Webinar Q+A

The Enhanced Frequency Control Capability (EFCC) Project wind, solar and battery webinar
5 February 2019

Introduction
On 5 February 2019, the project hosted a webinar to share the latest results from the hybrid solar and battery frequency response trials and wind inertial response analysis from project partners; Belectric and University of Strathclyde. This document captures the questions that were asked during the webinar and includes our responses.

Slides from the webinar can be downloaded here.

Questions

The University of Strathclyde's (UoS) modelling is just considering inertia response (IR) from onshore wind. What's the benefit on the system from IR coming from offshore wind radially connected, and far away from the actual network?
In the project studies conducted, the wind profiles which were used are generic, not specific to either an onshore or offshore windfarm. From a National Grid Electricity System Operator's (NGESO) perspective, if a windfarm can deliver a desirable response (e.g. fast ramp up, slow ramp down in power), it could be either from onshore or offshore wind farm. The studies define the requirements for the wind IR and the project team have looked at the effect of the wind resource being remote from the point of frequency disturbance to illustrate differences in frequency which whilst small in magnitude could materially influence frequency containment, particularly when considering variations in regional frequency. How the offshore windfarms can achieve the desirable response (e.g. to tackle the long-distance issue from remote offshore location), is not within the scope of these studies.

Rate of Change of Frequency (RoCoF) is different around the grid, and containing regional RoCoF is a valuable contribution from windfarms. If you compared the effect on regional RoCoF (instead of nadir), does this affect the amount of IR response that is beneficial to the system?
The studies show that while the location of the wind IR does not have significant impact on the frequency nadir, it will have a more obvious impact on how the frequency behaves across different regions of the system.

Could you find an even shorter response (e.g. 1s response) and slower ramp back? After 1s, there are many more resources available.
For the UoS studies, Siemens Gamesa provided 5s and 10s profile data based on the simulations they carried out, although a shorter duration and ramp rates can be achieved. The studies and tests conducted show that the initial fast injection of power is valuable, and the duration of the inertial response is not that significant. Greater consideration needs to be given to what resources are available after the inertial response and during the wind turbine energy recovery period. Handover or exchange of response during the recovery period to other types of resources (e.g. storage or demand side), could potentially make the duration of the inertial response shorter, though non-inverter based resources may struggle to be quicker than 1s.

The coordination between wind IR and other resources during the hand over process becomes an important issue to consider. This needs to consider the ramp-down characteristics of the wind IR and the capability of the resources taking over the response.

What performance and/or cost benefit does the solar unit provide in a hybrid configuration with a battery compared to a battery providing the frequency response duty on its own i.e. what does solar bring to the party?

The solar PV system increases the overall response during daylight of the system. The battery can provide a larger amount of positive power with the solar PV system providing most of the negative response power. With this, it is possible to have a larger amount of response power with a smaller battery in comparison to a battery-stand-alone set up. In a battery-stand-alone set-up the State of Charge (SoC) is usually around 50% to provide frequency response in both directions – positive and negative response - equally. In the solar PV and Battery Hybrid system the battery SoC is higher, around 80-90%, depending on control strategy, which increases the possible positive power response by a large amount. The negative response will now be provided by curtailing the solar PV output with additional fast ramp support by the battery. Therefore, a solar PV system helps to increase the marketable response power during daytime while at the same time reducing the capex necessary for a battery with the same power range – at least for frequency responses during daylight. This can be further optimised based on current and future economic and technical developments

How do you provide the high frequency response on solar if the battery is fully charged?

In the implemented control strategies, for combined frequency responses by the solar PV and Battery hybrid system, the SoC of the battery is between 80-90% to act as a first responder with a very fast ramp to provide negative response power until the slower ramping PV inverters start. The battery will then reduce its negative power output in relation to the power reduction by curtailing the solar PV system. As this usually takes only less than 1s, the SoC band reserved for negative power provision can be quite small.

Does the curtailment of the solar power damage the solar system in anyway?

The curtailing of the solar PV system is done by changing the voltage and therefore the output on the solar PV current-voltage curve. The solar PV modules are designed to withstand such changes in voltage and current and therefore curtailing is not an issue. Some limitations might occur from warranty conditions by the module supplier but that is very rare, especially in northern countries with relatively low irradiance. Other components of the solar PV park are not affected. Changing of working points is business-as-usual for central converter based solar PV farms. The provision of frequency response in the ancillary service market by curtailing solar PV systems requires only a retrofit of software, controls and communication set-ups for faster reactions.

What are the optimal sharing percentages for IRs coming from the PV + BESS (battery energy storage system) hybridisation in a daily basis?

The tests of the solar PV and battery hybrid are intended to illustrate the increased flexibility that hybrid control options across both technologies give; these are in summary:

- The BESS can ‘front load’ the response required i.e. respond first, this being then complemented with a ‘handshake’ between the solar PV and BESS. Allowing the solar PV to take on additional output and enabling the battery to increase the speed of the overall response, but avoiding exhausting its state of charge to provide a sustained response. This avoids other uses of the battery (e.g. arbitrage) being otherwise limited to the same extent in holding fast response.
- Improving the solar PV resource estimate as it changes ahead of real time provides the opportunity for extra solar PV resource to be used as part of the overall response offered - this control strategy allows the extra resource to be optimised in real time with the battery state of charge to provide the holding.
- Time of day, the amount of solar resource available and battery strategy would also influence the

proportions of response the control system used from each device at the time.

The precise proportions of service are defined by the control system and would vary from day to day and would be influenced by each site's approach to using its power in the energy market, and so cannot be generically defined. The results from the test site illustrate the proof of this control approach and demonstrate it should be considered for utilisation for fast frequency response.

The solar PV + BESS response shown in its current form is not strictly inertial in nature, it relies on frequency and df/dt measurement via the local controller to trigger the service. NGESO, Belectric and the University of Strathclyde are exploring separately the possibility of delivering Virtual Synchronous Machine (VSM) control on a battery under a further project which is scheduled to commence later in 2019.

What would NG ESO need from windfarms in order to monitor the IR capabilities in real time? Would a Power Available signal be required for example?

A Power Available (PA) signal can give the NGESO an indication of the amount of MW available which could be used to work out the IR capability, however a PA signal by itself would not be sufficient to monitor the IR capability. As the monitoring and control scheme (MCS), has access to real time information from resources (including capacity, ramp up and ramp down rate, activation delay and duration), it means the MCS would be able to take the available boost profiles and select the response across providers in real time. This information will be used for the optimisation of the mix of resources to be used for providing the response.

What level of investment do you expect from wind generators to be suitable for providing the service?

The EFCC project complements work under the frequency roadmap seeking to evolve frequency response products into the future. This roadmap will address future approaches towards service procurement and its remuneration. The resource provider would need to reflect on how best to provide real time MW capability profiles for EFCC response to an equivalent level of confidence (95th percentile).

As part of the project's next steps, is NG ESO planning on setting up a working group about the compliance requirements for a potential service provider?

No, at this stage NGESO does not have any plans on setting up a working group about the compliance requirements for a potential service provider.

Will this be implemented in a second phase for SNAPS or will fall into a different set of services? What is the interaction within NG ESO between technical and commercial teams for future deployment of EFCC?

The project team is exploring how the project learning may be incorporated into business as usual activities and potentially assist with future system operability issues. Any future next steps with be outlined in the closing down report which will be published at the end of March 2019 and will be available on the project's website.

If you have any questions that haven't been included in this document, please email us: box.EFCC@nationalgrid.com