ERCOT MARKET EDUCATION

Wholesale Markets 201

Day-Ahead Market
Module Overview

Enter

Introduction

Day-Ahead Market

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

• Identify the timeline and define the purpose of the Day-Ahead Market

• Describe the inputs into the Day-Ahead Market

• Identify the submittal requirements for the Day-Ahead Market offers and bids

• Illustrate the Day-Ahead Market clearing process

• Identify the charges and payments associated with the Day-Ahead Market
Products bought and sold in DAM:

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

Day-Ahead Market

- Energy Awards
- PTP Obligation Awards
- Ancillary Service Awards
DAM Participation is **Voluntary & Financially Binding**

**Day-Ahead Market**

- Energy Offers & Bids
- PTP Obligation Bids
- Ancillary Services

**Exceptions for Ancillary Services:**
- QSEs with load are financially obligated
- Awards are physically binding
Real-Time Prices are Volatile!

Houston Load Zone 7/22/2017

Why the Day-Ahead Market?
DAM involves both QSE and ERCOT activities

**QSE Activity**
- Submit:
  - Offers & Bids
  - Self-Arranged AS
  - COP
- Update:
  - COP
  - AS Trades

**ERCOT Activity**
- Publish AS Obligations and system conditions
- Begin DAM Execution
- Communicate DAM Awards

**Timeline**
- 0600
- 1000
- 1330
- 1430
ERCOT publishes Ancillary Service Obligations

**QSE Activity**
Submit:
- Offers & Bids
- Self-Arranged AS
- COP

Update:
- COP
- AS Trades

**ERCOT Activity**
- Publish AS Obligations and system conditions
- Begin DAM Execution
- Communicate DAM Awards

**Timeframe:**
- 0600
- 1000
- 1330
- 1430

DAM DRUC
Ancillary Service (AS) Plan

• Identifies the required amount of each Ancillary Service for each hour of the Operating Day

• Developed by ERCOT

Posted to MIS Public Area by 0600 Day-Ahead
Ancillary Service (AS) Obligations

• AS Plan allocated to QSEs by service, by hour

• Based on Load Ratio Shares from same day of previous week

Posted to MIS Certified Area by 0600 Day-Ahead
QSE chooses how to fulfill Obligations

Self-Arrange

Allow ERCOT to procure

DAM
ERCOT must assign AS Obligations

- ERCOT needs 500 MW of Regulation Up for Hour 0600
- Load from same hour last week was 50,000 MW
QSE Big Jake has two Load Serving Entities (LSEs)

### Adjusted Metered Load for Hour 0600

<table>
<thead>
<tr>
<th>LSE “Lazy P”</th>
<th>Load = 1000MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRS = ?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LSE “Diamond Bar”</th>
<th>Load = 1500MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRS = ?</td>
<td></td>
</tr>
</tbody>
</table>
Big Jake’s Load Ratio Share is based on the two LSEs

Big Jake’s Load Ratio Share

= ?

Big Jake’s Ancillary Service Obligation for Regulation in Hour 0600

= ?
ERCOT publishes System Conditions

**QSE Activity**
- Submit:
  - Offers & Bids
  - Self-Arranged AS
  - COP
- Update:
  - COP
  - AS Trades

**ERCOT Activity**
- Publish AS Obligations and system conditions
- Begin DAM Execution
- Communicate DAM Awards

**Timeline**
- 0600
- 1000
- 1330
- 1430
QSE Activities prior to 10 a.m.

**ERCOT Activity**
- Publish AS Obligations and system conditions
- Begin DAM Execution
- Communicate DAM Awards

**QSE Activity**
- Submit:
  - Offers & Bids
  - Self-Arranged AS
  - COP

**Update:**
- COP
- AS Trades

**DAM**

**DRUC**

- 0600
- 1000
- 1330
- 1430
QSE Activities prior to 10 a.m.

Submit:
- Offers & Bids for Energy
- Bids for PTP Obligations
- AS Offers
- Self-Arranged AS Quantities
- Current Operating Plan
Submit Three-Part Supply Offers

Submit:
- Offers & Bids for Energy
- Bids for PTP Obligations
- AS Offers
- Self-Arranged AS Quantities
- Current Operating Plan

QSE Activity

1000
What is a Three-Part Supply Offer?

- Offer to sell energy from a specific Generation Resource
- Must declare:
  - Offered hours
  - Expiration date and time
What is a Startup Offer?

- Cost to start Resource and reach Low Sustained Limit (LSL)
- Actually three separate offers
  - Hot Start
  - Intermediate Start
  - Cold Start
What is a Minimum-Energy Offer?

Cost per MW per hour to operate a Resource at Low Sustained Limit (LSL)
Startup and Minimum Energy Offer Caps:

- 200% of Generic Costs
- 200% of Verifiable Costs
### What is an Energy Offer Curve?

Offer to sell energy at or above a certain price, and at a certain quantity (above Low Sustained Limit).

<table>
<thead>
<tr>
<th>Startup Offer</th>
<th>Minimum Energy Offer</th>
<th>Energy Offer Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>A QSE may submit an Energy Offer Curve without Startup and Minimum Energy Offers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$/MWh

MW
An Energy Offer Curve must include:

- Monotonically increasing offer curve
  - Ten price/quantity pairs max
  - One MW minimum quantity
  - Prices between -$250 and System-Wide Offer Cap (SWCAP)
- Inclusive or exclusive designation relative to DAM Ancillary Service offers from the same Resource
- Percentage of Fuel Index Price (FIP) and Fuel Oil Price (FOP) for generation above LSL
Where are the Three Parts used?

<table>
<thead>
<tr>
<th></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>
</tr>
<tr>
<td>RUC-Commitment</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Real-Time Dispatch</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Submit Energy-Only Offers & Energy Bids

QSE Activity

Submit:
- Offers & Bids for Energy
- Bids for PTP Obligations
- AS Offers
- Self-Arranged AS Quantities
- Current Operating Plan

1000
**DAM Energy-Only Offer:**
- Is a QSE’s willingness to **sell** energy:
  - At or above a certain price
  - At a certain quantity
  - At a specific Settlement Point in the DAM.

**DAM Energy Bid:**
- Is a QSE’s willingness to **buy** energy:
  - At or below a certain price
  - At a certain quantity
  - At a specific Settlement Point in the DAM.
DAM Energy-Only Offer

- Energy-Only Offer is NOT resource-specific
- QSE does not have to own Resources to offer energy

How does this work?
DAM Energy Bid

• Proposal to buy energy at a specified Settlement Point
• QSE does not have to represent load to buy energy

How does this work?
QSE must include for each offer or bid:

- The Settlement Point
- First and last hour
- The expiration time and date
- Price and quantity for each hour
  - Curve
  - Fixed Quantity Block
  - Variable Quantity Block

Price/Quantity restrictions:
- DAM Energy-Only Offers priced between -$250.00 and SWCAP
- 1 MW Minimum offer/bid
Curve with up to 10 Price/Quantity Pairs

- Offers - Monotonically increasing
- Bids - Monotonically decreasing

Energy-Only Offer and Energy Bid Types
Block with Single Price/Quantity Pair

- Fixed Quantity – All MWs or nothing
- Variable Quantity – Up to specified MWs
QSE may also expand a Block Bid or Offer into a Multi-Hour Block

Variable Quantity Block

Fixed Quantity Block

Multi-hour Block? □

Multi-hour Block? ✓
A QSE submits a Variable Quantity Multi-hour Block Energy Bid for Hours 0700-2200

Scenario:

Day-Ahead Market Options?

Fixed vs. Variable Multi-hour Blocks
A QSE submits a Fixed Quantity Multi-hour Block Energy Bid for Hours 0700-2200

Scenario: Fixed vs. Variable Multi-hour Blocks

Fixed Quantity Block

$50/MWh

$50/MWh

10MW

Day-Ahead Market Options?
Submit Bids for PTP Obligations

Submit:
- Offers & Bids for Energy
- Bids for PTP Obligations
- AS Offers
- Self-Arranged AS Quantities
- Current Operating Plan
Price separation across the grid exposes buyers and sellers of energy to Congestion Costs.
Day-Ahead Market PTP Obligations

- Hedge congestion costs in Real-Time Market
- Purchased at DAM price spread
- Settled at Real-Time price spread
QSE must include

- Operating Day
- Source and Sink Settlement Points
- For each hour:
  - MW Quantity
  - (Sink – Source) price buyer is willing to pay
Submit Ancillary Service Offers

Submit:
• Offers & Bids for Energy
• Bids for PTP Obligations
• AS Offers
• Self-Arranged AS Quantities
• Current Operating Plan
What is an Ancillary Service Offer?

Offer to supply one or more Ancillary Service Capacities from a qualified Resource

<table>
<thead>
<tr>
<th>Type of AS</th>
<th>Offer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reg Up</td>
<td>Price / MW</td>
</tr>
<tr>
<td>Reg Down</td>
<td>Price / MW</td>
</tr>
<tr>
<td>Responsive</td>
<td>Price / MW</td>
</tr>
<tr>
<td>Non-Spin</td>
<td>Price / MW</td>
</tr>
</tbody>
</table>
Ancillary Service Offers must include:

<table>
<thead>
<tr>
<th>Type of Service</th>
<th>Quantity and Price</th>
<th>Hour</th>
<th>Expiration Time</th>
<th>Type of Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reg Up</td>
<td>MW $ / MW</td>
<td>0900</td>
<td>Jun 30 00:00</td>
<td>Variable</td>
</tr>
<tr>
<td>Reg Down</td>
<td>MW $ / MW</td>
<td>0900</td>
<td>Jun 30 00:00</td>
<td>Variable</td>
</tr>
<tr>
<td>Responsive</td>
<td>MW $ / MW</td>
<td>0900</td>
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<tr>
<td>Non-Spin</td>
<td>MW $ / MW</td>
<td>0900</td>
<td>Jun 30 00:00</td>
<td>Variable</td>
</tr>
</tbody>
</table>
Variable Quantity Block Ancillary Service Offer:

- Can be offered by Generation or Load Resource
- Single price ($/MW) and single “up to” quantity (MW)
Fixed Quantity Block Ancillary Service Offer:

- Can be offered only by a Load Resource
- Single price ($/MW) and single quantity (MW)
- Cannot exceed 150 MW
Ancillary Service Offer Limits:

- Priced between $0 and the System Wide Offer Cap
- Minimum offer quantity for each AS product is 0.1 MW
Ancillary Service Offers and Energy Offers may be linked

- Resource may be offered for Energy and Ancillary Services
- Resource may be offered for multiple Ancillary Services

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<td>Reg Down</td>
<td>Price / MW</td>
</tr>
<tr>
<td>Responsive Reserve</td>
<td>Price / MW</td>
</tr>
<tr>
<td>Non-Spin</td>
<td>Price / MW</td>
</tr>
</tbody>
</table>

Energy Offer Curve

Incremental cost above LSL ($/MWh)
AS Offers linked to a Three-Part Supply Offer:

- DAM assumes the Resource is Off-Line
- To award on-line Ancillary Services
  - DAM must also award Three-Part Supply Offer
  - The total award must not exceed Resource’s capacity

<table>
<thead>
<tr>
<th>Startup Offer</th>
<th>Minimum Energy</th>
<th>Energy Offer Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost up to LSL</td>
<td>Cost per hour at LSL</td>
<td>Incremental cost above LSL ($/MWh)</td>
</tr>
<tr>
<td>$/Start</td>
<td>$/MWh</td>
<td></td>
</tr>
</tbody>
</table>

Cost up to LSL

Cost per hour at LSL

Incremental cost above LSL ($/MWh)
AS Offers linked to stand-alone Energy Offer Curve:

• DAM assumes the Resource is On-Line
• The total award must not exceed Resource’s capacity
Submit Self-Arranged Ancillary Service Service Quantities

Submit:
• Offers & Bids for Energy
• Bids for PTP Obligations
• AS Offers
• Self-Arranged AS Quantities
• Current Operating Plan

QSE Activity

1000
A QSE may self-arrange its AS Obligations:

- All or part by Ancillary Service by hour
- Must submit Self-Arranged AS Quantities by 10:00

Impact:

Reduces the amount of each Ancillary Service that ERCOT procures on behalf of the QSE

This provision applies to both DAM and SASMs.
Options for self-arranged Ancillary Services

Using own Resources

Through AS trades
A QSE may self-arrange more than their AS Obligations:

- Up to 100 MW for Responsive and Non-Spin Reserve
- Up to 25 MW for Regulation Up and Down
- Self-arranged quantity from QSE’s own Resources may not exceed AS Obligation

Impact:

QSEs are paid for the extra Ancillary Services they provide.
A QSE may submit negative Self-Arranged AS Quantities:

- Limited to -500 MW for each Ancillary Service
- Limited in magnitude to net Ancillary Service Trades

Impact:

ERCOT procures extra AS Quantities in DAM on behalf of the QSE.

This provision applies only to DAM; not allowed in SASMs.
QSE has Ancillary Service Obligations for Regulation Up over a range of hours:

<table>
<thead>
<tr>
<th>Hour</th>
<th>QSE AS Obligation</th>
<th>Self-Arranged Quantity</th>
<th>ERCOT procures on QSE’s behalf</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400</td>
<td>10 MW</td>
<td>12 MW</td>
<td>-2 MW</td>
</tr>
<tr>
<td>1500</td>
<td>12 MW</td>
<td>12 MW</td>
<td>0 MW</td>
</tr>
<tr>
<td>1600</td>
<td>14 MW</td>
<td>12 MW</td>
<td>2 MW</td>
</tr>
<tr>
<td>1700</td>
<td>12 MW</td>
<td>12 MW</td>
<td>0 MW</td>
</tr>
</tbody>
</table>

QSE is paid

QSE is charged
Submit Current Operating Plan

Submit:
- Offers & Bids for Energy
- Bids for PTP Obligations
- AS Offers
- Self-Arranged AS Quantities
- Current Operating Plan

QSE Activity

1000
Any QSE representing Resources is obligated to submit a Current Operating Plan (COP)

COP must include for each Resource:

- The Name of the Resource
- Expected Resource Status
- High/Low Sustained Limit (HSL / LSL)
- High/Low Emergency Limit
- Ancillary Service Responsibilities
Current Operating Plan Overview

The COP provides information for:

• Day-Ahead Market

• Reliability Unit Commitment

The COP is not used in Real-Time Operations.
Submittal Timeframe:

- Must be maintained for each hour of the next seven Operating Days
- May be modified up to the end of the Adjustment Period
- Must be updated within 60 minutes of any event that changes a Resource’s availability

Three types of Resources have special submittal criteria

- Combined Cycle Generation Resources (CCGRs)
- Wind-Powered Generation Resources (WGRs)
- Photovoltaic Generation Resources (PVGRs)
Combined Cycle Generation Resource (CCGR):

- A registered configuration of a Combined Cycle Train
- Offered as a single Resource

QSE must include each registered CCGR in their COP
Wind-Powered Generation Resource (WGR):

ERCOT updates COP HSL to Short-Term Wind Power Forecast for first 168 hours.

Photovoltaic Generation Resource (PVGR):

ERCOT updates COP HSL to Short-Term Photovoltaic Power Forecast for first 168 hours.

... QSE may override to lesser values
ERCOT validates QSE submissions upon receipt

• If any submission is rejected,
  • ERCOT will notify the QSE
  • QSE may correct and resubmit within market timelines

• If all criteria are met, ERCOT will display submission on the MIS Certified Area
ERCOT begins clearing DAM at 10:00 a.m.
Economically & simultaneously clears Offers and Bids

- Energy Offers & Bids
- PTP Obligation Bids
- Ancillary Service Offers
- Network Operations Model
- Day-Ahead Market
- Energy Awards
- PTP Obligation Awards
- Ancillary Service Awards
Subject to the following constraints:

- Security constraints
  - Power Balance constraint
  - Transmission constraints
- Resource constraints
- Linked Offer constraints
- Block Offer and Bid constraints
- Ancillary Service Requirements
Load Distribution Factors

- Used to distribute bids and offers at Load Zones
- MWs are distributed to electrical buses based on historical power flows
- Allows DAM to model bids as MW withdrawals and offers as MW injections

Impact

- Award volumes
- DAM prices
Load Distribution Factors for DAM are chosen based on “cold,” “mild,” or “hot” proxy days.
Hub Distribution Factors

- Used to distribute bids and offers at Hubs
- MWs are distributed uniformly to all energized Hub buses in each Hub
- Allows DAM to model bids as MW withdrawals and offers as MW injections

Impact

- Award volumes
- DAM prices
Day-Ahead Market Objective:

Maximize \([\text{Bid-based Revenues} - \text{Offer-based Costs}]\)

Bid-based Revenues: \(\text{Sum} \left[ \text{Bid Price} \times \text{Cleared Bid Quantity} \right]\)

Offer-based Costs: \(\text{Sum} \left[ \text{Offer Price} \times \text{Cleared Offer Quantity} \right]\)

In this step, DAM uses Bid Prices and Offer Prices, not clearing prices.
Why do it this way?

DAM Clearing Process
Co-Optimizes Energy and Ancillary Services

DAM Clearing Process

- Energy Offers & Bids
- PTP Obligation Bids
- Ancillary Service Offers
- Network Operations Model

Day-Ahead Market

- Energy Awards
- PTP Obligation Awards
- Ancillary Service Awards
For HE 1300 ERCOT needs to procure:

- 1 MW of Regulation Up (Reg Up) and;
- 1 MW of Responsive Reserves (RRS)

Three QSEs submitted Offers and Bids as follows:

<table>
<thead>
<tr>
<th></th>
<th>Bids</th>
<th>Offers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MW</td>
<td>Energy</td>
</tr>
<tr>
<td>QSE A</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>QSE B</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>QSE C</td>
<td>1</td>
<td>$50.00</td>
</tr>
</tbody>
</table>
## Scenario

### A Few Potential Solutions

#### Case 1

<table>
<thead>
<tr>
<th></th>
<th>Energy</th>
<th>RegUp</th>
<th>RRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSE A</td>
<td>$25.00</td>
<td>$10.00</td>
<td></td>
</tr>
<tr>
<td>QSE B</td>
<td></td>
<td></td>
<td>$9.00</td>
</tr>
</tbody>
</table>

**Bid-based Revenues** – **Offer-based Costs**

- $50 – $25 – $10 – $9 = $6

---

#### Case 2

<table>
<thead>
<tr>
<th></th>
<th>Energy</th>
<th>RegUp</th>
<th>RRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSE A</td>
<td>$25.00</td>
<td></td>
<td>$5.00</td>
</tr>
<tr>
<td>QSE B</td>
<td></td>
<td>$11.00</td>
<td></td>
</tr>
</tbody>
</table>

**Bid-based Revenues** – **Offer-based Costs**

- $50 – $25 – $11 – $5 = $9

---

#### Case 3

<table>
<thead>
<tr>
<th></th>
<th>Energy</th>
<th>RegUp</th>
<th>RRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSE A</td>
<td></td>
<td>$10.00</td>
<td>$5.00</td>
</tr>
<tr>
<td>QSE B</td>
<td>$30.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bid-based Revenues** – **Offer-based Costs**

- $50 – $30 – $10 – $5 = $5
Determine Energy Price

- Cost of additional increment of Demand
- How would Day-Ahead Market clear additional MW?

### Offers Provided

<table>
<thead>
<tr>
<th></th>
<th>MW</th>
<th>Energy</th>
<th>RegUp</th>
<th>RRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSE A</td>
<td>2</td>
<td>$25.00</td>
<td>$10.00</td>
<td>$5.00</td>
</tr>
<tr>
<td>QSE B</td>
<td>2</td>
<td>$30.00</td>
<td>$11.00</td>
<td>$9.00</td>
</tr>
</tbody>
</table>

### Offers Awarded

<table>
<thead>
<tr>
<th></th>
<th>Energy</th>
<th>RegUp</th>
<th>RRS</th>
</tr>
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<tbody>
<tr>
<td>QSE A</td>
<td>$25.00</td>
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</tr>
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<td></td>
<td>$11.00</td>
<td></td>
</tr>
</tbody>
</table>
### Scenario

#### Offers

<table>
<thead>
<tr>
<th>MW</th>
<th>Energy</th>
<th>RegUp</th>
<th>RRS</th>
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<tr>
<td>QSE A</td>
<td>2</td>
<td>$25.00</td>
<td>$10.00</td>
</tr>
<tr>
<td>QSE B</td>
<td>2</td>
<td>$30.00</td>
<td>$11.00</td>
</tr>
</tbody>
</table>

#### Clearing Additional MW of Energy

<table>
<thead>
<tr>
<th>Energy</th>
<th>RegUp</th>
<th>RRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSE A</td>
<td>1MW @$25.00</td>
<td>$5.00</td>
</tr>
<tr>
<td>QSE B</td>
<td>1MW @$30.00</td>
<td>$11.00</td>
</tr>
</tbody>
</table>

- Increases cost by $30

<table>
<thead>
<tr>
<th>Energy</th>
<th>RegUp</th>
<th>RRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSE A</td>
<td>2MW @$25.00</td>
<td></td>
</tr>
<tr>
<td>QSE B</td>
<td></td>
<td>$11.00</td>
</tr>
</tbody>
</table>

- Increases cost by $29
### Scenario

### Offers

<table>
<thead>
<tr>
<th>MW</th>
<th>Energy</th>
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<td>QSE A</td>
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<td>QSE B</td>
<td>2</td>
<td>$30.00</td>
<td>$11.00</td>
</tr>
</tbody>
</table>

### Clearing Additional Ancillary Services

<table>
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<th>RRS</th>
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<tbody>
<tr>
<td>QSE A</td>
<td>$25.00</td>
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<td></td>
</tr>
<tr>
<td>QSE B</td>
<td></td>
<td>2 MW @ $11.00</td>
</tr>
</tbody>
</table>
In summary . . .

Three QSEs submitted Offers and Bids as follows:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Bids</th>
<th>Offers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MW</td>
<td>Energy</td>
</tr>
<tr>
<td>QSE A</td>
<td>2</td>
<td>$25.00</td>
</tr>
<tr>
<td>QSE B</td>
<td>2</td>
<td>$30.00</td>
</tr>
<tr>
<td>QSE C</td>
<td>1</td>
<td>$50.00</td>
</tr>
</tbody>
</table>

QSE A sells 1MW of Energy @ LMP of $29 and 1MW of RRS @ MCPC of $9

QSE B sells 1MW of RegUp @ MCPC of $11

QSE C buys 1MW of Energy @ LMP of $29
Also clears Energy and PTP Obligations simultaneously

DAM Clearing Process

Energy Offers & Bids
PTP Obligation Bids
Ancillary Service Offers

Day-Ahead Market

Energy Awards
PTP Obligation Awards
Ancillary Service Awards

Network Operations Model
Modeling of PTP Obligation Bids in DAM

• MW injection at Source
• MW withdrawal at Sink
• Clearing requires Transmission Capacity
Introducing a simple model ...

![Diagram]

- \( A \) = Settlement Point
- MW = Transmission Capacity
Energy Transactions with Transmission Limits

<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)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>

Prices

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LMP_A</td>
<td>LMP_B</td>
<td>LMP_C</td>
<td>LMP_D</td>
</tr>
</tbody>
</table>
In summary . . .

<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>
</tr>
</tbody>
</table>
### Energy Transactions with Transmission Limits and PTP Obligations

#### DAM Clearing with Energy and PTP Obligations

<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>
<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)

\[
\text{Bid-based Revenues} - \text{Offer-based Costs} = (10 \times \text{LMP}_A) + (90 \times \text{LMP}_D) - (70 \times \text{LMP}_B) - (20 \times \text{LMP}_C) = \$2000
\]

\[
(30 \times \text{LMP}_A) + (90 \times \text{LMP}_D) - (70 \times \text{LMP}_B) - (20 \times \text{LMP}_C) = \$2200
\]

Prices

- \( \text{LMP}_A \)
- \( \text{LMP}_B \)
- \( \text{LMP}_C \)
- \( \text{LMP}_D \)
In summary . . .

<table>
<thead>
<tr>
<th>Result</th>
<th>MW</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- QSE 1 sells Energy at $20
- QSE 2 sells Energy at $30
- QSE 3 buys Energy at $30
- QSE 4 buys PTP Obligations from A to B at $10 (Sink – Source)

Connections: A → B (100 MW), B → C (100 MW), B → D (100 MW)
After DAM solves, ERCOT communicates Awards

DAM Clearing Process

Energy Offers & Bids

PTP Obligation Bids

Ancillary Service Offers

Day-Ahead Market

Energy Awards

PTP Obligation Awards

Ancillary Service Awards
ERCOT Communicates DAM Awards by 1:30 p.m.

QSE Activity
- Submit:
  - Offers & Bids
  - Self-Arranged AS
  - COP
- Update:
  - COP
  - AS Trades

ERCOT Activity
- Publish AS Obligations and system conditions
- Begin DAM Execution
- Communicate DAM Awards

0600 1000 1330 1430
<table>
<thead>
<tr>
<th>By 1330, ERCOT Awards…</th>
<th>From …</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Sales</td>
<td>Three-Part Supply Offers &amp; Energy Offer Curves</td>
</tr>
<tr>
<td>Energy Sales</td>
<td>DAM Energy-Only Offers</td>
</tr>
<tr>
<td>Energy Purchases</td>
<td>DAM Energy Bids</td>
</tr>
<tr>
<td>PTP Obligations</td>
<td>PTP Obligation Bids</td>
</tr>
<tr>
<td>Ancillary Services</td>
<td>Ancillary Service Offers</td>
</tr>
</tbody>
</table>
### Day-Ahead Market Results

#### Title
- Aggregated Ancillary Service Offer Curve
- DAM Clearing Prices for Capacity
- DAM De-Energized Settlement Points in Base Case
- DAM Hourly LMPs
- DAM Price Corrections
- DAM PTP Obligation Results by Settlement Point
- 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
Finalized Day-Ahead Market Prices

• ERCOT monitors Market for errors:
  • Day-Ahead MCPCs
  • Hourly LMPs

• ERCOT “Flags” questionable prices before posting

DAM Prices are final at 10:00 on the second Business Day after the Operating Day.
QSE Activities Immediately After DAM

Submit:
- Offers & Bids
- Self-Arranged AS
- COP

Update:
- COP
- AS Trades

DAM

0600
0

1000

1330

1430

Publish AS Obligations and system conditions

Begin DAM Execution

Communicate DAM Awards

DRUC

ERCOT
QSEs with Resources may need to update their Current Operating Plans to reflect Day-Ahead Market Awards

**COP must include for each Resource:**

- The Name of the Resource
- Expected Resource Status
- Low/High Sustained Limit (LSL / HSL)
- Low/High Emergency Limit
- Ancillary Service Responsibilities
Ancillary Service (AS) Supply Responsibility

The net amount of Ancillary Service capacity that a QSE is obligated to deliver to ERCOT from Resources represented by the QSE.

- For each Ancillary Service type
- For each hour
Ancillary Service (AS) Supply Responsibility

Calculation

Self-Arranged AS Quantities
+ AS Trades where the QSE is the Seller
+ Awarded AS Offers
– AS Trades where the QSE is the Buyer

= Ancillary Service Supply Responsibility
Ancillary Service (AS) Resource Responsibility

The amount of Ancillary Service capacity that a QSE is reserving on an individual Resource

Reported through Current Operating Plan

- MW of each Ancillary Service type
- By Resource
- For each hour

QSE’s AS Resource Responsibilities must be arranged by 1430 day-ahead
By 1430 day-ahead, QSEs must notify ERCOT how Self-Arranged Ancillary Service quantities will be supplied.

**Using own Resources?**
- Update COP

**Through AS trades?**
- Report Trade
- Seller will update their COP
Validation of Ancillary Service Supply

- The sum of the QSE’s AS Resource Responsibilities must be sufficient to fulfill their Ancillary Service Supply Responsibility for each hour.

- If QSE’s AS Resource Responsibilities are not sufficient,
  - ERCOT will notify the QSE
  - QSE must correct deficiencies within one hour.
Summary of DAM Activities

QSE Activity
- Submit:
  - Offers & Bids
  - Self-Arranged AS
  - COP
- Update:
  - COP
  - AS Trades

ERCOT Activity
- Publish AS Obligations and system conditions
- Begin DAM Execution
- Communicate DAM Awards

DAM

DRUC

0600
1000
1330
1430
Day-Ahead Market Credit Limits
Introducing ... The Counter-Party

- Entity that is also a QSE and/or a CRR Account Holder
- Responsible for managing Available Credit
Allocation of Credit

Counter Party

Maintains Secured Collateral with ERCOT

Available credit is shared

CRR Auction Credit Limit

CRR Account Holder

QSE

Day-Ahead Market Credit Limit
Counter-Party posts Secured Collateral to make credit available to its QSEs and CRR Account Holders.
Available Credit

- **Secured Collateral**
  - Exposure for CRRs + 10%
  - Exposure for QSEs + 10%

- **Unsecured Credit**

**Available Credit**

- Satisfied *only* by Secured Collateral
- Satisfied by Secured Collateral and Unsecured Credit
Available Credit Limit for the DAM (ACLD)

- **Secured Collateral**
  - Available Credit Limit (ACLD)
    - Credit locked for Auction
    - Exposure for CRRs + 10%
- **Unsecured Credit**
  - Exposure for QSEs + 10%
Bids and Offers are checked against Available Credit upon submission

Energy Bids & Offers

PTP Obligation Bids

Ancillary Service Obligations not Self-Arranged

Credit Exposure less than ACLD?

Day-Ahead Market

Accepted in order received

Rejected Bids or Offers may be revised and resubmitted before 10:00
## Credit Exposure in Day-Ahead Market

<table>
<thead>
<tr>
<th>Submission</th>
<th>General Credit Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Bids</td>
<td>Volume * Bid Price</td>
</tr>
<tr>
<td>Energy Only Offers</td>
<td>Volume * (Historical RT – DAM price difference)</td>
</tr>
<tr>
<td>PTP Obligation Bids</td>
<td>Volume * (Bid price + Historical RT exposure)</td>
</tr>
<tr>
<td>AS Obligations</td>
<td>Volume not Self-Arranged * Historical MCPC</td>
</tr>
</tbody>
</table>

### No credit exposure:
- Three Part Supply Offers
- Ancillary Service Offers
# Exposure Reduction in Day-Ahead Market

<table>
<thead>
<tr>
<th>Submission</th>
<th>Reduction Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Bids</td>
<td>• High Bid Price&lt;br&gt;• QSE consistently has cleared offers</td>
</tr>
<tr>
<td>Energy Offers</td>
<td>• Low Offer Price</td>
</tr>
<tr>
<td>PTP Obligation Bids</td>
<td>• Reduced for expiring CRRs&lt;br&gt;• Same Source and Sink</td>
</tr>
</tbody>
</table>

ACLD
Exposure

Details in Protocol 4.4.10
Credit Adjustments for PTP Obligation Bids

For a given hour in DAM . . .

\[
\text{Credit Requirement} = (\text{Min}[\text{Bid MW}, \text{CRR MW}]) \times 10\% \text{ of Bid Price}
\]
DAM Credit Reports on Market Information System

- DAM Aggregate Credit Exposure
  - Posted after each DAM

- DAM Remaining Available Credit Limit
  - Posted every 15min before DAM

Available Credit Limit Summary

Minimum Current Exposure

DAM Credit Reports

Total Potential Exposure

Future Credit

Posted every 15min before DAM
Day-Ahead Market Financial Impacts
DAM determines optimal clearing of Bids and Offers

Day-Ahead Market

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

Day-Ahead Market

- Energy Awards
- PTP Obligation Awards
- Ancillary Service Awards
Day-Ahead Market Energy and AS Settlements

**Energy Awards**

Hourly Settlement = Price * Quantity
- **Price:** Settlement Point Price (SPP)
- **Quantity:** Awarded MW

**PTP Obligation Awards**

Hourly Settlement = Price * Quantity
- **Price:** $\text{SPP}_{\text{sink}} - \text{SPP}_{\text{source}}$
- **Quantity:** Awarded MW

**Ancillary Service Awards**

Hourly Settlement = Price * Quantity
- **Price:** Market Clearing Price for Capacity
- **Quantity:** Awarded MW
Settlement Point Prices (SPPs)

- DAM Clearing Engine produces LMPs
- Settlement Point Prices formed from LMPs

**Resource Node**

\[ SPP = \text{LMP} \]

**Load Zone**

\[ SPP = \text{Load-weighted Ave (LMPs)} \]

**345 kV Hub**

\[ SPP = \text{Simple Ave (HUB bus LMPs)} \]

... calculated for each hour
Each Ancillary Service has a Separate Market Clearing Price for Capacity (MCPC)

MCPCRU – Regulation-Up
MCPCRD – Regulation-Down
MCPCRR – Responsive Reserve
MCPCNS – Non-Spin Reserve

... calculated for each hour
Two parts to Day Ahead Make-Whole Settlements:

- Day-Ahead Make-Whole Payment
- Day-Ahead Make-Whole Charge
Why Make Whole Payment?

- Solution considers all costs
- LMPs and MCPCs are incremental costs
Day-Ahead Make-Whole Payment

- **Energy Revenue** + AS Revenue
- Incremental Energy Costs
- Minimum Energy Costs
- Startup Costs

DAM Guaranteed Amount
Day-Ahead Make-Whole Payment

What if revenues are less than costs?

Resource must run to be eligible

Make-Whole Payment

Energy Revenue + AS Revenue

Revenues Received

Costs Incurred

Incremental Energy Costs

Minimum Energy Costs

Startup Costs
Day-Ahead Make-Whole Settlemens

Make-Whole Charge allows Revenue Neutrality

Day-Ahead Make-Whole Payment

Day-Ahead Make-Whole Charge
Charged to each QSE with awarded bids

\[
\left( \text{Total DAM Make-Whole Payment ERCOT - Wide} \right) \times \left( \text{DAM Energy Purchase Ratio Share} \right)
\]

\[
\text{OR}
\]

\[
\left( \text{Total DAM Make-Whole Payment ERCOT - Wide} \right) \times \left( \frac{\text{A QSE’s DAM Energy Purchase}}{\text{Total DAM Energy Purchases ERCOT - Wide}} \right)
\]
### Calculating Make-Whole Charges

- Total DAM purchase: 100 MW
- Total Make Whole: $100

<table>
<thead>
<tr>
<th>QSE Name</th>
<th>QSE DAM Purchase</th>
<th>QSE DAM Energy Purchase Ratio Share</th>
<th>QSE Day-Ahead Make-Whole Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSE 1</td>
<td>20 MW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QSE 2</td>
<td>40 MW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QSE 3</td>
<td>10 MW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QSE 4</td>
<td>30 MW</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
You have learned about:

• The timeline and purpose of the Day-Ahead Market

• Various inputs into the Day-Ahead Market

• Submittal requirements for the Day-Ahead Market offers and bids

• The Day-Ahead Market clearing process

• Charges and payments associated with the Day-Ahead Market