SOF trends related to HVDC integration.

National HVDC centre; Operators Forum 2019

26th June 2019.

Ben Marshall,

Technical Specialist- System Performance,

Networks, National Grid ESO.

nationalgridESO

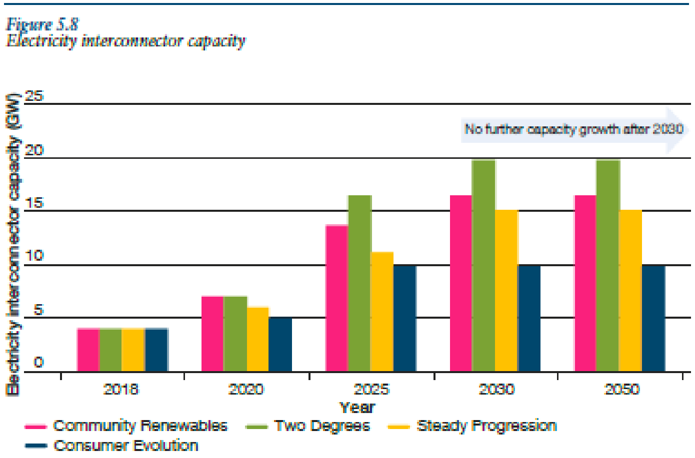
Disclaimer

National Grid is providing this information in good faith alone and accepts no responsibility or liability for it to provide any form of substitute to the Grid Code or Bilateral Agreement.

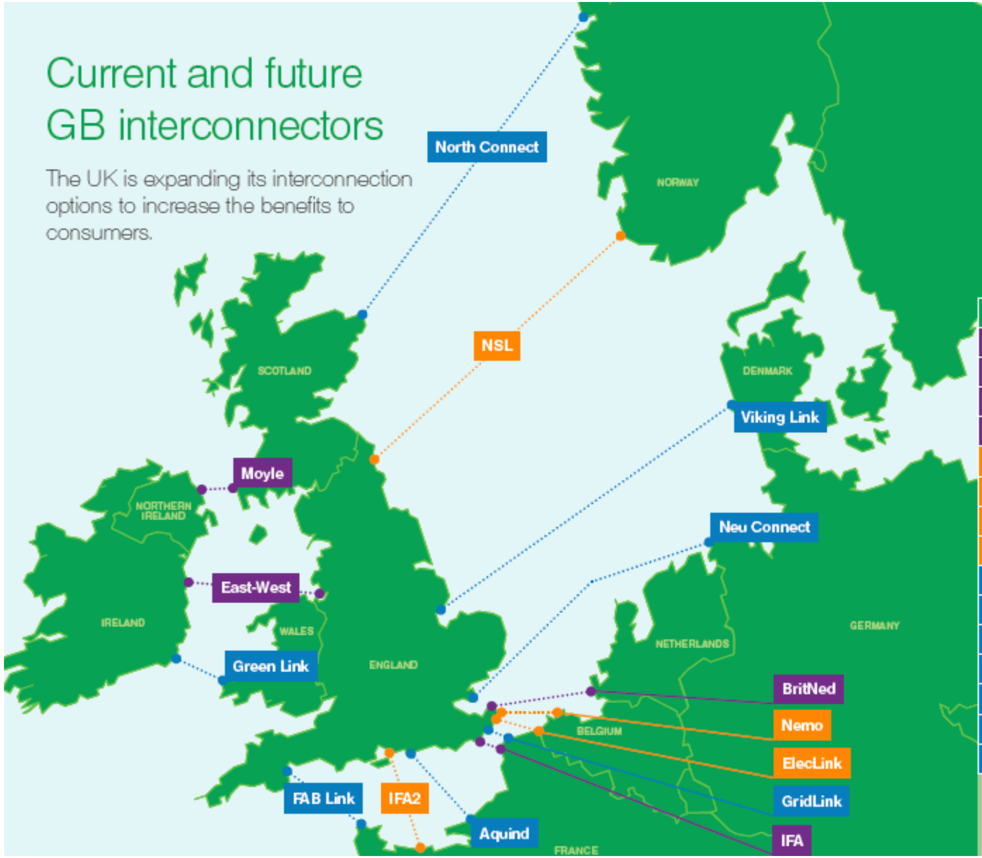
If you are an HVDC Developer seeking to connect an HVDC System to the System, and have specific technical queries we would urge you to contact National Grid (transmissionconnections@nationalgrid.com)
or your Customer Account Manager in the first instance so you can be put in touch with the correct contacts.

nationalgridESO

Growth in interconnectors



National Grid ESO-FES 2018



Project	Go-live date
IFA	1986
Moyle	2002
BritNed	2011
East-west	2012
Nemo	2019
ElecLink	2019
IFA2	2020
NSL	2021
Green Link	2021
FAB Link	2022
North Connect	2022
Neu Connect	2022
GridLink	2022
Aquind	2022
Viking Link	2023

National Grid Group: Interconnectors- connecting for a smarter future booklet

nationalgridESO

Short Circuit decline and impact

National Grid has published a series of publications identifying a general decline in short circuit current level:-

1. Our 2018 SOF report on '[Impact of declining short circuit levels]'. Summarised protection and control impacts across GB, Identifying areas of focus.
2. Our 2018 SOF report on '[Whole system short circuit level]' describes trends and modelling considerations at Transmission and Distribution levels.
3. Our 2018 '[Regional Trends and Insights]' document highlighted variation of synchronous generation across future years and its effect on SCL.
4. Our 2017 SOF report on '[Performance of Phase Locked Loop based convertors]' identified potential vulnerabilities relating to the magnitude and extent of the variation of SCL.
5. Our '[2014-2018 SOF documents]' illustrate the trends and distribution of SCL decline.

Voltage requirements can also be seen to change, both the need of reactive absorption of high voltage and in certain areas capacitive support to recover low voltages across disturbances on the network.

Figure 4.30
*Voltage containment and recovery requirement (**Consumer Power** 2020/21)*

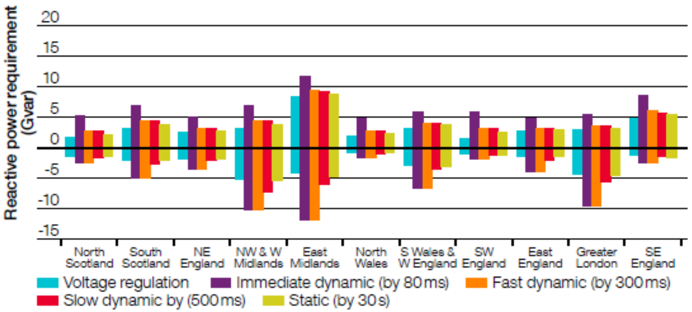


Figure 2: Regional short circuit level over the next 10 years

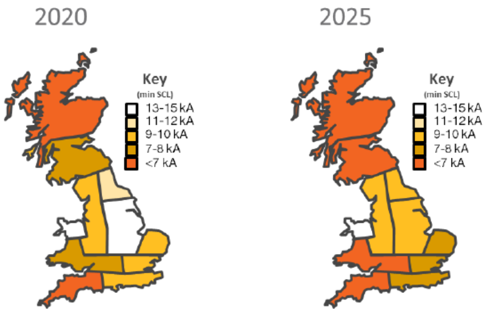
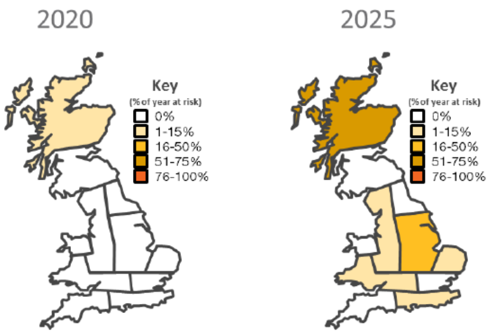


Figure 3: Regional Phased Locked Loop risk over the next 10 years



Frequency containment.

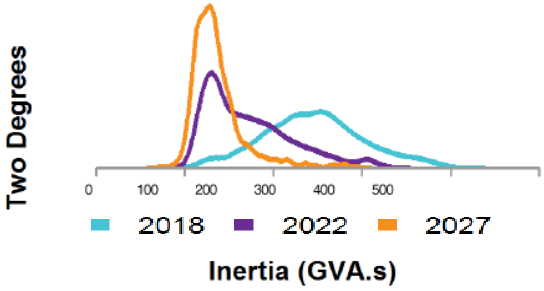
Frequency management is subject to the following effects discussed in SOF:-

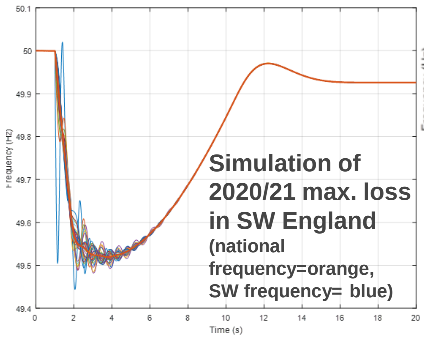
1. Total system inertia continues to decline as levels of synchronous generation availability fall
2. Our EFCC project noted that as inertia falls, and following completion of RoCoF relay change work, it becomes possible for the frequency to be contained to faster deviations, the variation of frequency movement become increasingly *regional* during an event
3. As such as fast frequency response will requires more than local data to be stably delivered.
4. Our 2018 SoF report on ‘Frequency and Voltage Dependency’ highlight that regional frequency can be impacted by fault conditions and can see oscillation related to the speed voltage recovery and availability of inertial response in MW and Mvar available in the area.

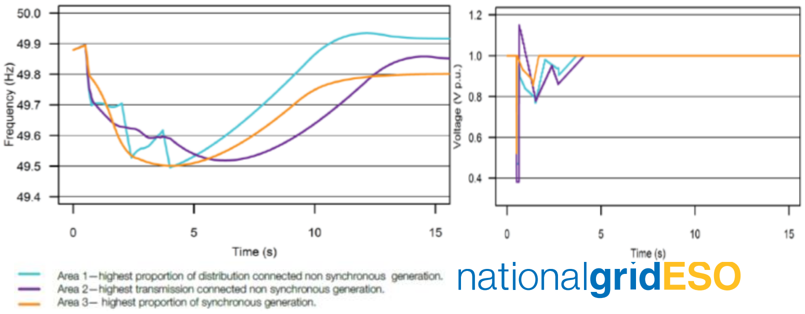
We have separately supported a Grid Code VSM Expert Working Group, exploring the specification of a Virtual Synchronous Machine or equivalent performance from Non-Synchronous Generation. We currently specify a “handshake“ between VSM energy storage and conventional frequency response that would need to occur across 20s.

Were an EFCC, or equivalent frequency response available- a future “handshake” could occur within 500-700ms of an event defining a smaller energy requirement.

The VSM approach, has several advantages for grid integration. Many HVDC technologies already have capabilities that resemble this, relating to grid forming in a Black Start condition.







Network Development Roadmap- Voltage and Stability Pathfinders.

National Grid has within the ‘Network Development Roadmap’ identified a series of pathfinding projects aimed at transforming our existing process –Network Options Assessment process (NOA) for efficient, coordinated and economic development of the transmission system-

1. Our **High Voltage pathfinding projects** consider as a first step for developing a regional options assessment for voltage requirements, our steady state high voltage needs within the **Mersey and Penine areas**. A RFI for needs in the Mersey area is underway, with the Mersey area, with a further RFI for the Pennine area to follow.

2. Our **Stability Pathfinder** explores the stability of frequency and voltage and the ability of a network user to remain connected to the system ,during normal conditions, and across the period of a fault and its clearance. We discuss our areas of focus in our most recent SOF document.

   We intend to invite technical and commercial solutions from across the industry to address specific locations, beginning with an RFI process in July 2019.

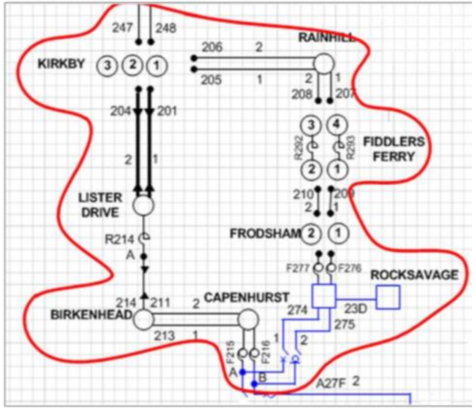
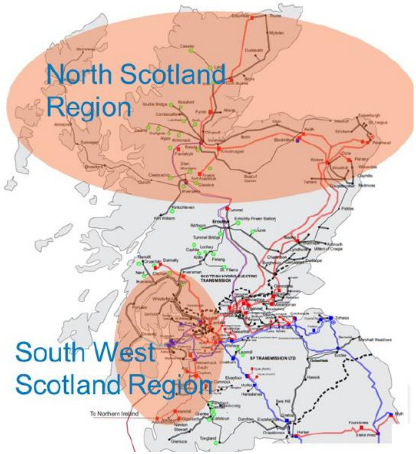
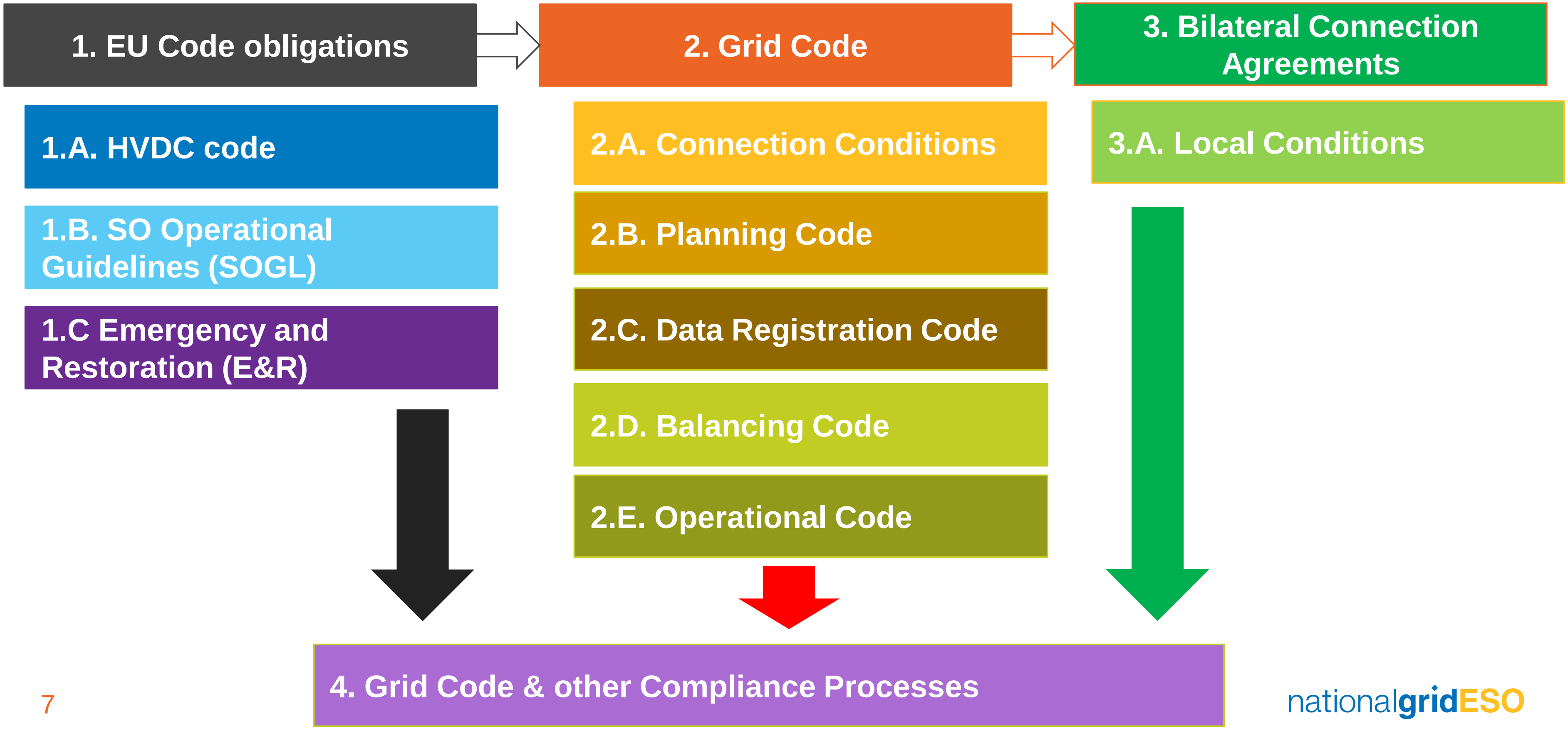


Figure 7: Map of areas of focus for Stability Pathfinder Project



Structure of HVDC Code performance areas



nationalgridESO

Current code arrangements

- Grid Code administered by National Grid ESO, but belongs to whole industry. Code change is subject to industry workgroup development, Industry consultation and Regulatory approval under Open Governance arrangements. Consistency with EU codes is also required.

- Promotes consistent frameworks across a range of technologies, including HVDC interconnector.

- Support transparent obligations for compliance demonstration, model and other data exchange.

- Mirrored within STC process obligation, Grid Code and SQSS obligations for a Transmission Owner HVDC connection. Compliance testing is the responsibility of the TO for such projects.

- Have flexibility within BCA to account for individual connection conditions (for example local power quality needs or the trend in short circuit level). Can request more information from users where justified and reasonable. This can include further models, including those related to EMT analysis.

nationalgrideso.com

National Grid ESO, Faraday House, Warwick Technology Park,
Gallows Hill, Warwick, CV346DA