Newsletter

Issue 32: ACDC 2023 Special Edition

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The National HVDC Centre

Welcome to this special edition of the HVDC Centre newsletter which focusses on the 2023 IET ACDC conference.

The ACDC conference is the IETs' premier event focussing on the application of HVDC and power electronic technology to network application, microgrids and specific other "offgrid" applications, which we have supported over several past conferences here at The National HVDC Centre.

This year we are both co-hosting the conference with the University of Strathclyde, presenting a number of papers on key innovations across small signal analysis and multi-terminal multi-vendor control, and also hosting a "technical visit" to the HVDC Centre. This edition describes some of the content discussed across these three days, focussing in particular on the Technical Visit itself.

Both the attendance and reach of the ACDC conference is increasing this year, with multiple such conferences to be held around the globe planned in future years, as the key role HVDC plays in the transition to zero carbon energy systems is appreciated, and the projects delivering those solutions progress. Interesting times!

Ben Marshall

Best Conference Paper: Towards HVDC Interoperability

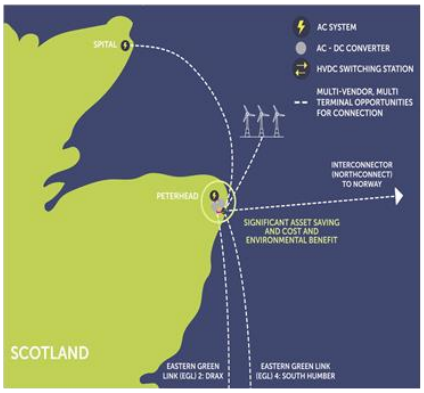
Our paper on Interoperability won the prestigious 'Best Paper' at the ACDC Conference.

Dong Chen presented his paper titled: "Towards HVDC Interoperability – Assessing Existence of Equilibrium with Reference to Converter Terminal Behaviour" at the Conference, describing a novel methodology to design offshore HVDC grid functions.


Towards HVDC Interoperability - Assessing Existence of Equilibrium with Reference to Converter Terminal Behaviour

The paper details the methodologies of assessing the grid strength for a multi-terminal-multi-vendor HVDC grid. The patented methodology serves as a stepping-stone to provide the principle of quantifying the contribution of vendor's converter and network infrastructure towards the security of DC transmission for both system planning and operation.

In a broader context, the paper will help to specify and then standardise the future offshore grid in the east coast of GB, while leading the way for the interoperability package of the flagship SSEN-Transmission project – "Aquila" - to deliver the 1st Multi-Vendor-Multi-Terminal (MVMT) HVDC grid in Europe.



The DC grid will include a DC hub at Peterhead in Scotland which interconnects onshore HVDC stations in north Scotland at Spital and down to south in England at South Humber and Drax.

Historically, MVMT HVDC schemes are difficult to achieve as the converted designs are protected by suppliers. This novel methodology ensures different vendors systems can work together.

Link to the paper: www.hvdccentre.com/library/towards-hvdc-interoperability-assessing-existence-of-equilibrium-with-reference-to-converter-terminal-behaviour/

Dong Chen

The National HVDC Centre

Technical Visit: Small Signal Analysis of Interactions

During the presentation, Nikhil and Ruiqi provided a concise demonstration of the Offshore Wind Farm Interaction Studies. They elaborated on creating an EMT model offline, specifically for studying the Offshore Wind Farms, with the purpose of performing Stability Analysis of the model.

The UK has seen a significant increase in the number of offshore wind farms to achieve its renewable energy targets, with a need to raise the offshore wind energy capacity from around 11 GW to nearly 40 GW by 2030 to achieve the government's Net Zero goal.

The problem of unstable resonances between wind turbines and the grid has gained considerable attention, particularly with Type IV wind turbines that use power electronics. These turbines are vulnerable to sub-synchronous and super-synchronous resonances when connected to AC Grid due to the closed-loop control design, which produces small-signal modes that can cause instability.

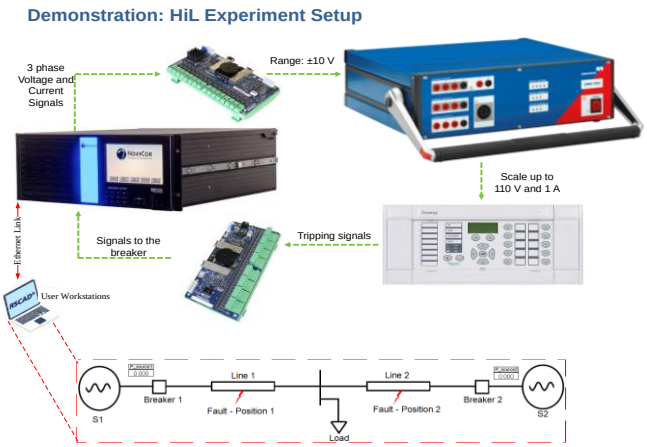
The insufficient small-signal stability margin of the interconnected system consisting of Type IV wind turbines and weak grid connection is the main reason behind these resonances. Demonstration was performed using PSCAD EMT tool to understand the methodology in detail.

Link to this presentation: www.hvdccentre.com/library/acdc-2023-wind-farm-interaction-studies/

Nikhil Sharma and Ruiqi Li

Technical Visit: Protection Workshop

The National HVDC Centre has a dedicated protection workshop where power system protection and control equipment can be tested. As a new facility at the Centre, a range of state-of –the-art testing tools have been installed to transform the workshop into a cutting-edge research and testing facility.



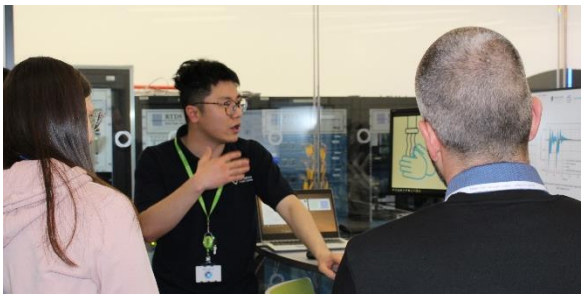
Simulation Engineer, Md Asif Uddin Khan demonstrated one of the most critical applications of RTDS® using a Hardware-in-the-Loop (HiL) configuration to test an AC distance protection relay. Using the above HiL configuration, Asif demonstrated a commercial distance relay's operation under different fault conditions simulated in the RTDS network model. He also discussed various applications of HiL for hardware testing with HVAC and HVDC transmission systems.

Link to the presentation: www.hvdccentre.com/library/acdc-2023-hardware-in-loop-testing/

Asif Khan

Technical Visit: INCENTIVE Project Presentation

Shangen Tian, a simulation engineer at the Centre, gave a presentation and demonstration of one the technical cases from Project INCENTIVE. The INCENTIVE project has identified an opportunity to utilise the connection of offshore wind farms to play an enhanced role in stabilising the GB network by using combinations of innovative technologies.



INCENTIVE aims to check the performance of the proposed solutions with regard to providing stability services, primarily inertia support to grid. Beyond this though there is a need to understand how the solution works as part of a whole power system (including the fundamental need to export offshore wind power reliably to the grid).

In the INCENTIVE Alpha phase, we seek to demonstrate the effectiveness of the considered solutions with grid forming control, e.g. STATCOM with energy storage, BESS, HVDC converter and synchronous condenser.

Link to the Presentation: www.hvdccentre.com/library/acdc-2023-incentive-project-update/

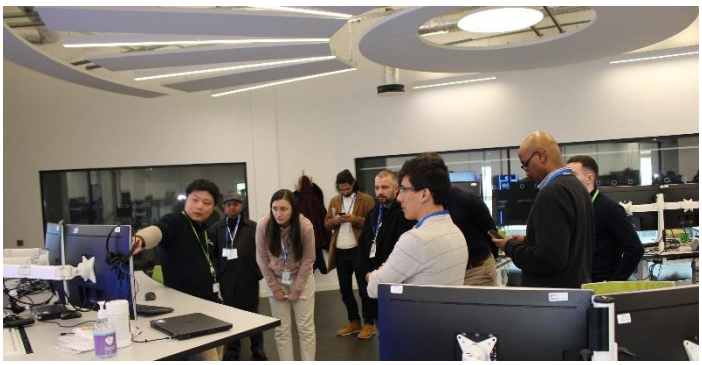
Shangen Tian

The National HVDC Centre

Technical Visit: Offshore Functional Design

Dong Chen presented the offshore functional design project, which is supported by Ofgem and BEIS; describing the overview of offshore HVDC plan as an enabler of GB's target towards net-zero.

The benchmark system of offshore HVDC network also fits into a broader plan of the Aquila project. As the flagship project of SSEN-Transmissions, Aquila will be the 1st interoperable multi-vendor HVDC project, and is being designed as to not require opening up vendor's IP to enable the multi-terminal design.



As an illustration of benchmark system to ensure interoperability of Aquila project, Dong demonstrated a real-time generic model of a 3-terminal bipolar HVDC system developed by the Centre. The demonstration also included the application of DC grid strength assessment (which is filed by a UK patent).

Link to presentation: www.hvdccentre.com/library/acdc-2023-offshore-functional-design-to-support-project-aquila/

Dong Chen

Poster Presentation: Stability Assessment

Nikhil Sharma, along with Shangen Tian, presented a paper titled "Stability Assessment of Offshore Wind Farm" at the IET Conference on AC/DC Transmission 2023.

The paper demonstrates an offshore wind farm arrangement and utilizes a small signal injection method in the PSCAD EMT model to assess the impedance and quantify the modes. The derived frequency domain models were validated by comparing them with the results of time domain analysis, which showed that the resonance frequencies were visible in both cases, and the response matched the expected outcome. The poster was nominated for the Best Poster Award at the conference.

Link to the Poster:www.hvdccentre.com/library/acdc-2023-impedance-assessment-of-offshore-wind-farm-poster/

Nikhil Sharma & Shangen Tian

Technical Visit: Software-in-the-Loop

Fabian Moore, a simulation engineer here at the Centre, gave a demonstration of Software-in-the-Loop (SIL) technology for the real-time simulation of a wind farm model using a manufacturer supplied "black box" model.

The presentation discussed building a real-time EMT model for studies focused on the Shetland Network, to carry out analysis on behalf of SSEN Transmission.

The Shetland power system will be dominated by power electronics with the connection of the 440 MW Viking wind farm, and a 600MW HVDC link to the mainland which forms part of the multi-terminal Caithness-Moray-Shetland (CMS) HVDC VSC system. The overall aim is to build a real-time EMT model of the network that includes a SIL model of the Viking wind farm alongside the physical replica of the control system for CMS HVDC VSC system hosted at the Centre.

The presentation focused on the merits of SIL models when compared to physical hardware replicas.

Link to the presentation: www.hvdccentre.com/library/sil-presentation-acdc-2023/

Fabian Moore

Technical Visit: HVDC In GB

Simon Marshall opened the Technical Visit with an overview of the current and future uses of HVDC in the GB electricity network; and describing the role of the HVDC Centre in the transition to a net-zero network.

Link to his presentation: www.hvdccentre.com/library/acdc23-hvdc-overview/

Simon Marshall