PROTOCOL DISCLAIMER

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/
## Suite of Wholesale Market Courses

<table>
<thead>
<tr>
<th>Format</th>
<th>Title</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBT</td>
<td>Wholesale Markets Overview</td>
<td></td>
</tr>
</tbody>
</table>
| ILT    | Wholesale Market Operations: Day-Ahead | Day-Ahead Market Inputs  
|        |                                 | Day-Ahead Market Clearing  
|        |                                 | Day-Ahead Market Financial Impacts  
|        |                                 | RUC and its Financial Impacts  
|        | Wholesale Market Operations: Real-Time | The Adjustment Period  
|        |                                 | Real-Time Dispatch and AS Deployments  
|        |                                 | Real-Time Financial Impacts |
WebEx Training Tips

- Windows
- Buttons

Attendance

Questions / Chat

Please enable video & audio capabilities
Wholesale Market Operations: Day-Ahead

Day-Ahead

Day-Ahead Market

DRUC

Operating Day

06:00

10:00

13:30 14:30

00:00

ERCOT posts market data by 0600
QSEs provide Day-Ahead Market inputs by 10:00
Day-Ahead Market Inputs
Products Transacted in DAM

- Energy Bids and Offers
- PTP Obligation Bids
- Ancillary Service Offers

DAM

- Hourly Awards
- Hourly Prices
Submitted by 10:00

Bids & Offers
- Energy Bids
- Energy-Only Offers
- Three Part Supply Offers
- Ancillary Service Offers
- PTP Obligation Bids

Other QSE Information
- Self-Arranged Ancillary Service Quantities
- Current Operating Plans
Submission via ERCOT Market Manager

Application Library

These are the applications available based on your Digital Certificate's permissions.

- **CRR MOI**
  - Internal Congestion Revenue Rights (CRR) Market Operator Inte...
  - Certified

- **Extract Subscriber**
  - Subscribe/unsubscribe to/from specific certified retail and s...
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  - Secure

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## User Guides

As a service to the market, ERCOT publishes helpful guides on how to use data extracts and applications. For descriptions of ERCOT extracts and reports, please refer to the [ERCOT Market Information List (EMIL)](https://www.ercot.com/market-information).

### Wholesale

<table>
<thead>
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This handbook sets practices, conventions, and fundamental parameters required for Market Participants to exchange data with ERCOT using ICCP protocol in the TX Nodal Market.
Submitted by 10:00

Bids & Offers
- Energy Bids
- Energy-Only Offers
- Three Part Supply Offers
- Ancillary Service Offers
- PTP Obligation Bids

Other QSE Information
- Self-Arranged Ancillary Service Quantities
- Current Operating Plans
Energy Bids and Energy-Only Offers

**DAM Energy Bid**
Proposal to *buy* energy:
- Quantity
- Price
- Settlement Point

**DAM Energy-Only Offer**
Proposal to *sell* energy:
- Quantity
- Price
- Settlement Point
Discussion: DAM Energy Bids

Purely Financial Transactions
Discussion: DAM Energy-Only Offers

Purely Financial Transactions

DAM → QSE → Real-Time
Energy Bid and Energy-Only Offer Format

Curve with up to 10 Price/Quantity Pairs

Energy Bid

$ / MWh vs MW

Energy-Only Offer

$ / MWh vs MW
Block with Single Price/Quantity Pair

**Variable Quantity Block**
- Multi-hour Block? 
- $ / MWh
- Up to specified MW

**Fixed Quantity Block**
- Multi-hour Block? ✓
- $ / MWh
- All MW or nothing
Scenario: Fixed vs. Variable Blocks

QSE submits the following Energy Bid for 0700-2200

Variable Quantity Block

Variable Quantity Block

$50/MWh

10MW

Multi-hour Block? ✓

Day-Ahead Market Options?
QSE submits the following Energy Bid for 0700-2200

- Fixed Quantity Block
  - $50/MWh
  - 10MW

Day-Ahead Market Options?
Submitted by 10:00

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Energy Offer from Generation Resource

- **Startup Offer**: $/Start
- **Minimum Energy Offer**: $/MWh
- **Energy Offer Curve**: $/MWh vs. MW

- **LSL** – Low Sustained Limit
- **HSL** – High Sustained Limit
Where are the three parts used?

<table>
<thead>
<tr>
<th>Three-Part Supply Offer</th>
<th>Startup Offer</th>
<th>Minimum Energy Offer</th>
<th>Energy Offer Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day-Ahead Market</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>RUC-Commitment</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Real-Time Dispatch</td>
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<td></td>
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## Ancillary Service Offers

### Resource-Specific Offers for Each Service

<table>
<thead>
<tr>
<th>Type of Service</th>
<th>Offer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation Up</td>
<td>MW $ / MW</td>
</tr>
<tr>
<td>Regulation Down</td>
<td>MW $ / MW</td>
</tr>
<tr>
<td>Responsive Reserve</td>
<td>MW $ / MW</td>
</tr>
<tr>
<td>Non-Spinning Reserve</td>
<td>MW $ / MW</td>
</tr>
</tbody>
</table>

... subject to $0 / MW price floor
Ancillary Service Offer Format

**Block with Single Price/Quantity Pair**

- **Variable Quantity Block**
  - Multi-hour Block?
  - Up to specified MW
  - Any qualified Resource

- **Fixed Quantity Block**
  - Multi-hour Block?
  - All MW or nothing
  - Load Resources Only
Single Resource may be offered multiple ways

<table>
<thead>
<tr>
<th>AS Type</th>
<th>Offer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reg Up</td>
<td>MW $ / MW</td>
</tr>
<tr>
<td>Reg Down</td>
<td>MW $ / MW</td>
</tr>
<tr>
<td>Responsive</td>
<td>MW $ / MW</td>
</tr>
<tr>
<td>Non-Spin</td>
<td>MW $ / MW</td>
</tr>
</tbody>
</table>

Total DAM award will not exceed Resource’s Capacity
Scenario: Linked AS and Three Part Supply Offers

But how would the Day-Ahead Market handle this?

<table>
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<tr>
<th>AS Type</th>
<th>Offer</th>
</tr>
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<tbody>
<tr>
<td>Reg Up</td>
<td>MW $ / MW</td>
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<td>MW $ / MW</td>
</tr>
<tr>
<td>Non-Spin</td>
<td>MW $ / MW</td>
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</tbody>
</table>

- **Startup Offer**: $/Start
- **Minimum Energy Offer**: $/MWh
- **Energy Offer Curve**: $/MWh vs MW, LSL to HSL
Submitted by 10:00

<table>
<thead>
<tr>
<th>Bids &amp; Offers</th>
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</thead>
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<tr>
<td>Energy Bids</td>
</tr>
<tr>
<td>Energy-Only Offers</td>
</tr>
<tr>
<td>Three Part Supply Offers</td>
</tr>
<tr>
<td>Ancillary Service Offers</td>
</tr>
<tr>
<td>PTP Obligation Bids</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other QSE Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Arranged Ancillary Service Quantities</td>
</tr>
<tr>
<td>Current Operating Plans</td>
</tr>
</tbody>
</table>
Like a coupled Energy-Only Offer and Energy Bid

Charge (If Awarded) = ?
Submitted between any two Settlement Points

<table>
<thead>
<tr>
<th>Source</th>
<th>Sink</th>
<th>Bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hub</td>
<td>Load Zone</td>
<td>MW $ / MW / h</td>
</tr>
<tr>
<td>Resource Node</td>
<td>Load Zone</td>
<td>MW $ / MW / h</td>
</tr>
<tr>
<td>Resource Node</td>
<td>Hub</td>
<td>MW $ / MW / h</td>
</tr>
<tr>
<td>Load Zone</td>
<td>Resource Node</td>
<td>MW $ / MW / h</td>
</tr>
<tr>
<td>Load Zone</td>
<td>Hub</td>
<td>MW $ / MW / h</td>
</tr>
</tbody>
</table>
Block with Single Price/Quantity Pair

Multi-hour Block? ✅

Variable Quantity Block

$ / MW / h

Up to specified MW

MW
Submitted by 10:00

Bids & Offers
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Other QSE Information
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A QSE may have Ancillary Service Obligations

Self-Arrange

Allow ERCOT to procure

May choose to Self-Arrange before DAM
**Scenario: Self-Arranged Ancillary Service Quantities**

QSE has Regulation Up Obligations for a range of hours

<table>
<thead>
<tr>
<th>Hour</th>
<th>QSE AS Obligation</th>
<th>Self-Arranged Quantity</th>
<th>Net Obligation</th>
<th>ERCOT action on QSE’s behalf</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500</td>
<td>7 MW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1600</td>
<td>6 MW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1700</td>
<td>5 MW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1800</td>
<td>4 MW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1900</td>
<td>3 MW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QSE Action</td>
<td>Limits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Self-Arrangement more than AS Obligation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsive Reserve</td>
<td>Up to 100 MW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Spin Reserve</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulation Up</td>
<td>Up to 25 MW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulation Down</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantity from QSE’s Resources may not exceed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AS Obligation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Negative Self-Arrangement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 500 MW per Service</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limited to Net AS Trades</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Submitted by 10:00

QSE Day-Ahead Market Inputs

Bids & Offers
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Other QSE Information
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- Current Operating Plans
### Current Operating Plan

<table>
<thead>
<tr>
<th>Resource Name</th>
<th>Resource Status</th>
<th>Resource Limits</th>
<th>Ancillary Service Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ThisOne</td>
<td>ON</td>
<td>600 120</td>
<td>Reg-up</td>
</tr>
<tr>
<td>ThatOne</td>
<td>ON</td>
<td>400 75</td>
<td>0</td>
</tr>
<tr>
<td>OtherOne</td>
<td>OFF</td>
<td>100 25</td>
<td>0</td>
</tr>
</tbody>
</table>

**Discussion:** Current Operating Plan for DAM

**What does DAM need from Current Operating Plans?**

- DAM needs **Limits**
- DAM needs **Status for Hour 2400**
Day-Ahead Market Clearing
Day-Ahead Market

Day-Ahead

- Day-Ahead Market
- DRUC

06:00
10:00
13:30 14:30
00:00

Operating Day
Economically optimized subject to constraints

- Energy Bids and Offers
- PTP Obligation Bids
- Ancillary Service Offers

DAM

Network Model

Hourly Awards

Hourly Prices
Maximize Bid-Based Revenues minus Offer-Based Costs

- Optimized Value
- Bids
- Offers
- Solution

$/MWh vs. MW
Energy Offers must equal Energy Bids

Energy Bids and Offers

PTP Obligation Bids

Ancillary Service Offers

DAM

Hourly Awards

Hourly Prices

Network Model
Network Constraints

Solution must represent allowable power flow

Energy Bids and Offers
PTP Obligation Bids
Ancillary Service Offers

DAM

Network Model

Hourly Awards
Hourly Prices
Introducing a simple Network Model …
**Determine Awards and Prices**

<table>
<thead>
<tr>
<th>QSE</th>
<th>Product</th>
<th>Bid or Offer</th>
<th>Location</th>
<th>MW</th>
<th>Price</th>
<th>Award</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSE 1</td>
<td>Energy</td>
<td>Offer</td>
<td>A</td>
<td>100</td>
<td>$20</td>
<td></td>
</tr>
<tr>
<td>QSE 2</td>
<td>Energy</td>
<td>Offer</td>
<td>C</td>
<td>60</td>
<td>$30</td>
<td></td>
</tr>
<tr>
<td>QSE 3</td>
<td>Energy</td>
<td>Bid</td>
<td>D</td>
<td>90</td>
<td>$40</td>
<td></td>
</tr>
</tbody>
</table>

**Bid-based Revenues – Offer-based Costs (Objective Value)**

<table>
<thead>
<tr>
<th>LMP&lt;sub&gt;A&lt;/sub&gt;</th>
<th>LMP&lt;sub&gt;B&lt;/sub&gt;</th>
<th>LMP&lt;sub&gt;C&lt;/sub&gt;</th>
<th>LMP&lt;sub&gt;D&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>$20</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
</tr>
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</table>

**Prices**
Discussion of Results

Does solution make sense?

<table>
<thead>
<tr>
<th>Result</th>
<th>MW</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSE 1:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QSE 2:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QSE 3:</td>
<td></td>
<td></td>
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Modeling of PTP Obligations Bids

Energy injection

A → PTP → B → C, 100 MW

Energy Withdrawal

B → D, 100 MW
Scenario: Optimization of Energy and PTP Obligations

Determine Awards and Prices

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<td>Offer</td>
<td>C</td>
<td>60</td>
<td>$30</td>
<td></td>
</tr>
<tr>
<td>QSE 3</td>
<td>Energy</td>
<td>Bid</td>
<td>D</td>
<td>90</td>
<td>$40</td>
<td></td>
</tr>
<tr>
<td>QSE 4</td>
<td>PTP Obl</td>
<td>Bid</td>
<td>A to B</td>
<td>30</td>
<td>$20</td>
<td></td>
</tr>
</tbody>
</table>

Bid-based Revenues – Offer-based Costs (Objective Value)

Prices

\[ P_{A} \quad P_{B} \quad P_{C} \quad P_{D} \]
Does solution make sense?

Discussion of Results

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<tr>
<th>Result</th>
<th>MW</th>
<th>Price</th>
</tr>
</thead>
<tbody>
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A to B: 100 MW, 100 MW, 100 MW

QSE 1 sells Energy at $20
QSE 2 sells Energy at $30
QSE 3 buys Energy at $90
QSE 4 buys PTP Obligations from A to B $30 (Sink – Source)
ERCOT must also clear Ancillary Service Requirements
Energy and Ancillary Services are co-optimized

Optimized Value

$/MWh

Bids

Offers (Energy and AS)

Solution

MW
Clear $30 Energy Offer + $10 increase in AS Cost → LMP $40

AS Offer = $10
Energy Offer = $30

AS Award
Energy Award
Gen 1

AS Offer = $20
Energy Offer = $50
Gen 2
Day-Ahead Market Results

Day-Ahead

06:00 10:00 13:30 00:00

Day-Ahead Market

Operating Day

ERCOT Posts Results by 13:30
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Market Information System

Reports & Extracts

- Applied Filters: Sub-Category: DAM Results Classification: Public

- Aggregated Ancillary Service Offer Curve
- DAM Clearing Prices for Capacity
- DAM De-Energized Settlement Points in Base Case
- DAM Hourly LMPs
- DAM PTP Obligation Results by Settlement Point
- DAM Price Corrections
- DAM Settlement Point Prices
- DAM Shadow Prices
- DAM System Lambda
- DAM Total Energy Purchased
- DAM Total Energy Sold
- Historical DAM Clearing Prices for Capacity
- Historical DAM Load Zone and Hub Prices
- Total Ancillary Service Offers
QSE may need to follow-up on Awards
Ancillary Service Supply Responsibilities

- **Awarded AS Offers**
- **Self-Arranged AS Quantities**
- **AS Trade as Seller**

... must be arranged by 14:30
Discussion: If a Three Part Offer falls in the woods …

A QSE has an awarded Energy Offer in DAM

What must they do next?
Resource Commitment

<table>
<thead>
<tr>
<th>Resource Name</th>
<th>Resource Status</th>
<th>Resource Limits</th>
<th>Ancillary Service Commitments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HSL</td>
<td>LSL</td>
</tr>
<tr>
<td>ThisOne</td>
<td>ON</td>
<td>600</td>
<td>120</td>
</tr>
<tr>
<td>ThatOne</td>
<td>ON</td>
<td>400</td>
<td>75</td>
</tr>
<tr>
<td>OtherOne</td>
<td>OFF</td>
<td>100</td>
<td>25</td>
</tr>
</tbody>
</table>

Resource QSEs must maintain a COP for each hour of the next 7 days
Day-Ahead Market Financial Impacts
ERCOT settles with QSEs

- Energy Bids and Offers
- PTP Obligation Bids
- Ancillary Service Offers

DAM

Hourly Prices
Hourly Awards
Market Clearing Prices for Capacity (MCPCs)

- **MCPCRU** – Regulation-Up
- **MCPCRD** – Regulation-Down
- **MCPCRR** – Responsive Reserve
- **MCPCNS** – Non-Spin Reserve
Day-Ahead Settlement Point Prices (DASPPs)

How do we get from LMPs to SPPs?
Charge for awarded Energy Bid

\[ = \text{Awarded MWs} \times \text{DASPP} \]

Charge for awarded PTP Obligation Bid

\[ = \text{Awarded MWs} \times (\text{DASPP}_{\text{sink}} - \text{DASPP}_{\text{source}}) \]

... calculated for each hour
Awarded Offers

Payment for awarded Energy Offer

\[ = (-1) \times \text{Awarded MWs} \times \text{DASPP} \]

Payment for awarded Ancillary Service Offer

\[ = (-1) \times \text{Awarded MWs} \times \text{MCPC} \]

... calculated for each hour
Payments for Ancillary Service Awards

Charges for Ancillary Service Obligations
Each QSE pays a share of the total cost for each Ancillary Service by hour

Charge = \text{AS Price} \times \left( \left( \text{QSE Obligation} \right) - \left( \text{Self-Arranged Qty} \right) \right)

Where …

\text{AS Price} = \frac{\text{Total AS Cost}}{\text{Total Obligation not self-arranged}}
Example: Ancillary Service Charge

QSE has Ancillary Service Obligations for Hour 1500

Self-arranges 15 MW of Regulation Up for Hour 1500

- RegUp Obligation is 20 MW
- Total RegUp Obligation not self-arranged is 150 MW
- Total RegUp Cost is $6750
Example: Ancillary Service Charge

QSE’s Ancillary Service Settlement

\[
\text{RegUp Price} = \left( \frac{\$6750}{150 \text{ MW}} \right) = \]

\[
\text{Charge} = \text{RegUp Price} \times \left( \left( \frac{150 \text{ MW}}{20 \text{ MW}} \right) - \left( \frac{15 \text{ MW}}{20 \text{ MW}} \right) \right) = 
\]
Day-Ahead Make Whole Settlement

Day-Ahead Make-Whole Payments  Day-Ahead Make-Whole Charges
Day-Ahead Make-Whole Payment

- **Energy Revenue** + AS Revenue
- **DAM Guaranteed Amount**
  - Incremental Energy Costs
  - Minimum Energy Costs
  - Startup Costs

Revenues Received vs. Costs Incurred
Day-Ahead Make-Whole Payment

Resource must run to be eligible

<table>
<thead>
<tr>
<th>Revenues Received</th>
<th>Costs Incurred</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Make-Whole Payment</td>
<td></td>
</tr>
<tr>
<td>Energy Revenue</td>
<td>Incremental Energy Costs</td>
</tr>
<tr>
<td>+ AS Revenue</td>
<td>Minimum Energy Costs</td>
</tr>
<tr>
<td></td>
<td>Startup Costs</td>
</tr>
</tbody>
</table>

Resource must run to be eligible.
Day-Ahead Make Whole Settlement

Day-Ahead Make-Whole Payments  Day-Ahead Make-Whole Charges
Each QSE with cleared bids pays a share of the total Make-Whole cost for the hour

\[
\text{Charge} = \left( \frac{\text{Day-Ahead Energy Purchase Ratio Share}}{\text{Day-Ahead Make-Whole Payment Total}} \right)
\]
Example: Day-Ahead Make-Whole Charge

Has cleared Bids for Hour 1600

- Energy Bids = 200 MW
- PTP Obligation Bids = 50 MW
- Total cleared bids in DAM = 25,000 MW
- Total Make-Whole Payment = $50,000

Charge = \left( \text{Day-Ahead Energy Purchase Ratio Share} \right) \times \left( \text{Day-Ahead Make-Whole Payment Total} \right)

= \text{Day-Ahead Energy Purchase Ratio Share} \times \text{Day-Ahead Make-Whole Payment Total}
RUC and its Financial Impacts
ERCOT may need to commit additional Resources

**DRUC** = Day-Ahead Reliability Unit Commitment

**HRUC** = Hourly Reliability Unit Commitment
RUC Make Whole Settlement

RUC Make-Whole Payments

RUC Capacity Short Charges
RUC Make-Whole Payment

- Real-Time Revenue
  - Less
  - Incremental Energy Costs

- Costs Incurred
  - Minimum Energy Costs
  - Startup Costs

- Revenues Received

RUC Guaranteed Amount
Resource must incur costs to be eligible

Make-Whole Payment

Real-Time Revenue
Less
Incremental Energy Costs

Minimum Energy Costs

Startup Costs

Revenues Received

Costs Incurred

$
RUC Make Whole Settlement

RUC Make-Whole Payments

RUC Capacity Short Charges
Assessed to QSEs with Capacity Shortfall

Capacity Obligations

Capacity Shortfall

Capacity Supplies
Potential Capacity Obligations for QSE

- Load
- Energy Trade Sales
- Capacity Trade Sales
- DAM Energy Sales
Potential Capacity Supplies for QSE

Committed Resource Capacity
DAM Energy Purchases
Energy Trade Purchases
Capacity Trade Purchases
Each QSE with a Capacity Shortfall pays a share of the total Make-Whole cost for the 15-minute Interval.

\[
\text{Charge} = \left( \frac{\text{RUC Capacity Shortfall Ratio Share}}{\text{RUC Make-Whole Payment Total}} \right) \times \left( \frac{\text{RUC Make-Whole Payment Total}}{\text{RUC Capacity Total}} \right)
\]

*Subject to a cap*

\[
\text{Charge} = 2 \times \left( \frac{\text{RUC Capacity Shortfall}}{\text{RUC Capacity Total}} \right) \times \left( \frac{\text{RUC Make-Whole Payment Total}}{\text{RUC Capacity Total}} \right)
\]
Scenario: How much is each QSE charged?

<table>
<thead>
<tr>
<th></th>
<th>QSE 1</th>
<th>QSE 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUC Capacity Total</td>
<td>100 MW</td>
<td>100 MW</td>
</tr>
<tr>
<td>RUC Make Whole Payment</td>
<td>$100</td>
<td>$100</td>
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<tr>
<td></td>
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<tr>
<td>QSE 1 Shortfall</td>
<td>40 MW</td>
<td>60 MW</td>
</tr>
<tr>
<td>QSE 2 Shortfall</td>
<td>0</td>
<td>40 MW</td>
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<tr>
<td>QSE 1 Shortfall Ratio Share</td>
<td></td>
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<tr>
<td>QSE 2 Shortfall Ratio Share</td>
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<tr>
<td>QSE 1 Share of Total Make-Whole</td>
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<tr>
<td>QSE 1 Short Charge Cap</td>
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<tr>
<td>QSE 2 Share of Total Make-Whole</td>
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<tr>
<td>QSE 2 Short Charge Cap</td>
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</table>
Capacity Short Charges not Enough?

RUC Make-Whole Payments

RUC Capacity Short + Make-Whole Uplift Charges
Course Wrap-Up
# Suite of Wholesale Market Courses

<table>
<thead>
<tr>
<th>Format</th>
<th>Title</th>
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<td>Day-Ahead Market Financial Impacts</td>
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<td>RUC and its Financial Impacts</td>
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<td>Wholesale Market Operations: Real-Time</td>
<td>The Adjustment Period</td>
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<td>Real-Time Dispatch and AS Deployments</td>
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