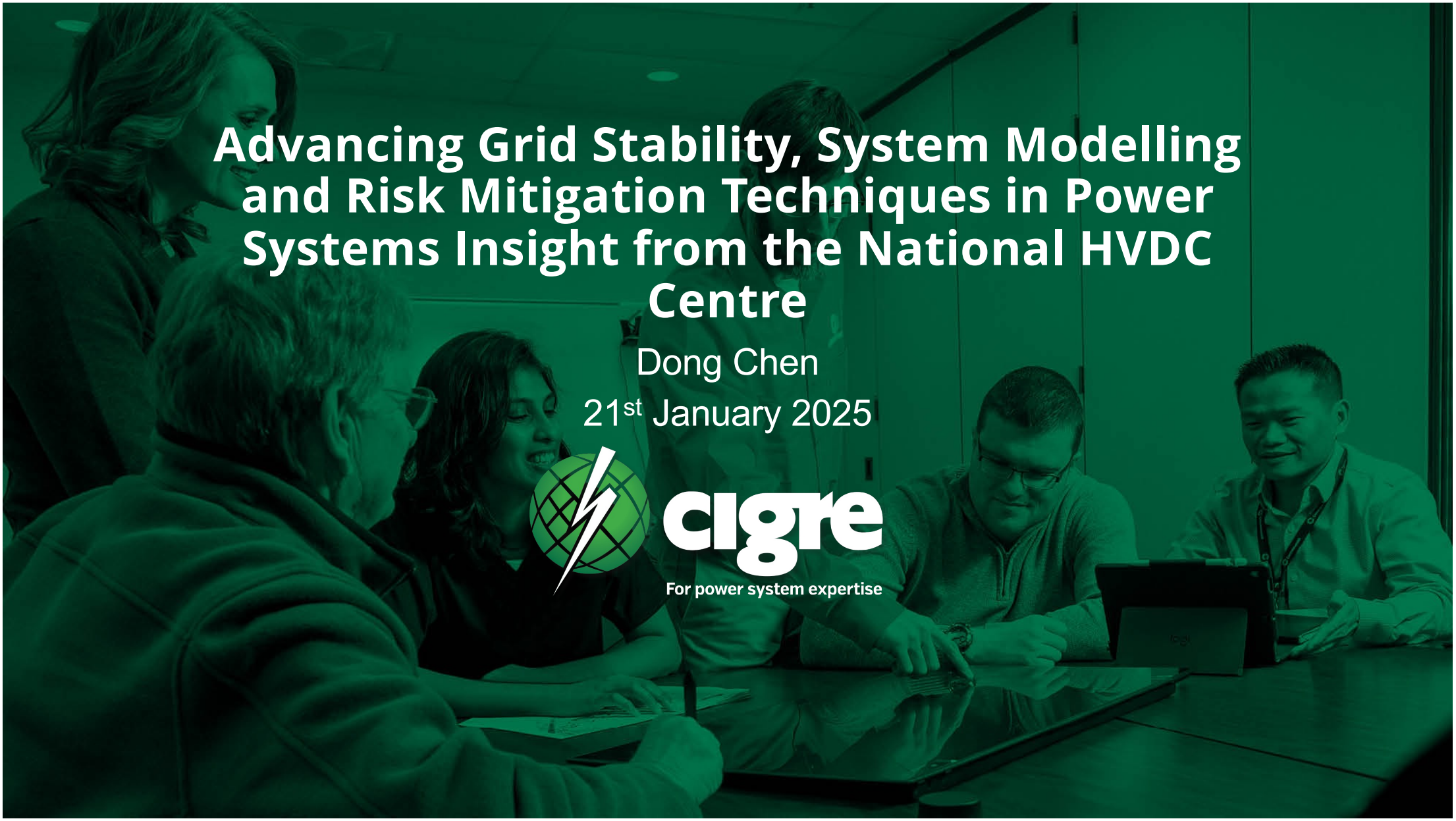


Advancing Grid Stability, System Modelling and Risk Mitigation Techniques in Power Systems Insight from the National HVDC Centre

Dong Chen

21st January 2025

cigre

For power system expertise

HVDC Centre: In a Nutshell

The National HVDC Centre delivers world-leading simulation, training and innovation; to de-risk, accelerate and enhance GB's efficient transition to a resilient Net Zero network.

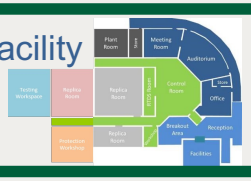
The National HVDC Centre *part of* Scottish & Southern Electricity Networks TRANSMISSION *together with* nationalgrid, SP ENERGY NETWORKS *and* NESO National Energy System Operator

Opened in **2017**

Originally established as an Ofgem Funded NIC Project. Now part of the Regulated Business.

Bespoke 1,030m^2 Facility

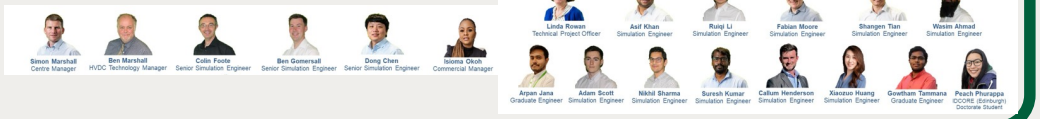
[extension completed in 2022]



20 Employees

Drawn from across HVDC Suppliers, TOs, ESO & Academia.

A Team of Industry Experts

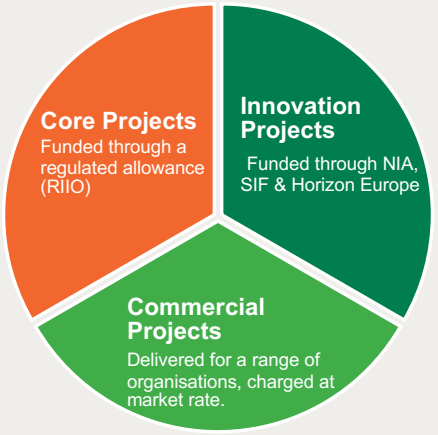


16 Current Projects *[Core, Innovation & Commercial]*

With 26 Projects completed for a range of Clients.

World-Leading Simulation Infrastructure:

- 9 RTDS Novacor Chassis & 3 PB5 Racks,
- 16 GTSOCs, 3 Power Amplifiers,
- 3 High-Power Off-line Simulation PCs,
- Software: RSCAD, PSCAD, DIgSILENT, PSSE, Matlab.

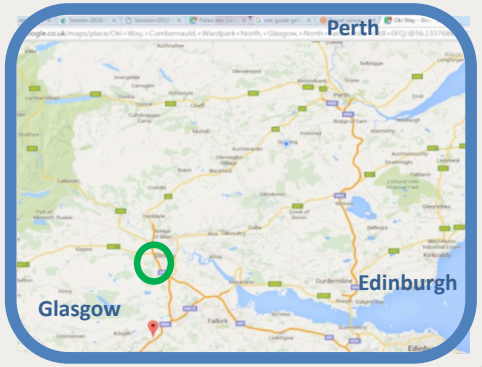


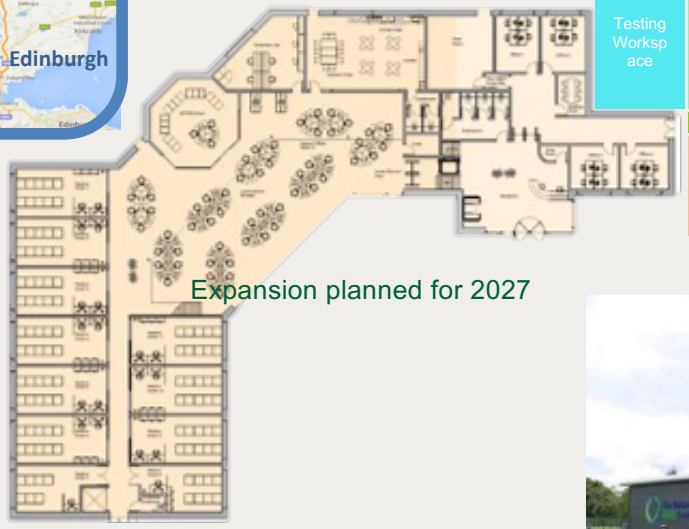
Expanding to meet GB Demand

The Centre is planning to more than double its: Experts, Infrastructure and Building in 2026-2031.

HVDC Centre: Building

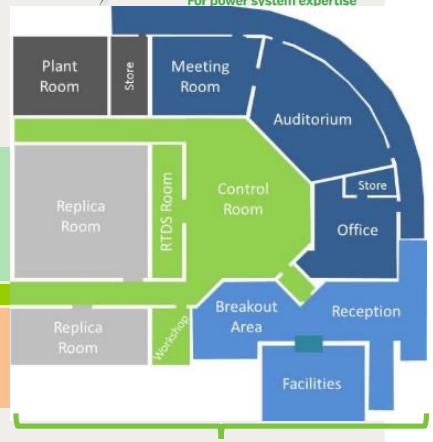
Located in the centre of Scotland…





2022 Extension

Expansion planned for 2027



Original Building Completed in 2017

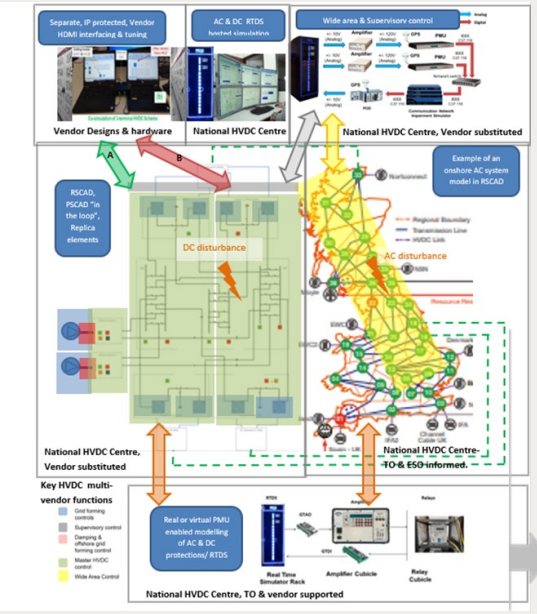
…our state-of-the-art facility provides a bespoke simulation and training environment.

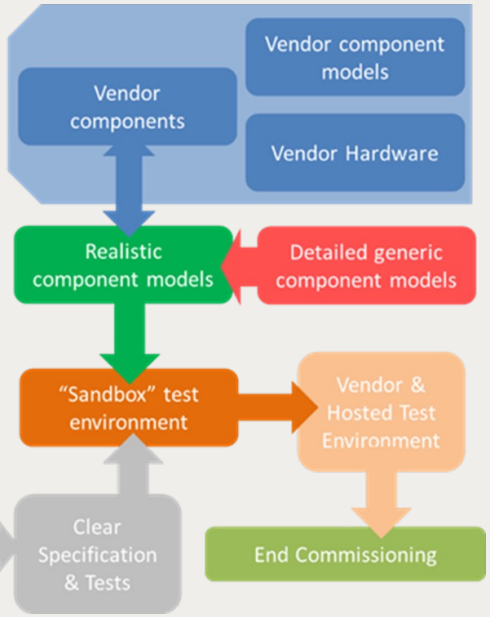
Some recent projects

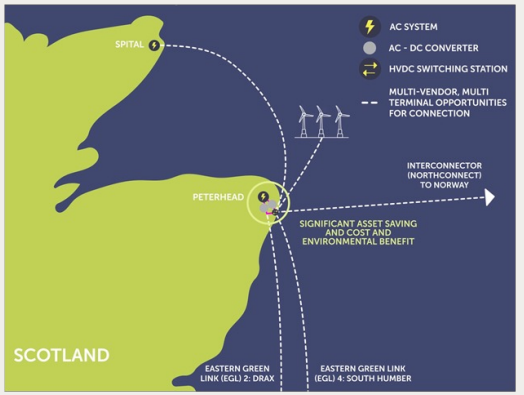
- Project Aquila
- Project NETWORK-DC
- Project MPI
- Supporting Delivery of CMS-HVDC

Project Aquila- what is it/ why are we doing it?

- Demonstration of 1st Multi-Vendor Multi-terminal solutions for GB as a business case.
- Respecting vendor IP in real-time simulation
- Foundation of DC grid to grow and develop in stages



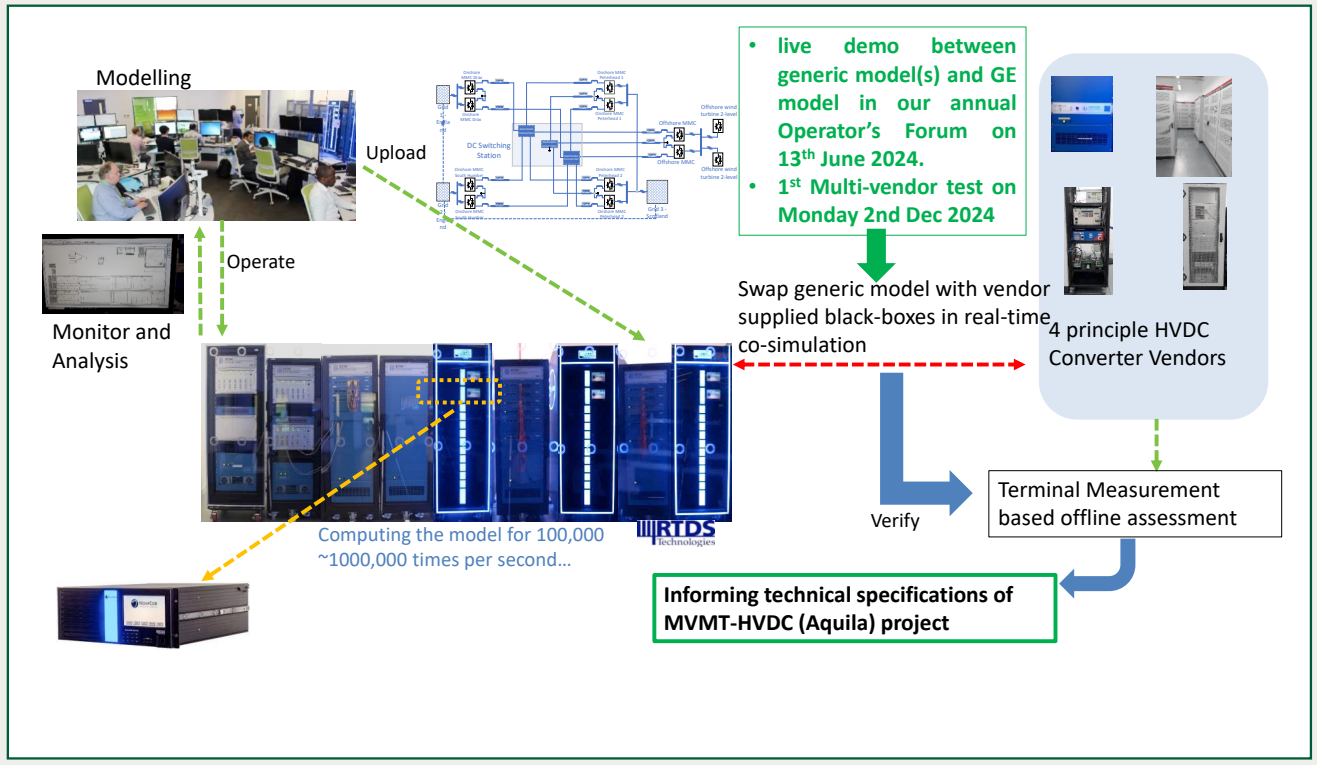




- Specifying converter for interoperability in a vendor-agnostic manner to guarantee stability with a mathematical proof

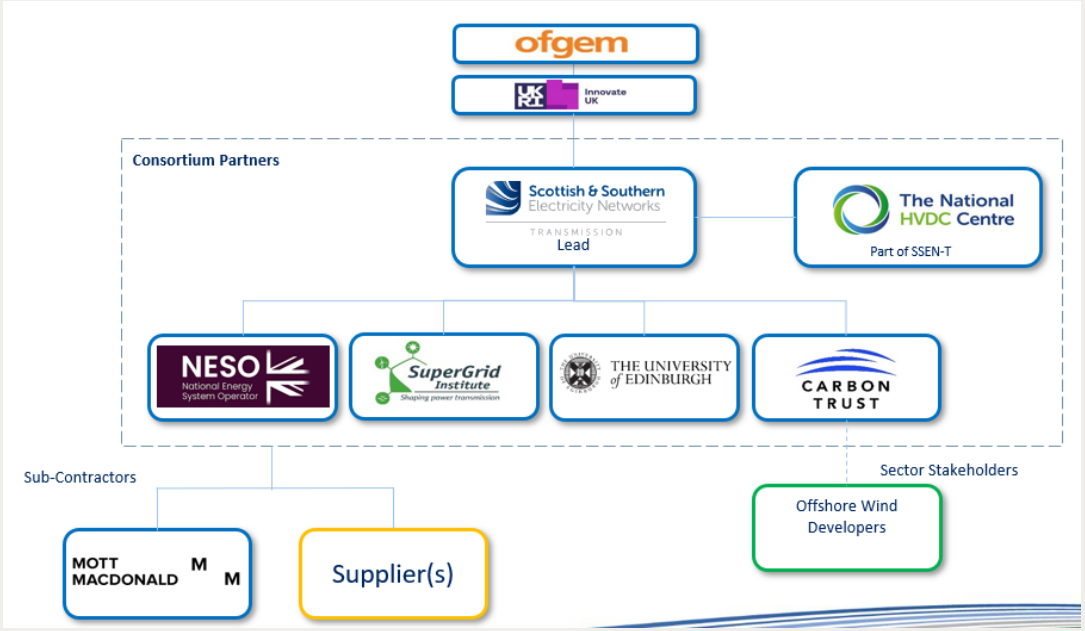
Project Aquila - Key Highlights.

- RTDS Encrypted SIL simulation at the National HVDC Centre
- Participation across 4 key vendors and NESO and GB TOs of Great Britain.
- Support received at Energy Minister, Ofgem and BEIS level
- Engineering methodologies to address regulatory/ framework & market blockers.
- On track for delivery to enable beyond 2030 grid development



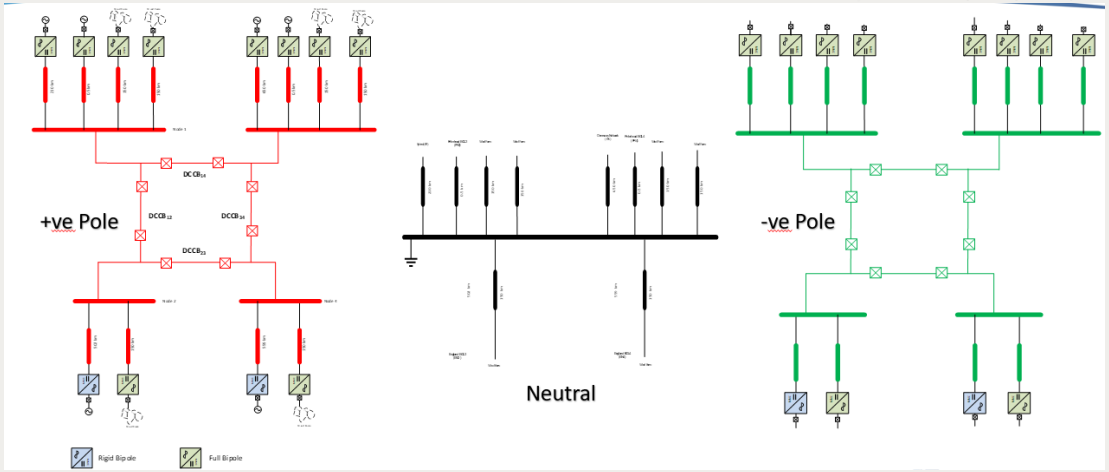
Network-DC project- what is it/ why are we doing it?

- Follow-up use case of Aquila project
- Ofgem Strategic Innovation Fund (SIF) project – Beta (3rd) phase.
- Demonstrating benefit of DCCB in cost saving and fault management with vendor supplied replicas
- Informing specifications and addressing regulatory and commercial barriers.



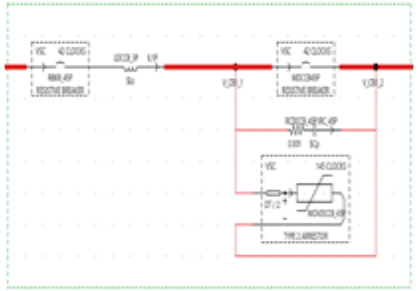
NETWORK-DC - Key Highlights.

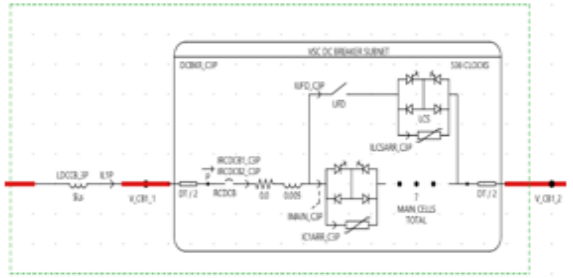
- Use case of Aquila DC switching station with novel design
- Conducted tender to onboard OEMs of DCCBs for detailed studies.
- Ongoing interoperability studies with academia and European Industry.
- Detailed studies with the Control & Protection replica.
- Consideration of reliability and failure mode.



Mechanical DCCB:

Hybrid DCCB:

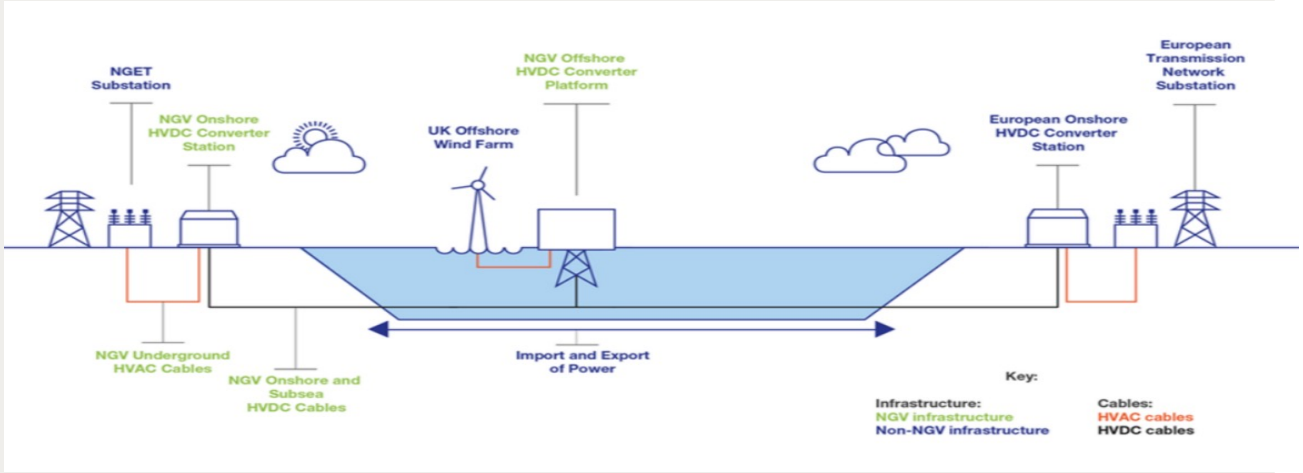




RSCAD Models used for the preliminary studies

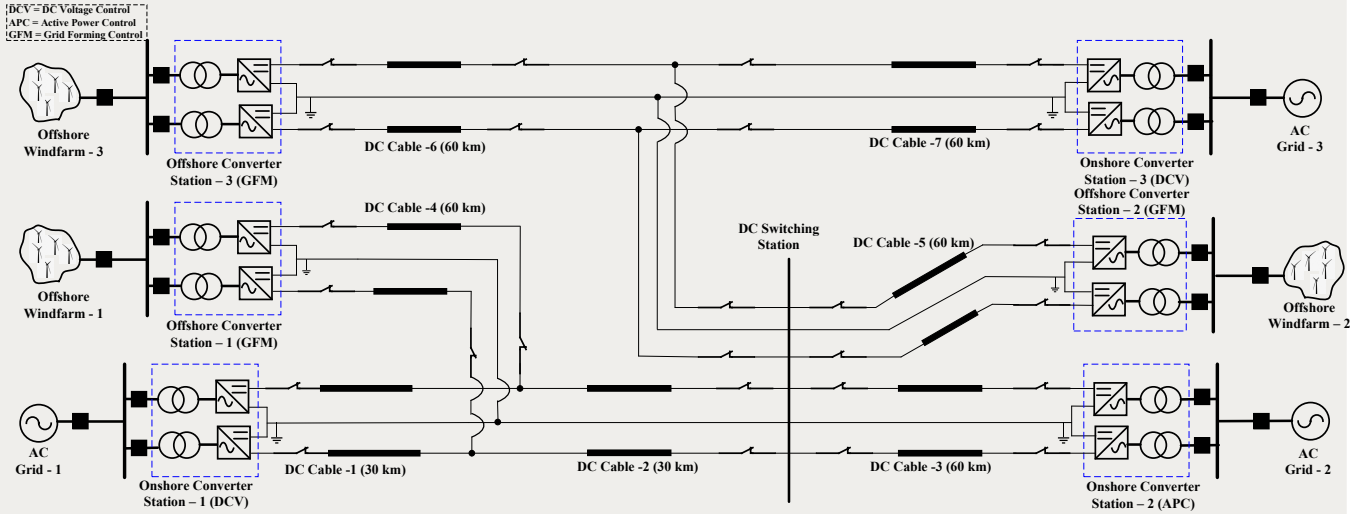
Multi-purpose Interconnector (MPI)

- Demand driven:
  - Offshore wind to enable net-zero
  - Energy exchange between power grids
- Multi-Purpose Interconnector (MPI):
  - Efficient use of transmission assets.
  - Maximum utilisation of wind resources
- Analyse the performance and identify operational challenges



MPI: Key Highlights

- Fully operational multi-terminal RTDS model
- Detailed control and protection algorithm to study both AC and DC faults
- Resilience studies against loss of converter station
- Energisation and black-start
- Challenges and feasibility of DC Circuit Breaker (DCCB) application



Context of Commissioning CMS - HVDC

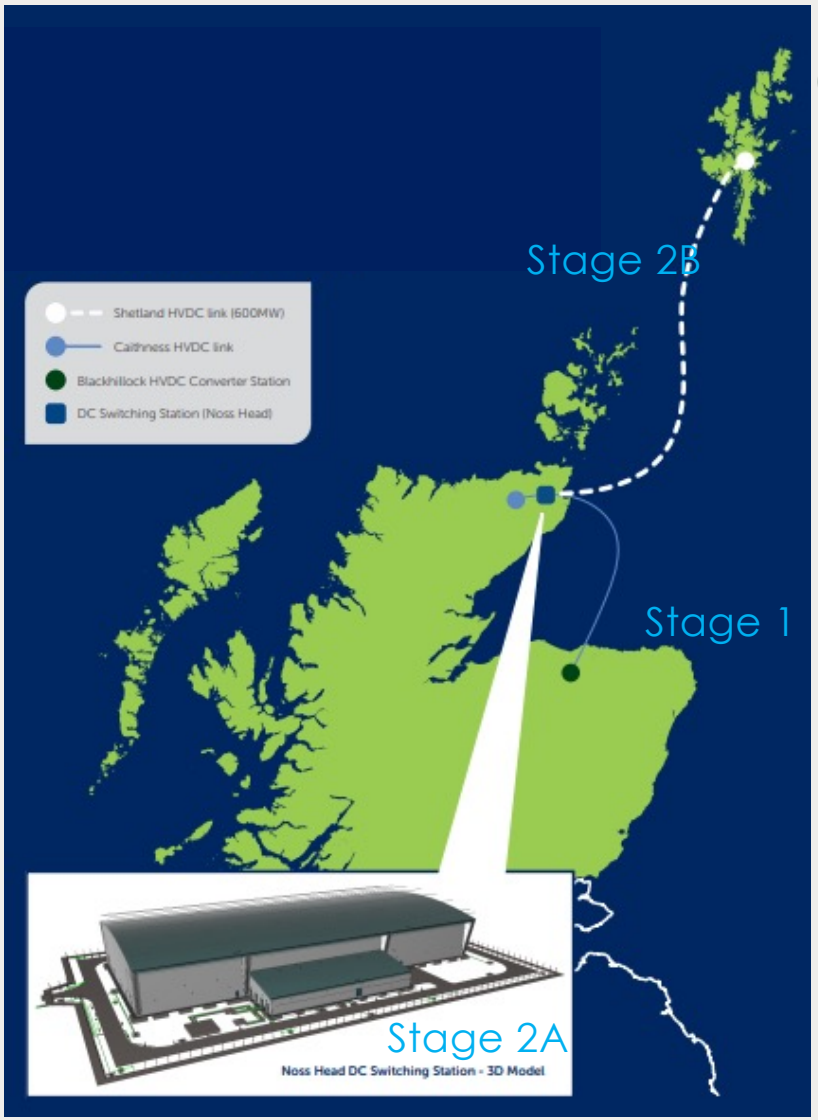
3-Terminal Monopole, ±320 kV

- North of Scotland, 1st MT-HVDC outside China

- Stage 1 Caithness-Moray Link, 2018

- Stage 2A - Commissioning of DC Switching Station, May 2023

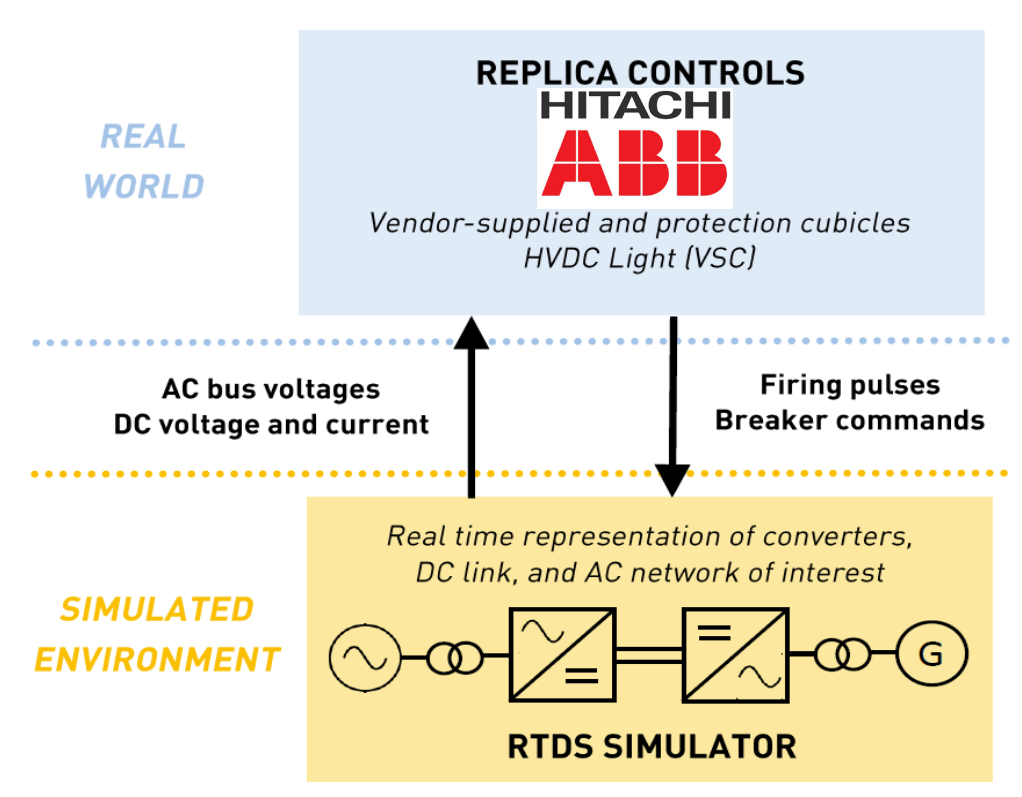
-Stage 2B - Commissioning of Kergord Station at Shetland, Aug 2024



Supporting Delivery of CMS-HVDC

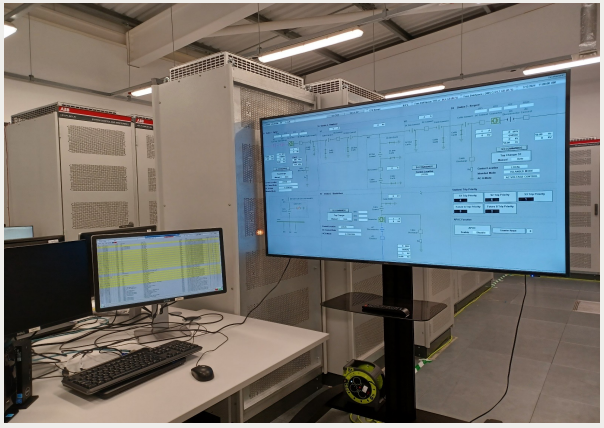
- Hosting replica for the CMS-HVDC since 2018. It is used to:

- Factory Acceptance Test (FAT)
- Commissioning: what action to take
- Delivery: what kind of tests should be carried out in future
- Operation Training: what to do in daily operation
- Operation Assistance: what design shall be changed



Caithness-Moray-Shetland Replica Hosting and Maintenance

- Replica-in-Loop real time simulation to protect IPs of OEM and TSO during real-time study.
- Typically over 20 revision orders were examined at the HVDC Centre for a converter station during one recent commissioning phase
- Training facilities for SSEN-T and NESO
- Lessons learned translated into recommendations for future replica hosting projects and stakeholders.



What’s in store for us in 2025?

- More of the same- Aquila completion dissemination, moving towards application of MTMV in real systems, Vendor testing of DCCB "completing the picture" of interoperability specification for a system including DCCB. More direct project de-risking
- Centre expansion- in numbers space and capabilities; as we prepare for the RIIO-T3 environment.
- GB-scale RT-simulation; NIA work on modelling, complemented by RT-vendor engagement on getting the best options available ahead of the push to deliver a far larger de-risking environment.
- Further Holistic Network Design (HND) support and offshore project de-risking.
- More replicas on their way, and preparing for them.


Thank you!
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