Reducing Wind Forecasting Uncertainty with PI and ECHO

Using Real-time Offsite Meteorological Observations

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Empowering Business in Real Time
PI Infrastructure for the Enterprise

WINData Inc

PI-enabled Real Time Off-site Meteorological Observations for Improved Short-term Wind Forecasting, Operating Economics and System Reliability

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Topics

- Who we are
- Wind power and forecasting
- Wind power: ups and downs
- The impact of remote observations
- How WINData leverages ECHO and PI
- Future plans

WINData background

- 20 years of experience in the wind industry
- Involved in
  - Prospecting
  - Siting
  - Site characterization
  - Landowner negotiations
  - Wind farm development
- Goal:
  - Improve the “state-of-the-art”
  - Create a new standard for meteorological data

Why forecasting is important

UWIG Utility Wind Integration Group

GE-NYSERDA Study for NYISO, 10% Penetration, 2005 Operating Costs with Wind Forecasts

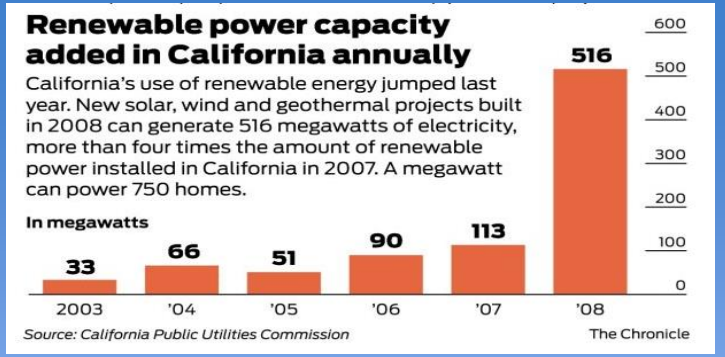
- Day-ahead unit commitment considers forecasted wind generation

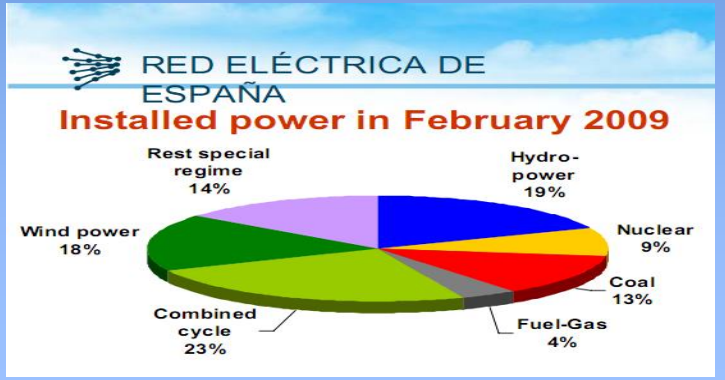
	No Wind Forecast	SOA Wind Forecast	Perfect Wind Forecast
Total Variable Cost Reduction	$335 M	$430 M	$455 M
Net Benefit		$95 M	$ 120 M
Wind Generation		8900 GWH	8900 GWH
Value of Forecast		$10.70/MWH	$13.50/MWH

Presented by GE at UWIG Sacramento Meeting, Nov. 2005

The critical role of forecasting

- Programs
  - California:
    - 20% renewables by 2010
    - 33% renewables by 2020
  - Europe:
    - 20% renewables by 2020
- Already in place
  - Denmark
    - 20% of demand today
    - 50% by 2025
  - Spain
    - 20,000 MW capacity by 2010
    - > 15,000 MW in place today
    - Peaked at 40% of demand (typically ~25% of demand)





The balancing act – wind power and the grid

System operator rules

- **Maintain**
  - **Supply >= Demand**
- **If**
  - **Demand > Supply**
    - Order more power
    - Shed load
    - Severe load shedding
- **If**
  - **Demand < Supply**
    - Relax

System operator headaches

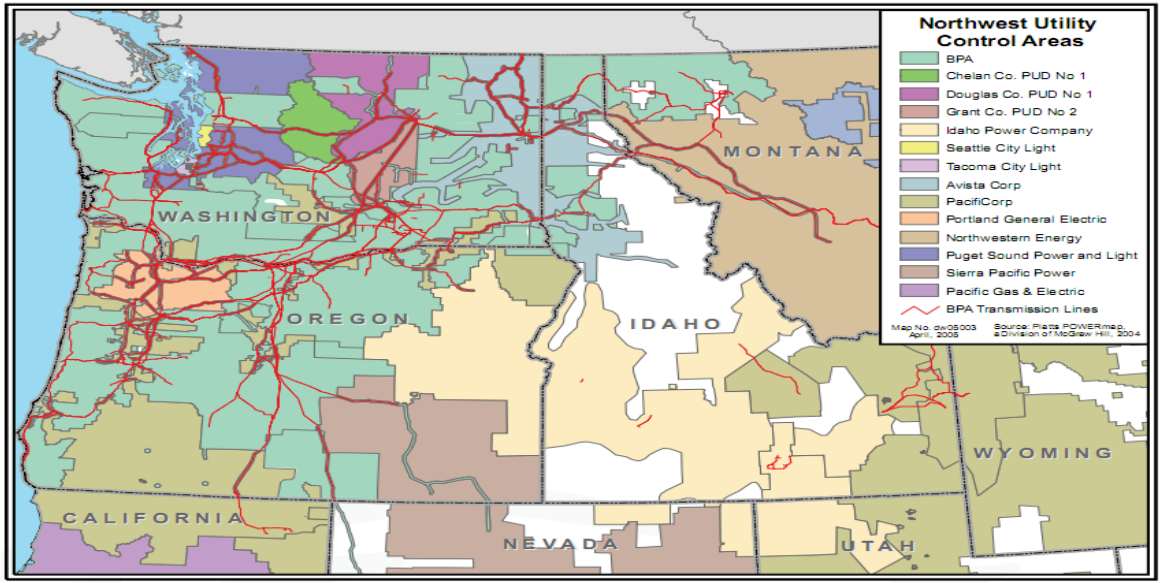
- Unanticipated demand
- Unanticipated supply problems
  - Participants do not meet commitments
  - Unplanned outages
- High spot market prices
- ~~Enron~~
- Intermittent renewables

The BPA balancing act

- Bonneville Power Authority
  - 19 wind farms interconnected (1,000 turbines)
  - Potentially 6,000 MW online by 2009
    - 11 years ahead of schedule
- Current “Balancing Area”
  - about 1,500 MW in size

BPA's Balancing Area

BPA's balancing authority area



BPA is the balancing authority responsible for maintaining a constant balance between the power load and power generation in the area ***shown in teal.*** *(A balancing authority is also known as a control area.) Most of the wind power on line and planned for the Pacific Northwest is clustered in BPA's balancing authority at the eastern end of the Columbia River Gorge. However, three-fourths of the wind power in BPA's balancing authority area serves loads in other utilities' balancing authorities.*

A sequence of events at BPA

- In the spring of 2008 BPA's balancing area:
  - Generated **400MW** over schedule for **several hours**
- In August 2008 BPA's balancing area:
  - Generated **730 MW** over schedule **in 1hr**
  - Generated **680 MW** over schedule **in 1hr**
- In September 2008 BPA's balancing area:
  - Generated **625 MW** under schedule **in 1hr**
- That's ≅ **25-50%** of their balancing area's load
- About the average power use of **Portland, OR**

What happens then?

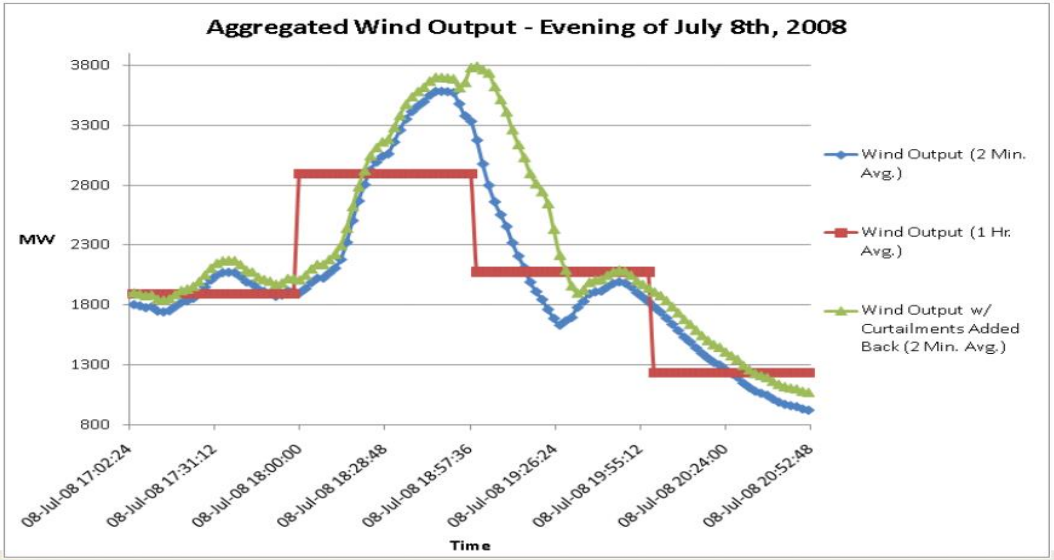
- Wind power is “backed” by another type of utility
  - Combined cycle gas turbines
  - Hydroelectric plants
  - Etc.
- In spring of 2008, the excess power production forced BPA to:
  - Violate WECC control standards (fines)
  - Over-spill a hydro dam, endangering fish (EPA fines)

Ramp-events

- Sudden increases or decreases in wind speed
  - Increases usually better than decreases
  - Subject to seasonal variation
  - Difficult to forecast in the short-term
- Causes:
  - Operating at reduced or conservative capacity
  - Inability to participate in day and hour-ahead markets
  - Purchase of make-up power at high prices
  - Dispatcher headaches

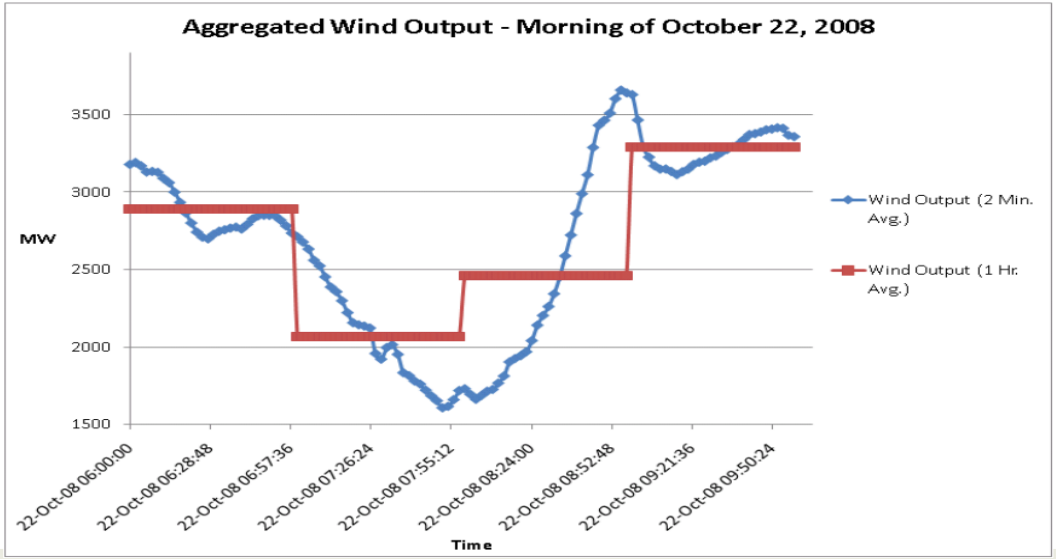
Ramp events captured by ERCOT (1)

Ramping Example 1 cont.



Ramp events captured by ERCOT (2)

Ramping Example 2

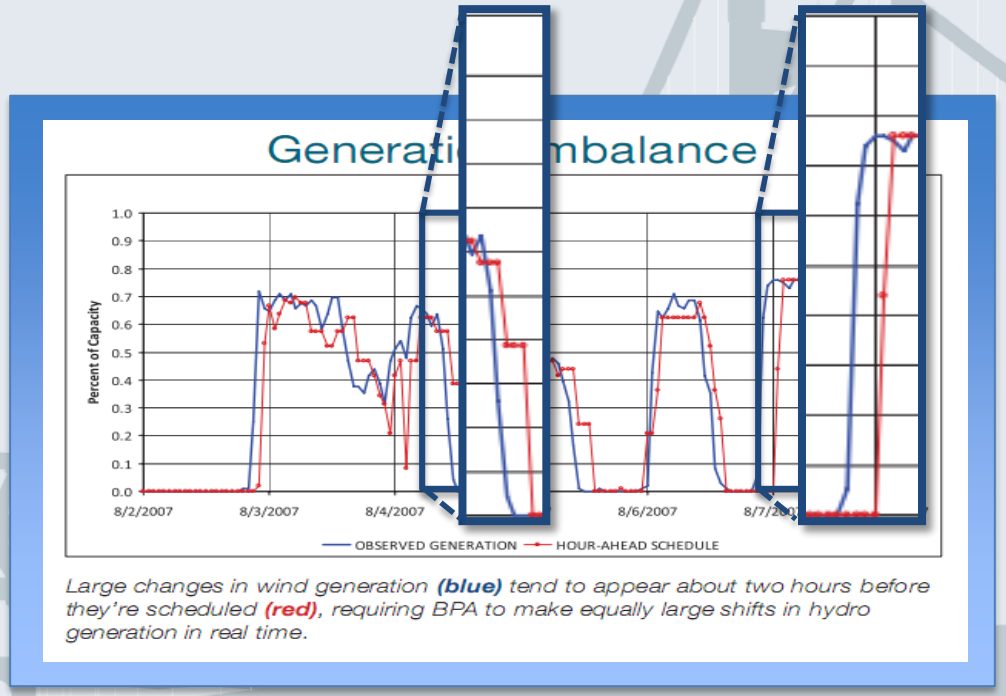


Ramp effects at ERCOT

- News article from Reuters (2/27/08):
  - Sudden **1,700 to 300 MW** drop in wind power
  - Increased demand due to colder temperatures
  - Ordered **1,100 MW** to be curtailed from interruptible customers within **10 min**
  - Other suppliers were unable to meet commitments
- Happy ending
  - No other customers lost power
  - Interruptible customers were back online 90 min later

Forecasting vs. ramp events

- Forecasts tend to be able to predict auto-correlated behavior
- Much of the forecast error that is reported accumulates around ramp events
- Most of the value comes around accurately predicting ramp events



WINData's Plan

Introducing WINDataNOW

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Goal: Reduce the forecast uncertainty

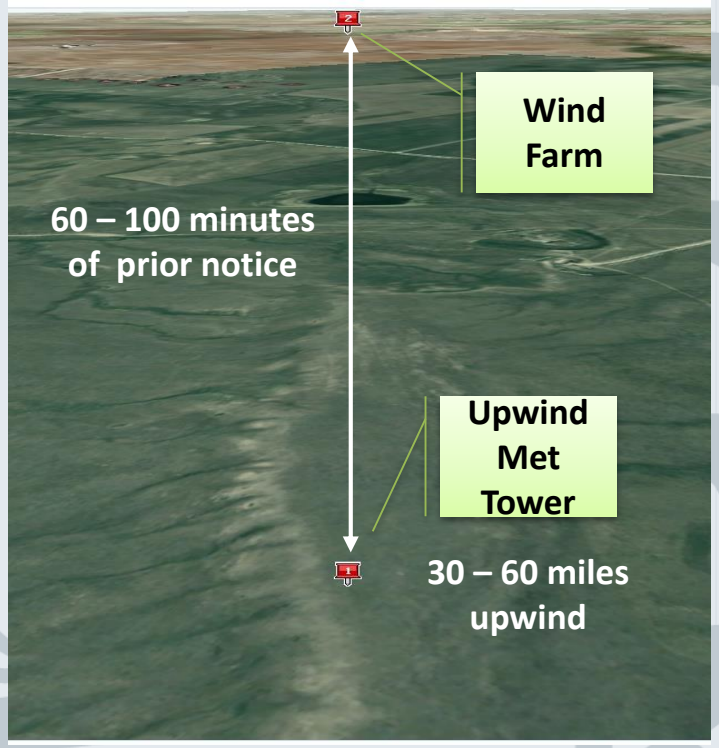
- Idea
  - Can short-term forecasts be improved by using actual upstream measurements from physical instruments?
- Requirements
  - Off-site meteorological data, at hub height, from predominant wind directions
  - Deliver measurements with enough resolution and timeliness to be useful

WINData's toolbox

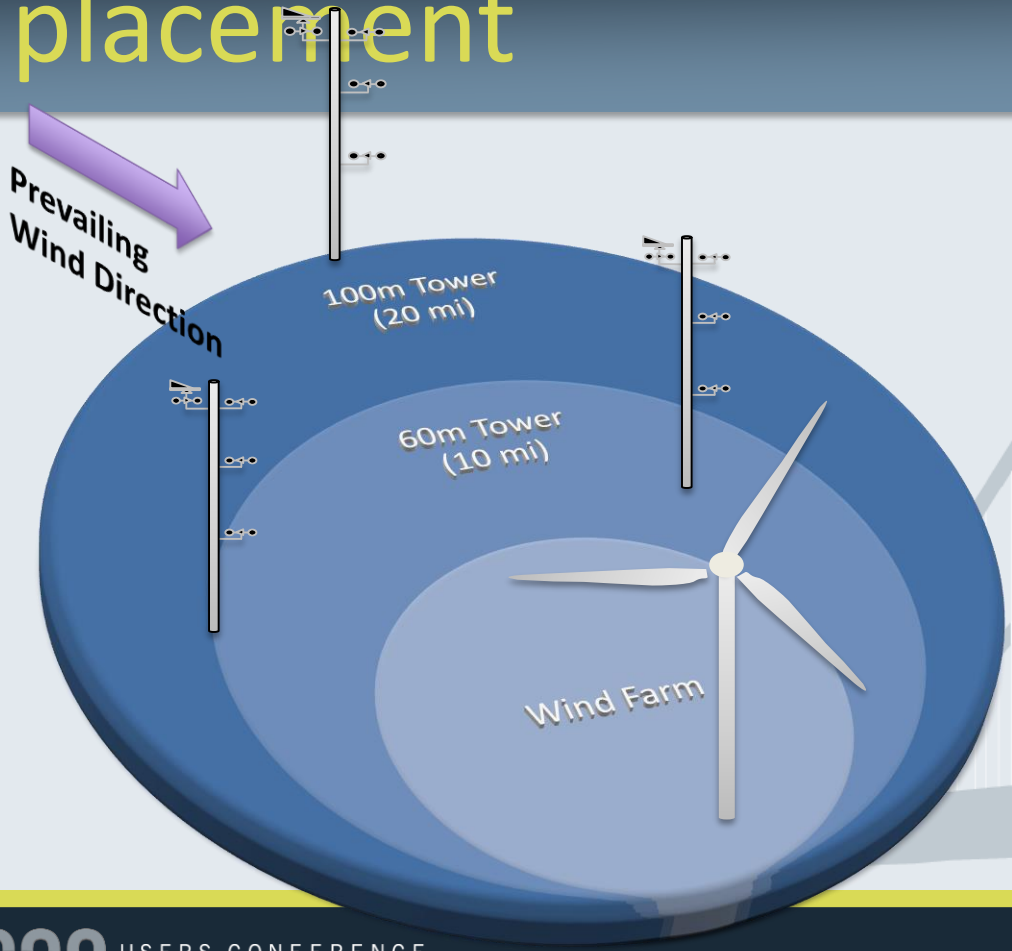
- Combine standard pieces of infrastructure and equipment to create a remote "met" sensing solution
- Most utilities and operators use the PI System
  - Though, as we've discovered, many renewable operations are not yet installed
- Focus on configuration vs. programming

WINDataNOW – remote met observations

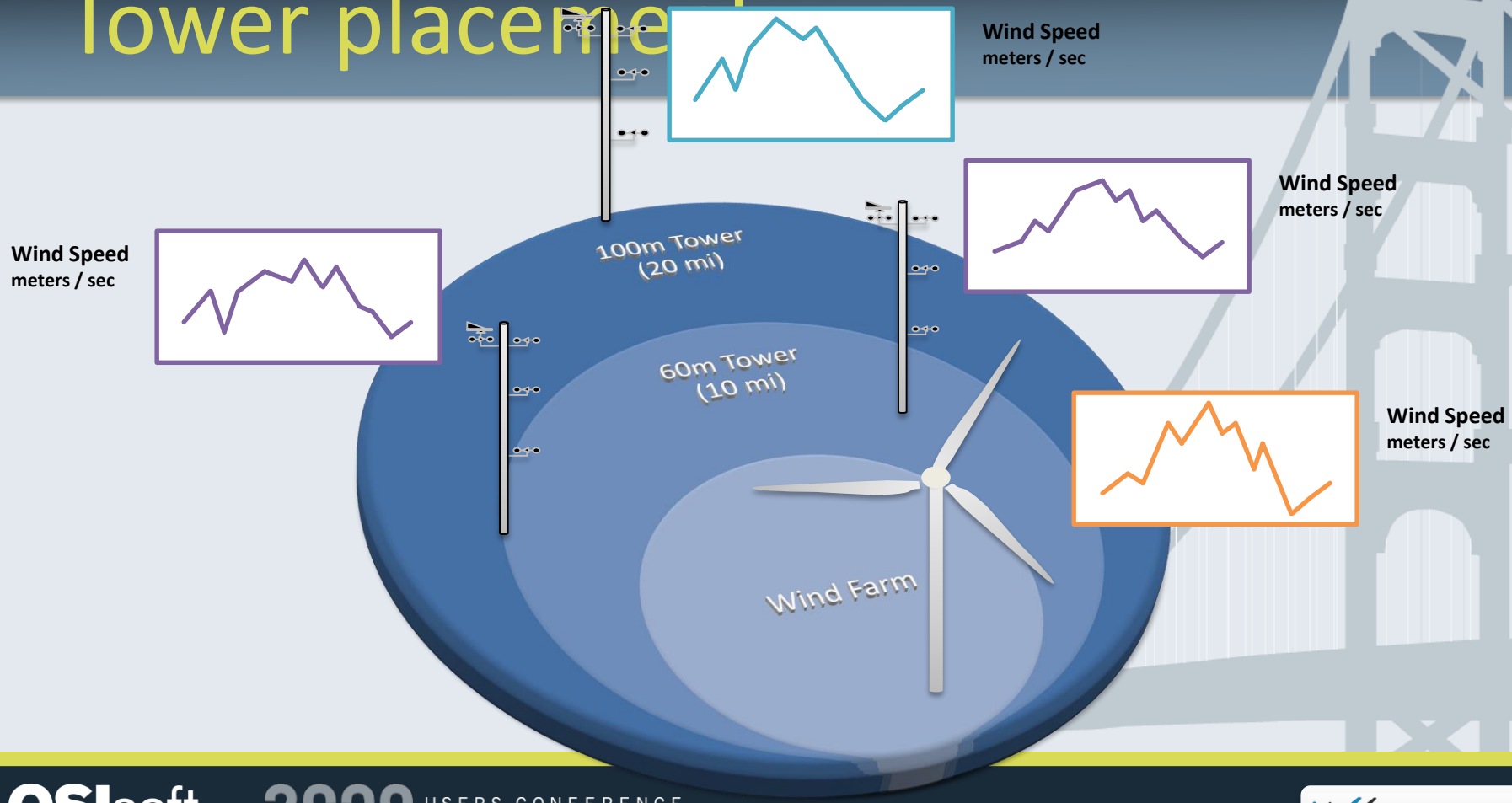
- Towers are located strategically upwind
- Transmit high fidelity “line of site” and hub height data
- Use this data to refine short-term forecasts from forecast provider
- Back-cast from historical data to develop a more detailed climatology of the surrounding area



Tower placement

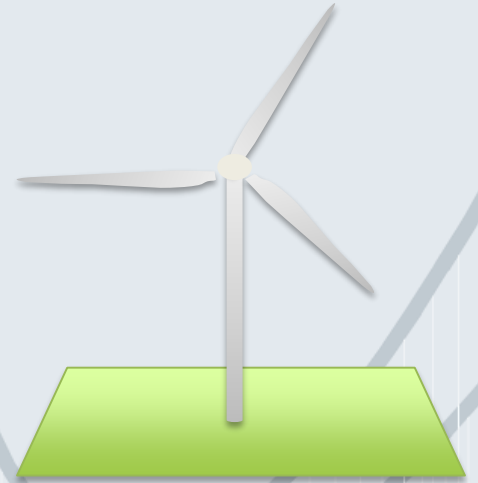


Tower placement

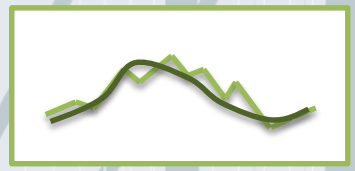


Forecast: smoother operations

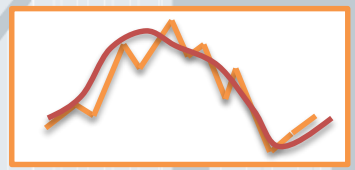
- Anticipate changes
  - Ramp up
  - Ramp down
  - Environmental curtailment
- Better wind energy integration to the grid
- Integrate with forecasting methods or models



Apply “line of site” data to better understand near-term transients



Power Production vs. Augmented forecast
MWH



Wind Speed vs. Augmented forecast
meters / sec

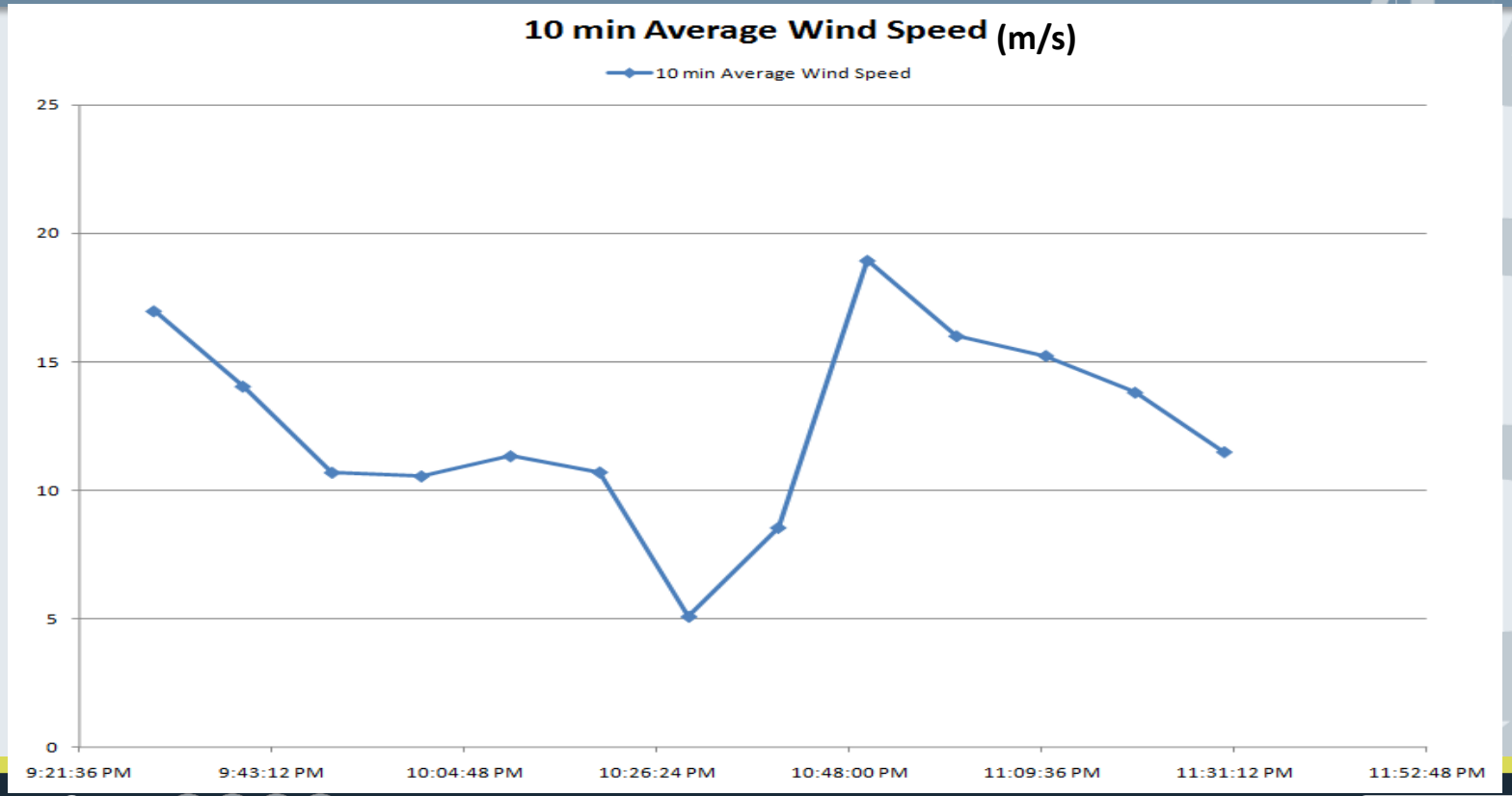
WINData's progress

- More than a year of development and testing
- Several trial sites to test equipment
- Comparisons and validation against existing market players
- Now in an industry validation phase with utility partners

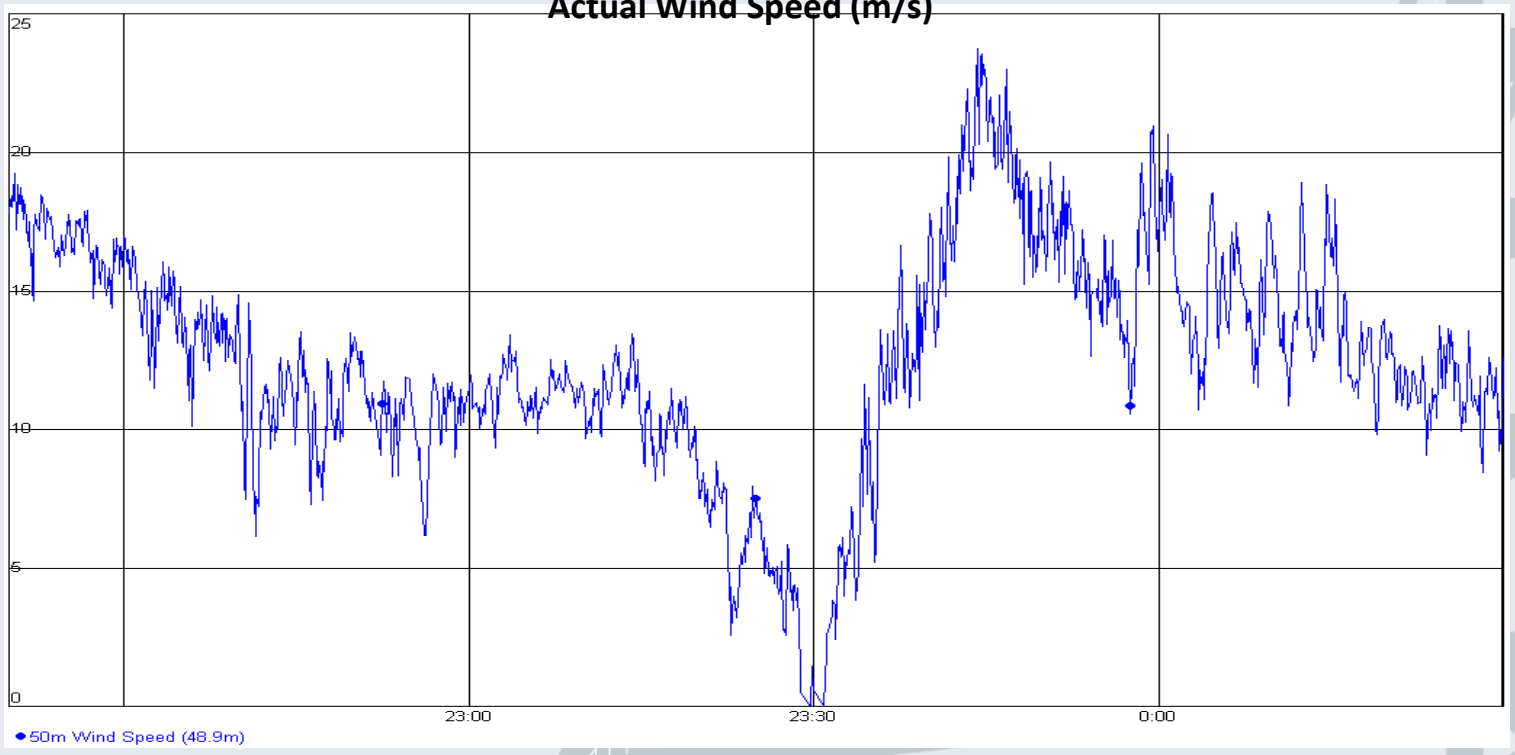
Example: Upstream data from a real site

- This met data comes from a real tower
- The tower's location is a few miles NW of an operating wind farm
- This data was captured during a high wind event
- Wind speeds are in meters per second (m/s)

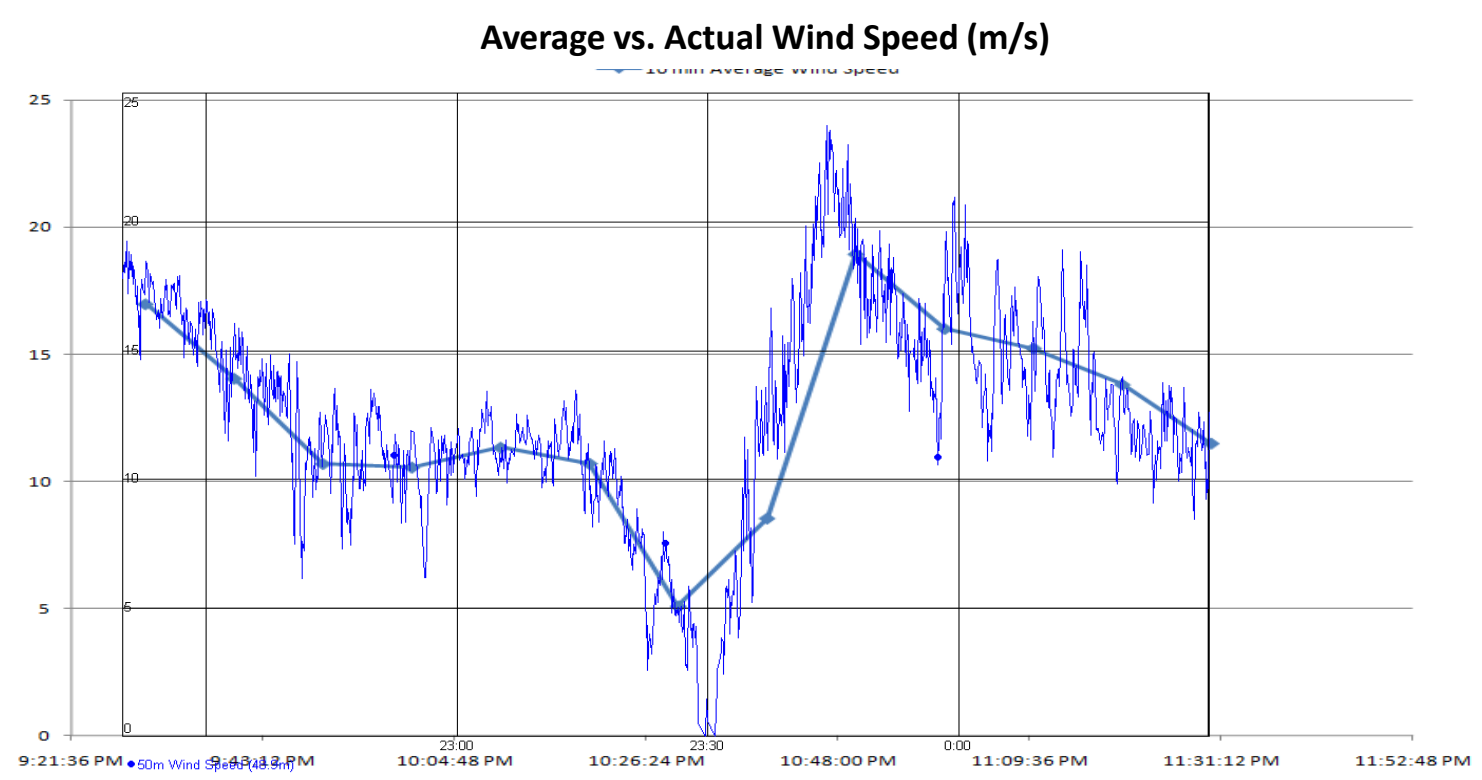
Averages are OK, on average…



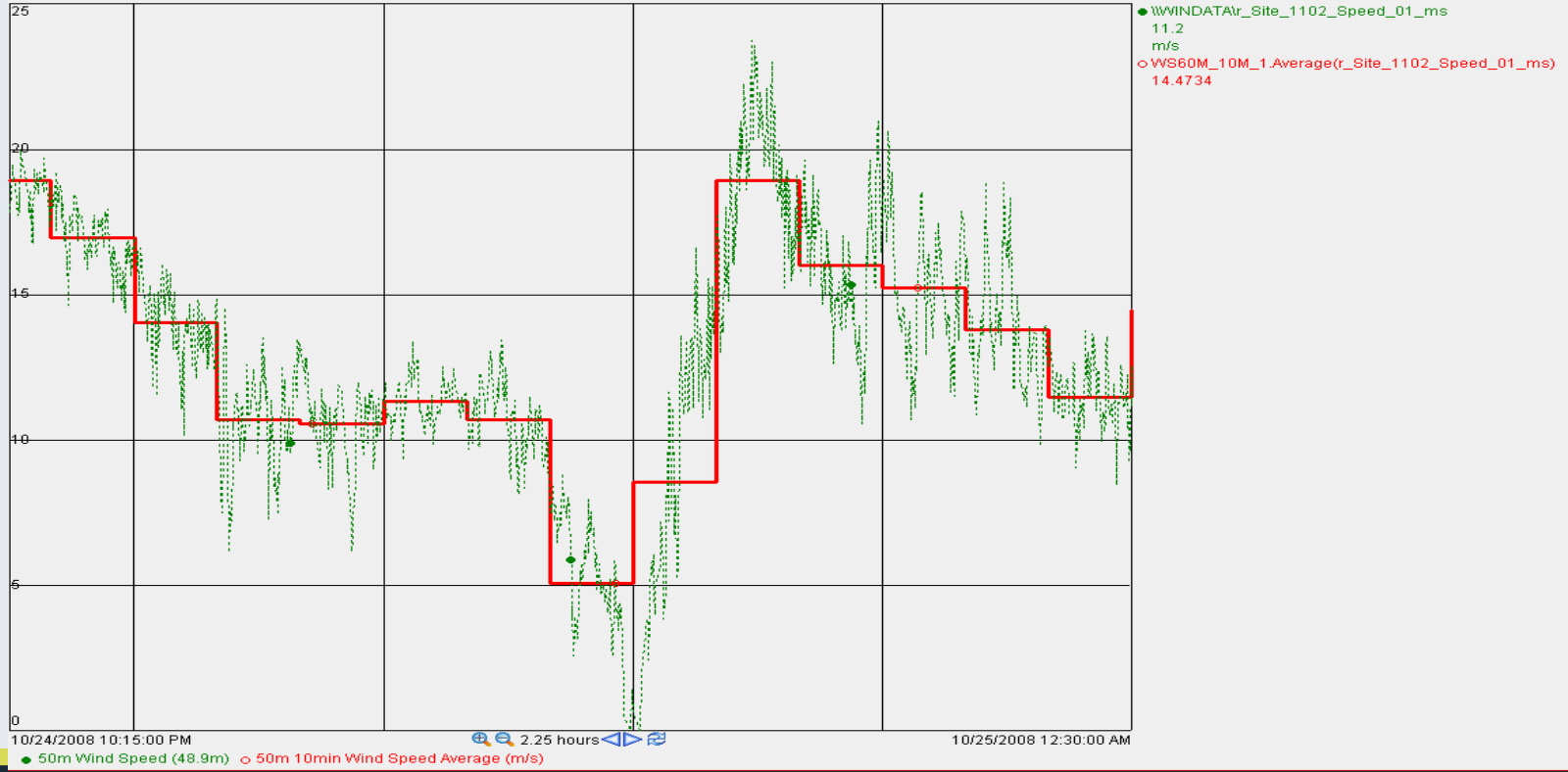
The same time period, now in high fidelity



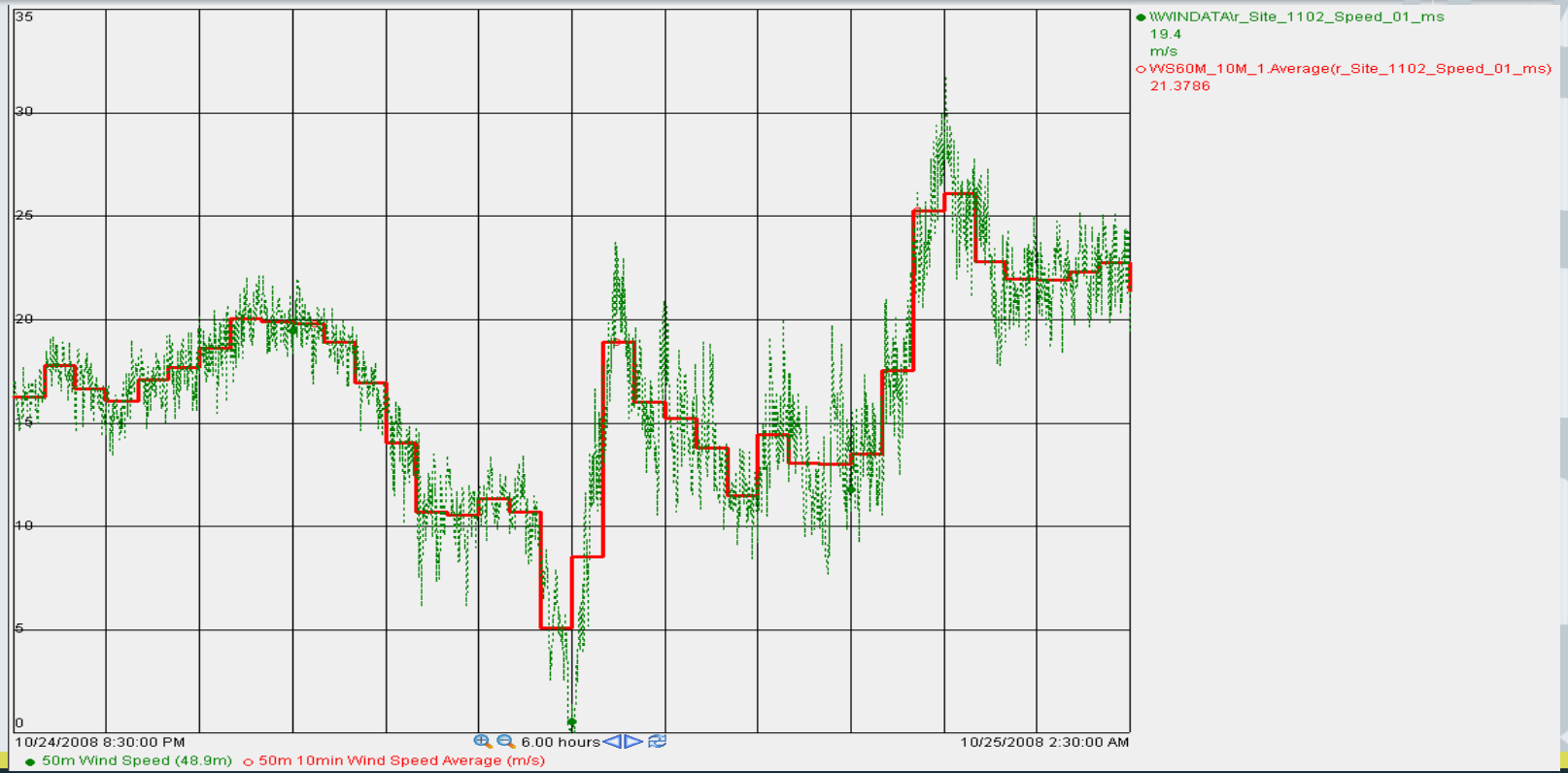
Comparison


Average vs. Actual Wind Speed (m/s)
10 min Average Wind Speed
25
20
15
10
5
0
9:21:36 PM
9:43:12 PM
10:04:48 PM
10:26:24 PM
10:48:00 PM
11:09:36 PM
11:31:12 PM
11:52:48 PM
23:00
23:30
0:00
50m Wind Speed (48.9m)

Using PI's 10m Averages



Zooming out a little more



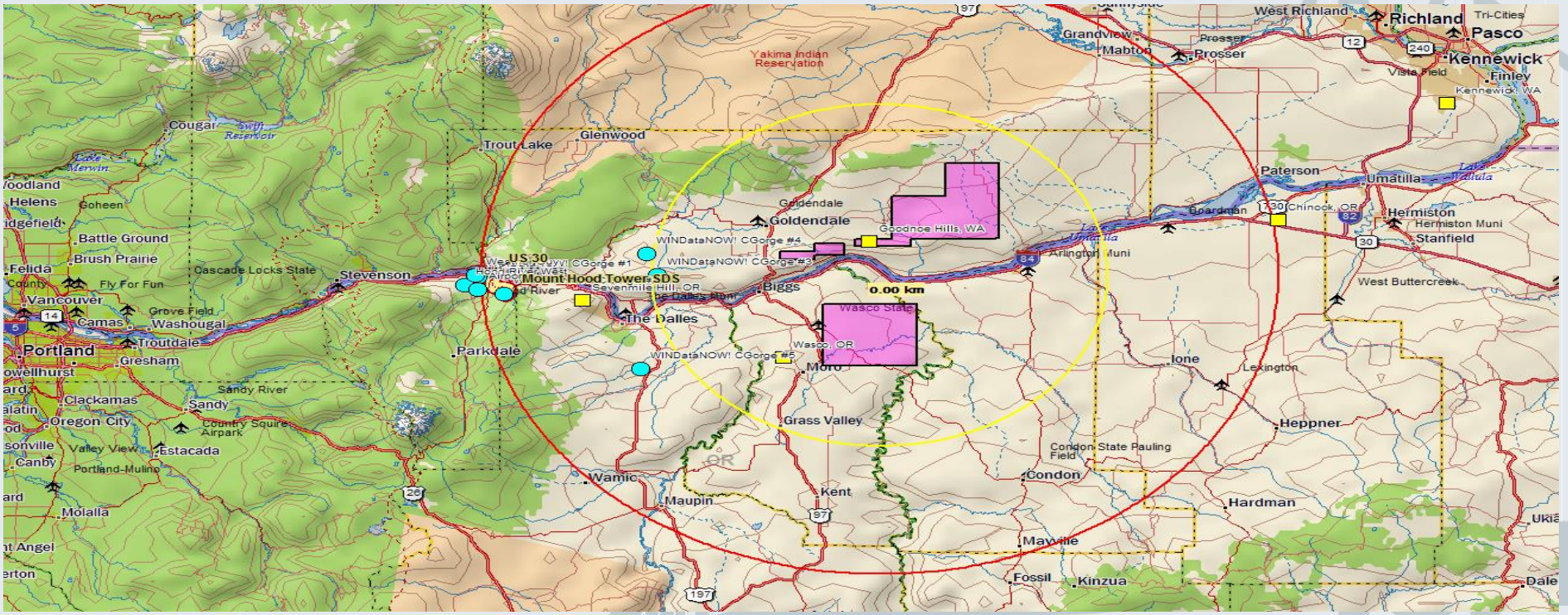
Increased meteorological insight

- Re-forecast
  - Account for actual upstream observations
  - Decrease forecast error around ramp events
- Advanced warning
  - Situational awareness
  - Reduce costs
  - Avoid penalties

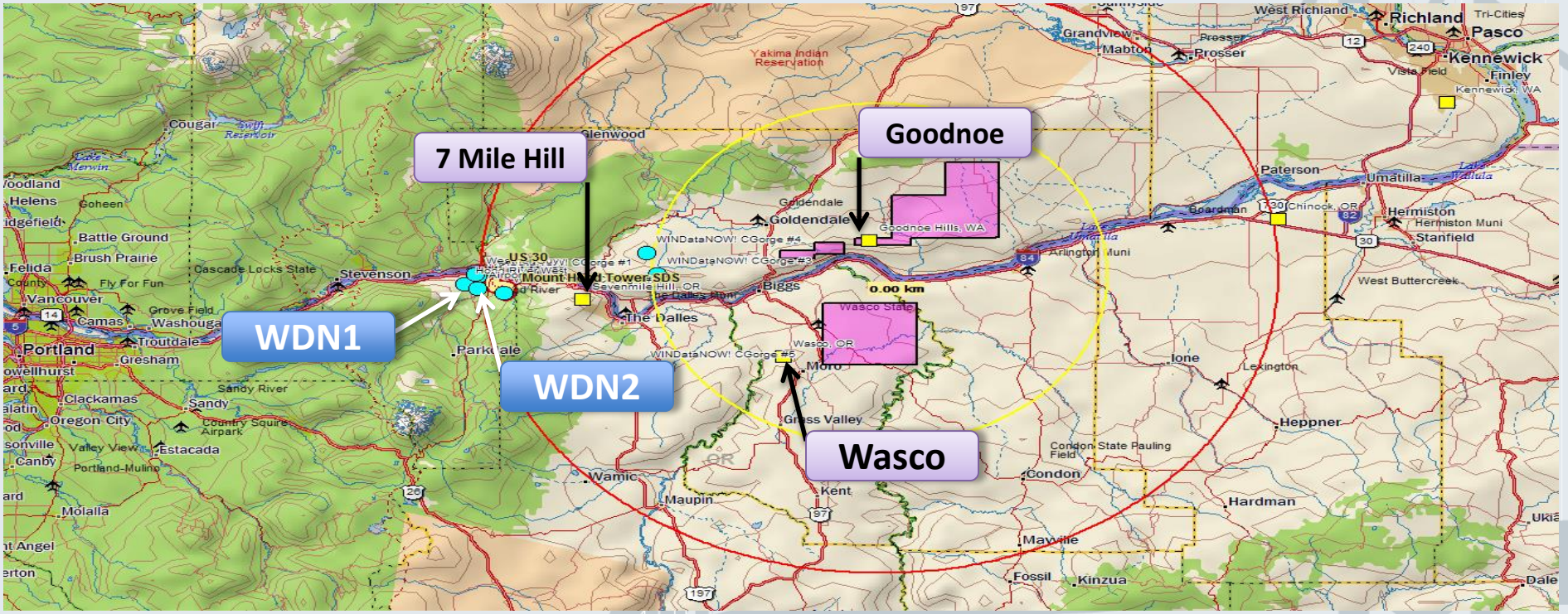
The C-Gorge Project

- WINDataNOW installation in the Columbia River Valley in Oregon
  - Started January, 2009
- Upstream from large wind farm installations
- Phase 1 includes installations in 2 locations
- Phase 2 & 3 brings online 3 more locations

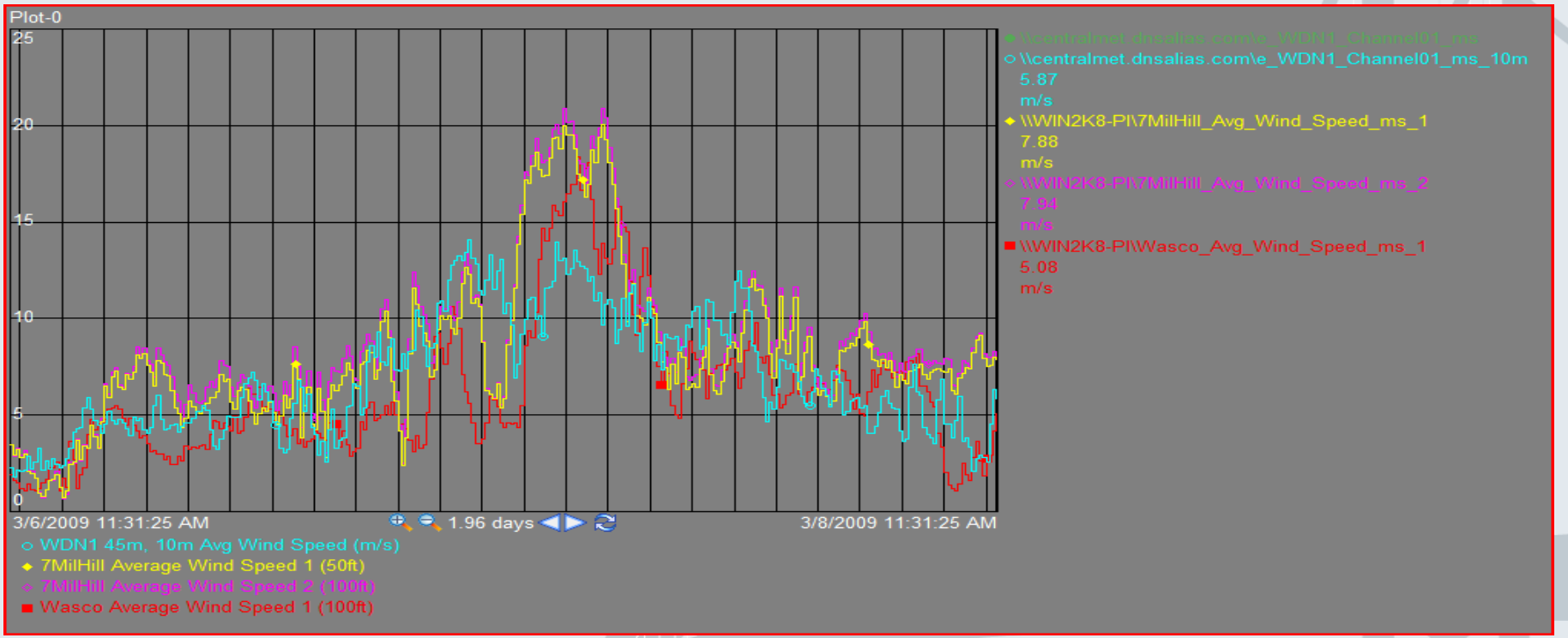
Map of C-Gorge vs. existing sites



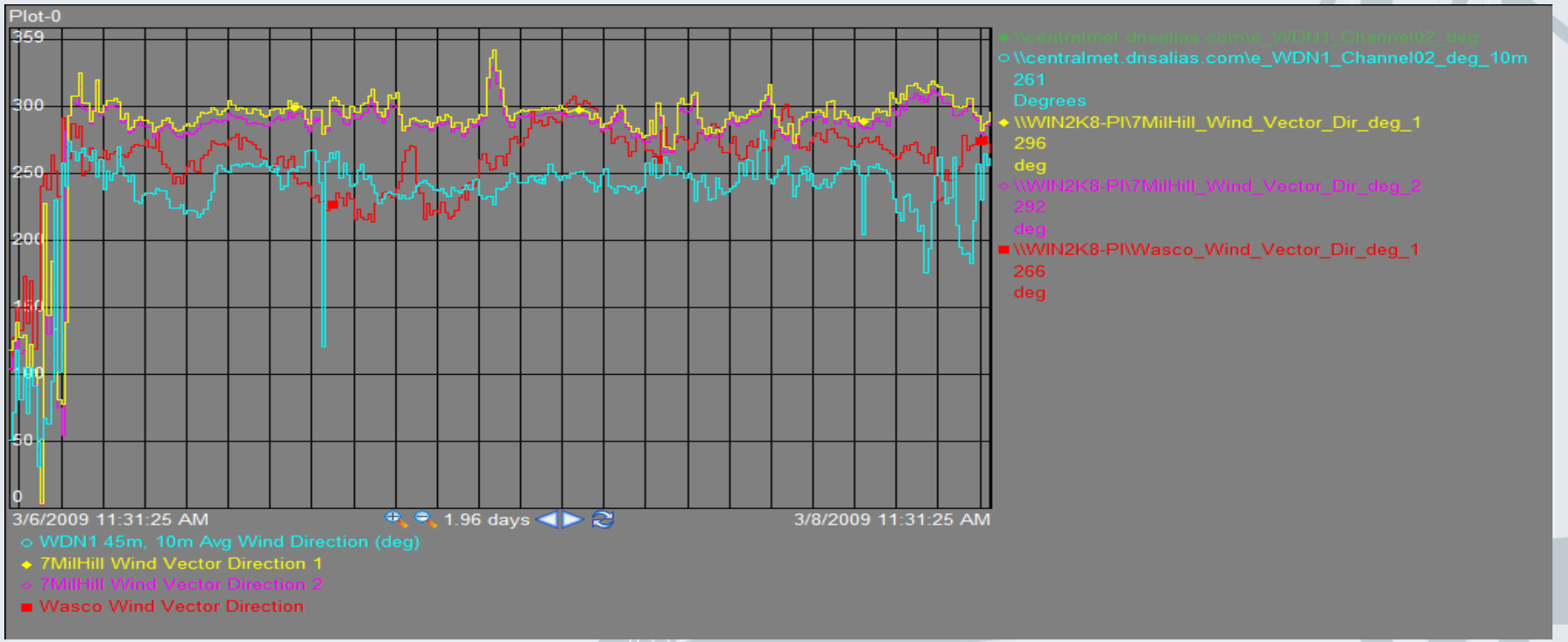
WDN Locations vs. BPA towers



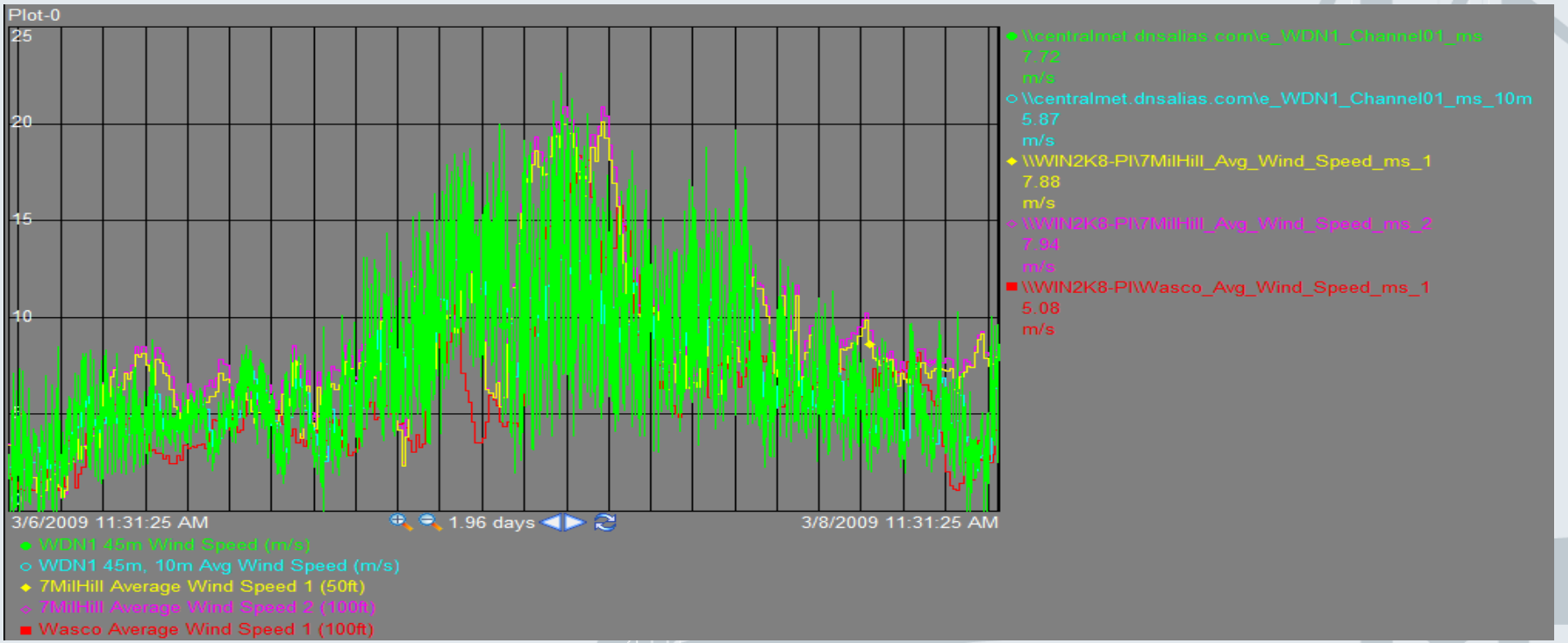
Average comparisons



Wind direction at the sites



Above average comparison



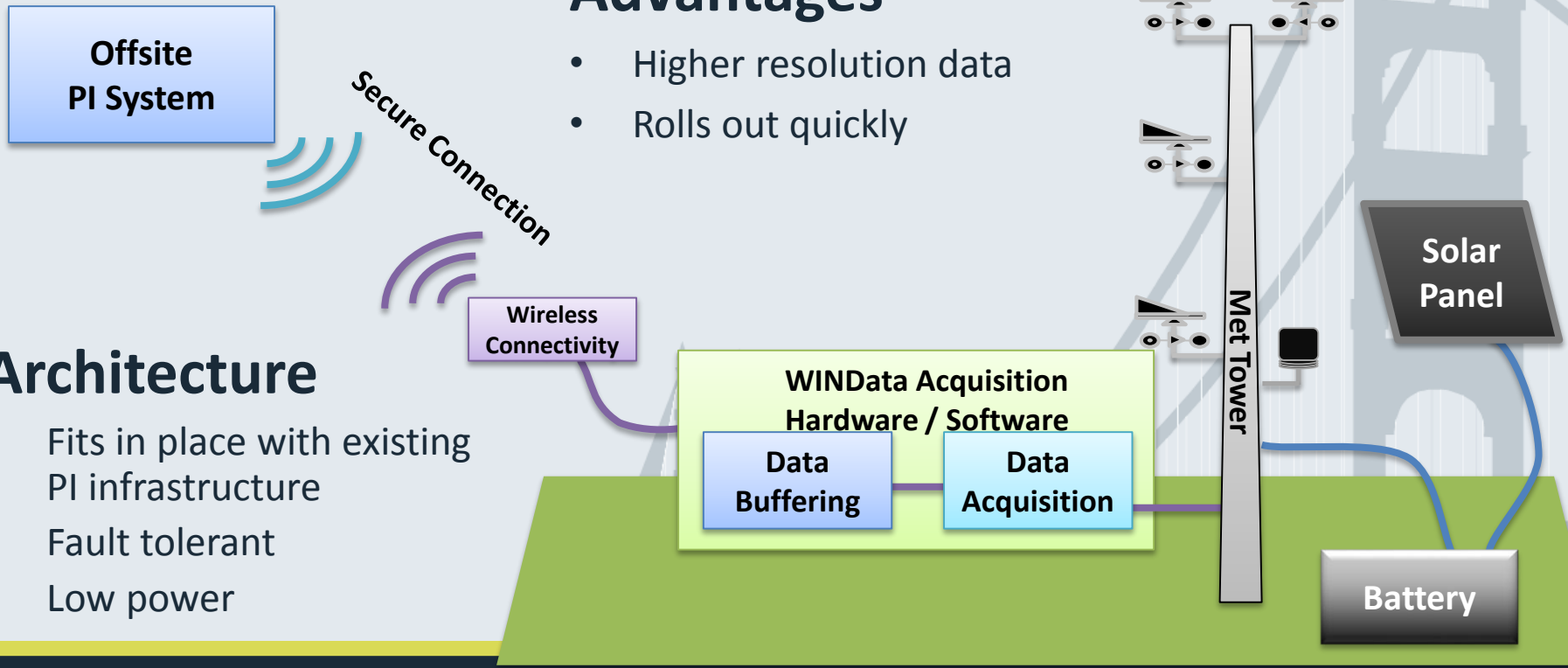
WINDataNOW model

- Data is consumed from neutral locations
  - Managed by WINData
- Data is available by subscription
  - Use PI to PI links to get the data
- Location sponsorship is available
- Some customers may want to retrofit their existing locations with WINData's logger

Acquisition architecture

Advantages

- Higher resolution data
- Rolls out quickly



Architecture

- Fits in place with existing PI infrastructure
- Fault tolerant
- Low power

Benefits of working on OSIsoft platform

Component	Advantage
PI Server	• Directly integrate with utilities and system operators • Spool data during connectivity outages
ECHO	• Speaks PINET over TCP/IP natively • Solution works immediately with Transpara's VisualKPI, Enterprise Horizons, and Industrial Evolution
New ECHO to PI Interface	
Partner network	

DEMO

D.I.Y.

http://demo.transpara.com/wind

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Conclusions

- WINData is nearing Phase 2 of its C-Gorge WINDataNOW project
- Working with forecast vendors, utilities, and system operators on how this can positively impact wind energy integration on the grid
- Working with some utilities on an informal basis in order to develop further insight

Special Thanks

- OSIsoft for its support
  - Johnson City office and the embedded team for ECHO work
  - Business Development and Sales for advocacy
- ProSoft for its continued support
- Transpara for use of it's VisualKPI software

Questions?

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