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To: AEMO
Planning and Forecasting
By email to forecasting.planning@aemo.com.au

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Re: Response to 2019 Planning and Forecasting Consultation Paper

Infigen Energy (Infigen) welcomes the opportunity to make a submission to the ISP. Infigen owns a 670 MW portfolio of wind capacity across New South Wales, South Australia, Victoria and Western Australia, is constructing a 25 MW / 52 MWh battery in South Australia and has entered into PPAs to provide an additional c90 MW of capacity in Victoria.

We see significant opportunity for AEMO to take a leadership role in Australia's readiness for the transition to a zero emissions economy. This would help avoid the urgent interventions that the market has faced recently which have been driven, at least in part, by faster-than-expected transitions. This aligns well with AEMO's new national planning responsibilities (e.g., actioning the ISP) and recent thought leadership in developing a sustainable grid and market.

At a high level, our submission considers:

- All scenarios should be consistent with Australia's commitments under the Paris agreement. The Neutral scenario should represent a reasonable extrapolation of existing policies, including a central scenario for emissions reduction (40-60%) by 2030.
- AEMO should develop a comprehensive view of the likely and potential impacts on the electricity sector from meeting the Paris agreement.
- AEMO should consult on and apply emissions reduction trajectories for each scenario (similar to the framework in previous years) but does not need to specify how those trajectories would be implemented in practice.
- AEMO should develop and publish assumptions around trajectories for Marginal Loss Factors for existing and new entrant connection points (particularly Renewable Energy Zones).
- Ensuring renewables traces consider technology improvements

1. THE CONTEXT OF SCENARIO DEVELOPMENT

AEMO's assumptions – particularly the Neutral case - are increasingly becoming key scenarios across the industry. They underpin not just AEMO's modelling but also RIT-Ts, policy development, market design questions, and inform industry investment decisions.

Infigen would like to particularly recognise AEMO's commitment to making detailed assumption books and data sets available during the consultation and implementation phases of the Integrated System Plan and related studies is valuable and very well implemented.

Infigen considers that AEMO has a vital role to play in informing industry and Government of potential generation, transmission and market development outcomes.

However, Infigen notes that market forecasts have consistently underestimated the pace of change of technology and generation mix in the market, particularly around decarbonisation. This has resulted in the need for rapid and costly intervention, with costs mostly borne by consumers. For example:

- Market forecasts did not anticipate the rate of transformation of the South Australian generation[1] mix or consider the impacts of that transformation until after they were already critical risks. While the closures would always have had a material impact on South Australia, the exit of aging plants (with limited fuel resources) was a credible (if challenging) event . Incorporating it contributed to significant costs to consumers, risks to investors, and threats to system security.
    - The unanticipated emergence of system strength and inertia shortfalls required AEMO to develop system models of unprecedented complexity in an extremely short timeframe. The introduction of the 1200 MW wind constraint in South Australia also resulted in significant lost revenue for the industry and created an uncertain investment environment broadly throughout the NEM (given concern such constraint could be implemented in other regions) .
    - At times, AEMO operated South Australia in what would now be considered an insecure system, with only a single synchronous machine online. Prudent forecasting would have identified this risk and resulted in earlier commencement of work programs to identify the necessary constraints for a secure system.
    - Directions in South Australia led to significant market disruption and ultimately the rapid need for intervention by ElectraNet. The need for directions could potentially have been avoided or minimised if *potential*

[1] For example, the closure of Northern Power Station was not raised in the 2014 ESOO (https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/NEM-Electricity-Statement-of-Opportunities/2014-NEM-ESOO)

issues had been identified well ahead of time, giving the market the opportunity to develop physical resources and frameworks to manage risks with the minimum cost and disruption.
    - AEMO unexpectedly introduced the 35 MW local FCAS requirement in South Australia when there was a credible risk of separation, at great cost to consumers. If AEMO's forecast scenarios had considered the possibility of unit closures in South Australia and implemented appropriate constraints well ahead of time, the market would have had time to respond and deliver solutions (such as battery storage).
- From approximately 2009 to 2013, demand forecasts were significantly overstated (see the Figure below), not anticipating the scope of rooftop PV, energy efficiency, and economic growth outcomes - even under the Low scenarios. These forecast errors contributed to a significant over-supply of capacity in the system.
    - We note that AEMO was originally required to rely on forecasts from network service providers. However, from 2012 AEMO developed its own forecasts which continued the same growth trends. Critically, the lowest forecast scenarios didn't consider demand falling from the previous year – until that had occurred for five years in a row. In that year, however, actual demand growth *exceeded* the High scenario forecast.
- AEMO has only recently begun to consider the extreme risks from high penetrations of uncontrolled rooftop PV and other distributed energy resources (DER) in South Australia[2]. Changing DER standards is a lengthy process and addressing the problem will only become more challenging as more devices with inadequate standards are installed. This is unfortunate, because credible scenarios could have been developed a decade ago with high uptake rates of rooftop PV, which would have raised this issue.
    - Similarly, the August 25th incident report[3] highlights mass tripping of DER from both voltage and frequency disturbances. Recommendation 5 is to improve DER standards and compliance processes, but limited information has been communicated to the market to date.
    - High uptake of suboptimal DER will ultimately result in increased operational costs in the form of increased need of frequency reserves (because DER are tripping when they shouldn't be) and consumers will have to pick up the bill.

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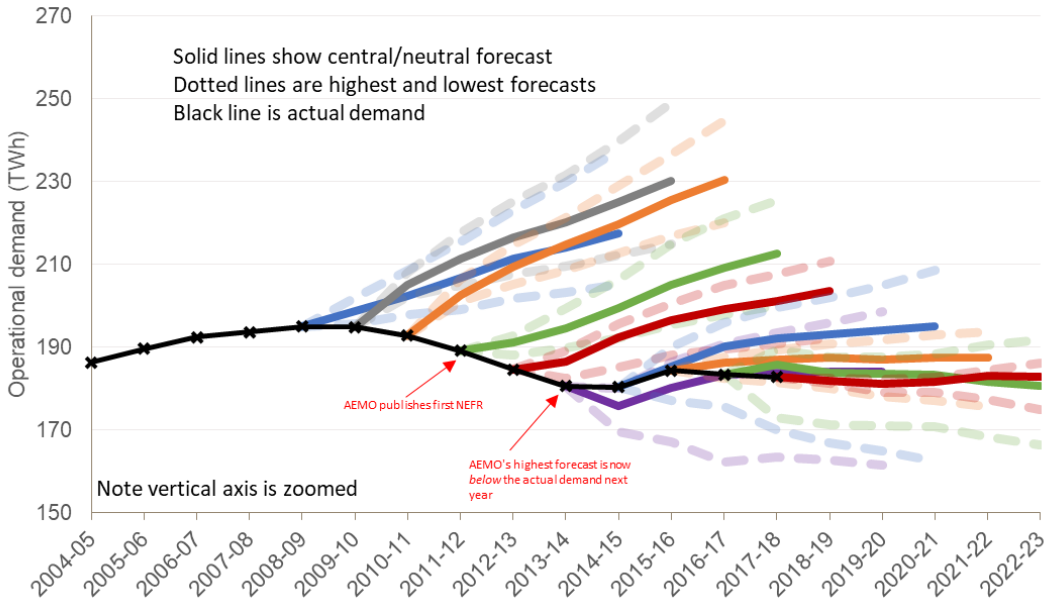
2 https://www.energynetworks.com.au/sites/default/files/open_energy_networks_consultation_paper.pdf

3 https://www.aemo.com.au/-/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2018/Qld---SA-Separation-25-August-2018-Incident-Report.pdf

AEMO demand forecast errors



We acknowledge that "Forecasting is hard, especially of the future", and it is easy with the benefit of hindsight to suggest specific scenarios that should have been considered. It's also clear that, in many cases, the NEM is at the forefront of operating grids with high penetrations of renewable generation, requiring the development of new modelling techniques.

Therefore, the intent of the above analysis is simply to highlight that there are real measurable costs that can be at least partially avoided if scenarios that are beyond current "straight line" projections are incorporated into modelling and allow for "step changes" in the grid. AEMO is uniquely placed to lead the industry towards incorporating more robust forecasts into planning studies.

Infigen therefore strongly recommends that AEMO incorporates the risk of rapid changes in its scenarios and modelling. Furthermore, given that "unknown unknowns" are inevitable, to help the market minimise the risk of being surprised, AEMO should be considering a broad range of "known unknowns" – particularly around emissions reduction policies, energy storage, and decarbonisation (and potentially electrification) of the transport sector.

Furthermore, while informative "bookend" scenarios are important, it is *also* important for AEMO to implement a credible Neutral scenario reflecting "middle of the road" assumptions and reasonable expectations of policy developments. AEMO's view of the Neutral scenario is highly influential to the market and policy makers. Taking an overly passive approach while ignoring likely (and necessary) market, technology and policy changes risks repeating history.

2. EMISSIONS REDUCTION TRAJECTORIES

2.1 Emissions reduction policies are a critical input

Emissions reduction trajectories (and related outcomes including coal closures, new renewable generation, and emissions constraints) will be one of the largest "known unknowns" in the grid. Even though policy uncertainty continues, modelling must look to fundamentals – and credible emissions reduction achievement cannot be relegated only to sensitivities.

Australia is party to the Paris agreement, which seeks to hold the increase in global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change. We note that there is bi-partisan support for the Paris agreement, with support from both major political parties as well as the largest minority party. Furthermore, every country in the world is currently a signatory[4].

It is generally recognised that current global commitments are currently insufficient to meet this target, that each country's level of ambition will need to rise over time[5], and that long-term (2040-2050) global emissions need to be zero or close to it.

All AEMO scenarios should be consistent with this key global agreement.

2.2 Impact of the Paris agreement on the electricity sector

The Paris agreement will require the transformation and decarbonisation of all sectors of the economy – not just electricity. Conversely, it may be that opportunities for emissions reduction in the electricity sector are more readily available in the near-term.

We see there is an opportunity for AEMO to take a lead role in identifying the potential impacts on the electricity sector from this transition, as well as opportunities to improve the efficiency of decarbonisation. This could include identifying:

- opportunities for electrification of various sectors and indicative volumes and costs – helping stakeholders to understand the range of outcomes
- the relative share of national emissions abatement targets that is expected from the electricity sector in order to meet the Paris agreement, taking into account the relative cost of abatement from various sectors as well as the maturity and lead times of abatement opportunities

[4] Noting the US has announced its intent to withdraw, but is not yet legally able to.

[5] See for example, https://www.nature.com/news/prove-paris-was-more-than-paper-promises-1.22378

- opportunities for energy efficiency (reduction in electricity demand) across various sectors, and resulting impact on AEMO demand forecasts (building on AEMO's recent demand forecasting approach)
- the greater impact climate change will have on peak demands in scenarios (if any) where lower global ambition is assumed.
- best practice strategies for operating coal plant during the transition, including reducing minimum loads or more efficient warm-start strategies – allowing coal plant to continue to deliver value to the grid while not conflicting with emissions reduction targets
- opportunities to leverage experiences around the globe, including informing and coordinating with other market operators.

This work program would build on the projects that AEMO already undertakes, but with a broader view of the eventual transition to a net-zero emissions economy. By looking ahead and focusing on fundamentals, this analysis will help AEMO and the industry avoid significant disruption when emissions reduction targets are ramped up or when the transition happens naturally.

We expect that AEMO would collaborate with the CSIRO or similar bodies, drawing together and leveraging the outputs of relevant studies and analysis from across industry and academic stakeholders (as well as AEMO's own internal modelling). (AEMO's recent collaboration on technology costs would seem to be a good example of a workable approach.) For example, AEMO could leverage the output of existing whole of economy models to identify requirements from the electricity sector, and provide input key inputs into future modelling exercises.

We would be keen to engage further with AEMO on how this could be implemented.

2.3 Emissions reduction trajectories

The Neutral scenario represents the "best available extrapolation of current policies and trends". AEMO therefore needs to consider a balance between current policies and the transformation required by the Paris agreement.

The first 10 years of forecasts are most impactful from both a net-present value basis and a decision-making basis, so it critical that the scenarios consider a broad range of outcomes over that period. For example, while a 26% reduction in electricity sector emissions is a *possible* outcome, it is also a "worst case" outcome especially given current state policies[6]. Projecting *only* a 26% reduction for the electricity sector would require assuming no change to national targets and policies by subsequent governments *and* the electricity sector doing only its pro-rata share – which may not

[6] Queensland and Victoria both have 50% renewable energy targets by 2030 as does NSW Labor

be credible given the absence of policies for other sectors, even if Kyoto credits are used.

Last year's 26% Neutral trajectory is therefore better aligned with the Slow change scenario, and a more credible trajectory should be applied to the Neutral scenario (40-60% reduction in emissions).

Longer-term, given that complete decarbonisation is a credible (and required) outcome by 2050, AEMO should model zero Australian emissions (across electricity *and* other sectors) by 2050 scenario for at least the Fast Change scenario. This faster trajectory would give AEMO an opportunity to identify potential challenges and possible solutions early: providing information to market that could avoid the need for more drastic action later. Infigen expects this could build on AEMO's previous high-quality analysis of a 100% renewables energy grid.

On this basis, Infigen recommends trajectories as outlined in the table below.

Table 1 - Infigen proposed emissions reduction trajectories

	2020 to 2030	**2030 to 2050**
Neutral scenario	The Neutral scenario consider a 40-60% reduction in electricity sector emissions by 2030. • This is consistent with the Climate Change Authority[7] analysis of Australia's contribution to global targets and is also a credible policy of at least one major party. • Even if national targets at less than 40-60%, multiple studies indicate that the electricity sector is well placed (and may be required) to deliver a more than "pro-rata" share of national targets.	Target 80-90% reduction in electricity sector emissions by 2050. High decarbonisation/electrification of other sectors (as discussed below).
Fast change scenario	At the upper end of the range proposed for the Neutral scenario	Complete decarbonisation of Australian economy Including 90% reduction in electricity sector emissions by 2040 and zero electricity sector emissions by 2050. Full decarbonisation of Australia, including consideration of possible electrification of other sectors of the economy.
Slow change scenario	Apply a lower electricity sector target (say 26% by 2030).	70-90% reduction in electricity sector emissions by 2050.

7 http://climatechangeauthority.gov.au/sites/prod.climatechangeauthority.gov.au/files/files/CFI/Chair-statement-FINAL-report-Australia-future-emission-reductions.pdf

		Alternatively, in this scenario, AEMO could consult on and apply a standard economic lifetime to existing coal assets, to be replaced by renewable generation. Less electrification of other sectors than the Neutral scenario.
DER scenario	Will depend on AEMO's goal for this scenario – aligning with the Neutral or Fast change would be appropriate.	It's likely that strong emissions reduction targets will align with DER uptake; the scenario with greatest transformation would probably be strong uptake of DER *plus* the emissions trajectories of the Fast change scenario.

2.4 Decarbonisation of other sectors

A commitment to limiting warming to 1.5 degrees above pre-industrial levels will require complete decarbonisation of other sectors such as transport, most likely by or before 2050. For a self-consistent scenario, these trajectories should be aligned with the national emissions reduction trajectory.

AEMO's previous forecasts have not been consistent with the Paris agreement. For example, the 2017 Energeia[8] report suggested that only 61.5% of new vehicles sales would be electric vehicles (EVs) by 2050 (with the implicit assumption that the balance would be petrol/diesel – not consistent with net zero emissions).

In their modelling, full electrification would result in approximately 60 TWh of additional demand but only ~5 TWh of demand is added by 2036 (which AEMO later somewhat increased[9]). In practice, EV uptake is likely to follow a more sigmoidal shape featuring a sudden uptick in capacity driven by policy or technological changes that cannot be forecasted from extrapolation models. (This is consistent with Energia's 2018 report to ARENA[10].) If such a scenario is not included, the NEM may not be prepared for the significant demand growth, generation and (potentially) transmission development required.

To the extent that electrification of other sectors is possible or likely, similar arguments would apply, and as noted above this should be included in the ISP scenarios.

[8] Electric Vehicles Insights, Prepared by ENERGEIA for the Australian Energy Market Operator's 2017 Electricity Forecast Insights (September 2017)

[9] https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/NEM-Electricity-Demand-Forecasts/Electricity-Forecasting-Insights/2018-Electricity-Forecasting-Insights/Summary-Forecasts

[10] https://arena.gov.au/assets/2018/06/australian-ev-market-study-report.pdf

Infigen also recommends that AEMO highlight the "saturation" levels for various technologies[11], and in the Neutral and Fast change scenarios (in particular) consider the full decarbonisation of the transport sector. This may or may not involve the conversion to electric vehicles – for example, hydrogen or less vehicle usage could be credible scenarios that AEMO (or its appointed consultant) should consider.

2.5 Modelling approach

Given the significance of emissions reduction trajectories, Infigen does not support AEMO's proposed approach of not consulting on specific emissions reduction trajectories. AEMO has not provided a clear proposal for how the level of coal retirements would be determined, or the basis for how replacement would be done (whether least-cost or otherwise). In the absence of an announced trajectory, it is not clear how AEMO would choose "delayed" or "accelerated" retirement timings or what would constitute "less aggressive" or "more aggressive" trajectories.

It is not sufficient to wait until the modelling has been conducted for industry to review AEMO proposed trajectories, nor is it appropriate for AEMO to determine these in isolation.

From a pure modelling perspective, we note that not including an explicit carbon trajectory or value of emissions abatement will make choosing replacement technologies challenging and will not value fuel switching. This also risks mis-valuing transmission upgrades – either because additional renewable generation is under-valued, or because facilitating great coal generation is over-valued.

Infigen recommends applying an emissions trajectory (as proposed above) to each scenario, allowing the model to determine the least-cost combination of technologies to meet demand and other constraints. This will enable AEMO to efficiently consider all technologies, including energy storage, gas (OCGT or CCGT), fossil fuel with carbon capture and storage.

This approach avoids the need for AEMO to make assumptions about the *mechanism* by which emissions might be reduced, instead focusing on *how* various levels of reduction could be achieved and impact on prices.

2.6 Technology costs

Infigen engaged with AEMO and the CSIRO on the development of technology cost scenarios. This was a helpful and collaborative process, and we congratulate AEMO for initiating it.

We question using the CSIRO "4 degree" technology costs for the Neutral scenario, which does not seem to be consistent with current international policy. Although we

[11] Noting that saturation levels are also modelling assumptions and can change if there is a material change in technology or another underlying assumption.

recognise the value in modelling cost sensitivities, Infigen recommends that the "2 degree" technology costs be used for all scenarios for this year's modelling. AEMO could consider requesting CSIRO to model a 1.5 degree scenario in future iterations of this work.

3. LOSS FACTORS

There would be significant value to the industry if AEMO were to, through the ISP, consider the long-term trajectory of marginal loss factors (MLFs) associated with various transmission connection points. This is particularly pertinent for renewable energy zones – understanding both congestion and loss impacts over time would help make AEMO's studies more robust, and also help inform investment decisions in the market.

4. HALF-HOURLY TRACES

We support AEMO's proposal to move towards incorporating multiple reference years into the capacity expansion model, although it would be appropriate to review (and potentially edit) the data during extreme events to ensure it is fit for purpose.

We note that the traces for renewable energy do not capture improvements in technology (e.g., greater capacity factors). An example is wind power, where turbines have gotten bigger and better at capturing wind but AEMO have kept capacity factors at historical levels (e.g., 27% in some cases), which distorts the capacity expansion decision.

It would be appropriate to apply a scaling metric to traces to increase capacity factor while preserving the basic shape. This could be based an assumed historical and future wind power curve.

5. ACCESS TO DATA

We support AEMO's proposal to make internal systems, including separate traces for different components of demand and embedded generation, available. This will help participants to undertake their own sensitivities.

6. CONCLUSION

We look forward to the opportunity to continue to engage with AEMO on this important process. If you would like to discuss this submission, please contact Dr Joel Gilmore (Regulator Affairs Manager) on joel.gilmore@infigenenergy.com or 0411 267 044.

Yours sincerely

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