The ERCOT Nodal Market

John Dumas
Director Wholesale Market Operations

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Quick Overview of ERCOT

- The ERCOT Market covers ~85% of Texas’ overall power usage (~75% of the land area)
- Approximately 4500+ buses
- Approximately 550+ Settlement points
- Record peak demand of 68,379 MW (occurred on 8/3/11)
- Total installed wind capacity of 9,600 MW
  - 19,400 MW of new wind capacity generation requests under review
- Record peak WGR net MW power output of 7,400 MW (occurred on 10/7/11)
Percent of Capacity and Energy by Fuel Type

**Installed Capacity 2011**
- Natural Gas: 57%
- Coal: 23%
- Nuclear: 7%
- Wind: 13%
- Hydro, Biomass, Other: <1%

**Energy Produced 2011**
- Natural Gas: 40%
- Coal: 39%
- Nuclear: 12%
- Wind: 8.5%
- Hydro, Biomass, Other: 0.5%
Overview of the ERCOT Market

- **Key Features**
  - Energy Only (System Wide Offer Cap = $3000)
  - Ancillary Services (Unit Specific)
  - Congestion Revenue Rights (Annual & Monthly Auctions)
  - Day-Ahead Market (Co-optimization of energy & ancillary services)
  - Real-Time Security Constrained Economic Dispatch

- **Metrics Related to Resource Adequacy**
  - Reserve Margins
  - Peaker Net Margin
  - Energy Prices

- **Wind Management**
  - Forecasting
  - Real Time Wind Generation Dispatch in a Nodal Market
  - Predicting Large Wind Ramps

- **Recent Design Changes**
Key Features of ERCOT Energy Only Market

- **System Wide Offer Cap**
  - Energy offers are limited to $3000/MWh per PUC rule
  - Administratively set the price of energy to $3000/MWh when ERCOT is out of competitive energy offers (scarcity price in ERCOT)
  - Offer Cap is reduced to $500/MWh when and if Peaker Net Margin reaches an accumulation $175,000 in a year (has not occurred thus far)

- **Ancillary Services**
  - Regulation Reserve (reserves deployed to maintain frequency)
  - Non-Spinning Reserve (30 minute reserves)
    - Considers Load Forecast Risk and Wind Forecast Risk
  - Responsive Reserve (10 minute reserves)
    - 2300 MW now going to 2800 MW in April
    - Contingency reserves supplied by generation & up to 50% from load resources

- **Emergency Interruptible Load Service**
Key Feature - Security-Constrained Economic Dispatch (SCED)

• Determines the optimal Generation Dispatch in order to meet demand and manage congestion

• Utilizes Resource Specific Energy Offer Curves

• Determines the Base Points for all generation units in the system including wind generation

• Assures the maximum use of wind generation delivered to the ERCOT Load centers
Congestion Rent of Top 10 Real-Time Constraints Managed by SCED

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Key Feature - Congestion Revenue Rights Cleared in the Day Ahead Market

Graphic to compare purchase cost of CRRs in auctions to CRR revenue collected and paid out to CRR Account Holders

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Metrics Related to Resource Adequacy

- Fuel Composition of Projects Undergoing Full Interconnection Studies - these projects may be cancelled or delayed beyond the indicated commercial dates shown
  - Monticello 1&2 – 1130MW (as a result of a federal court’s order to stay EPA’s CSAPR)
Metrics Related to Resource Adequacy

![Graph showing peaker net margin over time]

- 2/2 Avg SPP $790
- 2/3 Avg SPP $117
- 8/1-8/5 Avg SPP $179-$484
- 8/23-8/24 Avg SPP $279-$416

**Legend:**
- Green line: Avg SPP for $175,000 PNM/year
- Blue line: Daily Average HUBAVG SPP
- Orange line: Avg Peak Operating Cost (10 * Avg FIP)
- Purple line: Cumulative PNM

**Dates:**
- 1/1/2011 to 1/1/2012
Metrics Related to Resource Adequacy - Day-Ahead Settlement Points (DASPP) & Real-Time (RTSPP)

Nodal 2011 Average Energy Price

Average Real-Time Electricity Price

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<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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<td>$77.19</td>
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$\text{$/MWh}$
Real-Time Cost of Energy vs. Wind Output

Average Real-Time Cost of Energy for Various Levels of Aggregate WGR Output

Note: Orange line indicates that wind output was less than 1000 MW for 16% of all on-peak SCED intervals observed.
Real-Time Cost of Energy vs. Wind Output

Note: blue line indicates that the energy price was approximately $30 in 50% of all on-peak SCED intervals in which wind output was less than 1000 MW
ERCOT Wind Forecasting

- ERCOT Large Ramp Alert System (ELRAS)
  - Utilizes the same data that is being provided by ERCOT for the wind power forecasts
  - An estimation of the probability of a defined ramp event (i.e. 1000 MW up ramp in a hour) beginning in a particular interval
  - Information regarding the weather event which is most likely to cause the ramping event (i.e. a cold front)
  - Looks from the current time to 6 hours into the future
- ERCOT Wind Power Forecast
  - The Wind Generation Resource Production Potential (WGRPP) is an 80% probability of exceedence forecast
  - The Short-Term Wind Power Forecast (STWPF) is the most likely or 50% probability of exceedence forecast
  - Each hour a new forecast is created for each Resource for the next 48 hours
ERCOT Wind Power Forecasting

- ERCOT Large Ramp Alert System (ELRAS)

- Wind Power Forecast
  - STWPF – Red line
  - WGRPP – Green Line

~35% chance of wind output dropping by 2000 MW between 10 AM and 1 PM

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Observed Ramps in ERCOT

- **Ramp down on June 27<sup>th</sup>, 2011**
  - Ramp of ~3500 MW in 2 hours
- **Ramp up on July 5<sup>th</sup>, 2011**
  - Ramp of ~3500 MW in 3 hours
Recent Design Changes

- Ancillary Service methodology change to move 500MW of Non-Spinning Reserve Service to Responsive Reserve Service
- Implemented offer floors for Non-Spinning Reserve Resources
  - No less than $120 for Online Resources always available for dispatch
  - No less than $180 for Offline Resources available when deployed by system operator
- Implemented offer floors for Responsive Reserve & Reliability Unit Commitment Resources
  - Offer placed at the system wide offer Cap of $3000 for these Resources
- Evaluating feasibility of implementing Pilots for
  - Fast response regulation service
  - 30 min Emergency Interruptible Load Service (EILS)
  - Active deployment of Load Resources participating in Non-Spinning Reserve based on forecasted price
- Demand Response
  - Emergency Interruptible Load Service Proposed PUC Rule Enhancements
    • Allow Distributed Generation participation
    • Remove the 10 minute deployment limitation from the rule
ERCOT Resource Adequacy Focus

- ERCOT has contracted with the Brattle Group to Evaluate Resource Adequacy Incentives in ERCOT
- The study will focus on the following:
  - Identify and examine the factors that influence investment decisions related to the financing and development of projects to meet ERCOT’s resource adequacy goals.
  - Provide suggestions for ways to enhance favorable investment outcomes for long-term resource adequacy in ERCOT