Case Study: Maximising HVDC for Black Start

The HVDC Centre leads the improvement of Great Britain's Black Start capabilities using HVDC.

The evolution of a low carbon economy is driving changes in the electricity system. The changing profile of electricity generation in GB results in a lower system 'inertia' making the network more vulnerable to outages in the future. 'Black-Start' services are required to re-energise the electricity grid following a system shut down.

GB's current Black Start strategy is based on 6 zones (see Figure below) with Scotland and the North of England being most vulnerable in terms of low system strength due to the high concentration of renewables.

HVDC has the potential to provide excellent black start capabilities (as well as fast frequency support and synthetic inertia services), and there are a significant number of HVDC schemes planning to connect to the GB network.

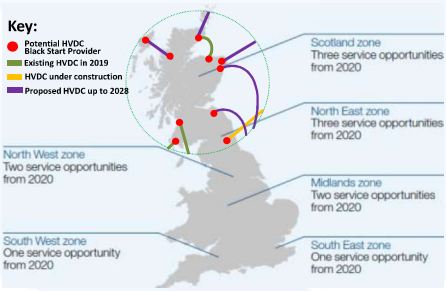
With costs the HVDC Centre to lead this review. rising of providing Black-Start services over the last 10 years, the Scottish Government wanted to investigate how to maximise the use of HVDC schemes to support Black-Start energisation, from a technical perspective; and commissioned

The HVDC Centre methodically reviewed how HVDC schemes can be utilised to support Black Start energisation

The HVDC Centre technical experts, in collaboration with specialists from SHE Transmission, Scottish Power, National Grid and the Scottish Government, carried out an in-depth study which included:

- Review of existing Black Start arrangements in GB alongside analysis of how HVDC schemes perform against Black Start technical requirements;
- Evaluation of global HVDC Black Start experience and examination of global black-out events;
- Mapping these findings against GB's current and future HVDC schemes (with a focus on Scotland and the North of England) to identify practical opportunities; and
- Developing specific recommendations, in consultation with Stakeholders, to maximise the use of HVDC schemes for improving GB's Black Start arrangements.

HVDC Black Start Potential is Scotland and North of England Zones



Source: National Grid ESO & The National HVDC Centre

Outcomes

Out of this technical analysis, seven recommendations are being progressed with relevant stakeholders.

Opportunity	Recommendation
There is little guidance for HVDC Schemes on what Black Start services should be specified.	Define (and promote) the Black Start services that should be specified in all future schemes.
Since Black Start is a highly unusual situation, the AC network protection, or the HVDC system protection, may may trip during energisation.	The protection settings for both the AC system and HVDC system should be tested (as a combined system), for restoration scenarios.
During re-energisation; energised 'islands' need to be connected (and re-synchronised), requiring complex control and data exchange.	System studies are required to ensure the HVDC controllers transition as required during re-synchronisation.
The limited testing of HVDC Black Start functionality does not give the required level of confidence that it would act as expected on the real network.	Combine factory testing, real-time demonstration and field trials to build confidence in the robustness of Black Start operation.
The Black Start services that HVDC schemes provide could be significantly enhanced if combined with an synchronous condenser.	Investigate enhancing the Black-Start services by combining HVDC Converters with synchronous condenser.
The criteria to provide Black Start services are not appropriate for HVDC schemes.	Review the Black Start service criteria to ensure that HVDC schemes are not unnecessarily dis-qualified.
There are additional HVDC Black Start enhancements that merit further investigation.	Investigate further: • Using offshore windfarms (or island generation) to help energise the network; and • Reducing system voltage during restoration to speed-up the time-to-restore.

Impact

These recommendations will help improve GB's Black Start capability by maximising the use of HVDC schemes.

Leading to the following benefits:

- Improving the stability of the Network (reducing the likelihood of outages);
- Facilitating quicker restoration times;
- Reducing the cost (to consumers) of Black Start services; and
- Providing assurance that restoration services will operate as expected, when required.

To find out more, please contact us to discuss or to arrange a visit:
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