Upon completion of this module, learners will be able to:

- Describe the Settlement impacts of Real-Time Operations.
- Demonstrate how Energy and Reserves are Settled after Real-Time Operations.
- Explain the Settlement impacts of Base Point Deviation.
- Calculate the impacts of Emergency Operations.
- Recognize the Real-Time Settlements associated with Ancillary Services.
- Explain the impacts of the CRR Auction, Trades and Day-Ahead Market on Real-Time Settlements.
Course Topics

CRR Auction
- Charges & Payments for CRRs
- Revenue Distribution

CRR Balancing Account
- Reconcile CRR Short payments

DAM
- Participation in DAM
  - Energy
  - AS
  - PTP Obligations
- DAM Commitment
  - Make-Whole
- Settlement of CRRs purchased in the Auction

RUC
- Commitment
  - Make-Whole
  - Clawback
- Decommitment

Real-Time
- Real-Time Activities
  - Imbalances
  - Base Point Deviations
  - Other odds & ends
- Settlement of PTP Obligations purchased in the DAM
- Real Time Ancillary Service Settlements
- Revenue Neutrality
Purpose of Real-Time Operations

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

Energy Dispatch Process

Real-Time Dispatch

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

Offers

Pricing

Dispatch Instructions

Telemetry

Network Operations Model

Contingencies
Locational Marginal Prices (LMPs)

- Produced by SCED
- Combined with Reserve Price Adders to form Real-Time Settlement Point Prices

LMPs are location-specific. Reserve Price Adders represent the value of reserves ERCOT-wide.
Real-Time Reserve Price Adders

• Produced outside of SCED

• Two flavors:
  • RTORPA – On-line Reserves
  • RTOFFPA – Off-line Reserves

... for each SCED interval

<table>
<thead>
<tr>
<th>RTORPA</th>
<th>Real-Time On-Line Reserve Price Adder</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTOFFPA</td>
<td>Real-Time Off-Line Reserve Price Adder</td>
</tr>
</tbody>
</table>
Real-Time Reserve Price Adders

**RTRSVPOR** = Time-Weighted Average \( \text{RTORPAs} \)

**RTRSVPOFF** = Time-Weighted Average \( \text{RTOFFPAs} \)

... for each 15-minute interval

<table>
<thead>
<tr>
<th>RTRSVPOR</th>
<th>Real-Time Reserve Price for On-Line Reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTRSVPOFF</td>
<td>Real-Time Reserve Price for Off-Line Reserves</td>
</tr>
</tbody>
</table>
ERCOT added a Reliability Deployment Price Adder on June 1, 2015

- Reliability deployments suppress Real-Time prices
- Price Adder reverses price suppression

Reliability deployments include RUC, Emergency Reserve Service (ERS), RMR and Load Resources
Reliability Deployment Price Adder

**RTORDPA** – Captures impact of reliability deployments during SCED Interval

RTRDP = \(\text{Time-Weighted Average} \left(\text{RTORDPAs}\right)\)

... for each 15-minute interval

<table>
<thead>
<tr>
<th><strong>RTORDPA</strong></th>
<th>Real-Time On-Line Reliability Deployment Price Adder</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RTRDP</strong></td>
<td>Real-Time On-Line Reliability Deployment Price</td>
</tr>
</tbody>
</table>
Settlement Point Prices

= Ave (LMPs) + RTRSVPOR + RTRDP

… for each 15-minute interval

The way the LMPs are averaged varies by Settlement Point
Real-Time Settlements

Real-Time Activities
- Imbalances
- Base Point Deviations
- Other odds & ends

Settlement of PTP Obligations purchased in the DAM

Revenue Neutrality

Supplemental Ancillary Services Market (SASM)
## Real-Time Energy Imbalance

### Fundamentals of Real–Time Energy Imbalances

<table>
<thead>
<tr>
<th>Who:</th>
<th>All QSEs that have Generation, Load, Trades, and DAM purchases or sales at any Settlement Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>What:</td>
<td>A charge or payment for the imbalance of Energy at a Settlement Point</td>
</tr>
<tr>
<td>Why:</td>
<td>To pay or charge a QSE for their injection or withdrawal at a Settlement Point</td>
</tr>
</tbody>
</table>
The basic idea at any Settlement Point:

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

Now, we simply fill in the appropriate elements for each Settlement Point.
Real-Time Energy Imbalance at a Hub:

\[ (-1) \left( \begin{array}{c} \text{DAM Energy Purchases} \\ + \\ \text{Trade Energy Purchases} \end{array} \right) - \left( \begin{array}{c} \text{DAM Energy Sales} \\ + \\ \text{Trade Energy Sales} \end{array} \right) \times \text{RTSPP} \]
At a Hub

**RTSPP** is used to settle financial transactions

**RTSPP** = RTRSVPOR + RTRDP + \[\text{Simple \\& Time-Weighted Average LMPs}\]

<table>
<thead>
<tr>
<th>RTSPP</th>
<th>Real-Time Settlement Point Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTRSVPOR</td>
<td>Real-Time Reserve Price for On-Line Reserves</td>
</tr>
<tr>
<td>RTRDP</td>
<td>Real-Time On-Line Reliability Deployment Price</td>
</tr>
</tbody>
</table>
Real-Time Energy Imbalance at a Load Zone:

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

\[
+ (-1) \left( \text{Non-Modeled Generation} - \text{Adjusted Metered Load} \right) \times \text{RTSPPEW}
\]
At a Load Zone,

**RTSPP** is used to settle financial transactions

\[ \text{RTSPP} = \text{RTRSVPOR} + \text{RTRDP} + \left( \text{MW-Weighted & Time-Weighted Average LMPs} \right) \]

<table>
<thead>
<tr>
<th>RTSPP</th>
<th>Real-Time Settlement Point Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTRSVPOR</td>
<td>Real-Time Reserve Price for On-Line Reserves</td>
</tr>
<tr>
<td>RTRDP</td>
<td>Real-Time On-Line Reliability Deployment Price</td>
</tr>
</tbody>
</table>
At a Load Zone,

**RTSPPEW** is used to settle physical energy consumption

\[ \text{RTSPPEW} = \text{RTRSVPOR} + \text{RTRDP} + \frac{(\text{MW} \times \text{Time})}{\text{LMPs}} \]

<table>
<thead>
<tr>
<th>RTSPPEW</th>
<th>Real-Time Settlement Point Price Energy-Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTRSVPOR</td>
<td>Real-Time Reserve Price for On-Line Reserves</td>
</tr>
<tr>
<td>RTRDP</td>
<td>Real-Time On-Line Reliability Deployment Price</td>
</tr>
</tbody>
</table>
Real-Time Energy Imbalance at a Resource Node:

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

\[
+ \ (-1) \left( \text{Metered Generation} \right) \times \text{RTRMPR}
\]
RTSPP is used to settle financial transactions

$$\text{RTSPP} = \text{RTRSVPOR} + \text{RTRDP} + \text{Time-Weighted Average LMPs}$$

<table>
<thead>
<tr>
<th>RTSPP</th>
<th>Real-Time Settlement Point Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTRSVPOR</td>
<td>Real-Time Reserve Price for On-Line Reserves</td>
</tr>
<tr>
<td>RTRDP</td>
<td>Real-Time On-Line Reliability Deployment Price</td>
</tr>
</tbody>
</table>
At a Resource Node,

**RTRMPR** is used to settle physical energy production

\[
RTRMPR = RTRSVPOR + RTRDP + \text{(Base-Point } \times \text{ Time)}
\]

<table>
<thead>
<tr>
<th><strong>RTRMPR</strong></th>
<th><strong>Real-Time Resource Meter Price</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RTRSVPOR</strong></td>
<td><strong>Real-Time Reserve Price for On-Line Reserves</strong></td>
</tr>
<tr>
<td><strong>RTRDP</strong></td>
<td><strong>Real-Time On-Line Reliability Deployment Price</strong></td>
</tr>
</tbody>
</table>
A QSE has Trades, DAM bids or DAM offers at a Hub

A QSE has Generation, Load, Trades, DAM bids or DAM offers at a Load Zone

A QSE has Generation, Trades, DAM bids or DAM offers at a Resource Node
At a Hub a QSE may have:

- Trades
- DAM Bids & DAM Offers

---

<table>
<thead>
<tr>
<th>If a QSE has…</th>
<th>The QSE will receive…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Supply</td>
<td>Payment</td>
</tr>
<tr>
<td>Net Obligation</td>
<td>Charge</td>
</tr>
</tbody>
</table>
Real-Time Energy Imbalance at a Hub

### Outcome #1

**QSE3**

- 8 MW DAM Energy Sale (2 MWh)
- 12 MW DAM Energy Purchase (3 MWh)
- Settlement Point Price is $40/MWh at Hub1

\[
(-1) \times \text{Price} \times (\text{Supplies} - \text{Obligations})
\]

\[
(-1) \times 40 \text{$/MWh} \times (3 \text{MWh} - 2 \text{MWh}) = -40
\]

<table>
<thead>
<tr>
<th>Supplies</th>
<th>Obligations</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAEP  DAM Energy Purchase</td>
<td>DAES DAM Energy Sale</td>
</tr>
<tr>
<td>RTQQEP Real-Time QSE to QSE Energy Purchase (Trade)</td>
<td>RTQQQES Real-Time QSE to QSE Energy Sale (Trade)</td>
</tr>
</tbody>
</table>
QSE3

- 8MW DAM Energy Sale (2MWh)
- 12 MW DAM Energy Purchase (3MWh)
- Settlement Point Price is $40/MWh at Hub1

\[
\text{RTEIAMT}_{q, p} = (-1) \times \text{RTSPP}_{p} \times \{(\text{DAEP}_{q, p} \times \frac{1}{4}) + (\text{RTQQEP}_{q, p} \times \frac{1}{4}) - (\text{DAES}_{q, p} \times \frac{1}{4}) - (\text{RTQQES}_{q, p} \times \frac{1}{4})\}
\]

\[-$40 = (-1) \times $40/\text{MWh} \times \{(12\text{MW} \times \frac{1}{4}) + (0\text{MW} \times \frac{1}{4}) - (8\text{MW} \times \frac{1}{4}) - (0\text{MW} \times \frac{1}{4})\} \]
Refer to your Settlements Workbook

In a small group, respond to the questions that relate to Scenario #RT1.

You have 5 minutes to complete your questions.

If you can not complete all questions, don’t worry – all questions will be reviewed as a class.
Real-Time Energy: Triggers

**Trigger #1**
A QSE has Trades, DAM bids or DAM offers at a Hub

**Trigger #2**
A QSE has Generation, Load, Trades, DAM bids or DAM offers at a Load Zone

**Trigger #3**
A QSE has Generation, Trades, DAM bids or DAM offers at a Resource Node
At a Load Zone a QSE may have:

- Metered Load
- Non-Modeled Generation
- Trades
- DAM Bids & DAM Offers

### If a QSE has… | The QSE will receive…
--- | ---
Net Supply | Payment
Net Obligation | Charge

**Don’t forget:** Load Zone has two prices
Real-Time Energy Imbalance at a Load Zone

Translated into a Settlement Equation,

\[
RTEIAMT_{q,p} = (-1) \times \left\{ \left[ RTSPP_{p} \times \left( DAEP_{q,p}^{\frac{1}{4}} \right) + \left( RTQQEP_{q,p}^{\frac{1}{4}} \right) \right] - \left( DAES_{q,p}^{\frac{1}{4}} \right) - \left( RTQQES_{q,p}^{\frac{1}{4}} \right) \right\} + \left[ RTSPPEW_{p} \times \left( RTMGNM_{q,p} - RTAML_{q,p} \right) \right]
\]

### Supplies

<table>
<thead>
<tr>
<th>DAEP</th>
<th>DAM Energy Purchase</th>
<th>DAES</th>
<th>DAM Energy Sale</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTQQEP</td>
<td>Real-Time QSE to QSE Energy Purchase (Trade)</td>
<td>RTQQES</td>
<td>Real-Time QSE to QSE Energy Sale (Trade)</td>
</tr>
<tr>
<td>RTMGNM</td>
<td>Real-Time Metered Generation Non-Modeled</td>
<td>RTAML</td>
<td>Real-Time Adjusted Metered Load</td>
</tr>
</tbody>
</table>
QSE4
• Has a 12MW DAM Energy Purchase (3MWh)
• Purchased 20MW through a Trade (5MWh)
• Has Load at LZ3 of 10MWh
• The RTSPP is $100/MWh at LZ3
• The RTSPPEW is $101/MWh at LZ3

$$\text{RTEIAMT}_{q, p} = (-1) \times \left\{ \left[ \text{RTSPP}_{p} \times \left( \left( \text{DAEP}_{q, p} \times \frac{1}{4} \right) + \left( \text{RTQQEP}_{q, p} \times \frac{1}{4} \right) \right) \right] - \left( \text{DAES}_{q, p} \times \frac{1}{4} \right) - \left( \text{RTQQES}_{q, p} \times \frac{1}{4} \right) \right\} + \left[ \text{RTSPPEW}_{p} \times \left( \text{RTMGNM}_{q, p} - \text{RTAML}_{q, p} \right) \right]\right\}$$

$210 = (-1) \times \left\{ \left[ $100/MWh \times \left( 12MW \times \frac{1}{4} \right) + \left( 20MW \times \frac{1}{4} \right) \right] - \left( 0MW \times \frac{1}{4} \right) - \left( 0MW \times \frac{1}{4} \right) \right\} + \left[ $101/MWh \times \left( 0MW - 10MWh \right) \right]\right\}$
Refer to your Settlements Workbook

In a small group, respond to the questions that relate to Scenario #RT2.

You have 10 minutes to complete your questions.

If you can not complete all questions, don’t worry – all questions will be reviewed as a class.
Trigger #1
A QSE has Trades, DAM bids or DAM offers at a Hub

Trigger #2
A QSE has Generation, Load, Trades, DAM bids or DAM offers at a Load Zone

Trigger #3
A QSE has Generation, Trades, DAM bids or DAM offers at a Resource Node
At a Resource Node A QSE may have:

- Metered Generation
- Trades
- DAM Bids & DAM Offers

Don’t forget: Resource node has multiple prices
Real-Time Energy Imbalance at a Resource Node =

\[
\begin{align*}
&(-1) \left[ \left( \text{DAM Energy Purchases} + \text{Trade Energy Purchases} \right) \right] - \\
&\left( \text{DAM Energy Sales} + \text{Trade Energy Sales} \right) \right] \times \text{RTSPPP} \\
&+ \text{(-1)} \left( \text{Metered Generation} \right) \times \text{RTRMPR}
\end{align*}
\]
But in reality . . .

Many Generation Sites are complex

• Multiple generators per meter
• Multiple owners
• Load and generation
• Combined Cycle Resources

ERCOT uses a single methodology to settle all Generation Sites
Introducing Net Metering . . .

Real-Time Energy Imbalance at a Resource Node =

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

\[+\ (-1) \left( \text{Splitting Percentage} \ast \text{Total Site Payment} \right) \]
Real-Time Energy Imbalance at a Resource Node

Splitting Percentage: **GSPLITPER**
- QSE’s per Resource share of Total Site Payment
- Calculated from SCADA telemetry

Total Site Payment: **NMSAMTTOT**
- For all Resources at Site
- For all QSEs at Site

<table>
<thead>
<tr>
<th>GSPLITPER</th>
<th>Generation Resource SCADA Splitting Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMSAMTTTOT</td>
<td>Net Metering Site Amount Total</td>
</tr>
</tbody>
</table>
Real-Time Energy Imbalance at a Resource Node

\[ \text{RESREV}_{q,r} = \left( \text{Splitting Percentage} \times \text{Total Site Payment} \right) \]

**Splitting Percentage**: GSPLITPER
- QSE’s per Resource share of Total Site Payment
- Calculated from SCADA telemetry

**Total Site Payment**: NMSAMTTOT
- For all Resources at Site
- For all QSEs at Site

<table>
<thead>
<tr>
<th>GSPLITPER</th>
<th>Generation Resource SCADA Splitting Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMSAMTTOT</td>
<td>Net Metering Site Amount Total</td>
</tr>
<tr>
<td>RESREV</td>
<td>Resource Share Revenue Settlement Payment for QSE</td>
</tr>
</tbody>
</table>
Real-Time Energy Imbalance at a Resource Node

Net negative energy is settled at a Load Zone.

Total Site Payment:

\[ \text{NMSAMTTOT} = \sum (\text{RTRMPR} \times \text{MEB}) \]

<table>
<thead>
<tr>
<th>RTRMPR</th>
<th>Real-Time Resource Meter Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEB</td>
<td>Metered Energy at Bus</td>
</tr>
</tbody>
</table>
QSE1

- Has one Resource with 60% of the generation at this site
- The metered energy at Bus 1 is 10MWh
- The metered energy at Bus 2 is 20MWh
- The Real Time Resource Meter Price is $30/MWh at both Bus 1 & Bus 2.

Total Site Payment:

\[
NMSAMTTOT = \sum (RTRMPR \times MEB)
\]

\[
= $30/MWh \times (10\text{MWh} + 20\text{MWh})
\]

\[
= $900
\]

QSE 1 Share = GSPLITPER \times NMSAMTTOT

\[
= 60\% \times $900
\]

\[
= $540
\]
Don’t forget: The Resource Node can have other transactions

\[
RTEIAMT_{q,p} = (-1) \times \left\{ \sum_{r} (RESREV_{q,r}) + RTSPP_{p} \times \left[ (DAEP_{q,p} \times \frac{1}{4}) + (RTQQEP_{q,p} \times \frac{1}{4}) - (DAES_{q,p} \times \frac{1}{4}) - (RTQQES_{q,p} \times \frac{1}{4}) \right] \right\}
\]

<table>
<thead>
<tr>
<th>Supplies</th>
<th>Obligations</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAEP</td>
<td>DAM Energy Purchase</td>
</tr>
<tr>
<td>RTQQEP</td>
<td>Real-Time QSE to QSE Energy Purchase (Trade)</td>
</tr>
</tbody>
</table>
In a small group, respond to the questions that relate to Scenario #RT3.

You have 5 minutes to complete your questions.

If you can not complete all questions, don’t worry – all questions will be reviewed as a class.
Volumetric determinants for Real-Time Energy Imbalance:

**RESMEB**\(_q\) = GSPLITPER \(\sum\) MEB for Generation Site

**RNIMBAL**\(_q\) = MWh Imbalance for all transactions at Resource Node

**LZIMBAL**\(_q\) = MWh Imbalance for all transactions at Load Zone

**HBIMBAL**\(_q\) = MWh Imbalance for all transactions at Hub

*For information only; not used in Settlements*

<table>
<thead>
<tr>
<th>RESMEB</th>
<th>Resource Share of total Metered Energy at Bus for QSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RNIMBAL</td>
<td>Resource Node Energy Imbalance per QSE</td>
</tr>
<tr>
<td>LZIMBAL</td>
<td>Load Zone Energy Imbalance per QSE</td>
</tr>
<tr>
<td>HBIMBAL</td>
<td>Hub Energy Imbalance per QSE</td>
</tr>
</tbody>
</table>
SCED will dispatch only the CCGR that is currently online. Metered generation is settled at the Logical Resource Node.
## Real-Time Energy Settlements - Combined Cycle Resources

<table>
<thead>
<tr>
<th>Bill Determinant</th>
<th>Description</th>
<th>Logical Resource Node</th>
<th>Physical Resource Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTEIAMT</td>
<td>Real Time Energy Imbalance Payment</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>DAES</td>
<td>Day Ahead Energy Sales</td>
<td>X (3PO)</td>
<td></td>
</tr>
<tr>
<td>GSPLITPER</td>
<td>Generation Unit Splitting Percentage</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bill Determinant</th>
<th>Description</th>
<th>Logical Resource Node</th>
<th>Physical Resource Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTEIAMT</td>
<td>Real Time Energy Imbalance Payment</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>DAEP</td>
<td>Day Ahead Energy Purchase</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>DAES</td>
<td>Day Ahead Energy Sales</td>
<td>X (Energy only)</td>
<td></td>
</tr>
<tr>
<td>RTQQEP</td>
<td>Real Time QSE to QSE Purchase</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>RTQQSES</td>
<td>Real Time QSE to QSE Sale</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Real-Time Energy Payment for DC Tie Import

**Who:** A QSE that has a DC Tie import

**What:** A Payment for the Energy that is imported into the ERCOT grid through a DC Tie

**Why:** When a QSE brings Power into the ERCOT grid they need to receive a payment for it
A QSE Schedules a DC Tie to import power into ERCOT area
• A QSE Schedules a DC Tie to import energy into ERCOT area

• The QSE receives a payment for the injection of energy
A QSE1

- Schedules 100 MW import on DC Tie one
- The Settlement Point Price is $50/MWh at DCTIE1

\[
\text{RTDCIMPAMT}_{q, p} = (-1) \times \text{RTSPP}_{p} \times (\text{RTDCIMP}_{q, p} \times \frac{1}{4}) \\
\text{\$-1250} = (-1) \times \$50 \times (100\text{MW} \times \frac{1}{4})
\]
### Fundamentals of Real–Time Ancillary Service Imbalances

<table>
<thead>
<tr>
<th><strong>Who:</strong></th>
<th>All QSEs that have Resource Capacity available to ERCOT during Real-Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What:</strong></td>
<td>A charge or payment based on the imbalance between available Capacity and Ancillary Service Reserves</td>
</tr>
<tr>
<td><strong>Why:</strong></td>
<td>To make Resources indifferent to the utilization of their capacity for energy or Ancillary Service reserves</td>
</tr>
</tbody>
</table>
The Basic Idea:

\[
\begin{align*}
\text{(-1)} \left( \left( \text{On-Line Reserve SUPPLIES} - \text{On-Line Reserve OBLIGATIONS} \right) \times \text{On-line Reserve Price} \right) \\
+ \left( \left( \text{Off-Line Reserve SUPPLIES} - \text{Off-Line Reserve OBLIGATIONS} \right) \times \text{Off-line Reserve Price} \right)
\end{align*}
\]

Calculated ERCOT-wide per QSE
Real-Time Ancillary Service Imbalance Overview

For Generation Resources:

HSL=125MW

100MW

HSL=125MW

Paid in RTEIMB

ADDER

LMP + ADDER

Paid in RTASIMB

ADDER

LMP + ADDER
Real-Time Ancillary Service Imbalance Overview

**For Generation Resources:**

- **HSL=125MW**
  - **100MW**
  - **AS Undeployed**
  - Energy Dispatched

  - Paid in DAM or SASM

  - Paid in RTEIMB
  - LMP + ADDER

- **HSL=125MW**
  - **100MW**
  - **AS Deployed**
  - Energy Dispatched

  - Charge (at Adder)

  - Paid in RTEIMB
  - LMP + ADDER
For Load Resources:

- HSL = 125MW
  - 100MW
  - LSL

Paid in RTASIMB
- LMP + ADDER
- ADDER

Charged in RTEIMB
- LMP + ADDER

Paid in DAM or SASM

Paid in RTASIMB
- LMP + ADDER
- ADDER

Charged in RTEIMB
- LMP + ADDER

AS Undeployed
Ancillary Service Imbalance Details:

\[
\begin{align*}
(-1) & \left( \text{Ancillary Service On-Line Reserve Imbalance} \right) \times \text{On-line Reserve Price} \\
+ & \left( \text{Ancillary Service Off-Line Reserve Imbalance} \right) \times \text{Off-line Reserve Price}
\end{align*}
\]
Ancillary Service On-Line Reserve Imbalance

\[ RTASOLIMB_q = RTOLCAP_q - [\text{Online Capacity already reserved}] \]

Online Capacity in Real-Time:

<table>
<thead>
<tr>
<th>RTASOLIMB</th>
<th>Real Time Ancillary Service On-Line Reserve Imbalance</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTOLCAP</td>
<td>Real-Time On-Line Reserve Capacity</td>
</tr>
</tbody>
</table>

Reserved
Ancillary Service On-Line Reserve Imbalance

$$RTASOLIMB_q = RTOLCAP_q - \text{[Online Capacity already reserved]}$$

Online Capacity in Real-Time:

- Capacity from Non-Controllable Load Resources Carrying Responsive Reserve (RTNCLRCAP)
- Capacity from Controllable Load Resources (RTCLRCAP)
- High Sustained Limits – Metered Generation (RTOLHSL - RTGMQ)

*Telemetered and Integrated to 15-minutes*
Real-Time Ancillary Service Imbalance

Ancillary Service On-Line Reserve Imbalance

\[ \text{RTASOLIMB}_q = \text{RTOLCAP}_q - [\text{Online Capacity already reserved}] \]

Online Capacity in Real-Time:

- Ancillary Service Supply Responsibility
  - RUC Ancillary Service Supply Responsibility
  - Ancillary Service Schedule for Off-line Generation
  - Controllable Load Resource Non-Spin Responsibility
  - Ancillary Service Supply Responsibility for RMR Units

Reserved
### Ancillary Service On-Line Reserve Imbalance

\[
RTASOLIMB_q = RTOLCAP_q - \left[ \left( RTASRESP_q \times \frac{1}{4} \right) - RTASOFF_q - RTRUCNBBRESP_q - RTCLRNSRESP_q - RTRMRRESP_q \right]
\]

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTASRESP</td>
<td>Real-Time Ancillary Service Supply Responsibility</td>
</tr>
<tr>
<td>RTASOFF</td>
<td>Real-Time Ancillary Service Schedule for the Off-Line Generation Resource</td>
</tr>
<tr>
<td>RTRUCNBBRESP</td>
<td>Real-Time RUC Ancillary Service Supply Responsibility in Non-Buy-Back hours</td>
</tr>
<tr>
<td>RTCLRNSRESP</td>
<td>Real-Time Controllable Load Resource Non-Spin Responsibility</td>
</tr>
<tr>
<td>RTRMRRESP</td>
<td>Real-Time Ancillary Service Supply Responsibility for RMR Units</td>
</tr>
</tbody>
</table>
Ancillary Service Imbalance Details:

\[
(-1) \left( \text{Ancillary Service On-Line Reserve Imbalance} \right) \times \text{On-line Reserve Price} + \left( \text{Ancillary Service Off-Line Reserve Imbalance} \right) \times \text{Off-line Reserve Price}
\]
Ancillary Service Off-Line Reserve Imbalance

$$RTASOFFIMB_q = RTOFFCAP_q - \text{[Offline Capacity already reserved]}$$

Offline Capacity in Real-Time:

<table>
<thead>
<tr>
<th>RTASOFFIMB</th>
<th>Real Time Ancillary Service Off-Line Reserve Imbalance</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTOFFCAP</td>
<td>Real-Time Off-Line Reserve Capacity</td>
</tr>
</tbody>
</table>
Ancillary Service Off-Line Reserve Imbalance

$$RTASOFFIMB_q = RTOFFCAP_q - \text{[Offline Capacity already reserved]}$$

Offline Capacity in Real-Time:

- Non-Spin Schedule for Controllable Load Resources (RTCLRNS)
- Generation Resources with Off-Line Non-Spin Schedule (RTOFFNSHSL)
- Generation Resources with Cold Start Available in 30 Minutes (RTCST30HSL)

 Converted to 15-minutes
Ancillary Service Off-Line Reserve Imbalance

\[ RTASOFFIMB_q = RTOFFCAP_q - \text{[Offline Capacity already reserved]} \]

Offline Capacity in Real-Time:

- **Reserved**
- **Controllable Load Resource Non-Spin Responsibility (RTCLRNSRESP)**
- **Ancillary Service Schedule for Off-Line Generation Resources (RTASOFF)**
Putting it all back together . . .

\[ RTASIAMT_q = (-1) * [(RTASOLIMB_q \times RTRSVPOR) + (RTASOFFIMB_q \times RTRSVPOFF)] \]

<table>
<thead>
<tr>
<th>RTASIAMT</th>
<th>Real-Time Ancillary Service Imbalance Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTASOLIMB</td>
<td>Real Time Ancillary Service On-Line Reserve Imbalance</td>
</tr>
<tr>
<td>RTRSVPOR</td>
<td>Real-Time Reserve Price for On-Line Reserves</td>
</tr>
<tr>
<td>RTASOFFIMB</td>
<td>Real Time Ancillary Service Off-Line Reserve Imbalance</td>
</tr>
<tr>
<td>RTRSVPOFF</td>
<td>Real-Time Reserve Price for Off-Line Reserves</td>
</tr>
</tbody>
</table>

All elements in these calculations are subject to a System-Wide Discount Factor.
A QSE has On-Line Reserves in Real-Time

Trigger #1

A QSE has Off-Line Reserves in Real-Time

Trigger #2
QSE1

- One Generation Resource online
- HSL is 200 MW (50MWh for 15 minutes)
- Metered Generation is 40 MWh
- No Ancillary Service commitments
- No other Resources available within the hour
- On-line Reserve Price is $20MWh
- Off-line Reserve Price is $5MWh

Assume Discount Factors are already applied

\[
RTASIAMT_q = (-1) \times \left[ (RTASOLIMB_q \times RTRSVPOR) + (RTASOFFIMB_q \times RTRSVPOFF) \right]
\]
Real-Time Ancillary Service Imbalance

Outcome #1

\[ RTASOLIMB_q = RTOLCAP_q - \text{[Capacity already reserved]} \]
\[ = (RTOLHSL - RTMGQ) - [0] \]
\[ = 50\text{MWh} - 40\text{MWh} \]
\[ = 10 \text{ MWh} \]

\[ RTASIAMT_q = (-1) \times [(RTASOLIMB_q \times RTRSVPOR) + (RTASOFFIMB_q \times RTRSVPOFF)] \]
\[ = (-1) \times [(10\text{MWh} \times $20/\text{MWh}) + (0 \times $5/\text{MWh})] \]
\[ = -$200 \]
Real-Time Ancillary Service Imbalance: Triggers

A QSE has On-Line Reserves in Real-Time

A QSE has Off-Line Reserves in Real-Time
QSE4

- No Resources online
- One Generation Resource offline and available within the hour
- HSL is 100 MW (25 MWh for 15 minutes)
- Entire Resource is reserved for Non-Spin
- No other Resources available within the hour
- On-line Reserve Price is $20/MWh
- Off-line Reserve Price is $5/MWh

Assume Discount Factors are already applied

\[
RTASIAMT_q = (-1) \times [(RTASOLIMB_q \times RTRSVPOR) + (RTASOFFIMB_q \times RTRSVPOFF)]
\]
Real-Time Ancillary Service Imbalance

**Outcome #1**

\[
\text{RTASOLIMB}_q = \text{RTOLCAP}_q - \left[ \text{Capacity already reserved} \right] \\
\quad = 0 - ((\text{RTASRESP} \times \frac{1}{4}) - \text{RTASOFF}) \\
\quad = 0 - [(100\text{MW} \times \frac{1}{4}\text{h}) - 25\text{MWh}] \\
\quad = 0 \text{ MWh}
\]

\[
\text{RTASOFFIMB}_q = \text{RTOFFCAP}_q - \left[ \text{Reserved Capacity} \right] \\
\quad = \text{RTOFFNSHSL} - [\text{RTASOFF}] \\
\quad = 25\text{MWh} - [25\text{MWh}] \\
\quad = 0 \text{ MWh}
\]

\[
\text{RTASIAMT}_q = (-1) \times \left[ (\text{RTASOLIMB}_q \times \text{RTRSVPOR}) + (\text{RTASOFFIMB}_q \times \text{RTRSVPOFF}) \right] \\
\quad = (-1) \times [(0 \times $20/\text{MWh}) + (0 \times $5/\text{MWh})] \\
\quad = $0
\]
In a small group, respond to the questions that relate to Scenario #RT4.

You have 10 minutes to complete your questions.

If you cannot complete all questions, don’t worry – all questions will be reviewed as a class.
### Real-Time Activities
- Imbalances
- Base Point Deviations
- Other odds & ends

### Fundamentals of Real–Time Reliability Deployment Ancillary Service Imbalances

<table>
<thead>
<tr>
<th>Who:</th>
<th>All QSEs that have Resource Capacity available to ERCOT during Reliability Deployments in Real-Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>What:</td>
<td>A charge or payment based on the imbalance between available Capacity and Ancillary Service Reserves</td>
</tr>
<tr>
<td>Why:</td>
<td>To make Resources indifferent to the utilization of their capacity for energy or Ancillary Service reserves</td>
</tr>
</tbody>
</table>
Real-Time Reliability Deployment AS Imbalance: Triggers

Trigger #1

A QSE has On-Line Reserves in Real-Time
QSE1

- Had a Real-Time Ancillary Service Online Reserve Imbalance

\[ RTRDASIAMT_q = (-1) \times (RTASOLIMB_q \times RTRDP) \]

<table>
<thead>
<tr>
<th>RTRDASIAMT</th>
<th>Real-Time Reliability Deployment Ancillary Service Imbalance Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTASOLIMB</td>
<td>Real Time Ancillary Service On-Line Reserve Imbalance</td>
</tr>
<tr>
<td>RTRDP</td>
<td>Real-Time On-Line Reliability Deployment Price</td>
</tr>
</tbody>
</table>
# Fundamentals of Base Point Deviation Charge

**Who:** QSEs that have Resources that do not follow Base Points as dictated by SCED

**What:** A charge for over generation or under generation – May not receive this charge when helping frequency

**Why:** The Resource did not follow Dispatch Instructions and Ancillary Services deployments within defined tolerances
Base Point Deviation Charge

- Resource did not follow Dispatch Instructions and Ancillary Services Deployments within defined tolerances

- Tolerances
  - ± 5% or ± 5MW, whichever is greater
  - + 10% for Intermittent Renewable Resources (when curtailed)
Base Point Deviation Charge

• Exclusions
  • No charge during a Frequency deviation greater than 0.05 Hz if the QSEs deviation helps frequency
  • No charge for any intervals with Responsive Reserve deployments
Base Point Deviation Charge

- Exemptions
  - RMR Units
  - Qualifying Facilities (QFs) that do not submit Energy Offer Curves
  - Quick Start Generation Resources (QSGRs) exempt for the first Settlement Interval in which they are deployed

Subject to Base Point Deviation Charge.

Base Point Deviation Charge

SCED Base Point

50MW
Determining Basepoint Deviation Charges

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

\[
\text{Adjusted Aggregated Base Point} = \text{Average Base Point} + \text{Average Regulation}
\]

- Adjusted Aggregated Base Point
- 15 Minute Value
- Considers Ramping
- Average Base Point
- Average Regulation
Base Point Deviation Charge: Triggers

Trigger #1
Resource did not follow Dispatch Instructions and OVER Generated

Trigger #2
Resource did not follow Dispatch Instructions and UNDER Generated
• Resource did not follow Dispatch Instructions and OVER Generated

• The Over Generation is outside of the 5% or 5 MW tolerance

• QSE is charged:
  Settlement Point Price * the MW above Tolerance

*If system frequency dipped below 59.95 Hz during the settlement interval, then the QSE would not be charged.*
**QSE1 unit 5**

- Adjusted Aggregated Base Point of 40MW
- Time Weighted Telemetered Generation of 12MWh (Operated at 48MW)
- Tolerances are 5% or 5MW
- Settlement Point Price is $20/MWh at RN5

**Base Point Deviation Charge**

\[
\text{Charge} = \text{Price} \times (\text{Generation} - \frac{1}{4} h \times \text{Max} (\text{AABP} + 5\% \text{ or } \text{AABP} + 5\text{MW}))
\]

\[
= $20/\text{MWh} \times (12\text{MWh} - \frac{1}{4} h \times \text{Max} (42\text{MW} \text{ or } 45\text{MW}))
\]

\[
= $20/\text{MWh} \times (12\text{MWh} - 11.25\text{MWh})
\]

\[
= $15
\]
Translated into Settlement Equations,

\[
BPDAMT = \max (PR1, \text{RTSPP}) \times \text{OGEN}
\]

\[
\text{OGEN} = \max \left( 0, \left( \text{TWTG} - \frac{1}{4} \times \max \left( (1 + K1) \times \text{AABP}, (\text{AABP} + Q1) \right) \right) \right)
\]

<table>
<thead>
<tr>
<th>BPDAMT (_{q, r, p})</th>
<th>Base Point Deviation Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>OG(\text{EN})</td>
<td>Over Generation Volume</td>
</tr>
<tr>
<td>TWTG (_{q, r, p})</td>
<td>Time Weighted Telemetered Generation</td>
</tr>
<tr>
<td>AABP (_{q, r, p})</td>
<td>Adjusted Aggregated Base Point</td>
</tr>
<tr>
<td>PR1</td>
<td>Minimum price for over-generation, $20.</td>
</tr>
<tr>
<td>K1</td>
<td>The percentage tolerance for over-generation, 5%.</td>
</tr>
<tr>
<td>Q1</td>
<td>The MW tolerance for over-generation, 5 MW.</td>
</tr>
</tbody>
</table>
QSE1 unit 5

- Adjusted Aggregated Base Point of 40MW
- Time Weighted Telemetered Generation of 12MWh (Operated at 48MW)
- Tolerances are 5% or 5MW
- Settlement Point Price is $20/MWh at RN5

**Outcome #1**

\[
\text{BPDAMT} = \max \left( \text{PR1}, \text{RTSPP} \right) \times \text{OGEN}
\]

\[
\text{OGEN} = \max \left(0, \left( \text{TWTG} - \frac{1}{4} \times \max \left( (1 + K1) \times \text{AABP}, (\text{AABP} + Q1) \right) \right) \right)
\]

\[
\text{OGEN} = \max \left(0, \left( 12\text{MWh} - \frac{1}{4} \times \max \left( 42 \text{ MW}, 45\text{MW} \right) \right) \right) = 0.75 \text{ MWh}
\]

\[
\text{BPDAMT} = \max \left( 20/\text{MWh}, 20/\text{MWh} \right) \times \text{OGEN} = \$15
\]
Key Differences between Intermittent Renewable Resources (IRRs) & Conventional Resources

IRR must be Curtailed

• Curtailment Flag

IRR must be Over-Generating

• Telemetered generation
• Instructed Base Point

Wider tolerance for deviation from Base Point
When are IRRs exposed to deviation charges?

<table>
<thead>
<tr>
<th></th>
<th>IRR output within 10% acceptable range</th>
<th>IRR output exceeds 10% acceptable range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curtailment Flag is not set</td>
<td>No Charge</td>
<td>No Charge</td>
</tr>
<tr>
<td>Curtailment Flag is set</td>
<td>No Charge</td>
<td><strong>Charge</strong></td>
</tr>
</tbody>
</table>
Translated into Settlement Equations,

If $\text{SBPBHDLFLAG} = 1$, then

$$\text{BPDAMT} = \max (\text{PR1}, \text{RTSPP}) \times \text{OGENIRR}$$

$$\text{OGENIRR} = \max \left(0, \left(\text{TWTG} - \frac{1}{4} \times \text{AABP} \times (1 + \text{KIRR})\right)\right)$$

<table>
<thead>
<tr>
<th>SBPBHDLFLAG</th>
<th>SCED Base Point Below HDL FLAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPDAMT $q, r, p$</td>
<td>Base Point Deviation Amount</td>
</tr>
<tr>
<td>OGENIRR</td>
<td>Over Generation Volume per IRR Generation Resource</td>
</tr>
<tr>
<td>TWTG $q, r, p$</td>
<td>Time Weighted Telemetered Generation</td>
</tr>
<tr>
<td>AABP $q, r, p$</td>
<td>Adjusted Aggregated Base Point</td>
</tr>
<tr>
<td>PR1</td>
<td>Minimum price for over-generation, $20.</td>
</tr>
<tr>
<td>KIRR</td>
<td>The percentage tolerance for IRRs, 10%.</td>
</tr>
</tbody>
</table>
Refer to your Settlements Workbook

In a small group, respond to the questions that relate to Scenario #RT5.

You have 5 minutes to complete your questions.

If you can not complete all questions, don’t worry – all questions will be reviewed as a class.
Base Point Deviation Charge: Triggers

**Trigger #1**
Resource did not follow Dispatch Instructions and OVER Generated

**Trigger #2**
Resource did not follow Dispatch Instructions and UNDER Generated
• Resource did not follow Dispatch Instructions and UNDER Generated

• The Under Generation is outside of the 5% or 5 MW tolerance

• QSE is charged:
  Settlement Point Price * the MW below Tolerance

If system frequency rose above 60.05 Hz during the settlement interval, then the QSE would not be charged.
QSE4 unit 8

- Adjusted Aggregated Base Point of 40MW
- Time Weighted Telemetered Generation of 8MWh (Operated at 32MW)
- Tolerances are 5% or 5MW
- Settlement Point Price is -$20/MWh at RN8

**Base Point Deviation Charge**

\[
\text{Charge} = (-1) \times \text{Price} \times \left( \frac{1}{4} h \times \min (\text{AABP} - 5\% \ or \ \text{AABP} - 5\text{MW}) - \text{Generation} \right)
\]

\[
= (-1) \times -$20/\text{MWh} \times \left( \frac{1}{4} h \times \min (38\text{MW} \ or \ 35\text{MW}) - 8\text{MWh} \right)
\]

\[
= (-1) \times -$20/\text{MWh} \times (8.75\text{MWh} - 8\text{MWh})
\]

\[
= $15
\]
Translated into Settlement Equations,

\[
BPDAMT = (-1) \times \min (PR2, RTSPP) \times \min(1, KP) \times UGEN
\]

\[
UGEN = \max \left( 0, \min \left( (1 - K2) \times \frac{1}{4} AABP, \frac{1}{4} (AABP - Q2) \right) - TWTG \right)
\]
Base Point Deviation Charge – Under Generation

**Outcome #1**

QSE4 unit 8
- Adjusted Aggregated Base Point of 40MW
- Time Weighted Telemetered Generation of 8MWh (Operated at 32MW)
- Tolerances are 5% or 5MW
- Settlement Point Price is -$20/MWh at RN8

**Base Point Deviation Charge**

\[ \text{BPDAMT} = (-1) \times \min(\text{PR2, RTSPP}) \times \min(1, \text{KP}) \times \text{UGEN} \]

\[ \text{UGEN} = \max(0, \min(1 - K2, AABP - Q2) - \text{TWTG}) \]

\[ \text{UGEN} = \max(0, \min(9.5\text{MWh}, 8.75\text{MWh}) - 8\text{MWh}) \]

\[ \text{BPDAMT} = (-1) \times \min(-$20/\text{MWh}, -$20/\text{MWh}) \times \min(1, 1) \times \text{UGEN} = $15 \]
<table>
<thead>
<tr>
<th><strong>Who:</strong></th>
<th>QSEs that have load</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What:</strong></td>
<td>Distributes the funds collected from Base Point Deviation Charges.</td>
</tr>
<tr>
<td><strong>Why:</strong></td>
<td>To keep ERCOT revenue neutral</td>
</tr>
</tbody>
</table>
Charges for Base Point Deviations are collected
• Resources Over or Under Generated
• ERCOT charges the QSEs representing the Resources

• Sum Base Point Deviation charges for the interval
• Calculate each QSE’s Load Ratio Share
• Pay each QSE their portion of the revenue
For interval one ERCOT charged for deviation

- Total Charges $255

QSE 5 has thirty percent of Load

- QSE 5 is paid for 30 percent of the $255

\[
LABPDAMT_q = (-1) \times BPDAMTTOT \times LRS_q
\]

\[-76.50 = (-1) \times 255 \times 0.30\]
Fundamentals of RMR Service Charge

Who: QSEs that have load

What: A Charge based on a QSEs Load Ratio Share to cover the costs of RMR units

Why: RMR units help ERCOT reliability serve all loads.
RMR UNIT

A Generation Resource operated under the terms of an Agreement with ERCOT that would not otherwise be operated except that it is necessary to provide voltage support, stability or management of localized transmission constraints under Credible Single Contingency criteria where market solutions do not exist.
ERCOT has incurred costs for RMR units
• All payments and charges related to RMR units are summed
• Net is allocated to QSEs with Load

<table>
<thead>
<tr>
<th>RMR Service Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome #1</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RMR Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMRSBAMTTOT</td>
<td>RMR Standby Amount Total</td>
</tr>
<tr>
<td>RMREAMTTOT</td>
<td>RMR Energy Amount Total</td>
</tr>
<tr>
<td>RMRAAMTTOT</td>
<td>RMR Adjusted Amount Total</td>
</tr>
<tr>
<td>RMRDAESRTVTOT</td>
<td>RMR Day-Ahead Energy Sale Real-Time Value Total</td>
</tr>
<tr>
<td>RMRDAEREVTOT</td>
<td>RMR Day-Ahead Energy Revenue Total</td>
</tr>
<tr>
<td>RMRDAMWREVTOT</td>
<td>RMR Day-Ahead Make-Whole Revenue Total</td>
</tr>
<tr>
<td>RMRNPAMTTOT</td>
<td>RMR Non-Performance Amount Total</td>
</tr>
</tbody>
</table>
• Standby Amount  = -$3,185
• Energy Payment = -$6,815
• All other values = $0
• QSE5 has 10% of the load

\[
\text{LARMRamt}_q = (-1) \times \left( \text{RMRSBAMTTOT} + \text{RMREAMTTOT} + \text{RMRAAMTTOT} - \sum \text{RMRDAESRTVTOT}_i - (\text{RMRDAEREVTOT} + \text{RMRDAMWREVTOT}) + \text{RMRNPAMTTOT} / \text{Hours in Operating Day} \right) \times \text{HLRS}_q
\]

\[
\begin{align*}
&= (-1) \times (-$3,185 + -$6,815 + $0 - $0 - ($0 + $0) + $0) \times 0.10 \\
&= (-1) \times ($10,000) \times 0.10 \\
&= $1000
\end{align*}
\]
## Fundamentals of Emergency Power Increases Payment

<table>
<thead>
<tr>
<th><strong>Who:</strong></th>
<th>QSEs that receive Emergency Base Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What:</strong></td>
<td>A payment to provide additional compensation for energy produced in response to Emergency Base Points</td>
</tr>
<tr>
<td><strong>Why:</strong></td>
<td>To make up the difference between the Settlement Point Price and the QSE’s actual cost for operating at the Emergency Base Point</td>
</tr>
</tbody>
</table>

### Real-Time

**Real-Time Activities**
- Imbalances
- Base Point Deviations
- Other odds & ends
Emergency Power Increases

- May be required when SCED can’t solve
- ERCOT operations issues new Base Points without corresponding price changes

Eligible for Emergency Energy Payment
Paid RTSPP for all energy produced

<table>
<thead>
<tr>
<th>SCED Base Point</th>
<th>40MW</th>
<th>50MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Base Point</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Payment for Emergency Power Increases
Emergency Power Increases

- Quick Start Generation Resources may also be eligible
- SCED Base Point below registered seasonal LSL
- QSE requests manual override of Base Point

Payment for Emergency Power Increases

Registered LSL

Paid RTSPP for all energy produced
Payment for Emergency Power Increases

A resource receives an Emergency Base Point

Trigger #1
Trigger #1

- SCED can’t solve
- ERCOT dispatches resource to an Emergency Base Point (EBP)

Outcome #1

- Resource moves to EBP
- Calculate the emergency energy produced by the Resource
- Calculate the price for emergency energy
- Pay the Resource when emergency price is higher than RTSPP
Payment for Emergency Power Increases

Determine the Emergency Energy Quantity

- Lesser of:
  - EBP or Actual
  - Output minus the original Base Point (BP)

Determine the Emergency Energy Price

- EBP average weighted price minus the RTSPP
- EBP average weighted price
  - From Resource’s offer curve at EBP
  - Time Weighted for the 15-minute Interval
QSE4 Unit 9 Receives Emergency Base Point

- BP of 150 MW
- EBP of 200 MW
- RTMG of 50 MWh

Pricing Information

- RTSPP is $50/MWh
- Unit 9 price at EBP is $55/MWh
## Determine the Emergency Energy Quantity

\[
\text{EMRE}_{q, r, p} = \max(0, \min(\text{AEBP}_{q, r, p}, \text{RTMG}_{q, r, p}) - \frac{1}{4} \times \text{BP}_{q, r, p})
\]

\[
12.5 \text{MWh} = \max(0, \min(200 \text{MW} \times \frac{1}{4} \text{h}, 50 \text{MWh}) - \frac{1}{4} \times 150 \text{MW})
\]

<table>
<thead>
<tr>
<th><strong>EMRE</strong>&lt;sub&gt;q, r, p&lt;/sub&gt;</th>
<th><strong>Emergency Energy</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AEBP</strong>&lt;sub&gt;q, r, p&lt;/sub&gt;</td>
<td><strong>Aggregated Emergency Base Point</strong></td>
</tr>
<tr>
<td><strong>RTMG</strong>&lt;sub&gt;q, r, p&lt;/sub&gt;</td>
<td><strong>Real-Time Metered Generation</strong></td>
</tr>
<tr>
<td><strong>BP</strong>&lt;sub&gt;q, r, p&lt;/sub&gt;</td>
<td><strong>Base Point</strong></td>
</tr>
</tbody>
</table>
Determine the Emergency Energy Price

\[ \text{EMREPR}_{q,r,p} = \max(0, \text{EBPWAPR}_{q,r,p} - \text{RTSPP}_p) \]

\[ \$5/\text{MWh} = \max(0, \$55/\text{MWh} - \$50/\text{MWh}) \]

<table>
<thead>
<tr>
<th>EMREPR (_{q,r,p})</th>
<th>Emergency Energy Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBPWAPR (_{q,r,p})</td>
<td>Emergency Base Point Weighted Average Price</td>
</tr>
<tr>
<td>RTSPP (_p)</td>
<td>Real-Time Settlement Point Price</td>
</tr>
</tbody>
</table>
• Payment when emergency price is higher than RTSPP

• No payment when the emergency price is lower than RTSPP

Outcome #1

Payment for Emergency Power Increases

\[
\text{EMREAMT}_{q, r, p} = (-1) \times \text{EMREPR}_{q, r, p} \times \text{EMRE}_{q, r, p}
\]

\[
$-62.50 = (-1) \times $5$/\text{MWh} \times 12.5\text{MWh}
\]
Fundamentals of Charges for Emergency Power Increases

**Who:** QSEs that have load

**What:** A Charge to cover the costs of Emergency Power payments

**Why:** To cover the costs of a service to ensure ERCOT reliability
Charge for Emergency Power Increases

Payments for Emergency Power Increases
• ERCOT made payments for resources that provided Emergency Power
• QSE has load in the ERCOT market

• Sum Emergency Power payments for the interval
• Calculate QSE’s Load Ratio Share
• Apply QSE’s LRS to total Emergency Power payments to determine charge
For interval one ERCOT made Emergency Power Payments

- Total Payments $62.50
- QSE 5 has thirty percent of Load
- QSE 5 pays for 30 percent of the $62.50

\[
\text{LAEMREAMT}_q = (-1) \times \text{EMREAMTTOT} \times \text{LRS}_q
\]

\[
$18.75 = (-1) \times -$62.50 \times .30
\]
# Real-Time

**Settlement of PTP Obligations purchased in DAM**

---

## Fundamentals of PTP Obligations Settled in Real-Time

### Who:

QSEs that have purchased PTP obligations in the DAM

### What:

A Charge or Payment based on Real-Time Congestion

### Why:

To Hedge the Cost of congestion in Real-Time
Payments or Charges for PTP Obligations in Real-Time

Day-Ahead Market
A QSE Purchases PTP Obligation in Day-Ahead Market.

Real-Time Settlements
PTP Obligation settled in the Real-Time market
A QSE buys a PTP obligation in the DAM
A QSE buys a PTP obligation in the Day-Ahead Market.

The Price is the Difference between the RTSPP of the Source and Sink.

- If Sink price is higher, the QSE is paid.
- If Source price is higher, the QSE is charged.
Settlement for DAM PTP Obligations

\[ \text{RTOBLAMT}_{q, (j, k)} = (-1) \times \text{RTOBLPR}_{(j, k)} \times \text{RTOBL}_{q, (j, k)} \]

\[ \text{RTOBLPR}_{(j, k)} = \sum (\text{RTSPP}_k - \text{RTSPP}_j) / 4 \]

**Determinants**

- **Real-Time Obligation Amount**
- **Real-Time Obligation Price**
- **Real-Time Obligation**
- **Real-Time Settlement Point Price**

[q = QSE]

[j = Source Settlement Point]

[k = Sink Settlement Point]
• QSE3 bought 40 MW of PTP obligations in the Day-Ahead Market.

• RT Settlement Point Prices during the hour

<table>
<thead>
<tr>
<th>Interval</th>
<th>Source</th>
<th>Sink</th>
</tr>
</thead>
<tbody>
<tr>
<td>0415</td>
<td>$17</td>
<td>$21</td>
</tr>
<tr>
<td>0430</td>
<td>$17</td>
<td>$22</td>
</tr>
<tr>
<td>0445</td>
<td>$16</td>
<td>$21</td>
</tr>
<tr>
<td>0500</td>
<td>$15</td>
<td>$21</td>
</tr>
</tbody>
</table>

• QSE3 receives a payment
**Payments or Charges for PTP Obligations in Real-Time**

\[
RTOBLPR_{(j, k)} = \sum (RTSPP_{k, i} - RTSPP_{j, i}) / 4
\]

\[
$5/MW_{(j, k)} = \frac{[($21/MWh - $17/MWh) + ($22/MWh - $17/MWh) + ($21/MWh - $16/MWh) + ($21/MWh - $15/MWh)]}{4}
\]

QSE3 receives a payment

\[
RTOBLAMT_{q, (j, k)} = (-1) \times RTOBLPR_{(j, k)} \times RTOBL_{q, (j, k)}
\]

\[
-200 = (-1) \times 5/MW \times 40 MW
\]
Real-time Settlement of DAM PTP Obligations with Links to Option

**Who:** NOIE that owns PTP Options before DAM and buys PTP Obligations in DAM linked to those Options

**What:** A Payment based on Real-Time Congestion

**Why:** To Hedge the Cost of congestion in Real-Time
NOIE buys DAM PTP Obligations based on PTP Options they own
Settlement for DAM PTP Obligations with Links to Options

\[
\text{RTOBLLOAMT}_{q, (j, k)} = (-1) \times \max(0, \text{RTOBLPR}_{(j, k)}) \times \text{RTOBLLO}_{q, (j, k)}
\]

\[
\text{RTOBLPR}_{(j, k)} = \sum (\text{RTSPP}_k - \text{RTSPP}_j) / 4
\]

**Determinants**

- **Real-Time Obligation with Links to an Option Amount**
- **Real-Time Obligation Price**
- **Real-Time Obligation with Links to an Option**
- **Real-Time Settlement Point Price**

\[q = \text{QSE}\]

\[j = \text{Source Settlement Point}\]

\[k = \text{Sink Settlement Point}\]
### Fundamentals of Payments for Services Sold in SASM

<table>
<thead>
<tr>
<th>Who:</th>
<th>QSEs that sold Reg-Up, Reg-Down, Responsive, or Non-Spin in a SASM</th>
</tr>
</thead>
<tbody>
<tr>
<td>What:</td>
<td>A Payment for the services sold in a SASM</td>
</tr>
<tr>
<td>Why:</td>
<td>To cover the costs of a services to ensure ERCOT reliability</td>
</tr>
</tbody>
</table>
ERCOT may procure Ancillary Services in the Adjustment Period for 3 reasons:

1) Replacement of Ancillary Services capacity due to a QSE’s failure to provide or purchase (trade) from someone else
   - Includes Reconfiguration SASM

2) Replacement of Ancillary Services capacity that is undeliverable due to transmission constraints

3) Increased need of Ancillary Services capacity above what was specified in the Day-Ahead
ERCOT executes a SASM and Ancillary Services are sold
In SASM1

- QSE1, 50 MW of Regulation Up at $8/MW
- QSE4, 4 MW of Regulation Down at $4/MW
- QSE4, 20 MW of Responsive Reserve at $8/MW
- QSE1, 40 MW of Non-Spin at $12/MW

Payments for Ancillary Services Sold in a SASM

\[
\begin{align*}
\text{RTPCRUAMT}_{q,M} &= (-1) \times \text{MCPCRU}_M \times \text{RTPCRU}_{q,M} \\
\text{RTPCRDAMT}_{q,M} &= (-1) \times \text{MCPCRD}_M \times \text{RTPCRD}_{q,M} \\
\text{RTPCRRAMT}_{q,M} &= (-1) \times \text{MCPCRR}_M \times \text{RTPCRR}_{q,M} \\
\text{RTPCNSAMT}_{q,M} &= (-1) \times \text{MCPCNS}_M \times \text{RTPCNS}_{q,M}
\end{align*}
\]

- $400_{q,M} = (-1) \times $8/MW \times 50MW_{q,M}$
- $16_{q,M} = (-1) \times $4/MW \times 4MW_{q,M}$
- $160_{q,M} = (-1) \times $8/MW \times 20MW_{q,M}$
- $480_{q,M} = (-1) \times $12/MW \times 40MW_{q,M}$
### Real-Time Ancillary Service Settlements

## Fundamentals of Payments for AS Procured through RUC

<table>
<thead>
<tr>
<th>Who:</th>
<th>QSEs who were committed to provide AS through RUC and Opted out of the RUC commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>What:</td>
<td>A Payment for the reserved capacity</td>
</tr>
<tr>
<td>Why:</td>
<td>To cover the value of the reserved capacity</td>
</tr>
</tbody>
</table>
Payments for Ancillary Services Procured through RUC

HSL=125MW

100MW

Ancillary Service

Energy Dispatched

Paid at Adder

Paid in RTEIMB

LMP + ADDER

Available only for QSEs who opt out of RUC
QSE1

- Was committed to provide Ancillary Services on several Resources
- Opted out of RUC commitment before the end of the Adjustment Period

Payments for Ancillary Services Procured through RUC

\[
RTRUCRSVAMT_q = (-1) \times (RTRUCRESP_q \times RTRSVPOR)
\]

Where

\[
RTRUCRESP_q = \sum_r \frac{1}{4} RTRUCASA_{q,r}
\]
QSE1

- Was committed to provide Ancillary Services on several Resources
- Opted out of RUC commitment before the end of the Adjustment Period

Also,

$$\text{RTRDRUCRSVAMT}_q = (-1) \times (\text{RTRUCRESP}_q \times \text{RTRDP})$$

<table>
<thead>
<tr>
<th>RTRDRUCRSVAMT</th>
<th>Real-Time Reliability Deployment RUC Ancillary Service Reserve Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTRUCRESP</td>
<td>Real-Time RUC Ancillary Service Supply Responsibility</td>
</tr>
<tr>
<td>RTRDP</td>
<td>Real-Time On-Line Reliability Deployment Price</td>
</tr>
</tbody>
</table>
### Real-Time Ancillary Service Settlements

#### Fundamentals of Charges for Failure to Provide

<table>
<thead>
<tr>
<th><strong>Who:</strong></th>
<th>QSEs that fail to provide their Ancillary Service Supply Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What:</strong></td>
<td>A charge for the Failure to Provide Ancillary Service Capacity</td>
</tr>
<tr>
<td><strong>Why:</strong></td>
<td>To ensure costs are met in order to replace Failed Ancillary Service Capacity</td>
</tr>
</tbody>
</table>
Charges for Failure to Provide

Max Price of AS Markets * Failed Quantity

RUFQAMT \(_q\) = \(\text{Max} (\text{MCPCRU} \_m) \times \text{RUFQ} \_q\),
RDFQAMT \(_q\) = \(\text{Max} (\text{MCPCRD} \_m) \times \text{RDFQ} \_q\),
RRFQAMT \(_q\) = \(\text{Max} (\text{MCPCRR} \_m) \times \text{RRFQ} \_q\),
NSFQAMT \(_q\) = \(\text{Max} (\text{MCPCNS} \_m) \times \text{NSFQ} \_q\),

<table>
<thead>
<tr>
<th>RUFQAMT</th>
<th>Reg-Up Failure Quantity Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCPCRU</td>
<td>Market Clearing Price for Capacity for Reg-Up</td>
</tr>
<tr>
<td>RUFQ</td>
<td>Reg-Up Failure Quantity</td>
</tr>
</tbody>
</table>
Charges for Reconfiguration SASM

Outcome #1

Charge for Failure to Provide

Reconfiguration SASM Price * Failed Quantity

\[
\text{RRUFQAMT}_q = \text{MCPCRU}_{rs} \times \text{RRUFQ}_q, \\
\text{RRDFQAMT}_q = \text{MCPCRD}_{rs} \times \text{RRDFQ}_q, \\
\text{RRRFQAMT}_q = \text{MCPCRR}_{rs} \times \text{RRRFQ}_q, \\
\text{RNSFQAMT}_q = \text{MCPCNS}_{rs} \times \text{RNSFQ}_q,
\]

Similar for other AS Types

<table>
<thead>
<tr>
<th>RRUFQAMT</th>
<th>Reconfiguration Reg-Up Failure Quantity Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCPCRU_{rs}</td>
<td>Market Clearing Price for Capacity for Reg-Up by RSASM</td>
</tr>
<tr>
<td>RRUFQ</td>
<td>Reconfiguration Reg-Up Failure Quantity</td>
</tr>
</tbody>
</table>
### Fundamentals of Adjustments to Cost for Ancillary Service

<table>
<thead>
<tr>
<th>Who:</th>
<th>QSEs that have Ancillary Service obligations</th>
</tr>
</thead>
<tbody>
<tr>
<td>What:</td>
<td>A charge to the QSE for its share of the net total costs incurred in both DAM and SASMs less its DAM charge</td>
</tr>
<tr>
<td>Why:</td>
<td>To cover the costs of a services to ensure ERCOT reliability</td>
</tr>
</tbody>
</table>
ERCOT has net costs for AS that must be collected from the market
Adjustments to Costs for Ancillary Services Procurement

Failed AS Amounts

DAM Procured Amounts
SASM Procured Amounts

Total AS Costs
A QSE’s share of the net total cost for an Ancillary Service for an Operating Hour is simply

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

**AS Price**

\[
\text{AS Price} = \left( \frac{\text{ERCOT Total AS Cost}}{\text{ERCOT Total Obligation not Self-Arranged}} \right)
\]

**AS Quantity**

\[
\text{AS Quantity} = (\text{QSE Obligation}) - (\text{Self-Arranged Qty})
\]
Adjustments to Costs for Ancillary Services Procurement

QSE Obligation = (ERCOT Total AS Capacity) * HLRS + AS Replaced as Undeliverable
ERCOT Total AS Capacity

Total ERCOT AS Capacity = \sum_{\text{All QSEs}} \left( \begin{array}{c}
\text{Self-Arranged Qty in all Markets} \\
\text{AS Procured in Real-Time} \\
\text{AS Procured in DAM} \\
\text{AS Replaced as Undeliverable} \\
\text{AS Failed Quantities}
\end{array} \right)

Adjustments to Costs for Ancillary Services Procurement
ERCOT Total AS Capacity

- Replacement
  - Failed Quantities
  - Self Arranged
  - DAM Procured
  - Real-Time Procured
Putting it all together,

\[
\text{QSE Obligation} = \sum_{\text{All QSEs}} \left( \begin{array}{l}
\text{Self-Arranged Qty in all Markets} \\
\text{AS Procured in Real-Time} \\
\text{AS Procured in DAM} \\
\text{AS Replaced as Undeliverable} \\
\text{AS Failed Quantities}
\end{array} \right) * \text{HLRS} + \text{AS Replaced as Undeliverable}
\]
Now, the QSE’s AS Cost is simply

\[ \text{AS Price} \times [ \text{QSE Obligation} - \text{(Self-Arranged Qty)} ] \]

Is this what the QSE pays for each Ancillary Service in Real-Time?
The QSE already paid part of this AS Cost in the Day-Ahead Market.

In Real-Time, the QSE pays or is paid for any difference between their AS Cost and their Day-Ahead AS Charge.

\[
\text{RT AS Amount} = \text{AS Cost} - \text{Day-Ahead AS Amount}
\]
Refer to your Settlements Workbook

In a small group, respond to the questions that relate to Scenario #RT6.

You have 15 minutes to complete your questions.

If you can not complete all questions, don’t worry – all questions will be reviewed as a class.
QSE’s Net Cost for Reg-Up is calculated as

\[ \text{RUCOST}_q = \text{RUPR} \times \text{RUQ}_q \]

Where:

- Net price for Reg-Up

\[ \text{RUPR} = \text{RUCOSTTOT} / \text{RUQTOT} \]

- A QSE’s net quantity for Reg-Up

\[ \text{RUQ}_q = \text{RUO}_q - \text{SARUQ}_q \]
QSE’s Net Cost for Reg-Up is calculated as

$$\text{RUCOST}_q = \text{RUPR} \times \text{RUQ}_q$$

Where:

- A QSE’s obligation for Reg-Up

$$\text{RUO}_q = \sum_q (\text{SARUQ}_q + \sum_m (\text{RTPCRU}_{q,m}) + \text{PCRU}_q, - \text{RURP}_q - \text{RUFQ}_q - \text{RRUFQ}_q) \times \text{HLRS}_q + \sum_m \text{RURP}_{q,m}$$
Finally, the QSE is charged the difference between their net Reg-Up Cost and their Day-Ahead Reg-Up Charge.

The Real-Time Reg-Up Amount for a QSE

\[ RTRUAMT_q = RUCOST_q - DARUAMT_q \]

There is a similar Charge Type for each Ancillary Service Type.
Real-Time Revenue Neutrality Allocation

**Fundamentals of Real-Time Revenue Neutrality Allocation**

<table>
<thead>
<tr>
<th>Who:</th>
<th>QSEs that have load</th>
</tr>
</thead>
<tbody>
<tr>
<td>What:</td>
<td>An Allocation on of a QSEs Load Ratio Share</td>
</tr>
<tr>
<td>Why:</td>
<td>To keep ERCOT revenue neutral</td>
</tr>
</tbody>
</table>
Revenue Neutrality

ERCOT Must Be revenue Neutral
Revenue Neutrality

Left over funds paid out to QSEs by Load Ratio Share
Revenue Neutrality

Short funds are collected from QSEs by Load Ratio Share
Revenue Neutrality: Triggers

**Trigger #1**
ERCOT has issued energy-related charges and payments and must achieve Revenue Neutrality.

**Trigger #2**
ERCOT has issued AS Imbalance charges and payments and must achieve Revenue Neutrality.
### Outcome #1

- All charges and payments related to energy and congestion are summed
- Allocated to QSEs with Load

### Table

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTEIAMTTOT</td>
<td>Real-Time Energy Imbalance Amount Total</td>
</tr>
<tr>
<td>BLTRAMTTOT</td>
<td>Block Load Transfer Resource Amount Total</td>
</tr>
<tr>
<td>RTDCIMPAMTTOT</td>
<td>Real-Time DC Import Amount Total</td>
</tr>
<tr>
<td>RTDCEXPAMTTOT</td>
<td>Real-Time DC Export Amount Total (Oklaunion)</td>
</tr>
<tr>
<td>RTCCAMTTOT</td>
<td>Real-Time Energy Congestion Cost Amount Total</td>
</tr>
<tr>
<td>RMRDAESRTVTOT</td>
<td>RMR Day-Ahead Energy Sale Real-Time Value Total</td>
</tr>
<tr>
<td>RTOBLAMTTOT</td>
<td>Real-Time Obligation Amount Total</td>
</tr>
<tr>
<td>RTOBLLOAMTTOT</td>
<td>Real-Time Obligation with Links to an Option Amount Total</td>
</tr>
</tbody>
</table>
Real-Time Revenue Neutrality Allocation

• Hourly values must be divided by 4
• Allocated based on Load Ratio Share

\[
LARTRNAMT \quad q = (-1) \ast \left( \begin{array}{c}
RTEIAMTTOT + BLTRAMTTOT \\
+ RTDCIMPAMTTOT + RTDCEXPAMTTOT \\
+ RTCCAMTTOT + RMRDAESRTVTOT \\
+ RTOBLAMTTOT/4 + RTOBLLOAMTTOT/4
\end{array} \right) \ast LRS \quad q
\]
Real-Time Revenue Neutrality Allocation

Outcome #1

- RT Energy Imbalance Total = $1500
- DC Tie Import Amount Total = -$400
- RT Obligation Amount Total = -$1200
- QSE 4 has 20% of the load

\[
LARTRNAMT_q = (-1) \times \left( \frac{RTEIAMTTOT + BLTRAMTTOT + RTDCIMPAMTTOT + RTDCEXPAMTTOT + RTCCAMTTOT + RMRDAESRTVTOT + RTOBLAMTTOT/4 + RTOBLLOAMTTOT/4}{LRS_q} \right) \\
= (-1) \times (\frac{1500 - 400 - 1200/4}{0.20}) \\
= (-1) \times (800) \times 0.20 \\
= -$160
\]
ERCOT has issued energy-related charges and payments and must achieve Revenue Neutrality

**Trigger #1**

ERCOT has issued AS Imbalance charges and payments and must achieve Revenue Neutrality

**Trigger #2**
Real-Time AS Imbalance Revenue Neutrality Allocation

• All charges and payments related to AS Imbalance are summed
• Allocated to QSEs with Load

\[
\text{LAASIRNAMT}_q = (-1) \times [(\text{RTASIAMTTOT} + \text{RTRUCRSVAMTTOT}) \times \text{LRS}_q]
\]

<table>
<thead>
<tr>
<th>LAASIRNAMT</th>
<th>Load-Allocated Ancillary Service Imbalance Revenue Neutrality Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTASIAMTTOT</td>
<td>Real-Time Ancillary Service Imbalance Market Total Amount</td>
</tr>
<tr>
<td>RTRUCRSVAMTTOT</td>
<td>Real-Time RUC Ancillary Service Reserve Market Total Amount</td>
</tr>
</tbody>
</table>
Real-Time AS Imbalance Revenue Neutrality Allocation

- RT AS Imbalance Total = $1200
- RT RUC AS Reserve Total = -$300
- QSE 5 has 30% of the load

\[
LAASIRNAMT_q = (-1) \times [(RTASIAMTTOT + RTRUCRSVAMTTOT) \times LRS_q]
\]
\[
= (-1) \times [($1200 - $300) \times 0.30]
\]
\[
= (-1) \times [$900 \times 0.30]
\]
\[
= - $270
\]
Real-Time AS Imbalance Revenue Neutrality Allocation

But wait, there’s more!

• All charges and payments related to Reliability Deployment AS Imbalance are summed
• Allocated to QSEs with Load

\[ \text{LARDASIRNAMT}_{q} = (-1) \times [(\text{RTRDASIAMTTOT} + \text{RTRDRUCRCSVAMTTOT}) \times \text{LRS}_q] \]

<table>
<thead>
<tr>
<th>LARDASIRNAMT</th>
<th>Load-Allocated Reliability Deployment Ancillary Service Imbalance Revenue Neutrality Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTRDASIAMTTOT</td>
<td>Real-Time Reliability Deployment Ancillary Service Imbalance Market Total Amount</td>
</tr>
<tr>
<td>RTRDRUCRCSVAMTTOT</td>
<td>Real-Time Reliability Deployment RUC Ancillary Service Reserve Market Total Amount</td>
</tr>
</tbody>
</table>
Payments for Ancillary Services Procured through RUC

QSE1

- Was committed to provide Ancillary Services on several Resources
- Opted out of RUC commitment before the end of the Adjustment Period

Also,

$$RTRDRUCRSVAMT_q = (-1) \times (RTRUCRESP_q \times RTRDP)$$

<table>
<thead>
<tr>
<th>RTRDRUCRSVAMT</th>
<th>Real-Time Reliability Deployment RUC Ancillary Service Reserve Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTRUCRESP</td>
<td>Real-Time RUC Ancillary Service Supply Responsibility</td>
</tr>
<tr>
<td>RTRDP</td>
<td>Real-Time On-Line Reliability Deployment Price</td>
</tr>
</tbody>
</table>
$ Describe the Settlement impacts of Real-Time Operations.

$ Calculate various charges and payments associated with Real-Time Operations

$ Explain the impacts of the CRR Auction, Trades and the Day-Ahead Market on Real-Time Settlements