

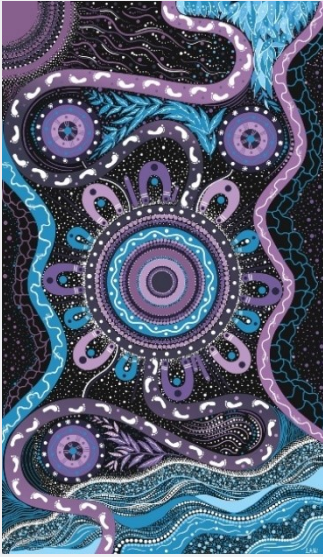
2024 Forecasting Assumptions Update

Consultation Summary Report

August 2024

For use in the 2024 National Electricity Market
Reliability Forecast





We acknowledge the Traditional Custodians of the land, seas and waters across Australia. We honour the wisdom of Aboriginal and Torres Strait Islander Elders past and present and embrace future generations.

We acknowledge that, wherever we work, we do so on Aboriginal and Torres Strait Islander lands. We pay respect to the world's oldest continuing culture and First Nations peoples' deep and continuing connection to Country; and hope that our work can benefit both people and Country.

'Journey of unity: AEMO's Reconciliation Path' by Lani Balzan

AEMO Group is proud to have launched its first [Reconciliation Action Plan](#) in May 2024. 'Journey of unity: AEMO's Reconciliation Path' was created by Wiradjuri artist Lani Balzan to visually narrate our ongoing journey towards reconciliation - a collaborative endeavour that honours First Nations cultures, fosters mutual understanding, and paves the way for a brighter, more inclusive future.

Important notice

Purpose

AEMO publishes this Consultation Summary Report for the Draft 2024 *Forecasting Assumptions Update* in accordance with the Australian Energy Regulator's Forecasting Best Practice Guidelines. This report summarises and responds to material issues raised in submissions on updated assumptions to apply for the forecasts within the 2024 *Electricity Statement of Opportunities* (for example, the Reliability Forecast and indicative reliability forecast), or other publications, as named in this report, for the National Electricity Market (NEM). This publication is generally based on information available to AEMO as at 12 June 2024 unless otherwise indicated.

Disclaimer

AEMO has made reasonable efforts to ensure the quality of the information in this publication but cannot guarantee that information, forecasts and assumptions are accurate, complete or appropriate for your circumstances.

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Contents

1	Introduction	4
1.1	Consultation opportunities on updated inputs and assumptions	5
2	Stakeholder feedback to the Draft 2024 <i>Forecasting Assumptions Update</i>	6
2.1	Stakeholder submissions	6
2.2	AEMO response to stakeholder feedback	7
3	FRG consultations	15
3.1	Economic forecasts	15
3.2	Demand side component forecasts	15
3.3	Demand side participation (DSP) forecasts	17
3.4	Unplanned outage rate forecasts	18
	Abbreviations	21

Tables

Table 1	Stakeholder consultation opportunities on updated inputs and assumptions	5
Table 2	Stakeholders who provided submissions to the Draft 2024 <i>Forecasting Assumptions Update</i>	6
Table 3	Summary of stakeholder submissions, by topic	6

1 Introduction

AEMO delivers a range of forecasting and planning publications for the National Electricity Market (NEM), including the NEM *Electricity Statement of Opportunities* (ESOO), East Coast Gas Market *Gas Statement of Opportunities* (GSOO), and *Integrated System Plan* (ISP). AEMO uses a common set of inputs, assumptions and scenarios in developing these publications.

Every year, AEMO works with stakeholders to update the inputs and assumptions that will be used in AEMO's major planning and forecasting publications for the year ahead. AEMO consulted¹ on the Draft 2024 *Forecasting Assumptions Update* in accordance with the Australian Energy Regulator's (AER's) Forecasting Best Practice Guidelines, with the report released in December 2023 for consultation over a period of eight weeks until February 2024.

In addition to the Draft 2024 *Forecasting Assumptions Update*, AEMO consulted on several additional draft updates to subsequent inputs and assumptions through the use of the Forecasting Reference Group (FRG) (FRG consultation), which provided interested stakeholders with an opportunity to engage with AEMO and its expert consultants to understand the draft updates, ahead of a two-week period to receive written submissions by stakeholders².

The Draft 2024 *Forecasting Assumptions Update* complements the 2023 *Inputs, Assumptions and Scenarios Report* (IASR). The Draft 2024 *Forecasting Assumptions Update* provides updated assumptions to apply for the forecasts in the 2024 ESOO (for example, the reliability forecast and indicative reliability forecast), and other publications, as named in this report, for the NEM.

This document summarises the material issues raised by stakeholders in the consultation opportunities outlined above, and AEMO's response to the stakeholder feedback.

The document is divided into the following sections to group key areas of stakeholder feedback and summarise AEMO's response and decisions in relation to that feedback:

- Section 2 – Summary of material issues in submissions on the consumer energy resources (CER) forecasts included in the Draft 2024 *Forecasting Assumptions Update*, and AEMO's responses to this feedback.
- Section 3 – Summary of material issues in submissions on draft forecasts provided for FRG Consultation, and AEMO's responses to this feedback, including:
 - Economic forecasts.
 - Demand side component forecasts.
 - Demand side participation (DSP) forecasts.
 - Unplanned outage rate forecasts.

There is a glossary of terms and abbreviations in the Abbreviations section.

¹ AEMO published the Draft 2024 *Forecasting Assumptions Update* on 20 December 2023 with submissions due 9 February 2024: <https://aemo.com.au/en/consultations/current-and-closed-consultations/2024-forecasting-assumptions-update-consultation>.

² As set out in AEMO's *Reliability Forecast Guidelines*, at https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2021/reliability-forecast-guidelines.pdf.

1.1 Consultation opportunities on updated inputs and assumptions

Consultation with consumers, market participants and all other stakeholders is a foundational element in AEMO's forecasting and planning activities.

The Forecasting Best Practice Guidelines (Section 2.2) require AEMO to follow the single stage consultation process in Appendix B of the Guidelines when developing the inputs and assumptions underpinning a reliability forecast to include in the IASR. The Draft 2024 *Forecasting Assumptions Update* proposed to update several 2023 IASR inputs and assumptions relevant to reliability forecasts in the 2024 ESOO, and identified additional inputs and assumptions that were considered in need of being updated ahead of adoption in the ESOO.

Table 1 below lists the topics included in this consultation summary report, with the means and timing of consultation for each topic.

Table 1 Stakeholder consultation opportunities on updated inputs and assumptions

Topic for consultation	Consultation mechanism	Consultation open	Consultation close
Consumer energy resources (CER)	Draft 2024 <i>Forecasting Assumptions Update</i>	20 December 2023	9 February 2024
Existing generation and transmission technical parameters	Draft 2024 <i>Forecasting Assumptions Update</i>	20 December 2023	9 February 2024
Draft 2024-25 GenCost feedback	Draft 2024 <i>Forecasting Assumptions Update</i>	20 December 2023	9 February 2024
Economics and population forecasts	FRG consultation	28 February 2024	13 March 2024
Updated demand side component forecasts: <ul style="list-style-type: none"> • Large industrial loads (LILs) • Electrification (non-electric vehicle (EV)) • Electricity price indices • Demand side participation • Energy efficiency • Appliance uptake Households and connections	FRG consultation	29 May 2024	12 June 2024
Unplanned outages affecting inter-regional power transfers	FRG consultation	12 June 2024	26 June 2024
Scheduled generator unplanned outage rates	FRG consultation	12 June 2024	26 June 2024

2 Stakeholder feedback to the Draft 2024 Forecasting Assumptions Update

2.1 Stakeholder submissions

In response to the Draft 2024 *Forecasting Assumptions Update* consultation, AEMO received four written submissions, and three verbal submissions from consumer advocates. Stakeholders who provided submissions are listed in Table 2.

Table 2 Stakeholders who provided submissions to the Draft 2024 Forecasting Assumptions Update

Written submissions	Verbal submissions
Electrical Vehicle Council (EVC)	Queensland Electricity Users Network (QEUN)
Griffith University (GU)	Etrog Consulting (EC)
Energy Users Association of Australia (EUAA)	Energy Flex (EF)
Energy Queensland (EQ)	

AEMO thanks all stakeholders who provided submissions to the Draft 2024 *Forecasting Assumptions Update* consultation.

Table 3 below summarises the material issues on which stakeholders provided feedback regarding the CER forecasts provided in the Draft 2024 *Forecasting Assumptions Update*.

Table 3 Summary of stakeholder submissions, by topic

Issue	Description
Photovoltaics (PV)	Distributed PV forecasts did not appropriately consider the distribution network hosting capacity.
Embedded energy storage	A greater diversity of battery technologies should be considered, and cost projection trends reflecting utility-scale future estimates are inappropriate for residential scale installations.
Virtual power plants (VPPs)	Forecasts for adoption of VPPs need to recognise that consumers are unlikely to embrace an arrangement that relinquishes asset control to third parties.
EVs	Forecast EV uptake was considered too fast, while forecast plug-in hybrid electric vehicle (PHEV) uptake was considered too low. Stakeholders demonstrated the uncertainty regarding vehicle-to-grid (V2G) uptake with mixed views submitted.

In addition to submissions to the CER forecasts, AEMO also received feedback on the Draft 2023-24 GenCost report. The GenCost report is an important complement to AEMO’s IASR and *Forecasting Assumptions Update*, providing current cost and technical information for various generation technologies, and forecast cost change expected for Australian generation developments, considering insights from domestic and international developments for each technology.

The following provides a high-level summary of key themes submitted by stakeholders:

- Data sources used in the levelised cost of electricity (LCOE) calculations.
- Global inflationary impacts and continuing cost reductions with these pressures.
- Workforce modelling.

- Capital cost projections and their disaggregated drivers.
- Nuclear technologies, including learning rates and development times.
- Technology subsidies and their impact on forecast technology costs.

The 2023-24 GenCost report was published on 22 May 2024, with consideration of the feedback provided on the draft report. The final report included an outline of feedback received and responses to those submissions³.

2.2 AEMO response to stakeholder feedback

CER predominantly means consumer-owned devices that can generate or store electricity as individual units and which may have the 'smarts' to actively manage energy import and export. It can also refer to consumer-shared devices, such as community batteries and other resources, that enable greater demand flexibility.

CER are addressed below in distributed photovoltaic (PV) systems, embedded energy storage, virtual power plants (VPPs), and electric vehicles (EVs).

2.2.1 Distributed PV systems

Summary of material issues raised in submissions

The growth rate and influence of distributed PV systems was a noted theme among stakeholders who submitted to the *Draft Forecasting Assumptions Update* consultation. Stakeholders generally considered that AEMO should more explicitly consider the limitations of the distribution system when forecasting the uptake of CER, particularly PV.

The **EUAA** noted there was a lack of detail regarding consideration of the distribution networks that will host most of the distributed PV including rooftop solar and PV non-scheduled generation (PVNSG). Without investment in the distribution networks, EUAA considered that the networks' hosting capabilities will limit distributed PV installation, reducing the economic viability of systems. The EUAA also questioned whether natural limits in either number of rooftops available were appropriately considered.

EC commented that CER should be forecast from a consumer focus point of view, noting that further analysis of consumer behaviours should be considered when forecasting CER uptake.

AEMO's consideration and assessment

AEMO acknowledges that it is difficult to incorporate the spatial granularity required to address the points raised by stakeholders. There is currently insufficient data available to AEMO to quantify the distribution investment required beyond current distribution network service provider (DNSP) investment strategies; AEMO considers adjustment to the uptake to reflect investment limitations is premature, particularly given that DNSP forecasts are not inconsistent with AEMO's projections.

³ At <https://aemo.com.au/consultations/current-and-closed-consultations/2024-forecasting-assumptions-update-consultation> published on the 22 May 2024.

AEMO will continue to engage with DNSPs to explore PV hosting capacity and related topics. While this will not be sufficiently advanced to influence the 2024 ESOO, it may impact AEMO's forecasting approach for future planning publications such as the ISP and future ESOOs. AEMO will keep stakeholders abreast of developments throughout the 2025 IASR and 2026 ISP, as data becomes available.

Regarding upper limits on PV uptake, AEMO acknowledges that not all households will have roof space sufficient for a 10 kilowatt (kW) PV system, but notes that the 10 kW figure is an average, and accommodates a wide range of PV system sizes. AEMO currently considers that system sizes will trend larger to match household load growth, and considering other investments in CER (EVs and household batteries).

Regarding behavioural considerations, AEMO recognises this is important in forecasting CER, and forecasts CER uptake given the relative payback that consumers may receive if investing in CER. This approach considers consumer investment behaviours given investment costs, costs that can be avoided given the investments, and the underlying cost of non-investment, considering current and potential electricity tariff changes. The approach also includes a behavioural response from PV-owning residential customers relative to non-PV customers when considering electricity consumption and EV charging profiles. AEMO will consider, in future forecasts, how PV, battery and EV uptake forecasts interact to reflect consumer behaviour.

2.2.2 Embedded energy storage

Embedded energy storage refers to behind-the-meter energy storage installations, such as home batteries.

Summary of material issues raised in submissions

Common submission themes related to the comparison between residential and utility-scale batteries and their respective cost decline over time and various battery technology types.

GU noted AEMO's residential battery projections assume that the cost premium over utility-scale battery energy storage systems (BESS) declines from roughly 100% currently to 17% in 2032, consistent with the premium for distributed solar PV over utility-scale. They disagreed with the projections and suggested GEM should better justify its viewpoint, including detailed capital expenditure (capex) projection breakdown into major components and installation cost.

QEUN suggested AEMO should investigate other battery technologies such as sodium batteries due to high fire risk in lithium batteries, for both home batteries and EVs.

AEMO's consideration and assessment

Regarding battery cost assumptions, residential battery system costs can be divided into battery and non-battery ("soft") costs. GEM noted that recent independent analysis by National Renewable Energy Laboratory (NREL) supported its expectation that battery costs (actual device costs) are likely to fall more quickly than soft costs (installation and other labour costs). GEM found that soft costs in the United States are approximately five times higher than those in Australia, when both figures are expressed in the same currency, while other sources support this view when it comes to solar⁴. Thus, as battery costs reduce, GEM considered that Australia would be expected to enjoy a greater percentage reduction in

⁴ See interview with Saul Griffith, "Why Solar is Cheaper in Australia than America", at <https://www.youtube.com/watch?v=3Sfxxx9m5U>.

overall battery system costs than the United States. AEMO has considered the feedback of stakeholders and reflected that GEM's findings are reasonable. The forecasts therefore maintain the battery cost forecast assumptions that were presented in the consultation.

In relation to different battery technologies, AEMO recognises the existence of a number of alternative technologies, but considers each of these alternatives present uncertainty with regards to the timing of their residential and commercial system adoption, compared with existing battery technologies that are more mature. AEMO's uptake forecasts are based on GenCost cost projections, which consider technological development and receive stakeholder feedback, as well as CER consultant insights.

2.2.3 Virtual power plants (VPPs) and demand flexibility

VPP broadly refers to the involvement of an aggregator to coordinate CER via software and communications technology, to deliver energy services similar to large-scale inverter-based generation and storage developments. This contrasts with household battery installations configured to offset household energy costs by reducing the volume of grid-supplied energy and increase self-consumption of complementary PV generation.

Summary of material issues raised in submissions

Common themes from stakeholders included flexible demand potential and VPP adoption.

EF commented, in relation to flexible demand, that in the updated assumptions most costs come from the assumption of reliability, that consumers want to keep their lights on all the time, although up to 30% of demand can become load-following. It was suggested that AEMO could explore possible outcomes, including making a large percentage of load price-sensitive, while monitoring consumer behaviour.

QEUN commented that flexible demand is very low in Queensland, with many households shifting to flat tariffs, while those on load control tariffs have batteries that are unavailable to the grid, while **EF** mentioned that consumers will not invest in CER if control is taken away from them.

AEMO's consideration and assessment

Regarding load flexibility, AEMO agrees with the comments, and notes that recognition of load flexibility occurs within AEMO's DSP forecast. AEMO currently includes DSP of approximately 700 megawatts (MW) across the NEM at prices above \$7,500/megawatt hour (MWh). Examples are consumers that agree to let their load/battery be controlled by a third party or are incentivised to switch off loads such as air-conditioners and small non-scheduled generators that have the ability to produce electricity at these times, offsetting local consumption. AEMO agrees with the stakeholder sentiment that demand flexibility could provide reliability improvements, and consistently seeks to gather the best datasets available to reflect both current and potential DSP. AEMO's long-term DSP assumption provides approximately 8.5% of DSP; this is distinct from embedded battery and EV uptake that would respond to price signals (particularly if appropriately coordinated) and assumes that total DSP and embedded resources may rise to almost 25% of maximum demand by 2040.

AEMO's forecasting and planning publications recognise the high value that is provided from CER, particularly if that CER is coordinated. AEMO's VPP forecasts recognise that not all consumers will be comfortable with sharing control of their CER, depending on their perspective, altruism and response to incentives. AEMO considers the potential financial benefits to

consumers of VPP solutions that may entice consumers to commit to VPP developments despite a lower level of control. The level of coordination is also varied between AEMO's scenarios, including sensitivity analysis where appropriate (for example, as considered in the 2024 ISP). GEM's report acknowledges that *'While there remains significant uncertainty, the [VPP] offers currently available are sufficiently attractive to some consumers that it would be sensible to take them into account'*. AEMO considers the VPP forecast to appropriately consider the breadth of consumer views towards VPP.

AEMO considers the forecast of demand flexibility from DSP and VPPs reasonably reflects the stakeholder feedback, and agrees that more demand response and CER coordination will improve the reliability of the power system in appropriate circumstances.

2.2.4 Electric vehicles (EVs)

In the Draft 2024 Forecasting Assumptions Update, EVs is a collective term for battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

Summary of material issues raised in submissions

Stakeholders' EV-related submissions covered multiple topics, including the EV sales forecast being too ambitious, and PHEV forecast being too low, while others related to EV charging profiles and vehicle-to-home (V2H) and vehicle-to-grid (V2G) parameters. The topics and responses are covered separately in the below sub-sections.

Regarding EV sales

Summary of material issues raised in submissions

EVC did not see a credible pathway to 3.9 million EVs in the NEM by 2030-31 and considered a more realistic figure to be around 1.35 million, while an upper scenario (driven by a more effective New Vehicle Efficiency Standard (NVES)) would lead to approximately 2.5 million. In addition, **EUAA** suggested AEMO use sales and registration data from state and territories (as done by EVC), rather than VFACTS (Federal Chamber of Automotive Industries).

AEMO's consideration and assessment

AEMO has considered the stakeholder feedback and amended the forecasts to include:

- The latest (Bureau of Infrastructure and Transport Research Economics (BITRE) data which underpins the assumed total vehicle sales, which in turn impacts the EV uptake.
- More differentiation between vehicle types when considering policy targets, including the Fuel Efficiency Standard (FES). The revised forecasts also accommodate recent PHEV sales data and as a result reflect greater sales of this vehicle category.

Regarding EV charging profiles

Summary of material issues raised in submissions

EVC considered AEMO's EV peak charging values as too high and recommended AEMO should explore multiple retailers offers targeting Time of Use (ToU) tariffs, which would reduce assumed peak demand contribution. **EUAA** agreed with AEMO's use of three charging profiles, but noted the Off-peak and Solar profile has Off-Peak charging occurring between

6.00 pm and 2.00 am, when, as identified in the text, off-peak tariffs usually start after 11.00 pm, which is when this type of sophisticated EV owner should commence charging.

AEMO's consideration and assessment

AEMO has reviewed both EV charging studies that EVC cited, and notes CSIRO's 2023 EV report indicates both were used in developing AEMO's charging profiles, but also noted difficulties in applying these to the forecasts. In particular, regarding the University of Queensland research:

- It recognised the value of EV research and cited 30 different EV studies/sources. It made clear that research gaps existed, and that trial settings can influence usage patterns and not reflect real-world behaviour.
- It was restricted to Tesla vehicles at inner-city locations, for half a year.
- It commented on grid charging during peak/non-peak time but did not provide data on what tariffs participants were on.

The Origin Energy trial:

- Found an average 400 watts (W) charging load during peak (without price incentive) fell to 167 W with a discounted overnight rate but noted that “engaged participants have self-selected”.
- Used a sample group of which 71% had solar panels. This is much higher than the approximate one-third of households with solar panels.

CSIRO also took into account the Queensland-based Ergon Network and Energex Network trial, which was longer and more diverse than the University of Queensland's; it assessed the behaviours of 167 participants over at least 15 months, with a range of vehicle types and locations, and included tariff-specific analysis. Finally, the report provides a large set of detailed charging profiles, making it very suitable for forecast development.

Regarding the off-peak charge profile featuring some charging during peak periods, AEMO notes that the charging profiles are aggregates of a high number of customers, and reflect ‘after-diversity’ profiles. This reflects that at times some customers may choose to charge their vehicle in other time periods despite an inherent preference to follow a predictable profile, while other customers may have less predictable charging patterns. The profiles also acknowledge that different network areas may have different ToU time period definitions.

AEMO considers the forecasts reasonably capture stakeholder concerns, and looks forward to increasing availability of relevant data to support EV profile development.

Regarding commercial EV unscheduled charging

Summary of material issues raised in submissions

EVC noted that the outlook for commercial EVs' unscheduled charging is too high, particularly for buses, trucks and commercial vehicles which will be highly scheduled due to the high capital cost of electrical infrastructure in their depots. In addition, buses and trucks will be in operation during network peak demand times and would not be expected to have high charging load during this time.

AEMO's consideration and assessment

AEMO thanks **EVC** for its input and agrees that truck and bus charging will be predominantly scheduled. The updated forecast now assumes the 'Off peak and Solar charging' charge category dominates (reflecting mainly overnight, with some middle-of day charging), with a longer term transition to favour ToU Dynamic charging.

Regarding vehicle-to-grid and vehicle-to-home uptake

Summary of material issues raised in submissions

EVC considered that the V2G forecasts are too low, considering that V2G and V2H compatible vehicles are already arriving in Australia in 2024, and therefore having no V2G penetration until the 2030s is unreasonable. EVC considered that even a small number of V2G vehicles would have a large impact, with each V2G vehicle able to offset the charging of up to 20 EVs.

EF and **QEUN** commented that V2G and V2H charging is forecast after 2030, but their uptake is stymied by policy, and if V2G capability is not properly considered, all the behind-the-meter EV uptake will not be helpful to the grid. In addition, **EQ** agreed EVs are not yet considered an alternative to home batteries due to the limited V2G options which are still evolving. However, longer term, as technologies mature and customers adopt innovative retail tariffs for bidirectional EVs, customers will utilise their EV battery to reduce usage from the grid, especially during high priced periods.

EQ encouraged AEMO forecasting assumptions to consider barriers to investment, such as initial cost and availability, for both V2G and home batteries, the credibility of them being overcome, and the potential of these technologies to influence future demand.

AEMO's consideration and assessment

AEMO notes the current rate of V2G and V2H is very low, effectively zero. AEMO agrees with stakeholder feedback sentiment that V2G and V2H will present highly valuable opportunities for demand flexibility, but AEMO acknowledges that there are a number of challenges that will need to be overcome (technical standards, warranty impacts, and the potential impact to a consumer's driving experience). As such, AEMO considers the current low penetration forecast increases in a reasonable timeframe as reflective of the time required for appropriate solutions to these challenges to support non-trivial V2G and V2H uptake.

Regarding **EQ's** feedback about V2G and home batteries, AEMO agrees with the need to consider barriers to investment, and notes that AEMO's forecasts consider the costs and timeframes of overcoming various barriers for these technologies. AEMO applies assumptions regarding the likelihood of the barriers to investment being overcome, and their potential to influence demand, varying appropriately across AEMO's scenarios. The scenarios consider (among other things) supply chain, technological development, cooperation, and degree of consumer support for such technologies.

Regarding EV utilisation rate per vehicle and EV uptake

Summary of material issues raised in submissions

EQ noted that the lower assumed utilisation rate per vehicle helps drive a high number of vehicles in the new forecast and sought clarification on how the assumptions are connected, while mentioning EV utilisation should impact the charging profile more than the uptake (number of units) and this should be reflected in the forecast.

AEMO's consideration and assessment

Transport planning and investment makes use of a broad body of data and models utilising the passenger kilometres metric, and integrates considerations including housing, technology, societal and economic trends. This work, when combined with related metrics such as vehicle utilisation, can be leveraged by the EV forecasting process to estimate total vehicles.

Thus, for a given number of passenger kilometres, a decrease in utilisation drives an increase in vehicle numbers. A decrease in utilisation also reduces the magnitude of the per vehicle charge profiles. Additional information can be found in Section 3.5.1 of CSIRO's EV report, which describes the methodology used regarding utilisation and its connection to vehicle forecasts.

AEMO considers that the potential impact of differing utilisation levels on charging profile shape will need further consideration and intends to examine this further in the 2025 IASR where possible.

Regarding the popularity of EV charging types

Summary of material issues raised in submissions

EVC considered that AEMO assumes unscheduled charging to be more popular than it actually is. It noted that the 2024 Forecast Assumptions Update EV workbook shows residential unscheduled charging at 69% in Victoria for 2023-24, with higher percentages in other states. In contrast, EVC noted Origin Energy smart charging trial studies⁵ showing unscheduled charging can be between 6% for owners with ToU tariff and 30% for owners with no incentive.

EQ noted the assumptions underlying the EV charging type (in Figure 15), reflect a shift away from 'Unscheduled' charging towards more coordinated charging behaviour (incentivised by tariff or otherwise) but AEMO's forecast shift towards 'Time of Use Grid solar' charging seems less than EQ's anticipation based on the progressive adoption of cost-reflective network tariff structures by electricity retailers in their tariffs.

EQ also mentioned data from the Energy Queensland EV Smart Charge Queensland Insights Report suggests that solar PV owners who are early EV adopters actively time the charging of their EVs to align with their PV generation, but this may vary from state to state depending on implementations of policies.

AEMO's consideration and assessment

In relation to the **EVC's** feedback on unscheduled charging, the Ergon Network and Energex Network report states that *"...when price or access to solar/ renewable generation is not available (collaborative charging tendency), coincidental convenience charging dominates"*. This finding is applied in the AEMO forecast, which shows unscheduled (convenience) charging initially at a high rate, and then reducing substantially as new tariffs (that is, various ToU tariffs) become popular and solar penetration increases.

Regarding **EQ's** comment on EV charging type: while AEMO's forecasts have considered the Energy Queensland (Energex Network and Ergon Network) Smart Charge report, there remains uncertainty regarding the introduction and consumer response to various tariffs. AEMO acknowledges the view that Time of Use Grid solar should have greater popularity and

⁵ See EVC submission page 5 of 9, second paragraph https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/2024-forecasting-assumptions-update-consultation-page/submissions/evc.pdf?la=en with reference to footnote 7 at <https://electricvehiclecouncil.com.au/wp-content/uploads/2022/08/Home-EV-charging-2030.pdf>.

considers there to eventually be an even greater consumer appetite for more dynamic tariffs including Time of Use Dynamic, V2H and V2G. Essentially these dynamic tariffs are able to unlock additional value relative to Time of Use tariffs, and thus result in greater consumer savings.

AEMO agrees with EQ's comment on EV owners aligning their charge with available PV generation and recognises that there is a correlation between PV uptake and EV uptake.

Regarding fuel cell electric vehicles (FCEV) projections

Summary of material issues raised in submissions

GU mentioned there is still insufficient detail to assess whether the full value chain costs of FCEV have been assessed, including by undertaking time sequential modelling. This has the potential to bias model results in favour of green hydrogen compared to alternatives such as BEVs.

AEMO's consideration and assessment

AEMO notes its forecasts show FCEV are predominately forecast for heavy vehicle/large trucks where BEV-equivalent vehicles are not considered as available, especially in the *Green Energy Exports* scenario where hydrogen availability is expected to be highest. In contrast, FCEVs for passenger vehicles is forecast to be limited, which AEMO considers to be aligned with the feedback received.

Regarding EV battery technologies

Summary of material issues raised in submissions

QEUN and EF commented that swappable batteries are available and need to be considered in modelling, while QEUN noted the emergence of battery technologies such as sodium batteries for both home batteries and EVs which would also have lesser fire risk than lithium batteries.

AEMO's consideration and assessment

Regarding swappable batteries specifically, AEMO is not aware of passenger EV models with swappable batteries on the Australian market, and the lack of a standardised battery ecosystem poses a major challenge to scaling up battery swapping technology.

In relation to sodium batteries, AEMO does not currently consider that the potential emergence of this technology will materially impact the forecast of BEVs or BEV electricity requirements in the foreseeable future.

3 FRG consultations

3.1 Economic forecasts

AEMO presented its draft economic forecasts at the 28 February 2024 FRG. AEMO received one submission, from Collgar Renewables (**Collgar**).

Summary of material issues raised in submissions

Collgar questioned whether the Gross State Product (GSP) forecasts by AEMO's consultant Deloitte Access Economics (**DAE**) appropriately reflected what it saw as a negative correlation between population and productivity, as well as the ability for state governments to finance the investments required to deliver the projected population growth. **Collgar** also suggested that services would grow relative to the other sectors in the economy and would be a relatively lower sector in terms of productivity.

AEMO's consideration and assessment

DAE provided responses to Collgar's feedback, in which DAE confirmed that its productivity forecast was informed by the assumptions for trend productivity in Treasury's Intergenerational Report. DAE stated that while weak productivity growth is expected to erode the potential long-term growth rate of the economy, population growth is likely to provide some degree of counterbalance. DAE went on to note that the relationship between population growth and long-term average labour productivity measured as average output per worker is driven by changes in the participation rate, which is also influenced by factors such as the composition of migration flows and demographics. DAE stated that in this regard, skilled migration tends to boost productivity within a sector, however, broader trend productivity in the economy might continue to slow due to other factors.

Considering DAE's responses, AEMO considered that the draft forecasts presented at the February FRG were appropriate to inform the economic component in AEMO's electricity consumption forecasts.

3.2 Demand side component forecasts

AEMO presented its draft demand side component forecasts at the 29 May 2024 FRG. AEMO received submissions from a number of stakeholders on several aspects of the component forecasts.

Summary of material issues raised in submissions

AEMO received the following feedback on its draft component forecasts:

- Boston Consulting Group (**BCG**) and the University of New South Wales School of Photovoltaic and Renewable Energy Engineering, Faculty of Engineering (**UNSW**) queried AEMO's estimate of 300 MW of existing data centre load, claiming that this figure was lower than estimates from other sources⁶.
- **Shell Energy** commented on AEMO's estimate of the 'PV rebound effect', whereby electricity customers who install rooftop PV are shown to increase their overall electricity consumption relative to their consumption prior to installing rooftop PV. **Shell Energy** claimed that international literature indicated an average 6% increase in electricity consumption, compared to AEMO's estimated 20%, and sought reasons for this difference. It also noted that the cause of the 'rebound' may be customers charging batteries or EVs and if so, AEMO should be careful not to double-count this consumption.
- The **EUAA** noted that AEMO collected information from Large Industrial Load (LIL) customers on downside or closure risks, but only applied these risks to the *Progressive Change* scenario. It expressed a preference for AEMO to include some form of LIL downside risks in all scenarios, or at the very least, as a sensitivity (to, for example, the ESOO Central scenario).
- The **EUAA** further commented that AEMO's hydrogen consumption forecasts adopted multi-sector modelling forecasts from 2022 which had been re-based and adjusted for the 2024 LIL surveys. It was concerned that this may under-estimate the forecasts, since the 2022 multi-sector modelling does not reflect recent advances in policy and investor preferences and that a low LIL survey response rate may not capture those LILs who are likely to consume large amounts of hydrogen. The EUAA suggested that AEMO perform sensitivity analyses of hydrogen consumption across all its scenarios.
- **GU** sought clarification on which forecasts had been re-based from a previous forecast version and which forecasts had been prepared on a standalone basis.

AEMO's consideration and assessment

AEMO notes the high level of interest in forecasts of data centre load. Regarding AEMO's estimate of 300 MW of current data centre load, this was sourced from analysis of metering data of known data centre customers and cross-referenced with information received through the annual Standing Information Request process (with network service providers) and analysis of emissions data reported via the National Greenhouse and Energy Reporting Scheme (NGERS). AEMO is aware of other, higher, estimates of data centre load, but does not consider these to be more reliable than the 300 MW currently used for forecasting purposes.

Regarding future data centre load growth, AEMO considers that its LIL and Business Mass Market (BMM) forecasts, which include data centre growth, are likely to reasonably capture the potential for growth in this emerging sector. However, AEMO agrees with stakeholders that increased transparency of data centres is desirable. In a consultation paper which recently commenced a review of AEMO's Electricity Demand Forecasting Methodology, AEMO raised the prospect of creating a new data centre-specific customer segment and also foreshadowed potential changes to how large loads may be included in its forecasts. AEMO will continue to engage with stakeholders on these potential changes to the electricity demand forecasting methodology, which will be applied to the 2025 ESOO.

⁶ For instance, the Asia Pacific Data Centre Update, published by Cushman & Wakefield, at <https://www.cushmanwakefield.com/en/singapore/insights/apac-data-centre-update>.

On the topic of the solar rebound effect, AEMO provided the paper on which it bases its 20% assumption to the FRG. AEMO notes that the findings from this paper may need to be revisited and in the consultation paper for the Electricity Demand Forecasting Methodology, AEMO foreshadowed further investigation of this impact, **but for the 2024 ESOO, reduced the solar rebound effect from 20% of the energy generated by rooftop PV systems to 10%** in response to stakeholder feedback to the FRG Consultation. AEMO welcomes further feedback to its demand forecasting methodology consultation.

On **EUAA's** observation that LIL closures only feature in AEMO's *Progressive Change* scenario, AEMO notes that the ESOO scenario spread results in significant differences in LIL forecasts. This provides the latitude within the forecast spread for consumption upside (through prospective facilities expansions) in the *Green Energy Exports* scenario and the exploration of consumption downside (via potential facility closures) through the *Progressive Change* scenario. LIL forecasts are strongly informed by LIL surveys, and specifically the *Step Change* forecast only includes closures or expansions that are considered committed, as per AEMO's current forecasting methodology. AEMO provides high transparency regarding each component forecast to enable stakeholders to adopt alternative assumptions in their own analysis if deemed appropriate.

Regarding the **EUAA's** suggestions on hydrogen consumption, AEMO notes that the returned LIL surveys covered close to 90% of industrial energy use in the current financial year and contained no forecasts of hydrogen use over the 2024 ESOO forecast period. While the **EUAA** is correct that the hydrogen forecasts used in the 2024 ESOO were developed from re-based 2022 multi-sector modelling, AEMO has observed that few major projects have achieved financial close since that modelling was applied in the 2023 ESOO. Given that AEMO assumes a five-year lead time for any projects that have not yet reached financial close, AEMO considers that the expected range of hydrogen-related electricity demand, re-based from that used in the 2023 ESOO, is adequately covered by the current scenarios for the purpose of the 2024 ESOO.

In response to **GU's** questions about which forecasts have been re-based and which forecasts are derived from new forecasts, these are made explicit in the final *Forecasting Assumptions Update*, with each input or assumption providing an 'input vintage', 'source' and 'updates since 2023 ESOO'.

AEMO considers that the above responses adequately address the issues raised, including an adjustment to the solar rebound component of its forecast. For the reasons explained above, AEMO has not adjusted its component forecasts for other components. There are, however, several points which have been raised by stakeholders that AEMO will further consider and consult on over the course of the review of its Electricity Demand Forecasting Methodology, which will apply to the 2025 ESOO and beyond.

3.3 Demand side participation (DSP) forecasts

AEMO presented its draft DSP forecasts at the 29 May 2024 FRG. AEMO received feedback on its DSP forecasts from two stakeholders: the **EUAA** and **GU**.

Summary of material issues raised in submissions

The **EUAA** supported AEMO reducing the number of DSP price trigger bands from six to three and was pleased to learn that residential DSP was being factored into the DSP forecasts. It also thanked AEMO for more clearly explaining how the various forms of demand flexibility fall within DSP forecasts, demand forecasts and supply forecasts. The EUAA also recommended that AEMO establish methodologies to better understand the breakdown of each response by National Metering Identifier

(NMI) customer group, rather than the current “Program” based classification, which it considered would improve DSP forecast accuracy.

GU provided AEMO with some information about demand response in aluminium smelters in New Zealand, which it urged AEMO to consider when preparing the 2026 ISP.

AEMO's consideration and assessment

Regarding the **EUAA's** recommendation to provide a DSP forecast at the customer group level, rather than program classification level, AEMO does not necessarily share the **EUAA's** view that this would improve forecast accuracy. AEMO considers that the drivers are better understood by assessing DSP programs, rather than customer groups. Further, in its 2023 review of the DSP forecasting methodology and DSP information guidelines, AEMO received support for the continuation of its DSP categories. Nevertheless, AEMO continues to monitor the accuracy of its forecasts via the annual *Forecasting Accuracy Report*⁷ and, if AEMO considers that DSP forecasting accuracy could be improved, AEMO may consult on changes to its approach, either through its *Forecast Improvement Plan* or via another review of the DSP forecast methodology and information guidelines.

AEMO thanks **GU** for the material provided regarding demand response overseas. As is noted in the DSP forecast methodology, AEMO does consider both domestic and international data sources when preparing its long-term DSP forecasts, and will consider the information provided in future DSP forecasts (for the 2026 ISP as suggested, for example).

For the reasons outlined above, AEMO has applied its draft DSP forecasts as final for the 2024 ESOO.

3.4 Unplanned outage rate forecasts

AEMO presented its draft unplanned outage rate forecasts at the 12 June 2024 FRG. AEMO received one written submission, from **Shell Energy**.

Summary of material issues raised in submissions

Shell Energy raised several points in its submission, including:

- Seeking confirmation of whether the 14-year period used to calculate generator unplanned outage rates had changed compared to the 2023 ESOO, and if so, why.
- Asking whether historical failure rates of retired generators had been removed from the data so the data used in the calculation for future outage rates reflects the current NEM fleet.
- Advocating for AEMO to engage with generator plant operators to better understand cause of outages, which may give AEMO grounds for removing some historical outages from its calculation if there was a low probability of a similar event occurring in the future.

⁷ At <https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/forecasting-accuracy-reporting>.

- Recommending that AEMO further disaggregate its small peaking plant categories into modular and non-modular varieties, to better reflect the distinctions in failure rates and mean time to repair between those types of plant.
- Raising a concern that applying historical outage rates for batteries to AEMO's forecasts may upwardly skew future outage rates, due to the possibility of improvements to battery technology, which is still relatively nascent.
- Suggesting that AEMO consider forecasting battery outage rates with reference to the size of individual inverters or storage modules, which it considered was the most likely failure event.
- Requesting that AEMO confirm the time period over which the key transmission flow paths unplanned outage rates have been collected and expressing a preference for the time period to align with that used for generator outage rates.
- Suggesting that AEMO undertake more analysis on the Moorabool – Heywood – Southeast – Tungkillo flow path in the South Australia to Victoria flow direction in both the credible contingency and reclassification categories, given the increase in generation in Victoria to the west of or at Moorabool and the potential future impact of Project Energy Connect Stage 2.

AEMO's consideration and assessment

AEMO provides the following responses to the issues raised by **Shell Energy**:

- For long duration outages, AEMO has used the previous 14 years of historical unplanned outage data, which includes an extra year of data compared to the 2023 ESOO.
- The generation included in both the historical long and short duration unplanned outage calculation is based on the current fleet of generators in the NEM, with any unplanned outages for generators which are now retired being excluded from the underlying calculations.
- AEMO has applied the methodology for unplanned outages as per the ESOO and Reliability Forecast Methodology⁸, which states that long duration outages that extend greater than five months are less likely to recur on the same unit but occur from time to time within the fleet. When assessing past long duration outages, AEMO has seen no trend supporting a decrease in long duration outages over time.
- Regarding small peaking plant, AEMO does consider categories of each station, but does not believe that adding another category will lead to improvements in the forecasts. Individual small peaking plants especially have a high variance due to low running hours, and adding another category will likely add high variance to both categories. AEMO would also need to formally collect data to confirm these categories.
- Regarding nascent battery technology, AEMO notes that the current actual outage rates may be impacted by 'new technology failure outcomes' and should be carefully monitored. AEMO has not found any solid evidence for what large-scale battery outage rates may be over the long term. To take into account that current battery unplanned outage rates may be higher than the longer-term rates, and in response to the stakeholder feedback, **AEMO has applied a 10% reduction to the large-scale battery rates calculated.**

⁸ At https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2023/esoo-and-reliability-forecast-methodology-document.pdf.

- Regarding the time period used to assess unplanned transmission outage rates, AEMO has used at least 11 years of data in its calculations (one extra year compared to 2023 ESOO), for some paths/outage types; a longer collection period is used where the data is available.
- Regarding the Moorabool – Heywood – Southeast – Tungkillio flow path, AEMO notes that the flow path modelled is from Mortlake to South East and does not extend to Moorabool or Tungkillio. There is some generation west of Mortlake, but due to the size and intermittent nature of these generators AEMO does not consider these generators to be significant and therefore do not meet the exclusion criteria in the methodology.
- AEMO agrees that based on the current modelling and assumptions after Project Energy Connect Stage 2, the outages on this flow path would be considered too immaterial to model. Acknowledging the stakeholder feedback, **AEMO will apply no outages to the Mortlake to South East flow path from when Project Energy Connect Stage 2 is assumed to be commissioned.**

In light of the feedback received in the submission from Shell Energy, AEMO has made the above bolded adjustments to its unplanned outage rate forecasts.

Abbreviations

Abbreviation	Meaning
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
BEV	battery electric vehicle
BITRE	Bureau of Infrastructure and Transport Research Economics
BMM	Business Mass Market
capex	capital expenditure
CER	consumer energy resources
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DNSP	distribution network service provider
DSP	demand-side participation
ESOO	<i>Electricity Statement of Opportunities</i>
EV	electric vehicle
EVC	Electric Vehicle Council
FBPG	Forecasting Best Practice Guidelines
FES	Fuel Efficiency Standard
FCEV	fuel cell electrical vehicle
FRG	Forecasting Reference Group
GEM	Green Energy Markets
GSOO	<i>Gas Statement of Opportunities</i>
GSP	Gross State Product
IASR	<i>Inputs, Assumptions and Scenarios Report</i>
ISP	<i>Integrated System Plan</i>
kW	kilowatt/s
LCOE	Levelised cost of electricity
LIL	Large Industrial Load
NEM	National Electricity Market
NMI	National Metering Identifier
NREL	National Renewable Energy Laboratory
NVES	New Vehicle Efficiency Standard
PHEV	plug-in hybrid electric vehicle
PV	photovoltaic
ToU	Time of Use
VFACTS	Vendor Field Analytical and Characterization Technologies System
V2G	vehicle-to-grid
V2H	vehicle-to-home
VPP	virtual power plant
W	watt/s