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Dear Secretariat

Energy Storage Registration – Consultation Paper

Background

The Australian Energy Market Operator (AEMO) welcomes the opportunity to respond to the consultation paper on energy storage registration released by the Energy Market Transformation Project Team (EMTPT).

AEMO is the independent market and power system operator of the National Electricity Market (NEM) along the eastern seaboard, and the South West interconnected system (SWIS) in Western Australia. AEMO also operates the wholesale gas markets across the eastern seaboard of Australia.

In this context, AEMO is responsible for the secure operation of the interconnected power system, and is currently undertaking a broad program of work to assess and address the technical challenges that are likely to emerge as the generation mix in the NEM continues to change and consumers become increasingly active in how their demand is met (known as the "Future Power System Security" (FPSS) program)[1]. While this work has an initial focus on the NEM, we anticipate the issue of data requirements is just as pertinent elsewhere, including in the SWIS, so we suggest a national approach be considered in relation to any register that is developed for energy storage devices.

This response draws on the work AEMO has undertaken on distributed energy resources[2] (DER) in its FPSS program.

The importance of data

AEMO appreciates the EMTPT initiating its analysis of the potential regulatory and policy issues concerning battery storage, particularly as it relates to power system planning and operation. A lack of visibility of DER has implications on AEMO's ability to manage power system security in the short-term and longer term.

Most DER do not need to register as a market participant, and through the FPSS program, AEMO has identified areas of concern in the collection and accessibility of information about

[1] Details of the Future Power System Security program are available at: http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability

[2] Distributed energy resources refer to any technologies, systems or devices that could in aggregate have a material impact on the power system. This could include (but not be exclusive to) small-scale PV and energy storage systems, energy management systems and electric vehicles.

small, individual facilities that can, in aggregate, have a material impact on the dynamic operation of the power system in the following areas:

- Forecasting in various future timeframes of the:
    - Demand for electricity to be supplied from the grid in real-time and in the short-term, which has implications on managing power system security, wholesale market operations and investment outcomes.
    - Demand for electricity to be supplied over the longer term, which has implications for the efficient planning and construction of infrastructure.
- Determination of the technical operating limits of the power system (called the *technical envelope*), where they depend on the existence, location, characteristics or performance of DER. This can result in AEMO needing to apply conservative safety margins to maintain the power system in a secure operating state.
- Impacting under-frequency load shedding schemes that are implemented to arrest frequency deviations following non-credible contingency events, particularly those involving the unforeseen major loss of generation or separation of the NEM into electrical islands.

These factors all create inefficiencies in asset utilisation, market operation, or investment decision-making, which ultimately lead to additional costs borne by consumers. Some also reduce the ability of AEMO or Network Service Providers (NSPs) to plan effectively for contingency events, or the efficacy of existing emergency management mechanisms.

While there is inevitably some limitation to AEMO's visibility of the demand side, load patterns have historically been adequately predictable, because of:

- Correlation with factors such as weather, time of day, day of week and economic drivers.
- An underlying diversity in the behaviour of consumers that means that, on an average day, they use their appliances at different times and in different ways. Where they don't, such as in the utilisation of air conditioners on a very hot day, the material increase in demand can be anticipated through weather patterns and AEMO puts in place operational measures to manage these instances. While these events have been operationally managed without direct knowledge of the usage patterns of these appliances, the need to predict and account for such outcomes without visibility generally results in higher market prices.

<u>Diversity</u>

With large volumes of DER the underlying diversity of human behaviour will still exist, but it will be partially offset by the undiversified operation of DER. For example, rooftop photovoltaic (PV) in a region will all be generating at the same time, or battery storage systems might all respond to the same retail tariff signal that is decoupled from the market price[3]. This means that the traditional relationships and diversity that AEMO has relied on in the past in determining the *technical envelope* will no longer hold in the presence of a significant uptake of DER.

[3] For information about how battery storage systems can interact with the power system see http://aemo.com.au/-/media/Files/PDF/Emerging-Technologies-Information-Paper.ashx

Technical characteristics of DER

The technical characteristics of DER devices mean they generally also respond differently to power system disturbances compared to traditional appliances. Most household appliances have induction motors, which means that if there is a power system disturbance (such as voltage or frequency fluctuations) they respond in a stable way and help dampen the deviation.

DER connect to the network via power electronic inverters. This means that their response to power system disturbances is determined by an electronic setting telling the device to disconnect from the network at a pre-set point. So, with more DER connected, power system operations will require an understanding of how the load, as a whole, would respond to power system disturbances due to the way devices interact with the network.

To date, rooftop PV installation data has been collected and managed by the Clean Energy Regulator (CER). This was possible because registration of installations was required from consumers wishing to claim subsidies under the Small-scale Renewable Energy Scheme (SRES), and this was facilitated by the requirement for installers to be accredited with the Clean Energy Council.

AEMO utilises this data to refine its rooftop PV forecasts in the Australian Solar Energy Forecasting System 2, which is used to adjust the Demand Forecasting System (DFS). The data has also been used to assess rooftop PV contingency response.

As the EMTPT correctly highlighted in its consultation paper, this framework is, in itself, not future-proofed in that it only captures:

- Systems registered to claim subsidies under the SRES.
- Installations under 100 kilowatts (kW).
- New installations.

This means that any upgrades or retrofits of systems not installed as part of the SRES are not registered with the CER and when the SRES program ends, installation data will no longer be collected or maintained. Consequently, unless a new registry of rooftop PV is created, AEMO would have no data relating to future rooftop PV installations.

When determining the data needs of any proposed registry, it is important to understand the level of granularity required in the data collected. A residential battery storage system, for example, will have three main components: the rooftop PV panels, the battery, and an inverter that interfaces with the network. AEMO's data needs will be specific to each of these components.

The data collected under the SRES does not include all the technical data required by AEMO for efficient power system planning and operations.

In April 2016, AEMO released a study into the frequency trip settings of the current fleet of inverters connecting rooftop PV to the grid[4]. This study was initiated because of concerns that these systems could respond *en masse* to frequency disturbances, which would have material impacts on system operations. Fortuitously, the CER had started collecting information on the inverter manufacturers and models for installations from 2010 and agreed to provide that information to AEMO. To determine the inverter settings, AEMO had to undertake a time-intensive survey of manufacturers for each of their models but only

[4] AEMO. *Response of existing PV inverters to frequency disturbances,* April 2016. Available at: http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/-/media/43BE01476E2D4992A3BDA2DA2E1A14A4.ashx

obtained relevant information for about 44% of the, then, installed fleet. Fortunately, AEMO could deduce from this data that there was sufficient spread in the inverter frequency trip settings that they wouldn't respond in concert, however, there is still the possibility that a subset of inverters would trip during large frequency deviations.

Similarly, without the installation data and generation output data from pvoutput.org, AEMO would not be able to forecast rooftop PV and take it into account into the DFS, which would make managing power system security more difficult.

EMTPT Storage Registration Initiative

AEMO requires access to data about energy storage systems to assist it in fulfilling its operational obligations to deliver secure and reliable supply in accordance with the National Electricity Law (NEL) and National Electricity Rules (NER).

The introduction of battery storage has the potential to materially change the volume and time of day that electricity is required to be supplied by the grid. There are various business models emerging in the market that influence the ownership and operation of these devices, such as retailers, third-party aggregators and stand-alone systems. How these are operated may result in coordinated aggregate behaviour that would affect power system security unless a very high cost, conservative approach is applied in determining the *technical envelope*.

It appears that battery storage systems at the residential level, or behind the meter (BTM), are anticipated to be the emerging technology that next achieves material market uptake following the now clear uptake of rooftop PV and solar hot water systems.

Any technology development, however, can pick up pace very quickly, particularly if customers are incentivised. The energy market is undergoing a transformation with changing generation technologies, new business models focused on consumers and smart digital technologies having the potential to empower consumers to be more active in choosing how their demand is met, including any desired trade-offs between service level and price. For example, electric vehicles, home energy management systems and smart grid technologies are within the foreseeable horizon. Exactly how and when changes will manifest is difficult to predict, but as witnessed by the uptake of rooftop PV, it can be rapid.

All of these, like rooftop PV and battery storage, change how the consumer interfaces with the network, and this, in turn, changes the expected net load profile of the consumer as seen by the system operator. This makes it important to have the frameworks in place to collect, store and enable access of information about DER well ahead of any mass uptake. Frameworks that require new technical standards, changes to regulation, or changes to communications devices can take a long time to develop. The consequence of this is that a significant amount of uptake can occur before anyone is collecting the information, and this data will likely be lost.

AEMO encourages the EMTPT to look more broadly than battery storage systems in considering the establishment and scope of a data registry. This consultation presents an opportunity to develop policy settings that can adapt to industry developments by establishing a national framework that will cater for emerging technologies, with battery storage and rooftop PV being the vehicle to drive this.

Developing frameworks for each technology that may emerge in the future one by one is inefficient because of:

- The cost of developing and implementing frameworks, even if, in the simplest case, this is a revision or cloning of existing measures.
- The time to develop frameworks, which creates a risk of lost data.

Elements of a general framework

Any registry framework should draw on current regulatory mechanisms where possible, including assessments of the body best placed, in terms of its relationship with the customer, to collect the data without further intrusion.

AEMO suggests that the efficient and effective development of a data registry framework might be supported by first developing a set of guiding principles to define the objectives. The following are put forward as a potential starting point:

- **Adaptability** - any necessary regulatory changes should be designed to be as readily adaptable as possible to the evolution of the power system. This is particularly important given that any changes to legislation or licence conditions are likely to be a significant and time-consuming step with limited opportunity for fine-tuning in the period immediately following their completion.

  By way of example, adaptability might be supported by having a broad formal obligation set by regulation to collect and make data available, and then data requirements for specific technologies determined and modified on a continual basis by application to an appropriate administering authority, who imposes the obligation. The administrative body would then assess the need, costs and benefits, and hence the reach of the framework. In particular, it addresses the objective noted in the consultation paper that the data registry should assist those who require the data in it to fulfil their regulatory functions.
- **Technology neutrality** – the principle of adaptability should be complemented by technology neutrality, so that it could be applied to new technologies, including load-related technology with minimal effort. This is particularly important with respect to the legislation and governing NER as any definition of technology could inadvertently exclude emerging systems.
- **Accessibility** – the framework should allow a pathway to evaluate access to data for different parties based on each entity having different needs, objectives and relative priorities. This would also need to be designed with data security in mind.
- **Efficiency** – A cost benefit assessment of the data registry would need to be balanced and apportion costs to the parties that value the data most.
- **National application** – the framework should apply across Australia, rather than having variations across states or regions. This should be the case even if each state has a different dominant technology.
- **Co-ordination within and across jurisdictions** – the framework needs to be co-ordinated if matching changes are required to legislation, state-based licensing conditions, and the NEL because each of those instruments has different decision-makers.
- **Compliance** – there needs to be confidence that the framework will achieve the desired outcomes at each step.

The consultation paper touches on the different elements of the registry, including data storage and the hosting body, collection mechanisms and access arrangements. AEMO suggests the EMTPT first determine the objective of the register, its scope, and some over-arching guiding principles. Once this has been established, the attributes of the "who" and "how" are likely to become clearer, paving the way for a more informed evaluation of options.

The EMTPT would then be in a position to consider the following, which are important factors in the design of any registry framework:

- The entity or entities collecting, storing, accessing or using any data: aside from having the relevant capability to keep the data secure, process requests responsibly and efficiently, there would need to be confidence that they will continue to have that capability on an ongoing basis and that the data will be similarly treated by the users.
- Registration of new installations: the EMTPT mentioned that electricians installing DER might be a potential avenue to register these devices. Given that licence arrangements, and more importantly compliance mechanisms, vary across jurisdictions, the EMTPT would need to ensure that sufficient measures are in place to maintain consistency and compliance nationally.

AEMO's FPSS Program

AEMO's objective in requiring increased data in respect of these technologies and their connection to the grid is to fulfil its obligations of managing power system security and supply reliability in accordance with the NEL and NER. A lack of visibility will have implications for the market during normal operations, and will likely have impacts on power system operations under contingency events:

- Under normal operations, AEMO may need to take a more conservative approach in determining the *technical envelope* in order to maintain power system security. This would create inefficiencies in asset utilisation, market operation, or investment decision-making, which ultimately lead to additional costs borne by consumers.
- AEMO's ability to understand and plan for some contingency events would be more limited. For example, the importance of relevant data about rooftop PV was highlighted in Europe in 2015 when it experienced a near total solar eclipse. The FPSS program progress report[5] released in August 2016 provided a case study of this event that required six months of planning by European system operators to ensure they could continue operating, which they could not have done without knowing what was connected to the power system.
- The efficacy of under-frequency loading shedding schemes may be compromised by rooftop PV that can reduce the load available to be shed. This is an important emergency control scheme used across all parts of the power system to contain the consequences of major unforeseen power system disruptions.

As part of its FPSS program, in the coming months AEMO will publish an information paper about its operational processes, and where DER can have an impact and the consequences of this. From this, AEMO will set out its broad data requirements and potential frameworks to access them.

[5] Available at: http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/-/media/823E457AEA5E43BE83DDD56767126BF2.ashx

As part of the FPSS program, AEMO will continue to assess the need for visibility of all components of the power system to perform its regulatory functions in an efficient manner. AEMO is keen to work with the EMTPT to further this work, and to complement the advice we will be submitting to the December 2016 COAG Energy Council meeting.

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Yours sincerely

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