Integrating Renewables into Power Systems

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Hamid Elahi
Large scale renewable studies by GE

These studies were commissioned by the Energy Commissions and ISOs of each region...

- Examining the Feasibility of 100+ GW of new wind and other renewable resource additions
- Considering Operability, Costs, Emissions, Transmission Constraints, Forecasting

Each successive study has raised the threshold for acceptable penetration of wind and solar

2004 New York:
3 GW Wind
10% of Peak Load
4% of Energy

2005 Ontario:
15 GW Wind
50% Peak Load
~30% Energy

2006 California:
13 GW Wind
3 GW Solar
5 GW Bio & Geo
26% Peak Load
15% Energy (33% Total)

2007 Texas:
15 GW Wind
25% Peak Load
17% Energy

2008-9 Western Wind & Solar:
(all of Western US)
72 GW Wind
15 GW Solar
50% Peak Load
27% Energy
**New England Wind Integration Study**

“To determine the operational, planning, and market effects of large-scale integration of utility-scale wind power as well as mitigation/facilitation measures available to ISO-NE and to make recommendations for the implementation of mitigation/facilitation measures.”

**Scenarios**
- Years 2015 and 2020
- Up to 20% total energy from wind resources
- Up to 12 GW total wind generation

**Types of Analysis**
- Statistical analysis
  - Variability, extreme events
  - Hourly, sub-hourly
- Production simulation analysis, MAPS
- Reliability analysis, MARS
- Sensitivity analysis

**Generation & Load**
- 400 existing conventional power plants
  - 40% gas, 25% oil, 15% nuclear, 10% hydro, 10% coal.
  - Fuel; heat rate; emissions, ramp rate; start/stop
- 26 GW Peak load in 2008
  - 32 GW peak projected for Year 2020

**Project**
- 15 months duration, completion in July 2010
- Collaborative effort with Enernex and AWS Truewind

Wind Data:
- Builds on sites from NREL Eastern Wind Interconnection Study
- Augmented with sites in NE-ISO Generation Queue
- Flexibility to select additional sites elsewhere in New England
Major Study Results:

Large interconnected power systems can accommodate variable renewable generation (Wind + Solar) penetration levels exceeding 25% of peak loads.

**But not by doing more of the same.....**

To reach higher levels of wind generation and other renewables:
- Reinvest in infrastructure
- Implement balanced market rules
- Incentivize owners and operators to better utilize technology and assets

The debate has changed:
No longer: “Is it possible?”
Now: “How do we get there?”
Lessons learned

Higher levels of wind generation penetration increase need for:

- Transmission reinforcement
- Wind forecasting
- Operational flexibility of the balance of the generation portfolio
  (Quick Start + Faster Ramp Up/Down + Lower Turn Down + Load Following)
- New operating strategies during light load hours & other high risk periods
- New ancillary services rules & incentives for ALL technologies
- Coordination across neighboring control areas
- Deployment of modern grid-friendly Wind and Solar Power Plants

Policy and market structures ... key to successful integration of wind and other renewables
Wind Study References

California Energy Commission’s Intermittency Analysis Project Study
“Appendix B - Impact of Intermittent Generation on Operation of California Power Grid”

New York State Energy Research and Development Authority’s “The Effects of Integrating Wind Power on Transmission System Planning, Reliability, and Operations”:

Ontario Power Authority, Independent Electricity System Operator, Canadian Wind Energy Association’s “Ontario Wind Integration Study”:

Electrical Reliability Council of Texas, “Analysis of Wind Generation Impact on ERCOT Ancillary Services Requirements”:

NREL, “Western Wind and Solar Integration Study“, Presentations for Stakeholder Meeting 8-14-08
http://wind.nrel.gov/public/WWIS/stakeholder%20meetings/8-14-08/