Building a Better Network :

A technical discussion on how HVDC can enable a more stable network whilst integrating renewable generation (3 of 4 webinars)

5th November 2021

The National HVDC Centre

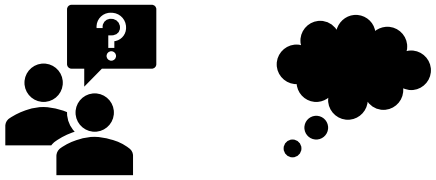
Scottish & Southern Electricity Networks

Welcome to the HVDC and Climate Change: What is HVDC and why is it important to achieving net-zero Webcast, the third in our series of 4

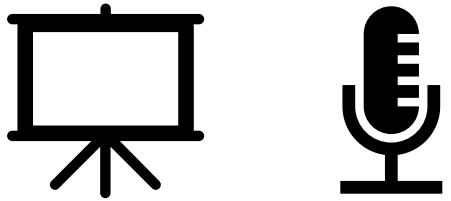
The National HVDC Centre

Due to large audience, please turn off video & put microphone on mute

Questions for speaker will be managed using MS Teams chat.



This webinar may be recorded. Link to slides will be shared after the webcast.



Considering a lot of participants are expected, it may not be possible to address all questions or comments live however we will do our best.

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Agenda:

1. Introductions
2. Overview of the HVDC Centre
3. Context
4. Video: **A technical discussion on how HVDC can enable a more stable network whilst integrating renewable generation.**
5. Panel Discussion

The National HVDC Centre – About us

The National HVDC Centre

The National HVDC Centre is an Ofgem funded simulation and training facility available to support all GB HVDC schemes.

Ofgem determination takes us from Innovation to BAU for RIIO-T2

The National HVDC Centre

part of Scottish & Southern Electricity Networks

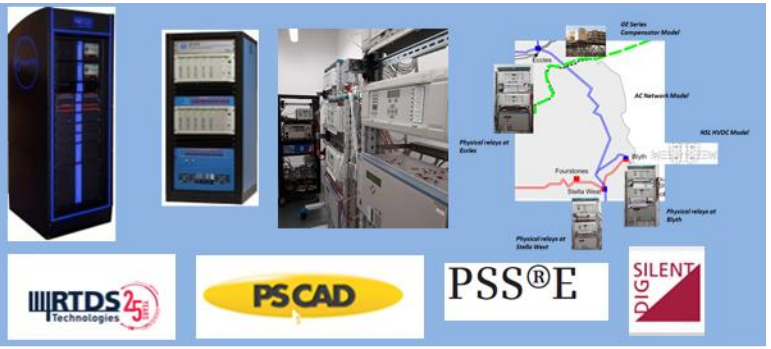
together with nationalgrid SP ENERGY NETWORKS

The National HVDC Centre is part of Scottish & Southern Electricity Networks and is funded through the Electricity Network Innovation Competition as the Multi-Terminal Test Environment (MTTE) Project. Scottish and Southern Electricity Networks is a trading name of Scottish Hydro Electric Transmission plc, Registered in Scotland No. SC213461, having its Registered Office at Inveralmond House, 200 Dunkeld Road, Perth, PH1 3AQ; and is a member of the SSE Group www.ssen.co.uk

Tools

RTDS and HiL environment
(Enhanced Testing, Multi- Device Grid Integration, Protection & Control system, modification acceptance, post event investigation validation analysis)

Simulation environment (RTDS->EMT->RMS)
(Validation, Benchmarking, analysis)



Systems

Collaboration
(models, analysis, direction)

The National HVDC Centre · SP ENERGY NETWORKS · Scottish & Southern Electricity Networks · nationalgrid · nationalgridESO

Codes, Standards, R&D
(expert input, workstream support)

Grid Code · cigre · entsoe · EPRI ELECTRIC POWER RESEARCH INSTITUTE · PROMOTioN PROGRESS ON MESHED HVDC OFFSHORE TRANSMISSION NETWORKS

Skills

Structured Training
(Webinars, Courses, Application & Implementation)

Control training
(Operator Certification, Scenario Planning, Updates)

Research dissemination
(Analysis Techniques, Risk Quantification, Solution Definition)

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Overview of the HVDC Centre: the Team

A team of HVDC experts; providing experience across: academia, system operator, power systems consultancy, transmission innovation and HVDC manufacturers.

Ben Marshall

HVDC Technology Manager

Simon Marshall MA

Centre Manager

Ian Cowan MEng MIET

Lead Simulation Engineer

Bharath Ponnalagan CEng MIET

Simulation Engineering Manager

Colin Cameron

ICT Engineer

Dr Linda Rowan

Technical Project Officer

Habibur Rahman

Simulation Engineer

Nikhil Sharma

Simulation Engineer

Fabian Moore

Simulation Engineer

Recruiting

Simulation Engineers

Panel Discussion

Panel members

Prof. Tim Green, Director of Energy Futures Lab and Professor, Imperial College London

Ben Marshall, HVDC Technology Manager, The National HVDC Centre

Perry Hoffbauer, Principal Power System Engineer, PSC Consulting

Robin Gupta, Net Zero Innovation Manager, National Grid Electricity Transmission

Afshin Pashaei, Power Quality and Dynamic Performance Manager, National Grid Electricity Transmission

Moderator: **Bharath Ponnalagan**, Simulation Engineering Manager, The National HVDC Centre

Future Webinars

4) HVDC R&D Strategy for Coordinate Offshore: Exploring the innovations required to meet net-zero.

Date: Thursday 11 November 2021

Time: 13:00-14:00 GMT

Click here to register: https://forms.office.com/r/0etQ5natdM

Context

- Changing Generation Mix to meet the Net Zero target
- Decommissioning of large traditional coal power thermal power generators
- Increased presence of converters in generation (Wind farms, Solar etc) and transmission system (HVDC, STATCOM etc)
- Declining Inertia and Short circuit level.
- Increased possibility of interaction (Sub Synchronous, Super Synchronous and Control Interaction)
- HVDC's role in enabling and supporting the integration of renewables.

https://www.ofgem.gov.uk/energy-data-and-research/data-portal/wholesale-market-indicators
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1028157/net-zero-strategy.pdf
https://www.nationalgrideso.com/document/172396/download

Development of HVDC Connections in GB

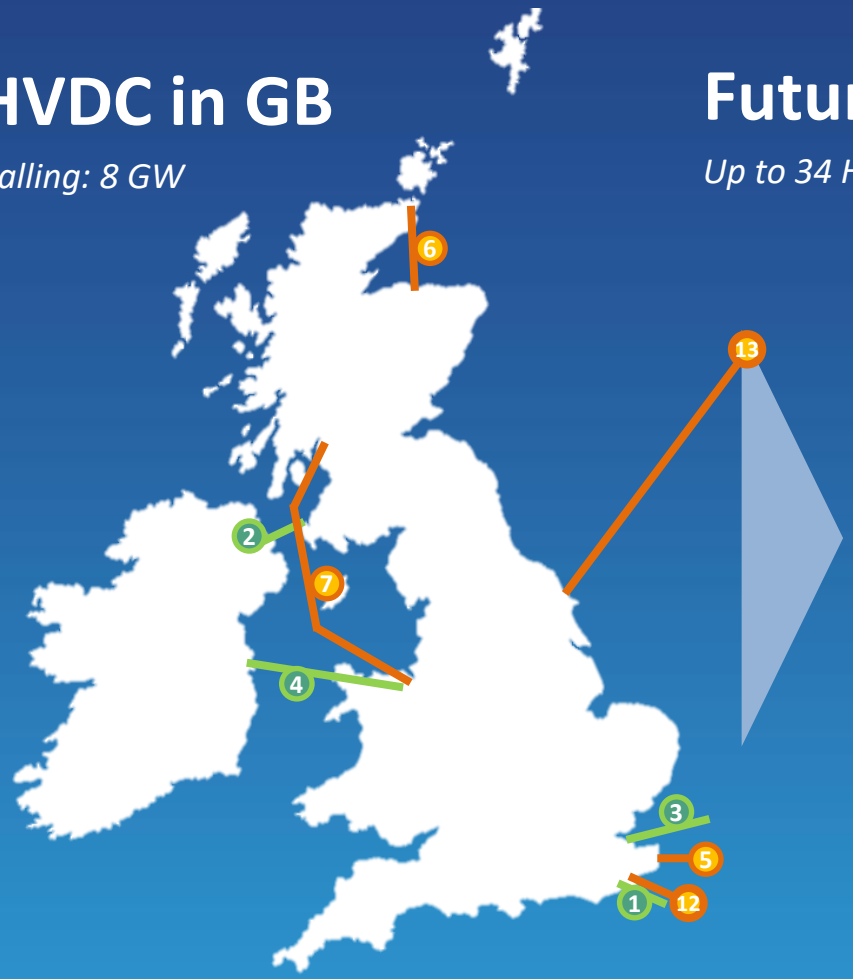
Current HVDC in GB

7 HVDC Links - Totalling: 8 GW

Interconnectors:
1) Cross Channel (IFA)
2) Moyle
3) BritNed
4) EWIC

New Interconnector:
5) Nemo
12) ElecLink
13) NSL

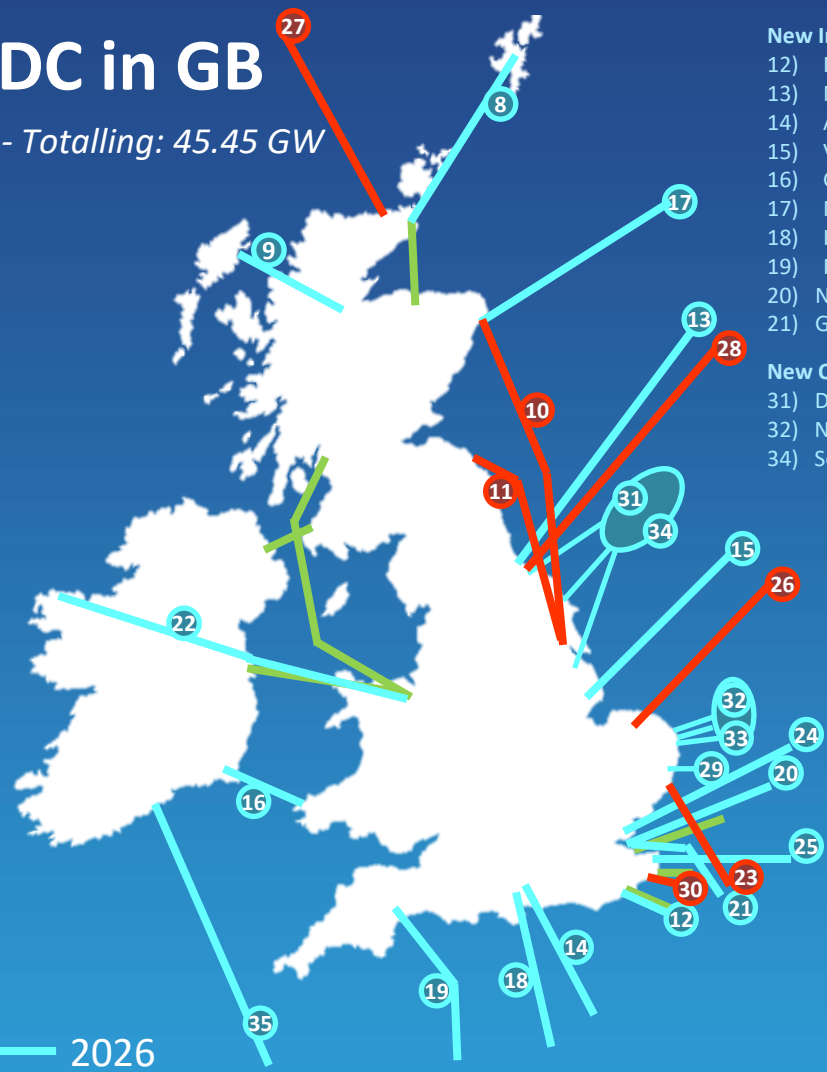
New Embedded Links:
6) Caithness – Moray
7) Western Link



Source: National Grid Interconnector Register 01 08 2019

Future HVDC in GB

Up to 34 HVDC Links - Totalling: 45.45 GW



New Island Links
8) Shetland
9) Western Isles

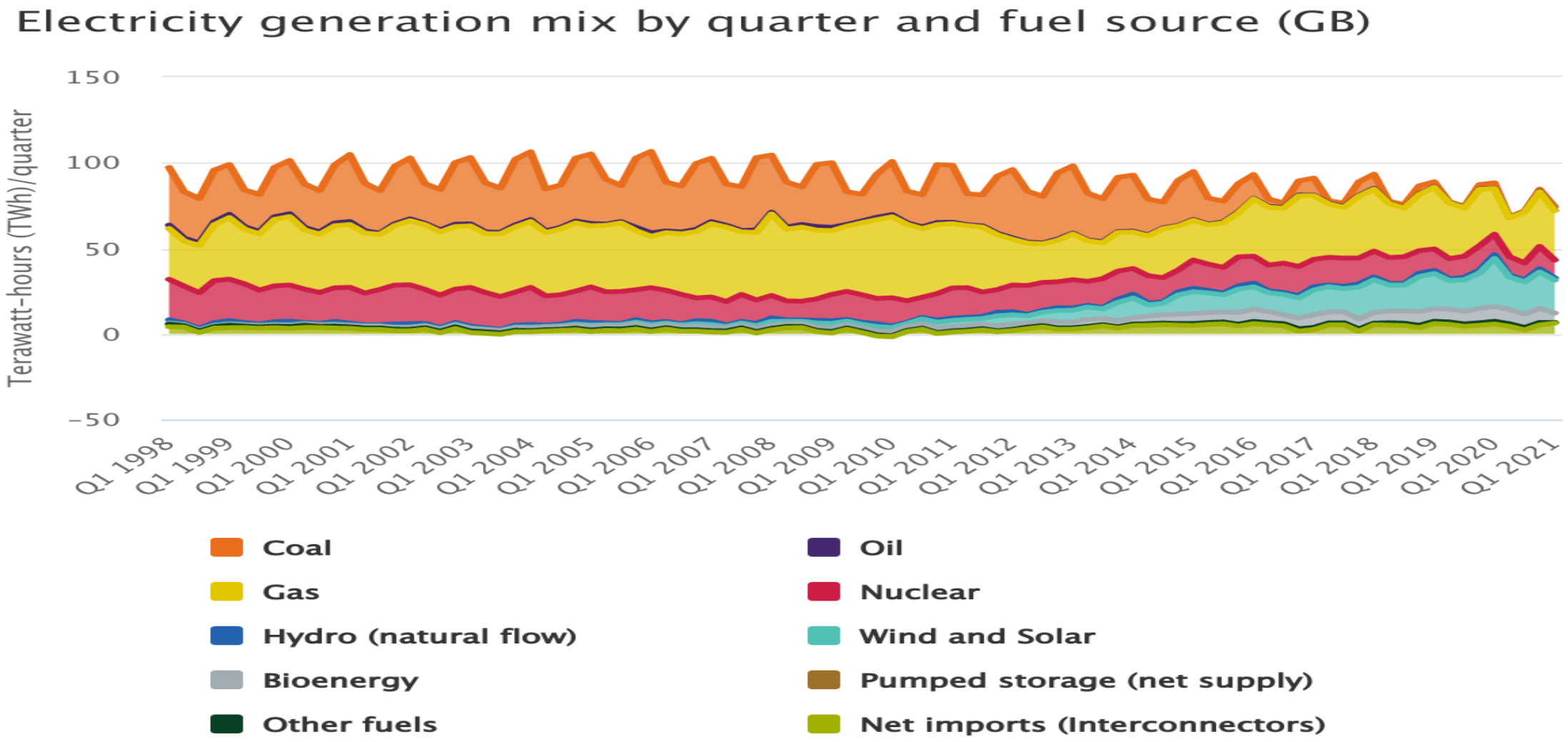
New Interconnectors
12) ElecLink
13) NSL
14) Aquind
15) Viking
16) GreenLink
17) NorthConnect
18) IFA2
19) Fablink
20) NeuConnect
21) Gridlink

New Offshore Wind Connections
31) Dogger Bank
32) Norfolk Vanguard
34) Sofia

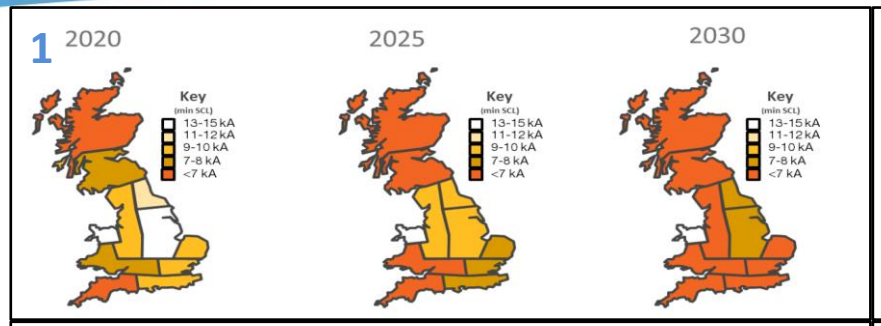
New Embedded Links
10) Eastern Link 2
11) Eastern Link 1

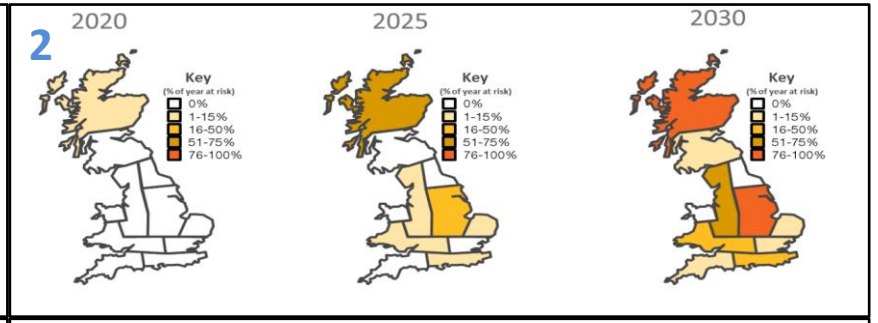
Additional Interconnectors
26) Aminth
27) Atlantic Super Connection
28) Continental Link

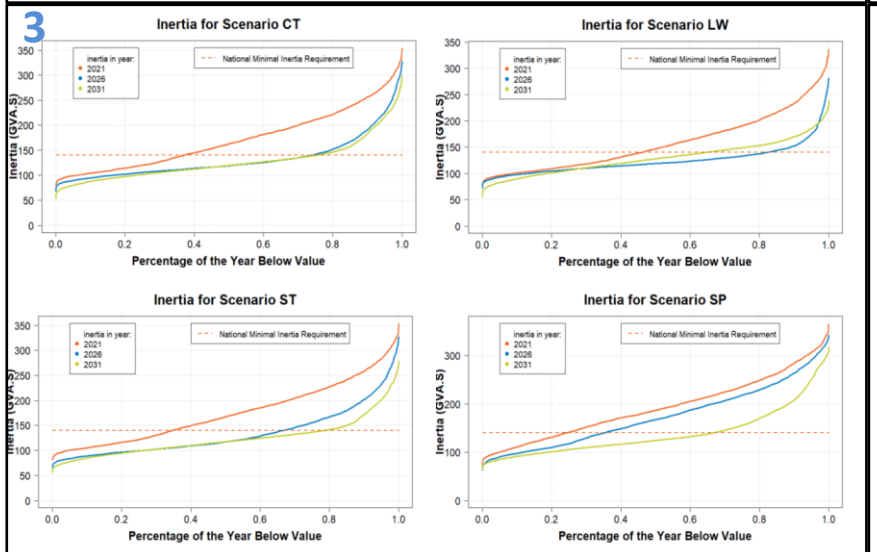
Electricity Generation Mix

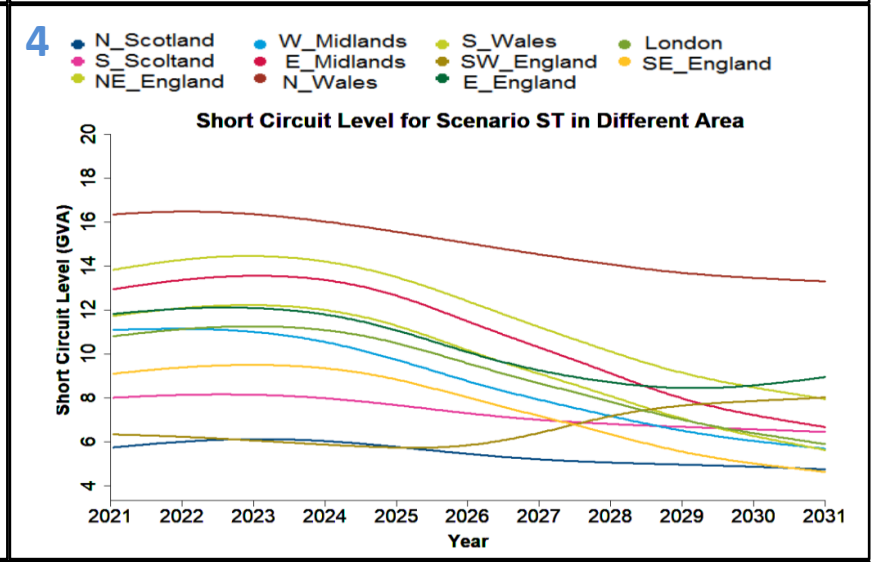


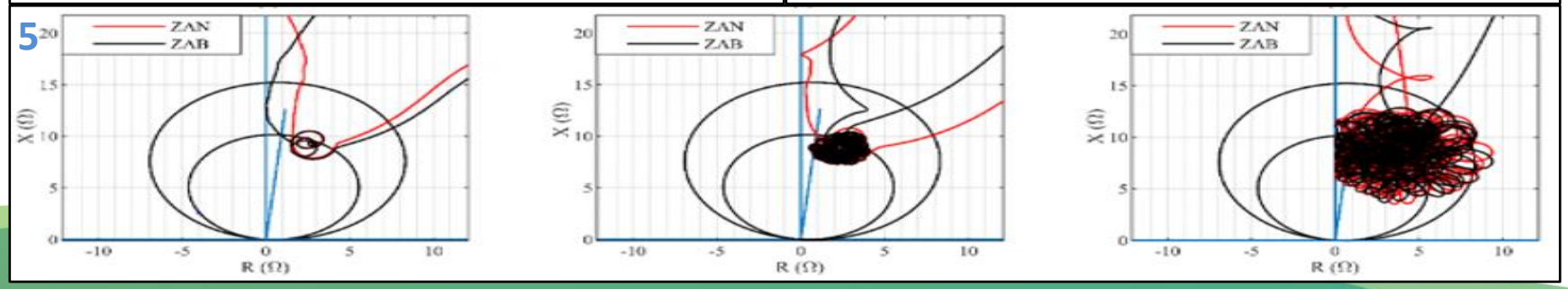
Background











Impact of declining Short circuit level (A System Operability Framework Document), National Grid ESO, download (nationalgrideso.com)

1. Phase Locked Loop Risk
2. Declining Short-circuit level
3. Mean Short Circuit Level for scenario System Transformation in different areas
4. Annual distribution of the inertia- where this is influences performance- not just the fault current, but its predictability!
5. Worsening Protection Performance on decreased Short-circuit level and increased converter penetration

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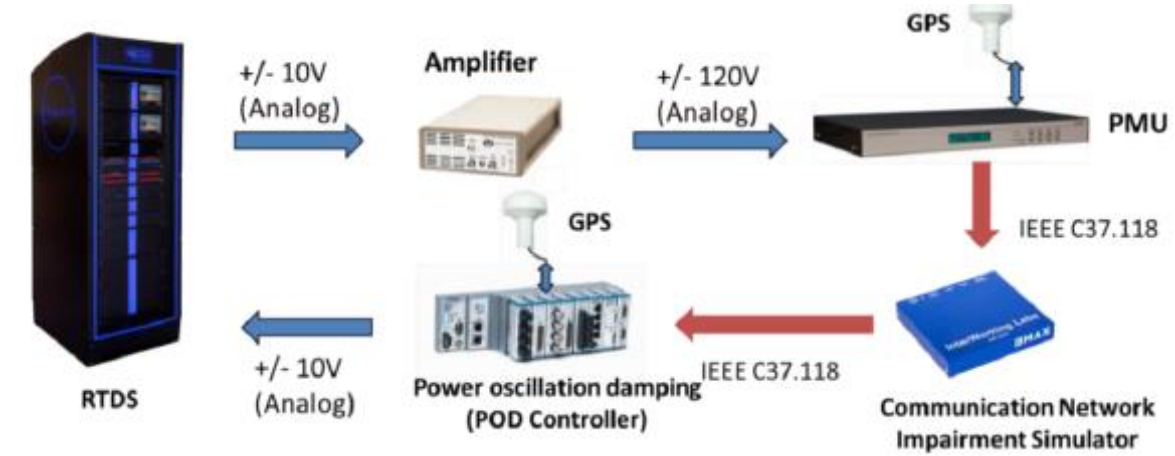
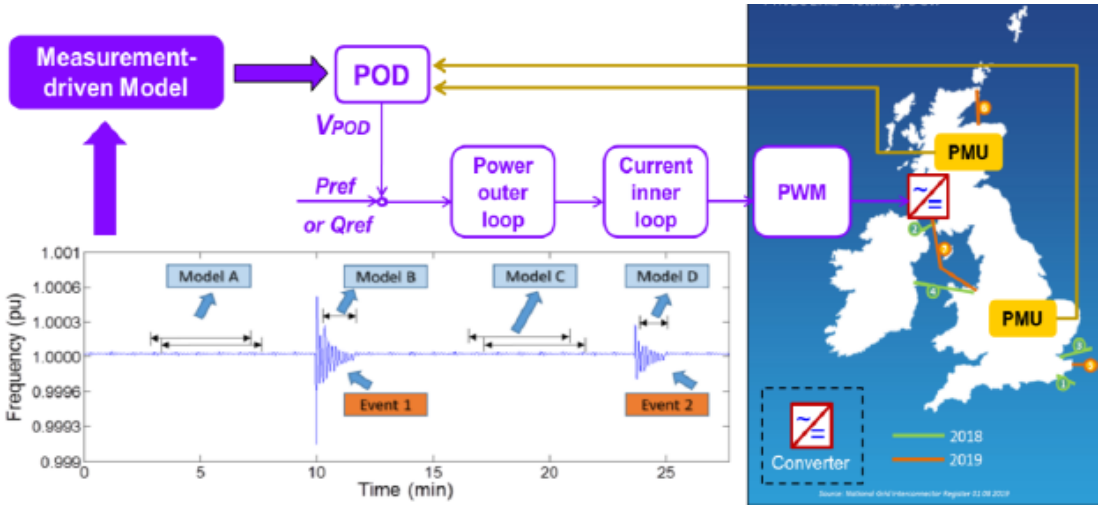
Video: A technical discussion on how HVDC can enable a more stable network whilst integrating renewable generation.

Adaptive Power Oscillation Damping Control via HVDC/FACTS Devices Using Measurement-Driven Model





Purpose of project

- conventional plant is displaced by new renewable sources
- new modes and locations of oscillation emerging
- conventional generators remaining may be inappropriate to suppress these modes

Method for the studies

- focuses on the design and demonstration of a wide-area POD controller through HVDC links based on a measurement-driven approach
- A reduced 36-bus GB power grid model was used in this study
- Designed offline then moved to RTS HIL platform to validate proposed solution

Outcomes

- performance of the designed POD controller was validated under different dispatches
- Findings show suppression of the targeted oscillation mode by modulating active power and/or reactive power of the selected HVDC link

Phasor-Based Monitoring with HVDC Control

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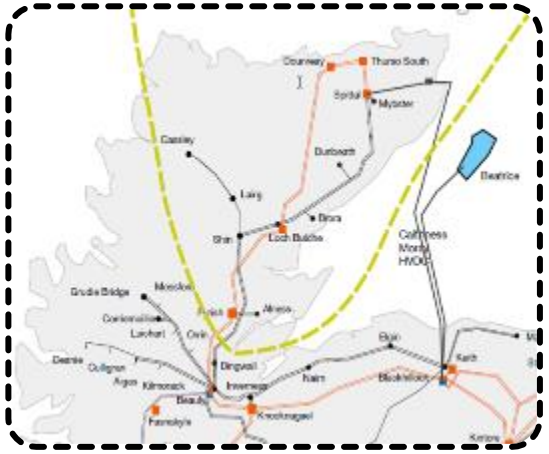
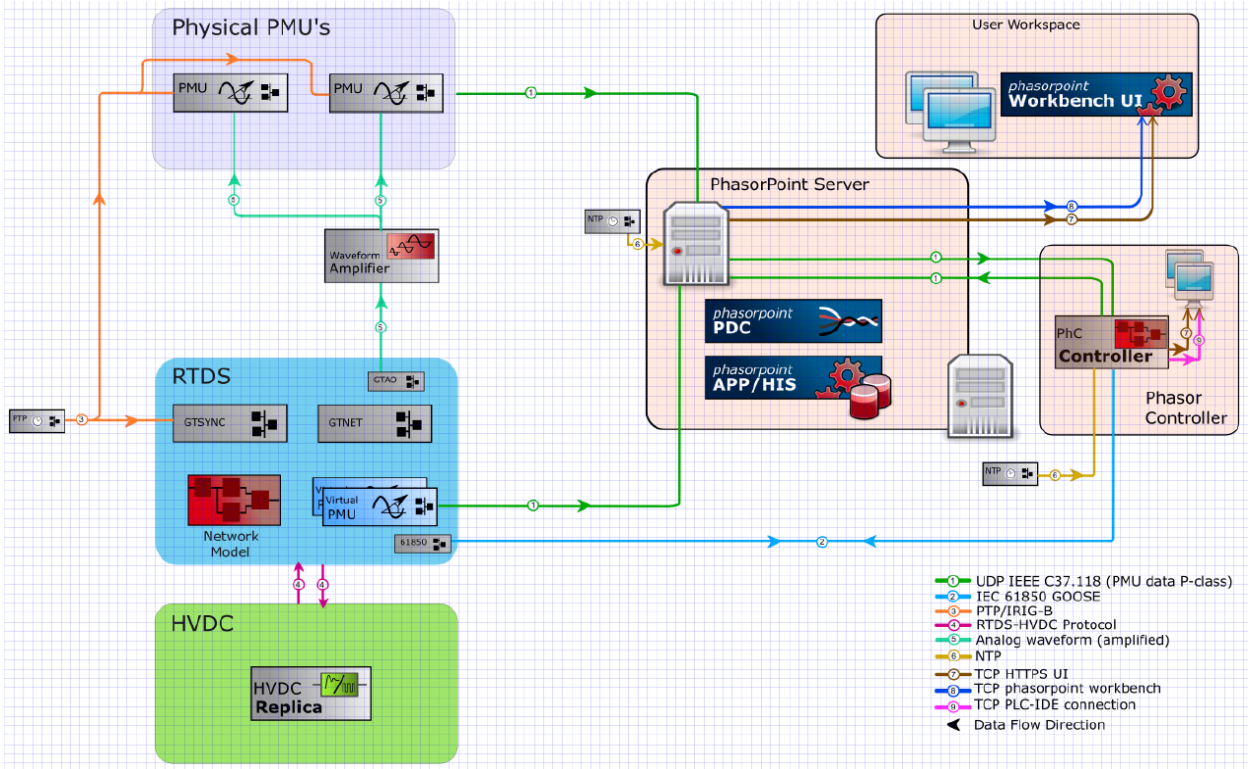
❑ Current situation

- Variable fault level at Spittal terminal
- Control mode change required for stability
- Offline study fault level analysis used to identify tipping point configurations
- Secondary system breaker position solution being used



National Grid Electricity Ten Year Statement 2018



❑ Purpose of project

- demonstrate capabilities to use Phasor Measurement Unit (PMU) data to derive real-time indicators of the state of the network.
- used to select an appropriate mode of operation by the HVDC control system.
- prove potential alternative to SSSNOB

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Assembling the picture of a future POD control

HVDC Centre & EPRI POD work

Visor, EFCC, Phasor control projects, TO programme of PMU delivery

Operation of the future GB system effectively damped

Individual converters with flexible range of damping frequencies, capable of layered damping actions

PMUs identifying latent frequencies of oscillation and informing Converter tuning locally

Small signal analysis work, Wide area control simulation, physical C&P and "PSCAD in the loop" of RTDS

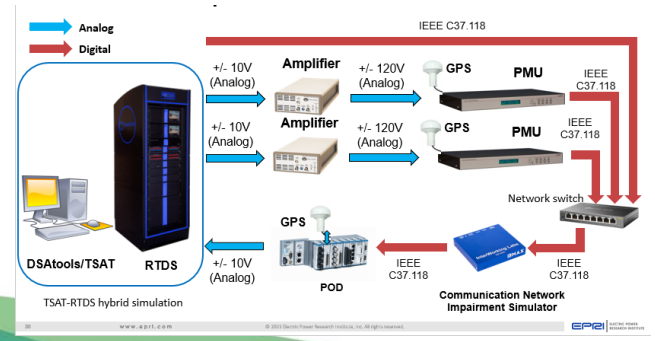
Supervisory approaches- Small signal analysis techniques identifying new states of risk+ classical frequencies of concern- to then inform local detection and control

HVDC Centre & EPRI POD work, EFCC & Visor projects

HVDC Centre & EPRI POD work

Optimisation approaches- optimal allocation of converters and other resources to damp oscillations identified

Robust POD control design, and operation.



(image from EFCC project https://www.nationalgrideso.com/document/144441/download)

Thanks for listening.

Any questions, please?

- For further information, please visit **www.hvdccentre.com** ; OR email: info@hvdccentre.com
- **https://www.hvdccentre.com/technical-films/**

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