

DEMAND RESPONSE SHUT-DOWN COSTS IN THE SYNCHRONIZED RESERVE MARKET

CDS Educational Document

Overview

The inclusion of shut-down costs in demand response (DR) offers and make-whole payments is intended to achieve comparable treatment for DR and generation resources in the PJM markets. The overriding principle of meeting load with the least expensive resources given security constraints has prompted PJM's symmetrical treatment of DR and generation resources, meaning that PJM is indifferent to resources that increase production or reduce load to in order to achieve and maintain load/supply balance at all times.

Application of these principles has led PJM and stakeholders to develop concepts for DR resources that mirror existing elements for generation. The result is that market rules provide for DR shut-down costs that mirror generator start-up costs and DR minimum downtime that mirrors generator minimum runtime.

These rules have been in place since the stakeholders began developing market rules for DR resources in 2002. Recently the MRC approved clarifying language added to Manual 28 Operating Agreement Accounting as part of the Quality Project. A stakeholder asked what costs qualify as shut-down costs. Since the Manuals currently provide no requirements or examples of qualified shut-down costs the MRC directed PJM staff to assign shut-down cost definition and qualification to the CDS.

PJM Tariff

In energy for Economic Load Response the Curtailment Service Provider (CSP) must offer "(ii) the real-time Locational Marginal Price above which the end-use customer will reduce load; and (iii) at the Economic Load Response Participant's option, shut-down costs associated with reducing load, including direct labor and equipment costs, opportunity costs, and/or a minimum number of contiguous hours for which the load reduction must be committed."ⁱ This treatment also applies to Economic Load Response offers made by CSPs into the Day-ahead Energy Market.ⁱⁱ

Finally, shut-down costs may be included in Emergency Load Response registrations for Full Program Option and Energy Only Option resources. PJM Settlements will pay shut-down costs only "[i]f, however, the sum of the hourly energy payments to a participant dispatched by PJM for actual, achieved reductions is not greater than or equal to the offer value (i.e. Minimum Dispatch Price, minimum down time and shut down costs) then the participant will be made whole up to the offer value for its actual, achieved reductions."ⁱⁱⁱ

In DASR : "to qualify to submit offers pursuant to this section, the Day-ahead Scheduling Reserves Resources shall submit energy offers in the Day-ahead Energy Market including start-up and shut-down costs for generation resource and Demand Resources, respectively..."^{iv}

PJM Manuals

Section 4.2.1 of Manual 11

Demand Resources can participate in the synchronized reserve markets as either Tier 1 or Tier 2:
“Resources participating in the synchronized reserve market are divided into two Tiers:

- **Tier 1** is comprised of all those resources on line following economic dispatch and able to ramp up from their current output in response to a synchronized reserve event, or demand resources capable of reducing load within 10 minutes.
- **Tier 2** consists of:
 - that additional capacity that is synchronized to the grid and operating at a point that deviates from economic dispatch (including condensing mode) to provide additional spinning synchronized reserve not available from Tier 1 resources; and
 - dispatchable load resources that have controls in place to automatically drop load in response to a signal from PJM.”

Demand Resources must also submit shutdown costs into eMKT:

- “Shutdown Costs. These are the costs a Demand Resource incurs when reducing load in response to a synchronized reserve event.”

Section 10.3.1 of Manual 11

The Load Response Bid could also include for each Demand Resource:

- Shut down costs, for each period
- Minimum down times for which the load reduction must be committed
- Shutdown costs and minimum down times are optional, and will default to zero (0) if not submitted.
- Shutdown cost will be expressed in dollars, and represents the fixed cost associated with committing a load response resource.
- Shutdown costs will be changeable only every six months, corresponding to the six-month periods during which price-based start-up costs may be changed for generators.

Section 6 of Manual 28

Essentially says that if DR is called for a synchronized reserve event, it will be made whole to the cost based offer including shut-down cost.^v

Section 8 of Manual 15

Currently there are no cost rules for DSR cost except for the DSR margin adders. The cost to provide synchronous reserves from DSR resources shall equal the margin up to \$7.50 per MWh of reserves provided.

PJM Training Documents

Currently, the most detailed documented definition of shut-down costs appears in the PJM training materials for Demand Side Response as follows: “[a]ny costs associated with reducing load, including direct labor and equipment costs, opportunity costs, and costs associated with the minimum number of contiguous hours for which the load reduction must be committed.”

The PJM training materials for Demand Side Response also instruct Curtailment Service Providers that shut-down costs are optional, will default to zero if not submitted, should be expressed in dollars per shutdown and represent the fixed cost associated with committing a DR resource. PJM training materials further instruct that shut-down costs are changeable every six months (same as price-based start-up costs for generators) in eMKT.

Example of how DR Shut-down Costs work in the Real-time Energy Market

Offer of Smart Steel Company

Assume the following:

Shut-down costs = \$1,500

Minimum Down Time = 6 Hours

MW Reduction = 5 MW

Strike Price = \$35/MWh

Smart Steel Company’s offer of \$85/MWh = $(\$1,500/6 \text{ Hours} * 1/5 \text{ MW}) + \$35/\text{MWh}$

PJM Dispatch

- PJM Forecasts RT LMP greater than \$87/MWh for Hours 12 – 18
- PJM Dispatches the load reduction

PJM Experience with DR Shut-down Costs

When registered DR has been modeled in eMkt CSPs have only very rarely included shut-down costs. There are no currently registered DR resources that have designated shut-down costs in effect.

No shut-down costs have ever been owed as result of a DR resource clearing as Tier 2 synchronous reserve.

DR Shut-down Costs in other RTOs/ISOs

Currently the concept of shut-down costs does not apply to DR participation in ERCOT or SPP. Shut-down costs for DR, while rarely used in practice, are provided for in the Energy Market rules of ISO-New

England, NYISO, MISO and CAISO. It should be noted that DR resources are not authorized to provide synch reserve in any wholesale market except for PJM.

Summary and Desired Outcome as Documented in the Problem Statement

Currently, Manual 15 Section 8: Demand Side Response (DSR) has no defined shut-down costs. The CDS will develop educational documents and manual language about DSR shut-down costs.

Appendix 1: Start Costs for Quick Start Combustion Turbines (CTs) in the Synchronous Reserve Market

Similar to shut down costs for DSR, combustion turbines that can respond within 10 minutes can provide Synchronous reserves. Total costs for CTs that are offline are as follows

$$\begin{aligned} \textit{Total Synchronous Reserve Costs} \\ = \textit{Start Costs} + \textit{VOM} + \textit{LMP} * \textit{condensing MW consumed} + \$7.50 \end{aligned}$$

Start costs when:

- a unit moves from cold to condensing operations
- when a unit moves from condensing operations to energy generation

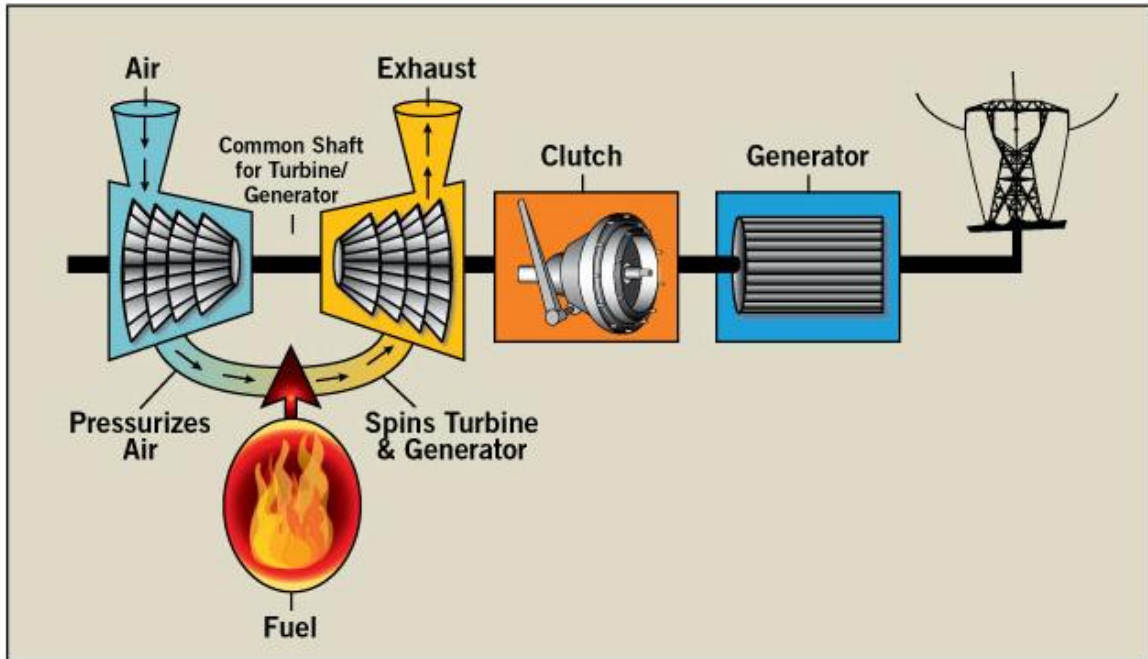
Variable Operating and Maintenance (VOM) cost (\$/MWh)

Actual cost of power consumed during condensing operations at real time bus LMP

Appendix 2: CT Condensing Mode operation One thing that is found in Manual 15 language for Synchronous Reserve costs for Combustion Turbines is that they can include start cost:

- unit moves from cold to condensing operations
- when a unit moves from condensing operations to energy generation

This is a quick explanation of what that means. Below is an illustration of an overly simple combustion turbine. Air comes in at the far right and is compressed, heat is added and the pressurized combustion gas spins the turbine. The clutch between the turbine and the generator allows for the turbine to disconnect from the generator and shutdown while the generator continues to spin like a motor. With the clutch open the turbine shutdown, and the generator spinning like a motor, this operating mode is called "condensing". In order to switch to a generation mode, combustion turbine must restart and the clutch must close to power the generator to create MWs.



i OATT p 1655

ii OATT p 1654

iii OATT p 1811

iv OATT 1654

v Also, Section 5.1 of Manual 28 provides that "Balancing Operating Reserve credits are calculated by operating segment within an Operating Day. A resource will be made whole for the duration of the greater of the day-ahead schedule or minimum run time (minimum down time for demand resources) and made whole separately for the block of hours it is operated at PJM's direction in excess of the greater of the day-ahead schedule or minimum run time (minimum down time for demand resources). Startup costs (shut down costs for demand resources), as applicable, will be included in the segment represented by the longer of the day-ahead schedule or minimum run time (minimum down time for demand resources)."

Also, Section 10 of Manual 28, which covers demand response accounting provides as follows: "PJM will accept demand reduction bids from an end-use customer or its representative CSP

for a specific MW curtailment (in minimum increments of .1 MW or 100 kW). The demand reduction bid will include the day-ahead LMP above which the end-use customer would not consume, and could also include shut-down costs and/or the number of contiguous hours for which the load reduction must be committed."

Total payments to end-use customers or their representative CSP for accepted day-ahead Economic Load Response bids will not be less than the total value of the load response bid, included any submitted shut-down costs. Any shortfall will be made up through normal, day ahead operating reserve"

Real-Time Operations:

Reimbursement for reducing load is based on the actual kWh relief provided in excess of committed day-ahead load reductions plus an adjustment for losses. The end-use customer or representative CSP will be paid by PJM the real-time LMP less an amount equal to the applicable generation and transmission charges. In cases where load response is dispatched by PJM, the total payment to end-use customers or their representative CSP will not be less than the total value of the load response bid, including any submitted shut-down costs. Any shortfall will be made up through normal, balancing operating reserve. In all cases, the applicable zonal or aggregate LMP issued as appropriate for the individual enduse customer. PJM shall recover LMP less an amount equal to the applicable generation and transmission charges from the LSE that otherwise would have the load that was reduced.