



Solar and Wind Forecasting: Achieving a 33% Solution

CEC Forecasting Workshop

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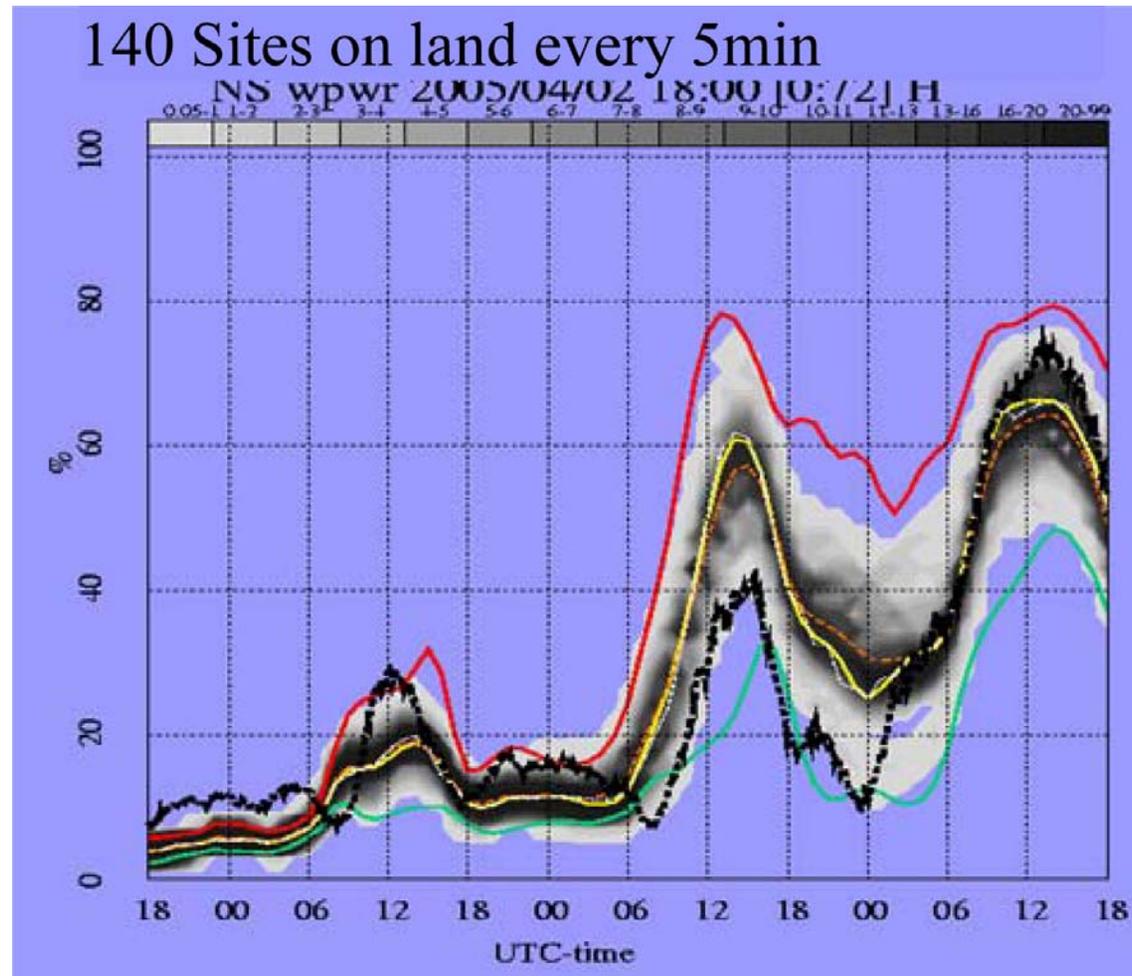
What is UWIG?

- ◆ Non-profit corporation established by 6 utilities in 1989 with support from EPRI and DOE/NREL
- ◆ Over 150 members, including utilities, developers, manufacturers, consultants, government organizations
- ◆ Focus on technical issues
- ◆ Mission: To accelerate the development and application of good engineering and operational practices supporting the appropriate integration of solar and wind power into the electric system

It's All About Dealing with Variability and Uncertainty

- ◆ Variability
 - Load varies by seconds, minutes, hours, by day type, and with weather
 - Supply resources may not be available or limited in capacity due to partial outages
 - Prices for power purchases or sales exhibit fluctuations
- ◆ Uncertainty
 - Operational plans are made on basis of best available forecasts of needs; some error is inherent
 - Supply side resource available with some probability (usually high)
- ◆ Key questions
 - How do wind and solar generation affect existing variability and uncertainty
 - What are the costs associated with the changes
 - What does the future hold

Forecasting for Reduced Uncertainty



Different Forecasts for Different Time Periods

- ◆ Situational awareness forecast: used for severe weather events (real-time)
- ◆ Hour ahead forecast: uses rapid update cycle to produce 10 min forecasts 4-6 hrs ahead, updated every hour
- ◆ Day ahead forecast: Hourly forecasts 2-4 days ahead, updated every 12 hours, uses national weather service models
- ◆ Nodal forecast: hourly forecast of transmission system nodal injections for managing transmission congestion
- ◆ Different performance metrics for different forecasts

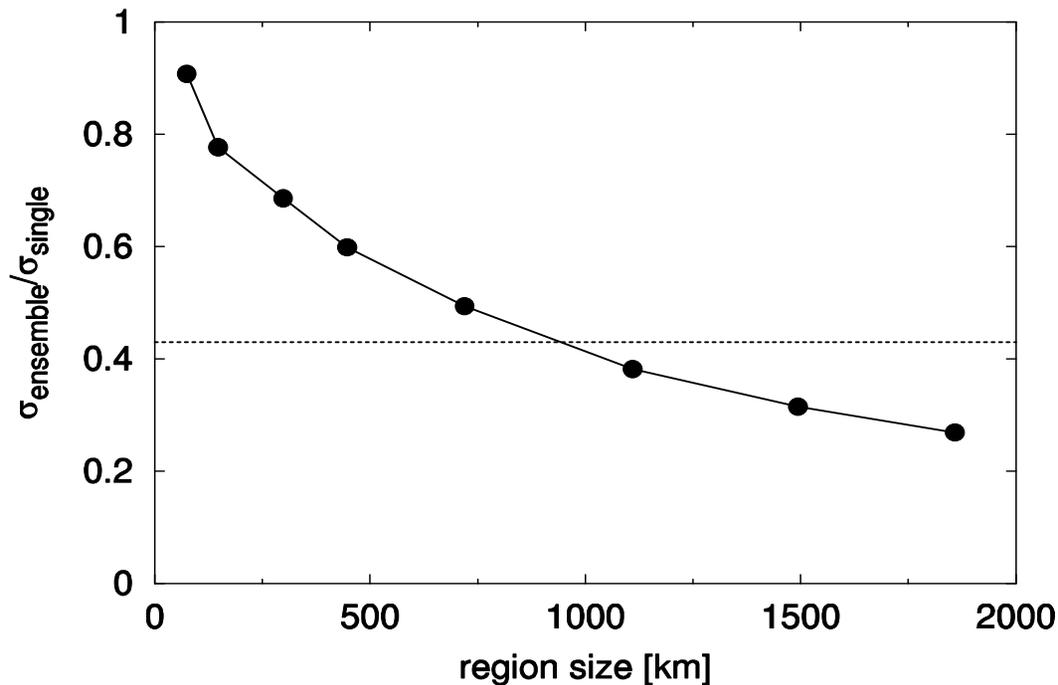
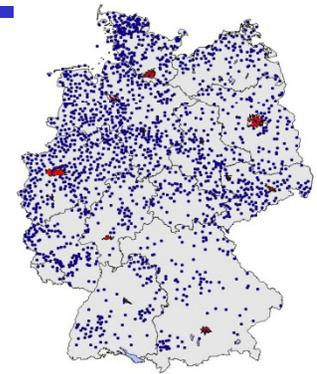
How Good is the Forecast?

- ◆ Wind plant output can be forecast within some margin of error, and forecasts are getting better

Forecast Error

	<u>Single Plant</u>	<u>Large Region</u>
<u>Hour Ahead</u>		
Energy (% actual)	10-15%	6-11%
Capacity (% rated)	4-6%	3-6%
<u>Day Ahead</u>		
Hourly Energy (% Actual)	25-30%	15-18%
Hourly Capacity (% Rated)	10-12%	6-8%

Error Decreases with Region Size

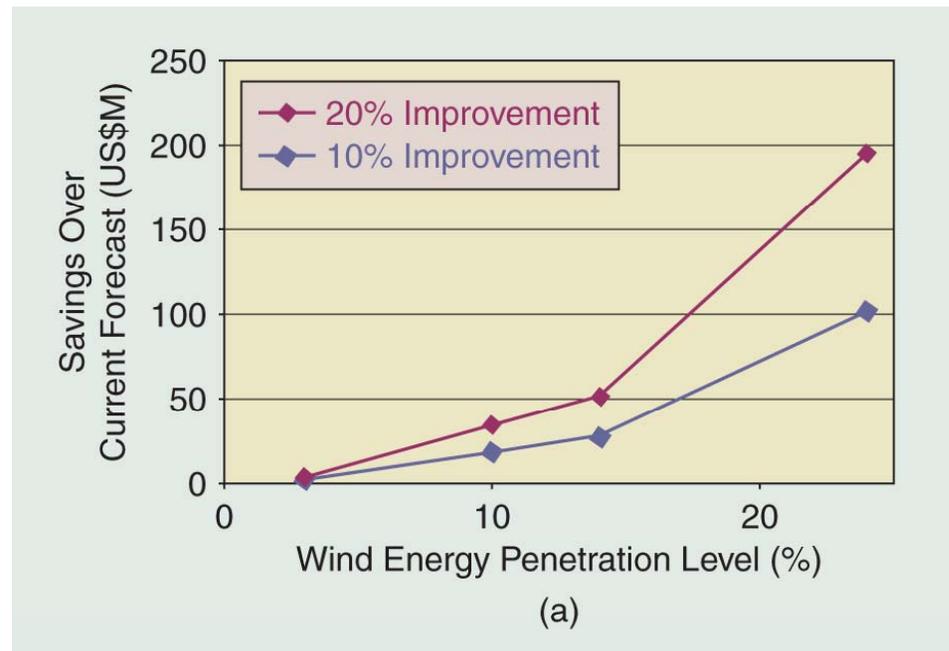


- ◆ Error decreases with increase of region size
- ◆ Regional smoothing depends only on region's size, not on number of sites
- ◆ Error is reduced in Germany to 42 % compared to single forecast

Why Is Forecasting Important

- ◆ **Economics**
 - Better forecasts mean lower operating reserves
 - Lower operating reserves mean lower operating costs
 - Avoid penalties for bad forecasts
- ◆ **Reliability**
 - Situational awareness for operators
 - System positioning for ramping events
 - Preparation for extreme events
- ◆ **Market Operation**
 - Understand need for and provide incentives for the right market products with high VG penetration
 - Align market rules with forecasting capabilities

Value of Wind Forecast Error Improvement in WestConnect



- ◆ Based on WWSIS results at wind penetration up to 30% of annual energy produced in WestConnect, 20% in rest of WECC
- ◆ Source: IEEE P&E Magazine, Vol 9, No 6, Nov-Dec 2011.

NERC VG Forecasting Recommendations 1-3

- ◆ NERC IVGTF Task 2.1 Report, Variable Generation Power Forecasting for Operations, May 2010
 - 1. Wind and solar plants require real-time meteorological and electrical data through SCADA systems using standard communication protocols for use in forecasting and system operation.
 - 2. Wind plant output forecasts, often several of them, should be adopted as standard system and market operation tools for economic operation and system reliability purposes. Multiple types of forecasts and forecast optimizations are practical and important.
 - 3. How forecasts are used is what really matters.
 - » Initial use of wind plant forecasts by reliability coordinators in the control room is a logical first step.
 - » Use of the forecast in unit commitment planning is very important.
 - » Probabilistic methods are increasingly important and the uncertainty distributions around all forecasts should be addressed more explicitly.

NERC Recommendation 4

- ◆ 4. There are overwhelming benefits from adjusting operating rules and practices, and these adjustments may have more benefit to both reliability and economic operations than the forecasting alone:
 - Sub-hourly markets with the ability to dispatch generation closer to real time
 - Incorporating the variable generation power forecast into unit commitment
 - Negative price offers can help maintain reliable and economical operation.
 - The benefits of larger balancing areas with fewer transmission constraints are overwhelming.

NERC Recommendation 5

- ◆ 5. Ongoing innovation is needed, with both government and private industry involvement. Innovation is needed to continue to improve forecasting products. This requires multiple cooperating players:
 - Government R&D and forecasting centers for improved data systems, model development and general operational weather deliverables,
 - A vibrant, competitive forecasting service community to assist in the R&D, applications and services for business-augmented use of operating data with forecasting products,
 - Developers of system operating tools and methods, both in private companies and in the system operator organizations, to deal with the true variability and forecast probability distributions that are implicit to our real-world systems, and
 - System operators and stakeholders.

Importance of Policy

- ◆ Align market rules with forecast capability
 - Motivate wind generators to be in the market and to do a better job of forecasting
 - » Look at the MISO Dispatchable Intermittent Resource (DIR) policy with a 15 min schedule adjustment
 - » If the forecast cannot be used to adjust schedules to improve market operation and reduce cost by enabling imbalances to be traded in short-term forward markets, what good is it
 - » Adjust output schedules in a time frame meaningful to wind forecasts – 1.5 to 2.5 hours ahead is a “no man’s land” between persistence and short term forecasts

FERC Variable Energy NOPR

- ◆ Says a lot of things, including that a wind integration charge may be allowed, if
 - You have adopted sub-hourly scheduling on seams, and
 - You are using wind forecasting in operations
- ◆ All plants have integration cost, and calculation is complicated and uncertain (compared to what?)
 - Cost causation attribution must be just and reasonable (fair) across all plants that cause cost to the system
 - Balance the system, not individual plants
 - » The value of aggregation across broad areas is that it reduces variability and enables more accurate wind plant output forecasts to begin with
 - This is a can of worms

Need to Learn Quickly

- ◆ Wind industry on a steep learning curve
- ◆ A number of recent events have highlighted the need for good wind plant output forecasts
 - Danish high wind event of Jan '05
 - European system breakup of Nov '06
 - Texas high wind event of Feb '08
- ◆ *Wind plant output forecasting increasingly recognized as an important tool in minimizing operating impacts and delivering critical information to operators*
- ◆ *Forecasting critical to minimizing wind integration cost and increasing wind value*

Where Are We Going

- ◆ VG forecasting still a work in progress, just like operating power systems with wind plants
- ◆ NWP models designed and tuned for VG plant operations are still in their infancy
- ◆ Significant value can be achieved using the results available from current generation of technology, and ...
- ◆ We have come a long ways in the past 10 years, but ...
- ◆ There is still a lot more to do!

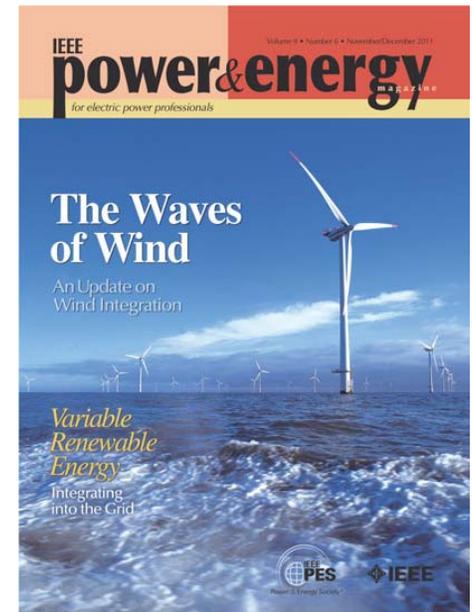


5th Annual Variable Generation (VG) Forecasting Conference

- ◆ Tucson, AZ
- ◆ February 8-9, 2012
- ◆ Conference Session Topics
 - VG Forecast Performance, Value, and Accuracy
 - Interesting High Penetration Hours: What Have We Learned?
 - Large System Forecasting Status and Progress
 - Advances in Applications of Short-term VG Forecasting
 - Integrating Forecasting into Market Operations, the EMS and Control Center
 - Wind Forecasting R&D Activities
 - Solar Forecasting Early Applications
 - Closing Panel Discussion – Where Are We, Where Are We Going, and What Else Needs To Be Done, ...

Outreach Activities

- ◆ IEEE *Power & Energy* magazine special issue on wind – 2005, 2007, 2009, 2011
- ◆ IEEE PES *Transactions on Sustainable Energy* special issue on wind energy
- ◆ Participation in Cigré wind activities
- ◆ Participation in IEEE
 - Wind Power Coordinating Committee
- ◆ NERC Wind Generator Task Force
- ◆ NERC Integration of Variable Gen TF



For More Information

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