

Domain Knowledge and Data Analytics: Towards a Holistic Approach to Power System Condition Monitoring and Asset Management

Current challenges faced in the operation and maintenance of legacy power systems are among the greatest in a generation with integration of renewables and decarbonisation of heating and transportation systems altering both the characteristics of end use demand and the performance envelope of network assets. Coupling this with regulatory enforcements on reliability and extreme weather events, precipitated the need for higher resolution condition monitoring data to remove the burden and uncertainty associated with sporadic testing of plant. However, with condition monitoring data is the need to understand the nature of the measurement with respect to plant health and to identify the artefacts associated with incipient degradation, which in turn requires detailed expert knowledge of the physical system coupled with the understanding of data models for reducing monitoring data to a manageable set of unknowns. Joining this with facilities to simulate plant operation and failure in a controlled and safe environment represents a powerful toolset for the development of diagnostic and prognostic methods to support proactive asset maintenance strategies and decision support. Challenges still remain though: domain expertise can be lost through staff retirement and general attrition, modern data analysis techniques reach beyond the bounds of orthodox statistics and understanding the physical modes of plant degradation require in depth knowledge of the physical and chemical changes encountered. To illustrate the routes to addressing these problems, case studies involving the testing of novel plant monitoring systems, the elicitation of domain knowledge from experienced engineers and the application of machine learning techniques to intensively condition monitored plant is presented. Generation, transmission and distribution assets are covered with commentary on the applicability to mobile and future power systems.