

## Section 22: Open-Loop Hybrid & Energy Storage

Welcome to the Open-Loop Hybrid & Energy Storage Resource Charging Energy section of the PJM Manual for Operating Agreement Accounting. In this section, you will find the following information:

- A description of the accounting procedures for Energy Storage Resource or Open-Loop Hybrid Resource Charging Energy.

### 22.1 Overview of Charging Energy

An Energy Storage Resource or Open-Loop Hybrid Resource is 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. Examples of Energy Storage Resource technologies include but are not limited to pumped storage hydroelectric plants, batteries, and flywheels. A hybrid resource is composed of more than one component, whereby each component is a ~~one~~separate generation component and/or one storage component behind the same Point of Interconnection operating as a single integrated resource; an Open-Loop Hybrid is a hybrid resource with a storage component that is physically and contractually capable of charging its storage component from the grid.

Charging energy that is purchased for storing in an Energy Storage Resource, or Open-Loop Hybrid Resource for later resale is always billed at the applicable Locational Marginal Price. However, different categories of charging energy accrue different sets of charges according to use. These categories are summarized as follows (formal definitions are in the PJM Tariff):

- “Direct Charging Energy” shall mean the energy that an Energy Storage Resource or Open-Loop Hybrid 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.  
Note that Direct Charging Energy is purchased by Energy Storage Resource Model Participants or Open-Loop Hybrid Resources and is divided into two subcategories:
  - o “Dispatched Charging Energy” shall mean Direct Charging Energy that an Energy Storage Resource Model Participant or Open-Loop Hybrid Resource receives from the electric grid pursuant to PJM dispatch while providing a service in the PJM markets.
  - o “Non-Dispatched Charging Energy” shall mean all Direct Charging Energy that an Energy Storage Resource Model Participant or Open-Loop Hybrid Resource receives from the electric grid that is not otherwise Dispatched Charging Energy. An example of Non-Dispatched Charging Energy is charging energy at an ESR that is self-scheduled and

not dispatchable.

- “Load Serving Charging Energy” shall mean energy that is purchased from the PJM Interchange Energy Market and stored in an Energy Storage Resource or Open-Loop Hybrid Resource for later resale to end-use load. Note that only Load Serving Entities may purchase Load Serving Charging Energy. Load Serving Charging Energy is comparable to ordinary load.

Non-Dispatched Charging Energy must pay applicable transmission charges as a Network Service User. By contrast, Dispatched Charging Energy does not pay such charges. Charging energy qualifies as Dispatched Charging Energy when the Energy Storage Resource or Open-Loop Hybrid Resource meets one of the following conditions:

- Provides Energy Imbalance Service under Schedule 4 of the PJM Tariff. Energy Storage Resource Model Participants or Open-Loop Hybrid Resource shall be considered to be providing Energy Imbalance Service when they are dispatchable by PJM in real time. An Energy Storage Resource or Open-Loop Hybrid Resource shall be considered dispatchable when the fixed generation flag is set to “no” and the dispatchable range exceeds 10% of the absolute value of the relevant economic limit and the resource follows PJM dispatch within 10% of the desired output.
- Assigned to Regulation, Synchronized Reserves, or Reactive Service;
- Being manually dispatched for reliability

## 22.2 Charges for Direct Charging Energy

Purchases of Direct Charging Energy and sales of energy from an Energy Storage Resource or Open-Loop Hybrid Resource are at the same pricing node.

Direct Charging Energy is purchased by an Energy Storage Resource or Open-Loop Hybrid Resource for later resale to PJM markets, is not purchased by a Load Serving Entity, is not end-use load, and is not Station Power. 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.

As described above, Direct Charging Energy purchases by Energy Storage Resource Model Participants or Open-Loop Hybrid Resource fall into two categories: Dispatched Charging Energy and Non-Dispatched Charging Energy. Dispatched Charging Energy does not pay transmission charges; 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 or Open-Loop Hybrid Resource 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. However, the PJM Tariff states that Direct Charging Energy (which includes Non-Dispatched Charging Energy) is exempt from other Transmission Customer charges. Further, because Direct Charging Energy (including Non-Dispatched Charging Energy) is not end-use load, charges that are applicable to

Load Serving Entities and to end-use load are not applicable to Direct 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
  
- MTEP Project Cost Recovery
- Transmission Enhancement
- Other Supporting Facilities
- Non-Firm Point-to-Point Transmission Service
- Black Start Service
- Unscheduled Transmission Service
- Reactive Supply and Voltage Control from Generation and Other Sources Service

An Energy Storage Resource or Open-Loop Hybrid 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.

The PJM Tariff exempts Direct Charging Energy (which includes Non-Dispatched Charging Energy) from the following Transmission Customer charges:

- Schedule 9-1 Control Area Administration
- Allocations of Operating Reserve costs to scheduled day-ahead load and to real-time load pursuant to Tariff Attachment K Appendix Section 3.2.3 – Operating Reserves;
- Allocations of Reactive Service costs pursuant to Tariff Attachment K Appendix Section 3.2.3B – Reactive Services;
- Allocations of Synchronous Condensing costs pursuant to Tariff Attachment K Appendix Section 3.2.3C – Synchronous Condensing for Post-Contingency Operation;
- 500 kV Meter Errors
- Meter Correction Between Control Areas
- Inadvertent Interchange
- Allocation of Balancing Congestion Charges

- Distribution of Total Transmission Loss Charges
- Allocation of Auction Revenue Rights

The following non-LMP charges that apply to Load Serving Entities are not applicable to Direct Charging Energy (which includes Non-Dispatched Charging Energy):

- Synchronized, Non-Synchronized, and Secondary Reserves;
- Regulation;
- Capacity Market charges;
- Economic Demand Response charges in Day-ahead and Real-Time; and
- Emergency Demand Response charges.

FERC directed that Dispatched Charging Energy shall be exempt from paying transmission charges, and therefore charges that are applicable to Transmission Customer use of the transmission system are not applicable to Dispatched Charging Energy. Dispatched Charging Energy therefore pays the same non-LMP charges as generation output, namely:

- Schedule 9-3, 9-MMU, 9-PJM Settlements

### **22.3 Charges for Load Serving Charging Energy**

Load Serving Charging Energy is PJM load that is purchased from PJM by a Load Serving Entity and stored in an Energy Storage Resource or Open-Loop Hybrid Resource for later end-use consumption. 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.

### **22.4 Methods to Differentiate Direct Charging Energy from Load Serving Charging Energy at an Energy Storage Resource Site**

The PJM Tariff and manuals shall not be construed as prohibiting an Energy Storage Resource or Open-Loop Hybrid Resource from providing energy directly to end use loads. Some such configurations are illustrated in Figure 1 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.

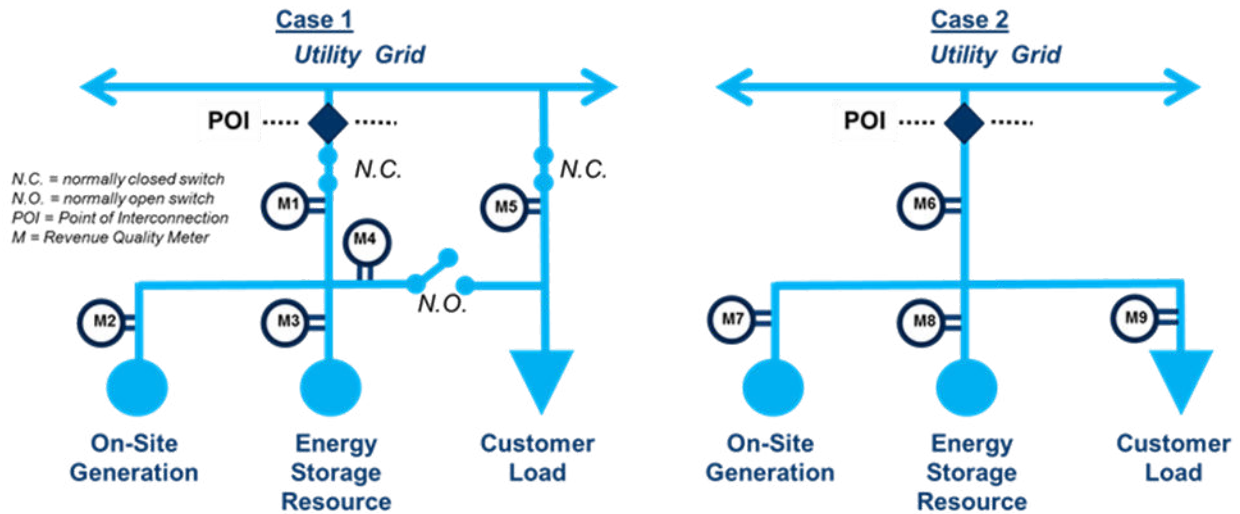


Figure 1

**Case 1a: Standalone Energy Storage Resource (no on-site generation)**

In any given month, all energy withdrawn from the grid from the Point Of Interconnection meter shown as “M1” in Figure 1 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.

**Case 1b: Open-Loop Hybrid or 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 1 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 or storage component of the Open-Loop Hybrid Resource can charge from the grid or from the on-site generation. The quantity of the Energy Storage Resource or storage component of the Open-Loop Hybrid 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 or storage component of the Open-Loop Hybrid 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 1 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.

**Case 2a: Load Co-Located with Energy Storage Resource (no on-site generation)**

PJM can accommodate Energy Storage Resources co-located with end-use load (as

shown in Case 2 of Figure 1 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”.

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 1 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.

#### **Case 2b: Load Co-Located with Open-Loop Hybrid or Energy Storage Resource plus Other On-Site Generation**

PJM can accommodate an Open-Loop Hybrid or Energy Storage Resources co-located with an on-site generator and also with end-use load (as shown in Case 2 of Figure 1 above) using a “virtual buy all/sell all” approach. In such cases, the Open-Loop Hybrid or Energy Storage Resource and the on-site generator transact 100% of energy at wholesale with PJM by relying on energy measured at meter “M7” and “M8”.

Alternatively, PJM can accommodate Open-Loop Hybrids or Energy Storage Resources co-located with end-use load and with an on-site generator by using a “net excess sale” approach. In this case, injections at meter “M6” are wholesale sales by the Open-Loop Hybrid or Energy Storage Resource and/or on site generator, 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 or storage component of the Open-Loop Hybrid Resource. In any given month, all energy withdrawn from the grid from the Point Of Interconnection meter shown as “M6” in Figure 1 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.

PJM shall not bill an Open-Loop Hybrid Resource or 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.



## 22.5 Reconciling Monthly Direct Charging Energy and Load Serving Charging Energy

Direct Charging Energy is not end-use load, is reported through Power Meter like generation sales, is settled at a nodal LMP, and pays fewer non-LMP charges than load. By contrast, Load Serving Charging energy is end-use load, is reported through InSchedule like all other load, and pays all the same non-LMP charges as any other load. 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 at Energy Storage Resources or Open-Loop Hybrids that are capable of directly serving end-use load and that are therefore capable of withdrawing and storing both Direct Charging Energy and Load Serving Charging Energy in a given month.

### Case 1

Settlements of standalone Energy Storage Resources or Open-Loop Hybrids that are not connected to load during normal operations (i.e., Case 1 in Figure 1 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 or Open-Loop Hybrid 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.

### Case 2

For sites with Energy Storage Resources or Open-Loop Hybrid 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 or Open-Loop Hybrid Resources that are co-located with load during normal operations (i.e., Case 2 in Figure 1 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 or Open-Loop Hybrid 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.

### **The Energy Storage Resource Meter Correction Process to Adjust Direct Charging Energy**

The Energy Storage Resource Meter Correction Process is similar to the Meter Error Correction process and applies to Energy Storage Resources and Open-Loop Hybrid Resources. The purpose is to provide an ex-post credit or a charge to an Energy Storage Resource or Open-Loop Hybrid 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 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 or Open-Loop Hybrid Resource, with an equal but opposite charge or credit to the Electric Distribution Company. The charge or credit is calculated according to this formula:

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

For sites co-located with load during normal operations (Case 2 in Figure 1 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.

### **Use of the Load Reconciliation Process to Adjust for Load Serving Charging Energy**

The Electric Distribution Company should use the ordinary Load Reconciliation Process to Adjust for Load Serving Charging Energy for the applicable Load Serving Entity. PJM can accommodate a separate InSchedule contract specifically for the Load Serving Charging Energy at a given customer or group of customers.