Order 841 for Energy Storage Resources: Manual 28 and Manual 27 Revisions

Andrew Levitt
Senior Business Solutions Architect
Applied Innovation
June 20, 2019
Market Settlements Subcommittee

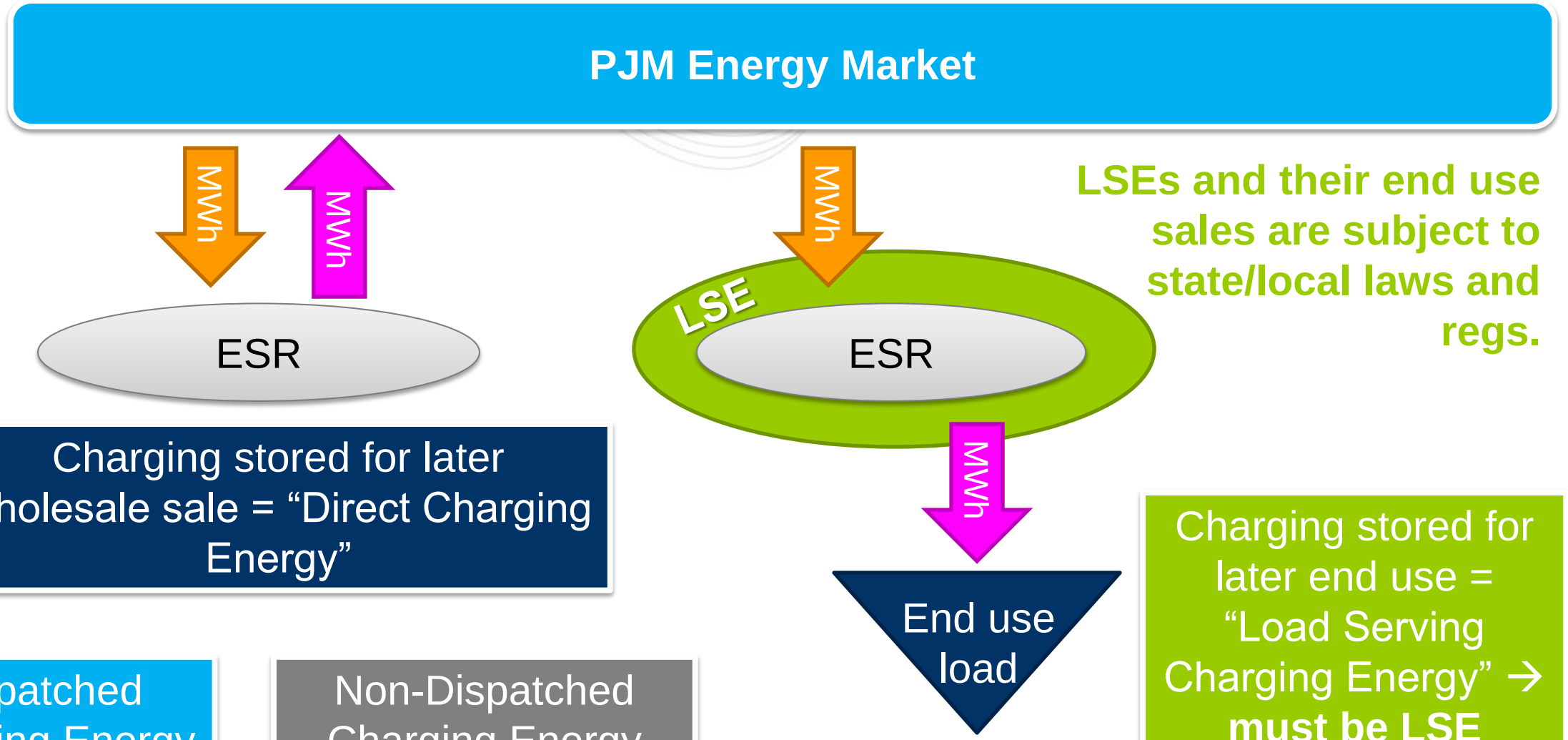
Manual 28

Station Power Updates for Order 841

"Section 13.1 Station Power Accounting Procedure

The net generation MW quantities that are used in PJM energy market settlements (excluding energy consumed for pumping at pumped storage hydro facilities, for compressors at compressed air energy storage resources, for synchronous condensing, and ***~~solely for the charging of Energy Storage Resources (i.e., batteries and flywheels) for the later injection of energy)~~Direct Charging Energy for Energy Storage Resources)*** *are netted over the calendar month for each generator and for each generation owner. The* ***end-use*** *charging of an electric vehicle (EV) battery used for operating the vehicle would be treated as* ***~~a retail transaction~~end-use load****, even if the EV battery is also used to provide wholesale regulation or other ancillary services. Any billing adjustments required for generators or generation owners with net negative totals are calculated and included in the subsequent month's billing cycle."*

Order 841 Compliance: categories of charging energy



Compliance Filing Definitions

"Direct Charging Energy" shall mean the energy that an Energy Storage Resource purchases from the PJM Interchange Energy Market and (i) later resells to the PJM Interchange Energy Market; or (ii) is lost to conversion inefficiencies, provided that such inefficiencies are an unavoidable component of the conversion, storage, and discharge process that is used to resell energy back to the PJM Interchange Energy Market.

"Dispatched Charging Energy" shall mean Direct Charging Energy that an Energy Storage Resource Model Participant receives from the electric grid pursuant to PJM dispatch while providing a service in the PJM markets.

"Non-Dispatched Charging Energy" shall mean all Direct Charging Energy that an Energy Storage Resource Model Participant receives from the electric grid that is not otherwise Dispatched Charging Energy.

"Load Serving Charging Energy" shall mean energy that is purchased from the PJM Interchange Energy Market and stored in an Energy Storage Resource for later resale to end-use load.

Manual 28 Section 22.1: Descriptions

"Direct Charging Energy – charging energy that is returned to PJM, including associated losses. Direct Charging Energy purchased by Energy Storage Resource Model Participants is divided into two subcategories:"

"Dispatched Charging Energy – Direct Charging Energy withdrawn from the grid by an Energy Storage Resource Model Participant pursuant to PJM dispatch while providing a service."

"Non-Dispatched Charging Energy – Direct Charging Energy withdrawn from the grid by an Energy Storage Resource Model Participant that is not Dispatched Charging Energy (for example, charging energy at an ESR that is self-scheduled and not dispatchable mode)."

"Load Serving Charging Energy – charging energy that is withdrawn from the grid and stored for later direct sale to an on-site end user. Only Load Serving Entities may purchase Load Serving Charging Energy. Load Serving Charging Energy comparable to ordinary load."

Manual 28: Section 22.2 and 22.3

"Direct Charging Energy" is negative generation & is <u>not</u> end-use load.

"Direct Charging Energy is purchased by an Energy Storage Resource for later resale to PJM markets, is not purchased by a Load Serving Entity, and is not end-use load. Direct Charging Energy is reported to PJM through Power Meter, similar to generation energy sales; Direct Charging Energy is not reported through Inschedule in the way that Load Serving Entity purchases of end-use load is reported. Direct Charging Energy shall not be included in a Load Serving Entity's Total Hourly Energy Obligation.

"Load Serving Charging Energy" is end-use load.

"Load Serving Charging Energy is purchased at the aggregate nodal LMP that is applicable to the corresponding Load Serving Entity load. Load Serving Charging Energy is eligible for the same charges as ordinary load, including all Load Serving Entity charges, end-use load charges, and Transmission Customer charges."

"Dispatched Charging Energy" is Direct Charging Energy that is dispatched to provide a service.

"Dispatched Charging Energy does not pay transmission charges…"

"Non-Dispatched Charging Energy" is Direct Charging Energy that is <u>not</u> dispatched to provide a service and it <u>does</u> take transmission service.

"…however Non-Dispatched Charging Energy does pay transmission charges, and must arrange for Network Transmission Service. Non-Dispatched Charging Energy uses the transmission system, and an Energy Storage Resource Model Participant purchasing Non-Dispatched Charging Energy is a Network Service User. As a result, certain Transmission Customer charges apply to Non-Dispatched Charging Energy that do not apply to generation output."

Manual 28 Section 22.2: Direct Charging Energy Details

"Energy Storage Resource Model Participants purchase Dispatched Charging when they receive energy from the electric grid pursuant to PJM dispatch while providing a service in PJM markets. Dispatched Charging Energy is purchased in intervals that Energy Storage Resource Model Participants follow dispatch and meet one of the following conditions:

- *Assigned to Regulation, Tier II Synchronous Reserves, or Reactive Service;*
- *Being manually dispatched for reliability"*

- *<Note: other Service(s) TBD>*

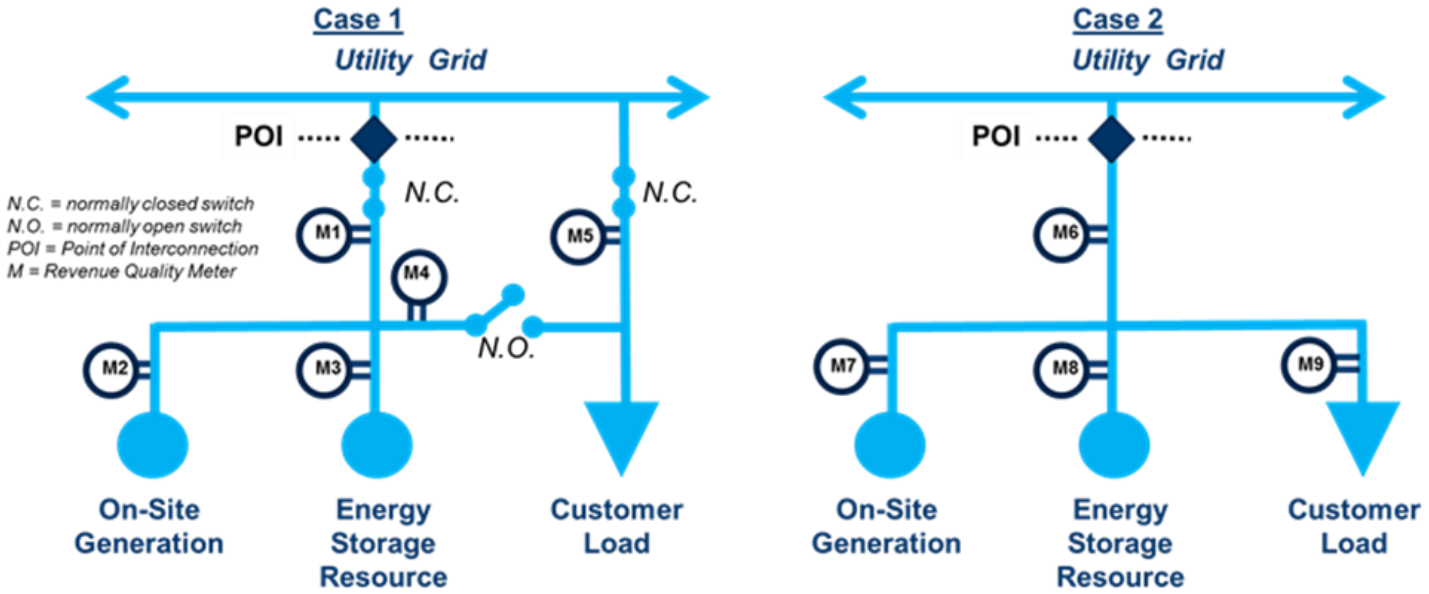
Section 22.2: Charges for Non-Dispatched Charging Energy

"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"*

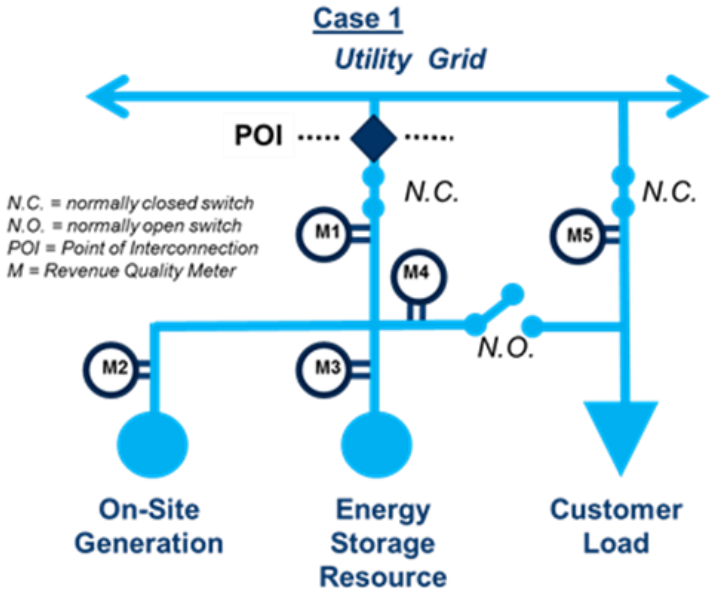
22.4: Methods for Load Serving Charging Energy

"The PJM Tariff and manuals shall not be construed as prohibiting an Energy Storage Resource from providing energy directly to end use loads. Some such configurations are illustrated in Figure XXX below. In order to ensure adequate visibility for PJM and to properly quantify Direct Charging Energy as defined in the PJM Tariff, additional metering requirements apply to such resources. These meters are used in a variety of use cases to assist the Electric Distribution Company in distinguishing and quantifying Direct Charging Energy and Load Serving Charging Energy. Note that Direct Charging Energy and Load Serving Charging Energy are mutually exclusive categories."



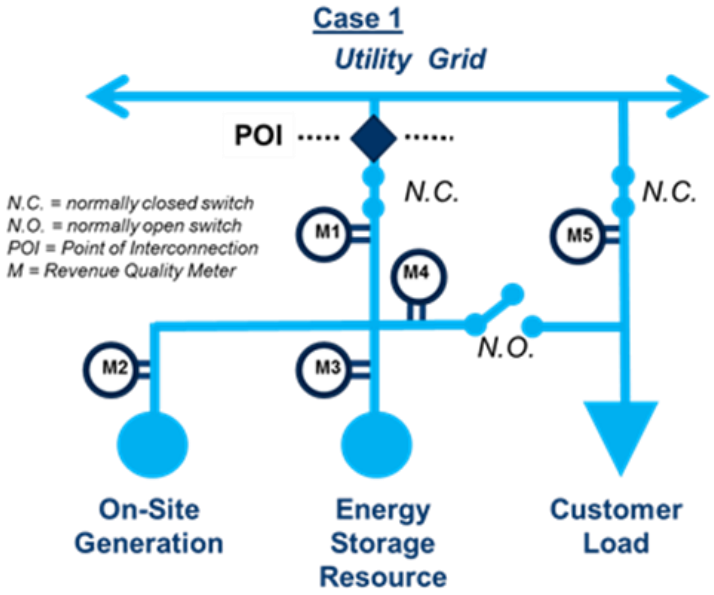
22.4: Case 1: *Standalone Energy Storage Resource Alone*

"In any given month, all energy withdrawn from the grid from the Point Of Interconnection meter shown as "M1" in Figure XXX above is Direct Charging Energy, except that meter "M4" appropriately measures the quantity of monthly Load Serving Charging Energy. Load Serving Charging Energy is withdrawn from the grid, stored in the Energy Storage Resource, then provided to end use loads, and is therefore not Direct Charging Energy."



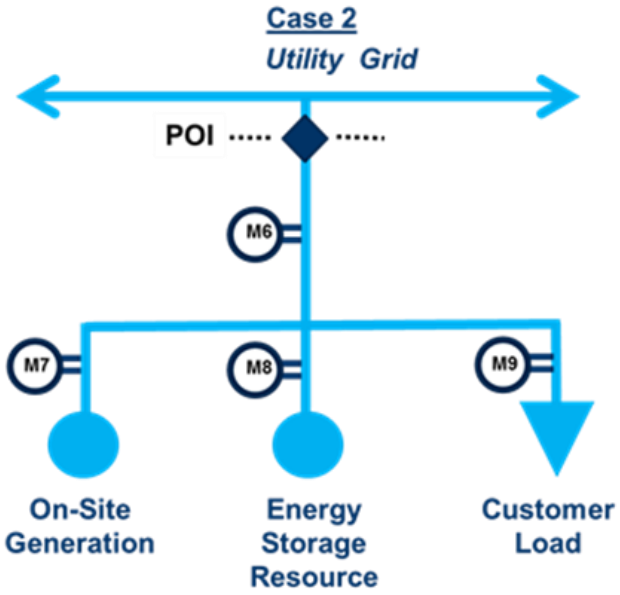
22.4: Case 1: *Standalone Energy Storage Resource plus Other On-Site Generation*

"In any given month, all energy withdrawn from the grid from the Point Of Interconnection meter shown as "M1" in Figure XXX above is Direct Charging Energy, except that any Load Serving Charging Energy that is withdrawn from the grid is not Direct Charging Energy. In this case, the Energy Storage Resource can charge from the grid or from the on-site generation. The quantity of the Energy Storage Resource inventory that is discharged to the end user that consists of energy originally withdrawn from the grid constitutes Load Serving Charging Energy. If the Electric Distribution Company determines that the Energy Storage Resource inventory that is discharged to the end user consists entirely of stored on-site generation, then no Load Serving Charging Energy was consumed by the end-use load. An appropriate method to make such a determination is to compare the monthly energy production from the on-site generation as measured at meter "M2" in above figure XXX with the monthly quantity of energy provided to the end-use customer through meter "M4"—if "M2" monthly quantity is greater than the "M4" monthly quantity, then no Load Serving Charging Energy was consumed."



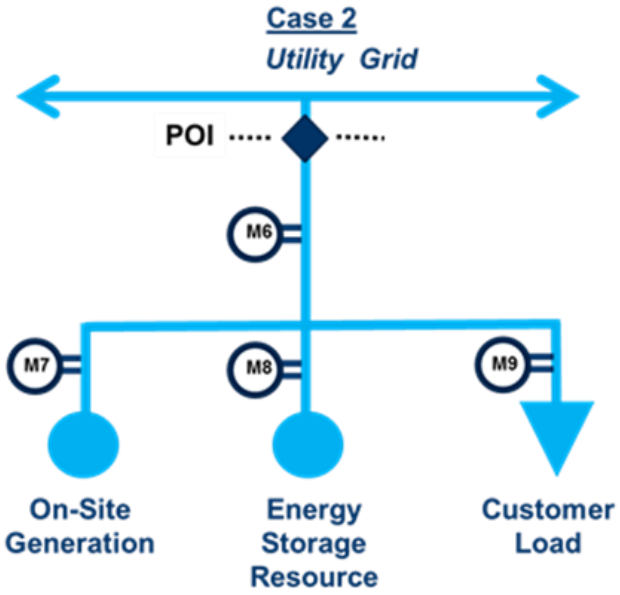
22.4: Case 2: Load Co-Located with Energy Storage Resource

"PJM can accommodate Energy Storage Resources co-located with end-use load (as shown in Case 2 of Figure XXX above) using a "virtual buy all/sell all" approach. In such cases, the Energy Storage Resource transacts 100% of its energy at wholesale with PJM by relying on energy measured at meter "M8"."



22.4: Case 2: Load Co-Located with Energy Storage Resource

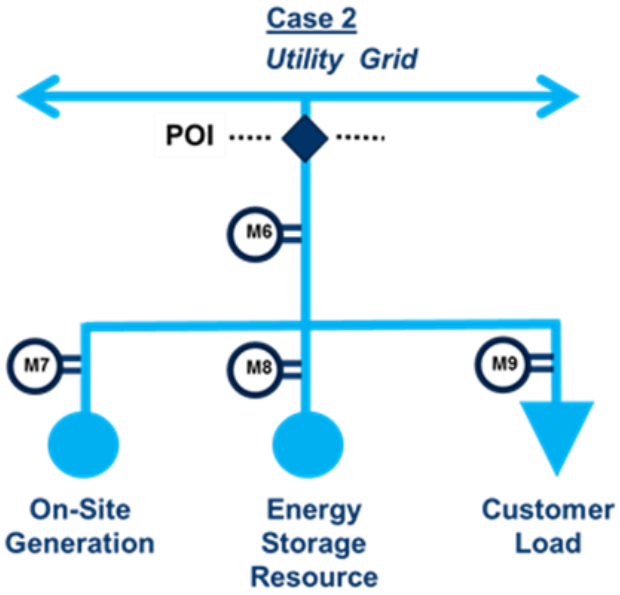
"Alternatively, PJM can accommodate Energy Storage Resources co-located with end-use load using a "net excess sale" approach. In this case, injections at meter "M6" are wholesale sales by the Energy Storage Resource, while withdrawals at "M6" are a mix of retail purchases by the host retail customer (with corresponding purchases by a Load Serving Entity from the PJM energy market) and purchases of Direct Charging Energy by the Energy Storage Resource. In any given month, all energy withdrawn from the grid from the Point Of Interconnection meter shown as "M6" in Figure XXX above is ordinary load (purchased by a Load Serving Entity) or is Load Serving Charging Energy, except for any Direct Charging Energy. Monthly energy injected onto the grid as measured at meter "M6" appropriately identifies the monthly quantity of Direct Charging Energy, together with any lost energy associated with the conversion and storage of grid energy for later injection onto the grid. The Energy Storage Resource may report such losses to PJM through PJM Power Meter, or the Electric Distribution Company may work directly with the Energy Storage Resource to quantify such losses. Direct Charging Energy is therefore the sum of monthly injections at meter "M6" plus associated losses."



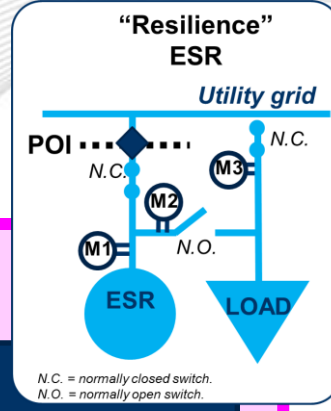
"PJM shall not bill an Energy Storage Resource for purchases of Direct Charging Energy if the host distribution utility is unable or unwilling to net out the Direct Charging Energy quantity from the host customer's retail bill."

22.4: Case 2: Load Co-Located with Energy Storage Resource plus Other On-site Generation

"In any given month, all energy withdrawn from the grid from the Point Of Interconnection meter shown as "M6" in Figure XXX above is Load Serving Charging Energy or end-use load, except for Direct Charging Energy. The Electric Distribution Company is responsible for calculating monthly Direct Charging Energy."



Section 22.5: Adjusting ESR 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

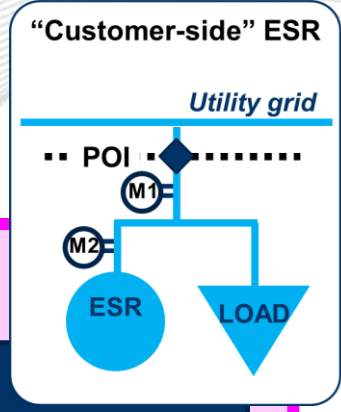
Load reconciliation

Debit

10%

LSE

Section 22.5: Adjusting ESR Charging Energy



Initial Settlement

PJM Settlements

Debit

100% of Charging

ESR

LSE

Final Settlement

PJM Settlements

EDC

Meter Correction

Debit

10%

ESR

Load reconciliation

Credit

90% of Charging

10%

LSE

22.5 Reconciling Monthly Load Serving Charging Energy

- *"PJM provides Electric Distribution Companies with a monthly quantification and reconciliation approach for the distinct settlements of Direct Charging Energy and Load Serving Charging Energy…"*

Section 22.5: Adjusting ESR Charging Energy: Case 1

"Settlements of standalone Energy Storage Resources that are not connected to load during normal operations (i.e., Case 1 in Figure XXX above) follow these steps:

1. *Initial settlements are 100% Direct Charging Energy, reported through Power Meter.*
2. *Monthly Load Serving Charging Energy is quantified after the end of the month according to the methods above.*
3. *The Electric Distribution Company initiates a PJM Energy Storage Resource Meter Correction process to reduce the MWh purchases of Direct Charging Energy by the Energy Storage Resource in the quantity that was in fact Load Serving Charging Energy as identified in step 2 above.*
4. *The Electric Distribution Company initiates a PJM Load Reconciliation process to increase the MWh purchase of Load Serving Charging Energy by the applicable Load Serving Entity in the amount identified in Step 2 above."*

Section 22.5: Adjusting ESR Charging Energy: Case 2

"For sites with Energy Storage Resources that are co-located with load during normal operations, purchases of Load Serving Charging Energy should in general apply to the same Load Serving Entity that serves the ordinary host customer load. Settlement of Energy Storage Resources that are co-located with load during normal operations (i.e., Case 2 in Figure XXX above) follow these steps:

1. *Initial settlements are 100% Load Serving Charging Energy or ordinary Load Serving Entity load purchases.*
2. *Monthly Direct Charging Energy is quantified after the end of the month according to the methods above.*
3. *The Electric Distribution Company initiates a PJM Energy Storage Resource Meter Correction process to increase the MWh purchases of Direct Charging Energy by the Energy Storage Resource in the quantity that was in fact Direct Charging Energy as identified in step 2 above.*
4. *The Electric Distribution Company initiates a PJM Load Reconciliation process to reduce the MWh purchase of Load Serving Charging Energy by the applicable Load Serving Entity in the amount identified in Step 2 above."*

Energy Storage Resource Meter Correction Process

The Energy Storage Resource Meter Correction Process is used to adjust monthly Direct Charging Energy quantities billed to an Energy Storage Resource.

"The Energy Storage Resource Meter Correction Process is similar to the Meter Error Correction process. The purpose is to provide an ex-post credit or a charge to an Energy Storage Resource in an amount corresponding to a greater or lesser proportion of monthly Direct Charging Energy withdrawn than used in the initial settlement. In order to preserve 5-minute Locational Marginal Pricing, the process uses a monthly average price that is weighted according to actual per-interval Energy Storage Resource charging quantities. The inputs to the Energy Storage Resource Meter Correction Process are the per-interval quantities of energy withdrawn from the grid and stored, as well as the monthly quantity of energy to be adjusted up or down. The result is a charge or credit to the Energy Storage Resource, with an equal but opposite charge or credit to the Electric Distribution Company. The charge or credit is calculated according to this formula:"

$$Rate = MonthlyCorrectionMWh \times \sum_{interval}^{i=end\ of\ month} \sum_{i=0} LMP_i \times \frac{StoredMWh_i}{MonthlyStoredMWh}$$

"For sites with Energy Storage Resources that are co-located with load during normal operations (Case 2 in Figure XXX above), the per-interval quantity of energy that is stored from the grid is calculated for each interval MIN[M8 _INBOUND, M6_INBOUND]. Such resources must provide both M6 and M8 to PJM through Power Meter."

Manual 27

Netting Interval for Identifying Charging Energy

"An Energy Storage Resource shall be considered charging when the Revenue Data for Settlements for a Real Time Settlement Interval corresponds to a withdrawal. The determination of Non-Dispatched Charging Energy vs. Dispatched Charging Energy shall be made for each Real Time Settlement Interval. Hourly Non-Dispatched Charging Energy is the sum of Revenue Data for Settlements for the Real Time Settlement Intervals which are determined to be Non-Dispatched Charging Energy over the hour divided by 12."

- Therefore, for typical Energy Storage Resources:
  - Net withdrawals over a 5 minute interval will register as charging
  - Any net withdrawals over a 5 minute interval for which the ESR is following dispatch and is providing one of the listed services will be accounted for as Dispatched Charging Energy
  - Any net withdrawals over any other 5 minute interval will be accounted for as Non-dispatched Charging Energy

PJM to Facilitate any EDC Calculation of NSPL

"PJM will report to Electric Distribution Companies all hourly Energy Storage Resource Model Participant purchases of Non-Dispatched Charging Energy in order to facilitate calculation of Network Service Peak Loads corresponding to those purchases."

Energy Storage Resources and Capacity Billing

- Existing RAA Schedule 8: "*Obligation Peak Load, defined as the daily summation of the weather adjusted coincident summer peak, last preceding the Delivery Year, of the end-users in such Zone (net of operating Behind The Meter Generation, but not to be less than zero) for which such Party was responsible on that billing day, as determined in accordance with the procedures set forth in the PJM Manuals*"
- Existing RAA: "*Load Serving Entity" or "LSE" shall mean any entity (or the duly designated agent of such an entity), including a load aggregator or power marketer, (i) serving end-users within the PJM Region…"*
- New Manual 27: "*Non-Dispatched Charging Energy is not end-use load, and therefore the Electric Distribution Company shall not allocate any Peak Load Contribution value to any purchases of Non-Dispatched Charging Energy."*
- New Manual 18 Section 7.3 Obligation Peak Load: "*Energy Storage Resources shall not be allocated a Peak Load Contribution for purchases of energy for later resale to PJM."**

** https://www.pjm.com/-/media/committees-groups/committees/mic/20190612/20190612-item-05a3-m18-esr-edits.ashx*