Module Overview

Introduction

Day-Ahead Market

Reliability Unit Commitment

Adjustment Period

Operating Period

Exit
Upon completion of this module, you will be able to:

• Identify the timeline and processes of the Operating Period

• Describe the inputs, processes, and outputs related to Real-Time Energy Dispatch

• Describe the functions of Load Frequency Control

• Illustrate the primary financial impacts associated with the Operating Period
The Operating Period Activity Timeline
Goals of Real-Time Operations

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

ERCOT finds the balance between Reliability and Economics
Constraints

- Power Balance
- Transmission constraints
- Resource constraints

Contributing Factors

- Weather conditions
- Planned and unplanned Outages
Real Time Processes

• Energy Dispatch
  • Achieve Power Balance
  • Manage Congestion
  • Least Cost Dispatch
• Load Frequency Control
  • Maintain Power Balance
Energy Dispatch Overview

- Telemetry
- Network Operations Model
- Contingencies
- Real-Time Network Security Analysis
- Security-Constrained Economic Dispatch
- Offers
- Real-Time Dispatch
- Pricing
- Dispatch Instructions
Real-Time Network Security Analysis

- Telemetry
- Network Operations Model
- Contingencies
- Offers
- Real-Time Network Security Analysis
- Security-Constrained Economic Dispatch
- Real-Time Dispatch
- Pricing
- Dispatch Instructions
Real-Time Network Security Analysis

Energy Dispatch Process

Real-Time Dispatch

- Telemetry
- Network Operations Model
- Contingencies

Security-Constrained Economic Dispatch

- State Estimator
- Offers

- Pricing
- Dispatch Instructions
Real-Time Network Security Analysis

Energy Dispatch Process

- Telemetry
- Network Operations Model
- Contingencies

- State Estimator
- Contingency Analysis

- Offers

- Security-Constrained Economic Dispatch

- Pricing
- Dispatch Instructions

Real-Time Dispatch
Real-Time Network Security Analysis

Energy Dispatch Process

- Telemetry
- Network Operations Model
- Contingencies

Real-Time Dispatch
- State Estimator
- Contingency Analysis
- Constraint Management

Security-Constrained Economic Dispatch

Offers

- Pricing
- Dispatch Instructions
Real-Time Network Security Analysis

Real-Time Network Security Analysis

Network Operations Model

Contingencies

Telemetry

Real-Time Dispatch

Pricing

Dispatch Instructions

Constraints & Shift Factors

Security-Constrained Economic Dispatch

Real-Time Dispatch
Real-Time Network Security Analysis

Energy Dispatch Process

Real-Time Network Security Analysis

- Telemetry
- Network Operations Model
- Contingencies
- Security-Constrained Economic Dispatch
- Real-Time Dispatch
- Offers
- Pricing
- Dispatch Instructions
Balancing Reliability and Economics

Security Constrained Economic Dispatch (SCED)

Network Security Analysis

Energy Offer Curves

SCED
The Texas Two Step

Security Constrained Economic Dispatch (SCED)

SCED executes twice each cycle

- Ensures competition
- Reduces Market Power
- Allows high prices under “the right circumstances”
The Texas Two Step

Circumstances for high prices

- All generation is expensive
- Expensive generation needed to resolve constraints
- Scarcity
The Texas Two Step

SCED

Competitive Constraints Only

All Constraints

Constraints are classified* as:
- Competitive
- Non-Competitive

* See Protocol Section 3.19.4 for details
The Texas Two Step

Step One

• Uses Energy Offer Curves for all On-Line Resources
• Observes the limits of Competitive Constraints only
• Determines “Reference LMPs”
The Texas Two Step

Step Two

- Observes limits of all Constraints
- Energy Offer Curve for each on-line Generation Resource capped at greater of Reference LMP or Mitigated Offer Cap

SCED Step Two produces binding LMPs and Dispatch Instructions
Scenario 1

SCED has completed Step One and determined Reference LMPs

*How will this Energy Offer Curve look in STEP Two?*
Scenario 2

SCED has completed Step One and determined Reference LMPs

1. How will this Energy Offer Curve look in STEP Two?

2. What will it take for this scenario to occur?
The SCED Process

Real-Time Dispatch

Security-Constrained Economic Dispatch

Pricing

Dispatch Instructions

Telemetry

Network Operations Model

Contingencies

Real-Time Network Security Analysis

Offers

Network Operations Model

Contingencies

Telemetry

Energy Dispatch Process
The SCED Process

Telemetry
Network Operations Model
Contingencies
Real-Time Dispatch
Security-Constrained Economic Dispatch
Pricing
Dispatch Instructions

Offers
Resource Limit Calculator
Constraints & Shift Factors
High Sustained Limit

Telemetered by the QSE every few seconds

Low Sustained Limit
High Ancillary Service Limit

Also telemetered by QSE
• AS Resource Responsibility (Reg)
• AS Schedule (RRS & Non-Spin)

Low Ancillary Service Limit
High Dispatch Limit

HDL ≤ HASL

LDL ≥ LASL

Low Dispatch Limit

Reg-Up, RRS & Non-Spin

Up Ramp Rate

Operating Point

Down Ramp Rate

Reg-Down

Base Point Region

5 minutes
The SCED Process

Real-Time Dispatch

- Resource Limit Calculator
- Constraints & Shift Factors
- Generation to be Dispatched

Security-Constrained Economic Dispatch

- Offers

Outputs:
- Pricing
- Dispatch Instructions

Inputs:
- Telemetry
- Network Operations Model
- Contingencies
The SCED Process

Energy Dispatch Process

Real-Time Dispatch

- Offers
- Security-Constrained Economic Dispatch
  - Resource Limit Calculator
  - Constraints & Shift Factors
  - Generation to be Dispatched

- Pricing
- Dispatch Instructions

Telemetry
Network Operations Model
Contingencies

Generation to be Dispatched

Resource Limit Calculator
Constraints & Shift Factors
Generation to be Dispatched
Energy Offer Curves for Generation Resources:

Avenues to Real-Time:

- Awarded offer in DAM
- Committed through RUC
- Committed by QSE

Resource with no Offer Curve:

- Is a price taker at current output
- Is last to be moved
RTM Energy Bid for Load Resources:

Loads dispatchable by SCED:

- Controllable Load Resources may qualify
- Bid represents price tolerance
- Load curtailed at the right price

May be an Aggregate Load Resource
The SCED Process

Energy Dispatch Process

Real-Time Dispatch

- Resource Limit Calculator
- Constraints & Shift Factors
- Generation to be Dispatched

Security-Constrained Economic Dispatch

Pricing

Dispatch Instructions
Scenario 1

**Energy Dispatch – Putting it all together**

### Energy Offer

#### Gen 1

- **Energy Offer**: $15/MWh
- **MW Limit**: 500 MW

#### Gen 2

- **Energy Offer**: $40/MWh
- **MW Limit**: 300 MW

---

**800 MW Load**

**500 MW Load**

---

**500 MW Limit**

---

**300 MW Limit**
A Generation Resource is available for SCED dispatch

The QSE has provided the following Energy Offer Curve.

SCED runs at 1100 and dispatches the Resource to 80MW @$40.

How is this possible?
**SCED Timeline**

SCED is executed:

- Every five minutes (at a minimum)
- More often as needed by ERCOT operators or other ERCOT systems.
The SCED Process

Energy Dispatch Process
Locational Marginal Prices (LMPs)

- Marginal cost of serving the next increment of Load at an Electrical Bus
- Used to calculate Settlement Point Prices
  - Resource Nodes
  - Load Zones
  - Hubs
SCED issues Resource-Specific Base Points

Base Point Dispatch instructions must include the following information:

- Resource Identifier
- Desired MW output level
- Time of the Dispatch Instruction
Communication of Dispatch Instructions

• ERCOT sends dispatch instructions to QSEs

• QSEs are responsible for communicating the instructions to the appropriate Resources
Market Information System Postings

- LMPs for each Electrical Bus
- Active and Binding Transmission Constraint and Contingency pairs
- Settlement Point Prices for each Settlement Point

Real-Time Prices are final at 16:00 on the second Business Day after the Operating Day.
Energy Dispatch Overview

- Real-Time Operations
- Telemetry
- Network Operations Model
- Contingencies
- Real-Time Dispatch
- Offers
- Real-Time Network Security Analysis
- Security-Constrained Economic Dispatch
- Pricing
- Dispatch Instructions
Resource Capacity in Real-Time

• Some is immediately available to SCED
  • Dispatched to achieve Power Balance
  • Dispatched to manage Congestion

• Some is reserved for Ancillary Services
Method Varies by Ancillary Service Product

Deployed by Load Frequency Control

• Regulation Service

• Responsive Reserve Service

Deployed by Operator Dispatch Instruction

• Non-Spin Reserve
Why Load Frequency Control?

- SCED is scheduled to run every 5 minutes
- In that same 5-minute interval, LFC runs 75 times
Purpose of Load Frequency Control

Load Frequency Control (LFC) maintains system frequency, without cost optimization

- Responds to frequency deviations
- Automated control signals to QSEs
  - Regulation Service
  - Responsive Reserve Service
Regulation Service

Provides capacity that can respond to signals from ERCOT within seconds to maintain system frequency

Two Types of Regulation Service

- Regulation Up (Reg Up)
- Regulation Down (Reg Down)

Must be capable of ramping through reserved capacity in 5 minutes
Regulation Service

May be provided by Generation Resources and Controllable Load Resources

Not a Resource-Specific Deployment

• Deployed proportionally by QSE’s share of Regulation provided

• QSE choses how to distribute across their Resources
Regulation Service Communications

QSEs to ERCOT:
- AS Resource Responsibility
- Participation Factors

ERCOT to QSEs:
- Control Signal (4 second)
- Portfolio deployment
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
Responsive Reserve Communications

QSEs to ERCOT:
- AS Resource Responsibility
- AS Schedule

ERCOT to QSEs:
- Control Signal (4 second)
- Portfolio deployment

For Responsive Reserve:
AS Schedule = AS Resource Responsibility – AS Deployment
Responsive Reserve Deployment

QSE chooses Resources by reducing AS Schedules

ERCOT triggers SCED to dispatch Resources
Non-Spinning Reserve Service

Provides additional capacity reserves that can be utilized within 30 minutes

Uses

- System-Wide capacity needs
- Local capacity needs
- Recover Responsive Reserve Service in a timely manner
## Non-Spinning Reserve Deployment

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Requirements</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-Line Generation Resource</td>
<td>Capable of ramping through Non-Spin Resource Responsibility within 30 minutes of Dispatch Instruction.</td>
<td>Energy is dispatched by SCED</td>
</tr>
<tr>
<td>On-Line Generation Resource</td>
<td>Standing Deployment during Operating Hour with $75 floor price</td>
<td>Energy is dispatched by SCED</td>
</tr>
<tr>
<td>Controllable Load Resource</td>
<td>Capable of ramping through Non-Spin Resource Responsibility within 30 minutes of Dispatch Instruction.</td>
<td>Energy is dispatched by SCED</td>
</tr>
</tbody>
</table>
Ancillary Services Capacity Monitor

• Calculates available levels of Resource capacity as per Real-time telemetry
• Calculated every 10 seconds
• Available on MIS
• Streamed over ICCP

http://www.ercot.com/content/cdr/html/as_capacity_monitor.html
Real-Time Operations Timeline
Real-Time Financial Impacts
Real-Time Financial Impacts

1. Real-Time Pricing
2. Real-Time Energy Imbalance
3. Real-Time Ancillary Service Imbalance
4. Base Point Deviation
Real-Time Financial Impacts

1. Real-Time Pricing
2. Real-Time Energy Imbalance
3. Real-Time Ancillary Service Imbalance
4. Base Point Deviation
Real-Time Pricing

- Energy Offers
- System Needs
- Reliability Deployments
- ORDC

Security Constrained Economic Dispatch (SCED)

- Base Points
- LMPs
- Extra SCED
- Price Adders
- Reserve Pricing
- Price Adders

Combined to form Settlement Point Prices
Real-Time Price Adders

RTORPA  –  On-Line Reserve Price Adder

RTOFFPA  –  Off-Line Reserve Price Adder

RTORDPA  –  On-Line Reliability Deployment Price Adder

... for each SCED interval
Combining LMPs and Price Adders

Settlement Point Prices

\[ = \text{Ave (LMPs)} + \text{Ave (RTORPA)} + \text{Ave (RTORDPA)} \]

... for each 15-minute interval
Real-Time Financial Impacts

1. Real-Time Pricing

2. Real-Time Energy Imbalance

3. Real-Time Ancillary Service Imbalance

4. Base Point Deviation
The Basic Idea at any Settlement Point:

\[
(-1) \left( \text{SUPPLIES} \right) - \left( \text{OBLIGATIONS} \right) \times \text{RTSPP}
\]

RTSPP = Real-Time Settlement Point Price
At a Load Zone:

\[
(-1) \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) - \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} + \text{Adjusted Metered Load} \right) \times \text{RTSPP}
\]

Each Settlement Point settled separately
At a Resource Node:

\[
\frac{-1}{ \text{Metered Generation} + \text{DAM Energy Purchases} + \text{Trade Energy Purchases} } \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} \right) \times \text{RTSPP} 
\]

Each Settlement Point settled separately
At a Hub:

\[
\begin{align*}
(1) & \quad \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \\
& \quad \text{DAM Energy Sales} + \text{Trade Energy Sales} \\
& \quad \star \text{RTSPP}
\end{align*}
\]

Each Settlement Point settled separately
DAM Awards & Trades in Real-Time Energy Settlements

- DAM is awarded as *hourly MWs*
- Energy Trades are reported as *hourly MWs*
- Real-Time is settled as *15-minute MWhs*

DAM awards and Trades must be multiplied by $\frac{1}{4}$ hour
Real Time Energy Imbalance Scenarios

- QSE with Load **but no** Generation
- QSE with *only* Generation
- QSE with *neither* Generation nor Load
QSE with Load but no Generation

DAM Energy Purchase for Hour 0900
• 28 MW
• North Load Zone

Real-Time Load for Interval 0900
• 5 MWh
• North Load Zone
• RTSPP = $40/MWh
Real-Time Energy Imbalance at North Load Zone

\[ (-1) \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) - \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} + \text{Metered Load} \right) \times \text{RTSPP} \]

\[ = (-1) \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) - \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} + 28 \text{MW} \times \frac{1}{4} \text{h} \right) \times \text{RTSPP} \]

\[ = (-1) \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) - \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} + 7 \text{MW} \right) \times \text{RTSPP} \]

\[ = (-1) \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) - \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} + 7 \text{MW} \right) \times \$40/\text{MWh} \]
Real-Time Energy Imbalance

Scenario 2

QSE with Load but no Generation

Trade Energy Purchase for Hour 0900
- 28 MW
- North Hub

Real-Time Load for Interval 0900
- 5 MWh
- North Load Zone
Real-Time Energy Imbalance

Scenario 2

Must calculate at two Settlement Points

North Hub
RTSPP = $35/MWh

North Load Zone
RTSPP = $40/MWh
Scenario 2: QSE has Trade Energy Purchase

Real-Time Energy Imbalance at North Hub

\[
\text{RTSPP} = (-1) \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) - \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} + \text{Metered Load} \right) \times \text{RTSPP}
\]

\[
\text{RTSPP} = (-1) \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) - \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} + \text{Metered Load} \right) \times 35\$/\text{MWh}
\]

\[
\text{RTSPP} = (-1) \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) - \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} + \text{Metered Load} \right) \times 35\$/\text{MWh}
\]
Real-Time Energy Imbalance at North Load Zone

\[
\text{Real-Time Energy Imbalance} = (-1) \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) - \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} + \text{Metered Load} \right) \times \text{RTSPP}
\]

\[
\begin{align*}
\text{Cost} &= (-1) \left( \left( \text{Trade Energy Purchases} \right) - \left( \text{Trade Energy Sales} \right) \right) \times 40 \text{$/MWh}
\end{align*}
\]
Scenario 2: QSE has Trade Energy Purchase

QSE’s Net Real-Time Energy Imbalance

Net = −$245 + 200 = −$45
Real Time Energy Imbalance Scenarios

- QSE with Load *but no* Generation
- QSE with *only* Generation
- QSE with *neither* Generation nor Load
QSE with only Generation

DAM Energy Sale for Hour 0900
- 120 MW
- BigGen Resource Node

Real-Time Generation for Interval 0900
- 25 MWh
- BigGen Resource Node
- RTSPP = $30/MWh
Scenario 3: QSE has DAM Energy Sale

Real-Time Energy Imbalance at BigGen Resource Node

\[
\begin{align*}
\text{RTSPP} & = \frac{\text{Metered Generation} + \text{DAM Energy Purchases} + \text{Trade Energy Purchases}}{\text{DAM Energy Sales} + \text{Trade Energy Sales}} \\
\text{RTSPP} & = \frac{(-1)}{} \times \frac{25 \text{ MWh} \times 30/\text{MWh}}{120 \text{MW} \times \frac{1}{4} \text{h}}
\end{align*}
\]
Real Time Energy Imbalance Scenarios

• QSE with Load but no Generation

• QSE with only Generation

• QSE with neither Generation nor Load
Awarded DAM Energy-Only Offer for Hour 0900

- 32 MW
- North Load Zone
- RTSPP = $40/MW
Scenario 4: QSE has Awarded DAM Energy-Only Offer

Real-Time Energy Imbalance at North Load Zone

\[
\text{RTSPP} = (-1) \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) - \left( \text{DAM Energy Sales} + \text{Trade Energy Sales} + \text{Metered Load} \right) \times RTSPPP
\]

\[
= (-1) \left( \right) - \left( \right) \times $40/\text{MWh}
\]
Real-Time Financial Impacts

1. Real-Time Pricing
2. Real-Time Energy Imbalance
3. Real-Time Ancillary Service Imbalance
4. Base Point Deviation
What if . . .

• We could keep on producing Energy from Gen 1?
• We could shift the AS from Gen 1 to Gen 2?
Real-Time Ancillary Service Imbalance

What would Real-Time Co-optimization look like?

QSE Real-Time Settlement:

- Paid RTSPP for energy produced in Real-Time
- Buy back AS Capacity at Real-Time AS Price
What would Real-Time Co-optimization look like?

QSE Real-Time Settlement:

- Paid RTSPP for energy produced in Real-Time
- Paid for AS Capacity at Real-Time AS Price
Real-Time Ancillary Service Imbalance

What would Real-Time Co-optimization Look Like?

Currently,
- No Real-Time Co-optimization
- No Real-Time AS Prices

But we do have
Real-Time Reserve Prices
Real-Time Ancillary Service Imbalance

Real-Time capacity reserves are settled at one of the Real-Time Reserve Prices.

- Approximates settlement impacts of Real-Time Co-optimization
- Provides payment for all capacity reserves that may be utilized during the next hour
The Basic Idea:

\[
(-1) \left( \begin{array}{c}
\text{On-Line Reserve SUPPLIES} \\
\text{Off-Line Reserve SUPPLIES}
\end{array} \right) - \begin{array}{c}
\text{On-Line Reserve OBLIGATIONS} \\
\text{Off-Line Reserve OBLIGATIONS}
\end{array} \right) \times \begin{array}{c}
\text{On-line Reserve Price} \\
\text{Off-line Reserve Price}
\end{array}
\] + \text{Calculated ERCOT-wide per QSE}

Real-Time Ancillary Service Imbalance
Real-Time Reserve Prices

On-line Reserve Price = Time-Weighted Average (RTORPAs)

Off-line Reserve Price = Time-Weighted Average (RTOFFPAs)

... for each 15-minute interval
Scenario 1

How’s it settled?

HSL

Energy Produced

Real-Time Generator

?
Scenario 2

How’s it settled?

HSL

Real-Time Generator

Energy Produced

How’s it settled?
Scenario 3

How’s it settled?

HSL

AS Capacity

HASL

Energy Produced

Real-Time Generator

??
Real-Time Ancillary Service Imbalance

Scenario 4

How’s it settled?

HSL

HASL

Real-Time Generator

Energy Produced

AS Deployed

Paid in Real-Time Energy Imbalance Price: RTSPP?

Charged in Real-Time AS Imbalance Price: On-line Reserve Price?

Scenario 4 (HASL)
Real-Time Ancillary Service Imbalance

Scenario 5

How’s it settled?

HSL

Capacity Off-line

Real-Time Generator

?
How’s it settled?

Real-Time Ancillary Service Imbalance

Scenario 6

HSL

Energy Consumed

LSL

Real-Time Controllable Load Resource

?
Real-Time Ancillary Service Imbalance

**Scenario 7**

How’s it settled?

- **HSL**
  - Energy Consumed
  - AS Capacity
  - LSL
  - Real-Time Controllable Load Resource

- **HSL**
  - On-line Reserve Price
  - RTSPP
  - Paid in DAM or SASM
  - Price: MCPC
How’s it settled?

Real-Time Ancillary Service Imbalance

Scenario 8

Real-Time Non-Controllable Load Resource

HSL

AS Capacity

LSL

Energy Consumed

Paid in DAM or SASM

Price: MCPC

Price: RTSPP

97
Scenario 9

How’s it settled?

Real-Time Ancillary Service Imbalance

HSL

AS Deployed

Energy Consumed

Real-Time Non-Controllable Load Resource
Real-Time Financial Impacts

1. Real-Time Pricing
2. Real-Time Energy Imbalance
3. Real-Time Ancillary Service Imbalance
4. Base Point Deviation Charge
From Resource Dispatch to Real-Time Energy Settlement

- Resource follows ERCOT’s Base Point instructions
- QSE settled through Real-Time Energy Imbalance

But what if the Resource:
- Over-generates?
- Under-generates?
From Resource Dispatch to Real-Time Energy Settlement

A QSE for a Generation Resource shall pay a base point deviation charge if the Resource did not follow Dispatch Instructions and Ancillary Services deployments within defined tolerances.

The ERCOT Protocols tolerances are:

• ± 5% or ± 5MW, whichever is greater
• + 10% for Intermittent Renewable Resources (IRR’s)
Base Point Deviation Charge Exclusions

• No charge during a frequency deviation greater than 0.05 Hz if the QSE’s deviation contributes to frequency correction

• No charge during intervals in which Responsive Reserve is deployed
Some Resources are Exempt

- RMR units
- Qualifying Facilities (as defined by PURA) that do not submit energy offer curves
- Quick Start Generation Resources (QSGRs) exempt for the first Settlement Interval after they are deployed
Setup for all scenarios:

1. QSE has a single generator in ERCOT system.
2. Resource is not a QSGR
3. QSE does not provide Ancillary Services.
4. QSE receives Base Point dispatches from ERCOT to operate at 40 MW during Interval Ending 0900.
Scenario 1

Conditions:

- Resource output exceeds Dispatch Instructions by 8MW
- System Frequency reaches 59.9400 Hz
System frequency was more than 0.05 Hz low, and over-generation helped restore frequency. Does the QSE incur a Base Point Deviation Charge?

Scenario 1

Does the QSE incur a Base Point Deviation Charge?

<table>
<thead>
<tr>
<th>Dispatch Instructions</th>
<th>QSE Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 MW</td>
<td>48 MW</td>
</tr>
</tbody>
</table>

Frequency at max deviation during interval

-0.06
Conditions:

- Resource output exceeds Dispatch Instructions by 8MW

- System Frequency reaches 60.0125 Hz

Scenario 2
Does the QSE incur a Base Point Deviation Charge?

Scenario 2

Dispatch Instructions

QSE Output

40 MW

48 MW

60.0125

Frequency at max deviation during interval

0.0125

Resource output exceeded tolerances, and harmed system frequency.
Conditions:

- Resource output falls short of Dispatch Instructions by 6MW
- System Frequency reaches 60.0125 Hz
Does the QSE incur a Base Point Deviation Charge?

Scenario 3

Frequency at max deviation during interval: 0.0125
Scenario 4

Conditions:

- Resource output falls short of Dispatch Instructions by 6MW
- System Frequency reaches 60.0525 Hz
System frequency was more than 0.05 Hz high, and under-generation helped restore frequency.

Does the QSE incur a Base Point Deviation Charge?

Scenario 4

Frequency at max deviation during interval: 0.0525

Dispatch Instructions
QSE Output

40 MW
34 MW

60.0525
Determining Base Point Deviation

ERCOT compares Adjusted Aggregated Base Points to the Time-Weighted Telemetered Generation.
Calculating Adjusted Aggregated Base Point

Adjusted Aggregated Base Point = Average Base Point + Average Regulation

15 Minute Value Considers Ramping
Base Point Deviation for QSE with Regulation

- Not following Reg-down instructions looks like *over-generating*.
- Not following Reg-up instructions looks like *under-generating*.

System Frequency

60.0000
You have learned about:

- The timeline and processes of the Operating Period
- Inputs, processes, and outputs related to Real-Time Energy Dispatch
- The functions of Load Frequency Control
- The primary financial impacts associated with the Operating Period
Conclusion:
You may amaze yourself!
Conclusion – You may a-MAZE yourself!

Introduction

Day-Ahead Market

Reliability Unit Commitment

Adjustment Period

Operating Period

Exit
Day-Ahead Market

1. What are some possible QSE outcomes in the Day-Ahead Market?

2. Why would a QSE want such outcomes?
Reliability Unit Commitment

1. What are some possible **operational** outcomes from the Reliability Unit Commitment process?

2. What are some possible **financial** outcomes from the Reliability Unit Commitment process?
Adjustment Period

1. What are some possible ERCOT actions during the Adjustment Period?

2. What are some possible QSE actions during the Adjustment Period?
Operating Period

1. Is the Operating Period operationally dependent on previous market processes?

2. Is the Operating Period financially dependent on previous market processes?
Congratulations! You’ve completed Wholesale Markets 201!

Enter

Introduction

Day-Ahead Market

Reliability Unit Commitment

Adjustment Period

Operating Period

Exit
ERCOT Protocols
http://www.ercot.com/mktrules/nprotocols/

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

ERCOT Account Management Services
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ERCOT Credit
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