S&C ELECTRIC COMPANY
Excellence Through Innovation

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The Hon Josh Frydenberg MP
Minister for the Environment and Energy
Chair
COAG Energy Council
C/O COAG Energy Council Secretariat
GPO Box 797
Canberra
ACT 2601

Our Ref: JC 2017-017 9 June 2017

Dear Minister,

S&C Electric Company submission to the COAG Energy Council National Battery Storage Register Cost-Benefit Analysis Public Consultation

S&C Electric Company welcomes the opportunity to provide a response on the development of a Battery Storage Register.

S&C Electric Company has been supporting the operation of electricity utilities in Australia for over 60 years, while S&C Electric Company in the USA has been supporting the delivery of secure electricity systems for over 100 years. S&C Electric Company not only supports "wires and poles" activities but has delivered over 8 GW wind and over 1 GW of solar globally. S&C Electric Company has been actively engaged in deploying Battery Energy Storage Systems since 2006 providing a full range of services and using a range of battery technologies and currently has 76 MW/189 MWh in operation, including the Ergon Grid Utility Support System in Queensland, which reduces peak loads and provides voltage support on rural lines.

We are particularly interested in facilitating the development of markets and standards that deliver secure, low carbon and low cost networks and would be very happy to provide further support to the COAG Energy Council on the treatment and potential of these technologies.

Yours Faithfully

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Summary:

We strongly support the development of a battery register, which will be necessary to ensure the continued safe and secure operation of our electricity networks and minimise the risk to both consumers, network staff, tradesmen (particularly electricians) and emergency services. AEMO looks to be the most cost-effective and beneficial host of the Battery Register and it will be necessary to incorporate smaller domestic-scale battery installations. This is because battery installations of this size will impact on the operation of the networks.

Introduction:

It is expected that as the cost of batteries continues to decrease, the rates of deployment for batteries at all scales will continue to grow. While utility-scale batteries are likely to be deployed on a site where appropriate maintenance and operating processes are in place, such as at a DNSP sub-station or on a renewable generation site, domestic scale batteries are not likely to be installed in an environment that has a strict requirement for fire safety and general electrical safety.

We agree that a register of battery installations would enhance the power system and network security, and protect the safety of consumers, line workers and installers and protect emergency responders, particularly fire-fighters. Many jurisdictions are trying to better manage the deployment of batteries at all scales, including domestic.

Notifiable Technologies Internationally

In the UK a number of high energy/demand assets that could be connected to the network are deemed to be "notifiable" and installers are required to notify the DNSP if they connect a notifiable technology. In the UK notifiable technologies include:

- Generation (including "microgeneration" such as rooftop solar panels)
- Heat pumps (reverse cycle air conditioners)
- Electric vehicles
- Electricity Storage

(see for example the UK Energy Networks Association, funded by required payments from UK regulated energy entities: http://www.energynetworks.org/electricity/futures/electric-vehicle-infrastructure.html)

Some of the UK reporting requirements fall under regulated connection requirements:
See the Decision Tree from UK Power Networks: https://www.ukpowernetworks.co.uk/internet/en/our-services/list-of-services/electricity-generation/distributed-generation-connection/

"Informing the DNO
Once your installation and commissioning is complete, the DNO needs to be made aware of your generating unit(s). This is so that the DNO can take this into account when operating and designing the network."
Taken from "Distributed Generation Connection Guide, Energy Networks Association (UK), June 2014)

Some of the UK reporting requirements full under Standards and Regulations:
Such as British Standard / Wiring Regulations BS 7671, section 132.16 and the UK Distribution Connection Code DPC 5.2.1:

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"Users shall contact the DNO in advance if it is proposed to make any significant change to the connection, electric lines or electrical equipment, install or operate any generating equipment or do anything else that could affect the DNO's Distribution system or require alterations to the connection."

Similar provisions for reporting are in place for the transmission system.

Some of UK reporting arises from the receipt of incentives:
Incentives, such as the Feed-in-Tariff (FiT) or Renewable Heat Incentive, cannot be claimed if various parties, including the regulator, have not been informed of the connection of small-scale generation or a heat pump.

So currently in the UK there are complex number of bodies that have a responsibility to collect data and maintain data. And in many cases, particularly in the case of domestic-scale batteries, installers do not comply with notification requirements because (a) deployment occurred prior to notification being established; (b) there is no incentive to do so (there is currently no equivalent to the FiT for batteries); (c) it's extra work and (d) many domestic-scale developers consider the imposition of the G83 connection requirements to be unnecessary "red tape" that hinders the rapid expansion of their business.

Impact of Domestic-scale Batteries

As in Australia there is an expectation in the UK that domestic-scale behind-the-meter batteries will provide system support and one option that has been explored to encourage notification is that participation in ancillary services markets would only be possible if the asset had been registered. However, a significant number of domestic-scale batteries will be employed behind-the-meter, coupled with rooftop solar PV, to maximise self-consumption and minimise import of electricity from a retailer, with no intention to export. Although research shows that import of electricity is highly likely even for those systems attempting to minimise that import, so the networks will have to manage increased demand of up to 16 kWh (current maximum size of domestic-scale systems) [Fares, R. L. and Webber, M. E., The impacts of storing solar energy in the home to reduce reliance on the utility. *Nat. Energy* 2, 17001, 2017].

While the partnering of batteries with rooftop solar is receiving a great deal of attention, it does not necessarily resolve the network issues caused by the export of solar PV generation in summer (see Appendix A for more detail). Studies have also shown that without proper incentives/guidance domestic-scale batteries will increase the cost of operating the wider system and do not deliver system benefits at lowest cost:
"Increased penetration of customer owned generators and electricity storage systems which, if left unmanaged may impact the supply and demand balance in distribution networks, increasing the risk of inefficient duplication of energy investments." Page 39.

"On current projections, investment in battery storage is likely to reach a critical mass before 2030 and without appropriate incentives or orchestration, mass scale battery charging profiles could lead to export/import imbalance in distribution networks or new peak demand events which would drive additional network investment.
Refining network tariffs to allow better integration of batteries, as storage technology becomes more affordable and smarter over time would alleviate this risk." Page 40.

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Electricity Transformation Roadmap: Final Report, ENA and CSIRO, April 2017

"Distributed storage at the household level, with no interaction with the network is neither the most economically attractive solution for end users, nor most beneficial to the network." Page 7.

"Customers (residential or small business) would expect the asset to be optimized for their own benefit first, with additional services provided where possible, which may not always be the optimal use of the asset from a systems perspective." Page 41.

Can Storage help reduce the cost of a future UK electricity system? Carbon Trust, March 2016

The wide-scale addition of small-scale batteries in conjunction with rooftop solar PV will negate the effectiveness of solar PV generation forecasting, which is used by networks and the market operator to effectively manage both the physical operation of the network and market needs. The inclusion of a battery decouples solar PV generation from weather (solar insolation and cloud) forecasting and without additional information, such as the battery's real-time state of charge, predicting generation and hence export from distribution connected resources will be far more complex (see Appendix A for further detail).

Securing home insurance may also be another route to ensuring that domestic-scale battery systems are registered, with non-registered assets invalidating insurance.

General Battery Safety

While batteries, including Lithium ion batteries, represent a very low fire risk, that is, they rarely initiate a fire, there is a much higher risk that batteries will become engaged in a fire that was ignited from a different source, such as a bushfire. A battery contains energy, which would be released in the event of a fire, complicating the management of any fire – current home battery systems can reach a maximum of approximately 20 kWh, which is the energy equivalent of storing 2 L of petrol inside the home. It is likely that as battery technologies improve the energy density will increase, which will mean that larger amounts of energy could be stored in the current footprint (a bar fridge).

We would hope that the Australian Standard (AS/NZS 5139, Electrical Installations – Safety of battery systems for use in inverter energy systems) will address issues around ensuring that the *enclosure* of any domestic-scale battery system is appropriately rated to ensure that the batteries within are protected from an external sources of fire. This would ensure that both householders and emergency services have the best opportunity to escape and manage a fire that might encompass a battery system.

This standard could also incorporate notification requirements for any battery register.

It should be noted that many of the well-established, "big names" who supply batteries have very sophisticated fire suppression system *at the cell-level*, within a single battery. This significantly minimises the risk of a battery initiating a fire. The concern would be with less established and new battery developers, who may have not developed such internal fire suppression approaches and with domestic-scale battery providers who do not necessarily incorporate a fire management within their system or use an enclosure that ensures an external fire does not penetrate to the batteries.

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Utility-scale Batteries

Larger utility-scale batteries are likely to be owned and operated by entities that have a great deal of experience in the management and appropriate safety arrangements for complex electrical equipment, including DNSPs, TNSPs and renewable generation developers. They will also have to meet more stringent connection requirements.

Response to Questions

Which of the advantages and challenges listed in Table 1 and Table 2 provide the most compelling reasons for choice of host? Why? Which host would stakeholders prefer? Why?

While AEMO seems to offer the best option in terms of longevity, there have been media reports calling for its demise. However, Australia is always likely to have a market/transmission system operator, so any functions assigned to AEMO now could be transferred. The future of the CER is less certain and therefore not a good option, since clarity and certainty in approach will facilitate both compliance and industry development.

AEMO also currently has access to data and the ability to manage that data. It already has well-established (regulated) pathways to access data from the networks, and it is both the networks and AEMO who will benefit most from any battery register.

Can stakeholders identify any other challenges or advantages for each option?

It will be necessary to include small-scale and domestic scale battery installations in the register. There is unlikely to be an incentive for domestic-scale storage, but potentially these assets may provide aggregated system services and so will interact with AEMO.

Note the severe negative impact on the life of a battery providing system services: Dubarry et al., Durability and reliability of electric vehicle batteries under electric utility grid operations: Bidirectional charging impact analysis, *Journal of Power Sources*, 358, 39-49, 2017.

Do stakeholders see a more efficient approach for collecting information from this wider set of equipment categories?

The installer or provider of the technology are both ideal targets to submit data to the register. The provider of the battery system would presumably support a warranty, so would need to retain installation details for some period. See also comments in the introduction on the UK approach, which requires notification of connection of a range of technologies, typically through network codes and connection codes. As in Australia, registration is necessary to receive incentives and in the absence of an incentive for storage, there are a number of other routes to promote compliance, including standards, insurance and the ability to receive an income for ancillary services (even if via an aggregator).

Do stakeholders agree on the required degree of information needed and the need for various stakeholders to access the data shown?

Yes.

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The ability to transparently share, at high time resolution (on network management time scales) the state of charge of a battery would additionally help DNSPs/TNSPs to manage their networks (e.g page 42, Section 5.3.2, “Can Storage help reduce the cost of a future UK electricity system?, Carbon Trust, March 2016. Link below).

Are there any other regulations that would require amendment? Is it possible to quantify the cost of a single regulatory change?

Are there any relevant network and connection codes that would support compliance?

Are there any issues with changing these regulations to capture batteries?

Changing regulations is always time consuming, but if the benefits outweigh the time cost, then the changes should be made.

Note also, that AS/NZS 5139, Electrical Installations – Safety of battery systems for use in inverter energy systems, currently under development, may also offer an opportunity to require registration.

Do the time estimates and other assumptions in Table 6 seem to be reasonable? If not, are you able to provide evidence to more appropriate estimates?

No Comment.

We note that there is already a private company developing an energy storage register: Paul McArdle: http://www.batterystorage.info/explanations/other-resources/batteryfinder/.

Are any of the quantitative benefits or the assumptions or approach underlying their evaluation questionable? If so, why?

The approach does not include the newly proposed Fast Frequency Response service nor the requirement for newly connecting non-synchronous generation to provide support to system security targets (AEMC, System Security Market Frameworks Review, March 2017).

The deadline for this response is coincident with the release of the “Finkel Report”: Independent Review into the Future Security of the National Electricity Market”, chaired by Dr A. Finkel AO. There may be outcomes from this report that may have a material effect on the benefits and/or assumptions and approaches used here.

There has been a great deal of work done on the costs of unplanned storage development versus coordinated development.

See the reports below and their associated academic assessments:

http://www.energynetworks.com.au/electricity-network-transformation-roadmap (April 2017)

https://www.gov.uk/government/publications/smart-power-a-national-infrastructure-commission-report (March 2016)

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https://www.carbontrust.com/resources/reports/technology/energy-storage-report/ (March 2016)

https://www.ice.org.uk/media-and-policy/policy/electricity-storage-realising-the-potential (October 2015)

http://www.theiet.org/factfiles/energy/brit-power-page.cfm (December 2014)

Are stakeholders able to provide data or case studies that would support the quantification (in monetary terms) of any of the costs and benefits listed above?

Not specifically related to a battery register, but see above reports for the impact of uncoordinated versus coordinated management of storage delivery.

Are any of the qualitative benefits questionable? If so, why?

No Comment.

Would a new data collection app be appropriate if it was designed to streamline time taken to fill in forms? Or would industry have a preference to use existing industry developed apps? What advantages do industry developed apps offer?

Engaging stakeholders, particularly those that will have to provide the data will be critical to ensure compliance and the success of any register.

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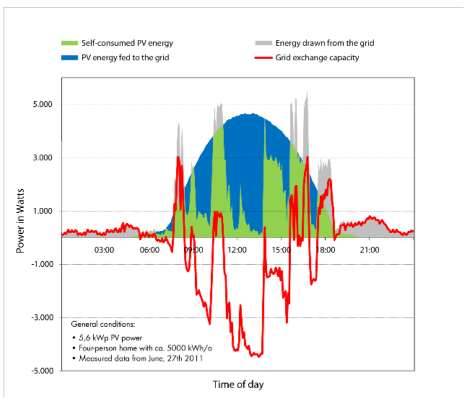
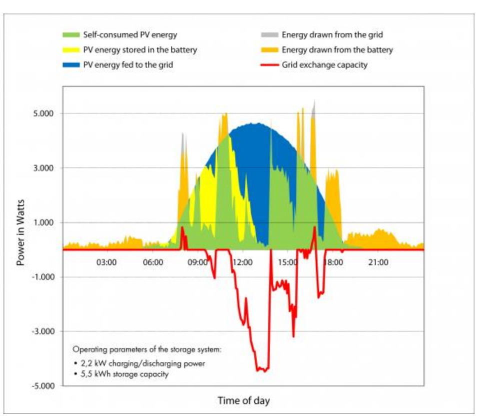
Appendix A

Impact of Behind-the-Meter batteries

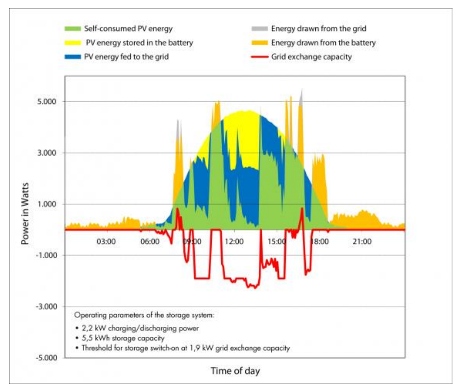
The figure below demonstrates how unconstrained solar PV generation exports to the network beyond the front door. The use of appliances allows the self-consumption of the generation and reduces the electricity exported to the grid, but on a sunny day, the export can be considerable and may cause reverse power flows and voltage issues.



In the figure below a battery has been added to the same situation. The battery begins charging as soon as the sun rises and is fully charged by 1pm (this time will vary depending on the size of the Solar PV array and the capacity of the battery). Once the battery is fully charged, and in the absence of any appliance load, significant export occurs, which may cause network issues.



In the figure below a battery with a "smart" manager has been used to ensure that the battery is charged to minimise export and so reduce the impact on the grid. By using weather forecasts and management algorithms, the export to the grid is reduced from 4.5 kW to about 2 kW. In this case the homeowner still has the benefit of using energy from the battery to minimise import and reduce the spending on electricity, while supporting the grid.



However, very few domestic scale battery providers offer the facility to support both the homeowner and the system. In cases where batteries have no intelligence and the network has no visibility of the behind-the-meter batteries' state of charge, forecasting the likely export from distributed Solar PV systems using weather data becomes impossible.

In Europe, regulators and the electricity storage industry are considering whether there should be a standard requirement for the state-of-charge of any battery connected to the network or that has an impact on the network (since the battery may be entirely "off-grid", but still impact on export), to be transparent to the network operator.

All figures taken from SMA (http://en.sma-sunny.com) and represent a four-person home, with 5.6 kW_{peak} Solar PV generation and where storage is used, a 2.2 kW 5.5 kWh battery.