HVDC Centre-
Operators forum 2023

How Innovation Projects are Paving the Way:
Project Aquila, InterOPERA, HVDC-WISE and Ready4DC,

Ben Marshall, The National HVDC Centre

Why innovating DC capability is important: direction in GB

The National HVDC Centre

Today

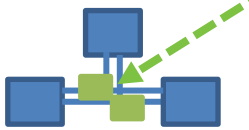
Radial AC (1.3GW max, 220kV)

Radial/ multi terminal HVDC (1.4GW max, 320kV)- max 5 ends

- Going beyond point-point
- DC Switching Stations (DCSS)

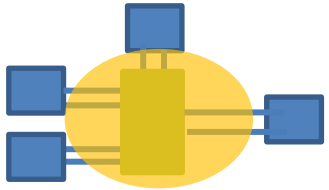
By 2030

Offshore DCSS (HND)



Radial/ multi terminal HVDC bipole (2x1.2GW max, 525kV)- max 5 ends

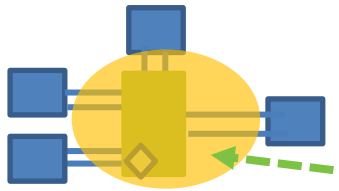
Project Aquila



HVDC DCSS hubs onshore (2x1.2GW max, 525kV)- multi-terminal multi vendor demonstration

- Specifying & operating DC networks
- Multi-terminal, Multi-vendor HVDC

SIF Network DC

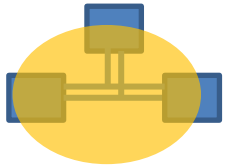


HVDC CB demonstration on existing hubs.

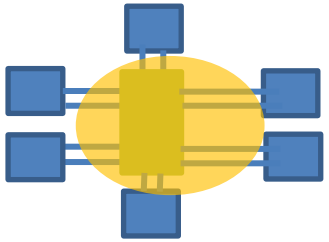
By 2035

Radial AC (2.1GW max, 275kV {using 400kV substation plant offshore})) HND proposed, if developed.

New higher ratings of HVDC- the next standard?

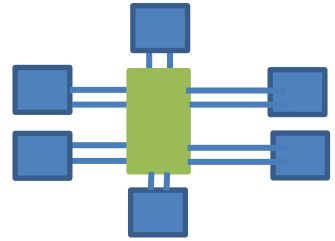


Radial/ multi terminal HVDC bipole (2x1.8GW max, 640kV)- no inherent limit to ends- if developed

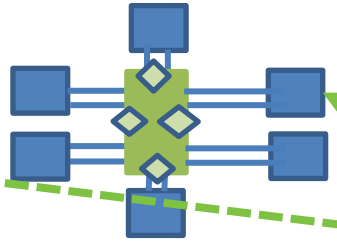


HVDC DCSS hubs onshore with DC generation connection BAU, small offshore DCSS being implemented.

By 2040



Offshore large hubs



Onshore DCCBs at scale within big hubs >3600MW generation

DCCB use onshore

By 2050

Offshore DC networks

Offshore meshed network across north sea.

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Centre work on Functional Designs for HVDC (2022-2023)

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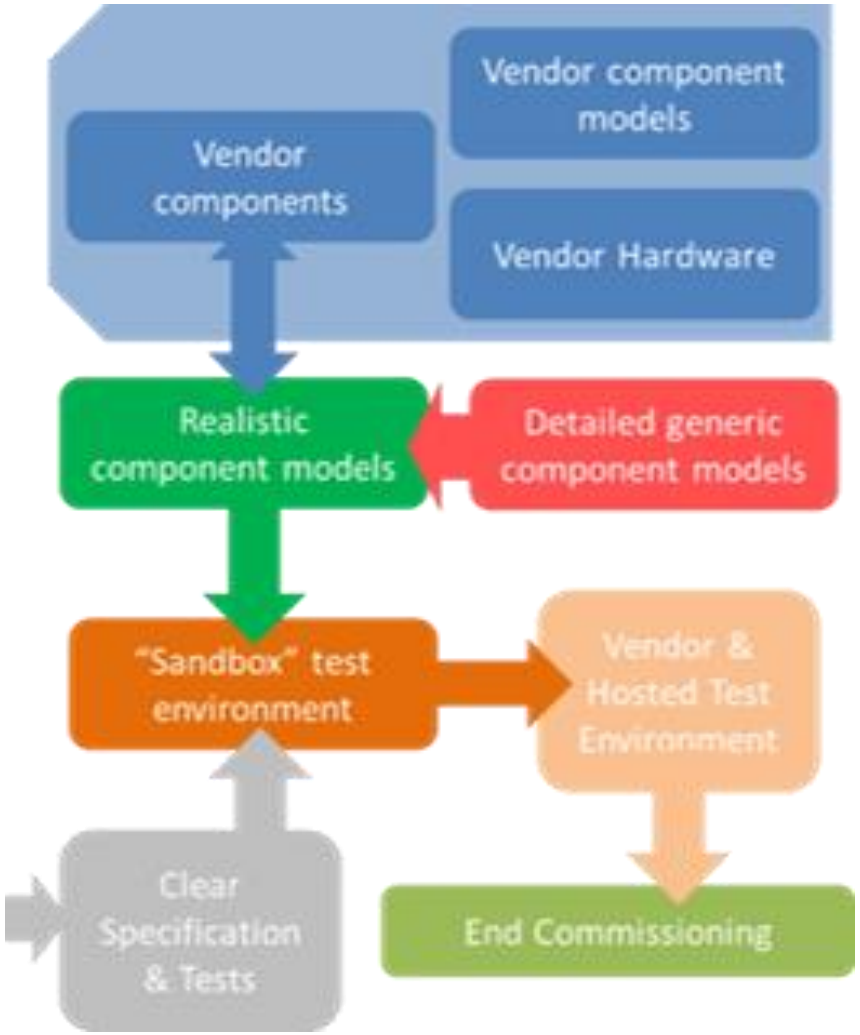

We see this project as a critical component of enabling GB delivery:

- Providing a flexible 'test-bed' for TOs/ESO/Developers/ Manufactures to test their coordinated designs.
- Component, control and protection elements of DC systems
- Includes patent filed approaches to control

This enables:

- ***TOs;*** to test the technical performance of offshore network designs on onshore networks;
- ***ESO;*** to assess potential interaction risks and ancillary service capability of integrated solutions.
- ***Developers;*** to investigate technical feasibility and operability of shared transmission solutions; and
- **Manufacturers;** to verify performance of confidential 'black-box' models within offshore network designs comprising equipment from another supplier.

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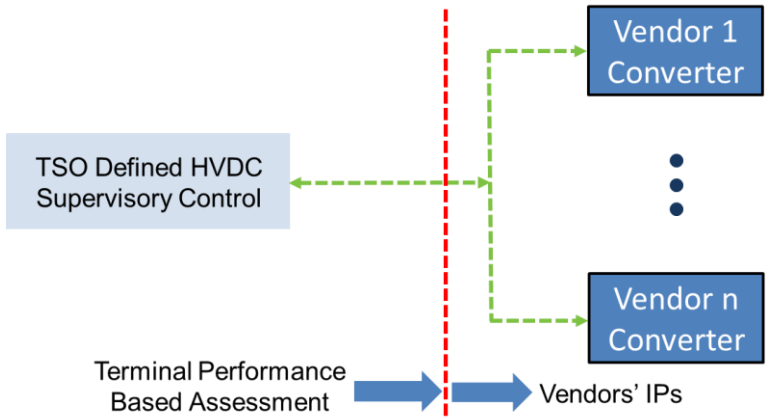
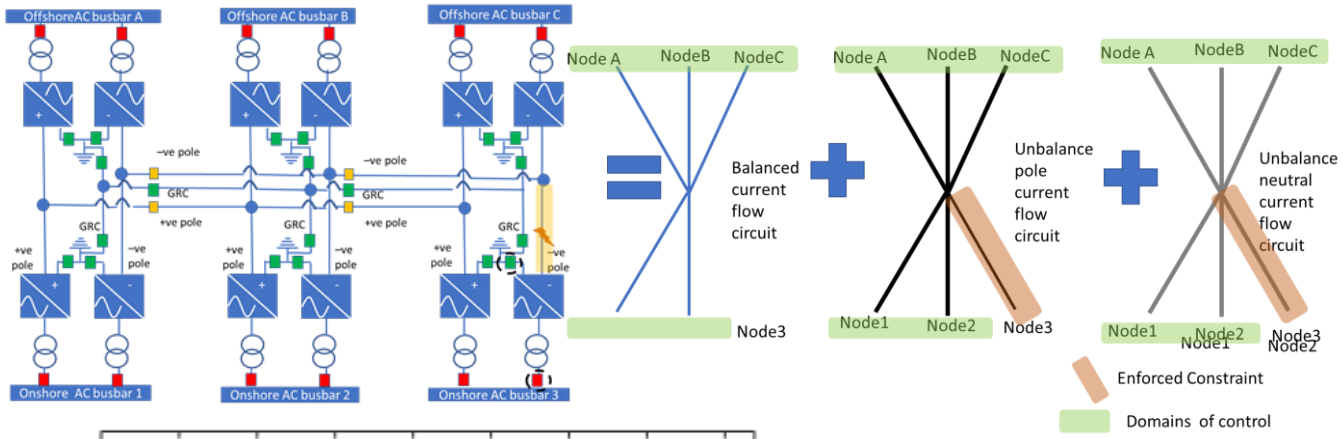
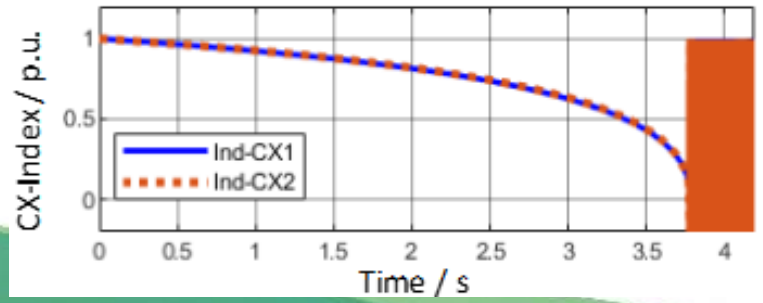
The importance of new control patent areas

- Multi-terminal Multi-vendor control basis
  - Allows networks > than a limited number of terminals
  - Allows standard control interfaces to a common basis
  - “Stability first” philosophy, avoids dependence on communication
- Asymmetric control
  - Allows availability and capacity of an existing DC network to be optimised.
  - “future proofs” the networks for DCCB use at later stages
- Stability metrics.
  - Inform operation and dispatch in real time.







Project Aquila - Demonstration of MTMV HVDC - Stage 1

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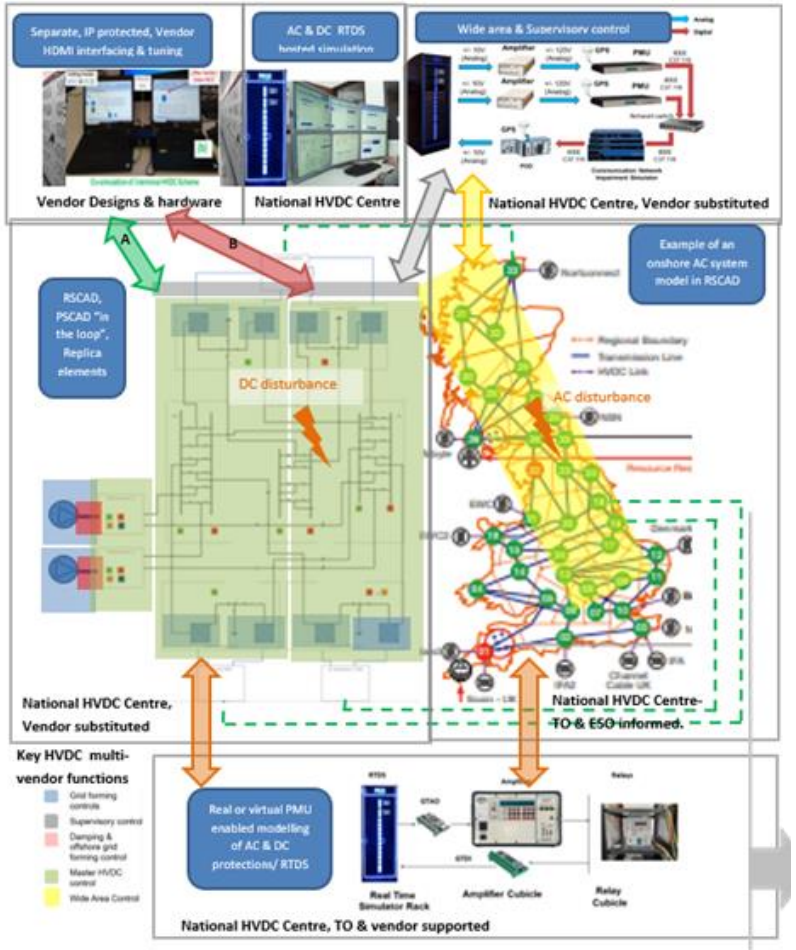
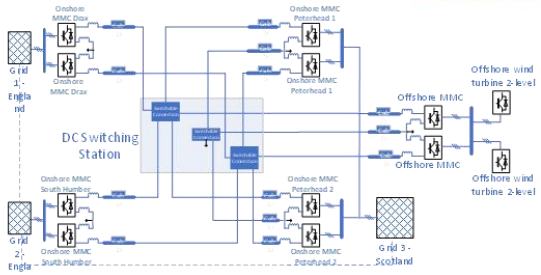
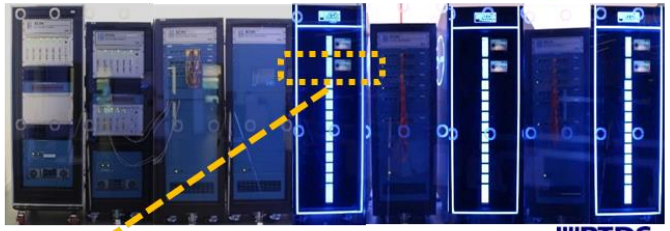


Monitor and Analysis

Operate

Upload





Swap benchmark control with vendor's control solution

RTDS Technologies

Computing the model for 100,000 ~1000,000 times per second…

✓ Converter Control (µs ~ ms):
- operate based on local measurement
- respond to supervisory control
- sustainable when communications are lost

✓ Supervisory Control (ms ~ s):
- monitor
- assess
- optimize

The DC Grid should be sustainable when any communication channel or power line is lost.

- Tests Multivendor for real using vendor virtual replicas
- Delivers specification of how to do it
- Delivery on a real project

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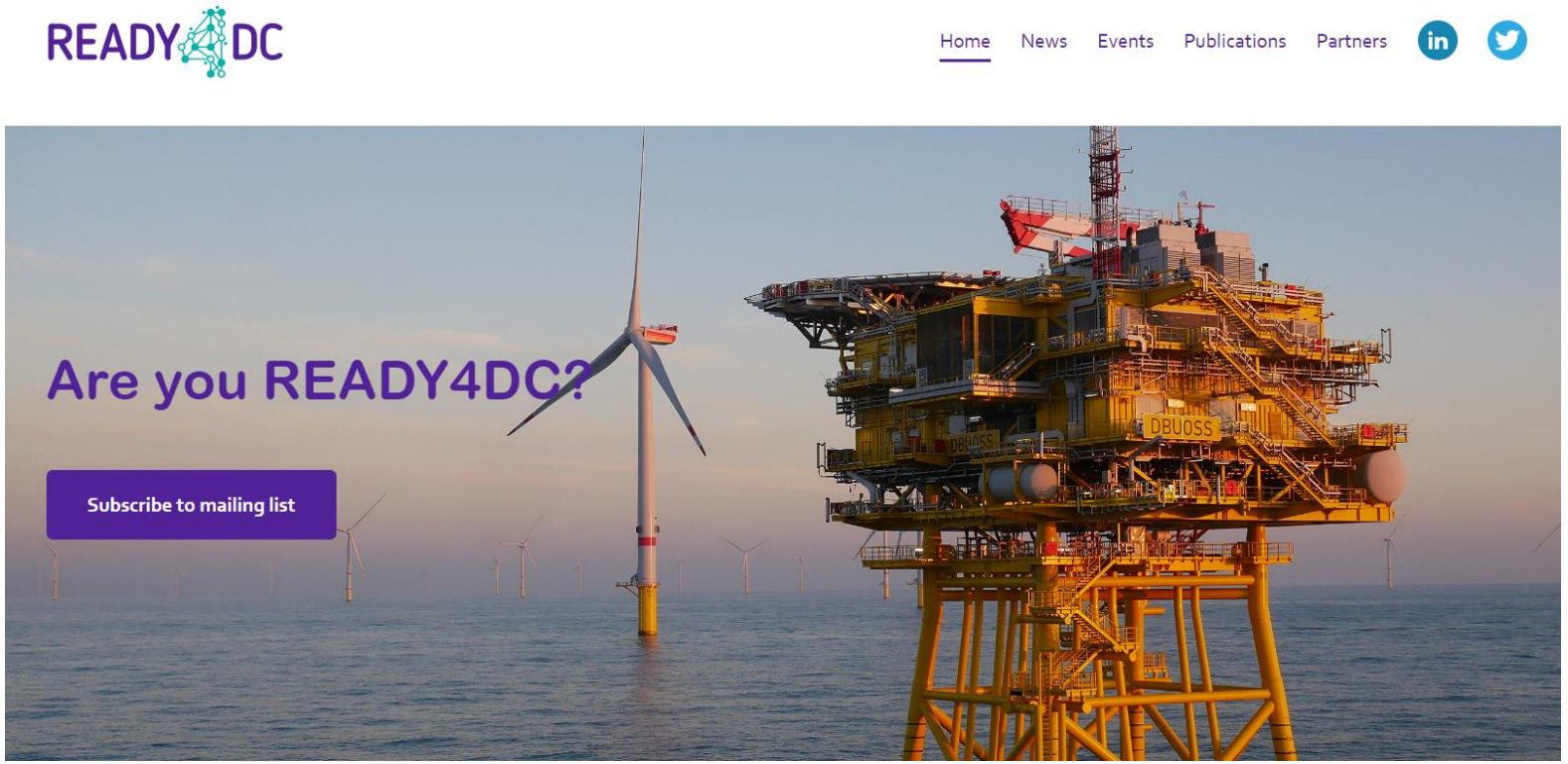
EU Direction and policy on HVDC

>450GW of offshore networks by 2050..

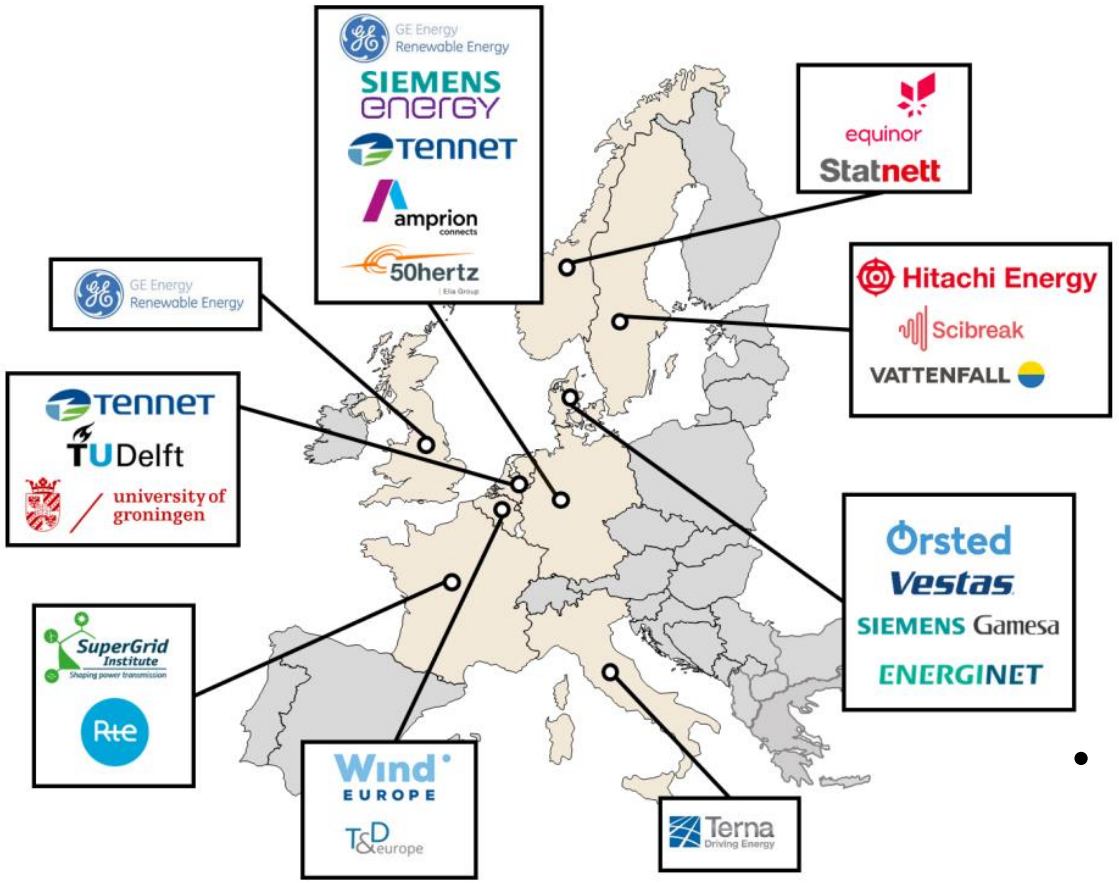
- HVDC resilience, Interoperability, Multi- terminal, Multi- vendor are all themes.
- GB a partner/ advisor across programmes up to €55m in scale
- National HVDC Centre active in supporting the setting of the research direction in Europe

What is Ready4DC?



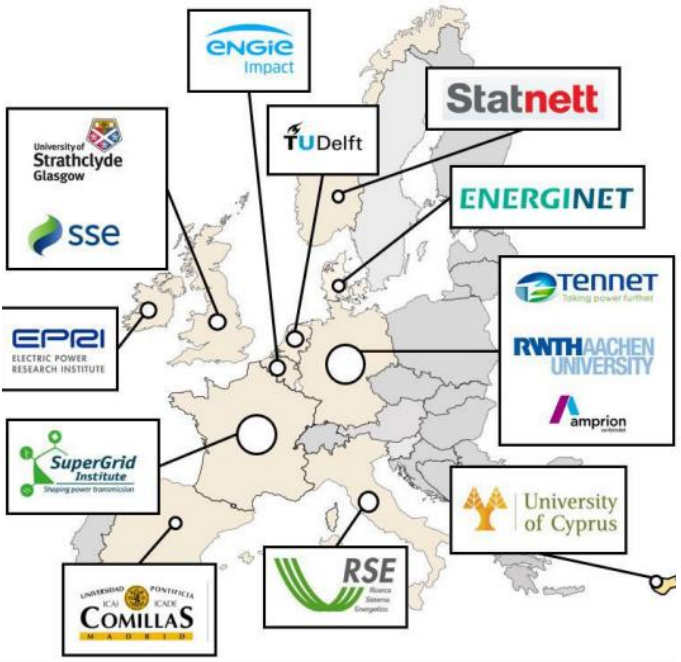
- Defining the requirements that the first Multi-vendor Multi-terminal project in Europe needs to satisfy.
- Identify the key enablers
- Identify the processes & activities
- Identify Legal/ commercial solutions
- Centre on Advisory Board

What is InterOPERA?

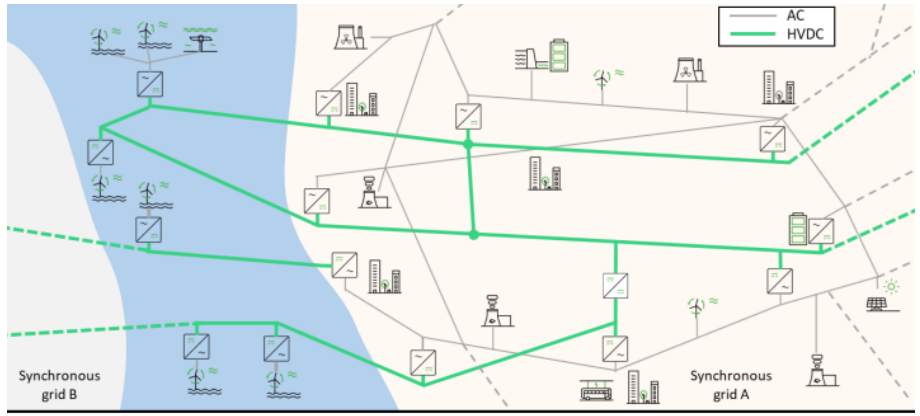


- Delivering the first Multi-vendor Multi-terminal project demonstration in Europe
- Centre on Advisory Board

What is HVDC-WISE?



- Foster the development of HVDC technologies and implementation of hybrid AC/DC grid throughout Europe
- 14 international organisations
- European HORIZON funding (UKRI for GB partners)
- Kick-off meeting 10-11 October 2022 in Lyon, France
- Duration: 42 months (3.5 years)

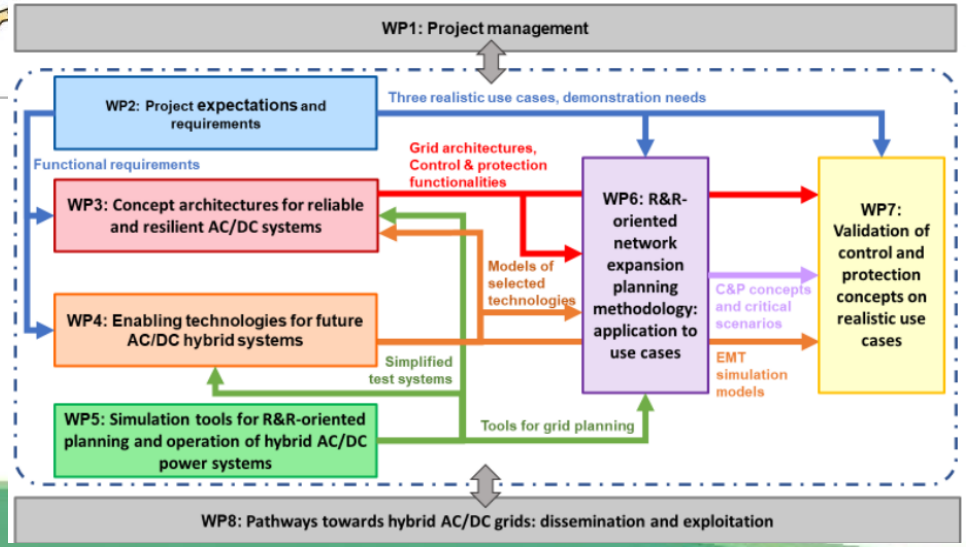


Overall Aim: Propose, design and validate HVDC based grid architecture and technologies that can

- Reduce risks associated with use of HVDC
- Enhance the R&R of the transmission system

Centre is leading WP2,

And delivering simulations of use cases within WP6



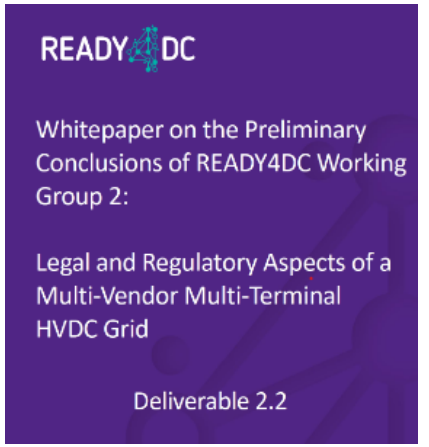
For more, see:

https://hvdc-wise.eu/

Our various EU engagements on interoperability

The National HVDC Centre

- Ready4DC published papers inputted/ co-authored with Centre
- Supporting TSOs directly on next steps from Ready4DC
- Supported a European TSO workshop on interoperability spring '23
- Aquila team presented on "Aquila method" to InterOPERA 28th April 2023
- EU TSO teams attending Operators forum 14th-15th June with interoperability discussions surrounding this
- Hosting a Netherlands team, government, regulator visit & workshop TSO in June 2023
- Director level contact with European TSOs on bilateral co-operation surrounding interoperability.
- Centre delivering interoperability analysis to support a range of European MPI projects.
- Active InterOPERA discussion on use of Aquila related patent filings



Increasing number of eyes on the progress of Aquila…

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A range of outputs from the Centre supporting HVDC innovation

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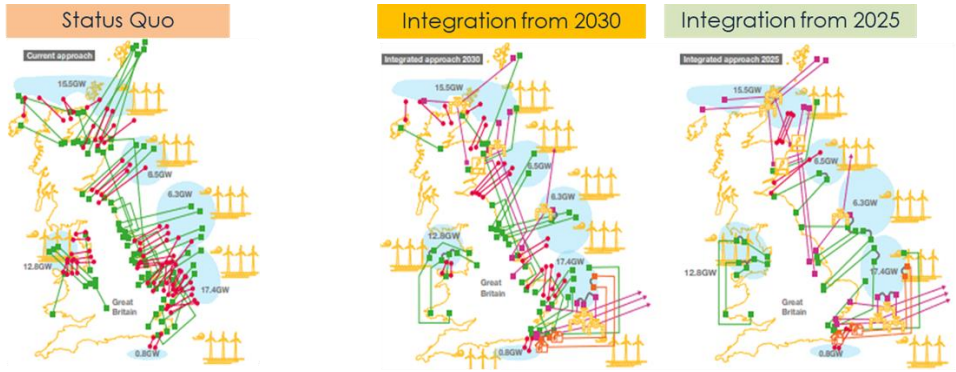
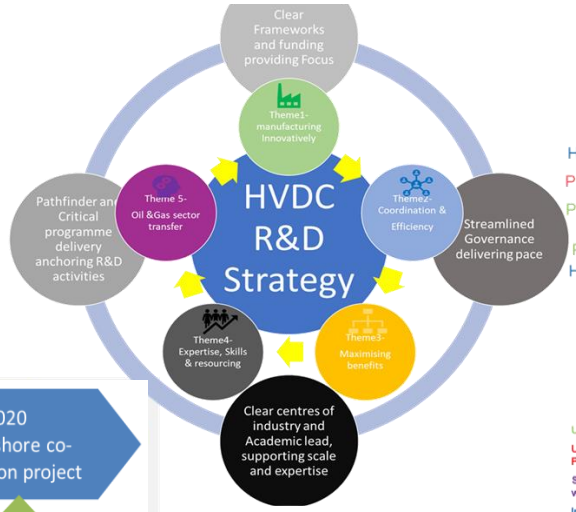
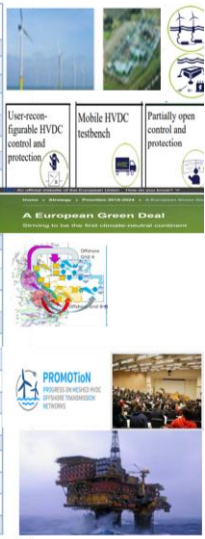
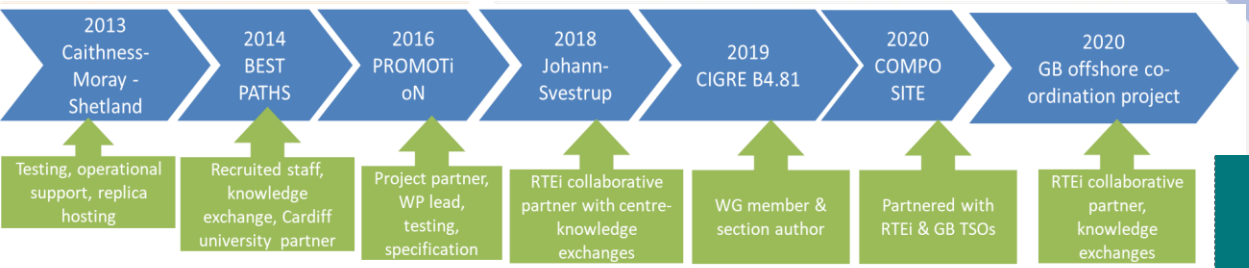
2020-2023 Co-ordinated offshore in GB and the R&D strategy that supports it

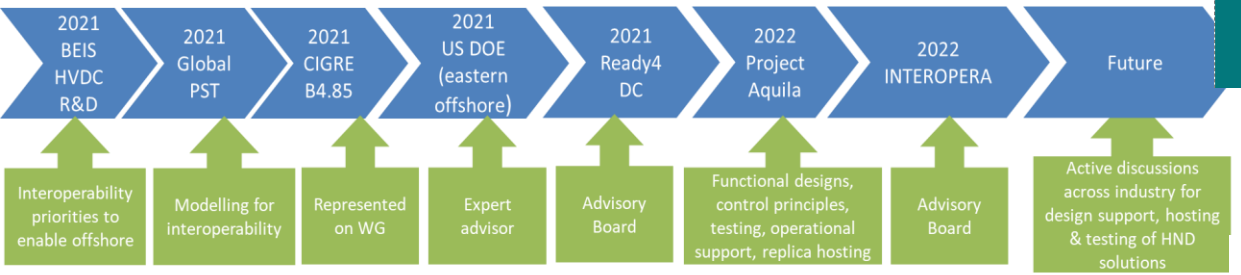




2021- 2027 R&D strategy Delivery

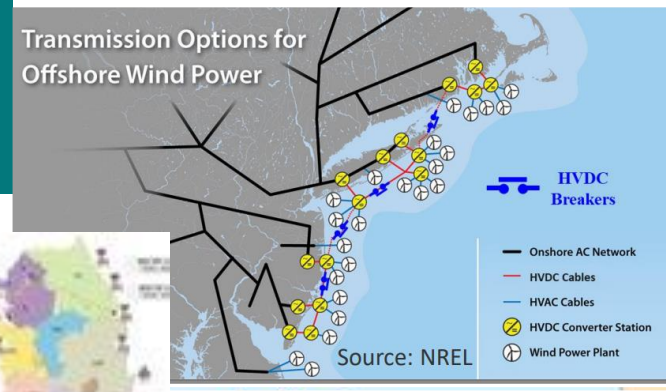






Project Aquila- survey of parallel TSO Project activity

SSE Networks Transmission in collaboration with the National HVDC centre, National Grid Electricity Transmission and the Electricity System Operator in GB is delivering Project Aquila by 2030.
This project will deliver a DC switching station at Peterhead in the NE of Scotland allowing a multi-terminal DC hub to be established across a range of HVDC projects co-located at Peterhead- https://vimeo.com/722976957
(Project Aquila overview video).



Surveys, dissemination 2021- present

International Advisory and consultancy 2022- present

Engagement, support and collaboration 2013- present

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The National HVDC Centre

Virtual presentation

Findings from the North Sea Power Hub project

Alberto Bertinato

SuperGrid Institute

Scottish & Southern Electricity Networks

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