The IEEE Dielectrics and Electrical Insulation Society Workshop on Smart Grid Technologies

Written by Victoria Catterson and James Pilgrim

Smart grid technologies are changing the way we utilize high voltage assets, with a consequential effect on asset management practices and maintenance planning. At the same time, smart grid technologies present an opportunity for improvements in asset performance, through better materials, more sensors, and online data processing for monitoring and control. The IEEE Dielectrics and Electrical Insulation Society (DEIS) addressed this topic through a workshop at the Electrical Insulation Conference in June 2015, held in Seattle, USA.

The major applied research conference of the IEEE DEIS is the annual Electrical Insulation Conference. The day before the conference in June 2015, a full day workshop was run on The Impact of Smart Grid Technologies on Plant Health, with seven speakers on diverse topics under this theme. The workshop was attended by a mixture of graduate students and active researchers, and a panel discussion identified further activities where the DEIS Technical Committee on Smart Grids could focus their efforts.

The workshop was chaired by Victoria Catterson from the University of Strathclyde, and covered two broad topics. The first was the potential for the smart grid to bring *improved devices*, through self healing capabilities, and novel sensing technologies to achieve self managing systems. The second topic was *new usage patterns*, where the operation and maintenance of traditional assets has to adapt to accommodate changes to load profiles and ratings, and new methods of modelling asset health and deterioration.

Looking first at novel devices, HVDC has a crucial role to play in transporting power over long distances, such as from off-shore wind farms. The monitoring and maintenance of these assets is critical to the cost-effectiveness of the technology. Jerome Castellon of the Université de Montpellier discussed a critical difference between HVDC and AC cable systems as being the accumulation of space charge under the DC field, which can lead to extreme electric field distortions in service, and thus early failure of the cable.

Jerome presented on techniques for measuring space charge developed by his team. Discussion with the audience revealed that as yet there is no method of monitoring the condition of cable accessories, and that this is a massive challenge for currently deployed subsea high voltage cables.

Peter Morshuis of Delft University of Technology introduced the potential for special dielectric materials to harvest power from ocean waves. Energy in the wave is converted to electrical energy through the deformation of an electro-active polymer, a material which changes in size or shape in response to electric field. Some challenges for building a commercial solution include finding a material which can maximise energy density, and how to bond electrodes to such a material.

Kaori Fukunaga from the National Institute of Information and Communication Technology gave a summary of recent work by the Institute of Electrical Engineers of Japan on electromagnetic compatibility (EMC) issues. The increased number of devices, and particularly power electronics-based devices, associated with smart networks leads to more potential for

for inadvertant or malicious interference. The appropriate standards were summarised, and a significant gap identified as being the sub-150kHz bands.

On the second topic area of new ways of utilising existing assets, James Pilgrim from the University of Southampton identified the changing load patterns in distribution networks, and the resultant effects on network assets. Factors such as embedded renewable generation and electrification of transport can lead to bi-directional current flows and generally increased loading, which in turn increases temperatures of transformers and cables, and accelerates their aging. One avenue of research is to improve the models used for asset management, to take account of these new aging effects.

However, automation within the smart grid may also be the solution to this problem. James highlighted the potential for demand side management to be used for peak shaving, which flattens out the load profile and correspondingly reduces the aging effects on assets. In either case, increased levels of condition monitoring would be beneficial, to gain greater visibility of asset health.

Another changing parameter within networks is the level and type of harmonics present. Gian Carlo Montanari from the University of Bologna highlighted the aging effect of non-conventional voltage waveshapes on cables, transformers, and rotating machines. If harmonic data were used as an input to an asset health scoring system, the condition assessment would be more accurate, which would enable better decision-making. A point raised in the discussion was that standard health scoring systems may be too simplistic in the way they combine sub-component health, and further research is needed into the link between monitoring and asset management as a whole.

Brian Sparling from Dynamic Ratings Inc. spotlighted new NERC requirements for generators to report their operational capability every 10 minutes. This essentially requires real time condition assessment for all assets critical to plant functionality, in order to determine normal and emergency ratings for the plant. This can be enabled by condition monitoring, but careful consideration of the visualisation of data is also essential for situational awareness.

The workshop finished with an open discussion of the areas where DEIS should be addressing smart grid topics, and which should be focus areas in the coming months. It was recognised that the society must have good links with others, such as IEEE PES and CIGRE, while avoiding overlap. The topic of smart materials is a natural fit for the DEIS even if not commonly considered as a smart grid topic more generally. One recurrent theme was the need for improved models of asset deterioration, and from that a call for open datasets which would make scientific advances in asset models faster and easier to verify. These ideas will now be taken forward to the DEIS Technical Committee on Smart Grids to plan the next focus activities.

Dr Victoria Catterson is the National Grid Lecturer in Condition Monitoring at the Institute for Energy and Environment, University of Strathclyde, Glasgow, Scotland. She received her B.Eng. (Hons) in 2003, and a Ph.D. degree in transformer diagnostics in 2007, both from Strathclyde. Since then, she has worked on the application of intelligent system techniques to diagnostics and prognostics of power assets, including transformers, circuit breakers, and cables. She has published

over 40 technical papers in the field of diagnostics and health analysis for the power industry, and currently serves as the Chair of the IEEE DEIS Technical Committee on Smart Grids. She is also a member of the IEEE Power and Energy Society, and serves on the Cigre Working Group on Intelligent Transformer Monitoring A2.44.

Dr James Pilgrim is a Lecturer in Electrical Power Engineering at the Tony Davies High Voltage Laboratory, University of Southampton. He received the BEng (Hons) degree in Electrical Engineering from the University of Southampton in 2007, subsequently gaining his Ph.D. degree for work on the modelling of high voltage cable systems in 2011. He joined the academic staff of the University in 2012. His research interests include of aspects of high voltage cables and their interaction with the power network. He has published over 50 technical papers in the field of high voltage assets. He is a member of the IEEE Power and Energy Society, represents the United Kingdom in Cigre Working Groups B1.35 and B1.50 and is a member of IEC TC 20 WG 19.