ercot

Real-Time Market Operations

Greetings and Introductions

Attendance

Questions

Presentation Materials

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:

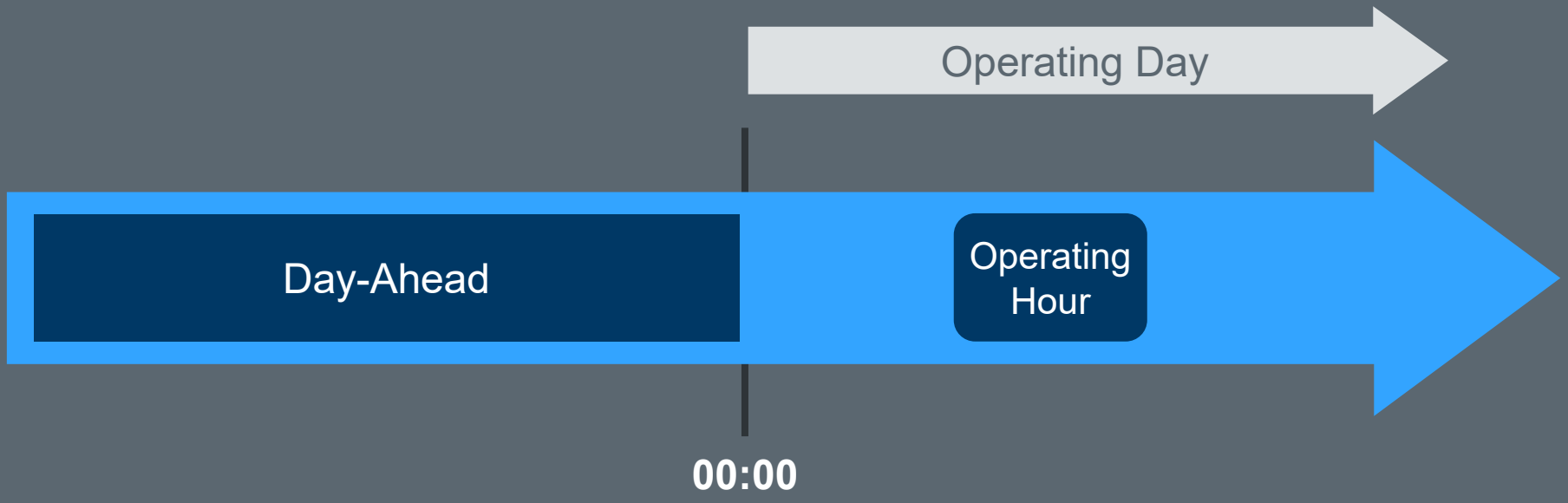
http://www.ercot.com/mktrules/nprotocols/

Wholesale Market Operations Curriculum

Format	Title
WBT	Wholesale Markets Overview

Format	Title	Topic
ILT	Day-Ahead Market Operations	Inputs
		Market Clearing
		Financial Impacts
	Reliability Unit Commitment	Overview
		Process
		Financial Impacts
	Real-Time Market Operations	Security Constrained Economic Dispatch
		Load Frequency Control
		Financial Impacts

Real-Time Operations



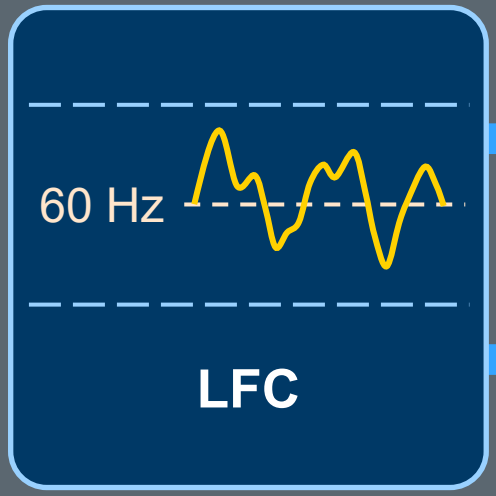
Two Main Real-Time Processes

Security Constrained Economic Dispatch

Five-minute Awards

Five-minute Prices

Load Frequency Control



Regulation Service

Updated Desired Set Point

Security Constrained Economic Dispatch

Balancing Reliability and Economics

SCED

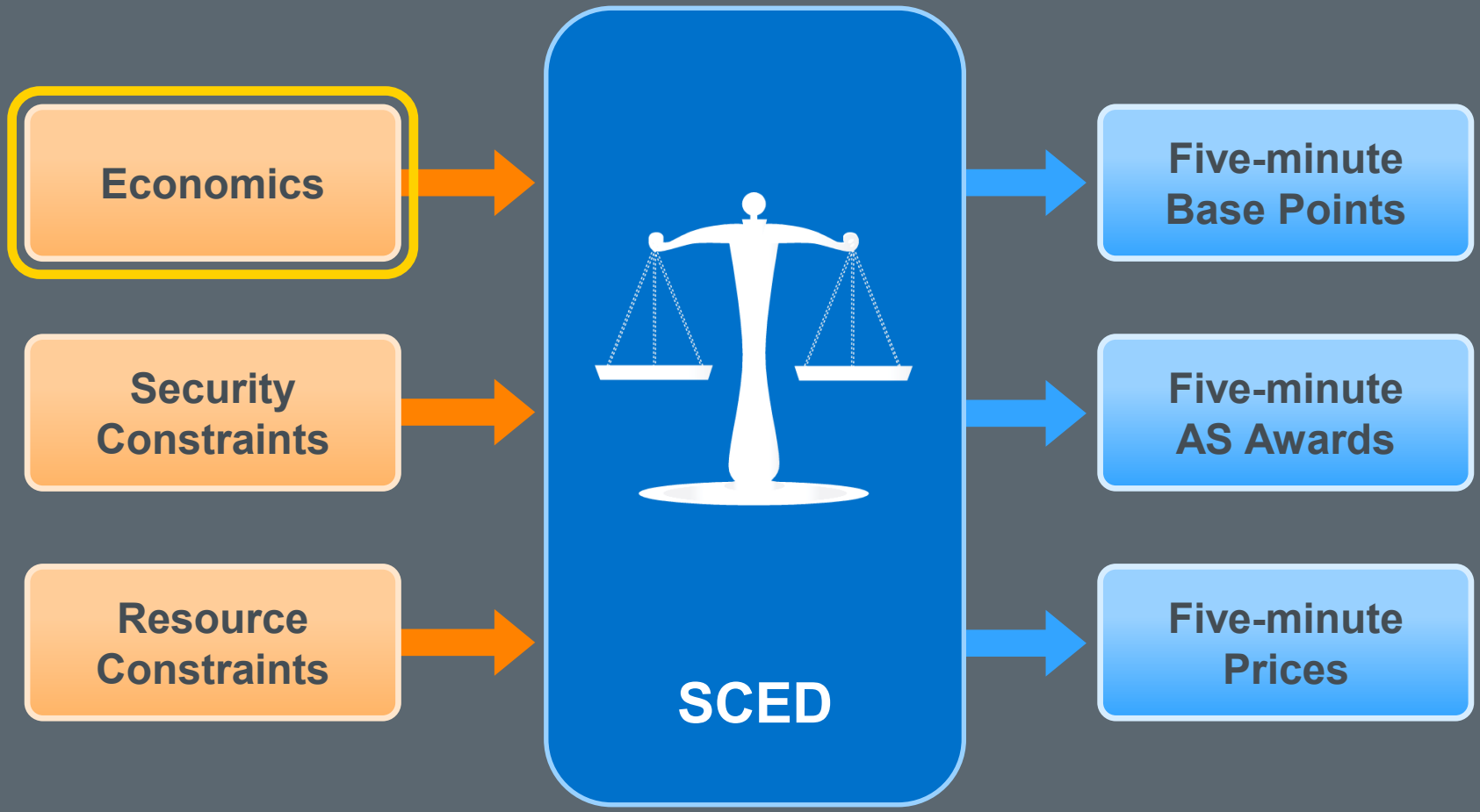
In accordance with PUCT Scarcity Pricing Mechanism,

ERCOT Market Caps		HCAP	LCAP*
Day-Ahead System Wide Offer Cap	DASWCAP	$5000	$2000
Real-Time System Wide Offer Cap	RTSWCAP	$2000	$2000
Value of Lost Load	VOLL	DASWCAP	

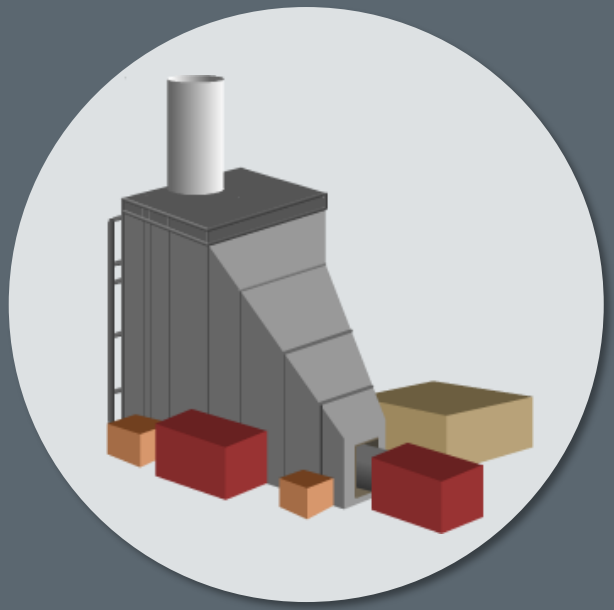
* Used when Peaker Net Margin exceeds annual threshold

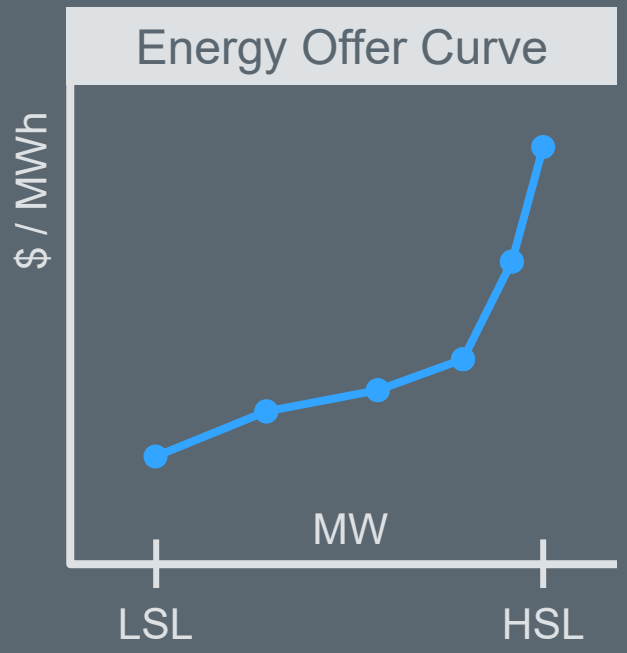
SCED Inputs

Manages Reliability at Least Cost



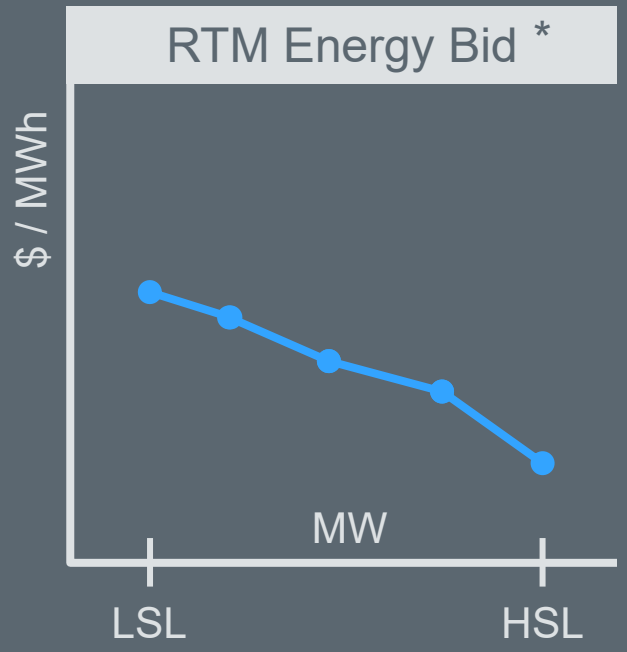
May be updated during any time before SCED





HSL = High Sustained Limit
LSL = Low Sustained Limit

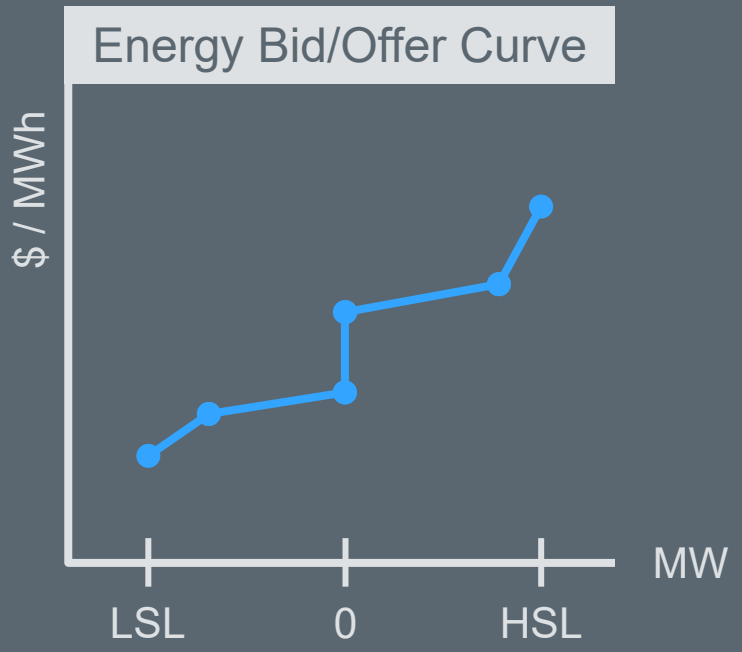
May be updated during any time before SCED



HSL = High Sustained Limit
LSL = Low Sustained Limit

* Capped at VOLL

May be updated during any time before SCED

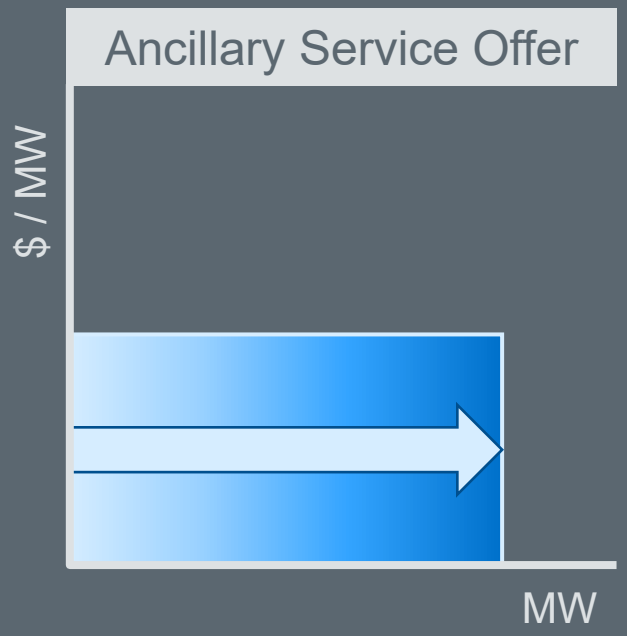


HSL = High Sustained Limit
LSL = Low Sustained Limit

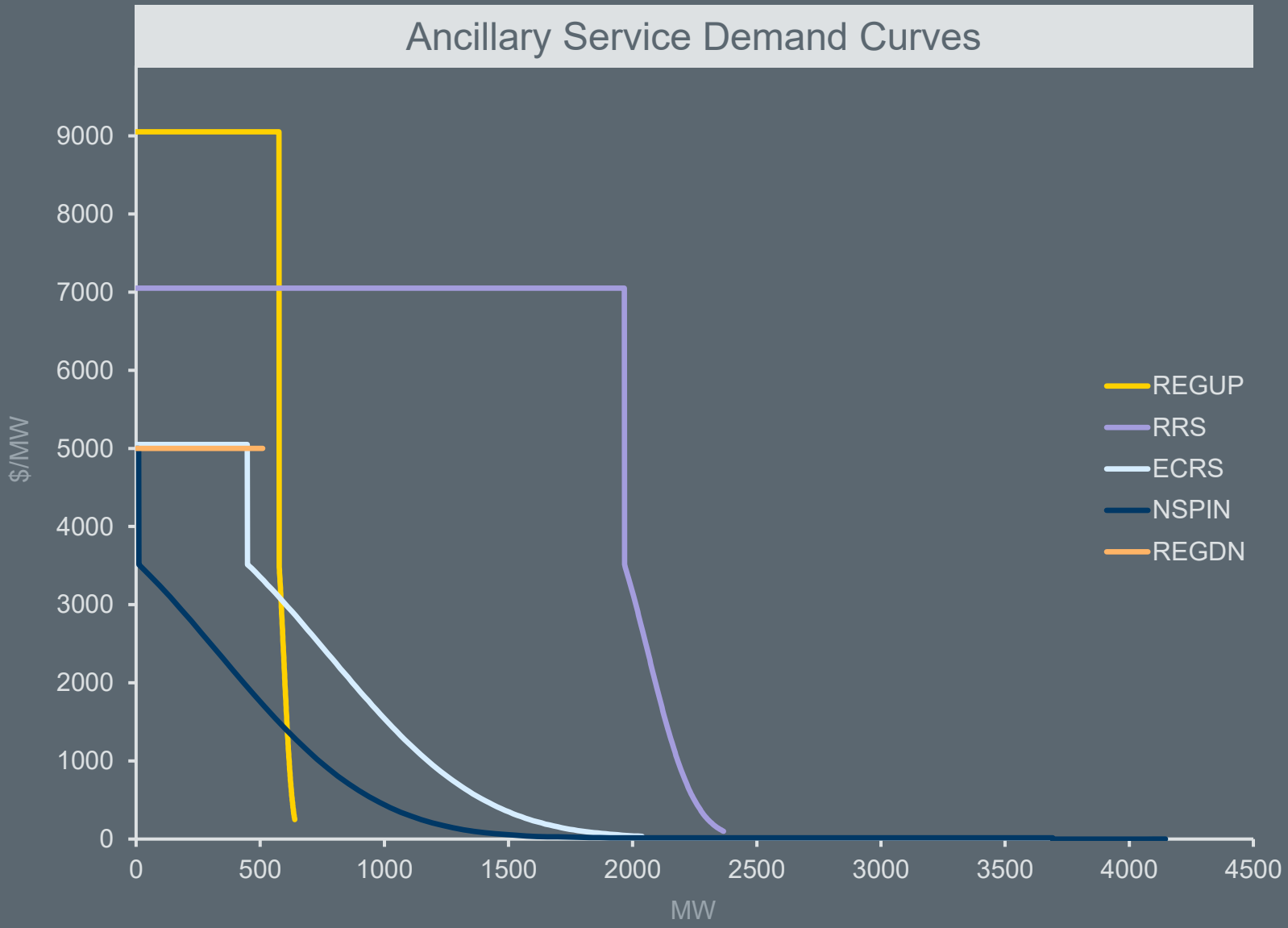
May be updated during any time before SCED

Resource-specific offer for each qualified AS Type

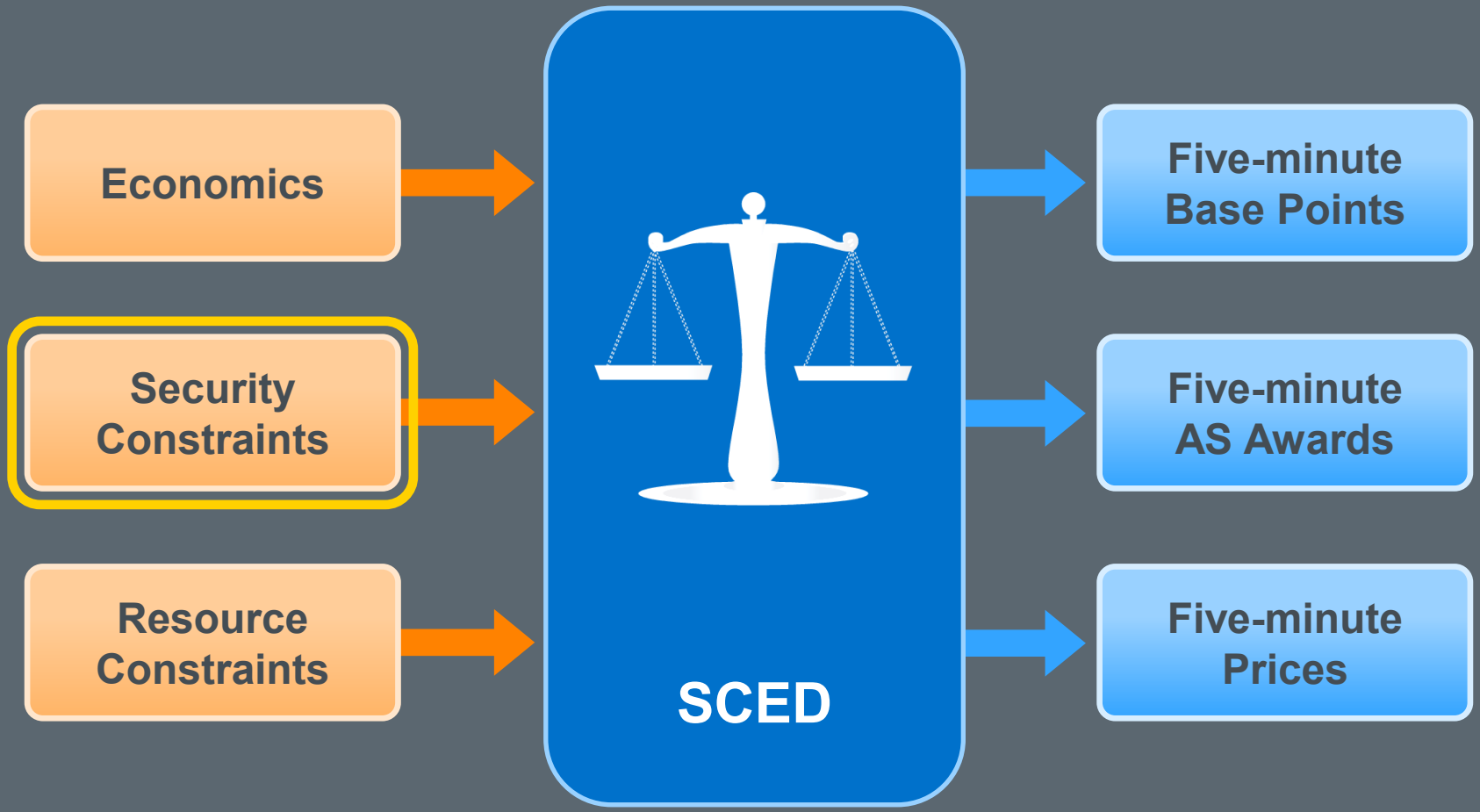
ERCOT creates proxy offers for each qualified Resource not offered by QSE



Economics: Ancillary Service Demand Curves (ASDCs)

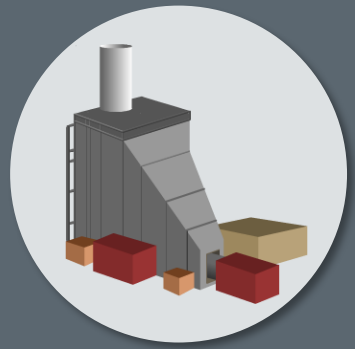


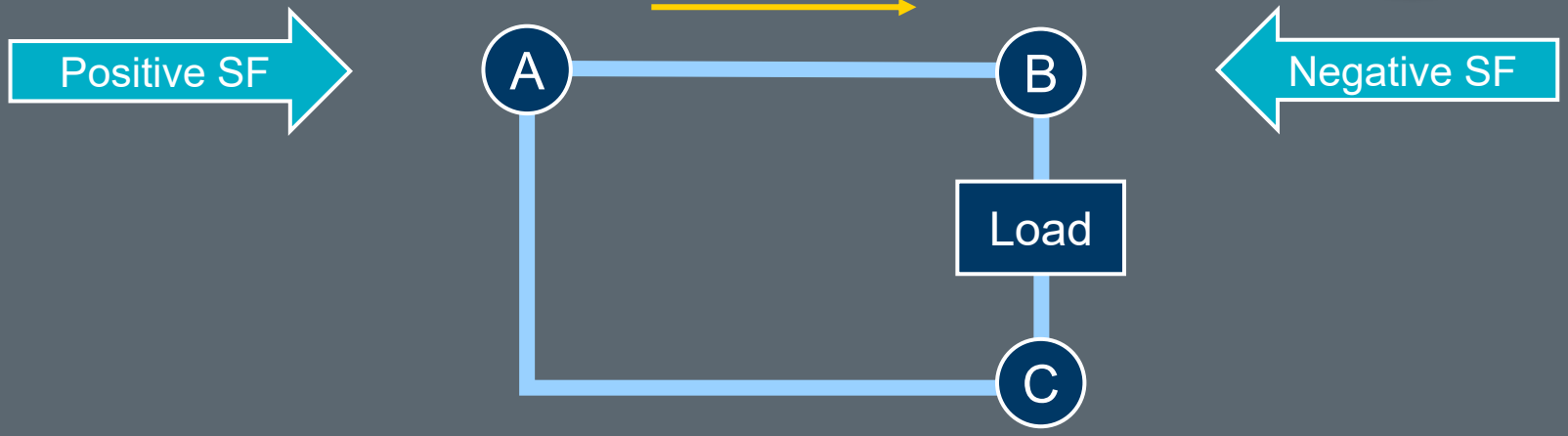
Solves Power Balance and Transmission Constraints



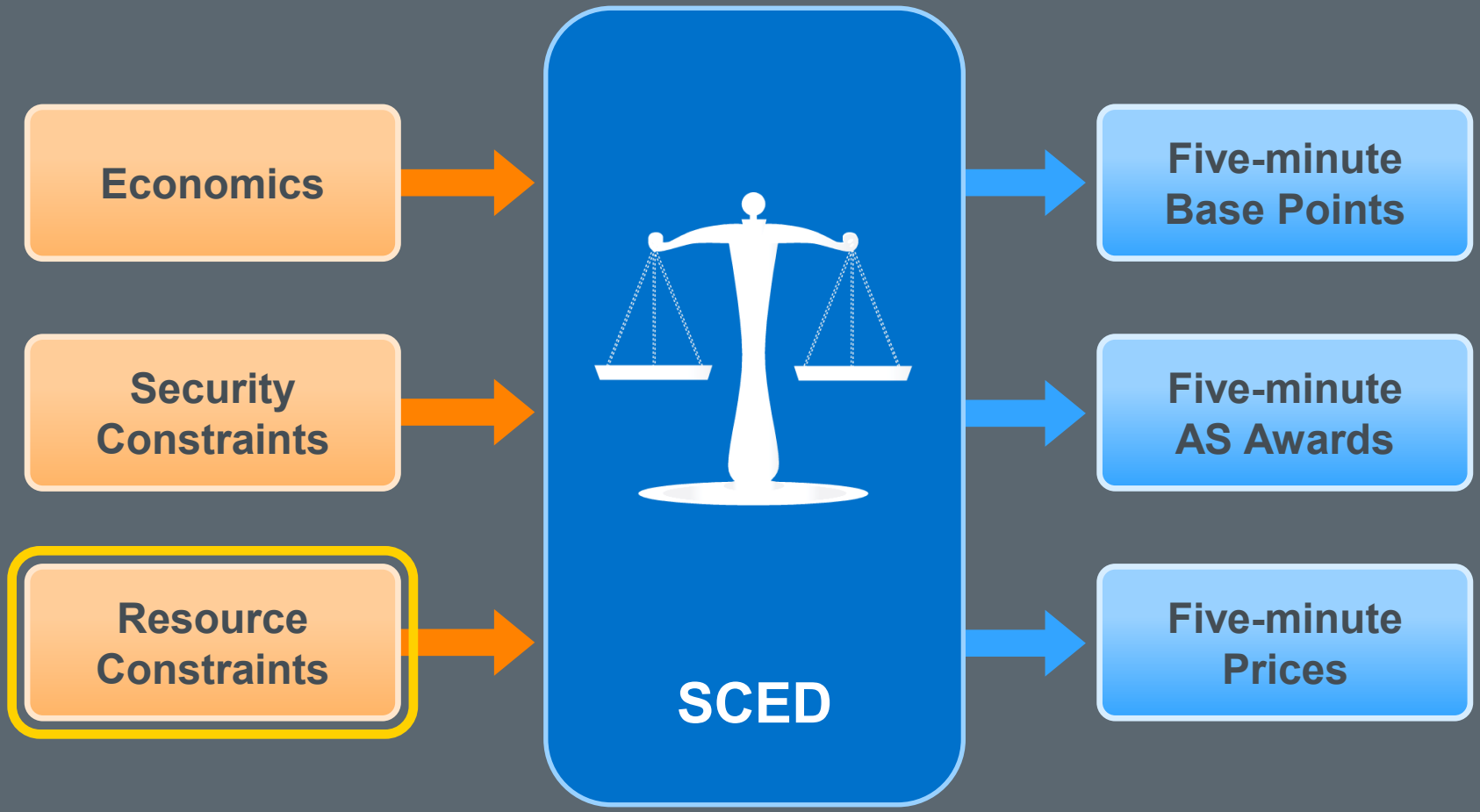
Security Analysis before each SCED cycle

How Resource impacts a Transmission Constraint

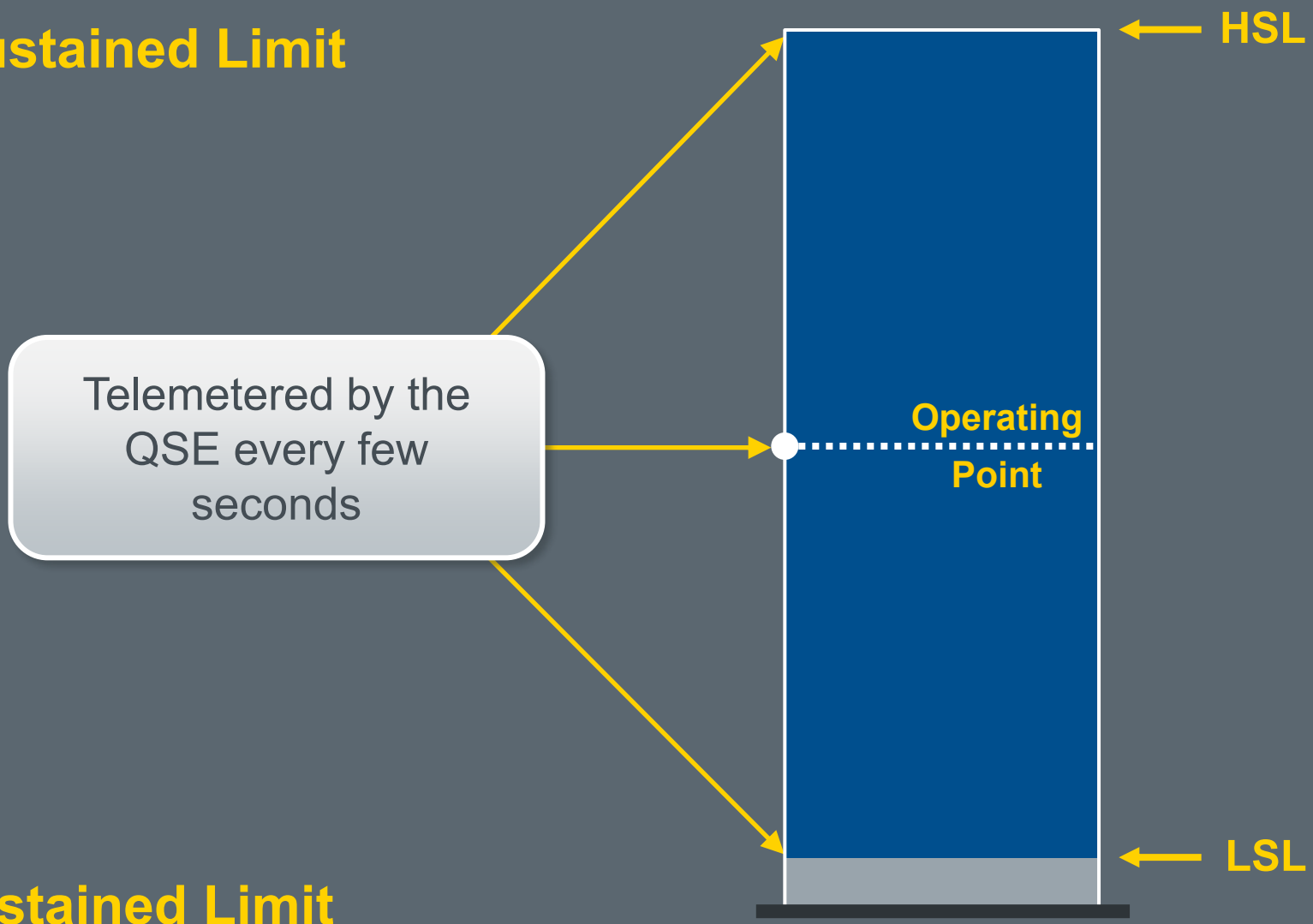




Observes Resource capabilities when dispatching



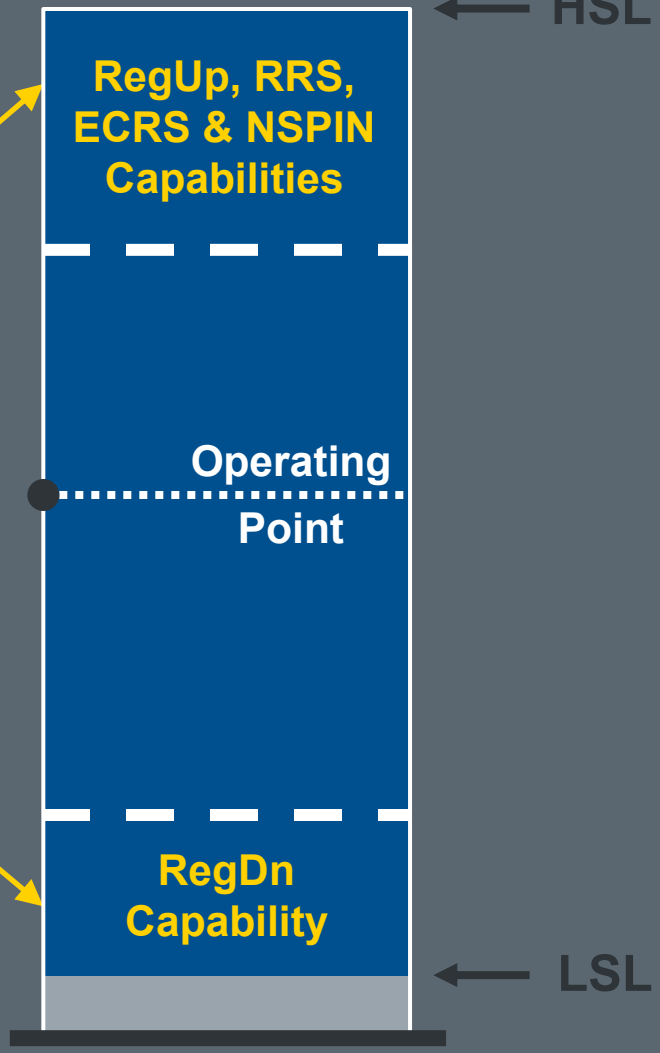
High Sustained Limit



Low Sustained Limit

Ancillary Service Capabilities

Telemetered by the QSE every few seconds

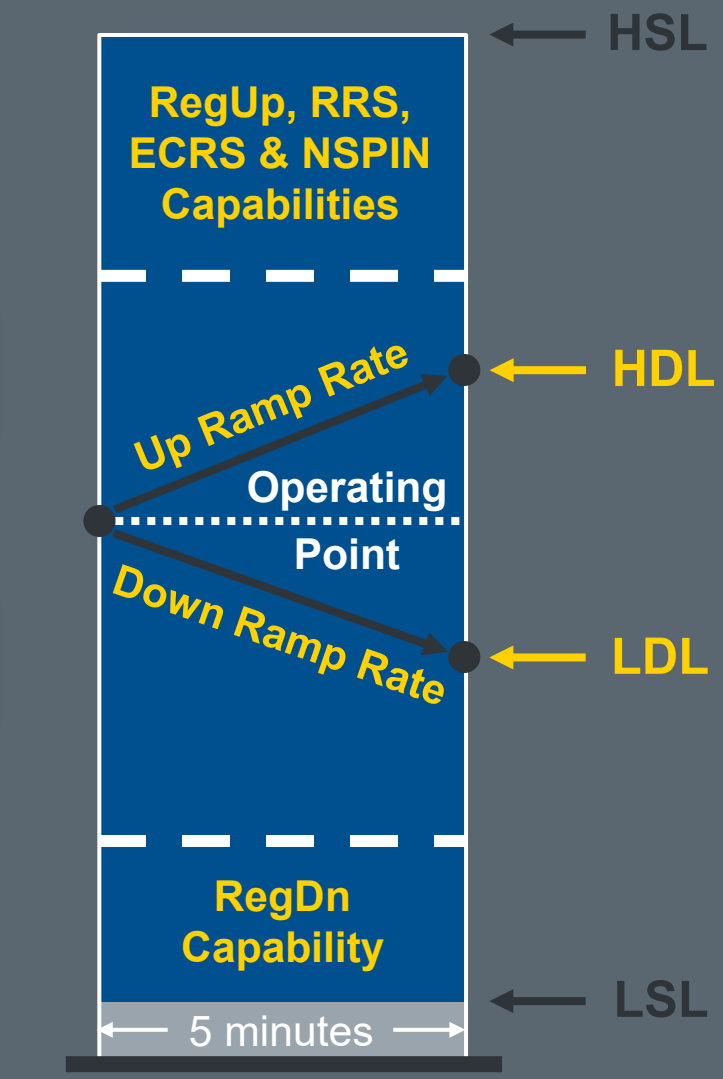


High Dispatch Limit

Base Point + (5/7) RegUp Award ≤ HDL

Base Point – (5/7) RegDn Award ≥ LDL

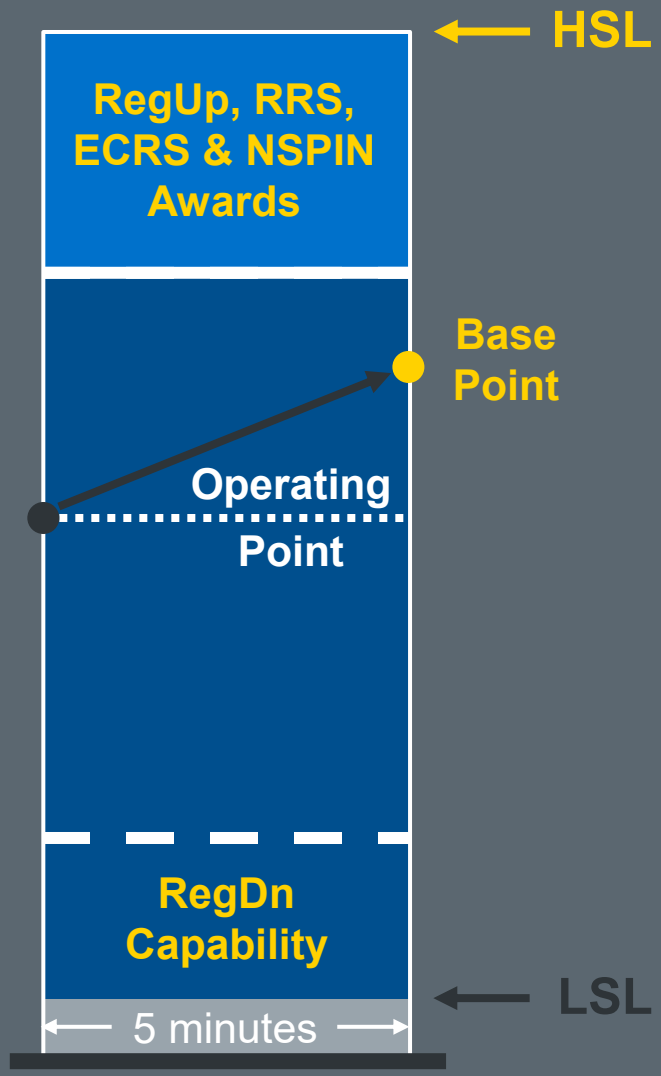
Low Dispatch Limit



Resource Limit Calculator

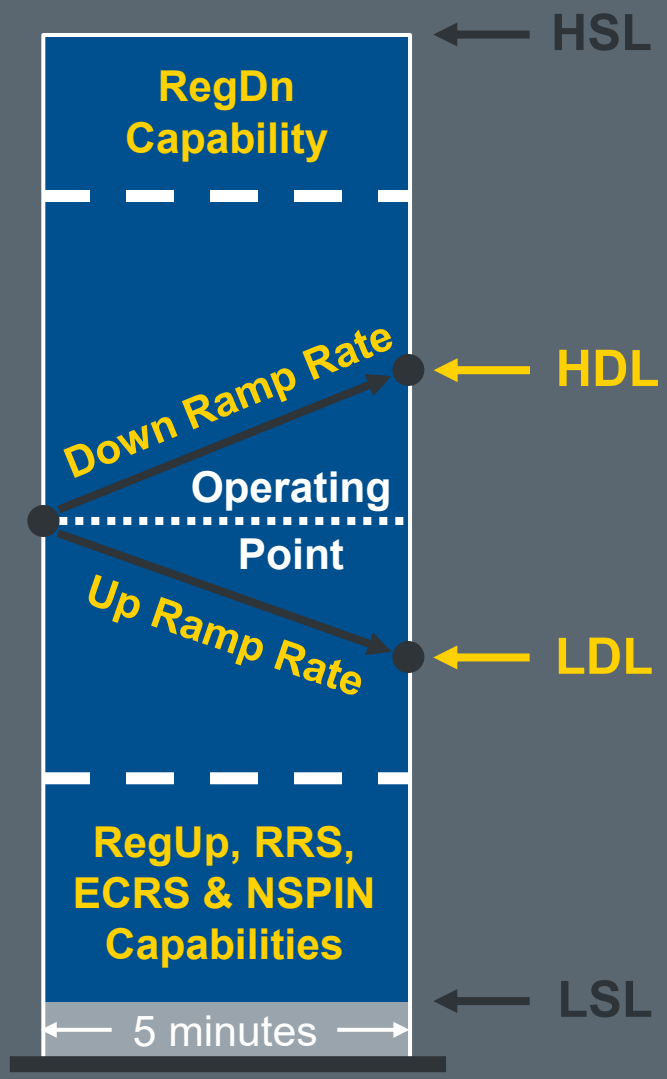
Resource Award Constraints

Base Point + RegUp Award
+ RRS Award + ECRS Award
+ NSPIN Award ≤ HSL



High Dispatch Limit

Low Dispatch Limit



Resource Limit Calculator

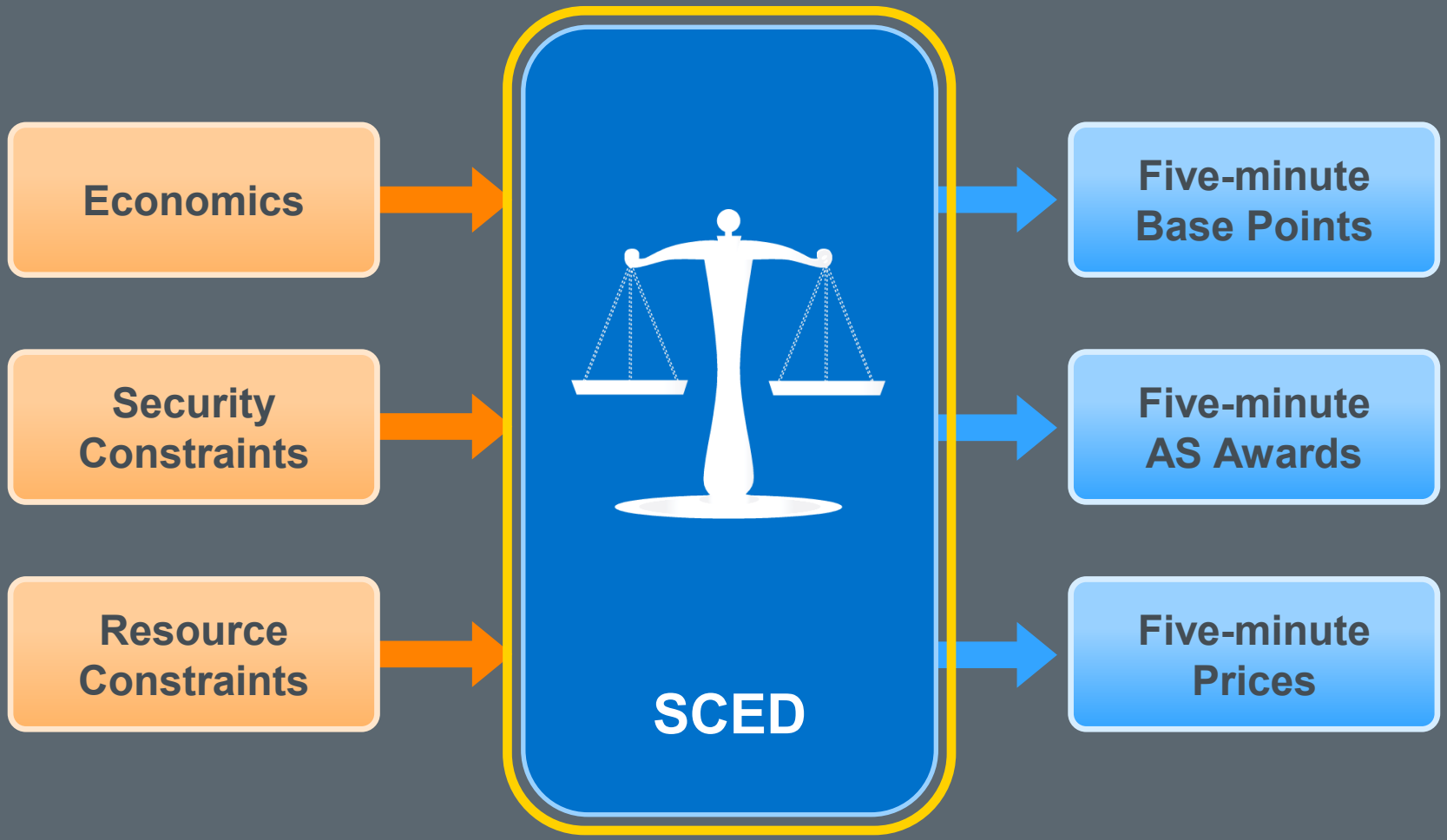
Ancillary Service awards have duration constraints

Ancillary Service	Duration
RegUp	30 minutes
RegDn	30 minutes
RRS	Depends
ECRS	1 hour
Non-Spin	4 hours

… calculated from State-of-Charge Telemetry

SCED Process

So what does SCED do with all this stuff?



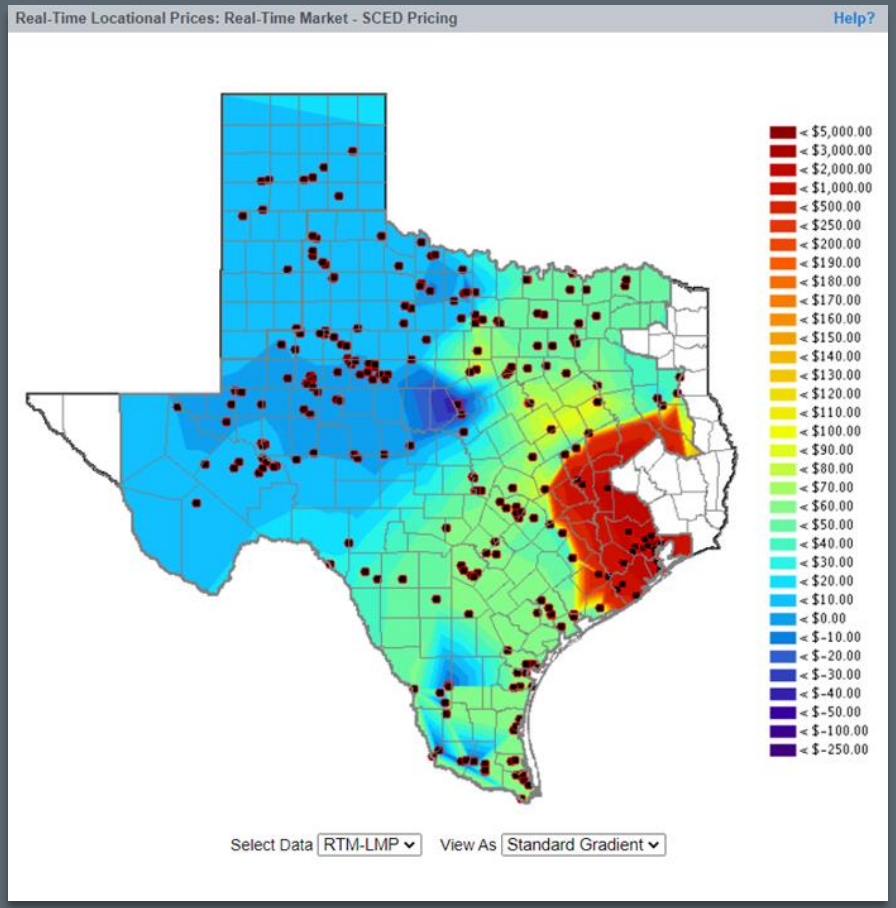
The Texas Two Step

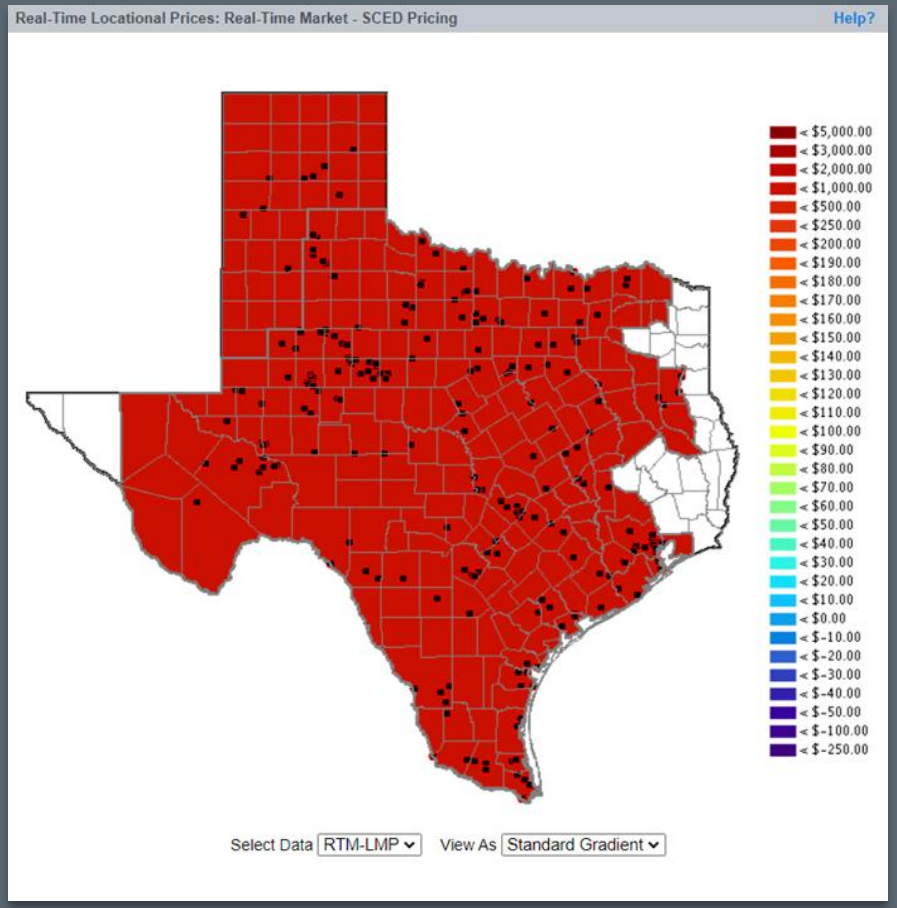
SCED Two Step Process

SCED executes twice each cycle

- Reduces Market Power
- Allows high prices under the right circumstances

Discussion: Right Circumstances for High Prices?





Transmission Constraints must be classified*

Competitive?

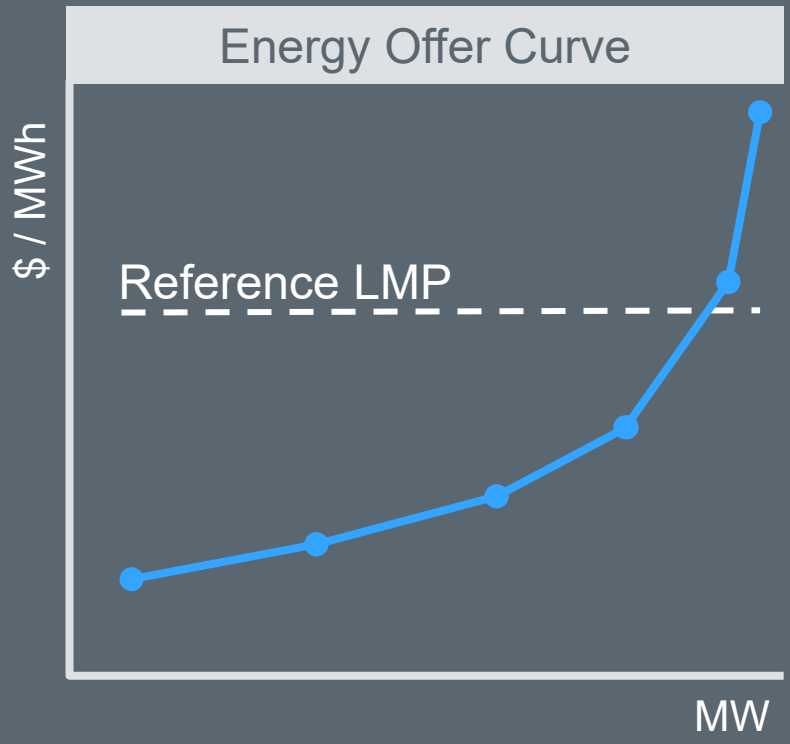
-- or --

Non-Competitive?

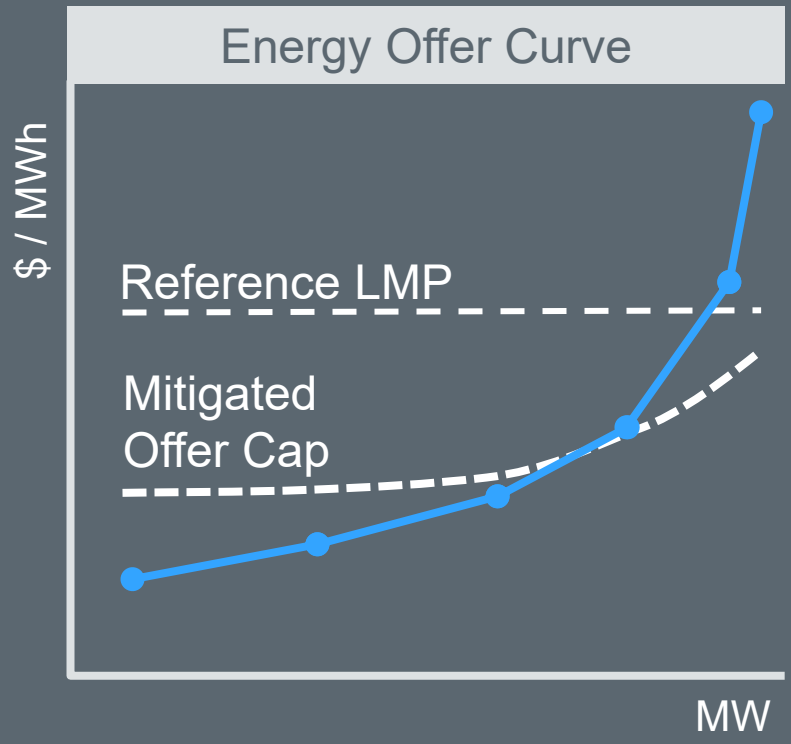
*See Protocol Section 3.19.4 for details

Step One

Two-Step
Competitive Constraints Only


Energy Offer Curve
$ / MWh
Reference LMP
MW

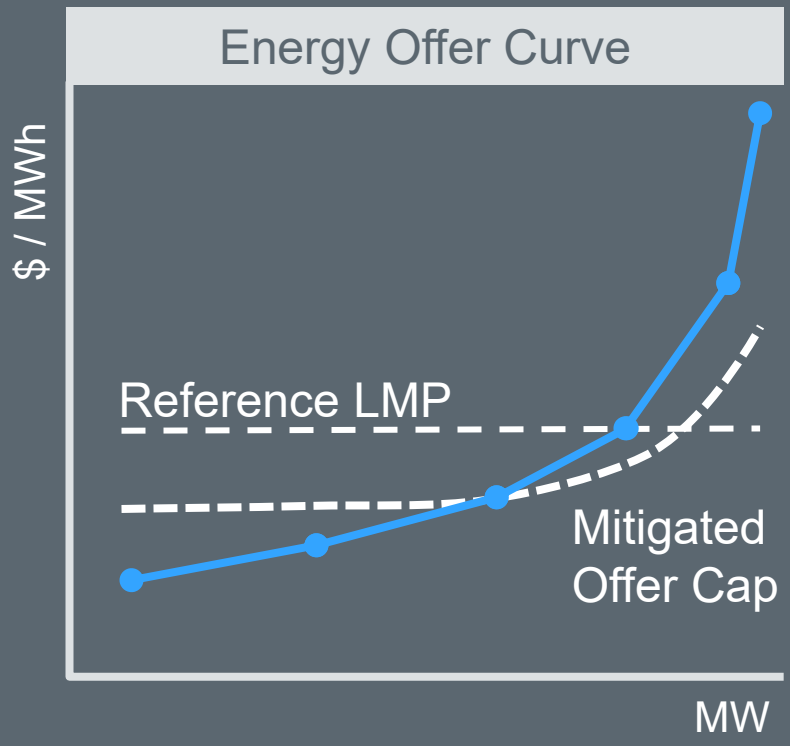
Step Two



Capped at greater of
Reference LMP or Mitigated Offer Cap

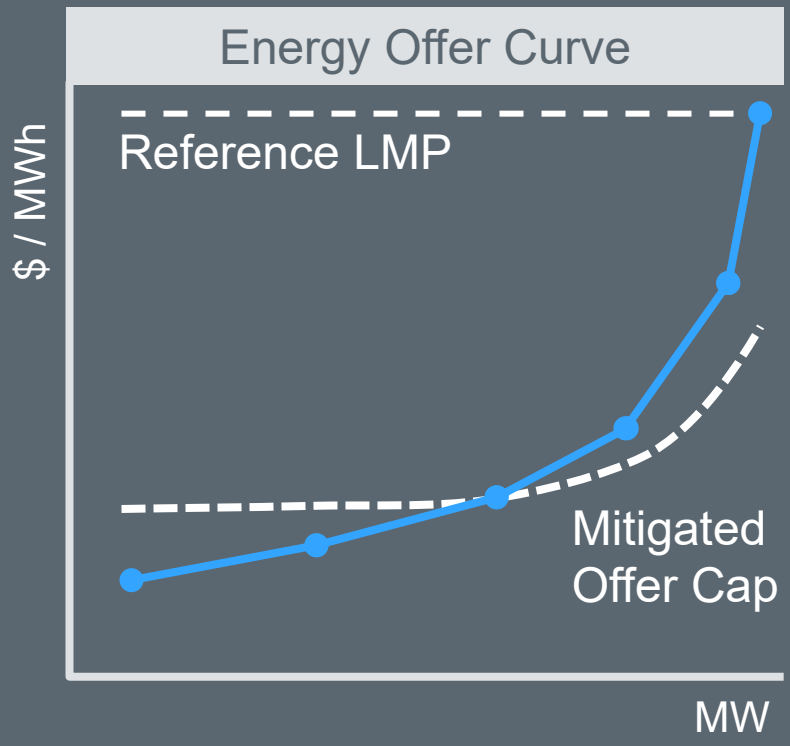
SCED has completed Step One

How will this Energy Offer Curve look in STEP Two?

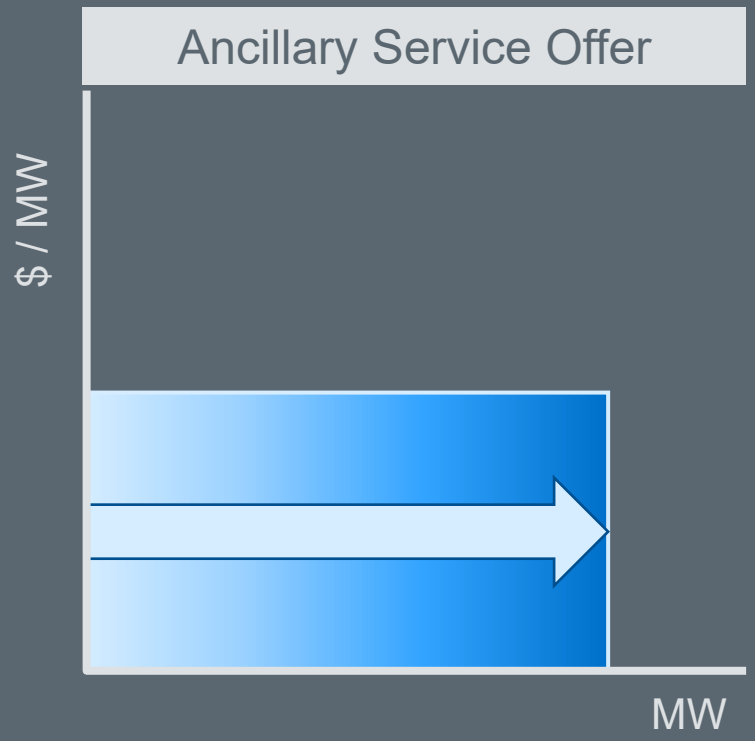


SCED has completed Step One

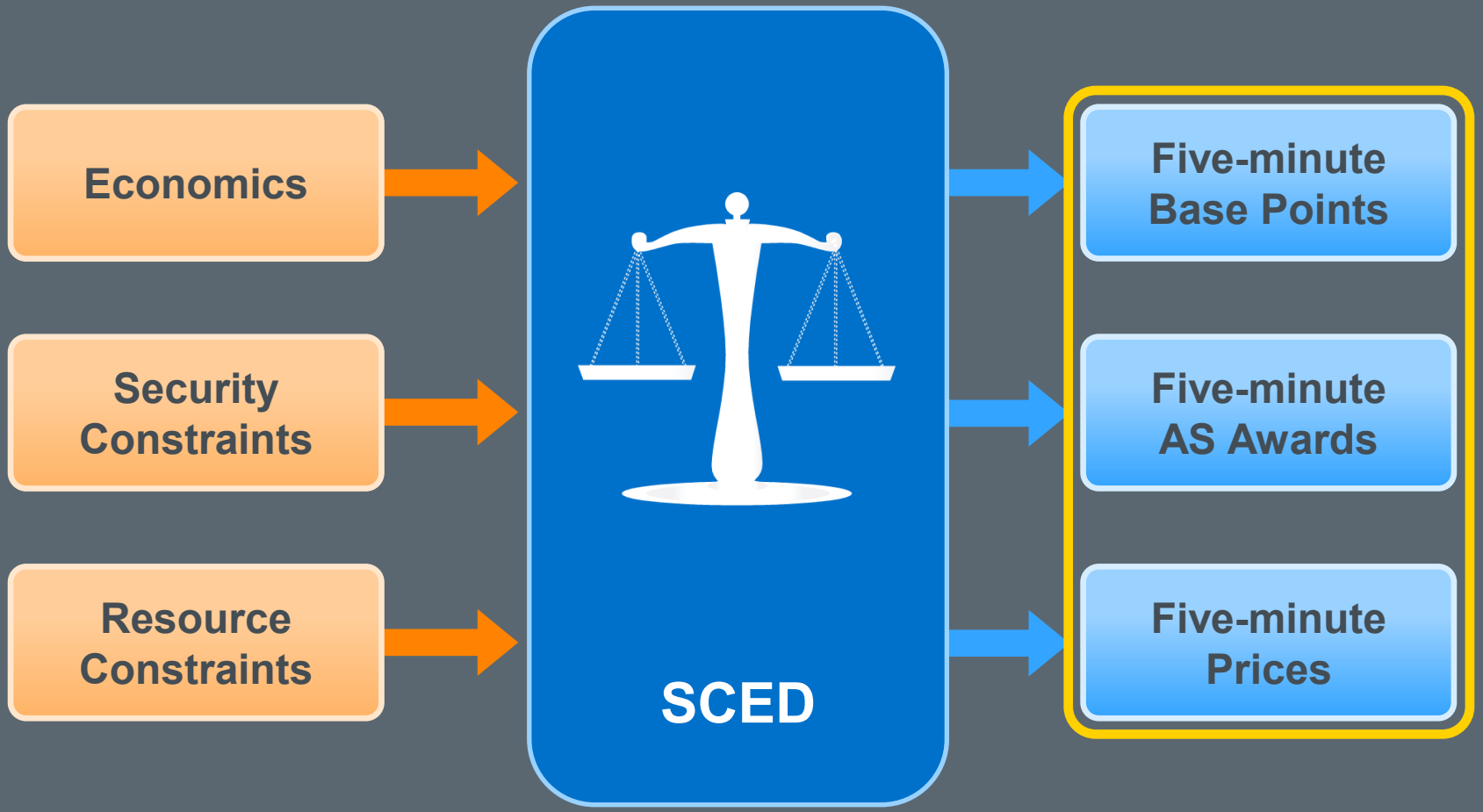
How will this Energy Offer Curve look in STEP Two?



Discussion: How does the Two-Step treat AS Offers?



SCED Results



Base Points, AS Awards and prices sent to QSEs

ICCP = Inter-Control Center Protocol

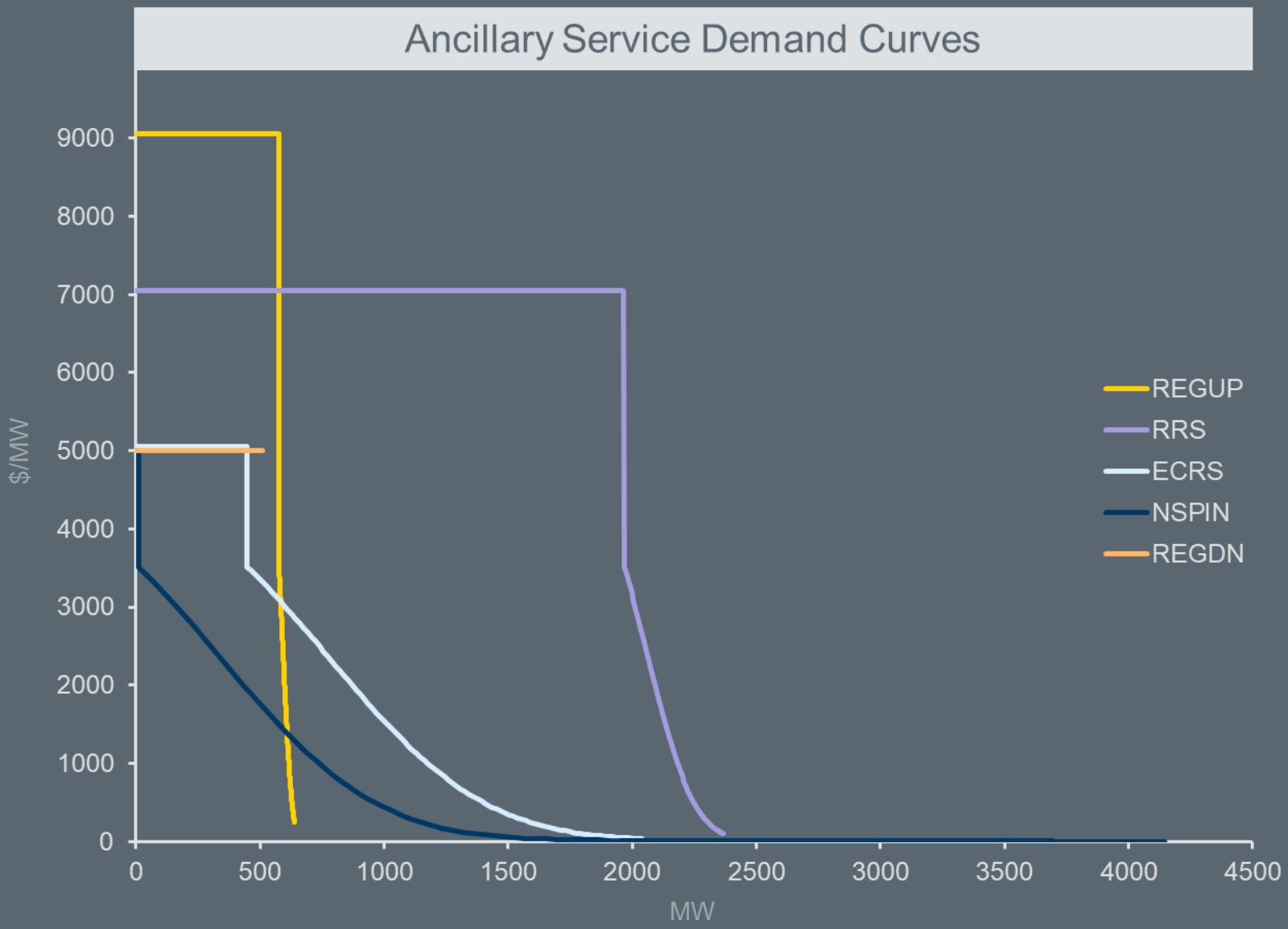
Deployment of Ancillary Services

AS Type	Deployment Methodology
ERCOT Contingency Reserve Service	SCED
On-line Non-Spin	SCED
Off-line Non-Spin	Operator Dispatch Instruction
Regulation Up and Regulation Down	Load Frequency Control
Responsive Reserve Service	Frequency Trigger

Reserves are managed by SCED

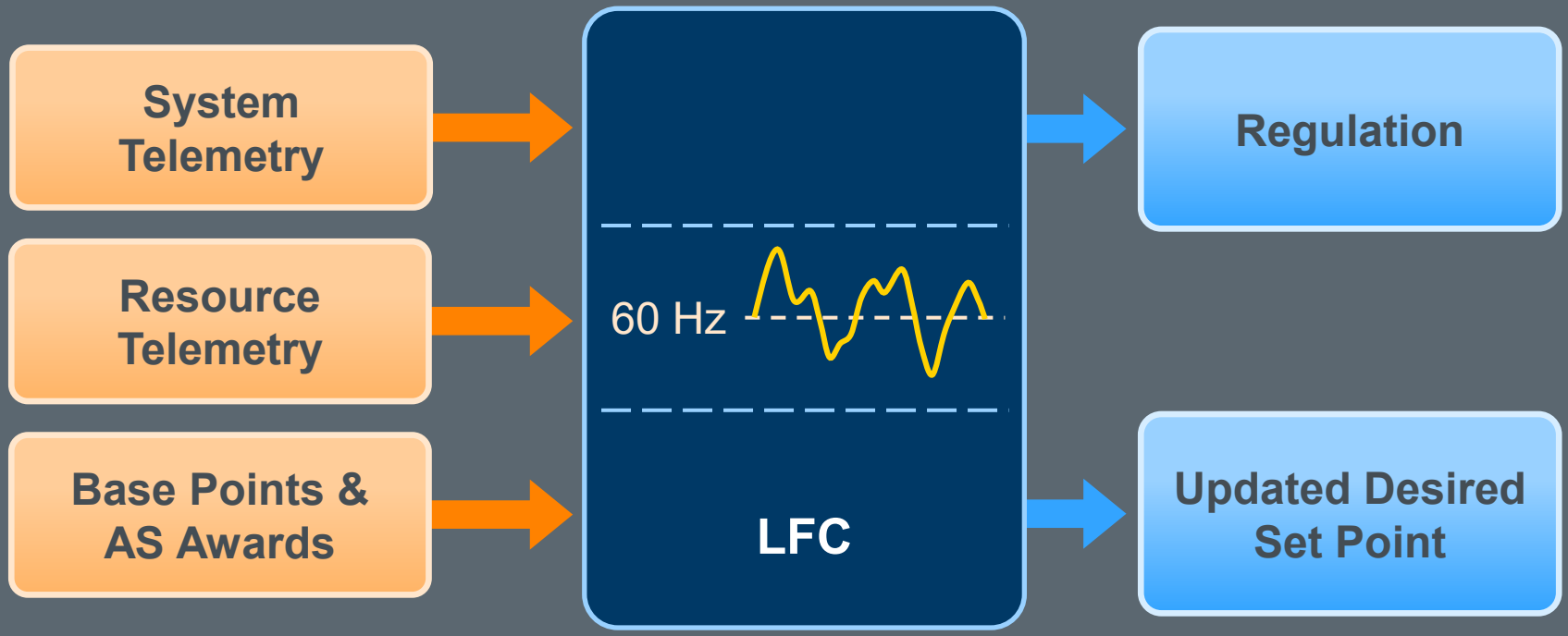
1. *SCED needs more energy*
2. *Converts AS into Energy*
   - *Less AS Award*
   - *New Base Point*
3. *Which AS does it choose?*

Discussion: Going Short on Ancillary Services



Load Frequency Control

Load Frequency Control (LFC)



Runs every 4 seconds!

Deployed by pro-rata share

- Resource-specific
- No price consideration

Updated Desired Set Point (UDSP)

Instructed output level of Resource to meet:

- SCED Base Point Ramping
- Regulation deployments
- Expected FFR deployments

Responsive Reserve is frequency responsive

RRSPF – Primary Frequency Response

- Automatic Response at 59.983 Hz
- Proportional to frequency decay

RRSFF – Fast Frequency Response

- Auto-deployed at 59.85 Hz
- Responds within 15 Cycles

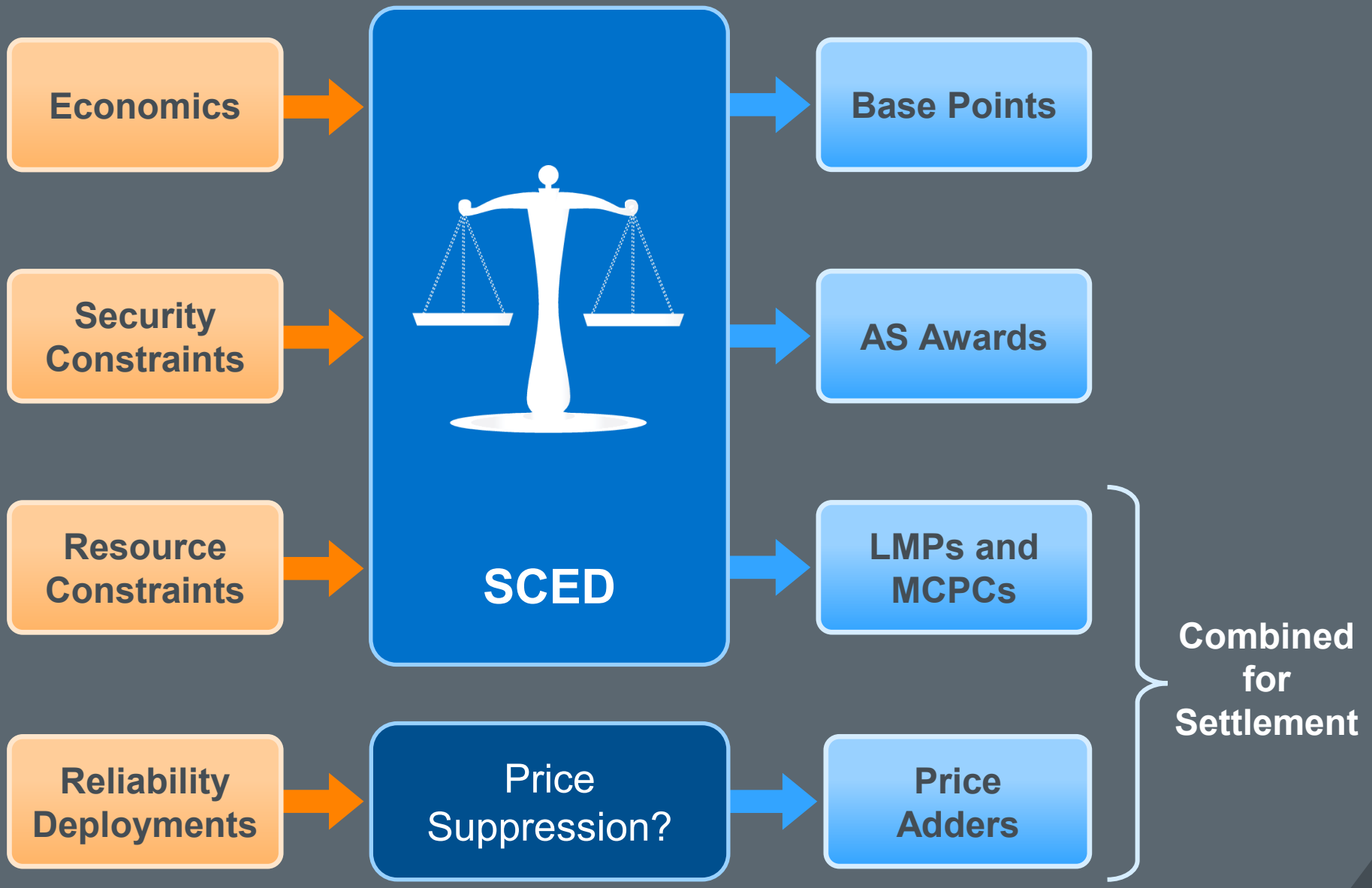
RRSUF – Load Resource on Under-Frequency Relay

- Auto-deployed at 59.70 Hz
- Trips within 30 cycles

Regulation Deployments and UDSP sent to QSEs

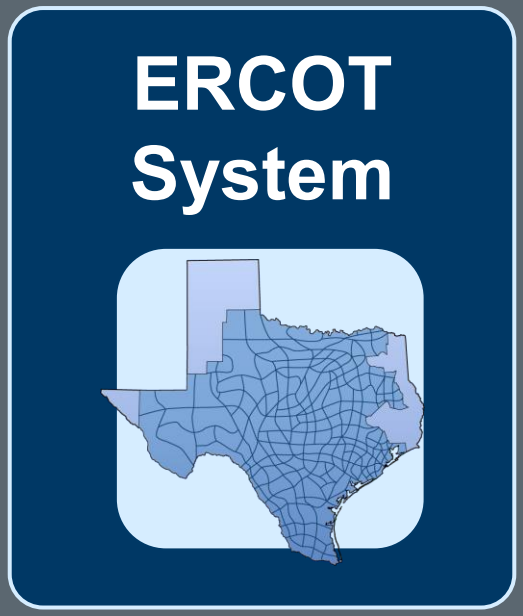
Financial Impacts

1. Real-Time Pricing
2. Energy and Ancillary Service Settlement
3. Set Point Deviation


Economics
Security Constraints
Resource Constraints
Reliability Deployments
SCED
Price Suppression?
Base Points
AS Awards
LMPs and MCPCs
Price Adders
Combined for Settlement

RTRDPA – Real-Time Reliability Deployment Price Adder

RTRDPA[AS] – Real-Time Reliability Deployment Price Adder per AS Product



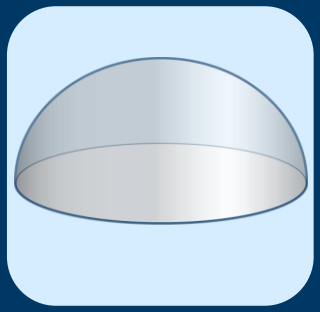
… for each SCED interval

Real-Time Settlement Point Prices (RTSPPs) = Ave (RTLMPs) + Ave (RTRDPAs)

Resource Nodes

Load Zones

Hubs



… for each 15-minute interval

Real-Time Market Clearing Prices for Capacity (MCPCs) *

Regulation-Up

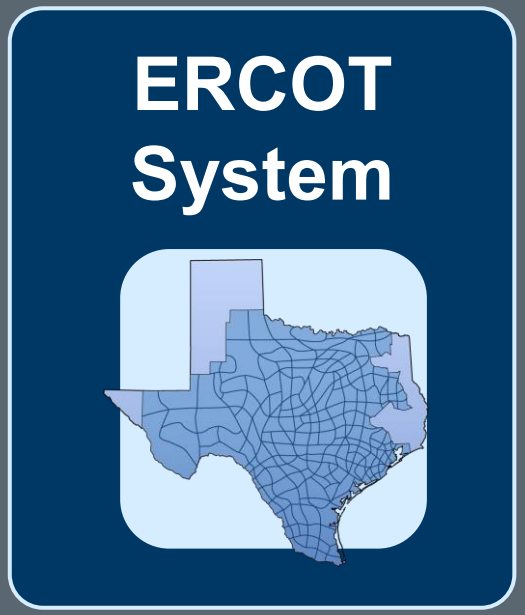
RTMCPCRU = Ave (RTMCPCRUS)+ Ave (RTRDPARUS)

RTMCPCRD – Regulation-Down

RTMCPCRR – Responsive Reserve

RTMCPCECR – Contingency Reserve

RTMCPCNS – Non-Spin Reserve



** RT MCPCs capped at VOLL*

… for each 15-minute interval

1. Real-Time Pricing
2. Energy and Ancillary Service Settlement
3. Set Point Deviation

Real-Time Energy Imbalance

$$= (-1) \left(\left(\begin{array}{c} \text{Metered Generation} \\ + \\ \text{DAM Energy Purchases} \\ + \\ \text{Trade Energy Purchases} \end{array} \right) - \left(\begin{array}{c} \text{DAM Energy Sales} \\ + \\ \text{Trade Energy Sales} \\ + \\ \text{Metered Load} \end{array} \right) \right) * \text{RTSPP}$$

Supplies

Obligations

Each Settlement Point settled separately

Real-Time Ancillary Service Imbalance

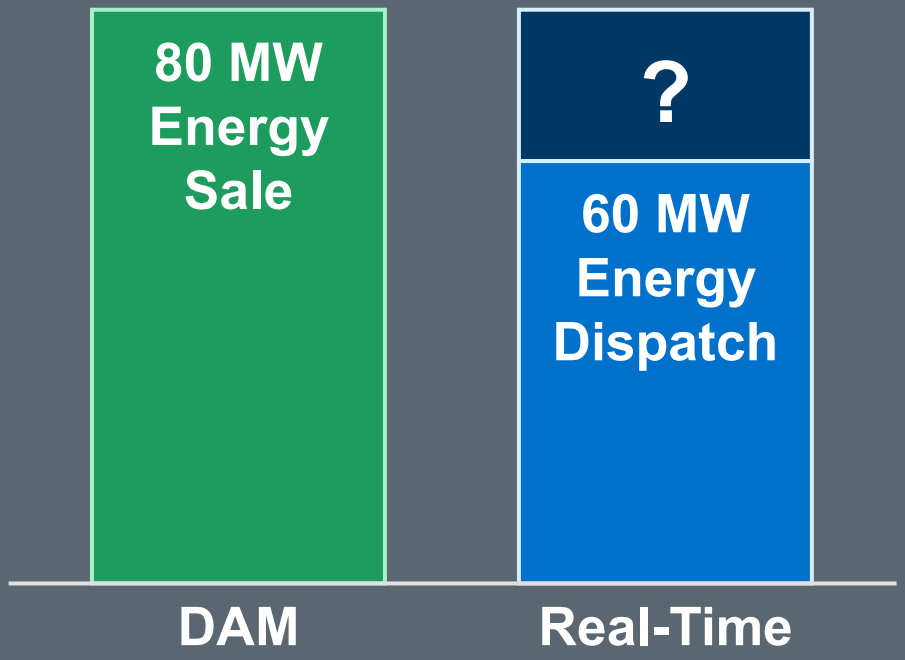
$$= (-1) \left[\left(\text{Real-Time AS Awards} + \text{Trade AS Purchases} \right) - \left(\text{DAM AS Awards} + \text{DAM Self-arranged AS} + \text{Trade AS Sales} \right) \right] * \text{RTMCPC}$$

Supplies — Obligations

Settled ERCOT-wide per AS product

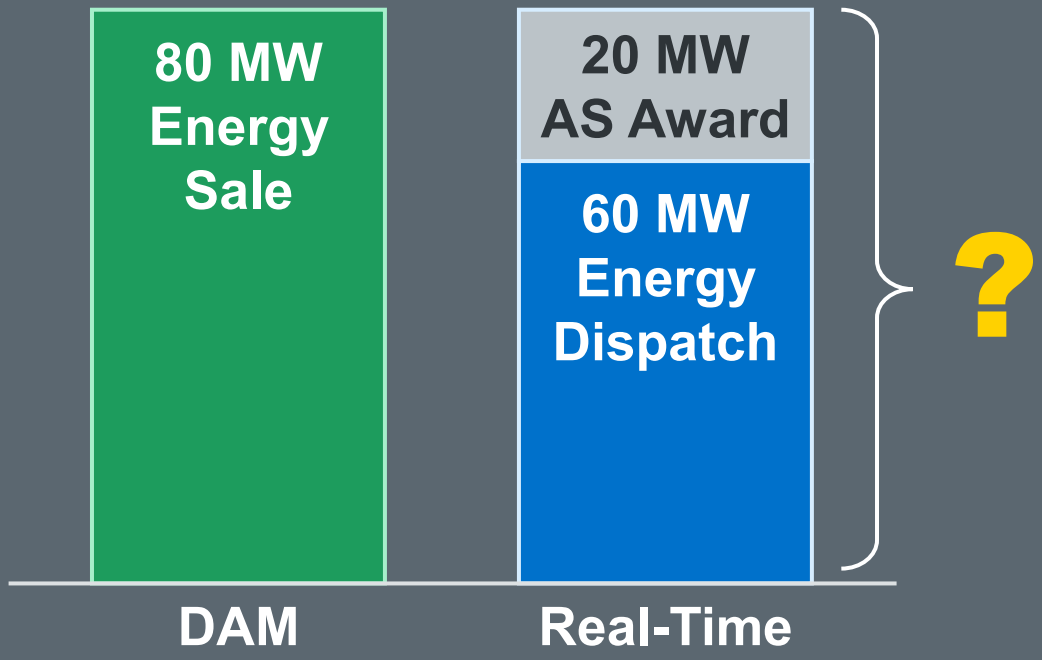
QSE has transactions for their Resource

Generation Resource



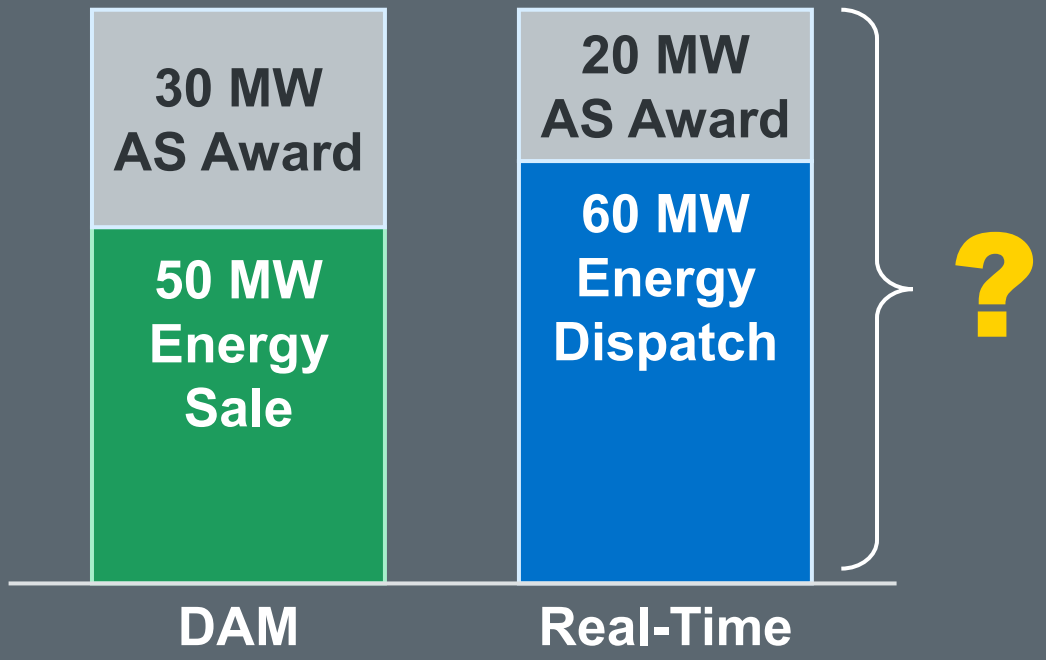
Scenario: How's it Settled?

Generation Resource

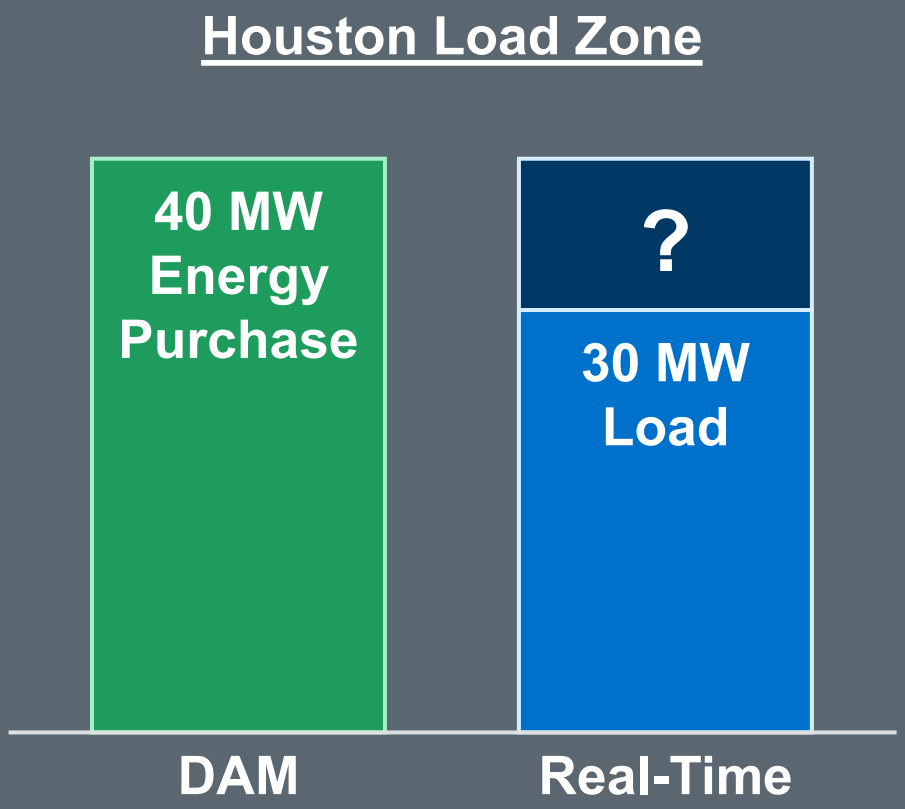


Scenario: How's it Settled?

Generation Resource

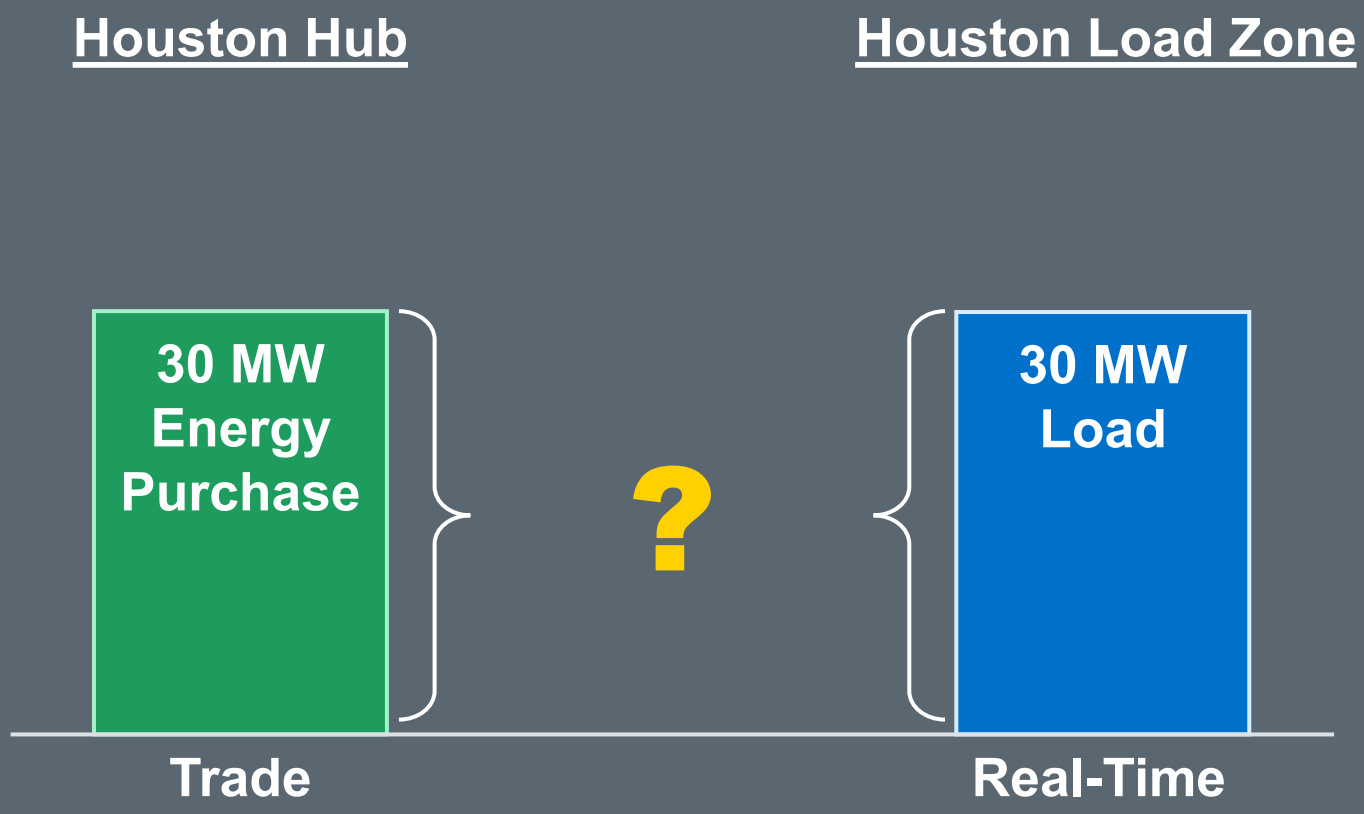


QSE has transactions for their Load



Scenario: How's it Settled?

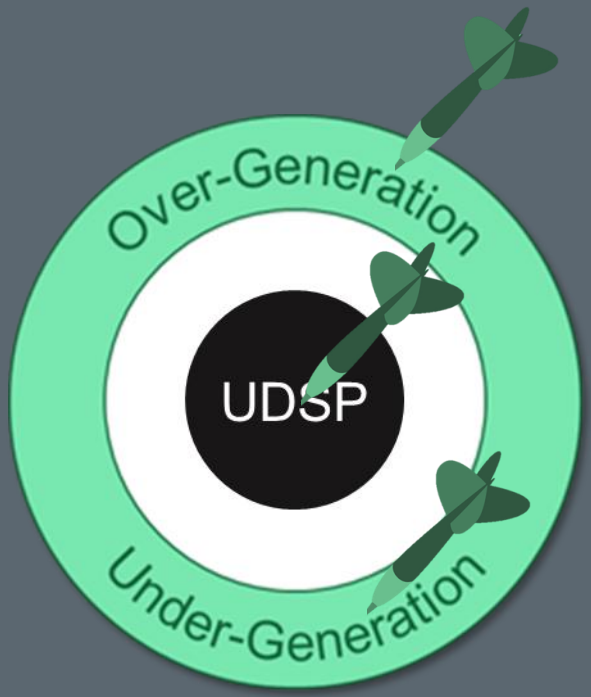
QSE has transactions for their Load



1. Real-Time Pricing
2. Energy and Ancillary Service Settlement
3. Set Point Deviation

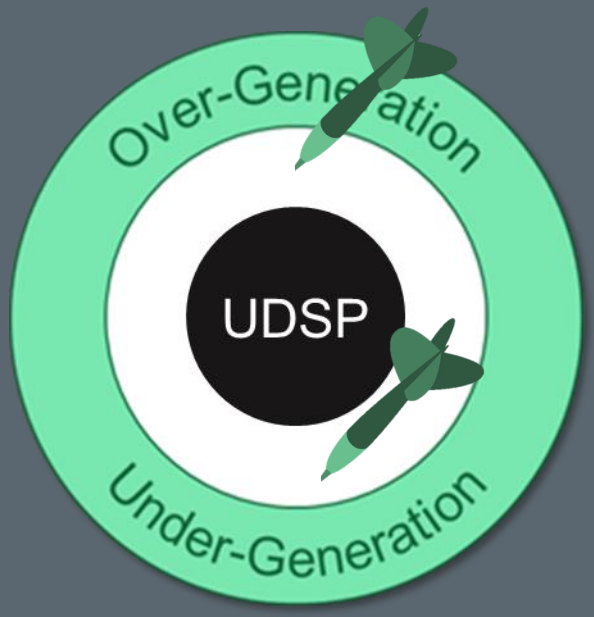
Resource shall follow Updated Desired Set Point

QSE may be charged if Resource outside tolerance



Protocol Tolerances

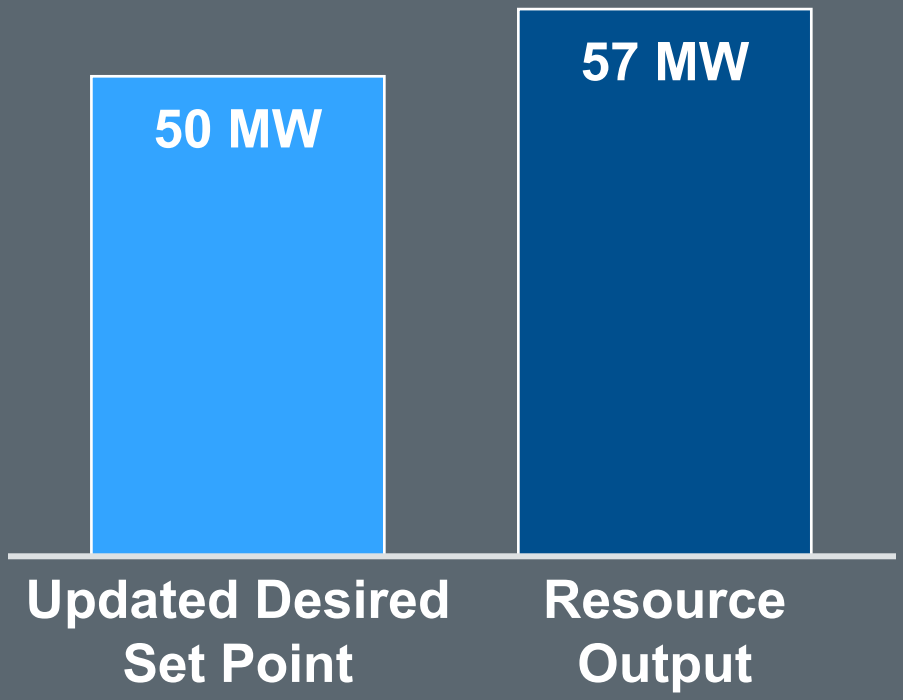
- Greater of ± 5% or ± 5MW
- 5% for IRRs that over-generate with no Ancillary Service awards
- Greater of ± 3% or ± 3MW for ESRs



Waived if two conditions are met

1. Frequency deviation greater than 0.05Hz
2. Resource's deviation helps correct frequency

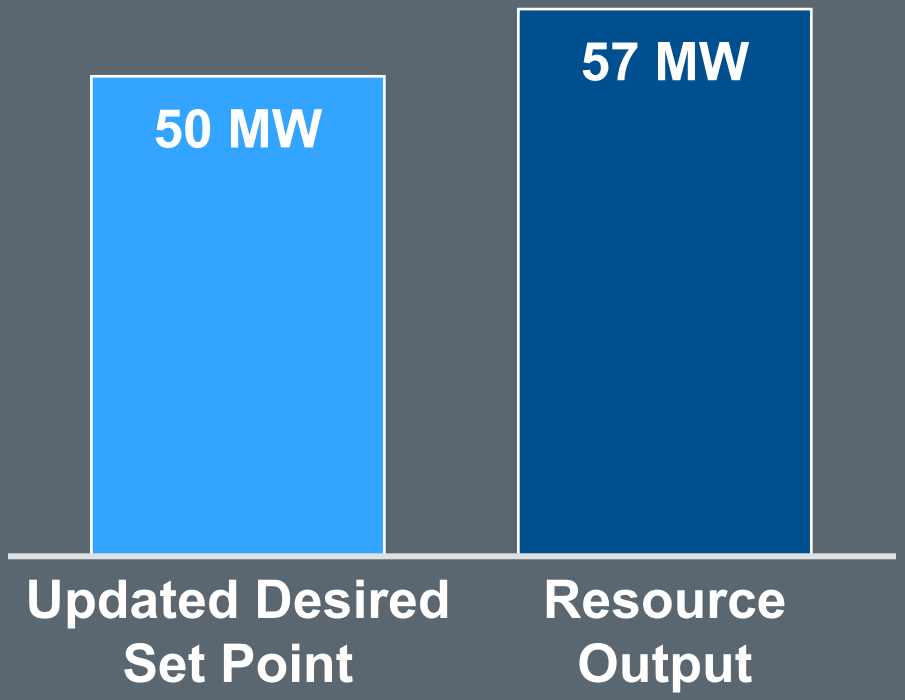
Does the QSE incur a Set Point Deviation Charge?



59.940

Frequency at max deviation during interval

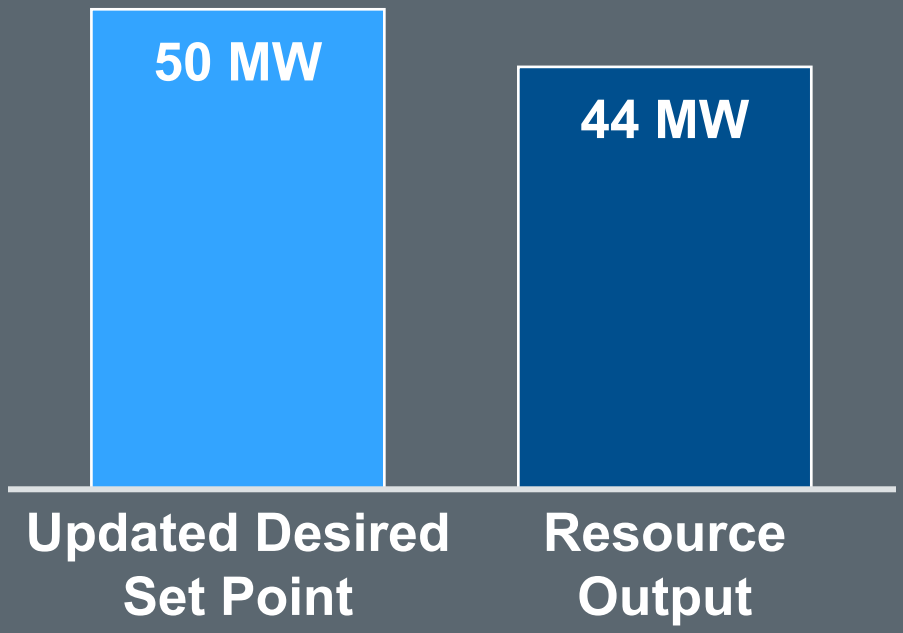
Does the QSE incur a Set Point Deviation Charge?



60.020

Frequency at max deviation during interval

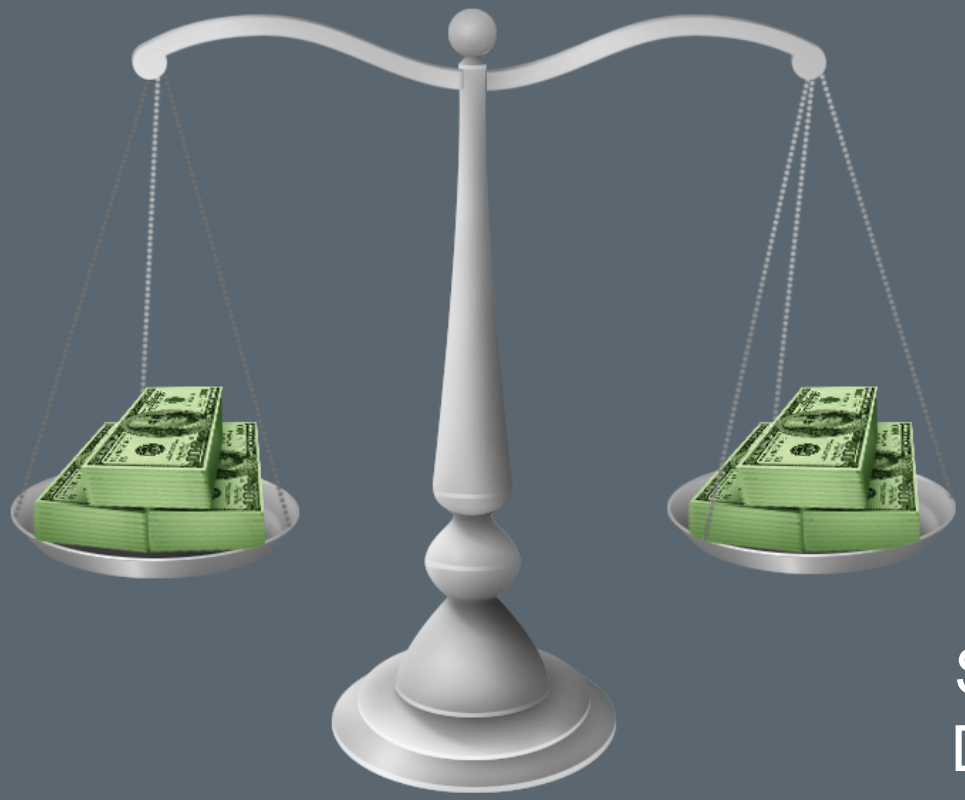
Does the QSE incur a Set Point Deviation Charge?



60.020

Frequency at max deviation during interval

Set Point Deviation Payment



Set Point Deviation Charges

Set Point Deviation Payments

Course Wrap-Up

Suite of Wholesale Market Courses

Format	Title
WBT	Wholesale Markets Overview

Format	Title	Topic
ILT	Day-Ahead Market Operations	Inputs
		Market Clearing
		Financial Impacts
	Reliability Unit Commitment	Overview
		Process
		Financial Impacts
	Real-Time Market Operations	Security Constrained Economic Dispatch
		Load Frequency Control
		Financial Impacts

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