Evolution of Forecasting, Operations and Market Design for Wind Integration

Mark Ahlstrom

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WindLogics Background

Founded in 1989
Assessment, forecasting & integration of renewable energy
- 65 people
- 50% Meteorology
- 25% Math, Statistics, CompSci
Became a NextEra Energy company in 2006

**Forecasting & optimization solutions that enable low cost, reliable & sustainable power systems**
Operating the Power Grid

Keeping the lights on is job #1

Must maintain a constant balance between load and generation

Requires additional services so that unexpected events do not impact reliability
Initial Perceptions from Power System Operators

“Uncertainty of the load forecast is bad enough, and adding wind and solar will increase my problem.”

“How can I view a wind or solar plant as a real power plant if I don’t dispatch its output?”

“I need a perfect forecast… like I get from other generators.”

“I’ll need to set aside a fixed amount of additional reserves to deal with this uncertainty and intermittency of wind and solar.”

“I can’t integrate large amounts of renewables without adding large amounts of storage to the system.”
Significant Resistance to Change

Current assumptions, operating practices and market rules embody the characteristics of conventional generation.

Huge capital investments were made and power plants last a long time.

States rights versus interstate commerce.

Local economic development (subsidized by ratepayers).
A Very Brief History of Power Systems
Connecting Power Systems for Reliability
Energy is Not Enough

Reserves for rare events
  – Contingency
  – Spin
  – Non-spin

Ancillary products for reliability
  – Regulation
  – Reactive voltage

Meeting future needs
  – Capacity
Independent Systems Operators (ISOs) run energy markets

- Both regulated utilities and other "independent power producer" companies can generate, sell and trade energy

- Day-ahead market with hourly schedules

- Real-time market with five minute schedules
Maintaining Balance with Changing Load

Hour of the Day

System Load
Changes from Wind Energy

System Load

Hour of the Day

2  4  6  8  10  12  14  16  18  20  24
Wind Integration - Perception & Evolution

The success of wind integration is influenced by the perception of integration costs and operating limitations.

Our current perception is largely based on past assumptions, tools and experience.

Rules were created with conventional power plants in mind
– All power plants and fuel supplies have their own operational characteristics and “integration costs”

A change in perspective often simplifies a complex problem.
Best Practices #1 - Improved Operations

Larger balancing areas

Shorter scheduling intervals

Committing closer to real time

Demand response, smarter loads and microgrids will help... but are potentially very disruptive to regulated utility business models
Best Practices #2 - Renewables as Power Plants

Forecasting

Integrated into next-day plan

Renewables submit a schedule

Renewables follow dispatch
Best Practices #3 - Value Flexibility

Ramping capability of generators

Considering ramp needs in commitment and dispatch

Flexibility ancillary products

Flexible capacity planning
Market Rules and Wind Forecasting Value

Are better forecasts valuable to power system operators, market participants or power traders?

What forecasting timeframes are important?

Do better market rules make forecasts more valuable? Or less valuable?
Midcontinent Independent System Operator (MISO)

MISO runs a fairly standard “Day Two” market system:

– Submit day-ahead offer

– Some ability to adjust day-ahead offers until 4 hours ahead

– Submit real time offer
  – Submitted 30 minutes in advance of each operating hour

– Follow five-minute dispatch signal from MISO (+/- 8% band)

Dispatch & curtailment are based on offer prices (offers “set price”) and reliability needs (security constrained economic dispatch)
MISO Dispatchable Intermittent Resource Tariff

MISO runs a fairly standard “Day Two” market system:

– Submit day-ahead offer

– Some ability to adjust day-ahead offers until 4 hours ahead

– Submit real time offer
  – Wind provides a rolling five-minute forecast for the next hour
  – The 10-minute-ahead forecast value is used for each 5-minute dispatch

– Follow five-minute dispatch signal from MISO (+/- 8% band)

Dispatch & curtailment are based on offer prices (offers “set price”) and reliability needs (security constrained economic dispatch)
The Short Term Wind Forecast Error Curve

AESO Shortterm Forecast Mean Absolute Error August 2012

From: Jacques Duchesne, AESO
The Short Term Wind Forecast Error Curve

Adapted from Jacques Duchesne, AESO
Dispatching Wind Changes the Perception of the Problem

“Variability” is the change or error within the dispatch period
Uses some regulation, but not much given geographic aggregation

“Uncertainty” is mostly the error from the day-ahead forecast
Largely handled through the real time dispatch stack
Uses some non-spin reserve for extreme situations

Is there a ramping or flexibility problem?
With a deep and robust real time market… not really
• Wind ramping up - you have dispatch control of wind if needed
• Wind ramping down - other units backed down and have room to move up
Benefits of Wind as a Full Market Participant

**Real time**
Wind is fully incorporated into real time market and operations
A robust real time market encourages wind to offer day ahead

**Day ahead**
Wind is incorporated into day-ahead planning and optimization
Enhances the importance of better day-ahead forecasts
Increases the value of improved forecasts to system operators, market participants and traders!

**Within the day**
Forecasting ramps and reducing day-ahead forecast error
Value to system operators for rolling commitment decisions
Value to market participants and traders depends on market design
Implications on Forecasting Value

The cost of integrating wind into well-functioning markets is low
Therefore the perceived value of better forecasts may be muted
Can we sustain a strong R&D value proposition?
Are prices and revenues sufficient to sustain forecasting services?

Intra-hour forecasting
Is persistence enough? What is the value of being a bit better?
More value for next-generation controls and plant-level optimization?

Day-ahead forecasting
Better forecasts are valuable, but customer expectations are high
Probabilistic forecasts difficult for customers to understand and use

Intra-day (rapid refresh and ramp forecasts)
Some value to system operators for starting natural gas plants, etc.
Challenging to make ramp forecasts precise and actionable
Limited ability for market participants or traders to benefit from them
Discussion

Mark Ahlstrom
mark@WindLogics.com
651-556-4262