Fiber-Optic Sensing for Power and Energy Industries

Dr Pawel Niewczas, *University of Strathclyde, Glasgow, UK*

Optical sensors and photonic devices have technically matured to the point that they are increasingly considered as alternatives for their electronic counterparts in numerous applications across industry. In particular, the utilization of optical sensors has been considered for harsh, high-voltage or explosive environments where conventional transducers are difficult to deploy or where their operation is compromised by electromagnetic interference. This tutorial will explain the motivation for research on fiber-optic sensors, highlight the basic theories underlying their operation, and present selected examples of R&D projects carried out within the Advanced Sensors Team in the Institute for Energy and Environment at the University of Strathclyde, Glasgow, UK, targeting a range of industrial applications. The goal is to highlight great potential of optical sensors and to enrich recipients' experience in instrumentation and measurement using alternative, non-electronic methods. Alternatively, for audiences with greater photonics sensors awareness, the presentation can be tailored to solely focus on reporting the most recent progress in fiber sensing research for power and energy industries carried out within the team. In this instance, it will highlight specific examples of the measurement needs within the power and energy sectors and report on the novel approaches in fiber sensing to address these needs. In particular, it will discuss such applications as downhole and subsea electrical plant monitoring; distributed voltage and current measurement for advanced power system control and protection; magnetic field monitoring in the context of thermonuclear fusion research; and, measurement of the loss of loading within concrete prestressing steel tendons in nuclear power plant applications. As the potential good solutions to these respective measurement needs, this tutorial will introduce such emerging technologies as the hybrid fiber Bragg grating (FBG) voltage and current sensors; novel solid-state FBG interrogation schemes utilizing wavelength division multiplexing (WDM) and time domain multiplexing (TDM) architectures (not requiring tunable spectral filters or lasers); and novel FBG sensors and interrogation schemes utilizing some promising intrinsic sensing mechanisms capable of measuring such quantities as magnetic and electric fields.