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Putting the power in People's hands - Distributed Energy Resources can be a key contributor to Australia's clean energy transition

Accelerating the take up of Distributed Energy Resources (DER) in Australia could help Australia meet its renewable energy and emissions reductions targets, by circumventing the bottlenecks being faced in developing and connecting large-scale renewable energy generation and its associated transmission.

Australia is a world leader in both rooftop solar photovoltaic (PV) deployment and in its research and development. Australians love rooftop solar. They love the cost-of-living impact, they love the climate impact, and they love the control over their electricity costs and supply.

Installing rooftop solar PV reduces power costs, and a household or business' dependency on the wider electricity system. That has a direct impact on that consumer's power consumption costs. Rooftop solar PV also reduces electricity wholesale prices and the emissions associated with electricity because when the systems are generating more power than is being used in the home or business the excess electricity is exported to the wider grid, flooding the market with 'free and clean' excess electricity.[1]

DER is already contributing almost half (3.3GW in 2021 and 2.7 GW in 2022) of the annual 6GW of new renewable generation it is estimated we need to build over the seven years to meet our targets to generate 82 per cent of our electricity from renewable sources by 2030. It will need to contribute even more if we can't get the large-scale renewable generation, and associated transmission, projects out of the twin quagmires of planning and investment uncertainties.

If DER is to accelerate and help Australia's decarbonisation, we need a coordinated national energy strategy. A key part of that strategy would be removing some of the barriers to DER take-up by households and businesses. One of those barriers is the lack of trust consumers have in the monopoly power providers – quite rightly, they aren't levelling with their customers even now.

Australian states and territories either have, or are working towards, an 'emergency backstop mechanism' that will cost consumers right in their hip pockets. This mechanism means that their systems can be shutdown remotely. That doesn't just mean there will be times when they are not able to make money exporting their excess power to the grid, they won't even be able to consume that sunshine as power themselves – they will have to buy electricity from their retailer.

At the moment the cost of the emergency backstop in South Australia is estimated to be $1-2 per rooftop solar PV customer per event[2] (based on a one-hour event in South Australia in March 2021[3]).

A second event in South Australia in November 2022 resulted in 410 MW of rooftop solar PV systems being turned off for 4-10 hours on five consecutive days, and some further outage on a sixth day[4]. This almost week-long event is conservatively estimated to have cost customers close to $5 million[5] in electricity they would not otherwise have had to purchase.

With increasing numbers of installations and the severe weather related to climate change it is likely that there will be more frequent system stress events which will require the use of the emergency backstop, so customers will be cut off from their generation more frequently.

[1] https://www.accc.gov.au/system/files/Inquiry%20into%20the%20National%20Electricity%20Market%20-%20June%202023%20Report.pdf
[2] https://www.wa.gov.au/organisation/energy-policy-wa/information-consumers-emergency-solar-management
[3] https://www.pv-magazine.com/2021/03/19/south-australian-rooftop-solar-switched-off-in-search-for-stability/
[4] https://aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2022/trip-of-south-east-tailem-bend-275-kv-lines-november-2022.pdf?la=en
[5] Assuming an average system size of 7 kW, an average of 7 hours per day disconnected and a cost per customer per hour of $2 based on the March 2021 backstop event.

The myth – rooftop solar destabilises the national grid

There are a number of technical issues with the volume and speed of installation of rooftop solar in Australia. However, these are being solved overseas so they certainly aren't insurmountable here. The one that is talked most about is the 'minimum demand problem', which market operators want to solve by having an 'emergency back stop' option of taking control of a customer's power generation and switching it off when needs be.

It is true that minimum demand problem may mean that sometimes the power system is less stable and secure. This is especially the case if the power system has already experienced a problem, as was the case in South Australia when a tower fell down on the transmission interconnector to Victoria in November 2022.

However, a number of studies[6] have identified that, while rooftop solar PV does slightly increase network voltage, the major issue is that networks are maintaining the legacy average system voltage of 240 V, rather than adopting the general voltage standard of 230 V (AS61000).

The impact of operating the distribution electricity network at the legacy threshold is that it takes only a small amount of additional electricity generation to approach the upper limits of the current standard (see box below).

The requirement to meet a voltage standard managed by the state electricity regulators rather than through the Australian Energy Regulator.

Reforming Australia's voltage standards, in all states and territories, in line with global best practice would significantly ease the minimum demand problem, and allow more DER into the system.

What is the emergency backstop mechanism?

The emergency backstop mechanism allows the Australian Energy Market Operator (AEMO) to instruct the Distribution Network Service Providers (DNSPs) to reduce generation and increase demand.

The DNSPs then take steps to do this by turning off remotely disabling the inverter in rooftop solar panels. Currently this means that no generation is possible either for self-consumption of electricity or export. This means that those that have invested in rooftop solar PV have to purchase electricity from their retailer.

It is technically possible with 'smart' inverters to stop export while still allowing customers to generate electricity from their rooftop solar PV for their own use. However, since the role of the emergency backstop is to both stop export from rooftop solar PV and increase demand the mechanism does not currently use that option and so has a double impact on customers.

While AEMO have undertaken numerous studies on minimum demand issues[7,8] the need for an emergency backstop was not progressed in a way which would have required a consultation and industry assessment of the problem and proposed solution. Only Victoria has consulted on the need for an emergency backstop. Other states have consulted only on the technical approach to delivering the emergency backstop having already decided it was essential.

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[6] https://www.ceem.unsw.edu.au/sites/default/files/documents/ESB%20Report%20Voltage_Master_040520_Final_0.pdf
[7] ibid
[8] https://aemo.com.au/-/media/files/major-publications/ris/2020/renewable-integration-study-stage-1.pdf?la=en&hash=BEF358122FD1FAD93C9511F1DD8A15F2

How does the emergency backstop work?

South Australia and Queensland have operational emergency backstops. Victoria is developing an emergency backstop approach. However, the technical approach to delivering the shutdown of rooftop solar PV is very different in each state, complicating the design for inverter manufacturers.

In South Australia, SA Power Networks (SAPN) currently relies on its ability to increase network voltage to the level that forces inverters to automatically disconnect. Recent new requirements will require all inverters to be remotely accessible to SAPN over the internet, so that they can turn off the inverters. This approach is reliant on a working internet and communications connection to the inverter, which, in a power outage, is unlikely.

In Queensland, Energy Queensland, are using Audio Frequency Load Control (AFLC – 'ripple control') switches to receive an electronic signal sent over the electricity network to turn off inverters. This requires fitting a switch to each new inverter that is not 'smart' but is not dependent on the internet or communications networks during a power failure.

When AEMO deems, on the basis of its own analysis, that a Minimum System Load (MSL) event is likely to occur it will issue a warning. Currently, the warning process is undeveloped and untried, but it is anticipated that there will be three levels of warnings.

MSL 1 and 2 would allow for market-led approaches to address minimum system load, that would see customers reduce generation or increase demand as a paid service. MSL 3 is the emergency backstop, where rooftop solar generation needs to be turned off. Currently, only MSL 3 is operational as the market approaches to MSL 1 and 2 have yet to be developed by DNSPs. However, third-party providers (aggregators) are very keen to provide market-based services and have demonstrated that they can provide services to meet MSL 1 and 2.

Alternative approaches to managing rooftop solar PV

Australia is pursuing a requirement for standards and compliance for rooftop solar PV inverters that will allow centralised control by AEMO and DNSPs.[9][10] This extends beyond the system security issues that might be posed by unconstrained rooftop solar PV, to day-to-day management of export, export tariffs, and direct control of inverters through 'flexible' or 'dynamic' connections.[11]

Unfortunately, there has been little exploration of approaches to managing rooftop solar PV that utilise collaboration with customers with DER to enhance flexibility, such as increased use of batteries or EVs, or demand-side response.

Project Edith (Ausgrid, NSW) is looking at dynamic network tariffs to manage network constraints by enabling customer-side responsiveness (via an aggregator).

There are some trial 'solar sponge' tariffs that mean electricity is lower cost to encourage all customers to use electricity when excess rooftop solar PV generation is high (noting that these network-based tariffs may not be passed on by the retailer to customers).

This focus on pursuing direct control of rooftop solar PV inverters is out of step with other locations, with similar proportions of large-scale and small-scale renewables, which are taking the route of tariff and flexibility to managing rooftop solar PV.

California and Hawai'i have:

- Incentivised demand response (through requirements on electricity networks and retailers)
- Undertaken tariff reform
- Undertaken a review of system operation to develop services for the system of the future
- Incentivised batteries (all scales)
- Incentivised EVs

[9] https://www.standards.org.au/blog/as-5385-2023-the-new-smart-energy-standard-supporting-australias-move-to-a-renewable-energy-future
[10] https://reneweconomy.com.au/solar-switch-off-a-must-for-all-states-says-aemo-to-control-seven-erarings-of-rooftop-pv/
[11] https://reneweconomy.com.au/queensland-slammed-for-bespoke-demands-on-inverters-in-controversial-rule-change/

Feed-in-Tariffs (FiT) have been cancelled, but in California the utility (retailer) has to purchase rooftop solar at market value at time of generation. This is very similar to the UK scheme where the FiT was cancelled in 2019, but the Smart Export Guarantee (SEG) requires retailers to offer to buy (through a tariff) exported solar PV[12].

California also halted net metering and tried and failed to introduce the export charging that Australia has embraced. Neither California or Hawai'i is trying to 'flexibly' control exports nor set up emergency backstops., Both countries have undertaken system planning that recognises the need to actively encouraging rooftop solar PV to achieve climate goals.

Approaches in other high renewable generation and rooftop solar PV systems:

Location	***System Generation Capacity, GW***	***Large VRE Capacity, %age***	***Rooftop PV, GW***	***%age***	***Approach***
Australia[13]	65	38	21	32	Direct control
South Australia[14]	5.3	45	2.7	51	Direct control
Qld[15]	16.3	28	5.2	32	Direct control
Western Australia[16,17]	5.8	20	1.9	34	Direct control
Victoria[18]	14.6	50	4.0	27	Developing direct control
New South Wales[19]	18.9	45	5.5	29	N/A
Hawai'i[20,21]	3.5	29	1.1	31	78% have a battery (incentivised)
California[22,23]	80	35	9	11	DSR, Tariffs
Nevada[24]	33	37	3.9	12	
UK[25]	76.7	56	15.2	20	No direct control
Germany[26]	261	57	3	1	No direct control

12 https://www.ofgem.gov.uk/environmental-and-social-schemes/smart-export-guarantee-seg
13 https://www.aer.gov.au/system/files/AER_Generation_Registered%20capacity%20by%20fuel%20source%20regions%20DATA_2_202307171333 32.CSV
14 https://www.pv-magazine-australia.com/2023/06/30/rooftop-solar-on-radar-as-south-australia-looks-to-future/
15 https://www.pv-magazine.com/2023/03/01/australian-rooftop-solar-capacity-hits-20-gw/
16 https://aemo.com.au/en/energy-systems/electricity/wholesale-electricity-market-wem/about-the-wholesale-electricity-market-wa-wem
17 https://www.westernpower.com.au/our-energy-evolution/consumer-advice/solar/solar-suburb-checker/
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20 https://www.eia.gov/state/print.php?sid=HI
21 https://www.hawaiianelectric.com/documents/about_us/company_facts/power_facts.pdf
22 https://www.nrdc.org/bio/mohit-chhabra/rooftop-solar-california-ready-take-next-step
23 https://www.infoplease.com/us/census/california/housing-statistics
24 https://www.eia.gov/state/?sid=NV#tabs-4
25 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1174357/DUKES_2023_Chapter_5.pdf
26 https://www.energy-charts.info/charts/installed_power/chart.htm?l=en&c=DE&chartColumnSorting=default&partsum=1&stackLabelDecimalPlaces=2

Table 1: Generation mix for a variety of locations internationally and in Australia

What can be done?

Nexa Advisory has made five recommendations for consideration at the energy ministers' meeting in November, including:

- Immediately establish of a national DER body with appropriate funding to:
  i. deliver a coordinated national strategy and policy plan to accelerate DER.
  ii. direct the market bodies, including the operator, on the technical and regulatory approaches to DER.
- Prioritise (in parallel to the national DER body) energy programs and reforms in three key areas:
  i. Reform 'export' management and tariffs with a focus on consumer outcomes and trust
  ii. Obligate network service providers to make network data publicly available to enhance innovation and competition and reduce monopoly behaviour
  iii. Reform outdated network voltage standards in line with global best practice

About Nexa Advisory

Nexa is a full-service advisory firm. We work with public and private clients including renewable energy developers, investors and climate impact philanthropists to help accelerate efforts towards a clean energy transition. We've been shaping the energy industry for over 20 years. With a proven track record across policy creation, advocacy, political risk assessment and project delivery, we're holistic in our approach and deliver solutions with commercial intent.

The Nexa Advisory team is a collaboration of passionate energy specialists, all committed to the successful transformation of Australia's energy markets. The team is focused on helping clients grasp the unpredicted opportunities the energy transformation will bring with trusted and innovative thinking and advice.

Authors

Stephanie Bashir CEO and Principal Nexa Advisory

Dr Jill Cainey Policy and Research Director Nexa Advisory