Invited Speaker: Dr Khaled Ahmed, University of Strathclyde, Glasgow, UK

Biography: Dr Khaled Ahmed received the B.Sc. and M.Sc. degrees from Alexandria University, Egypt in 2002 and 2004, respectively. He received the PhD degree in power electronics applications from the Electronic and Electrical Engineering Department, University of Strathclyde, UK, 2008. In 2011, he was appointed as a Lecturer in Power Electronics at the University of Aberdeen, and was promoted to Senior Lecturer in 2015. Currently, He is a Reader (Professor) in power electronics at the University of Strathclyde (PEDEC Group). He has over 19 years of research experience in power electronics, renewable energy integration, solar energy systems, off-shore wind energy, smart grids, DC/DC Converters and HVDC. He has won funding of £4.4 million as Primary and Co-Investigator on projects funded by EPSRC, the EU, KTP, the British Council, the Royal Society, the Carnegie Trust, the Scottish Funding Council, the Oil and Gas Technology Centre, and industry (Rolls-Royce, Scottish Power, and Scottish and Southern Energy). He has supervised 23 PhD students; 15 have graduated and the others are ongoing. Dr Ahmed has published over 150 technical papers in refereed journals and conferences, 1 book, 1 book chapter, and a patent (PCT/GB2017/051364). Total citations of 5060 and h-index of 27. Two of his journal papers are rated in the top 1% of those cited in the academic field of Engineering (Web of Science). He is a senior member of the Institute of Electrical and Electronics Engineers (IEEE) Industrial Electronics and Power Electronics Societies, IET member, Chartered Engineer, and Senior Fellow of Higher Education Academy (HEA). He serves as a Co Editor-in-Chief of Elsevier Alexandria Engineering Journal, and as an Associate Editor of IEEE Open Journal of the Industrial Electronics Society (OJIES), and IEEE Access.

DC Transmission Systems: Developments, Opportunities and Challenges

Summary:

DC grid is a promising choice for future DC transmission system. It can be defined as a DC transmission network, which includes more than two terminals with at least one meshed DC line. With DC grids there are multiple power-flow paths between two grid terminals. Power flow between two DC grid terminals may not be affected (or partially affected) by tripping a single DC line. DC grids will require some protection technology in order to isolate faulted lines/units allowing remaining part of the grid to continue power transfer. Normally, any number of new terminals can be added to an existing DC grid.

It is expected that DC grids will eventually evolve into large meshed networks, which will inevitably have multiple DC voltage levels. A DC-DC converter will be needed in order to connect two DC grids operating at different DC voltage levels. One evident DC-DC application is to connect DC cables (which have DC voltage up to 600 kV) with overhead DC lines, which may have a higher DC voltage. The existing HVDC (high-voltage direct-current) links have wide range of highly optimized DC voltage levels and their possible integration into the DC grid will require DC-DC converters. It is also expected that medium-voltage DC grids, either distribution or collection systems (like those with offshore wind farms) will rapidly develop following acceptance of DC transmission grids, and their connection to DC transmission will require high-stepping ratio DC-DC converters. This role is similar to a transformer function in traditional AC systems.

Nevertheless, even in a DC grid with a single nominal DC voltage there might be a need for DC-DC converters in order to regulate the power flow in some cables or DC voltage level at some

nodes. These DC-DC converters may have low stepping ratio and perform a similar function to tap-changing transformers and phase-shifting transformers in AC systems. The power flow in DC grids will be primarily controlled using AC/DC converters located at grid terminals (connecting points with external AC grids).

The main objective of the talk is to discuss the DC transmission systems including developments, opportunities and challenges. The talk will discuss DC transmission operation, control and interactions with AC systems. The interactions of voltage source HVDC with AC systems through controls and harmonics will be analysed. The connection between VSC (Voltage Source Converter) and LCC (Line Commutated Converter) DC systems will be analysed via DC-DC converters. The talk covers also the latest modular multilevel converter based DC-DC converter topologies. AC and DC faults analysis for different DC-DC converter technologies will be presented. The talk is supported with simulation on MATLAB/SIMULINK software and practical prototype results.