The Voice of the Networks

Energy Networks Association

Open Networks Project

Whole System Operability Progress

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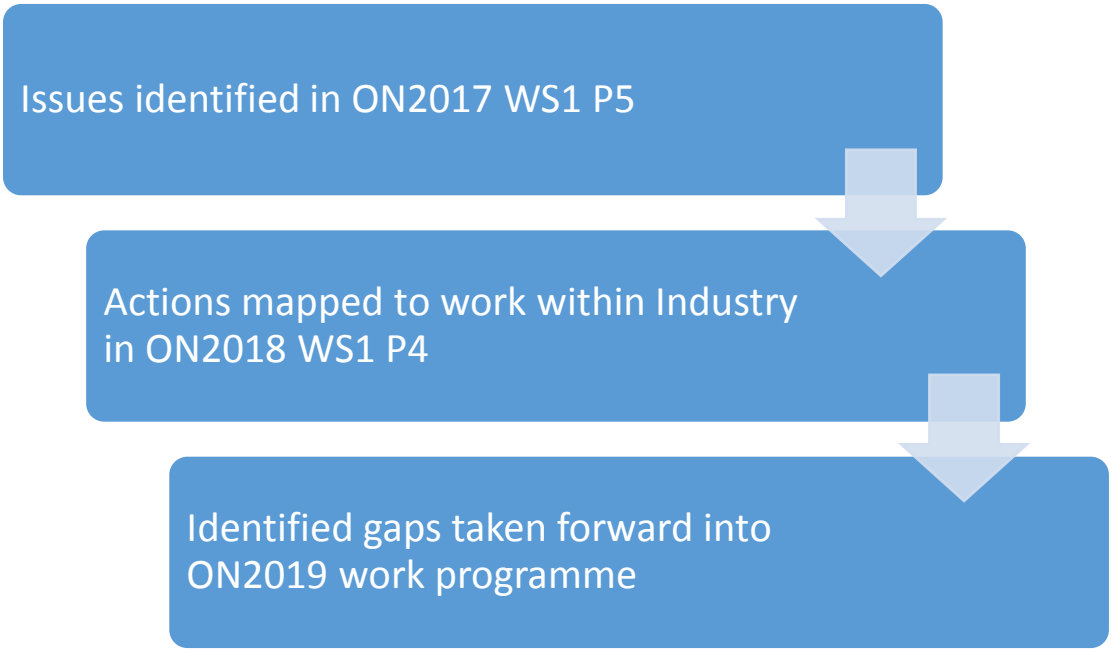
1 Summary

This document sets out to describe a number of key actions being undertaken by Network and System operators within the UK which contribute to ensuring the security and resilience across the whole electricity system.

The issues identified within ON2017 WS1 P5 have been mapped to actions being undertaken by the industry within 2018 and gaps relating to potential future worlds of operation identified. These will be taken forward as part of the 2019 Open Networks Project.



2 Introduction and Purpose

The UK has one of the most reliable electrical systems in the world. Network and system operators are committed to ensuring service delivery levels are maintained.
As the electricity system changes, becoming more active across all voltage levels, then some existing resilience functions may be affected. These electricity system functions can be grouped into three main categories:

1. Contribution to Inertia
2. Automatic Frequency Response
3. Manual Control Interventions

By understanding the impacts of changes due to the evolving electricity system and ensuring any reduction in the existing resilience within those three categories is mitigated, a move to a more active system operation will not affect whole system security.

The following report identifies, at a high level, some areas of whole system operability that need to be continually assessed in light of future electricity system operation and the work collaboratively being undertaken by Industry to mitigate impacts.

3 Contribution to Inertia

3.1 Fault Ride Through Capability

In in order to ensure the National Electricity Transmission System can maintain frequency standards and avoid risks of a major loss of supply event caused by volumes of generation disconnecting or late arrival of dispatched generation in an uncoordinated way, DER needs to stay connected following a transmission fault. This would require that DER have the capability to ride through faults and that their protection systems do not inadvertently trip them for an event that does not require them to be deenergised.

DER has not consistently had fault ride through requirements imposed on them. Also, their G59/G83/LoM protection have been susceptible for inadvertent tripping.

To a lesser extent lack of fault ride through can also affect the local network – e.g. cause a voltage disturbance.

Activity	Impact	Group	Timeline
Implementation of G98 and G99	Introduces new requirements for ride through capability for 1MW+ generation to meet RfG EU codes	-	April 2019
Accelerated VS change programme summer 2018	Collaborative working between DNOs and ESO have enabled distribution connected resources to quickly provide a solution to ride through issues	GC0079	Sept 2018
Consultation on frequency changes during large disturbances	Consultation to review opinion of proposals to remove vector shift protected equipment from the network and increase fault ride through capability	GC0079	August 2018
Implementation of consultation recommendations	Implementation of outcomes to resolve fault ride through capability concerns	GC0079	2019

3.2 Low Frequency Demand Disconnection (LFDD) – Impact of falling inertia

As inertia drops and RoCoF increases, high rates of frequency drop may lead to unnecessary demand disconnection by LFDD relays. If the disconnection is excessive, it may lead to frequency exceeding 52Hz and to generation tripping by over-frequency relays.

Activity	Impact	Group	Timeline
Review of the scheme settings	Review the settings and the sizes of the disconnection blocks to ensure they are fit for purpose and would function as required over a wide range of system inertia levels.	LFDD	June 2020
LFDD SOF	Analysis identified additional risks and proposed further work to be developed under LFDD group	SOF	July 2017

4 Automatic Frequency Response

4.1 Low Frequency Demand Disconnection (LFDD) – Impact of Embedded Generation

Volumes of generation on the downward side of LFDD relays mean operation of the relays will also disconnect generation. If the supply point is exporting, this will actually make the frequency event worse. Even if the supply point is not exporting, it will disconnect more demand than is necessary. Current view is LFDD will still protect from frequency run away leading to total system loss, but under certain conditions demand losses will be considerably higher than they should be.

Activity	Impact	Group	Timeline
Implementation of G98 and G99	Introduces new requirements generation to meet RfG EU codes, including LFSM-U for Types C & D	-	April 2019
Options and Impact assessment	Options and impact assessment being undertaken by Industry to make further recommendations on implementation such that the risk is minimised as embedded generation capacity continues to increase	LFDD	Sept 2019
Implementation of recommendations	Implementation of actions recommended following the options and impact assessment	LFDD	Dec 2019
LFDD SOF	Analysis identified additional risks and proposed further work to be developed under LFDD group	SOF	July 2017

4.2 Combination of Fault Ride Through followed by LFDD

The issues identified in the fault ride through capability section, combined with an additional large transmission system generation loss could lead to an LFDD event. This could then be compounded by triggering Vector Shift then RoCoF, followed by LFDD.

Activity	Impact	Group	Timeline
Actions required under LFDD mitigation completed	Individual LFDD mitigation actions completed will resolve near term issues	LFDD	2020
Actions required under Fault Ride Through mitigation completed	Individual Fault Ride Through mitigation actions completed will resolve near term issues	GC0079	2019
Collaboration between LFDD group and GC0079	Collaboration between working groups to ensure HILP events do not have an escalated impact on the network	LFDD/GC0079	2019

4.3 High Frequency Generation Disconnection (HFGD)

G59 high frequency settings are settings are primarily meant to prevent conventional generation damage. G59 protection will disconnect generation if the system frequency exceeds defined parameters, however it may not necessarily be co-ordinated to other system actions and is a uniform disconnect to all embedded generation, rather than an incremental or staggered disconnection.

Activity	Impact	Group	Timeline
Implementation of G98 and G99	Introduces new requirements for generation to meet RfG EU codes, including LFSM-O requirements		April 2019
Consider requirements as part of LFDD options work	LFDD group to consider any additional requirements to relay modifications to better protection and secure the network	LFDD	2020

5 Manual Control Interventions

5.1 DER Emergency Disconnection

In order to preserve network integrity and limit the effect of unsecured events on consumers and other network users, the SO has a clear process to emergency instruct demand and large generation, but not DER. Historically with low proportion of DER this was not an issue, but with some regions at times dominated by DER the network is at risk to contagion and smaller incidents unnecessarily spreading to larger incidents as a result.

Activity	Impact	Group	Timeline
Emergency Disconnection of Embedded Generation	Definition of an explicit and clear requirement in the Grid Code, Distribution Code, CUSC, and DCUSA that DNOs disconnect DER following an instruction from NGET under emergency conditions.	RPMF	Under review

Voltage Reduction and Emergency Demand disconnection

Applying voltage reductions to reduce demand becoming less effective owing to voltage response from embedded generation as well as changes in voltage dependency of demand.
Risk that demand disconnection sequences will also disconnect generation, hence higher volume of demand disconnection required / higher risk of LFDD operation.
Potential risks that emergency requirements also sterilise flexibility that could otherwise be used for whole system benefits.
There is also the possibility that DER could assist in supporting demand during a rota disconnection event and perhaps provide a service during an event, but these aren't covered by the electricity supply emergency code and there is no formal agreement/process in place to make use of any potential services. Modern telemetry and control which is placed further downstream towards customers could offer a finer level of disconnection than provided by existing schemes.

Activity	Impact	Group	Timeline
BAU testing of demand reduction by voltage reduction	Ensures effectiveness of demand reduction by voltage reduction is tested and meets system operability requirements	BAU	On-going
Review of Methodology for Demand Disconnection Groupings	Options and impact assessment being undertaken by Industry to make further recommendations on methodology of demand disconnection groupings which make allowances for DER support	RPMF	On-going
Consideration within Open Networks of DER Support for Restoration	Ensure products for DER flexibility can provide support for restoration of demand disconnected under system emergencies	ON WS1 P2	2019

5.2 Black Start

Black start is the ability of a power system to restart itself after a complete or partial system loss of electrical power. The Transmission System Operator is responsible for maintaining a Black Start strategy and managing the process. The closure of large Power stations or long periods of "summer cold" means alternative providers are required. Furthermore, automatic reconnection of DER during system restoration could result in destabilising restoration plans.

Activity	Impact	Group	Timeline
Black Start Whole System SOF	Identification of some potential problems arising from the reduced number of large central generating units that have been historically contracted to provide black start service	Collaborative SOF	Dec 2017
Black Start from DER (NIC project bid)	NIC project reviewing options for whole system Black Start	NIC project	Apr 2022

5.3 Protection Operation

Reduced fault levels owing to the operation of regions and adjacent regions with little synchronous plant leading to protection not operating, or being slow to operate, or not providing sufficient discrimination for faults.

Activity	Impact	Group	Timeline
Fault Level Whole System SOF	Understand and quantify the future variability of fault levels	Collaborative Whole system SOF	Jan 2019

5.4 Priority of actions under a DSO model

Under a future world not led by the TSO, the DSO would secure the D network and filter out any flexibility actions that are not secure on the D network before passing the availability of

remaining actions to the TSO for wider flexibility actions. This would be expected under normal operation when national flexibility resources are adequate; however, if national flexibility resources become inadequate (resulting in the ESO issuing a Notice of Inadequate System Margin (NISM)), this model might put local security for a few customers ahead of wider security for a more significant number of customers. Under a future world not led by the TSO, it would be necessary to consider a new emergency process to decide how to prioritise actions during periods covered by a NISM.

Activity	Impact	Group	Timeline
Review requirements for processes under DSO Coordinates, Coordinated DSO-ESO procurement or Price-Driven Flexibility Worlds	Following the outcome of the consultation on future worlds, the various worlds chosen for further development must be able to facilitate whole system security, regardless of future world chosen. Further work should be undertaken in 2019 to work through how to priortise actions to ensure whole system security.	Open Networks 2019 Programme	2019

5.5 Negative Reserve Active Power Margin (NRAPM)

During low demand with high DER generation periods, combined with inflexible transmission connected generation (nuclear), it is becoming increasingly difficult to carry negative response to cater for loss of large demand (pumps and interconnectors exporting etc.)

Similar issue is encountered on a local level where local demand and high output of DER cause a constraint that cannot be managed via the BM.

Activity	Impact	Group	Timeline
Consideration within Open Networks of DER Support for NRAPM	Ensure products for DER flexibility can provide alternative options for ensuring resilience for loss of large demand.	ON WS1 P2	2019
Southern Operational Tripping Schemes	Development of automated schemes to allow instruction of emergency generation disconnection	NG, SSEN, UKPN, WPD	April 2019
Regional Development Plan Works	RDPs to provide connect & manage processes to provide visibility and commercial control of DER	RDP	Dec 2018
Wider BM Access	The facilitation for optional access for DER to the Balancing Mechanism will increase the generation available in the BM which should reduce the time where there is an NRAPM	Wider Access Roadmap	Dec 2019