WEBINAR FAQ

Unlocking new revenue and stabilizing electric grids with energy storage

1. **What is the monetary value of wasted (due to variability in the grid) energy right now? How does this vary from state-to-state, localities, etc?**
The monetary value of grid energy varies based on time of day and local market conditions. You can use production modelling tools such as PROMOD to evaluate and forecast this.

2. **Does this graph represent the data during COVID-19 or before that?**
   All demand data are pre-COVID-19.

3. **Could you tell us how much conventional power generation California needs in order to mitigate duck curve?**
   Battery energy storage systems (BESS) are and will increasingly address the duck curve ramping and low load challenges. Critically, BESS with VSM can provide additional services associated with system strength and stability.

4. **Are you able to model to your inverter to any grid condition?**
   We have models in most established simulation tools for conducting power flow and dynamic studies for grid transients.

5. **What are the issues experienced in the Dalrymple project?**
   These are well documented in the Knowledge Sharing section of the project website: [www.escri-sa.com.au](http://www.escri-sa.com.au).

6. **What type of electric storage?**
   PowerStore™ is a high-power grid-forming inverter with smart controls. We are storage technology agnostic but the ESCRI project uses Lithium-Ion NMC batteries.

7. **In case of fault disturbances, does the BESS contribute with fault current?**
   Yes, it can contribute stable fault current and ride through all types of grid disturbances. We showed some charts to demonstrate the benefits of this – please refer to the slides and the recently released Project Operational Report #2 at [www.escri-sa.com.au](http://www.escri-sa.com.au).
8. **Is the BESS economically feasible yet?**
   Yes, in fact the project has generated significantly more revenue than anticipated under the business case from 2017 and the battery prices have come down since then.

9. **Are you able to deliver a proper inverter model for Australian network models?**
   We have models in most established simulation tools for conducting power flow and dynamic studies for grid transients.

10. **What was the total BESS cost in either US or Australian $?**
    Total installed cost stated in the public project documents available at www.escri-sa.com.au was $30M AUD. The project was conceptualized between 2014-2017 and the economics have since then improved.

11. **What is your incentive to participate in non-monetized functionality?**
    Not all services are monetized but they have value. Additionally, they are a part of the core functionality of the virtual synchronous machine technology and we anticipate future monetary streams are possible.

12. **Prior to implementing a solution, we need to properly model this. Can you provide the limits to the BESS?**
    Our PowerStore BESS is part of the modular e-mesh platform that can be adapted based on project requirements.

13. **How many people does this system serve?**
    Around 4,500 customers.

14. **What was the cost?**
    Total installed cost stated in the public project documents available at www.escri-sa.com.au were $30M AUD. The project was conceptualized between 2014-2017 and the economics have since then improved.

15. **What software is used for doing simulation?**
    In the results we presented comparing the response of virtual inertia and synchronous inertia the simulations were carried out in DIgSILENT PowerFactory. Most of the other charts presented were based on measured data.

16. **You mention earned AU 5M in year one through frequency control ancillary services. What services do you mean? Can you be more specific? What was the payroll and expenses of those ancillary streams?**
    The ESCRI BESS presently brings in revenue from two market streams: contingency frequency control ancillary services and energy arbitrage. As the Australian National Electricity Market evolves, the services can be expanded. When this
technology is deployed in other locations, the exact revenue streams can be adapted to local market conditions.

17. What type of batteries were used: e.g. lithium-ion?
   PowerStore includes a high-power grid-forming inverter with smart controls. We are storage technology agnostic but the ESCRI project is based on Lithium-Ion NMC batteries.

18. Have you guys had solid projects that have proven this?
   The data presented is real data from the actual ESCRI BESS project, which went into commercial operation in 2018.

19. How do you coordinate virtual inertia action? How do BESS and wind turbine control work together?
   The virtual inertia response is inherent. Please refer to the presentation for detailed descriptions and graphs of performance. The operation of the BESS and the wind farm is coordinated by the e-mesh control system.

20. Can BESS also perform load shedding in islanded mode?
   The BESS can invoke a downward frequency shift, which can be used as a trigger for load shedding. Load shedding wasn’t necessary to achieve stable operation.

21. Are the batteries able to supply power for 4 hours?
   The PowerStore can be coupled with any duration storage. The ESCRI project used a high-power battery that fit ElectraNet’s need and has generated good ROI.

22. How do you deal with the weather variability in the control system? Do you use weather forecasts?
   The system is designed to operate under all expected weather conditions. Variability in output from distributed energy resources and the wind farm are compensated by the PowerStore.

23. What does RoCof stand for?
   Rate of change of frequency.

24. What technology is ABB using for sensing changes in RoCoF and what response time is achieved? I think this can be a technical challenge for truly achieving the virtual inertia concept
   Inertial response from the virtual synchronous machine is inherent; the response is identical to that from a conventional synchronous generator. The rise time can be tuned according to the project and system needs.
25. In your modelling of VSM vs synchronous machines, for the SM power outputs, are you modelling the damper windings and the power that flows from SM from them (in addition to the power proportional to angle)? Clearly you have modelled some different damping coefficients, and your converter is highly damped. Just wondering if you have used a full model for the SM modelling, or a "simplified model" of SM, some of which (Simulink for example) ignores the damper winding power from the real SM.

Most of the presented results were measured in the field either during commissioning or since commercial operation began in December 2018. The grid-forming BESS and synchronous machines were modelled in the RMS domain of DiGSIILENT PowerFactory 2019. Synchronous machines contain one damper winding in the d-axis and two damper windings in the q-axis.

26. What kind of transformer uses to connect BESS to the grid?
   The BESS is coupled via 3-winding dry type coupling transformers.

27. A synchronous machine can typically increase power around 10% of their total capacity within 5ms. Can BESS with VSM meet the same response time with full power output if needed?
   Yes.

28. How long has this installation been in operation?
   Since December 2018.

29. Do you think the Dalrymple islanding function would operate as effectively if the wind turbines were inverter-connected rather than direct-connected induction machines? Also with solar-inverter-connected.
   It depends on how effectively and quickly the wind turbine inverters’ controls can react to the frequency deviation upon islanding. This would be an interesting case for a simulation study. The ESCRI BESS is already operating with 3.4 MW total PV inverter capacity installed on local customer rooftops.

30. Please tell us the BESS lifecycle and the battery efficiency through the lifecycle.
   The battery was sized based on project requirements. This is a detailed question with several factors at play. For more details, please refer to the project documentation at www.escri-sa.com.au.

31. Are these technologies available in Europe and Russia?
   Yes, they are available in Europe and in Russia.
32. For indoor units, what are the fire protection system in place?
   The BESS was designed to meet the local fire code. For more details, please refer to the project documentation at www.escri-sa.com.au.

33. What is the smallest size of project you are focused on for BESS projects? Is it 250kW/250kWh based on the smallest product you offer?
   We size our system based on application needs and can supply solutions suitable for smaller systems. Please reach out to ABB Power Grids’ Grid Edge Solution team for more information and support.

34. What optimal mix of base load power (e.g., nuclear) with renewable sources do you see to best balance the “duck” curves? 50-50?
   The optimal mix will be based on regional requirements and conditions. Critically, it is also a moving target as technology evolves. However, we’ve shown that it is technically feasible to operate a utility grid with 100% renewable sources when coupled with a Virtual Synchronous Machine.

35. How do the wind turbines withstand strong hurricane like winds?
   The BESS was installed in an existing section of the grid, also referred to as brownfield. 3.4 MW of solar PV were installed over the last decade. The wind farm was commissioned in 2005 prior to this project. We integrated all these generating assets with the BESS and demonstrated that you can successfully island them without interruption of supply. This increases reliability for customers in the local network, minimizing outages from storms.

36. Places like New Orleans are considering wind farms in the gulf, but how could the turbines withstand hurricane force winds without requiring major repairs? Could we fold the blades and have them sink into a base during storms using a gps weather tracker?
   Our project focus was on integration of the wind farm with the network. Please refer to the similar question above.

37. Please clarify, during black start application through BESS, say a transformer is energized, by a voltage ramp from BESS voltage source, whether V/F control is employed to avoid saturation of transformer core?
   To achieve soft transformer energization, we ramp the voltage up over 1 second while we keep the frequency constant at 50 Hz.

38. To what extent does BESS compete with Syncon solutions?
   A grid forming BESS equipped with a virtual synchronous machine, like the PowerStore, can provide the same services as synchronous condensers. However,
the BESS can also generate revenue from frequency ancillary services and other streams over its lifetime.

39. Which Lithion battery is ABB using?
PowerStore is a high-power grid forming inverter with smart controls. We are storage technology agnostic but the ESCRI project is based on Lithium-Ion NMC batteries. The project owner sourced those from Samsung SDI.

40. How did you size the battery and inverter to 30MW/8MWh?
This is the result of the business case that the project owner ElectraNet developed. The high-power inverters and batteries are ideally suited for the services that the BESS provides to the network and the market. Please contact us if you’d like ABB Power Grids to help you in developing a business case.

41. Bring in value from energy and ancillary service markets, how? Which?
The ESCRI BESS presently brings in revenue from two market streams: contingency frequency control ancillary services and energy arbitrage. As the Australian National Electricity Market evolves the services can be expanded. When this technology is deployed in other locations, the exact revenue streams can be adapted to local market conditions.

42. By 2050 US states like FL, NT, CA are planning to be 100% renewables. To meet this challenge, now many EPC & OEMs are developing hydrogen fired large scale gas turbines as a 100% renewable fuel. How does this technology compare to your BESS, wind & solar based renewable technology?
Meeting the ambitious needs of a high renewable future will require a wide combination of new technologies.

43. Did ABB Power Grids provide the recent BESS system for the Jamaica utility? Are the inverters grid forming? Are they VGMs?
Yes, ABB Power Grids supplied that system. All PowerStores include grid-forming VGM capability.

44. 8MWh 30MW, meaning the BESS is 3.75C?
8 MWh is the projected battery capacity at end of life. Usable capacity at installation time is 12.2 MWh.

45. How does virtual inertia help in seamless power transfer from grid-connected to islanded mode?
Virtual inertia stabilizes frequency in the transition.
46. What is the limit of power factor the VSMs can operate on the grid (lag/lead). Are they able to operate in full lag/lead reactive power continuously? How the SVM produces or absorbs the reactive power? Virtual capacitor?
The VSMs can supply reactive power at nameplate capacity at no real power load.

47. Is there a version of the BESS that can be deployed and set up in a remote area in a 24-hour period?
We've considered this in our deployment models. If you have an application in mind, please contact us and we can work through your solution.