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Australian Energy Market Operator (AEMO)
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RE: Stakeholder input to modelling questions 1.1 and 1.2 outlined in AEMO ISP Consultation Report, December 2017

Dear AEMO,

Fluence is a global energy storage technology solutions and services company. Our solutions are built on the foundation of three industry-leading technology platforms that are optimized for different application groupings.

Fluence also offers a comprehensive services suite to ensure customers are staying ahead of the market. From early stage feasibility and cost-benefit analysis that stand up in the real world, to ensuring optimal performance of storage assets, Fluence provides the expert advice and services to propel customers forward.

Fluence offers the attached set of comments on AEMO's Integrated System Plan (ISP) consultation.

1.3.1 **Modeling uncertainties and questions to address**

Grid-scale energy storage resources are a cost-effective alternative to building conventional generation and transmission infrastructure that are fractionally utilized. While making any asset investment decision, the key is to determine whether the asset would be utilized throughout the year or only use during specific periods of the year. For example, a peaking generation facility or a network upgrade project may only be needed when the load exceeds a threshold value. Energy storage offers an economic option to either defer or displace such investment decisions.

Co-optimization of supply resources that include central station generation, demand side management, energy storage and transmission has been one of the key challenges facing system planners and regulators in the last several years across the globe. On the modeling front, the trade-off occurs between hourly modeling with detailed transmission network and economic decision making algorithms. With the level of data being handled in long-term capacity expansion modeling tools, due to computational requirements, hourly commitment and dispatch becomes impossible and there would have to be approximations to the dispatch algorithm[1]. Or alternately, the model formulation may need to decompose the problem into separate energy and capacity procedures which are then iteratively or heuristically examined to ensure convergence of solutions.

We appreciate AEMO's efforts on this front to consider an integrated framework for the country. We look forward to working with all stakeholders to develop the right thinking process on the ISP's, define the right type of scenarios and also think about the least-regrets investments that can be pursued to enhance the reliability of the grid and lower cost to consumers. Given Fluence's global portfolio of energy storage projects, we hope to add value to this effort by providing diverse perspectives and examples from global markets.

- What is the best way to achieve the policy objectives of affordable, reliable, secure power and meeting emissions targets?

Fluence Comment: We do think this is a critical overarching question that should drive the ISP process. In particular, aspects of islanding local systems and the determination of limits to the power transfer capability across the states should be considered within the context of broader objectives.

In determination of the transmission limits across neighboring states the following criteria should be applied for synchronized operation up to the stated transfer level, both in the undisturbed state and following any single contingency, including the loss of any single generation or transmission element or the clearing of any two phase-to-ground single circuit fault by primary protection:

a) the interconnected system will remain synchronized;

b) all generation plants will operate within thermal capability;

c) loads other than interruptible load will not be shed;

d) damping of system oscillations will be adequate; and

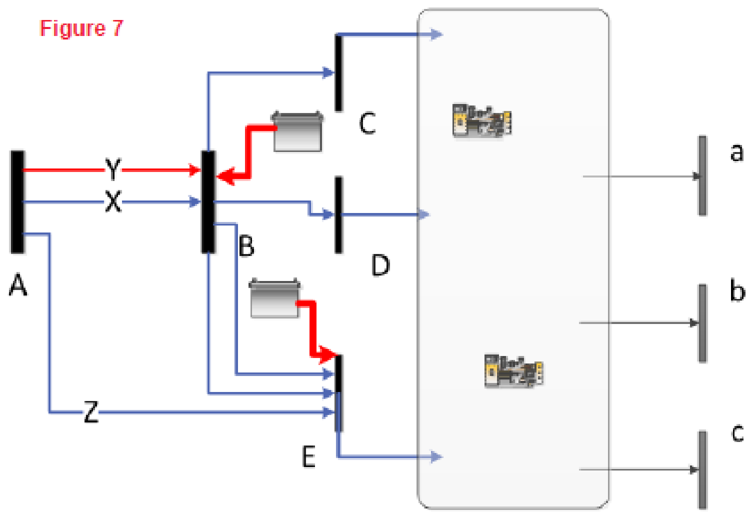
e) voltage stability criteria will be satisfied.

After satisfying the reliability and security of the power system the long-term cost for consumers should be determined. One of the key applications of energy storage technology on the transmission system is to release capacity from thermal or voltage constrained lines or interfaces. Consider the following simplistic example. In figure below, assume that the lines X, Y and Z are all rated at 500 MW. Technically, this should provide a total transfer capability of 1500 MW across the interface from substation A to B. However, to be "N-1" secure, we can

[1] "Co-optimization of transmission and other supply resources", EISPC, NARUC, September, 2013. Accessed here - https://pubs.naruc.org/pub.cfm?id=536D834A-2354-D714-51D6-AE55F431E2AA

only operate the interface at a maximum of 1000 MW. The result is that we end up not fully utilizing the transmission lines that we currently have in the system. Technologies like energy storage can help transmission planners and operators overcome this limitation by freeing up unused capacity on existing lines. In the same example, appropriate storage capacity additions at substations B and E can help increase throughputs across the interface from substations A to B. In this mode of operation, the storage units will be pre-programmed to respond to a contingency event to maintain the reliability of the system.

Figure 7



Source: Quanta Technology Whitepaper[2]

We encourage AEMO and other stakeholders to consider these types of applications of energy storage while performing transmission needs analysis. In our view this is important because it addresses the issue of better utilizing the existing transmission infrastructure.

In pursuing this pathway:

- o What are the least-regret generation and transmission developments which are most robust to different futures?

Fluence Comment: The methodology to arrive at the least-regrets infrastructure development plan requires a consideration of multiple scenarios and analysis of common elements that show up as consistent needs. However, the assumptions on various key market inputs and the nature of the considered scenarios are critical in driving a robust set of

[2] " Market Design for Congestion Relief With Energy Storage", Quanta Technology, available at http://quanta-technology.com/sites/default/files/doc-files/Emerging%20Technologies%20White%20Paper%20-Energy%20Storage_final3.pdf, accessed on Feb 2, 2018

results. The input assumptions must accurately reflect the true range of possible futures.

To do this, one must include futures that may seem impossible in today's context but become the baseline a few years from now. A good example of this is the dramatic cost declines in solar energy costs over the past decade. If these book-end scenarios are not adequately considered there is a risk of developing infrastructure investments that increase costs without supporting reliable, secure power and which meets emissions target. We encourage AEMO to work with stakeholders to establish input assumptions which fully encompass different futures.

- To what extent could aggregated load shifting and price-responsive load management, made available through investment into distributed energy resources (DER), reduce the need for large-scale generation and transmission development to replace the existing generation fleet as it reaches end of life, while maintaining power system reliability and security?

Fluence Comment: We think this question should be expanded to include battery-based energy storage systems that can also replace the need for large-scale generation and transmission. As an example, Fluence is currently delivering the world's largest battery-based energy storage project (100 MW, 400 MWh) that will provide peaking capacity to the local market in California, US to replace retiring capacity in the system. This will substitute for the need to build new gas-fired peaking generation in a constrained load area.

Rendering of 100 MW, 400 MWh Energy Storage System in Late Stage Development in Long Beach, CA

Additionally, planning for future investments across generation and transmission domains have always been centered around the top 1% of the peak hours unless there is an underlying energy need in the system. This makes it even more important to address this question and consider all available demand-side and storage options for identified needs.

- What is the optimal balance between the lowest-cost pathway and having the optionality to ramp up new development if required by circumstances, such as earlier than expected generator retirements, lower than expected DER uptake/orchestration, or higher than expected development of renewable generators?

Fluence Comment: This is an extremely important issue to consider. Different asset types and solutions have different life-times and expected pay-back periods. The longer the pay-back period, the higher the likelihood that underlying system conditions can change, jeopardizing the ability of the asset to be the most effective way to deliver secure and reliable power. Lead times on construction and development also have to be factored into developing the "optimal" balance. We propose that the following question be included in developing the plan:

"What are the lead-times associated with developing traditional generation, T&D, demand-side and energy storage solutions? How does the lead time on going from concept to construction to operation, impact development of an optimal investment set considering the risks of changing system conditions for assets with longer lead times?"

As an example, last year, in just 6 months, Fluence built the largest lithium-ion battery-based energy storage project in the world with SDG&E; the 30 MW/4-hour Advancion project deployed at Escondido, as well as an additional 7.5MW/4-hour project in El Cajon. These two projects are currently providing 37.5 MW of flexible capacity to communities in the San Diego region, reinforcing the utility's commitment to ensuring the highest level of reliability and delivering more clean energy for its customers.

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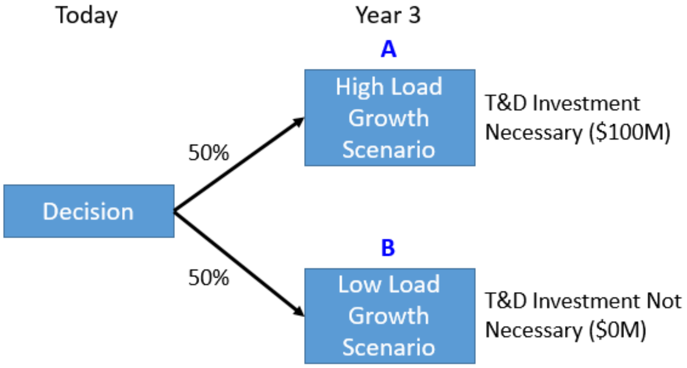
Escondido 30 MW, 120 MWh Energy Storage Array in San Diego, CA

To illustrate the financial impact of delaying or fully deferring a traditional T&D project, consider the following example. Utility X is considering a $100M T&D upgrade today based on forecasted load growth in 3 years and foresees two scenarios each with a 50% probability (see figure below).



If the T&D upgrade is made today, the utility will spend $100M. However, if the utility is able to spend $10M on an energy storage solution that can address the near-term reliability need, then there is an option value of delaying the capital expenditure decision until year three. Note that with a "right-sized" energy storage solution in place, the traditional distribution capital expenditure will only be made in the High Load Growth Scenario (A) and not in the Low Load Growth Scenario (B). Because (A) has a 50% probability of occurring, the expected capital expenditure today decreases from $100M to $50M because of the optionality provided by deferring the investment decision. After accounting for the $10M cost of energy storage, the net savings of energy storage is $40M, see table below:

Scenario	Formula	Expected CAPEX
Base case: Without energy storage	$100M x 100%	$100M
With energy storage optionality	$0M x 50% + $100M x 50%	$50M
Savings with Energy Storage		$50M
Cost of Energy Storage		($10M)
Net Savings with Energy Storage		$40M

This model can become far more sophisticated to account for multiple time periods, but it illustrates how optionality is financially valuable.

Note that we do believe and agree that central, high voltage, transmission backbone projects should be pursued and prioritized. In particular, transmission projects that connect load centers together should be considered as priority. Examples that we have highlighted above are more applicable in cases where there is a local or regional issue in load serving capability.

Fluence Comment - Scenario Design

We recognize and fully acknowledge the time limitations involved in studying scenarios and producing the ISP by mid-2018. Given the broader objective of book-ending scenarios, we strongly suggest that the "Fast Change" scenario as described in Table 1 (see below) be modified to "Rapid Cost Reductions" on Grid scale battery storage costs.

The energy storage industry is going through rapid cost reductions; advanced battery-based energy storage lithium-ion batteries have come down in costs by 85% since we first started in 2008. We continue to see sharp declines in prices; battery costs have decreased 65% in the last 5 years alone and we expect it to continue the decline as production levels scale-up. As manufacturers around the world scale up production to meet the demands from consumer electronics and electric vehicles, the price of batteries will continue to fall.

Reflecting such rapid cost reductions in grid scale energy storage costs coupled with cost declines in wind and utility PV will help provide a good book-end scenario for AEMO.

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Table 1 Proposed scenarios for the Integrated System Plan

Key input	Neutral – business as usual	Slow change	Fast change
Demand settings			
Economic growth and population outlook	Neutral	Weak	Strong
Rooftop PV capacity	Neutral	Neutral	Neutral
Battery storage installed capacity	Neutral	Neutral	Neutral
Large-scale demand side participation and distributed storage aggregation	Neutral	Strong	Weak
Electric vehicles	Neutral	Weak	Strong
Policy settings			
Emissions reduction trajectory*	28% 2005 - 2030	28% 2005 - 2030	52% 2005 - 2030
	70% 2016 - 2050	70% 2016 - 2050	90% 2005 - 2050
Government renewables targets	LRET+VRET (to 2025) QRET (to 2020)**	LRET VRET+QRET (to 2020)	LRET VRET+QRET (to 2020)
Energy efficiency	Neutral	Weak	Strong
Supply side settings			
Wind + utility PV	Neutral cost reductions	Slower cost reductions	Rapid cost reductions
Grid scale storage costs	Neutral cost reductions	Neutral cost reductions	Neutral cost reductions
Small scale PV + distributed battery costs	Neutral cost reductions	Neutral cost reductions	Neutral cost reductions
Gas market settings			
Gas demand: LNG export	Neutral	Weak	Strong
Gas demand: Residential/commercial/industry	Neutral	Weak	Strong***
Gas demand: Gas powered generation	Model outcome	Model outcome	Model outcome

* Emissions reduction trajectory assumptions are discussed further in Section 2.1.4 below.
** AEMO notes the recent Queensland election outcome and will determine the most appropriate assumption to apply for the QRET through stakeholder consultation.
*** Underlying growth strong, but increased shift to electricity for heating and industrial processes will moderate any increase.

COMMUNICATIONS

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