Monday 1 February 2021

Australian Energy Market Operator
Via email: forecasting.planning@aemo.com.au

Dear AEMO,

RE: Consultation on key forecasting inputs in 2021 - Draft 2021 Inputs, Assumptions and Scenarios Report and CSIRO's GenCost 2020-21 Consultation draft report

Hydro Tasmania welcomes the opportunity to comment on two important inputs to the Australian Energy Market Operator's (AEMO) key forecasting activities in 2021 - both the Draft 2021 Inputs, Assumptions and Scenarios Report (Draft 2021 IASR) and CSIRO's GenCost 2020-21 Consultation draft report (GenCost report).

AEMO's efforts to consult widely and transparently with stakeholders are commended and will be important in continuing to build confidence in the breadth and balance of inputs, assumptions and scenarios that inform critical AEMO forecasts such as the 2022 Integrated System Plan. We acknowledge the complexity of this work and commend AEMO on their progress thus far.

While we have commented separately to both the Draft IASR and GenCost report, we consider our responses to be inter-related and should be considered collectively, these are provided as Attachments A and B respectively.

Attachment A provides specific responses associated with AEMO's Draft 2021 IASR, covering:

1. Scenario modelling
2. Risk scenario modelling
3. Public policy settings
4. Emission trajectory assumptions
5. Pumped Hydro Energy Storage (PHES) assumptions
6. Regional cost factors
7. Electric Vehicle (EV) assumptions
8. Battery assumptions
9. Consumption and demand: historical and forecasting components
10. Forced outage rates
11. Hydro modelling

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12. Climate data within consumption and demand forecasting
13. Power system security services
14. Peaking gas technologies
15. Real vs. generic (modelled) development options
16. Perfect foresight

Attachment B provides specific responses associated with the CSIRO's GenCost report, covering:

1. Pumped Hydro Energy Storage (PHES) cost assumptions
2. Tasmania's proximity to Victoria
3. Economic life for pumped hydro
4. Contingency costs for batteries
5. Battery charge/discharge characteristics

For further information or follow-up on any aspects of this submission, please contact Prajit Parameswar (prajit.parameswar@hydro.com.au or (03) 6230 5471).

Yours sincerely,

Alex Beckitt

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Attachment A – Comments in response to AEMO's Draft 2021 Inputs, Assumptions and Scenarios Report (IASR)

1. Scenario modelling

Hydro Tasmania recommends that the scenarios included in the Final 2021 IASR be assigned probability weightings to reflect the likelihood of them occurring. This is particularly important when making judgements on modelling outcomes. We note AEMO acknowledges that some of the scenarios are improbable, as noted:

> *"While some of the above proposed scenarios and risks may be considered relatively unlikely, their purpose is to inform policy-makers, investors, consumers and researchers and other energy stakeholders of the possible opportunities in these directions, and critically, what would be needed to access these opportunities."* (pp 5)

To this end, Hydro Tasmania would suggest that the IASR modelling could benefit from the inclusion of probability weightings for each scenario to better inform system planning and development activities.

The following comments are made in regard to specific scenarios included in the Draft 2021 IASR:

a. Sustainable Growth

We acknowledge AEMO's assumption under the Sustainable Growth scenario that Australia will pursue net-zero emissions by 2050. Electricity has traditionally, and will in coming decades, do the heavy lifting to achieve an 'economy wide' net zero target by 2050. To achieve this, the electricity sector will have to decarbonise early (by 2040). This is being observed in Europe and is likely to be followed by the United States in coming years under the Biden-led administration.

b. Slow Growth

Hydro Tasmania requests AEMO's reconsideration of its assumption that operational demand will fall to the levels assumed in the Slow Growth scenario. There is a possible future, if history is an indication, in which governments intervene to support major industrials to ensure broader socio-economic objectives such as employment. This seems particularly important considering the ongoing economic recovery measures from the Covid-19 pandemic. As such, we would suggest AEMO undertake further analysis of this potential intervention.

c. Diversified Technology

The Diversified Technology scenario is intended to align with the International Energy Agency's 2020 World Energy Outlook Sustainable Development Scenario (SDS). Currently, however, the Diversified Technology scenario diverges considerably from the SDS. It does so by placing a cap on renewable energy targets (40%) on the basis that physical and social constraints limit access to variable renewable energy (VRE) resources in most regions of the world (which ensures greater reliance on

non-renewable technologies). By being inconsistent with the IEA's narrative for the SDS,[1] the logic of the Diversified Technology Scenario becomes questionable. If retained, the generator and storage build cost assumptions for this scenario should be updated, and we would recommend using CSIRO's GenCost Central settings.

The Diversified Technology scenario should also be reconsidered noting the 'gas cliff' forecast by AEMO beyond 2023 – if this gas shortage occurs, then the Diversified Technology scenario is called into question due to its heavy reliance on said gas generation. In this context, should this scenario simply be included as a risk scenario in the Final IASR?

d. Export Superpower

Hydro Tasmania supports AEMO's assumption that Australia targets net-zero emissions by 2040 under the Export Superpower scenario. There is global momentum towards a decarbonised future within this timeframe, with the real possibility that the electricity sector achieves net-zero emissions even earlier.

Hydro Tasmania welcomes the inclusion of the hydrogen-focused Export Superpower scenario within the Draft IASR. Grid connected hydrogen is likely to be a key part of Australia's domestic hydrogen growth. However, based on Hydro Tasmania's analysis it would seem reasonable that domestic hydrogen growth will also be significant in at least the Sustainable Growth scenario (consistent with current policy and scenario settings). Hydro Tasmania recommends AEMO consider inclusion of some grid-scale hydrogen within the Sustainable Growth scenario.

2. Risk scenario modelling

Hydro Tasmania would like to make the following comments regarding the risk scenarios included in the Draft 2021 IASR:

a. Early Victorian coal closure

Early coal closures can have a significantly adverse impact on wholesale prices, as observed following the closure of the Hazelwood power station in 2017. Hydro Tasmania considers it critical that the market is set to deliver investment in new capacity before coal exits. On this basis, Hydro Tasmania views this sensitivity as key to any modelling of the future National Electricity Market (NEM), and supports its inclusion in the Final IASR.

b. Marinus Funding arrangements not resolved

Hydro Tasmania acknowledges the ongoing work by various levels of government, as well as market bodies, to establish appropriate cost-allocation methodologies for major transmission investment processes, including the Marinus Link interconnector. We recognise the bilateral Memorandum of Understanding (MOU) between the Federal and Tasmanian Governments, which outlines a shared path forward, and provides greater certainty, to the progression of Marinus Link. Additionally, the work undertaken by the Energy National Cabinet Reform Committee (ENCRC; formerly the COAG

[1] https://www.iea.org/reports/world-energy-model/sustainable-development-scenario

Energy Council) and the Energy Security Board (ESB) to develop a fair cost allocation methodology for inter-regional transmission developments provides additional confidence in the future resolution of this issue. To this extent, Hydro Tasmania questions the validity of this sensitivity.

c. Additional risk scenarios

The Final 2021 IASR should be sensitive to a broad range of potential realities. As such, we suggest AEMO consider two additional scenarios for inclusion in the final IASR:

(1) A risk scenario with a delayed Snowy 2.0; and
(2) A risk scenario in which a specific mainland interconnector is not developed commensurate with the retirement of coal-fired generation (e.g. VNI West, Humelink).

In relation to (2), we would note that mainland interconnectors have large land coverage and may encounter difficulty in securing stakeholder support when compared to Marinus Link, which is a largely underwater development. At a minimum we would advise AEMO to include some granularity in their land cost factors between regions (Table 25). An underwater interconnector like Marinus Link will likely have lower land development costs.

3. Public policy settings

Hydro Tasmania supports the inclusion of the Tasmanian Renewable Energy Target (TRET) across all scenarios. Hydro Tasmania commends the Tasmanian Government for legislating the TRET and notes the target will support Tasmania's development opportunities in pumped hydro, renewable hydrogen, and VRE such as wind and solar.

4. Emissions trajectory assumptions

The global commitment to realise the Paris Agreement goals has strengthened, supported by national commitments by China, potential forthcoming policy announcements from the new Biden administration in the U.S. and the EU Green Deal. This significantly increases the likelihood of even stronger global action to mitigate greenhouse gas emissions, and should be reflected in the scenario assumptions.

In our view, the approach to Australian emissions trajectories being consistent with a range of temperature outcomes (Figure 2) - developed using methodologies broadly consistent with the modified contraction and convergence approach suggested by the Climate Change Authority - appears robust. However, we would observe that the way this is translated into a NEM emissions budget, by scaling down the Australian emissions budget by the current share of NEM electricity emissions of total Australian emissions, is problematic. In reality the electricity sector's share of national emissions is guaranteed to fall from the current level over time, and this should be modelled accordingly. As AEMO notes in the Draft IASR:

> *"Furthermore, the methodology currently assumes the emissions budget for the electricity sector is based on its current share of emissions, when it is often noted that electricity may need to decarbonise more rapidly and do "more of the heavy lifting" given its advantages in this regard over other sectors. This would therefore result in a tighter emissions budget for the sector, which would offset any increase through cross-sector allocation."* (pp 52)

We agree with this observation and encourage the proposed scenarios to represent the NEM as having a decreasing share of Australia's emissions budget over time.

5. Pumped Hydro Energy Storage (PHES) assumptions

Hydro Tasmania notes the inconsistency in locational cost factors for PHES between the Draft IASR and the GenCost report. For Tasmanian 24 hour PHES the Draft IASR assumes (see Table 27) a cost factor of 0.62, compared to 0.46 in the GenCost report (see pp 44). We recommend that AEMO align the IASR's assumptions with those of the GenCost analysis.

Hydro Tasmania is at an advanced stage in our feasibility study into the development of Tasmanian PHES, and in December 2020 announced Cethana as our preferred site. We have undertaken extensive work into understanding the geology of this site, and can indicate with a high degree of confidence that Tasmanian PHES will cost in the order of $1.6 million to $2 million per MW (includes an amount for contingency). The GenCost figures (with a cost factor of 0.46) for PHES locational cost factors are more aligned with this latest analysis.

Furthermore, the Draft IASR (Table 27) implies that long duration storage (greater than 12 hours) is an option across all Australian states by considering scaling factors. The potential for cost effective long duration storage is entirely dependent on appropriate project-specific physical site conditions that are conducive to long duration PHES. Apart from specific projects in Tasmania and NSW, there is no evidence of projects with the site characteristics required for realistic 24 hour or 48 storage durations. It is recommended that Victoria, Queensland and South Australia not be included in the 24 hour and 48 hour PHES locational cost factors unless/until specific projects are identified with the required combined physical characteristics of high head, short connection distance, and terrain able to support large storage volumes.

Additionally, as affirmed by the International Finance Corporation (IFC), hydropower assets offer extremely long operating lifespans of 40-50 years[2] that can often be extended to 100 years with some rehabilitation. Hydro Tasmania has 100 years of experience in operating hydro power plants and strongly agrees with the IFC report. To this extent, Hydro Tasmania recommends AEMO to conservatively use '40 years' as the assumption for hydropower plants' 'economic life'.

6. Regional cost factors

Hydro Tasmania notes that the cost estimate provided above for Tasmanian PHES ($1.6 million to $2 million per MW) includes regional cost factors. To this extent, Hydro Tasmania requests AEMO not further increase pumped hydro costs in Tasmania due to regional factors. The use of disproportionately high regional cost factors has the effect of artificially inflating investment costs.

The state-based cost multipliers appear to have a very narrow margin of uncertainty in Victoria, when compared to all other states. Newer technologies (such as hydrogen), are likely to be built at large scale, and would likely reduce regional cost differences. Hydrogen capital costs are inherently uncertain, due to the limited maturity of the technology. The uncertainty is likely to be homogenous

[2] https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/hydroelectric_power_a_guide_for_developers_and_investors

across the regions. On this basis, we encourage AEMO to review the proposed Victorian banding on costs for hydrogen developments. Additionally, we would highlight the availability of port facilities in Tasmania, which will be a means to reduce costs when compared to inland locations for Renewable Energy Zones.

Furthermore, Hydro Tasmania sees merit in AEMO reviewing the state-based cost multipliers and considering alternate methodologies, such as the cost of living index[3] provided by the Australian Bureau of Statistics.

7. Electric Vehicle (EV) assumptions

Hydro Tasmania agrees that light vehicles will predominately transition to battery electric, particularly in the early years (of the 20-year forecast period). Battery electric vehicles are also likely to be more economically efficient until hydrogen technology matures significantly. Hydro Tasmania considers it most probable that hydrogen fuel cell vehicles are likely to remain more segmented to heavy long distance transport.

8. Battery assumptions

Please refer to Attachment B (sections 4 and 5) for relevant comments to the IASR.

9. Consumption and demand: historical and forecasting components

Hydro Tasmania notes that battery costs are expected to fall significantly throughout the forecast period. Assuming this is true across all battery applications, Hydro Tasmania considers it likely that this will also drive a greater uptake of EVs. Subsequently, it is likely we will also experience an increase in energy demand across this period. Hydro Tasmania notes that while there has been some uptake in consumption in Table 4 of the Draft IASR, we would query whether this takes into account the full cascading effect on energy demand.

10. Forced outage rates

Hydro Tasmania notes the need for AEMO to align assumptions around thermal outage rates based on the age of plant, including recently observed behaviour of increased tripping and decreased reliability.

11. Hydro modelling

Hydro modelling is a complex practice. AEMO's commitment to work with industry stakeholders to reflect this should be commended. We look forward to ongoing engagement with AEMO to further improve the representation of hydro modelling in the next iteration of the ISP.

[3] https://www.abs.gov.au/statistics/economy/price-indexes-and-inflation/selected-living-cost-indexes-australia/latest-release

12. Climate data within consumption and demand forecasting

Several scenarios in the Draft IASR (Central and Slow Growth) include significant hydro inflow reductions in Tasmania, but also particularly in mainland catchments.[4] For consistency, Hydro Tasmania queries whether AEMO should also increase their forecast energy consumption due to ongoing climate impacts. For instance, the increased need for desalination plants due to reduced rainfall, and the increased need for cooling, are two of factors of many, which would significantly increase energy consumption in Victoria by around 20% of current consumption levels. Hydro Tasmania is working to understand the long-term impacts of climate change on its hydro plants; once this internal work is completed we would welcome the opportunity to share this analysis with AEMO for inclusion in their modelling.

13. Power system security services

Hydro Tasmania would like to note that the Draft IASR modelling does not appear to recognise the significant ancillary service benefits that will arise as a result of investment in the Marinus Link interconnector. In particular, the Marinus Link interconnector will enable a significant increase in FCAS transfers between Tasmania and the rest of the NEM. These services are expected to become increasingly important as the NEM's energy mix transitions. Therefore, we encourage AEMO to include benefits from ancillary services in the modelling.

14. Peaking gas technologies

Hydro Tasmania's analysis suggests that it is increasingly likely (particularly with the transition to 5-minute settlements) that more responsive aero-derivative generation assets will be built in preference to OCGT assets. This trend can already be observed from proposed developments in the market. The need for such flexible assets will continue to increase as our system adapts to effectively integrate higher shares of VRE. As such, aero-derivative generation assets, rather than OCGT assets, should be included as an input into AEMO's modelling as the basis for fast start gas plants required for capacity. Hydro Tasmania also encourages AEMO to consider including fixed cost/s for gas transportation in the final IASR, considering early contracting requirements for peak period running.

15. Real vs. generic (modelled) development options

Candidate supply options for new developments consist of a mixture of real proposed projects, and "generic" opportunities. While it is necessary to have generic opportunities available to model, as not all possible future opportunities will have been identified, it is important to consider the relative credibility of various options. This is particularly important for technologies that are highly site dependent, such as PHES.

As Hydro Tasmania has outlined in other submissions, we believe precedence should be given to real identified projects over generic modelled generation development options. This should particularly apply where there is a credible proponent attached to a development who has already invested

[4] https://www.climatechangeinaustralia.gov.au/media/ccia/2.1.6/cms_page_media/529/ESCI%20WCR%20Scenario%20Workshop%202%20-%20July%202019.pdf – see figure 13 specifically

significantly in the site. To do this, AEMO could consider an appropriate threshold test, such as: feasibility studies; formal steps towards development approvals; material spend (e.g. greater than $5m); community information sessions and/or consultation.

16. Perfect foresight

The assumption of perfect foresight will substantially impact the outcomes of the next ISP. AEMO's modelling 'knows' what generation, demand, costs etc. will be at all times over the modelling period. As a result, both investment decisions and operational dispatch decisions will be made to perfectly minimise cost. In reality, without perfect foresight (and also perfect confidence to invest on the basis of perfect foresight) less optimal decisions will be made and more dispatchable and flexible supply options will be needed to minimise the cost to consumers.

The use of perfect foresight is particularly problematic for the assessment of the dispatch of energy-constrained resources, such as energy storage. Hydro Tasmania has over 100 years of experience in managing a power system reliant on hydropower, an energy-constrained supply. For fuel-based generation types, it may be sufficient to approximate them as having access to fuel when they need it, subject to fuel costs. However, energy storages need to make decisions about when to store and when to supply, based on uncertain forecasts.

Analysis by Hydro Tasmania has identified that with more realistic generation forecasts (e.g. daisy chaining of batteries to meet a VRE drought), more and longer duration storages are likely to be required to deliver similar system outcomes. To achieve a similar value to that predicted by a model with perfect foresight, a storage with 2-3 times the duration would be required when using real (imperfect) forecasts – and that is not including the relative price impact of scarce long-duration options. To this end, more work to accommodate the limits of perfect foresight on modelling is strongly recommended, and Hydro Tasmania would welcome continuing our collaboration with AEMO to resolve this dilemma.

Attachment B – Comments in response to CSIRO's GenCost 2020-21 Consultation draft report

1. Pumped Hydro Energy Storage (PHES) cost assumptions

We strongly support CSIRO's conclusion that Tasmanian PHES is of lower cost compared to mainland PHES. The report notes that, *"Tasmania 24 hour pumped hydro storage is 46% the cost of the mainland*." Based on our analysis this cost assumption should be applied to 24 hour storage as well as 48 hour storage (singled out in Figures 2-2 and 2-3 of the GenCost report). Hydro Tasmania recommends CSIRO include a 24 hour comparison for Tasmanian pumped hydro in both charts (Figure 2-2 and 2-3).

In December 2020, Hydro Tasmania announced Cethana as the preferred site for Tasmanian PHES development following completion of our initial feasibility work across three project sites, and has progressed the feasibility study on Cethana to an advanced stage. Due to the mature stage of this feasibility study, and the detailed analysis undertaken, Hydro Tasmania is confident of its PHES cost assumptions. Our latest analysis indicates with a high degree of confidence that Tasmanian PHES will cost in the order of $1.6 million to $2 million per MW (includes an amount for contingency).

We would also like to emphasise that PHES costs are heavily dependent on key physical site parameters. The hypothetical approach for storage costs in the GenCost report does not appropriately consider physical (i.e. geographical) attributes of potential PHES sites. The statement in the GenCost report; *"Tasmania 24 hour pumped hydro storage is 46% the cost of the mainland* ***owing to greater confidence in Tasmanian project cost estimates"*** [emphasis added], implies the costs can be lower because Entura (2018) have provided clear and well-modelled estimates. While that is the case, Tasmanian PHES costs are more competitive because of the physical site attributes the state's landscape provides, which most other projects will not be able to match. The cost of long duration PHES is heavily dependent on three site specific characteristics; high heads, short connection distances and site terrain that naturally lends itself to large storage volumes, all three of which Tasmanian sites provide in abundance.

2. Tasmania's proximity to Victoria

We support the GenCost report's assertion that *"the proximity to Tasmania's hydro resources means Victoria does not have to build as many storage resources locally"*. There is great potential value in the development of Marinus Link to mainland NEM jurisdictions, particularly Victoria. Interconnection between Tasmania and Victoria will be needed to ensure low-cost firming capability is available to Victoria as the state's coal-fired generation retires. Analysis shows that Marinus Link will be needed by 2027 (in a 2020 ISP step change scenario).

3. Economic life for pumped hydro

Hydro Tasmania also encourages the CSIRO to increase the assumed economic life for pumped hydro assets from 30 years to 40 years (see Attachment A, section 5, for further comments).

4. Contingency costs for batteries

To ensure modelling provides even and fair comparison between technology options and development pathways, the treatment of critical parameters should be the same wherever possible. An example of this is the inclusion of contingency costs. It does not appear that contingency costs have been applied to batteries in the GenCost modelling, while they have been included for all other

technologies. Hydro Tasmania considers that contingency costs should be applied consistently for fair comparison between all technologies.

5. Battery charge/discharge characteristics

The GenCost draft notes that *"Aurecon (2020) has revised the current capital cost of batteries downwards to around $300/kWh."* Hydro Tasmania queries whether this estimate includes realistic charge/discharge characteristics for batteries. Hydro Tasmania has been made aware that the product warranty for utility-scale batteries currently in use in the NEM mandates that the systems be operated in such a way that they are not discharged below 20 percent or recharged above 80 percent of their storage capacity. We would recommend to CSIRO that this charge/discharge range be modelled so that realistic battery cost assumptions can be made.