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/
• Restrooms
• Refreshments
• Attendance sheet
• Exam
• Questions

Please silence smart phones & other electronics
Course Introduction
This course is designed for …

Load Serving Entities (LSEs), including:

• Retail Electric Providers
• Electrical Cooperatives
• Municipally-Owned Utilities
Upon completion of this course you will be able to:

• Identify key Wholesale Market costs associated with serving load in the ERCOT Market

• Describe several means of hedging these costs

• Evaluate your current strategies against your needs
Topics covered in this course:

1. Nodal Market Overview
2. Nodal Market Pricing
3. Market Costs of Serving Load
4. Nodal Market Tools
   - Trades
   - Day-Ahead Market
   - Congestion Revenue Rights
5. Using Tools to Manage Costs
Module 1
Nodal Market Overview
Topics in this Lesson …

• Registration Requirements
• Network Modeling
• CRR Auction
• Day-Ahead Market
• Reliability Unit Commitment
• Adjustment Period
• Real-time Operations
• Settlements
• Market Information System (MIS)
Nodal Market Overview – The Market Structure

**Registration**
- Market Participants
- Relationships
- Assets
- Qualification

**CRR Auction**
- Offers to Sell
- Bids to Buy
- Semi-Annual & Monthly

**Reliability Unit Commitment**
- Transmission Security Analysis
- Resource commitment
- Day-Ahead RUC
- Hourly RUC

**Real-Time Operations**
- Network Security Analysis
- Security Constrained Economic Dispatch (SCED)
- Load Frequency Control (LFC)

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**Market Information System (MIS)**
- Access Market Reports
- Submit Market Inputs
- Download Information
- Access Market Reports
- Submit Market Inputs
- Download Information
Nodal Market Overview – Registration
A Load Serving Entity (LSE) provides electrical service to end-use customers.
LSEs in ERCOT – Defining LSEs

Types of LSEs:
- Retail Electric Providers
- Electrical Cooperatives
- Municipally-Owned Utilities
Registration Requirements:
- Registration as an LSE
- Designation of a QSE
To register as an LSE
- Market Participant application
- Standard Market Participant agreement
Designating a QSE
• Occurs during registration
• LSE may also be a QSE

Changing QSE Representation
• LSE must inform ERCOT
• New QSE must confirm
Nodal Market Overview – Network Modeling

Monitoring Credit • Monitor Performance
• Update Outages • Update and Validate Current Operating Plans (COPs)

Registration
• Market Participants
• Relationships
• Assets
• Qualification

Network Modeling
• Network Operations Model
• Network Operations Model Change Request (NOMCR)

CRR Auction
• Offers to Sell
• Bids to Buy
• Semi-Annual & Monthly

Day-Ahead Market
• Energy Offers and Bids
• Ancillary Service Offers
• PTP Obligation Bids

Reliability Unit Commitment
• Transmission Security Analysis
• Resource commitment
• Day-Ahead RUC
• Hourly RUC

Real-Time Operations
• Network Security Analysis
• Security Constrained Economic Dispatch (SCED)
• Load Frequency Control (LFC)

Adjustment Period
• Energy Offers
• Trades
• Current Operating Plans
• Supplemental Ancillary Services Market (SASM)

Settlement
• Statements & Invoices
• Settlement Disputes

Market Information System (MIS)
• Access Market Reports • Submit Market Inputs • Download Information

LSEs in ERCOT – LSE Registration

**Congestion Revenue Rights (CRR)**
- Financial instrument
- Hedge against congestion costs
CRR Account Holders

- Must register with ERCOT and meet qualification requirements
- LSE may also be a CRR Account Holder
Nodal Market Overview – Day-Ahead Market
Nodal Market Overview – Reliability Unit Commitment
Nodal Market Overview – Real-Time Operations

Registration
- Market Participants
- Relationships
- Assets
- Qualification

CRR Auction
- Offers to Sell
- Bids to Buy
- Semi-Annual & Monthly

Reliability Unit Commitment
- Transmission Security Analysis
- Resource Commitment
- Day-Ahead RUC
- Hourly RUC

Real-Time Operations
- Network Security Analysis
- Security Constrained Economic Dispatch (SCED)
- Load Frequency Control (LFC)

Market Information System (MIS)
- Access Market Reports
- Submit Market Inputs
- Download Information
- Access Market Reports
- Submit Market Inputs
- Download Information
You’ve learned about …

- Registration requirements
- The purpose of Network Modeling
- The role CRRs play in the Nodal Market
- Participation in the Day-Ahead Market
- Reliability Unit Commitment
- Activities of the Adjustment Period
- The components of Real-Time Operations
- The goals of Settlements
- The uses of the MIS
Module 2
Nodal Market Pricing
Topics in this lesson ...

• Settlement Points
• Settlement Point Pricing
• Locational Marginal Pricing
All Energy in the ERCOT Market is settled at one of three types of Settlement Points:

- **Resource Nodes**
- **Load Zones**
- **Hubs**

Each Settlement Point has its own Settlement Point Price.
What is a Resource Node?

An Electrical Bus where a Resource’s measured output is settled
What is a Load Zone?

A grouping of Load Buses where Load is settled.

All Load must be assigned to a specific Load Zone for Settlement purposes.
Three types of Load Zones

- Competitive Load Zones
- Non Opt-in Entity Load Zones
- DC Tie Load Zones
Settlement Points

What is a Hub?

A grouping of 345kV buses where financial transactions are settled.

Specific buses in each Hub defined by Protocols
Six Hubs in ERCOT Market

Four Regional Hubs

• North
• West
• South
• Houston

Two Average Hubs

- ERCOT Hub Average
- ERCOT Bus Average
Settlement Point Prices are calculated from Locational Marginal Prices:

- **Resource Node**: LMP at Resource Node

- **Load Zone**: Load-weighted average of LMPs at Load Buses within the Load Zone

- **Hub**: Simple Average of LMPs at defined Hub Buses within the Hub
Additional Real-Time pricing component ...

- **Reserve Price Adder**: the economic value of reserves that are available for energy dispatch in Real-Time
- LMPs and Reserve Price Adders are used together to form SPPs in Real-Time

LMPs are location-specific. Reserve Price Adders represent the value of reserves ERCOT-wide.
What is **Locational Marginal Pricing (LMP)**?

**Pricing:** Cost

**Marginal:** to serve the next increment of Load

**Locational:** at an Electrical Bus

**Buses can be:**
- Load Buses
- Generation Resource Buses
- Hub Buses
- Other Buses
LMP components

- Energy
- Congestion

In some markets, LMPs have a component for losses.

The ERCOT Market does **NOT** include losses in LMPs.
Introducing the players ...

Example

Locational Marginal Pricing
Let’s solve for LMPs at each Bus

- **Gen 1**: 20 MW @ $20
- **Gen 2**: 20 MW @ $10
- **Gen 3**: 40 MW @ $30

**Hub Bus**: 345kV

**Load Bus**: 69kV

- 5 MW Limit
- 10 MW Limit

**LMP?**
Since we have *congestion* ...

### Payments to Sellers

<table>
<thead>
<tr>
<th>Gen</th>
<th>LMP</th>
<th>MW</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gen 1</td>
<td>$20</td>
<td>5</td>
<td>$100</td>
</tr>
<tr>
<td>Gen 2</td>
<td>$10</td>
<td>5</td>
<td>$50</td>
</tr>
<tr>
<td>Gen 3</td>
<td>$30</td>
<td>10</td>
<td>$300</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$450</strong></td>
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</table>

### Charges to Buyers

<table>
<thead>
<tr>
<th>LMP</th>
<th>MW</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>$30</td>
<td>20</td>
<td>$600</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$600</strong></td>
</tr>
</tbody>
</table>
Locational Marginal Pricing

Charges to Buyers: $600
Payments to Sellers: $450

Day-Ahead Market Congestion Rent funds Congestion Revenue Rights (CRRs)

Congestion Rent: $150
How often are LMPs & Settlement Point Prices calculated?

LMPs and Settlement Point Prices
• Every Hour

LMPs and Reserve Price Adders
• Every 5 minutes*

Settlement Point Prices
• Every 15 minutes

* Generated every SCED cycle
Market Information System

- LMP Contour Map
- Day-Ahead Market SPPs
- Real-Time LMPs
- Real-Time SPPs
You’ve learned about …

• Settlement Points
• Settlement Point Pricing
• Locational Marginal Pricing
Topics in this lesson ...

• The LSE Business Environment
• Wholesale Market Costs of Serving Load
• The Challenges of Predicting Cost Exposure
Settlement Exposure

Primary Costs to Manage:

- Energy
- Capacity
- Congestion
- Ancillary Services

Other costs:

- Reliability Must Run
- Black Start
- Voltage Support
- ERCOT Administrative Fee
What are the *wholesale market* costs for serving load?
Market Costs of Serving Load

Acquire Energy to serve Load

- Bilateral Trade
- Day-Ahead Market
- Real-Time Purchase
Market Costs of Serving Load

Arrange Capacity to serve Load

- **Bilateral Trade**
  - Energy & Capacity

- **Day-Ahead Market**
  - Energy & Capacity

- **Real-Time Purchase**
  - Energy
Congestion Cost exposure

Congestion costs are built into the energy prices.
Ancillary Services Costs

QSEs (with Load)

- Regulation Up
- Regulation Down
- Responsive Reserve
- Non-Spin Reserve
Ancillary Services Costs (continued)

Ancillary Service Plan

• Ancillary Services (MW) for each hour of the Operating Day

• Based on forecasted load

• Posted to MIS Public
Ancillary Services Costs (continued)

Ancillary Service Obligation

- AS Plan allocated to each QSE, by service, by hour.
- Based on Load Ratio Share
Ancillary Services Costs (continued)

QSE settles with LSE

- ERCOT charges QSE for any Obligation not self-arranged
- QSE may charge LSE for Ancillary Services
Factors Impacting Wholesale Market Costs:

- Supply and Demand
- Transmission Congestion
- Transmission and Generation Outages
- Weather
Predicting Cost Exposure

Wholesale Costs

- Ancillary Services ✔
- Capacity ✔
- Energy
- Congestion

Day-Ahead to Real-Time Comparison Load Zone

- Day-Ahead Prices
- Real-Time Prices

Hour

24
Market Costs of Serving Load
You’ve learned about …

• The LSE Business Environment
• Wholesale Market Costs of Serving Load
• The Challenges of Predicting Cost Exposure
Topics in this lesson ...

• Why do anything?

• Tools available in ERCOT, including:
  • Trades
  • Day Ahead Market
  • Congestion Revenue Rights

• Criteria for using these tools

• Financial impact of using these tools
The Tools for Managing Wholesale Costs

- **Bilateral Trades**
  - Energy, Capacity, Ancillary Services

- **Day-Ahead Market**
  - Energy, Capacity, Congestion

- **Congestion Revenue Rights**
  - Congestion
In general ...

The more forward the Energy is purchased the higher the price.

So, why would an LSE buy energy forward?
Real-Time Price Volatility!

Trades and Day-Ahead Market provide Price Certainty
Avoid Capacity-Related charges!

- Bilateral Trade
  - Energy & Capacity
- Day-Ahead Market
  - Energy & Capacity
- Real-Time Purchase
  - Energy
Trades
Trades

• QSE-QSE transactions
• Transfers financial responsibility
• Types
  • Capacity
  • Energy
  • Ancillary Service

Trades are used *only* in Settlements
Trade Options:
- LSEs may trade
- QSEs report trades to ERCOT
Buyer and Seller QSE must confirm Trades

- Trades do not “exist” until both QSEs agree.
  - One QSE reports the trade
  - The other QSE confirms the trade

After the Trade is confirmed, either party may reject it if the deadline for doing so has not passed.
## Submittal Criteria by Trade

<table>
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<tr>
<th>Information Needed</th>
<th>Energy Trade</th>
<th>Capacity Trade</th>
<th>AS Trade</th>
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<tr>
<td><strong>Buying QSE</strong></td>
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<td>✔️</td>
<td>✔️</td>
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<td><strong>Selling QSE</strong></td>
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<td>✔️</td>
<td>✔️</td>
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<td><strong>Type of AS:</strong></td>
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<td></td>
<td>✔️</td>
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<td><strong>Settlement Point:</strong></td>
<td>✔️</td>
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<tr>
<td><strong>MW quantity for each Settlement Interval</strong></td>
<td>15 minute</td>
<td>Hourly</td>
<td>Hourly</td>
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<tr>
<td><strong>Start and Stop Time</strong></td>
<td>1st / Last 15-minute Settlement Interval</td>
<td>1st / Last Hour</td>
<td>1st / Last Hour</td>
</tr>
</tbody>
</table>
Submitted prior to 1430

Energy Trade
- Energy supply in Real-Time
- Capacity supply in Day-Ahead RUC

Capacity Trade
- **No** Energy supply in Real-Time
- Capacity supply in Day-Ahead RUC

Submitted after 1430

Energy Trade
- Energy supply in Real-Time
- Capacity supply in subsequent Hourly RUC

Capacity Trade
- **No** Energy supply in Real-Time
- Capacity supply in subsequent Hourly RUC
Day Ahead Market
The Day-Ahead Market

- Centralized Forward Market
- QSEs buy and sell Energy
- ERCOT buys Ancillary Services
- Forward market provides price certainty
When does the Day-Ahead Market occur?

- Market opens at 0600
- Clearing Process begins at 1000
- Results posted by 1330
Only QSEs participate in the Day-Ahead Market.
The Day-Ahead Market

- Offers
- Bids
- Current Operating Plans
- Network Operations Model

Day-Ahead Market

- Pricing
- Awards
The Day-Ahead Market

Types of Bids:
- Energy Bid
- PTP Obligation Bid
Day-Ahead Market Energy Bid

- Submitted at any Settlement Point
- Includes:
  - MW Quantity
  - Price buyer is willing to pay

Energy bids are used only in DAM. Load is a price taker in Real-Time.
Day-Ahead Market PTP Obligations

- Financial instruments
  - Hedge against congestion costs
  - Financial Investment

- Purchased at DAM price spread

- Settled at Real-Time price spread
DAM PTP Obligation Bid

• Submitted for any two Settlement Points

• Includes:
  • MW Quantity
  • (Sink – Source) price buyer is willing to pay
Awarded DAM Energy Bid

- Energy supply in Real-Time
- Capacity supply in RUC

Awarded DAM PTP Obligation

- Payment or Charge in Real-time
- No Energy supply in Real-Time
- No Capacity supply in RUC
Congestion Revenue Rights
Congestion Revenue Rights

• Financial instruments
  • Hedge against congestion costs
  • Financial Investment
• Purchased at Auction Clearing Price
• Settled at DAM price spread
As a Financial Hedge for …

- Price certainty - Locking in the cost of congestion at the cost of purchasing the CRR

*Price Separation between two Settlement Points*
As a Financial Investment …

CRRs may be purchased as a financial tool to speculate:

Congestion Rent > Purchase Price
Types of Congestion Revenue Rights

- Designated point of injection (source) and point of withdrawal (sink)

- Settlement based on difference between sink and source Settlement Point Prices

- Two Instruments:
  - Point-to-Point Options
  - Point-to-Point Obligations
Types of Congestion Revenue Rights

Point-to-Point Options
• Can only result in a payment

Point-to-Point Obligation
• Can result in a payment or charge
Point-to-Point (PTP) Options

Option $_{AB}$ Payment = $10.00
Option $_{CB}$ Payment = ?
Point-to-Point (PTP) Obligations

Source A  $10/MWh → Sink B  $20/MWh → Source C  $30/MWh

Obligation \( AB \) Payment = $10.00

Obligation \( CB \) Payment = ?
Three ways of acquiring CRRs:

- CRR Auction
- Allocation (NOIEs only)
- Bilateral Trades
CRRs are auctioned and allocated by:

- Time-of-Use Blocks
- One month strips

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</thead>
<tbody>
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<td>Off-Peak (0100 – 0600)</td>
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<td>Peak Weekday (0700 – 2200)</td>
<td>Peak Weekend (0700-2200)</td>
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<td></td>
<td>Off-Peak (2300 – 2400)</td>
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</tbody>
</table>
CRR Auction

- Monthly and Semi-Annual Auctions
- Based on Network Operations Model
Only CRR Account Holders can become owners-of-record for CRRs
Auctions take place twice per month:

- Monthly Auction
- Long Term Auction Sequence
  - Six successive auctions
  - Six-month windows
  - One window each month

*Exact dates on CRR Activity Calendar - http://www.ercot.com/mktinfo/crr
Available Capacity

- 90% in Monthly Auction
- Less in Long-Term Auctions
  - 70% for first window
  - 55% for second window
  - 40% for third window
  - 30% for fourth window
  - 20% for fifth window
  - 10% for sixth window

CRR Auction Awards are also constrained by Credit Limits
Market Tools – Congestion Revenue Rights

CRR Auction Settlement

Annual and Monthly CRR Auctions

CRR Auction Revenues

Pay to QSEs representing Load

Distribution occurs once a month.
Trading CRRs Bilaterally

- PTP Options
- PTP Obligations
  - Characteristics remain unchanged
  - Both parties must meet credit requirements
You’ve learned about …

• The need for forward energy purchases
• Tools available in ERCOT, including:
  • Trades
  • Day Ahead Market
  • Congestion Revenue Rights
• Criteria for using these tools
• Financial impact of using these tools
Module 5
Using Market Tools to Manage Costs
In this lesson we will ...

• Introduce our Laboratory LSE and the experimental conditions

• Use various market tools to manage costs for our LSE
  • Explore many scenarios
  • Use single tools and combinations of tools
  • Compare costs

• Discuss the benefits and risks associated with each tool.
MEGALOAD CORPORATION

Goals in doing Business in the ERCOT Market:

• Provide reliable electric service at a competitive rate
• Manage cost exposure
• MegaLoad is it’s own QSE.
• MegaLoad is also a CRR Account Holder.
• MegaLoad does not own any generation.

Introducing…

Scenario Conditions

What do I do now?
### Scenario Conditions

#### Hour Ending 1200

<table>
<thead>
<tr>
<th></th>
<th>Resource Node A</th>
<th>West Hub</th>
<th>West Load Zone</th>
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<tbody>
<tr>
<td>Trade Price</td>
<td>$23</td>
<td>25</td>
<td>$35</td>
</tr>
<tr>
<td>DAM SPP</td>
<td>$20</td>
<td>25</td>
<td>$30</td>
</tr>
<tr>
<td>RT SPP</td>
<td>$30</td>
<td>40</td>
<td>$50</td>
</tr>
</tbody>
</table>

#### Peak Weekday Block PTP Option Clearing Price

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>West Hub to West Load Zone</td>
<td>$5</td>
</tr>
<tr>
<td>Resource Node A to West Load Zone</td>
<td>$8</td>
</tr>
</tbody>
</table>
Comparing Forward & Real-time transactions

• DAM transactions & Trades are conducted hourly

• Real-Time is settled in 15 minute intervals

For simplicity, we will

• Calculate all examples on an hourly basis

• Assume Real-Time prices and loads are constant for an hour
Managing Energy Costs

Costs

- Energy
- Congestion
- Capacity
- Ancillary Services

Tools

- Day-Ahead Market
- Bilateral Trades
- CRRs
- Do Nothing
Managing Energy Costs

Costs

Energy

Congestion

Capacity

Ancillary Services

Tools

Do Nothing
Loads in Real-Time

- Are price takers
- Pay for all energy not previously arranged through Trade or DAM

QSE Representing Load

- Settled for difference between Real-Time Load and Trade or DAM transactions
- Settles with LSE
Real-Time Energy Settlement

ERCOT calculates each QSE’s Real-Time Energy Imbalance:

\[
\text{Supplies} - \text{Obligations} \times (-1) \text{ RTSPP ($/MWh)}
\]

Real-Time Settlement Point Price

ERCOT settles a QSE’s Energy Imbalance at each Settlement Point
Managing Energy Costs

Scenario 1

Real-Time Energy Purchase:

• QSE does not buy forward energy
• Load is 5 MW in West Load Zone for hour ending 1200
• Settlement Point Price: $50/MWh

\[
\left( \text{Supplies} - \text{Obligations} \right) \times (-1) \text{ RTSPP}
\]
Real-Time Energy Purchase:

- Load is exposed to Real-Time Price
- QSE pays $250 (per hour)

\[
\begin{pmatrix}
0 \\
-5
\end{pmatrix}
\cdot (-1) \times $50.00 = $250.00
\]

Supplies  Obligations
## Scorecard

<table>
<thead>
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<th>Type of Settlement</th>
<th>Hour 12:00</th>
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</thead>
<tbody>
<tr>
<td><strong>Real-Time</strong></td>
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<tr>
<td>Real-Time Energy Imbalance</td>
<td>$250.00</td>
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<tr>
<td>Payment for DAM PTP Obligations</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Day-Ahead</strong></td>
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</tr>
<tr>
<td>DAM Energy Charge</td>
<td>N/A</td>
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<tr>
<td>Payments for CRRs Settled in DAM</td>
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</tr>
<tr>
<td>Charge for DAM PTP Obligations</td>
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<tr>
<td><strong>CRR Auction</strong></td>
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<tr>
<td>Charge for Awarded CRR Auction Bid</td>
<td>N/A</td>
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<tr>
<td><strong>Total ERCOT Settlement</strong></td>
<td>$250.00</td>
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<tr>
<td><strong>Energy Trade</strong></td>
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<tr>
<td>Cost to LSE for Energy Traded</td>
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<tr>
<td><strong>NET MegaLoad Cost</strong></td>
<td>$250.00</td>
</tr>
</tbody>
</table>
Managing Energy Costs

Costs

Energy

Congestion

Capacity

Ancillary Services

Tools

Day-Ahead Market
Day-Ahead Market Purchase

- QSE buys 5MW in the West Load Zone for Hour Ending 1200
- Day-Ahead Settlement Point Price
  - West Load Zone: $30/MWh

\[
5\text{MW} \times \$30.00/\text{MWh} = \$150.00 \text{ for the hour}
\]
Managing Energy Costs

Scenario 2

Real-Time Settlement

- QSE bought 5MW in DAM
- Load is 5 MW in West Load Zone for interval 1200

\[
(Supplies - Obligations) \times (-1) \text{ RTSPP}
\]
Real-Time Settlement

- Load is not exposed to Real-Time Prices
- Settlement Point Price
  - West Load Zone: $50/MWh

\[
\left( \frac{5}{5} - \frac{5}{5} \right) \times (-1) \times $50.00 = $0.00
\]

Supplies \quad Obligations
# Scorecard

<table>
<thead>
<tr>
<th>Type of Settlement</th>
<th>Hour 12:00</th>
</tr>
</thead>
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<tr>
<td><strong>Real-Time</strong></td>
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<tr>
<td>Real-Time Energy Imbalance</td>
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<td>Payment for DAM PTP Obligations</td>
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<td>DAM Energy Charge</td>
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<td>Payments for CRRs Settled in DAM</td>
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<td>Charge for DAM PTP Obligations</td>
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<td><strong>CRR Auction</strong></td>
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<td>Charge for Awarded CRR Auction Bid</td>
<td>N/A</td>
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<tr>
<td><strong>Total ERCOT Settlement</strong></td>
<td>$150.00</td>
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<tr>
<td><strong>Energy Trade</strong></td>
<td></td>
</tr>
<tr>
<td>Cost to LSE for Energy Traded</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>NET MegaLoad Cost</strong></td>
<td>$150.00</td>
</tr>
</tbody>
</table>
Managing Energy Costs

Costs

- Energy
- Congestion
- Capacity
- Ancillary Services

Tools

- Bilateral Trades
Scenario 3

Trade Energy Purchase

• QSE buys 5MW at the West Hub for Hour Ending 1200

• Trade Price
  • West Hub: $25/MWh

5MW × $25.00/MWh = $125.00 for the hour
Real-Time Settlement

- QSE bought 5MW through Trade
- Load is 5 MW in West Load Zone for Hour Ending 1200
Real-Time Settlement

- Trade energy is delivered to West Hub
- Settlement Point Price
  - West Hub: $40/MWh

\[
\left( \frac{5 - 0}{\text{Supplies}} \right) \times (-1) \times $40.00 = -$200.00
\]
Real-Time Settlement

- QSE still has load at the West Load Zone
- Settlement Point Price
  - West Load Zone: $50/MWh

\[
\left(0 - 5\right) \times (-1) \times \$50.00 = \$250.00
\]

Supplies - Obligations
### Real-Time Settlement Scenario 3

<table>
<thead>
<tr>
<th>Resource Node A</th>
<th>West Hub</th>
<th>West Load Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>$30/MWh</td>
<td>$40/MWh</td>
<td>$50/MWh</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Payment at West Hub</th>
<th>Charge at West Load Zone</th>
<th>Real-time Net Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Scenario Breakdown:**
- **Payment at West Hub:** $30/MWh
- **Charge at West Load Zone:** $40/MWh
- **West Load Zone:** $50/MWh

**Net Cost Calculation:**
- Total Cost: $30 + $40 + $50 = $120/MWh
- Net Cost: $200, $250, $50
## Scorecard

<table>
<thead>
<tr>
<th></th>
<th>Type of Settlement</th>
<th>Hour 12:00</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Real-Time</strong></td>
<td>Real-Time Energy Imbalance</td>
<td>$50.00</td>
</tr>
<tr>
<td></td>
<td>Payment for DAM PTP Obligations</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Day-Ahead</strong></td>
<td>DAM Energy Charge</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Payments for CRRs Settled in DAM</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Charge for DAM PTP Obligations</td>
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</tr>
<tr>
<td><strong>CRR Auction</strong></td>
<td>Charge for Awarded CRR Auction Bid</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Total ERCOT Settlement</strong></td>
<td></td>
<td>$50.00</td>
</tr>
<tr>
<td><strong>Energy Trade</strong></td>
<td>Cost to LSE for Energy Traded</td>
<td>$125.00</td>
</tr>
<tr>
<td></td>
<td><strong>NET MegaLoad Cost</strong></td>
<td><strong>$175.00</strong></td>
</tr>
</tbody>
</table>
Managing Congestion Costs

Costs

- Energy
- Congestion
- Capacity
- Ancillary Services

Tools

- Day-Ahead Market
- CRRs
### Managing Congestion Costs

<table>
<thead>
<tr>
<th>Costs</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Day-Ahead Market</td>
</tr>
<tr>
<td>Congestion</td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td></td>
</tr>
<tr>
<td>Ancillary Services</td>
<td></td>
</tr>
</tbody>
</table>
Managing Congestion Costs

Scenario 4

Congestion Cost exposure

- 5MW Trade Energy Purchase at West Hub
- 5MW Load at West Load Zone
The Day-Ahead Market

Day-Ahead Market

Types of Bids:
- Energy Bid
- PTP Obligation Bid
Managing Congestion Costs

Scenario 4

Day-Ahead Market PTP Obligations

Price in Day Ahead Market = ?

Value in Real Time = ?

DAM Prices:
- West Hub: $25/MWh
- Source: $40/MWh

Real-Time Prices:
- West Hub: $30/MWh
- West Load Zone: $50/MWh
DAM PTP Obligation Purchase:

- QSE buys 5MW of PTP Obligations from West Hub to West Load Zone for hour ending 1200
- Day-Ahead Price = $5/MW

$5\,\text{MW} \times \$5.00/\text{MWh} = \$25.00$
Scenario 4

Real-Time Settlement

• 5MW Trade Energy Purchase at West Hub
• 5MW Load at West Load Zone
• 5MW PTP Obligation Hub to Load Zone
Managing Congestion Costs

Scenario 4

Real-Time Settlement

<table>
<thead>
<tr>
<th>Payment at West Hub</th>
<th>Charge at West Load Zone</th>
<th>Payment for PTP Obligation</th>
<th>Real-time Net Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>$200</td>
<td>$250</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Scorecard

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<td></td>
</tr>
<tr>
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</tr>
<tr>
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</tbody>
</table>

Don’t forget: A PTP Obligation can result in a charge in Real-Time
Managing Congestion Costs

Costs

- Energy
- Congestion
- Capacity
- Ancillary Services

Tools

- CRRs
CRR Auction

• Monthly and Semi-Annual Auctions
• Based on Network Operations Model
### MegaLoad buys CRRs in Monthly Auction

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-Peak (0100 – 0600)</td>
<td>Peak Weekday (0700 – 2200)</td>
<td>Off-Peak (2300 – 2400)</td>
<td>Peak Weekend (0700-2200)</td>
<td>5 MWs of Peak Weekday CRRs</td>
<td>Clearing price is $5 per MW per hour</td>
<td>ERCOT will charge MegaLoad for all hours in the Time-Of-Use block</td>
</tr>
</tbody>
</table>
CRR Purchase:

- CRR Account Holder buys 5MW Peak WD PTP Option from West Hub to West Load Zone
- Auction Clearing Price = $5/MW

$$5\text{MW} \times $5.00/\text{MWh} = $25.00$$
For Hour Ending 1200
Managing Congestion Costs

Scenario 5

Congestion Revenue Rights

- 5MW Trade Energy Purchase at West Hub
- 5MW Load at West Load Zone
- 5MW PTP Option from Hub to Load Zone

Source: West Hub
Sink: West Load Zone

DAM Prices:
- West Hub: $25/MWh
- West Load Zone: $30/MWh

Real-Time Prices:
- West Hub: $40/MWh
- West Load Zone: $50/MWh
Managing Congestion Costs

Scenario 5

Congestion Revenue Rights

Source: West Hub
Sink: West Load Zone

PTP Option

DAM Prices:
- Source: $25/MWh
- Sink: $30/MWh

Real-Time Prices:
- Source: $40/MWh
- Sink: $50/MWh

<table>
<thead>
<tr>
<th>CRR Payment in DAM</th>
<th>Real-Time Congestion Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>$25</td>
<td>$50</td>
</tr>
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</table>
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Managing Congestion Costs

Scenario 6

Congestion Revenue Rights

Source: West Hub
Sink: West Load Zone

PTP Option

DAM Prices:
- West Hub: $25/MWh
- West Load Zone: $30/MWh

Real-Time Prices:
- West Hub: $40/MWh
- West Load Zone: $50/MWh

CRR Payment in DAM
- Source: $25
- Sink: $50

Real-Time Congestion Cost:
- Source: $25
- Sink: $50

Might bridge with DAM PTP Obligation
## Scorecard

<table>
<thead>
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</tr>
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<td>$150.00</td>
</tr>
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</table>
Scenario 7

Day-Ahead Congestion Hedging

- 5MW DAM Energy Purchase at West Load Zone
- 5MW PTP Option from Resource Node A to West Load Zone
CRR Purchase:

• CRR Account Holder buys 5MW Peak WD PTP Option from Resource Node A to West Load Zone
• Auction Clearing Price = $8/MW

\[
5\text{MW} \times \$8.00/\text{MWh} = \$40.00
\]

For Hour Ending 1200
### Scenario 7

**Day-Ahead Congestion Hedging**

<table>
<thead>
<tr>
<th>Resource Node A</th>
<th>West Hub</th>
<th>West Load Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>$20/MWh</td>
<td>$25/MWh</td>
<td>$30/MWh</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy Purchase</th>
<th>PTP Option Payment</th>
<th>Net Day-Ahead Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Managing Congestion Costs**
- **Scenario 7**
- **Congestion Hedging**
- **West Hub**: $25/MWh
- **West Load Zone**: $30/MWh
- **Resource Node A**: $20/MWh
Scenario 7

Real-Time Settlement

- Load is *not* exposed to Real-Time Prices
- Settlement Point Price
  - West Load Zone: $50/MWh

\[
\left( 5 - 5 \right) \times (-1) \times $50.00 = $0.00
\]

Supplies - Obligations
## Scorecard

<table>
<thead>
<tr>
<th>Type of Settlement</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Real-Time</strong></td>
<td></td>
</tr>
<tr>
<td>Real-Time Energy Imbalance</td>
<td>$0.00</td>
</tr>
<tr>
<td>Payment for DAM PTP Obligations</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Day-Ahead</strong></td>
<td></td>
</tr>
<tr>
<td>DAM Energy Charge</td>
<td>$150.00</td>
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<td>N/A</td>
</tr>
<tr>
<td><strong>NET MegaLoad Cost</strong></td>
<td>$140.00</td>
</tr>
</tbody>
</table>
Split into groups:

• Maximum of 5 people per group
• Minimum of 3

• Analyze pricing information for Interval 0800
• Minimize MegaLoad’s costs for serving 5MW of Load at the West Load Zone
## Class Activity Conditions

### Hour Ending 0800

<table>
<thead>
<tr>
<th></th>
<th>Resource Node A</th>
<th>West Hub</th>
<th>West Load Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trade Price</strong></td>
<td>$25</td>
<td>30</td>
<td>$35</td>
</tr>
<tr>
<td><strong>DAM SPP</strong></td>
<td>$20</td>
<td>25</td>
<td>$30</td>
</tr>
<tr>
<td><strong>RT SPP</strong></td>
<td>$15</td>
<td>20</td>
<td>$28</td>
</tr>
</tbody>
</table>

### Peak Weekday Block PTP Option Clearing Price

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>West Hub to West Load Zone</strong></td>
<td>$3</td>
</tr>
<tr>
<td><strong>Resource Node A to West Load Zone</strong></td>
<td><strong>$5</strong></td>
</tr>
</tbody>
</table>
A few other things you should know about ...

- Funding of CRRs
- CRR Balancing Account
- Derations
CRR Settlement

Hourly Congestion Rent -> Payment due to CRR Account Holders
CRR Settlement

Hourly

Congestion Rent

may be short paid in some hours

Payment due to CRR Account Holders

CRR Balancing Account
CRR Balancing Account Fund

Payment due to CRR Account Holders

Monthly

Pay to QSEs representing Load

CRR Balancing Account Fund

$10M

BALANCING ACCOUNT FUND

Pay to QSEs representing Load

CRR Balancing Account
CRR Rolling Balancing Account

Payment due to CRR Account Holders

Monthly
Payment due to CRR Account Holders

may remain short paid
CRR payments may be derated if:

- Transmission elements are oversold
- The Target Payment is a positive value
- CRR source or sink is a Resource Node
Managing Capacity Costs

Costs

Energy
Congestion
Capacity
Ancillary Services

Tools

Day-Ahead Market
Bilateral Trades
Reliability Unit Commitment (RUC)

It ensures:

• Enough capacity is committed to serve the forecasted load

• Committed capacity is in the right locations
If ERCOT commits a Resource through RUC

• ERCOT provides QSE with a payment guarantee
• May provide “Make-Whole Payment”

Cost recovery

• QSEs are responsible for capacity
• QSEs who are capacity short responsible for Make-Whole
What is included in the QSE’s capacity obligation?

- Load (Adjusted Metered Load)
- Capacity Trades where the QSE is a seller
- Energy Trade where the QSE is a seller
- Cleared DAM Energy Offer
How can a QSE arrange to meet these obligations?

- Show capacity from its Resources in its COP
- Capacity Trades where the QSE is a buyer
- Energy Trades where the QSE is a buyer
- Cleared DAM Energy bids
Capacity Short Charge

QSEs that do not arrange enough capacity to cover obligations are responsible for the costs of RUC.
RUC Make-Whole Uplift Charges

- RUC Capacity-Short Charges are subject to a cap
- Remaining Make-Whole funds are collected on a Load Ratio Share basis.
Managing Ancillary Service Costs

Costs

- Energy
- Congestion
- Capacity
- Ancillary Services

Tools

- Bilateral Trades
A QSE’s share of the Ancillary Service cost for an Operating Hour is

\[(\text{AS Price}) \times (\text{AS Quantity})\]

\[
\text{AS Price} = \left( \frac{\text{ERCOT Total AS Cost}}{\text{MW procured by ERCOT}} \right)
\]

\[
\text{AS Quantity} = \left( \frac{\text{QSE Obligation}}{\text{Self-Arranged Qty}} \right)
\]
QSE chooses how to fulfill Obligations

Self-Arrange

Allow ERCOT to procure

DAM
SASM
LSE may have Ancillary Service trades

• May become part of QSE’s Self-Arrangement

• Reduces AS cost exposure in DAM or SASM
You’ve learned about ...

• The risks of “doing nothing”
• The impact of forward energy purchases on costs
• The risks associated with delivery points for energy
• Hedging congestion costs
  • Real-Time congestion costs
  • Day-Ahead congestion costs
• Hedging capacity costs
• Managing Ancillary Service costs

Wow! That’s a lot.
You should now be able to …

• Identify key Wholesale Market costs associated with serving load in the ERCOT Market
  • Energy
  • Congestion
  • Capacity
  • Ancillary Services

• Describe several means of hedging these costs

• Evaluate your current strategies against your need
• ERCOT Client Services
  Clientservices@ercot.com

• ERCOT Mailing Lists
  http://lists.ercot.com/

• ERCOT Nodal Market Protocols
  http://www.ercot.com/mktrules/nprotocols/

• ERCOT Training
  http://www.ercot.com/services/training/

• Market Education Contact
  Training@ercot.com
Scan this QR code to take the course survey!