Legal Disclaimers

This presentation provides a general overview of the Texas Nodal Market and is not intended to be a substitute for the ERCOT Protocols, as amended from time to time. If any conflict exists between this presentation and the ERCOT Protocols, the ERCOT Protocols shall control in all respects.

For more information, please visit:

http://www.ercot.com/mktrules/nprotocols/
Housekeeping

• Restrooms
• Refreshments
• Attendance sheet
• Questions

Please silence smart phones & other electronics
Course Introduction
This course is intended for personnel responsible for registering, operating and marketing Resources in ERCOT.

Includes:

- Resource Entities
- Qualified Scheduling Entities
- ERCOT staff
Upon completion of this course, you should be able to:

- Summarize how ERCOT utilizes Resources to meet reliability goals
- Delineate the responsibilities of Resource Entities and QSEs in managing Resources
- Explain how Resource constraints are formed and predict how they impact market solutions
- Compare and contrast how Resources are utilized in Day-Ahead and Real-Time Operations
- Illustrate financial outcomes of the markets and evaluate strategies for offering resources.
Modules in this course include:

1. Overview of Resources in the ERCOT Market
2. Resource Requirements
3. Resources in the Day-Ahead Market
4. Resources and Reliability Unit Commitment
5. Resources in Real-Time Operations
Module 1
Overview of Resources in the ERCOT Market
Topics in this module ...

- Markets and Reliability
- ERCOT Market Pricing
- Resource Types in the ERCOT Market
Markets and Reliability
The ERCOT market systems are designed to . . .

- Manage reliability
  - Match generation with demand
  - Operate transmission system within established limits
- Operate the system at least cost

Resources are the primary tool to achieve these goals.
Two needs for Capacity

- Some must be available for Energy Dispatch
  - Enough to serve the Forecasted Load
  - Distributed sufficiently to manage congestion
- Some must be reserved as Ancillary Services
Three Types of Ancillary Services

- Quantity of each service may vary by hour
- Methodology for determining quantities posted on ercot.com
  - Approved by TAC
  - Reviewed annually
Regulation Service

Provides capacity that can respond to signals from ERCOT in order to maintain system frequency

<table>
<thead>
<tr>
<th>Regulation Service Products</th>
<th>General Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation Up</td>
<td>Respond within 5 sec</td>
</tr>
<tr>
<td>Regulation Down</td>
<td></td>
</tr>
<tr>
<td>Fast Responding Regulation Up</td>
<td>Responds within 60 cycles of ERCOT signal</td>
</tr>
<tr>
<td></td>
<td>-or- By frequency trigger (+/- 0.09Hz)</td>
</tr>
<tr>
<td>Fast Responding Regulation Down</td>
<td></td>
</tr>
</tbody>
</table>
Responsive Reserve Service

Provides capacity reserves intended to:

• Respond to significant frequency deviations
• Serve as backup Regulation
• Provide additional capacity during an Energy Emergency Alert (EEA)

Must be capable of ramping through reserved capacity in 10 minutes
Non-Spinning Reserve Service

Provides additional capacity reserves with longer lead time

- Must be capable of synchronizing and ramping to a specified output level in 30 minutes
- Must be capable of running at a specified output level for at least one hour
- May be used for system-wide or local needs
ERCOT needs capacity available for energy dispatch and additional capacity reserved as Ancillary Services

How do Market Participants make Ancillary Service Capacities available to ERCOT?

What compels Market Participants to make capacity available for energy dispatch?

What does ERCOT do if the market processes do not provide sufficient capacity?
ERCOT Market Pricing
ERCOT is an energy-only market

Wholesale energy pricing must provide economic signals that maintain an adequate supply of Resources.

**Scarcity pricing** – higher energy prices during periods where energy reserves are scarce
Energy Offers may be structured to set Scarcity Pricing

- Moderate price at most MWs, reflecting:
  - Fuel costs
  - O&M costs
  - Other factors
- High price for last few MWs

But how high can the price go?
PUCT §25.505 defines the Scarcity Pricing Mechanism

• Establishes the System-Wide Offer Cap (SWCAP)
  • $9000/MWh and $9000/MW/h
  • Applies to Energy Offers and Ancillary Service Offers

• If accumulated Peaker-Net Margin exceeds a threshold value, SWCAP is reduced
Peaker Net Margin (PNM)

- Represents net revenue that a Peaker Generation Resource could have earned from the Real-Time Market
- Total Revenue less variable production Costs
- For a 15 minute interval,

\[ \text{PNM} = \text{Max} \left( (\text{RTEP} - \text{POC}) \times \frac{1}{4}h, 0 \right) \]

<table>
<thead>
<tr>
<th>RTEP</th>
<th>Real-Time Energy Price</th>
<th>HB_HUBAVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>POC</td>
<td>Peaking Operating Cost</td>
<td>10 \times \text{Fuel Index Price (previous day)}</td>
</tr>
</tbody>
</table>
Peaker Net Margin accumulates through the year

- Allowed to accumulate to threshold within a calendar year
  - Three times the cost of entry for new generation
  - Currently $315,000 per MW
- If threshold reached,
  - SWCAP = Max [$2000, (50 * Fuel Index Price)]
  - SWCAP remains low for remainder of year

ERCOT posts PNM and current SWCAP daily on the MIS Public Area
Day-Ahead Market Scarcity Pricing

- SWCAP

Day-Ahead Market can set Scarcity Pricing based on Energy Offer Curves

Price of Energy ($ MWh)

Time
Real-Time Scarcity Pricing

Real-Time Dispatch can set Scarcity Pricing based on Energy Offer Curves.

SWCAP

Real-Time Dispatch can administratively set Scarcity Pricing.

Time

Price of Energy ($ MWh)
But there is additional value for Real-time Reserves

- Sufficient real-time reserves help avoid load-shedding events
- There is value in avoiding load-shedding events

Value of real-time reserves = Value of avoiding load-shed
ERCOT implemented an Operating Reserve Demand Curve on June 1, 2014

- Created a Real-time Price Adder to reflect the value of available reserves
- Reflects Value of Lost Load (VOLL)
- Based on Loss of Load Probability

Value of Lost Load (VOLL) is administratively set to $9000.
Operating Reserve Demand Curve (ORDC)
Real-Time Scarcity Pricing

Operating Reserve Demand Curve may also set Scarcity Pricing

Real-Time Dispatch can set Scarcity Pricing

Price of Energy ($ MWh)

$9000

Time
Resource Types in the ERCOT Market
The ERCOT Market Environment
A Few Definitions

All-Inclusive Resource

- Generation Resource
- Load Resource
- Non-Modeled Generator
Generation Resource

- Capable of producing energy
- Capable of providing Ancillary Service capacity
- Connected to the ERCOT Transmission System (>60kV)
- Responds to dispatch instructions
A Few Definitions

All-Inclusive Resource

- Generation Resource
- Load Resource
- Non-Modeled Generator
## All-Inclusive Resources

### Load Resource

- Capable of curtailing consumption of energy
- Capable of providing Ancillary Service capacity

<table>
<thead>
<tr>
<th>Type</th>
<th>Operation</th>
<th>Ancillary Services Permitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Controllable Load Resource</td>
<td>Trips by under-frequency relay or dispatch instruction</td>
<td>Responsive Reserve</td>
</tr>
<tr>
<td>Controllable Load Resource</td>
<td>Reduces or increases consumption under dispatch control</td>
<td>Regulation Reserve Non-Spin Reserve</td>
</tr>
</tbody>
</table>
A Few Definitions

All-Inclusive Resource

- Generation Resource
- Load Resource
- Non-Modeled Generator
Non-Modeled Generator

- Capable of producing energy
- Cannot provide Ancillary Services
- Less than 10MW
- Greater than 10MW and registered with PUCT as a Self-Generator
- Settled at a Load Zone
A Few Definitions

Other Types of Resources
• ERS Resources
• Wholesale Storage Loads
An emergency service consistent with PUCT §25.507, used during an Energy Emergency Alert (EEA) to assist in maintaining or restoring ERCOT System Frequency.

• Two types of Service
  • ERS-10 has a 10 minute ramp
  • ERS-30 has a 30 minute ramp
Emergency Response Service (ERS) Resource

- Can be Load
- Can be Generation
  - Not a registered Generation Resource
  - Not intermittent renewable generation
- Can be an aggregation of either
Load can provide “Weather-Sensitive ERS”

- Allows consumers with increased consumption during peak hours to offer demand response during those hours
- Deployment during a single event not to exceed three hours
- Qualification criteria spelled out in ERCOT Protocols
Load or Gen can provide “Non-Weather-Sensitive ERS”

- Deployment during a single event may be as long as twelve hours
Standard Contract Terms and Time Periods

- Peak Week-Day Hours
  - 0900-1300
  - 1400-1600
  - 1700-1900
- All Other Hours
- February through May
- June through September
- October through January
ERS Procurement

ERCOT issues Request for Proposal each Contract Term

- ERS Annual cost cap of $50 million
- Cost cap apportioned to Time Periods in each Contract Term based on risk of EEA event
- Quantities awarded for each Time Period based on offers
  - Volume
  - Price

Offer price cap is $80 per MW per hour
Costs are borne by QSEs with Load

- Each QSE assigned an obligation by Load Ratio Share
- QSEs may self-provide their obligation
- ERCOT Settles ERS 20 days after Final Settlement for last operating day of Standard Contract Term
  - Posts on a Final Settlement Statement
  - Payments to QSE who provide ERS
  - Charges to QSEs who don’t self-provide their obligation
ERS is deployed only during an Energy Emergency Alert

**EEA Levels**

- **Level 1**: ERCOT may deploy ERS-30
- **Level 2**: ERCOT shall deploy ERS-10 and any undeployed ERS-30
- **Level 3**: ERCOT shall order firm load shed

**ERS Resources shall return to ready state no later than 10 hours after release from deployment**

**VDI = Verbal Dispatch Instruction**
A Few Definitions

Other Types of Resources
- ERS Resources
- Wholesale Storage Loads
The Basic Idea

• Store electrical energy when it is not wanted
  • High supply with low demand
  • Low prices
  • High System Frequency
• Release electrical energy when it is wanted
  • High demand
  • High prices
  • Low System Frequency
Wholesale Storage Load

The Big Picture

Energy storage Load Resource modeled as generator and load

Must be metered separately from all other facilities

Other Load

Other Generation

Wholesale Storage Load is the energy used for charging the energy storage Load Resource

ERCOT-Polled Settlement (EPS) Meter
Wholesale Storage Load

- Settled at Resource Node
- Settled separately from other generation and load
- Exempt from Load Ratio Share charges and payments

Load Resource output (re-generated from storage)

- Treated as wholesale sale
- Settled like any other generation
- May be netted with other load
Limited to the following technologies

- Batteries
- Flywheels
- Compressed air energy storage (CAES)
- Pumped hydro-electric power
- Electro chemical capacitors
- Thermal energy storage associated with turbine inlet chilling
Private Use Network (PUN) - An electric network connected to the ERCOT Transmission Grid that contains Load that is not directly metered by ERCOT
A Private Use Network may contain any of the following:

- Generation Resource
- Load Resource
- Non-Modeled Generator
- ERS Resource
- Wholesale Storage Load
You’ve learned about ...

- The Market Role in Reliability Operations
- ERCOT Market Pricing
- Resource Types in the ERCOT Market