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
ERCOT Nodal 101

A high-level overview of the ERCOT Nodal Market for all Market Participants and ERCOT personnel.
Course Objectives

Upon completion of this course you will be able to:

• Identify major components of the Nodal Market

• For each component of the Nodal Market, describe
  • Purpose
  • Inputs
  • Outputs
  • Processes
Modules in this course include:

1. Introduction to ERCOT and Market
2. Locational Marginal Pricing
3. Congestion Revenue Rights
4. Day-Ahead Market
5. Reliability Unit Commitment
6. Real-Time Operations
Module 1
Introduction to ERCOT
Topics in this lesson . . .

- Key features of the ERCOT Grid
- ERCOT Responsibilities
  - Reliability and Markets
  - Capacity and Energy
  - Congestion Management
  - Network Modeling
- Market Overview
Key Features of the ERCOT Grid

- Represents 90% of Texas Load
- 77,000 MW of generation capacity
- 46,500 miles of transmission lines
- Electrical island with several DC Ties

2015 Generation Capacity

*Includes solar, hydro and biomass

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<thead>
<tr>
<th>Fuel Type</th>
<th>Percentage</th>
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<tr>
<td>Natural Gas</td>
<td>53%</td>
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<tr>
<td>Coal</td>
<td>22%</td>
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<tr>
<td>Wind</td>
<td>18%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>6%</td>
</tr>
<tr>
<td>Other*</td>
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ERCOT’s Primary Responsibility is Reliability

• Match generation with demand
• Operate transmission system within established limits

ERCOT Responsibility

Execute competitive markets for reliability services
Reliability and Competitive Markets

- Markets support reliability
- Reliability makes the markets possible

ERCOT finds the balance between Reliability and Economics
ERCOT dispatches *Energy* to follow the system demand.
Energy and Capacity

ERCOT must also ensure sufficient *Capacity* is on-line to meet the forecasted demand.
More about Capacity

 ERCOT Responsibility

Capacity Reserved for Ancillary Services

Ancillary Services needed to respond quickly to changing system conditions

Forecast

System Capacity

System Demand
Ancillary Service Capacity

Acquired through competitive markets
Ancillary Service Capacity

Three types of Ancillary Services

- Regulation Reserve
- Responsive Reserve
- Non-Spin Reserve

System Capacity
Transmission Congestion

• Generators and Loads separated by distance

• Transmission system has limits

Congestion management keeps transmission system operating within limits
Network Operations Model

Models allow ERCOT to:

• “See” grid at any point in time
• Predict how various actions affect grid

Representation of a physical system.
Network Operations Model

- Physical characteristics
- Ratings
- Operational limits

Including

- Transmission elements
- Resources
- Topology
- Telemetry mapping
Market Introduction
Who are the ERCOT Players?

- Qualified Scheduling Entities
- Load Serving Entities
- Transmission and/or Distribution Service Providers
- Resource Entities
Commercial Markets

• Bilateral Market
• ERCOT Facilitated Markets
  • Day-Ahead Ancillary Services Market
  • Day-Ahead Energy Market
  • Real-Time Energy Market
Energy Dispatch

• Resource-specific offers
• Resource-specific dispatch

Goal

• Balance generation & demand
• Manage congestion

Energy Pricing

• Location-specific prices for energy
• Prices include congestion costs
 Congestion Costs

• All costs are directly assigned

• Congestion Revenue Rights available for hedging
ERCOT is an energy-only market … but what does that mean?

It’s all about the recovery of costs to build generation.

In ERCOT, these costs must be recovered with revenues from energy production and operating reserves.
ERCOT is an energy-only market … but what does that mean?

Energy Pricing must support investment in new generation

**Scarcity pricing** – higher energy prices during periods where energy reserves are scarce
An Independent Market Information System Registered Entity (IMRE) may register with ERCOT solely to access MIS Secure.
You Are Here!

Market Information System (MIS)
- Access Market Reports
- Submit Market Inputs
- Download Information
- Review Market Outputs
- Submit Market Inputs
- Download Information
Topics in this lesson ... 

• Locational Marginal Prices (LMPs)
  • Define LMPs
  • Determination of LMPs

• Congestion Rent

• Settlement Point Prices

• Scarcity Pricing Mechanism

• Market Information
What is **Locational Marginal Pricing** (LMP)?

**Pricing:** Cost

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

**Locational:** at an Electrical Bus
LMP Components

• Energy
• Congestion

In some markets, LMPs have a component for losses.

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

Example

Locational Marginal Pricing

Gen 1
10 MW
($4 per MWh)

Gen 2
20 MW
($2 per MWh)

LMP ?

10 MW

LMP ?

LMP ?

LMP ?
Introducing the players ...

When there is no congestion, all LMPs are equal.
### Example: No Congestion

#### Payment to Resources

<table>
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<tr>
<th>Gen</th>
<th>LMP</th>
<th>MW</th>
<th>Payment</th>
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<td>0</td>
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**Total** $20

#### Charges to Load

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<tr>
<td>$2</td>
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<td>$20</td>
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**Total** $20
Now there is congestion

Example

Gen 1
10 MW
($4 per MWh)

Gen 2
20 MW
($2 per MWh)

4 MW constraint

10 MW
Example

Gen 1
10 MW
($4 per MWh)

Gen 2
20 MW
($2 per MWh)

With congestion, LMPs are different
### Example: Congestion

#### Payment to Resources

<table>
<thead>
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<td>6</td>
<td>$24</td>
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#### Charges to Load

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</table>
Locational Marginal Pricing

$40

Charges to Load

$32

Payments to Resources

$8

Congestion Rent

Congestion Rent used to fund Congestion Revenue Rights (CRRs)
LMPs and Settlement Point Prices

- LMPs at Electrical Buses
- Settlement Points used for financial settlement
- Settlement Point Prices calculated using LMPs
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.
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

* LMPs and Reserve Price Adders generated at each SCED cycle (possibly more often than 5 minutes)
Three Types of Settlement Points:

- **Resource Nodes**
- **Load Zones**
- **Hubs**
What is a Resource Node?

An Electrical Bus where a Resource’s measured output is settled.
Settlement Point Prices for Resource Nodes

Day-Ahead Market
LMP at the Resource Node

Real-Time Operations
Time-Weighted Average of LMPs at the Resource Node

Time-Weighted Average of Reserve Price Adders

Resource
Electrical Bus
What is a Load Zone?

A group of Electrical Buses assigned to the same geographical zone

Every Electrical Bus with Load must be assigned to a Load Zone for Settlement purposes
Settlement Point Price for Load Zones

Day-Ahead Market
Load-Weighted Average of LMPs in Load Zone

Real-Time Operations
Load-Weighted and Time-Weighted Averages of LMPs in Load Zone
+ Time-Weighted Average of Reserve Price Adders
Three types of Load Zones

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

- North
- South
- West
- Houston

2003 Congestion Management zones
Non Opt-in Entity Load Zones

- Established by one or more NOIE(s)

- Some large NOIEs required to establish own NOIE Load Zones

- NOIEs that don’t establish NOIE Load Zone are assigned to Competitive Load Zone
DC Tie Load Zones

- Used to settle exports across DC Ties
- One for each DC Tie
- Contains only the electrical bus connected to the DC Tie

All Load must be assigned to a Load Zone for Settlement purposes
What is a Hub?

- Group of 345kV Hub-buses
- 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

Settlement Point Price for Hubs

Day-Ahead Market

• Simple average of LMPs at Hub Buses in each Hub

Real-Time Operations

• Simple average of Time-Weighted Average LMPs at the Hub Buses in the Hub

• Time-Weighted Average of Reserve Price Adders
• LMP Contour Map
• Day-Ahead Market SPPs
• Real-Time LMPs
• Real-Time SPPs
Nodal Market Operations
Market Components

- CRR Auction
- Day-Ahead Market
- Reliability Unit Commitment
- Real-Time Operations
Module 3
Congestion Revenue Rights
Topics in this lesson . . .

- Purpose of CRRs
- CRR Account Holders
- Types of CRRs
- How CRRs are acquired
- Settlements
- Market Information System
Purpose of Congestion Revenue Rights

- Financial instruments
  - Hedge against congestion costs
  - Financial investment
- Payment or charge when Grid is congested

A CRR is not a right to deliver physical energy
Congestion Costs

Congestion Cost exposure

Resource Node A

$30/MWh

Load Zone

Resource Node B

$40/MWh

$45/MWh

Congestion costs are built into the Settlement Point prices
Introducing a new player: CRR Account Holder
To own CRRs, Market Participants:
- Must be registered with ERCOT
- Must qualify as CRR Account Holders
Congestion Revenue Rights

Barred from owning CRRs:
- TSPs & DSPs
- ERCOT
Congestion Revenue Rights as Financial Instruments

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

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

- Two Instruments:
  - PTP Options – *payment only*
  - PTP Obligations – *payment or charge*
Point-to-Point (PTP) Obligations

- Source A to Sink B: $5/MWh
- Source C to Sink B: $10/MWh
- Source C to Source A: $15/MWh

Obligation $_{AB}$ Payment = $5.00
Obligation $_{CB}$ Payment = ?
Point-to-Point (PTP) Options

Source A → $5/MWh → Sink B

Source B → $10/MWh → Source C

Source C → $15/MWh → Sink B

Option \(_{AB}\) Payment = $5.00

Option \(_{CB}\) Payment = ?
Three ways of acquiring CRRs:

• CRR Auction
• Allocation (Special Case)
• Bilateral Trades
CRRs are auctioned and allocated by:

- Time-of-Use Blocks
- One month strips

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Congestion Revenue Rights

- CRR Auction
- Monthly and Semi-Annual Auctions
- Based on Network Operations Model
Allocation of CRRs

Pre-Assigned CRRs (PCRRs)

- Allocated to Non-Opt-In Entities (NOIEs)
- Based on long-term supply contracts
- May be allocated as Options or Obligations
- No charge or a percentage of the Auction clearing price
Trading CRRs Bilaterally

- PTP Options
- PTP Obligations
  - Characteristics remain unchanged
  - Both parties must meet credit requirements
CRR Settlements

Three Settlement Processes

- CRR Auction Settlement
- CRR Settlement
- CRR Balancing Account
CRR Auction Settlements

Auction Clearing Prices

Awarded Bids

Awarded Offers

Allocated PCRRs

Settlements

Payments

Charges
CRR Auction Settlement Timeline

- **Auction Completed**
- **Day 1** (ERCOT Business Day)
- **Day 2** (Bank Business Day)
- **Day 3** (ERCOT Business Day and Bank Business Day)
- **Day 4** (Payments Due to ERCOT)
- **Day 5** (Payments Due to CRR Account Holders)

Legend:

- * ERCOT Business Day
- ** Bank Business Day
- *** ERCOT Business Day and Bank Business Day
CRR Auction Settlement

CRR Auction Revenues + PCRR Revenues

Monthly

CRR Auction Revenues

Pay to QSEs representing Load
CRR Settlement

CRRs are settled in the Day-Ahead Market
CRR Settlement

Hourly Congestion Rent

Payment due to CRR Account Holders

CRR Balancing Account
CRR Settlement

Hourly

Congestion Rent

Payment due to CRR Account Holders

may be short paid in some hours
CRR Balancing Account

Pay to QSEs representing Load

Payment due to CRR Account Holders

Monthly
CRR Balancing Account

Payment due to CRR Account Holders

may remain short paid

Monthly
Posted after each Auction:

- CRRs awarded
- CRR Account Holders
- Auction clearing prices
- CRR Bids and offers
Topics in this lesson ...

- Purpose of Day-Ahead Market
- Market Participants
- Day-Ahead Market Process
- Process Inputs and Outputs
- Settlements
- Market Information System
You Are Here!

Market Information System (MIS)
- Access Market Reports
- Submit Market Inputs
- Download Information
- Review Market Outputs
- Submit Market Inputs
- Download Information

Registration
- Market Participants
- Qualifications
- Assets
- Relationships

CRR Auction
- Annual & Monthly Auctions
- CRR Offers and Bids
- PTP Options and Obligations
- Flowgate Rights

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

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

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

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

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

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

Settlement
- CRR Auction
- Day-Ahead Market
  - 1 Hour Settlement Interval
- Real-Time Operations
  - 15 Minute Settlement Interval

Monitor Credit • Monitor Performance • Update Outages • Update and Validate Current Operating Plans (COPs)
Purpose of the Day-Ahead Market

- Centralized Forward Market
- Buy and sell Energy
- Sell Ancillary Services to ERCOT
- Forward market provides price certainty
Only QSEs participate in the Day-Ahead Market.
CRRs are settled with Day-Ahead Market Prices
When does the Day-Ahead Market occur?

- Market opens at 0600
- Clearing Process begins at 1000
- Results posted by 1330
An Offer is a proposal to sell:

- A Product
- At a Location
- For a Price

A Bid is a proposal to buy:

- A Product
- At a Location
- For a Price
The Day-Ahead Market

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

Day-Ahead Market

- Pricing
- Awards
The Day-Ahead Market

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

Day-Ahead Market

- Pricing
- Awards
The Day-Ahead Market

Types of Offers:
- Three-Part Supply Offer
- Ancillary Service (AS) Offer
- Day-Ahead Market Energy-Only Offer

Pricing
Awards

Offers
Bids
Current Operating Plans
Network Operations Model
Three-Part Supply Offer

Energy Offer Curve can be submitted without Start-up or Minimum Energy Offers
Ancillary Service (AS) Offers:

- Resource specific
  - Regulation Reserve
  - Responsive Reserve
  - Non-Spinning Reserve
- A Resource may be offered
  - For multiple Ancillary Services
  - For Energy and Ancillary Services
Day-Ahead Market Energy-Only Offer

- Proposal to sell energy in DAM
- Offered at any Settlement Point

Valid only in the Day-Ahead Market

Financial obligation in Real-Time
The Day-Ahead Market

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

- Proposal to buy energy
- Submitted at any Settlement Point

Valid only in the Day-Ahead Market

Financial credit in Real-Time
Day-Ahead Market

Day-Ahead Market PTP Obligation Bids

Purpose of DAM PTP Obligations

- Hedge against congestion costs in Real-Time
- Charge or payment when Grid is congested in Real-Time
Day-Ahead Market PTP Obligation Bids

- Like coupled Energy Bid and Energy Offer
- Purchased at DAM Settlement Point Price Spread
- Settled at Real-Time Settlement Point Price Spread

DAM PTP Obligation can result in a payment or charge
Day-Ahead Market PTP Obligations

QSE charge in Day Ahead Market = ?

QSE payment in Real Time = ?
The Day-Ahead Market

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

Day-Ahead Market

- Pricing
- Awards
The Current Operating Plan (COP)

- Anticipated Resource operating conditions
  - Resource Status
  - Resource Limits
  - Ancillary Service Commitments

- Submitted by QSE

QSE must maintain the COP for each hour of the next 7 days
The Day-Ahead Market

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

Day-Ahead Market

- Pricing
- Awards
The Network Model in the Day-Ahead Market

• Day-Ahead Market does not solve reliability issues

• System must support the Day-Ahead Market solution

The Network Operations Model ensures that DAM solution respects system limits
The Day-Ahead Market

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

Day-Ahead Market

- Pricing
- Awards
The Day-Ahead Market

Cleared Offers = Costs
Cleared Bids = Revenues
The Day-Ahead Market clearing process

Maximize The Gap

Bid-based Revenues

Offer-based Costs
The Day-Ahead Market clearing process

The Day-Ahead Market is a *Co-optimized* Market

Maximize The Gap

Bid-based Revenues

Energy & Ancillary Service Costs

The Day-Ahead Market
The Day-Ahead Market

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

Day-Ahead Market

Pricing
Awards
After Day-Ahead Market

• QSEs may update COP
  • Awarded Energy Offers
  • Ancillary Service Commitments

• QSEs may submit Trades
Trades

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

Trades are used only in Settlements
Day-Ahead Settlement Timeline

Daily statements include

- Payments due
- Charges incurred
Daily invoices include

- DAM Statements
- RTM Statements

**Single Daily Settlement Invoice**

- DAM Statements
- RTM Statements

- Day-Ahead Market
- Invoice Day
- Invoice Day + 2
- Invoice Day + 3

**ERCOT Issues Invoice**
- DAM
- RTM initial
- RTM final
- RTM True-Up

**Payment Due**
- (to ERCOT)
- (to Market Participant)

1700

MIS Certified Area
Posted by 0600 Day-Ahead:

- Network Operations Model
- Weather Assumptions
- Load Forecasts (next 7 days)
- Forecasted Load Profiles
Posted by 1330 Day-Ahead:

- LMPs
- Settlement Point Prices
- MCPCs for each Ancillary Service
- Energy bought and sold
Module 5
Reliability Unit Commitment
Topics in this lesson ...

- Purpose of Reliability Unit Commitment (RUC)
- Market Participants involved
- The RUC Process
- Settlements
- Capacity Shortfall
- Market Information System
It ensures:

• Enough capacity is committed to serve the forecasted load
• Committed capacity is in the right locations
Reliability Unit Commitment

Operational impacts on: QSEs with Resources
Funds collected from:
- Capacity-Short QSEs
- QSEs representing Load
The Reliability Unit Commitment Process

- Current Operating Plans
- Network Operations Model
- Contingencies
- Load Forecast

- Transmission Security Analysis (TSA)
- Reliability Unit Commitment (RUC)

- Three-Part Supply Offers

- Resource Commitments
- Resource Decommitments
Comitting Enough Capacity

- Current Operating Plans
- Network Operations Model
- Contingencies
- Load Forecast

Transmission Security Analysis (TSA)

Reliability Unit Commitment (RUC)

Resource Commitments

Resource Decommitments
Committing Capacity in the Right Locations

Current Operating Plans
Network Operations Model
Contingencies
Load Forecast

Offers
Three-Part Supply Offers

Transmission Security Analysis (TSA)
Reliability Unit Commitment (RUC)

Reliability Unit Commitment

Resource Commitments
Resource Decommitments
What if ERCOT must commit additional capacity?

Reliability Unit Commitment (RUC)

Transmission Security Analysis (TSA)

Network Operations Model

Current Operating Plans

Contingencies

Load Forecast

Resource Commitments

Resource Decommitments
Potential Results of RUC Process:

- Resource Commitments
- Resource Decommitments
- No additional Commitments
When does Reliability Unit Commitment (RUC) occur?

- Day-Ahead Reliability Unit Commitment (DRUC)
- Hourly Reliability Unit Commitment (HRUC)
Reliability Unit Commitment

Make-Whole Payments

Make-Whole Uplift Charges

Capacity Short Charges

Resource Costs*

Resource Revenues*

Capacity Obligations

Capacity Supplies

Settlements

*RUC-Committed Resources
• Make-Whole Payments

• RUC-committed Resources recover their commitment costs
QSEs with Capacity Shortfall may be assessed Capacity Short Charges

Capacity Shortfall

Capacity Obligations

Capacity Supply
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
To Minimize Capacity Short Charges …

QSE must arrange for enough Capacity to meet Obligations
Revenues may not be enough for make-Whole Payments

Difference uplifted to QSEs representing Load
RUC Payments and Charges are included in Real-Time Settlements.
Posted after process completion:

- Resources committed
- Resources decommitted
- Active transmission constraints
Topics in this lesson ...

• Purpose of Real-Time Operations
• Market Participants
• Real-Time Operations Process
  • Security Constrained Economic Dispatch
  • Load Frequency Control
• Settlements
• Market Information System
Purpose of Real-Time Operations

- Manage reliability
  - Match generation with demand
  - Operate transmission system within established limits
- Operate the system at least cost
ERCOT provides dispatch instructions to QSEs with Resources
ERCOT may also provide dispatch instructions to TSP’s
When do Real-Time Operations occur?

- Operating Period
- Includes Operating Hour and Hour-Ahead
The Operating Period includes:

- Operating Hour - Real-Time dispatch of energy
- Hour-Ahead – Preparations for Real-Time Operations
Real-Time Operations

- Telemetry
- Network Operations Model
- Contingencies

Offers

Real-Time Network Security Analysis → Security-Constrained Economic Dispatch

Pricing
  - Locational Marginal Prices

Dispatch Instructions
  - Base Points
Network Security Analysis and SCED

- Network Security Analysis identifies transmission constraints
- Security Constrained Economic Dispatch (SCED) determines least-cost solution
Provide Real-Time system data

Real-Time Operations

Telemetry
Network Operations Model
Contingencies

Real-Time Operations

Real-Time Network Security Analysis

Security-Constrained Economic Dispatch

Offers

Pricing
Locational Marginal Prices

Dispatch Instructions
Base Points
Identify **Constraints**, both **Transmission** & **Resource**

Real-Time Operations

- **Telemetry**
- **Network Operations Model**
- **Contingencies**

Real-Time Operations

Transmission Constraints & Resource Dispatch Limits

Offers

Pricing
- Locational Marginal Prices

Dispatch Instructions
- Base Points
SCED evaluates *Offers* to determine least-cost solution

- **Telemetry**
- **Network Operations Model**
- **Contingencies**

**Real-Time Operations**

- **Offers**
- **Transmission Constraints & Resource Dispatch Limits**

**Pricing**
- Locational Marginal Prices

**Dispatch Instructions**
- Base Points
SCED uses Energy Offer Curves:

Submitted by QSEs:
- Three-Part Supply Offer
- Stand Alone Energy Offer Curve

During:
- Day-Ahead Market
- Adjustment Period
SCED produces **Prices** and **Dispatch Instructions**

**Real-Time Operations**

**Telemetry**

**Network Operations Model**

**Contingencies**

**Real-Time Operations**

1. **Offers**
2. **Pricing**
   - Locational Marginal Prices
3. **Dispatch Instructions**
   - Base Points

**Real-Time Network Security Analysis**

**Security-Constrained Economic Dispatch**
How often does all this happen?

At least every 5 minutes

Real-Time Operations

Real-Time Network Security Analysis

Security-Constrained Economic Dispatch

Pricing
  Locational Marginal Prices

Dispatch Instructions
  Base Points

Offers

Telemetry

Network Operations Model

Contingencies
Real-Time Price Calculations

**Every 5 minutes (when SCED runs)**

LMPs
- Electrical buses

Reserve Price Adders
- ERCOT-wide

**Every 15 minutes**

Settlement Point Prices
- Resource Nodes
- Load Zones
- Hubs
Security Constrained Economic Dispatch (SCED)

• Matches generation with demand
• Manages congestion
• Achieves least cost dispatch
Load Frequency Control (LFC)

- Matches generation with demand
- Responds to frequency deviations
- Deploys Regulation Reserve Service

Real-Time Operations

Frequency (Hz)

60.0000

5 minutes

Base point

5 minutes

Base point

5 minutes

Base point
Real-Time Operations Settlements

Settlements

Payment for Net Supply

Charge for Net Obligation

Settlement point prices

Energy Supplies

Energy Obligations
Examples

• ____________________
• ____________________
• ____________________
Examples

• ____________________
• ____________________
• ____________________
Real-Time Operations Settlements

Real-Time Settlement Timeline

Daily statements include

• Payments due
• Charges incurred

When are Real-Time Statements available?

Operating Day  | Day 5 | Day 55 | Day 180
---|---|---|---
Initial Statement | Final Statement | True-Up Statement
Single Daily Settlement Invoice

Daily invoices include

- DAM Statements
- RTM Statements

Real-Time Operations Settlements

ERCOT Issues Invoice
- DAM
- RTM initial
- RTM final
- RTM True-Up

Payment Due
(to ERCOT)

Payment Due
(to Market Participant)

Day

Day + 2

Day + 3

1700

1700
Posted after completion of SCED:

- Locational Marginal Prices
- Settlement Point Prices
- Active transmission constraints
• 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!
Access Market Information System from ERCOT public website:

Digital Certificate required
LMP Contour Map: http://www.ercot.com/content/cdr/contours/rtmLmpHg.html
CRR Auction Results

Public access:


CRR Auction section, Auction Results posting (zip folder)

• CRRs, CRRAHs awarded, and Auction Clearing Prices
  • Common Market Results file (CSV or XML format)
• CRR Bids and Offers
  • Common Auction Bids and Offers file (CSV or XML format)
Appendix: Pathways to Referenced Data

CRR Auction Results via Market Information System
Appendix: Pathways to Referenced Data

Day-Ahead Network Operations Model (posted by 0600)
Posted by 0600 Day-Ahead:

• Weather assumptions
  • MIS Secure: Markets > Day-Ahead Market > Day-Ahead Public Information

• Forecasted Load Profiles
  • MIS Secure: Markets > Load Profiling > Load Profiling Reports and Extracts (Public)
Appendix: Pathways to Referenced Data

Posted by 0600 Day-Ahead:

• Load Forecasts (next 7 days)
  • Public access: 
  • MIS Secure: Grid > Forecasts > Significant System Conditions

• List of transmission constraints
  • Public access: 
  • MIS Secure: Grid > Generation > Public Generation Information > Weekly RUC Active and Binding Transmission Constraints
Appendix: Pathways to Referenced Data

Posted by 1330 Day-Ahead:

- DAM Hourly LMPs
- DAM Settlement Point Prices
- DAM Clearing Prices for Capacity
- DAM Total Energy Purchased
- DAM Total Energy sold


- MIS Secure: Markets > Day-Ahead Market > Day-Ahead Market Results
Posted after RUC completion:

- RUC Committed or Decommitted Resources
  - MIS Secure: Grid > Generation > Reliability Unit Commitment
- Active transmission constraints
  - Public access: 
    http://www.ercot.com/gridinfo/generation/index.html under Current Information
  - MIS Secure: Grid > Generation > Public Generation Information
Posted after completion of SCED:

• Locational Marginal Prices
• Settlement Point Prices
  • Public access: http://www.ercot.com/mktinfo/rtm/index.html, under Real-Time Prices Reports
  • MIS Secure: Markets > Real-Time Market > Real-Time Prices
• Active transmission constraints
  • MIS Secure: Markets > Real-Time Market > Real-Time Operations