

# Review of Black Start Formula and Cost Components

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## Black Start: Executive Summary

Black Start Service is the ability of generating units to start without an outside electrical supply or the demonstrated ability of a generating unit with a high operating factor (subject to Transmission Provider concurrence) to automatically remain operating at reduced levels when disconnected from the grid.

PJM's Open Access Transmission Tariff, relating to Black Start Service, requires PJM to review the formula and cost components utilized to compensate Black Start Service providers at least every two years. Specifically, Schedule 6A: Section 18 states:

***At least every two years, PJM shall review the formula and its costs components set forth in this section, and report on the results of that review to stakeholders.<sup>i</sup>***

This paper is the report required by the tariff, a review of the components and formulas in the current approved version of Schedule 6A: Section 18. **This report is not a review of the annual revenue requirements calculated by the tariff and whether the compensation black start units receive is adequate to keep the unit in black start service and maintain it reliably.**

Areas that require further consideration in this report include; possible update to the CRF table, the Fixed Black Start Service Cost (FBSSC) for units not requesting capital recovery costs under Section 5, more specific definitions to clarify and provide guidance when calculating cost for units requesting capital recovery costs under section 6 and the clarification of fuel storage cost to remove any interpretation from the tariff.

## Black Start: Total Revenue Requirements

Black start service supplies electricity for system restoration in the unlikely event that the entire PJM Interconnection grid would lose power. In the event that power would be lost across the entire grid, black start service is used to supply electricity to help restore the system. Black start service is provided by generating units that have the ability to start up and deliver power to the grid without an outside source of power – or units that can remain in operation at reduced output levels when disconnected from the grid. Such units must be able to reconnect to the grid within 90 minutes after a request from PJM. They also must be able to maintain frequency and voltage under varying loads. To be designated as a black start resource, a generating facility must pass a series of performance tests every 13 months. In a system-restoration situation, black start units can be used to reestablish the regional electric system. Once connected, they supply power to other generating units and help restore load. This must be a careful, deliberate process that keeps generation in balance with load in order to avoid the possibility of another loss of service.

The owners of black start units receive cost-based payments for providing the service to the grid. Schedule 6A section 18 outlines the formulas used to calculate the revenue requirements. The primary formula is as follows:

$$\text{Generator's Annual Black Start Service Revenue Requirement} = \{\text{Fixed BSSC} + \text{Variable BSSC} + \text{Training Costs} + \text{Fuel Storage Costs}\} * (1 + Z)$$

Where:

- Fixed BSSC = Fixed Black Start Service Cost
- Variable BSSC = Variable Black Start Service Costs
- Training Costs = \$3,750 per plant per delivery year (50 staff hours per plant per year \*\$75 per staff hour)
- Fuel Storage Cost is the cost defined in the tariff for oil units with onsite storage (discussed below)
- Z= the incentive factor of 10%

The total revenue requirements are the amount of compensation a black start unit receives per delivery year if it fulfills all the black start requirements under the tariff. This amount is allotted monthly, and may change every delivery year (June 1 – May 31). PJM records the tests of all black start units receiving compensation through the PJM tariff and alerts PJM Settlements to stop payment if requirements are not met.

### ***Automatic Load Rejection Units (ALR) or Units with a High Operating Factor***

Automatic Load Rejection Units are generating units with a high operating factor that have demonstrated the ability (subject to Transmission Provider concurrence) to automatically remain operating at reduced levels when disconnected from the grid. These units can be considered black start where appropriate, but they do not receive the same black start payments as black start units that start without an outside electrical supply. The revenue requirements for ALR units are as follows<sup>ii</sup>:

$$\text{ALR Generator's Annual Black Start Service Revenue Requirement} = \text{Training Costs} * (1 + Z)$$

- Where Z is a 10% incentive factor
- Training costs are calculated as 50 staff hours per plant per year \*\$75 per staff hour = \$3,750 per plant per delivery year

For ALR units, the total annual compensation from black start is \$4,125 per plant per delivery year.

**Fixed Black Start Service Cost (FBSSC)**

Fixed Black Start Service Cost are calculated in two possible ways depending on whether the unit is recovering costs under section 5<sup>iii</sup> or Section 6<sup>iv</sup> of Schedule 6A with the central difference being whether the black start unit owner seeks to recover new or additional capital costs through application of the Schedule 6A formula rate. The following figure shows the 2 methods for recovery of Fixed BSSC.

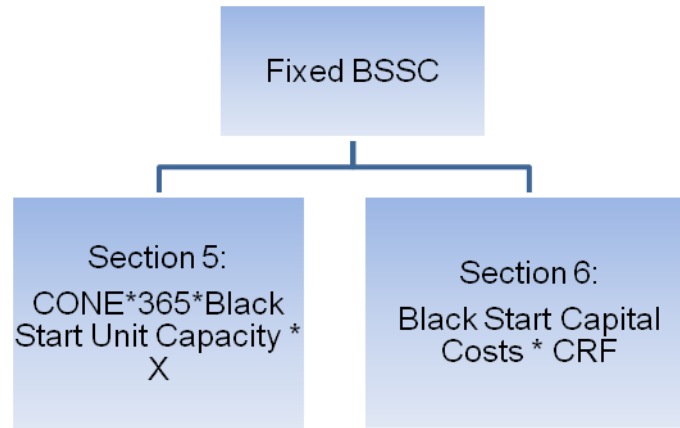


Figure 1: Two methods to recover fixed black start costs per Schedule 6A

If units recover Fixed BSSC through Schedule 6A, section 5, they are electing to forgo any recovery of black start capital costs and fall into the lower left-hand box above. If units prefer to recover through Schedule 6A, Section 6, then they do submit capital costs for recovery and fall into the lower right-hand box above.

**Section 5 Fixed Black Start Service Cost for Units not requesting Capital Cost Recovery**

For units recovering costs under Section 5 and not recovering black start capital costs, Fixed Black Start Service Costs are defined below:

Where CONE is equal to “then current net Cost of New Entry for the CONE Area where the Black Start Unit is located as set forth in Section 5.10 of Attachment DD”. These are the CONE areas set forth in Attachment DD:

<b>Geographic Location Within the PJM Region Encompassing These Zones</b>	<b>Cost of New Entry in \$/MW-Year</b>
PS, JCP&L, AE, PECO, DPL, RECO (“CONE Area 1”)	122,040
BGE, PEPSCO (“CONE Area 2”)	112,868
AEP, Dayton, ComEd, APS, DQL (“CONE Area 3”)	115,479
PPL, MetEd, Penelec (“CONE Area 4”)	112,868
Dominion (“CONE Area 5”)	112,868

The formula refers to a table with gross CONE in \$-MW-year, but is referring only to the five CONE areas in the 2013-2014 delivery year. The use of UCAP CONE or ICAP CONE is not specified. Cost of New Entry is a Reliability Pricing Model (RPM) parameter and is related to the cost to build a GE Frame 7F in an area specified above. As CONE values used in planning parameters are calculated before Base Residual Auctions (BRA), the CONE values are three years old during the “current” delivery year in which the black start units are paid. The five CONE areas listed here are not applicable to every delivery year.

The net CONE is then multiplied by 365 so as to convert the \$/MW-day net CONE value to a \$/MW-year value. It is PJM staff opinion that units of measurements should be explicit in this formula to avoid confusion.

The Black start unit capacity is defined, as the installed capacity (ICAP).

The term X is:

*the Black Start Service allocation factor unless a higher or lower value is supported by the documentation of the actual costs of providing Black Start Service. For such units qualifying as Black Start Units on the basis of demonstrated ability to operate at reduced levels when automatically disconnected from the grid, X shall be zero. For Black Start Units with a commitment established under section 5, X shall be .01 for Hydro units, .02 for Diesel or CT units.*

PJM staff would recommend changing “Hydro” to include “Storage Units”.

#### **Section 6 Fixed Black Start Service Cost for Units requesting Capital Cost Recovery**

Black Start Capital Cost Recovery =

Capital Costs for incremental equipment solely necessary for Black Start \* CRF

For units recovering black start capital costs under Section 6, Fixed Black Start Service Costs are defined below:

*“Black Start Capital Costs” is the capital cost documented by the owner or accepted by the Commission for the incremental equipment solely necessary to enable a unit to provide Black Start Service in addition to whatever other product or services such unit may provide. Such costs shall include those incurred by a Black Start Owner in order to meet NERC Reliability Standards that apply to Black Start Units solely on the basis of the provision of Black Start Service by such unit.*

This section (Black Start Capital Costs) should be well defined to clarify what is meant by the statement, “for the incremental equipment solely necessary to enable a unit to provide Black Start Service in addition to whatever other product or services such unit may provide”.

This statement could be interpreted in different ways – for example it could refer to s to only the equipment required to allow the unit to be black start capable, such as a diesel generator, air starter, batteries, or specific control functions. This section could also imply that the entire generating unit could be replaced or repaired through Schedule 6A. This ambiguity needs to be clarified.

“CRF” or “Capital Recovery Factor” includes age and years of remaining life, but the tariff specifies that the CRF is based on “the age of the unit.”

Age of Black Start Unit	Years of Remaining Life of Black Start Unit	Levelized CRF
1 to 5	20	0.125
6 to 10	15	0.146
11 to 15	10	0.198
16+	5	0.363

The CRF table has several different assumptions such as: the Capital Recovery Factor based on a levelized proforma for a 100MW Combustion Turbine for \$1M, 2.5% inflation, 36% federal tax rate, 9% state tax rate, income tax rate 41%, 50% equity and 50% debt with a 7% interest rate, and a 12% internal rate of return on equity.

This CRF table was originally taken from the capacity market, and the capacity market CRF table has since been updated to the following:

Age of Existing Units (Years)	Remaining Life of Plant (Years)	Levelized CRF
1 to 5	30	0.107
6 to 10	25	0.114
11 to 15	20	0.125
16 to 20	15	0.146
21 to 25	10	0.198
25 Plus	5	0.363
Mandatory CapEx	4	0.450
40 Plus Alternative	1	1.100

Whether this is a more appropriate fit for the CRF table for Black Start should be explored.

### **Variable Black Start Service Cost (VBSSC)**

$$\text{Variable Black Start Service Cost} = \text{Black Start Unit O\&M} * Y$$

O&M is the Operating and Maintenance Cost that is calculated for all cost offers through following Manual 15: Cost Development Guidelines. Y is 1% of the total annual O&M.

### **Training Cost**

$$\text{Training Costs} = 50 \text{ staff hours/year/plant} * \$75/\text{hour}$$

\$75 is a fixed rate written into the tariff that does not change with inflation or other economic indicators. This currently does not seem to be an inadequate amount. This cost is independent of the number of people trained, how many do restoration drills, and the cost of training to determine the true cost for training.

## Fuel Storage Cost

Fuel Storage Costs =

$$\begin{aligned} & (\text{Minimum Tank Suction Level} + (\# \text{ of Run Hours Required} * \text{Fuel Burn Rate})) \\ & * (12 \text{ month forward strip} + \text{basis}) * \text{Bond Rate} \end{aligned}$$

PJM staff believes units of measure in this component should be explicit. For the 12 month forward strip and bond rate, the value from May 1 every year should be used to keep recovery consistent across resources. Determination of basis should also be defined.

## Conclusion

The areas that require further consideration include; possible update to CRF table, the Fixed Black Start Service Cost (FBSSC) for units not requesting capital recovery costs under Section 5, more specific definitions to clarify and provide guidance when calculating cost for units requesting capital recovery costs under Section 6 and the clarification of fuel storage cost definitions should be clarified to remove any interpretation from the tariff.

## Potential Parking Lot Items

- Fixed Black Start Service Cost (FBSSC) Formula Clarifications
- Evaluation of CRF table
- Fuel Storage Cost Clarifications

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<sup>i</sup> <http://www.pjm.com/documents/~media/documents/agreements/tariff.ashx> page 512

<sup>ii</sup> <http://www.pjm.com/documents/~media/documents/agreements/tariff.ashx> page 509

<sup>iii</sup> Owners of Black Start Units selected to provide Black Start Service in accordance with section 4 and electing to forego any recovery of new or additional Black Start Capital Costs shall commit to provide Black Start Service from such Black Start Units for an initial term of no less than two years and authorize the Transmission Provider to resell Black Start Service from its Black Start Units. The term commitment shall continue to extend until the Black Start Unit owner, or the Transmission Owner, with the consent of the Transmission Provider, or the Transmission Provider, with the consent of the Transmission Owner, provides written, one-year advance notice of its intention to terminate the commitment.

<sup>iv</sup> Owners of Black Start Units selected to provide Black Start Service in accordance with section 4 and electing to recover new or additional Black Start Capital Costs shall commit to provide Black Start Service from such Black Start Units for a term based upon a reasonable estimate of the expected life of the Black Start Unit, as set forth in the CRF Factor Table in section 18, and authorize the Transmission Provider to resell Black Start Service from its Black Start Units. Either the Transmission Provider, with the consent of the Transmission Owner, or the Transmission Owner, with the consent of the Transmission Provider, may terminate the commitment with one year advance notice of its intention to the Black Start Unit owner, but the Transmission Owner shall reimburse the Black Start Unit owner for any amount of unrecovered Fixed Black Start Service Costs over a period not to exceed five years. A Black Start Unit owner may terminate the provision of Black Start Service with one year advance notice (or its commitment period may be involuntarily terminated pursuant to the section 15 below). Such Black Start Unit shall forego any otherwise existing entitlement to future revenues collected pursuant to this Schedule 6A and fully refund any amount of the Black Start Capital Costs recovered under a FERC-approved rate (recovered on an accelerated basis pursuant to the provisions of section 17(i)) in excess of the amount that would have been recovered pursuant to section 18 during the same period. At the conclusion of the term of commitment established under this section 6, a Black Start Unit shall commence a new term of commitment under either section 5 or 6, as applicable.

<sup>v</sup> <http://www.pjm.com/documents/~media/documents/agreements/tariff.ashx> Page 2267