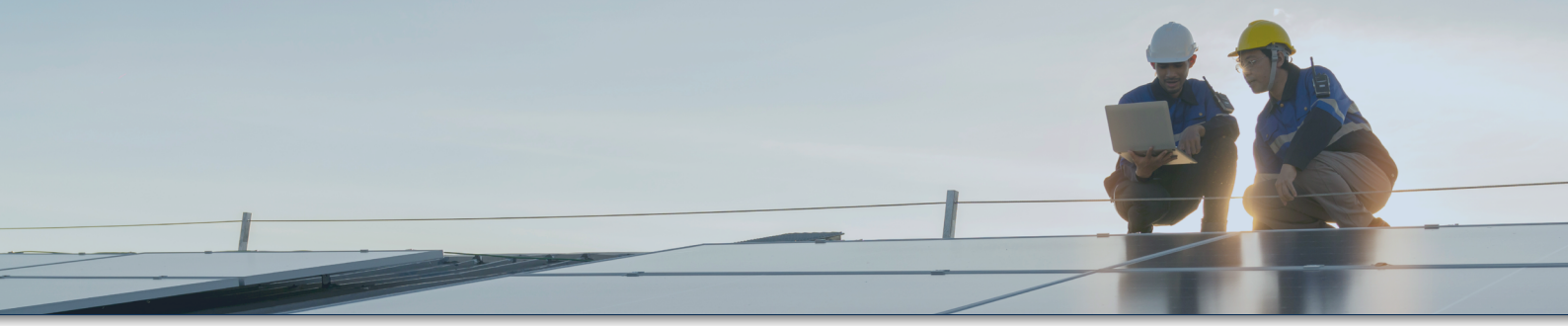
Institute for Energy Economics and Financial Analysis

Briefing Note



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Integrated System Plan needs greater ambition on DER to be a true whole-of-system plan

- *Distributed energy resources (DER) in homes and businesses will likely be the largest component of generation capacity, storage and flexible load in the National Electricity Market (NEM) by 2050.*
- *The Australian Energy Market Operator's (AEMO's) DER forecasts are conservative in several respects, meaning DER could play a much greater role than currently forecast.*
- *A higher DER sensitivity is needed in the 2024 Integrated System Plan (ISP), and a high DER scenario is required in the 2026 ISP.*
- *Without co-optimisation between the demand side and the supply side, AEMO risks over-estimating how much large-scale generation and new transmission will be necessary.*

The small stuff adds up – distributed energy resources (DER) in homes and businesses will likely be the largest component of generation capacity, storage and flexible load in the NEM by 2050, according to AEMO in its draft 2024 ISP. The electricity system is being flipped on its head, with what happens behind the meter becoming crucial to the costs of the system for all consumers into the future.

However, IEEFA's analysis suggests that AEMO's forecasts of rooftop solar and electric vehicle (EV) vehicle-to-grid (V2G) in the draft 2024 ISP are conservative in several respects. Therefore, DER could play an even greater role in the system than AEMO is currently estimating in its Step Change (central) scenario.

In addition, other types of DER are not examined with enough clarity and transparency in the draft 2024 ISP. Flexible demand opportunities are not specified sufficiently clearly to inform energy policy and planning. IEEFA recommends AEMO examine flexible demand opportunities in more detail in the short term, and co-optimise between demand and supply in the 2026 ISP. We concur with the findings of the Energy and Climate Change Ministerial Council (ECMC)'s review of the ISP, which recommended: "AEMO should … develop an appropriate approach to optimising investment across both the supply- and demand-side over the longer term."

IEEFA also recommends that AEMO include a high DER sensitivity in the current 2024 ISP, and a higher uptake DER scenario or scenarios in the next 2026 ISP. To underestimate DER's role in energy planning is to make the transition slower, more expensive and less democratic. With a greater range of DER scenarios, there is the opportunity for a more informed public policy discussion about the relative role of DER compared with large-scale generation and storage.

Recommendations

Rooftop solar:

- IEEFA recommends that AEMO use the more up-to-date 2023 Green Energy Markets (GEM) forecasts for the final 2024 ISP modelling to get to a more accurate rooftop solar photovoltaic (PV) forecast.
- IEEFA suggests that AEMO re-examine its rooftop PV forecasts in light of the technical potential estimated by the University of New South Wales (UNSW), the Institute for Sustainable Futures (ISF) and the Australian PV Institute (APVI) and the increase in PV panel power density.
- IEEFA suggests that ARENA's target solar PV capital cost trajectory should be used in a sensitivity for the 2024 ISP, and that the 2026 ISP develop a broader range of solar PV capital cost scenarios.

Electric vehicles (EVs):

- IEEFA recommends that AEMO explore faster and higher EV V2G uptake scenarios in the ISP.

Flexible demand:

- IEEFA recommends that AEMO considers forecasting and separately reporting on the following categories of DER flexible demand in its demand forecasts:
    - Household and business electrification resulting in flexible demand – for example, hot water systems or industrial heat pumps.
    - Household and business flexible demand through new and replacement appliances – for example, air conditioning.
    - Household and businesses participating in flexible demand via retailer programs (such as Origin Spike).
    - Changes to hot water load control – as seen for example, in South Australia.
- It would be helpful to have greater transparency around the Demand Side Participation (DSP) forecasts and explanation of how they were arrived at included in the ISP or its appendices.
- IEEFA supports all the ECMC's recommendations regarding transparency and improvements in the demand-side forecasts, and suggests that where possible, AEMO should make these changes in the 2024 ISP, without waiting for the 2026 ISP.
- IEEFA recommends that co-optimisation between the demand side and supply side be undertaken in the 2026 ISP, and that sensitivity analyses be undertaken in the 2024 ISP testing variations in the demand side and its impacts on the supply side.

Overall:

- IEEFA recommends that AEMO include a higher DER scenario in the 2026 ISP, and a high DER sensitivity in the 2024 ISP.

Rooftop solar

In its draft 2024 ISP, AEMO forecasts that on average 2 gigawatts (GW) of rooftop PV will be installed each year until 2050, and capacity in 2049-2050 will be 71.5GW. However, these forecasts may be conservative due to the trends of increasing solar photovoltaic (PV) system size and falling capital costs, which do not appear to be fully accounted for in AEMO's forecast

Moreover, UNSW, ISF and APVI studies have shown there is much higher technical potential for rooftop PV than contemplated within AEMO's set of forecast scenarios. These factors point to the need for the ISP to include a sensitivity or scenario with higher rooftop PV uptake.

This section discusses each of these observations in turn.

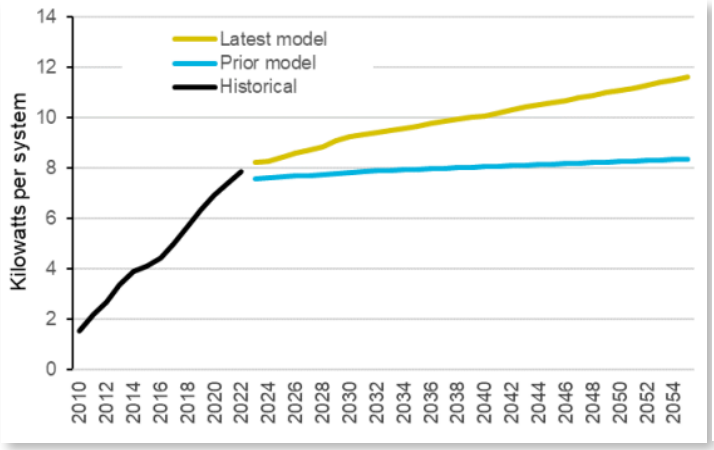
Rooftop PV system size growth is conservative

AEMO's rooftop PV forecasts are informed by projections from Green Energy Markets (GEM) and CSIRO. GEM recently released updated projections that accounted for the trend of growing rooftop PV system size. In the updated projections, rooftop PV system size grows from 8kW currently to around 12kW by 2054 (Figure 1), while the prior projections remained stable around the 8kW mark from 2028 onwards. The draft 2024 ISP uses the outdated GEM projections, which do not include this correction for higher anticipated solar PV system size.

CSIRO's 2022 projections for AEMO, which also helped form the draft 2024 ISP distributed solar forecast, have significantly lower solar PV system size than GEM's new projections – with system size remaining stable from around 9kW from 2028 onwards (see Figure 2).

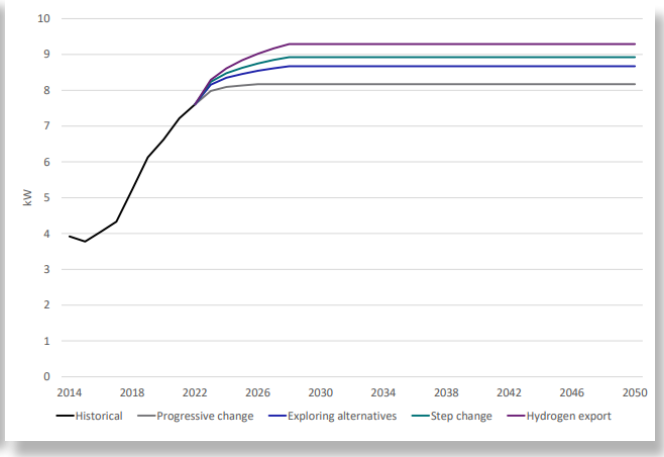
Figure 1: Size of new residential solar PV systems (historical and forecast)

Green Energy Markets



Source: Green Energy Markets

CSIRO



Source: CSIRO

IEEFA recommends that AEMO use the more up-to-date 2023 GEM forecasts for the final 2024 ISP modelling to get to a more accurate rooftop PV forecast.

Faster rooftop PV capital cost reductions should be explored

AEMO's PV forecasts rely on a narrow range of capital cost projections. GEM estimates the current residential solar PV capital cost at around $1.5 per watt (this *excludes* discounts from government support measures such as small-scale technology certificates (STCs), and *includes* GST). Under the Green Energy Exports scenario, which has the most ambitious solar PV cost

reductions, GEM projections put residential rooftop PV capital cost at 80 cents per watt in 2030, while the charts provided in CSIRO's projections suggest a cost of about 75 cents per watt.

However, the Australian Renewable Energy Agency (ARENA) is aiming for utility-scale solar to be 30 cents per watt by 2030, 75% lower than the current cost of about $1.20 per watt. ARENA stated: "To achieve [the vision of 30 cents per watt], we are targeting an LCOE [levelised cost of energy] of <$20/MWh with a primary focus on utility-scale solar." Meanwhile, UNSW solar pioneer Professor Martin Green estimates that solar PV could even reach an LCOE of $15/MWh by 2030.

If 30 cents per watt for utility-scale solar is achieved, and the residential market follows the same trajectory, residential solar PV systems could cost 37.5 cents per watt 37.5 cents per watt, based on our calculations. While ARENA's vision could be considered ambitious, these numbers suggest the possibility that capital costs could come down further than anticipated by AEMO and its modellers.

Given that solar has come down the cost curve by 90% in the last 10 years without plateauing, new technological breakthroughs continue to be made, and solar efficiency records continue to be set, the modelling that feeds the ISP should explore faster cost reduction trajectories.

IEEFA suggests that ARENA's target solar PV capital cost trajectory should be used in a sensitivity for the 2024 ISP, and that the 2026 ISP develop a broader range of solar PV capital cost scenarios.

Rooftop PV has significant technical potential

The draft 2024 ISP forecasts rooftop PV capacity in 2049-2050 to be 71.5GW in Step Change scenario and 76.3GW in Green Energy Exports.

However, a 2019 report by UNSW, ISF and APVI estimated the technical potential of rooftop PV across Australia to be much larger at 179GW and 245 terawatt-hours (TWh). Produced for the Clean Energy Finance Corporation and the Property Council of Australia, the report found that half of this technical potential was found in residential rooftop PV (96GW). The second largest potential (34GW) was in primary or rural production zones, followed by commercial and industrial zones (28GW).

However, in the four years since that report was written, the power density of rooftop PV has increased by 45% (based on a comparison between the panels assessed in the 2019 report and PV Magazine's best-performing rooftop panels as of October 2023). Assuming a straight-line conversion and not allowing for expected future improvements in the efficiency of panels, this implies an updated rooftop PV technical potential for Australia of 259GW and 354TWh.

AEMO's draft 2024 inputs, assumptions and scenario workbook finds the 2023-24 capacity of rooftop PV in the NEM in the Step Change scenario to be around 20GW. This would suggest that Australia has perhaps fulfilled around 8% of its rooftop PV technical potential, despite around one third of households already having rooftop PV.

It also suggests there is significant growth potential for commercial and industrial rooftop PV, and rooftop PV in rural / primary production zones. Only 8% of commercial businesses in Australia currently have rooftop PV, though there have been notable recent developments in commercial and industrial installations, for example, both Woolworths and Bunnings have committed to multiple rooftop PV installations. Woolworths Group has installed 231 solar systems across Australia and New Zealand, totalling 48MW, with at least a further 16MW under construction.

New embedded network solar start-up SunPlan says in its second phase it plans to install 200MW of solar across 600 hectares of commercial rooftops over two years, though it will need to succeed in its first phase first.

While a lot of industrial rooftop space does not have large demand during daylight hours, it is likely that as businesses and vehicles electrify and battery storage costs fall further, there will be greater use of large rooftops for solar installation.

IEEFA suggests that AEMO re-examine its rooftop PV forecasts in light of the technical potential estimated by UNSW, ISF and APVI and the increase in PV panel power density.

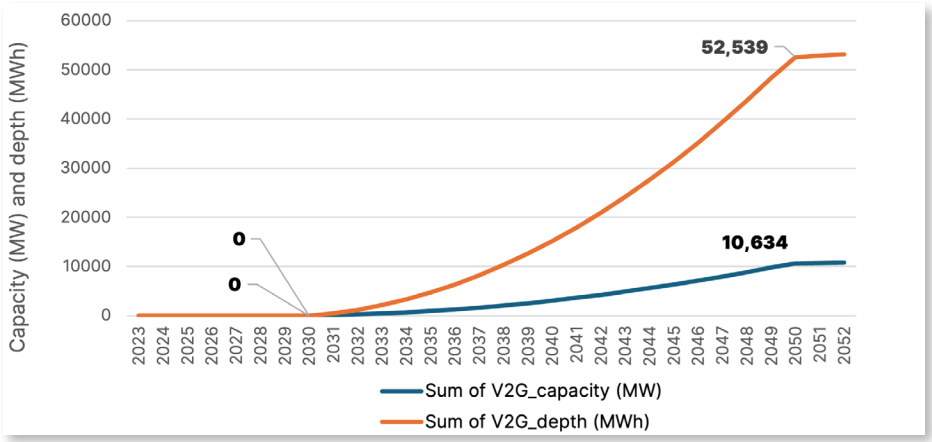
Electric vehicles

Vehicle-to-grid capacity is likely underestimated

AEMO is likely underestimating the potential of electric vehicles (EVs) to act as batteries on wheels that can supply the electricity grid. As IEEFA explored in our submission to AEMO on the draft ISP, AEMO's vehicle-to-grid (V2G) forecasts assume no V2G capacity before 2030 (per Figure 3).

The Electric Vehicle Council reports that, while sales of EVs are currently small, they are already accelerating due to international trends, the government's recent announcement of fuel efficiency standards, and the growing availability of lower-cost EVs. There are already a few vehicles in Australia using V2G already. In addition, the manufacturers of the top five most popular EVs sold in Australia intend to include bidirectional charging as standard in upcoming models, if they are not included already. It seems inevitable that V2G capacity will measurable before 2030.

Figure 2: AEMO's EV V2G capacity



Source: AEMO.

The second issue is that AEMO appears to have underestimated the longer-term future capacity of V2G. AEMO's forecasts show 10.6GW / 52.5GWh in V2G capacity by FY2050, which can be called on by a retailer or aggregator to supply back to the grid, based on the 2022 CSIRO trajectories developed for AEMO.

Energy consultancy enX has modelled the EV fleet usable battery capacity to 2050 based on CSIRO's EV uptake forecast and found 2,340GWh of available EV storage depth by 2050. AEMO's estimated V2G depth of 52.5GWh in FY50 therefore represents only 2% of the available EV storage depth that enX has forecast. While not all vehicles will be used for V2G, it would

seem likely that a greater proportion of the storage available in EVs would be used by the electricity system to make the most of this valuable asset.

IEEFA has estimated that V2X (the collective term for vehicle-to-grid, vehicle-to-load and vehicle-to-home) could unlock consumer revenues of $1,000/year or even above, if the right regulatory and market settings were put in place, making V2X highly appealing for EV owners.

International examples have shown that EVs have the ability to compete with large-scale gas power generation to provide grid firming services, even at early stages of the uptake curve. AEMO's use of conservative V2G forecasts risks the over-build of large-scale generation and storage, which could increase the cost of the transition.

IEEFA recommends that AEMO explore faster and higher V2G uptake scenarios in the ISP.

Flexible demand

Limited transparency and focus around flexible demand

Flexible demand is covered in three different parts of AEMO's modelling. Appliance demand flexibility (such as hot water load control or time-of-use tariffs) is taken into account in demand forecasts, while dynamic flexible storage (Virtual Power Plants (VPPs) and V2G) and scheduled loads (pumped storage) are included in supply forecasts.

Figure 3. AEMO's definition of demand flexibility

Demand Flexibility in demand forecasts	Demand Flexibility in DSP forecasts	Demand Flexibility in supply forecasts
Hot water load control	Market exposed customers	VPP energy storage
Type of use tariffs	ONSG - peaking	EV vehicle-to-grid (V2G)
Passive CER storage	Aggregated dynamic customer response	Scheduled loads (pumped storage)
EV charging (non V2G)	Wholesale demand response	
ONSG - non peaking	Network reliability programs	

Source: AEMO. Note: ONSG = other non-scheduled generation.

AEMO assumes a level of residential electrification uptake in the ISP scenarios based on Multi-Sector Modelling outputs from CSIRO and Climateworks Centre. However, it is unclear if or how these forecasts are used to project increased demand flexibility.

Research by University of Technology Sydney (UTS) modelled four scenarios for the electrification of domestic hot water systems in Australia:

Table 1: Potential flexible demand capacity and depth in 2040 for all four scenarios

Scenario	Flexible Demand Potential	Percentage of AEMO forecast	Flexible demand depth	Percentage of AEMO forecast
	(GW)	(%)	(GWh/day)	(%)
Business as usual	9	25	19	23
Highly Flexible	24	70	50	61
Highly Efficient	17	48	34	41
Rapid Electrification	22	64	45	55

Source: UTS.

Under UTS's rapid electrification scenario, if there were no sales of gas-fuelled residential hot water systems after 2025, and all hot water systems are electrified and controllable by 2035, this would make 22GW/45GWh of flexible demand available per day, roughly two-thirds of peak demand.

The scale of flexible demand that can be unlocked by domestic hot water is extraordinary. As the UTS report's authors highlight, this could displace the need for utility battery storage and could play a significant role in managing minimum demand challenges. There are a number of other flexible demand opportunities that should also ideally be reported on in the ISP, such as air conditioning and industrial heat pumps. AEMO needs to make clear what assumptions it is making about demand flexibility to allow for consultation on this trajectory, as it also should with other components of the forecast.

Given that the ISP explicitly forecasts DER flexible demand in supply forecasts (VPPs and V2G) and Demand Side Participation (DSP), **IEEFA recommends that AEMO considers forecasting and separately reporting on the below categories of DER flexible demand in its demand forecasts:**

- Household and business electrification resulting in flexible demand – for example, hot water systems, industrial heat pumps.
- Household and business flexible demand through new and replacement appliances – for example, air conditioning.
- Household and businesses participating in flexible demand retail programs - such as Origin Spike.
- Changes to hot water load control – as seen for example, in South Australia.

In the draft 2024 ISP, 'Demand Side Participation' is limited to responses to peak demand events, the wholesale demand response mechanism and the NSW peak demand reduction scheme. AEMO's forecasts for DSP are by summer and winter, by state region, by wholesale price band, by 'Reliability Response', and by reliability response as a percentage of peak demand – the last of which is set out in Table 2.

Table 2: AEMO Demand Side Participation ISP forecasts (MW)

Reliability response as % of peak demand	2022-23	2029-30	2049-50
NSW – Summer	2.44	5.45	7.29
NSW – Winter	2.61	2.99	4.25
QLD – Summer	2.52	2.92	4.25
QLD – Winter	2.21	2.68	4.25
SA – Summer	1.46	2.11	4.25
SA – Winter	1.82	2.38	4.25
Vic – Summer	2.53	2.92	4.25
Vic – Winter	2.63	3.00	4.25
Tas – Summer	0.41	2.38	4.25
Tas – Winter	0.33	1.30	4.25

Source: AEMO.

It is not clear what the basis is for the 4.25% reliability response in 2049-50 in all states in all seasons other than in NSW in summer. More clarity in this regard would be helpful.

It would be helpful to have greater transparency around the DSP forecasts and explanation of how they were arrived at included in the ISP reporting or appendices.

IEEFA notes that the ECMC has stated that there was scope for AEMO to improve the demand forecasts and transparency in the ISP. **IEEFA supports all the ECMC's recommendations in this regard, and suggests that where possible, AEMO should make these changes in the 2024 ISP, without waiting for the 2026 ISP.** In particular, AEMO could implement the following recommendations from the ECMC before the completion of the 2024 ISP:

- "Analysing how electrification and CER [consumer energy resources] / distributed resources development sensitivities affect operational demand projections and consider these directly in the ISP modelling where relevant."
- "In the interests of transparency, AEMO should provide more clarity on if and how uncertain or unfunded policies are considered in the 2026 ISP to enhance stakeholder understanding and engagement."

Additionally, AEMO should include a statement in the 2024 ISP similar to the one suggested by the ECMC for the 2026 ISP:

- "Including a statement in the 2026 ISP, and subsequent ISPs, aimed at informing the market and policy makers about the expected development of CER and distributed resources. The statement should be sufficiently detailed to provide a baseline for the identification of opportunities to promote the uptake of CER and distributed resources within each jurisdiction."

Lack of co-optimisation between the demand side and supply side

At the moment demand-side measures and DER are treated as an input to the ISP process, and supply-side measures are designed to fit the demand side. However, in the longer term the ISP would ideally co-optimise between the demand side and supply side.

We concur with the findings of the ECMC review of the ISP, which recommended: "AEMO should … develop an appropriate approach to optimising investment across both the supply and demand side over the longer term." The ECMC stated: "The System Planning Working Group and AEMO will work with the relevant stakeholders, including DNSPs [distribution network service providers], to develop a suitable approach to trade off the cost of unlocking increasing tranches of orchestrated CER and distributed resources against other investment options for use in the earliest ISP practicable."

It would be ideal to start the co-optimisation between demand-side and supply-side measures as early as possible. As IEEFA wrote in our submission to the draft 2024 ISP process: "If it is not possible to do this for the 2024 ISP, then iterations in modelling could be performed to optimise between supply and demand, and various scenarios or sensitivity analyses could be undertaken."

IEEFA recommends that co-optimisation between the demand side and supply side be undertaken in the 2026 ISP, and that sensitivity analyses be undertaken in the 2024 ISP testing variations in the demand side and its impacts on the supply side.

AEMO should develop a high DER scenario and sensitivity in the ISP

While each scenario in the ISP does include different levels of DER uptake, it is difficult to isolate the impact of DER from the various other inputs across each scenario. There would be value in developing a high DER scenario or scenarios in the 2026 ISP and a high DER sensitivity in the 2024 ISP and comparing these to the other scenarios or sensitivities. This would act as an upside equivalent to the hydrogen export scenario for the large scale.

With a greater range of information on DER, there is the opportunity to have the public policy discussion about the value (or not) of higher DER uptake and what would be needed for that to be made reality. Recent IEEFA research drew on modelling from NERA, Energy Synapse and Baringa to show that DER could deliver at least $19 billion in NPV economic benefits by 2040. The ISP could provide a helpful indication of the system cost and benefits from higher DER penetration.

IEEFA recommends that AEMO include a higher DER scenario in the 2026 ISP, and a high DER sensitivity in the 2024 ISP.

Conclusion

Both small-scale and large-scale generation and storage will be needed for Australia to reach 82% renewables by 2030. Small-scale DER have the advantages that:

- They are fast to roll out as, in most cases, land acquisition and planning permission is not required.
- Network upgrades are not generally required.
- There is a large workforce, with more than 10,000 people currently engaged in the rooftop PV and storage industries.
- In general, there are no social licence issues – indeed electrification provides significant health benefits by removing fossil gas pollution from homes and workplaces.
- The capital cost is largely paid for by households and businesses.

To underestimate the role of DER in energy planning is therefore to make the transition slower, more expensive and less democratic.

This report shows that AEMO's forecasts of rooftop PV and V2G appear conservative, and that the draft 2024 ISP lacks sufficient focus on or transparency around flexible demand, including through electrification, especially given the importance of flexible demand in a variable renewable energy system. IEEFA recommends that AEMO explore the demand side in significantly more detail.

IEEFA also recommends that AEMO include at least one stronger DER scenario in the 2026 ISP and a stronger DER sensitivity in the 2024 ISP, modelling higher DER levels than those in the step change scenario. With a greater range of DER scenarios, there would be the opportunity to have the much-needed public policy discussion about the value (or not) of higher DER uptake, and what would be necessary for that to be made reality. In addition, it would allow for a clearer analysis of the trade-offs between small-scale resources and large-scale generation and transmission build.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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