



Energy Storage (Order 841) Education

December 6, 2019

1. Update on 841 filing status
2. Overview
3. Rule/manual changes
4. Opt-in process/timeline
5. Markets Gateway changes
6. Operating in the Energy Markets
7. Participating in Ancillary Services
8. Settlements

“In this order, we accept PJM’s proposed revisions, to become effective December 3, 2019, ***subject to a further compliance filing***, to become effective on a date to be established by PJM, as discussed below. We also institute an investigation pursuant to section 206 of the Federal Power Act (FPA) and establish ***paper hearing procedures*** regarding the justness and reasonableness of PJM’s minimum run-time rules and procedures.” - Issued October 17, 2019

<https://www.ferc.gov/whats-new/comm-meet/2019/101719/E-2.pdf>

New filing by December 16, 2019 in existing docket ER19-469:

1. Add additional definitions and items into the Tariff.
2. Add to the Model to account for additional parameters.
 - FERC allowing PJM to propose a later effective date in order to achieve full compliance with the Final Rule.

New filing by Dec 12, 2019 in new docket EL19-100 (including paper hearing):

3. Add provisions reflecting “minimum run-time” * rules and procedures applicable to all resources into the Tariff.
4. Brief on “minimum run-time” rules as applied to Capacity Storage Resources (10 hour rule).

****“Minimum run-time” in Order 841 refers to the continuous output capability requirement in the Capacity market. This usage is not related to the PJM Tariff Term “Minimum Run Time”.***

- A. Add Minimum and Maximum Charge Limit; Minimum and Maximum Discharge Limit; and Charge and Discharge Ramp Rate bidding parameters into Tariff language.
- B. Add descriptions of three modes (continuous, charge, discharge) into Tariff language.
- C. Add which services constitute “dispatched to provide a service” in Dispatched Charging Energy definition into Tariff language.
- D. Add a general description and references for metering and accounting practices into Tariff language.
- E. Add provisions ensuring the separation and proper accounting of wholesale and retail uses into Tariff language.
- F. Add statement that PJM will not charge a distribution-connected Energy Storage Resource for charging energy if the distribution utility is unwilling or unable to net out any energy purchases associated with the Energy Storage Resource’s wholesale charging activities from the host customer’s retail bill into Tariff language.

- G. Enhance the participation model to more appropriately account for an ESR's State of Charge, Maximum State of Charge, and Minimum State of Charge through bidding parameters or other means in both PJM's day-ahead and real-time market dispatch.

Initial Proposed PJM ESR Participation Model

**Go Live
Dec 3**

ER19-469

More Definitions & Detail in Tariff

Dec 16

EL 19-100

Continuous Output Requirement for RPM in Tariff

ER19-469

“Account for State of Charge” enhancement in PJM ESR Participation Model

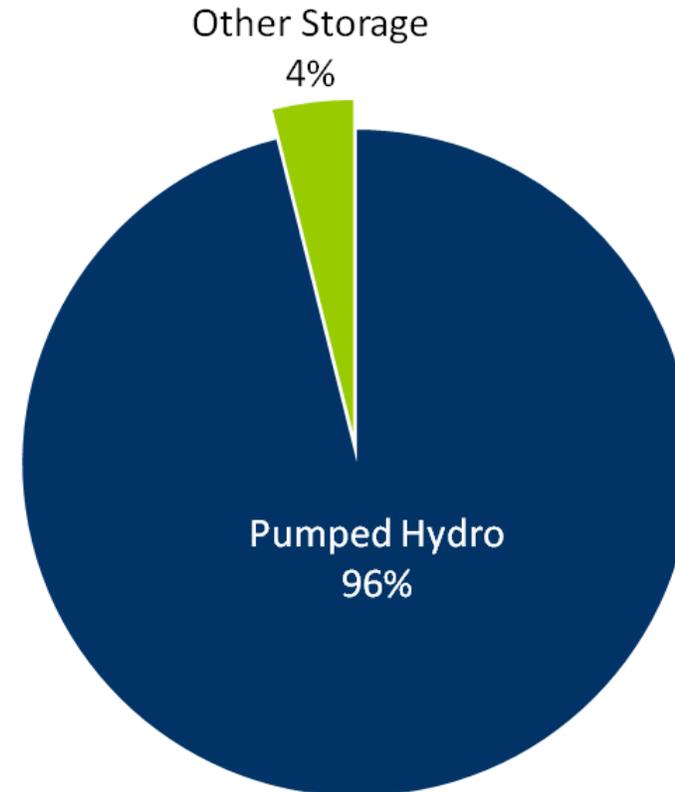
Energy Storage Overview

- | | |
|--|---|
| 1. Can sell* energy, <u>Capacity</u> , and A/S (incl. Black Start etc.) the resource is technically capable of providing | |
| 2. <u>Dispatched</u> and <u>sets price</u> as seller and buyer | |
| 3. Bid parameters that account for ESR characteristics | |
| 4. Min market threshold is 100 kW |  = already in compliance |
| 5. Stored MWh are billed at LMP as wholesale | |

* “Eligible to provide...”

- Electric Storage Resource (**ESR**)= “a resource capable of receiving electric energy from the grid and storing it for later injection of electric energy back to the grid.”
- Connected at: transmission, distribution, or behind a customer meter.
 - PJM has ESR at both T and D today, none behind a meter **that inject.**
- Excludes demand response.
- Includes pumped hydro

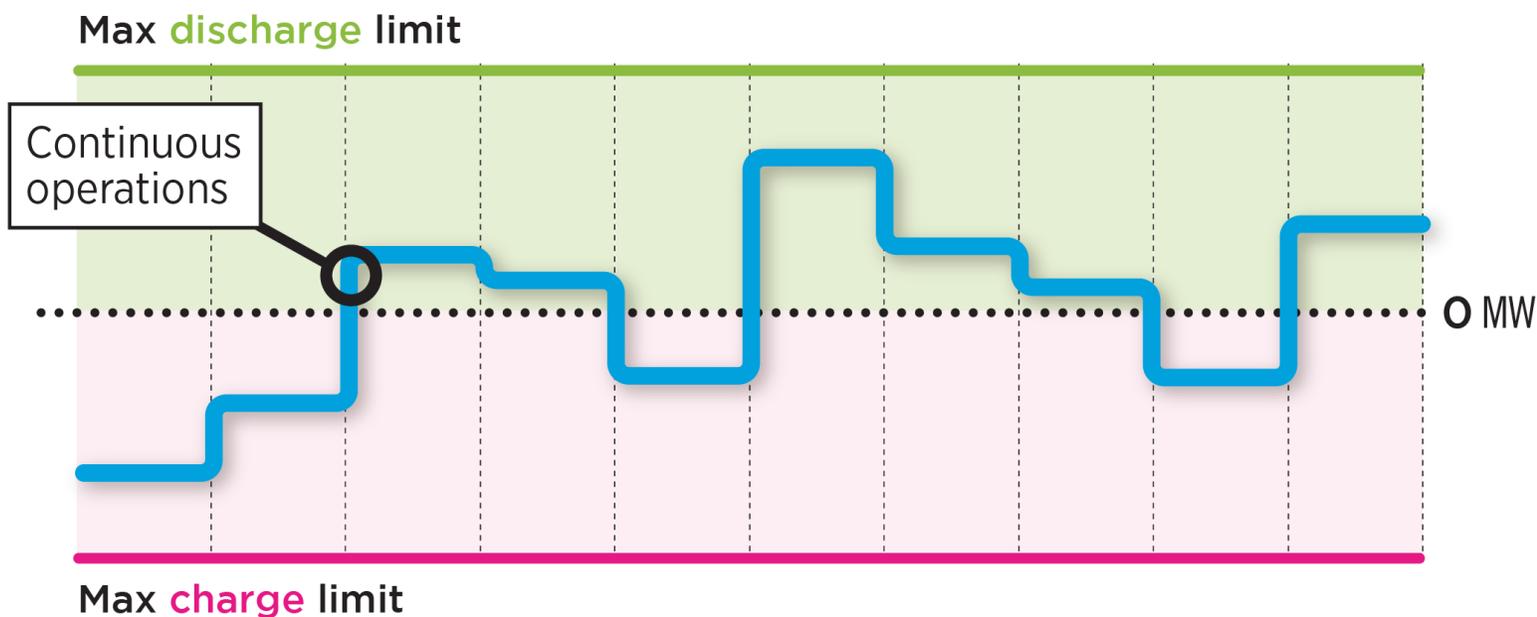
Over 5,300 MW of Electric Storage Resources currently in PJM



** Data taken from Generation Queue and EIA 860

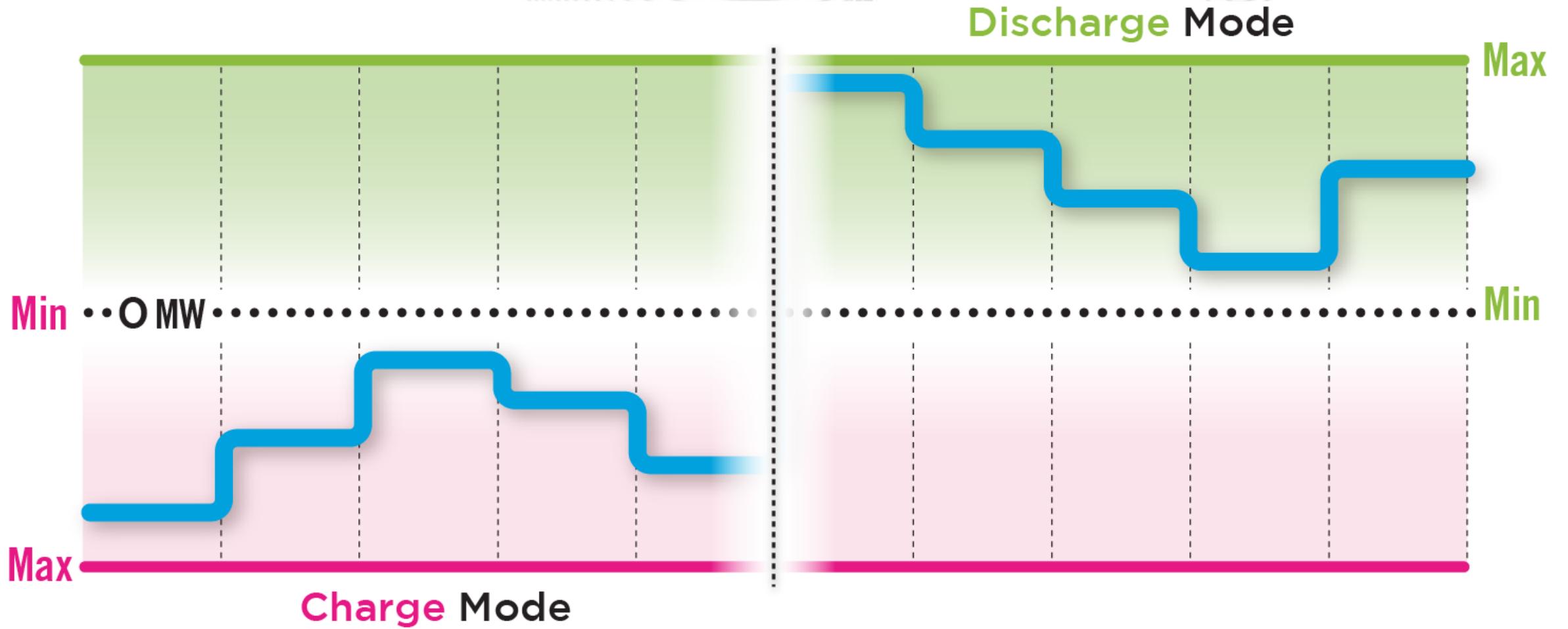
- ESRs will be modeled as one continuous resource
- PJM will not make commitment decisions in the ESR model
 - Start-up and no load cost will not be considered
- PJM will not manage state of charge
 - Resource owners use mode of operation, offers, and parameters
- 3 modes of operation:
 - Continuous, Charge & Discharge
- Parameters
 - Max/Min charge/discharge, etc
 - Ramp rate considered infinite only in continuous mode

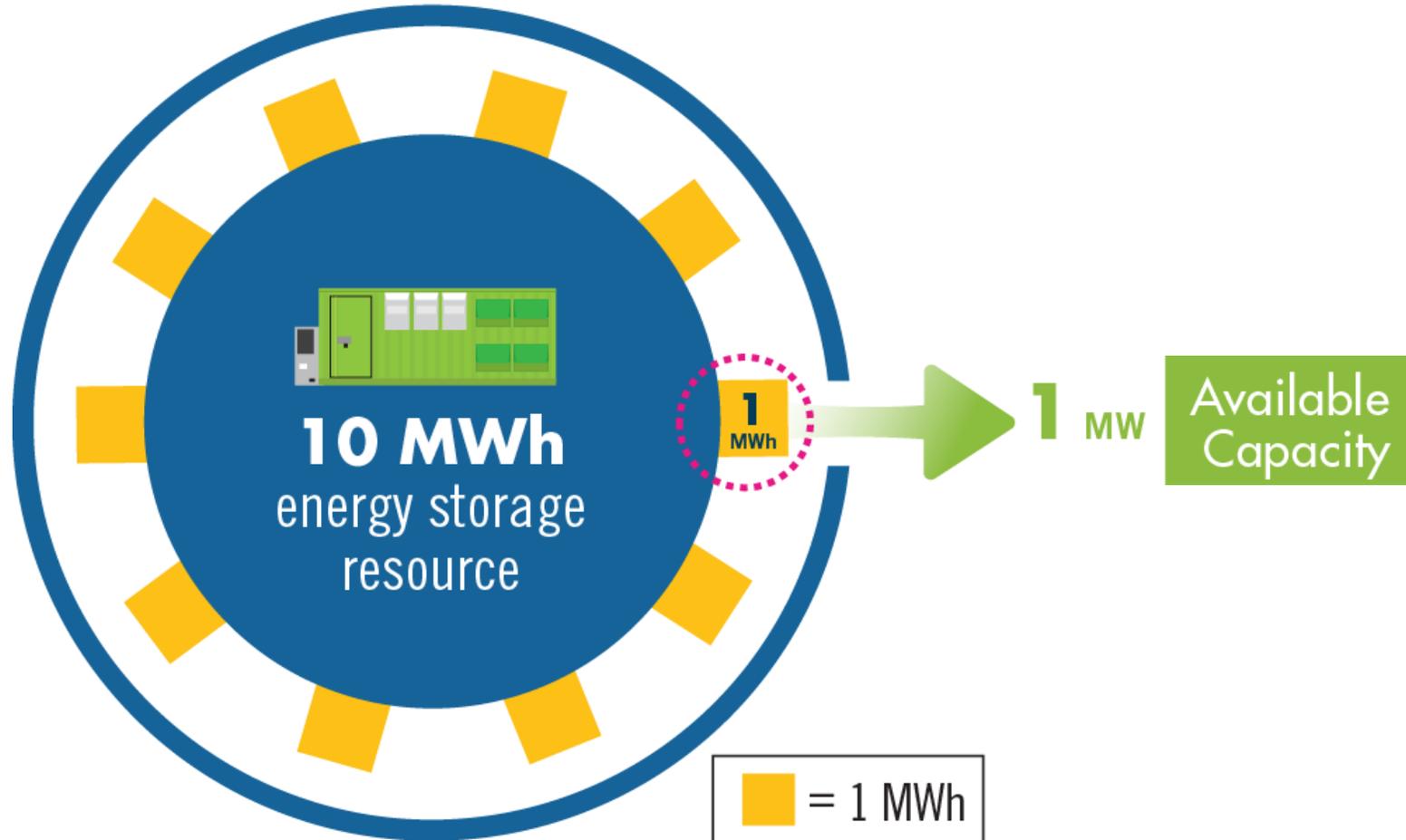
ESRs can update their max charge and discharge limits hourly in day-ahead, and more frequently in real-time.



Price	MW
\$ 10.00	20
\$ 9.00	15
\$ 8.00	10
\$ 7.00	5
\$ 6.00	0
\$ 5.00	0
\$ 4.00	0
\$ 3.00	-5
\$ 2.00	-10
\$ 1.00	-15

** State of charge telemetry will be requested for telemetered resources



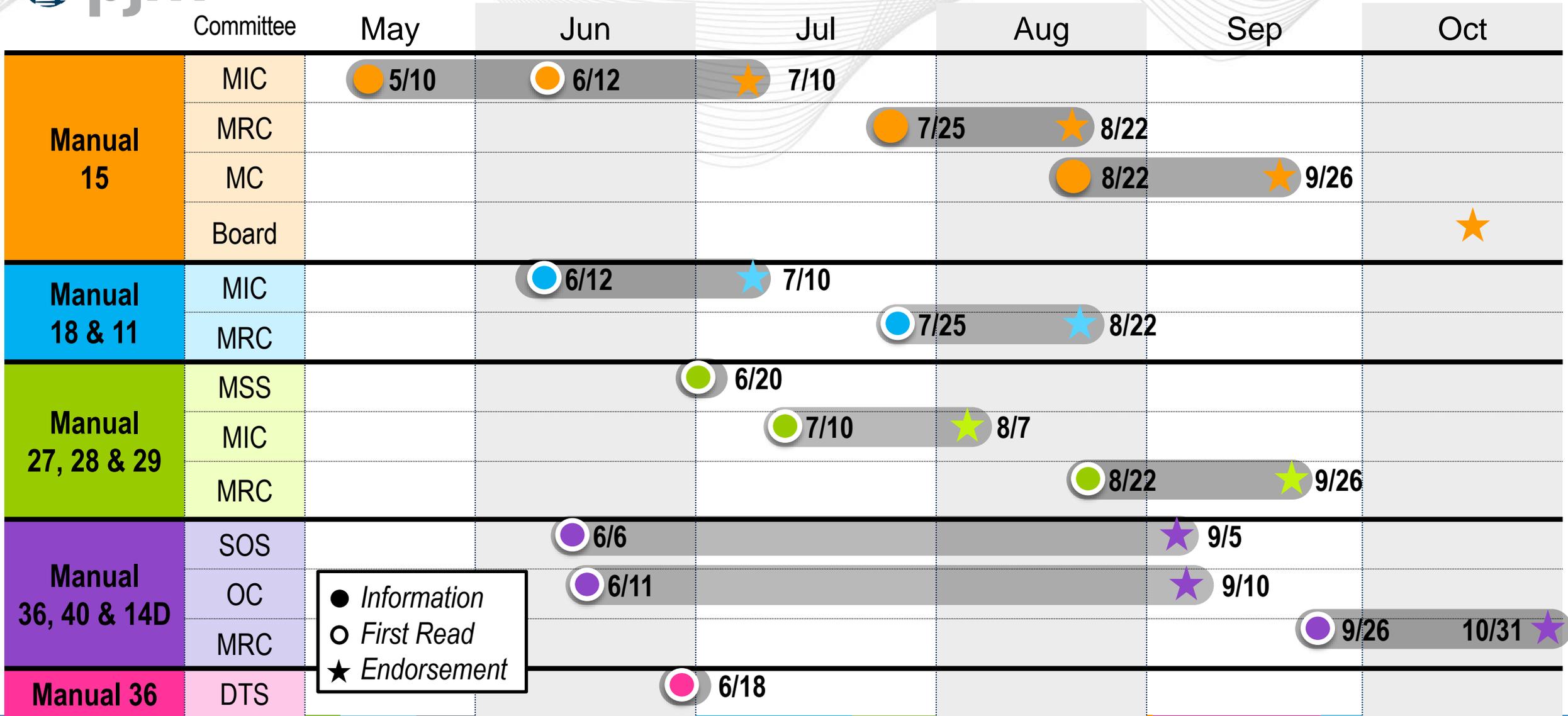


PJM maintaining the requirement, per manual 21, that capacity resources have a minimum 10 hour duration.

ESR capacity interconnection rights will be derated based on the total energy capability of the resource

- Total MWh/10h

Review of Manual Updates



Review Opt-in Process

- Per Manual 11: ESR Participation Model Election (i.e. Opt In/Opt Out)
 - Existing resources must send opt-in requests no later than September 30 for the upcoming January 1 to December 31 participation months.
 - Resources within the new resource queue process must send an opt in request no later than three months in advance of their initial start in the energy markets.

Markets Gateway Changes

Markets Gateway

Market Day: 10/11/2019 Portfolio: PJM TEST PORTFOLIO Location: PJM TEST UNIT

Hourly Updates | Detail | Energy Ramp Rates | Synchronized Reserve Ramp Rates | Wind Forecast | Solar Forecast | IntraDay Opt Out | ESR Updates

PJMST >> 2019-10-11 >> PJM TEST UNIT (UnitID) Last Updated Date/Time:

Discharge Emer. Min. : 2.0 Econ. Min. : 3.0 Econ. Max. : 5.0 Emer. Max. : 6.0 Charge Emer. Min. : -2.0 Econ. Min. : -3.0 Econ. Max. : -5.0 Emer. Max. : -6.0 Commit Status : Unavailable Fixed Gen : No

Hour	Discharge Emer. Min. (Default)	Discharge Econ. Min. (MW)	Discharge Econ. Min. (Default)	Discharge Econ. Min. (MW)	CIR	Discharge Econ. Max. (Default)	Discharge Econ. Max. (MW)	Discharge Econ. Max. (Default)	Discharge Econ. Max. (MW)	Charge Emer. Min. (Default)	Charge Emer. Min. (MW)	Charge Econ. Min. (Default)	Charge Econ. Min. (MW)	Charge Econ. Max. (Default)	Charge Econ. Max. (MW)	Charge Econ. Max. (Default)	Charge Econ. Max. (MW)	Charge Emer. Max. (Default)	Charge Emer. Max. (MW)	Commit Status	Fixed Gen.?	Ancillary Only?
1	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
2	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
3	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
4	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
5	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
6	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
7	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Charge	No	No
8	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Discharge	No	No
9	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Continuous	No	No
10	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
11	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
12	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
13	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
14	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
15	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
16	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
17	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
18	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
19	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
20	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
21	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
22	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
23	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No
24	2.0		3.0			5.0		6.0		-2.0		-3.0		-5.0		-6.0		-6.0		Unavailable	No	No

pjm | Markets Gateway

Market Day: 10/11/2019 | Portfolio: PJM TEST PORTFOLIO | Location: PJM TEST UNIT

Refresh | Save

Hourly Updates | **Detail** | Energy Ramp Rates | Synchronized Reserve Ramp Rates | Wind Forecast | Solar Forecast | IntraDay Opt Out | ESR Updates

PJMST >> 2019-10-11 >> PJM TEST UNIT (UnitID) | Last Updated Date/Time:

Description

Type of Unit	All Battery Units	Plant Name	PJM
Unit Number	1	Unit Name	PJM TEST UNIT
Node	PJM69 KV NODE	Operating Company	PJMST
Capacity Resource	<input type="checkbox"/>	Regulation Resource	<input type="checkbox"/>
Capacity Performance	<input type="checkbox"/>		Energy Storage <input checked="" type="checkbox"/>

Defaults

Commit Status	Not Available	Ramp Rate	0.1
Fixed Generation	<input type="checkbox"/>		

Miscellaneous

Reduced Ramp Rate Percent	0	Self Supply	<input type="checkbox"/>
Discharge Spinning Max	5	Charge Spinning Max	-5
State Of Charge Min		State Of Charge Max	

Economic & Emergency

Discharge Emergency Min	2	Charge Emergency Min	-2
Discharge Economic Min	3	Charge Economic Min	-3
Discharge Economic Max	5	Charge Economic Max	-5
Discharge Emergency Max	6	Charge Emergency Max	-6

Condense

Available	<input type="checkbox"/>	Startup Cost	
Energy Usage		To Generation Cost	
Notification Time		Hourly Cost	

- Bilaterals
- Con Edison
- Demand
- ▶ Demand Response
- ▼ Generator
 - Unit
 - Schedules
 - Dispatch Lambda
 - Market Results
 - Regulation Market
 - Synchronized Reserve Mar
 - Day-Ahead Scheduling Res
 - Unit Limitations
 - Interface Pricing
 - Opportunity Cost Calculator
 - Parameter Limits
 - Price Responsive Demand

Market Day Portfolio Location

PJMTST >> 2019-10-02 >> PJM TEST UNIT (UnitID)

MW	Up Ramp Rate	Down Ramp Rate
-3.0	0.5	0.5
3.0	0.5	0.5

One continuous ramp rate that supports negative MW

pjm | Markets Gateway

Market Day Portfolio Location

PJMTST >> 2019-10-02 >> PJM TEST UNIT (UnitID)

MW	Rate
-3.0	3.0
-2.0	4.0
2.0	5.0

One continuous ramp rate that supports negative MW



Generator > Unit > ESR Updates (information only)

pjm | Markets Gateway

Market Day: 10/11/2019 Portfolio: PJM TEST PORTFOLIO Location: PJM TEST UNIT

Hourly Updates | Detail | Energy Ramp Rates | Synchronized Reserve Ramp Rates | Wind Forecast | Solar Forecast | IntraDay Opt Out | **ESR Updates**

PJMTST >> 2019-10-11 >> PJM TEST UNIT (UnitID)

<input type="checkbox"/>	Hour	State Of Charge (MW)
<input type="checkbox"/>	1	
<input type="checkbox"/>	2	
<input type="checkbox"/>	3	
<input type="checkbox"/>	4	
<input type="checkbox"/>	5	
<input type="checkbox"/>	6	
<input type="checkbox"/>	7	
<input type="checkbox"/>	8	
<input type="checkbox"/>	9	
<input type="checkbox"/>	10	
<input type="checkbox"/>	11	
<input type="checkbox"/>	12	
<input type="checkbox"/>	13	
<input type="checkbox"/>	14	
<input type="checkbox"/>	15	
<input type="checkbox"/>	16	
<input type="checkbox"/>	17	
<input type="checkbox"/>	18	
<input type="checkbox"/>	19	
<input type="checkbox"/>	20	
<input type="checkbox"/>	21	
<input type="checkbox"/>	22	
<input type="checkbox"/>	23	
<input type="checkbox"/>	24	

Markets Gateway

Market Day: Portfolio: Location: Schedule:

PJMTST >> 2019-10-11 >> PJM TEST UNIT (UnitID) >> Schedule (1) Use Offer Slope

MW	Price
-5.0	-5.00
Supports negative MW -4.0	Supports negative price -2.00
-3.0	4.00
-2.0	11.00
4.0	17.00
5.0	29.00

- Bilaterals
- Con Edison
- Demand
- ▶ Demand Response
- ▼ Generator
 - Unit
 - Schedules**
 - Dispatch Lambda
 - Market Results
 - Regulation Market
 - Synchronized Reserve Mar
 - Day-Ahead Scheduling Res
 - Unit Limitations
 - Interface Pricing
 - Opportunity Cost Calculator
 - Parameter Limits
 - Price Responsive Demand
 - Pseudo Tie Transaction
 - ▶ Public
 - System Utilities
 - Up-To-Transaction
 - Virtual
 - Weather Forecast

Market Day Portfolio Location Schedule

Refresh Save

Offers Offer Updates Detail Detail Updates Manager Selection Availability Update Restriction Information TPS Schedule Switch

PJMTST >> 2019-10-11 >> PJM TEST UNIT (UnitID) >> Schedule (1) Last Updated Date/Time: No Updates

<input type="checkbox"/>	Hour	MW	Price	Capped Price
<input type="checkbox"/>	1			
<input type="checkbox"/>	2			
<input type="checkbox"/>	3			
<input type="checkbox"/>	4			
<input type="checkbox"/>	5			
<input type="checkbox"/>	6			
<input type="checkbox"/>	7			
<input checked="" type="checkbox"/>	8			
		Supports negative MW	-5.0	17.00
			-4.0	18.00
			-3.0	24.90
			-2.0	27.00
			4.0	28.00
			5.0	29.00
<input type="checkbox"/>	9			
<input type="checkbox"/>	10			
<input type="checkbox"/>	11			

- Bilaterals
- Con Edison
- Demand
- ▶ Demand Response
- ▼ Generator
 - Unit
 - Schedules**
 - Dispatch Lambda
 - Market Results
 - Regulation Market
 - Synchronized Reserve Mar
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 - Unit Limitations
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- Opportunity Cost Calculator
- Parameter Limits
- Price Responsive Demand
- Pseudo Tie Transaction
- ▶ Public
 - System Utilities
 - Up-To-Transaction
 - Virtual
 - Weather Forecast

Market Day Portfolio Location Schedule Refresh XML Save CSV

- Offers
- Offer Updates
- Detail**
- Detail Updates
- Manager
- Selection
- Availability Update
- Restriction Information
- TPS Schedule Switch

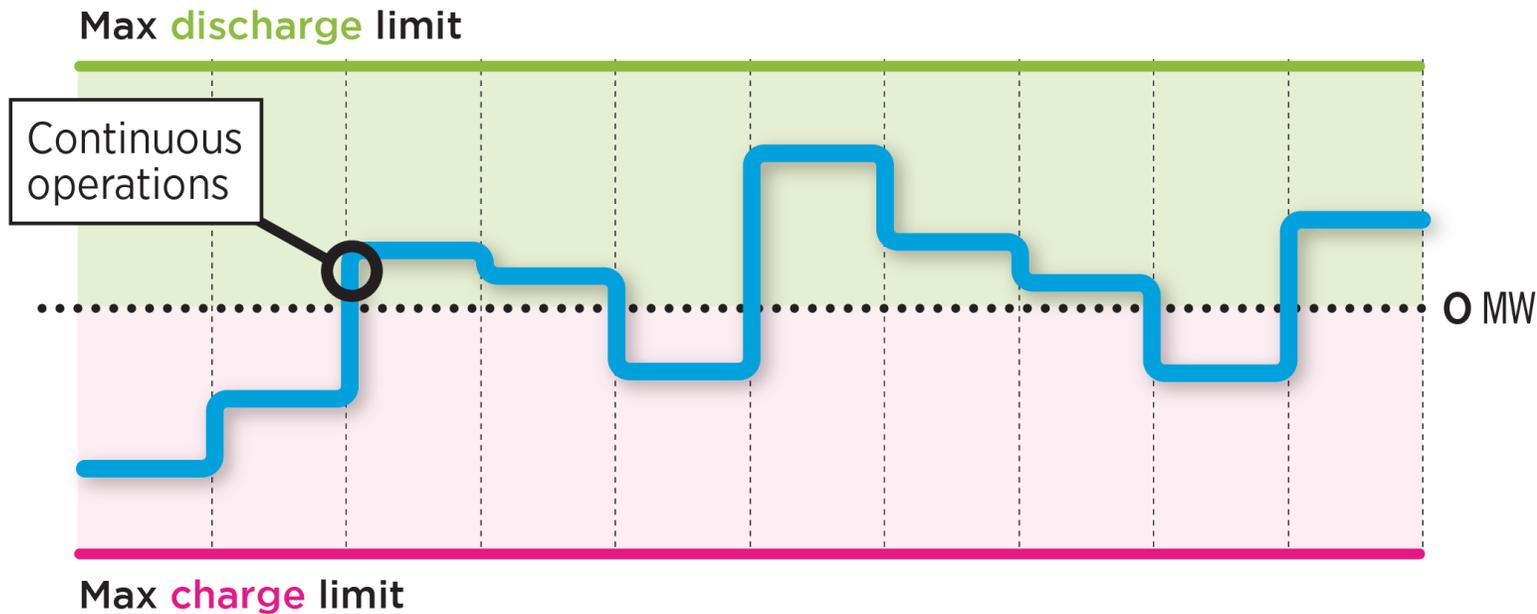
Time			
Cold Notification	<input type="text"/>	Cold Startup	<input type="text"/>
Cold Notification Limit	<input type="text"/>	Cold Startup Limit	<input type="text"/>
Intermediate Notification	<input type="text"/>	Intermediate Startup	<input type="text"/>
Intermediate Notification Limit	<input type="text"/>	Intermediate Startup Limit	<input type="text"/>
Hot Notification	<input type="text"/>	Hot Startup	<input type="text"/>
Hot Notification Limit	<input type="text"/>	Hot Startup Limit	<input type="text"/>
Hot-To-Cold	<input type="text"/>	Hot-To-Intermediate	<input type="text"/>
Cold Soak Time	<input type="text"/>	Intermediate Soak Time	<input type="text"/>
Hot Soak Time	<input type="text"/>		

Economic & Emergency			
Discharge Emergency Min	<input type="text" value="2"/>	Charge Emergency Min	<input type="text" value="-2"/>
Discharge Emergency Min Default	<input type="text" value="2"/>	Charge Emergency Min Default	<input type="text" value="-2"/>
Discharge Economic Min	<input type="text" value="3"/>	Charge Economic Min	<input type="text" value="-3"/>
Discharge Economic Min Default	<input type="text" value="3"/>	Charge Economic Min Default	<input type="text" value="-3"/>
Discharge Economic Max	<input type="text" value="5"/>	Charge Economic Max	<input type="text" value="-5"/>
Discharge Economic Max Default	<input type="text" value="5"/>	Charge Economic Max Default	<input type="text" value="-5"/>
Discharge Emergency Max	<input type="text" value="6"/>	Charge Emergency Max	<input type="text" value="-6"/>
Discharge Emergency Max Default	<input type="text" value="6"/>	Charge Emergency Max Default	<input type="text" value="-6"/>

Operating in the Energy Markets (DA & RT)

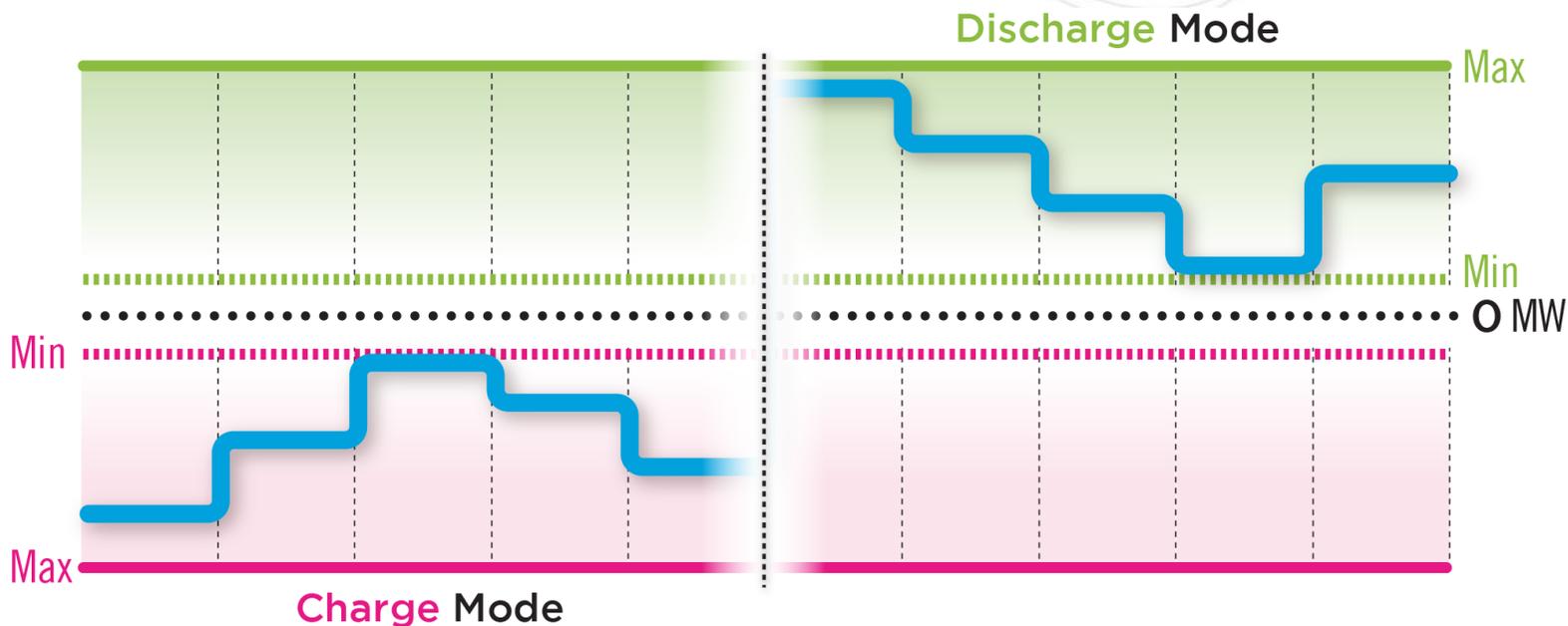
- ESRs will be modeled as one continuous resource
- PJM will not make commitment decisions in the ESR model
 - Start-up and no load cost will not be considered
- PJM will not manage state of charge
 - Resource owners use mode of operation, offers, and parameters
- 3 modes of operation:
 - Continuous, Charge & Discharge
- Parameters
 - Max/Min charge/discharge, etc
 - Ramp rate considered infinite only in continuous mode

ESRs can update their max charge and discharge limits hourly in day-ahead, and more frequently in real-time.



Price	MW
\$ 10.00	20
\$ 9.00	15
\$ 8.00	10
\$ 7.00	5
\$ 6.00	0
\$ 5.00	0
\$ 4.00	0
\$ 3.00	-5
\$ 2.00	-10
\$ 1.00	-15

** State of charge telemetry will be requested for telemetered resources



Charge & Discharge mode will be available to ESR resources in Day Ahead and Real Time.

- ESRs will be dispatched following the operational mode for the applicable hour.
 - Economic limits for the operational mode will be honored.
 - Ramp considered infinite only in continuous mode.
 - State of charge managed by the market participant.
- Dispatchable ESRs will have the ability to set price.
 - Applies to all three operational modes.
- Regulation assignments for ESR will be honored in the real time dispatch.
 - No change from current logic.

Participating in Ancillary Services

- Resources cannot be both in the ESR model and also a non-energy resource
- However, ESRs can select Ancillary Only = 'Yes' for any hours they wish to provide Regulation or Reserves and not provide Energy

Markets Gateway

Market Day: 11/4/2019 Portfolio: Location:

Refresh Save

Hourly Updates Detail Energy Ramp Rates Synchronized Reserve Ramp Rates Wind Forecast Solar Forecast IntraDay Opt Out ESR Updates

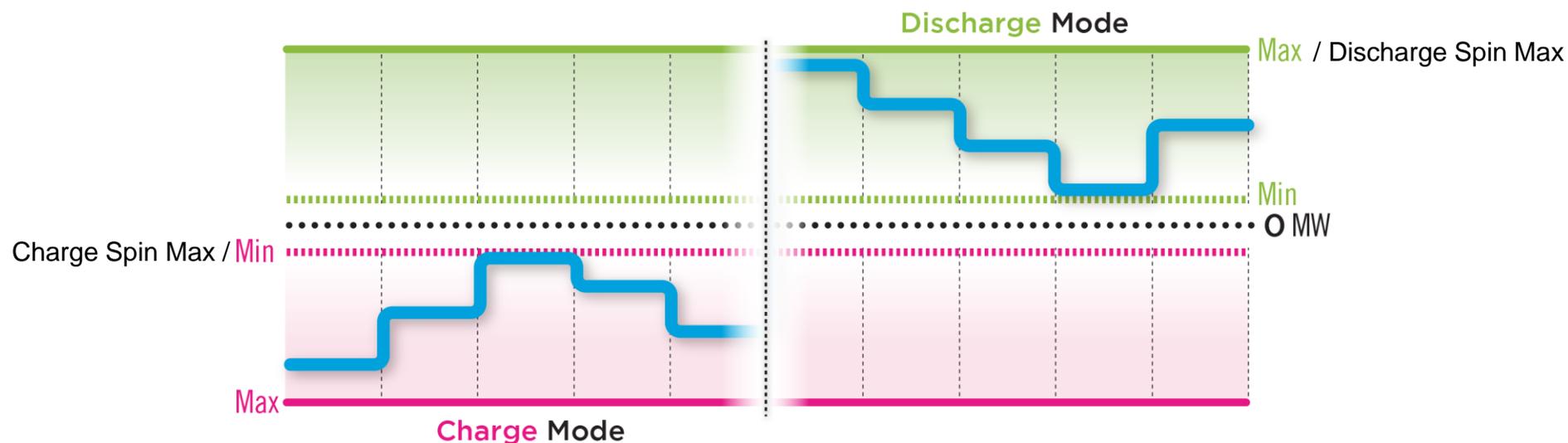
Last Updated Date/Time:

Discharge Emer. Min. Econ. Min. Econ. Max. Emer. Max. Charge Emer. Min. Econ. Min. Econ. Max. Emer. Max. Commit Status Fixed Gen. Ancillary Only?

Hour	Discharge Emer. Min. (Default)	Discharge Emer. Min. (MW)	Discharge Econ. Min. (Default)	Discharge Econ. Min. (MW)	CIR	Discharge Econ. Max. (Default)	Discharge Econ. Max. (MW)	Discharge Emer. Max. (Default)	Discharge Emer. Max. (MW)	Charge Emer. Min. (Default)	Charge Emer. Min. (MW)	Charge Econ. Min. (Default)	Charge Econ. Min. (MW)	Charge Econ. Max. (Default)	Charge Econ. Max. (MW)	Charge Emer. Max. (Default)	Charge Emer. Max. (MW)	Commit Status	Fixed Gen.?	Ancillary Only?
1																		Unavailable		No
2																		Unavailable		No
3																		Unavailable		No
4																		Unavailable		No
5																		Unavailable		No
6																		Unavailable		No
7																		Unavailable		No
8																		Unavailable		No
9																		Unavailable		No
10																		Unavailable		No
11																		Unavailable		No
12																		Unavailable		No
13																		Unavailable		No
14																		Charge		No
15																		Charge		No
16																		Charge		No

- ESRs can provide Synchronized Reserve in charge, discharge, or continuous modes
- An ESR that is providing both Energy and Reserves will be considered flexible Tier 2 SR
- For ESRs that choose Ancillary Only:
 - Pumped storage hydro will need to offer as Spin as Condenser = Yes and will be considered inflexible Tier 2 SR
 - All other Ancillary Only ESRs can set their flexibility by the Flexible parameter under Unit > Synchronized Reserve Market > Offers (Daily) or Updates (Hourly)
- By default, ESRs are not included in the Tier 1 Synchronized Reserve calculation, but can follow the current process to request an exception
- Available ESRs are always considered online, therefore they are not eligible to be considered for Non-Synchronized Reserve

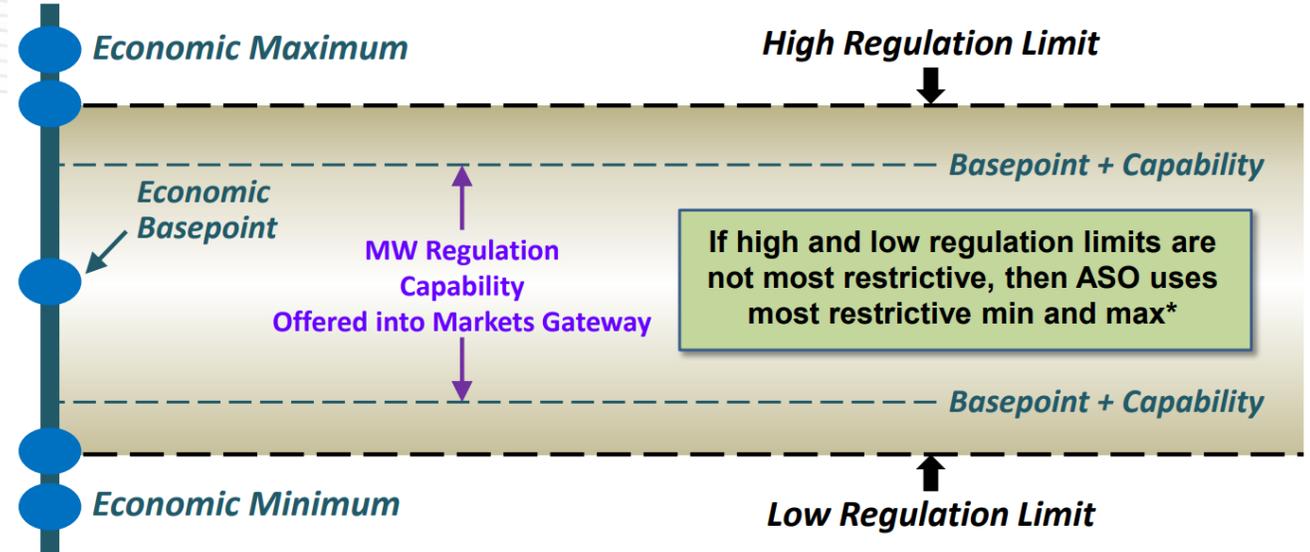
New Parameters	Location
Charge Spin Max	Unit > Detail (Default) Synchronized Reserve Market > Updates (Hourly)
Flexible	Synchronized Reserve Market > Offers (Daily) & Updates (Hourly)
Ancillary Only	Unit > Hourly Updates



- ESRs can provide Regulation in charge, discharge, or continuous modes

The Regulation MWs available to clear are bounded by the following limits:

$$RegMW \leq \text{Min}\left[\frac{\text{Abs}[RegHigh - RegLow]}{2}, Reg\ Offer\right]$$



	Charge Mode	Discharge Mode	Continuous Mode
RegHigh =	Min(RegMax, ChargeMin)	Min(RegMax, DischargeMax)	Min(RegMax, DischargeMax)
RegLow =	Max(RegMin, ChargeMax)	Max(RegMin, DischargeMin)	Max(RegMin, ChargeMax)

Settlements

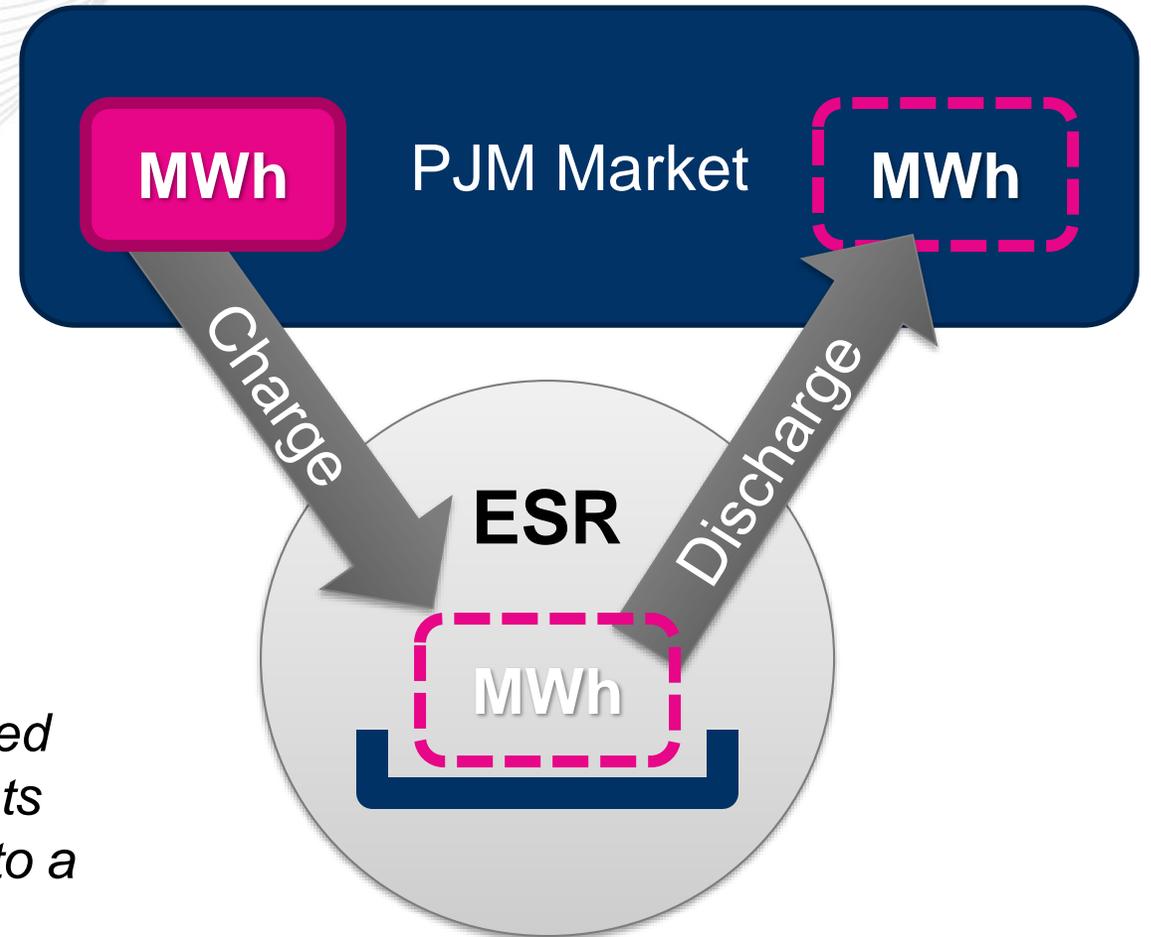
Definition of Energy Storage Resource and Charging

PJM Order 841 Compliance filing
ER19-462 and current Tariff:

“Energy Storage Resource” shall mean a resource capable of receiving electric energy from the grid and storing it for later injection to the grid that participates in the PJM Energy, Capacity and/or Ancillary Services markets as a Market Participant.

M28 draft:

“An Energy Storage Resource shall be considered charging when the Revenue Data for Settlements for a Real Time Settlement Interval corresponds to a withdrawal.”



Non-Dispatched Charging Energy

- New sections 22.1 and 22.2 of Manual 28 and matching new sections 8.1 and 8.2 of Manual 27
- Manual 28 new section 8.4

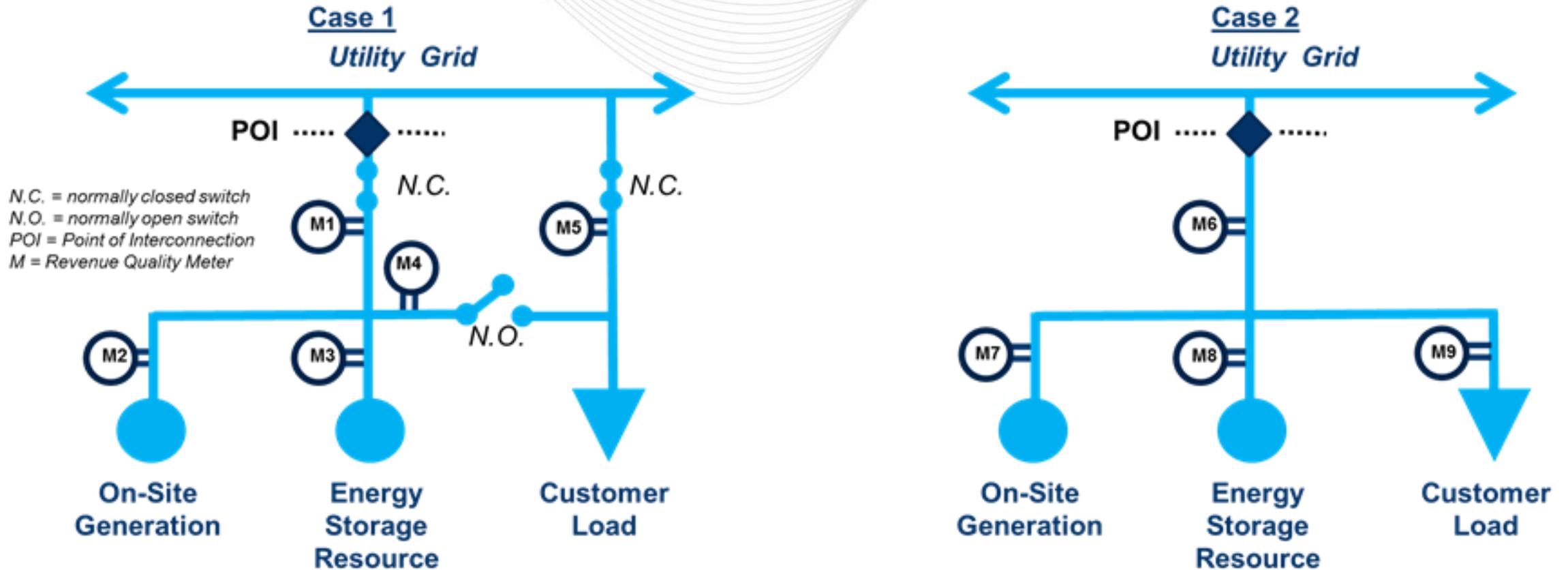
- Dispatched Charging Energy
 - Dispatched for a service
 - Economically dispatched by PJM in real-time
 - Assigned Regulation, Tier 2 Sync Reserves or Reactive Service
 - Manually dispatched for system reliability
- Non-Dispatched Charging Energy
 - Pays applicable transmission service charges as a Network Service User

“Therefore, Non-Dispatched Charging Energy is eligible for allocation of the following non-LMP charges and credits:”

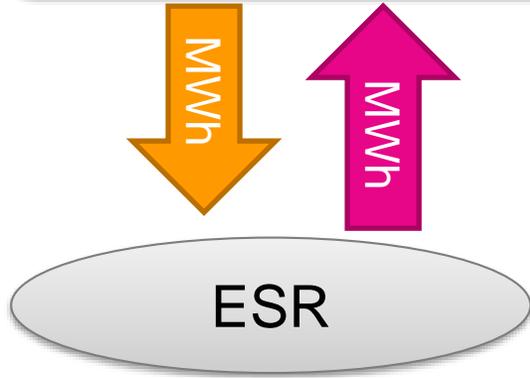
- *Schedule 1A Transmission Owner Scheduling, System Control and Dispatch Service*
- *Schedule 9-3, 9-FERC, 9-OPSI, 9-CAPS, 9-FINCON, 9-MMU, and 9-PJM Settlement*
- *Schedule 10-NERC and 10-RFC*
- *Network Integration Transmission Service*
- *Network Transmission Service Offset*
- *Network Integration Transmission Service (ATSI Low Voltage)*
- *MTEP Project Cost Recovery*
- *Transmission Enhancement*
- *Other Supporting Facilities*
- *Non-Firm Point-to-Point Transmission Service*
- *RTO Start-up Cost Recovery*
- *Black Start Service*
- *Unscheduled Transmission Service*
- *Reactive Supply and Voltage Control from Generation and Other Sources Service”*

Load Serving Charging Energy

- New section 22.1 of Manual 28 and matching new section 8.1 of Manual 27
- Manual 27 new section 8.3
- Manual 28 new sections 22.3, 22.4, and 22.5



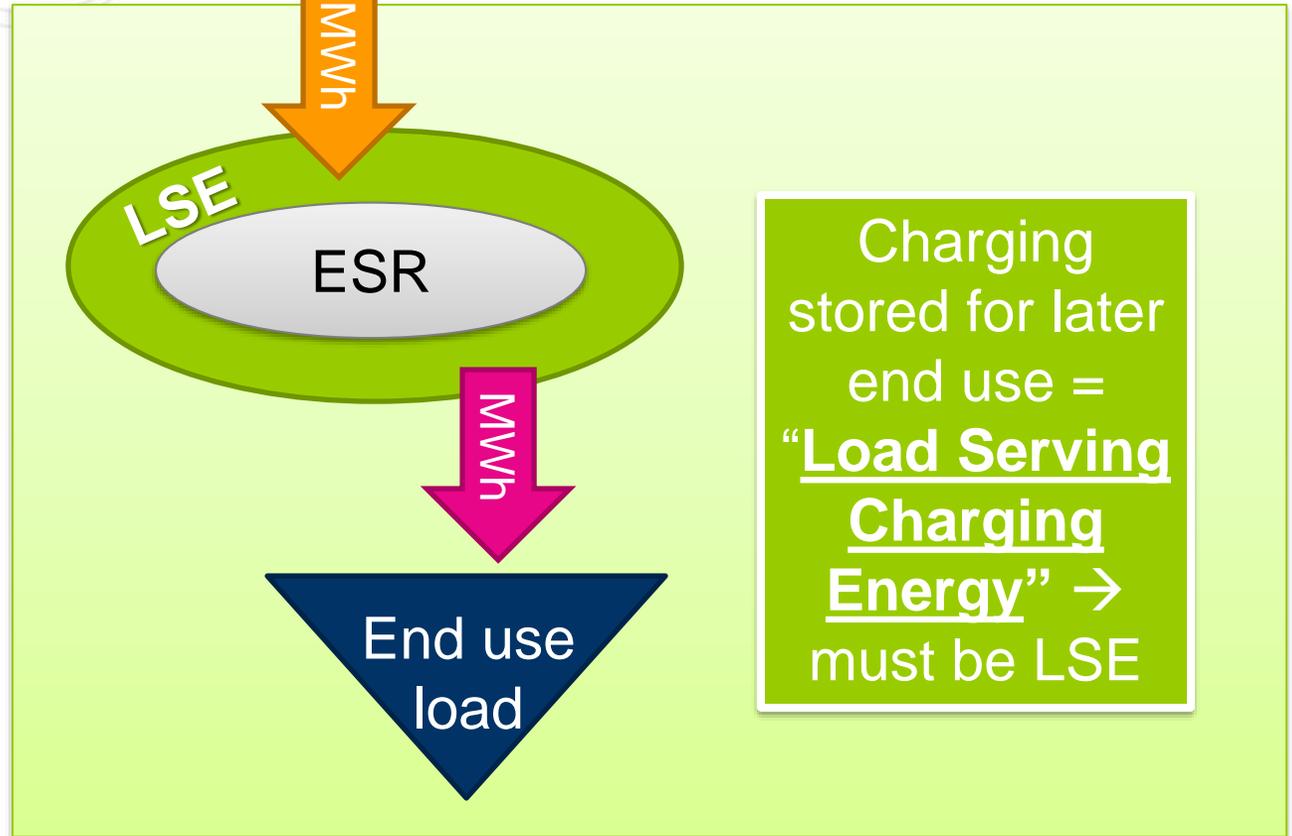
PJM Energy Market



Charging stored for later wholesale sale = **“Direct Charging Energy”**

Dispatched Charging Energy

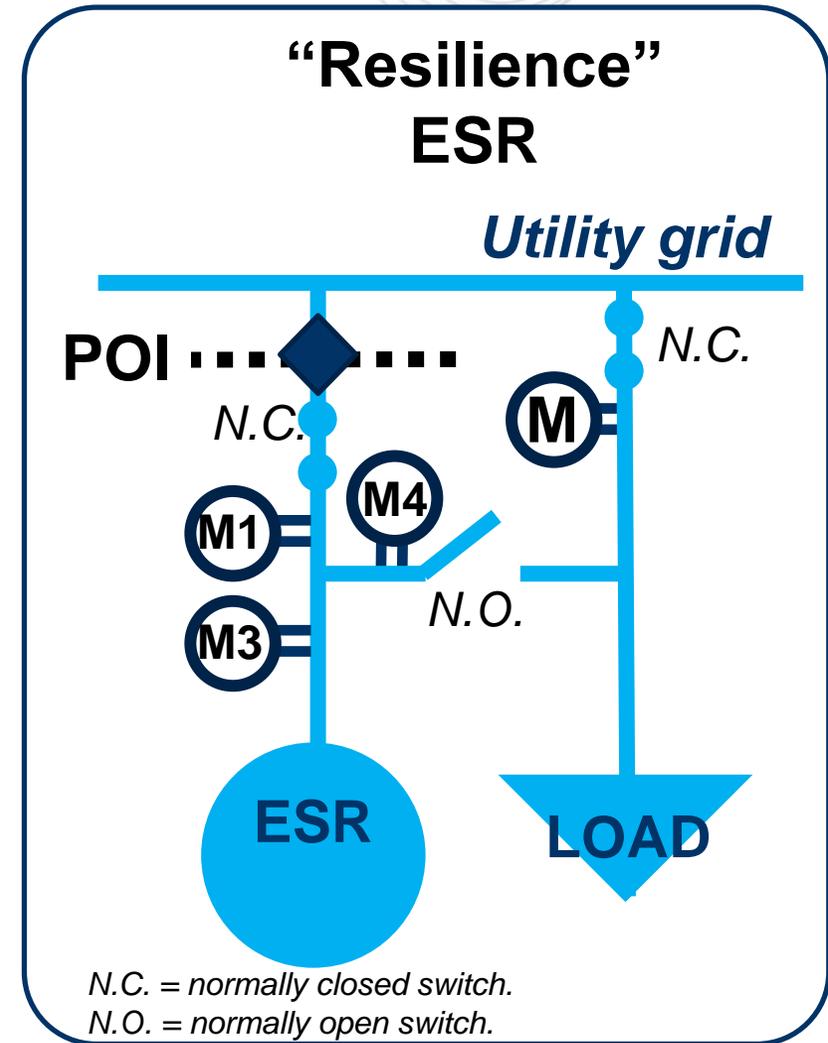
Non-Dispatched Charging Energy

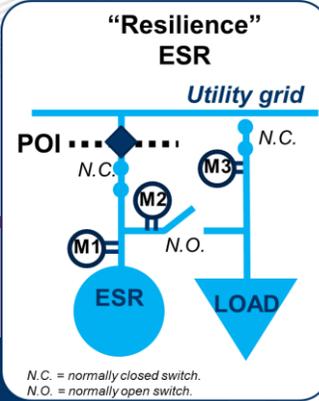


Charging stored for later end use = **“Load Serving Charging Energy”** → must be LSE

- Load Serving Energy Storage Resources are capable of directly serving end use load.
- Metering and methods are defined to distinguish:
 1. Charging energy that is later returned to PJM (“Direct Charging Energy”) from
 2. Charging energy that is later provided to end use load (“Load Serving Charging Energy”)
- PJM to provide Electric Distribution Company with processes to appropriately account for Direct Charging Energy (as negative generation) vs. Load Serving Charging Energy (as load).

- 100% of withdrawals initially settled as negative generation (i.e., Direct Charging Energy)
- ESR can only charge from grid.
- **Monthly M4 appropriately captures stored grid energy that is sent to end user → monthly “Load Serving Charging Energy”.**
- The sum of M4 over a month is the monthly quantity that should be ex-post adjusted from “Direct Charging Energy” into “Load Serving Charging Energy”.





Initial Settlement

PJM Settlements

Debit

100% of Charging

ESR

LSE

Final Settlement

PJM Settlements

EDC

Meter Correction
Credit

90% of Charging

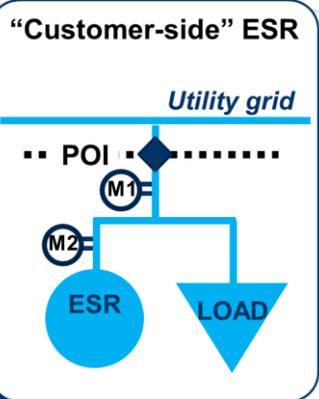
10%

ESR

Load reconciliation
Debit

10%

LSE



Initial Settlement

PJM Settlements

Debit



Final Settlement

PJM Settlements

EDC

Meter Correction

Debit

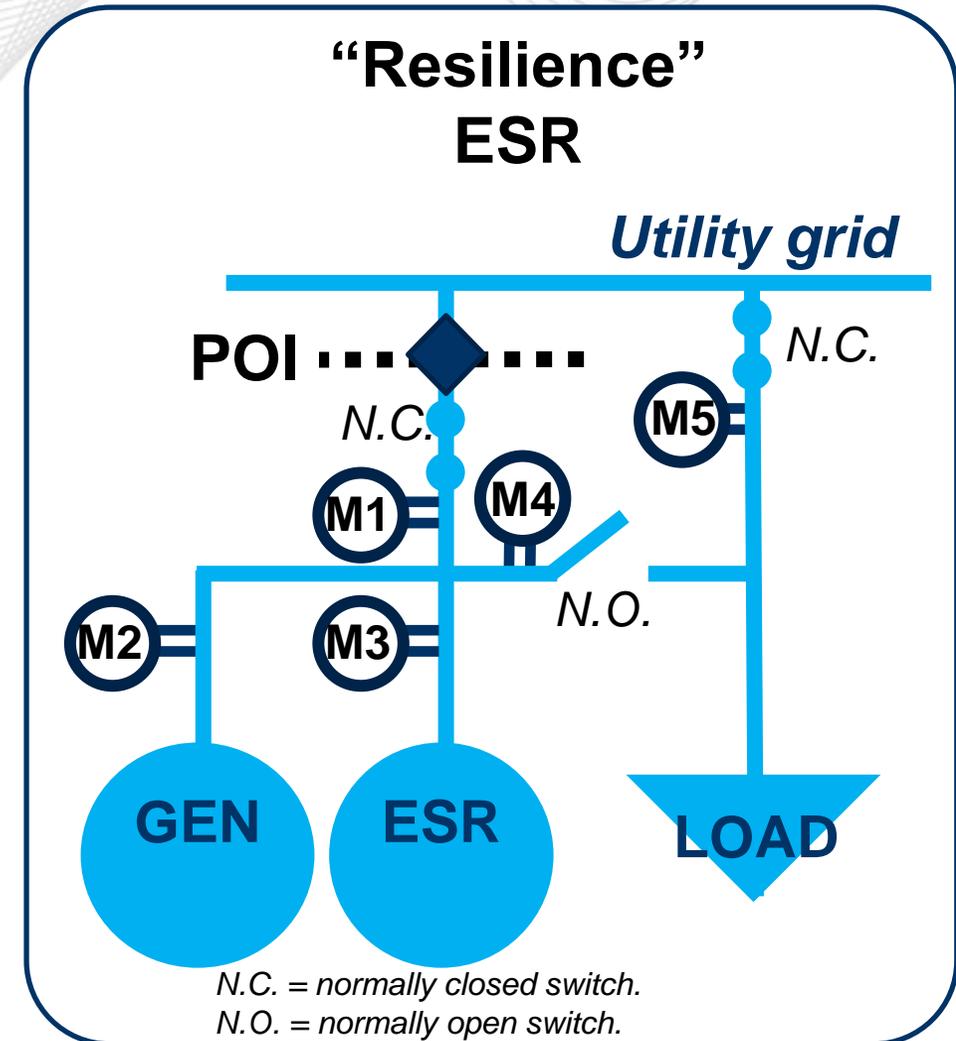


Load reconciliation

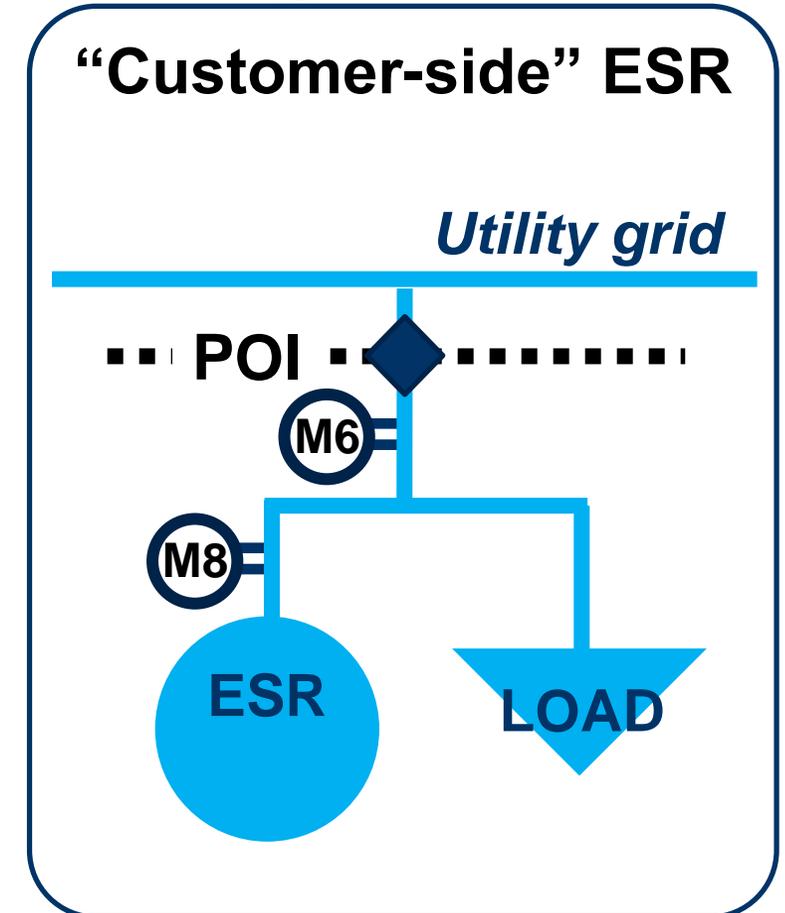
Credit



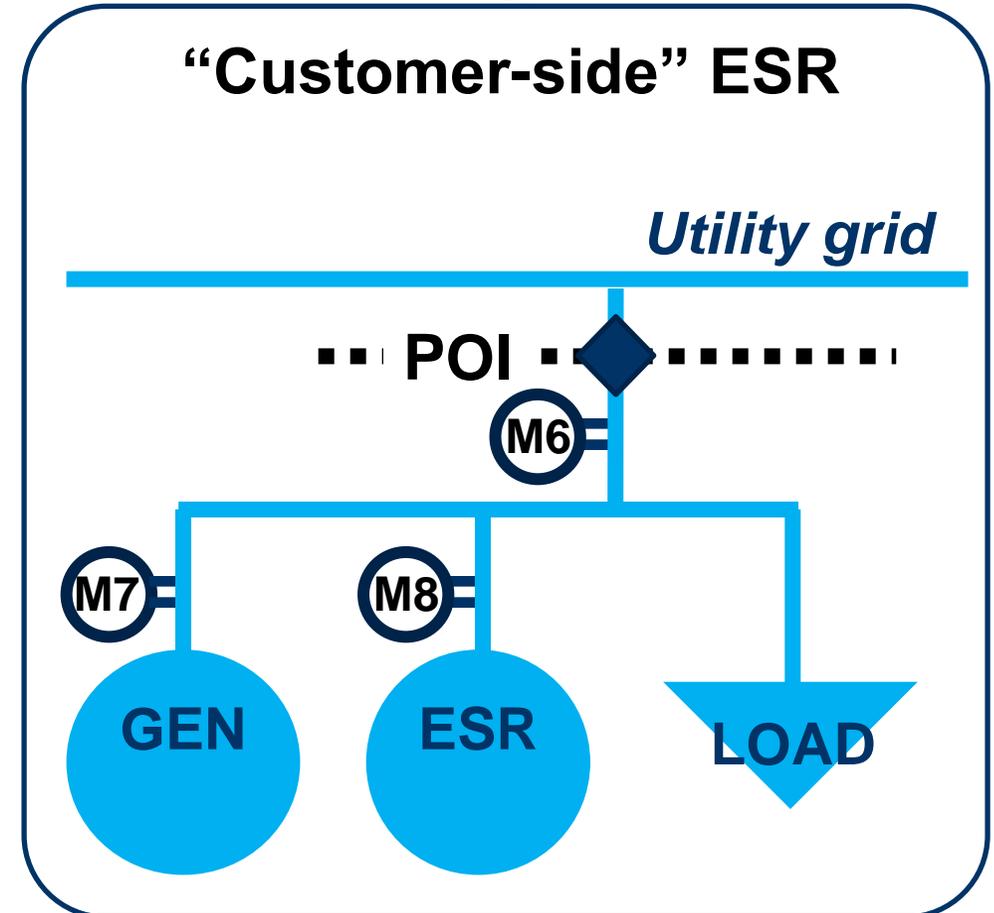
- 100% of withdrawals initially settled as negative generation (i.e., Direct Charging Energy)
- ESR can charge from grid or on-site gen.
- EDC to determine how much of the ESR inventory that was discharged to the end user consisted of energy charges from the grid → “Load Serving Charging Energy”
- **An appropriate billing convention: if monthly M2 > monthly M4, then all end-use energy came from stored or directly-provided on-site gen, and no Load Serving Charging Energy was consumed.**



- 100% of withdrawals initially settled as load (i.e., load and/or Load Serving Charging Energy)
- Net injections measured at M6 consist of previously-stored Direct Charging Energy.
 - Corresponding losses are also Direct Charging Energy. ESR can report losses to EDC through PJM, or EDC can work directly with ESR to quantify losses.
 - **Monthly Direct Charging Energy is the sum of monthly injections at meter “M6” plus associated losses.**
 - EDC calculates monthly quantity for ex-post adjustment from Load Serving Charging Energy into Direct Charging Energy.
- M8 is required to identify which intervals the ESR was charging to use in ex-post adjustment.



- Net injections measured at M6 could consist of Direct Charging Energy, self-supplied charging energy, and/or on-site Generation.
 - The inventory in the ESR could also consist of a mix of grid energy and self supplied energy.
 - Losses corresponding to stored grid energy that is resold to PJM is also Direct Charging Energy.
- **EDC calculates monthly Direct Charging Energy for ex-post adjustment.**
- M8 is required to identify which intervals the ESR was charging for ex-post adjustment.



Questions?