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Guest Editorial

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This Special Issue *IET Generation, Transmission and Distribution* is dedicated to selected papers from one of the flagship conferences of the IET: The IET AC/DC conference. The IET AC and DC Power Transmission Conference and Workshop has been one of our most successful international events and the 11th edition was once again attended by over 225 delegates.

The two day conference covered a wide range of subjects along three tracks: "Recent projects and present technology", "Future innovation and international projects" and "Real implications and applications". There were two well-attended workshops on the third day covering typical modular multi-level converter (MMC) topologies, future grid operation with HVAC and HVDC as well as discussions on an integrated approach to offshore wind development.

From all the papers that were presented at the conference, a selection of 20 papers was made for this Special Issue. Based on the papers and the presentations, session chairs nominated 22 "best papers" in their session which would be invited to publish an extended version in this Special Issue. 16 papers were submitted, and 9 of them are currently presented in this Special Issue.

All submitted papers focussed on voltage source converter (VSC) HVDC applications, with five papers covering system modelling and control aspects and four papers focussing more on technology/components and their modelling.

Systems aspects of VSC HVDC

Within the system aspects, three groups of papers have been selected. The first group of papers investigates the behaviour of HVDC converters connected to (weak) AC systems and the occurring interactions. Suul *et al.* investigate how the introduction of a virtual impedance in the design of the Phase Locked Loop (PLL) can extend the stability range of the system, both for the maximum power capacity and for the small signal stability of the connection. Zhou and Gole review the maximum available power (MAP) definition and this for both line commutated converter and voltage source converter HVDC. Bayo Salas *et al.* investigate the control interactions and interferences in AC systems with several VSC converters connected close to each other, as well as the control interactions with the AC network in the frequency domain using the admittance-based stability assessment.

The second group of system studies consists of two papers, investigating the controller interactions in VSC HVDC grids. Akkari *et al.* focuses on the interaction between two droop controllers within the DC converter: the frequency droop and voltage droop controller. Barker *et al.* shows that while voltage droop control for HVDC grids has been widely accepted, with various variants being proposed, the potential exists for undesired control interactions and the paper proposes a method which avoids future interactions.

Components for HVDC grids and their modelling

Four papers were selected that investigated the modelling or design of components in HVDC systems.

Lian *et al.* provides the modelling of a DC/DC converter with multiple modules which can be used to efficiently collect the energy from a wind farm on low voltages and transmit it at higher voltage. The paper proposed the appropriate controllers for the converter, both during normal operation and faults.

Beerten *et al.* proposes a new model for cables which can be used for small signal analysis. The proposed model allows a state-space representation of the cable system which is superior to the often used pi-section model, by accounting for the frequency-dependency of the series impedance of the cable.

Zhang *et al.* focuses on the control of the MMC. The authors present a method to decouple the coupling between the AC and DC voltage offset. The paper proposes an asymmetric MMC control and its control system.

The final paper of this Special Issue is dedicated to the design of test methods and envelopes for DC breakers. Cwikowski *et al.* presents a first approach to standardised testing DC breakers and characterising their behaviour. The developed testing envelopes allows for improved specifications for DC breaking equipment.

Summary/Conclusion

All of the papers selected for this Special Issue show the importance of VSC HVDC research in the power sector and specifically the interest in HVDC grid research.

I hope you will enjoy reading the papers and feel inspired by these works to submit your material to the next edition of the IET AC/DC Conference or to *IET Generation, Transmission and Distribution*.

DIRK VAN HERTEM
 GUEST EDITOR

Guest Editorial Board for the Special Issue

Jef Beerten received his M.Sc. degree in electrical engineering and a Ph.D. in electrical engineering from the University of Leuven (KU Leuven), Belgium, in 2008 and 2013, respectively. In 2011, he was a visiting researcher at the Royal Institute of Technology (KTH), Stockholm, Sweden, for three months. From April 2014 until March 2015, he was a visiting postdoctoral researcher at the Norwegian University of Science and Technology (NTNU), Trondheim, Norway. Currently, he is a postdoctoral researcher with KU Leuven and EnergyVille. His research interests include future power system dynamics, modelling, and control. Dr. Beerten is an active member of both the IEEE and CIGRE. Dr. Beerten received the KBVE/SRBE Robert Sinave Award and the Prix Paul Caseau from the Institut de France - EDF Foundation for his Ph.D. thesis on modelling and control of DC grids.

Colin Davidson is Chief Technology Officer - HVDC, at GE's Grid Solutions Business, with overall technical authority for the HVDC Activity, whose Centre of Excellence is in Stafford, UK. He joined the company in January 1989, when it was part of GEC, and progressed through the positions of trainee

Thyristor Valve Design engineer; manager, Thyristor Valves; engineering director and R&D Director, to his current role. He is a Chartered Engineer and a Fellow of the Institution of Engineering and Technology, and has served on several IEC standardisation committees for HVDC and FACTS. He has a degree in natural sciences, specialising in physics, from the University of Cambridge.

Padmanaban Sanjeevikumar received his B.Eng (first class), M.Tech (with distinction), and Ph.D degree in Electrical Engineering from University of Madras (India), Pondicherry University (India), and University of Bologna (Italy), in 2002, 2006, and 2012 respectively. After completing his Ph.D degree he worked as Associate Professor with VIT University from August 2012 to May 2013. Furthermore he joined as

Faculty with National Institute of Technology, Pondicherry, from July 2013 to December 2013. He was invited as visiting fellow at the Department of Electrical Engineering, Qatar University, Qatar from January 2014 to February 2014. He continued his research activities with Dublin Institute of Technology, Ireland from April 2014 to November 2014. Since September 2014 he has been Project Head in Research & Development and Consultant with Ohm Technologies, Chennai, India.

He has published scientific papers in the field of power electronics, with particular reference to multiphase and multilevel converters. He has received the Most Excellent Research Paper Award of IET-4th International Conference on Sustainable Energy and Intelligent System in 2013.

Dirk Van Hertem graduated as a M.Eng. in 2001 from the KHK, Geel, Belgium and as a M.Sc. in Electrical Engineering from the KU Leuven, Belgium in 2003. In 2009, he obtained his PhD, also from the KU Leuven. In 2010, Dirk Van Hertem was a member of EPS group at the Royal Institute of Technology (KTH), in Stockholm. Since spring 2011 he has been back at the University of Leuven where he is an assistant

professor in the ELECTA group. His special fields of interest are power system operation and control in systems with FACTS and HVDC and building the transmission system of the future, including offshore grids and the supergrid concept. He is an active member of both IEEE (PES and IAS) and Cigré.

Xiao-Ping Zhang is a Professor of Electrical Power Systems, Director of Smart Grid, Birmingham Energy Institute, and Co-Director of Birmingham Energy Storage Centre sponsored by UK, and Head of the Electrical Power & Control Systems Group.

Xiao-Ping has published over 100 research papers in scientific journals, conference proceedings as well as reviews, five books and book chapters in the fields of Energy

Union, Global Power & Energy Internet, Super Power Grids, Smart Grids, modelling and control of FACTS and HVDC, renewable generation (wind and wave) control, integration of PHEVs into power grids, energy markets & game theory applications, smart metering, distributed energy management and services for homes and buildings and wide area grid awareness. He has received major grants from UK Government Science City Initiative, FP7 EU Smart Energy Network (Smart Grid) Programme, EPSRC and Industry etc. In 2010, he initiated the UK-China Smart Grid Workshop series, which has led to 13 UK-China joint research projects on smart grid, electric vehicles and energy storage. In June 2011, he proposed the concept of “Global Power & Energy Internet” in the CIGRE Workshop held at the University of Birmingham. He pioneered the concept of “Energy Union”, which has been adopted by European Commission. He also pioneered the vision and concept of Midlands as the UK’s “Energy Valley” where this became true with the establishment of UK’s Energy Research Accelerator and UK’s Energy Systems Catapult in the region.

Dr. Kai Zhou received a B.Sc in Physics from the University of Science and Technology of China, China, in 2005, and a Ph.D. in Physics from the Electrical Insulation Research Center, University of Connecticut, USA in 2011. He then joined R&D, G&W Electric Co., Bolingbrook, IL, US, as a product development engineer, where he has been working on the research and development of transmission level AC/DC products.

Kai is currently serving the IET *Generation, Transmission and Distribution* Editorial Board as Associate Editor. He is also a member of IEEE DEIS/PES/SA and a senior member of the Insulated Conductor Committee. He has been serving the IEEE Dielectrics and Electrical Insulation Society for several years as Administrative Committee Member and Membership Chair. He is also involved in many international conferences as Technical Committee Member and Session Chair.