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21st November 2024

Subject: Response to AEMO's NEM ISP Methodology Issues Paper published on 23rd Oct. 2024

Sumitomo SHI FW Energia Oy (SFW) welcomes the opportunity to provide the Australian Energy Market Operator (AEMO) with a response to the National Electricity Market (NEM) Integrated System Plan (ISP) Issues Paper published on 23rd October 2024.

At Sumitomo SHI FW, we drive the decarbonization of energy with innovative technologies for long duration energy storage, sustainable fuels, carbon capture, energy generation and waste to energy. Our 1,800 experts across 20 locations in 14 countries deliver sustainable energy solutions for diverse industries, powering a decarbonized world for everyone. We are currently commercializing the liquid air energy storage (LAES) technology for long duration energy storage (LDES) applications in key markets across the globe.

AEMO's Issues Paper highlighting the key proposed changes to the ISP methodology is timely and has been published ahead of extensive stakeholder consultations and the actual modelling work. Our responses are based on our interpretation of the content presented in the consultation document. Our responses reflect our position on the treatment of various mathematical constraints and technologies in the consultation document.

We look forward to interacting with AEMO in the near future and supporting all the ongoing discussions related to the decarbonization of the NEM in general and the role of long duration energy storage systems in particular.

For more details on this submission, please contact the undersigned at:
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Yours sincerely,
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1. Do you consider that the proposal to develop a gas supply expansion model appropriately addresses the action in the Energy Ministers' response to the Review of the ISP for additional gas analysis to be incorporated in the ISP? If yes, why? If not, why not, and how could this action otherwise be achieved?
2. Do you agree with the proposal for AEMO to develop at least one gas development projection per ISP scenario, and apply the projection as an input to the capacity outlook model? If yes, why? If not, what method would you recommend for the inclusion of gas development projections in the ISP?
3. What alternative approaches should AEMO consider for enhancing the incorporation of gas in the ISP to address the action in the Energy Ministers' response?
4. What improvements could be made to AEMO's proposed approach to increase consideration of gas availability, considering gas transportation and storage capacity?

Combined response to 1-4:

It appears that AEMO will not consider the costs associated with building gas infrastructure (including pipeline and storage) in the ISP model. Ideally, the costs associated with gas network infrastructure enhancements need to be included in the CAPEX and OPEX costs of various gas turbine technologies. This is because the infrastructure would never need to be built in the absence of additional gas-based generator capacity. Furthermore, not adding these costs to the gas turbine technology options would distort the outcomes of the capacity expansion model being simulated in the ISP, leading to potentially higher system costs due to cheaper technologies or combinations of technologies being ignored.

The mathematical formulation of the proposed gas expansion and modified ISP (including gas availability constraints) is not clearly expressed in the consultation paper. For example, if the ISP has an inequality constraint defining the hourly availability of gas from the network, it will only build and retire gas-based assets in a manner which aligns with the availability of natural gas. On the other hand, an unconstrained problem could deliver a solution with an impractical gas-based generator capacity which does not correspond to the available pipeline capacity. The interactions between the electricity and gas models are also unclear from the explanation outlined in the consultation paper. If the electricity model informs the gas model as shown in Fig. 3, the gas model will only expand the infrastructure needed to deliver enough gas for the generation expected in the electricity model. Consequently, the influence of the gas expansion model on the electricity expansion model will be quite minimal. AEMO needs to spell out the interactions between the models using clear mathematical equations for stakeholders to fully understand the approach being proposed and offer constructive suggestions. Additionally, the division of gas consumption between electricity and other sectors is also not highlighted in the consultation paper. This can be critical during certain time intervals because the pipelines may not be designed to serve the peak consumptions in various sectors at the same time. In the US, winter blackouts have been observed due to gas network congestions during time intervals when industrial and domestic consumption has soared at the same time as demand from gas-based energy generators. Gas-based generators with non-firm pipeline capacity for fuel supply can face delivery constraints during periods of high consumption by domestic and industrial consumers and by non-generator users who may have contracted for firm capacity. Coupled gas and electricity simulations can highlight these instances. AEMO can consider using selected time intervals to simulate extreme cases to understand how the gas network can cope. Finally, the dynamics of the gas network can also be considered in the proposed expansion model, at least for selected time intervals. Network dynamics can make the optimization problem (non-linear) difficult to solve but adds a lot of value in terms of results. The importance of co-optimizing the electricity and gas networks has been highlighted in numerous works in the literature. Some references can be found in reports published by NREL such as this.

Additionally, to account for net-zero targets, AEMO can consider adding carbon capture units with new build gas-based generators. The costs associated with building CO2 sequestration infrastructure and the costs associated with transporting the CO2 can be passed through proportionally to the gas-based generation expansion candidate technologies.

6. What are your views on AEMO's proposed inclusion of distribution network capabilities and their impact on CER within the ISP model? What further enhancements could be made?

Response: As rightly pointed out in the consultation document, it is challenging to consider any level of detail related to distribution networks in the ISP due to the granularity of the ISP model. One concern with the inclusion of distribution network capabilities could be on model runtimes. Along with the other proposed changes, the ISP model could take inordinately long to solve. The problem is exacerbated when the number of scenarios and sensitivities usually modelled is taken into consideration. AEMO needs to take these issues into consideration before committing to include the distribution network capabilities in the ISP framework. One option to reduce the computational burden could be to utilize time domain reduction techniques to identify representative periods in the year which need to be modelled. Such techniques have been widely covered in scientific literature and a detailed discussion is avoided here for the sake of brevity.

Leaving aside any issues with computation times, the concept of including distribution network capabilities in the ISP is interesting. It is not clear from the description whether the ISP model will consider a pre-determined CER capacity as an input or whether the CER capacity will be a model output. As an extension, will the model consider the distribution network enhancements to accommodate a fixed CER input as an additional cost? This is not really a parameter to be optimized since the distribution network has to be enhanced to accommodate a fixed CER. On the other hand, if the CER capacity can be freely sized by the solver, does it mean that each distribution utility has to use that as a yardstick to determine how much CER their network can account for? These considerations need to be carefully thought through before including distribution network capacities in the model.

7. Do you agree with AEMO's proposals to improve its hydrogen electrolyser load modelling, or have further enhancements to suggest? Please provide any supporting evidence.

Response: AEMO can consider a separate modelling approach for green ammonia. The load demand in such cases would depend on the production profile for ammonia which can be a continuous process. In this scenario, the load demand from the Haber Bosch process needs to be added. Moreover, the tradeoff between hydrogen storage or energy storage starts to become pertinent. A continuous green ammonia process can either be supported by an energy storage system which keeps the electrolyzers running continuously or a hydrogen storage system which stores excess hydrogen produced by the electrolyzers to keep the Haber Bosch process running. A solution could also be a combination of these options i.e energy storage plus hydrogen storage. The hydrogen storage can be included as an object in the model which is co-located with a green hydrogen/green ammonia plant. The hydrogen storage can be modelled as an electrical energy storage system by converting hydrogen flows into electrical energy flows. This would enhance the detail of the simulation models being run by AEMO. The hourly profile of hydrogen/ammonia production needs to be considered while simulating the models. Furthermore, different electrolyzer technologies have different capital costs, operational constraints and lifetimes associated. These need to be accounted for while preparing the simulation models to obtain an optimal combination. Finally, it might be advantageous to locate green hydrogen production for export near the ports to save on logistical costs. With the NEM covering a vast area and the models not considering factors such as the availability of water and port infrastructure, the results could indicate that a lot of green hydrogen or green ammonia capacity is required far from the infrastructure required to support their production.

9. Do you agree with AEMO's proposed approach to model storage devices with headroom and footroom energy reserves and imperfect energy targets in the time-sequential modelling component? What improvements should be made to model energy storage limits to better reflect actual behaviour and address issues of 'perfect foresight'? Please provide any supporting evidence.

Response: If our understanding is correct, AEMO proposes to adjust the minimum and maximum SoC constraints routinely applied to battery energy storage systems to account for errors in the perfect foresight. Based on SFW's modelling observations, the revenues earned by energy storage systems from real-time markets can vary significantly depending on the look-ahead period used in the simulation settings. We have seen a 30% swing in some cases when using a 1-year look-ahead versus a 1-day look-ahead. AEMO can consider reducing the look-ahead period and observe the results to verify the impact. In addition, adjusting the min and max SoC constraints would force storage systems to contribute to system reserves which might not correspond to reality in all situations. AEMO can consider implementing a system-wide reserve constraint instead of throttling the SoC of the battery energy storage systems. This is a fairly standard constraint applied in similar models and it is not clear why the BESSs need to have their minimum and maximum SoCs clipped. Finally, AEMO needs to clearly specify whether the same treatment will be applied to storage technologies other than BESSs. The consultation text seems to indicate that the proposed changes would apply only to BESSs.

10. What risks should AEMO consider when assessing how IBR can complement synchronous machines in providing system strength and inertia?
11. Do you agree with AEMO's proposed approach for uplifting cost and modelling representation for system security services in the ISP? If not, what alternative methods would you recommend? Please provide any supporting evidence.

Response: The assumption is that synchronous condensers will essentially replace the system strength provided by existing synchronous generators. This is rather premeditated and completely ignores the fact that mechanical long duration energy storage systems such as compressed air, liquid air, pumped hydro and others can also provide system strength, thereby reducing the need for additional, standalone synchronous condensers. In fact, storage technologies such as liquid air energy storage have the option of incorporating a stability island concept in the design which would enable the system to operate as a synchronous condenser if needed. A flywheel+clutch option can also be added to the design to provide additional inertia if needed. SFW strongly objects to premeditated, technology specific constraints which can distort the ISP results in favour of only a small subset of technologies (in this case synchronous condensers and BESS to some extent). AEMO must treat system strength separately through extensive ACOPF and dynamic fault studies using the results from the generation planning model. There is a need to recognize the value addition provided by mechanical energy storage systems in the grid beyond the routine energy shifting. AEMO must come up with a more holistic formulation which can recognize the potential of mechanical LDES technologies to play a pivotal role in ensuring system reliability through the provision of services such as voltage regulation, inertia and short circuit capacity.

12. Do you agree with AEMO's proposal to model more than two wind resource quality tranches for geographically large REZs? If not, what alternatives should AEMO consider?

Response: Yes, the accuracy of the model can be improved by considering multiple wind generation profiles for REZs depending on the availability of good quality data from met masts or other sources.