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Australian Energy Market Operator
Level 22, 530 Collins Street
Melbourne VIC 3000

Submission by email to: ISP@aemo.com.au

INTEGRATED SYSTEM PLAN CONSULTATION PAPER

Snowy Hydro Limited welcomes the opportunity to comment and provide feedback on the Integrated System Plan (ISP) consultation paper.

Snowy Hydro Limited is a producer, supplier, trader and retailer of energy in the National Electricity Market ('NEM') and a leading provider of risk management financial hedge contracts. We are an integrated energy company with more than 5500 megawatts (MW) of generating capacity. We are one of Australia's largest renewable generators, the third largest generator by capacity and the fourth largest retailer in the NEM through our award-winning retail energy companies - Red Energy and Lumo Energy.

Snowy Hydro supports the primary objective of the ISP which is to consider the material issues caused by the energy transition and evolving generation mix, and to identify the most efficient pathways to deliver continued reliability and security in the NEM under a range of scenarios.

The Changing NEM

The dynamics and the economics of the NEM are becoming more complex as the generation mix moves to more renewable generation, which is characterised by intermittency.

Figure 1 illustrates the change that is occurring. It shows the generation pattern for a typical week in 2017 and that projected in 2025 based on current renewable energy policies (LRET, VRET and Queensland 50% by 2030). The figure shows generation by fuel type, with the yellow area being large-scale intermittent wind and solar generation.

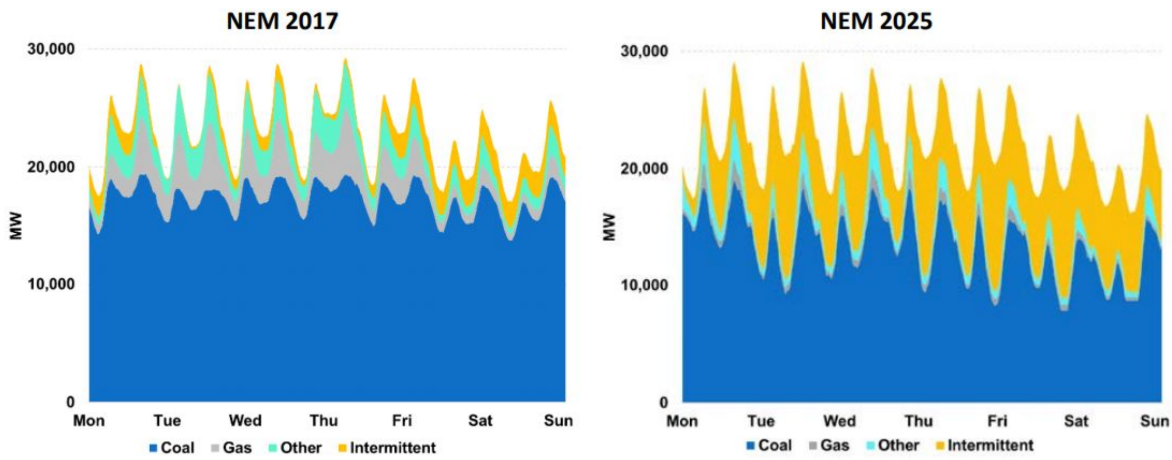

Figure 1: NEM generation, typical week in 2017 and 2025 (projected)
Source: Marsden Jacob Associates

Wholesale Market Dynamics Under Increasing Intermittent Generation

Supply reliability is based on matching generation and demand at all times, and that requires dispatchable generation to be economic and available when required. Because renewable generation has very low production costs once built, those generators will generate before coal and gas fired generators. This means that the demand to be supplied by coal and gas fired generators will be the residual demand after low operating cost intermittent generation is dispatched (unless renewable generation is reduced for system security reasons).

The residual demand to be supplied by dispatchable generators has been termed ‘dispatchable demand’ (defined as scheduled demand less generation from all large-scale renewable generators). The profile of dispatchable demand will increase in volatility as the amount of intermittent forms of renewable generation increases.

Based on reasonable projections of the penetration of solar PV (both rooftop and large-scale) and wind generation, by 2030 and on a state-by-state basis, the residual demand supplied by dispatchable generation has the potential to vary from near zero (when renewable generation is very high) to very high levels (when renewable generation is very low).

This is demonstrated in Figure 2, which shows the average daily profile (solid line) and potential variation from that profile (shaded) of dispatchable demand for 2016 (historical), 2023 (projected) and 2030 (projected). Increased intermittent generation can result in a very large range of demand levels to be met by dispatchable generation.

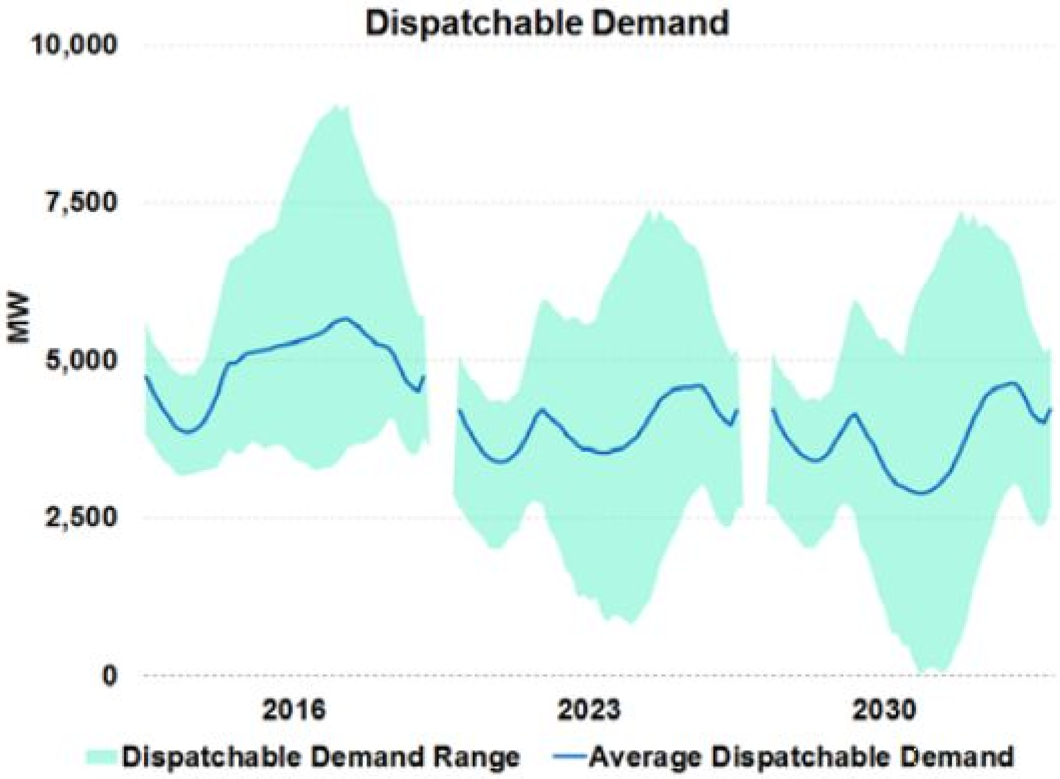

Figure 2: Profile and spread of scheduled and dispatchable demand – Victorian Summer (MW). Source: Marsden Jacob Associates

Renewable Energy Zones and the Need for Complementary Large Storage

AEMO has performed good analysis capturing the range of potential Renewable Energy Zones (REZ) in eastern Australia. Our submission will focus on the question "What are the potential barriers to developing REZs, and how should these be addressed?"

Conceptually large-scale renewable generation in targeted zones can be part of future power system development. However, our concern with these zones which may only contain wind and solar generation is the impact of prolonged wind and solar droughts. Without adequate large scale energy storage the effectiveness of these renewable energy zones would be greatly diminished.

Germany has experienced issues with the impact of prolonged multiple consecutive days of low wind and solar. For instance, in December 2016 a winter high-pressure system with dense fog throughout Germany left the wind and solar generation at extremely low levels for several weeks (Figure 3). Germany is much like the NEM which is undertaking an energy transition that has increased the generating capacity of intermittent energy. With approximately 20 per cent of Germany's generation coming from wind and solar, these Variable Renewable Energy sources were only able to generate less the 1 per cent of the total generation mix during relevant periods in December 2016.

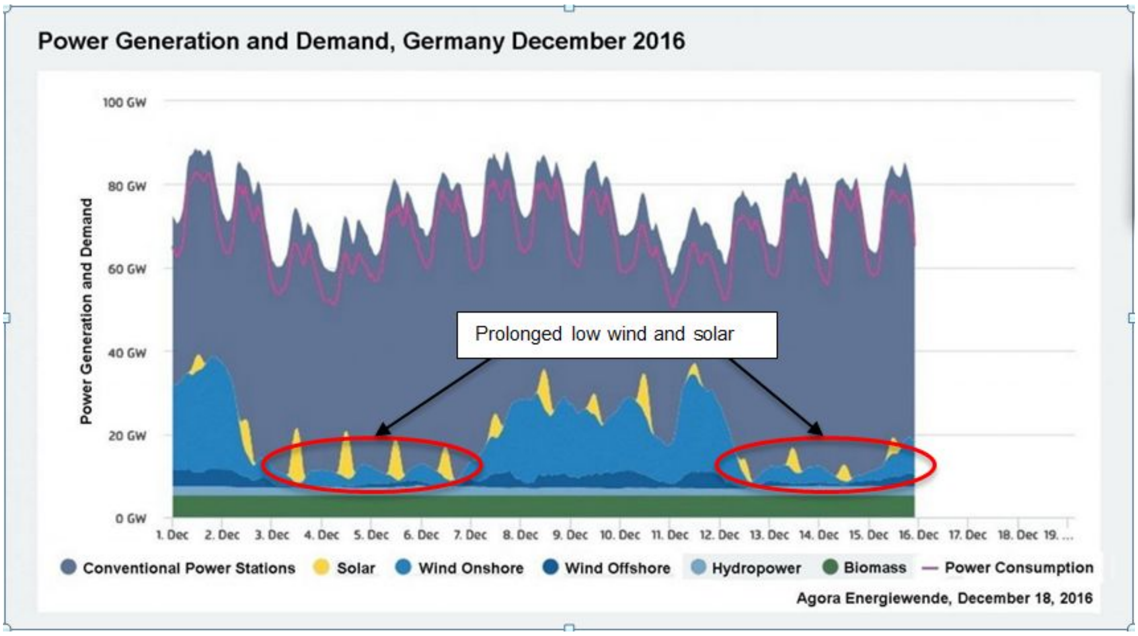

Figure 3 - Prolonged multiple days/weeks solar and wind drought
Source: Adapted from http://energypost.eu/end-energiewende/

As another example, the DNV GL study into the United States of America wind drought in 2015 provides some pertinent observations for the NEM. The study states[1]:

> *The resulting drop in wind levels -- a wind drought not seen since before 1979 -- affected states from Washington to Florida and causing wind power output to fall dramatically short of expectations. In 2015, California, Oregon, Washington, Nevada, Arizona, southeast Texas and Florida were among the regions reporting their lowest recorded wind levels in more than 25 years.*

The key point is that without adequate large scale and longer term energy storage, the effectiveness of these renewable energy zones would be greatly diminished thereby compromising energy affordability, emissions, and security and reliability objectives.

[1] DNV GL, https://www.dnvgl.com/news/dnv-gl-study-el-nino-not-cause-of-2015-wind-drought--57798

The Rationale for Snowy 2.0

The rationale for Snowy 2.0 as a large storage pump hydro generator is clear. Snowy 2.0 would pump and store energy at times of high intermittent generation and generate at times of low intermittent generation thereby balancing the supply/demand in the NEM.

The large storage capability of Snowy 2.0 would allow the NEM to reliably and securely function in the plausible scenario of prolonged multiple days of low wind and solar generation.

This is further reinforced by the text box below which highlights the immense energy storage of Snowy 2.0 which can smooth out the variability in prolonged wind and solar drought periods.

> **Snowy 2.0**
> Energy Storage: 350,000 MWh
> Capacity: 2,000 MW
>
> This means Snowy 2.0 can continuously generate at 2,000MW for over 7 days. This would cater for prolonged wind and/or solar droughts.

Source: Snowy Hydro

Independent Modelling Shows Snowy 2.0 Would Provide Substantial Market Benefits to the NEM

The independent study by Marsdens Jacob Associates (MJA) concluded that Snowy 2.0 would provide market benefits that reflect a reduction in capital and operating costs (including fuel costs) that would otherwise be needed for the production of wholesale electricity and maintaining supply reliability in the NEM.

Key observations from the MJA modelling of market benefits are as follows:

- The market benefits are substantial and reflect the 2,000 MW of firm dispatchable capacity provided and the utilisation of renewable and coal generation at times of low value;
- Snowy 2.0 would have the capacity and storage size to address the full needs of the NEM until the early 2030's. Those needs include smoothing intermittent generation profiles, providing dispatchable capacity to address the foreshadowed coal-fired power station closures in NSW and Victoria;

- Increasing the availability of hedging contracts necessary for retailers' risk management and retail competition;
- Reduce spot price volatility, and
- Energy price reduction to NEM consumers.

Snowy 2.0 is a Committed Project

Snowy Hydro has already spent $34 million on the Snowy 2.0 feasibility study. The feasibility study released confirms that the Snowy 2.0 pumped hydro expansion project is both technically and financially feasible. The comprehensive study provides a base case design and a strong investment case that exceeds Snowy Hydro's investment hurdles.

Snowy Hydro has committed additional tens of millions to progress to Final Investment Decision (FID) in late 2018.

On 26 October 2017, Snowy Hydro made a request to have the Snowy 2.0 project declared as Critical State Significant Infrastructure (CSSI) in NSW. This declaration will provide a pathway for planning assessment and approval in NSW under the Environment Planning and Assessment Act 1979 (NSW).

During 2017 Snowy Hydro undertook extensive Snowy 2.0 connection feasibility investigations and has now commenced the Connection process with TransGrid (local NSP) in 2018.

Snowy 2.0 was included in the National Energy Guarantee (NEG) modelling scenarios as a core Government Policy expected to help provide the flexible and dispatchable resources required. In a letter sent by Minister Frydenberg to the ESB, Snowy 2.0 was specifically referenced for modelling in the future generation mix:

> *"In undertaking this exercise, the Energy Security Board should take account of other Government policies expected to impact on the NEM including, but not limited to, the proposed expansion of Snowy Hydro".*

It is important that AEMO's modelling is built on previous analyses of the proposed NEG modelling which recognised that Snowy 2.0 will be a critical asset that facilitates the NEMs transition to more renewable and intermittent generation. The Snowy 2.0 project however cannot proceed without transmission investment, which would allow the 2000MW of pumping and generation capacity to be utilised throughout the NEM.

Snowy 2.0 is a strategic investment which will provide a diverse range of optionality to cater for an unpredictable future where the closure of thermal generation, the increase penetration of variable renewable generation, and the rise of the consumer will present challenges to the efficient coordination of both transmission and generation investment.

In all plausible scenarios we believe Snowy 2.0 will be a vital and strategic asset which will help the National Electricity Market transition in a way that meets the National Electricity Objective and is the long term interest of consumers. Hence, we don't agree with the consultation paper suggestion that the Snowy 2.0 project is a sensitivity[2]. In summary, Snowy 2.0 would be a committed project but needs transmission access. Therefore the ISP modelling should have Snowy 2.0 as a sunk investment and have other transmission developments build on this.

Transmission Development

The concept of "least-regret" generation and transmission developments which is robust to different futures is strongly supported. This is similar to the concept of option value. A generation and/or generation project may not meet strict cost-benefit threshold now but may have high option value to cater for a highly uncertain future where many facets such as the retirement of fossil fuel plant, emissions policy, technology costs, and the uptake of distributed energy resources may inherently increase the option value of this investment. In a sense this type of investment may be deemed strategic. Snowy 2.0 is a highly strategic investment which has high option value. This option value extends to also the potential to develop Snowy 3.0 and Snowy 4.0 to reinforce the value of strengthening the transmission network between Melbourne, Sydney, local REZ's and the Snowy area.

Compatibility with the Integrated System Plan

The following figures 4 and 5 illustrate Snowy Hydro's Snowy 2.0 proposal for the NSW connection and the VIC northeast corridor reinforcement relative to existing TNSP RIT-T's and REZ concepts as drawn from Annual Planning Reports (APRs) and supporting presentations.

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[2] ISP Consultation Paper, December 17, section 1.4.1 page 16.

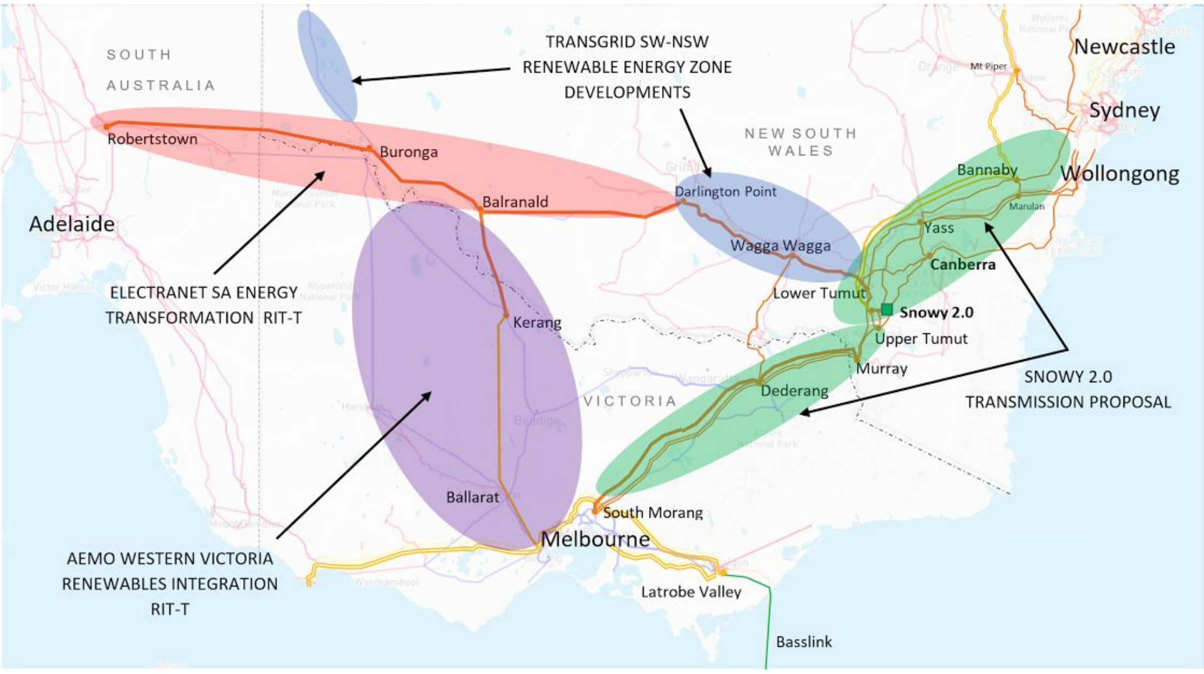

Figure 4 - An Integrated System Plan

The following figure 5 is extracted from the AEMO Slide Pack (Integrated Grid Plan Consultation Paper Slide 29) but with the Victorian Northeast Corridor upgrade included.

Figure 5

NSW Transmission

Snowy Hydro's preferred transmission development for NSW is set out chapter 10 of the Feasibility Report[3].

The Snowy Hydro Scheme (initially with Snowy 2.0) is a potential renewable energy zone. Existing transmission constraints must be addressed in order to fully utilise the 2000 MW of generation and pumping capacity of Snowy 2.0.

The nearest node in southern NSW with sufficient capacity to accomodate Snowy 2.0 generation and pumping capacity without significant reinforcement is the Bannaby 500 kV bus. Connecting Snowy 2.0 to the Bannaby 500 kV bus also has a number of advantages in terms of the ISP including:

- **Interconnection** - Extends the existing 500 kV network from Bannaby to southern NSW providing a strong node for future interconnection with SA, south west NSW and north west VIC;
- **Reliability of Supply** - provides the major Newcastle, Sydney and Wollongong load centre with scale appropriate high reliability supply path;
- **Asset Utilisation** - increases use of the existing NSW 500 kV network;
- **System Strength** - enhances the "backbone" of the NEM, facilitating the transport of system strength;
- **Avoids expenditure** - the existing southern NSW 330 kV system is aged and would require extensive upgrade to accommodate the proposed ISP or the Snowy 2.0 development.

VIC Transmission

Snowy Hydro's preferred transmission development for Victoria is set out chapter 10 of the Feasibility Report.

Snowy Hydro considers that a sufficiently route diverse[4] Victoria northeast corridor reinforcement comprising new line(s) Murray to Dederang to South Morang (or to another metropolitan Melbourne 500 kV terminal station) should be included in the Integrated System Plan options.

VIC import considerations

Existing VIC import from NSW is constrained by intra-regional constraints between Murray to Dederang and between Dederang to South Morang, and by regional voltage stability constraints (loss of largest VIC generator). Whilst the Dederang-Lower Tumut path (shown in dark blue on figure 18 of the consultation paper) addresses the intra-regional constraints between Dederang and South Morang, the Murray to Dederang constraints will remain.

[3] The Feasibility Study report can be found on www.snowyhydro.com.au
[4] Route diversity is required to reduce the risk of reclassification of non-credible contingencies to credible contingencies (such as when bushfires approach multiple lines in the same easements).

Snow Hydro considers that upgrading Murray to Dederang with new route diverse lines would achieve a significant increment in VIC import capability and, in conjunction with the Dederang to South Morang path upgrade, provide a valid option for consideration within the context of the ISP.

There are a number of reasons why a route diverse northeast corridor path from Murray to Dederang to South Morang is a favourable option:

- **Known Upgrade** - upgrade of the northeast corridor path (Murray to Dederang and Dederang to South Morang) has been included in the AEMO VAPR for over ten years;
- **Lower Cost** - The northeast corridor is the shortest geographical route between NSW and the VIC 500 kV backbone;
- **Preferred Electrical Path** - The series compensated Dederang to South Morang lines reduce the effective "electrical" distance between Melbourne and Murray switching station to approximately 230 km, meaning power flows from NSW to VIC will always favour this path rather than flow via the alternate (longer) western options (unless they are significantly overbuilt to sufficiently reduce impedance);
- **Less Complex** - Alternately for the western options power flow control devices may be required to "force" power to flow via these longer route options. However using the northeast corridor avoids this requirement as it is already the shortest electrical route between NSW and VIC;
- **Integrates with RIT-T's** - the northeast corridor upgrade option coordinates with the AEMO Western VIC Renewables RIT-T, the ElectraNet SA Energy Transformations RIT-T and TransGrid's SW-NSW REZ proposals;
- **Scaleable** - The northeast corridor upgrade can be constructed as 500 kV allowing for future expansion and eventual 500 kV interconnection between NSW and VIC;
- **Flexible at Southern End** - If entry of additional lines into the South Morang Terminal Station is constrained it would be possible to divert to one of the other 500 kV north-metro substations eg Sydenham.

Risks associated with the Western VIC options:

- Due to the preferred electrical route through the existing northeast corridor, power flow control devices or significant additional construction may be required in order to fully utilise the western options;
- Forced outages in the western options will tend to force power flows back towards the existing northeast corridor, potentially overloading this corridor and therefore requiring its reinforcement in any case.

Is the Existing Regulatory Framework Suitable for Implementing the ISP

There are a number of issues that make the RIT-T unsuitable for assessing the economic value of highly strategic transmission investment. There needs to be consideration of an approvals process for highly strategic transmission investment through the regulated transmission funding process which is both timely and avoid of gaming opportunities from Stakeholders who are incentivised to delay the relevant investment. Snowy Hydro believes consideration should be given be a process that allows a strategic transmission investment identified in the ISP to only require the relevant NSP to competitively source the most efficient means to deliver the transmission investment. That is, the RIT-T test is not required to be undertaken.

Conclusion

The NEM is changing at a rapid rate and the time is now right for Snowy 2.0. As Australia decarbonises, Snowy 2.0 is required to support an orderly transition, prevent blackouts and put downward pressure on energy prices. Snowy 2.0 provides new dispatchable energy generation with large-scale storage to provide secure and reliable energy to the NEM, which ultimately benefits consumers.

Snowy 2.0 can play a crucial role in providing long term storage and dispatchable generation that can fill the void left from the exist of fossil fuel generation. The concept of "least-regret" generation and transmission developments which is robust to different futures is strongly supported. This is similar to the concept of option value. A generation and/or transmission project may not meet strict cost-benefit threshold now but may have high option value to cater for a highly uncertain future where many facets such as the retirement of fossil fuel plant, emissions policy, technology costs, and the uptake of distributed energy resources may inherently increase the option value of this investment. In a sense this type of investment may be deemed strategic.

Snowy 2.0 is a highly strategic investment which has high option value. In all plausible scenarios we believe Snowy 2.0 will be a vital and strategic asset which will help the National Electricity Market transition to a more renewable and distributed generation mix. Hence, we don't agree with the consultation paper suggestion that the Snowy 2.0 project is a sensitivity.

Snowy 2.0 would be a committed project but needs transmission access. Therefore the ISP modelling should have Snowy 2.0 as a sunk investment and have other transmission developments build on this. The ISP should highlight the optionality or strategic value of a new development such as Snowy 2.0 and not just present the lowest-cost transmission only pathway for the NEM. This approach would be prudent given the certainties that exist in the NEM and the limitations of the modelling that underpin the ISP.

We provide responses to specific questions raised in the consultation in Attachment 1 to this submission.

Snowy Hydro appreciates the opportunity to participate in this consultation process. For further clarification on our submission, contact me on kevin.ly@snowyhydro.com.au.

Yours sincerely

Kevin Ly
Head of Wholesale Regulation

Attachment 1 - Responses to Consultation Questions

2.1 What are the key factors which can enable generation and transmission development to be more coordinated in future?

Key principles in co-ordinated generation and transmission development which lead to a least regrets outcome are considered to be:

1. Utilise and strengthen the existing NEM transmission backbone wherever possible – this will maintain transmission asset utilisation, help maintain market stability, and enhance overall system stability and reliability.

2. Avoid expensive transmission “stub-lines” off to the far-flung corners of the NEM regions purely to enable a REZ. The Latrobe Valley transmission lines (example in the consultation paper) are such “stub-lines” built to exploit a specific fuel resource in a specific location and which are (now) facing stranding risk. Note that the stranding risk is arising because of technology change, not because of depletion of the fuel resource at that location. Technology change is a factor with ongoing relevance for the renewables industry.

3. It follows to consider that if the REZ technology is subject to rapid development and change, then the need to locate in remote areas should be questioned. For example locating in a remote region to gain the last couple of % of efficiency improvement may not be relevant to the next generation of plant, which may seek to locate and connect closer to load centres in any case.

4. Also consider the lifespan of the REZ technology – renewable hydro generation and pump hydro storage technology with lifespans of 50 to 100 years (and beyond) represent sound transmission investment opportunities for secure and reliable energy supply and to support the stability of the grid and the market in the long term. On the other hand, if the REZ technology has a relatively short life-cycle (eg relative to the lifespan of the transmission asset) then the transmission asset will carry a stranding risk throughout its life (ie is not a least regret option).

5. Consider the REZ proximity to the major load centres – it’s unlikely these major load centres will be relocating even in the long-term. New load centres may evolve in the long-term, but these will be connected via the existing mechanisms (eg the RiT-T).

We consider that if applied across the ISP network development scenarios then these principles will capture a least regrets outcome.

3.1 Does this analysis capture the full range of potential REZs in eastern Australia?

Yes, but the long-term transmission investment risks for relatively short-life generation and storage technologies are not adequately recognised.

3.2 What other factors should be considered in determining how to narrow down the range of potential REZs to those which should be prioritised for development?

Refer to 2.1 response

3.3 What are the potential barriers to developing REZs, and how should these be addressed?

At present and based on NSP comments it would appear that the most significant barrier to developing REZs is the lack of transmission capacity to suitable locations.

4.1 – Have the right transmission options been identified for consideration in the ISP?

Given the time available for the development of the first ISP the options are reasonable although some represent very significant projects and will therefore require extensive consultation, refinement and lengthy approval periods.

Technical and construction risks associated with these larger proposed augmentations include the development of hundreds of kilometres of new line routes with an all-or-nothing commitment level (ie lack of scalable development options), un-specified technical impacts on the existing transmission networks (eg potential for major impacts on existing substation fault levels along the proposed route), and major technical impacts on existing participants, particularly in Southern NSW. The actual costs of these proposed transmission developments may yet far exceed those estimated costs provided in the ISP Consultation document, and particularly so if accelerated timelines are proposed.

In addition to these technical and construction risks there are also access risks arising from the larger of the AEMO proposals. For example, and despite its size, the Bendigo-Wagga 500 kV option cannot accommodate both the increased VIC export (+2700 MW) and the expected southern NSW renewable generation levels (>+2000 MW), leading immediately to network constraints in the southern NSW network with potential to constrain off existing and proposed NSW renewable generation (something which the proposed augmentation is seeking to avoid in Victoria).

The AEMO Bendigo-Wagga 500 kV option (and the Kerang – Darlington Point 500 kV option) can partially alleviate these constraints by extension of the 500 kV line development all the way to the greater Sydney load centre (eg 500 kV development to Sydney west) but at significant additional cost and market disruption during construction (the existing 330 kV lines between Bannaby/Marulan and Sydney/Wollongong are not capable of handling the combined additional VIC export and existing and proposed southern NSW generation, even with a PST on TL39). However, even with the 500 kV network extended into Sydney West this will only partially relieve the southern NSW constraints and so further work looking at existing and proposed generation placement, substation fault level increases (particularly around Canberra) and power spill into the existing 330 kV network will be required before the real costs and market impacts of these options can be fully established established.

4.2 – How can the coordination of regional transmission planning be improved to implement a strategic long-term outcome?

The factors outlined in the Section 2.1 of this response will assist in coordination. Snowy Hydro's Snowy 2.0 Transmission Proposal illustrated in figures 4 and 5 of this submission provided an illustrative example of a coordinated intra and inter-regional transmission planning response which was based to the largest extent on previously published NSP annual planning reports, current "in-progress" RiT-Ts, and more recent REZ workshops and presentations.

This illustrated example, which is not claimed to be the final solution but is used to illustrate the concept of staged intra and inter-regional transmission network development which captures REZ zones and reinforces the existing NEM transmission backbone.

4.3 – What are the biggest challenges to justifying augmentations which align to an over-arching long-term plan? How can these challenges be met?

Incorporating individual state renewables targets into a cohesive integrated system plan (a long term plan) seems to be a significant challenge at the moment, and these state renewables targets are presently dominating the ISP transmission development options.

From an integrated system plan VRET and QRET are disruptive in terms of when and where renewables locate and they appear to be the main drivers behind the significantly large transmission network augmentation options proposed in the ISP (particularly VIC-NSW but also for the QLD-NSW upgrade).

As they stand the VRET and QRET targets and timing require immediate action in respect of designing, approving and constructing extensive transmission system augmentations with an all-or-nothing commitment and leave little room for adopting a least regrets strategy. Given the magnitude of the intra and inter-regional transmission development that is required it is unlikely that even an immediate start will meet the required timelines.

A more considered placement of renewables across the NEM would reduce the amount of transmission interconnection development required, would allow better timing and staging of transmission projects, and would certainly promote a clearer path to a "least regret" option if based on the principles noted in the Question 2.1 response.

A more even distribution of renewables across the NEM would perhaps even increase the locational diversity benefits of renewable energy.