

Ongoing Technical Developments in Grid and Distribution Codes

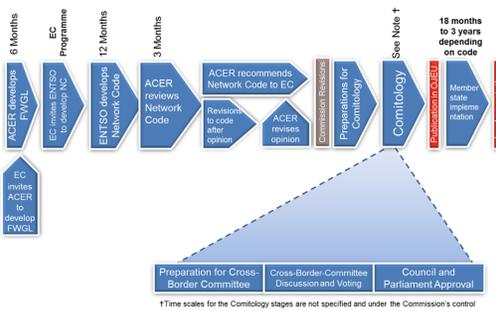
System Operability Framework

GC0100-GC0104 EU Codes Implementation

European 3rd package drivers



European Network Codes Development Process



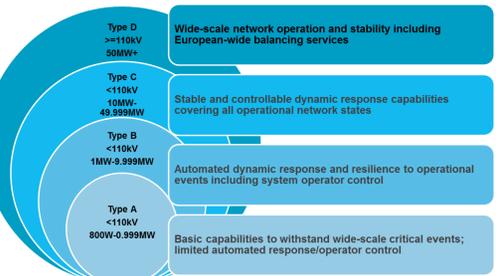
Overview of the EU Connection codes

- Requirements for Generators (RfG)**
Entry Into Force: 17th May 2016
Applies to: New generation connections (800 Watts capacity and up) to Distribution and Transmission systems
From: 17th May 2018 onwards
- Demand Connection Code (DCC)**
Entry Into Force: 7th September 2016
Applies to: New HVDC connections, including DC Connected Power Park Modules and remote end HVDC Converters.
From: 7th September 2018 onwards
- High Voltage Direct Current (HVDC)**
Entry Into Force: 28th September 2016
Applies to: New HVDC connections, including DC Connected Power Park Modules and remote end HVDC Converters.
From: 28th September 2018 onwards

Connection Codes - Progress

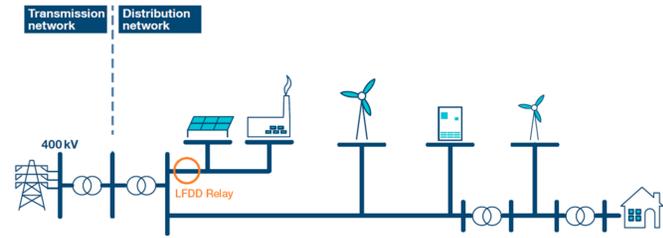
- Requirement for Generators (RfG) and High Voltage Direct Current (HVDC) codes : Final Modification Report submitted to Authority, response expected on 27th March 2018.
- Demand Connection Codes (DCC): Workgroup consultation and legal drafting issued on 8th March 2018.

RfG Generator Bandings

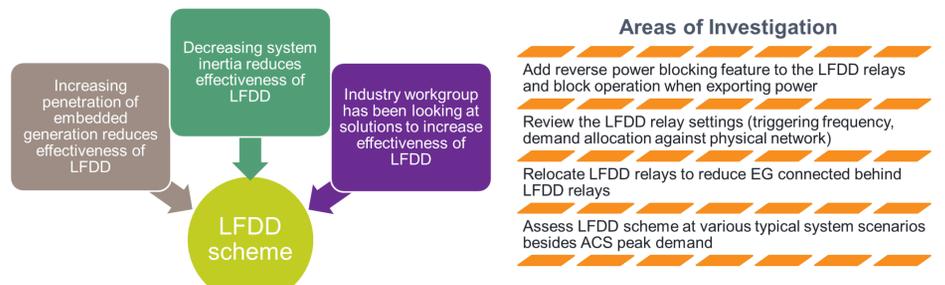


Low Frequency Demand Disconnection

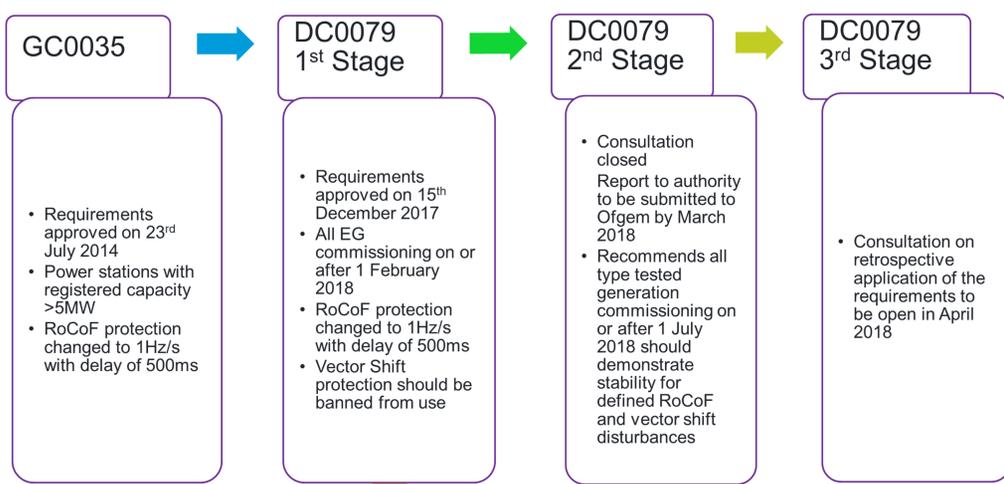
Stage 1: System Operability Framework analysis in July 2017 identified the risk of LFDD scheme not being as effective in the future due to decreasing system inertia and increasing penetration of distributed generation.



Stage 2: Industry working group is established to investigate potential solutions.



Loss of Mains Protection



DC0079 1st Stage Requirements
all embedded generators with a commissioning date on or after 1 February 2018

- RoCoF protection used as loss of mains protection 1Hz/s with a definite time delay of 500ms.
- All generation using discrete relays should demonstrate stability for appropriate RoCoF and vector shift disturbances
- Vector shift protection is banned from use as loss of mains protection for all generation using discrete relays

Ofgem approved this modification on 15th December 2017

Fast Fault Current Injection Expert Workgroup

- With current technology/models, the studies show that the system potentially becomes unstable when more than 65% of generation is Non-Synchronous.
- In 2017, National Grid consulted on its proposals for Fast Fault Current Injection and Fault Ride Through (GC0100) as part of the implementation of the RfG and HVDC European Network Codes. As part of this consultation, National Grid proposed the following three options.

Option 1	Option 2	Option 3
The requirement for enhanced converter control performance similar to that of a Synchronous machine, for implementation by 2021 –Virtual Synchronous Machine (VSM)	The use of currently available converter control technology with a ceiling current of 1.25pu	The use of currently available converter control technology with a ceiling current of 1.0pu.

Following the workgroup consultation, there was an overwhelming response for Option 3, largely as this option is already technically available in today's market. As a result, and in line with the GC0100 consultation, National Grid is therefore proposing to set up an expert group to examine and address these issues.

