Tutorial on

Integration of Large Renewable Energy Sources

Abstract of Tutorial

As large renewable power plants tend to be located far from consumption centres, integration of the power collected from these power plants represent a major challenge. For example, the electrical outputs of these renewable power plants could be DC or AC voltage with magnitude and frequency which are incompatible with the AC grids. Therefore, power electronic interfacing is needed to decouple the AC grids from the power plants, control active and power exchange with AC grid, and assist renewable power plants to ride-through different AC and DC network faults. The current state of the art in commercial high voltage direct current (HVDC) link technology is current based HVDC or voltage based HVDC. Most existing DC transmission systems are based on current source thyristor converter technology because thyristor devices have low losses and are available in robust high current capacity single wafer capsules. On the other hand, thyristors inject significant low frequency harmonics, which must be eliminated by large passive filtering, cannot decouple the real and reactive power injected into the network, and require large passive components leading to large footprint systems. HVDC transmission systems based on voltage source converter were developed to address the shortcomings associated with HVDC transmission systems based on current source. The most known commercial technologies are ABB HVDC Light technology, Siemens HVDC PLUS and Alstom HVDC MaxSine. The main objective of the tutorial is to investigate the HVDC systems with clarifying different topologies advantages and disadvantages. The current, future, and challenges of HVDC systems will be covered. The tutorial will study integration of large renewable energy sources, operation, control and interactions with AC systems. The interactions of current source and voltage source HVDC with AC systems through controls and harmonics will be analysed. The tutorial covers also the latest modular multilevel converter based HVDC topologies. AC and DC faults analysis for different HVDC technologies will be presented. The tutorial is supported with simulation on MATLAB/SIMULINK software.

Organized by:

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Dr Khaled H. Ahmed received the B.Sc. and M.Sc. degrees from Alexandria University, Egypt in 2002 and 2004, respectively. He received the Ph.D. degree in power electronics applications from the Electronic and Electrical Engineering Department, University of Strathclyde, UK, 2008. He has been appointed as an Assistant Professor at Alexandria University, Egypt in 2008. He was a Research Fellow at the University of Strathclyde, UK from 2009 to 2011. Currently Dr. Ahmed is a Senior Lecturer in Power Electronics at the University of Aberdeen, UK, where he was a Lecturer from 2011 to 2015. He is a senior member of the IEEE industrial and power electronics societies. He has over 14 years of research experience in electrical power engineering, particularly in renewable energy integration, distributed generation, digital control of power electronic systems, solar energy systems, offshore wind energy, DC/DC converters, smart grid and HVDC. He is the guest Editor-in-Chief and Editorial Board member for IET power electronics journal and Electric Power Components and Systems Journal, International Journal of Renewable Energy Technology, Innovative Engineering Journal, and Journal of Control Science and Engineering. Dr Ahmed has published over 80 technical papers in refereed journals and conferences, 1 book, and 1 book chapter. Total citations of 1615 and h-index of 19. He has been PI/CI on Encompass, EU, EPRSC, Royal Society, Carnegie Trust, British Council, and industrially funded research grants, with total value of £1.8 million. Recent funding included the EPSRC grant “DC Networks with DC/DC Converters for Integration of Large Renewable Sources” EP/K006428/1 (£734,786) with Chinese partners and EU Project, “Smart Grid Technology”, €626k, 2016-2019. Dr. Ahmed has supervised 9 PhD students; 6 have graduated and the others are ongoing. He was a part of a 2-lecturer team who designed and delivered a continuing professional development (CPD) course on HVDC for the Scottish and Southern Energy (SSE) HVDC technology engineering team, UK.