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Energy System Analysis Using Data-Driven Modelling and Bayesian Methods

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Abstract : The dynamic performance of all energy generation technologies is impacted to varying degrees by the stochastic properties of the wider system within which the generation technology is located. This stochasticity can include the varying nature of ambient renewable energy resources such as wind or solar radiation, or unpredicted changes in energy demand which impact upon the operational behaviour of thermal generation technologies. An understanding of these stochastic impacts are especially important in contexts such as highly distributed (or embedded) generation, where an understanding of issues affecting the individual or aggregated performance of high numbers of relatively small generators is especially important, such as in ESCO projects. Probabilistic evaluation of monitored or simulated performance data is one technique which can provide an insight into the dynamic performance characteristics of generating systems, both in a prognostic sense (such as the prediction of future performance at the project's design stage) as well as in a diagnostic sense (such as in the real-time analysis of underperforming systems). In this work, we describe the development, application and outcomes of a new approach to the acquisition of datasets suitable for use in the subsequent performance and impact analysis (including the use of Bayesian approaches) for a number of distributed generation technologies. The application of the approach is illustrated using a number of case studies involving domestic and small commercial scale photovoltaic, solar thermal and natural gas boiler installations, and the results as presented show that the methodology offers significant advantages in terms of plant efficiency prediction or diagnosis, along with allied environmental and social impacts such as greenhouse gas emission reduction or fuel affordability.

Keywords : renewable energy, dynamic performance simulation, Bayesian analysis, distributed generation
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