Renewable Integration Through Risk-Limiting Dispatch And Distributed Resource Aggregation

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Project objective

The research develops two approaches for aggregating intermittent power generation (such as wind and solar) with reserves of different types, including fast-responding generation, electric storage, and demand response.

The first approach extends current dispatch rules to create a dynamic portfolio of generation resources that collectively behaves as reliably as dispatchable thermal generation, while minimizing the cost of reserve generation and capacity and maintaining the risk of imbalance below a pre-specified acceptable level. The approach makes the optimum use of probabilistic forecasts and the opportunities offered by multiple decision stages: day-ahead, 6-hours ahead, 1-hour ahead, etc. The analysis reveals the advantage of additional decision stages and better forecasts.

The second approach focuses on aggregating distributed energy resources in a manner that makes use of the flexibility in certain loads in terms of their deferability with forecasts of renewable resources and loads. The analysis reveals that appropriate coordination (scheduling) of loads can significantly reduce distribution system losses, and reduce the need for reserve generation and transmission capacity in the grid.

Major technical accomplishments that will be completed this year (FY 2012)

The first approach is developed in a series of studies on “risk limiting dispatch (RLD).” The studies show that the cost of reserve energy and capacity can be significantly reduced by additional intra-day markets for energy and capacity and by better probabilistic forecasts. Numerical examples show that the savings are considerable. These studies however do not take into account transmission constraints and unit commitment.

The second approach was developed under two scenarios. The first considers a set of tasks (loads) each of which must be served before a specified deadline, using (free) variable renewable power or (expensive) grid power. The study shows significant advantages from coordination of loads to match renewable power. The second scenario considers decomposing variable renewable power into “slices” of power of varying reliability, with each slice priced separately. The study analyzes how the prices of power of variable reliability can be formed, and compares the allocation with what is achieved by ‘real-time’ pricing.

Deliverables and schedule for activities to be completed under FY2012 funding

At least four papers documenting the results will be published.

Risk factors affecting timely completion of planned activities

The publication of one or two papers may be postponed because of journal editorial delays.

Early thoughts on follow-on work that should be considered for funding in FY2013

We would like to explore three research directions that appear to be very fruitful in the light of current work:

1. Extension of risk limiting dispatch to include transmission network constraints. Quantify the benefits of better forecasts.
2. Study more fully the benefits for the distribution system and the grid of coordination of distributed renewables and loads in the distribution system. Benefit metrics include distribution vs transmission system utilization; losses; variability of power demand at the sub-station.
3. Analyze several contractual mechanisms to support demand-supply coordination. The analysis will be concerned with communication and computational complexity for coordination.