

Across 17-19 March 2025, The National HVDC Centre supported the 22nd International IET ACDC conference, held in Birmingham. ACDC, held every 2 years, is a world recognised conference specifically for HVDC & FACTS technologies.

The Centre contributed significantly to papers, presentations, keynote speeches and panel sessions, as described in the special edition of our quarterly newsletter.

Aquila Lite Innovation Stand

Across the conference, SSEN-T manned a stand devoted to HVDC innovation work with a specific focus on Aquila- Lite and Network DC.

The stand was used as a focal point for follow-up discussions with potential partners in future SIF, NIA activities and international TSO collaborations seeking to use the Aquila patents and apply these to future projects.

Special thanks to Nithian and Peach for their support covering the stand while others were committed elsewhere across the conference sessions.

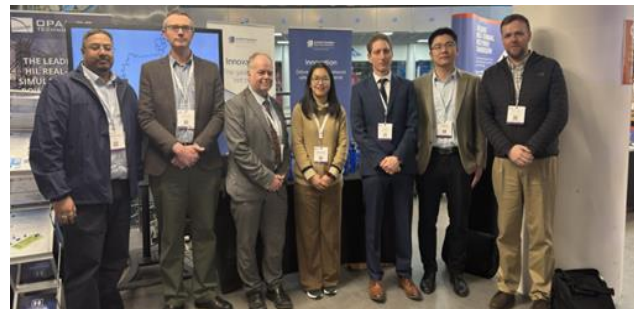
Ben Marshall

Trilateral meeting of vendors: The Centre demonstrates world's first multi-vendor HVDC network

Ahead of the planned tutorial session (overleaf), vendors GE Vernova and Mitsubishi Electric joined Ben Marshall and Peach Phurappa from the Centre in person, together with Adam Scott, Wasim Ahmed, and Xiaozuo Huang remotely for the first trilateral multi-vendor multi-terminal meeting. This provided an opportunity both to ask questions and finalise the content of agreed demonstrations later that day.

This meeting represented the first time the vendors had together been able to discuss the outcome of a combined simulation which was found to be highly productive by all.

Ben Marshall & Adam Scott



SSEN-T and The National HVDC team at the IET ACDC conference sharing Project aquila insights (left to right): Nithian Vejjayan, Colin, Ben Marshall, Peach Phurappa, Pablo Briff, Shangan Tian & Ryan Tumilty.



Left to right: Nithian Vejjayan, Dumisani Simfukwe, Fainan Hassan (GE Vernova), Carl Barker (GE Vernova), Ben Marshall, Yamato Kentaro (Mitsubishi Electric), Yohei Okada (Mitsubishi Electric) & Steve Langdon (Mitsubishi Electric).

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Tutorial demonstrating Project Aquila: The world's first successful Multi-Vendor DC network in operation

Across the afternoon of 17 March, Dong Chen, Senior Simulation Engineer and Project Aquila lead from the HVDC Centre, hosted a 3-hour tutorial on the concepts and application of vendor agnostic approaches to multi-terminal network control, which included streaming example performance from the Centre of real-time simulation hosting black-boxed models from GE Vernova and Mitsubishi Electric.



Over 32 people signed up to the tutorial, which received significant positive feedback from those in attendance, mainly from industry, including several international TSOs. This was the first time in the world that a successful multi-vendor, multi-terminal HVDC real-time simulation had successfully demonstrated to a public audience a range of capabilities and resilience to disturbances required for future DC systems; setting the tone for Project Aquila interest throughout the 3-day event.

Dong Chen

HVDC-WISE Panel Session

HVDC-WISE is an EU Horizon project with 14 partners from 11 countries covering the academic, TSO and industrial domains. The goal is to support further development of hybrid AC/DC transmission grids by developing new reliability and resilience oriented planning and analysis tools and identifying HVDC-based grid architectures and technologies that can improve system performance and facilitate the integration of new renewable sources.

Colin Foote leads the HVDC Centre's involvement in the project and joined project colleagues in delivering a successful panel session, updating the industry on progress since a similar session was delivered at ACDC 2023 in Glasgow.



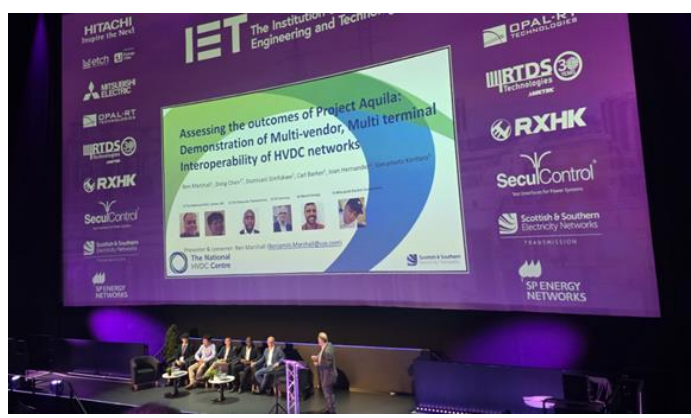
This included insights on how the project use cases are exploring issues of concern to TSOs in future hybrid AC/DC grids. The project has already delivered a range of reports, software tools, and models. The next year will see completion of the most detailed analysis, including significant activity at the HVDC Centre's world-class real-time simulation facilities. The session included interactive polling of the audience, gathering views on progress and prospects in HVDC-dominated networks. This revealed a mix of optimism and pessimism, highlighting the significant achievements of recent years and the big challenges that remain.

Colin Foote

Keynote on Project Aquila experience and outcomes

Day 2 of the conference began with representatives of the National HVDC Centre, the SSEN-Transmission HVDC engineering team, GE Vernova, Hitachi Energy, and Mitsubishi Electric participating in a panel session within the main auditorium reflecting on the projects' work, approach and outcomes to date. A vibrant Q&A session followed with a representative from National Grid at the conference stating his view that this project represented a pivotal moment in the development of HVDC technology.

Ben Marshall & Dong Chen

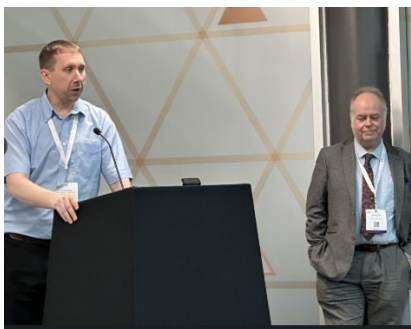


Announcement of the successful interoperability demonstration and reflections on project Aquila's outputs from: Ben Marshall, Dong Chen, Dumi Simfukwe, Carl Barker (GE Vernova), Joan Hernandez (Hitachi Energy) and Yamamoto Kentaro (Mitsubishi Electric).

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Presentation on MPI analysis

On the afternoon of Day 2 of the conference, Dr Richard Poole and Ben Marshall of The National HVDC Centre jointly presented findings on the analysis relating to Multi-Purpose Interconnectors, noting further analysis of expanded Energy Island and DC Circuit Breaker considerations to follow.



Key conclusions and their effect on implementation of new prototype projects such as Lion Link and Nautilus were also briefly covered to a packed audience. The core take-aways were that such multi-terminal full bipole projects were both feasible and could meet relevant onshore TSO codes and standards but had a number of fundamentally different considerations to point-to-point projects, particularly in areas of control and protection.

Ben Marshall

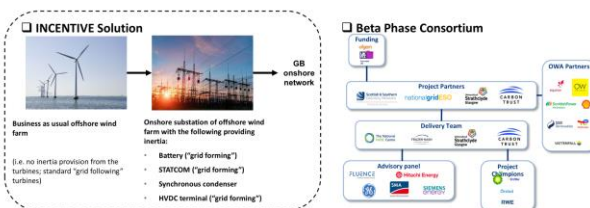
Project INCENTIVE

Also on the afternoon of day 2, Shangen Tian from the Centre presented his paper on the testing of hybrid energy storage grid forming devices in combination with grid following devices under the INCENTIVE project.

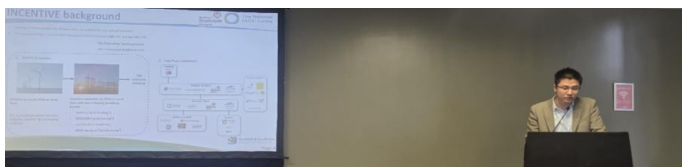
INCENTIVE background



- Seeking to demonstrate how offshore wind can stabilise the GB onshore networks
- Focussing on bring to market ASAP innovative solutions that are high TRL, but low CRL / IRL



This analysis, across testing scenarios and frequency containment strategies highlighted the capability to present tuned energy storage solutions of reduced capacity to a stand-alone single source of grid forming and frequency support to enhance network stability more efficiently than before.



Shangen Tian

Knowledge Dissemination from Network DC

The Network DC project aims to advance GB industry readiness to enable use of DC Circuit Breakers (DCCBs) and development of offshore HVDC networks. It is a Strategic Innovation Fund (SIF) project currently in its Beta phase. Partners include SuperGrid Institute in France and the University of Edinburgh. Recent project work resulted in two papers being published at ACDC 2025.

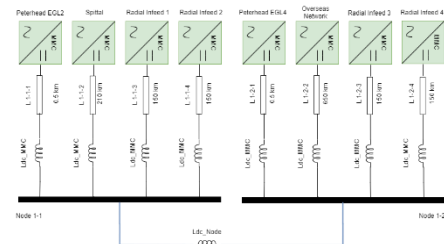


Figure: T_{th} for different grounding configurations and $I_{arm,bk} = 1.5pu$

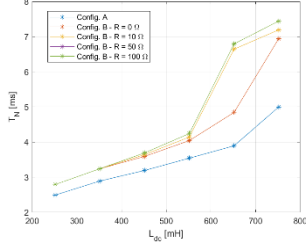
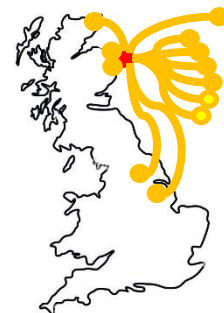
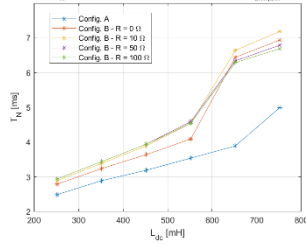


Figure: T_{th} for different grounding configurations and $I_{arm,bk} = 1.5pu$



Our assessment of OPTIONS FOR MITIGATING CONVERTER BLOCKING DURING CLEARANCE OF DC FAULTS was the subject of a poster that prompted a lot of discussion through the conference. The authors of papers in related areas were keen to understand the findings from this project, which is at the forefront of GB efforts on DCCBs.

Edinburgh University led on a STUDY OF INTERNAL FAULTS IN THE SOLID-STATE SWITCH TRANSFER BRANCH FOR MODULARISED HYBRID DC CIRCUIT BREAKERS, which was ably presented by our project colleague, Sebastian Neira. This highlights the HVDC Centre's role in supporting research of new technologies and methods that can support SSEN-T and wider GB efforts in implementing the grid needed to support net zero.

Colin Foote

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Appendix A - Notable Papers

Please find below a selection of the 61 papers published at the 22nd IET ACDC conference, which are relevant to the HVDC Centre's work.

Paper No.	Title	HVDC Centre's Observations	Topics of Interest
53	Enhancing Stability of Power Grids with High Levels of Inverter-Based Generation Using a Novel Control Technique	Latest iteration of the HVDC Excellence company patented advanced vector control approach for improving outer loop stability of large power Converter sources - intended to support retrofit across vendors. Potential for vulnerabilities to combined frequency and voltage events.	Enhanced grid following converter controls in low strength operation
101	Dynamic Voltage Control with Negative Phase Sequence and Fast Fault Current Injection for VSC HVDC Solution	GE approach to fault response of a grid following control optimised to provide maximum NPS content under unbalanced disturbance. Illustrates trade-of in amplitudes of response available without over-sizing converters	Enhanced grid following converter controls in low strength operation
22	PERFORMANCE TESTING OF A SOLAR PV SYSTEM CONTROLLED AS A VIRTUAL SYNCHRONOUS MACHINE TO VERIFY GRID CODE COMPLIANCE	MHIs approach to generic PV models with VSM - some limitations - many control structures including non-grid forming overlaid on one-another, which need hierarchy and time delay. Paper notes inertia unconstrained, so not realistic against operating point without a non-ideal energy model being added also.	Grid forming models
52	Enhancing AC Line Emulation controls for improved inter-area oscillation damping and application to Multi-Terminal DC Grid	SuperGrid Institute & Tennet. Augments the AC line emulation to combine with inter-area damping. This is conditional on the synthetic impedance adopted on the model and a limited number of operating conditions are considered. The concern would be the practical implementation being dependent on ever more state variable acquisition from the AC system and whether the optimised damping can be effective in practice. Centre will test and critique further within HVDC WISE project.	Parallel HVDC system implementation to enhance AC system.
35	Analysis of voltage control interactions between converters in weak grids	Siemens analysis of converter interactions superposed on classical voltage instability within a region. This has historically been discussed in various papers considering the south coast system for GB, which Siemens possess a detailed model of from NGET. Paper highlights the danger of fast outer-loop control and the positive effect of optimising the bandwidth tolerances of these controllers in such scenarios to allow measurement to calm down ahead of action.	Enhanced grid following converter controls in low strength operation
41	Evaluation of Interactions between Bipolar HVDC Connections with Grid-Forming Converters	Recipient of conference best paper award. Considers AC system focussed grid forming, examines co-ordination needs across poles and interaction management between grid forming controls across AC network distances and characteristics	Grid forming analysis.

Appendix A - Notable Papers (continued.)

Paper No.	Title	HVDC Centre's Observations	Topics of Interest
64	Impact of Frequency Droop Control on Critical Clearing Time Calculation of GFM Converters	Classical machine AC fault critical clearance times for protection. Vendor specific findings which reassure findings without frequency droop are conservative in nature. Neither drive new protection timings.	Grid forming analysis
85	Comparative Analysis of VSC-HVDC Converters under Phase Jumps, Frequency Change, and Short-Circuit Faults	NESO and Cardiff paper at overview level illustrating requirements and rationale. Base assumptions of grid forming model are basically articulated.	Grid forming analysis
91	RESOURCE-AWARE GRID-FORMING CONTROL FOR INVERTER-BASED RESOURCES IN RENEWABLE ENERGY SYSTEMS	An academic paper (CITCEA-UPC Barcelona) highlighted as we understand at least two HVDC vendors have progressed this "conditional" grid forming line. A risky control approach for the AC network if the resource to support grid forming is not available as triggers a grid following reversion in a control role shift at an otherwise unpredictable point in a given event.	Grid forming modelling
58	STUDY OF INTERNAL FAULTS IN THE SOLIDSTATE SWITCH TRANSFER BRANCH FOR MODULARISED HYBRID DC CIRCUIT BREAKERS	A Network-DC supported paper authored by University of Edinburgh and Centre. Highlights worst case conditions of switch failure – how to model and impact on wider system- these considerations will be applied to vendor modelling in next phase- using these models to complement & sense-check CB fail strategies.	DCCB analysis
83	IMPLEMENTATION OF LOCAL SUPPLEMENTARY POLE BALANCING CONTROL IN MULTITERMINAL BIPOLE HVDC SYSTEM	A vendor approach echoing and referencing the project Aquilla patented method for its basis highlighting industrial adoptions of control principles for unbalanced operation.	Multi-terminal DC systems
102	HVDC System Energization from Very Weak Onshore Island AC System Utilizing Synchronous Grid-Forming Control	A vendor HVDC grid forming control identifying same capabilities for black start and islanding control. Again resource conditional.	Grid forming analysis
82	TO BE OR NOT TO BE MULTITERMINAL READY – THAT IS THE QUESTION	Hitachi's perspective on multi-terminal thinking, in alignment with Aquila, debating when to design for but not with. Useful reference paper on considerations.	Multi-terminal DC systems

A copy of the full conference agenda can be found here [ACDC - Programme](#).

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