Handling variability in electric grid: From theory to deployment

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Abstract

Renewable energy sources offer promise towards solving the impending energy crisis. However, integration of renewable energy sources into a traditional electric grid poses many challenges. One of the fundamental challenges is how to handle non-controllable and fast varying renewable power sources like wind. Traditionally, the electric grid was designed and operated for large, centralized and controllable energy sources, while renewable sources are distributed and often the uncertainty in the power produced is higher.

In this talk I will present two solutions to tackle the variability problem. In the first part of my talk, I will describe the theory, analyses methods and tools to study a system that has variable generation sources. The approaches suggested in the past for modeling uncertainties in the electric power system are either probabilistic, or to use computer simulation. Both approaches have drawbacks when applied to systems with variable sources and loads: the key challenges are that, in the case of probabilistic modeling, not all uncertainties in the electric grid can be represented by a probability density function, and for simulation based studies, there often aren't enough data points to span the entire sample space. In this talk I will present an alternate modeling approach based on interval method of analysis, which allows derivation of strong upper and lower bounds for reliable operation which can then be used to determine design boundaries.

In the second part of my talk, I will present a design and deployment of a large scale electric utility system that is mostly powered by wind energy. The electric utility is responsible to meet the demand every instant while maintaining the supply voltage and frequency constant. This is challenging if there is significant amount of generation sources like wind that is variable and whose power output cannot be completely controlled. In order to overcome this challenge, I proposed the idea of using batteries in electric cars as temporary storage to balance out wind power variation. Although this idea is easy to comprehend, many engineering challenges had to be overcome for this

idea to be adopted into practice. I will discuss these challenges and present the architecture we proposed for the Danish electric system which is currently under deployment.

Finally, I will give an overview of the open challenges specifically related to renewable power and smart grid and provide some insights into the future trends and directions.

Bio

Divya obtained her PhD degree from Indian Institute of Science, India in 2006. At present she is a Systems Engineer at Corporate Technology, Siemens Corporation and prior to this she worked as a Research Scientist at GE Global Research Centre and as a post doctoral researcher at Technical University of Denmark.

In her academic and industrial projects she has conceived, researched and developed new technologies, and control systems that would allow reliable operation of an electric grid having large amounts of wind or solar power sources. Some of these technologies are in operation today.

She has one issued US patent and several publications in peer reviewed journals and conferences and a book chapter in Energy Storage Ed. Marc A. Rosen. She is the sole editor of upcoming book on Wind Power: Recent Developments, Physical/Technological Limitations and Impacts on Power System. She is involved in the IEEE 1547.8 standards activity, she is the co-editor for the IEEE e-newsletter on "Transportation Electrification" and is also a reviewer for many journal in the area of power and energy systems including IEEE transactions. She received Technical Achievement award at GE in recognition for her contribution to the development of WindINERTIA product.

Faculty Host: Ricardo Bianchini