

Wholesale Market Operations: Day-Ahead



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/>

Format	Title
WBT	Wholesale Markets Overview

Format	Title	Topic
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

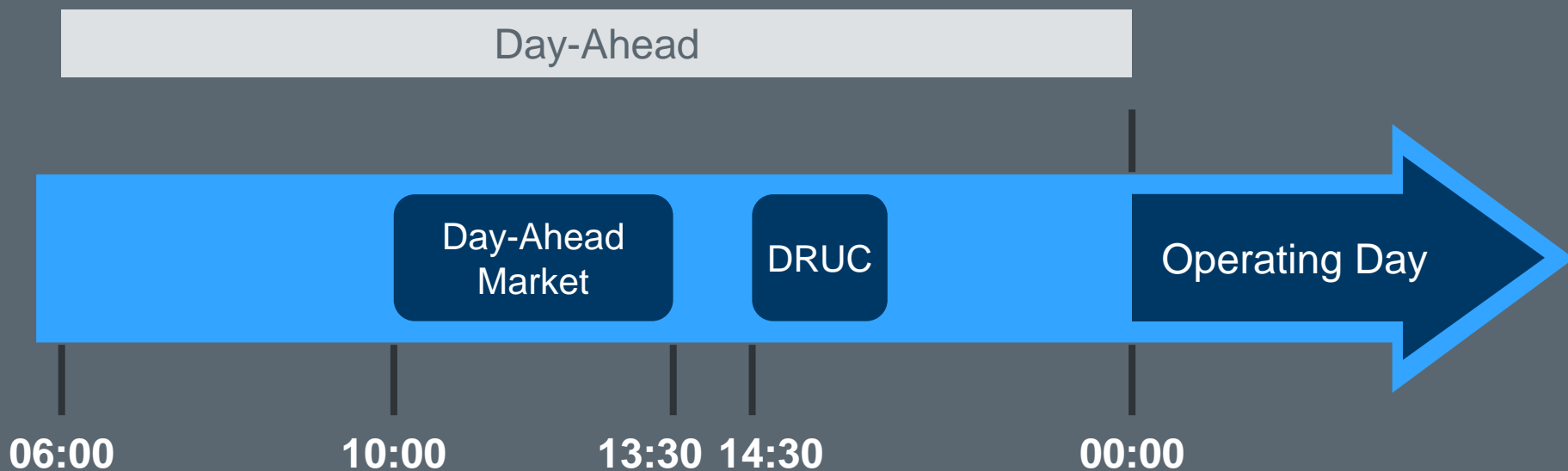
- Windows
- Buttons

Attendance

Questions / Chat

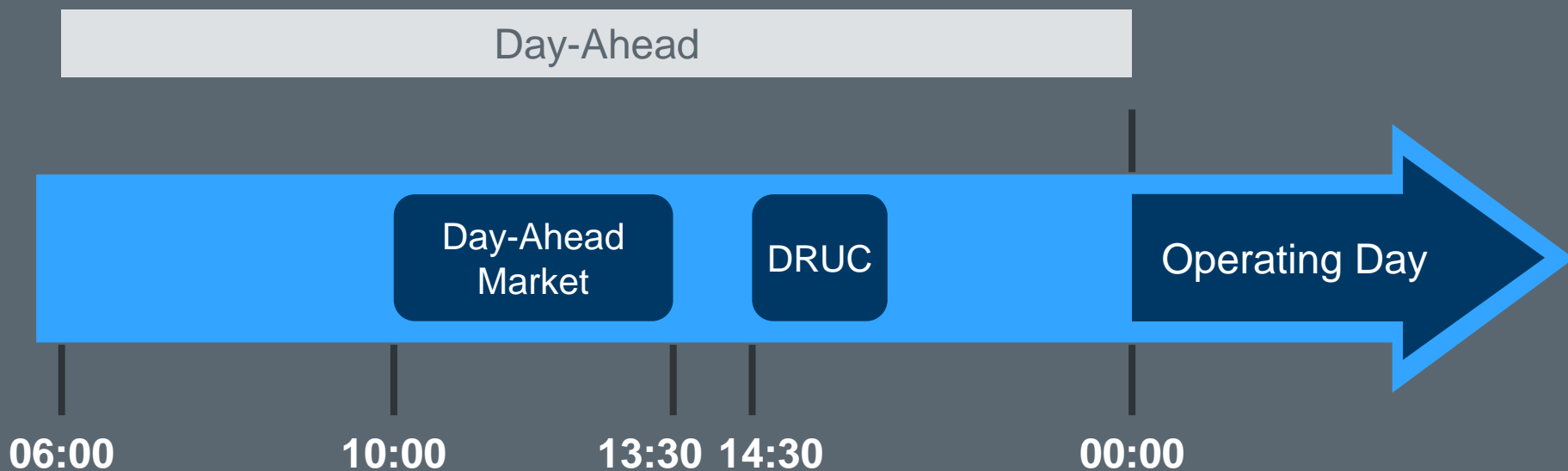


**Please enable video
& audio capabilities**



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

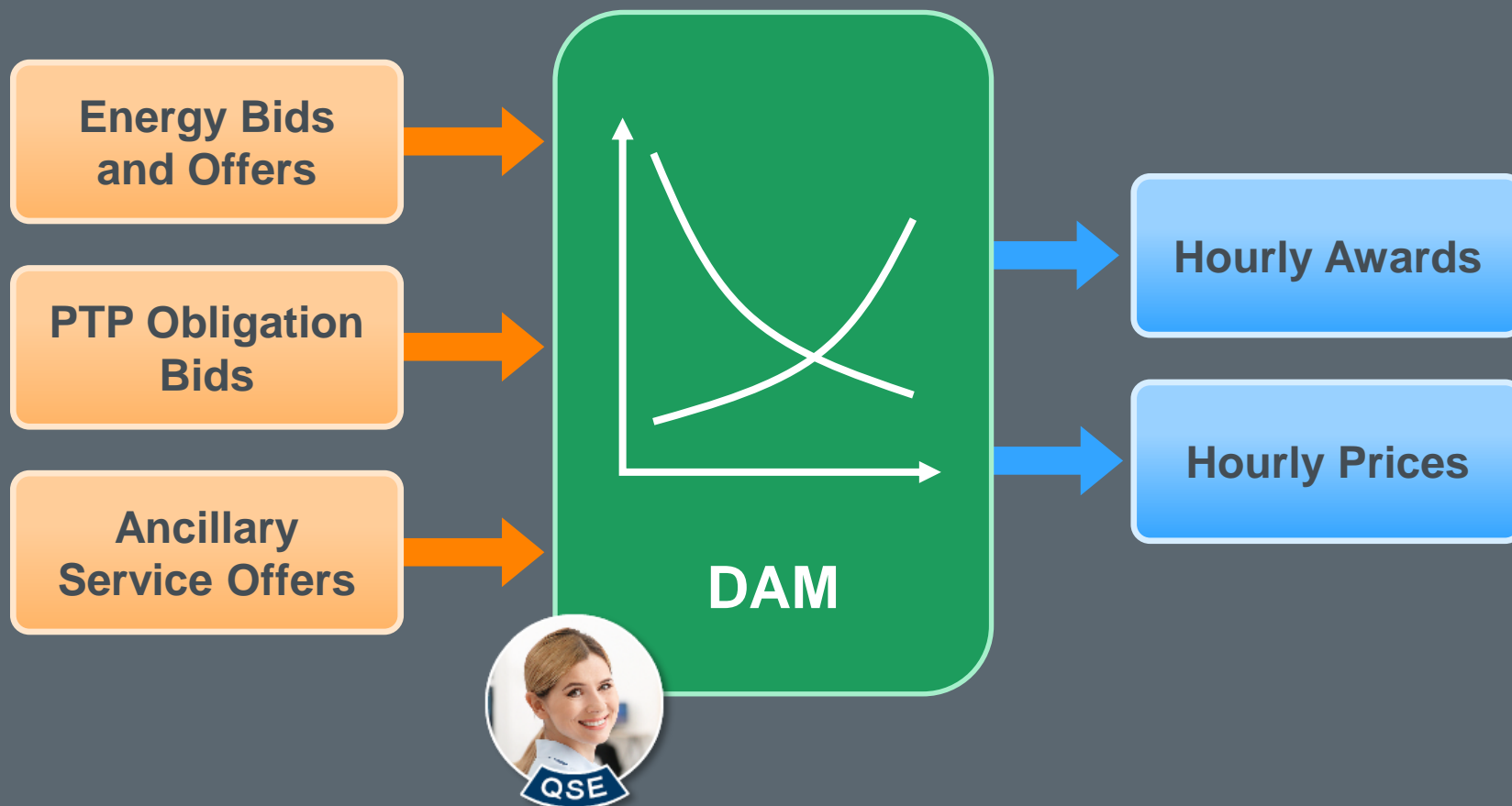
ERCOT posts market data by 0600



QSEs provide Day-Ahead Market inputs by 10:00

Day-Ahead Market Inputs

Products Transacted in DAM



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

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 Market Data Transparency Web Services Self-service data request access for a subset of AMS, Service...	 Market Manager (MMSUI) Market Manager (MMSUI) is used to create and review market su...	 NDCRC Net Dependable Capability and Reactive Capability (NDCRC) app...
 Outage Capacity Calculation Tool Used by ERCOT to calculate outaged capacity.	 Outage Scheduler Outage Scheduler (OS) is used to view, submit, and modify Out...	 Renewable Energy Credits Link to Texas Renewable Energy Credits (REC) website.
 Service Requests Create or find Service Requests.	 Settlement Disputes Create or find Settlement Disputes.	



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Wholesale

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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

DAM Energy Bid

Proposal to buy energy:

- Quantity
- Price
- Settlement Point

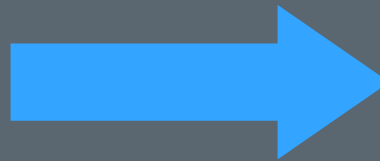
DAM Energy-Only Offer

Proposal to sell energy:

- Quantity
- Price
- Settlement Point

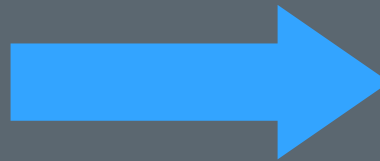


Purely Financial Transactions

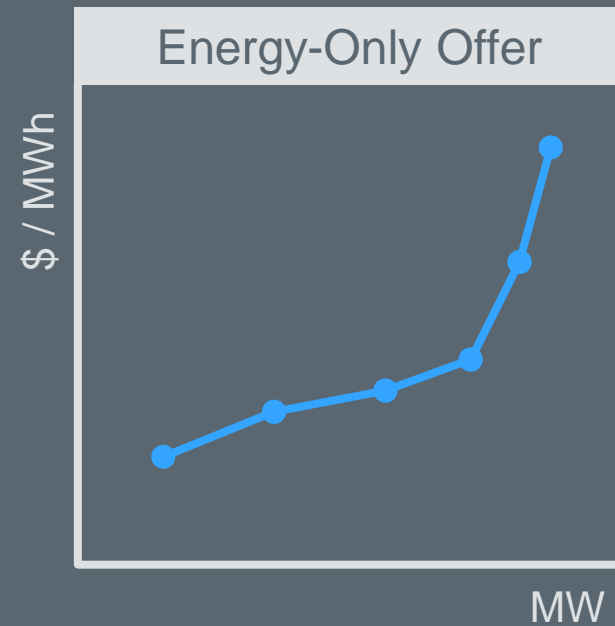
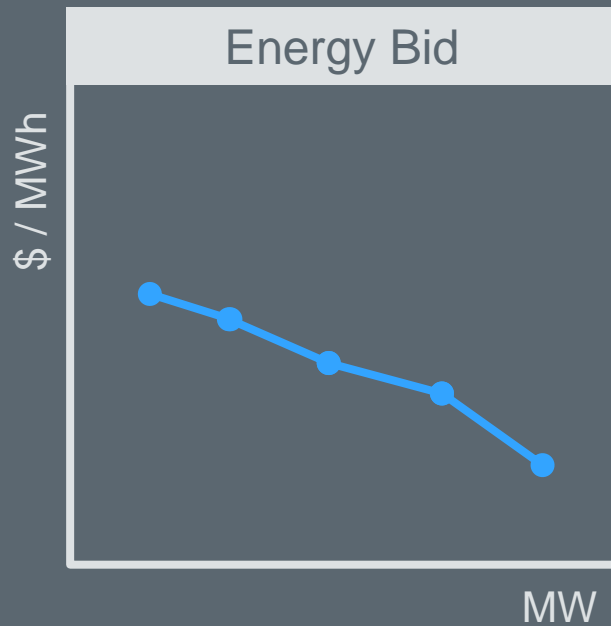




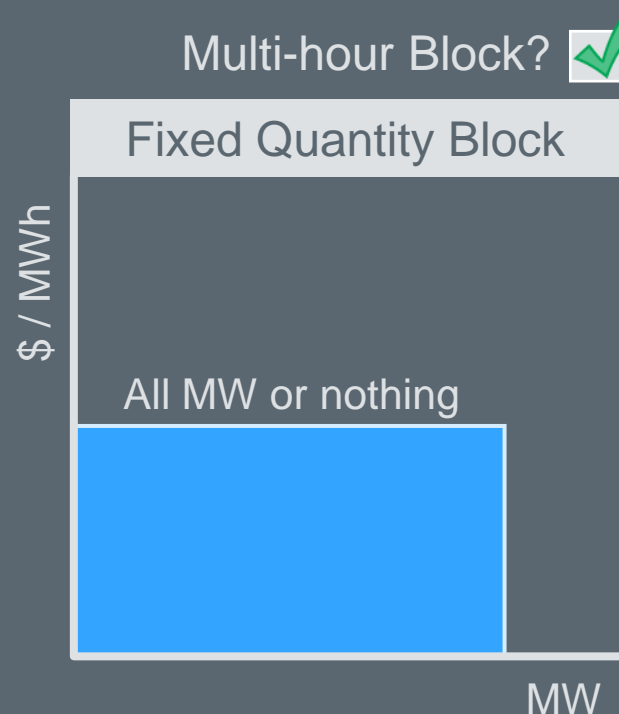
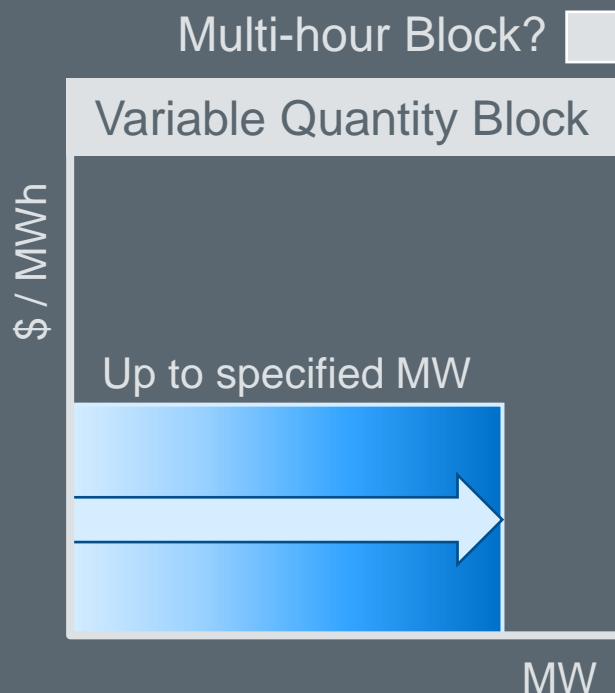
Purely Financial Transactions



Curve with up to 10 Price/Quantity Pairs



Block with Single Price/Quantity Pair



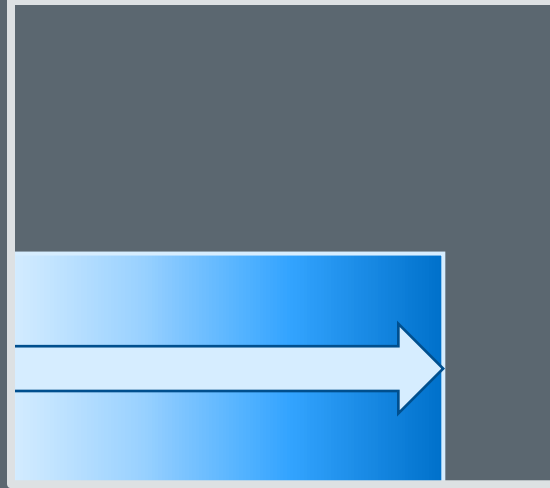


QSE submits the following Energy Bid for 0700-2200

Multi-hour Block?

Variable Quantity Block

\$50/MWh



10MW

Day-Ahead Market Options?

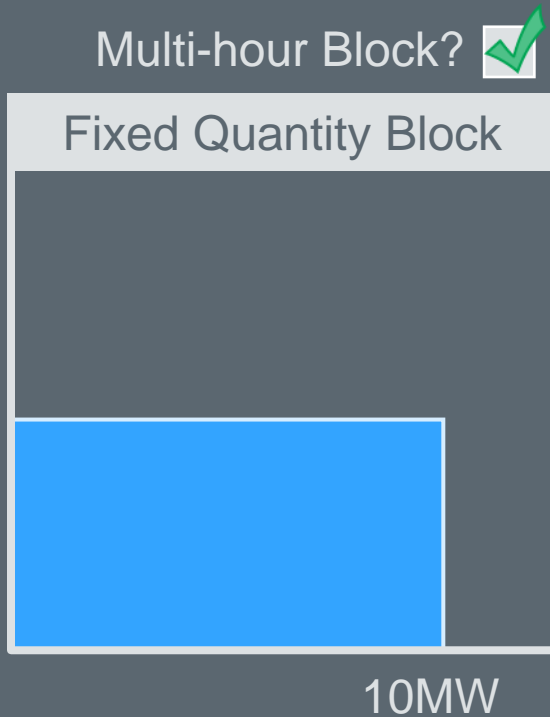


QSE submits the following Energy Bid for 0700-2200

Multi-hour Block?

Fixed Quantity Block

\$50/MWh



Day-Ahead Market Options?

Submitted by 10:00



Bids & Offers

Energy Bids

Energy-Only Offers

Three Part Supply Offers

Ancillary Service Offers

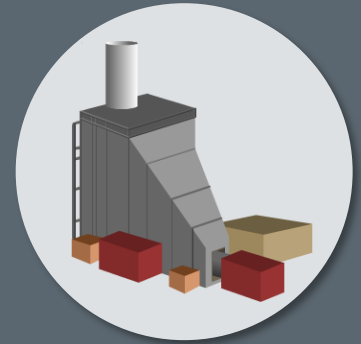
PTP Obligation Bids

Other QSE Information

Self-Arranged Ancillary
Service Quantities

Current Operating Plans

Energy Offer from Generation Resource



Optional

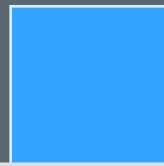
Startup Offer

\$/Start



Minimum Energy Offer

\$/MWh



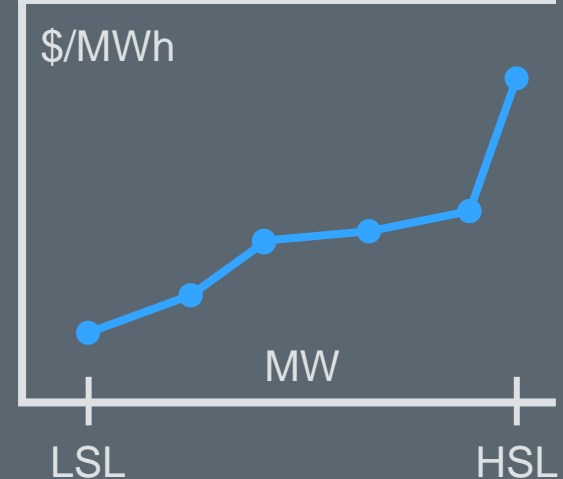
Energy Offer Curve

\$/MWh

MW

LSL

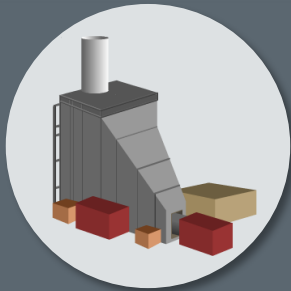
HSL



LSL – Low Sustained Limit

HSL – High Sustained Limit

Where are the three parts used?



	Three-Part Supply Offer		
	Startup Offer	Minimum Energy Offer	Energy Offer Curve
Day-Ahead Market	✓	✓	✓
RUC-Commitment	✓	✓	
Real-Time Dispatch			✓

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

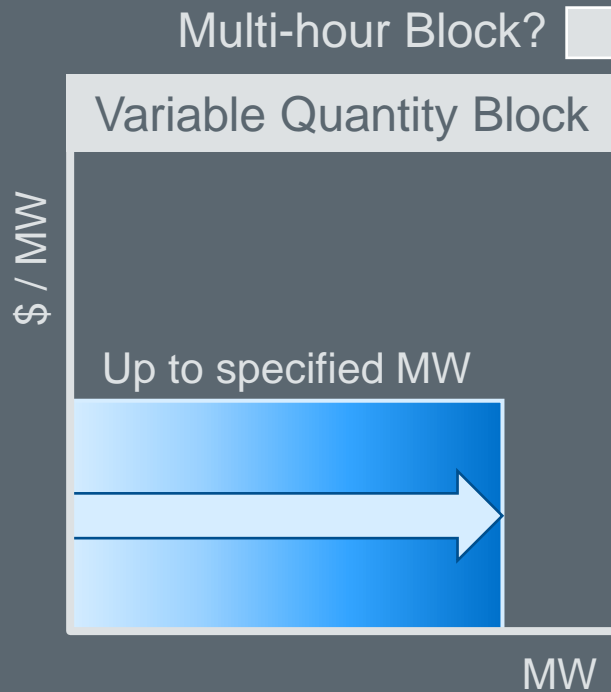
Current Operating Plans

Resource-Specific Offers for Each Service

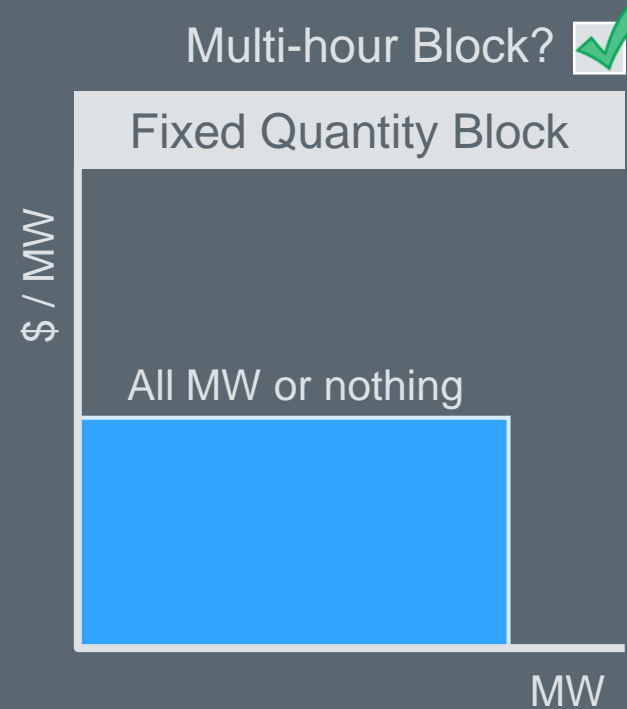
Type of Service	Offer	
Regulation Up	MW	\$ / MW
Regulation Down	MW	\$ / MW
Responsive Reserve	MW	\$ / MW
Contingency Reserve	MW	\$ / MW
Non-Spinning Reserve	MW	\$ / MW

... subject to \$0 / MW price floor

Block with Single Price/Quantity Pair



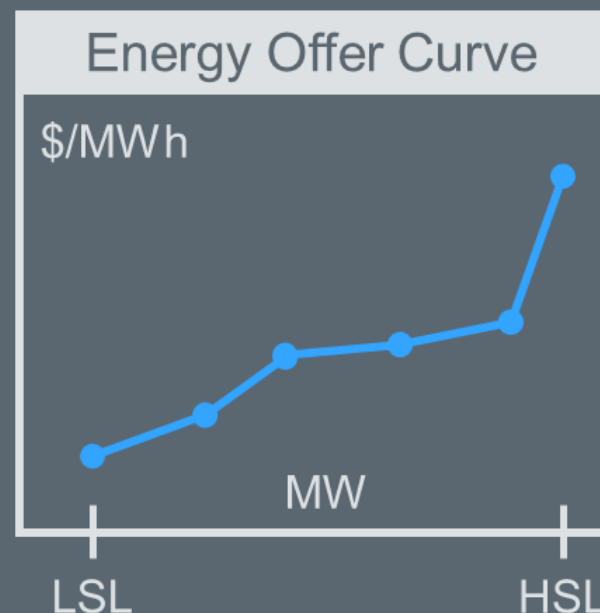
Any qualified Resource



Load Resources Only

Single Resource may be offered multiple ways

AS Type	Offer	
Reg-Up	MW	\$ / MW
Reg-Down	MW	\$ / MW
Responsive	MW	\$ / MW
ECRS	MW	\$ / MW
Non-Spin	MW	\$ / MW

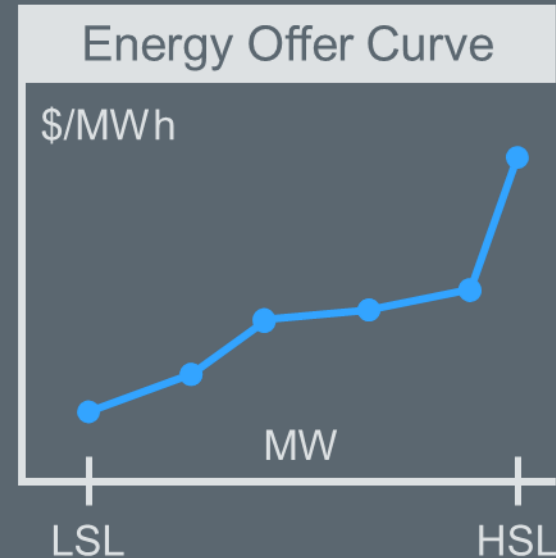
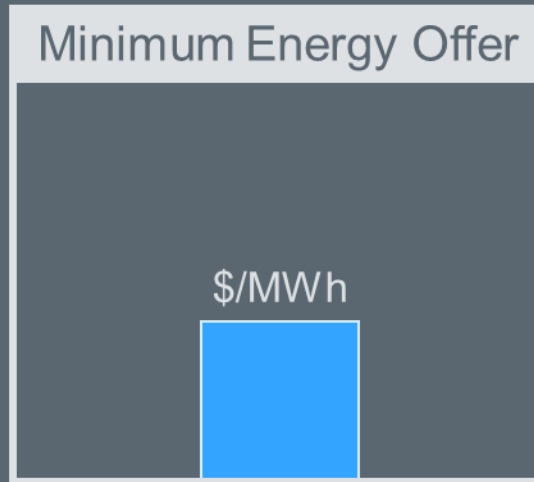


Total DAM award will not exceed Resource's Capacity



But how would the Day-Ahead Market handle this?

AS Type	Offer	
Reg-Up	MW	\$ / MW
Reg-Down	MW	\$ / MW
Responsive	MW	\$ / MW
ECRS	MW	\$ / MW
Non-Spin	MW	\$ / MW



Submitted by 10:00



Bids & Offers

Energy Bids

Energy-Only Offers

Three Part Supply Offers

Ancillary Service Offers

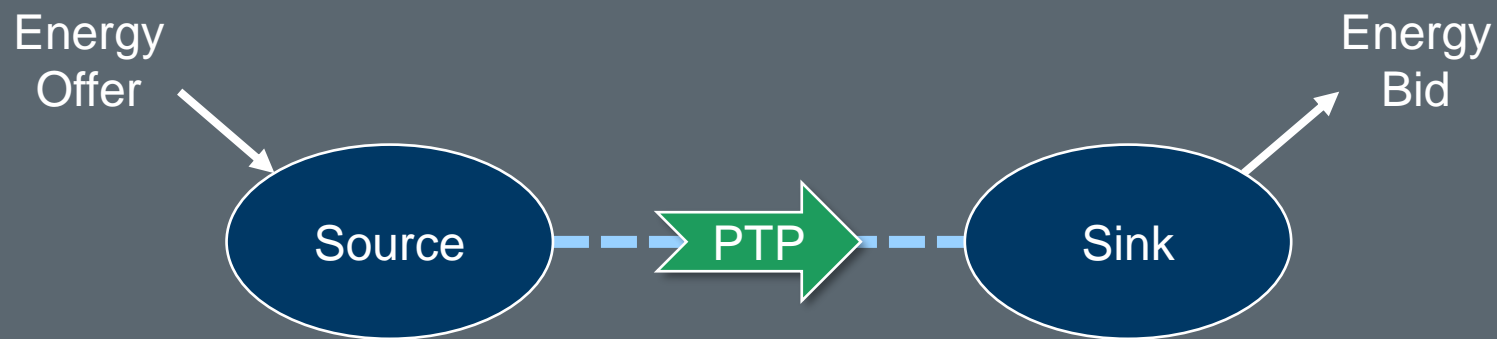
PTP Obligation Bids

Other QSE Information

Self-Arranged Ancillary
Service Quantities

Current Operating Plans

Like a coupled Energy-Only Offer and Energy Bid



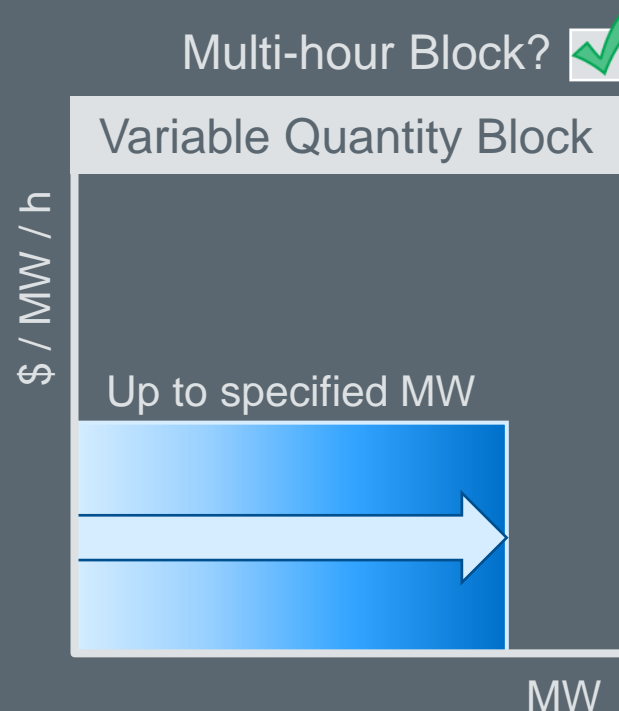
Charge
(If Awarded) =

?

Submitted between any two Settlement Points

Source	Sink	Bid	
Hub	Load Zone	MW	\$ / MW / h
Resource Node	Load Zone	MW	\$ / MW / h
Resource Node	Hub	MW	\$ / MW / h
Load Zone	Resource Node	MW	\$ / MW / h
Load Zone	Hub	MW	\$ / MW / h

Block with Single Price/Quantity Pair



Submitted by 10:00



Bids & Offers

Energy Bids

Energy-Only Offers

Three Part Supply Offers

Ancillary Service Offers

PTP Obligation Bids

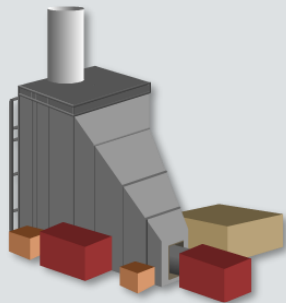
Other QSE Information

Self-Arranged Ancillary
Service Quantities

Current Operating Plans

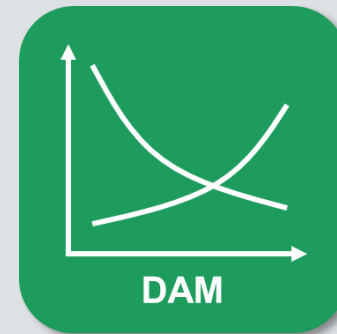
A QSE may have Ancillary Service Obligations

Self-Arrange



Bilateral Trade

Allow ERCOT to procure



DAM

May choose to Self-Arrange before DAM



QSE has Regulation Up Obligations for a range of hours

Hour	QSE AS Obligation	Self-Arranged Quantity	Net Obligation	ERCOT action on QSE's behalf
1500	7 MW			
1600	6 MW			
1700	5 MW			
1800	4 MW			
1900	3 MW			

A Few Rules:

QSE Action	Limits	
Self-Arrangement more than AS Obligation	Responsive Reserve Contingency Reserve	Up to 100 MW
	Non-Spin Reserve	Up to 50 MW
	Regulation Up Regulation Down	Up to 25 MW
	Quantity from QSE's Resources may not exceed AS Obligation	
Negative Self-Arrangement	Up to 500 MW per Service Limited to Net AS Trades	

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

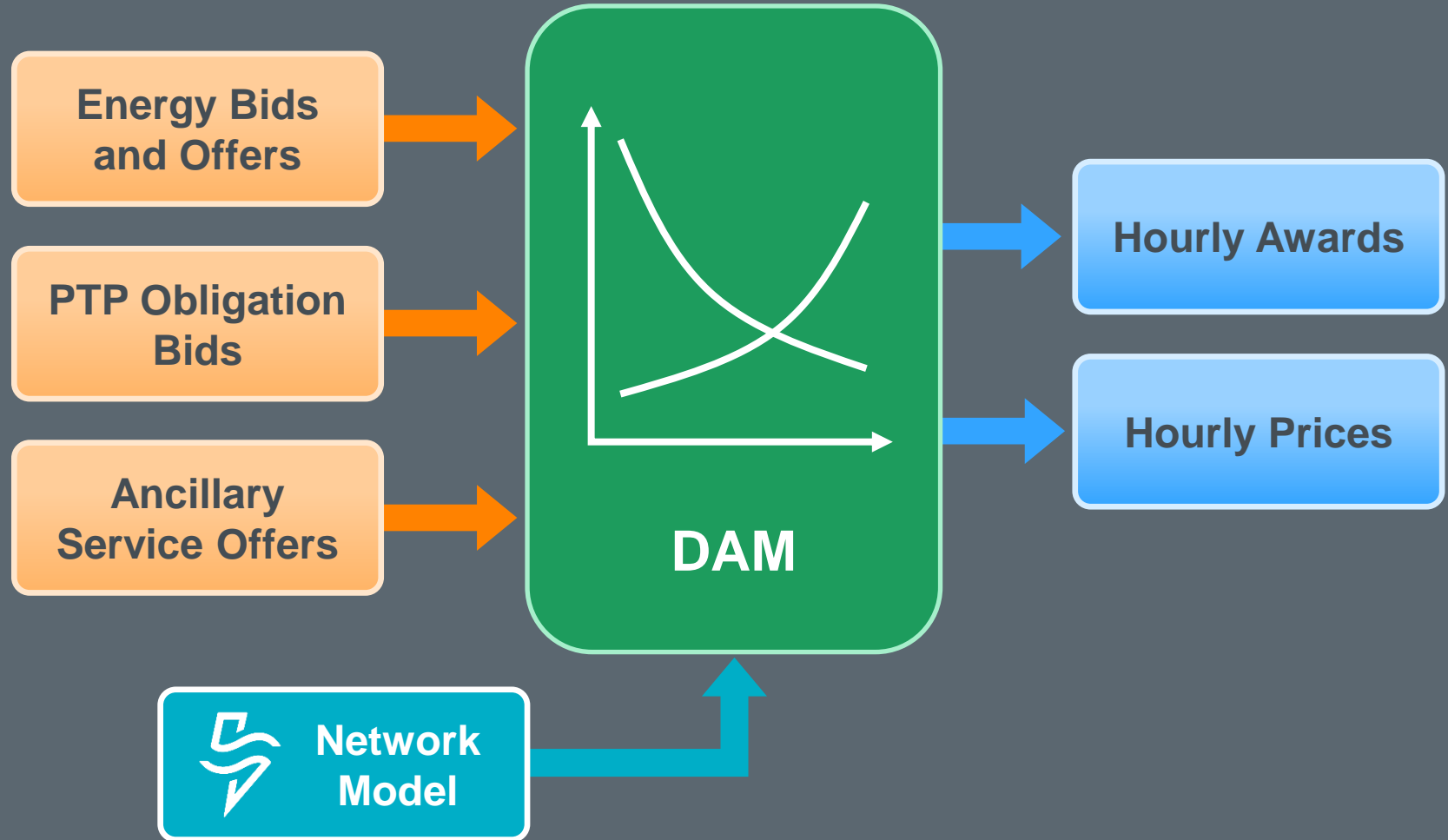
What does DAM need from Current Operating Plans?

Current Operating Plan								
Resource Name	Resource Status	Resource Limits		Ancillary Service Commitments				
		HSL	LSL	Reg-up	Reg-Dn	Responsive	ECRS	Non-Spin
ThisOne	ON	600	120	0	0	0	0	0
ThatOne	ON	400	75	0	0	0	0	0
OtherOne	OFF	100	25	0	0	0	0	0

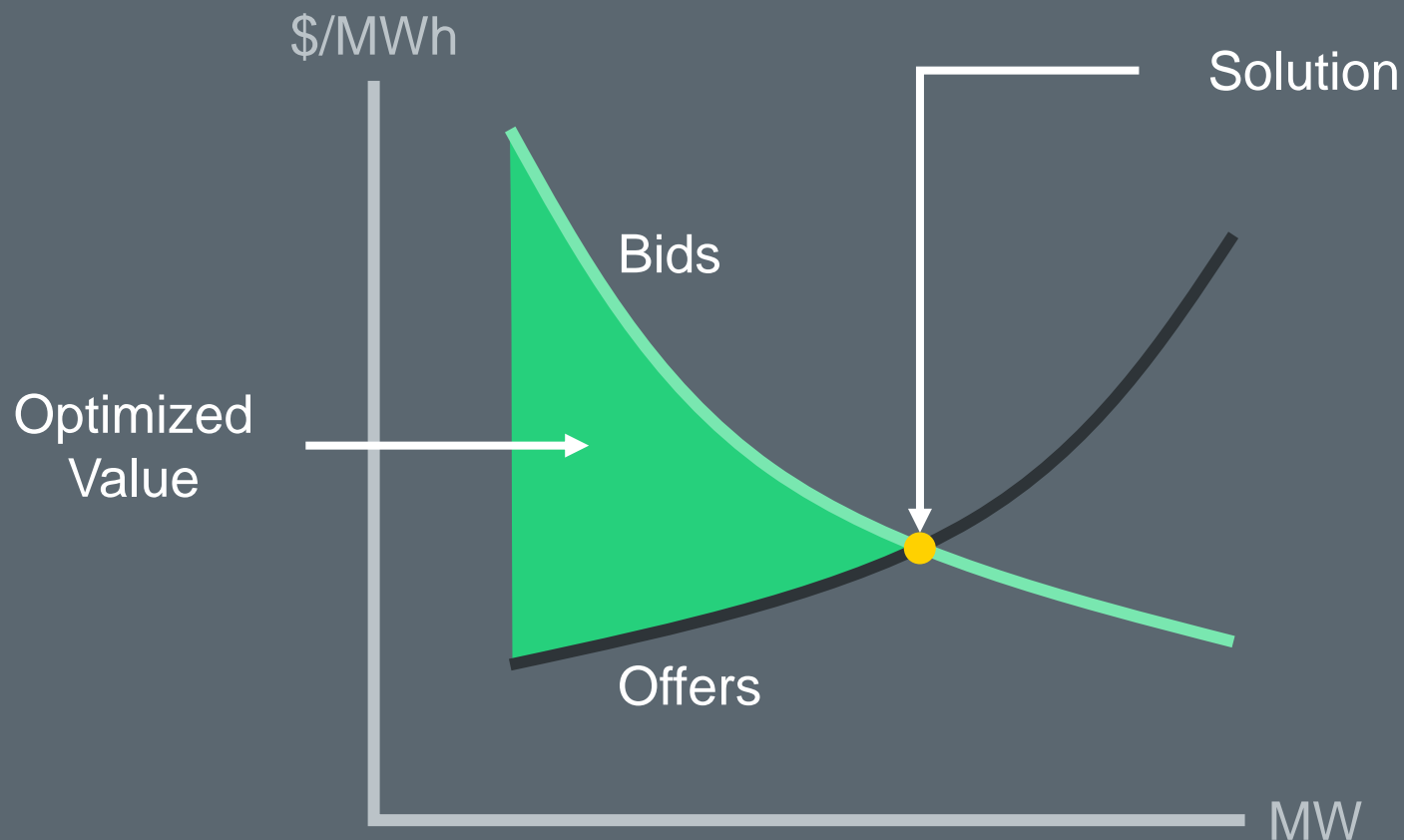
Day-Ahead Market Clearing



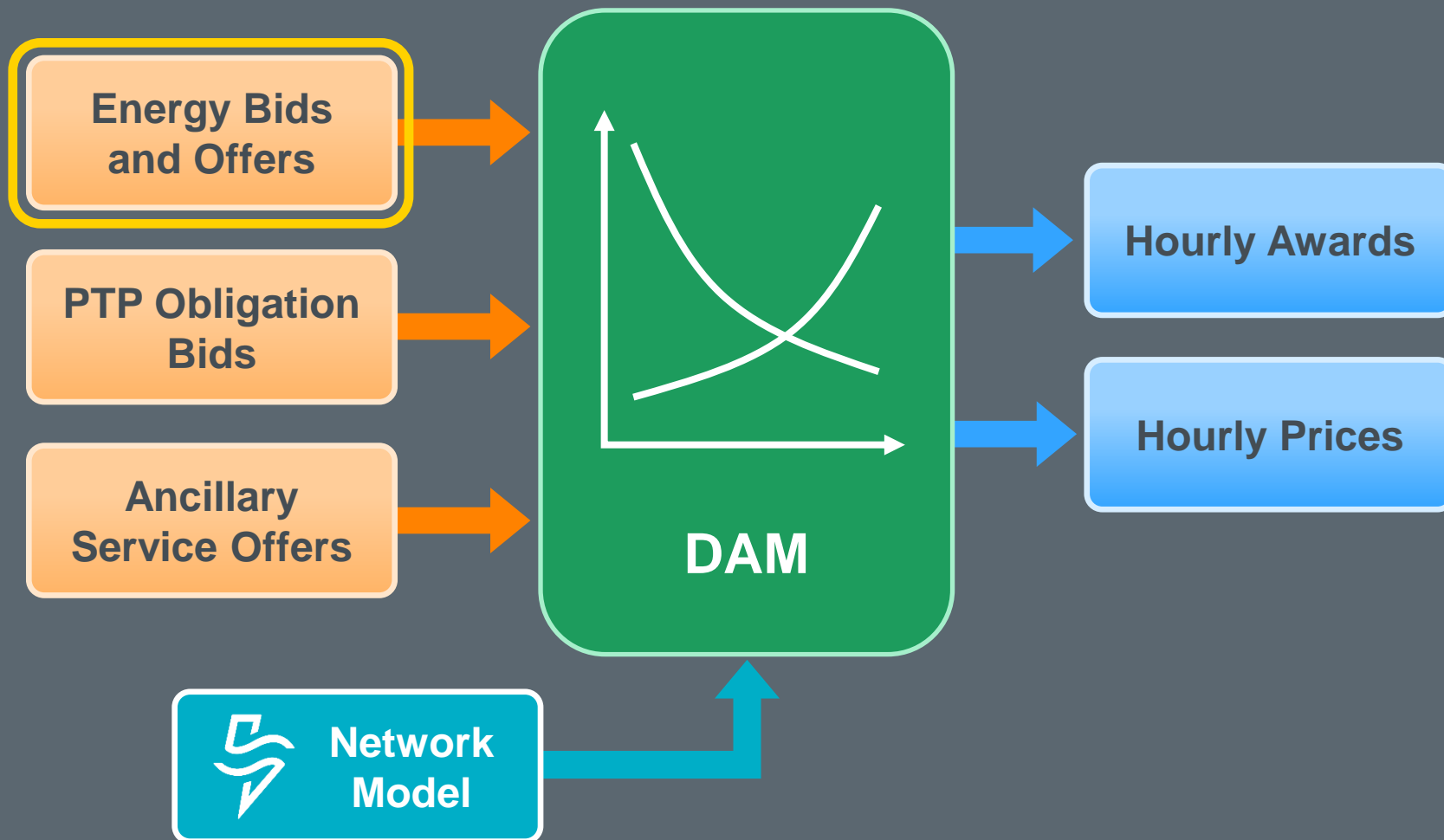
Economically optimized subject to constraints



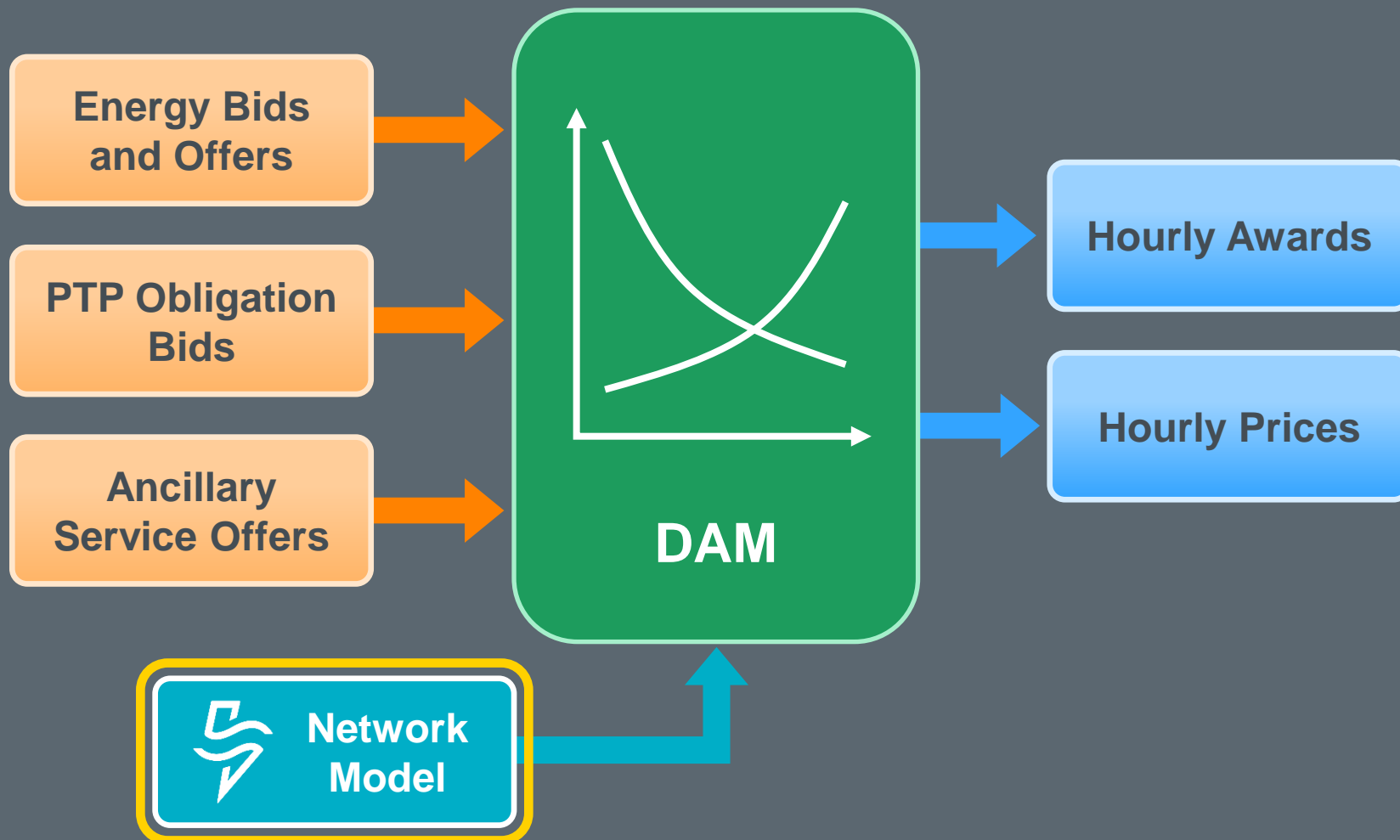
Maximize Bid-Based Revenues minus Offer-Based Costs



Energy Offers must equal Energy Bids

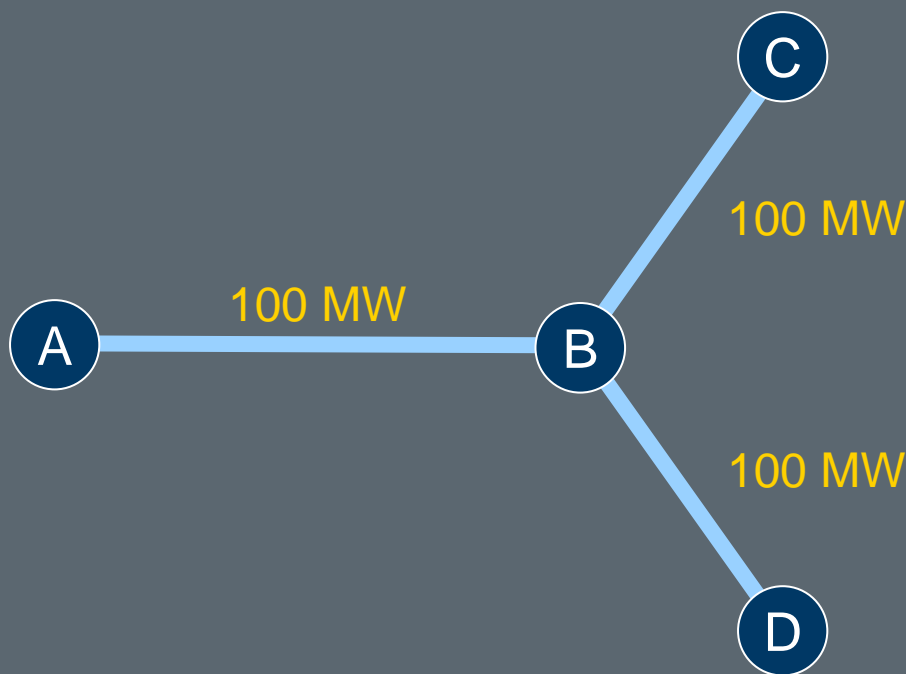


Solution must represent allowable power flow





Introducing a simple Network Model ...



= Settlement Point

MW = Transmission Capacity



Determine Awards and Prices

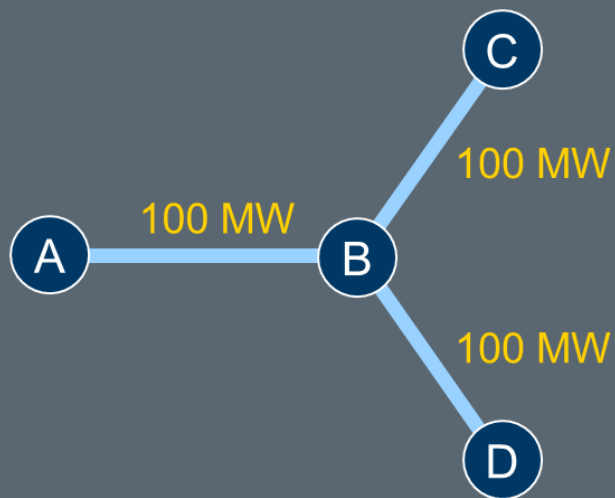
QSE	Product	Bid or Offer	Location	MW	Price	Award
QSE 1	Energy	Offer	A	100	\$20	
QSE 2	Energy	Offer	C	60	\$30	
QSE 3	Energy	Bid	D	90	\$40	

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

Prices			
LMP _A	LMP _B	LMP _C	LMP _D

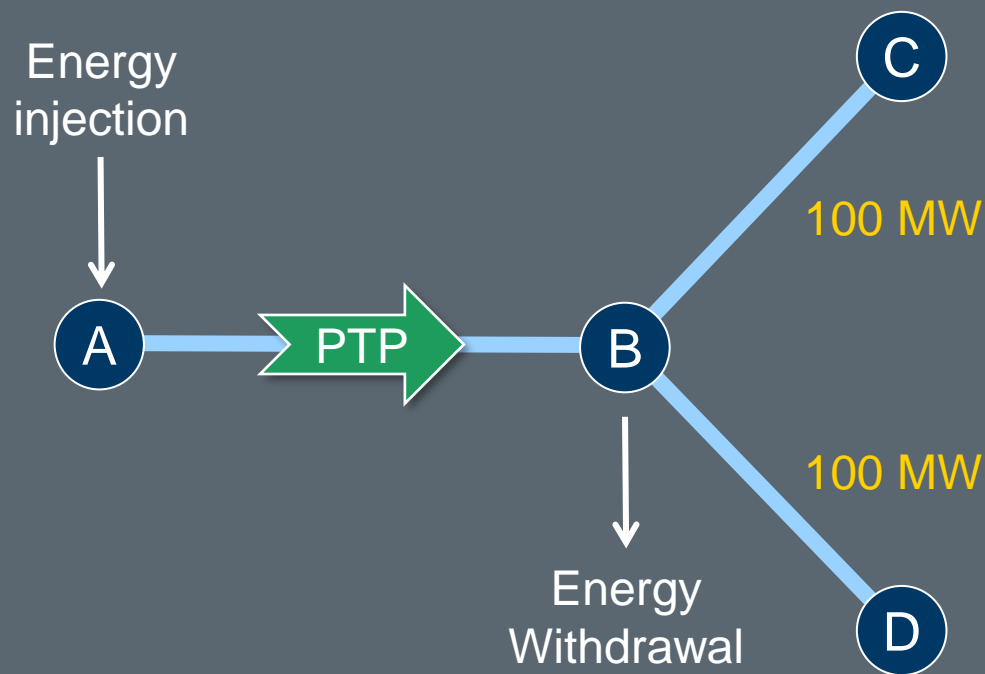


Does solution make sense?



	Result	MW	Price
QSE 1:			
QSE 2:			
QSE 3:			

Modeling of PTP Obligations Bids





Determine Awards and Prices

QSE	Product	Bid or Offer	Location	MW	Price	Award
QSE 1	Energy	Offer	A	100	\$20	
QSE 2	Energy	Offer	C	60	\$30	
QSE 3	Energy	Bid	D	90	\$40	
QSE 4	PTP Obl	Bid	A to B	30	\$20	

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

--

Prices

LMP_A

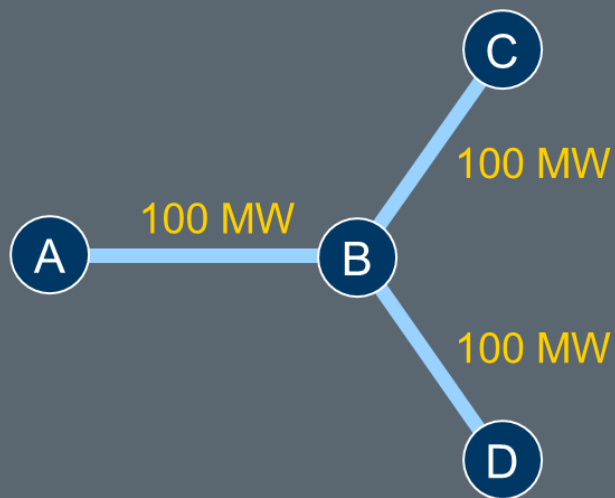
LMP_B

LMP_C

LMP_D

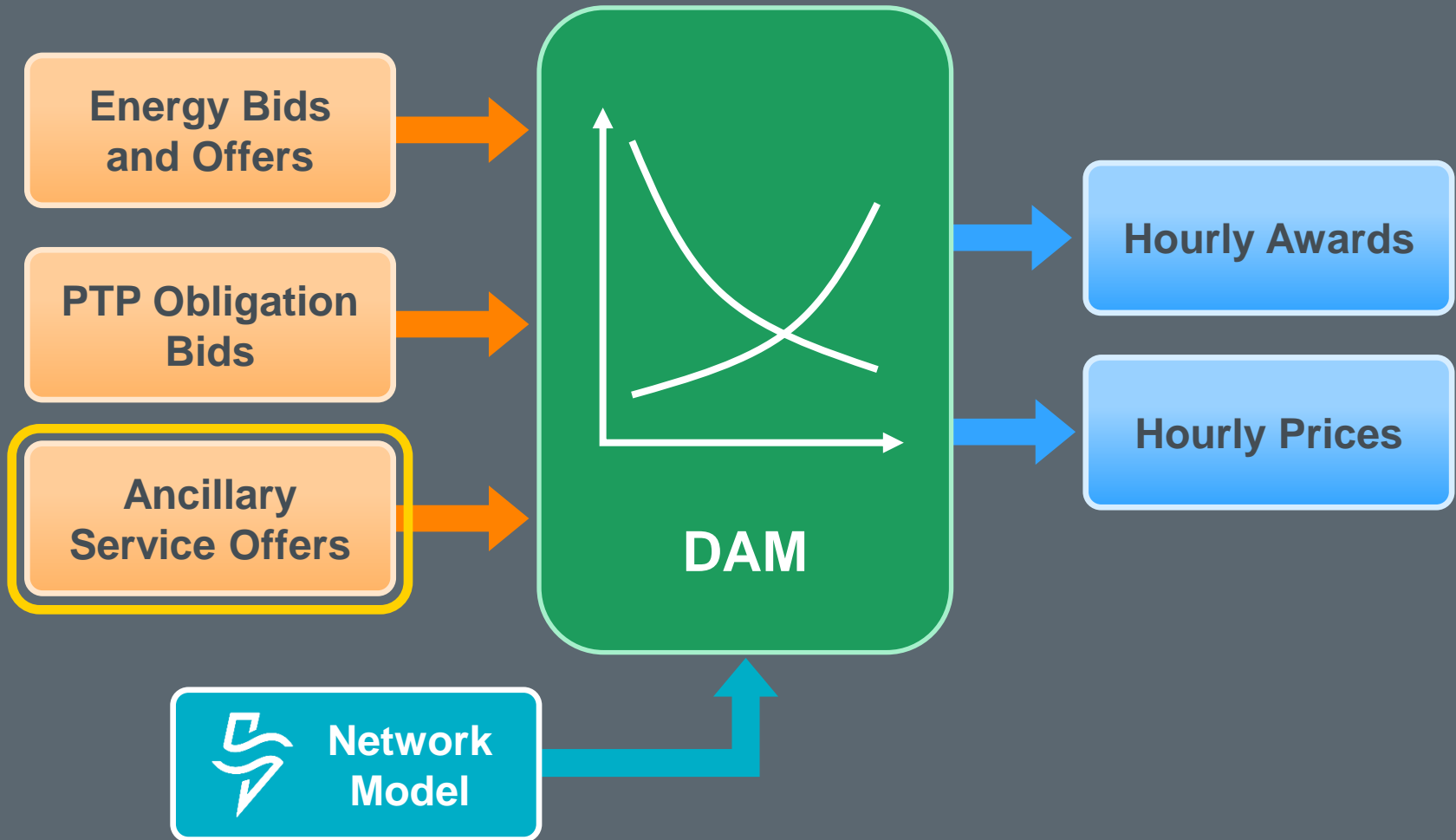


Does solution make sense?

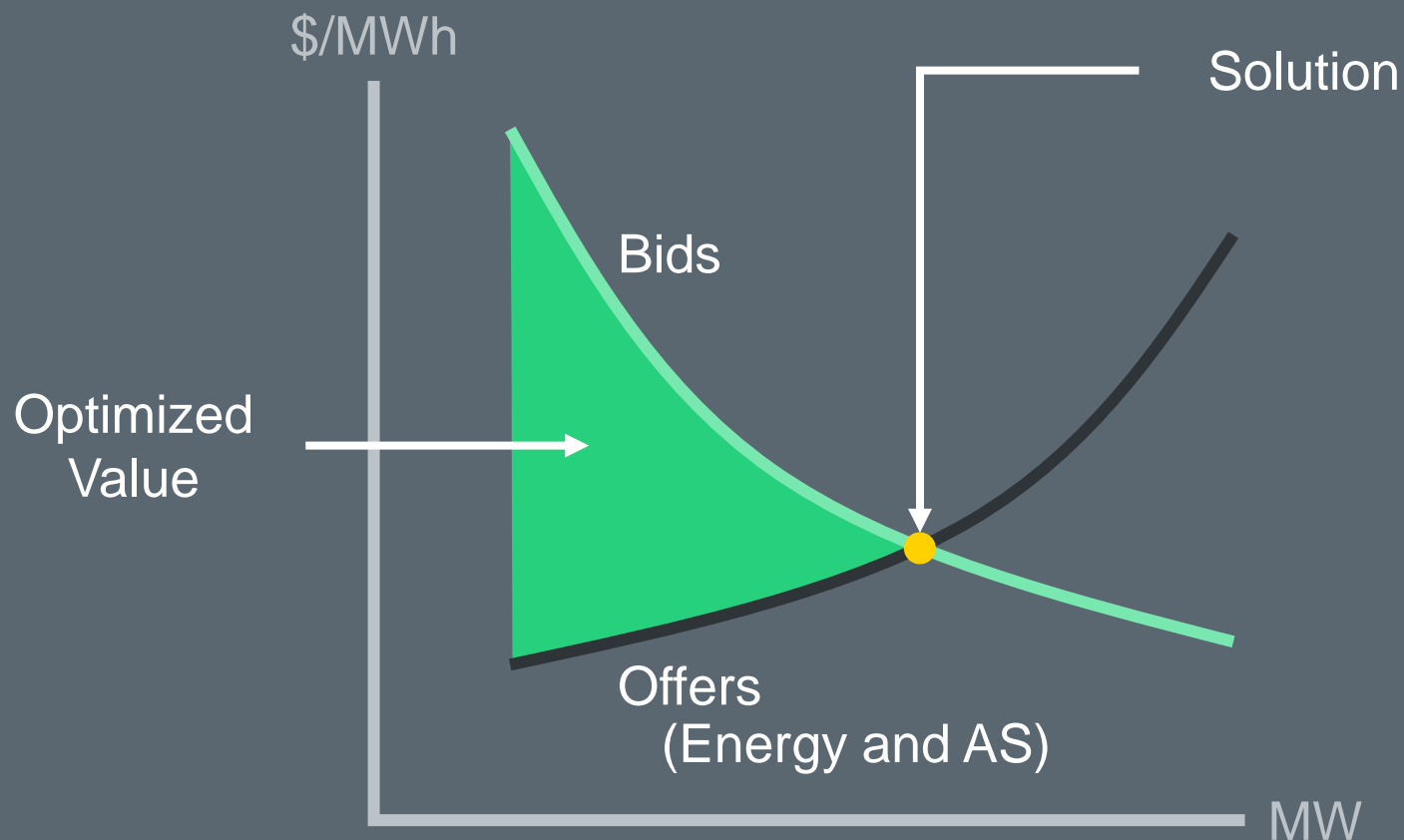


Result	MW	Price

ERCOT must also clear Ancillary Service Requirements

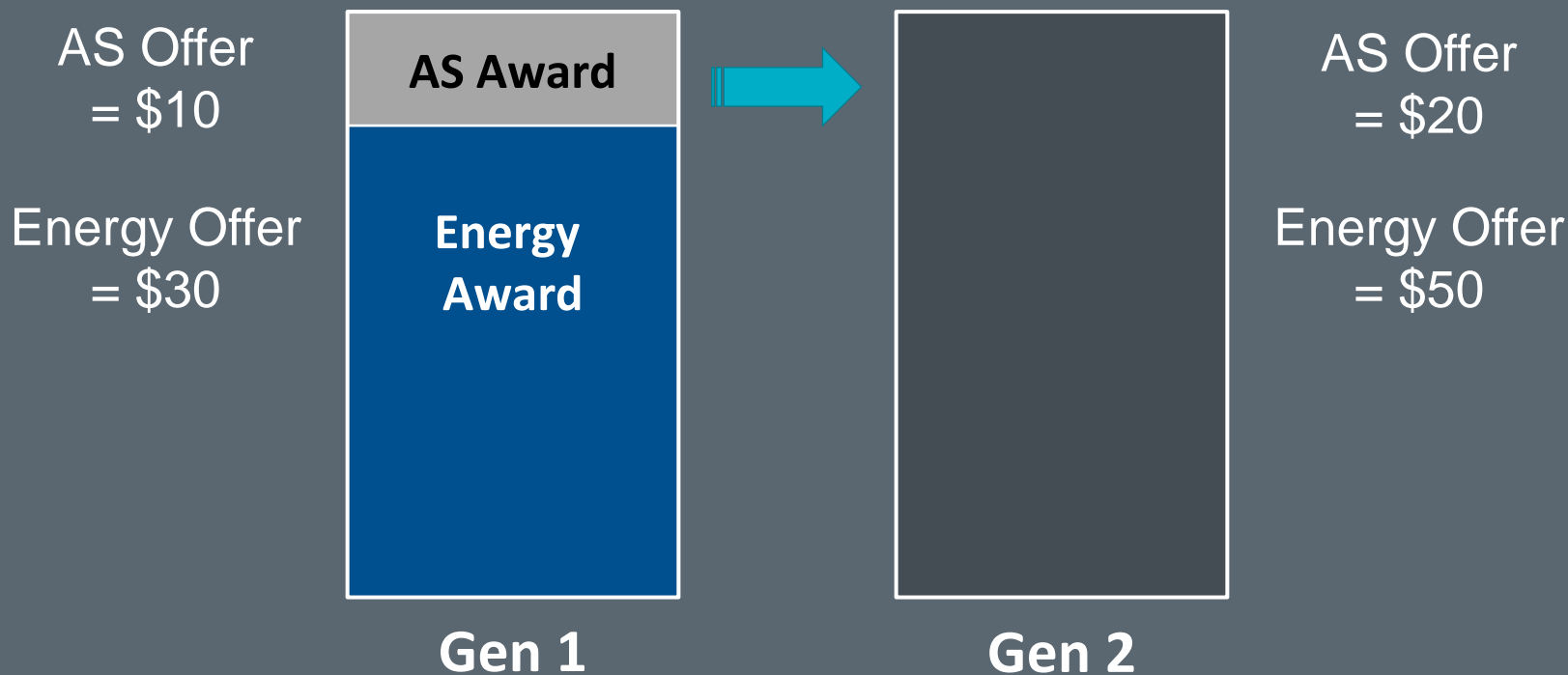


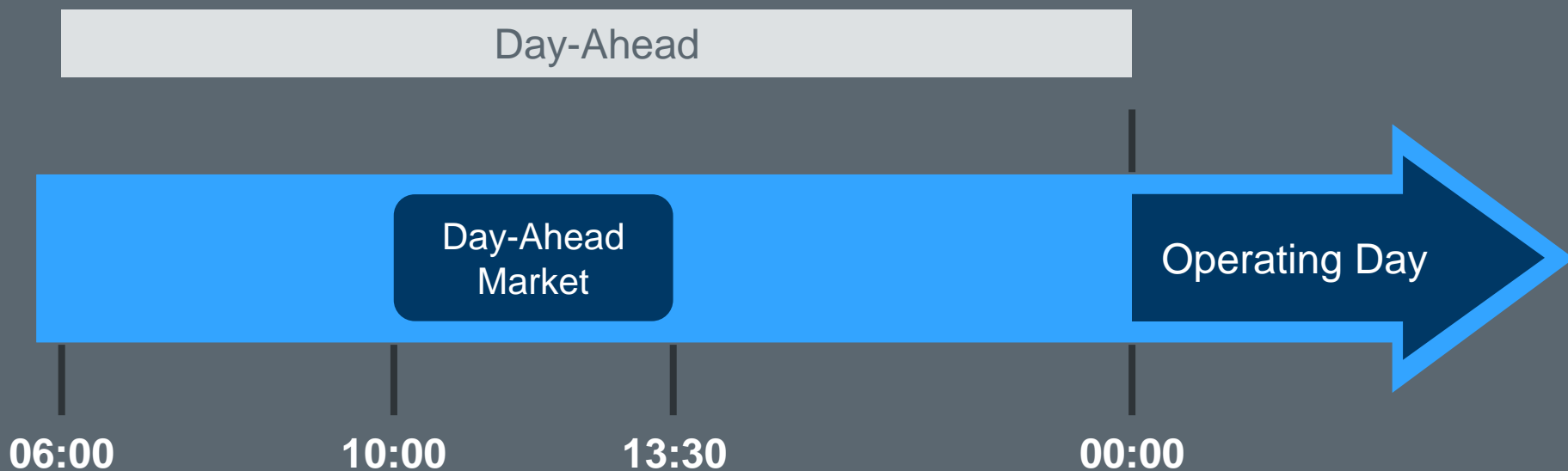
Energy and Ancillary Services are co-optimized





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
















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by 13:30**

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[Availability](#) [Sub-Category](#) [Classification](#)

Applied Filters [Sub-Category: DAM Results](#) [Classification: Public](#) [X Clear All Filters](#)

[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](#)

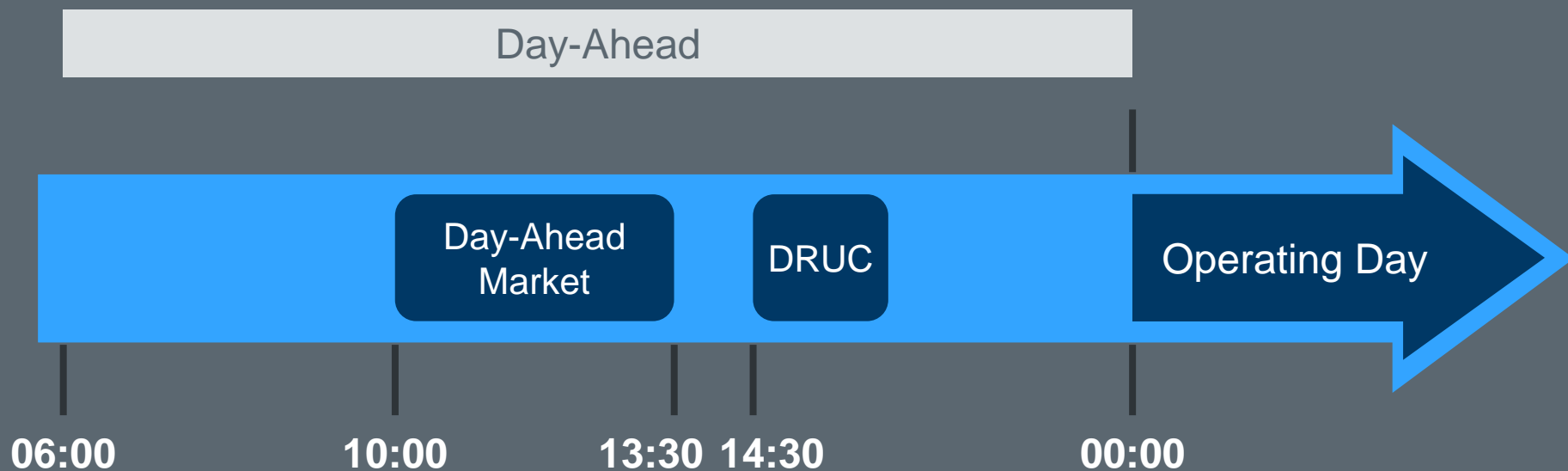
[DAM Total Energy Purchased](#)

[DAM Total Energy Sold](#)

[Historical DAM Clearing Prices for Capacity](#)

[Historical DAM Load Zone and Hub Prices](#)

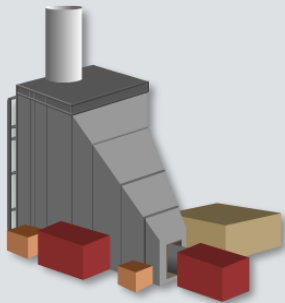
[Total Ancillary Service Offers](#)



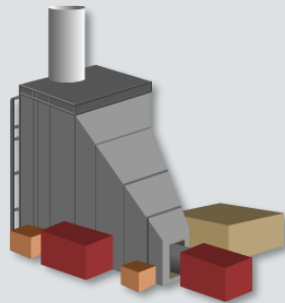
QSE may need to follow-up on Awards

Ancillary Service Supply Responsibilities

Awarded AS Offers



Self-Arranged AS Quantities



AS Trade as Seller



... must be arranged by 14:30



A QSE has an awarded Energy Offer in DAM



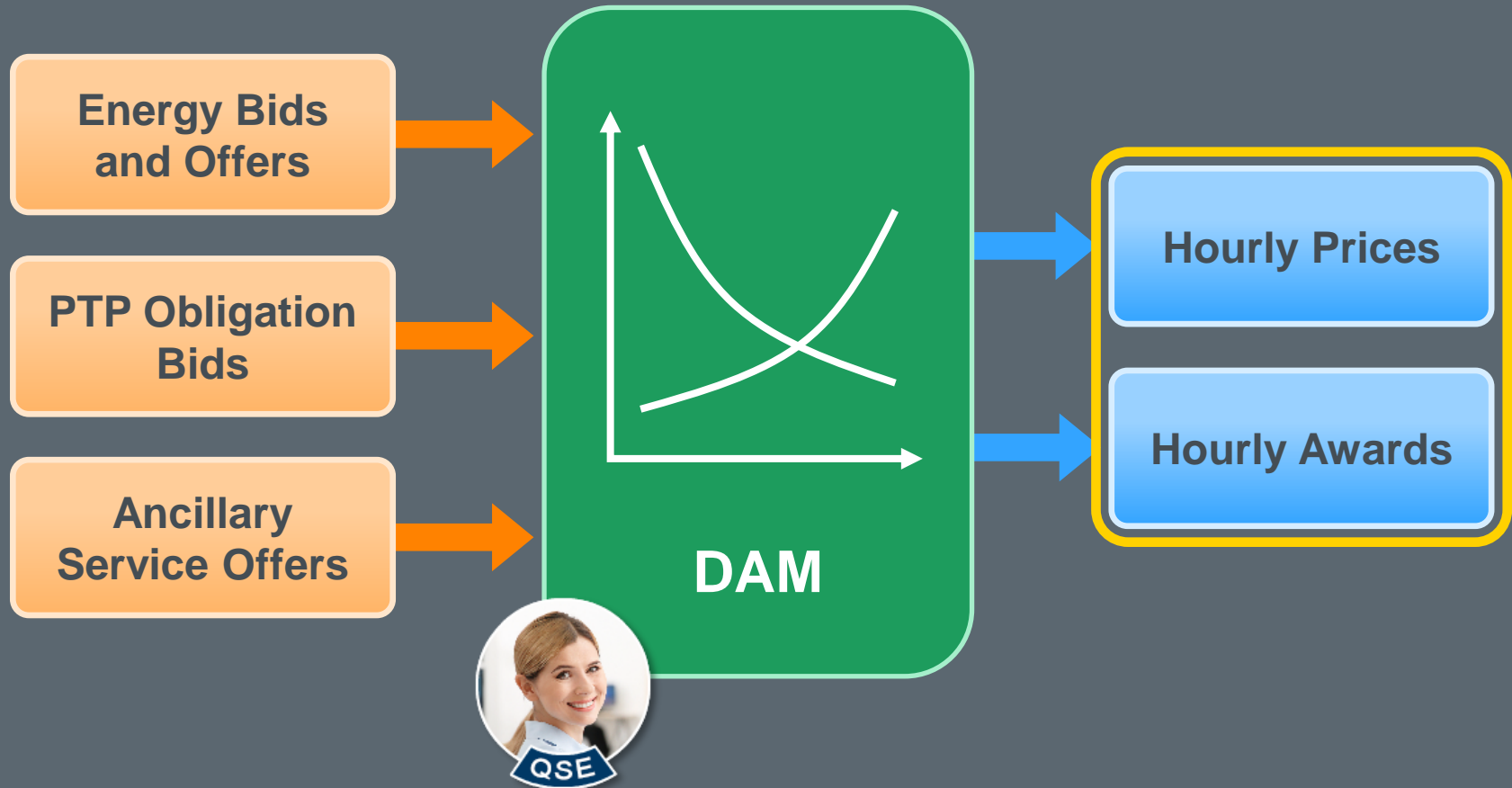
What must they do next?

Current Operating Plan								
Resource Name	Resource Status	Resource Limits		Ancillary Service Commitments				
		HSL	LSL	Reg-up	Reg-Dn	Responsive	ECRS	Non-Spin
ThisOne	ON	600	120	20	20	0	0	40
ThatOne	ON	400	75	30	0	20	80	0
OtherOne	OFF	100	25	0	0	0	0	0

Resource QSEs must maintain a COP for each hour of the next 7 days

Day-Ahead Market Financial Impacts

ERCOT settles with QSEs



Market Clearing Prices for Capacity (MCPCs)

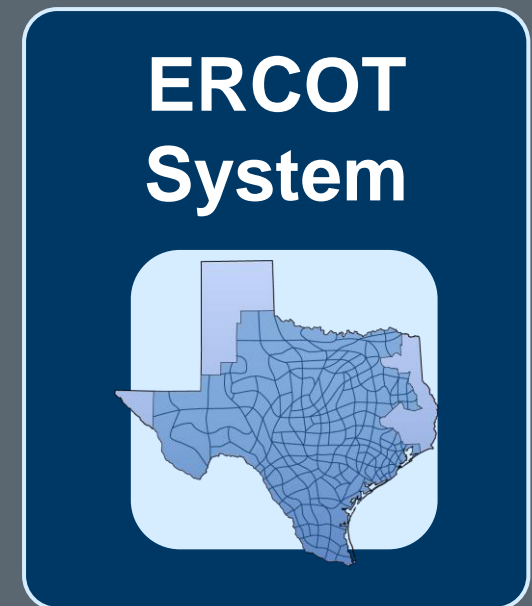
MCPCRU – Regulation-Up

MCPCRD – Regulation-Down

MCPCRR – Responsive Reserve

MCPCECR – Contingency Reserve

MCPCNS – Non-Spin Reserve



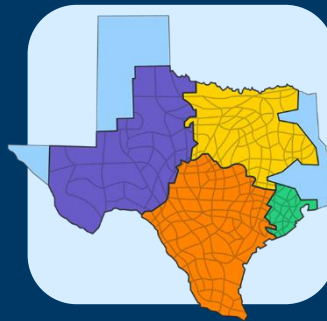


Day-Ahead Settlement Point Prices (DASPPs)

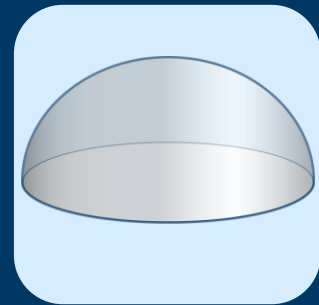
**Resource
Nodes**



**Load
Zones**



Hubs



How do we get from LMPs to SPPs?

Charge for awarded Energy Bid

$$= \text{Awarded MWs} * \text{DASPP}$$

Charge for awarded PTP Obligation Bid

$$= \text{Awarded MWs} * (\text{DASPP}_{\text{sink}} - \text{DASPP}_{\text{source}})$$

... calculated for each hour

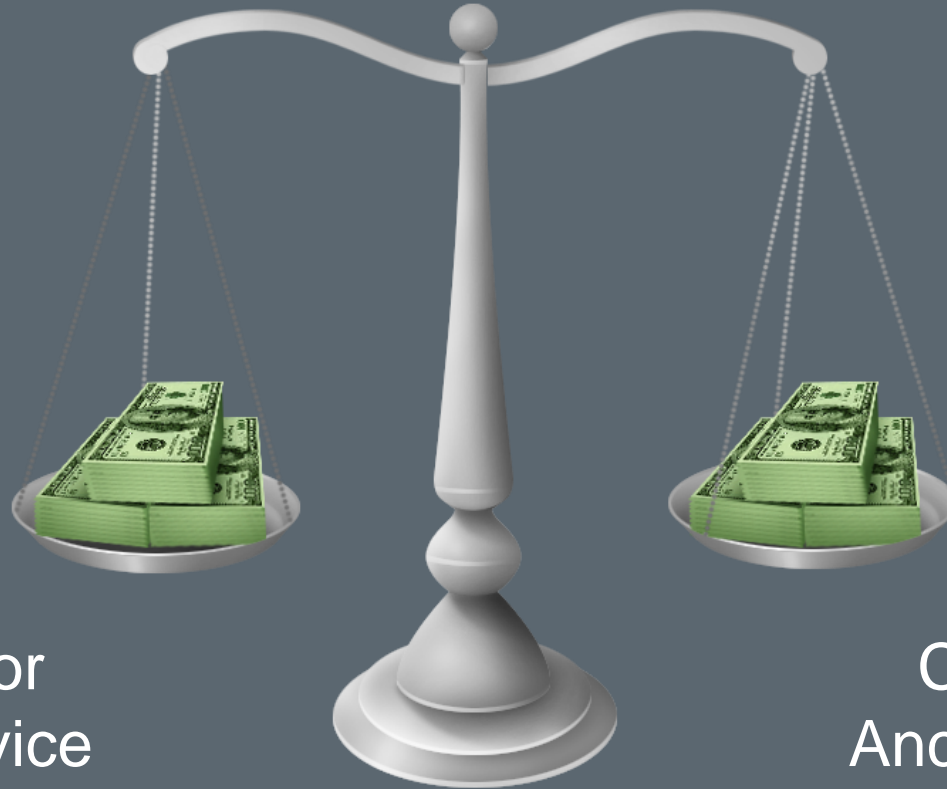
Payment for awarded Energy Offer

$$= (-1) * \text{Awarded MWs} * \text{DASPP}$$

Payment for awarded Ancillary Service Offer

$$= (-1) * \text{Awarded MWs} * \text{MCPC}$$

... 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



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

Where ...

$$\text{AS Price} = \left(\frac{\text{Total AS Cost}}{\text{Total Obligation not self-arranged}} \right)$$



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



QSE's Ancillary Service Settlement

$$\text{RegUp Price} = \left(\frac{\quad}{\quad} \right) =$$

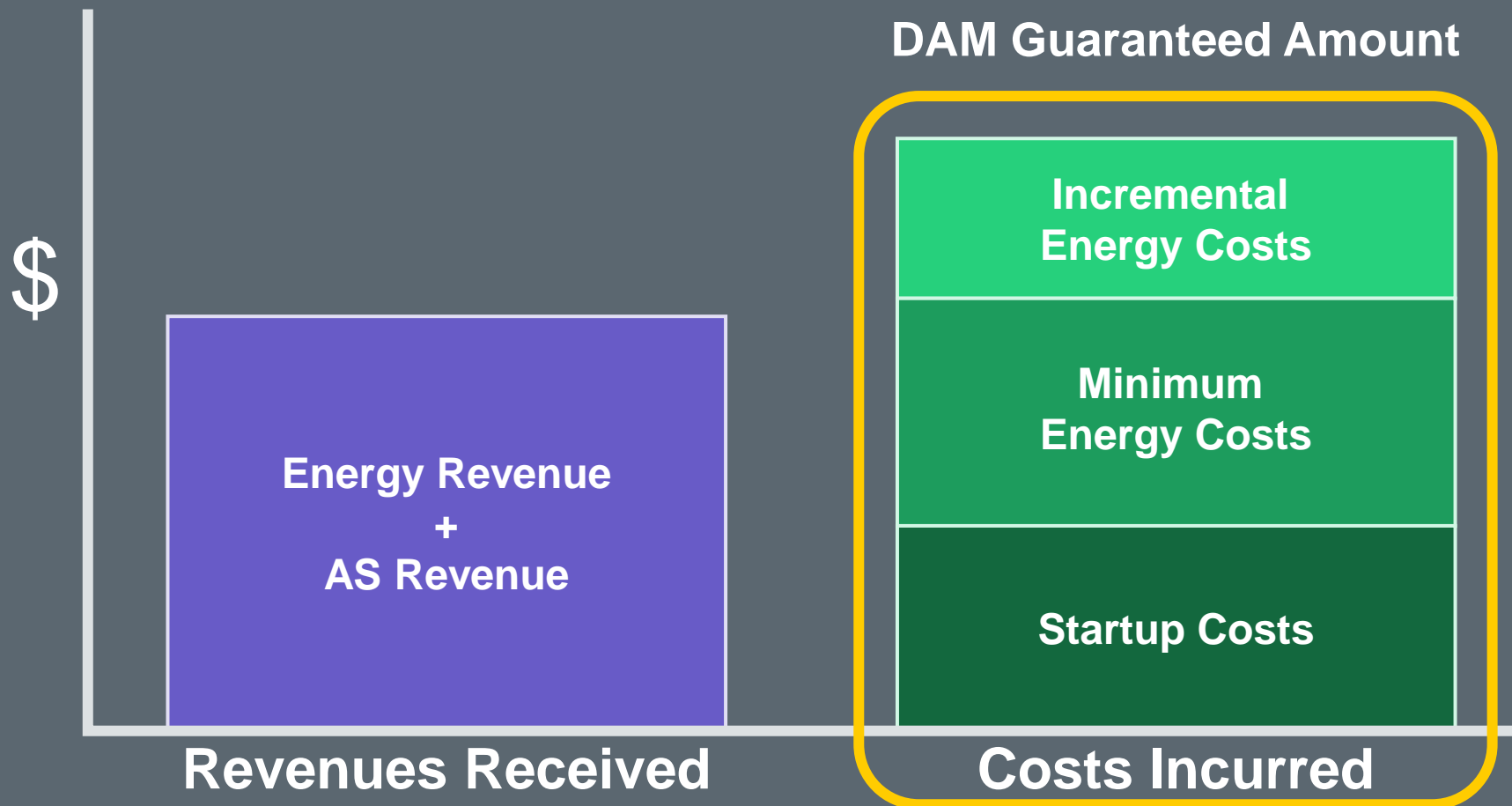
$$\text{Charge} = \text{RegUp Price} * \left(\left(\quad \right) - \left(\quad \right) \right)$$

$$=$$

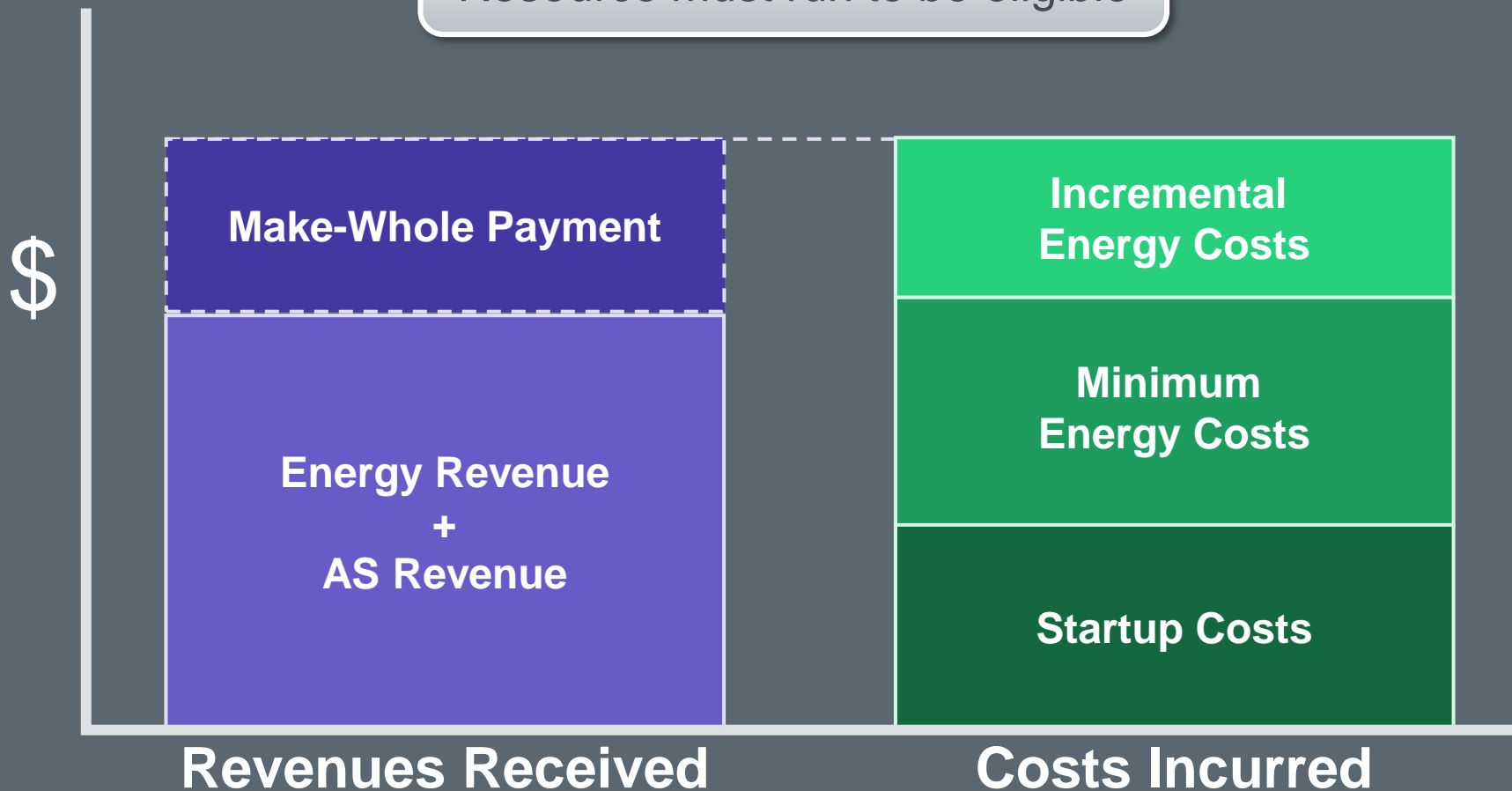


Day-Ahead
Make-Whole
Payments

Day-Ahead
Make-Whole
Charges



Resource must run to be eligible





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



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



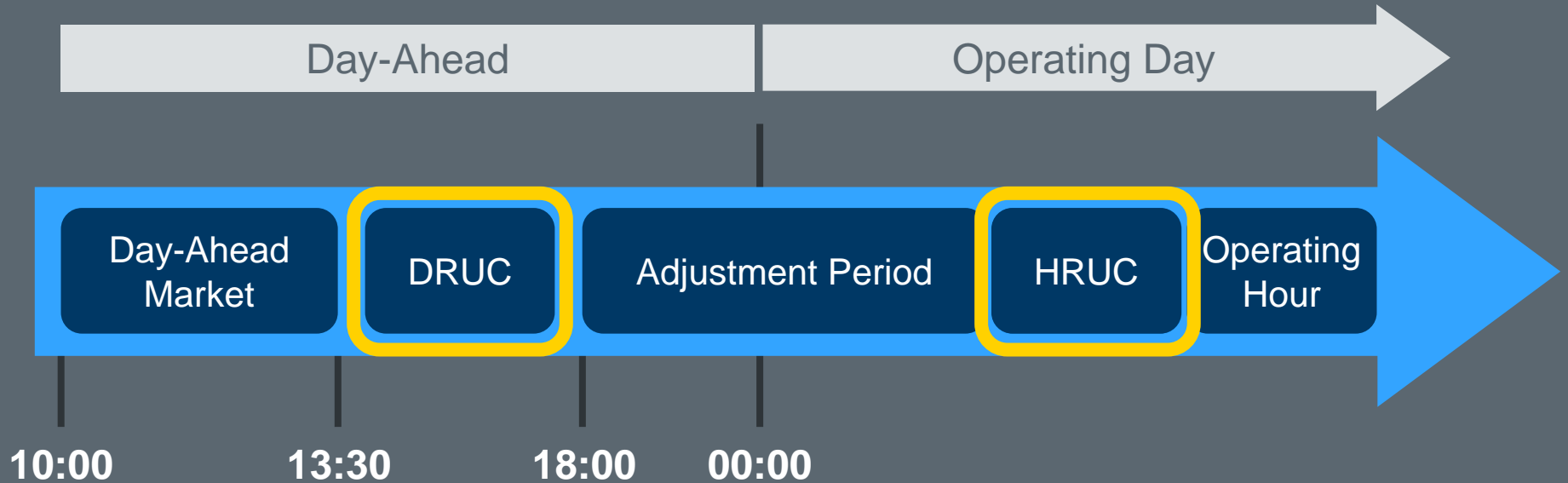
Has cleared Bids for Hour 1600

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

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

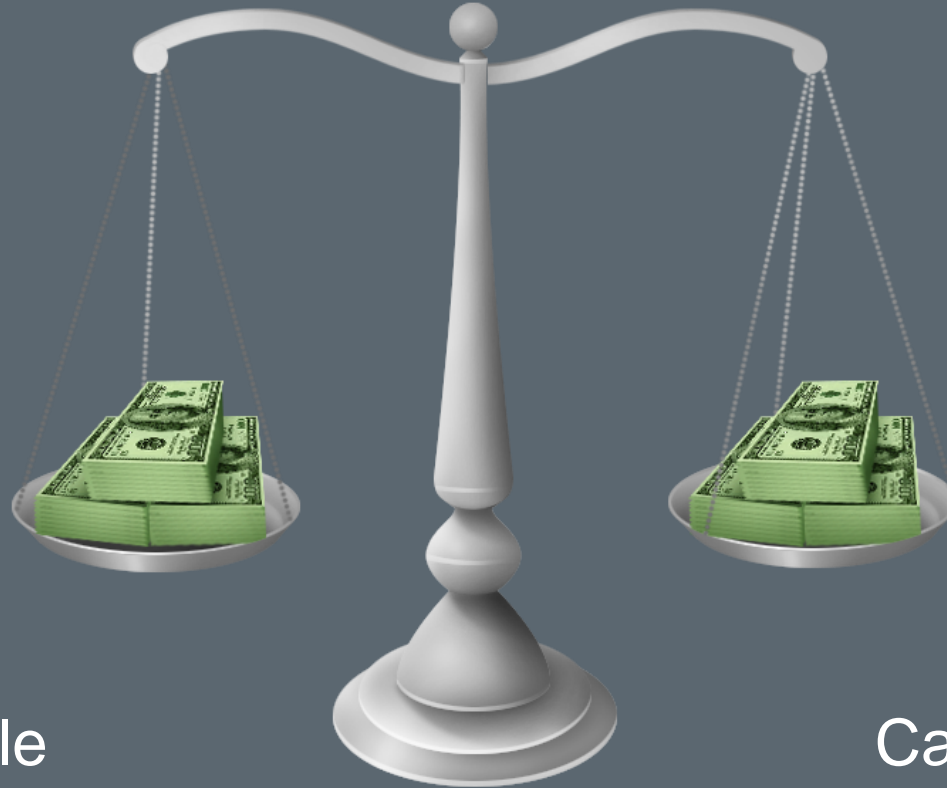
RUC and its Financial Impacts

ERCOT may need to commit additional Resources



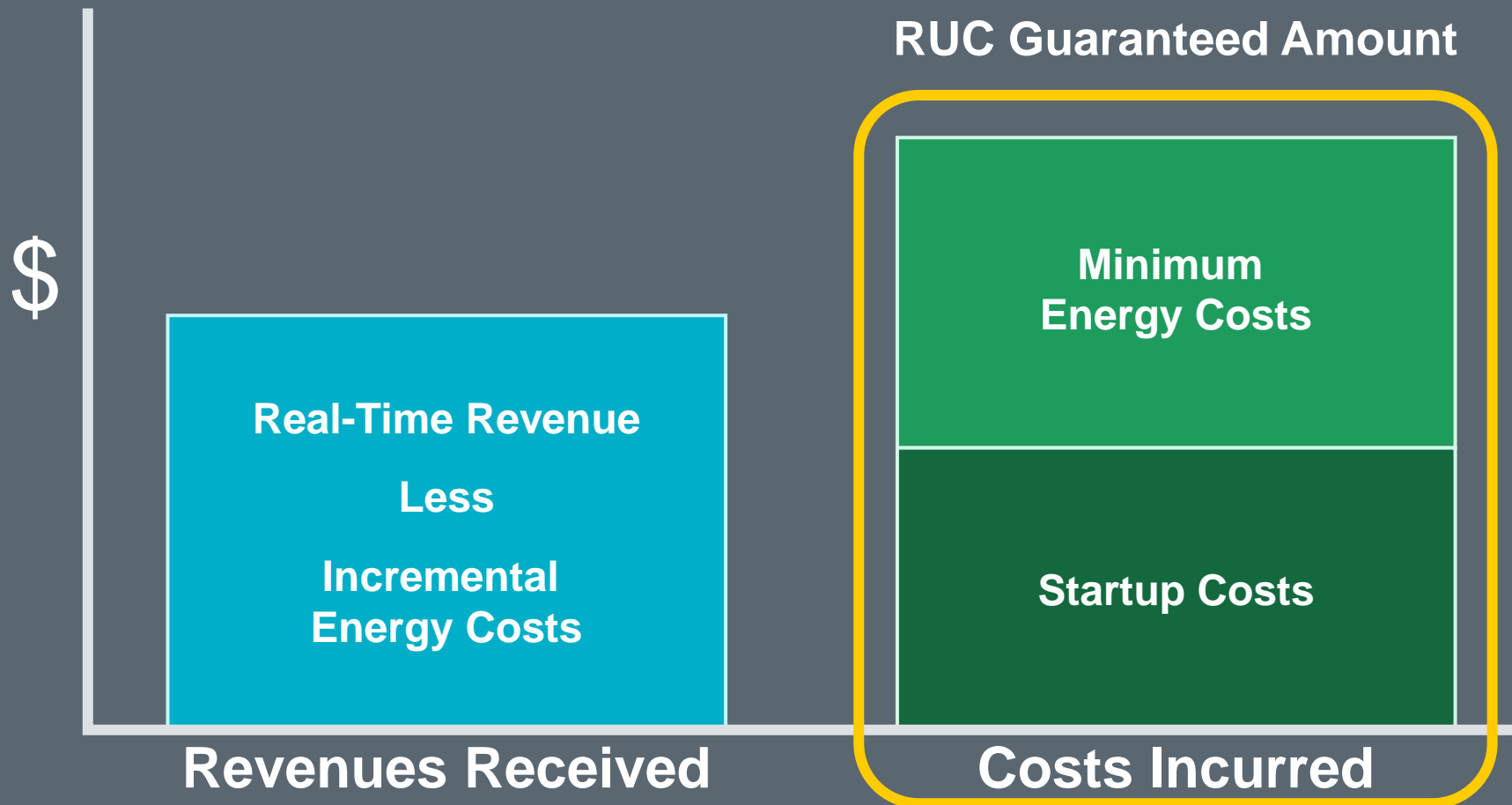
DRUC = Day-Ahead Reliability Unit Commitment

HRUC = Hourly Reliability Unit Commitment

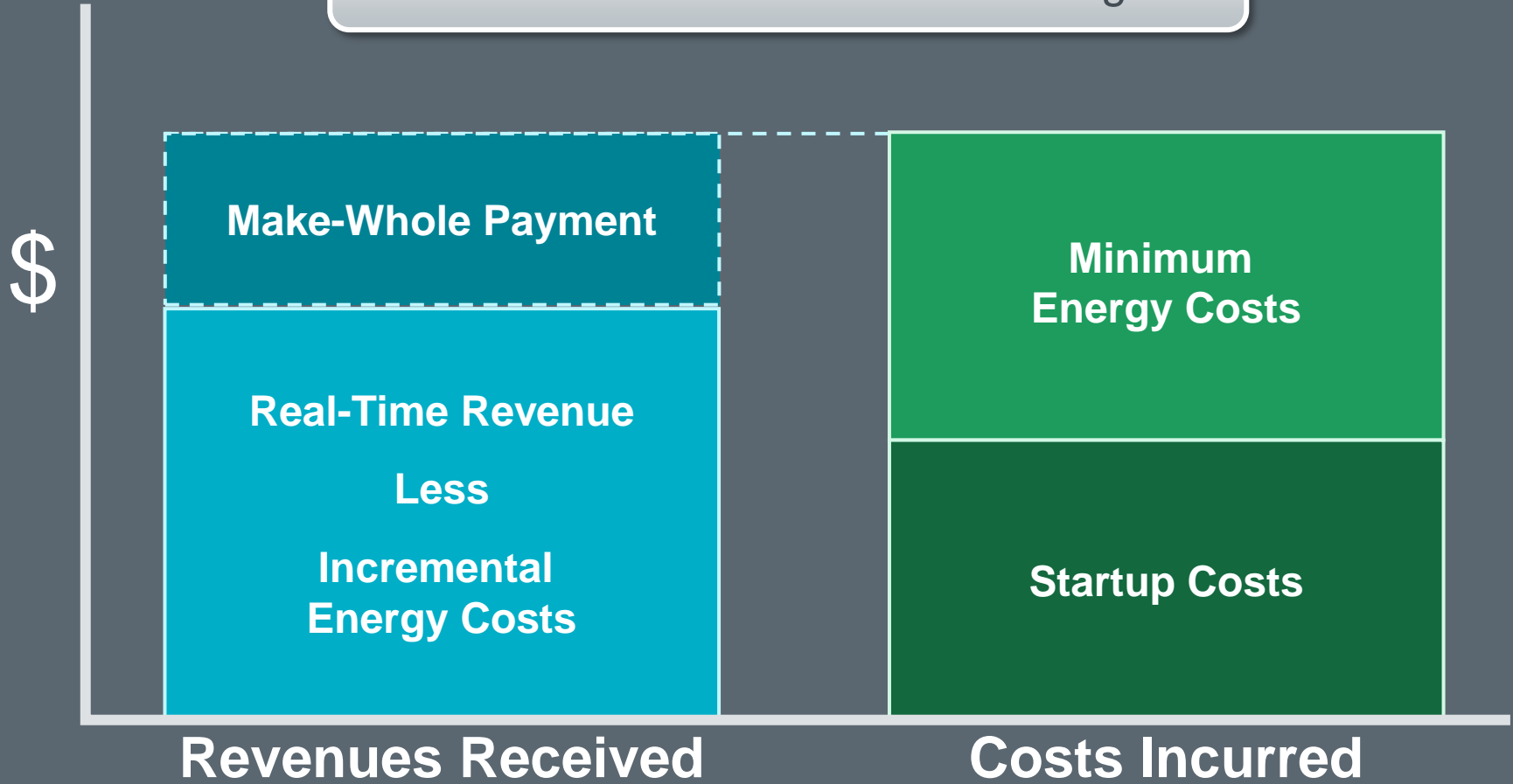


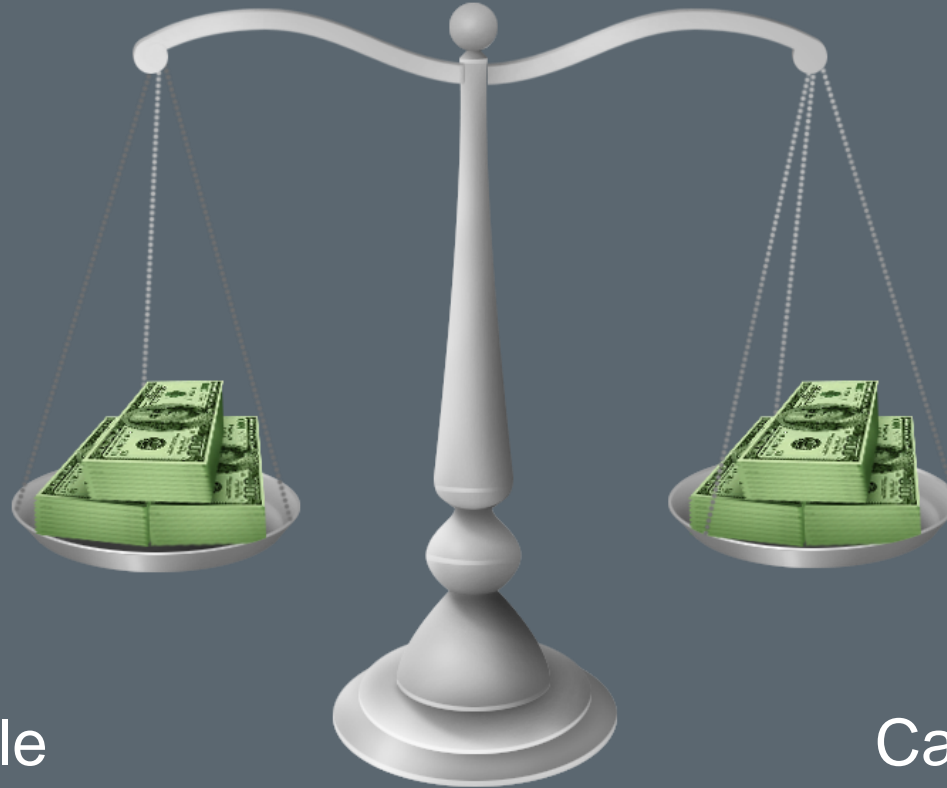
RUC
Make-Whole
Payments

RUC
Capacity Short
Charges



Resource must incur costs to be eligible

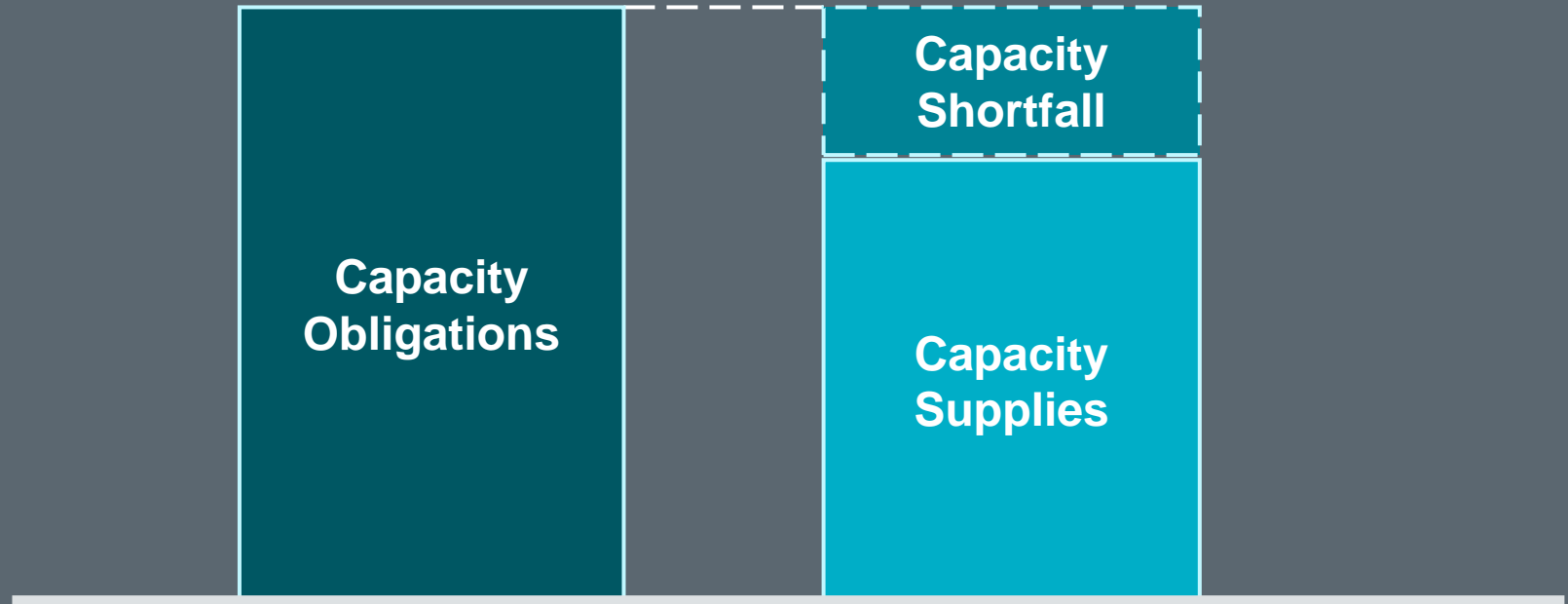




RUC
Make-Whole
Payments

RUC
Capacity Short
Charges

Assessed to QSEs with Capacity Shortfall



Potential Capacity Obligations for QSE



**Capacity
Obligations**

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

Capacity
Supplies

**Each QSE with a Capacity Shortfall
pays a share of the total Make-Whole
cost for the 15-minute Interval**



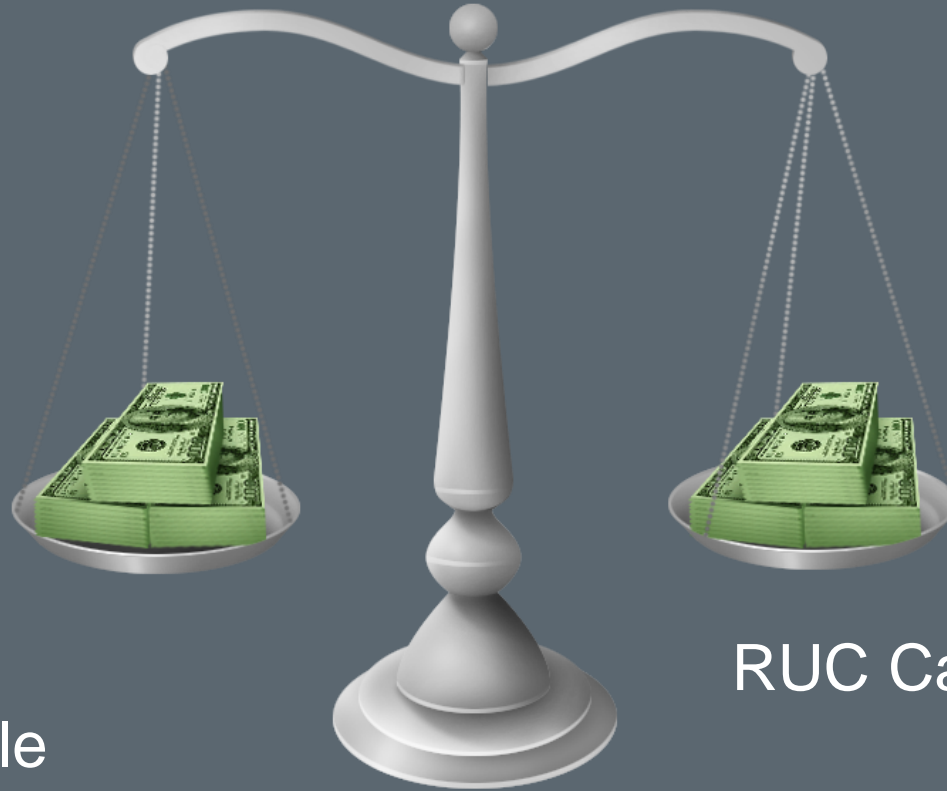
$$\text{Charge} = \left(\text{RUC Capacity Shortfall Ratio Share} \right) * \left(\text{RUC Make-Whole Payment Total} \right)$$

Subject to a cap

$$\text{Charge} = 2 * \left(\text{RUC Capacity Shortfall} \right) * \left(\frac{\text{RUC Make-Whole Payment Total}}{\text{RUC Capacity Total}} \right)$$

Scenario: How much is each QSE charged?

RUC Capacity Total	100 MW	100 MW	100 MW
RUC Make Whole Payment Total	\$100	\$100	\$0
QSE 1 Shortfall	40 MW	60 MW	60 MW
QSE 2 Shortfall	0	40 MW	60 MW
QSE 1 Shortfall Ratio Share			
QSE 2 Shortfall Ratio Share			
QSE 1 Share of Total Make-Whole			
QSE 1 Short Charge Cap			
QSE 2 Share of Total Make-Whole			
QSE 2 Short Charge Cap			



RUC
Make-Whole
Payments

RUC Capacity Short
+
Make-Whole Uplift
Charges

Course Wrap-Up

Format	Title
WBT	Wholesale Markets Overview

Format	Title	Topic
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

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