



2023 Forecast Improvement Plan

Final Report

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Executive summary

The publication of this final report concludes the consultation procedure conducted by AEMO to finalise the 2024 Forecast Improvement Plan which is prepared and published under National Electricity Rules (NER) 3.13.3A(h)(2). In accordance with the Reliability Forecast Guidelines¹, AEMO has followed the single stage consultation process described in the Forecasting Best Practice Guidelines (FBPG) Appendix B. AEMO thanks all stakeholders for their feedback.

The priority improvements proposed for 2024, outlined in Section 8 of the Forecast Accuracy Report (FAR), include:

1. Review the sensitivity of short-term annual consumption models.
2. Review large industrial loads.
3. Review forecast minimum demand models.
4. Improve EV forecast approaches.
5. Understand change in future load shape from technology uptake and usage.
6. Track electrification trends.
7. Improve renewable generation and demand traces, including quantity used and their shape.
8. Improve visibility of sectoral consumption.
9. Monitor demand side participation trends.
10. Monitor planned outages.

AEMO received direct feedback in relation to improvement 4 above, and about its forecasting approach to EVs and batteries in general. There was further general feedback on the improvement plan in relation to topics not ultimately identified by AEMO in the priority improvements above.

¹ AEMO Reliability Forecast Guidelines, Section 4.2 Forecast Improvement Plan, at https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2021/reliability-forecast-guidelines.pdf?la=en.

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1. Stakeholder consultation process

As required by the National Electricity Rules (NER) 3.13.3A(h)(2), AEMO must publish any improvements made by AEMO or other relevant parties to the forecasting process that will apply to the next Electricity Statement Of Opportunities (ESOO) for the National Electricity Market (NEM), in accordance with the Reliability Forecast Guidelines².

AEMO consulted on the 2023 Forecast Improvement Plan, which outlines proposed forecasting improvements that may apply to the 2024 ES00, in accordance with the single stage consultation procedure in the AER's Forecasting Best Practice Guidelines (FBPG), Appendix B.

AEMO's process and timeline for this consultation are outlined below.

Table 1 Consultation process and timeline

Consultation steps	Dates
Presentation at Forecasting Reference Group	29 November 2023
Draft report and Forecast Accuracy Report published	5 January 2024
Submissions closed on draft report	5 February 2024
Final report published	27 May 2024

AEMO's consultation webpage at <https://aemo.com.au/consultations/current-and-closed-consultations/2023-forecast-improvement-plan-consultation> contains all published papers and reports, written submissions, and other consultation documents or reference material.

In response to its draft report, AEMO received one written submission.

AEMO thanks all stakeholders for their feedback on the draft report through written submissions and discussion at the Forecasting Reference Group (FRG), which has been considered in preparing this final report.

² Reliability Forecast Guidelines, section 4.2 Forecast Improvement Plan, available at https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2021/reliability-forecast-guidelines.pdf?la=en.

2. Background

2.1. The draft Forecast Improvement Plan

As required by NER clause 3.13.3A(h)(1), AEMO must, no less than annually, prepare and publish on its website information related to the accuracy of its demand and supply forecasts, and any other inputs determined by AEMO to be material to its reliability forecasts. This requirement is met by the publication of the 2024 Forecast Accuracy Report (FAR).

AEMO also includes in the FAR information related to proposed improvements to the forecasting processes that may apply to the next ESOO (a Forecast Improvement Plan) as required by NER clause 3.13.3A(h)(2), with a particular focus on those arising from forecast deviations. In accordance with AEMO's Reliability Forecast Guidelines³, AEMO consults on the Forecast Improvement Plan using the single stage consultation process outlined in Appendix B of the FBPG. An FRG discussion on the topic was also held.

The priority improvements proposed for 2024, outlined in Section 8 of the FAR, include:

1. Review the sensitivity of short-term annual consumption models.
 - AEMO proposes to expand the annual review of recent growth trends for Tasmania in particular.
2. Review large industrial loads.
 - AEMO proposes to expand the annual review of large industrial load (LIL) forecasting. This review will monitor LIL consumption that shows the largest variances compared to the forecast, including unplanned outages and significant operational variations
3. Review forecast minimum demand models.
 - AEMO will undertake a review of its minimum demand forecast models to further establish whether the lower-than-90% probability of exceedance (POE) results recorded for minimum demand were related to under-forecast of rooftop photovoltaics (PV) or some other factor(s).
4. Improve electric vehicle (EV) forecast approaches.
 - AEMO plans to improve EV forecasts by adjusting short-term forecast models to respond more dynamically to recent sales data and by improving the consideration of the popularity and longevity of plug-in hybrid electric vehicles (PHEVs).
5. Understand change in future load shape from technology uptake and usage.
 - AEMO will assess data from Project Edge⁴ and Project Symphony⁵ to support insights into future load shapes, and will continue to collaborate with industry participants, researchers and government in researching the uptake and operation of EVs and battery storage.
6. Track electrification trends.

³ Section 4.2, Forecast Improvement Plan.

⁴ At <https://aemo.com.au/en/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/project-edge>

⁵ At <https://aemo.com.au/en/initiatives/major-programs/wa-der-program/project-symphony>

- AEMO will investigate whether electrification trends may already be observable in meter data. This may enable better understanding of the impact of electrification on the short-term forecasts, and improved validation of inputs from multi-sector modelling.
7. Improve renewable generation and demand traces, including quantity used and their shape.
 - AEMO plans for more weather reference years to be available for the 2024 ESOO, including a limited number of synthetic years, and demand traces will need to be created for those.
 8. Improve visibility of sectoral consumption.
 - AEMO’s aim is to improve the breakdown of both the existing LIL and the broader business mass market sectors. This will help identify opportunities for data and model improvements to reduce consumption forecast variance in the 2024 ESOO. This will also enable better integration with economy-wide modelling, such as integrated assessment models (IAMs).
 9. Monitor demand side participation trends.
 - AEMO will continue to monitor how wholesale demand response (WDR) is used compared to forecast, to guide any future updates of the demand side participation (DSP) forecast. The response of large DSP providers during lack of reserve (LOR) events (for example, in New South Wales in 2022-23) will be monitored to ensure current assumptions about their responses during reliability events are still valid.
 10. Monitor planned outages.
 - AEMO will monitor planned outages for scheduled generators and determine whether methodology changes are required for planned outages in ESOO model.

2.2. The national electricity objective

Within the specific requirements of the NER applicable to this proposal, AEMO has sought to make a determination that is consistent with the national electricity objective (NEO) and, where relevant, to select the option best aligned with the NEO.

The NEO is expressed in section 7 of the National Electricity Law as:

to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:

- (a) *price, quality, safety, reliability and security of supply of electricity; and*
- (b) *the reliability, safety and security of the national electricity system.*
- (c) *the achievement of targets set by a participating jurisdiction—*
 - (i) *for reducing Australia’s greenhouse gas emissions; or*
 - (ii) *that are likely to contribute to reducing Australia’s greenhouse gas emissions.*

3. List of material issues

AEMO received one written submission to the draft 2023 Forecast Improvement Plan consultation, from Ergon Energy Network and Energex. AEMO thanks these stakeholders for their considered submission.

The issues raised in submissions to the draft report are listed in Table 2 in summary form.

Table 2 List of issues raised

No.	Issue	Raised by
1.	Forecasting project specific to EVs and battery storage.	Ergon Energy Network and Energex
2.	Energy Not Supplied, both planned and unplanned, at a more granular forecasting level covering availability of supply, size of the reliability gap and intervals, and impacted loads.	Ergon Energy Network and Energex
3.	Impacts of weather and climate related events on the short- and long-term forecasting of reliability gaps, given that cyclones, bushfires, severe storms, floods and heat waves have impacts on demand and lost energy well beyond Major Event Days.	Ergon Energy Network and Energex
4.	In Table 3 of the FAR: Key scenarios and sensitivities used in the 2022 ESOO, the current and projected mix of generation sources is presented as a series of comparisons against historical ESOOs. To improve benchmarking of the scenarios, it would be informative to document how the current mix of generation is tracking against expectations in the scenarios and how recent events may relate to the likelihood of being on the path towards a particular scenario.	Ergon Energy Network and Energex
5.	In Table 4 of the FAR: Connections forecast for 2022-23 and actuals for 2022-23, the terms 'connections' and 'customers' are used interchangeably. We note the importance to maintain the distinction between the two terms. For example, in embedded networks such as residential apartment blocks, one connection to the distribution network may serve multiple customers.	Ergon Energy Network and Energex

Each of the issues in Table 2 is discussed below.

3.1. Further forecasting project specific to electric vehicles (EVs) and battery storage

3.1.1. Issue summary

As part of its Forecast Improvement Plan (item 4), AEMO proposed to improve EV forecast approaches. Improvements that AEMO proposed included adjusting the short-term forecast models to respond more dynamically to recent sales data and improving the consideration of the popularity and longevity of PHEVs.

3.1.2. Submissions

Ergon Energy Network and Energex submitted their recommendation to include a further forecasting project specific to EVs and battery storage. They proposed that this project could examine:

- The interdependencies between forecasts of rooftop solar PV systems, behind-the-meter batteries and EVs;
- The extent to which EV batteries may be repurposed to function as home batteries, potentially increasing the installed capacity of home energy storage systems earlier than anticipated;
- The relationship between EV charging pattern forecasts and maximum 10% probability of exceedance (POE) forecasts, 50% POE forecasts and in particular minimum 90% POE forecasts;
- The extent to which growth in EV numbers correlates with growth in EV-related demand, plus diversification of that demand from the use of EV chargers in different locations, such as at homes compared to carparks at workplaces, public transport hubs and shopping centres; and
- How the use of Artificial Intelligence (AI) could improve energy storage and EV-related forecasting, and AI's role in the smart management of charging and discharging.

3.1.3. AEMO's assessment

As part of the 2023 Forecast Improvement Plan, AEMO stated that it will improve EV forecast approaches by focussing on the following areas.

Firstly, the interdependencies between PV, battery and EV forecasts will be considered as much as practical in future consumer energy resources (CER) forecasting. The possibility of EV batteries being repurposed as home batteries will be considered as part of this.

In AEMO's current methodology, EV traces already flow into maximum/minimum demand traces. However, AEMO agrees that where possible further analytical work to explore the relationship between EV charging and minimum/maximum demand forecasting may be beneficial. Investigations to date indicate it is a nuanced task, as demand is contingent upon various factors such as weather patterns, seasonal variations, holidays, weekday/weekends and time of the day.

AEMO's forecasts already includes diversification across vehicle and charging types, acknowledging the time of day when those vehicles and charging types are utilised. AEMO (and its consultant) develop charging profiles from the most relevant data and consult on them. Over time, those profiles will become increasingly data-driven as the uptake of EVs increases. AEMO also notes that its forecasting publications at regional or sub-regional level do not require highly geographically specific outputs, and that it is satisfactory to aggregate the differing load profiles across home, public and other chargers.

AEMO will continue to explore a range of technologies and algorithms (potentially including AI) to enhance the accuracy of the forecasts. AEMO notes that some forecasting techniques achieve higher accuracy at the expense of lower interpretability, and seeks to work with stakeholders to utilise the most appropriate methods.

3.1.4. AEMO's conclusion

As per the Forecast Improvement Plan, AEMO will continue to investigate improvements in capturing EVs in its forecasts.

3.2. Report on energy not supplied

3.2.1. Issue summary

AEMO's Forecast Accuracy Report reports on metrics used to generate unserved energy (USE) as part of its ESOO forecasts. The USE that AEMO must report on is defined under NER clause 3.9.3C and does not include any transmission outages that do not impact the ability to transfer power into a region.

3.2.2. Submissions

Ergon Energy Network and Energex submitted their recommendation to include energy not supplied, which is energy associated with power system security events (such as transmission outages).

3.2.3. AEMO's assessment

AEMO must report on USE as per the definition in NER clause 3.9.3C. The energy not supplied is explicitly excluded from the USE definition as per NER clause 3.9.3C(b)(2). This means it is not included in any forecasts and is not a relevant metric in the forecasting reports.

3.2.4. AEMO's conclusion

AEMO does not intend to report on energy not supplied, as this is not in the ESOO scope.

3.3. Impacts of weather and climate related events

3.3.1. Issue summary

In its ESOO, AEMO models several weather reference years to capture the impacts of diversity in weather. The Central scenario is based on an average across all the weather reference years.

3.3.2. Submissions

Ergon Energy Network and Energex submitted their recommendation to include the impacts of weather and climate related events on the short- and long-term forecasting of reliability gaps, given that cyclones, bushfires, severe storms, floods and heat waves have impacts on demand and lost energy well beyond Major Event Days.

3.3.3. AEMO's assessment

When calculating USE relating to the interim reliability measure and the reliability standard AEMO must follow the definition of USE in NER clause 3.9.3C. AEMO must calculate USE using this definition, which does not include multiple contingency events or acts of God.

In previous publications AEMO has published sensitivities looking at the impacts of weather events, such as bushfires in the 2020 ESOO. As there are many different types of extreme weather events which could disrupt the electricity system in different ways, it is very challenging to include a consistent sensitivity in its ESOO reliability modelling.

3.3.4. AEMO's conclusion

AEMO will continue to calculate USE in the ESOO in accordance with the NER clause 3.9.3C definition for the Central scenario using a range of reference years that consider a variety of weather patterns.

AEMO will continue to consider the impact of more extreme weather in its sensitivities and may include these sensitivities in future reports.

AEMO is also working on including synthetic weather traces in its modelling, which will increase the range of weather modelled.

3.4. Generation mix in the scenarios

3.4.1. Issue summary

In Table 3 of the FAR: Key scenarios and sensitivities used in the 2022 ESOO, the current and projected mix of generation sources is presented as a series of comparisons against historical ESOOs.

3.4.2. Submissions

Ergon Energy Network and Energex submitted that it sought improved benchmarking of the scenarios. They believed it would be informative to document how the current mix of generation is tracking against expectations in the scenarios and how recent events may relate to the likelihood of being on the path towards a particular scenario.

3.4.3. AEMO's assessment

In the Forecast Accuracy Report, AEMO compares many of the inputs of the ESOO Central scenario to assess its accuracy. AEMO notes that it tracks generation mixes of forecast against actuals in several places in the Forecast Accuracy Report, including rooftop PV in chapter 4, and generation by fuel type during hot days and total number and capacity values of operating facilities in chapter 6. AEMO notes that the majority of supply inputs would not vary at all between the scenarios.

AEMO has also configured the ESOO model to most appropriately reflect dispatch during reliability events; the ESOO is not configured to replicate market bidding, which means it would be unsuitable to compare annual generation output levels.

AEMO also notes that in the first year (where comparison is currently done) a lot of the scenario inputs are very similar, and that the differences between scenarios generally widen further out in the horizon.

3.4.4. AEMO's conclusion

As the purpose of the FAR is to assess the accuracy of the ESOO, AEMO will continue to compare installed generation capacity against the inputs used in the 'most likely' Central scenario in the ESOO.

3.5. Distinction between 'connections' and 'customers'

3.5.1. Issue summary

In Table 4 of the FAR: Connections forecast for 2022-23 and actuals for 2022-23, it is unclear whether AEMO is referring to 'connections' or 'customers'.

3.5.2. Submissions

Ergon Energy Network and Energex noted the importance of maintaining the distinction between the two terms. For example, in embedded networks such as residential apartment blocks, one connection to the distribution network may serve multiple customers.

3.5.3. AEMO's assessment and conclusion

AEMO agrees that there is distinction between 'connections' and 'customers' and will make clearer whether it is talking about a 'connection' or a 'customer' in future reports. For clarity, the National Metering Identifier (NMI) connections forecast does use actual NMI connections as the basis, taking into account dwelling growth rates in the future.

4. Final determination on the Forecast Improvement Plan

Having considered the matters raised in submissions to the draft report, AEMO's determination is to make the 2023 Forecast Improvement Plan in the form published with additional change to the EV forecasting approach as below in this final report:

- Improve EV forecast approaches AEMO plans to improve EV forecasts by:
 - Adjusting short-term forecast models to respond more dynamically to recent sales data.
 - Improving the consideration of the popularity and longevity of PHEVs.
 - Considering interdependencies between PV, battery and EV forecasts.
 - Considering EV batteries being repurposed as home batteries.

Effective date

The effective date of this determination is 27 May 2024.