

# Wind Energy on an ISO System: Case Study

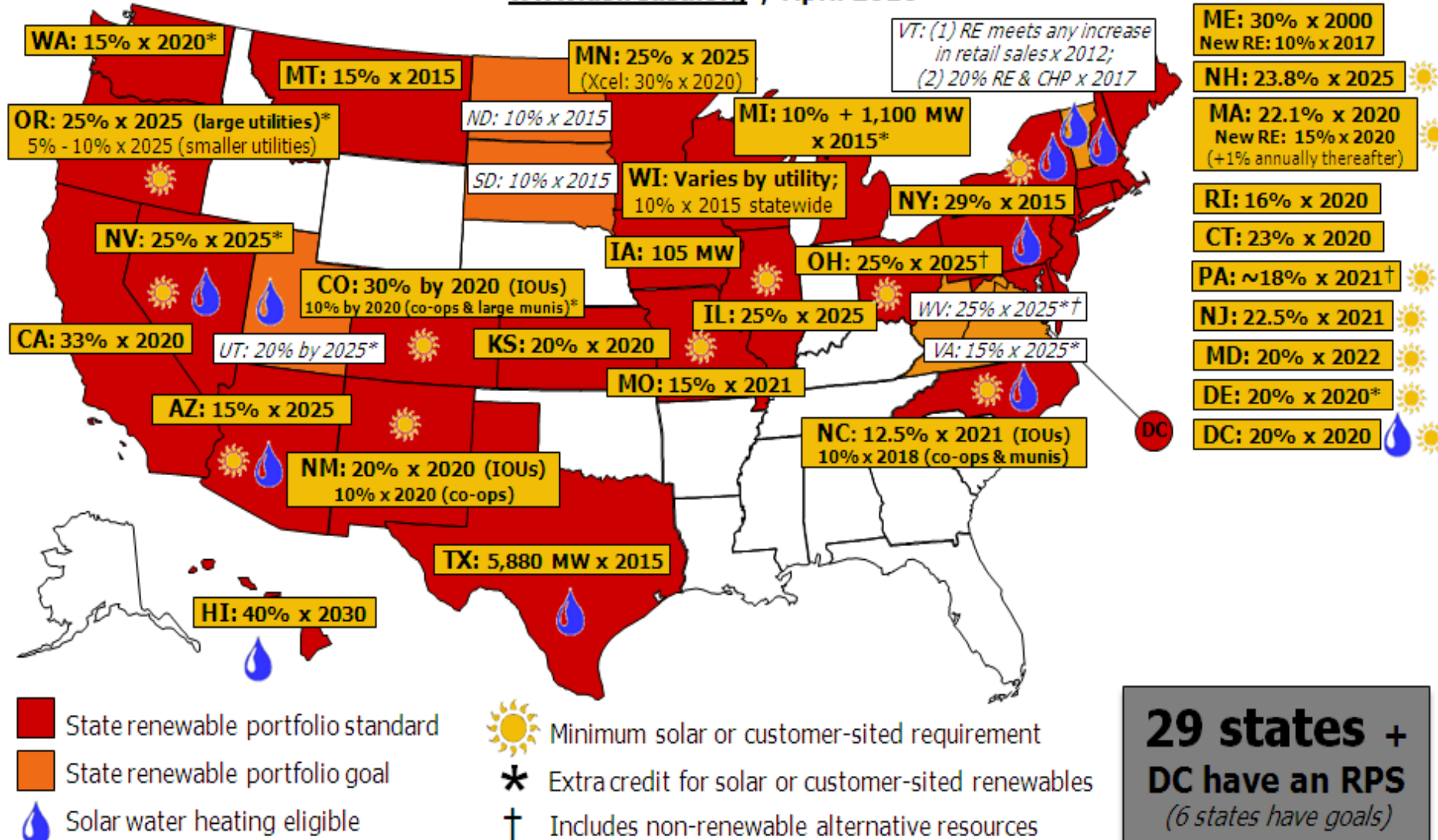
# The Daffy Duck Syndrome



# Groundswell of Government Mandates

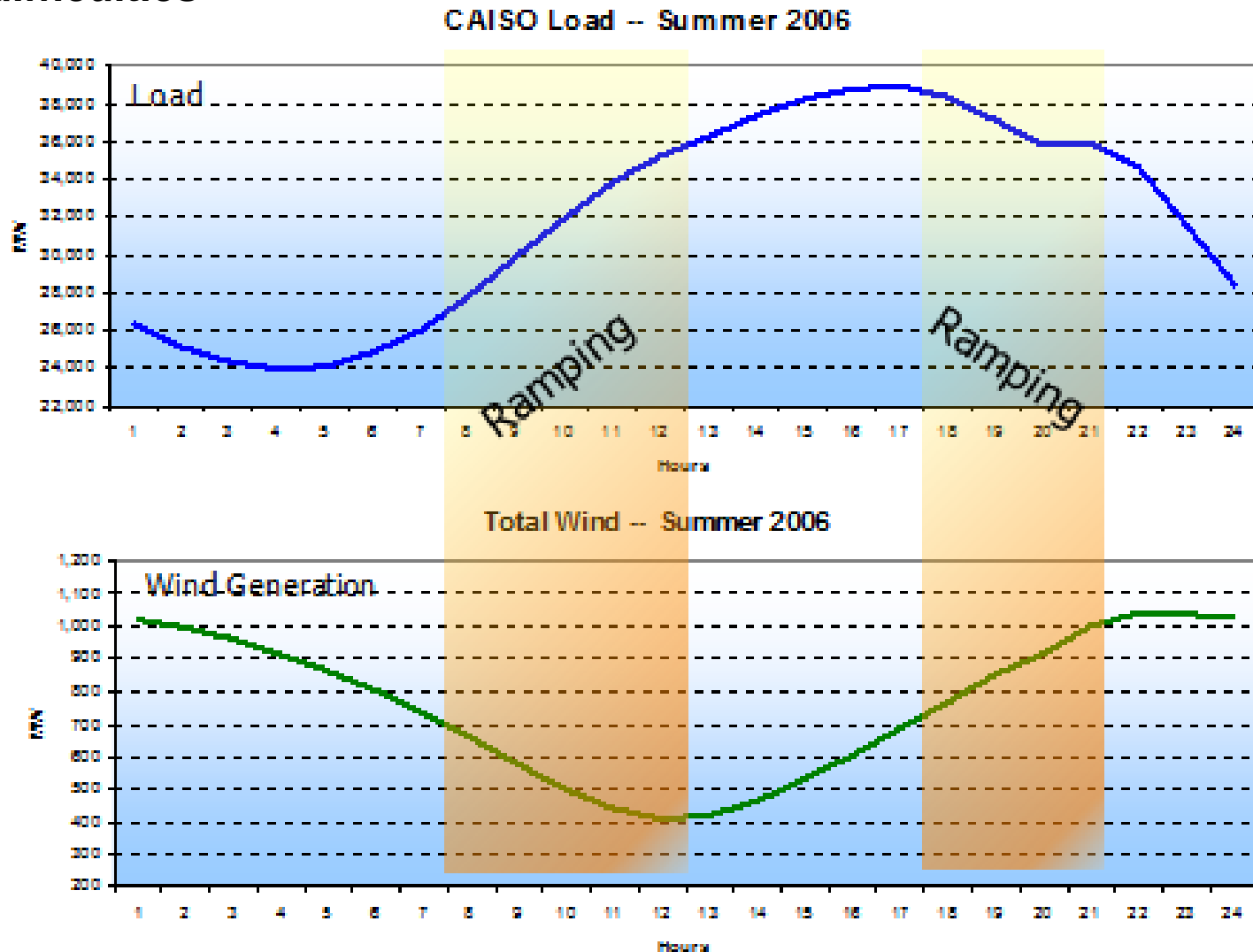
## Renewable Portfolio Standards

[www.dsireusa.org](http://www.dsireusa.org) / April 2010



# The Complicating Factor\* Intermittency

Supply prediction difficulties lead to regulation, reliability and market stability difficulties



\* Courtesy – Jim Detmers, CAISO & Daniel Brooks, EPRI

- **Average Forecast Error = 35%**
- **Total Annual Wind Mandate by 2020 = 10,000 TWh**
- **35% Error = 3500 Twh**
- **Price Per Mwh = \$ 40 (adjusted for inflation)**

$$3500 * 1000 * 1000 * \$ 40 = \$ 140,000,000,000$$

**\$ 140 Billion**

# Cosmic Dodge Ball



# Case Study: ISO

## Profile

- **Non Profit**
- **13 states**
- **131,000+ MW of generation capacity**
- **Stringent renewable portfolio mandates**
- **30 private wind farms**

## Operational Priorities

- **Smooth regional flow of electricity**
- **Competitive wholesale energy market**
- **Hedging congestion via financial transmission rights**
- **Regional planning**

## Challenges

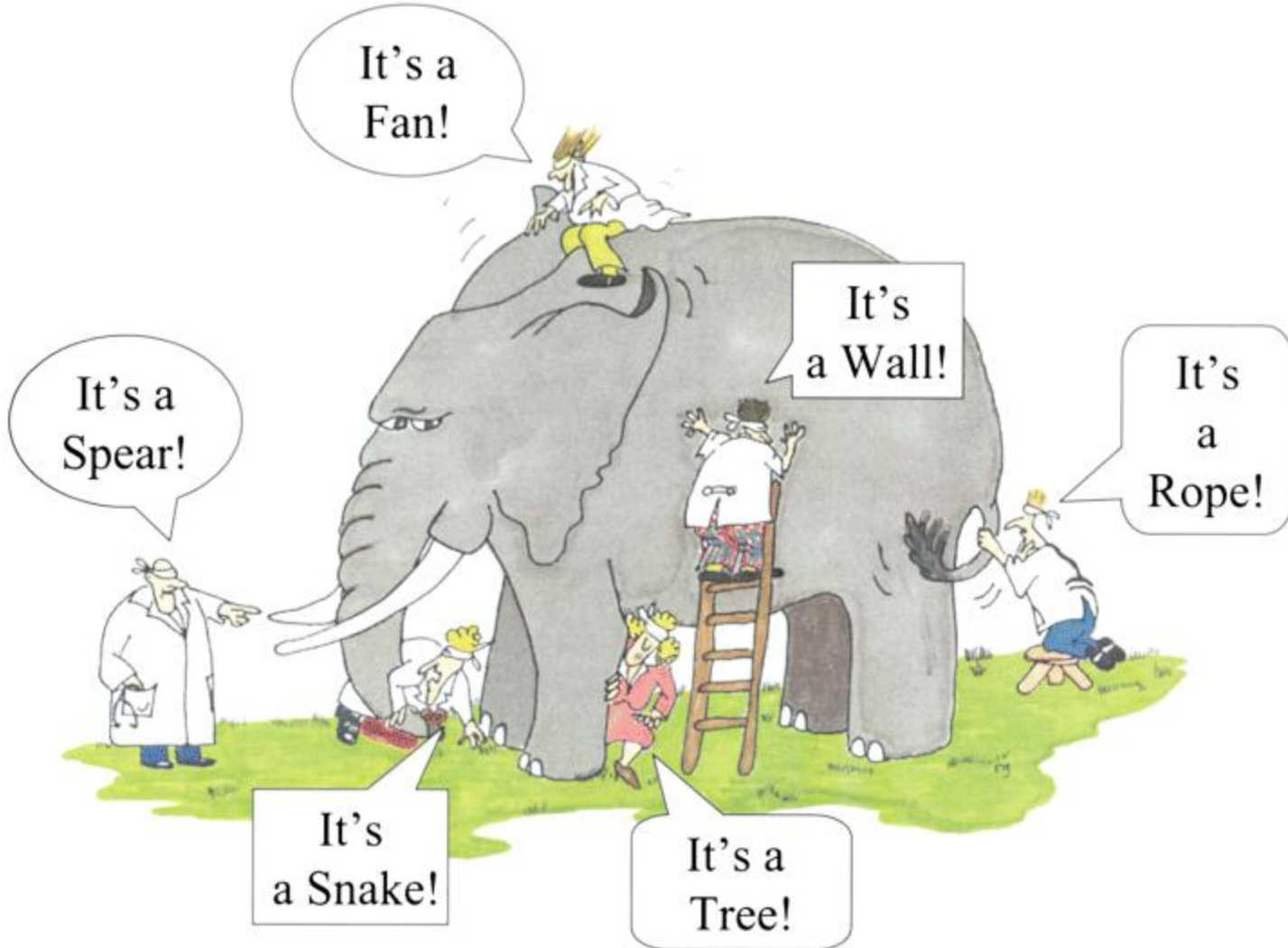
- **Wind forecasting - Variability and predictability**
- **Remote locations - Wind conditions at farm vs load conditions**
- **System flexibility - Ramping burdens**

## What's needed

- **Situational awareness for better wind & production forecasts**
- **Better ramp management**
- **Situational view of all virtual & physical generation options**
- **Geospatial asset monitoring to improve capacity factors**



# The Big Picture View



## **Situational Intelligence**

- **Real-Time monitoring of grid with enhanced visualization**

## **Contingency Analysis**

- **Optimal power flow under various conditions**

## **Alerts & Alarms**

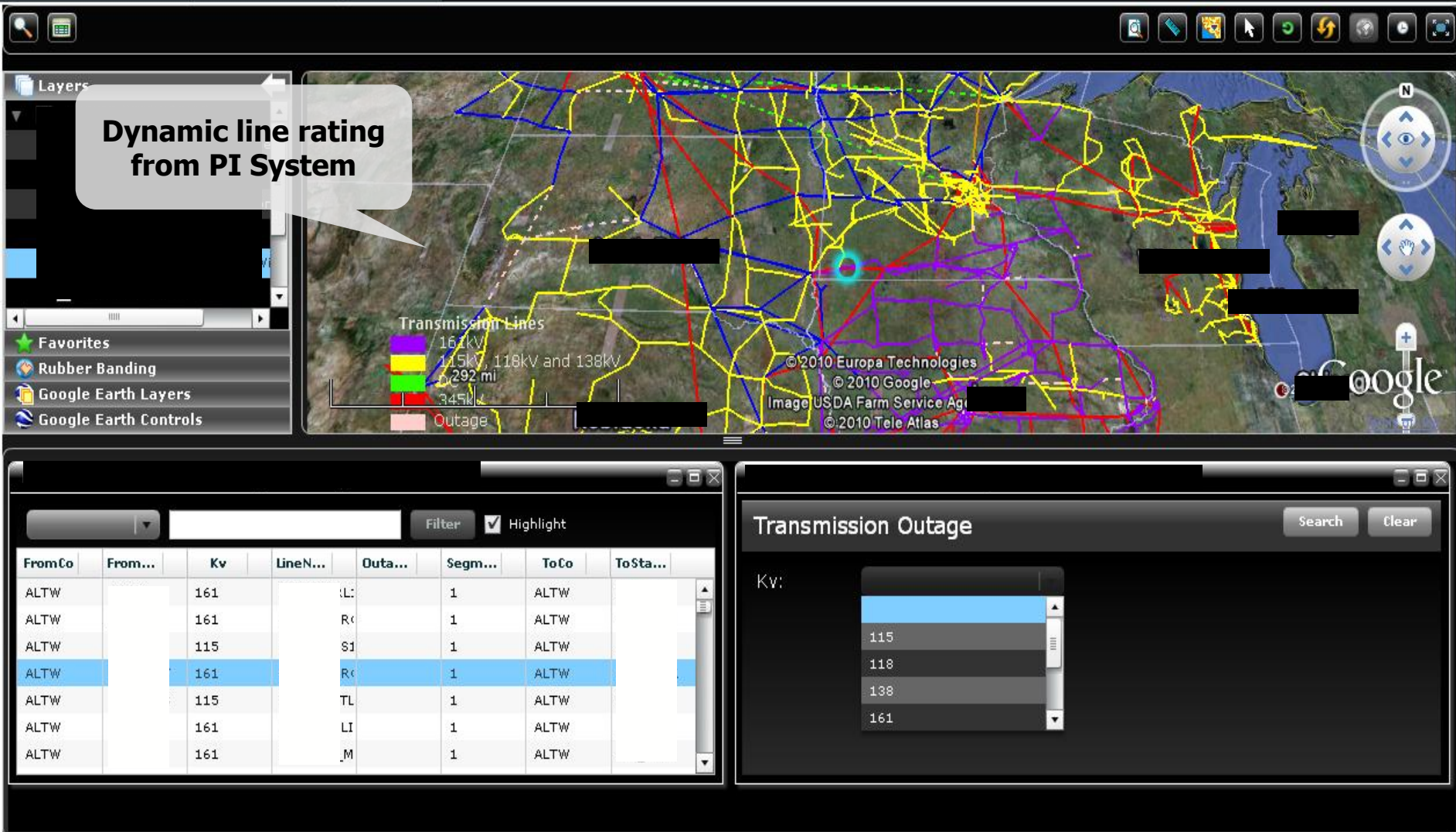
- **Unit commitment, dispatch, out-of-band performance**

## **Wind Energy Integration to Transmission Grid**

- **Economical integration with decreased curtailment.**

# Visualization of Real-Time Transmission Line Rating

SPACE•TIME•INSIGHT



Done

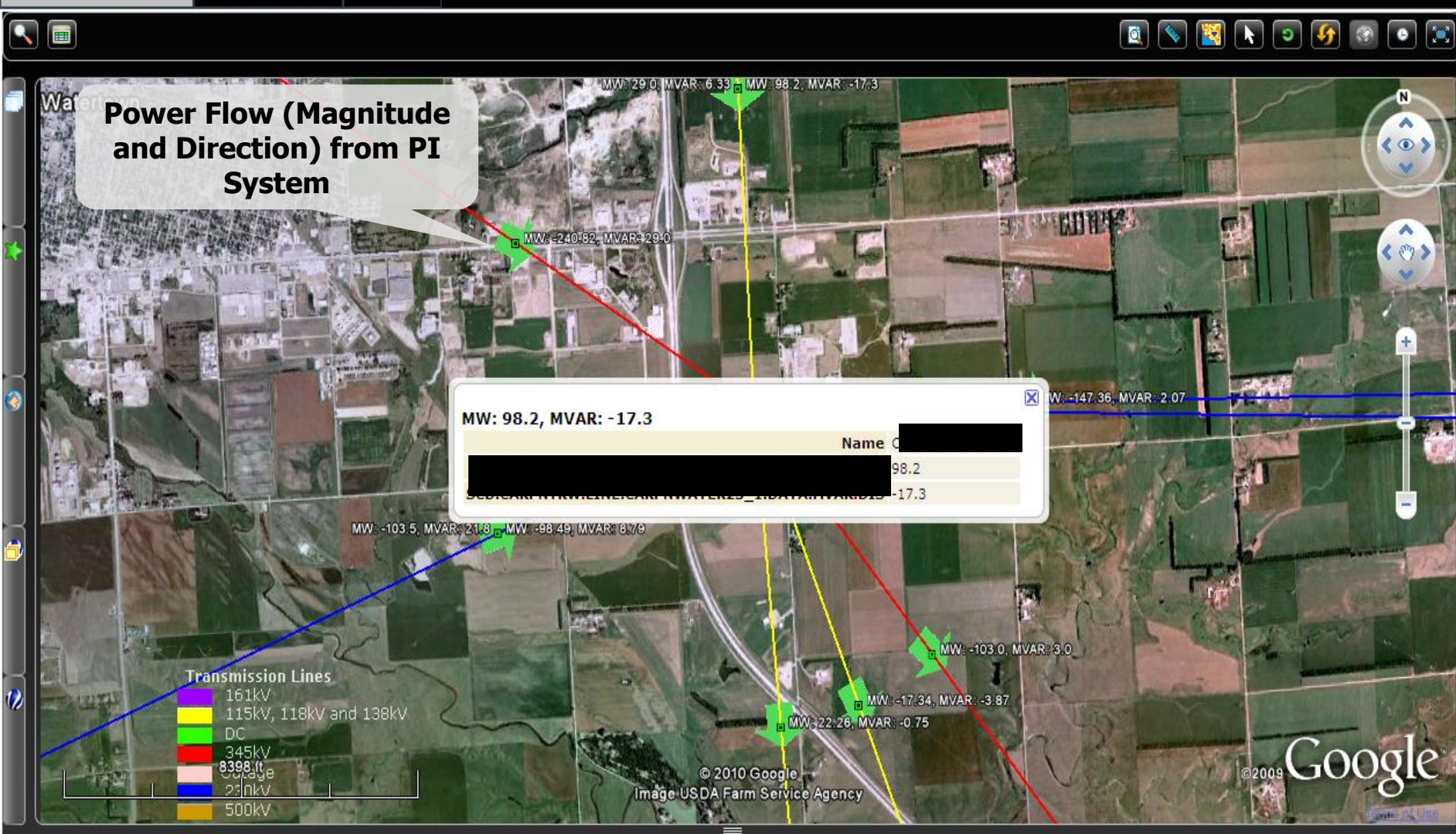
**To make this work reliably, the PI System is ...**

- **The system of record**
- **Real-time data and event infrastructure**
- **Repository for all time-series data**



# Real-Time Power Flow Visualization

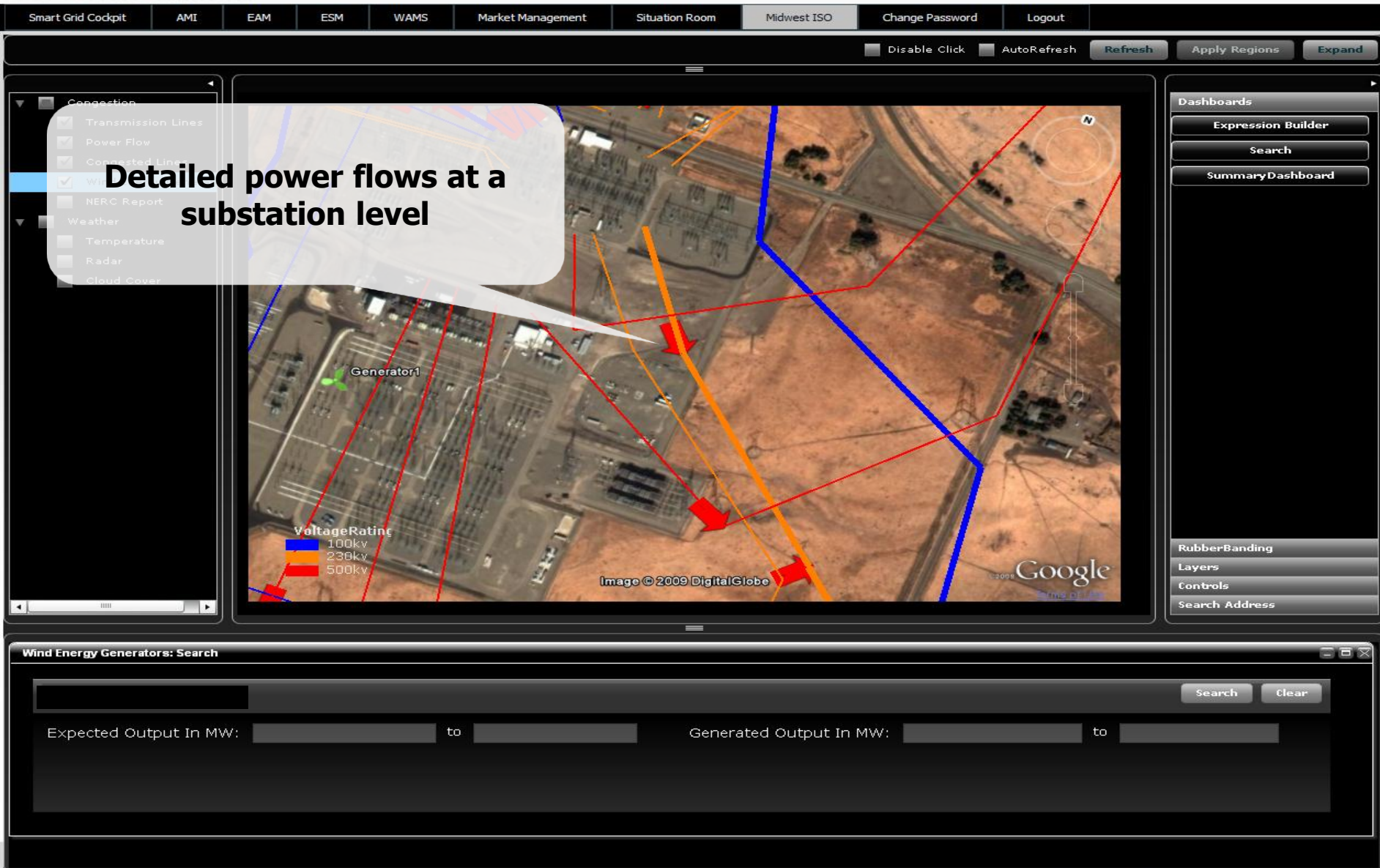
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Done

# Grid Integration - Detailed Visualization

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Done



# Wind Generation – Forecast Vs Actual

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Real Time Operations

Situation Ro



Actual Generation from PI

Forecasted Generation Based on Wind Forecast

Info Window

Actual

From: 04/14/2010 11:07:25 To: 04/14/2010 11:37:25

History: [Download] [Refresh] [Zoom]



Forecast

From: 04/14/2010 12:00:00 To: 04/19/2010 21:00:00

History: [Download] [Refresh] [Zoom]



Wind Curtailment Calcul:

Done

Local intranet

100%

# Wind Curtailment

SPACE•TIME•INSIGHT

Real Time Operations

Situation Ro



Wind Curtailment Calculations:

Constraint Name	MW Relief Needed
[Redacted]	100

Calculate

	Sensitivity	Firm	MW Reduction Needed From Each Unit	Unit Output
[Redacted]	-0.0692	0	1173	47.6
[Redacted]	-0.0684	0	275	11.177333
[Redacted]	-0.0684	0	0	0.0

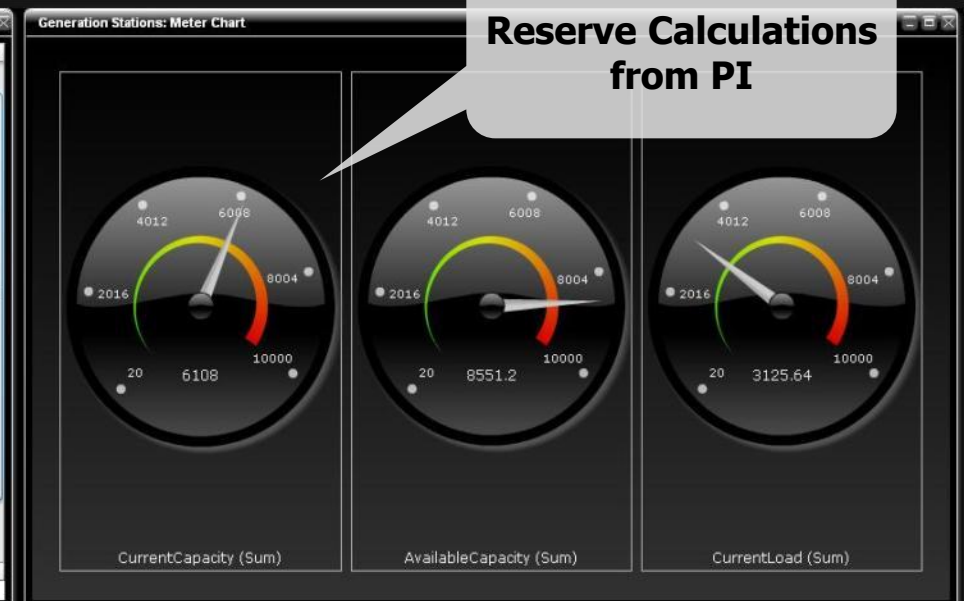


# Generation Imbalance and Reserve Calculations

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Welcome Demo User

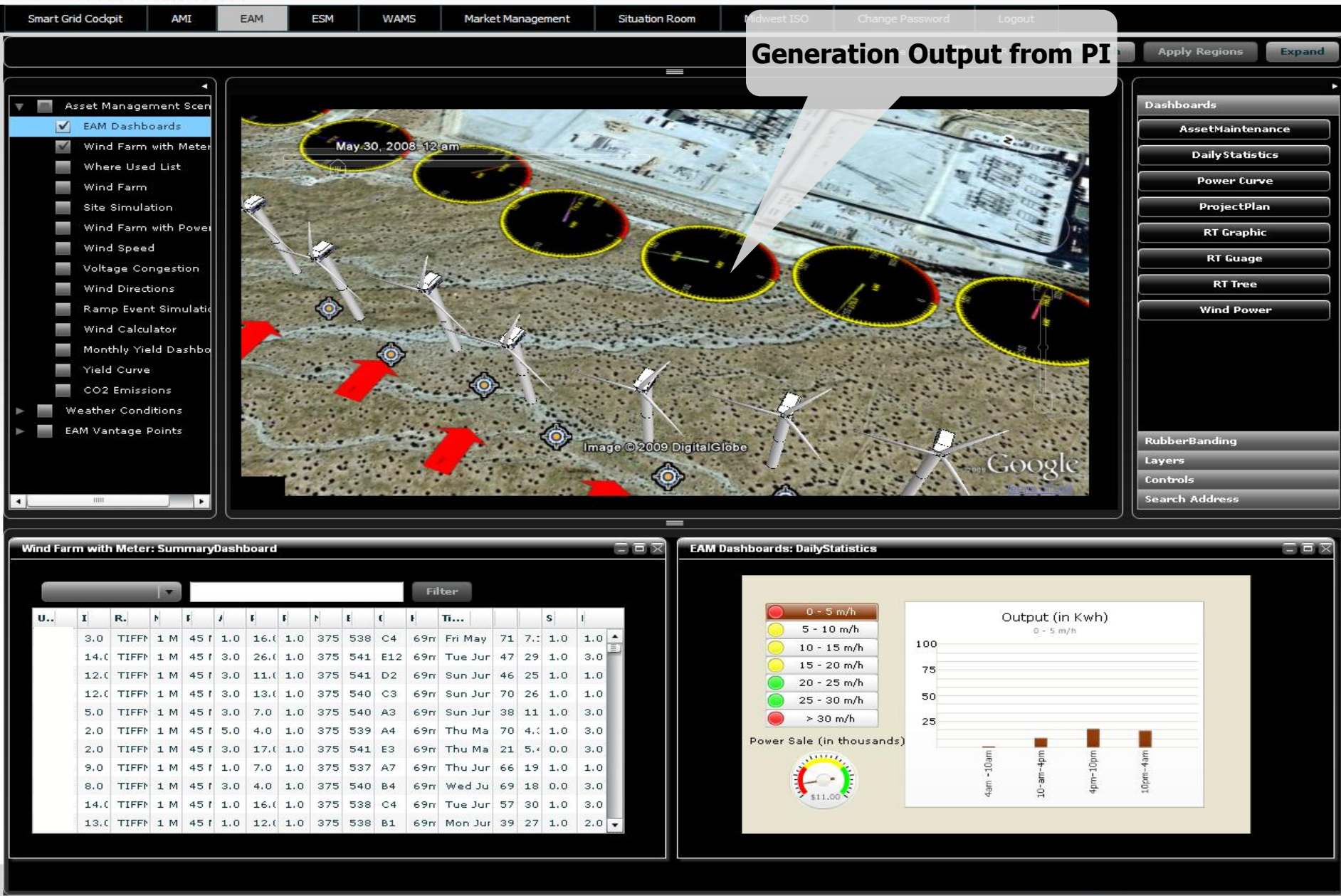
Perfect Dispatch Cockpit | Smart Cockpit | AMI | Renewable | Field Workforce | **WAMS** | Crisis Management | Market Management | ISO | Situation Room | SupplyChain | Logout



Done

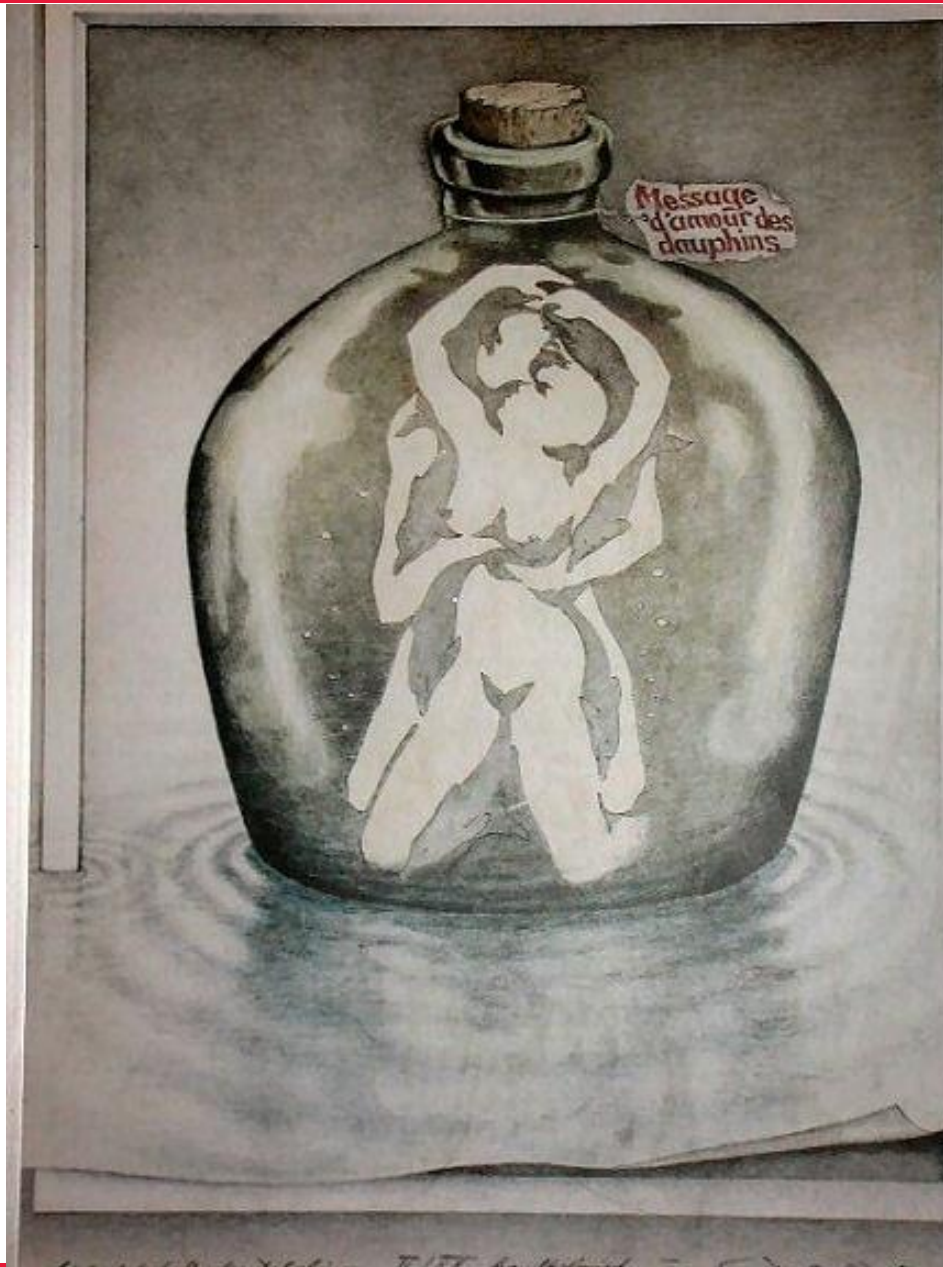
# Generation Forecast – Aggregated and Unit Simulation

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# Visual Bias



# Alerts: System Intact, Prior Outages , Pre-Contingency Conditions

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Real Time Operations

Situation Ro



**LWOG57:**

**115 kV line overload >95 % in RTCA :Check Lango**

al Generation Output -  
Wind



**Generation Output  
from PI**

Transmission Lines

- 161kV
- 115kV, 118kV and 138kV
- DC
- 345kV
- Outage
- 230kV
- over

**Audio / Text Alert for  
Line Overload Event**

**Visual Alert for Line  
Overload event**

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Done



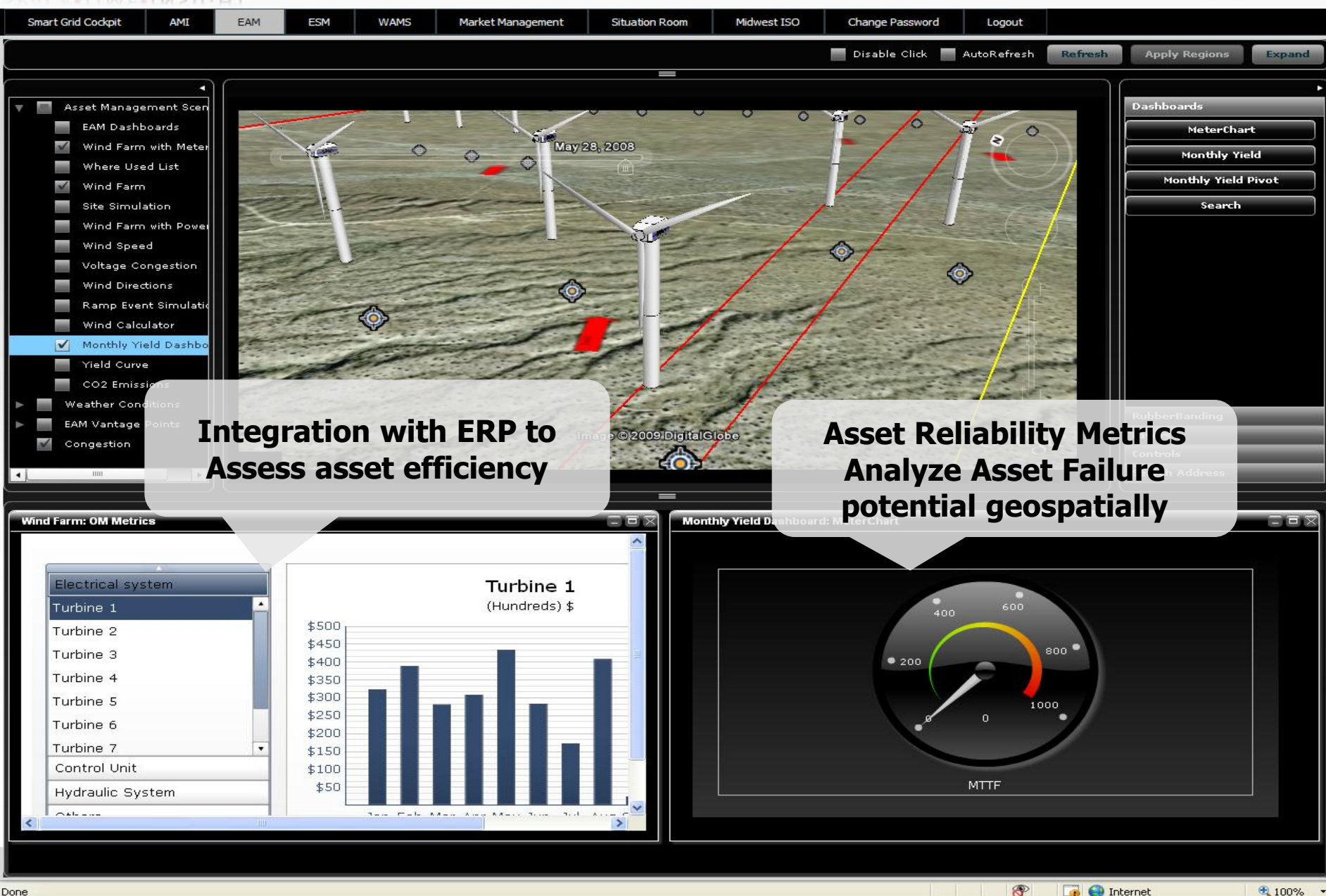
Local intranet

100%



# Renewable Assets – Operations

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# Asset Management

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Smart Grid Cockpit   AMI   **EAM**   ESM   WAMS   Market Management   Situation Room   Midwest ISO   Change Password   Logout

Disable Click   ☒ AutoRefresh   Refresh   Apply Regions   Expand

**Work Order Creation with SAP within SAP system by clicking on geo-artifacts**

**Realign production schedule on dashboard based on actual and available capacities**

**EAM Dashboards: RT Guage**

Create Notification

OK   Cancel   Reset

**Notification Details**

Notification Type: \* 11 - Malfuncn report RE  
Status: ☐ Complete  
Priority:   
Reported By:   
Short Description: Pump breakdown  
Detailed Description:

**Location**

Maintenance Plant: 3000 - New York  
Reference Object: Functional Location: Equipment: 10005706

**Work Planning**

Required Start Date: 03/02/2009  
Required End Date:   
Planner Group: 100 - Mr. Trintz  
Work Order: Order is not assigned

**EAM Dashboards: AssetMaintenance**

Q2, 2007

Name	1	Apr	May	Jun
1 Mw WTG				
WTG Unit 1				
WTG Unit 10				
WTG Unit 11				
WTG Unit 13				
WTG Unit 2				
WTG Unit 7				
500Kw WTG				
WTG Unit 12				

**Edit Maintenance**

New Maintenance  
Delete Maintenance

**Properties**

Wind Asset:  
WTG Unit 13

**Reason:**

☒ Upgrade  
☐ Operation  
☐ Operation Status  
☐ Preventive Maint

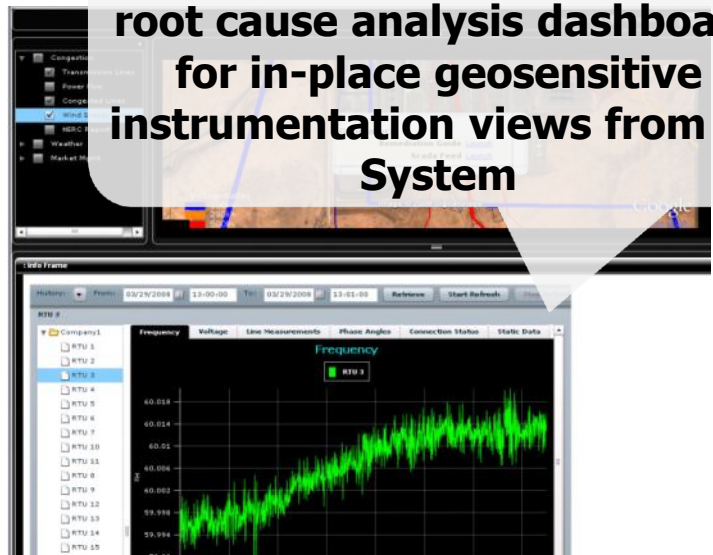
**From:**  
05/29/2007

# Reports

**Capacity assessments yield curve, capacity factor, actual vs. forecast assessments**



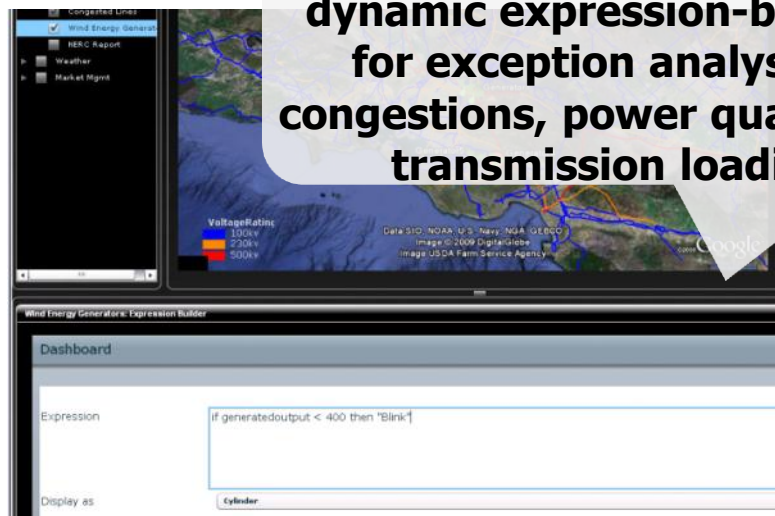
**Root cause analysis SCADA, root cause analysis dashboard for in-place geosensitive instrumentation views from PI System**



**Historical contingencies transmission congestion, power flow visualization, substation telemetry**

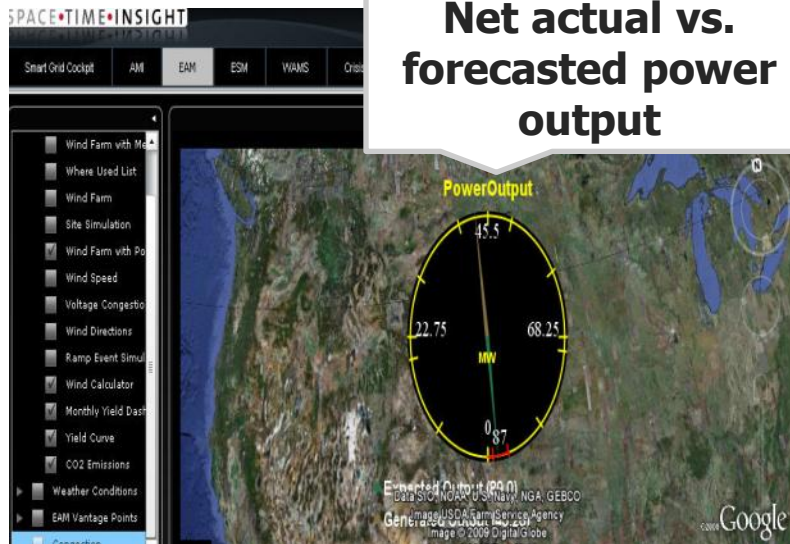


**Exception management dynamic expression-building for exception analysis of congestions, power quality and transmission loading**

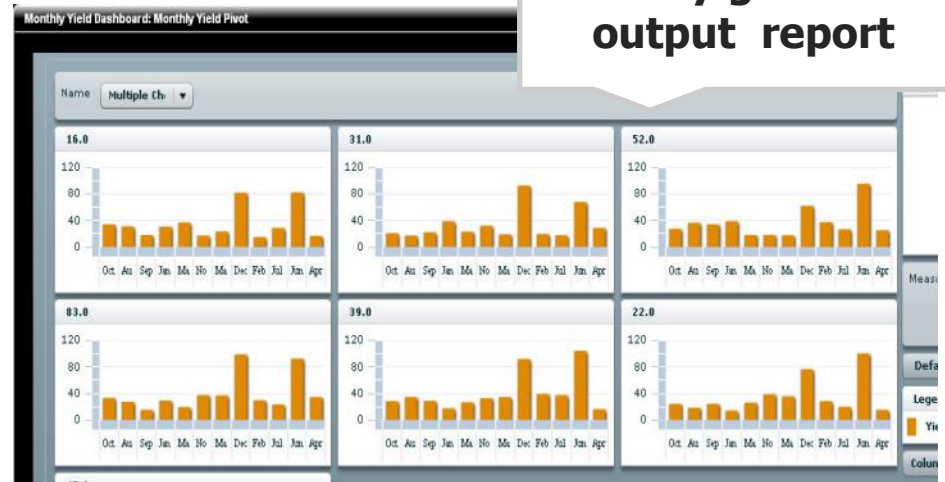




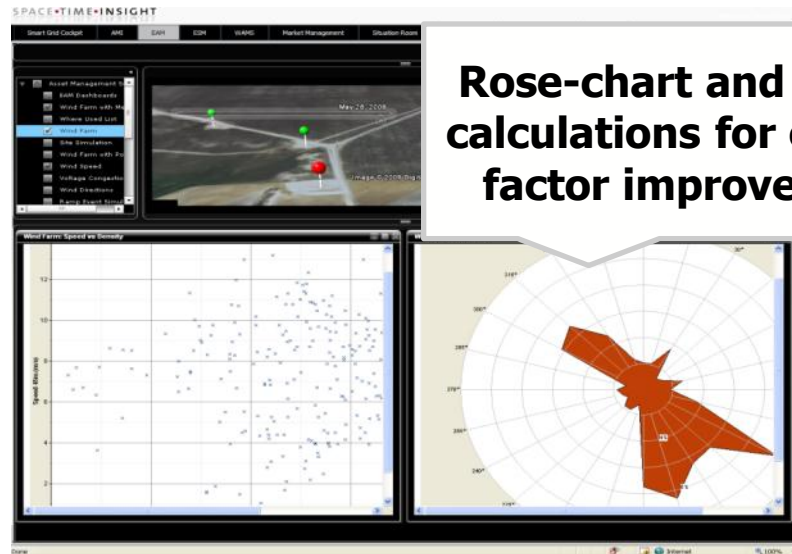
**Net actual vs. forecasted power output**



**Monthly generated output report**



**Rose-chart and density calculations for capacity factor improvements**





- **Economical integration** of renewable energy
- Operational & market **impact assessment**
- Better production forecasts **improved reliability and stability**
- **Better carbon footprint** management
- **Tracking** renewable portfolio and energy efficiency **goals**
- **Peak load reduction** through better renewable usage
- Improved flexibility in **balancing generation** portfolio
- Faster **ramp response** times
- **More renewable energy** to market - **faster, lower cost**

# Thank You !

