribution-connected CER for addressing minimum system load, if deemed necessary.

Outdated tariff structures

Network tariffs have failed to adapt to the two-way energy flow or acknowledge the potential of CER in network and power system management.

During periods of minimum energy demand in the middle of the day, surplus energy generated by rooftop solar PV could be used by EVs to charge, mitigating potential network management issues.

EV network tariffs and "solar soaker" network tariffs that incentivise both rooftop solar PV customers and non-solar customers to shift their EV charging to the middle of the day have proven highly effective elsewhere[41] in managing load without requiring direct orchestration or managed charging[42].

However, if an export tariff is imposed on rooftop solar PV during this period it could diminish the surplus generation available for EV charging. Currently, none of the current or proposed network tariffs include one that is EV-specific.

There is also an imbalance in charges for importing and compensation for exporting energy. Networks charge more for daytime exports than the compensation they offer for evening exports.

All but two networks have already implemented or are considering implementing tariffs on residential rooftop solar PV exports. TasNetworks (Tasmania) lacks a significant penetration of rooftop solar PV to warrant an export tariff. EvoEnergy (ACT)[43], after trialling an export tariff, has chosen to focus on offering a residential "solar soaker" tariff instead.

Despite most networks proposing charges for exporting energy to the grid, the investment needed to facilitate exports constitutes no more than 1% of network investment in capital and operational expenditure[44]. This suggests limited justification for export tariffs. This is reflected in the AER's recent review[45] who have made it clear that there is no justification for export charges.

Please see Appendix B for more details on offered tariffs.

Capex and Opex bias

Electricity networks earn a regulated annual revenue of 4-5% on their Regulated Asset Base (RAB), which includes assets like poles and wires[46]. Capital expenditure (capex) allowed by the AER increases the RAB, while operational expenditure (opex), such as IT support, does not contribute to the RAB.

The combined RAB of distribution networks is $82.7 billion, with total network revenue at $8.9 billion, meaning regulated revenue is just under $4 billion[47]. Revenue related to the RAB and asset depreciation accounts for over 60% (opex is 36%) and is secured by charging customers through network tariffs billed via retailers, with network costs representing 30-35% of the average customer bill[48].

The 2017 Finkel Review[49] recommended the AEMC undertake a review to assess whether electricity networks favoured capex. The AEMC identified in the 2018 Electricity Network Economic Regulatory Framework (ENERF) review a bias toward capex solutions, particularly for long-life assets like traditional poles and wires[50]. The 2019 ENERF review considered increasing choices between capex and opex solutions. However, after gathering input from stakeholders and considering the rise of CER, the AEMC determined not the introduce a new model[51].

As part of the AEMC review, ENA explored a "totex" model treating opex like capex to remove incentives for asset investment and revenue growth[52], but ultimately recommended the status quo. However, currently the only incentives for customer/demand-side responses include the Demand Management Innovation Scheme and Allowance (DMIS and DMIA). Networks have utilised an average of 33% of the available allowance, indicating reluctance to access demand-side flexibility[53].

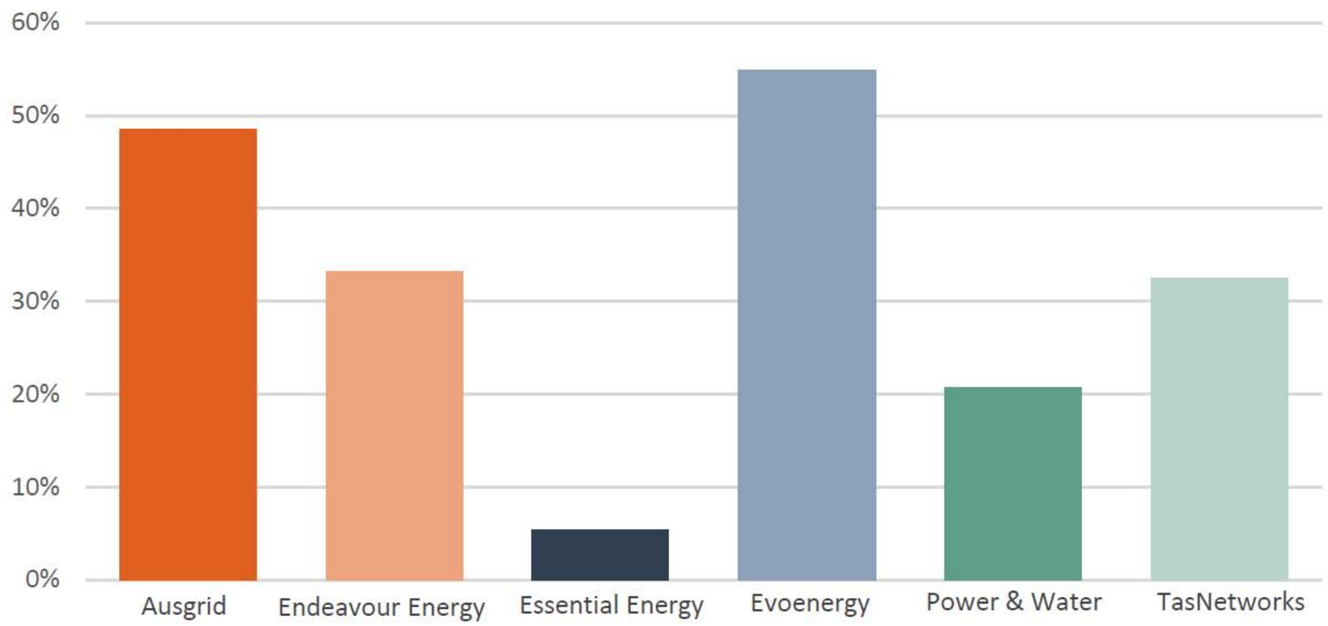


Figure 5: Utilisation of the Demand Management Incentive Schemes by the Networks

CASE STUDY – UK 'Totex' model

In the UK, a capex bias was identified in 1999[54]. The regulator, Ofgem, ran a 'paper' scheme alongside the 2010-2014 determination period to understand the issue better[55]. This enabled Ofgem to commence 'totex' arrangements which were introduced in the first 8-year Revenue = Incentives + Innovation + Outputs for Electricity Distribution (RIIO-ED1) framework from 2015-2023[56].

Ofgem's approach focused on resolving the bias towards capex by introducing a Totex model that valued opex and a presumption that smart and innovative approaches such as flexibility services would deliver a more cost-efficient future grid. Under the RIIO-ED1, Ofgem highlighted the importance of networks adopting "smart grid" solutions and considering all options before investing in asset reinforcement. This led to the creation of flexibility service markets where networks seek non-network solutions through consumer-side services[57].

Ofgem also enforced appropriate separations in monopoly activities, such a prohibiting UK networks from owning and operating batteries due to conflicts of interest[58].

However, this has not been the case in Australia. Australia faces concerns about anti-competitive behaviours of regulated monopoly networks in competitive areas of its power markets, particularly community batteries and large-scale batteries for grid support.

The AER's explanatory statement accompanying the November 2021 Ringfencing Guideline thoroughly addresses its concerns regarding DNSPs owning and operating batteries. The AER states:

> "Battery technology is still relatively new and emerging. There are a number of potential deployment models, one of which involves DNSP ownership. Relative to other models, DNSP ownership of batteries presents risks to competition that needs to be carefully considered. As a result, we do not think that the research provides a conclusive position on this. DNSPs are only one of many potential providers of community-scale batteries. It is therefore important that the regulatory framework supports a range of deployment models.[59]"

> "We are concerned that allowing DNSPs to actively engage in this market, without appropriate controls, risks the foreclosure of other players. This would not be in the long-term interest of consumers" and "It could mean that the benefits from batteries might not materialise to the same extent and may hinder innovation and competition from what is currently an emerging technology and market.[60]"

The absence of ring-fencing measures poses a risk of distorting the innovative CER market and impeding service development and commercialisation.

Reccommendation	Federal and State Energy Ministers to:
Addressing electricity network tariff barriers and capex bias	Initiate a review of the ENERF of distribution networks. • Task DCCEEW and the AEMC with evaluating the regulatory framework for electricity networks, with a particular focus on capex bias. • The framework should emphasise allocation of funds to achieve outcomes (regardless of opex or capex) and incentivise DNSPs to explore non-network solutions that create flexible service markets through consumer side services. • Revise electricity distribution network tariff design: re-examine the recent rule change (ERC0311) permitting DNSPs to impose export tariffs. This must ensure electricity retailers provide transparency and options to customers. • To ensure that Networks develop tailored tariffs, preferably dynamic, to facilitate CER responsiveness (export reduction) or load activation, such as EV charging, during minimum system load events. Federal and State Energy Ministers should task the CER Working Group and DCCEEW, in collaboration with the AEMC, to establish a tariff reform work stream such as the annual Electricity Networks Economic Regulatory Framework (ENERF) review. • This initiative should be adequately resourced, inclusive, and transparent, engaging an array of stakeholders beyond the traditional electricity players. • The work stream should adopt a principle-based approach focused on consumer outcomes and benefits. • Seek to provide immediate recommendations on tariff design, informed by ongoing DNSP trials, focussed on consumer-centric technologies and services such as community energy initiatives and battery solutions, solar rooftop PV, electric vehicle charging, demand participation and behind-the-meter batteries.

Reccommendation	Federal and State Energy Ministers to:

Enforce ring-fencing of regulated monopoly businesses	Federal and State Energy Ministers to direct the AER to protect the benefits of the ring-fencing guidelines and uphold these arrangements. The AER must ensure:
	• Ring-fencing guidelines are updated without delay to:
	  • Enhance their robustness in terms of level and manner of separation required in overseeing compliance.
	  • Acknowledge the evolving energy industry, recognising that allowing monopoly DNSP involvement could distort not only generation and retail markets, but also other service sectors linked to the distribution network, particularly the behind-the-meter market for CER (such as solar PV, battery storage systems, and home energy management).
	• The granting of waivers by the AER should be assessed based on consumer value principles, ensuring that competitive service offerings are not distorted for the benefit of DNSPs and that opportunities for RAB expansion are not unfairly increased. The AER to assess the appropriateness of the streamlined waiver process for DNSP-led batteries
	• Implement clear and transparent mechanisms for regular monitoring and reporting on DNSP compliance with the guidelines, with civil penalties to apply for non-compliance.
	• Mandate that regulated networks cannot own batteries or generation facilities. This would support the competitive delivery of microgrids and non-wired solutions by third-parties and DNSPs, including ring-fenced unregulated network entities. This approach would ensure competitive neutrality is maintained and increase cost-effectiveness and efficiency for customers.

Lack of data transparency

All networks release information annually about network constraints at the zone substation and sub-transmission levels as part of their Distribution Annual Planning Report (DAPR) obligation under the National Electricity Rules (NER).

In recent years, networks have explored using mapping platforms to share this data and other data on lower voltage assets. While all networks now have digital maps of their network areas, the detail and availability of information varies greatly.

Victorian networks generally have more detailed data due to access to smart meters, although this data may not always be publicly available or easily accessible, even to customers. Currently, most map data focusses on demand constraints, with limited data on export constraints being published.

The Rosetta Analytics[62] portal offers publicly available information on the Australian energy system, but it does not directly identify areas where CER capacity exceeds local network capacity.

The AER's Network Visibility review aims to make more network information available to CER consumers, installers, and operators[62], building on the data strategy developed by the Energy Security Board (ESB)[63]. Recent rule changes require DNSPs to share data with a select group of stakeholders including the market bodies, AEMO and federal and state governments[64], but there is no broad requirement for them to share network data with current and new CER owners, their agents and third parties beyond the DAPR.

The AER, through the ESB, has identified several cases in which customers would benefit from increased data access[65].

Variable	Current & potential CER owners and providers	CER providers, advisors & providers	AEMC, policy and planning bodies (including state level governments and regulators)
Current and remaining headroom for consumption	Y		Y
Network plans for augmenting capacity	Y		Y
Value of deferring/avoiding network capacity	Y	Y	Y
Current and remaining headroom for export	Y	Y	Y
Plans to increase CER hosting capacity	Y	Y	Y
Value of deferring network expenditure to increase hosting capacity	Y	Y	Y
Level of historical and current CER curtailment	Y	Y	Y
Historical and current-voltage levels	Y		Y
The historical and current level of network reliability	Y		Y
Outage events	Y		Y

Table 1: DNSP CER-related data use cases (Green: progressed through legislation in 2023; Red: not yet progressed)

The current data sharing requirements imposed on the networks (such as DAPR and zone sub-station constraints) lack sufficient detail and do not extend adequately into the network to where CER are located. The data required in the DAPR is limited to zone sub-station information, which sits at the boundary of the sub-transmission network (at 66 kV) and the distribution network, significantly distant from customers and CER (below 11 kV), with many other low voltage network assets in between that are not required to be detailed in the DAPR.

The DAPR content was established in 2014[66], and since then, the network's function has evolved significantly, along with shifts in industry and customer preferences. As such, the data necessary to foster innovation in customer offerings is unavailable.

By providing detailed network data publicly, including information on the low voltage network and the associated costs for network improvements, third party providers would have the opportunity to competitively offer alternative solutions to achieve the same outcomes.

Access to accurate meter data, network data, and meta data, would unlock opportunities for transparency in network constraints and allow customers and their agents to understand limitations on further DER deployment. Sharing network data broadly would enable new providers to develop innovative offers and business models, benefiting both customers and networks.

The UK regulator, Ofgem, mandated networks share all their data in 2021, through publicly accessible portals managed by each local network[67]. This access underpinned the rapid deployment of flexibility services markets and demand-side response offerings from aggregators. A single UK network issued tenders for more than 400MW of flexibility, aiming to save its customers £400 million[68] over 5 years (equivalent to $780 million). The response attracted bids of 1,000 MW[69]. This approach has significantly reduced overall costs to customers and demonstrated the effectiveness of prioritising flexibility over traditional infrastructure investments.

Access to smart meter data in Victoria has allowed the Victorian Government to work with the state's networks to reduce network voltage, allowing greater penetration of rooftop solar PV[70]. This contrasts with other states and networks, where the penetration of smart meters is lower.

See Appendices C and D for further information.

Trust is a major issue

The focus on network and power system issues in CER integration has eroded consumer trust in the Australian energy sector, ranking it the second lowest after social media[71]. This erosion of trust is further emphasised by the work of the ESB[72] and AEMO Project EDGE[73], highlighting the extent of the trust issue among customers.

Consequently, customers are expressing significant concern about relinquishing control over their investments. While many are willing to participate, trust hinges on the perceived value of participation. Nearly half of all customers (46%) prefer complete control, with a further (48%) open to some level of automation, provided they retain the ability to override[74]. This indicates that there is still progress needed before customers are willing to surrender control over their energy agency impacting broader adoption of flexible services, Virtual Power Plants (VPPs) and other new energy services.

Through data sharing, networks would operate with greater transparency, enabling third parties and customer agents to assess the necessity for network proposed upgrades and the feasibility of non-network alternatives, such as CER or customer side services. This will help build trust with customers.

Remote communities and microgrids

The Stand-Alone Power System (SAPS) rule change[75] aimed to eliminate long rural lines by implementing SAPS, which operate independently from the wider network. This reduces maintenance and management costs and lowers overall network costs while enhancing reliability[76]. However, few SAPS have been developed in the NEM. Where they have been developed, they have mostly been for 1-3 isolated customers[77]. Complex market arrangements, including pseudo-competitive retail arrangements, have hindered the creation of third-party SAPs[78].

To identify customers that would be better served by a SAPS, it is essential to gain an understanding of the costs associated with the local electricity network, as well as the reliability and resilience of the network servicing and connecting the local community to the broader network, as well as the growth in electricity demand within the community.

Networks are now exploring 'islandable' microgrids, maintaining long rural lines but adding batteries and generation to create systems that can be isolated, for instance before or after severe weather events, ensuring communities have some access to power.

However, retaining long lines reduces cost savings while adding expenses for microgrid development and maintenance[79], increasing the value of the RAB. In addition, communities often do not understand the highly technical solutions provided by the network or find them suitable for their needs[80].

Rural, sparsely populated communities have worse reliability outcomes than more dense urban networks (see Appendix E for more detail). A lack of network data restricts the development of microgrids and impedes developers' and communities' capacity to identify poor reliability and resilience in regulatory terms. Similarly, it inhibits the development of network plans aimed at improving the reliability of specific power lines, reinforcing lines to accommodate electrification, and assessing cost-effectiveness. Only networks have access to the cost analysis of reinforcing existing lines compared to alternative approaches (cost-to-serve) and have the authority, albeit not the obligation, to develop microgrids or reinforce long power lines.

Additionally, the operation of a microgrid typically requires generation capacity and a battery. This requires the coordination and cooperation of multiple partnerships and arrangements. Lack of publicly available network visibility and data means that incumbent networks have the advantage when building a robust business case for a SAPS or islandable microgrid, preventing communities and third-parties from providing lower cost, efficient solutions.

Ring-fencing rules ensure that networks are restricted from mis-using their regulated monopoly advantage. However, waivers have been easily facilitated in recent years (as seen in the recent community battery programs). Caution is needed to ensure competitive neutrality principles are maintained. Regulated monopoly companies must not be given advantages that limit competition and innovation from third-party providers, including the unregulated business owned by the network, of SAPS and islandable microgrids[81].

Reccommendation	Federal and State Energy Ministers to:
Data transparency	• Prioritise access to accurate meter and network data to unlock opportunities for transparency in network constraints, allowing customers and their agents to understand limitations on further DER deployment. • Mandate free public access to DNSP network operations data, including voltage for regulated electricity networks. This should be enforced through jurisdictional licencing bodies as a licence condition. Direct the AER to: • Establish open access to network data by the end of 2024 by making it a regulated requirement for all network service providers. • Immediately initiate a review into the DAPR template to ensure its suitability as a guide for future network and non-network investment across all levels in the distribution system. This review should encompass an annual digitisation roadmap and visibility of estimated costs of network upgrades.

APPENDIX A – Minimum Demand and Emergency Backstops

AEMO has set a Minimum Demand Threshold (MDT) for South Australia, Queensland and Victoria[82]:

Region	System Condition	Minimum operational demand thresholds	Forecast date when thresholds will be reached
South Australia	Secure operation of an island	600 MW	Occurred
	Credible risk of separation	400 MW	Occurred
Victoria	System normal threshold for system strength units	800-1600 MW	2023
	Secure operation of Victoria and South Australia as an island	1800-3500 MW	2021-2022
Queensland	Secure operation of an island	2500-3400 MW	2021-2022
	System normal threshold for system strength units	1200-1700 MW	2025-2026

Table A1: Minimum Demand Thresholds set by AEMO

In Queensland, the MDT under normal operation is 1.2-1.7 GW, increasing to 2.5-3.4 GW when Queensland is islanded from the rest of the NEM. Load duration curves for Queensland indicate that minimum demand consistently exceeds the MDT under normal operating conditions, meaning export from rooftop solar PV poses no threat to power system security in Queensland under normal conditions. Even under islanded conditions, minimum demand is below the MDT less than 3.5% of the time, demonstrating that rooftop solar PV can export without jeopardising network or power system security for 96.5% of the time, even in an islanded (stressed) Queensland power system.

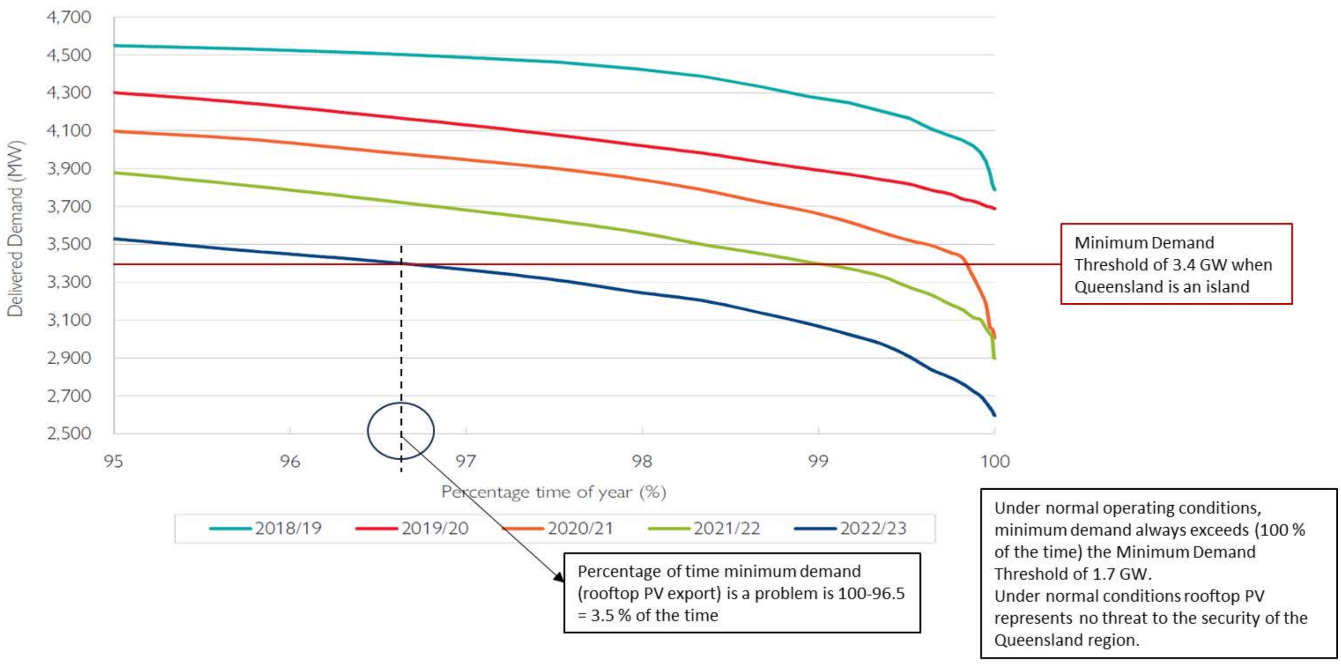


Figure A1: Load duration curves, expanded to show minimum demand for Queensland[83]

For South Australia, the MDT is 400 MW under normal operating conditions and 600 MW when South Australia is islanded from the rest of the NEM. Under normal conditions, minimum demand falls below 400 MW 2% of the time and falls under 600 MW 9% of the time when the South Australia is islanded.

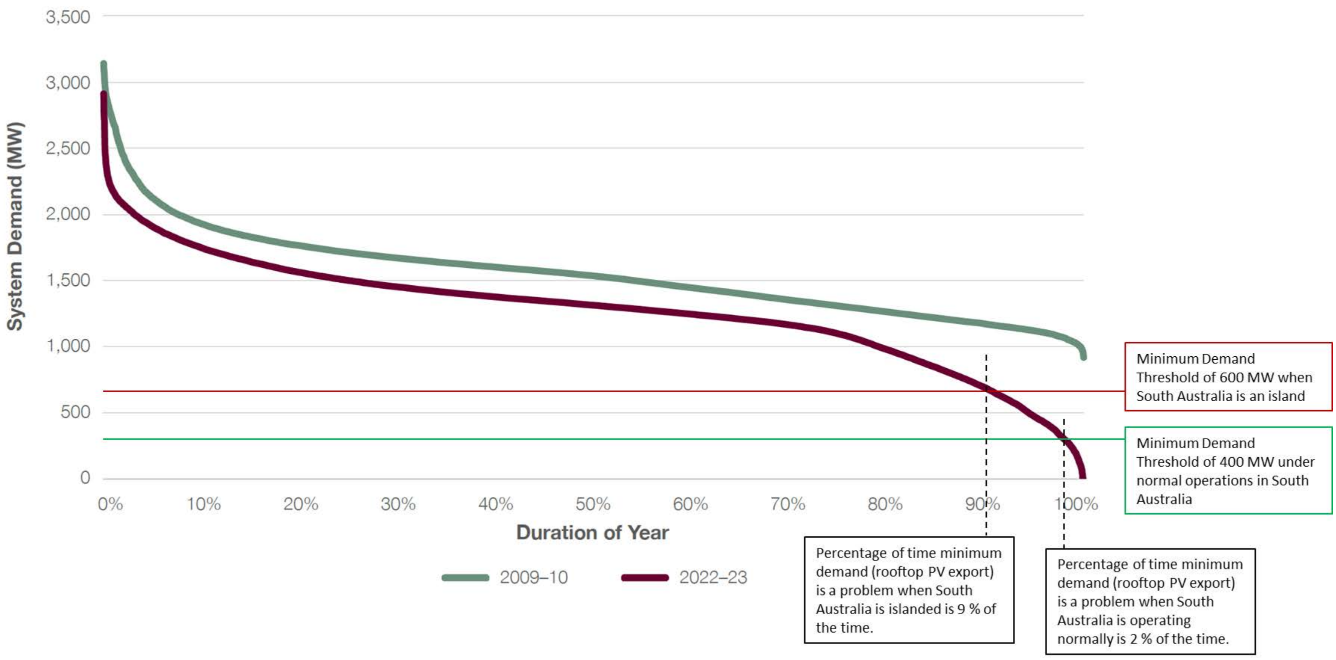


Figure A2: Load duration curves for South Australia[84]

However, AEMO and the TNSPs and DNSPs have focused on the 2-9 % of the time, when the power system is under stress, to drive the introduction of emergency backstops in South Australia, Queensland and Victoria[85,86,87], rather than the over 90 % of the time, even when power systems are under stress, that the export from rooftop solar PV presents few challenges to the network or the system.

APPENDIX B – Network Tariffs

A review of the existing network tariffs gazetted by the AER in Tariff Structure Statements (TSS) reveals that currently there are no DER-related tariffs in operation. With the exception of trials, none of the networks are offering a "solar soaker" tariff, a reward for exporting at peak demand times, nor are they offering EV or stationary battery tariffs.

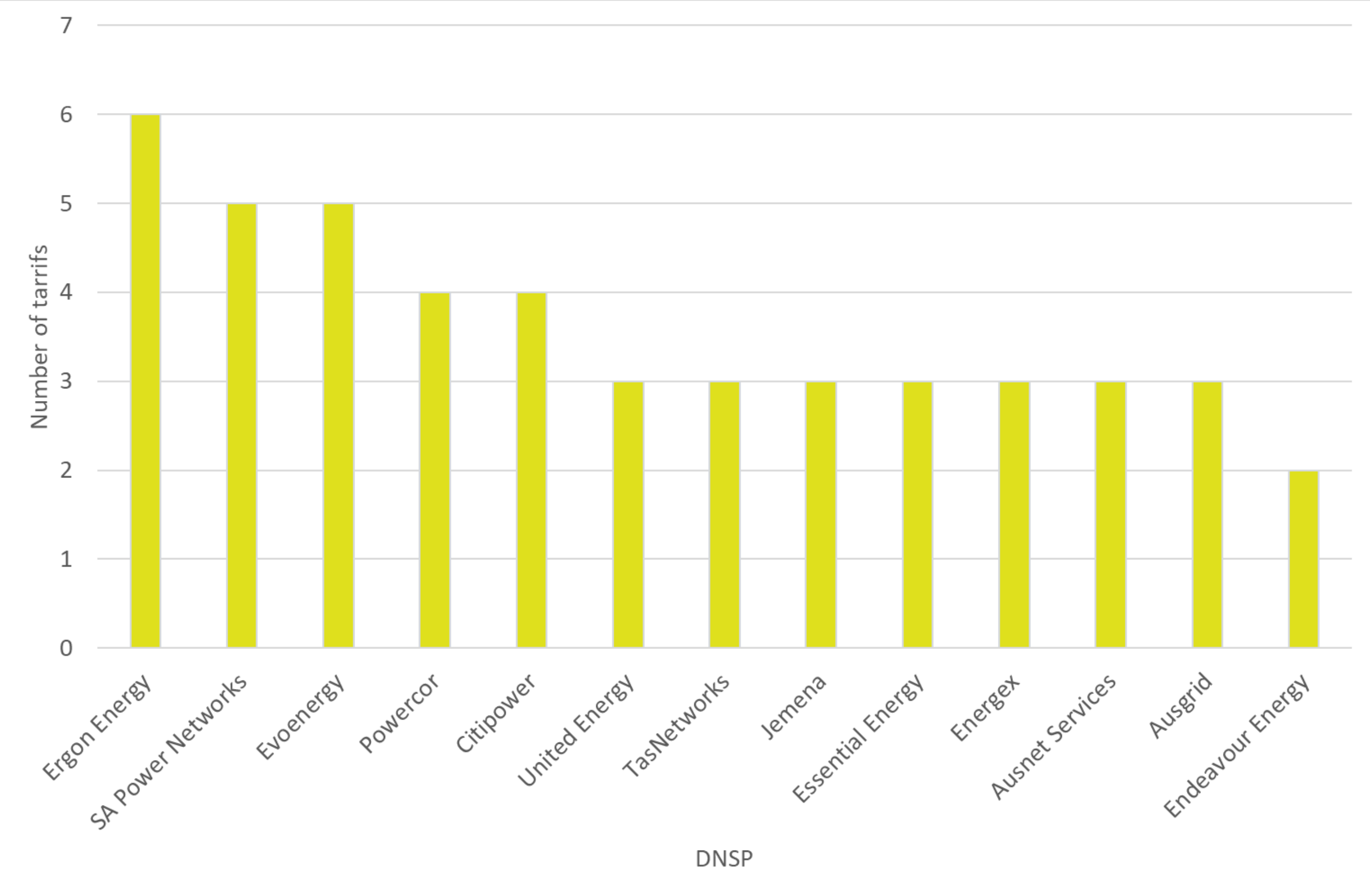


Figure B1: Number of tariffs currently offered by each DNSP

All DNSPs offer a flat fixed "anytime" tariff, with some DNSPs also offering block tariffs. Several DNSPs provide residential customers time-of-use (ToU) tariffs, with some featuring three defined periods (off peak, peak, shoulder), while most others offer only off-peak and peak. Some of these ToU tariffs incorporate a seasonal component.

TSS's are not easy to navigate and offer little opportunity for residential customers to explore the tariff options offered by their DNSP.

The average number of tariffs offered is 3.5, with Ergon Energy offering 6 and Endeavour Energy offering 2 tariffs. Some DNSPs prefer to offer fewer tariffs to simplify the offering for customers (e.g. Evoenergy's approach in its current regulatory reset proposal).

Tariff reform, including ensuring that tariffs are cost-reflective, has seen little progress, except for the introduction of the opportunity for DNSPs to implement an export tariff[88]. The most recent significant work on tariffs was undertaken by the AEMC in 2014[89], while the ENERF review was halted by the AEMC in 2020[90].

Review of TSS proposals for the 2024-2029 Regulatory Period

A number of DNSPs have submitted revised proposed TSS's for the regulatory period 2024-2029. These proposed tariffs are currently being reviewed by the AER for[91]:

- Ausgrid
- Essential Energy
- Evoenergy
- Endeavour Energy
- TasNetworks

Review of TSS proposal for the 2025-2030 Regulatory Period

Three of the DNSPs have submitted initial proposed TSS's for the regulatory period 2025-2030. These proposed tariffs are currently being reviewed by the AER for:

- SA Power Networks
- Energex
- Ergon Energy

The Access and Pricing rule change proposal led to the prohibition on DNSPs charging for export overturned in August 2021[92]. The networks listed above are the first to have the opportunity to develop a tariff for customers who export to the network.

Where tariffs (c/kW) are provided, export at peak can be (but may not always be) of higher value than the charge to export in the middle of the day. For instance, Ausgrid will charge between 0.91-1.18 c/kW to export to the network in the middle of the day and will reward export in the evenings between 1.17-2.19 c/KW.

TasNetworks does not anticipate the need to introduce either an export tariff or a solar soaker tariff in the 2024-2029 regulatory period due to the low penetration of rooftop solar in their distribution network.

Evoenergy, after conducting a trial of tariffs charging for export in the middle of the day and rewarding export at evening peak, has opted not to proceed with export charges. Instead, they have focused on a solar soaker tariff to manage the export of rooftop solar PV generation. Evoenergy has streamlined its tariff offerings (offers have dropped from 5 to 3) and plans to engage with customers over the next 5 years to assess the role and purpose of export tariffs.

APPENDIX C – The Power of Network Data

Networks are obliged by the Rules to share limited network data (to the zone sub-station) annually by 30 June[93]. However, there are a range of reasons to limit the availability of that data. Nevertheless, most networks now provide this information via mapping portals:

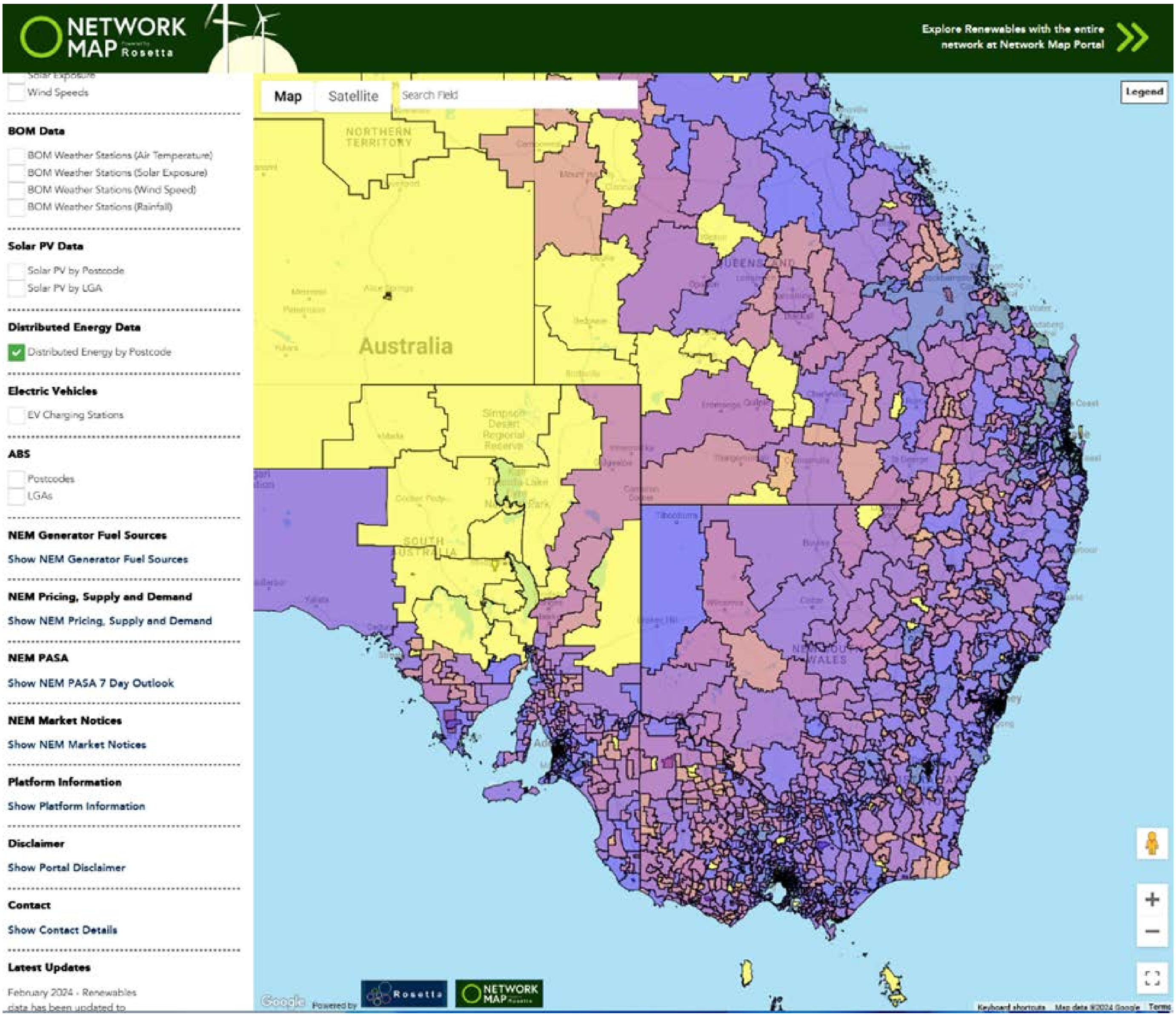


Figure C1: CER by postcode [94] (accessible for a fee)

Standalone power systems

The cost to serve customers in remote areas of the grid is more expensive than in highly dense areas. Historically, this has slowed the expansion of the grid to those areas where it is economic or feasible to connect.

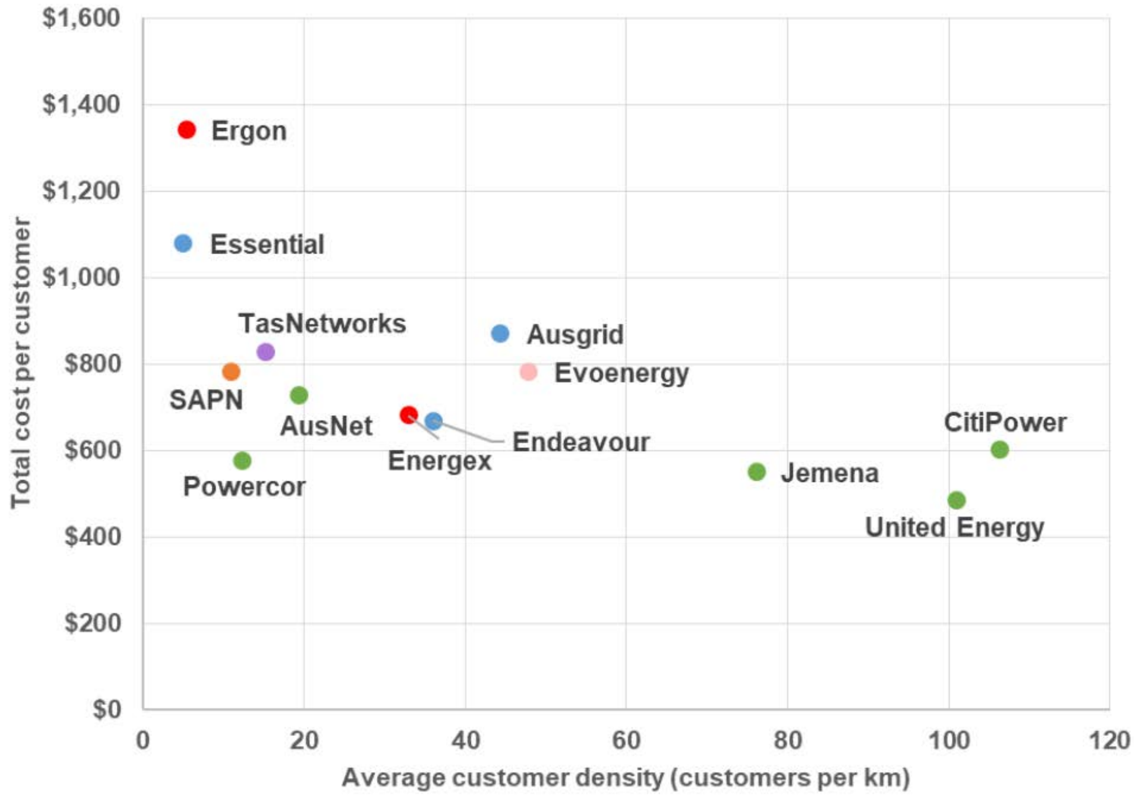


Figure C2: Cost to service DNSP customers based on network density ($2021)[95]

The declining costs of CER (PV and batteries in particular) means that there are now alternate means for providing a safe, reliable and cost-effective electricity supply. Standalone power systems have long been used in remote areas where it was not feasible to connect to the grid. The ongoing price reductions for CER means that some areas that are currently grid connected would be better served from a standalone system.

For example, Western Power, the electricity network provider in the South-West of Western Australia has identified that up to 50% of its overhead network will be removed and replaced with standalone power systems over the coming decades[96]. These standalone power systems provide a cheaper, safer and more reliable electricity supply.

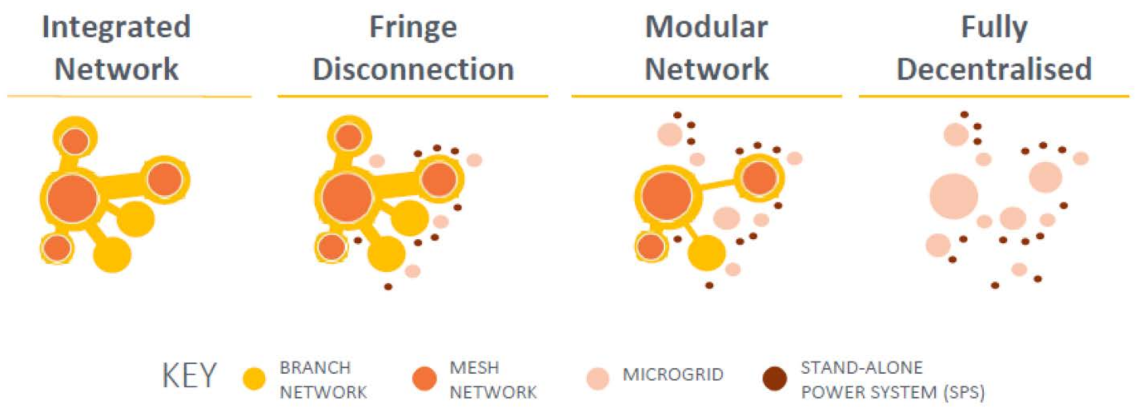


Figure C3: The transition to Standalone Power Systems in Western Australia[97]

APPENDIX D - Voltage

Managing network voltage

In 1983 the International Electro-technical Commission (IEC) adopted the standard of 230 V nominal for electricity supply systems[98] (Australia joined the IEC in 1925), with the goal to transition from 240 V and 220 V to 230 V. While all the DNSPs have adopted the 230 V standard through state regulators, most distribution networks remain at 240 V nominal.

As shown in Figure D1 below, for this network, the average night-time voltage (illustrated in blue, when there is no solar PV generation) exceeds 240 V, diverging from the green line of 230 V.

During the day, the average voltage varies and is dependent on electricity demand and generation (in red). At times, the upper extent of the red data closely approaches the upper boundary of 253 V.

Operating networks at 230 V would create significantly more 'headroom' for solar PV generation, with an estimated increase in network capacity of 35[99]. This would increase the networks' capacity to host more rooftop solar PV. The red and blue data points would align with the green horizontal line and would not approach the upper boundary. The lower boundary could be a concern, however it is narrower (230 V less 6%) compared to the upper boundary (230 V plus 10%). Internationally, consideration is being given to a symmetrical standard of 230 ±10% V to help resolve the lower boundary[100].

However, DNSPs require real-time voltage data to remotely monitor voltage. Historically DNSPs have lacked effective monitoring or insights into the real-time operation of their networks. The AEMC Review of the regulatory framework for metering services has proposed that metering operators share voltage data openly with the DNSPs[101], which could potentially resolve voltage visibility issues, particularly in cases where the DNSP lack direct access to smart meter data.

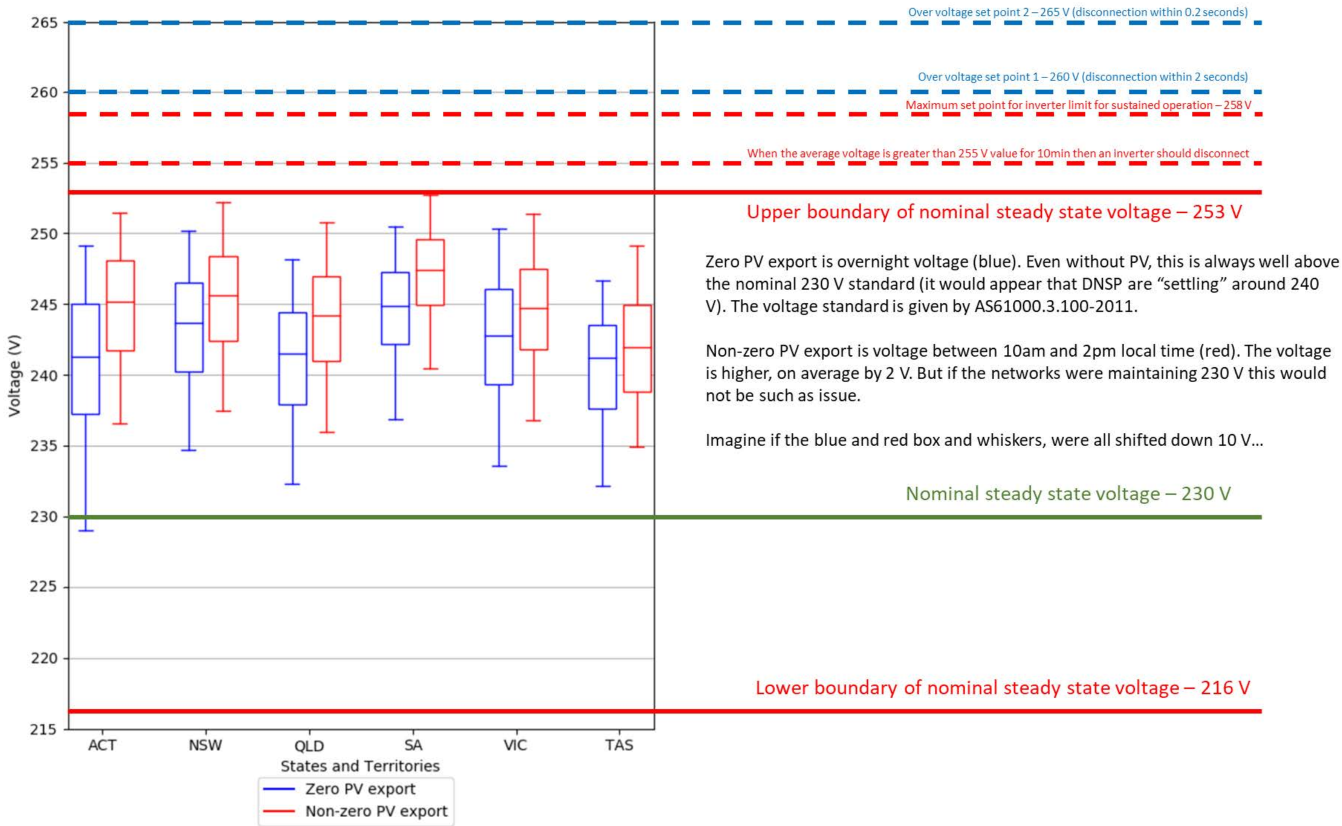
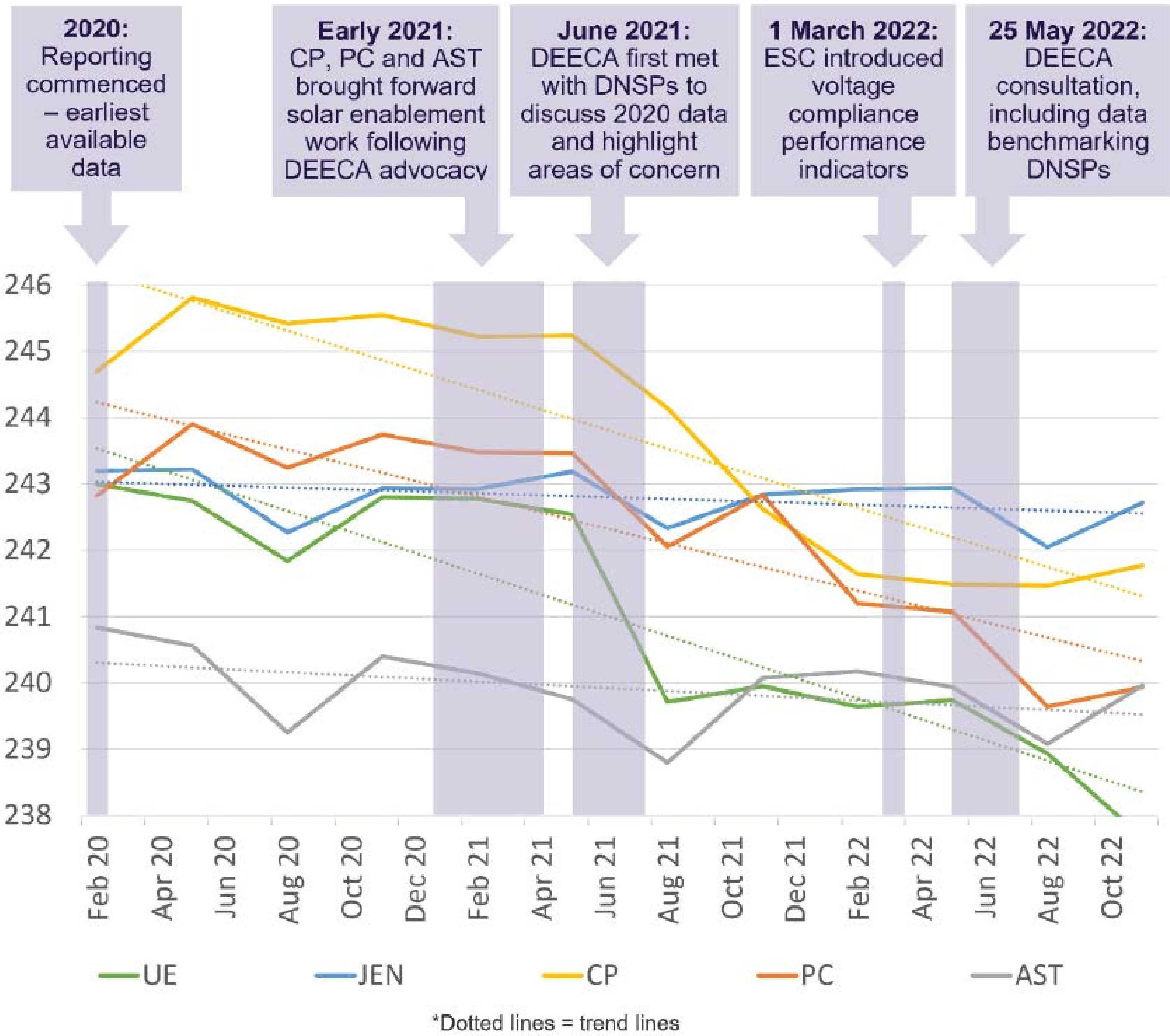


Figure D1: Slow transition to the 230 V standard

In Victoria, where the DNSPs do have direct access to smart meter data (DNSPs are responsible for the provision of smart meters in Victoria, with a near 100% mandated coverage), the Victorian Government has been working with the Victorian DNSPs to ensure that network voltage is brought closer to the 230 V standard with the average network voltage in Victoria trending down from 243 V to 240 V[102].



UE = United Energy; JEN = Jemena; CP = Citipower; PC = Powercor; AST = Ausnet Services

Figure D2: Reductions in network voltage in Victoria

Smart meters and overvoltage

The AER review of Export Services Performance highlighted a very clear benefit from smart meters, with the data from smart meters supporting the electricity networks in effectively managing voltages on the network, particularly reducing overvoltage.

The following charts use AER data to compare the number of customers experiencing overvoltage in 2022 across the networks that have full access to smart meter data (Victoria), and those without (figure D3a). Additionally, the charts illustrate the improvements in voltage outcomes as a result of access to smart meter data (figure D3b):

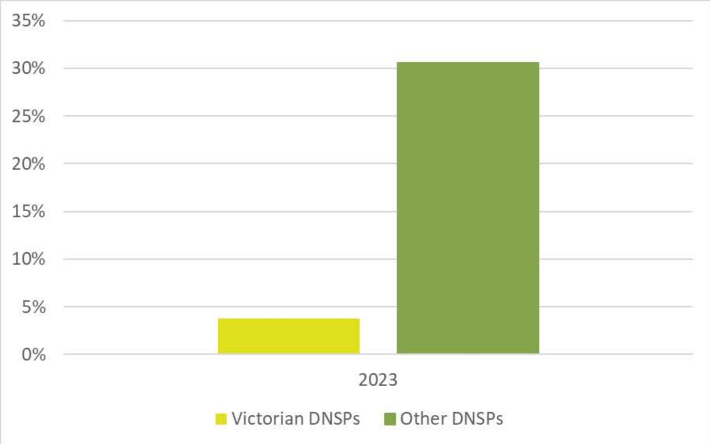


Figure D3(a): Customers experiencing overvoltage

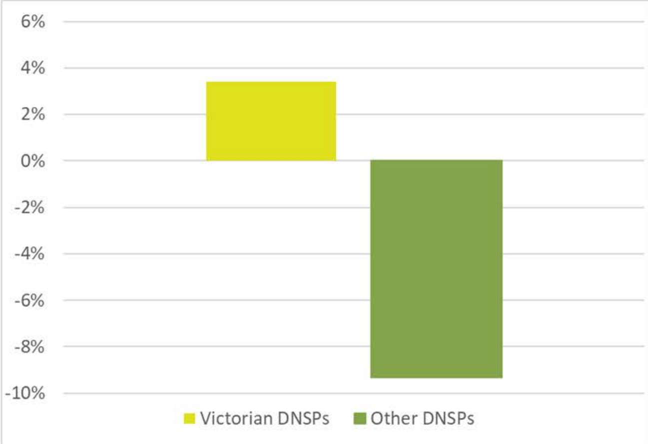


Figure D3(b)B: 2022 Voltage improvement

Overvoltage can impact customers in a number of ways, including:

- Damage to and excessive heating of electrical devices
- Increased overall consumption (higher bills)
- Reduced PV generation

These outcomes observed Victoria support the AEMC's decision to expedite the rollout of smart meters and facilitate the sharing of specific data with DNSPs. A rule change to implement the AEMC review has just progressed to the draft determination stage with aim of commencing aspects of the rule in July 2024 and 2025[103].

With the exception of the Victorian DNSPs, there is no significant improvement in over-voltage (TasNetworks is static). Endeavour Energy, Evoenergy and SA Power Networks customers are experiencing increases in over-voltage incidents. The over 70% figure for SA Power Networks is a result of the DNSP deliberately raising network voltage to force inverters to disconnect during November 2022, when South Australia was isolated from the NEM following the collapse of transmission towers. Even accounting for the emergency backstop approach, 35% SA Power Networks' customers experience over-voltage, representing a deterioration from 2022 (approximately 20 %)[104].

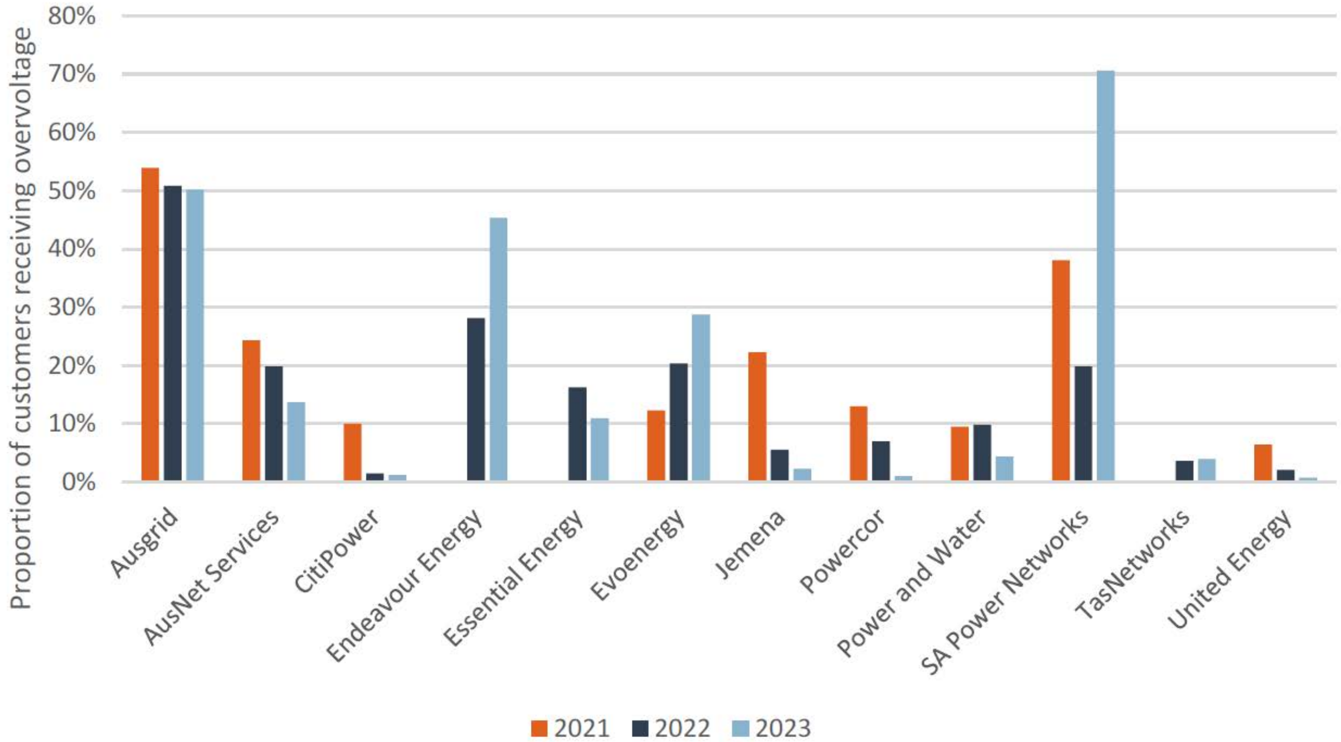


Figure D4: Customers experiencing overvoltage 2019-2022 (taken from AER report[105])

Queensland has the highest penetration of rooftop solar PV (46%) and only adopted the 230 V voltage standard in 2018 on the basis that it would support increased deployment of rooftop solar PV. However, Energex and Ergon Energy were unable to supply overvoltage data to the AER for the Export Benchmarking Report, making it impossible to assess the impacts on customers.

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