Updates

- Revised RUC Cap Short slides for clarity





ercot

Energy Storage Resources





Greetings and Introductions

- Attendance
- Questions
- Presentation materials
- Recording for internal purposes



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/

Purpose	Format	Title
Pre-requisite	WBT	Resources in ERCOT
		Resource Responsibilities in ERCOT
Core Courses	ILT	Resources in ERCOT Market Operations
		Energy Storage Resources
		Operational Requirements
		ESRs in the ERCOT Markets
		Financial Considerations
		Intermittent Renewable Resources
		Combined Cycle Generation Resources
Post-requisite	WBT	IRR Forecasting
		Quick Start Generation Resources



Operational Requirements



Topics in this module include:

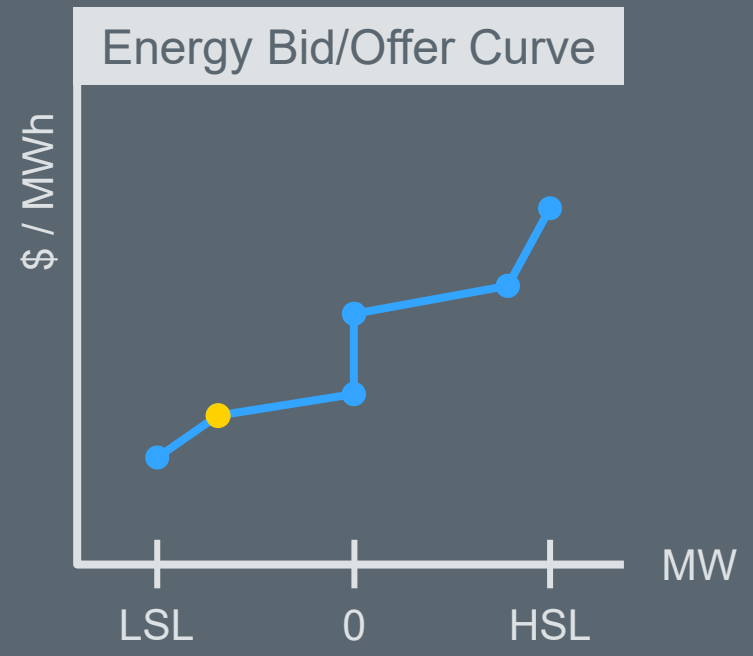
1. Basic ESR Capabilities
2. Current Operating Plan
3. Telemetry Requirements

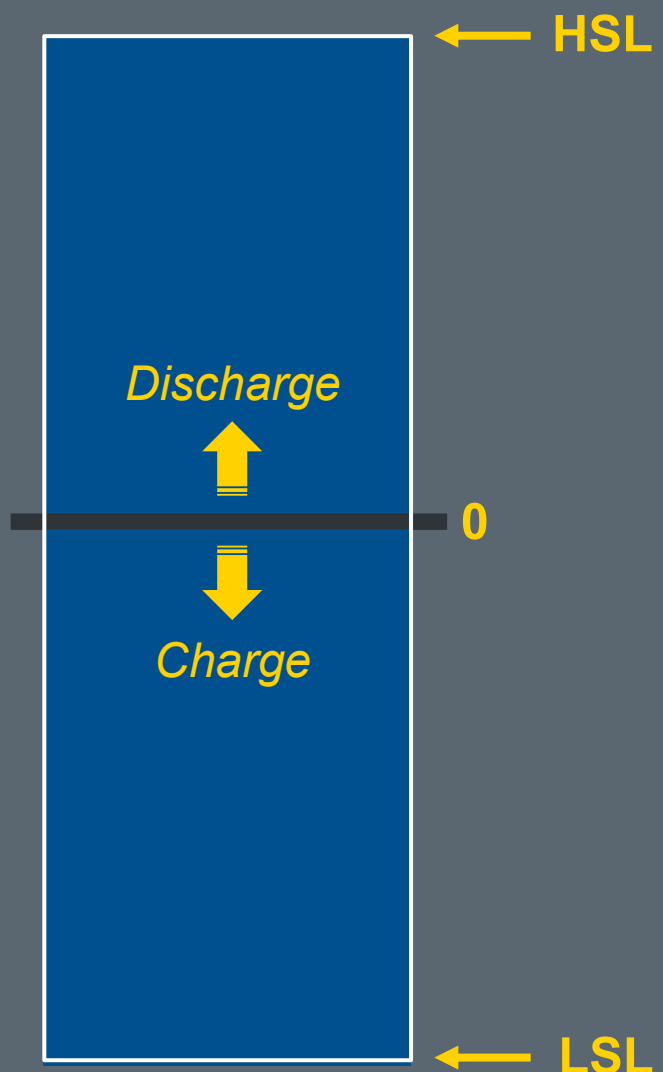


Energy Storage System

- Store energy when plentiful
- Release energy when scarce
- May provide Ancillary Services

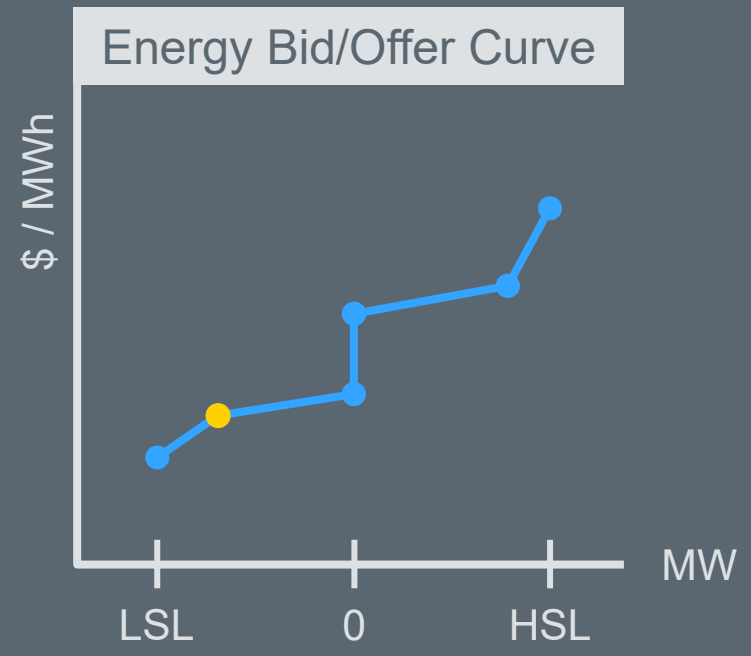
Dispatched by ERCOT whether charging or discharging

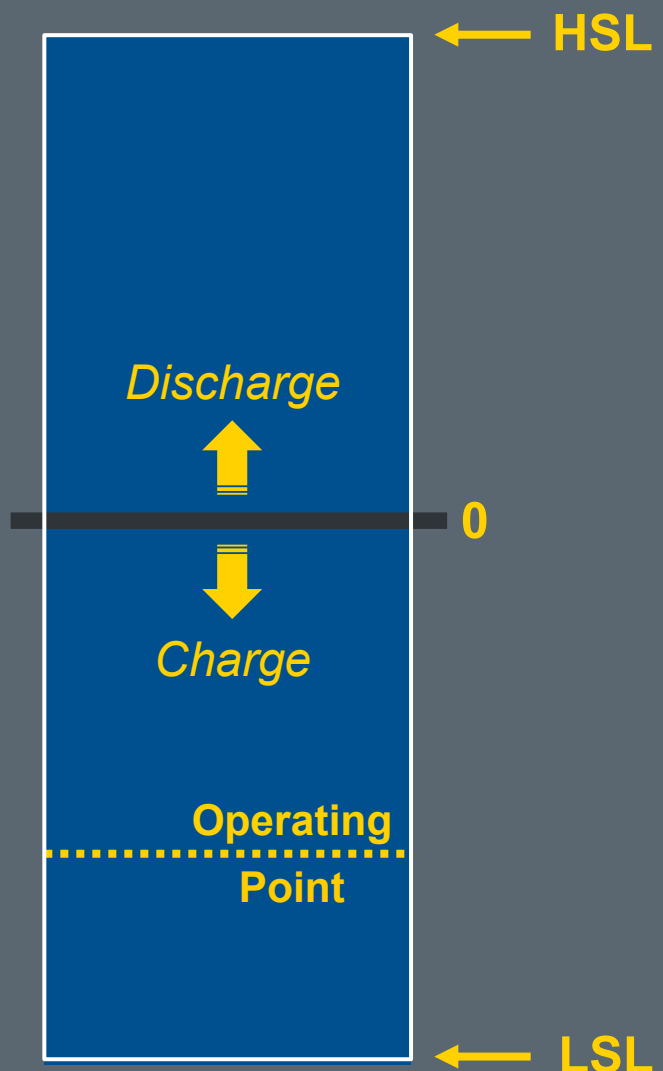




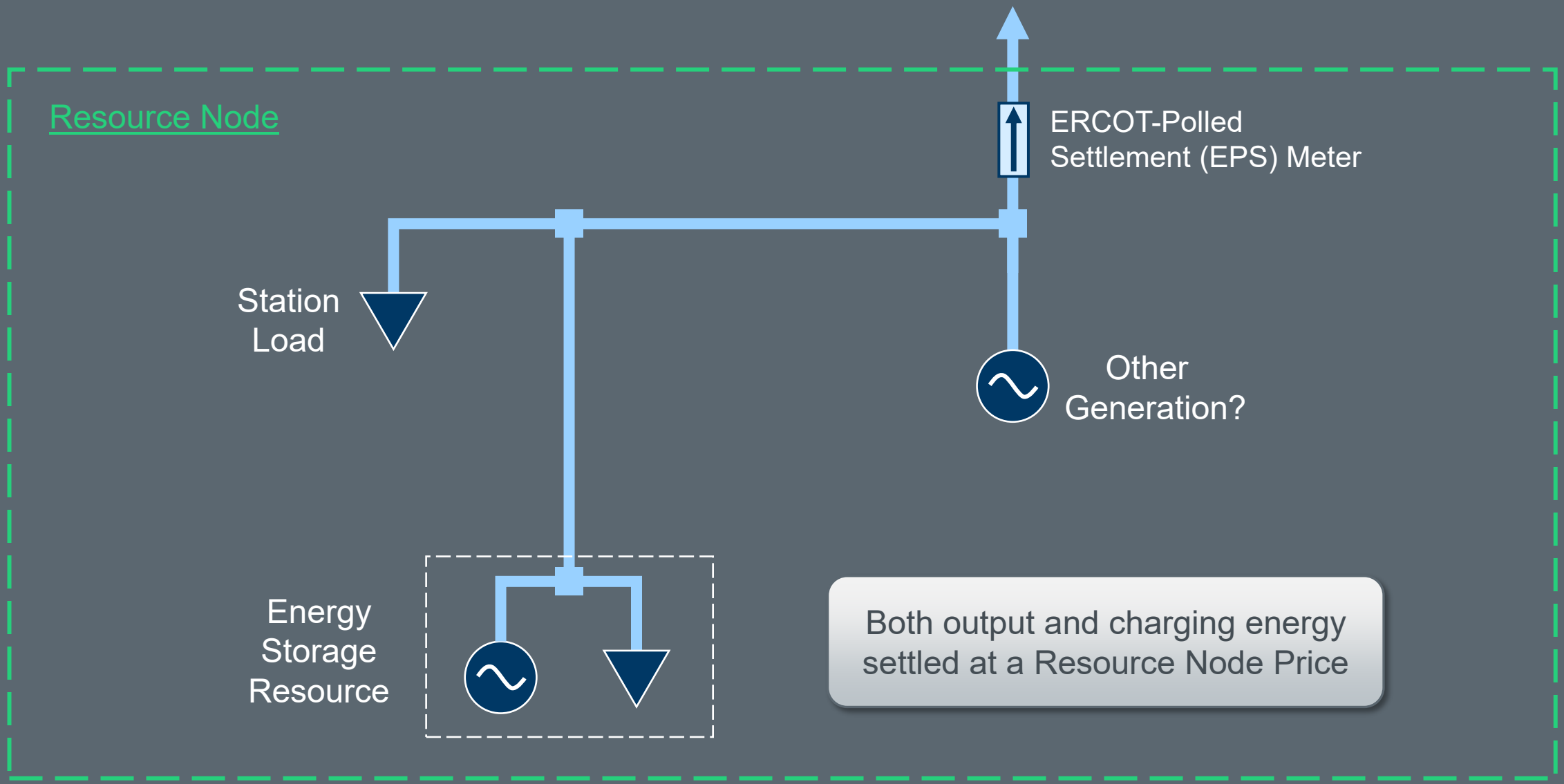
HSL = High Sustained Limit
LSL = Low Sustained Limit

Discussion: What drives HSL and LSL?

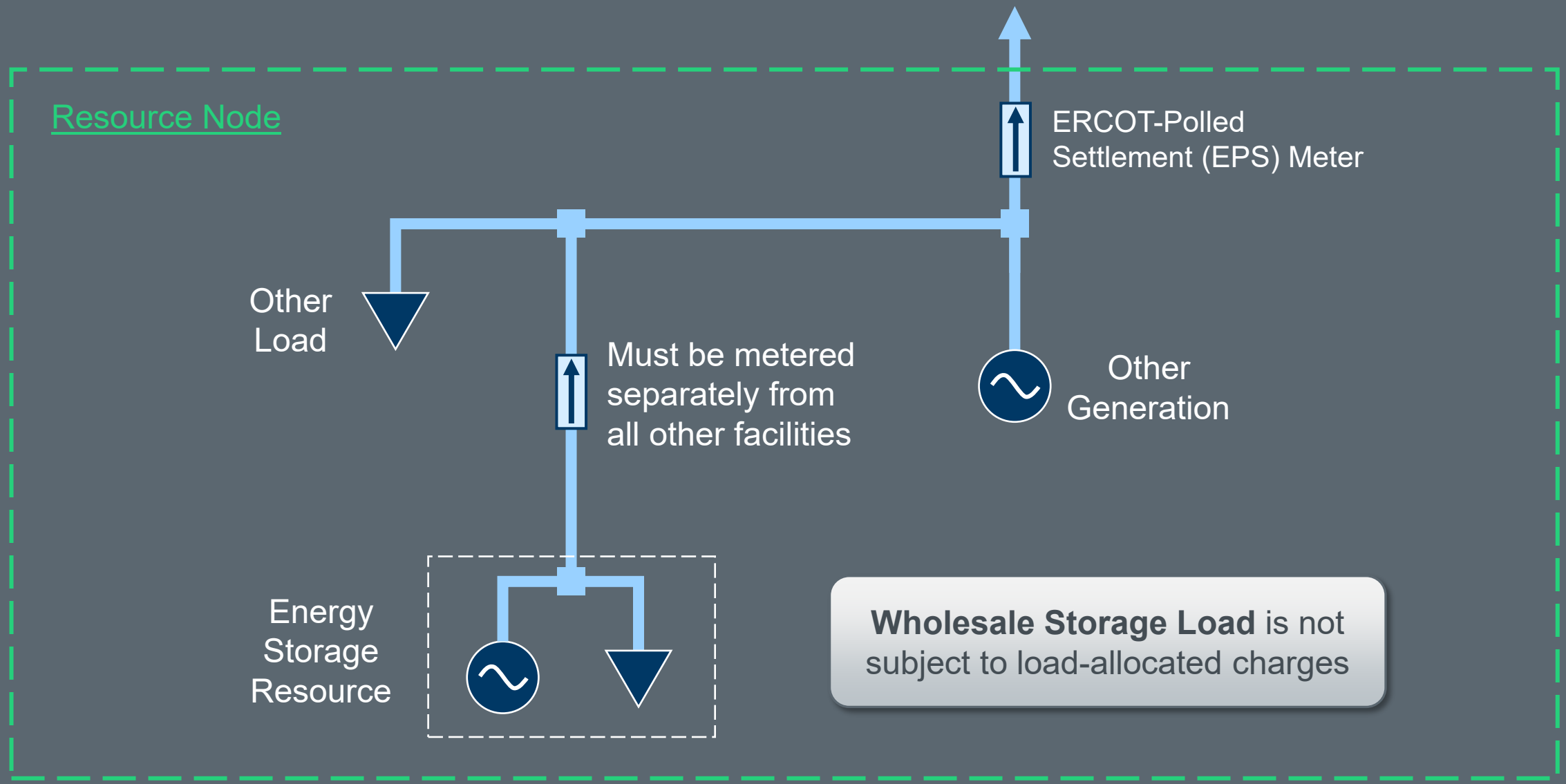




HSL = High Sustained Limit
LSL = Low Sustained Limit


Resource Node
ERCOT-Polled
Settlement (EPS) Meter
Station
Load
Other
Generation?
Energy
Storage
Resource
Both output and charging energy settled at a Resource Node Price

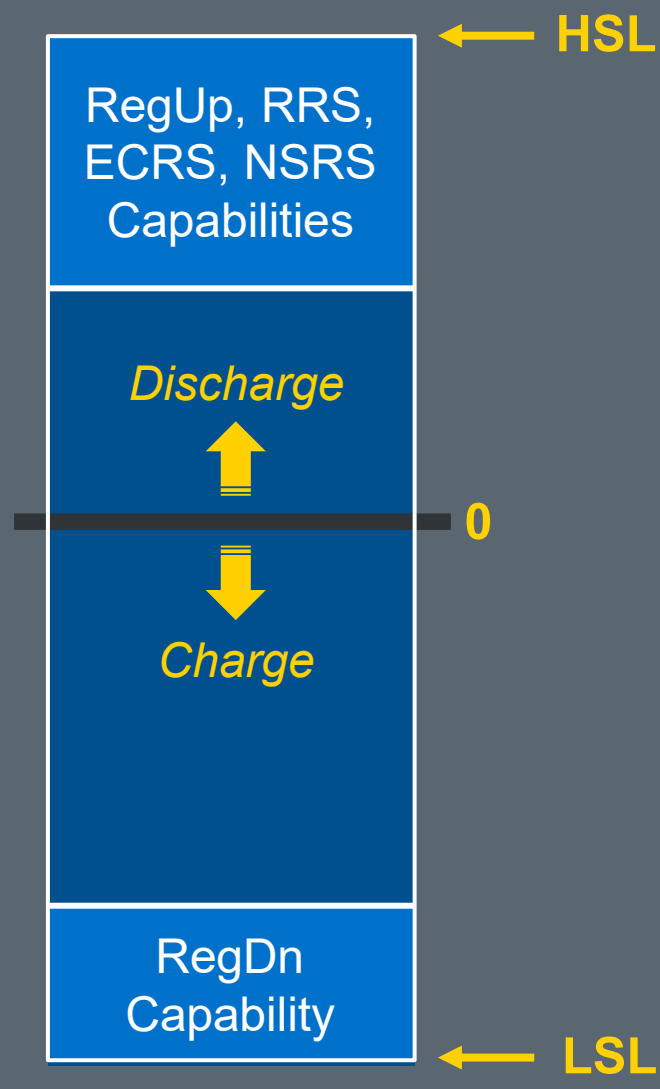
Wholesale Storage Load Treatment



Discussion: Qualifying Ancillary Services on Energy Storage Resources

Ancillary Service		Ramping Requirement	Duration Requirement
RegUp		5 minutes	30 minutes
RegDn		5 minutes	30 minutes
RRS	RRSPF	N/A*	30 minutes
	RRSFF	15 cycles	15 minutes
ECRS		10 minutes	1 hour
Non-Spin		30 minutes	4 hours

*RRSPF for ESRs limited to 20% of (HSL-LSL)



Topics in this module include:

1. Basic ESR Capabilities
2. Current Operating Plan
3. Telemetry Requirements

Current Operating Plan													
Hour	Resource Name	Resource Status	Resource Limits		ESR SOC Limits			Ancillary Service Capabilities					
			HSL	LSL	Min	Max	Hour Beginning	Reg-Up	Reg-Dn	RRSPF	RRSFF	ECRS	NSRS
15	ESR1	ON	40	-40	0	40	30	0	0	0	30	30	0
16	ESR1	ON	40	-40	0	40	40	0	0	0	20	20	0
17	ESR1	ON	40	-40	0	40	20	0	0	0	10	10	0
18	ESR1	ON	40	-40	0	40	10	0	0	0	10	10	0
19	ESR1	OUT	0	0	0	40	0	0	0	0	0	0	0

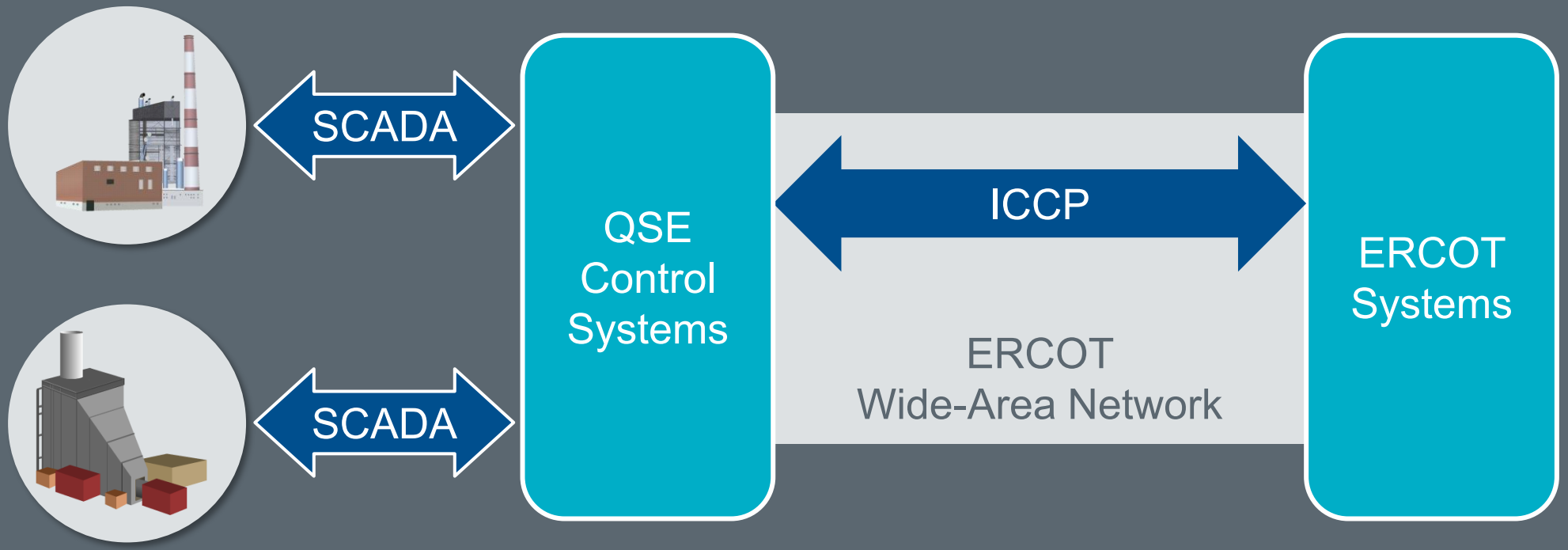
Two allowable Statuses

MWh *not* MW

Must be feasible based on max charge/discharge rates

Topics in this module include:

1. Basic ESR Capabilities
2. Current Operating Plan
3. Telemetry Requirements



Communicates Real-Time Resource Capabilities:

- Operational Status and Limits
- Ramp Rates
- AS Capabilities
- Self-Provided Ancillary Services
- SOC data for ESRs

See ICCP Handbook for details

Discussion: Special ESR Telemetry Data Received from QSEs

ICCP Resource Telemetry								
Name	Operational Status and Limits					State of Charge		
	Power Output/Consumption (MW)	Max Discharge Power Limit (MW)	HSL (MW)	LSL (MW)	Max Charge Power Limit (MW)	Min (MWh)	Max (MWh)	Current (MWh)
ESR1	0	40	40	-40	(-)40	0	40	20
ESR2	-10	40	0	-40	(-)40	0	40	0
ESR3	0	40	40	0	(-)40	0	40	40
ESR4	35	40	40	-24	(-)40	0	40	38

What's the difference?

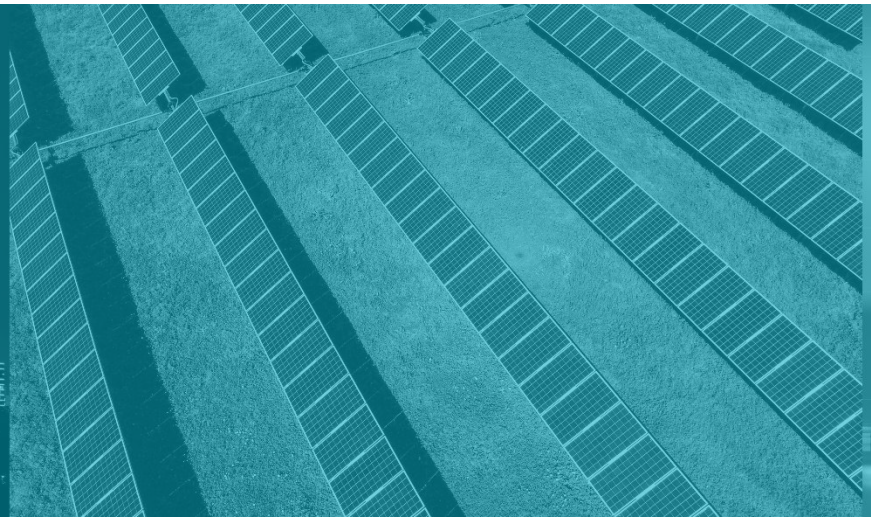
What's the difference?

Must be updated every 2 seconds





ESRs in the ERCOT Markets

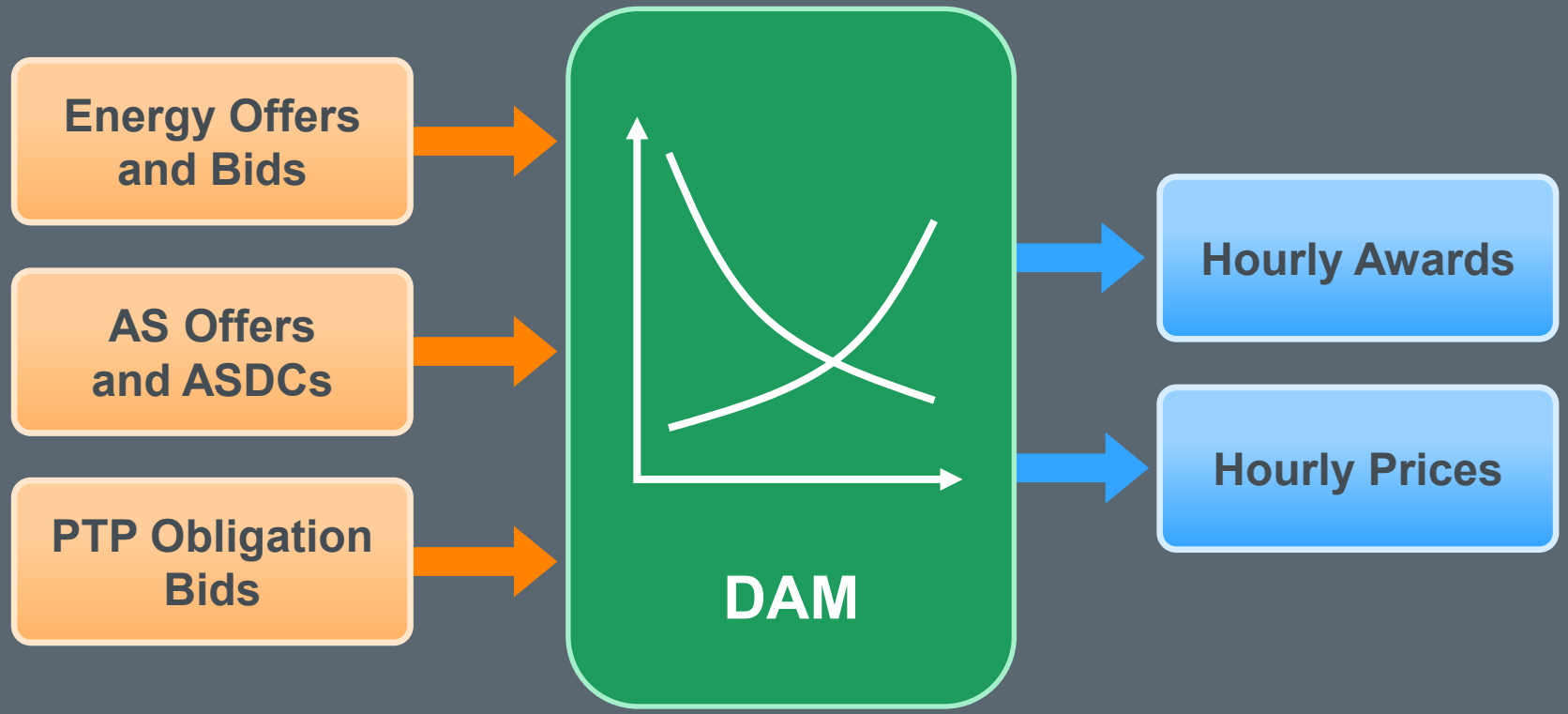




Topics in this module include:

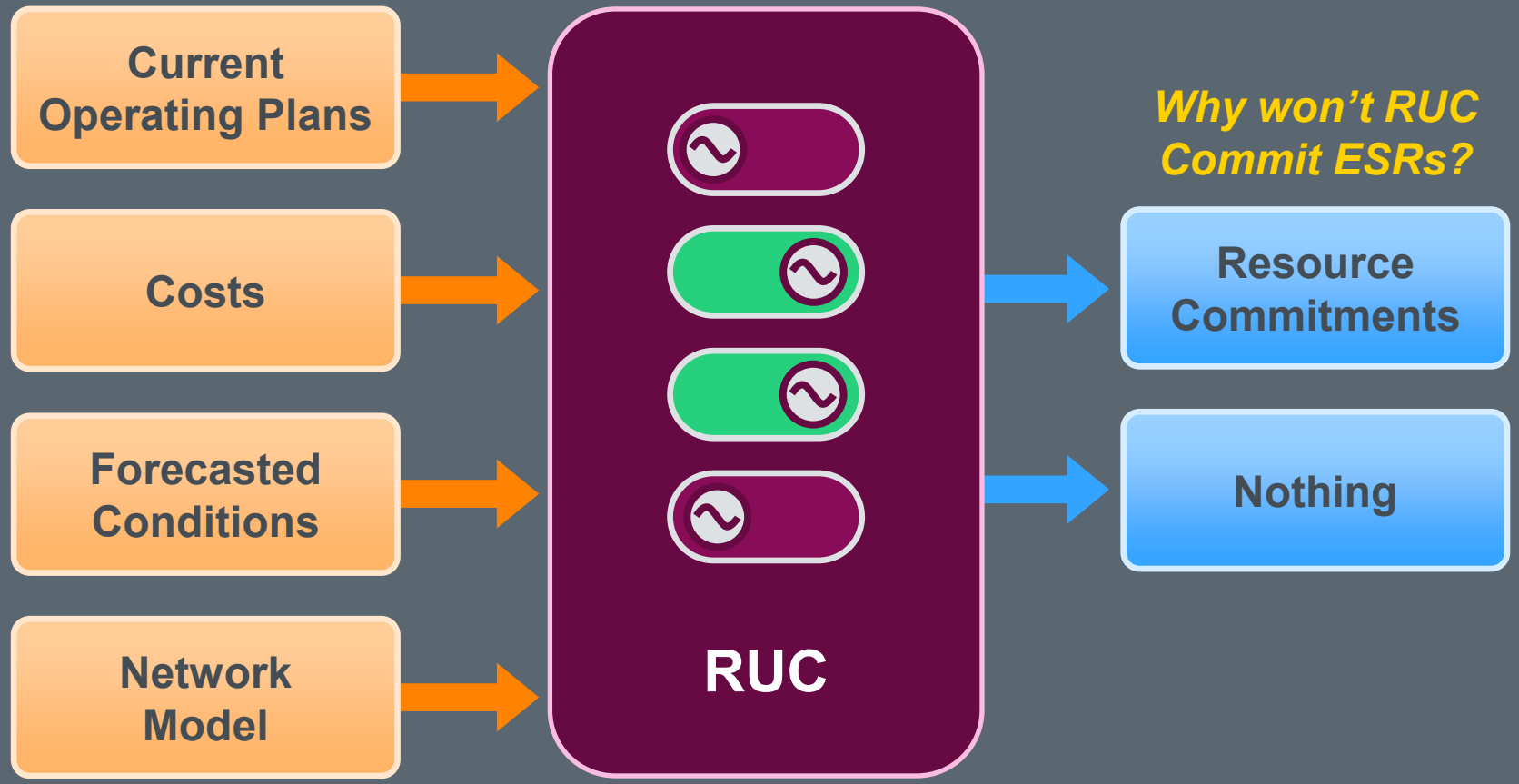
1. Participation across Market Processes
2. Energy Dispatch and Real-Time AS Awards
3. AS Deployment

What can Energy Storage Resources do in DAM?

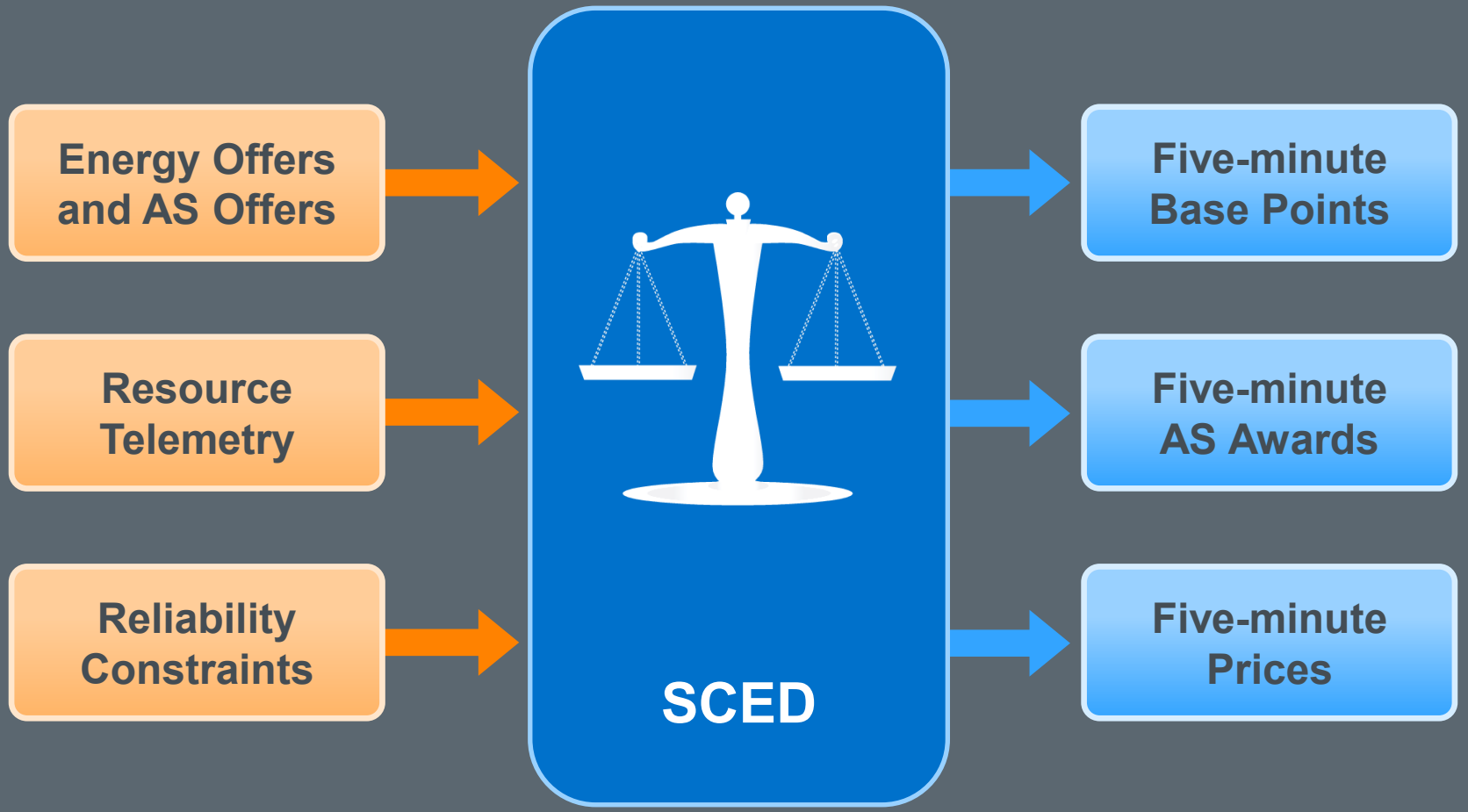




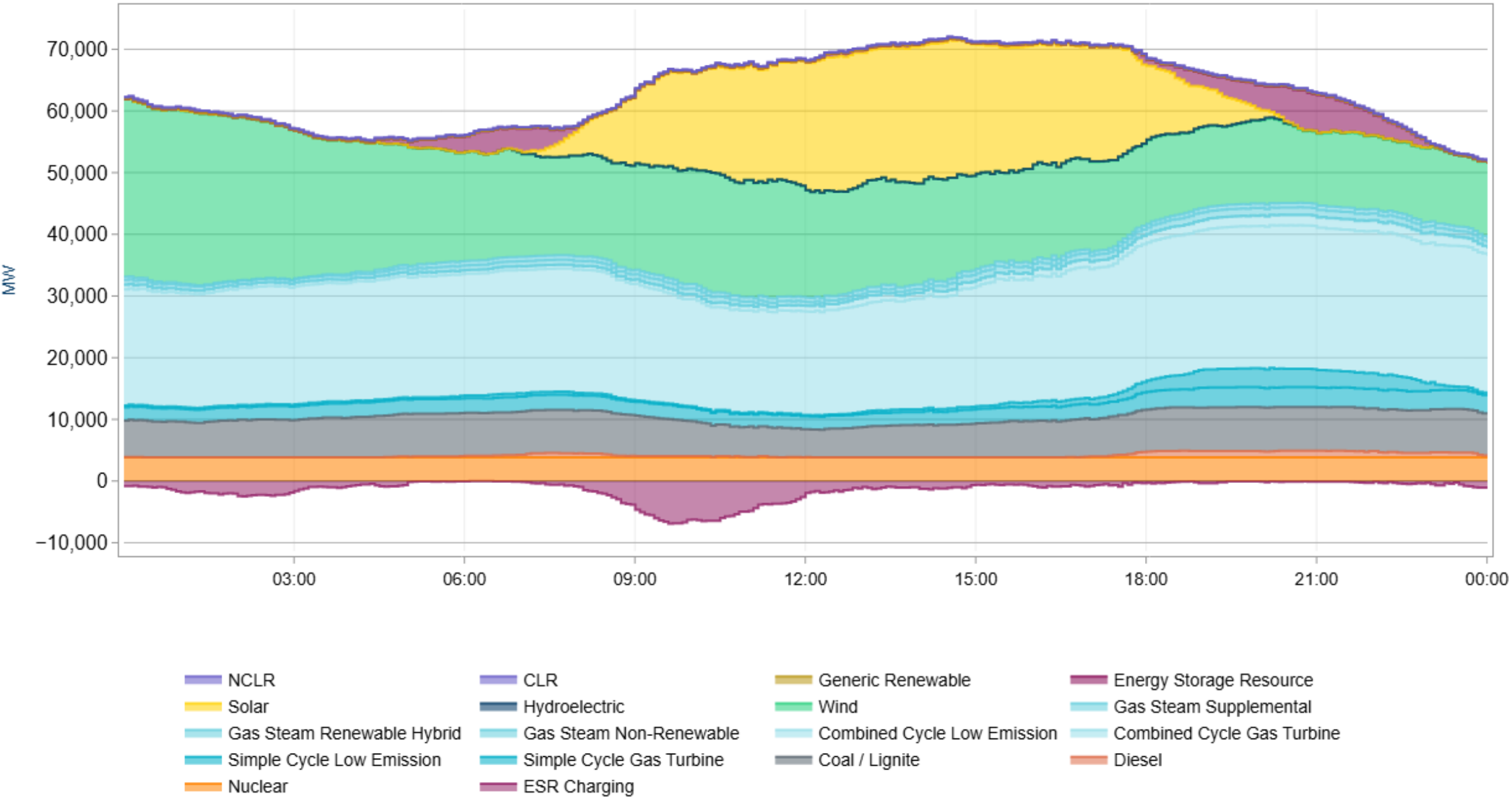
Considers Energy Storage Resource Impact



ESRs play an increasing role in Energy Dispatch and Ancillary Services



Energy Production Resource Mix



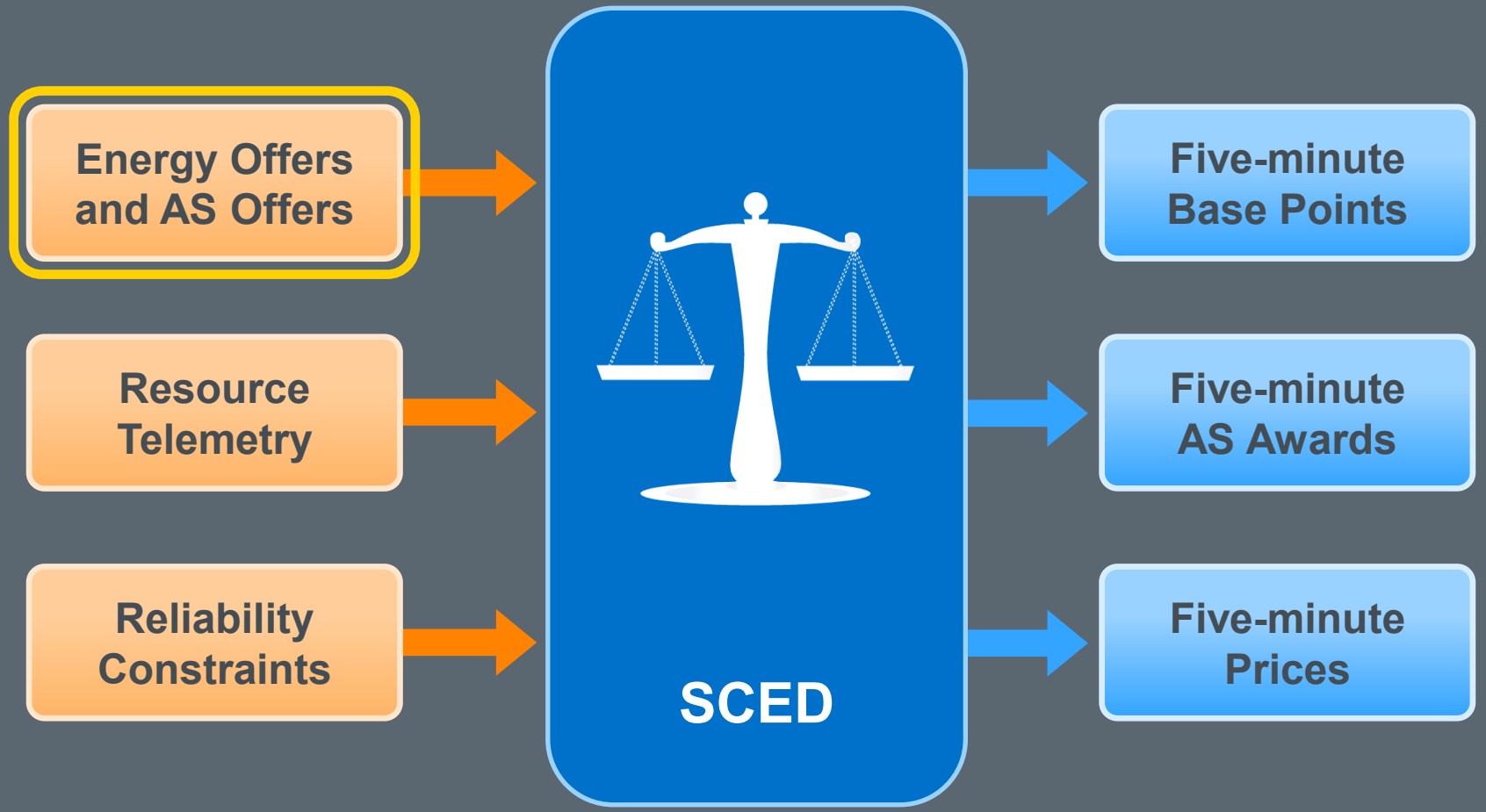
Real-Time AS Award Resource Mix



Topics in this module include:

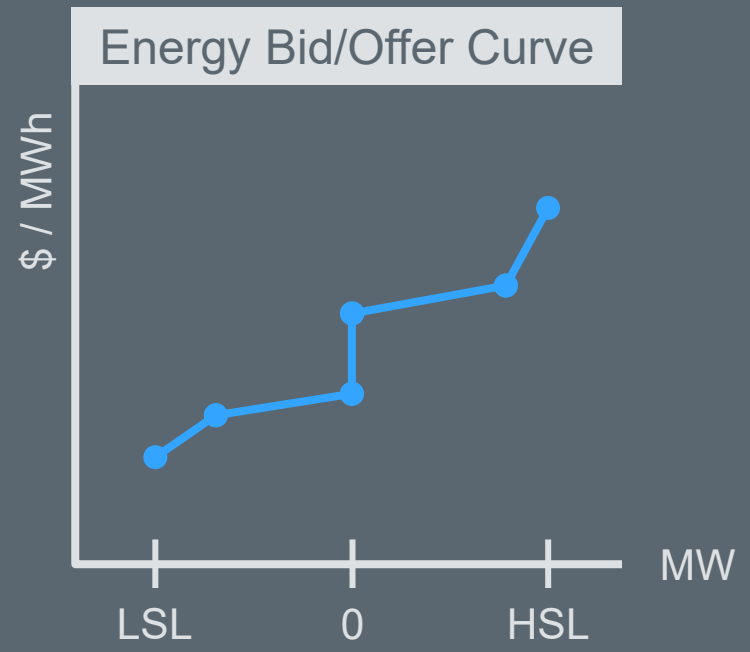
1. Participation across Market Processes
2. Energy Dispatch and Real-Time AS Awards
3. AS Deployment

Manages Reliability at Least Cost

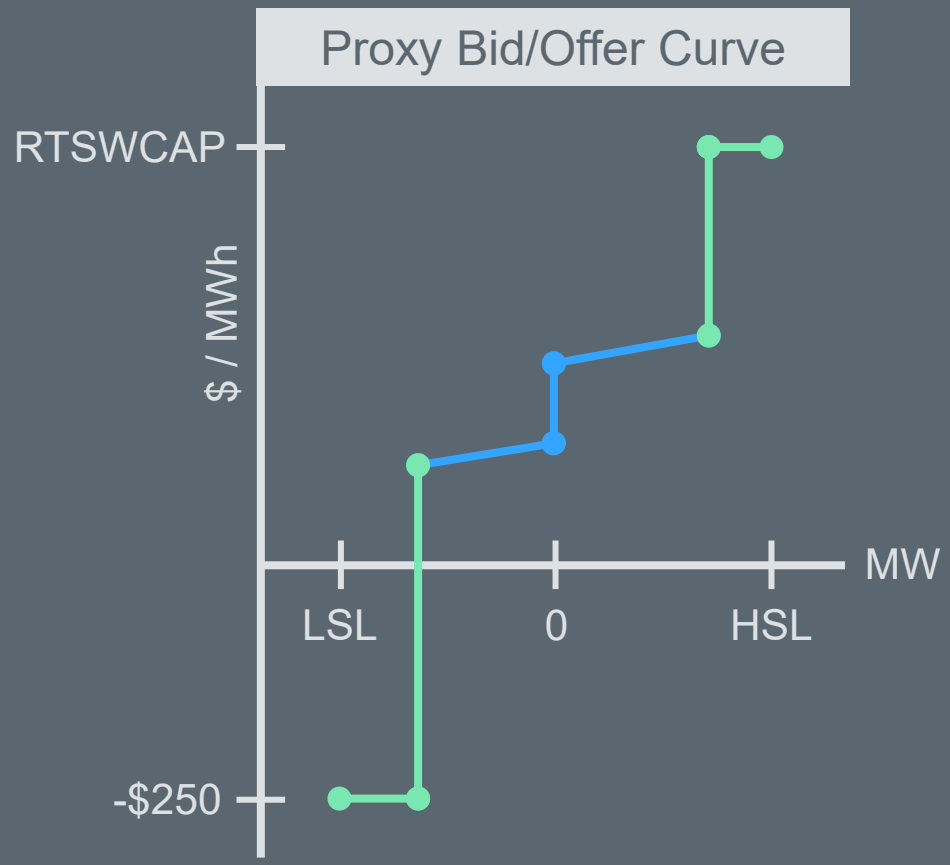


May be updated any time before SCED

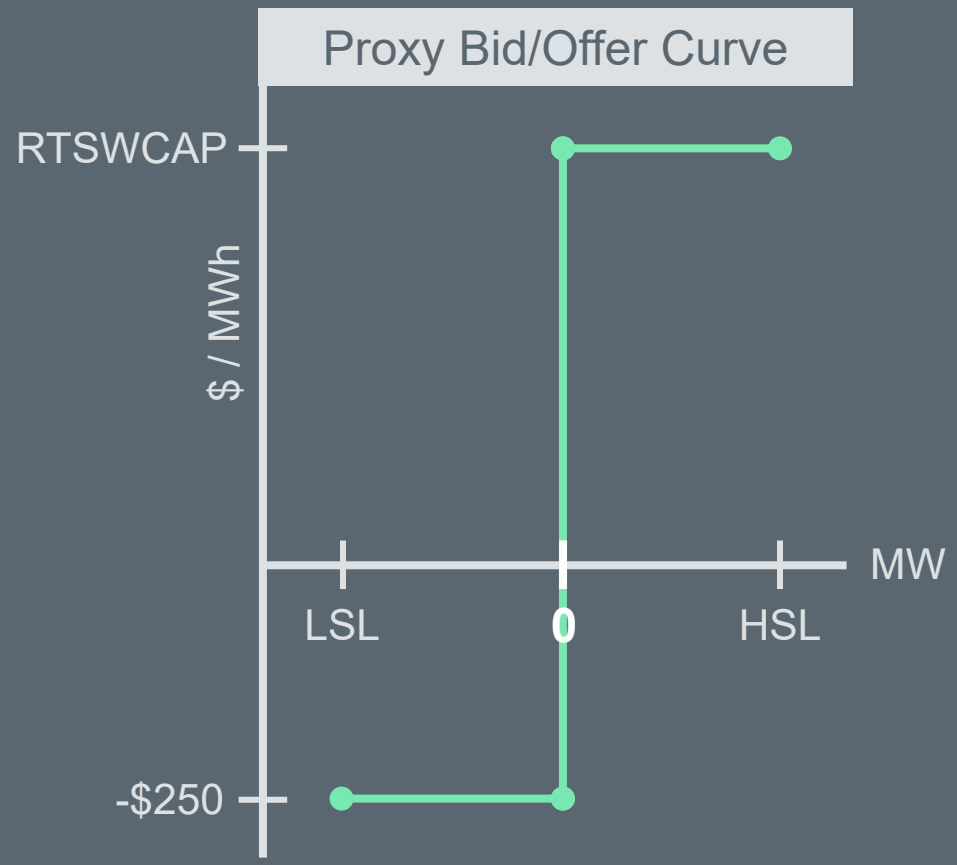




Scenario: What if?

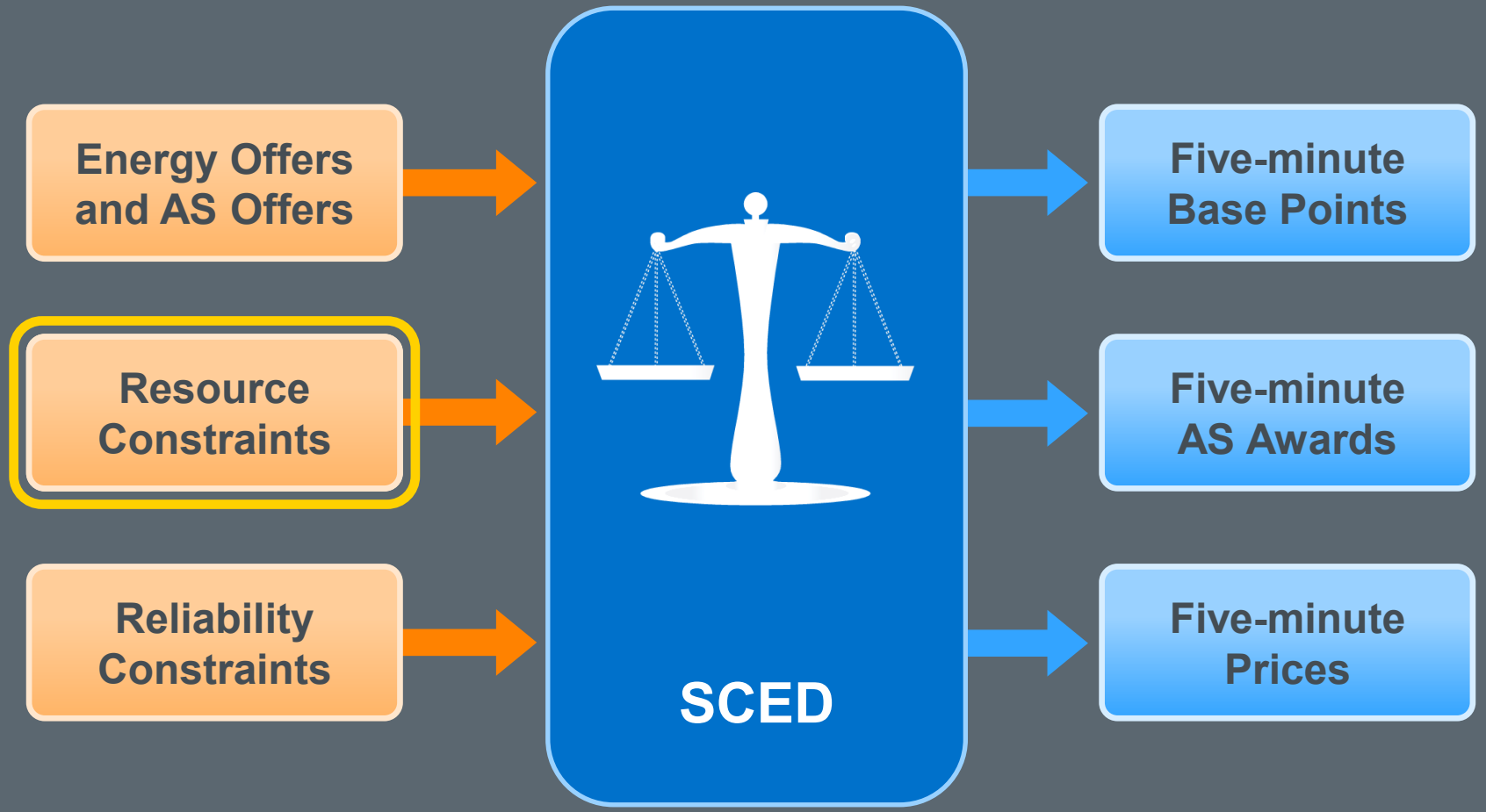


Not full-range



No offer at all

Manages Reliability at Least Cost

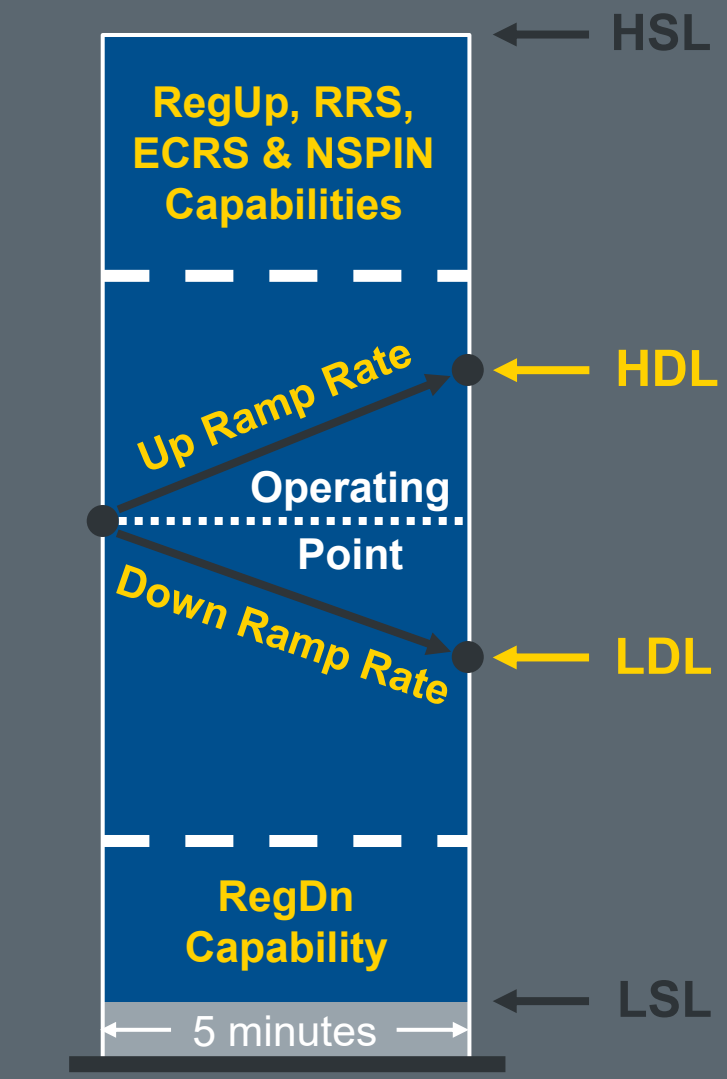


High Dispatch Limit

Base Point + (5/7) RegUp Award ≤ HDL

Base Point – (5/7) RegDn Award ≥ LDL

Low Dispatch Limit

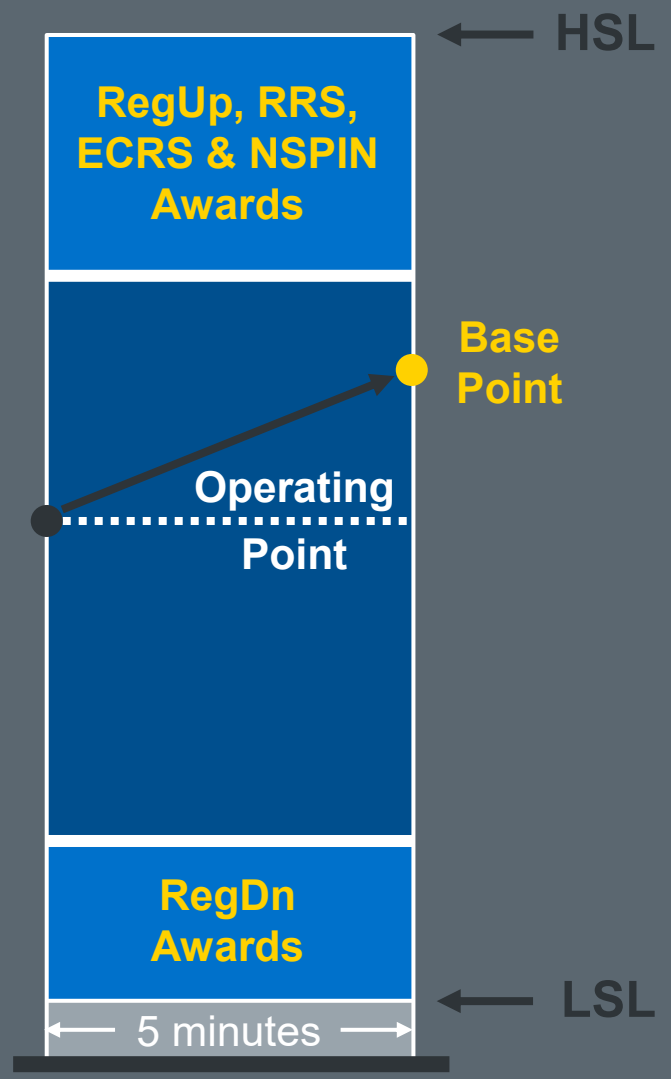


Resource Limit Calculator

Additional Energy Storage Resource Award Constraints

Base Points and AS Awards must be feasible based on

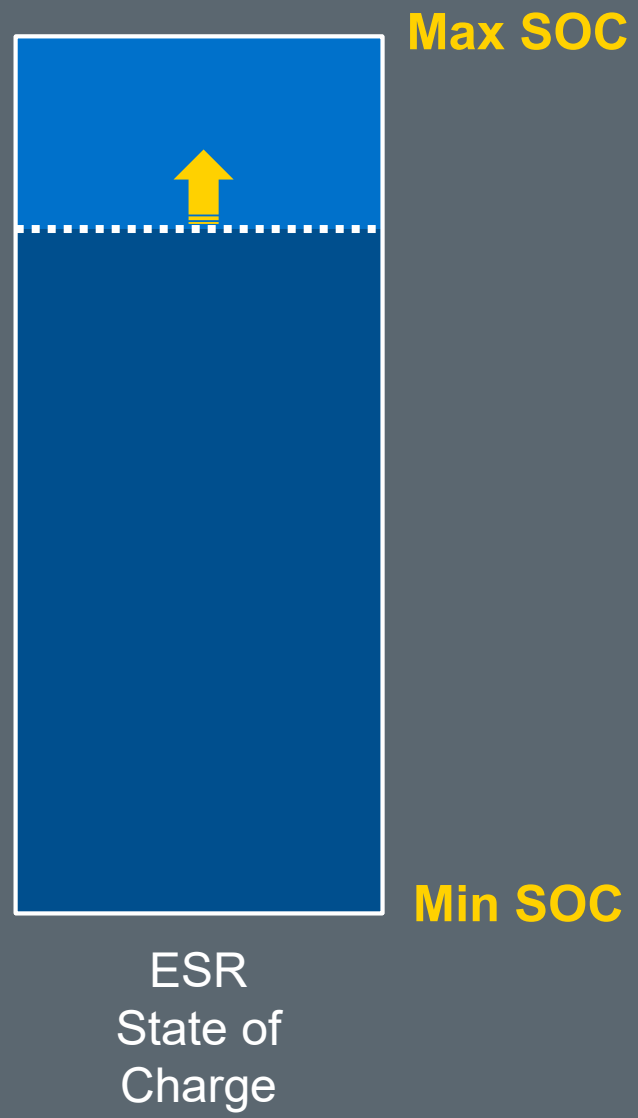
- **State-of-Charge (SOC)**
- **Min/Max SOC limits**
- **Duration requirements**



Used in RUC and SCED Optimizations

- ESR consumes more than it can return
- Charging Base Point allows for losses





Topics in this module include:

1. Participation across Market Processes
2. Energy Dispatch and Real-Time AS Awards
3. AS Deployment

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



RRSPF – Primary Frequency Response

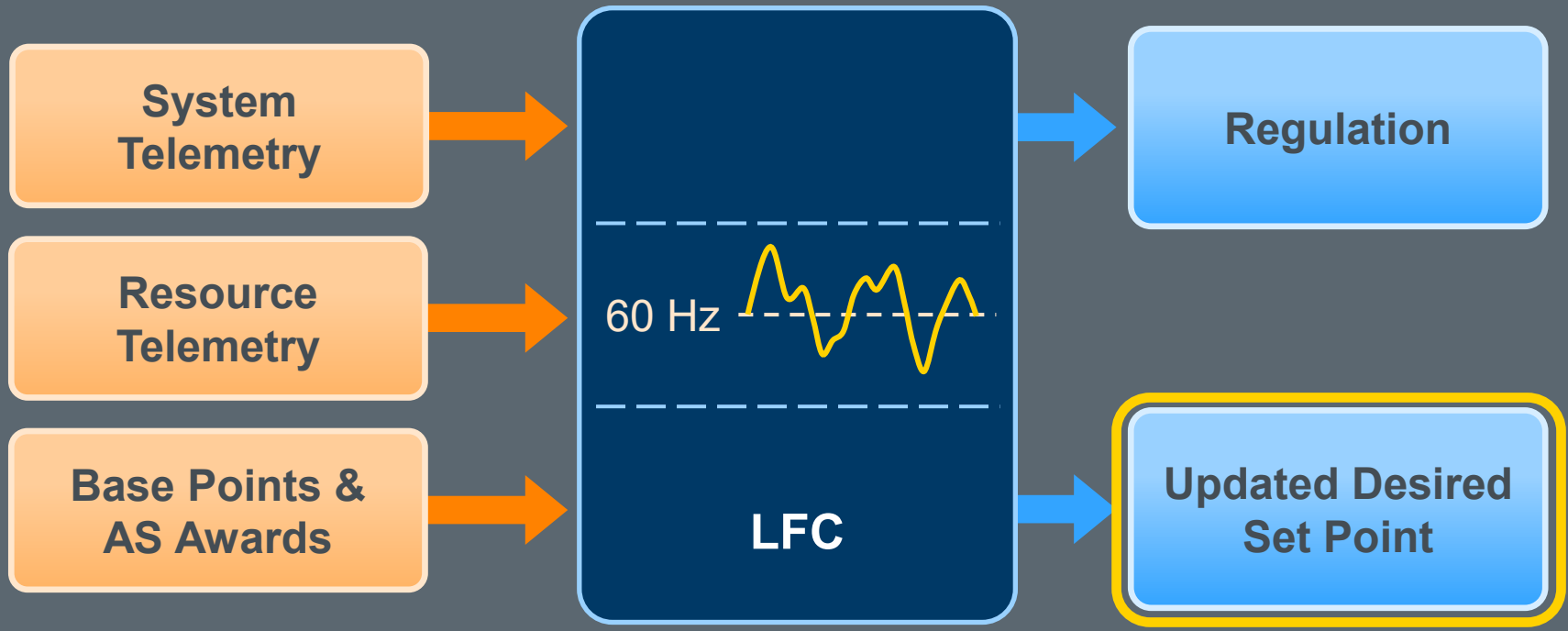
- Automatic Response at 59.983 Hz
- Proportional to frequency decay

RRSFF – Fast Frequency Response

- Auto-deployed at 59.85 Hz
- Responds within 15 Cycles
- Recalled at 59.95 Hz

RRSUF – Load Resource on Under-Frequency Relay

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



ICCP signals updated every 4 seconds



Instructed output level of Resource to meet:

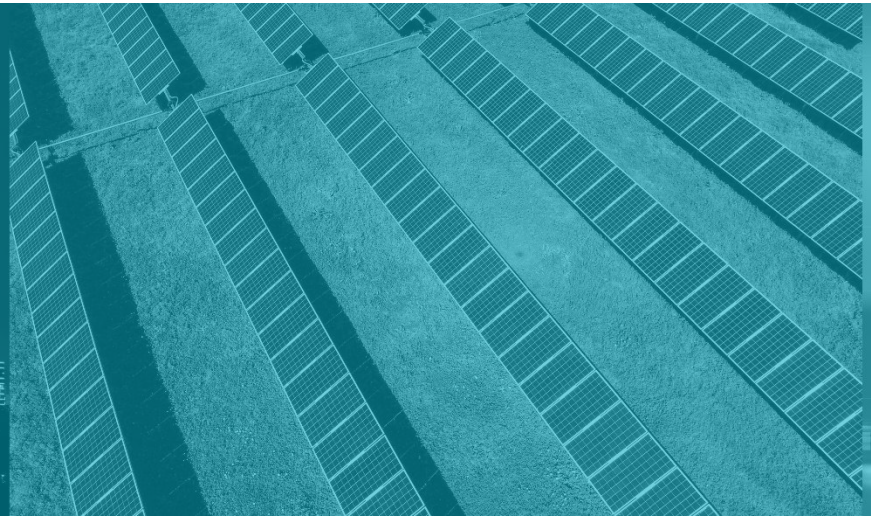
- SCED Base Point Ramping
- Regulation deployments
- Expected RRSFF deployments

ERCOT also sends FFR Active Flag (FFAC) via ICCP





Financial Considerations

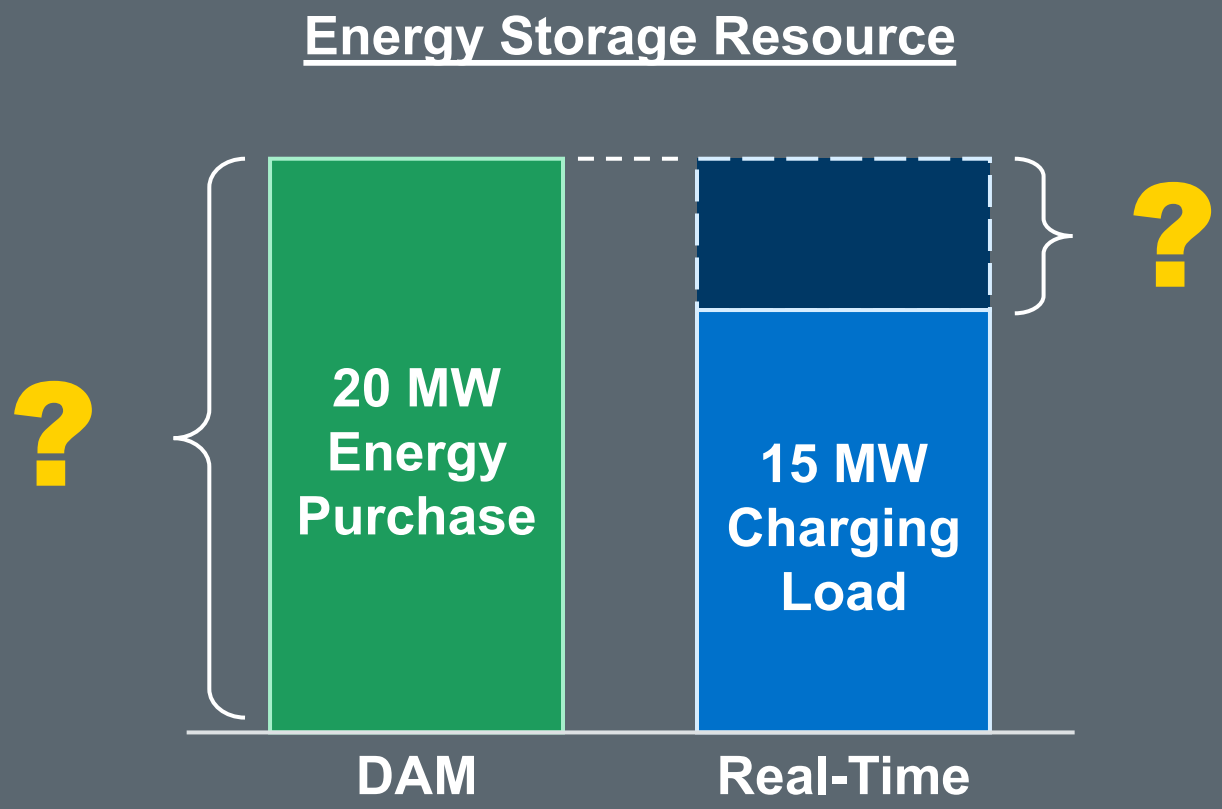




Topics in this module include:

1. Energy and Ancillary Services
2. RUC Capacity Short Charge

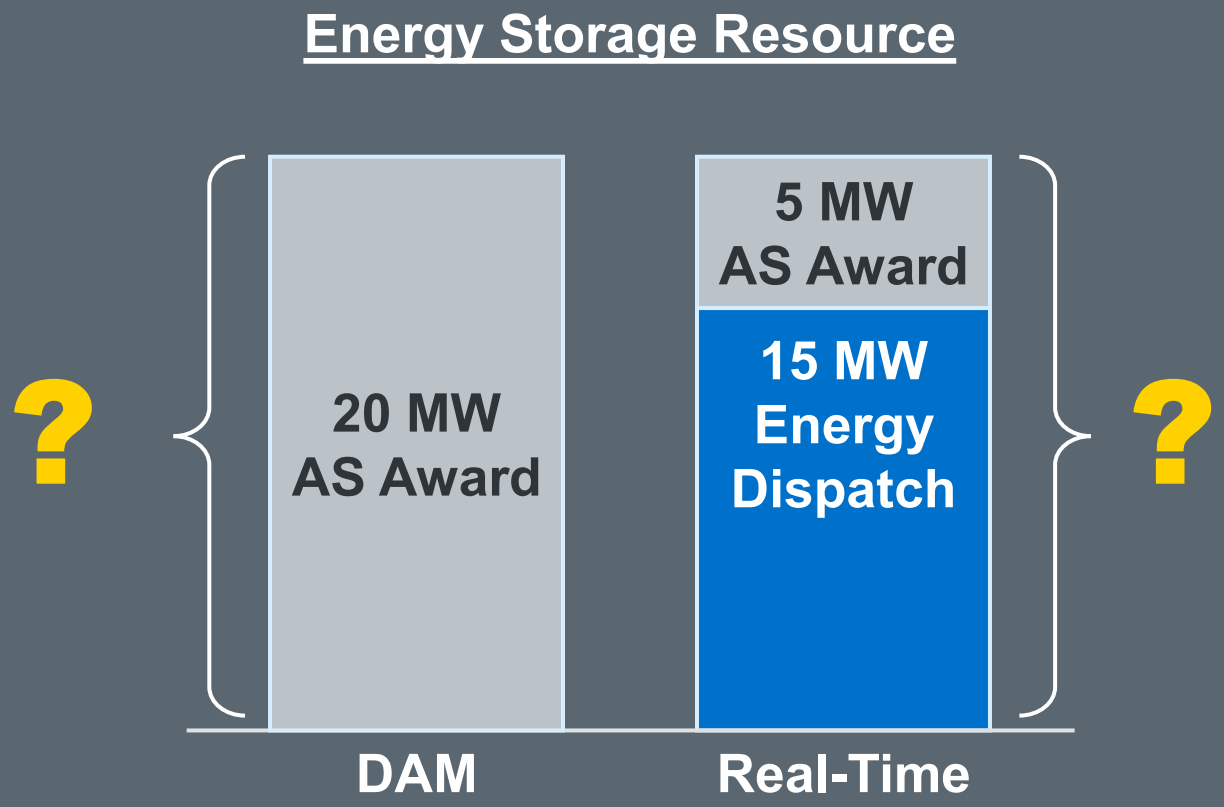
QSE has transactions for their Resource





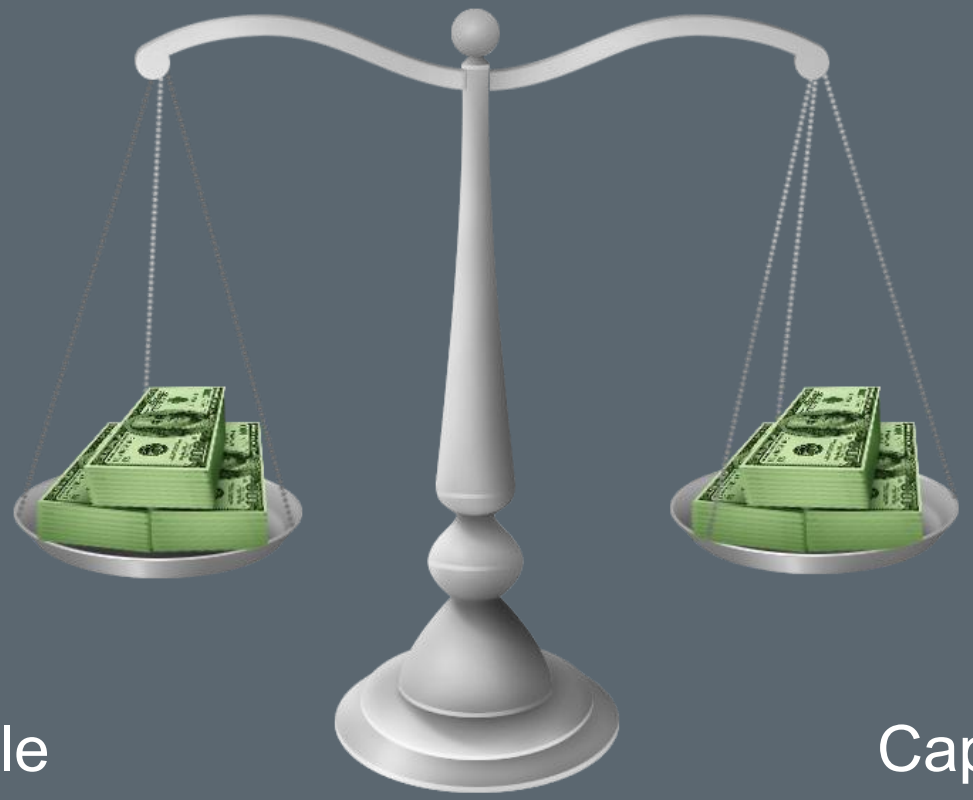
QSE has transactions for their Resource





Topics in this module include:

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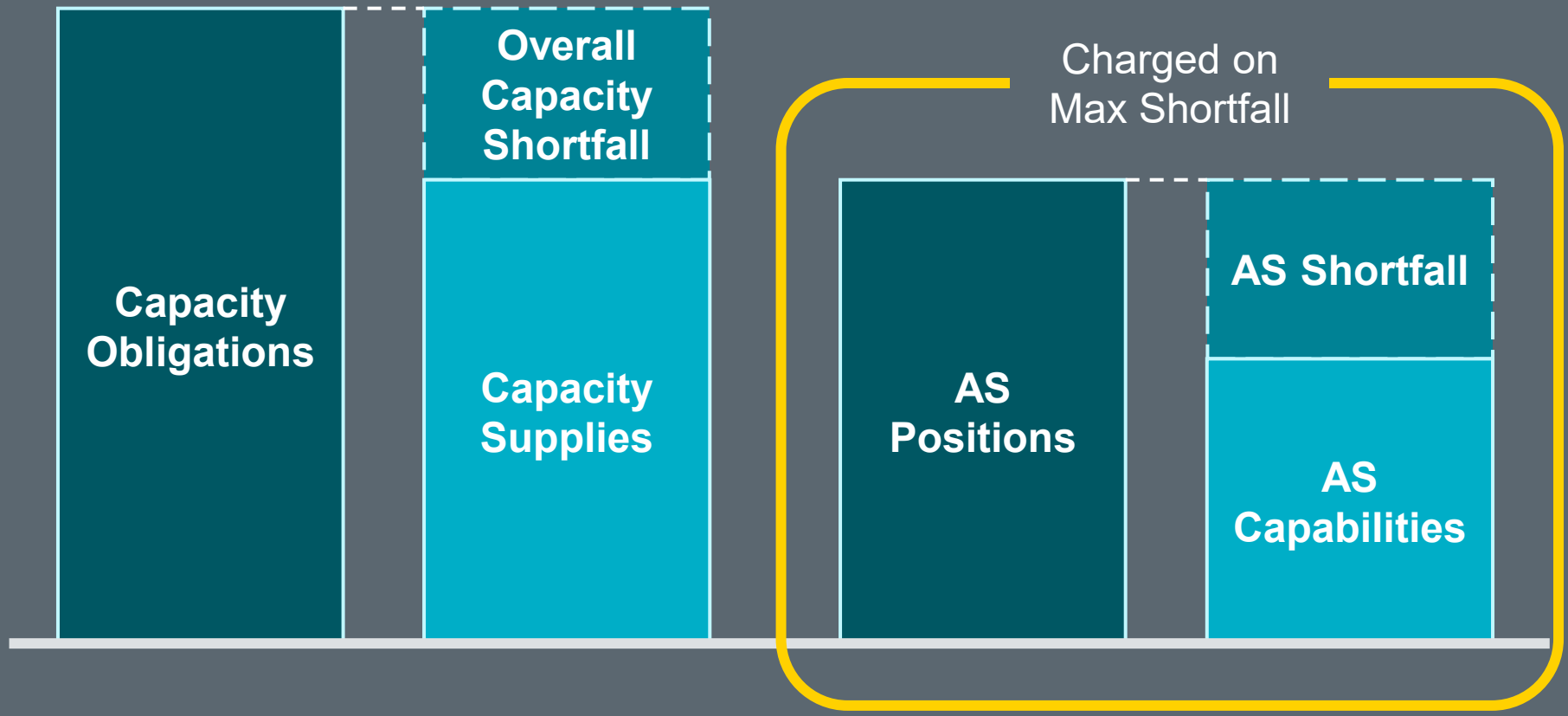


RUC
Make-Whole
Payments

RUC
Capacity Short
Charges

Two Ways for QSE to be Capacity Short





Potential Capacity Obligations for QSE



Capacity Obligations

- Load
- Energy Sales (DAM and Trades)
- On-Line AS Sales (DAM and Trades)
- Self-Arranged AS from DAM
- ESR Planned Charging

Potential Capacity Supplies for QSE



Committed Resource Capacity

Energy Purchases (DAM and Trades)

On-Line AS Purchases (DAM and Trades)

AS from Load Resources

ESR Planned Discharge and/or AS Capabilities

Capacity Supplies

Ancillary Service Financial Obligations for QSE





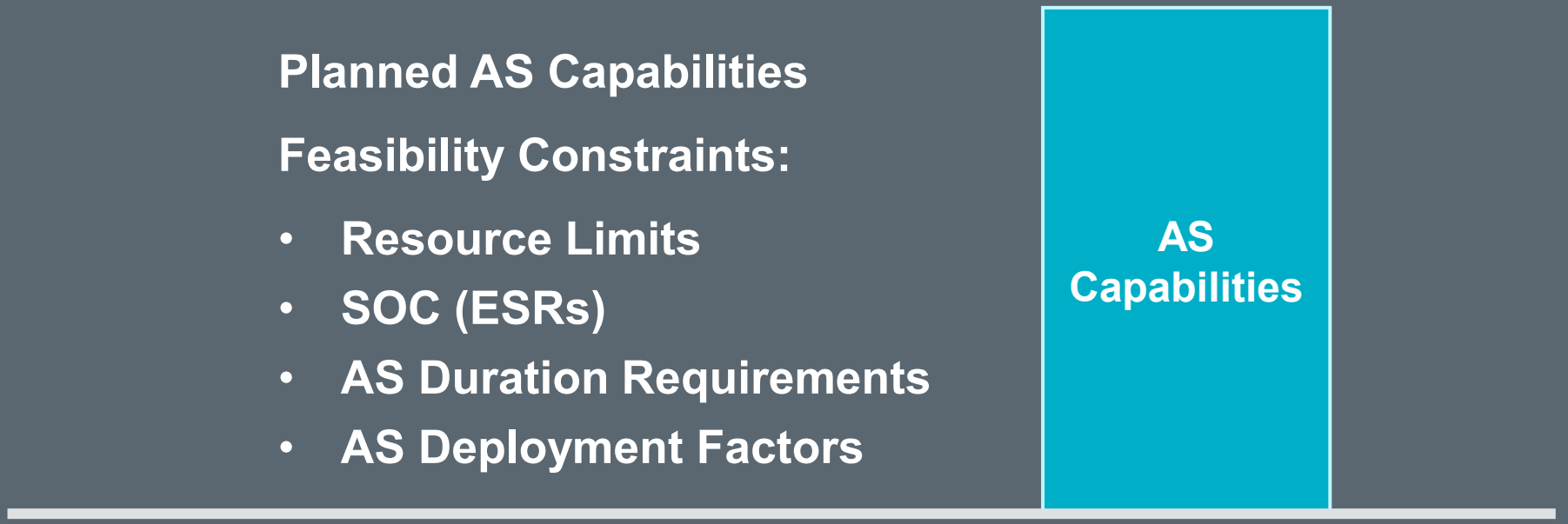
Ancillary Service Physical Supplies for QSE



Planned AS Capabilities

Feasibility Constraints:

- **Resource Limits**
- **SOC (ESRs)**
- **AS Duration Requirements**
- **AS Deployment Factors**



RUC Information for Hour 15



- QSE sold 40 MW ECRS through Trade
- QSE has no DAM Transactions
- ECRS Deployment Factor = 0

Current Operating Plan											
Hour	Resource Name	Resource Limits		ESR SOC Limits			Ancillary Service Capabilities				
		HSL	LSL	Min	Max	Hour Beginning	Reg-Up	Reg-Dn	Responsive	ECRS	NSRS
15	ESR3	40	-40	0	40	0	0	0	0	40	0
16	ESR3	40	-40	0	40	40	0	0	0	40	0

Two Ways for QSE to be Capacity Short



Overall Capacity Shortfall?

Capacity Obligations

Capacity Supplies

Ancillary Service Shortfall?

AS Positions

AS Capabilities

RUC Information for Hour 15

- QSE sold 40 MW ECRS through Trade
- QSE has no DAM Transactions
- ECRS Deployment Factor = 1



Current Operating Plan											
Hour	Resource Name	Resource Limits		ESR SOC Limits			Ancillary Service Capabilities				
		HSL	LSL	Min	Max	Hour Beginning	Reg-Up	Reg-Dn	Responsive	ECRS	NSRS
15	ESR3	40	-40	0	40	0	0	0	0	40	0
16	ESR3	40	-40	0	40	40	0	0	0	40	0

Two Ways for QSE to be Capacity Short



Overall Capacity Shortfall?

Capacity Obligations

Capacity Supplies

Ancillary Service Shortfall?

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AS Capabilities

RUC Information for Hour 15

- QSE sold 40 MW ECRS through Trade
- QSE has no DAM Transactions
- ECRS Deployment Factor = 1



Current Operating Plan											
Hour	Resource Name	Resource Limits		ESR SOC Limits			Ancillary Service Capabilities				
		HSL	LSL	Min	Max	Hour Beginning	Reg-Up	Reg-Dn	Responsive	ECRS	NSRS
15	ESR3	40	-40	0	40	40	0	0	0	40	0
16	ESR3	40	-40	0	40	0	0	0	0	40	0

Two Ways for QSE to be Capacity Short



Overall Capacity Shortfall?

Capacity Obligations

Capacity Supplies

Ancillary Service Shortfall?

AS Positions

AS Capabilities

RUC Information for Hour 15



- QSE sold 40 MW ECRS through Trade
- QSE has no DAM Transactions
- ECRS Deployment Factor = 0

Current Operating Plan											
Hour	Resource Name	Resource Limits		ESR SOC Limits			Ancillary Service Capabilities				
		HSL	LSL	Min	Max	Hour Beginning	Reg-Up	Reg-Dn	Responsive	ECRS	NSRS
15	ESR3	40	-40	0	40	40	0	0	0	40	0
16	ESR3	40	-40	0	40	0	0	0	0	40	0

Two Ways for QSE to be Capacity Short



Overall Capacity Shortfall?

Capacity Obligations

Capacity Supplies

Ancillary Service Shortfall?

AS Positions

AS Capabilities

RUC Information for Hour 15



- QSE sold 40 MW ECRS through Trade
- QSE has no DAM Transactions
- ECRS Deployment Factor = 0.5

Current Operating Plan											
Hour	Resource Name	Resource Limits		ESR SOC Limits			Ancillary Service Capabilities				
		HSL	LSL	Min	Max	Hour Beginning	Reg-Up	Reg-Dn	Responsive	ECRS	NSRS
15	ESR3	40	-40	0	40	40	0	0	0	40	0
16	ESR3	40	-40	0	40	20	0	0	0	40	0

Two Ways for QSE to be Capacity Short



Overall Capacity Shortfall?

Capacity Obligations

Capacity Supplies

Ancillary Service Shortfall?

AS Positions

AS Capabilities

RUC Information for Hour 15

- QSE sold 40 MW ECRS through Trade
- QSE has no DAM Transactions
- ECRS Deployment Factor = 0.5



Current Operating Plan											
Hour	Resource Name	Resource Limits		ESR SOC Limits			Ancillary Service Capabilities				
		HSL	LSL	Min	Max	Hour Beginning	Reg-Up	Reg-Dn	Responsive	ECRS	NSRS
15	ESR3	40	-40	0	40	40	0	0	0	40	0
16	ESR3	40	-40	0	40	10	0	0	0	40	0

Two Ways for QSE to be Capacity Short



Overall Capacity Shortfall?

Capacity Obligations

Capacity Supplies

Ancillary Service Shortfall?

AS Positions

AS Capabilities

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Pre-requisite	WBT	Resources in ERCOT
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		Quick Start Generation Resources

ERCOT Training Information
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Course Recommendations
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