INNOVATION STRATEGY CLOSE-OUT REPORT

PROJECT TITLE	Facilitation of Fast DS3 System Services
PROJECT OWNER	Dr Pádraig Lyons - Senior Specialist, Future Networks Development, ESB Networks.
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BRIEF OVERVIEW OF PROJECT & EXPECTED BENEFITS

Maintaining the levels of resilience and reliability on the electricity system that customers expect is a key principle of how ESB Networks plan and operate the distribution network. The decarbonisation of generation and the requirement for flexibility within the distribution network creates new challenges for us to maintain and improve system performance.

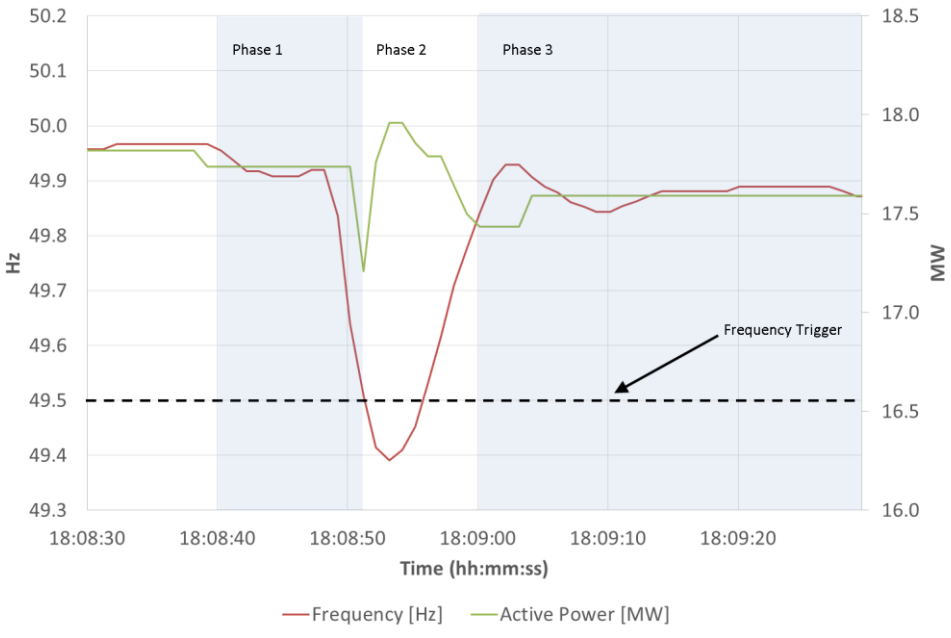
The availability of DS3 system services such as Fast Frequency Response (FFR) has led to flexibility providers looking to provide flexibility from DER (Distributed Energy Resources) such as energy storage, generation and demand side response (DSR) from within the distribution network. The provision of these services from DER has implications for the operation of the distribution network.

This project entailed necessary learning, procedures and tests to enable the advance technical assessment by ESB Networks to detect any adverse impacts on distribution network planning or operation, which arise as a direct result of the participation by ESB Networks customers, either directly or through aggregators, in the provision of DS3 System Services to the TSO or other parties. The primary source of data was taken from the Qualifying Trial Process (QTP) trials that took place in 2017.

RESULTS

<u>Waste-to-heat plant:</u>

Ten frequency events were observed during the 8 months FFR trial period of waste-to-heat plant that participated in the trial. The results indicate that the synchronous machine reacts as intended during frequency events, initially reducing active power in line with reduction of system frequency but once FFR is triggered the machine's active power export is increased within 2 seconds. As system frequency stabilised the machine's active power is slightly reduced and returns to normal operation as illustrated below.

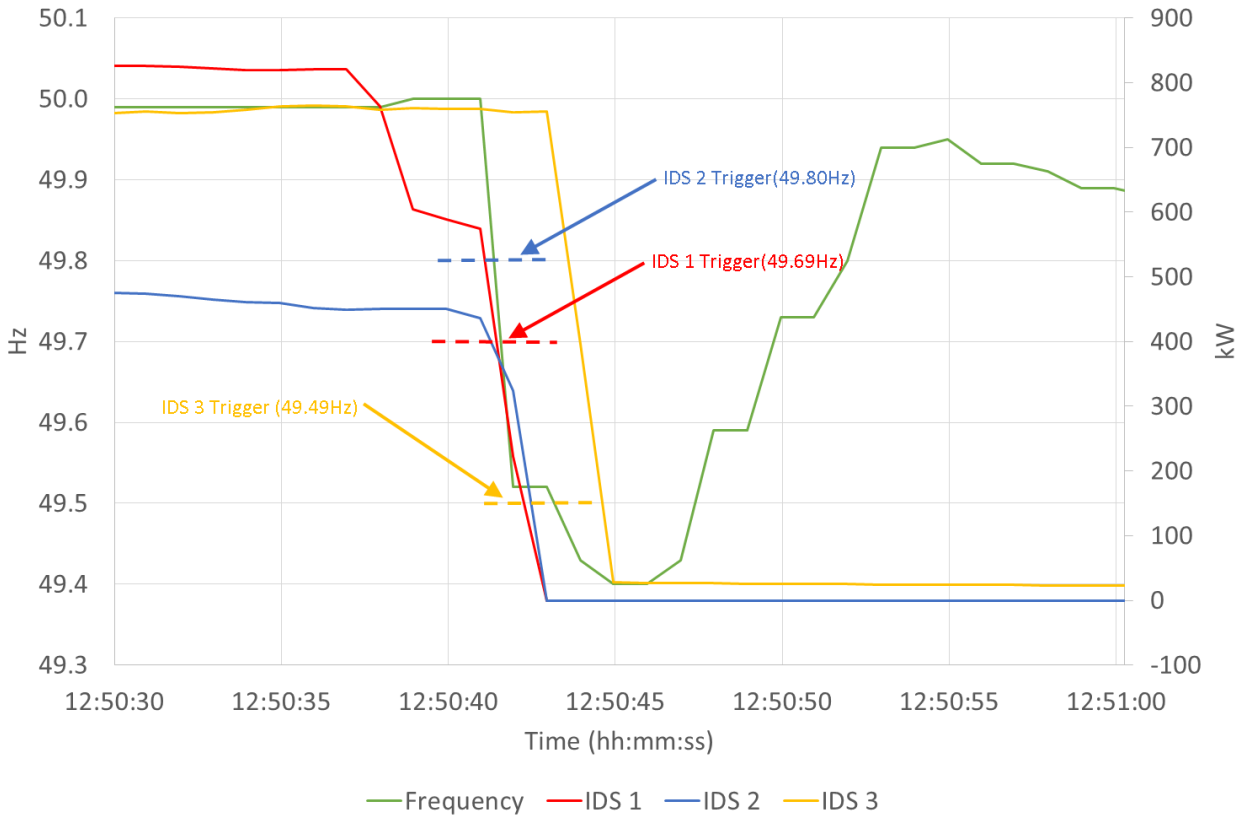


Windfarm

The windfarm was not dispatched down at times of events and was not in a position to provide FFR (DS3 service not triggered).

Demand Side Unit

Three individual demand sites (IDS) that were part of a demand side unit (DSU) that participated in the trial reacted to a frequency event as illustrated below. Each IDS has a different frequency trigger point. Once the system frequency dips below the trigger set point each individual demand site reduces load (stops consuming electricity), assisting with frequency restoration.



LEARNINGS

The full list of Eirgrid's DS3 system services is seen below in Table 1.

SIR	Synchronous Inertial Response	**SRP**	Steady - state reactive power
FFR	Fast Frequency Response	**POR**	Primary Operating Reserve
DRR	Dynamic Reactive Response	**SOR**	Secondary Operating Reserve
RM1	Ramping Margin 1 Hour	**TOR1**	Tertiary Operating Reserve 1
RM3	Ramping Margin 3 Hour	**TOR2**	Tertiary Operating Reserve 2
RM8	Ramping Margin 8 Hour	**RRD**	Replacement Reserve (De-Synchronised)
FPFAPR	Fast Post - Fault Active Power Recovery	**RRS**	Replacement Reserve (Synchronised)

Table 1: Eirgrid DS3 System Services [2]

High level initial analysis has shown that the following services will not have a significant impact on the distribution system that affects system reliability and performance.

- SIR
- DRR
- SRP

We found that the following services may have demonstrable impacts in the operation of the distribution network in areas where we have identified where congestion may occur.

- RM1
- POR
- TOR2
- RM3
- SOR
- RRD
- RM8
- TOR1
- RRS

This congestion is currently identified by offline powerflow studies. Where congestion is identified by these studies, under the current system, instruction sets are issued to the TSO, Eirgrid, who then issue instruction sets to the Demand Side Unit (DSU). With instruction sets issued, the TSO knows which specific Individual Demand Sites (IDS) may not be despatched and the DSUs make arrangements to ensure that the affected IDSs are not activated.

However, the impact of the three remaining services on the distribution network are more complex. In this work, FFR, FPFAPR and DRR are investigated in terms of their characteristic impacts on the distribution network: -

1. FFR –
    a. the impact of this service on the capability of generation to sustain islanded areas of distribution network;
    b. the impact of this service on voltage fluctuations on the network due to the coincident operation of multiple DER providing these services on the same electrical node;
2. FPFAPR – the impact of this service on the operation of impedance relays in distribution networks;
3. DRR - the impact of this service on the operation of impedance relays in distribution networks.

Fast Frequency Response (FFR):

Disturbing loads are not currently considered to be additive however FFR services are instead designed to provide synchronised support to the TSO.

Possible Mitigations

- Appropriate connection infrastructure;
- Different frequency trigger points;
- Ensure mixture of static and dynamic FFR;
- Ensure mixture of units providing very fast (< 150ms) and those providing a slower (<2s) response;

Full impact on voltage fluctuations is made less clear by the lack of indication as to the frequency of these activations in either the immediate future or indeed long-term.

Fast Post Fault Active Power Recovery (FPFAPR)

This system service is a generators quick recovery of its active power export (to at least 90% active power export pre disturbance within 250ms after disturbance) following a voltage disturbance in order avoid negative follow on impact on the system frequency.

No operational learnings on the provision of this service from Centrally Dispatched Generating Units (CGDU) we found during the 2017 QTP trial. This was because the units on the trial were out of merit during the voltage events that occurred. Trials were also carried out with windfarms, however the dips observed at these sites were 87% and 88% retained and therefore no operational learnings were taken from these trials.

Dynamic Reactive Response (DRR)

This system service is a generators rapid increase (40ms rise time and 300ms settling time) in reactive current providing reactive power of at least of 31% of registered capacity to counteract a system voltage dip in excess of 30% and assist with system voltage recovery.

The measurement of this product will require high quality phasor measurement units to be installed at the provider's site with appropriate communication and access arrangements agreed with the TSOs. Therefore, no operational learnings for DRR were taken during the trials.

BENEFITS REALISED/VALIDATED

The impact of the fast DS3 services was assessed. FPFAPR and DRR were found to have limited impact on the normal operation of the distribution network as they are triggered during fault events. In contrast, FFR and the other frequency services could be triggered under normal distribution network operation, so they need to be assessed with more consideration. The assessment concluded that FFR poses risks to power quality on the distribution network and therefore may need to be considered as a disturbing load when planning the connection of energy storage units or for other DER providing this service.

NEXT STEPS – BAU, TRANSFER OF OWNERSHIP

System services providers of dynamic and static FFR connected to the distribution network may need to be treated as disturbing loads and associated disturbing load guidelines practices should be followed as part of the planning assessment.

Further engagement with UK Distribution Network Operators has been carried out who are already connecting storage to understand how they are applying disturbing load guidelines in their planning approaches for energy storage.

In addition, the combined import and export capacities (MIC and MEC) should be considered when assessing the impact on voltage fluctuations of these energy storage devices such BESS (Battery Energy Storage System). BESS and other energy storage will be treated primarily as generation but with the load requirements considered also.

With the increase in system non-synchronous penetration it is recommended that ESB Networks closely monitor frequency and the of the resultant nature of voltage fluctuations caused by providers of these services and this requirement should be considered in future strategy for Power Quality systems.

FINAL TIMELINES (REASONS FOR ANY DELAYS IF THEY OCCURRED)

No delays.

FINAL COSTS

No CAPEX costs. Time and expenses for ESB Networks Staff.