Case Study: ESO Stability Pathfinder

The HVDC Centre investigate the impact of declining system strength on stability of HVDC links.

With climate change providing a massive threat to the UK, there is a requirement to decarbonise the UK energy system using renewable technologies. Doing this will result in large volumes of fossil-fuel power stations being replaced by renewable generation and other low-carbon technologies such as wind, solar and HVDC interconnectors. This could potentially result in a decline in system strength, and increased risk of the network operation, as the system becomes more volatile.

The National Grid Electricity System Operator (ESO) identified that Scotland could be one of the most vulnerable areas of the network to investigate in terms of low system strength, due to the high penetration of renewable technologies in the region.

The ESO sought guidance from the HVDC Centre to investigate the impact of declining system strength on stability of HVDC links and other low carbon technologies that are connected through power electronic converters.

Current practices were to undertake GB-wide system studies in RMS-type simulation tools, but this is not 100% accurate and does not accurately represent the dynamic operation or control performances that would be apparent in the EMT-type model.

The piece of work carried out by the HVDC Centre used EMT (PSCAD) and RMS (Digsilent) simulations to test the hypothesis of the ESO 2017 study that when HVDC links are connected to very weak AC grids, the HVDC system no longer operate correctly.

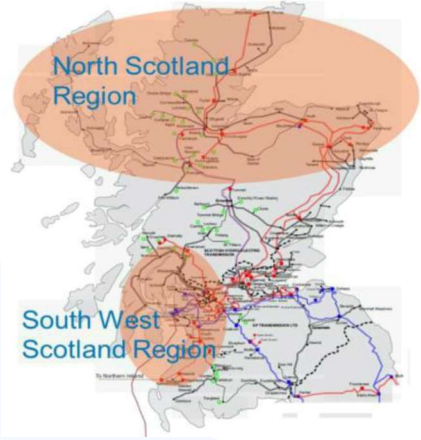

Figure 1: Map of area of focus for the stability pathfinder project (Source: NG ESO)

The HVDC Centre used power system simulation tools to model HVDC links and different low-carbon technologies (including wind farms and battery inverters), by testing their stability performance across a range of different system conditions on the electricity grid.

The Centre used open-access converter models to repeat the studies that the ESO had conducted in 2017 to prove whether their models were true in the same conditions and uncover what component in the HVDC system triggers those adverse interactions between the converter and the AC network.

Outcomes

The scope of the project will be analysed in 3 stages:

- In Phase 1 the project output is expected to inform the ESO on the fundamental principles of devices within HVDC links and low-carbon technologies that could interact adversely with the electricity grid. This should provide insights on the specifications that the ESO should provide to customers who want to connect with the GB network and outline opportunities for improving system stability.

- Phase 2 of the project will be to explore with the ESO how customers, looking to connect with the GB network, can test the technology models to provide the confidence that they would respond in the same way as when connected to the network. Considering that any power electronic based source that connects with the network will experience this challenge of declining inertia, the HVDC Centre developed model description guidelines, which was fed as input to the customer Request for Information, published by the ESO in August 2019.

- Phase 3 of the project is expected to feature system testing of a range of different stability technology solutions in a real-time simulation environment, using both hardware and software models of equipment manufacturers to increase confidence level of industry in the effectiveness of the proposed solutions.

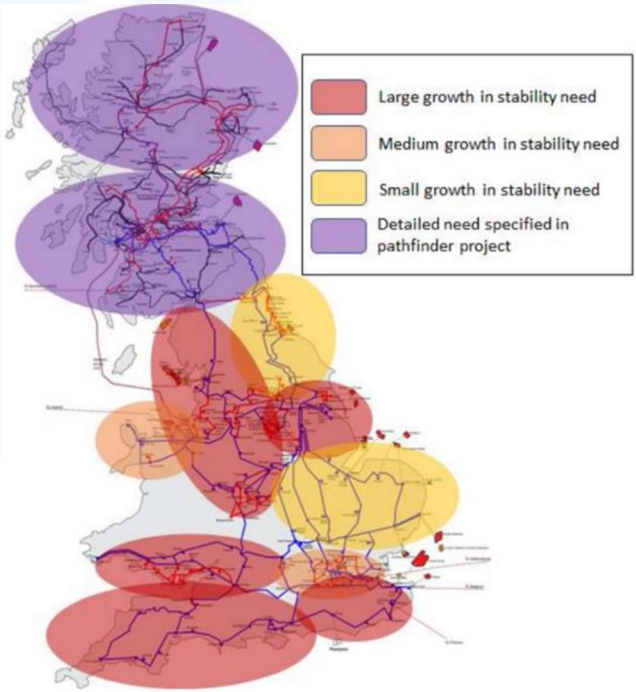

Figure 2: Stability needs across GB electricity grid (Source: National Grid ESO)