

FRG CONSULTATION FOR THE 2021 INPUTS, ASSUMPTIONS AND SCENARIOS REPORT

DISTRIBUTED ENERGY RESOURCE (DER) FORECASTS

Published: **May 2021**





1. STAKEHOLDER CONSULTATION PROCESS

AEMO utilises photovoltaics (PV) Battery and Electric Vehicle (EV) forecasts from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and PV and Battery forecasts from Green Energy Markets (GEM) to develop its distributed energy resource (DER) forecasts in its 2021 Inputs, Assumptions and Scenarios Report (IASR). The IASR is used in major publications such as the 2021 Electricity Statement of Opportunities (ESOO) and the 2022 Integrated System Plan (ISP).

In March 2021 AEMO conducted a Forecasting Reference Group (FRG) Consultation on the draft DER forecasts, according to Section 2.3.2 of AEMO's Reliability Forecast Guidelines¹ and as advised in the Draft IASR published for consultation in December 2020.

AEMO's timeline for this consultation is outlined below.

Deliverable	Indicative date
Draft IASR ² published for consultation with FRG Consultation dates and information	11 December 2020
Draft IASR Consultation Submissions due	1 February 2021
Draft IASR Scenario and Submissions webinar	3 March 2021
Notice of FRG Consultation circulated to registered FRG and ISP stakeholders	25 - 26 March 2021
Forecasting Reference Group Presentation and discussion	31 March 2021
FRG Consultation Submissions due	14 April 2021
FRG Consultation Report published	4 May 2021
Final IASR published	30 July 2021

This document should be read in conjunction with the consultation material, FRG meeting and discussion minutes, and written submissions available under "FRG Consultations" at:

<https://aemo.com.au/en/consultations/industry-forums-and-working-groups/list-of-industry-forums-and-working-groups/forecasting-reference-group-frg>

2. CONSULTATION DETAILS

The Draft IASR included interim draft DER forecasts based on the previous forecasts developed in April 2020 for use in the 2020 ESOO. An interim input is one that is intended to be updated before the release of the final IASR. It is shared in the Draft IASR to stimulate discussion on appropriateness and seek feedback on areas of continuous improvement to be considered during the remaining IASR development process.

The forward plan provided in Table 6 of the Draft IASR indicated when interim inputs would be updated and how stakeholders could provide feedback on the updated inputs.

Section 4.4.4 of the Draft IASR sought feedback on whether DER forecasts reflected a reasonable spread of potential outcomes for the NEM, suitable for continued application in the 2021-22 scenarios. It also highlighted that these forecasts would be updated in early 2021, with opportunity for stakeholders to get involved through an FRG Consultation in March - April 2021.

¹ Available at: <https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-approach>

² See Table 6 in the Draft IASR, available at: <https://www.aemo.com.au/consultations/current-and-closed-consultations/2021-planning-and-forecasting-consultation-on-inputs-assumptions-and-scenarios>



DER related stakeholder submissions to the Draft IASR³ focussed on the importance of DER, and the risks of underestimating uptake. Some submissions specifically stated they believed the forecast PV uptake rates were too low. Energy Consumers Australia requested AEMO explore human factors in consumer interaction with the energy system, including trust and motivations. The Maritime Union of Australia (MUA) noted the need for social equity measures associated with a high uptake of DER and EVs. Several stakeholders emphasized that updated policy information must be taken into account.

EV related stakeholder submissions to the Draft IASR emphasized the uncertainty of EV projections, and the importance of government policies. Some submissions noted the role for hydrogen in commercial vehicles.

The submissions were considered in the scenario development work, and were discussed with the consultants. GEM and CSIRO then commenced DER forecasting, and performed revisions as the scenarios were revised.

When initiating the DER FRG Consultation, AEMO provided stakeholders the 2020 DER reports from CSIRO⁴ and GEM⁵ as reference material, to guide stakeholder understanding and consideration of the following questions:

- Do you support the approach of continuing to escalate the short-term annual growth rate in high-growth scenarios given the historical trend supports this?
- With reference to the scenario settings:
 - Do you think the spread of cumulative PV uptake across the scenarios adequately captures potential future outcomes, given uncertainty around customers' future propensity to install PV?
 - Do you think the spread of cumulative batteries uptake across the scenarios adequately captures potential future outcomes, given uncertainty around customers' future propensity to install batteries?
 - Do you think the spread of cumulative EV uptake across the scenarios adequately captures potential future outcomes, given the infancy of the EV market?
- In the Export Superpower scenario, do you think the assumption regarding hydrogen fuel cells mostly being applied to heavy haulage vehicles is valid? In your response, please consider the higher efficiency but lower range of Battery Electric Vehicles (BEV's).

Following the 2021 Draft DER forecast FRG presentations, AEMO asked for feedback during the FRG meeting and/or during the subsequent two week written submission window. Feedback during the meeting was responded to in the FRG meeting minutes. This report focuses on the two written submissions received, from Sligar and Associates and Energy Australia (EA).

³ See <https://aemo.com.au/en/consultations/current-and-closed-consultations/2021-planning-and-forecasting-consultation-on-inputs-assumptions-and-scenarios>

⁴ Available at: https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/inputs-assumptions-methodologies/2020/csiro-der-forecast-report.pdf?la=en

⁵ Available at: https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/inputs-assumptions-methodologies/2020/green-energy-markets-der-forecast-report.pdf?la=en

3. DISCUSSION OF MATERIAL ISSUES

3.1. PV and battery

3.1.1. Uptake and general

3.1.1.1. Issue summary and submission

Sligar and Associates submitted that export tariff uncertainty will impact PV and battery uptake. EA sought more detail on matters affecting uptake, including the potential for Network Service Providers (NSPs) to remotely control PV and/or limit installations.

EA sought additional information regarding PV actual installations by region, noting such information increases transparency and insights, and cited Victoria in particular. It also sought a summary of assumption changes since the 2020 forecast.

EA asked:

- whether the carbon abatement revenue treatment had changed, and whether a suitable discount rate methodology had been used
- whether the reduction in battery uptake is due to fewer, longer duration batteries
- what are the drivers and values of battery duration values used by GEM?
- whether GEM and CSIRO's assumptions of solar and battery installation costs and subsidy assumptions differ
- how the regional trend in network charges and tariffs are modelled, and their directions and impacts

3.1.1.2. AEMO's Assessment

AEMO understands there is uncertainty about the impact of rising payback period for PV systems, but believes the uncertainty is adequately reflected by the spread of PV uptake outcomes across scenarios.

Regarding EA's request for additional information: regional actuals and forecasts were omitted due to presentation time constraints. The final IASR will include the regional actuals and forecasts. AEMO agrees to include regional actuals and forecasts in future draft DER forecast presentations.

In 2019 the full impact of the Victorian Solar Homes policy was included in high uptake scenarios only as the policy had only recently been announced. In 2020 and 2021 the Solar Homes program has been included in all scenarios. The GEM and CSIRO presentations from the March FRG detailed differences to the prior year forecasts, including graphs showing scenario level comparisons.

The following table responds to specific EA questions:

EA question:	AEMO assessment
(for GEM) Whether the carbon abatement revenue treatment had changed, and whether a suitable discount rate methodology had been used?	GEM has applied the same approach as last year, with updated market values.
(for GEM) Whether the reduction in battery uptake is due to fewer, longer duration batteries?	In this year's model, GEM's residential battery size increases from an average of 10kWh towards 15kWh over the 2030's. The report will include full details. Rather than any change in capex assumptions relative to last year, the change is



What are the drivers and values of battery duration values used by GEM?	based on further reflection and research of likely battery market developments given what has been seen in the solar market. As solar module costs per watt declined, average solar system sizes increased as installers aimed to offset relatively fixed installation labour costs over a larger number of watts. GEM has concluded this is likely to also happen with batteries.
Whether GEM and CSIRO's assumptions of solar and battery installation costs and subsidy assumptions differ?	GEMs adjustments to the CSIRO GenCost figures will be detailed in their 2021 Forecast report, in line with Section 4.2 and 4.3 of their 2020 report.
(for GEM) whether the three customer types, system configurations and two tariff structures apply for both batteries and solar, and whether they sufficiently reflect the range of cases across all regions, and whether they reflect existing policy settings	<p>The three customer types (Residential, Small Commercial, and Large Commercial) apply for both PV only and PV plus battery combined. Details can be found in section 3.2 of GEMs 2020 forecast report⁶.</p> <p>The forecast assumes that consumption tariffs evolve over time with details provided in GEM's forecast report. For example, in the first few years of the projection it is assumed that small customers (covering residential and business mass market) receive single rate smeared tariffs. These customers migrate to time of use tariffs consistent with the AEMC directive to move towards "cost-reflective tariffs" and the WA DER Roadmap recommendations. The TOU tariff structure is the same as last year and detailed in last year's report. It reflects a hybrid of Ausgrid and South Australian Power Network's (SAPN) recently approved TOU tariffs that are designed to account for daytime periods coinciding with lower prices. The draft forecasts presented at the FRG described assumed retail rates for each time period. To keep model complexity manageable, these customer types and tariff structures are uniform across states, however this still represents a reasonable reflection of practices and network demand patterns. The key thing in uptake modelling is the degree of change in paybacks relative to historical levels, and this simplified approach is likely to show change patterns comparable to what would be seen with greater tariff structure diversity.</p>
Additional detail is required on whether GEM and CSIRO are incorporating assumptions about AEMO or NSP's being able to remotely control output of rooftop PV (this may increase the amount hosting capacity), plus views on how NSP technical restrictions may limit installations by supply zone (number and size by customer segment, etc, which may	The forecasts assume that NSPs will not limit installations. CSIRO notes that interventions to limit output during low state demand events belongs to a broad group of actions for times when exports have little value. The group of actions includes low daytime wholesale prices, changing retail tariff structures and inverter outages during high voltage events or other forms of curtailment. CSIRO use a purely economic approach to capture these part economic part physical events because of a current lack of data on

⁶ https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/inputs-assumptions-methodologies/2020/green-energy-markets-der-forecast-report.pdf.

<p>limit PV installs)–and therefore what impact these could have on uptake assumptions.</p>	<p>the future frequency and depth of these events. The approach is an assumed decline in the value of daytime exports. The main offsetting factor to this is growth in energy storage in the large and small scale sector, and EVs, creating demand during times of high renewable output.</p> <p>GEM's model does not explicitly model NSP or AEMO curtailment in estimating payback over time due to considerable uncertainty about the degree to which this might be required at given levels of installed capacity. However, GEM moderates consumer uptake responsiveness to a given payback to account for curtailment becoming more likely and more significant as solar penetration rises. In particular, consumer uptake is limited as:</p> <ul style="list-style-type: none"> • PV approaches a high proportion of average electricity demand within a state and • the proportion of PV households within a whole state approach the upper levels of penetration already seen in some postcodes currently. <p>AEMOs energy consumption and demand models currently assume that PV systems are unconstrained, this ensures the forecast considers how to accommodate consumer preferences in the absence of future controls. However, as these controls begin to roll out, such as is now the case in South Australia, AEMO will consider ways to quantify the impact of these in future consumption and demand forecasts.</p>
<p>GEM forecasting rooftop PV and batteries without doing EVs appears an issue. EV uptake can directly impact BTM battery economics, especially if EVs have V2G discharges and are effectively mobile batteries with wider use case and emissions implications. Clearly the complexities of a payback model approach would be challenging here, but EA believes forecasting one component without the other can lead to inconsistencies, so suggests AEMO seek GEM's views on the interdependencies of these components</p>	<p>Due to cost and time constraints EV is only forecast by one consultant (CSIRO). GEM does not incorporate any assumed impact of adoption V2H/V2G technology on Battery uptake as this was not defined as part of the forecast input assumptions. V2H/V2G when installed on commuting vehicles may not allow the household to arbitrage so may not fully offset the attractiveness of a stationary battery, however AEMO notes that this could be better considered for scenarios that include a portion of V2H/V2G uptake so will consider ways to better capture this in future Battery forecasts where EVs have not been forecast in parallel.</p>
<p>Does the use of a common weighted retail price index across all regions and the approach to extrapolating the intraday shapes(see for example slide 18 from the GEM slides) accurately capture the hollowing out of mid-day prices that is expected to be observed across the</p>	<p>Retail price is built up from a combination of wholesale, network, environmental and retail components and the wholesale component reflects a hollowing out in midday prices as a result of increasing supply of solar. This is the same as what was adopted in last year's modelling.</p>

entire outlook periods for all scenarios, and therefore the economics of installs.	
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3.1.1.3. AEMO's conclusion

AEMO considers the stakeholder consultation on scenario development has resulted in a spread of scenarios that appropriately reflect the range of possible DER while remaining consistent with scenario narratives. AEMO notes the stakeholder submissions seeking a greater level of detail, and that the final reports will provide this.

3.1.2. PV Uptake – detailed

3.1.2.1. Issue summary and submission

EA asked whether:

- the 3c/kWh export tariff premium over wholesale prices is sustainable across the entire forecast period and how sensitive the forecasts are to this assumption
- GEM's assumed reduction in borrowing costs and their updated payback period could be analysed further
- the retail price index weighting across all regions accurately captures the expected reduction in midday prices.

3.1.2.2. AEMO's Assessment

AEMO appreciates that some stakeholders may have particular interest in detailed aspects of the DER forecast, but notes that AEMO only focusses on the level of detail required by its remit.

AEMO's consultants formulate their forecasts, and make and document assumptions, to a level of detail appropriate to their expected impact on the forecast quantity. Where key drivers are uncertain, stakeholder views are considered during the scenario definition consultations. AEMO limits its analysis and sensitivity work focusses to key drivers.

EA's questions relate to factors that are sub-components to PV uptake. For example, the 3c/kWh figure is a premium over baseline wholesale rates, but the total rate is one of several drivers for PV uptake. As such, the premium figure is a sub-component of overall uptake and a sensitivity analysis is unwarranted. For sub-components, AEMO and its consultants assume, in the absence of contrary information and stakeholder feedback, that current values are reasonable future values. This practice reflects the fundamental fact that forecasts become less accurate over time.

3.1.2.3. AEMO's conclusion

AEMO's publication of the consultant's report and associated data is suited to stakeholders seeking detailed information prepared for the IASR, ISP and ESOO publications.

3.2. Multiple Consultants

3.2.1. Issue summary and submission

EA submitted several points regarding AEMO's use of multiple forecasts:

- The concern regarding internal consistency within scenarios if the three interdependent inputs of PV, batteries and EV are not jointly forecast.
 - The economic impact of EV uptake with V2G charging on battery uptake.

- Blending different policy assumptions, for example, GEM’s March FRG presentation considered the NSW Peak Demand Reduction scheme, but its absence in CSIRO’s presentation implied that it was not considered.
- The need for transparency in the application of multiple forecasts. AEMO should show:
 - how it will apply each of GEM and CSIRO’s projections to the DER components of forecasts,
 - the divergence in battery capex assumptions between GEM and CSIRO, and how these have varied from previous versions.
 - all changes from previous forecasts.

3.2.1.1. AEMO’s Assessment

Slide 12 of Presentation 1 at the March FRG describes the proposed selection methodology relating to the two consultants’ forecasts of PV and Battery uptake. The overarching goal is to recognise the uncertainty via broadening the uptake rates adopted. In cases where a single forecast is used, consistency follows directly.

In scenarios where the two forecasts are averaged, battery and PV are also averaged from their respective forecasts. Any strong discrepancy between the PV and battery projections that might be associated with increased V2G or EV subsidies will be carefully reviewed. AEMO consider the downside of averaging inputs is more than compensated for by the benefits of averaging the outputs to create a middle ground.

The current trajectory scenario has consistent policy assumptions across GEM and CSIRO. For other scenarios, the consultants adhere to IASR scenario settings, which stakeholders have provided feedback on. This allows consideration of a broader range of possible outcomes and maximises the benefit of engaging two consultants. Both CSIRO and GEM have considered the NSW Peak Demand Reduction Scheme in their modelling for the final forecasts.

GEM has maintained the same approach as last year for capex assumptions, but with updated market values. The March 2021 FRG meeting invitation included the 2020 forecasting reports from GEM and CSIRO, to support the FRG’s presentations which described changes since then.

3.2.1.2. AEMO’s conclusion

AEMO utilises two consultants’ forecasts for PV and battery to explore the uncertainties in these important areas. Consistency within each scenario is ensured through the selection methodology described in the March FRG presentation, and will also be documented in the final IASR.

GEM and CSIRO’s final presentations at the April FRG will describe material changes since their 2020 report. Full details will be available in each consultant’s 2021 report.

3.3. Economic growth and Tariffs

3.3.1. Issue summary and submission

Sligar and Associates submitted that the economic growth rates which drive high long term DER uptake seemed optimistic.

EA asked how the impacts on retail price forecasts due to trends in network charges and tariffs out to 2050 have been captured, and whether these are rising, falling or steady in real terms and how do these assumptions affect payback and uptake models?

3.3.2. AEMO’s Assessment

AEMO notes that while BIS Oxford Economics’ forecasts are factored into the DER forecasts, historical observations reveal that DER uptake is only mildly related to economic growth, and that other factors may

have greater influence. For example, in 2020 NEM PV installations grew despite the significant COVID related economic recession. Similarly, in Western Australia, PV installations grew in the SWIS over the post mining boom economic slowdown (2015-2018).

Retail price forecasts are in real terms. Transmission cost price changes are factored in based on the AEMO ISP. Distribution price changes are not modelled to change outside of the AER determination window. AEMO acknowledges that tariff types (which may not change the overall price) could change over time, and the DER consultants consider this when modelling uptake as outlined in Section 3.1.1.2 above.

3.3.3. AEMO's conclusion

AEMO considers the economic forecasts incorporated in the DER models as fit for purpose.

3.4. Electric Vehicles

3.4.1. Issue summary and submission

Sligar and Associates submitted that EV uptake is primarily dependent on reasonably priced cars being available together with Government action.

EA's submission requested further information, particularly:

- changes since the 2020 EV forecast
- influence of PV uptake on EV uptake, and the influence of V2G on battery uptake
- charging infrastructure, including Vehicle to Grid (V2G) charging
- load shape impacts on maximum and minimum demand.

3.4.2. AEMO's Assessment

AEMO agrees that EV uptake is strongly related to affordability and potential government action. CSIRO's uptake model considers the cost parity with internal combustion engine (ICE) vehicles by scenario. Details will be available in CSIRO's methodology report, which is expected to be published with the ESOO in mid-June 2021, if not before. The uptake model also considers a range of federal and state policies, and varies them by scenario.

The general projection of EV uptake is similar to the 2020 report, with updates for the 2021 scenarios. The major changes include:

- updated relative shares of charge profiles to reflect greater prevalence of convenience charging. Without clear policies encouraging alternatives, there is little indication of a shift from this trend. Over the forecast horizon, the scenarios cover a spread of charging behaviours around the trend, the scenarios with stronger decarbonisation are expected to be more integrated to meet NEM goals.
- updated manufacturer commitments to discontinue development and manufacture of ICEs over time, and to continue development of EVs
- inclusion of road charges for EVs

The high-level methodology for EV forecasting is set out in AEMO's Electricity Demand Forecasting Methodology⁷, and AEMO will publish CSIRO's final report which will also include updated uptake, energy consumption and charge profile data.

AEMO acknowledges the potential for PV uptake to influence EV uptake, however the energy cost of an EV is a reasonably small driver for uptake compared to capital costs. This is considered in CSIRO's model.

⁷ <https://aemo.com.au/en/consultations/current-and-closed-consultations/electricity-demand-forecasting-methodology>



The influence of V2G on battery uptake is considered within CSIROs battery uptake modelling. The final report will provide the additional information requested on the scale of V2G. The proportion of charging from V2G will be treated dynamically in AEMO's models.

The Electricity Demand Forecasting Methodology also notes AEMO applies the EV load shapes to the demand forecasting process to address peaks and troughs. The specific impacts of EV charging behaviours on maximum and minimum demand will be transparent within AEMO's final forecasts. The impact cannot be determined (beyond the granularity provided by the profiles themselves) until those forecasts are produced and the timing of maximum and minimum demand over time assessed.

3.4.3. AEMO's conclusion

FRG presentations and the Electricity Demand Forecasting Methodology describes the EV forecasting methodology. The consultant's report, when published with the ESOO (if not before), will provide a further break down of assumptions regarding the growth of the EV fleet.

AEMO recognises that EVs and particularly charge profiles may impact minimum and maximum demand and energy consumption. Stakeholder feedback drove the development of the scenarios used to test these impacts.

4. CONCLUSION

AEMO notes the requests for more detail and have passed them onto the consultants for inclusion in their final reports. In future years, AEMO will aim to include regional forecasts during the draft DER forecast presentation.