



Fuel Requirements for Black Start Resources Package H Clarifications

Daniel Bennett
Lead Engineer, Generation
MIC / OC
September 7 / 8, 2022

Level of Fuel Assurance - Each transmission owner zone is required to be fuel assured in accordance with the following:

- **Minimum criteria:** One fuel-assured black start site per zone
- **Additional black start solutions beyond minimum fuel-assurance criteria:** Based on reliability criteria that identifies high-impact black start sites

Key Benefit

Ensures a zonal minimum level of fuel-assured black start resources while using a reliability-focused approach to address only the more extreme cases of potential restoration time increases

Key Fuel Assurance Enhancements:

- 16 hour run hour requirement
- Fuel assurance requirements by primary fuel type
- Testing and verification requirements
- Implementation through RTO wide RFP process / reliability backstop
- Compensation for black start resources on Base Formula Rate:
 - For fuel assured resources selected via RFP Z factor = 20%
 - For all other resources, Z factor = 10% (Status Quo)
- BS monthly revenues foregone where onsite fuel, water level, stored energy, etc. is not maintained for run hour requirement



Matrix Change

Minimum Level of Fuel Assurance for Black Start Resources

One individual Fuel Assured Black Start (meeting the requirements in Design Component Section B and C) site per zone.

PJM ~~may~~ will select more than one Fuel Assured Black Start site if on the base formula rate **or on the capital recovery rate (if no additional capital needs to be expended), but would only award one fuel assurance conversion to meet the zonal criteria.**

If an individual Fuel Assured Black Start site is not currently available, two Black Start sites connected to different interstate gas pipelines is an acceptable alternative to meet the minimum.



Matrix Change

Black Start Fuel Assurance Solutions by Primary Fuel

Ability to provide black start MW for the minimum run time duration with 90% confidence as calculated by PJM

PJM will calculate both fuel assured and non-fuel assured hydro resource's confidence level using unit specific historical data submitted to PJM ~~for the ELCC analysis performed in December 2021~~. This historical data includes hourly streamflow data, minimum & maximum flows, and exigent & ordinary storage converted into MWh. For non-fuel assured resources PJM will calculate a yearly confidence level based on a simple average of the number of days the unit can provide its black start ICAP for 16 hours in a day. The overall confidence level for the historical years is calculated using a ELCC weather weighted average. For fuel assured resources, PJM will iterate the Black Start MWs in the non-fuel assured calculation to obtain an ELCC weather weighted confidence level of 90% on a monthly basis.

Note: Applicable to Hydro (Run of River)



Matrix Change

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Meet all requirements in Design Component Section B and PJM OATT Schedule 6A

Note: Applicable to Hybrid Resources and Intermittent Resources

Fuel Assured units must communicate starting system limitations as soon as possible but within ~~one hour~~ **24 hours** of recognition to PJM ~~via Markets Gateway Resource Limitation Reporting~~ if starting systems not able to meet the run time requirement



Matrix Change

Non-Fuel Consumables (e.g. water, ammonia) Inventory Verification

Fuel Assured units must communicate non-fuel consumables inventory limitations as soon as possible but within ~~one hour~~ **24 hours** of recognition to PJM ~~via Markets Gateway Resource Limitation Reporting~~ if consumables fall below the run time requirement



Matrix Change

Portion of Fuel Assured Capital Recovery That Is Solely Necessary for Black Start

In order to determine how much of the capital recovery is solely necessary for Black Start, any energy revenues obtained as a result of a fuel assurance conversion minus the unit's cost to provide those MWs, by month, would be netted from the black start revenues for that month.

If the modification increases the overall capacity of the unit, the capacity payments for the increased capacity will be netted from the black start revenues on a monthly basis



Matrix Change

Onsite Fuel, Water Level, Stored Energy, Etc., Starting Systems, and Non-Fuel Consumables Compensation

If the on-site fuel inventory, water level, stored energy, etc. of a Fuel Assured black start resource falls below the run hour requirements for any length of time during any period, PJM must be notified within 24 hours.

Black start monthly revenues will be foregone for months in which the fuel inventory is deficient. If the fuel inventory, water level, stored energy falls below the run hour requirement as the result of a regulatory requirement for approved planned outage (full derate) **or as a result of operating during a PAI, monthly Black Start revenues will not be withheld.**

SME / Presenter:
Daniel Bennett
Daniel.Bennet@pjm.com

Facilitator:
Janell Fabiano
Janell.Fabiano@pjm.com

Secretary:
Natalie Tacka
Natalie.Tacka@pjm.com

Fuel Requirements for Black Start Resources



Member Hotline

(610) 666-8980

(866) 400-8980

custsvc@pjm.com

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Appendix

	Thermal, Pumped Storage Hydro, & Energy Storage Resources		Run of River Hydro, Intermittent Resources, & Hybrid Resources	
	Non-Fuel Assured (Status Quo)	Fuel Assured	Non-Fuel Assured (Status Quo)	Fuel Assured
Revenue Black Start MW	ICAP	ICAP	ICAP	Monthly MW amount based on 90% confidence level (calculated by PJM every five years)
Restoration Plan MW	ICAP	ICAP	ICAP * % of year unit can provide ICAP for the 16 hours ¹	Annual MW amount based on 90% confidence level (calculated by PJM every five years)
Run Hour Requirement	Thermal: 16 Hours PSH / ESR: Determined by TO Restoration Plan ¹	16 Hours at ICAP	Determined by TO Restoration Plan	16 Hours at 90% Confidence MW
X Factor	Thermal: 0.02 PSH / ESR: 0.01	0.02	0.01	0.02 (Same as CT)
Z Factor	10%	20% ²	10%	20% ²
Fuel Assurance Penalties	None	Monthly revenues forgone in months where onsite fuel, water level, stored energy, etc. is not maintained for run hour requirements	None	No penalties because Revenue Calculation MW is determined by PJM calculation of confidence level

Note 1: Text in red is a change from the current status quo
 Note 2: See Slide 15 for cost impact details

Minimum One Fuel-Assured Black Start Site Per Zone

The majority of TO zones currently meet the minimum criteria and there is no current projected capital cost impact to meet this minimum.

Additional Black Start Z Factor Incentive ¹	20% Z Factor (Single Site Per Zone Cost Range)	20% Z Factor (All Sites)
Total Cost	\$174,000 - \$272,000	\$436,000
Cost Per MWh	\$0.0002 - \$0.0003 / MWh	\$0.0006 / MWh

Additional Black Start Solutions Beyond Minimum Criteria

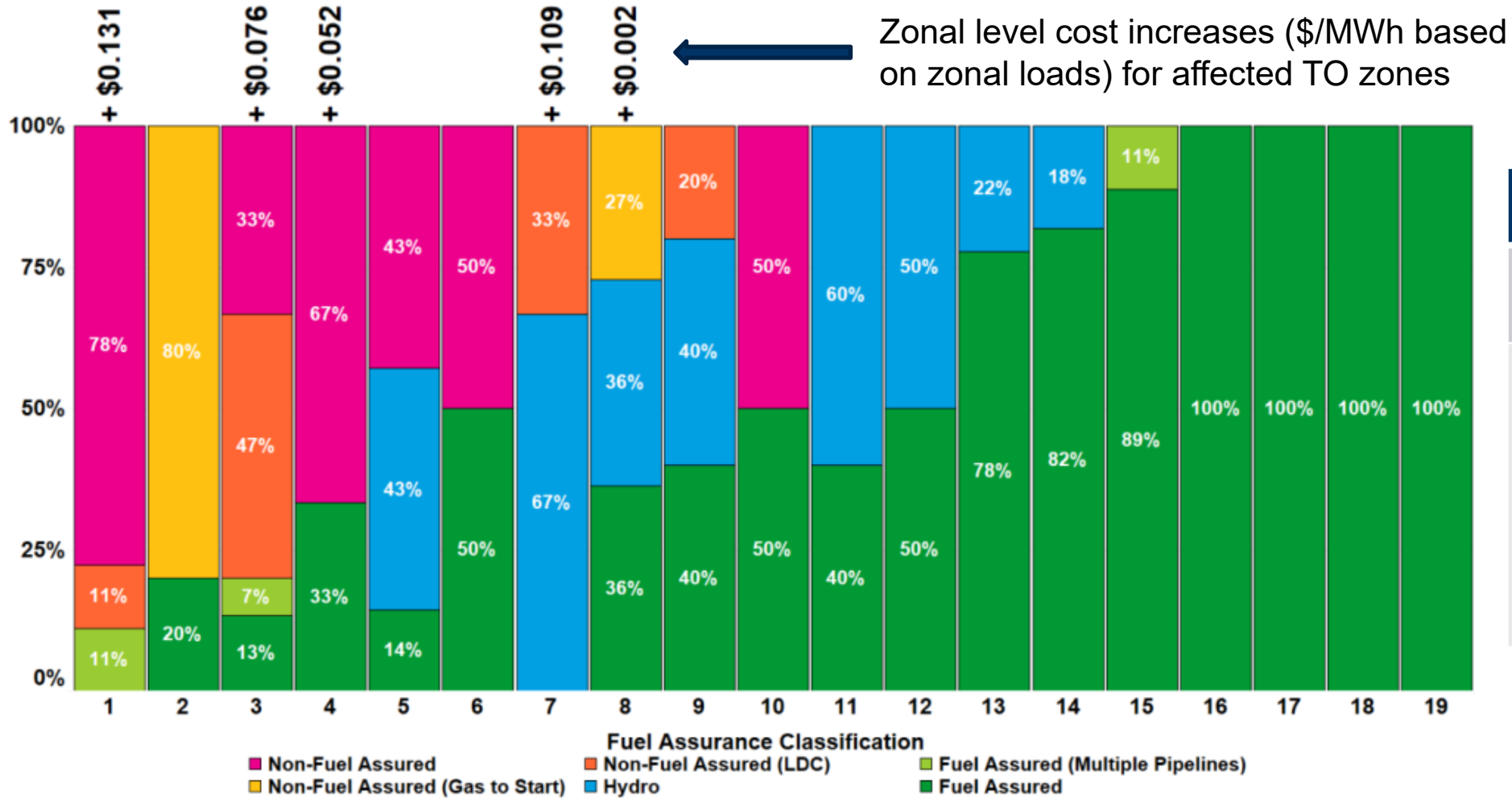
Mitigation of 8 high-impact BS sites in 5 TO zones is estimated to increase the RTO BS Annual Revenue Requirement by \$28,175,000 per year (\$0.036 per MWh based on RTO load); see Appendix for projected zonal cost increases on \$ / MWh basis). ^{2, 3}

Note 1: Z Factor increase only impacts Black Start units on the Base Formula Rate and that currently meet fuel assurance requirements

Note 2: For reference, the 2021 RTO BS Annual Revenue Requirement is \$68,230,718 per year (\$0.087 / MWh)

Note 3: See Appendix slides for cost estimate assumptions and for projected cost increases on \$ / MWh basis

Projected Zonal Cost Increase (\$/MWh) for High-Impact Black Start Sites



Notes

Percentages based on a black start unit count basis

Costs represent the projected incremental zonal increase in black start annual revenue requirement on a cost per MWh basis for fuel-assurance conversions

Cost Projection Assumptions/ Clarifications

- It is currently unknown which hydro resources would choose to be fuel assured.
- High impact black start sites agree to convert to become fuel assured (at black start resource owner discretion).
- Costs estimates based on dual fuel conversions, other fuel assurance solutions (e.g., LNG, CNG) could result in higher costs.

A minimum of one black start site per zone meeting the following fuel-assurance criteria, in order of preference:

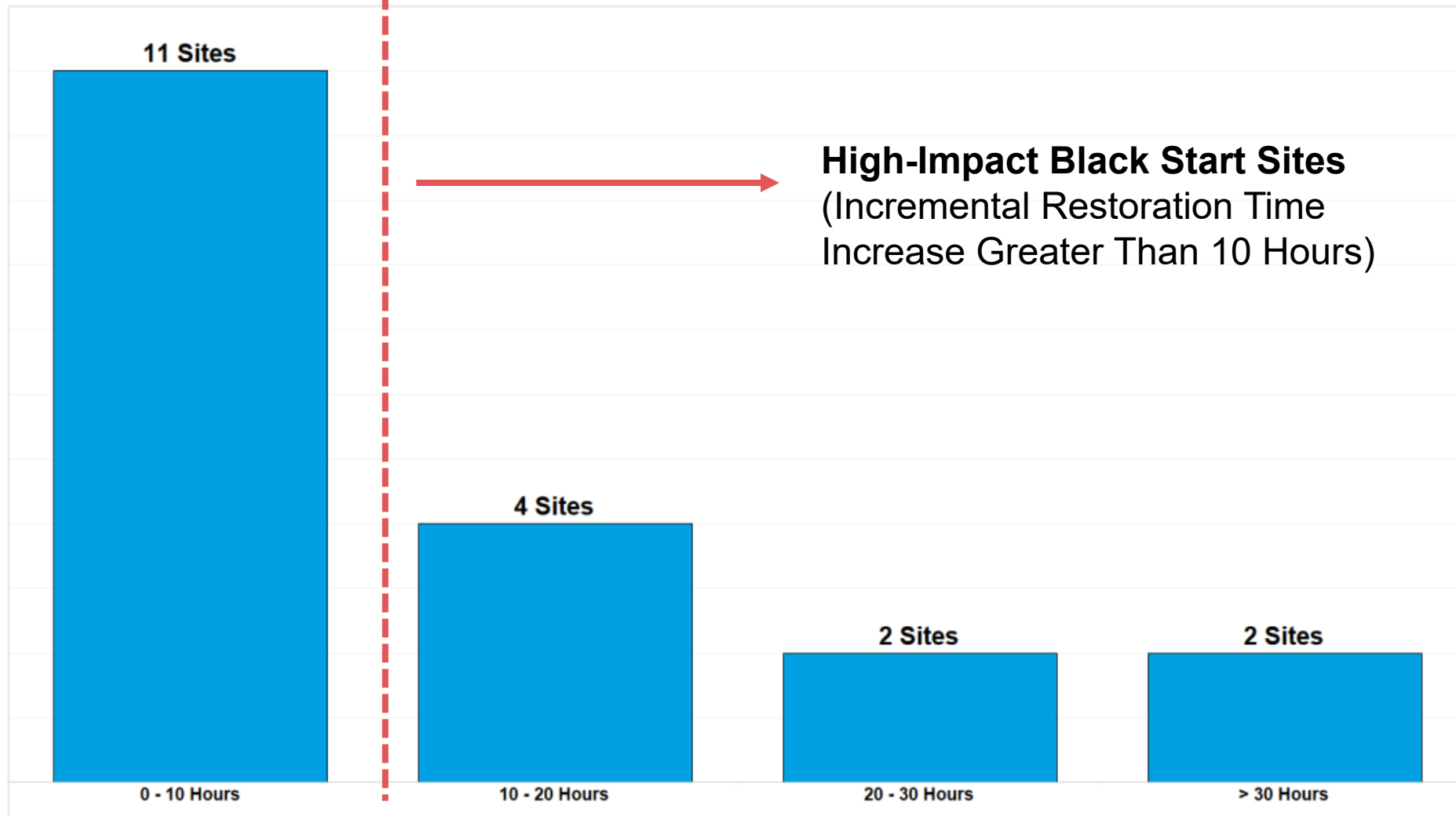
1. On-site fuel storage (e.g., dual fuel)
2. Connected to multiple pipelines
3. Gas-only black start site connected to a single source fed directly from a gas supply basin/gathering system ahead of interstate pipeline
4. Fuel-assured hydro black start site in accordance with the new hydro proposal
5. Fuel-assured intermittent or hybrid black start site in accordance with methodology that aligns with the new hydro proposal and also meets all other black start technical requirements
6. Minimum of 2 separate gas-only black start sites in a TO zone connected to 2 separate interstate gas pipelines (excludes connections to LDCs) would also be acceptable to meet min. fuel assurance requirement if 1–5 are not currently available

- Additional black start solutions (fuel-assurance conversions or additional fuel-assured or non-fuel-assured black start generation) beyond minimum fuel-assurance criteria to be based on reliability criteria that identifies high-impact black start sites.
 - Reliability criteria is incremental increase in restoration time greater than 10 hours upon the loss of a non-fuel-assured black start site.

- Hydro units (run of river or pumped storage) to align with new hydro proposal
 - Fuel-assurance criteria for future intermittent black start resources to follow similar methodology as in new hydro proposal.
- Includes all the other key fuel assurance enhancements:
 - 16 hr. run-hour requirement, fuel-assurance requirements by primary fuel type, testing and verification requirements, compensation
- Implementation through RTO-wide RFP or future incremental RFP

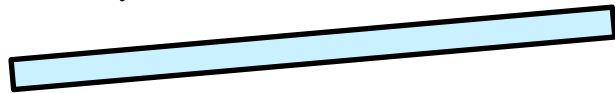
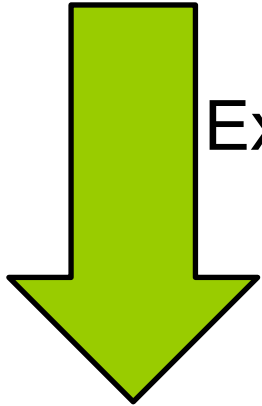
- Reliability Backstop
 - Existing Reliability Backstop Process (in PJM Manual 14D, Section 10.3 and OATT Schedule 6A, Section 6A) to be implemented in the event of insufficient response to RTO-wide RFP or future incremental RFP (2 failed RFP processes), to meet minimum of one black start site per zone meeting fuel-assurance criteria **and** reliability (PLUS) criteria beyond minimum criteria for high-impact black start sites.
 - For Reliability Backstop RFP, TO required to submit RFP proposal.

PJM Non-Fuel Assured Black Start Site Incremental Restoration Time Increase Results



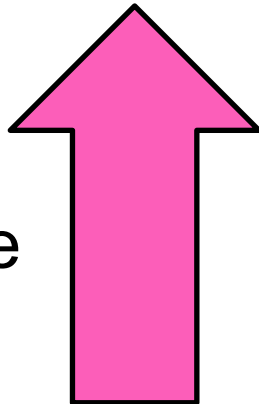
Benefit

Mitigated Increase
in Blackout
Expected Cost



Cost

Fuel Assurance
Conversion



Using a range of probabilities of a coincident black out and fuel delivery failure and a range of VoLLs, PJM has calculated the increase in the blackout expected cost that would be incurred if a Black Start site were unavailable due to a fuel failure during a restoration event.

The benefit of avoiding this additional expected cost can be weighed against the fuel conversion cost to provide supplemental financial input into fuel conversion decision.

This cost vs. benefit assessment can be displayed visually for each black start site so that all probability and VoLL combinations can be evaluated.

Inputs to Model Include:

- Incremental Restoration Time Increase
- Site Conversion Cost
- Zonal Load

