

### 3.7 Areas where increasing levels of DER potentially affects operation of the system under Emergency Conditions

#### Whole system issues list

As the electricity system changes, moving to more active operation across all voltage levels, then some existing resilience functions may be affected. The following list identifies at a high level some areas of whole system operability that need to be reassessed in light of future electricity system operation.

Area	Issue	Work to Date	Additional Comments
Fault Ride Through Capability	<p>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. DER has not consistently had these requirements imposed on them.</p> <p>To a lesser extent lack of fault ride through can also affect the local network – e.g. cause a voltage disturbance.</p>	<p>There are some “no trip” requirements in G59, but these are not adequate and only say that the interface protection can’t trip the gen off, they do not form a requirement for the generation to stay on.</p> <p>It has been identified that existing week 24 reporting requirements do not adequately cover the level of detail for accurate modelling.</p> <p>RfG will address the future for generation above 1MW from 17/05/2019 and G99 (G59 replacement) will align, however there are significant risks that are not addressed. E.g. known G59 issues and existing generation in general.</p> <p>Additionally, there are significant volumes of sub 1MW generation not covered by any fault ride through standard.</p>	<p>Existing G59 issues:</p> <p>Vector Shift disconnecting DER during period of fault current rather than because of resultant network following fault clearance.</p> <p>RoCoF settings sub 5MW operating for large in-feed losses within the SQSS design standard. This occurs on low inertia networks. Lower inertia brought about by the change to T&amp;D connected power electronic connected generation.</p> <p>Under / Over voltage tripping timescales do not align with the timescales allowed in the SQSS.</p> <p>Some generator owners may choose to select factory settings on their equipment in addition to the G59 requirements, which disconnects rather than ride through a fault with the view this protects their plant.</p>
Low Frequency Demand Disconnection	Volumes of generation on the downward side of LFDD relays mean operation of the relays will also disconnect generation.	Case studies have been published in National Grid’s SOF July 2017 and WPD’s DSOF – September 2017	Much work and analysis has been completed, but there have been no recommendations introduced

(LFDD)	If the supply point is exporting this will actually make the frequency event worse. Even if supply point not exporting 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.	Previous work undertaken by the LFDD working group convened by NGET demonstrates a broadly compliant network with current levels of DG; however improvements could be made.  LFDD working group still active in 2017.	to the relevant network codes.  Protected Customer' status (as defined in the ESEC document Electricity Supply Emergency Code) being reviewed by a ENA working group which may change to include DG in certain cases
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.)	Some modelling and analysis of the impacts of coincidence of these events has been undertaken, but further quantification of risk is required.	
High Frequency Generation Disconnection (HFGD)	G59 high frequency 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.	Due to the relative dominance of demand on the network versus the level of uncontrolled generation on the distribution network, there is currently a limited risk of significant impacts occurring.	Mechanisms should be in place to allow embedded generation to arrest an over-speeding network.
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.	A grid code modification to provide a useable process for the existing ability to disconnect plant and apparatus under emergency conditions to date has failed and requires further engagement.  Some areas of the network, particularly at risk have had requirements placed on the DNO via the GSP BCA for the DNO to provide a "stop gap" measure via DNO tele-control sequential switching pending a successful Grid Code review.	There is some potential for more active distribution networks to undo emergency actions if the automated systems are not programmed with this behaviour in mind.

<p>Voltage Reduction and Emergency Demand disconnection</p>	<p>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.</p> <p>Risk that demand disconnection sequences will also disconnect generation, hence higher volume of demand disconnection required / higher risk of LFDD operation.</p> <p>Potential risks that emergency requirements also sterilise flexibility that could otherwise be used for whole system benefits.</p>	<p>Project Divide was going to look at effectiveness of voltage reduction but is on hold and is being re-scoped.</p> <p>Operation Phoenix (4 to 5 years ago) tested the effectiveness of voltage reduction and lowered the grid code requirement from 5% to 1.5%. Further trials are planned.</p>	<p>There is some potential for more active distribution networks to undo emergency actions if the automated systems are not programmed with this behaviour in mind.</p>
<p>Black Start</p>	<p>Closure of large Power stations / long periods of “summer cold” means alternative providers required.</p> <p>Automatic reconnection of DER during system restoration destabilising restoration plans.</p>	<p>A WSOF – whole system operability framework assessment on Black Start has been undertaken between National Grid and Northern Powergrid as part of Open Networks WS1 product 3. Publication is expected in January 2018.</p>	<p>Consideration of smaller DSO zones which can sustain islanded operation and allow smaller amounts of aggregated blackstart generation to provide support.</p>
<p>Protection Operation</p>	<p>Reduced fault levels owing to the operation of regions and adjacent regions with little synchronous plant leading to protection not operating / slow to operate / not discriminating.</p>	<p>National Grid’s 2016 SOF has some high level analysis on declining Short Circuit Levels.</p>	<p>Will affect Distribution networks as well as Transmission networks. Some assessments have been done on Distribution fault levels, but varying results have been found, depending on the likely timeline and contribution of Transmission fault level decline. While short circuit levels are declining on the transmission system they may continue to rise on some distribution networks due to DER.</p> <p>Further work is planned under Open Networks WS1, under a WSOF case study between</p>

			<p>National Grid and Western Power Distribution.</p> <p>G74 under review, including the methods for calculating the contribution to short circuit levels from DER.</p>
<p>Priority of actions under a DSO model</p>	<p>Under a DSO-led Market Model, the DSO will secure the D network and filter out any balancing actions that are not secure on the D network before passing the availability of remaining actions to the TSO for wider balancing. This is the most sensible way under normal operation when balancing resources are adequate. If balancing resources become inadequate this model will put local security for a few customers ahead of wider security for a more significant number of customers. Need to consider a new emergency process to prioritise actions during periods of inadequate balancing margin.</p>	<p>Potential conflicts have been newly identified.</p>	<p>Even under a TSO lead model the DNO ANM may have the same effect.</p> <p>The availability of balancing actions passed from the DSO to the TSO does not need to have a hard limit. Cost functions could be defined that make additional actions available at a cost, which is then used to compensate the D network customers that are affected.</p>
<p>Negative Reserve Active Power Margin (NRAPM )</p>	<p>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.)</p>	<p>Potential conflicts have been newly identified.</p>	<p>Visibility and control of non-BMU DER for SO to be able to emergency instruct</p>
<p>Electricity Supply Emergency Code - Rota disconnections</p>	<p>There is 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</p>	<p>Potential conflicts have been newly identified.</p>	<p>Potential for obligations to be placed on DER services under emergency system conditions.</p>

	agreement/process in place to make use of any potential services.		
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