The Institution of Engineering and Technology

ACDC 2023

Wednesday 1st March – Technical Visits and Tutorial

	Stream A	Stream B	Stream C
09:30 - 10:00	**Registration for Technical Visit 1 - HVDC Centre & PNDC Centre** Entrance Foyer Technical Visit		**Tutorial Registration - PSCAD Training** Level 9 Foyer Tutorial
10:00 - 11:00	**Technical Visit 1 - Travel Outbound** Technical Visit		**PSCAD Training Part 1 - Integration of Inverter Based Resources into Modern Grids – EMT Modelling & System Studies** Executive Room A/B Tutorial
11:00 - 13:00	**The National HVDC Centre** Technical Visit		
13:00 - 13:30	**Networking Lunch** Tutorial	**Registration for Technical Visit 2 - Scottish Power Whitelee Windfarm** Entrance Foyer Technical Visit	**Networking Lunch** Level 9 Foyer
13:30 - 14:00		**Technical Visit 2 - Travel Outbound** Technical Visit	
14:00 - 16:00	**Power Networks Demonstration Centre (PNDC)** Technical Visit	**Scottish Power Whitelee Windfarm** Technical Visit	**PSCAD Training Part Two - Integration of Inverter Based Resources into Modern Grids – EMT Modelling & System Studies** Executive Room A/B Tutorial
16:00 - 17:00	**Travel Inbound** Technical Visit	**Travel Inbound** Technical Visit	
17:00 - 18:30	**Conference Meet Up - Drygate Brewing Co.** Drygate Brewing Co. Meet up with your conference peers at Drygate Brewing Co. for a drink. No need to register, just turn up. Please note this will be at your own expense.		

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Thursday 2nd March – Day 1 of the conference

	Stream A	Stream B	Stream C
08:30 - 09:00	**Welcome Refreshments & Registration** Level 2 Foyer		
09:00 - 09:05	**Chairman's Welcome** Auditorium B&C Dr Khaled Ahmed, Reader Electronic and Electrical Engineering. University of Strathclyde		
09:05 - 09:25	**The Need for Speed: Building the Grid of the Future** Auditorium B&C Chris Fox, Deputy Director (Jobshare), Europe & Offshore Electricity Networks at Department for Business, Energy & Industrial Strategy (BEIS Keynote Sharing experience from the newly created Department for Energy Security and Net Zero's work on the Offshore Transmission Network Review and British Energy Security Strategy, Chris will examine the role of grid as a keystone in the delivery of a decarbonised energy system, the strategic challenges facing transmission network delivery and how HVDC and other technologies might offer solutions.		
09:25 - 09:45	**Overcoming Barriers To Achieve Net Zero in this Turbulent Global Climate?** Auditorium B&C Julian Leslie, Chief Engineer, National Grid ESO Keynote This session will explore some of the challenges in delivering a decarbonised whole energy system. It will provide a view of what is working well and where some of the challenges lay. The session will have a GB focus but will reflect learnings and experiences that are been seen around the globe from leading decarbonising systems.		
09:45 - 09:50	**Q&A** Auditorium B&C		
09:50 - 11:00	**Policy Navigation - Are We In An Impossible Disconnected Maze?** Auditorium B&C Nicolaos Cutululis, Chris Fox, Deputy Director (Jobshare), Europe & Offshore Electricity Networks at Department for Business, Energy & Industrial Strategy (BEIS, Susan McDonald, Energy Transition lead, Deloitte., Joseph Northwood, Head of Commercial, Stakeholder & Delivery Strategy. National Grid, Prof Keith Bell, Holder of the Scottish Power Chair in Future Power Systems and Professor of Smart Grids University of Strathclyde, Rannveig S. J. Loken, Team Manager of Protection Panel		
11:00 - 11:30	**Refreshments, Exhibition and Posters** Level 2 Foyer **The posters are listed on the last page of the programme**		
11:30 - 11:50	**Developments in Ireland** Auditorium B Liam Ryan, Chief Innovation and Planning Officer. EIRGRID	**Journey to Morocco** Auditorium C Nigel Williams Project Director, HVDC Transmission. Xlinks	**Energy ransition in Spain: A Picture of a Power System with Large Amounts of Power-Electronic Devices**

	Editorial Presentation Session Chair - TBC	Editorial Presentation Session Chair - Dirk Van Hertem	Conference Room 4&5 Alberto Rodriguez Cabero Editorial Presentation Session Chair - Ahmed Zobaa
11:50 - 11:55	**Q&A** Auditorium B	**Q&A** Auditorium C Q&A	**Q&A** Conference Room 4&5 Q&A
11:55 - 12:55	**Session 1A: Transitions to Net Zero- Case Studies of New Technology Implementation** Auditorium B Technical Paper Presentation Session Chair - TBC **[1a.1]** **AC/DC Hybrid Grid Modelling Enabling a High Share of Renewables: The Celtic Interconnector Use Case** Giacomo Bastianel, Hakan Ergun, Olivier Antoine, Pieter Tielens, Lampros Papangelis, Adedotun Agbemuko, Dirk Van Hertem, Jef Beerten, Karim Karoui **[1a.2]** **Delivery of a Mid-Life Refurbishment of an HVDC Interconnector Control System** Sam Gibson, Nathaniel Cowton, Mojtaba Mohaddes, Helmut Klimsa **[1a.3]** **Energy Transition in Shetland Islands Towards Net Zero: Development, Challenges and Opportunities** Shuren Wang, Han Xu, Yousef Abdelaziz, Kyle Jennet, Khaled Ahmed, Graeme Burt **[1a.4]** **On the Uk Smart Metering System and Value of Data for Distribution System Operators** Mohamed Numair, Ahmed A. Aboushady, Mohamed E. Farrag, Eyad Elyan	**Session 1B: Solutions to New and Novel Areas of HVDC System Operation and Design.** Auditorium C Technical Paper Presentation Session Chair - Dirk Van Hertem **[1b.1]** **Experimental Study on the Influence of MMC Control Design on the Propagation of AC Grid-Unbalance to A DC Network** Caspar Collins, Philip Clemow, Tim Green **[1b.2]** **Managing Harmonics and Resonances in HVDC Connected 66 kV Offshore Windfarms** Casper Karlsson **[1b.3]** **Challenges and Safety Aspects for Effective Fault Location on Long HVAC and HVDC Cables** Robert Probst, Ahmed El-Rasheed **[1b.4]** **Single Branch of Energy Storage Submodules to Integrate Energy Storage Devices in HVDC Systems** Joan Sau Bassols, Florent Morel, Florian Errigo, Hind Bekkouri, Juan-Carlos Gonzalez, Abdelkrim Benchaib	**Session 1C: Optimisation and Operation of HVDC Systems** Conference Room 4&5 Technical Paper Presentation Session Chair - Ahmed Zobaa **[1c.1]** **Increasing DC System Stability Thanks to Energy Control in MMC Based DC-DC converters** Juan Páez, Kosei Shinoda, Daniel Gómez Acero, Florent Morel **[1c.2]** **Security Constrained OPF Model for AC/DC Grids with Unbalanced DC Systems** Chandra Kant Jat, Vaishally Bhardwaj, Hakan Ergun, Dirk Van Hertem **[1c.3]** **Efficient Congestion Management using Embedded MVDC-connections between Distribution Systems** Johannes Kayser, Steffen Schlegel, Dirk Westermann **[1c.4]** **An Online Power System Voltage Stability Index for a VSC HVDC Using Local Measurements** David Li, Xiao-Ping Zhang
12:55 - 13:50	**Lunch, Exhibition and Posters** Level 2 Foyer **The posters are listed on the last page of the programme**		

13:50 - 14:10	**Plenary - Grid Resilience: A Global Perspective** Auditorium B&C Stuart Whyte Plenary The conflict within Ukraine serves as a stark reminder of the impact that geopolitical relations have on energy cost and supply. The global covid pandemic has also profoundly changed the way we work. Society is reliant on a secure energy supply that is clean, fair, and affordable but in an uncertain world, this will only be achieved by building more resilience into our organisations and networks. This plenary will explore a whole of community approach to achieving resilience in the energy systems of the future, and will discuss how we can break down organisational silos beyond the energy industry. We have seen more extreme weather events, such as the Christmas storms in Buffalo US, as the impact of climate change becomes evident. This session will showcase a systemic approach for assessing the impact of climate change, enabling the action needed to adapt our networks for the future.
14:10 - 14:30	**Plenary - The American Dream of US Macro-grid** Auditorium B&C Dr Julia Matevosyan, Chief Engineer. ESIG Plenary The massive expansion of the bulk transmission system necessary to support very high levels of clean electricity requires rethinking U.S. current approach to expanding the grid. The presentation will discuss challenges with transmission planning currently in the U.S. as well as articulate a set of recommendations for the next stage of proactive transmission planning of a national-scale HVDC macrogrid, which could be built over and interconnected into the existing AC grid. The presentation will draw from the recent Energy System Integration Group (ESIG) report U.S. Macrogrid: A Path to Achieving the Nation's Energy System Transformation Goals which is based on several comprehensive studies of a clean energy future for the United States and a series of workshops hosted by ESIG that brought together experts from across the industry, and delves into the reliability, resilience, economic, and operational aspects of the design.
14:30 - 14:35	**Questions** Auditorium B&C
14:35 - 14:55	**HVDC offshore networks – the next phase** Auditorium B&C Grant McKay, Hitachi Energy With the first projects using HVDC technology to connect large scale offshore wind in the UK now under construction, what are the next steps and what challenges must be taken into account when considering the coordinated approach to future offshore grid development initiated by the Holistic Network Design.
14:55 - 15:45	**Panel - HVDC-WISE : EU project on HVDC resiliency and reliability of HVDC systems** Auditorium B&C Juan Carlos Gonzalez, Prof Keith Bell, Holder of the Scottish Power Chair in Future Power Systems and Professor of Smart Grids University of Strathclyde, Ilka Jahn, Florent Morel, Dr Agusti Egea-Àlvarez, Senior Lecturer. Electronic And Electrical Engineering. University of Strathclyde, Dr Colin Foote, Senior Simulation Engineer. SSE National HVDC Centre, Robert Dimitrovski, Tennet Panel The EU-GB HVDC-WISE project brings together TSOs and a range of power systems research groups from across industry and academia. Project goals include the development of a complete reliability-&-resilience-oriented grid expansion planning toolset, the identification of planning approaches that realise the benefits of deep integration of HVDC technology into the future EU-GB transmission systems, and finally, the identification of different grid architectures that can be readily deployed in grid development plans. During this panel session, a brief outline will be provided of the goals of the project and some initial project outputs will be presented. A panel and audience interaction session will follow, where the challenges of planning for reliable and resilient hybrid AC/DC grids will be discussed.
15:45 - 16:15	**Refreshments, Exhibition and Posters** Level 2 Foyer **The posters are listed on the last page of the programme**

16:15 - 16:35	**Resilience and Flex as we push to Net Zero** Auditorium B Niall McDonald, Chief Engineer. Ofgem Editorial Presentation Session Chair - Chidinma Agwu	**Protection for Power Electronic Based Future Networks** Auditorium C Fainan Hassan, Lead Engineer . GE Power Conversion Editorial Presentation Summary: The penetration of grid connected generators using fully rated power electronics is predicted to continue to increase. This will impact the protection of the power systems in a number of ways. Most impacts are due decreased fault currents contribution and inertia. Various power system protective measures to insure grid resiliency are going to be explored in this talk including their implementation maturity levels. Session Chair - Carl Barker	**Energy Storage Systems Embedded in Statcom and HVDC Systems** Conference Room 4&5 Dr Hani Saad, HVDC Expert. ACDC Transient, France Editorial Presentation Session Chair - Jun Laing
16:35 - 16:40	**Q&A** Auditorium B	**Q&A** Auditorium C	**Q&A** Conference Room 4&5
16:40 - 17:35	**Session 2A: Microgrid and Battery System Deployment Considerations** Auditorium B Technical Paper Presentation Session Chair - Chidinma Agwu **[2a.1]** **An Impedance-Based Fault Detection and Classification Technique for DC Microgrid.** Pooja Chauhan, C.P. Gupta, Manoj Tripathy **[2a.2]** **Economic Viability of Domestic Battery Storage Participation in British Flexibility Markets** Timothy Capper, Jaise Kuriakose, Maria Sharmina **[2a.3]** **Experimental Validation of Reactive Power Capability of Battery Systems following the Danish Grid Code** Mirko Ledro, Zoltan M Pinter, Tatiana Gabderakhmanova, Mattia Marinelli **[2a.4]** **Localized Fault Detection and Classification Technique for Low Voltage DC Microgrid** Saurabh Sharma, Manoj Tripathy	**Session 2B: Protection and Fault Management Within HVDC Systems** Auditorium C Technical Paper Presentation Session Chair - Carl Barker **[2b.1]** **A Review of HVDC and MVDC Grid Protection** Amila Kaharević, Jaqueline Cabanas Ramos, Ilka Jahn, Ferdinanda Ponci, Antonello Monti **[2b.2]** **Protection Study for SST-Integrated LVDC Networks with Multiple Feeders** Vasileios Psaras, Rafael Pena Alzola, Ibrahim Abdulhadi, Mazheruddin Syed, Graeme Burt, Ali Kazerooni, Francis Shillitoe **[2b.3]** **Preventive DC-Side Decoupling: A Control and Operation Concept to Limit the Impact of DC Faults in Offshore Multi-Terminal HVDC Systems** Patrick Düllmann, Christopher Klein, Pascal Winter, Hendrik Köhler, Michael Steglich, Jan Teuwsen, Albert Moser **[2b.4]** **Onshore And Offshore AC Grids Short-Circuit Analysis of VSC-HVDC Integrated Offshore Wind Power Plants** Jie Song, Marc Cheah-Mane, Eduardo Prieto-Araujo, Oriol Gomis-Bellmunt	**SSPWG: Addressing Scotland's Transmission Challenges** Conference Room 4&5 Ryan Tumilty Head of System Performance. SSE, Gordon Mckinstry, Lead Engineer, Systems Analysis. SP Energy Networks, Xiaoyao Zhou Panel Session Chair - Jun Laing

18:00 - 22:00	**Conference Dinner and Awards** Citation Glasgow

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Friday 3rd March – Day 2 of the conference

	Stream A	Stream B	Stream C
08:15 - 08:30		**Walking Tour** All delegates are invited to join a short morning walk around Glasgow. Meet at the registration desk at 08.15 sharp, no sign-up required! This is a great opportunity to meet other conference delegates in an informal setting.	
08:30 - 08:45	**Welcome Refreshments & Registration** Level 2 Foyer		
08:45 - 09:00			
09:00 - 09:05	**Chairman's Welcome** Auditorium B&C Ben Marshall, Power System Engineer. SSE National HVDC Centre		
09:05 - 09:25	**Keynote - Planning and Design of Denmark's Future Energy Islands** Auditorium B&C Fitim Kryezi, Senior Lead of the electrical design: North Sea Energy Island. Energinet Keynote		
09:25 - 09:55	**Keynote - DC Hub Heide, an Onshore 4-way Multi-Terminal Hub** Auditorium B&C Dr Cora Petino-Wagner, Electrical System Design HVDC. TenneT TSO GmbH, Andreas Saciak, Large Projects and Stability Analysis 50 Hertz Keynote Due to the high offshore wind integration goals, the role of HVDC becomes increasingly important. In order to save landspace and costs for society, the interconnection of DC projects becomes an important building block for the future transmission grid. Planning first steps to a DC grid, TenneT introduces the first multiterminal system as a DC hub in northern Germany, interconnecting offshore and onshore system in a four terminal system, together with the partner TSO 50Hertz.		
09:55 - 10:05	**Q&A** Auditorium B&C		
10:05 - 10:25	**HVDC Circuit Breakers - Enabling an Interconnected DC Energy System** Mitsubishi Electric Future multi-terminal HVDC networks are expected to unlock significant renewable energy resources by reducing the need for excessive cabling, converter stations and land area. They also provide efficient transmission of energy across borders, helping to balance load and generation across large geographical and synchronous regions. However, high-performance, cost-effective HVDC circuit breakers will be required to rapidly clear faults, segregate multi-terminal networks and provide stable power delivery. To be effective and limit ancillary equipment costs these must operate in a few milliseconds – an order of magnitude faster than those found in AC systems. This presentation discusses ongoing development of DCCB technology demonstrated during the Horizon 2020 PROMOTioN project.		
10:25 - 11:15	**Panel - The Balancing Act of Innovation, Money and Delivery** Auditorium B&C Dr James Yu MBE, Head of Innovation Team. SP Energy Networks, Vijay Shinde, Head of New Technology Solutions. Siemens Energy, Prof Mike Barnes, Head of Power and Energy Division,. University of Manchester, Dr Pablo Briff, Head of R&D - HVDC, GE Renewable Energy, Nicola Todd, Head of Strategy and Innovation. National Grid Panel		

Innovation is at the core of technological development. Innovation must be met with appropriate levels of funding, which is to be aligned with the business and funding entities objectives. Industry, academic institutions, and funding entities shall work in close collaboration to make innovation sustainable, and impactful, with clear benefits to the society.

11:15 - 11:45

Refreshments, Exhibition and Posters
Level 2 Foyer

The posters are listed at the end of the programme

11:45 - 12:05

Reliability Considerations for the Design and Maintenance
Auditorium B
Dave Mckay, Director of Asset Management and Operation. SSE
Editorial Presentation
Session Chair - Sara Walker

Threats and Opportunities
Auditorium C
Perry Hofbauer, Lead Principal HVDC Engineer. SSEN
Editorial Presentation
Discuss various open working groups, how they dovetail, what are the opportunities presented and what are the risks of moving / not moving the industry forward

Session Chair - Magnus Callavik

Evolving Capability and Need of Grid Forming Control
Conference Room 4&5
Colin Davidson, Consulting Engineer GE Renewable Energy
Editorial Presentation
Grid forming converters are already available and used in HVDC schemes designed to import power from offshore wind farms. However, with the rapid growth in converter-fed generation (mainly from wind and solar) and the consequent reduction of traditional rotating machines, grids face increasing stability risks. Existing designs of grid-forming converters cannot be used in conjunction with other grid-forming converters or synchronous machines and therefore cannot be used for the onshore AC grids. There is therefore a pressing need to develop enhanced grid-forming converters with additional functionality, which will enable new HVDC converters to provide a fault response that is more similar to that provided by synchronous machines, while still respecting the need to keep transient currents within the limits of the IGBT capability.

Session Chair - Mike Barnes

12:05 - 12:10

Q&A
Auditorium B

Q&A

Q&A

12:10 - 13:10

Session 3A: Operation and Testing Considerations for HVDC Systems
Auditorium B
Technical Paper Presentation
Session Chair - Sara Walker

[3a.1]
A Health Index Based Remaining Useful Life Estimation Method for Distribution Switchgear in Power Grids
Nan Zhou, Yan Xu, Sungin Cho, Cheng Tian Wee

[3a.2]
Electrical Design for the Conversion of Existing UK HVAC Overhead Lines to HVDC Operation under Severe Pollution Conditions, Ranging from 170 to 500 kV DC
Davide Pinzan, Manu A. Haddad, Oliver Cwikowski

[3a.3]
On HVDC Protection IED Testing: Challenges and Outlook
Muhammad Haroon Nadeem, Willem Leterme, Mudar Abedrabbo, Geraint Chaffey, Dirk Van Hertem

[3a.4]

Session 3B: The Future of HVDC Systems
Auditorium C
Technical Paper Presentation
Session Chair - Magnus Callavik

[3b.1]
Swing Equation Modelling of GFL Inverter and Comparison of its Damping and Inertia with GFM Inverter
Eugenie Ducoin, Yunjie Gu, Balarko Chaudhuri, Timothy Green

[3b.2]
Future Offshore Wind Farm Electrical Networks: A Comparative Framework
Mathieu Kervyn, Debranjan Mukherjee, Anup Nambiar, Michael Smailes, Arijit Banerjee, Paul McKeever

[3b.3]
Towards HVDC Interoperability - Assessing Existence of Equilibrium with Reference to Converter Terminal Behaviour
Dong Chen, Benjamin Marshall, Colin Foote, Suresh Rangasamy, Shangen Tian

[3b.4]

Session 3C: Advanced HVDC Controls to Improve Grid Stability
Conference Room 4&5
Technical Paper Presentation
Session Chair - Mike Barnes

[3c.1]
Limitations on the Virtual Inertia Provision From Grid-Forming-Connected Renewable Energy Sources
Jaume Girona-Badia, Vinícius Albernaz Lacerda, Eduardo Prieto-Araujo, Oriol Gomis-Bellmunt

[3c.2]
Basic Comparison of Primary Control Between Load Frequency Control and Angle-Based Control
Hassan Alhomsi, Franz Linke, Dirk Westermann

[3c.3]
Coordinated Control of VSC-HVDC Synchronous Grid Forming and Grid Following Stations
Carl Barker, John Fradley, Andrzej Adamczyk

[3c.4]

	Inherent Phase-Based Real Inertia Power Response of STATCOM with Supercapacitors During High ROCOF Events in AC Grid Sebastian Schneider, Ralph Morgenstern, Kamil Lipiec, S M Iftekharul Huq	**Small-Signal Stability Analysis of an MMC-Based Bipolar HVDC Link in Grid-Forming Control Mode** Francesco Giacomo Puricelli, Jef Beerten	**Grid Following Converters Stability Study and Control Enhacements Using an Improved Test Setup** Yahya Lamrani, Liang Huang, Frédéric Colas, Xavier Guillaud, Frede Blaabjerg, Carmen Cardozo, Thibault Prevost
13:10 - 14:05	**Lunch, Exhibition and Posters** Level 2 Foyer **The posters are listed at the end of the programme**		
14:05 - 14:25	**Extracting Greater Value from Interconnection, Multi-Purpose Interconnectors** Auditorium B&C Dennis de Decker, Head of Engineering. WindGrid Elia Group Plenary		
14:25 - 14:45	**Plenary Case Study – The Orion Clean Energy Project: Transforming Shetland into a Entirely Secure and Affordable Renewable Energy Island** Auditorium B&C Gunther Newcombe OBE, Energy Hub Project Coordinator. ORION Energy Hub Plenary The vision of the ORION Project is to transform Shetland into a renewable clean energy hub with the export of green hydrogen at industrial scale, providing clean affordable energy to local consumers and helping the oil & gas sector decarbonize. This vision is now becoming a reality with onshore wind providing clean energy onshore and both on and offshore wind being evaluated to provide the energy to produce green hydrogen and hydrogen derivative fuels on Shetland for local use and export. This plenary case study sets out the journey ORION has taken, the achievements to date and plans for the future which will provide valuable insights for other large scale renewable energy projects.		
14:45 - 14:50	**Questions** Auditorium B&C		
14:50 - 15:40	**Panel - Is a Whole System Approach the Way Forward?** Auditorium B&C Priya Bhagavathy, Lead R&D Engineer University of Strathclyde., Dr Alessandra Parisio, Reader of Power and Energy,. University of Manchester, Grace Millman, Senior Energy Analyst, Offshore Sector Lead Regen, Dr Sara Walker University of Newcastle and EPSRC National Centre for Energy Systems Integration Panel Looking forward, decarbonisation will fundamentally transform our energy systems and how consumers use energy and engage with their energy use. Do we really need a “whole system approach” to this huge challenge and why, what we miss out on if policies, regulations, decision-making mechanisms and processes are still based on traditionally separate energy networks? - What are the main challenges and barriers that need to be addressed when adopting a whole-system approach to planning and operating out energy networks and systems? - Can a whole-system approach contribute unlocking the potential flexibility of energy networks and, if so, how? How can a whole-system approach reduce the impact of decarbonisation of the heat and transport networks on the electrical network? How can a whole-system approach be embedded into decision making for network operation? - The development of decarbonisation strategies needs to include both technical and societal implications/barriers of this revolutionary transformation. Can such a transition be achieved without or with limited sustained support and participation from citizens? The changes will affect multiple aspects of people’s lives – from transport, heating and cooking to urban planning and jobs. How people can be incentivised to participate and change their energy behaviour and a “whole-system” approach can positively contribute? What can the key areas of development be? - What is the role played by digitalisation and use of data in this context?		
15:40 - 16:10	**Refreshments, Exhibition and Posters** Level 2 Foyer **The posters are listed at the end of the programme**		

16:10 - 16:30	**The Net Zero Operability Challenge** Auditorium B Beth Warnock, Power Systems Practice Manager . Energy Systems Catapult Editorial Presentation The talk will look at some of the key operability parameters and how they will change in a fully decarbonised system. Areas such as the role of storage and security of supply will be discussed and what it means when we no longer have access to the stores of fossil fuels we have today. Session Chair - Magnus Callavik	**Day in the Life of a 2035 Net Zero Power System** Auditorium C Sophie Whinney Energy Analyst. Regen Session Chair - Vijay Shinde	**Opal-RT Technologies - Title TBC** Jean Bélanger CEO, Opal-RT Technologies
16:30 - 16:35	**Q&A** Auditorium B	**Q&A** Auditorium C	
16:35 - 17:05	**Session 4A** Auditorium B Technical Paper Presentation Session Chair - Magnus Callavik **[4a.1]** **A New Grid-stabilizing Component: A Flywheel Energy Storage System based on a Doubly Fed Induction Generator and Modular Multilevel Matrix Converter** Jonas Kienast, Gino Sturm, Wilfried Hofmann, Steffen Bernet, Martin Pieschel, Ruediger Jansen, Jens Rosendahl, German Kuhn **[4a.2]** **Optimization of String Size in a Large DC Windfarm** Ibrahim Shehu, Dragan Jovcic, Peng Li	**Session 4B** Auditorium C Technical Paper Presentation Session Chair - Vijay Shinde **[4b.1]** **Comparative Assessment of Swarm-Based MPPT Techniques in MPC-Based Single-Stage Grid-Connected PV System** Jubaer Ahmed, Prabhat R Bana, Mohammad Amin **[4b.2]** **Optimal Hybrid Multiplexed AC-DC-AC Power Converters** Matthew Deakin	**Electrical Infrastructure for The Spherical Tokamak For Energy Production** Auditorium C Ioannis Antoniou, Steven Wray Editorial Presentation

The Institution of Engineering and Technology

Posters

[P1]
AC Power System Stability with Voltage Source Converters
Robert H. Renner

[P2]
Comparative Research on DC Braking Choppers for VSC-HVDC with Offshore Wind Farms
Chengyi Wu, Xiao-Ping Zhang, Xiaoyao Zhou, Dechao Kong

[P3]
Analysis and Extension of Switched Inductor and Capacitor-Based High Gain DC-DC Boost Converter with Flexible Control at Higher Gains
Atif Iqbal, Md Samiullah, Mohammed Al-Hitmi, Abdulla Mohsin A B Al-Wahedi

[P4]
Modelling and Evaluation of the Benefits of Coupling Wind-Solar-Coal Systems in an Annual Bilateral Trading Environment
Guoliang Bian, Peng Liu, Qingchun Li, Yiqun Meng, Chuang Liu, Ye Zhang, Wenjian Liu, Miao Liu

[P5]
A Unified Fault Analysis Framework for MMC VSC-HVDC Scheme
Li Zou

[P6]
System Stress With Expanded Use of Interconnectors in the Transition to Net-Zero
Susan Scholes, David Greenwood, Ilias Sarantakos, Sara Walker, Philip Taylor

[P7]
High Gain DC-DC Switched Inductor Multilevel Boost Converter to Enable Transformer less Grid Connection for Wave Energy
Abdulrahman Alsafrani, Mahmoud Shahbazi, Alton Horsfall

[P8]
Improving Resilience of Islanding Protection - Implementation of a Q-f Droop for Inverter-Based Generation
Mark Kent, Andrew Peebles, Scott Williams, Ross Hendry, Ricardo Kemp-Garcia, Adam Dysko

[P9]
Enabling the Use of Lower Current-rated SiC MOSFET Devices in Large-current Power Converters by Paralleling Multiple H-Bridges in the Sub-Modules
Chuantong Hao, Paul Judge, Stephen Finney, Michael Merlin

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[P10]
Median Valve Submodule Voltage Control of MMC VSC for Energy Management Application
Kassem El Cheikh Ali, Pablo Briff, Andrzej Adamczyk, Omar Jasim

[P11]
Frequency-Domain Component Models for HVDC Protection Studies
Mudar Abedrabbo, Willem Leterme, Dirk Van Hertem

[P13]
Impedance Assessment of Offshore Wind Farms
Nikhil Sharma, Shangen Tian, Dong Chen, Ben Gomersall, Benjamin Marshall

[P14]
Dynamic Rating of HVDC Interconnectors
Tamás Borbáth, Geraint Chaffey, Abhimanyu Kaushal, Dirk Van Hertem

[P15]
Partially Underground Transmission Circuits: Safety Issue for Current and Future Power Systems
Himanshu Negi, Andrew Leith

[P16]
Iterative Simulation for Protective Relays Closed Loop Testing Using EMTP-ATP and CM Engine
Renzo Fabián, Paulo Godoy, Guilherme Justino, Jonas Pesente

[P17]
Active Filter Control Based On Single-Delta Bridge-Cell Modular Multilevel Converter
Taoufik Qoria, Ibrahim Elsabrouty, Emre Durna, Matthias Ruß, Raul Santiago Munoz Aguilar

[P18]
Multi-port Modular Multilevel Converters for the Supply of the Future Circular Collider Two-Stage Klystrons
Manuel Colmenero, Ricrdo Vidal-Albalate, Francisco Rafael Blanquez Delgado, Ramon Blasco-Gimenez

[P19]
Economic Value of Inertia Support From HVDC System
Abhimanyu Kaushal, Hakan Ergun, Dirk Van Hertem