



# Australia's distributed energy resources journey: Deployment and integration

December 2025

Electricity demand in Southeast Asia is projected to more than double – and possibly triple – by 2050 compared to today.<sup>1</sup> In parallel, most countries have set net-zero targets. Meeting this growth will require accelerating clean energy deployment to decarbonise energy systems, while safeguarding energy security and ensuring affordable, fair access for all.

Distributed energy resources (DER) can play an important role alongside large-scale generation in meeting this demand. Currently, DER uptake in Southeast Asia is limited. Vietnam is an exception, with rapid solar deployment – both rooftop and utility-scale – but planning and coordination challenges have led to significant curtailments. Additionally, most rooftop solar installations in Vietnam have been on business premises; the potential for residential rooftop solar has yet to be realised.

Australia leads the world in per capita rooftop solar adoption and is seeing strong growth in home battery storage.<sup>2</sup> Beyond electricity supply, DER can deliver multiple services, including emergency backup and ancillary services. DER can also reduce the need for costly transmission and distribution infrastructure investments because it co-locates generation and demand.

Australia offers a compelling case for how DER can be integrated into local and national grids to support grid reliability, maintain affordability, enhance resilience and advance decarbonisation.

<sup>1</sup> International Energy Agency (IEA), *Integrating Solar and Wind in Southeast Asia: Status and outlook for secure and efficient strategies*, IEA, September 2025, p 14; Asian Development Bank (ADB), *ASEAN Power Grid*, ADB website, n.d., accessed 17 December 2025.

<sup>2</sup> Clean Energy Council (CEC), *Rooftop Solar and Storage Report: January–June 2025*, CEC, September 2025, pp 5, 7, 8.

## Key terms and definitions

**Distributed energy resources (DER)** are small- to medium-scale energy resources connected to the distribution network, either in front of or behind the meter. There are 3 broad categories of DER:

- **Distributed generation:** electricity generated at or close to the site of use.
- **Energy storage:** capturing energy locally produced at one time in chemical, thermal or other forms for use at a later time.
- **Flexible demand:** appliances or machines that are able to have their time of use altered passively (for example, through a timer) or dynamically in response to local or external signals.

**Note:** In Australia, the term ‘consumer energy resources’ (CER) is also used to describe DER technologies from the perspective of consumer ownership and control – whether by individuals, households or businesses. This document uses the term ‘distributed energy resources’ (DER), consistent with the above definition and categorisation, to align with terminology commonly used in Southeast Asia, except where authors specifically refer to CER in their publications.

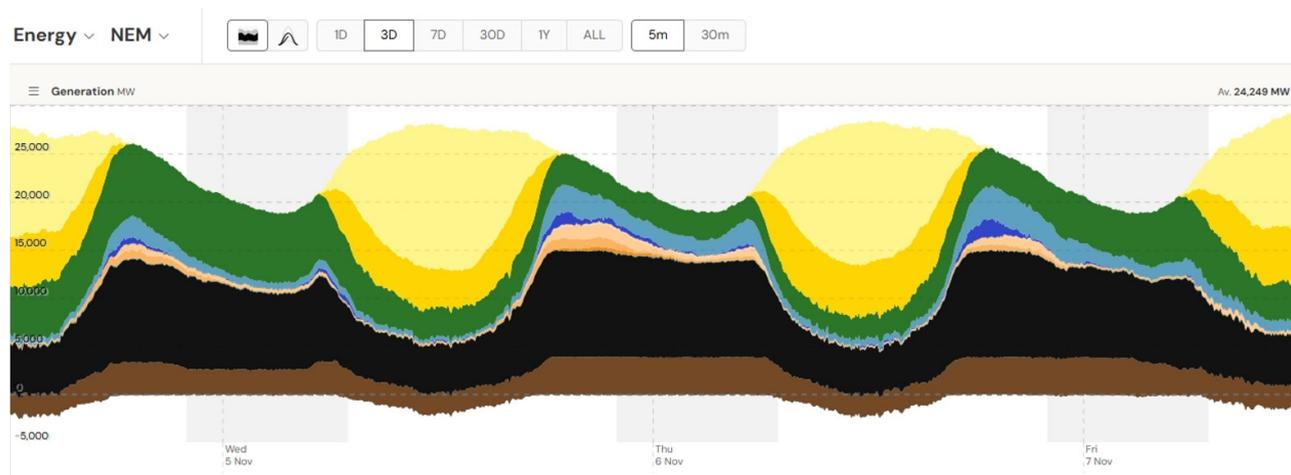
**Source:** G Kuiper, *The revolution will be in distribution: Faster, cheaper decarbonisation through integrating Distributed Energy Resources (DER)*, Engineers Australia, January 2025.

## Current deployment of distributed energy resources in Australia

Australian households and small businesses are accelerating investment in DER, particularly rooftop solar. According to Australia’s Clean Energy Council, by mid-2025 more than 4.2 million homes and businesses across Australia had installed rooftop solar systems. Recent projections estimate rooftop solar capacity will reach 37 gigawatts (GW) by June 2030,<sup>3</sup> slightly ahead of the Australian Energy Market Operator’s Integrated System Plan target of approximately 36 GW.<sup>4</sup>

Together, these rooftop solar systems contributed nearly 13% of Australia’s total electricity generation in the first half of 2025, whereas utility-scale solar only provided 8% of supply.<sup>5</sup> Rooftop solar now regularly meets 50% of the National Electricity Market’s demand in the middle of the day in spring (Figure 1).<sup>6</sup> In South Australia, where over half of all households have rooftop solar, rooftop generation can exceed 100% of local electricity demand, with surplus power exported to neighbouring states.<sup>7</sup>

**Figure 1: National Electricity Market consumption, by energy source, 5–7 November 2025**



Note: Rooftop solar appears as light yellow on the chart. Visit source for full key to chart.

Source: Open Electricity, [Tracker: NEM](#), accessed 7 November 2025.

<sup>3</sup> CEC, [Rooftop solar generated power for more than 4.2 million homes and small businesses – delivered 12.8 per cent of Australia’s electricity in first half of 2025](#) [media release], CEC, 15 September 2025.

<sup>4</sup> Australian Energy Market Operator (AEMO), [2024 Integrated System Plan](#), AEMO, June 2024, p 48.<sup>5</sup> Energy Security Board (ESB), [Consumer Energy Resources and the Transformation of the NEM](#), ESB, February 2024.

<sup>5</sup> CEC, [Rooftop Solar and Storage Report: January–June 2025](#), CEC, September 2025. Note: These figures are estimates, and some installations may represent replacements or upgrades rather than new capacity.

<sup>6</sup> For more information on Australia’s National Electricity Market (NEM), see Partnerships for Infrastructure (P4I), [Forming the National Electricity Market: Australia’s electricity market reforms](#), P4I, November 2025.

<sup>7</sup> Open Electricity, [Tracker: NEM](#), accessed 7 November 2025.

## Australian households and small businesses are also investing in battery energy storage systems.

According to recent estimates, the total number of installed home battery systems has reached approximately 271,000.<sup>8</sup>

Electric vehicles (EVs) also present a significant storage opportunity, particularly given that they remain idle approximately 90% of the time (Box 1).<sup>9</sup>

### Box 1

## Electric vehicles – a significant source of energy storage

According to the Electric Vehicle Council, the total fleet of electric vehicles (EVs) in Australia passed 410,000 in September 2025. In the first half of 2025, EVs represented around 12% of all new car sales – a figure expected to grow steadily in coming years.<sup>1</sup>

EVs equipped with bidirectional charging technologies – such as vehicle-to-everything (V2X), vehicle-to-home (V2H), and vehicle-to-grid (V2G) – can supply power from their batteries to external systems, enhancing energy flexibility for households, electricity networks and broader infrastructure.

- V2X is the overarching concept, enabling energy transfer from an EV to homes, grids or other connected systems to support optimised energy management.
- V2H allows EV batteries to power a household, providing backup during outages or high-price periods, while charging occurs during off-peak times.
- V2G enables EVs to feed energy back into the utility grid, helping balance demand and improve grid stability through aggregated EV fleets.

Projections for EV battery storage capacity by 2050 range from 67 gigawatt hours (GWh) (CSIRO) to 2,359 GWh (enX Consulting),<sup>2</sup> compared to the National Electricity Market's projected storage requirement of approximately 660 GWh.<sup>3</sup> These estimates suggest that widespread EV adoption could deliver aggregate storage capacity well beyond the needs of the National Electricity Market, offering a cost-effective alternative to large-scale stationary storage infrastructure.

<sup>1</sup> Electric Vehicle Council, *State of Electric Vehicles 2025*, October 2025, pp 6, 17.

<sup>2</sup> Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Renewable Energy Storage Roadmap*, CSIRO, March 2023, p 137; enX Consulting, *V2X.au Summary Report – Opportunities and Challenges for Bidirectional Charging in Australia*, Australian Renewable Energy Agency, June 2023, p 3.

<sup>3</sup> Australian Energy Market Operator (AEMO), *2024 Integrated System Plan*, AEMO, June 2024, p 66.

## Benefits and services provided by distributed energy resources

Because energy is generated and stored close to demand and is mainly driven by consumers:

- **DER can reduce the investment burden on utilities by limiting the need to finance new generation capacity and storage.**

High levels of DER integration in Australia could deliver savings up to A\$19 billion by 2040. This includes approximately A\$11 billion in avoided transmission and distribution costs, and A\$8 billion in reduced generation and storage costs.<sup>10</sup>

- **DER can enhance the resilience of energy systems by reducing dependence on large-scale transmission and distribution assets that are vulnerable to extreme weather events.**

Rural communities in Western Australia are highly vulnerable to climate-induced power outage events. The distances over which power is transmitted means that in times of climate disaster and grid overload, these communities become isolated and face long wait times for repairs. To address this, community microgrids are being deployed in Western Australia.<sup>11</sup>

<sup>8</sup> CEC, *Rooftop Solar and Storage Report: January–June 2025*, September 2025, pp 5, 7, 8.

<sup>9</sup> Australian National University (ANU), *Electrified cities could become giant batteries: ANU study*, ANU Reporter, ANU, 22 July 2025.

<sup>10</sup> G Kuiper, *DER could provide \$19 billion economic boost by 2040*, Institute for Energy Economics and Financial Analysis, February 2024, p 6. Meta-analysis, drawing on studies including Baringa Partners, Potential Network Benefits from More Efficient DER Integration, Baringa Partners, June 2021; and NERA Economic Consulting, *Valuing Load Flexibility in the NEM*, Australian Renewable Energy Agency, February 2022. Note that the studies used different modelling approaches and carry inherent uncertainties.

<sup>11</sup> Western Power, *Micro-grids: A brighter future for WA*, Western Power, n.d., accessed 17 December 2025.

- **DER can complement utility-scale projects and contribute to a more inclusive, flexible and decentralised energy transition.**

The ongoing Project Jupiter in Western Australia, supported by the Australian Renewable Energy Agency (ARENA), is testing a live DER marketplace with wholesale markets – demonstrating that DER can be scaled without compromising the reliability and security of Western Australia’s main power system.<sup>12</sup>

DER can also provide an array of services, either individually or collectively, across the electricity system (Figure 2).<sup>13</sup> These include:

- support for the broader power system, helping to balance supply and demand and maintain system stability
- services to local distribution networks, improving efficiency and reliability at the community level
- support at the grid’s edge, including the management of microgrids and remote or islanded systems.

**Figure 2: Services provided by DER in an integrated electricity market**



Source: G Kuiper, *DER could provide \$19 billion economic boost by 2040*, Institute for Energy Economics and Financial Analysis, February 2024, p 9.

## Australia’s policy journey with distributed energy resources

Australia’s understanding and use of DER expanded significantly during the 2010s. Western Australia released the country’s first DER roadmap in April 2020. As DER uptake accelerated, the need for a national roadmap to improve planning and integration became clear.

### National-level distributed energy resources roadmap and vision

From 2019 onwards, the Energy Security Board (ESB) – which acted as an umbrella body for the energy market institutions including the Australian Energy Regulator (AER), the Australian Energy Market Operator (AEMO) and the Australian Energy Market Commission (AEMC) – began work on post-2025 National Electricity Market design. As part of this work, the ESB employed a DER strategy specialist and, in September 2020, published a DER roadmap and work plan. Its aim was to optimise the benefits of DER for all electricity system users, not just DER owners, reducing total system costs and ensuring a secure, reliable grid.

**In November 2023, federal and state energy ministers recognised the need to promote better coordination and optimisation of DER, and agreed to develop a national-level roadmap, to be produced by the Consumer Energy Resources Working Group, comprising state and territory officials.**

<sup>12</sup> Australian Renewable Energy Agency (ARENA), *Project Jupiter*, ARENA, n.d., accessed 17 December 2025.<sup>13</sup> Western Power, *Micro-grids: A brighter future for WA*, Western Power, n.d., accessed 17 December 2025.

<sup>13</sup> G Kuiper, *The revolution will be in distribution: Faster, cheaper decarbonisation through integrating Distributed Energy Resources (DER)*, Engineers Australia, January 2025.

Endorsed in July 2024, the National Consumer Energy Resources Roadmap spans 4 workstreams: consumers, technology, markets and power system operations. The roadmap provides a consistent policy framework to fully integrate DER – including rooftop solar, batteries and electric vehicles – into the electricity system by 2030. It also highlights priority reforms and sequencing considerations to achieve the vision and outcomes.<sup>14</sup>

## The National CER Roadmap’s vision

**‘Consumer energy resources are an integral part of Australia’s secure, affordable and sustainable future electricity systems, delivering benefits and equitable outcomes to all consumers through efficient use which smooths the transition, rewards participation and lowers emissions.’**

Source: Department of Climate Change, Energy, the Environment and Water (DCCEEW), [National Consumer Energy Resources Roadmap: Powering decarbonised homes and communities](#), DCCEEW, July 2024, p 11.

Across the roadmap’s 4 workstreams, Australia is implementing a range of national reform priorities between 2025 and 2030 to achieve the roadmap’s vision (Table 1).

**Table 1: National CER Roadmap workstreams and reform priorities**

Workstream	Reform priorities
<b>Consumers</b>	<ul style="list-style-type: none"> <li>• Extending consumer protections for CER</li> <li>• More equitable access to benefits of CER</li> <li>• CER information to empower consumers</li> </ul>
<b>Technology</b>	<ul style="list-style-type: none"> <li>• Nationally consistent standards, including vehicle to grid</li> <li>• National regulatory framework for CER to enforce standards</li> <li>• Establish secure communication systems for CER devices</li> </ul>
<b>Markets</b>	<ul style="list-style-type: none"> <li>• Enable new market offers and tariff structures to support CER uptake</li> <li>• Data-sharing arrangements to inform planning and enable future markets</li> <li>• Redefine roles for market operations</li> </ul>
<b>Power system operations</b>	<ul style="list-style-type: none"> <li>• Enable consumers to export and import more power to and from the grid</li> <li>• Faster, harmonised CER connection processes, including EV chargers</li> <li>• Improve voltage management across distribution networks</li> <li>• Incentivising distribution network investment in CER</li> <li>• Redefine roles for power system operations</li> </ul>

Source: Department of Climate Change, Energy, the Environment and Water (DCCEEW), [National Consumer Energy Resources Roadmap: Powering decarbonised homes and communities](#), DCCEEW, July 2024, p 11.

The Department of Climate Change, Energy, the Environment and Water organises regular public consultations on the roadmap. Federal and state energy ministers have committed to annually updating the roadmap’s implementation plan, which tracks progress against outcomes.<sup>15</sup> An in-depth review of the roadmap will occur in 2027.

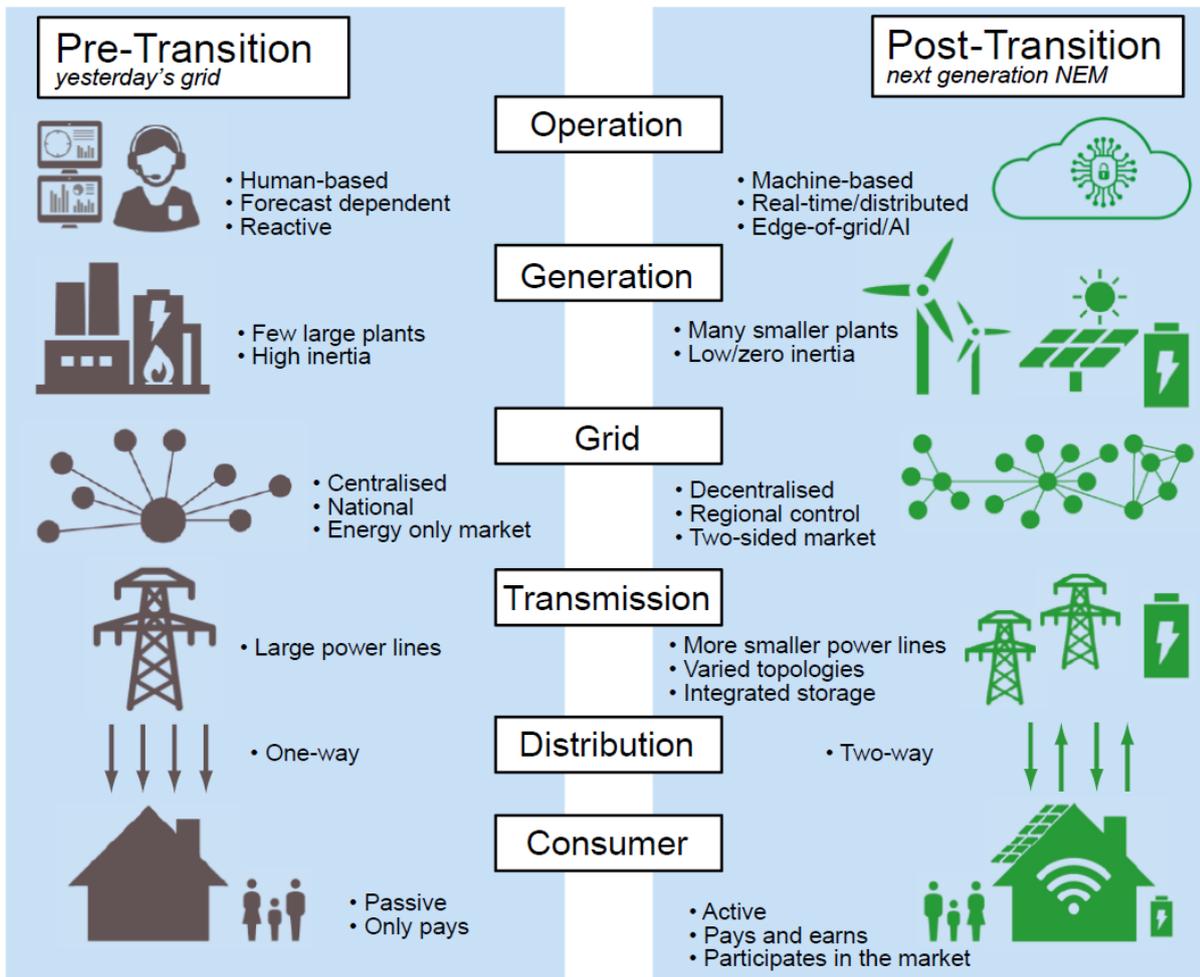
<sup>14</sup> Department of Climate Change, Energy, the Environment and Water (DCCEEW), [National Consumer Energy Resources Roadmap: Powering decarbonised homes and communities](#), DCCEEW, July 2024.

<sup>15</sup> DCCEEW, [National Consumer Energy Resources Roadmap: Implementation Plan Update](#), DCCEEW, August 2025.

## Grid modernisation to support two-way electricity flows

Australia's National Electricity Market is transitioning from traditional thermal power generation (coal and gas) to renewable electricity (both utility-scale and DER), with a target of 82% renewable supply by 2030.<sup>16</sup> The scale and complexity of change are significant. **A key aspect of this transformation is the shift in distribution network flows, from conventional one-way systems to dynamic, two-way electricity flows** (Figure 2).

**Figure 3: Transformation of the National Electricity Market**



Source: T Finnigan, *Australia's opportunity to plan ahead for a secure zero-emissions electricity grid*, Institute for Energy Economics and Financial Analysis, March 2021, p 10.

This shift is reshaping how the distribution system operates. The system is evolving from a largely static and mechanical operation into a dynamic one where digitalisation and data flows are crucial. In the distribution networks, power systems engineering now involves a growing amount of software development and data science (including machine learning, artificial intelligence and cybersecurity), as well as power electronics. This combination of approaches used to be known as a 'smart grid' but is increasingly just called 'grid modernisation'. Therefore, multiple kinds of engineering, including interdisciplinary engineering, is required for the potential of DER integration to be fulfilled.<sup>17</sup>

<sup>16</sup> DCCEEW, *Energy and Electricity Sector Plan*, DCCEEW, September 2025.

<sup>17</sup> G Kuiper, *The revolution will be in distribution: Faster, cheaper decarbonisation through integrating Distributed Energy Resources (DER)*, Engineers Australia, January 2025.

## Practical insights for Southeast Asia's distributed energy resources planning

Australia's experience shows that the uptake and integration of DER can decarbonise power systems faster and at lower cost. But DER need to be treated as a priority, not as an afterthought to large-scale generation and transmission. Policies and planning should recognise the multiple benefits and services that DER can provide. **Australia's own reforms for DER are still underway.** Key insights from Australia's experience include:

- **Plan and coordinate early**

Rapid rooftop solar uptake without proper planning can lead to grid instability and limit the return on investment for households and businesses. Australia is learning that integrating DER requires strong focus and coordination from policymakers, regulators, network operators, and industry.

- **Develop and strengthen technical standards and regulatory frameworks**

Clear, nationally consistent standards for DER devices, installation and operation are critical. Standards should cover grid support, interoperability, cybersecurity and real-time monitoring to ensure safe integration and support future market participation.

- **Integrate DER into electricity markets and pricing**

Traditional markets were built for centralised generation. Modernising markets means setting clear tariff roadmaps, allowing DER to participate in energy markets and provide associated services.

- **Engage consumers as active participants**

Households and businesses drive DER adoption. Policies that simplify connection processes, offer fair incentives and provide clear information empower consumers to participate in the energy transition.



Rooftop solar systems, South Australia. Source: Shutterstock

## About this document

This insights brief, edited by Partnerships for Infrastructure (P4I), summarises and updates information shared by CSIRO at the Vietnam–Australia Technology Exchange on grid integration of distributed energy resources in July 2025. Dr Gabrielle Kuiper (Australia – Southeast Asia DER Lead) and Ms Bridget McIntosh (Southeast Asia Energy Strategy Lead) presented on behalf of CSIRO, with P4I providing coordination and planning support.

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Partnerships for Infrastructure acknowledges Aboriginal and Torres Strait Islander peoples as the traditional custodians of Country throughout Australia, and we pay our respects to Elders past and present. P4I also recognises early connections between Southeast Asia and the First Nations peoples of Australia.

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