



# Tools for Site Selection of Utility Scale Renewable Power

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ABB Automation & Power World, WRE – 117-1

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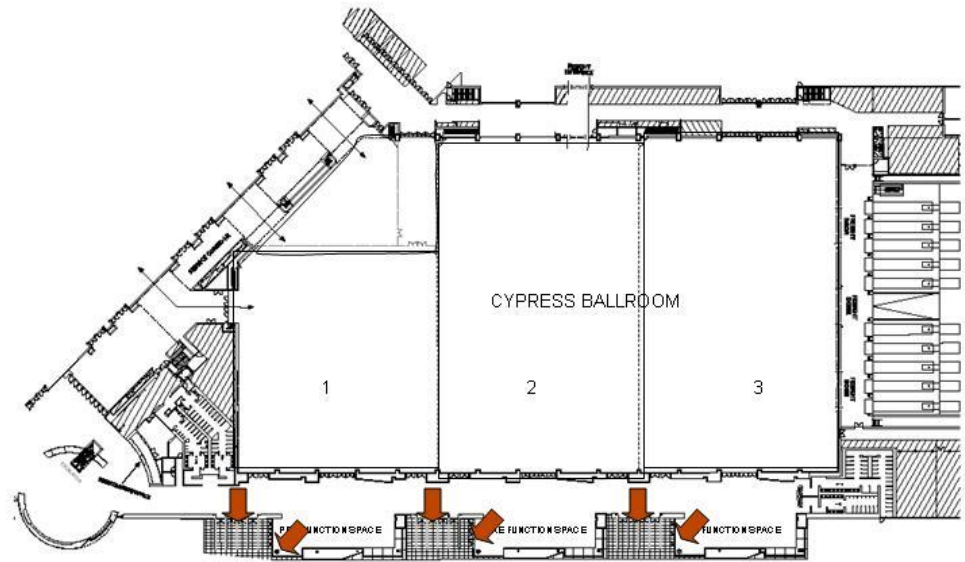
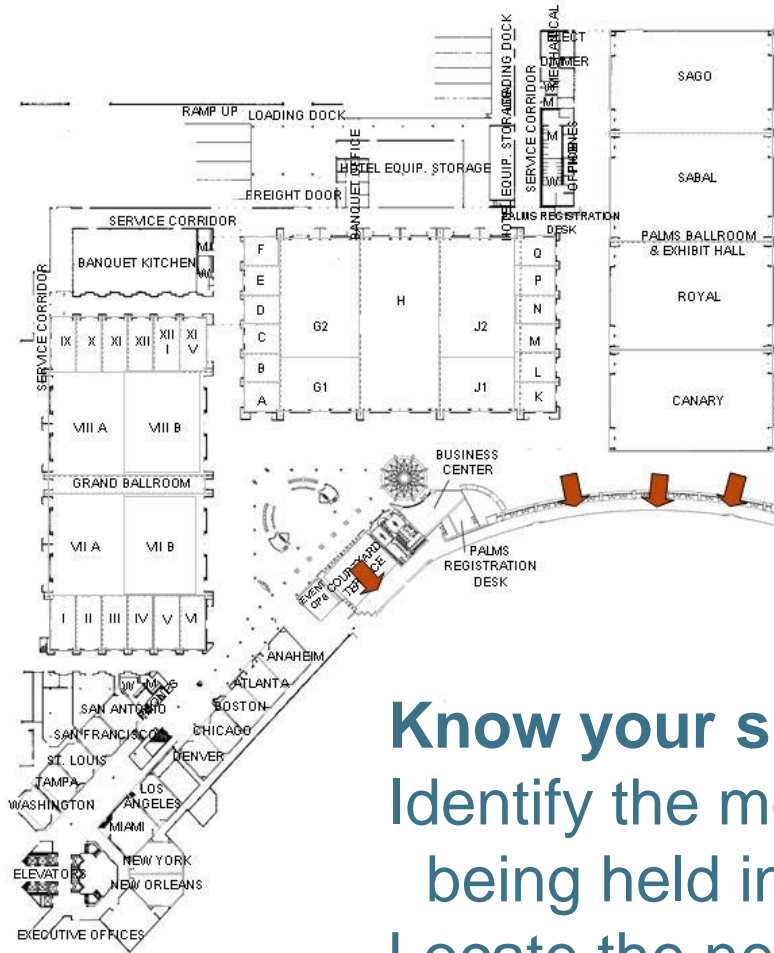
# Your safety is important to us

## Please be aware of these emergency procedures

- In the event of an emergency please dial ext. 55555 from any house phone. Do not dial 9-1-1.
- In the event of an alarm, please proceed carefully to the nearest exit. Emergency exits are clearly marked throughout the hotel and convention center.
- Use the stairwells to evacuate the building and do not attempt to use the elevators.
- Hotel associates will be located throughout the public space to assist in directing guests toward the closest exit.
- Any guest requiring assistance during an evacuation should dial “0” from any house phone and notify the operator of their location.
- Do not re-enter the building until advised by hotel personnel or an “all clear” announcement is made.

# Your safety is important to us

## Convention Center exits in case of an emergency

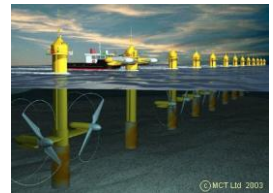


**Know your surroundings:**  
Identify the meeting room your workshop is being held in  
Locate the nearest exit

# Data, Mapping and Analytical Tools to Aid in Siting and Analysis of Renewable Plants



- Identifying existing and planned renewable plants
- Isolating potential project sites through intelligent Map tools
- Determining how congestion and losses affect prices
- Analyzing historical LMP prices and specific project locations
- Extracting historical LMP weather data impacting renewable plant operation
- Researching projects within ISO Interconnection Queues
- Charting hourly intermittent generation patterns





# Ventyx Strategic Focus is Aligned with Our Client's Biggest Challenges



## Managing Critical Infrastructure

- Real Time Awareness, Security & Control
- Asset Health, Safety, Compliance & Reliability
- Workforce Enablement and Optimization
- Asset Optimization and Performance



## Repowering the Future

- Enabling the nuclear renaissance
- Renewable energy expansion and operations
- Fifth fuel strategy adoption



## Source to Socket – A Smarter Grid

- Grid efficiency, reliability and DER integration
- Customer enablement and demand response
- Market management and participation

# Ventyx Solutions

## Business Intelligence

- ETL and Enterprise BI Model
- Data Warehousing

- BI & Performance Mgmt Applications
- Ad Hoc Reporting

- Reporting
- Dashboards & Scorecards

## Physical Asset & Work Mgmt.

- Asset Mgmt.
- Supply Chain
- Work Mgmt.
- Performance Monitoring
- Maintenance Optimization
- Operations Mgmt.
- Safety & Compliance
- System Health
- Equipment Reliability

## Mobile Workforce Mgmt.

- Forecasting & Planning
- Scheduling & Dispatch
- Mobile Work Execution

## Customer Mgmt.

- Customer Information
- Billing Management
- Call Center Management

## Network Management Systems

- Generation Coordination & Control
- Automated Generation Control
- Real Time Market Communications
- Control Area Function

- Security Control & Assessment
- Switching Control
- Transmission Coordination
- Reliability Management

- System Monitoring
- Switching Orders
- Reliability Control
- Volt/VAR Optimization

SCADA – Supervisory Control & Data Acquisition

## Energy Commercial Operations

- Load & Rev Forecasting
- Demand Response
- Trading & Risk Mgmt
- Smart Grid Operations
- Unit Optimization & Bidding
- Physical Scheduling
- Market Comms & Settlement

## Energy Planning & Analytics

- Forecasting & Analysis
- Market Price Formation
- Portfolio Analysis and Planning
- Market Data Intelligence
- Advisory Energy Consulting

# Renewable Project Development

## *Project Viability*



- *Financial*
- *Logistics*
- *Operation*
- *Risks*



# Renewable Project Development

## *Project Viability*



- **Revenue**
  - **Market Price**
  - **Purchase Agreement**
  - **Incentives**
- **Build**
  - **Location**
  - **Infrastructure**
  - **Grid Integration**
  - **Permitting & Regulatory Requirements**
  - **Politics**
  - **Design & Equipment Alternatives**

- **Financial**
- **Logistics**
- **Operation**
- **Risks**

- **Costs**
  - **Maintenance**
  - **Financing**
  - **Construction**
- **Operation**
  - **Intermittency**
  - **Curtailement**
  - **Reliability**

# Renewable Project Development

## Project Viability



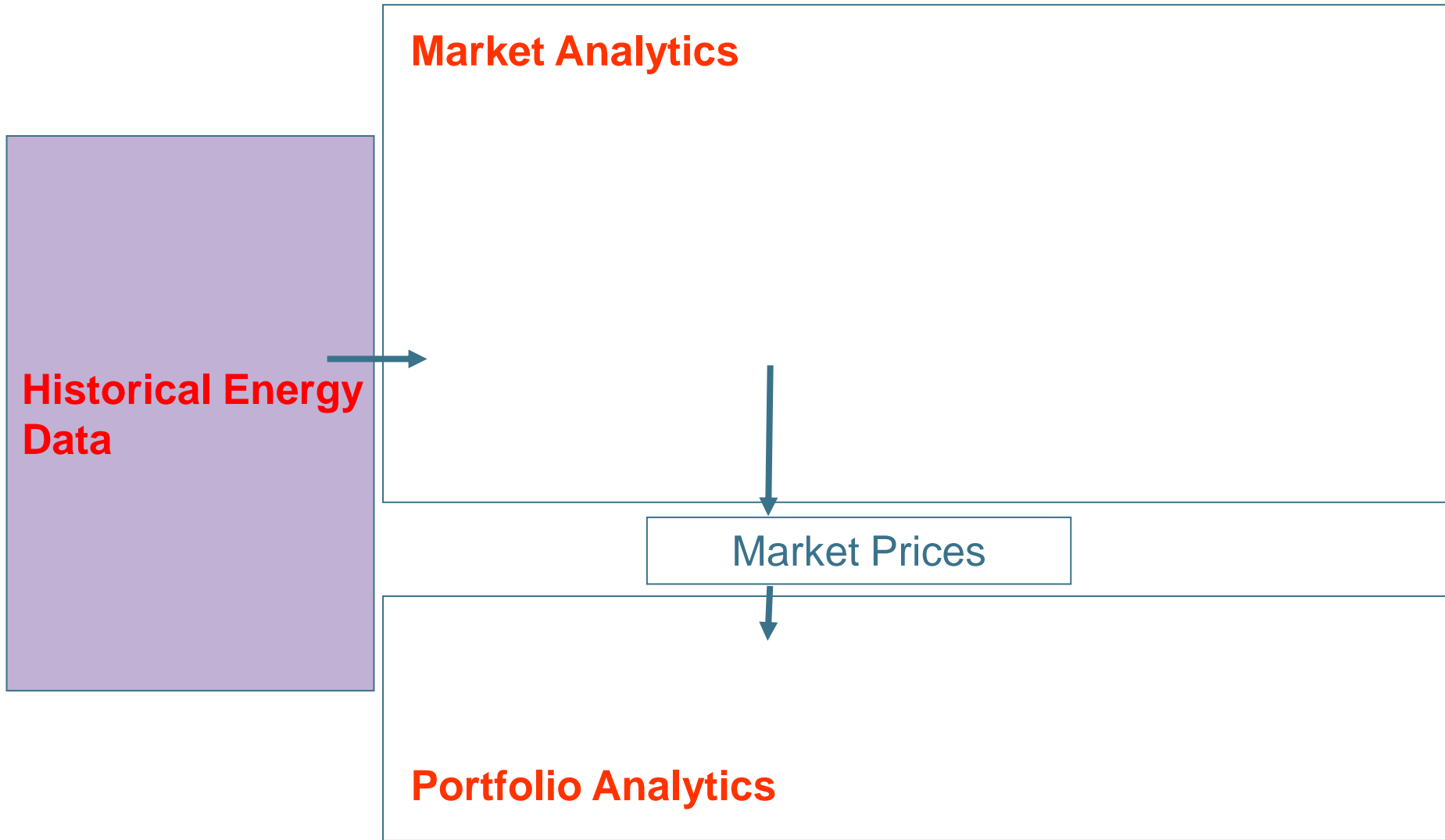
- Revenue
  - Market Price
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  - Grid Integration
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  - Politics
  - Design & Equipment Alternatives

- **Financial**
- **Logistics**
- **Operation**
- **Risks**

- Costs
  - Maintenance
  - Financing
  - Construction
- Operation
  - Intermittency
  - Curtailment
  - Reliability

- **Uncertainty**
  - Market Need
  - Market Structure
  - Competing Projects
  - Technology
  - Weather
  - Regulation
  - Value
  - Timing

# Tools to Understand & Quantify Uncertainty



# Tools to Understand & Quantify Uncertainty

## Historical Energy Data

- Demand
- Weather
- Unit Efficiency
- Unit Operation
- Fuel Usage
- Market Prices
- New Entrant Plans
- Retirement Plans

## Market Analytics

Market Prices

## Portfolio Analytics

# Historical Energy Data

## North America - Velocity Suite

### • **Market intelligence**

- Data Mining & Querying Capability
- Integrated visualization and relationship connectivity
- “Virtual Analyst” automate common tasks  
(e.g. Supply Curve, Briefing Books, Basis/Spark Spread)

### • **Content delivered in modules organized around areas of interest:**

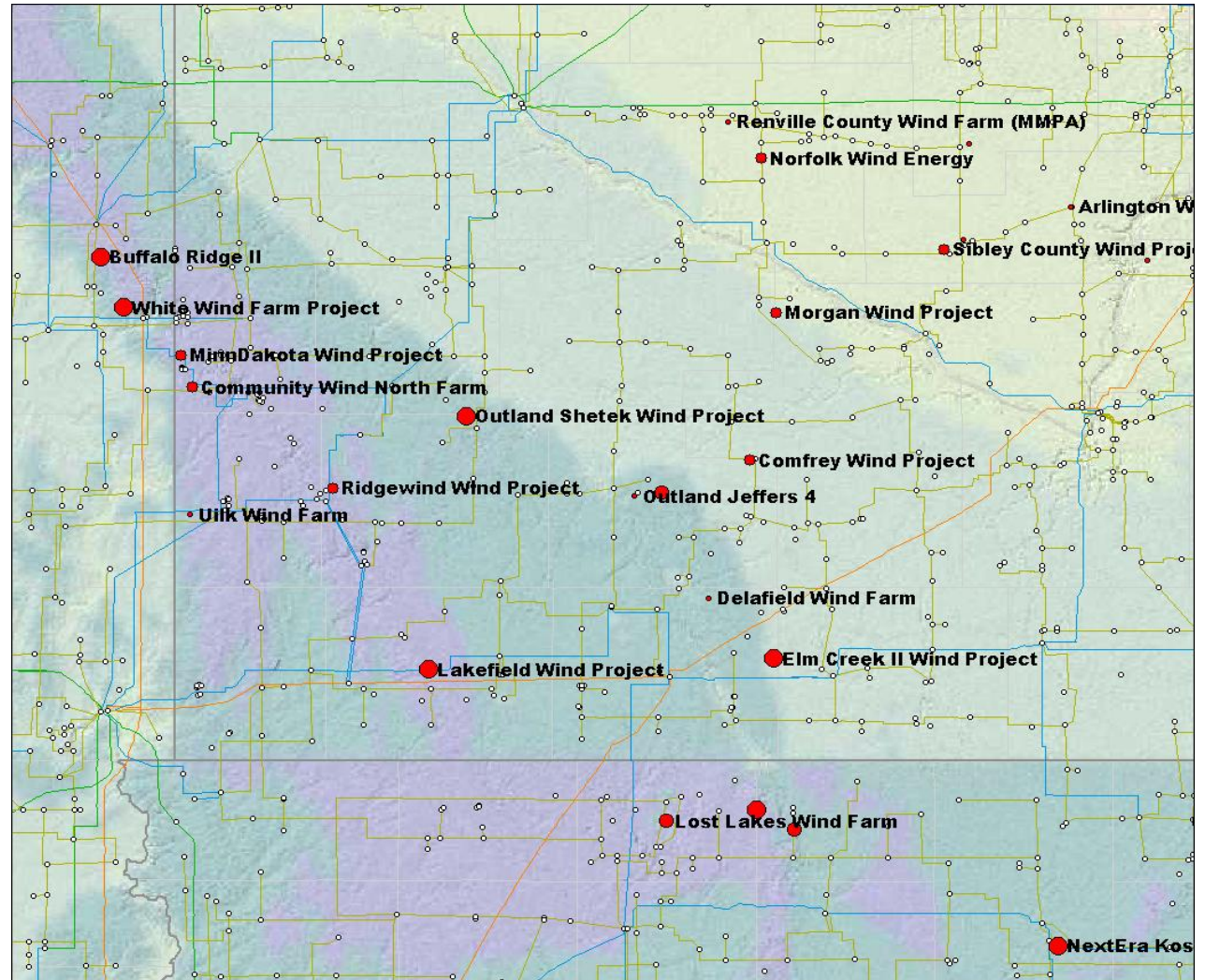
- EV Power & New Entrants: Higher level data on power plants, utilities, New Entrants research
- EV Market-Ops: ISO Price and Load, EPA Unit-level Emissions
- FTR Trader: Analytical support for FTR/CRR portfolio analysis
- \*\* EV Power Transactions: Highly detailed power transactions data from FERC EQR
- EV Energy Map: Integrated GIS platform for spatial analysis and data presentation
- \*\* EV GridMap: For visualizing nodal market results from PROMOD IV
- EV Fuels: Coal and Gas Market Data
- EV Weather: Historical Weather and Load

# Data Intelligence Insight

- **Data Services in one Integrated Application**
- **Investment Grade Data; Model Ready Data**
- **Data updated daily – “Yesterday’s Data for Use in Today’s decisions”**
- **EV Power with New Entrants**
  - Historical to current day coverage of electric markets
  - Tracking of future generation activity
  - Two year rolling electric price forecast
- **EV Fuels**
  - Pipeline activity
  - LDC coverage
  - Coal market fundamentals
- **FTR Trader**
  - Historical FTR source/sink performance
  - ISO auction results
  - Valuation of current or what-if portfolios
    - Ownership and profitability tracking
- **Power Transactions**
  - FERC EQR Data
- ▶ **EV Market-Ops**
  - EPA CEMS data
  - ISO pricing
  - Simulation model inputs
  - Hourly granularity
- ▶ **EV Energy Map**
  - Infrastructure of electric, natural gas, coal and emission markets
- ▶ **EV Weather**
  - Hourly historic weather observations
  - Normalized market data
  - 50 years of historic heating & cooling data
- ▶ **NG MarketView**
  - Daily NG market activity

# EV Energy Map

- ▶ Location, Location, Location
- ▶ What's a good place to build?
- ▶ Where can I connect?
- ▶ Who am I competing against?
- ▶ What other infrastructure is nearby?



# EV Power (and New Entrants)

- ▶ Who else is building in my area?
- ▶ What's the status of nearby projects?
- ▶ How much generation is being built in this area?
- ▶ Who else is building?
- ▶ How much more needs to be built to meet the state RPS?
- ▶ Where do we rank among our peers?

The screenshot displays the 'New Entrants Analyst' software interface. The main window is titled 'New Entrants Analyst - Summary : 1'. It features several sections for data selection and navigation:

- Entity Selection:** Includes dropdowns for 'Entity Type' (set to 'Holding Company Name') and 'Entity Values' (set to '<No Selected Values>').
- Geography Selection:** Includes dropdowns for 'Geographical Entity Type' (set to 'Plant NERC Region Name') and 'Entity Values' (set to 'Western Electricity Coordinating Council').
- Project Characteristics:** Includes a dropdown for 'Primary Fuel' (set to 'Wind').
- Navigation:** Includes buttons for back, forward, home, and search.

Below these sections is a list of 'Plant Name' entries, with 'Dry Lake Wind' selected. Below the list is an 'Intelligent Query Results - New Entrants' section showing a table of holding companies:

Holding Company Name
▶ Energias de Portugal SA
Invenergy LLC
Iberdrola SA
Clipper Windpower Inc
DKR Development LLC

The secondary window is titled 'New Entrants Analyst - Plant Report : 1'. It shows a detailed report for 'Dry Lake Wind' with the following sections:

- View Report For:** 'Dry Lake Wind'
- Overview Tab:** Contains a 'Project Description' and a 'Plant Attribute' table.

**Project Description:**

Dry Lake Wind is a newbuild project that consists of 2 phases. All phases are in development, the latest phase is due to be operational as of June 30, 2012 and the phases will add an additional 341.14 megawatts to the power supply. The project is powered by Wind. Of the capacity in the operational and in development phases, 63.00 megawatts have been contracted to specified buyers. The first reference for this project is dated September 9, 2005 and it was last edited on May 11, 2009.

**Plant Attribute Table:**

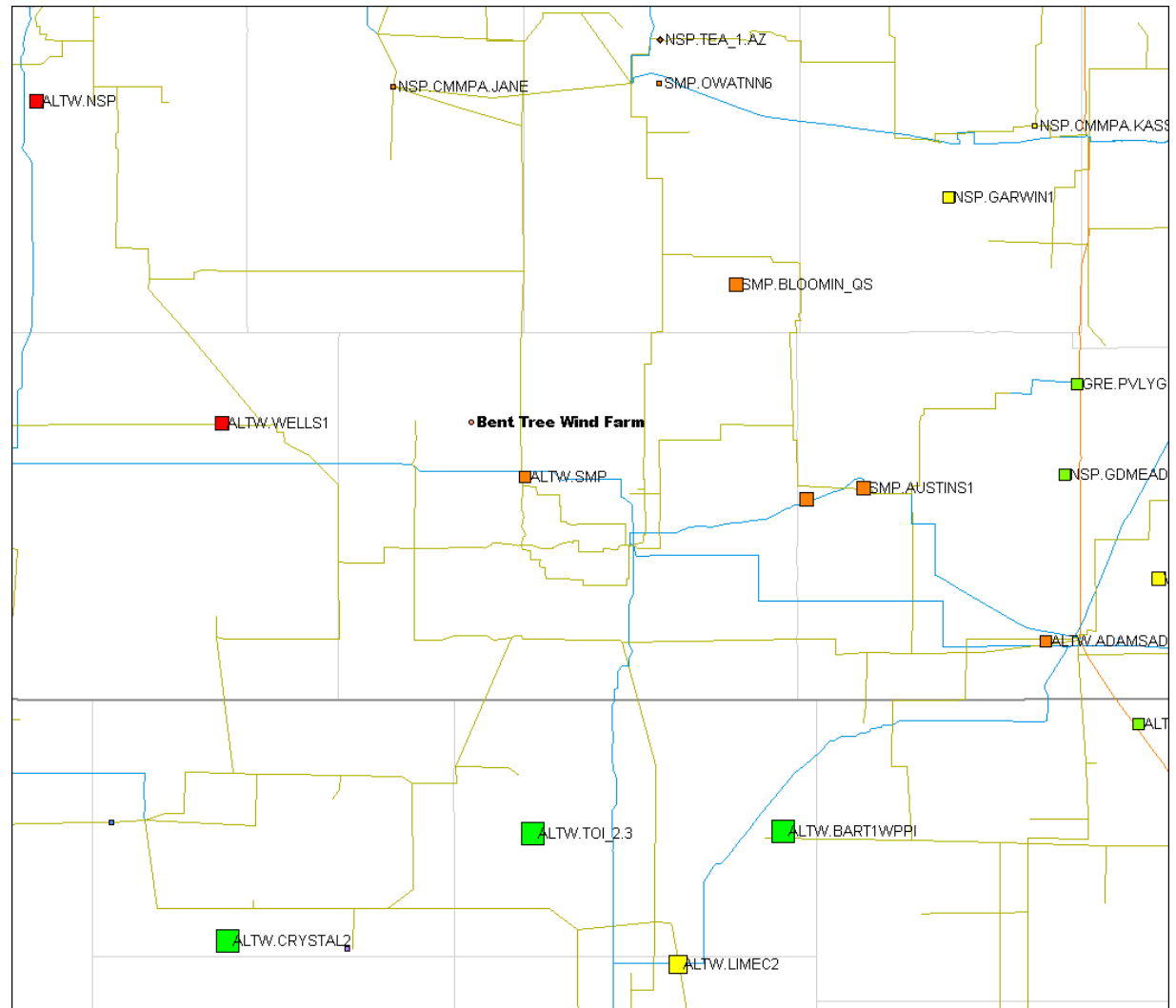
Plant Attribute	Plant Attribute Value
▶ Plant Name	Dry Lake Wind
Plant Aliases	PPM Navajo Wind
Plant Operator Name	Iberdrola Renewables Inc
Plant NERC Region Abbrev	WECC
Plant NERC Sub Region Abbrev	AZNSMNW
Plant State Abbrev	AZ
Plant City	
Plant County	Navajo
Weather Station	Flagstaff Pulliam Arpt
Plant ICE Gas Price Point Name	Transwestern Pipeline Co Central Pool
Latitude	34.6802
Longitude	-110.3290

On the right side of the report, there is a map showing the project location in Arizona. The map includes a legend for 'Power Plants' (red circle), 'Transmission Lines' (yellow line), and 'Substation Overview' (orange square). The Ventyx logo is visible in the bottom right corner of the map area.



# EV Market-Ops

- ▶ What are LMP prices near my site?
- ▶ How much congestion?
- ▶ How volatile are prices?
- ▶ What are the hourly pattern of prices?
- ▶ What is the hourly generating pattern of thermal plants?



# Value of Velocity Suite to Solar Developers

- **Project Site Analysis**

- Overlaying plant locations on solar intensity maps
- Assess nearest electric and physical infrastructure (roads, transmission lines, substations)
- Competitor assessment
- Congestion screening

- **Estimate revenue potential of project**

- Matching site locations to historical nodal prices or future forecasts to assess measured value by PPA purchaser

# Ventyx Solutions for Wind Developers

- Market Data Intelligence: GIS-Interactive Mapping, Existing and Future Power Project Tracking, Historical Market Pricing (zonal and nodal), PPA Pricing Analysis, Flowgate Analysis, Infrastructure and Ownership Analysis, Project Siting Analysis, Short-term Power and Fuel price forecasts
- Customer Intelligence: Wind turbine manufacturers use our database of over 8,000 wind projects that have not publically announced a turbine manufacturer selection to mine and qualify prospects. Linked with the project locations, owners, phone numbers, and other projects in the pipeline, this is a great resource for identifying and screening prospects. Gathering background data on US developers who are inquiring about your turbines.
- Generation and Transmission infrastructure is accurate to within 40 feet; includes ownership and future projects. Fully integrated with over 130 datasets for market and project-specific analysis.
- Web-based solution with advanced querying and interactive GIS mapping tools.

# Summary of EQR Data

- **Filed Quarterly**
  - Market Based Rate Tariff Holders
- **MBR filers must file even with no transactions**
- **Reports all existing contracts**
  - By buyer and Seller and includes terms.
- **Over 50 separate products reports**
  - Energy
  - Booked Out Power
  - Energy Imbalance
  - Regulation & Frequency Response
- **Transaction by Transaction Detail**
  - Over 217 million rows of data.
  - Averages 8.9 million records per quarter

# Wind Data within the EQR

- **Data is filed by company**

- Sometimes EQR respondent is a small wind LLC

- and the company owns/operates a single wind plant

- Klondike Wind Power II LLC

- Diablo Wind LLC

- Can see Quarterly Contract Data

Year	Quarter	Seller Company	Buyer Company	Contract Type	Contract Term	Contract Increment	Contract Product Type	Contract Product	Contract Rate	Contract Units
2009	Q2	Klondike Wind LLC	Bonneville Power Administration	Firm	Long-Term	Yearly	Market Based	Energy	35.00	\$/MWH
2009	Q2	Klondike Wind LLC	Iberdrola Renewables Inc	Firm	Short-Term	Hourly	Market Based	Energy	34.65	\$/MWH
2009	Q1	Klondike Wind LLC	Bonneville Power Administration	Firm	Long-Term	Yearly	Market Based	Energy	35.00	\$/MWH
2009	Q1	Klondike Wind LLC	Iberdrola Renewables Inc	Firm	Short-Term	Hourly	Market Based	Energy	34.65	\$/MWH
2008	Q4	Klondike Wind LLC	Bonneville Power Administration	Firm	Long-Term	Yearly	Market Based	Energy	35.00	\$/MWH
2008	Q4	Klondike Wind LLC	Iberdrola Renewables Inc	Firm	Short-Term	Hourly	Market Based	Energy	34.65	\$/MWH
2008	Q3	Klondike Wind LLC	Bonneville Power Administration	Firm	Long-Term	Yearly	Market Based	Energy	35.00	\$/MWH
2008	Q3	Klondike Wind LLC	Iberdrola Renewables Inc	Firm	Short-Term	Hourly	Market Based	Energy	34.65	\$/MWH
2008	Q2	Klondike Wind LLC	Bonneville Power Administration	Firm	Long-Term	Yearly	Market Based	Energy	35.00	\$/MWH
2008	Q2	Klondike Wind LLC	Iberdrola Renewables Inc	Firm	Short-Term	Hourly	Market Based	Energy	34.65	\$/MWH
2008	Q1	Klondike Wind LLC	Bonneville Power Administration	Firm	Long-Term	Yearly	Market Based	Energy	35.00	\$/MWH
2008	Q1	Klondike Wind LLC	Iberdrola Renewables Inc	Firm	Short-Term	Hourly	Market Based	Energy	34.65	\$/MWH
2007	Q4	Klondike Wind LLC	Bonneville Power Administration	Firm	Long-Term	Yearly	Market Based	Energy	35.00	\$/MWH
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2007	Q4	Klondike Wind LLC	Bonneville Power Administration	Firm	Long-Term	Yearly	Market Based	Energy	35.00	\$/MWH
2007	Q4	Klondike Wind LLC	Bonneville Power Administration	Firm	Long-Term	Yearly	Market Based	Energy	35.00	\$/MWH

# Wind Data within the EQR

- **Hourly Transaction Data**
  - Includes Delivery Control Area

Year	Quarter	Seller Company	Buyer Company	Transaction Start	Transaction End	Delivery Control Area	Quantity	Price	Units	Total Transaction Charge
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 23	07/01/2009 00	CISO	17.73	43.43	\$/MWH	769.86
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 21	06/30/2009 23	CISO	17.75	43.43	\$/MWH	770.73
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 21	06/30/2009 21	CISO	17.71	43.43	\$/MWH	769.30
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 20	06/30/2009 21	CISO	17.52	43.43	\$/MWH	760.79
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 18	06/30/2009 20	CISO	12.37	43.43	\$/MWH	537.11
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 18	06/30/2009 18	CISO	2.59	43.43	\$/MWH	112.61
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 17	06/30/2009 18	CISO	0.09	43.43	\$/MWH	4.04
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 12	06/30/2009 14	CISO	0.01	43.43	\$/MWH	0.27
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 09	06/30/2009 11	CISO	0.07	43.43	\$/MWH	2.91
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 09	06/30/2009 09	CISO	1.55	43.43	\$/MWH	67.35
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 08	06/30/2009 09	CISO	6.93	43.43	\$/MWH	300.81
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 06	06/30/2009 08	CISO	6.22	43.43	\$/MWH	269.96
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 06	06/30/2009 06	CISO	11.07	43.43	\$/MWH	480.97
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 05	06/30/2009 06	CISO	15.65	43.43	\$/MWH	679.89
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 03	06/30/2009 05	CISO	17.61	43.43	\$/MWH	764.79
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 03	06/30/2009 03	CISO	17.80	43.43	\$/MWH	773.09
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 02	06/30/2009 03	CISO	17.74	43.43	\$/MWH	770.59
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 00	06/30/2009 02	CISO	17.74	43.43	\$/MWH	770.37
2009	Q2	Diablo Wind LLC	Pacific Gas & Electric Company	06/30/2009 00	06/30/2009 00	CISO	17.75	43.43	\$/MWH	770.75

# Wind Data within the EQR



# EQR Data going to EV Power

## • Quarterly Summary Information

- For Energy and Book Out Power
- Includes Seller and Buyer Totals for MWh and \$

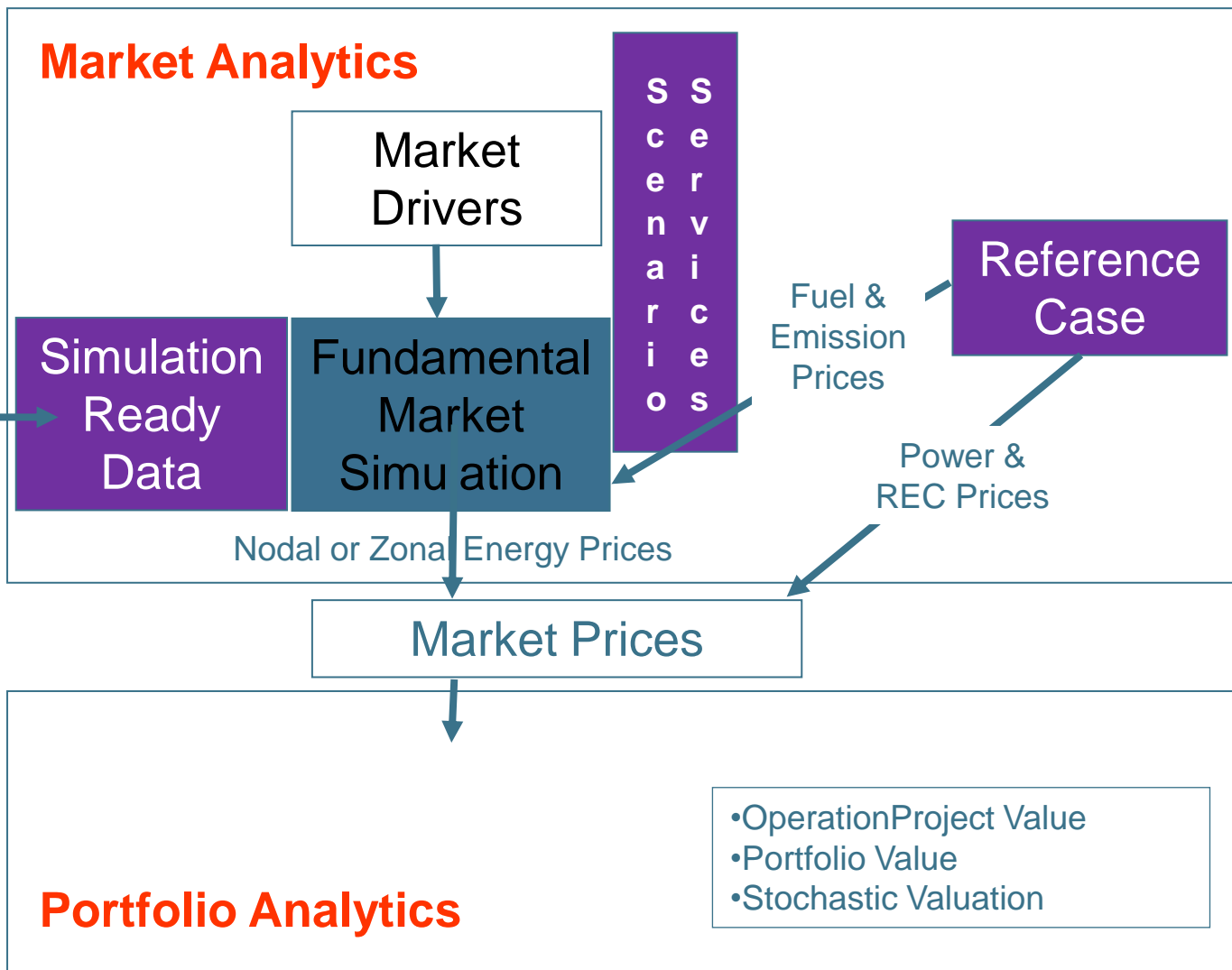
Year	Quarter	Seller Company	Buyer Company	Quantity Total	Transaction Total	Rate \$/MWh
2009	2	Arlington Wind Power Project LLC	Pacific Gas & Electric Co	73,681.40	5,655,047.45	76.75
2009	2	Barton Windpower II LLC	Iberdrola Renewables Inc	23,017.20	311,536.95	13.53
2009	2	Barton Windpower LLC	Northern Indiana Public Service Co	15,688.90	646,797.53	41.23
2009	2	Barton Windpower LLC	WPPI Energy	9,500.40	532,335.91	56.03
2009	2	Bendwind LLC	Northern States Power Co (Minnesota)	910.90	30,059.73	33.00
2009	2	Big Horn Wind Project LLC	MSR Public Power Agency	145,609.03	7,207,646.99	49.50
2009	2	Blue Canyon Windpower II LLC	American Electric Power Co Inc	139,317.00	3,820,439.13	27.42
2009	2	Blue Canyon Windpower LLC	Western Farmers Electric Coop	67,675.00	1,659,202.96	24.52
2009	2	Buffalo Ridge I LLC	Northern Indiana Public Service Co	35,814.91	1,612,000.11	45.01
2009	2	CR Clearing LLC	Associated Electric Coop Inc	28,016.60	1,260,747.00	45.00
2009	2	Canastota Windpower LLC	New York Independent System Operator	16,280.23	460,956.77	28.31
2009	2	Casselman Windpower LLC	FirstEnergy Solutions Corp	20,927.10	1,277,180.91	61.03
2009	2	Central Hudson Gas & Electric Corp	New York Independent System Operator	60,188.00	2,230,357.33	37.06
2009	2	Cloud County Wind Farm LLC	Empire District Electric Co (The)	43,476.00	1,695,564.00	39.00
2009	2	Cloud County Wind Farm LLC	Westar Energy Inc	43,476.00	1,978,158.00	45.50
2009	2	Colorado Green Holdings LLC	Public Service Co of Colorado	130,764.59	4,843,508.47	37.04
2009	2	Cow Branch Wind Power LLC	Associated Electric Coop Inc	15,940.83	701,396.52	44.00
2009	2	Crystal Lake Wind II LLC	Midwest Independent Transmission System Operator Inc	98,569.50	1,290,920.52	13.10
2009	2	Degreeff DP LLC	Northern States Power Co (Minnesota)	842.38	27,798.54	33.00
2009	2	Degreeff PA LLC	Northern States Power Co (Minnesota)	907.78	29,956.88	33.00
2009	2	Diablo Wind LLC	Pacific Gas & Electric Co	24,200.88	1,051,044.16	43.43
2009	2	Dillon Wind I LLC	Southern California Edison Co	57,670.94	3,493,169.19	60.57
2009	2	Dillon Wind I LLC	California Independent System Operator Corp	-660.59	-12,757.58	19.31
2009	2	ESI Vansycle Partners LP	Portland General Electric Co	17,423.21	1,023,778.19	58.76
2009	2	EcoGrove Wind LLC	PJM Interconnection LLC	17,589.00	374,343.58	21.28
2009	2	Elk River Windfarm LLC	Empire District Electric Co (The)	137,138.88	3,771,318.93	27.50



# Tools to Understand & Quantify Uncertainty

**Historical Energy Data**

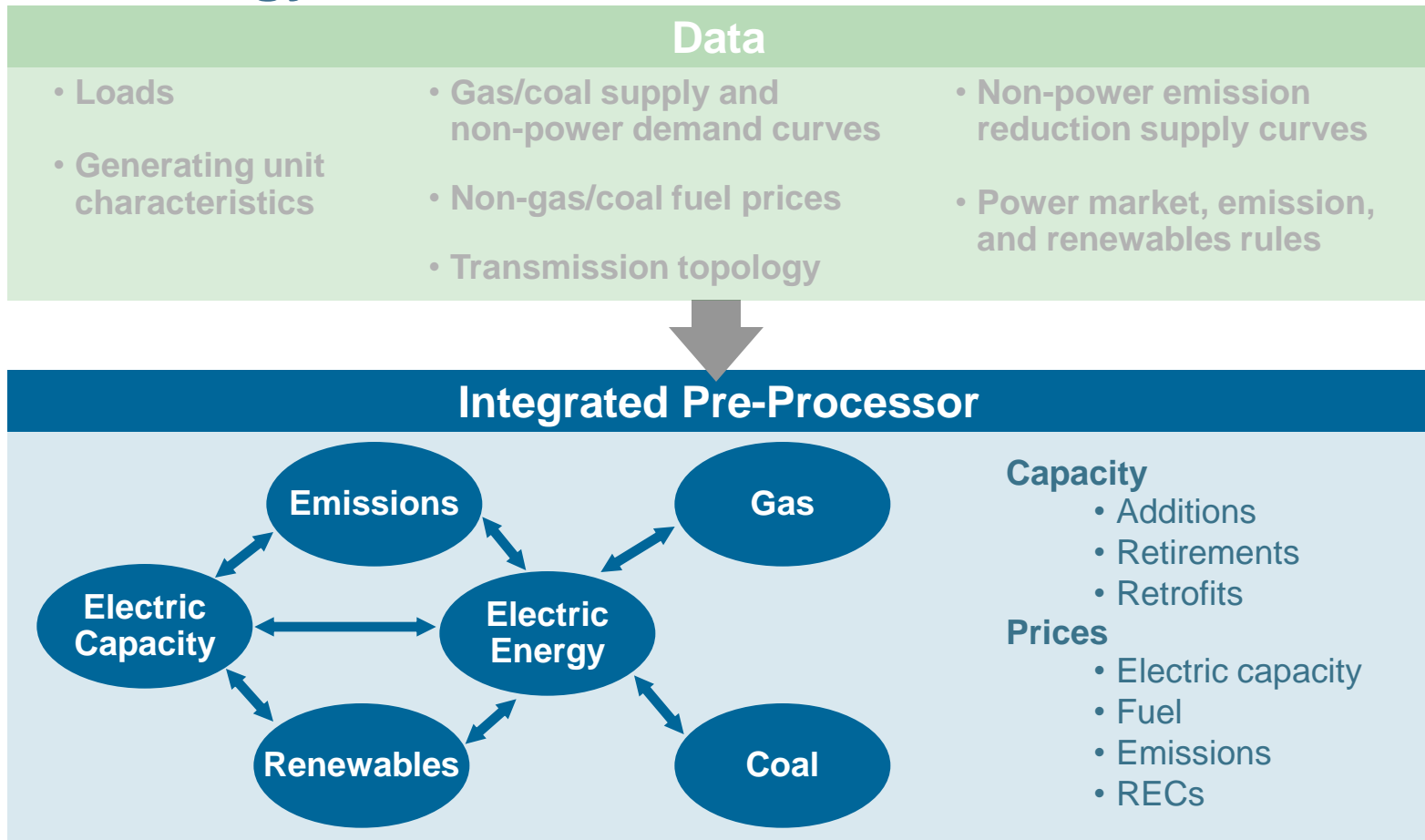
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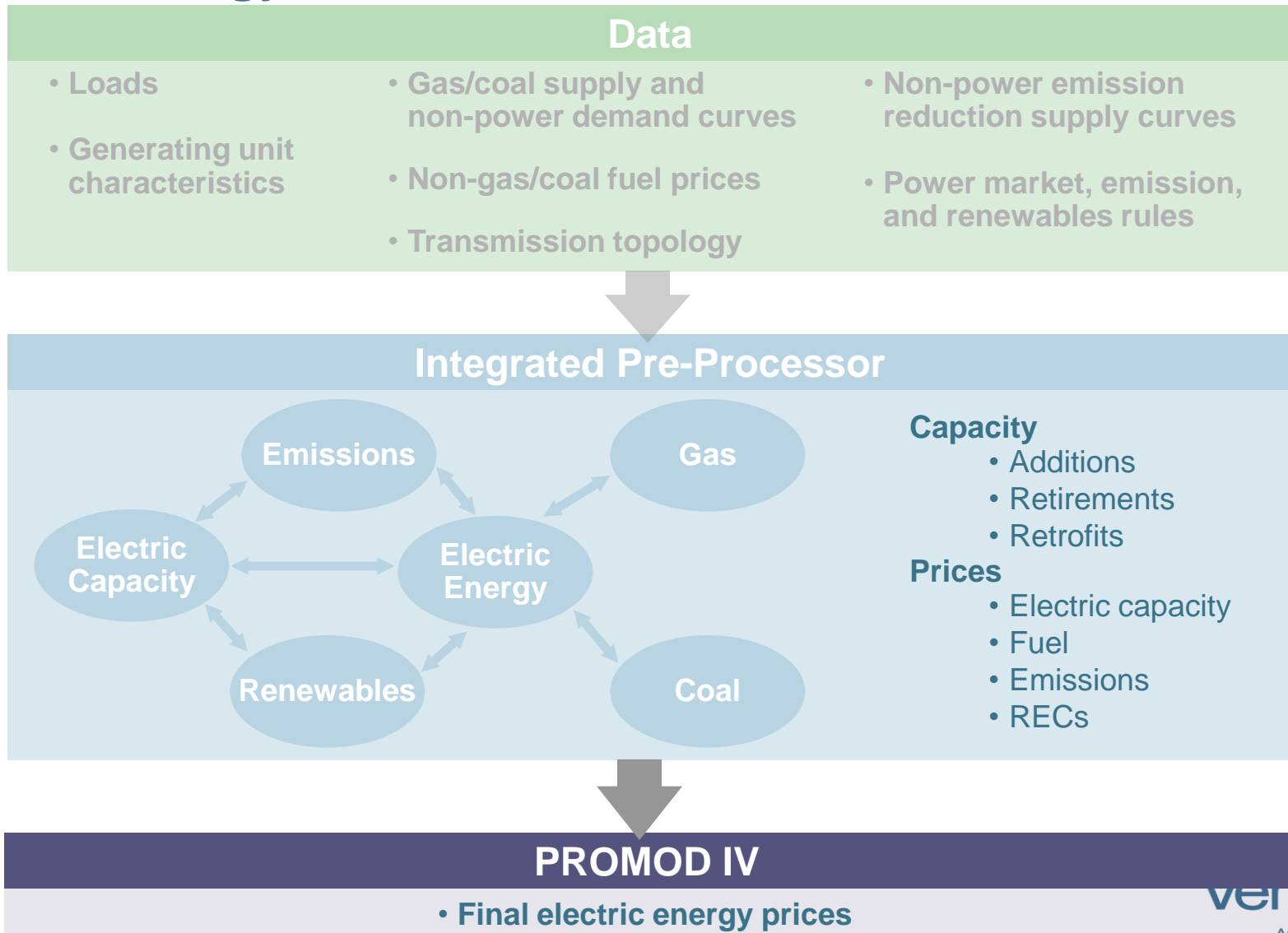
# Methodology Overview

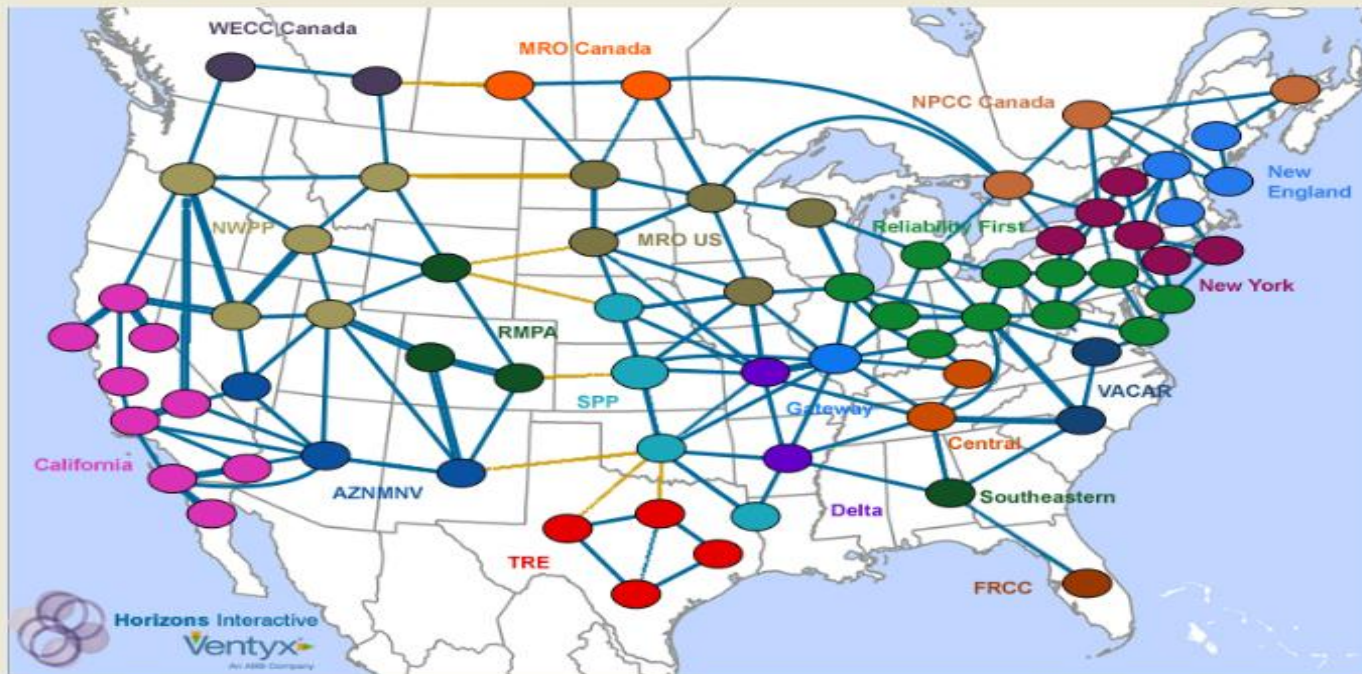
Data		
<ul style="list-style-type: none"><li>• Loads</li><li>• Generating unit characteristics</li></ul>	<ul style="list-style-type: none"><li>• Gas/coal supply and non-power demand curves</li><li>• Non-gas/coal fuel prices</li><li>• Transmission topology</li></ul>	<ul style="list-style-type: none"><li>• Non-power emission reduction supply curves</li><li>• Power market, emission, and renewables rules</li></ul>

# Methodology Overview, continued



# Methodology Overview, continued





Data

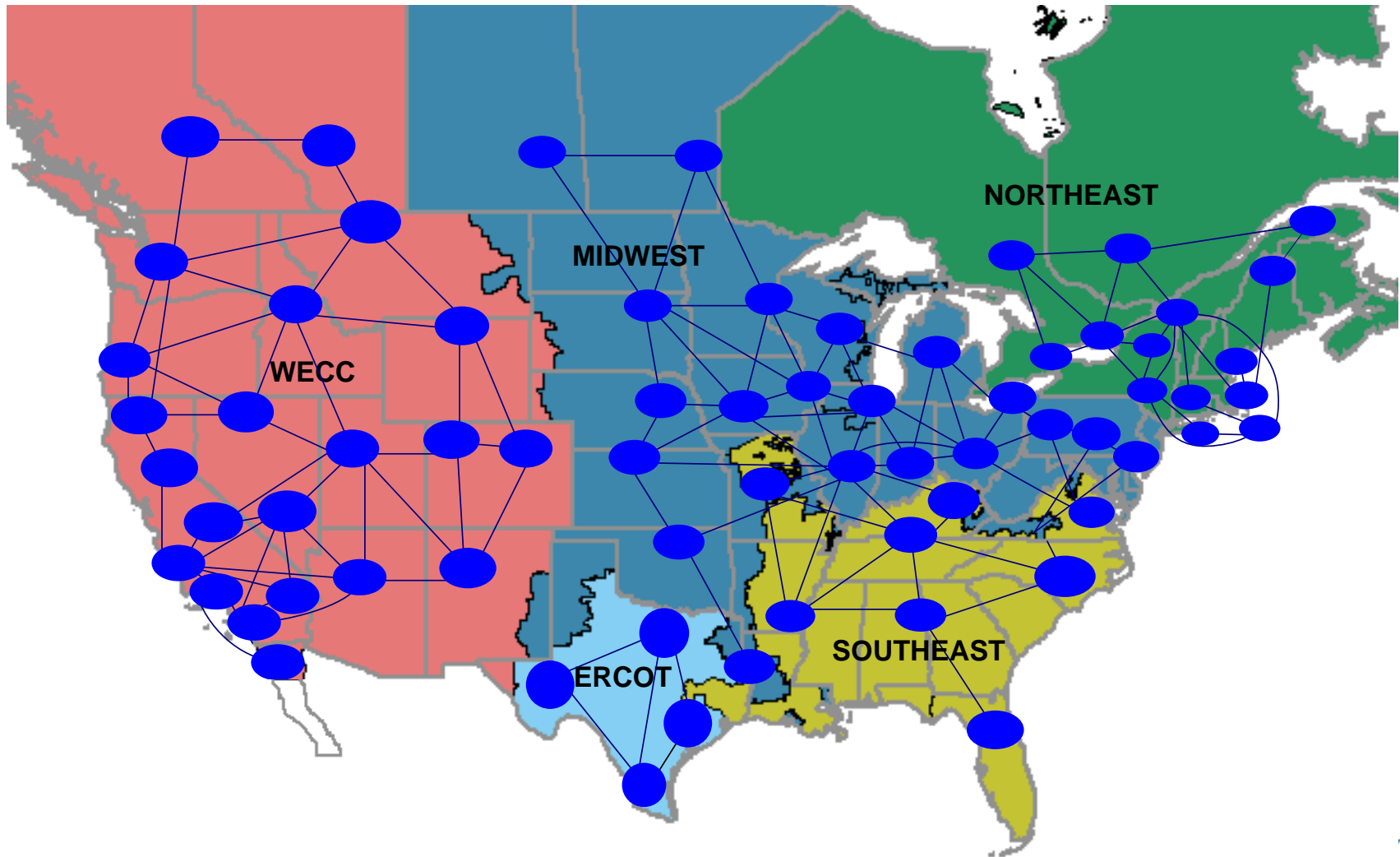
Transmission	Emissions	Natural Gas / Oil	Coal Markets	Load Forecast
Thermal	Stochastics	Forecast Additions	Coal Model	Integrated Mode

# Power Reference Case Overview

- **25-year price forecasts for:**
  - Power (zonal energy and capacity)
  - Fuel (coal, natural gas, and fuel oil)
  - Emission Allowances (SO<sub>2</sub>, NO<sub>x</sub>, and CO<sub>2</sub>)
  - Renewable Energy Credits (RECs)
- **Reports are available on a one-time basis or as an annual subscription with two reports per year and monthly updates to power and gas prices**
- **North America 5 regional reports**
  - WECC (including Western Canada)
  - ERCOT
  - Midwest (SPP/PJM/MISO/MRO)
  - Southeast (SERC/Florida)
  - Northeast (NYISO, ISO-NE, Eastern Canada)
- **Select European Market reports**
- **Reports include chapters on regional power market analysis (supply and demand outlooks, load forecasts, etc.), gas, coal, renewables, and environmental issues**
- **Includes at least 3 scenarios: High Gas, Low Gas, Federal Climate (for Spring 2011 may include heavy coal retirement case)**
- **Only market-based methodology that integrates power, fuel, and environmental**

# Power Reference Case, continued

## Region and Market Area Definitions



# PROMOD Applications Summary

- **PROMOD IV<sup>®</sup> is a detailed nodal and zonal market simulation tool.**
  - Economic transmission expansion planning
  - **Power purchase/sale evaluation**
  - **Locational Marginal Price (LMP) forecasting**
  - **Zonal market price forecasting**
  - **Financial Transmission Right/Congestion Revenue Right (FTR/CRR) valuation**
  - **Asset evaluations (generation and transmission)**
  - Unit dispatch and profitability assessment
  - **Transmission congestion and curtailment management**
  - Security Constrained Unit Commitment and Dispatch with energy and reserve co-optimized
  - Ancillary price forecasting
  - **Thermal and Wind project siting, sizing, congestion/curtailment**
  - ISO cost/benefit analysis

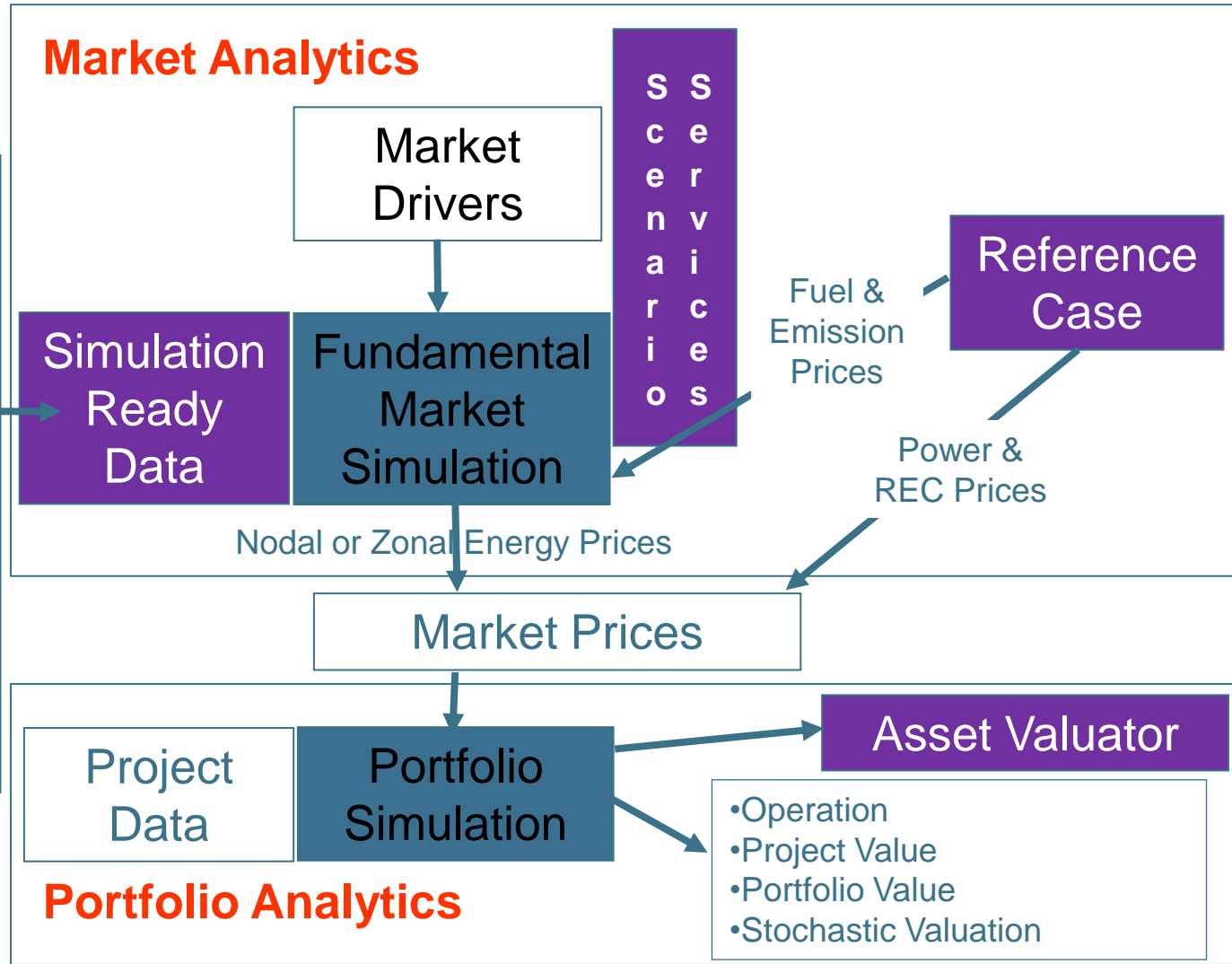


# Market-Based Nodal LMP Forecasting

- PROMOD IV LMP utilizes a Security-Constrained Unit Commitment (SCUC) algorithm, recognizing the following bids and constraints:
  - Generation:
    - Minimum Capacity with No-Load Energy Bid
    - Segmented Energy Bids with Ramp Up and Ramp Down Limits
    - Startup Cost Bid
    - Minimum Runtime and Minimum Downtime (hours)
    - Operating Reserve Contribution and Bids
  - Transmission:
    - Individual Transmission Flow Limits (including DC ties)
    - Flowgate Limits on Interfaces
    - Nomograms based on Interface Flows and Zonal Load or Generation
    - Phase Angle Regulator (PAR) angle limits
    - Dynamically Determined Transmission Loss Penalty Factors
  - Market:
    - Load Balance with Market Net Interchange Limits and Hurdle Rates
    - Regional Operating Reserves (both spinning and non-spinning)
- LMP is calculated for individual nodes and hubs, with congestion price (broken out by flowgate) and loss price components
- Spinning reserve market prices calculated for each region

# Tools to Understand & Quantify Uncertainty

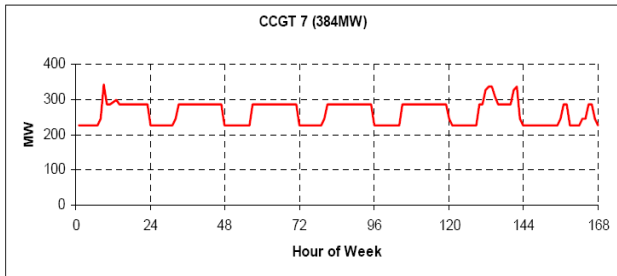
- Historical Energy Data**
- Demand
  - Weather
  - Unit Efficiency
  - Unit Operation
  - Fuel Usage
  - Market Prices
  - New Entrant Plans
  - Retirement Plans



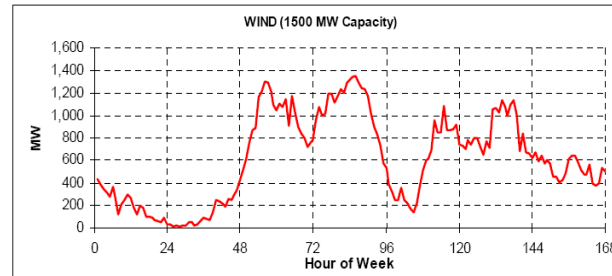
# Wind Modeling

- Firm / non-firm impacts of wind on thermal commitment
- Re-dispatch due to hourly volatility
- Transmission congestion implications
- Reliability implications
- Project siting, sizing and financial analysis

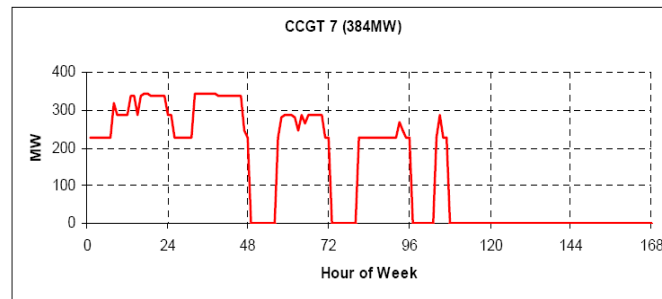
## Client Study – Thermal Generator Operation Before and After Wind Farm Introduction



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“Impact of Wind Power Generation In Ireland on the Operation of Conventional Plant and the Economic Implications,” ESB National Grid

# Thermal / Wind / Renewable Curtailment (Focus)

- **Curtailment decision made by system operator**

- Generator with greatest impact on congestion
- Firm / non-firm transmission
- ISO curtailment rules
- Self-curtailment in a nodal market – negative LMP

- **Impact on Generation Owner / Developer:**

- Farm or Facility Sizing
- Connection locations, choice of transmission path
- Need for Firm Transmission
- Revenue stream

- **Impact on Regional Planner / Regulator:**

- RPS Goal Feasibility / Penetration Level
- Range of Curtailment Need
- Generation Expansion Plan feasibility
- Transmission Plan Analysis – curtailment relief?

# Curtailment In-Depth

- **Locational Curtailment Risk a factor of:**

- Grid topology and capability

- Location of system generation & load

- System operation - ancillary services, market rules

- Demand and non-dispatchable generation hourly shape

- Flexibility of generation – ramp capability, minimum capacity, storage

- System commitment & dispatch, outages

- Wind & load forecast error

- Variations in these factors over time

- **Shift factor measures impact of generator on line flow**

- **Nodal price is indicator of need for curtailment due to congestion, regardless of market rules or presence of market**

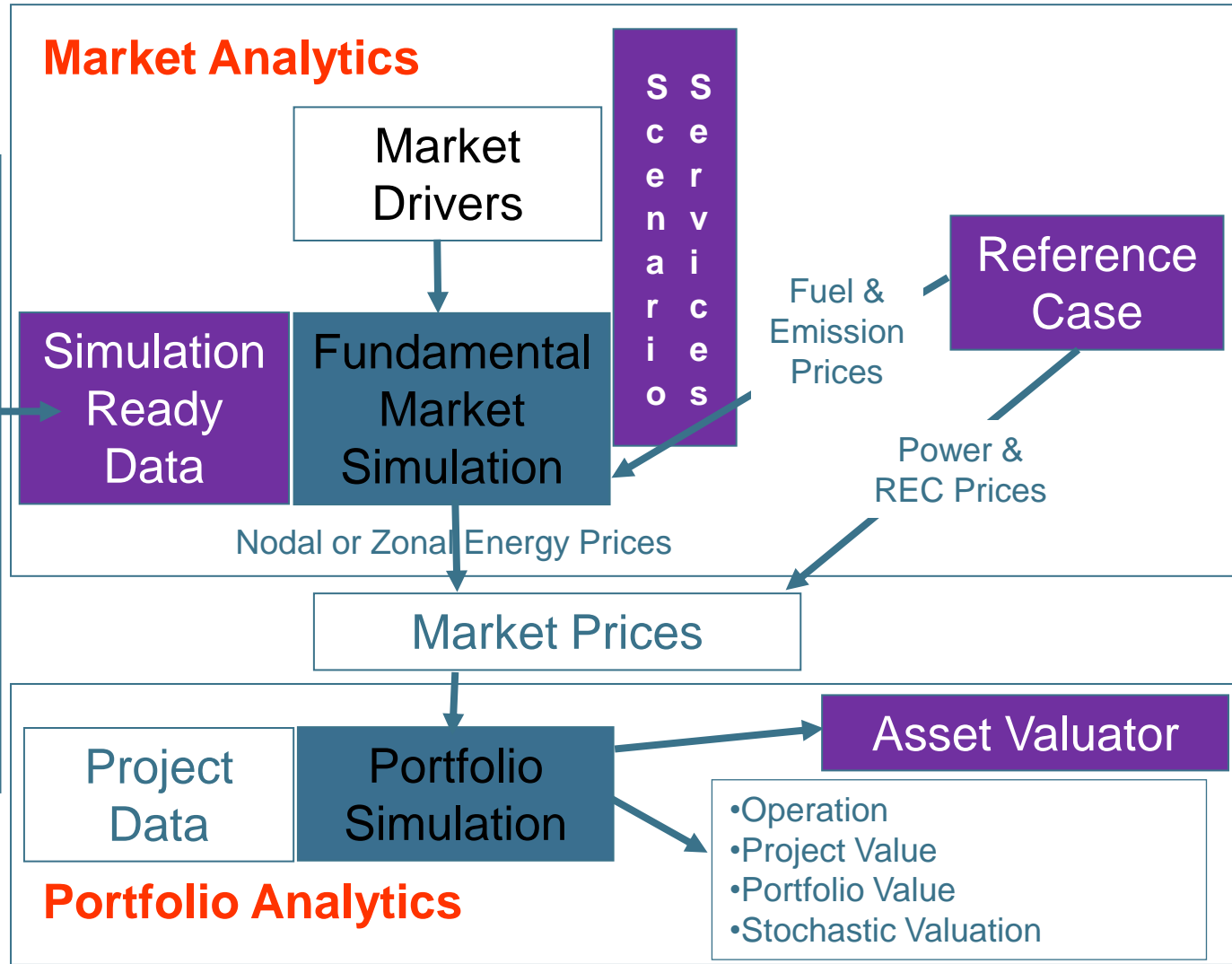
# Ventyx Solutions for Wind Developers

## •Renewable Project Consulting

- Energy consultants that utilize the most current energy market data (which we produce) and the industry-leading simulation models (which we develop) to perform market and project-specific engagements to support our wind developer and wind turbine manufacturer clients including:
  - Deliverability Analysis: current/future congestion, curtailment, potential PPA off-takers
  - Site-Level Analysis: Siting & Sizing Analysis for wind project(s)
  - Market-Level Analysis: Market potential for wind projects, state-by-state, utility-by-utility; based on RPS, REC pricing, carbon cap-and-trade/tax legislation, financial incentives, customer demand, premium pricing for PPA's, merchant structure or blend (PPA and merchant)

# Tools to Understand & Quantify Uncertainty

- Historical Energy Data**
- Demand
  - Weather
  - Unit Efficiency
  - Unit Operation
  - Fuel Usage
  - Market Prices
  - New Entrant Plans
  - Retirement Plans



# Questions/Additional Information

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## **Recorded Webcasts**

- **EPM Intelligence Webcast Series**  
**<http://www1.ventyx.com/resources/ondemand-webcasts-10.asp>**



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