



Fuel Requirements for Black Start Resources PJM / Brookfield / DC OPC Package

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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



Consolidated PJM / Brookfield / DC OPC Package

Thermal / Pumped Storage Hydro / Energy Storage Resource Summary

Fuel Assurance Requirements	Non-Fuel Assured (Status Quo)	Fuel Assured
Black Start MW	ICAP	ICAP
Run Hour Requirement	Thermal: 16 hours Pumped Storage Hydro / Energy Storage: Determined by TO restoration plan	16 hours at ICAP
Black Start Calculator MW	ICAP	ICAP

Text in red is change from Status Quo



Consolidated PJM / Brookfield / DC OPC Package Run of River Hydro / Intermittent / Hybrid Resources Summary

Fuel Assurance Requirements	Non-Fuel Assured (Status Quo)	Fuel Assured
Black Start MW	ICAP	Run of River Hydro, Hybrid and Intermittent - PJM calculates black start MW unit can provide for the minimum run time duration with 90% confidence (calculated monthly)
Run Hour Requirement	Determined by TO restoration plan	16 hours at 90% confidence MW
Black Start Calculator MW	ICAP * (% of year unit can provide ICAP for 16 hours)	Run of River Hydro, Hybrid and Intermittent - MW the unit can provide for 16 hours with 90% confidence on an annual basis calculated every 5 years

Text in red is change from Status Quo



Consolidated PJM / Brookfield / DC OPC Package Thermal / Pumped Storage Hydro / Energy Storage Resource Summary

Compensation	Non-Fuel Assured (Status Quo)	Fuel Assured
Revenue Calculation MW	ICAP	ICAP
X Factor	0.02 – Thermal 0.01 – Storage	0.02
Z Factor Incentive	10%	20%*
Penalties	None	BS monthly revenues foregone in months where onsite fuel, water level, stored energy, etc. is not maintained for run hour requirement

*See slide #8 for cost impact



Consolidated PJM / Brookfield / DC OPC Package Run of River Hydro / Hybrid/Intermittent Resources Summary

Compensation	Non-Fuel Assured (Status Quo)	Fuel Assured
Revenue Calculation MW	ICAP	Monthly MW calculation with 90% confidence value
X Factor	0.01	0.02 (same as CT)
Z Factor Incentive	10%	20%
Penalties	None	No penalties because of PJM calculation of confidence level



RTO Annual Black Start Revenue Increase

Increase	20% Z Factor (Lowest Single Site Per Zone Cost)	20% Z Factor (Highest Single Site Per Zone Cost)	20% Z Factor (All Sites)
Total Cost (\$)	174,000	272,000	436,000
Cost Per MWh (\$/MWh)	0.0002	0.0003	0.0006

- Z Factor increase only impacts Black Start units on the Base Formula Rate and that store oil onsite
- For reference – 2021 RTO BS Annual Revenue Requirement: \$68,230,718/yr. (\$0.087/MWh)

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Fuel Requirements for Black Start Resources



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Appendix

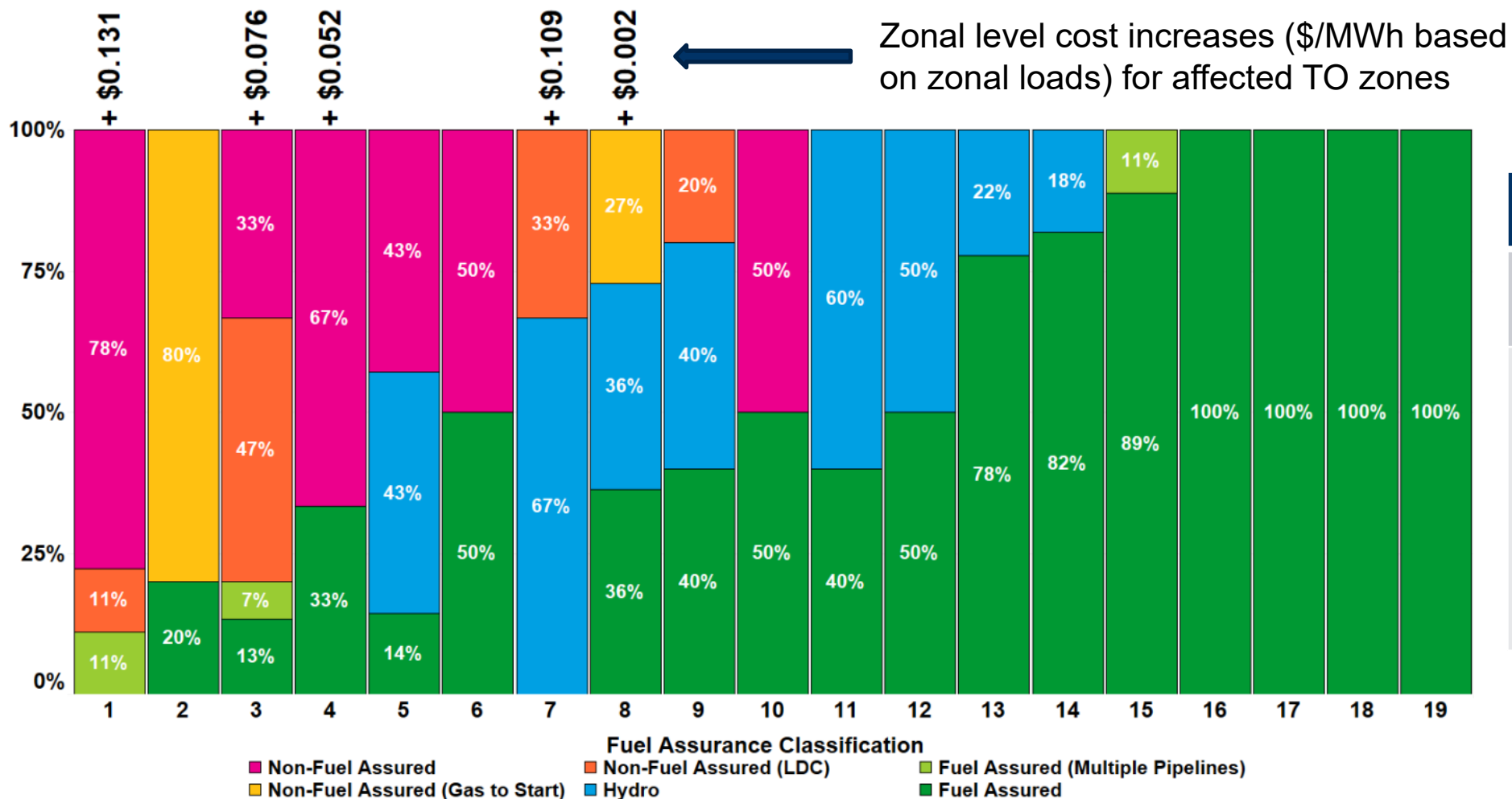
Minimum One Fuel-Assured Black Start Site Per Zone

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

Additional Black Start (BS) Solutions Beyond Minimum Criteria

- Mitigation of 8 high-impact BS sites in 5 TO zones
- Est. additional RTO BS Annual Revenue Requirement for 8 high-impact BS sites: +\$28,175,000/yr. (+\$0.036/MWh based on RTO load; see slide 4 for projected zonal cost increases on \$/MWh basis)
- For reference – 2021 RTO BS Annual Revenue Requirement: \$68,230,718/yr. (\$0.087/MWh)

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

