

GE
Energy

Integrating Renewables into Power Systems

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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

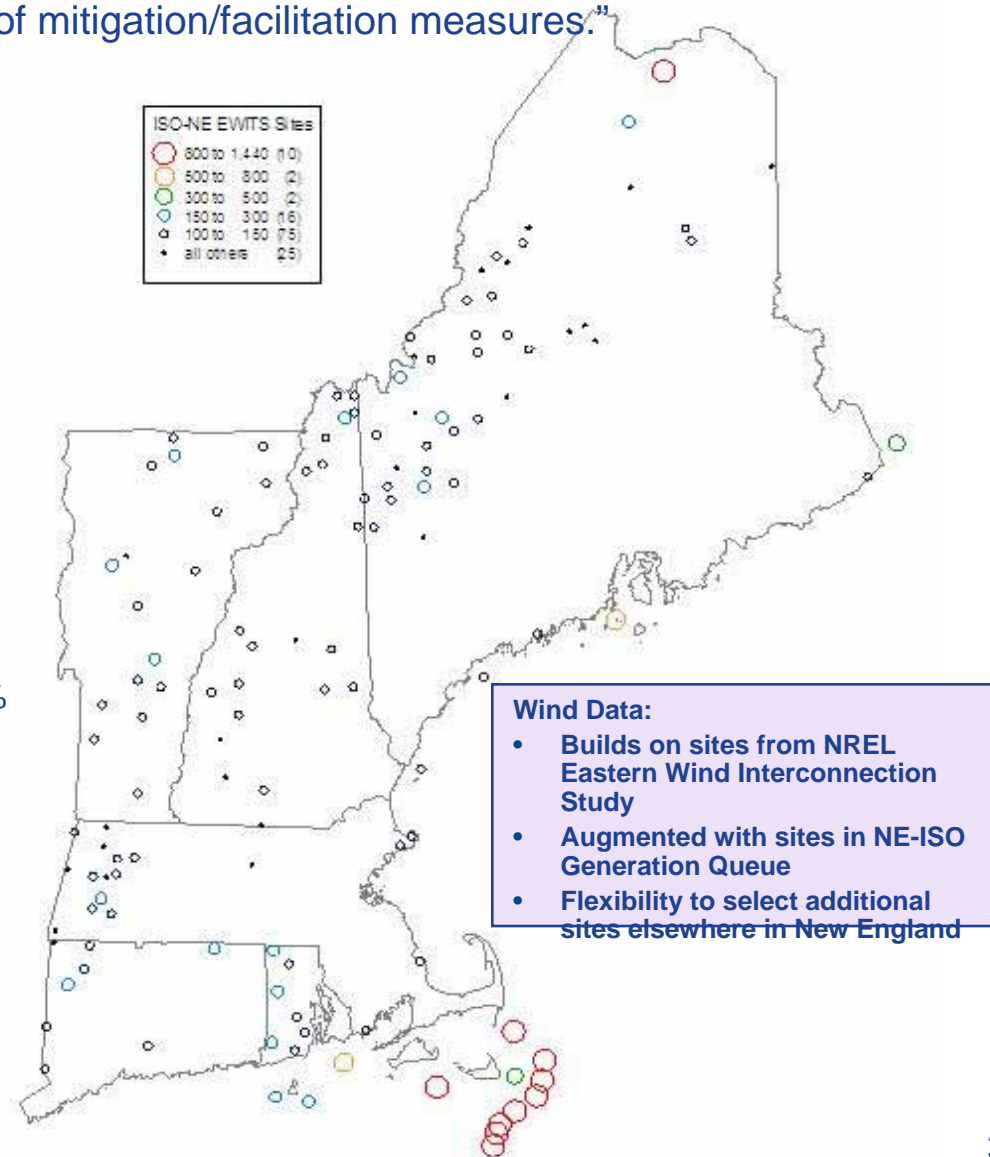
- Statistical analysis
 - Variability, extreme events
 - Hourly, sub-hourly
- Production simulation analysis, MAPS
- Reliability analysis, MARS
- Sensitivity analysis

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



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**