Export services network performance report

December 2023

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AER Reference: 14846548

Amendment Record

Version	Date	Pages	Reason for amendment
1	December 2023	30	N/A

Contents

1 Overview

1.1 Scope

This is the AER's first annual export services network performance report[1], published in accordance with 6.27A(a) of the National Electricity Rules (NER). It analyses the performance of electricity distribution network service providers (DNSPs) in providing services for embedded generators, such as residential solar and batteries, to export into their networks.

This report provides an overview of the growing role that customer exports have within distribution networks in the National Electricity Market (NEM) and the Northern Territory. It seeks to provide enhanced transparency of export service performance, support more informed regulatory and policy decisions by government agencies and inform investment and operating decisions by customers, solar installers and service providers such as aggregators.

The datasets used in this report were obtained directly from electricity DNSPs for the 2021, 2022 and 2023 financial years, and are published separately on the AER website. Data in this report specifically cover services provided by DNSPs for exports from generating units with a nameplate rating of less than 30MW and which the Australian Energy Market Operator (AEMO) has exempted from the requirement to register as a generator[2].

1.2 Key findings

8% of all energy delivered by electricity DNSPs was sourced from export customers with smart meters in the 2023 financial year[3]. Export customer numbers, export volumes and average export capacity have consistently trended upwards over the three year measured period, with 25% of network customers using export services in the 2023 financial year.

Customers export from low-carbon sources of energy (photovoltaic solar with or without batteries) and earn a return for generating energy used by other network customers. Over the period, DNSPs have only used a small proportion of their total expenditure to support the provision of export services.

DNSPs impose limits on customer exports to ensure network power quality is maintained and network capacity is shared fairly between export customers. These limits vary between networks and there are areas within networks that are particularly constrained. New technologies and methods of export control are being deployed to reduce the constraints on customers exporting to the network, such as smart meters, more sophisticated inverters and flexible export limits. These developments take time to deploy across the different networks and where they are deployed there remain challenges in validating compliance with technical standards for installation and commissioning.

[1] Note that in future years, the export services performance report may be published as part of the AER's electricity network performance report.

[2] i.e. exports from small generating units as defined by the National Electricity Rules.

[3] 8% of energy was measured to be sourced from exporting customers with smart meters. Since one third of exporting customers do not have smart meters, the total volume of energy exported by customers will be higher than the measured value of 8%.

Key operational findings:

- 25% of **DNSP customers** used export services in 2023, up from 24% in 2022 and 22% in 2021.
- 68% of export customers had **smart meters** in 2023, up from 61% in 2022 and 56% in 2021.
- 8% of all **energy delivered** by electricity DNSPs was sourced from export customers with smart meters in 2023, up from 7% in 2022 and 5% in 2021.
- 3% of export customers had **batteries** in 2023. This proportion was highest for Evoenergy (11%) and SA Power Networks (9%).
- The average **export capacity** per export customer was 5.7kVA across all DNSPs in 2023. Average capacity per customer was highest for Evoenergy (7.2kVA) and lowest for AusNet Services and Energex (4.9kVA).
- On average, approximately 1% of **capital and operational expenditure** by DNSPs is specifically attributed to providing export services.

Key performance findings:

- The proportion of **customers on static zero export limits** has remained flat at about 0.4% of all export customers over the period. However, the proportion of customers on static zero export limits increased over the period for AusNet Services and Power and Water Corporation.
- The **average static export limit** applied to residential export customers was 5.6kVA in 2023. **Exports were available up to a customer's limit** for an average of 86% of the year**.**
- 30% of export customers experienced **overvoltage** in 2023.
- **Flexible export limit** trials were undertaken by 4 DNSPs in 2023 (AusNet Services, Energex, Ergon Energy and SA Power Networks). Flexible export limits allow for an increased volume of exports than would be allowed by static export limits alone.
- Average **time for DNSPs to offer an export customer a connection agreement** in accordance with their **model standing offer** was less than 4 days for all DNSPs except for Power and Water Corporation which had an average time of 27 days.
- Average **time for DNSPs to offer an export customer a connection agreement** that is **not in accordance with their standing offer** was above 20 days for AusNet Services, SA Power Networks and TasNetworks. Average time for Power and Water Corporation to provide an offer was 99 days.

1.3 Background

In August 2021, the Australian Energy Market Commission (AEMC) published its access, pricing and incentive arrangements for distributed energy resources final determination[4]. The Rule change amended the National Electricity Rules and National Energy Retail Rules and tasked the AER with strengthening customer protections and our regulatory oversight of DNSPs provision of export services.

In March 2023, we published our final report "Incentivising and measuring export service performance"[5] which outlined our consultation and final decision for delivering against 3 different workstreams of the Rule change. One of the workstreams discussed was our commitment to produce annual export services network performance reports. Alongside the final report we published the information request for electricity DNSPs to provide 2021 and 2022 financial year data. The selection of measures requested from DNSPs was determined through direct workshops between the AER and the DNSPs and informed by a concurrent research project led by the University of Technology Sydney[6].

1.4 Data collection

The datasets used in this report have been collected directly from DNSPs. DNSPs have different measuring capabilities (e.g. due to different levels of smart meter penetration) and may use different methods to collect data.

A portion of the data that DNSPs have reported is sourced from AEMO's Distributed Energy Resources (DER) register[7], where DER installers are required to record details of installations. DNSPs do not have direct oversight of the installers who input data in the DER register. In some cases, DNSPs correct for apparent mistakes in the DER register before submitting data to the AER (e.g. some installers may report installation size in watts, where installation size in kilowatts may be requested by the DER register). We are continuing to work with DNSPs to improve measurement consistency for future annual export services performance reports.

1.5 Stakeholder engagement

Our stakeholders value the opportunities for transparency provided by our efforts to engage with them. In addition to the consultation undertaken for the report "Incentivising and measuring export service performance", we've undertaken further stakeholder engagement to develop this report, which included:

- Individual meetings with each of the 14 electricity DNSPs to understand their perspectives and challenges in providing export services data for reporting.
- 2 workshops with all electricity DNSPs to finalise the content and methods of collecting data for the 2023 financial year data information request.
- Providing DNSPs, consumer representatives and jurisdictions an opportunity to review and comment on the data and analysis presented in this report.

[4] AEMC, *Access, pricing and incentive arrangements for distributed energy resources*.

[5] AER, *Incentivising and measuring export services performance*.

[6] RACE for 2030, *Measuring and communicating network export service quality*.

[7] AEMO, *Distributed energy resource register*.

2 Services provided

The 14 electricity DNSPs that we regulate have different numbers of export customers, technology and export capacity on their networks, and subsequently face different challenges and opportunities in managing export services. This chapter focuses on metrics that describe the operational contexts of the different networks.

Export service customers:
In this report, an export service customer is considered to be a customer of a DNSP who has requested to be able to export from an on-site consumer energy resource (CER) into the network. If the DNSP does not allow the customer to export (i.e. applies a static-zero export limit), that customer is still considered to be an export service customer.

When an export customer connects their CER to a network, the DNSP typically applies a maximum allowance for what the customer is allowed to export to the network (an export limit). In general, customers may install systems of a larger capacity than their export limit and use any excess capacity over the export limit for self-consumption.

There were a total of 2.8 million export customers (25% of around 11 million total customers) across all DNSPs in 2023.

More than 99% of all export services customers used on-site solar photovoltaic panels (PV) and approximately 3% of all export customers used batteries in conjunction with PV. Other uses of export services were much less common, with only 0.1% of export customers using batteries without PV and only 0.03% of customers being reported as using neither PV nor batteries[8].

Table 1 provides a summary of the operational metrics for each of the DNSPs. High and low values in each of the measures are highlighted in green and red respectively.

[8] 836 export services customers were reported as using neither PV nor batteries. Some DNSPs have included systems in this category from AEMO's DER register that are marked as "unknown". Some DNSPs have suggested renewable generation sources in this category may include wind, hydro and biogas. Non-renewable sources may include diesel and gas fuel generators. Inaccuracies in recording this figure may be significant given the relatively small numbers involved.

Table 1 Export service operational metrics summary, 2023

	DNSP	Proportion of customers using export services	Export capacity per export customer (kVA)	Proportion of export customers with a battery	Measured exports as a proportion of all energy delivered
	All DNSPs	25%	5.7	3%	8%
ACT	Evoenergy	21%	**7.2**	**11%**	8%
NSW	Ausgrid	**13%**	6.4	5%	5%
	Endeavour Energy	24%	5.7	**0%**	8%
	Essential Energy	**27%**	6.3	3%	10%
NT	Power and Water	21%	5.2	3%	3%
QLD	Energex	**43%**	**4.9**	2%	8%
	Ergon Energy	**32%**	5.4	2%	5%
SA	SA Power Networks	**37%**	6.5	**9%**	**16%**
TAS	TasNetworks	**15%**	5.6	4%	5%
VIC	AusNet Services	**26%**	**4.9**	2%	**18%**
	CitiPower	**6%**	5.1	2%	**1%**
	Jemena	17%	5.3	2%	5%
	Powercor	24%	6.2	2%	12%
	United Energy	17%	5.4	2%	6%

Table 1 shows that Energex, Ergon Energy and SA Power Networks have the highest proportion of customers that are export customers, while CitiPower, TasNetworks and Ausgrid have the lowest. AusNet Services and SA Power Networks have the highest proportions of energy delivered attributed to measured exports from customers, while Evoenergy and SA Power Networks have the highest battery penetration.

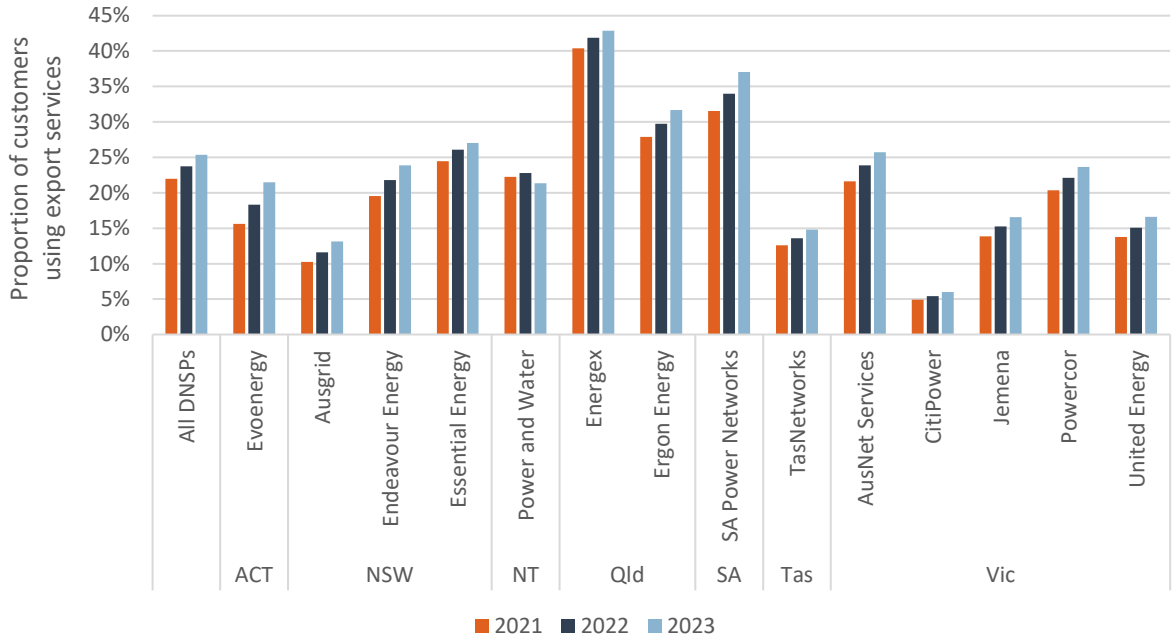
The operational data on the services provided by each of the DNSPs are described in more detail throughout the remainder of this chapter.

2.1 Customers using export services

Usage of export services has increased for nearly every DNSP over the measured period. 25% of DNSP customers used export services in 2023, up from 24% in 2022 and 22% in 2021. Of all DNSPs, only Power and Water Corporation reported a decrease in export customer numbers from 2022 to 2023.

Energex, Ergon and SA Power Networks had the highest proportion of export customers. CitiPower had the lowest proportion of export customers, likely due to CitiPower serving a higher proportion of CBD customers than other DNSPs. Figure 1 shows the proportions of export customers for each electricity DNSP over 2021, 2022 and 2023.

Figure 1 Proportion of customers using export services



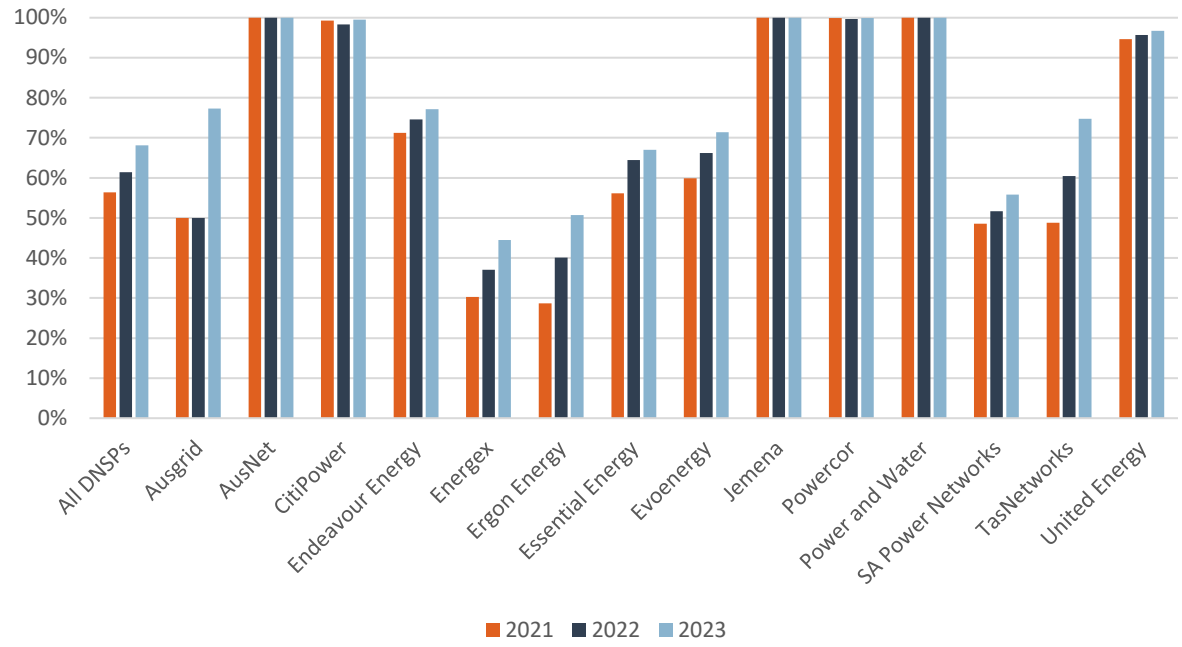
2.1.1 Smart meter usage

Smart meters are electricity meters that are able to automatically measure certain customer data. Smart meters support the deployment of export services as they allow DNSPs to see local customer voltage levels and the timing and volume of exports. All Victorian electricity customers have had smart meters since 2013 under Victorian Government policy, while other networks have less smart meter penetration. The AEMC's metering review[9] is targeting a 100% rollout of smart meters in the NEM by 2030.

New solar customers were increasingly required to have net-metering capabilities (via smart meters) since 2010. This requirement has resulted in an increase in the proportion of export customers with smart meters over time. Some DNSPs note that lower than average reported proportions of export customers with smart meters in their networks may be due to high numbers of solar installations occurring before net-metering and smart meters were required. Figure 2 shows the proportions of export service customers with smart meters for each DNSP over the measured period.

[9] AEMC, Metering review.

Figure 2 Proportion of export service customers with smart meters

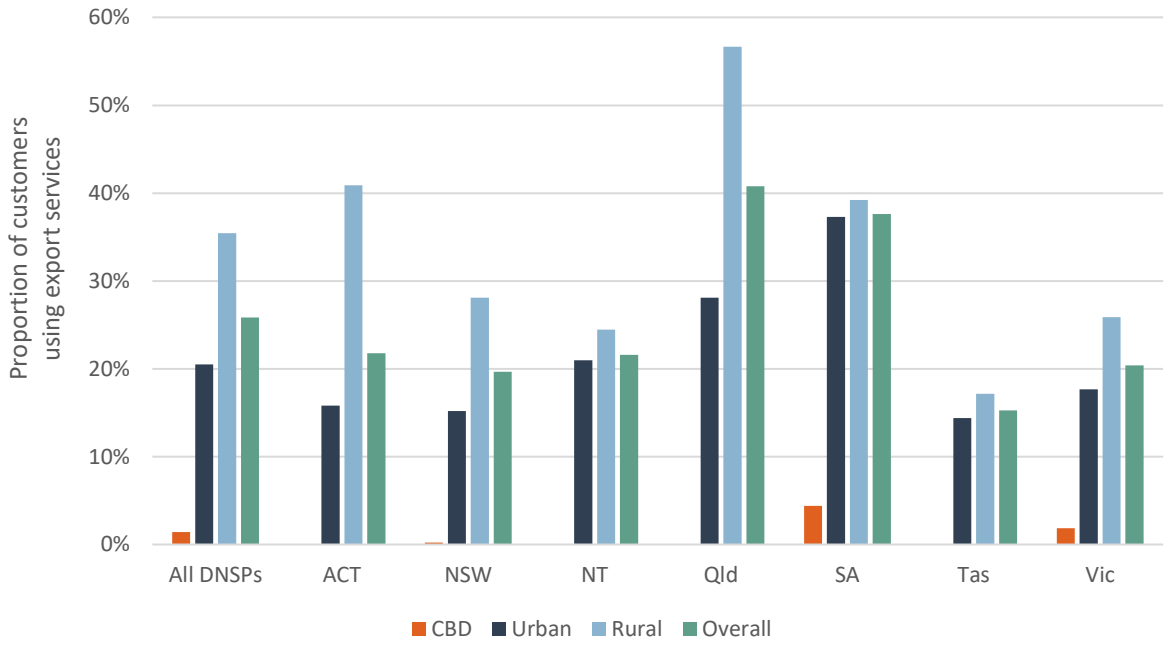


2.1.2 Customer numbers across feeder zones

Electricity DSNPs also provide data that is disaggregated by feeder classification. This allows us to compare trends in data between central business district (CBD), urban and rural feeder classifications.

Data provided by DNSPs (as shown in Figure 3) show that customers on rural feeders are the most likely to be users of export services across all states and territories, and CBD customers are the least likely. The higher density of customers and the associated lower roof space available for solar installations per customer (e.g. for customers in apartment buildings) drives lower use of export services in CBD areas.

Figure 3 Proportion of customers using export services by feeder classification, 2023[10]



Note: DNSPs in the ACT and Tasmania do not classify any feeders as serving CBDs.

2.2 Export capacity

Average export capacity per export customer across all DNSPs increased to 5.7kVA[11] in 2023, up from 5.5kVA in 2022 and 5.1kVA in 2021 (Figure 4).

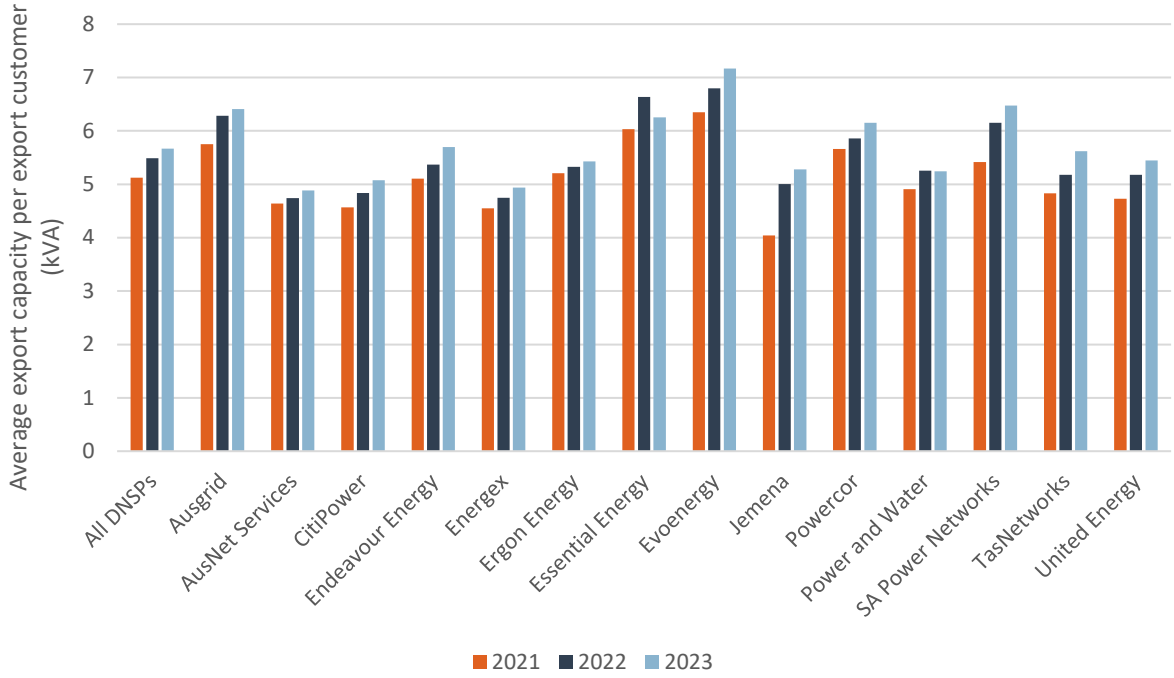
Export capacity per customer is influenced by a number of factors, including:

- Higher or lower export limits by DNSPs. This subject is discussed further in section 3.2 of this report.
- Reduction in the cost of PV systems over time, as lower installation costs encourage customers to install larger CER systems.
- Changes in electricity import or export tariffs which may incentivise larger or smaller CER installation sizes.

[10] Some data used in this chart is 2022 data, as the 2023 data was not finalised at the time of publication. See the dataset published alongside this report for more details.

[11] kVA (kilovolt-ampere) is a measure of apparent power. Some readers may be more familiar with the metric kW (kilowatt), which is a measure of usable power. Our analysis of network data found that networks have different approaches to labelling export figures with kVA and kW. For the sake of simplicity, although at the cost of some technical accuracy, readers of this report may consider one kVA to be equal to one kW of export capacity.

Figure 4 Average export capacity per export customer



2.3 Battery penetration

On-site batteries are currently the second most popular exporting technology at about 3% usage among export customers. In future reports we may include data on other emerging technologies such as electric vehicle-to-grid capabilities.

As shown in Figure 5, the proportion of customers with batteries has been increasing across all DNSPs. Evoenergy and SA Power Networks had the highest proportion of customers with batteries of all DNSPs in 2023 at 11% and 9% penetration respectively.

Battery penetration may be influenced by electricity price incentives (such as low feed-in tariff rates), or differences in state/territory government policy incentives (e.g. the ACT government's sustainable household scheme[12] and the South Australian government's home battery scheme[13]).

[12] Everyday Climate Choices, *Sustainable household scheme*.

[13] Note the home battery scheme is no longer in operation.

Figure 5 Proportion of export customers with a battery

Note: Endeavour Energy did not report having any customers with batteries over the measured period.

2.4 Energy exported by customers with smart meters

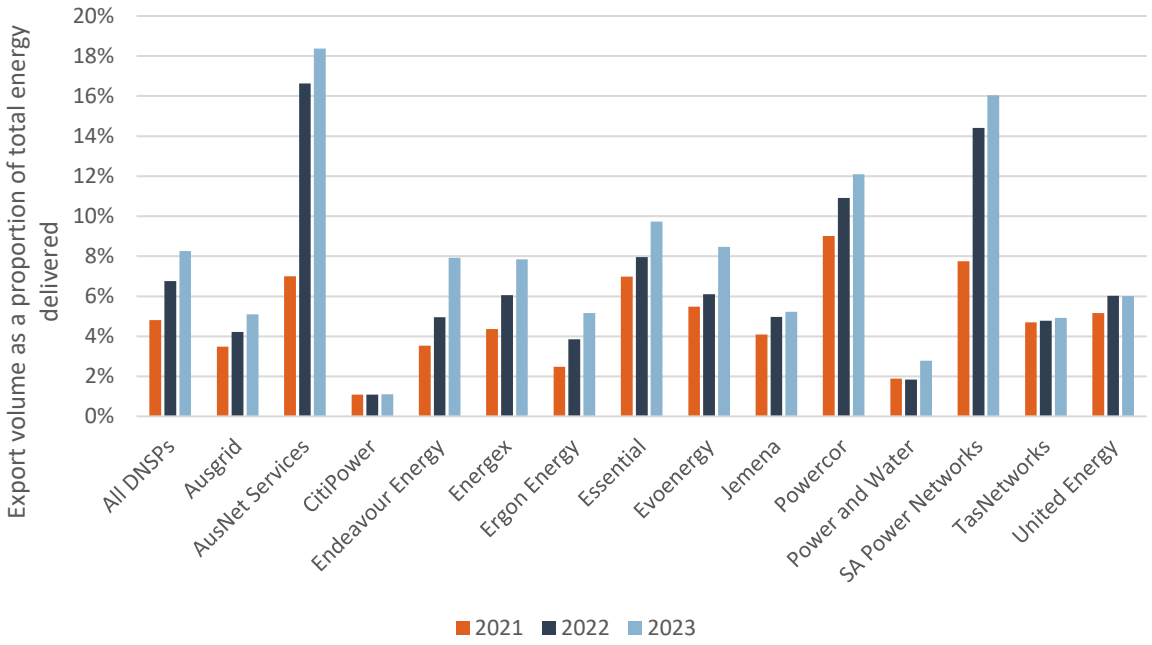
Smart meters allow DNSPs to measure the amount of energy exported by customers. Exports from customers without smart meters generally cannot be directly measured by DNSPs.

The total volume of energy exported by customers with smart meters increased across all DNSPs in each year from 2021 to 2023 (Figure 6). However, the amount of exported energy decreased marginally for Power and Water in 2022 and for United Energy in 2023. Export volumes are influenced by a number of factors, including:

- Increasing amounts of installed solar PV capacity will increase the volume of energy exported.
- Increased smart meter penetration rates (Figure 2) ensure a higher proportion of exported energy is measured.
- Increased overall demand for electricity (e.g. due to electrification of buildings and transportation) will reduce export volume as a proportion of total energy delivered.
- Increased self-consumption of PV electricity (e.g. facilitated by batteries, smart devices or electric vehicles) will reduce the volume of energy exported.
- Years with sunnier weather will result in increased exports as customers generate more electricity from their on-site solar, while years with less sunny weather will result in reduced exports.

- Years without extreme hot or cold weather may cause customers to self-consume less electricity for heating and cooling and therefore export more of their generated solar power to the network.

Figure 6 Export volume from customers with smart meters as a proportion of total energy delivered



3 Export limits and curtailment

Export services are part of the core services provided by DNSPs. Electricity customers that invest in consumer energy resources such as rooftop solar PV expect to be able to use the electricity they generate and export excess electricity to the grid. These exports provide benefits to all customers via cheaper and cleaner electricity. However, DNSPs impose export limitations to ensure that any energy exported is within the network's hosting capacity.

Network hosting capacity

Hosting capacity refers to the ability of a power system to accept energy generated by consumer energy resources without adversely impacting power quality such that the network continues to operate within defined operational limits (without experiencing voltage or thermal violations). Hosting capacity varies by location and time due to changes in consumption and the level of consumer energy resource penetration.

Distribution networks have an intrinsic level of capacity to host a certain level of consumer energy resource exports within operational limits. This is because network assets constructed for consumption services have the capacity to support some reverse power flow without additional investment.

For the purpose of this report, export customer curtailment is the reduction in a customer's exports due to a network constraint[14]. Curtailment can be quantified as the difference between the amount a customer's CER is allowed to export and the theoretical potential output of the installed CER if no network constraint was present. DNSPs control or have influence over a number of forms of CER curtailment:

- Static export limits – Static export limits are imposed on customers by their DNSP when customers install rooftop solar PV. Static export limits set the maximum level of export that a customer is allowed at any time.
- Flexible export limits – Export limits that vary over time according to a network's control. This allows DNSPs to significantly constrain solar exports only when the network is congested, while allowing higher exports at other times. Over the measured period, flexible export limits were only available via trials with a small number of DNSPs and will likely be rolled out at greater scale in the future.
- Voltage-response curtailment – Modern inverters are designed to limit customer generation in response to a high local distribution network voltage. This may prevent customers from both exporting electricity to the grid and self-consuming their own generated electricity.
- Network outages – Like electricity imports, customer exports are constrained when there is a network outage. This type of curtailment is addressed in the Electricity Network Performance Report[15] and is therefore not focussed on in this chapter.

[14] Curtailment may also occur due to AEMO directing DNSPs to reduce CER output to support system reliability, such as in an extreme minimum demand scenario. Since this form of curtailment is not directly influenced by DNSPs, it is not a focus of this report. See AEMO's emergency backstop mechanism for more detail on this form of curtailment.

[15] AER, *Electricity network performance report 2023*.

Curtailment is sometimes necessary to ensure that network power quality is not negatively impacted, however inflexible curtailment can also unnecessarily restrict customer exports. Technologies that are in the process of being deployed such as flexible export limits and inverters capable of voltage response help to maintain power quality while not unnecessarily restricting exports.

The total amount of energy curtailed per customer by a DNSP would be a valuable metric for measuring export service performance. However, in general, DNSPs are not currently calculating these estimates. Further, were these estimations to be made the methods would need to be sufficiently similar between DNSPs in order to be comparable. We are continuing to work with DNSPs to enable consistent estimation of overall CER curtailment so an energy curtailed per customer metric may be used in future reports.

In lieu of direct estimates of curtailment, a number of indirect measures of curtailment can be used for assessing network export service performance. These are summarised in Table 2 below. High and low values are highlighted in the table in green and red respectively. These metrics (and how they are trending over time) are discussed in more detail in the remainder of this chapter.

Table 2 DNSP export limit and curtailment overview, 2023

	DNSP	Average residential non-zero export limit (kVA)	Duration of export access against the export limit	Customers on static-zero export limits	Customers receiving overvoltage
	All DNSPs	5.6	86%	0.39%	30.4%
ACT	Evoenergy	5.5	-	0.04%	28.7%
NSW	Ausgrid	-	-	0.00%	**50.2%**
	Endeavour Energy	5.9	100%	0.00%	**45.3%**
	Essential Energy	**9.5**	**25%**	0.25%	11.0%
NT	Power and Water	-	100%	**2.09%**	4.4%
QLD	Energex	5.0	-	0.47%	-
	Ergon Energy	5.0	-	**1.24%**	-
SA	SA Power Networks	5.0	100%	0.03%	**70.6%**
TAS	TasNetworks	**6.3**	100%	0.00%	3.9%
VIC	AusNet Services	**4.5**	**88%**	**1.37%**	13.7%
	CitiPower	5.7	99%	0.04%	1.2%
	Jemena	**4.2**	100%	0.03%	2.3%
	Powercor	5.5	98%	0.16%	1.0%
	United Energy	4.4	99%	0.18%	0.8%

Note: Data for "All DNSPs" are weighted averages based on total export customer numbers. A '-' symbol signifies that a DNSP did not report the relevant metric.

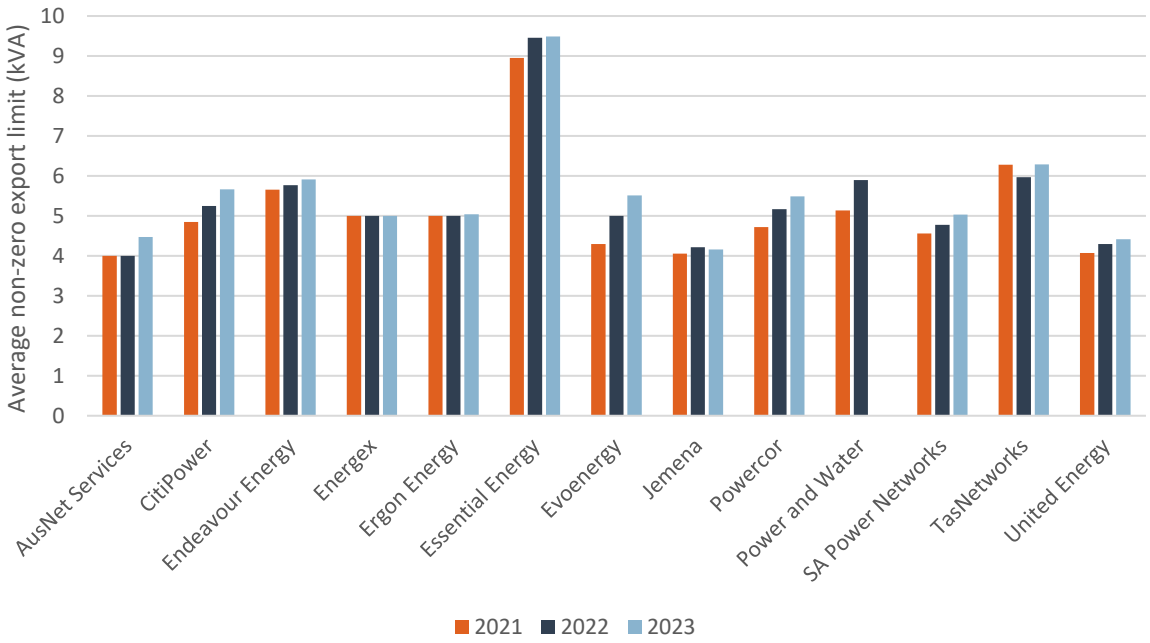
3.1 Static export limits

Static export limits are the primary source of export curtailment. The average size of a new small-scale solar PV installation in Australia is increasing and has passed 9kW[16]. However, the standard export limit for a customer of most DNSPs has remained below this level. In some locations, DNSPs are applying limits that are lower than 5kW or even zero to protect network assets and maintain power quality.

Figure 7 shows the average non-zero export limits for residential customers in 2023. While we also collect export limit data on non-residential customers, these limits are more bespoke than for residential customers and are therefore not as readily comparable between different DNSPs[17].

Static limits are not guarantees of a fixed or maximum level of export, as a customer's ability to export is still subject to local system constraints. Figure 8 includes estimates from the DNSPs of how long their customers are able to export up to the limit (e.g. they are not limited due to network voltage constraints). Most customers exports are not constrained below their export limit most of the time, although AusNet Services have somewhat lower access and Essential Energy report having significantly lower access[18].

Figure 7 Average non-zero static export limit, Residential customers



Notes: Ausgrid has not provided this metric as they report that they typically only apply a static export limit if requested by a customer. Ausgrid allow systems up to 10kW per phase to connect automatically without any technical assessment provided that they comply with AS4777, noting that these systems are intended to automatically curtail when the network does not have capacity to accept export. Power and Water did not report an average non-zero export limit for 2023.

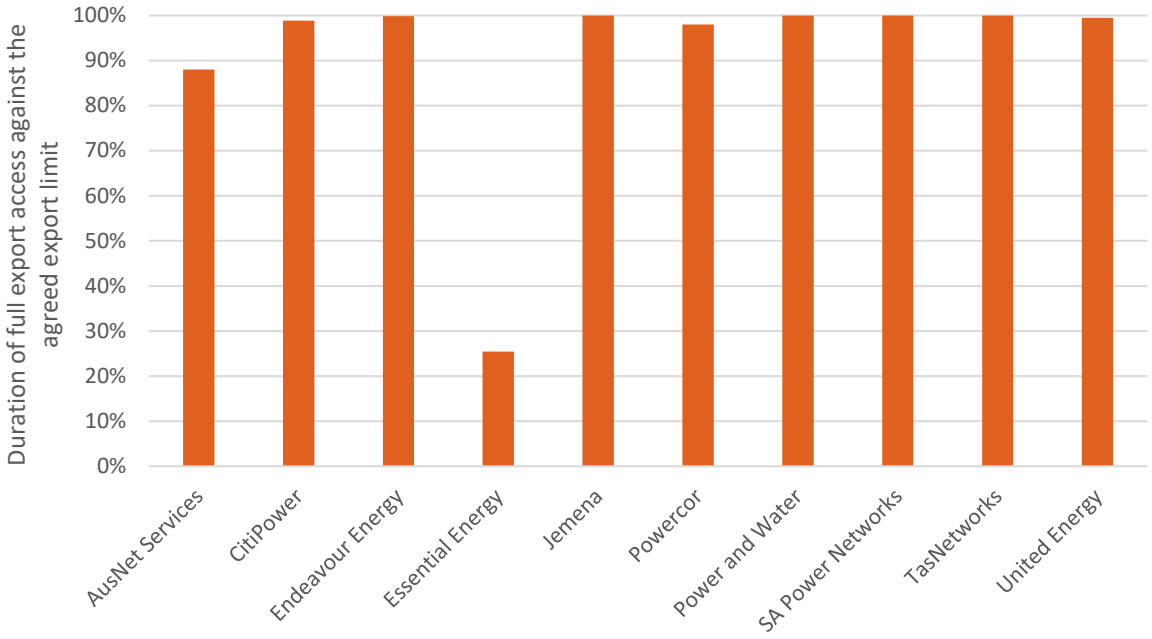
Essential Energy note that in the 2022 financial year and earlier, only export customers that installed systems larger than allowed by their connection agreement were considered to be on export limits. Part-way through the 2023 financial year, Essential Energy changed their methodology so that any limit specified in a connection agreement is considered to be a static export limit, which aligns with typical practices of other DNSPs. This may lead to an overestimate of export limits for Essential Energy compared to other DNSPs in this figure.

16 Australian Photovoltaic Institute Market Analyses, accessed 5 September 2023.

17 Average non-residential export limits can be accessed in the dataset that accompanies this report.

18 Commentary is provided on figures 7 and 8 noting discrepancies in the way Essential have reported this data compared to other networks.

Figure 8 Duration of full export access against the agreed export limit, Residential customers, 2023



Notes: Ausgrid, Energex, Ergon Energy and Evoenergy did not report this metric.

Essential Energy have used a more stringent approach to reporting this metric than other DNSPs, contributing to their lower reported result. Essential Energy have considered export access to be reduced when a customer's local voltage exceeds 240V, while other DNSPs consider export access to be reduced when local voltage exceeds 253V[19].

19 This difference in interpretation is due to AS 4777.2(2020) requiring a small reduction in real power output at 240V for volt-VAr curtailment, but a larger reduction in real power output at 253V for volt-watt curtailment.

Are export customers complying with export limits?

Network customers do not always comply with export limits. Customers may inadvertently export above their allowed export limit if their inverters have not been configured by the installer to comply with the limit imposed by a DNSP. DNSPs do not have a widely used method of verifying or enforcing export limits in cases where customers are non-compliant.

Table 3 shows the proportion of customers that different DNSPs estimate to be complying with the static export limits nominated in their connection agreements. These values are reported by only 3 DNSPs, are highly variable and may be only rough estimates. Nevertheless, these estimates highlight inherent measurement challenges in some of the data collected for this report. These reported estimates may change as estimation methods are improved or as the levels of monitoring or regulation are increased. Work to improve compliance with CER technical standards is ongoing at the AEMC and energy market bodies*.

Table 3 DNSP estimates of customer compliance with export limits, 2023

	Estimated compliance with export limits
AusNet Services	65%
Endeavour Energy	60%
Essential Energy	15%

* See “are export customer installations compliant with inverter requirements” in section 3.3 of this report.

3.2 Static-zero export limits

Static-zero export limits are static export limits where a customer is constrained from exporting any electricity (i.e. they have a static export limit of zero). Under our connection charge guidelines for electricity customers (April 2023)[20] DNSPs may only impose static-zero limits on customers under limited circumstances, i.e.:

- the export from the generator will have a high probability of resulting in the DNSP not meeting a regulatory obligation or to maintain the network within its technical limits (e.g. voltage or power quality standards); and
- the cost of augmenting the DNSP’s assets in order to allow a reasonable export capacity outweighs the benefits arising from providing the additional export capacity.

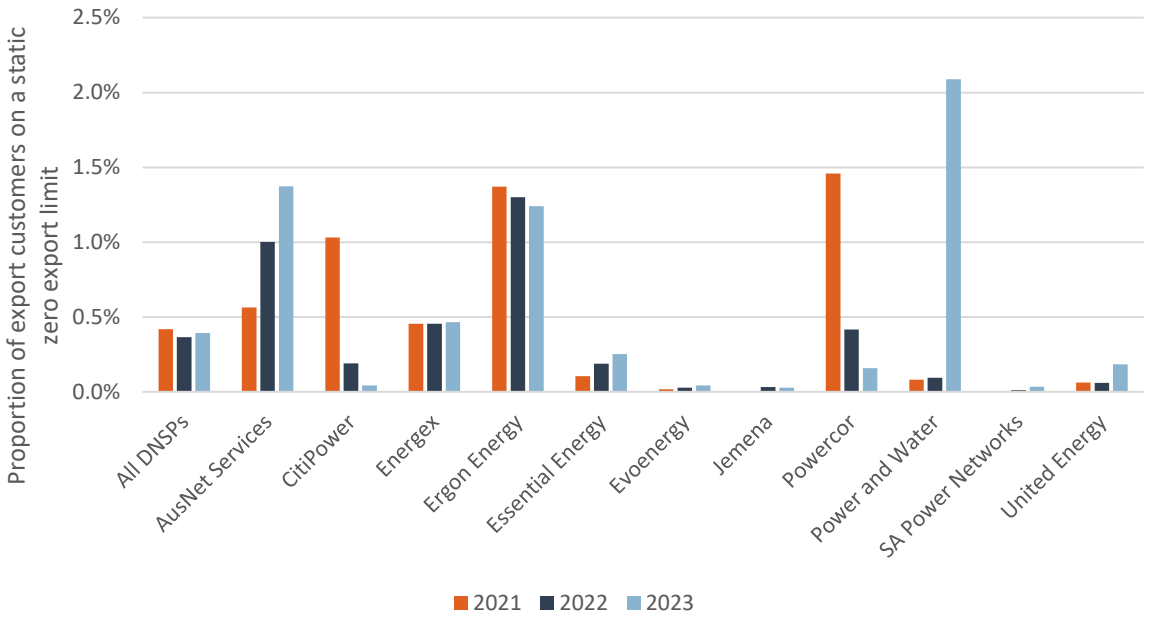
A DNSP may also impose a static zero export limit if it is expressly requested by a customer.

The increased adoption of flexible export limits provides an opportunity for DNSPs to offer alternative options to static zero export limits (chapter 4). Flexible export limits make it possible for DNSPs to restrict customer exports at times where it may be necessary for network stability, while allowing exports to occur at other times.

[20] AER, *Connection charge guidelines for electricity consumers*.

As shown in Figure 9, the total proportion of export customers on static zero export limits has remained relatively stable overall between 2021 and 2023, with significant decreases being observable for Citipower and Powercor. The proportion of customers on static zero export limits has increased for Ausnet, Essential Energy, United Energy and PWC, with a particularly large increase occurring in 2023 for PWC. PWC's increase has occurred primarily for non-residential low voltage customers, classified to be on "short rural" feeders.

Figure 9 Proportion of export customers on a static zero export limit



Note: Over the measured period Ausgrid and Endeavour Energy report having no static-zero export limit customers, while TasNetworks report having under 0.01% of their customers on static-zero export limits.

3.3 Overvoltage and inverter technology

Network overvoltage:

In this report, network overvoltage is considered to occur when an export customer's network voltage reaches a point where their generating unit should reduce its real power output in response to increased voltage[21]. This is typically considered to occur when network voltage exceeds 253V[22].

As shown in Figure 10, network overvoltages do not show a clear overall trend over the 3-year reporting period. While most DNSPs show a decrease in overvoltage, Endeavour Energy, Evoenergy and SA Power Networks had a significant increase in customers experiencing overvoltage in 2023. SA Power Networks have noted that they were requested by AEMO to curtail

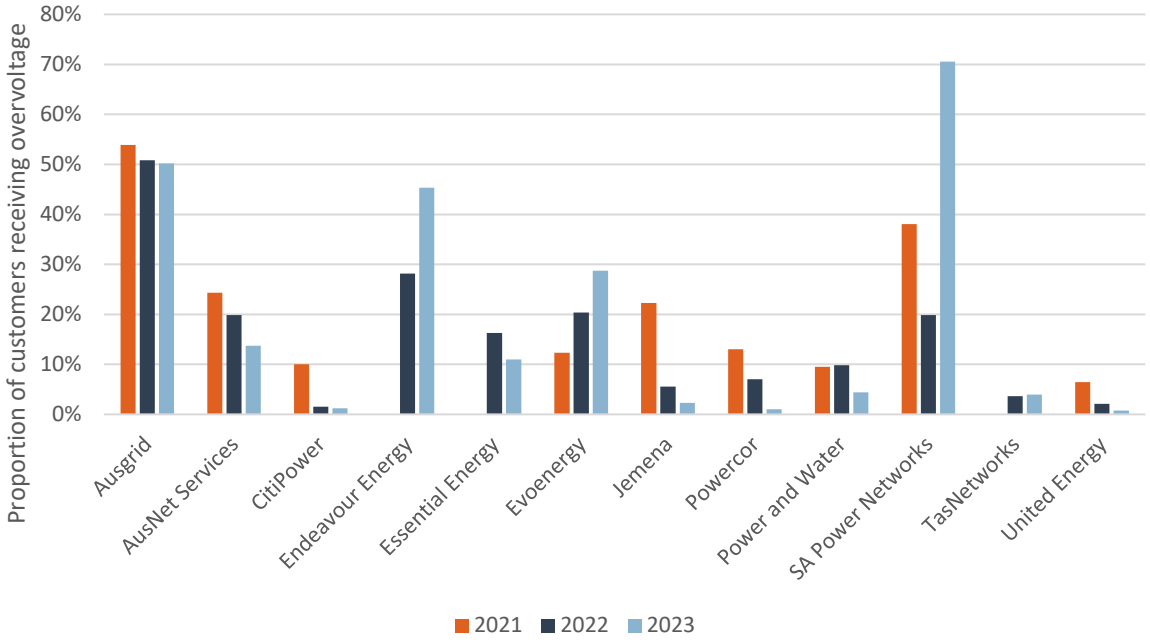
[21] Some generating units may curtail at undervoltage conditions when reactive power response is enabled in inverters. We have not requested networks to report at this voltage level for ease of reporting in this inaugural report.

[22] The maximum steady-state voltage allowed by AS 61000.3.100-2011 and the voltage at which volt-watt curtailment occurs for inverters compliant with AS 4777.2(2020).

exports by deliberately causing overvoltage while an interconnection to Victoria was being repaired after storm damage. Not including this event, SA Power Networks note that overvoltage occurred for 35% of customers in 2023 rather than the 70% value recorded in Figure 10.

Overvoltage causes increased customer curtailment as inverters reduce power output in response to high voltage levels. Particularly excessive overvoltage may cause damage to network infrastructure or customer devices.

Figure 10 Proportion of customers receiving overvoltage

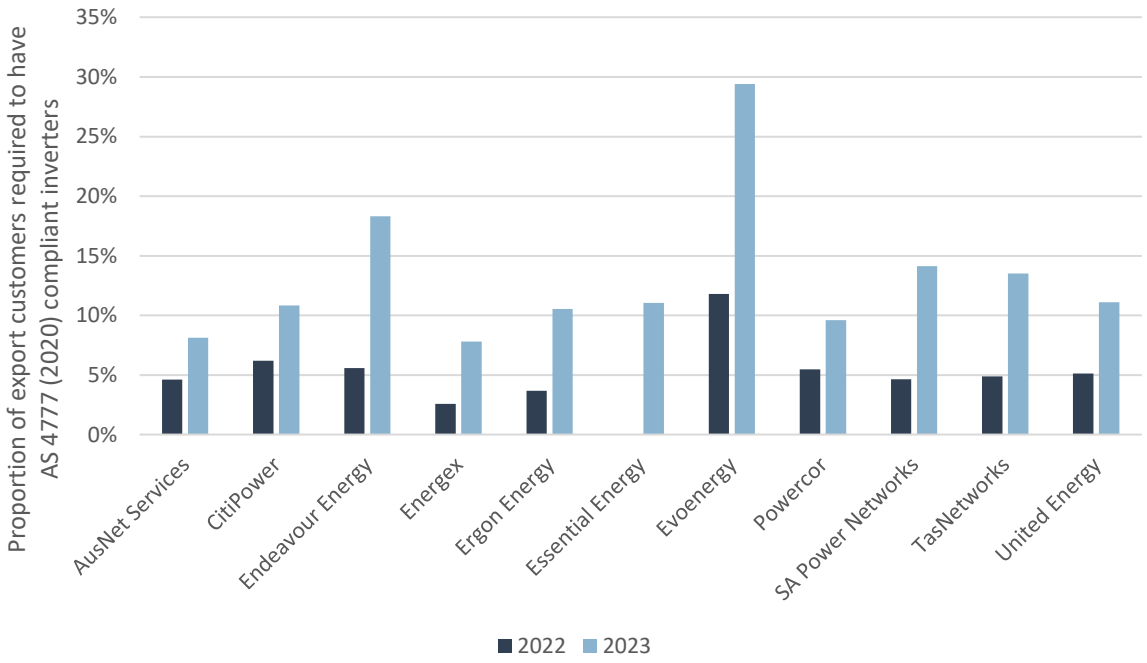


Note: This chart shows the number of customers receiving overvoltage as a proportion of the total number of customers that have measured voltage levels. Energex and Ergon Energy do not currently have records of customers measured to receive overvoltage.

As of 2021, the National Electricity Rules require new inverters to comply with the standard AS 4777.2(2020). AS 4777.2(2020) is an update of the 2015 version of the standard which requires inverters to be capable of a defined reduction of exports in response to overvoltage. The 2020 standard also requires inverters to be configured appropriately by installers so that overvoltage response occurs in practice. AS 4777.2(2020) requires inverters to respond in a defined way in response to voltage dips, improving system stability by minimizing the sudden loss of CER during short duration low voltage events.

Figure 11 shows the proportion of export customers required to have AS 4777.2(2020) compliant inverters for each DNSP. As would be expected, the number of inverters required to be compliant with AS 4777.2(2020) has increased since the standard was mandated for new installations. However, the majority of inverters for all DNSPs are not yet required to be compliant as they were installed before the standard was introduced.

Figure 11 Proportion of export customers required to have AS 4777 (2020) compliant inverters



Note: Ausgrid, Jemena and Power and Water Corporation did not report this metric. No networks reported any customers as being required to have AS 4777 (2020) compliant inverters in the 2021 financial year.

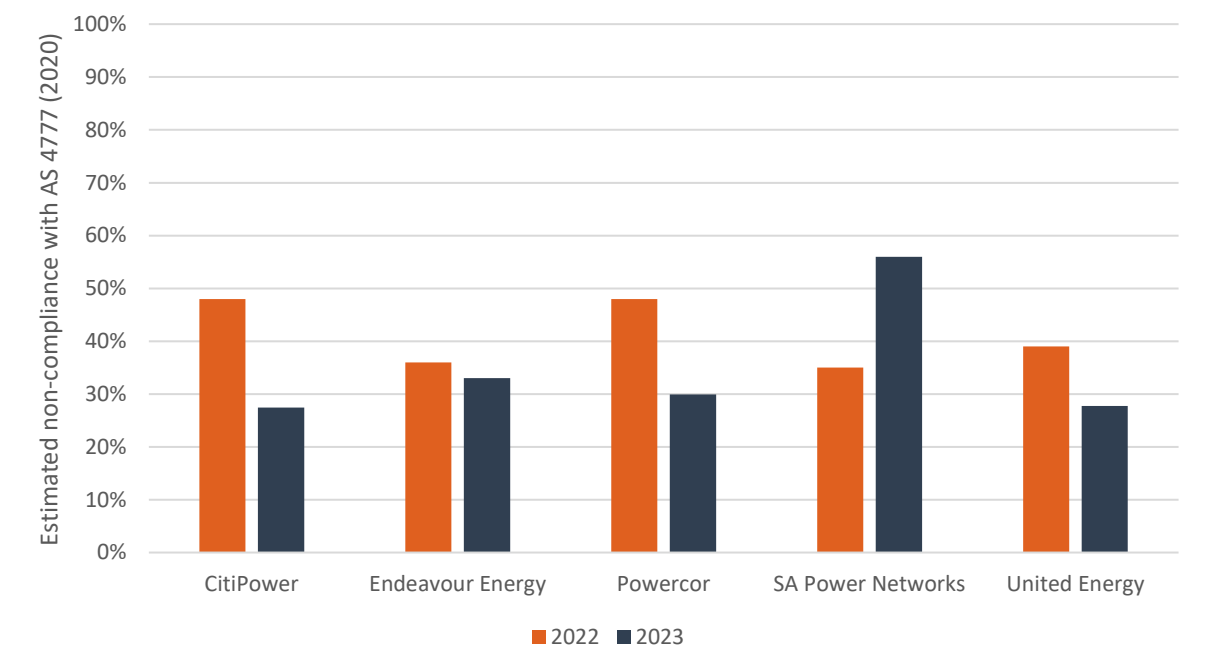
Are export customer installations compliant with inverter requirements?

AS 4777.2(2020) requires CER installers to configure inverters to have appropriate settings applied at the time of installation. If the installer does not apply these settings, or the settings are changed by the customer after installation, the inverter won't respond to network voltage fluctuations as intended.

While there are generally no mechanisms to ensure that installers comply with AS 4777.2(2020), some networks have begun conducting surveys to estimate inverter compliance. These estimates are shown in Figure 12. As with compliance with static export limits, ensuring inverter compliance is an ongoing challenge. It's important to note that we consider technical compliance of CER to be a systemic challenge, rather than a problem that is specifically caused by, or must be solved by, consumers.

The AEMC recently concluded its review into consumer energy resource technical standards*. The review provided 10 recommendations to improve CER compliance, addressing simplified devices at manufacture and supply, promotion of compliant installations and support for ongoing compliance. The review recommended development of a national CER technical standards framework and provided a number of options for a potential future body to oversee technical regulation of CER.

Figure 12 Estimated non-compliance with AS 4777.2(2020)



* AEMC, *Review into consumer energy resources technical standards*.

4 Flexible export limits

In the National Electricity Market, the export of excess energy generated from consumer energy resources within distribution networks has generally been managed through static export limits. Static limits are conservative to keep generation within a network's hosting capacity and share that network's capacity across all consumers, particularly during periods of high congestion. Static limits are not guarantees of a fixed maximum level of export, as a customer's ability to export is still subject to local system constraints, however they provide a general indication of export capability. As more consumer energy resources are connected, consumers may face lower static export limits due to DNSPs seeking to avoid the risk of breaching operational limits.

Static limits are generally set at a level that is considered safe when the network is congested, reflecting periods when the network will not be able to accommodate additional export, even if these periods occur infrequently. These conservative limits constrain consumers during times where there may still be capacity to export to the network.

As such, some DNSPs have begun implementing 'flexible export limits', where customers are given variable export limits which could, as an example, be set at 10kW most of the time and then be limited to 1.5kW at other times when there is network congestion.

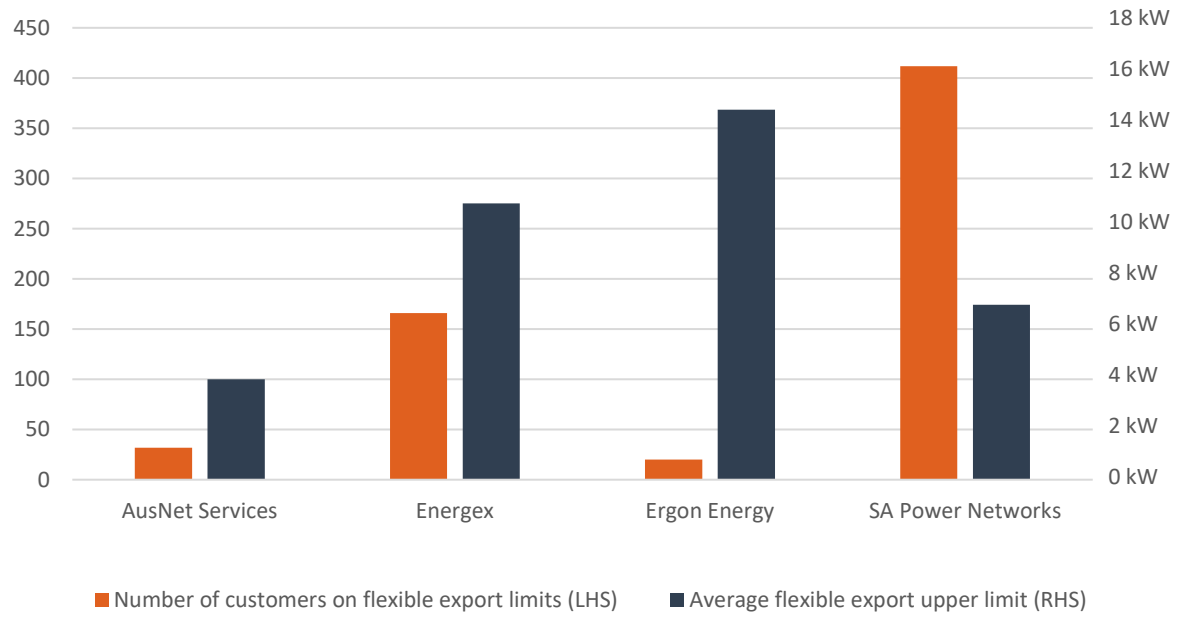
In our recent report "Flexible export limits final response and proposed actions"[23] we discuss the steps we are taking to support DNSPs in providing flexible export limits, which include development of a flexible export limits guideline (including principles for capacity allocation) and principles for customer engagement.

4.1 Flexible export limit trials

In 2023, flexible export limits were available in small-scale trials with 4 electricity DNSPs. The upper limits and number of customers participating in those trials are shown in Figure **13** below. SA Power Networks had the largest number of customers on flexible export limits, while Ergon Energy undertook the trial with the highest recorded average upper limit.

[23] AER, Flexible export limits final response and proposed actions.

Figure 13 Flexible export limit customer numbers and upper limits



Note: Ausnet and SA Power Networks have noted that they have reported upper limits on a per-phase basis, and typically target flexible export limit offers to customers that would otherwise be highly constrained on static export limits. It is unclear the extent that Ergon Energy or Energex are reporting limits for three-phase customers and the extent that their trials are being offered to highly constrained customers.

4.2 Flexible export limits as a standard connection offer

SA Power Networks have noted that they will be progressively rolling out flexible export limits as a standard connection offer for customers in the 2023-24 financial year[24]. Two local government areas (approximately 15% of customers) are currently eligible and the full rollout of flexible export limits across the network is intended to be complete by July 2024. i.e. SA Power Networks intend for all customers to have the option of selecting a flexible export connection when installing solar PV by July 2024.

[24] SA Power Networks, Fixed v Flexible.

5 Time to provide an offer

DNSPs are responsible for assessing customer applications to connect CER to their networks, although they generally are not involved with the actual completion of the installation. Long wait times from when a customer applies for a connection and when the connection is offered by the DNSP results in a poorer connection experience for consumers, and delays CER systems from coming online.

Table 4 provides a summary of the length of time taken for DNSPs to provide export connection offers to their customers. By a significant margin, Power and Water Corporation take the longest on average to provide export offers to customers (27 days for model standing offers and 99 days for other offers). Other DNSPs take less than 4 days to provide an offer in accordance with their model standing offer, however some DNSPs take longer than 20 days to provide an offer that is outside of their model standing offer (SA Power Networks, TasNetworks and AusNet Services). Offers outside of model standing offers may involve bespoke arrangements between DNSPs and customers, and are therefore more difficult to compare between DNSPs than time taken to provide a standing model offer.

Table 4 Time for DNSPs to provide a connection offer, 2023

	DNSP	Time to provide a standing model offer (Days)	Time to provide a low voltage offer outside of the model standing offer (Days)
ACT	Evoenergy	3.3	10
NSW	Ausgrid	3.0	-
	Endeavour Energy	0	7
	Essential Energy	-	-
NT	Power and Water	27.2	99
QLD	Energex	1.0	18
	Ergon Energy	1.0	16
SA	SA Power Networks	Auto Approval	34
TAS	TasNetworks	3.2	37
VIC	AusNet Services	1.0	28
	CitiPower	0.1	2
	Jemena	1.0	-
	Powercor	0.1	1
	United Energy	0.5	3

Note: A '-' symbol signifies that a DNSP did not report the relevant metric.

6 Expenditure

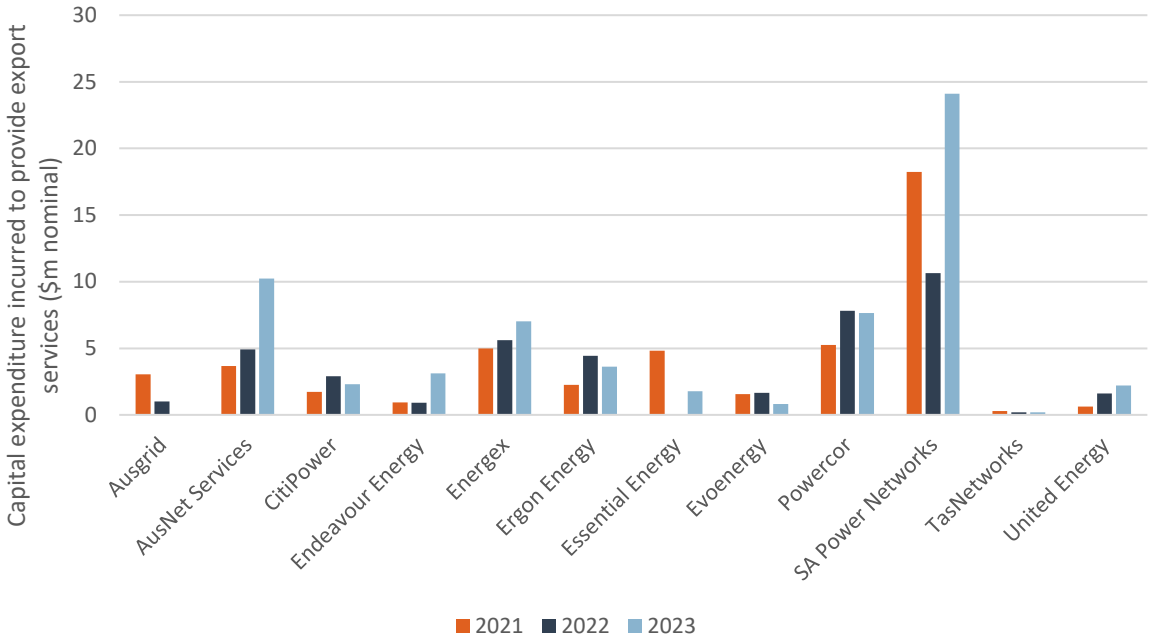
Expenditure on enabling export services is not a measure of export service performance. However, expenditure on enabling export services does indicate (1) current or emerging constraints relating to exports; and (2) DNSP activity to address or prevent export-related constraints. We may expect to see the following outcomes of a prudent DNSP providing export services:

- An efficient level of export curtailment, although there may be cases where it is prudent to prevent constraints before they emerge.
- Prudent expenditure on solutions to prevent or rectify emerging or actual constraints. Depending on the cost and nature of the solutions, we would expect to see a business case for this expenditure as part of the DNSP's DER integration plans and investment proposals, consistent with AER guidance.[25]
- Evidence that implemented solutions yield their projected benefits (within a reasonable margin of error). For example, if a DNSP justifies expenditure on the basis that it would prevent or reduce export curtailment against a counterfactual, we would expect to see this benefit in the data. If export customers had been given static export limits to manage a constraint, and that constraint was then removed, the DNSP would endeavour to remove the legacy limit.

Figure 14 and Figure 15 illustrate the capital and operational expenditure that DNSPs incurred in providing export services. This expenditure has been modest to date (around 1% of DNSPs' total capital and operational expenditure on average). SA Power Networks reported the highest capital expenditure over the period (including a large spend for ICT systems), while Energex reported the highest operating expenditure (with a large spend attributed to overvoltage complaints management).

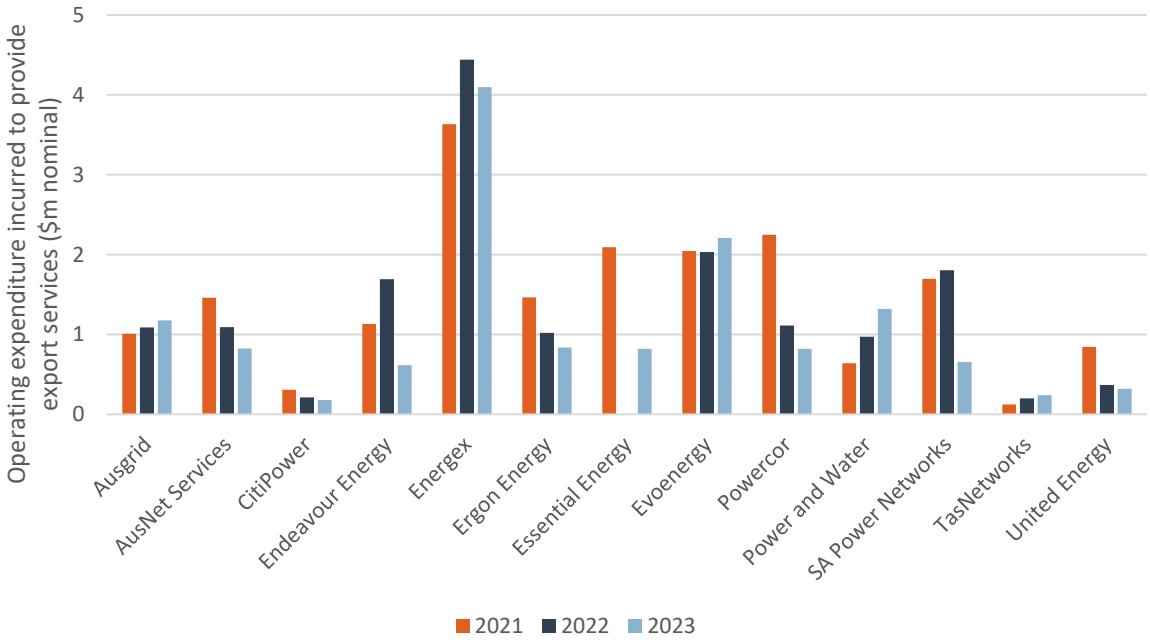
[25] AER, *DER integration expenditure guidance note*, June 2022.

Figure 14 Capital expenditure incurred to provide export services



Note: Jemena and Power and Water did not report capital expenditure to provide export services over the measured period. Jemena noted that they will capture this data from 2024.

Figure 15 Operating expenditure incurred to provide export services



Note: Jemena did not report operating expenditure to provide export services over the measured period. Jemena noted that they will capture this data from 2024.

7 Looking ahead

7.1 Network services

The nature of export services provided by DNSPs is continuing to evolve, CER penetration is increasing, governance and technologies are changing, and networks are becoming more involved with active monitoring, dispatchment and curtailment of customer exports. Network tariffs on customer exports will be allowed for some DNSPs from 2024, and for all DNSPs by 2026[26]. More broadly, discussions of possible "distribution system operator" models provide examples of how the roles of DNSPs in the energy system may significantly change in the future, to enable greater optimisation of CER to directly benefit customers and the system[27,28].

Export services provided by DNSPs should be provided at the lowest cost possible for consumers. The export services network performance reports will seek to support this goal by providing public information on network performance and expenditure.

7.2 Future performance reports

Information reported in future export service network performance reports will continue to evolve. For instance, we intend to measure and report on the emergence of new exporting technologies as they are adopted.

From 2025, information collected from DNSPs will be standardised through the AER's regulatory information orders (RIOs)[29]. In addition to standardising the core measures collected from networks, the RIOs require DNSPs to provide additional auditing and assurance compared to the information requests that were used to collect data for this 2023 report.

In the future, our reports may include additional metrics such as estimates of total CER generation and total energy curtailment and how they compare to generation and curtailment in the overall system. These metrics will require ongoing consultation with DNSPs to ensure consistency in methods of calculation to provide comparability between networks. To this end we will continue to develop and refine our annual export services performance reports and metrics in consultation with key stakeholders, including DNSPs, state and territory jurisdictions and consumers.

[26] AER, Export tariff guidelines.

[27] AEMO, Open energy networks project.

[28] Energy Networks Australia, Open energy networks project.

[29] AER, Networks information requirements review.

Glossary

Term	Definition
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
CER	Consumer Energy Resources
Curtailment	Any reduction on the capacity of an inverter to generate power. This could be caused by the inverter tripping in response to voltage disturbances or formally imposed through network static or dynamic voltage limits.
Connection agreement	An agreement between a DNSP and a customer by which the customer is connected to the distribution network and receives distribution services.
DER	Distributed Energy Resources
DNSP	Distribution Network Service Provider
Energy delivered	The total amount of energy transported through a distribution network.
Export	Electrical Energy that flows from a customer's premises to a distribution network via the connection point.
Export access against the agreed limit	The annual percentage of time that customers have the unconstrained ability to export to the distribution network up to the maximum export limit set in their connection agreement.
Export capacity	The maximum amount of electricity a customer's system is capable of exporting to the distribution network in accordance with the connection agreement.
Flexible export limit	The maximum level of export that a customer is allowed by a DNSP which can be varied based off network conditions.
Hosting capacity	The ability of a power system to accept energy generated by consumer energy resources without adversely impacting power quality such that the network continues to operate within defined operational limits.
kVA	Kilovolt-ampere
kW	Kilowatt
Model standing offer	A document approved by the AER as a model standing offer to provide basic connection services in accordance with Chapter 5A of the NER.
NEM	National Electricity Market
NER	National Electricity Rules
Static export limit	A fixed maximum level of export a customer is permitted by their DNSP.
Static zero export limit	A static export limit of zero, preventing a customer from exporting any electricity to a distribution network.
Overvoltage	The network voltage reaching a point where a customer's generating unit reduces its real power output in response to increased voltage.