

2020 Integrated System Plan webinar - responses

This document provides a summary of participant feedback and the full QandA table from the ISP webinar held on 24 August 2020.

Quick summary

Active users: 196

Questions: 100

Likes/dislikes for the questions: 763

Poll votes: 49 responses

How useful today's webinar: 47% (4/5); 39% (5/5); 10% (3/5); 4% (2/5)

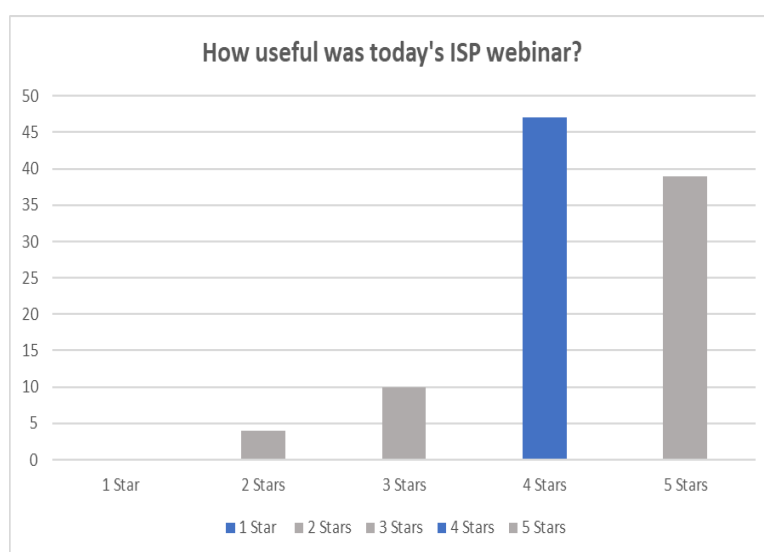
Feedback

What was most useful?

- Q&A.
- Great presentation, I particularly enjoyed the passing on of questions between the members of your team to best inform the audience and highlight expertise.
- It was great to hear about all the engagement in the 2020 ISP. I'm excited to be a part of the next one!

What changes would you make?

- Record session.
- Provide summary.
- I am not sure this instance really added value. Since the type of questions that can be asked is really shallow due to character limit and rating system, I would put the huge amount of panellists to reply to written questions for two hours (replies in a video format or something like that, to increase speed) rather having a large set of them in a deadlock for a good part of that window of time. Users then could check the questions and replies and rate them to help people find good questions and also useful answers.
- None – it was very good and very well done by the entire team.



Where can I find more information?

For further enquiries, please email isp@aemo.com.au

#	Questions	Answer
1	The NSW and QLD governments have recently committed to building new transmission to support REZs, separate to ISP scenarios. How do these plans affect the ISP?	<p>We have worked closely with the NSW government on its electricity strategy. Consequently, the Central-West Orana REZ transmission component is actionable to reflect the government's intentions. These plans are essentially strongly aligned with the ISP. The announcement on New England is still being developed.</p> <p>The QLD announcement was after release of the ISP. We understand it to be based on the ISP and we will work with the government and Powerlink Queensland to develop further.</p>
2	Will AEMO be providing both the questions and answers given today as a document after the webinar?	Yes, AEMO will be providing the Questions and Answers on its website and to participants of the webinar.
3	Could AEMO publish the questions and answers given after this webinar on its website please?	
4	The NSW energy security target imposes a generation reserve margin on top of existing mechanisms. How does this affect ISP cost and capacity modelling?	AEMO has not explicitly modelled the NSW energy security target, but has provided significant analysis demonstrating the reliability and security of the future power system (see Appendices 6 and 7).
5	Has the ISP modelled where deep storage is most valuable? My guess is that neither Snowy or Tassie makes the grade – best places are between generation and load.	Storage is optimised at a regional level in the capacity expansion stage of the ISP. This is then allocated sub-regionally according to REZ generation development and the ability for storage to reduce or avoid transmission augmentations. Please refer Appendix 5 for details.
6	Where is CopperString 2.0?	CopperString is a multi-billion dollar development outside of the NEM. If the proposals develop further with greater certainty, then this may be considered in the 2022 ISP.
7	Was CopperString 2.0 included as a sensitivity for the scenarios given Mt Isa is not in the NEM?	
8	Does the ISP consider grid forming (and other technical) capabilities of batteries displacing the need for costly transmission upgrades?	Non-network options are considered, including batteries as alternative. Please refer ISP Appendix 3 for details.
9	It is questionable that ISP builds only 3 GW renewables in for Central-West Orana REZ, given the resource availability is up to ~10 GW.	<p>In the 2020 ISP:</p> <ul style="list-style-type: none"> • There is significant resource availability across the NEM (200+ GW). Building generation in each REZ up the resource availability limit is not required as it would far exceed demand. • The actionable transmission project for Central-West Orana REZ (underwritten by the government) provides 3,000 MW of additional hosting capacity. This is aligned to the stage 1 of the REZ as per NSW Government. • Beyond this 3,000 MW of hosting capacity, an additional transmission expansion cost is applied to additional generation built in the Central-West REZ. for Central-West Orana REZ is still effectively 'competing' with the other REZ. • Depending on the scenario, the ISP projects additional generation of 3,000 MW in the Central scenario and 7,000 MW in the Step Change scenario.
10	The ISP assumes that energy storages are run optimally with perfect foresight. Have you assessed the impact of more "real-world" sub-optimal storage operation?	In summary, the modelling considers multiple weather patterns (reference years) down to half-hourly dispatch. This includes the natural weather variability in assessing the reliability of the power system. While storage management is optimally targeted, deviations due to unplanned events can occur, much like the real world (particularly given the availability of systems such as ST and MT PASA and EAAP that provide a forward view of supply, demand and energy availability).
11	How do you model the scheduling and control strategy of shallow, medium and deep storage when evaluating the capacity adequacy?	The ISP has assessed the reliability and operability of the power system, including the requirement for storage management. While storage management is optimally targeted, deviations to plan from unplanned events can occur, much like the real world (particularly given the availability of systems such as ST and MT PASA and EAAP that provide a forward view of supply, demand and energy availability). Appendix 9 and the Market Modelling Methodology report provides greater detail on the technical considerations within this assessment.

#	Questions	Answer
12	Thoughts on expansion of the NEM through HVDC transmission lines connecting east and west – is it viable? Good for greater geographic diversity of renewables?	At this time, the development of an east-west HVDC was not seen to be efficient compared to development within the NEM. The NEM has scope for a large amount of efficient development of comparable generation, with good diversity across regions between technologies available. The potential diversity is not considered to be sufficient to offset the additional cost of the east-west transmission lines.
13	ASEAN Power Link project is well underway and receiving government support. Why are interlinking states and neighbouring countries beyond your scope/model?	Sun Cable/ASEAN Power Link is a proposal to build a 3,700 km 2.2 GW undersea HVDC cable from Darwin to Singapore, and a 10 GW solar plant near Tennant Creek, combined with very large batteries at Darwin and Singapore. This is outside of the NEM (the NT is not part of the NEM) – the ISP is focused on the NEM. Further, the NEM has scope for a large amount of efficient development of comparable generation, with good diversity across regions between technologies available.
14	Are there signals for the model to install new storage at different REZ locations beyond varying costs, or is it done on a regional basis?	At the power system analysis stage of the ISP process, AEMO allocates regional storage to REZ/sub-regions according to REZ generation development and the ability for storage to reduce or avoid transmission augmentations. Please refer Appendix 5 for details. Notwithstanding this, there will always be scope for individual developers to invest in other areas – the ISP does not direct these developments.
15	Do any of the ISP models examine a pathway where the RIT-T is replaced with a more fit-for-purpose and broader Economic Benefit Test?	The 2020 ISP has been prepared using the new Cost Benefit Assessment guidelines of the AER. The RIT-T arrangements have also been amended to integrate with the actionable ISP rules.
16	Have you modelled performance of Snowy Hydro as deep storage during a protracted drought over at least 3-5 years?	The modelling included an explicit “drought year” within the reference year framework, representing one of the lowest inflow years since the NEM began. Low inflow yields are also observed in two of the eight other reference years. The respective scenarios also consider varying reductions in inflows as a response to climate change impacts. The ISP does not consider the impact of multi-year drought conditions; however, it also conservatively does not allow draw-down of hydro storages when inflows are low. While hydro yields are one consideration, Appendix 6 also examines the operability impacts across a range of conditions, including broader “VRE droughts”.
17	Did the ISP factor in potential hydrogen energy storage/hydrogen gas generation?	At this time there is insufficient clarity on policy for hydrogen to enable the rigorous modelling of potential development pathways required in the ISP. However, a qualitative assessment was provided that explored the dimensions of potential hydrogen development – please refer to Appendix 10 for details. AEMO will explore with stakeholders the appropriate inclusion of hydrogen as part of the scenario development for the 2022 ISP.
18	With all the inverter-based renewables being added to the grid, has system strength been considered, and if so, what will be done to prevent issues?	Yes, system strength issues have been considered extensively with shortfalls being quantified for each REZ (please refer Appendix 5), and available fault level projects being shown in Appendix 7.
19	The CSIRO GenCost report includes a carbon price in the model of future generation build rates and costs. Do the ISP assumptions include this carbon price?	The ISP does not use an explicit carbon price as an input.
20	Will synchronous condensers have a bigger role to play with more wind/ solar generation or will batteries with their synthetic inertia likely fill that void?	The need for system strength and inertia and frequency services are likely to increase as traditional synchronous machines retire, because the current NEM relies on these to provide the essential system services. However, in the future, AEMO expects a combination of technologies to meet those needs, not limited to synchronous machines, and a range of feasible technological solutions will be employed. Please refer Appendix 7 for more information. In addition, work by the ESB on post-2025 market design, and in particular arrangements for provision of security services, is relevant.
21	Oil prices have changed significantly including the outlook forecast from the EIA. Will you update your gas price assumption?	As part of the ISP timeline, consultation on the 2022 Inputs, Assumptions and Scenarios will commence ahead of the 2022 ISP modelling, and will include stakeholder consultation. Gas prices will be part of this update, reviewed and updated for the 2021 GSOO also.

#	Questions	Answer
22	Have you received "push back" from any stakeholders that the ISP's end-state can be reliable? E.g. 94% renewable?	The ISP notes the requirements that need to be satisfied to implement very high levels of inverter-based resources; for further information on the technical requirements and associated reforms in the markets and regulations, please see Appendices 6 and 7, and the Renewable Integration Study Stage 1 report (the outcomes of which were incorporated in the ISP).
23	Can AEMO provide clarity that the Central scenario is NOT meant to be seen as the most likely scenario?	The Central scenario presents projections under current policy settings and currently observed trends. A full description of the scenarios and their objectives is provided in Part B of the ISP.
24	Do you have data for future % of NEM rooftop solar (DER) energy generation that's curtailed because of over-supply when it's sunny and demand is weak?	The ISP's modelling does not directly model the curtailment of rooftop solar generation. It instead dispatches down dispatchable generation and if needed also constrains the output of utility VRE to balance the power system. Please refer Appendix 6.3 (https://aemo.com.au/-/media/files/major-publications/isp/2020/appendix--6.pdf?la=en), which outlines that overall utility VRE curtailment is expected to not exceed 4.2% in the Central scenario, subject to timely investment in storage, transmission and associated infrastructure for power system services, and the flexible operation of thermal power supplies. This forecast curtailed generation could potentially occur at the DER level instead.
25	Is AEMO concerned about the potential for community opposition to large transmission projects (like we're already seeing with the WVTNP)?	The relevant TNSP will engage with communities, landowners, and first people representatives, as part of the design, routing, and planning and environmental approvals for each and every transmission project. Should this result in material changes to the design or cost of the projects, the NER provide for a feedback loop for AEMO to reassess the project as part of the optimal development path in light of these changes.
26	Do the ISP databases include any MLF forecasts?	Appendix 5 contains an assessment of MLF robustness for each REZ.
27	Investors and developers have been burned by a hostile regulatory framework and connection issues. Is anything expected to change? If not, who will invest?	The objective of the ISP is to provide a clear roadmap for future development of generation that is integrated with any requisite network, to the efficient levels. The optimal development path is intended to provide greater certainty of coordinated and planned future development.
28	Has there been much collaboration between AEMO and DISER, i.e. feeding into each other's publications the ISP and Technology Investment Roadmap respectively?	AEMO's 2020 ISP followed the AER's CBA guidelines, which prescribe extensive consultation for development of inputs and assumptions on technology – AEMO undertook eight months of consultation on these in 2019 and used the outcomes in the 2020 ISP. AEMO will revisit the inputs in 2021 and will integrate recommendations as relevant from the Technology Investment Roadmap in this process.
29	Will you be refining the scenarios for the 2022 ISP?	Yes – consultation on the inputs, assumptions and scenarios are a key element of the 2022 ISP Timeline. Stakeholder engagement will commence in Q4 2020, and formal consultation will proceed from approximately December 2020 to February 2021, before concluding the assumptions and scenarios to apply for the 2022 ISP by June 2021.
30	Can increased interconnection of around 6 GW really be considered 'dispatchable'/equivalent to 8 GW of new gas peakers?	The NEM currently dispatches both interstate and local regional generation up to constraints. The ISP recommends the most efficient mix of technologies and resources across the shared network, including interconnection. The increased capacity to share resources will enable efficient utilisation of geographically distributed resources between regions,
31	Why hasn't the ISP factored in offshore renewable energy sources, particularly wind?	The ISP has considered the development of offshore wind resources, in particular in the Gippsland REZ. This is included in the REZ assessments in Appendix 5.
32	In the 2019 draft ISP, the initial development of the Far North Queensland REZ was a 'phase one' priority, but now it's dropped off. Why is that?	The development priority for REZ in each region is driven by: <ul style="list-style-type: none"> • State and federal policy settings. • The efficient and optimal development of resources combined with required network, to provide reliability and security. The Final ISP did not highlight FNQ as a Phase 1 project, however there was generation projected to be built there by 2030. The analysis highlighted concerns for significant expansion of FNQ, as the REZ is a long distance from load centres with significant

#	Questions	Answer
		network constraints between, poor MLFs, losses, and system strength. Significant network investment will be required to realise large developments in the area.
33	Will the 2020 ISP Plexos model be published (i.e. xml files like ESOO)? Currently can only see OPSO and Solar/Wind traces.	Yes – AEMO has recently published the PLEXOS expansion planning model (the Detailed Long Term [DLT] model) and its companion input traces on the ISP webpage.
34	Some states will become less self-sufficient following evolution a la ISP. Does the leadership in those states understand this, and are they OK with it?	The ISP assumes all legislated state and federal policies and is based on delivery of the objectives of the National Electricity Rules. The ISP optimises the future power system as an integrated system plan, delivering the NEO for efficient outcomes for consumers. AEMO engages regularly with governments during the development of the ISP to ensure alignment with requirements and regional policy objectives.
35	In the capacity outlook model, does it only consider inter-connector limits in a 5-node model, or does it capture some key intra-regional limits?	The Capacity Outlook model includes the notional inter-regional transfer limits that are appropriate under peak demand conditions. It also includes the key intra-regional transmission capability between the Snowy region and Sydney. In addition, the model captures the hosting capacity of REZs within the existing network, with the application of financial penalties to expand beyond the existing hosting capacity commensurate with the cost associated with the scale of intra-regional augmentation transmission required. Please refer Appendix 9 for more information on the modelling approach.
36	How likely is it that AEMO will be able to utilise DER when operating the NEM? And have these costs been accounted for in the 2020 ISP?	Limits on power system operation as a result of high levels of DER are integrated within the modelling (for example, security constraints), and the ISP assumes as a requisite that the recommendations of the RIS Stage 1 report are implemented – including in particular changes to regulations, market reforms, and evolved arrangements for load management. AEMO has parallel workstreams underway to leverage DER in the NEM, as part of the ESB, and in collaboration with networks and service providers. Please refer Appendix 4 (scenarios, High DER) for more details.
37	Do the ISP scenarios include consideration of FCAS costs? Are FCAS costs expected to decline with increased storage capacity in the NEM?	The ISP does not directly model FCAS costs, rather, the outcomes of the ISP can be utilised to assess potential future FCAS prices under different scenarios and technology projections. In general, the ISP signals the need for new resources to replace retiring thermal generation in the next two decades – not just the capacity and energy, but critically, the security services and governor/frequency controls that these units implicitly provide in today's NEM will need to be provided by the new replacement technologies. A number of other factors influence FCAS costs, including competition in FCAS markets. While levels of competition are not within AEMO's control, AEMO is taking some actions to increase competition – for instance , through Virtual Power Plant trials.
38	Given the critical role of gas in firming, can you explain where this gas will come from, with particular reference to the chart on Page 57 of the ISP.	The ISP complements the analysis provided in the 2020 GSOO, which identifies that while gas supplies are in decline for southern fields, new gas infrastructure (new gas fields, pipelines, import terminals etc) can support continued adequacy. However, if gas supplies are not forthcoming, LNG exports may need to reduce to support domestic consumption needs, as would be required by the Australian Domestic Gas Security Mechanism (ADGSM). Please refer to the 2020 GSOO, chapters 4 and 5, for more detailed gas supply/demand balance information.
39	Re answer to question on where new gas come from, the answer did not explain how Qld would deliver the 1,000 PJ in 2038-39 and 2039-40 as per page 57 of ISP.	The ISP has not identified the precise source of new gas supply required in the long term, however as noted above, if gas supplies are not forthcoming, LNG exports may need to reduce to support domestic consumption needs, as would be required by the Australian Domestic Gas Security Mechanism (ADGSM). Please refer to the 2020 GSOO, chapters 4 and 5, for more detailed gas supply/demand balance information.
40	The ISP refers to the prospect of low gas price, eg page 12, but worksheet shows high prices. How do you reconcile this difference between ISP and worksheet?	While gas prices may currently be at low prices in response to lowering global consumption from COVID-19, the long-term price of gas in the ISP is assumed to return to pre-COVID-19 levels which are much higher (above \$8/GJ) as shown in the Inputs and Assumptions Workbook. With high gas prices, the role for new gas generation is expected to be limited, as demonstrated in the ISP, however existing gas generation will have a key role, and possibly a larger role than modelled if able to secure gas supplies at lower spot prices.

#	Questions	Answer
41	What is the impact of considering extreme weather conditions and the heatwaves which Australia is facing in the summers?	Given the extent of power system vulnerability to heat, AEMO has considered this factor extensively in the quantitative modelling that informs market benefits, reliability and operability assessments. In the 2020 ISP Appendix 8, AEMO explored the impacts of extreme weather further, reporting that "AEMO remains confident that the optimal development path will strengthen the resilience of the energy system" but that "additional actions and investments are required to avoid further decline in resilience over time". The appendix documents actions proposed for more comprehensive consideration in the 2022 ISP.
42	How are the 31 years of wind/solar/ demand traces derived from each reference year? Does this maintain the original correlations between the wind/solar and demand?	AEMO applies two alternative methods, as described in the Market Modelling Methodology Report: <ul style="list-style-type: none"> • In Capacity Outlook modelling, AEMO applies a 'rolling reference year' approach, rotating between the eight historical reference years and the additional 'drought year'. • In time sequential modelling, AEMO models all reference years for each simulation year, ensuring that all weather patterns are part of the detailed assessment. To develop the traces, original weather correlations between temperature, wind, solar generation, water inflows, network line ratings (where applicable) and consumer energy consumption patterns are maintained.
43	The ISP calls for new dispatchable capacity, but the market may not reward this investment. Will future ISP central scenario include coal-power life extension?	The ISP projects the most economically efficient future mix of resources that also meet federal and state policies on renewables and emissions reduction, using least cost modelling. The Central scenario will be informed by the closure dates for generation provided by the generation owners and operators. While that remains the best information it will be applied, however AEMO will consult on the inputs, assumptions and scenarios ahead of modelling the 2022 ISP.
44	Do you take into account the trade-offs between transmission investment (inter- and intra- regional) and storage for managing operational flexibility constraints?	The ISP fully optimises the mix of generation, storage, and network. The outcomes are the most optimal mix of alternative technologies. Please refer Appendix 9 for more information on the modelling approach.
45	There's a large push for the proposed Western Victoria transmission line to go underground. Is this technically feasible? Are undergrounding costs included in modelling?	AusNet Services is assessing all economic options for this project. Please contact https://www.westvictnp.com.au/ for more information.
46	The impact of EVs/renewable exports (NH3/H2) on demand is enormous (>50 TWh/yr) – would this change group 1 transmission decisions (e.g. higher capacity lines)?	In the 2020 ISP, there was not sufficient clarity on policy for detailed modelling of hydrogen development pathways, so AEMO considered the potential development of hydrogen qualitatively (please refer Appendix 10). It was not expected that any of the currently actionable ISP projects would be impacted. AEMO intends to develop a hydrogen scenario in the 2022 ISP to examine future requirements in more detail.
47	Does ISP 2020 design factor in the significant increased electricity demand arising from the switch from petrol-powered to electrically-powered motor vehicles?	The ISP scenarios include consideration for the potential electrification of the transportation sector within the electricity consumption forecasts, including the charging behaviours that may impact on peak demands. Given the uncertainty of the speed and scale of the transition away from internal combustion engine vehicles, the scenarios provide a relatively wide range for this significant emerging sector. Further information on the demand forecasts is available in the Inputs and Assumptions Workbook, and the 2019-20 Scenarios, Inputs and Assumptions Report at (https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/inputs-assumptions-methodologies/2019/2019-20-forecasting-and-planning-scenarios-inputs-and-assumptions-report.pdf?la=en).
48	A larger limit for question entry would have been useful.	Thank you for your feedback. AEMO is reviewing the applications used for webinars and will take this into account.
49	Given the potential for growth of energy-intensive industry, will the 2020 plan include scenarios that go beyond the 100% renewables?	AEMO will commence consultation on the scenarios to apply in 2021-22 publications, including the 2022 ISP in Q4 2020 and Q1 2021. AEMO has released an Expressions of Interest to stakeholders to register their interest in participating in this critical activity. If you are interested in engaging with us, please complete this form , or contact forecasting.planning@aemo.com.au .

#	Questions	Answer
50	What equity returns are assumed for developers of renewable energy and transmission, given regulatory, political and system risk have dramatically increased?	AEMO models the development outlook by optimising the least-cost development mix of generation and transmission solutions to meet the forecast energy needs of consumers. The evolution of the NEM market structure may be informed by the efficient development outlook forecast by the ISP. The return on investment for any individual asset or asset class is not considered, and AEMO applies a consistent weighted average cost of capital assumption for all technology classes. Refer to Appendix 9 for further information on the ISP Methodology.
51	Do you publish data of the exact locations of committed and publicly announced (etc.) projects? Useful for developers trying to assess MLF/congestion risk.	While exact coordinates of developments are not published, AEMO does publish a description of generator site locations in the Key Connection Information (KCI) datafile. Please refer to the KCI datafile within the Generator Information page: Key Connection Information Datafile 22 July 2020.
52	For what I have been able to read in the report and appendices, it seems like VPPs are modelled as an aggregation of distributed batteries. Is this correct?	That is correct – the ISP assumes a proportion of distributed batteries are available for coordinated operation. The degree of aggregation varies across scenarios.
53	Is the per-state storage development forecast available?	Detailed generation and storage development outlooks are available by region in the Generation Outlooks file at (https://aemo.com.au/-/media/files/major-publications/isp/2020/final-2020-isp-generation-outlook.zip?la=en)
54	The RIS has several actions to enable instantaneous VRE up to 75%. Did the ISP consider all the required actions to enable 96% average VRE in the Step Change scenario?	The ISP projections assume that all the recommendations of the Renewable Integration Study Stage 1 are undertaken. Further work is continuing to discern additional requirements to implement very high levels of IBR penetration in the transmission and distribution systems.
55	Have you estimated the expected investment in transmission needed to achieve ISP goals? What is the comparison of cost and benefits?	Extensive assessment of costs and benefits is provided in the ISP. Please refer Parts D and E of the ISP, and Appendix 2.
56	To what extent has ISP stress tested a power system so dependent on the weather, including half of (declining) dispatchable capacity and increasing maximum demand?	Extensive assessment of the operations of the power system with increasing renewable energy penetration has been performed with the capacity outlook and time-sequential market models, as well as detailed engineering analysis. These assessments were performed against a range of weather and climate conditions, taking into account realistic combinations of temperature, rainfall, windspeed and solar intensity. Please refer Appendix 6 for further details.
57	Does the ISP model account for the potential risk to consumers, through increasing electricity prices, from stranded regulated assets (eg transmission infrastructure)?	The ISP identifies the economically efficient mix of generation and transmission assets to meet the evolving needs of consumers, and particularly in response to the evolving thermal generation fleet. Transmission developments are strongly linked to the retirement of existing generation assets and the efficient replacement of these resources. Decision rules regarding actionable transmission investments are designed to minimise risks of under- or over-investment in transmission solutions and reduce risks to consumers.
58	How does the change to the reliability standard by COAG from 0.005% to 0.0006% earlier this year affect the ISP?	Assessment of the reliability of the power system is provided in Appendix 6 (see Section A6.3). While the Interim Reliability Measure (0.0006%) is only intended to cover the period to 2025, AEMO has also assessed reliability against this measure throughout the modelling horizon on the assumption that any future measure that replaces the IRM will have a similar requirement to ensure the electricity system remains reliable during a 1-in-10 year summer.
59	Do retirement dates for coal take into account that Victorian generators have a longer time notification to Victorian Government than specified in national rule?	Retirement dates for coal generators modelled in the ISP are as per the Generation Information page – owners are required to provide this information under the NER. In scenarios that identify earlier closures than provided by generators to meet decarbonisation requirements, the analysis captures the requirements for notice period, including the longer 5-year closure notification period for Victorian generators.
60	Does the model consider combined gen and TUOS costs (eg solar in Latrobe valley is less efficient but may be lower cost than farm in REZ with new transmission)?	The ISP identifies the economically efficient mix of generation and transmission assets to meet the evolving needs of consumers, and particularly in response to the evolving thermal generation fleet. Generation and transmission investments are co-optimised to ensure that the total system costs are minimised and REZ developments (and supporting transmission infrastructure) are optimally developed considering the needs of the transmission system.

#	Questions	Answer
61	Does the ISP 2020 factor in the increased electricity demand (both peak load and total) arising from the possible phase-out of natural gas for residential use?	The electricity consumption and peak demand forecasts do include assumptions of fuel-switching from consumers shifting from gas to electric appliances (particularly for space heating). While this has a minimal impact on annual peak demands (which typically occur on the mainland during summer months), annual energy consumption considers the overall increased electric appliance usage. The degree of fuel-switching varies across the scenarios. More information on gas-to-electric fuel switching outlook included in the forecasts is available in the 2020 GSOO.
62	Has there been a factoring in of the transition of home heating from gas to air-conditioning?	
63	Will the ISP development and REZs location indicate the new pricing nodes in the regional market?	The ESB and AEMC are considering the outcomes of the ISP when developing the post-2025 market reforms.
64	How does the ISP align with/achieve the stepped (2025/2030/2050) emission targets for each state in the NEM?	<p>The ISP considers in the Central scenario the policies that have met key criteria (funding, legislation, COAG direction etc) as described in the 2019-20 scenarios, inputs and assumptions report. The Central scenario therefore targets explicit achievement of the Federal emissions reduction objective of at least 26% economy-wide by 2030, with the NEM taking a pro rata share. The various state renewable energy targets (VRET, QRET) also contribute to near-term renewable generation development, which will lower the emissions intensity of the grid.</p> <p>In other scenarios (Fast and Step Change), AEMO includes carbon budgets to achieve a stronger decarbonisation outcome for the NEM.</p>
65	Are the only "deep" storages considered in this ISP Snowy 2.0 and Battery of the Nation?	Deep storages are defined in the ISP as those storages offering 24-hour or greater storage. This includes the Snowy 2.0 and Battery of the Nation developments, as well as 24-hr and 48-hr pumped hydro systems identified in the Inputs and Assumptions Workbook.
66	Does the ISP include consideration of grid-forming (and other technical) capabilities of batteries delaying/ displacing the need for transmission upgrades?	<p>Non-network technologies have been and are being considered as part of the assessments in the ISP and subsequent RIT-Ts to reduce or defer the need for network builds.</p> <p>In many cases, the transmission builds in the ISP's optimal development path are based on economics of dispatch and unlocking the capacity and energy provided by REZs to replace retiring generation; network is needed as these are remote from load centres.</p> <p>However, the projection of very large REZs will require extensive integration of grid-forming capabilities along with other security services from inverter-based resources.</p>
67	Has the latest development of Primary Frequency control requirement on all generation contributed to the ISP? Frequency control of NEM?	While it was taken into account when undertaking engineering assessments of the outcomes, this was not directly modelled in the ISP.
68	Will the interactive map include the location of new/proposed solar, wind, battery projects?	AEMO is intending to augment the interactive map to show this in the near future, along with other information on REZs, subject to resourcing and priorities. The ISP provides more information on projected amounts of VRE in each REZ; please refer Appendix 5.
69	In terms of managing peaks and troughs in demand, what is the role of demand response in the ISP scenarios?	The ISP considers the availability of demand response through the growth in demand side participation capacity. This assumes a price-triggered response to reduce demand at various price levels, including at extreme price levels to avoid unserved energy. More information on the operation of DSP is available in the Market Modelling Methodology report, and the outlook for DSP across the scenarios is included in the Inputs and Assumptions Workbook.
70	Pumped hydro (PHES) is very site specific. Will the 2022 ISP include REZ-level analysis of PHES \$/MWh (similar to LCOEs given for wind and solar for each REZ)?	AEMO is considering changes to inputs and assumptions suitable for the 2022 ISP, including consideration of PHES availability and costs. AEMO will consult with stakeholders on changes to the inputs, assumptions and scenarios in Q4 2020 prior to commencing the 2022 ISP modelling.
71	Has jurisdictional risk (i.e. states not freely sharing energy) been considered when arriving at the optimal development path?	The ISP optimises the future power system as an integrated system plan, delivering the NEO and the objectives of the NEM as a whole.

#	Questions	Answer
72	What is AEMO's view on the NEM outlook if there is a prolonged economic downturn due to the COVID?	The ISP's Updated Demand sensitivity examines the impact of updates to electricity forecasts from the 2020 ESOO, capturing the estimated impact of COVID-19 as well as the record distributed PV sales observed in 2019.
73	Has the Tasmanian drought a few years back been considered in the ISP to avoid heavily relying on hydro generation, such as Snowy 2.0?	The ISP includes consideration of eight different weather patterns (reference years) for each of the last eight financial years (2010-11 to 2018-19). Low inflow yields are observed in two of the eight reference years. In addition, an explicit "drought year" is modelled, representing one of the lowest inflow years since the NEM began.
74	The interactive system map is very useful. What do the colour codes for the 2019-20 System Normal Congestion relate to?	The graphic provides a heat map that indicates areas of relative congestion. The shading refers to the number of 'binding hours' for the constraint representing network limits in the area, with red representing the most hours binding. The more binding hours, the more hours that network limit is causing congestion. For further information and quantities of binding hours see AEMO congestion information resource at https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/congestion-information-resource .
75	Congratulations on the outstanding depth and strategy in the ISP. Was energy from waste considered as part of the ISP?	Wood waste biomass generation is a candidate development technology, but not found to be developed within the least cost generation mix. Other biomass technologies (such as waste to energy facilities) have not been considered.
76	Will the 2022 ISP take into account resilience, eg impact on REZs and rooftop solar from hailstorms, droughts on hydro and PHS, high temperatures on wind output?	The 2020 ISP considers resilience to climate change and other factors; please refer Appendix 8 for more information. This appendix includes the additional actions proposed to better consider resilience in the 2022 ISP, including: <ul style="list-style-type: none"> • Further quantification of climate change and extreme weather trends in economic market benefits, reliability and operability assessments, and • A selection of extreme weather case studies to stress test the system beyond normal operating conditions for differentiating between more and less resilient risk management solutions. AEMO will incorporate its 2022 approach in the ISP Methodology, to be consulted on ahead of the 2022 ISP modelling.
77	Given the chart showing major seasonal requirement for deep storage, it seems surprising that the ISP only indicates 2 GW. Won't we need more?	The ISP co-optimises the development of renewable energy and the storages needed to support the variability in production. With flexible operation of the existing generation fleet (including coal, gas and hydro assets), as well as new developments in a range of storage solutions, the ISP modelling has demonstrated the resilience to seasonal variability with the developments forecast. Appendix 6 provides more information regarding the operation of storages in future.
78	Although not part of AEMO's brief, to give us some feel, what is the likely cost of the associated new generation works (by others) over the 2020-2050 period?	Appendix 2 provides significant detail on the Cost Benefit Analyses performed in the ISP. This includes detailed breakdowns of net system costs across the horizon of developing transmission relative to the counterfactual without transmission development. The Generation Outlooks zip file also provides detail of the costs in each scenario, including generation capital investments.
80	Given the significant slow-down in renewable investment, what is AEMO doing to ensure the post-2025 market design delivers the investment assumed by the ISP?	AEMO is supporting the ESB and market bodies in the development of post-2025 market design.
81	Have community microgrids and virtual power plant been taken into account in dispatchable resources? Has any off-grid trend in the community been considered?	The 2020 ISP did not consider explicit off-grid shifts in energy consumption, however, the development of behind-the-meter storages are a key feature of each scenario. This includes assumptions on storage aggregation into VPPs. More information on the DER forecasts, including VPPs, is included in the 2019-20 Scenarios, inputs and assumptions report, and the Inputs and Assumptions Workbook.
82	What modelling has been done using "published start times" of ALL "publicly announced" proposed generation projects since ISP only include committed projects	The ISP includes all committed and anticipated projects, as included in the February 2020 Generation Information update. This includes projects which have demonstrated progress towards three of the five commitment criteria. Details on the anticipated projects are included in the Inputs and Assumptions Workbook.

#	Questions	Answer
		The ISP does not include all 'publicly announced' projects, but the scale of the project development pipeline has influenced the limits of technologies available in REZs.
83	Is the RIT-T process fit for purpose given it has not delivered the type of large greenfield, transmission infrastructure required in a short timeframe?	The objective of the ISP is to provide increased certainty with a clear roadmap for future large-scale development of new generation, storage, and associated network.
84	What is the role of demand response programs as a non-network solution?	Demand response is considered to be part of a portfolio of possible non-network options to address identified needs in part for actionable ISP projects, along with other technologies.
85	Have outcomes from the RIS been factored into ISP scenarios/ recommendations? eg. have limits of instantaneous VRE informed investment/operability conclusions?	The outcomes of the draft ISP were used for modelling in the RIS. The outcomes of the RIS were integrated in the analysis for the final ISP – please refer Appendix 7 for more information in specific areas.
86	Growth in demand side participation (DSP) is minimal even in the high DER scenario. Keen to understand the assumptions/thinking behind this modelling?	The forecast level of DSP varies across the scenarios. The rationale for the projection is in the 2019-20 Scenarios, Inputs and Assumptions Report. The report explains that, based on a review of international literature and reports of demand response potential (primarily in the US and Europe), DSP growth expands to an upper estimate of approximately 8.5% of maximum demand.
87	Finkel recommended the resigning of the Australian Energy Market Agreement by mid-2018. Does ISP assume it will be resigned and states will not go their own way?	The ISP is undertaken on the basis of current governance, policy and market arrangements, including the Australian Energy Market Agreement; however, the ISP outcomes rely on reforms currently being investigated as part of the post-2025 market development being implemented, particularly in respect of future security services.
88	Did the ISP account for the dynamics of the Snowy dam system (if 2.0 ran for a week most would not be able to be pumped back up (lost downstream)?	AEMO collaborated with major hydro scheme operators (Snowy Hydro and Hydro Tasmania) to calibrate the inflow assumptions across reference years for existing hydro facilities, and the operational capabilities of the Snowy 2.0 scheme.
89	By AEMO explicitly determining limits for where they believe generation will be located, ie AEMO's answer to the CW NSW 2build outcome, doesn't this then flow through to what transmission augmentations are required to be but particularly TLs between regions? If more gen in CW REZ then other TLs not required.	AEMO does not explicitly determine the network limits. More generation (above hosting capacity provided by the actionable project) can be built there as long as the transmission expansion cost is applied, the same as all REZs. The transmission limit is separate from the resource limit, which represents the upper bound for generation in each REZ.
90	The demand-supply graph showed significant gas-powered generation in 2035. What were the trade-offs between gas-powered peakers and batteries in the ISP model?	AEMO's modelling shows that while there is a large development need for new storage capacity of various depths to complement renewable energy developments, the role for existing gas generation is still considerable to meet the flexibility requirements of the future energy mix.
91	If the central scenario unfolds, will Marinus Link progress?	The decision rules applicable to actionability of MarinusLink are detailed in part E of the ISP.
92	How is the Central-West Orana REZ modelled in the ISP?	The network associated with Central-West Orana REZ is regarded as no regret, with government underwriting that investment should it not pass the RIT-T. The modelling then determines the optimal development of resources in that REZ, with specific sensitivities undertaken to examine faster delivery.
93	Does AEMO publish data for offshore wind quality, as well as for onshore wind?	AEMO has provided wind traces (including off-shore wind at Gippsland, and solar and demand traces) as part of the 2020 ISP Database materials, at https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2020-integrated-system-plan-isp/2019-isp-database . Offshore projects are also included in the REZ assessment for the Gippsland REZ (as outlined in Appendix 5).
94	Are there any existing renewable projects operating outside the REZs identified in this ISP? If so, what will happen to these projects?	The ISP captures all existing, committed, and anticipated developments, and then projects future developments of renewable projects. The ISP aligns these in REZ to realise efficiencies of scale for cost savings to consumers. The ISP does not, however, dictate where renewable developments will locate. Where projects lie outside of REZs,

#	Questions	Answer
		future development of any shared network would be considered on a case-by-case basis by the TNSP and AEMO.
95	Can you outline what definitions/ parameters apply to your modelling of 'dispatchable' storage?	The Market Modelling Methodology Report outlines the approach to modelling all generation technologies, including energy storages. The technical parameters for the ISP are also included in the Inputs and Assumptions Workbook.
96	Regarding reliability impacts, have you assessed the impact certain storage technologies coming online (or not) will have on likelihood of lost load?	Appendix 6 provides assessments of reliability across snapshot years for the Central and Step Change scenarios. This includes the reliability with the collection of generation and transmission developments. The ESOO provides reliability assessments of the NEM without anticipated and future generation and transmission projects.
97	When is the ISP going to be updated with the updated behind-the-meter capacity?	The ISP's Updated Demand sensitivity examines the impact of updates to electricity forecasts from the 2020 ESOO, capturing the estimated impact of COVID-19 as well as the record distributed PV sales observed in 2019. The 2022 ISP will update assumptions regarding DER developments, and will be consulted with stakeholders before modelling commences.
98	The NEM has delivered well with surplus dispatchable capacity. The ISP has little safety margin. Shouldn't we ensure surplus capacity at all times?	The ISP complies with the Cost Benefit Analysis framework developed for the Actionable ISP by the AER. This means AEMO's development path must consider the efficient development of generation and transmission assets at lowest cost to consumers. This includes the optimal amount of efficient new development, considering the variability of new resources and need for firming supplies. The least regrets decision framework that AEMO has applied has identified actionable transmission projects with decision rules to minimise risks to consumers.
99	Does AEMO have any internal projection or expectation for beyond 2042?	The ISP forecasts the development opportunities to 2050 within AEMO's Integrated Model (IM), which co-optimises development of the electricity and gas systems, considering the interdependencies between each system. The model determines optimal thermal generation investments, retirements, transmission, gas field and pipeline investment plans, over the longest time horizon (25 years or beyond). This model is relatively coarse, and is validated and verified by AEMO's Detailed Long Term (DLT) model. AEMO's DLT model has been simulated to 2041-42 only. More details on the modelling approach taken for the ISP can be found in Appendix 9 and the Market Modelling Methodology document.
100	Regarding the methodology: Given that a 12-hour storage asset can also provide 2-hour storage, how does the modelling allow for this?	A deep storage facility is not restricted to solely operate as a seasonal storage management solution, and is able to charge and discharge within its technical operating envelope with the frequency expected of a shallower facility. As such, a deep facility is modelled as being able to provide daily energy management.
101	Regarding the methodology: No generation technology brings only electrons. All have other services they provide as well. For instance, pumped hydro can significantly reduce the cost of transmission lines by smoothing output from the various REZs, while also reducing the investment needed in synchronous condensers by providing inertia and system strength. How does the modelling allow for these different benefits?	This is true. AEMO has considered the services that each technology can provide as part of the assessments. While the modelling does not (yet) adequately cost and compare technologies based on services, the outcomes are assessed. It is also worth noting that many services previously provided by physical synchronous machines are now developing in inverter based alternatives. Additionally, the work by ESB on post-2025 market design, and in particular on system services, is assumed as a basis for the ISP projections.
102	Regarding the methodology: To what extent does the ISP consider the project pipeline? For instance, it appears to consider >5GW of wind in QLD and <2GW of solar, however the current project pipeline is >12GW solar and <2GW wind.	The 2020 ISP does not give much consideration to specific implementation requirements. As these may give rise to increased costs and risks of delay, this is one priority for the subsequent work. The requirements for concurrent implementation of major projects (transmission and REZ scale generation development) will influence timing and cost. As a result, AEMO is currently engaging broadly with industry on the issues around scarcity pricing of critical personnel and equipment, "implementability", and examining the potential to smooth developments to reduce bottlenecks, improve

#	Questions	Answer
		long term employment, and reduce overall costs. This will be included in the development of the 2022 ISP.
103	<p>According to the ISP 2020 Report, the total capital cost of the recommended transmission new/upgrade works across the NEM is of the order of \$30 billion.</p> <p>Associated with these works, numerous new public/private investments in generation, distribution and storage assets, and demand side developments all aimed at reconfiguring the NEM to deliver say a zero emissions outcome by 2050, will be required</p> <p>Although not necessarily part of AEMO's brief, to give us some feel for the total size of the task ahead, what is the likely order of magnitude – to say the nearest \$100 billion – of the cost of these extra NEM-wide works over the 2020 - 2050 period?</p>	<p>The total cost of the actionable ISP projects and future projects modelled in the ISP is \$13 billion.</p> <p>As detailed in the ISP including its appendices, the optimal development path provides the most economic future development of the NEM. Approximately \$11-25 B of future investment is required in the NEM (depending on the scenario) to replace retiring generation and meet emissions reduction and renewable energy targets. By adopting the ISP's optimal development path, the ISP has demonstrated that consumers could be \$11B on average better off.</p>