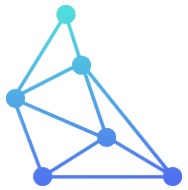
Brandon Shores Retirement Analysis

Project Update

February 2024



TELOS ENERGY

GridLAB

Agenda

1. Overview of Brandon Shores Retirement Analysis
2. Proposed Alternative Technical Feasibility
3. Proposed Alternative Cost Feasibility
4. Summary
5. Technical Appendix

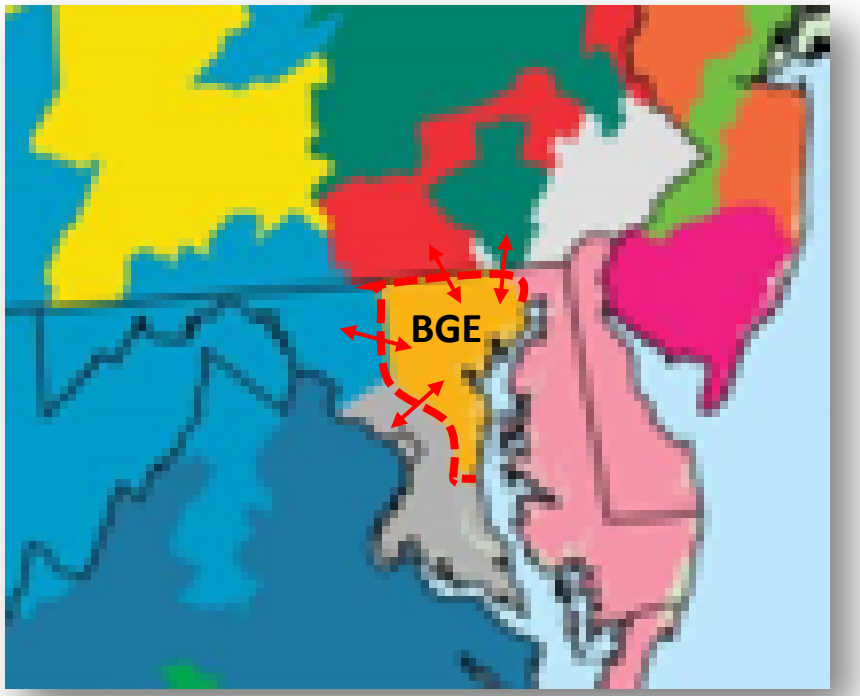
Overview of Brandon Shores Retirement Analysis

Overview of Analyses

PJM's results found issues with:

- **Load Deliverability (LD)** – A thermal analysis to check the ability to transfer power into a load pocket under stressed conditions (coincident high demand)
- **Generator Deliverability (GD)** – A thermal analysis to check the ability to transfer power out of a generation pocket under stressed conditions (coincident high generation dispatch)
- **N-1-1 Contingencies** – An analysis to evaluate thermal and voltage violations under a planned maintenance outage plus an unplanned contingency (outage of a transmission line or generator)

BGE and Transmission Transfer Paths



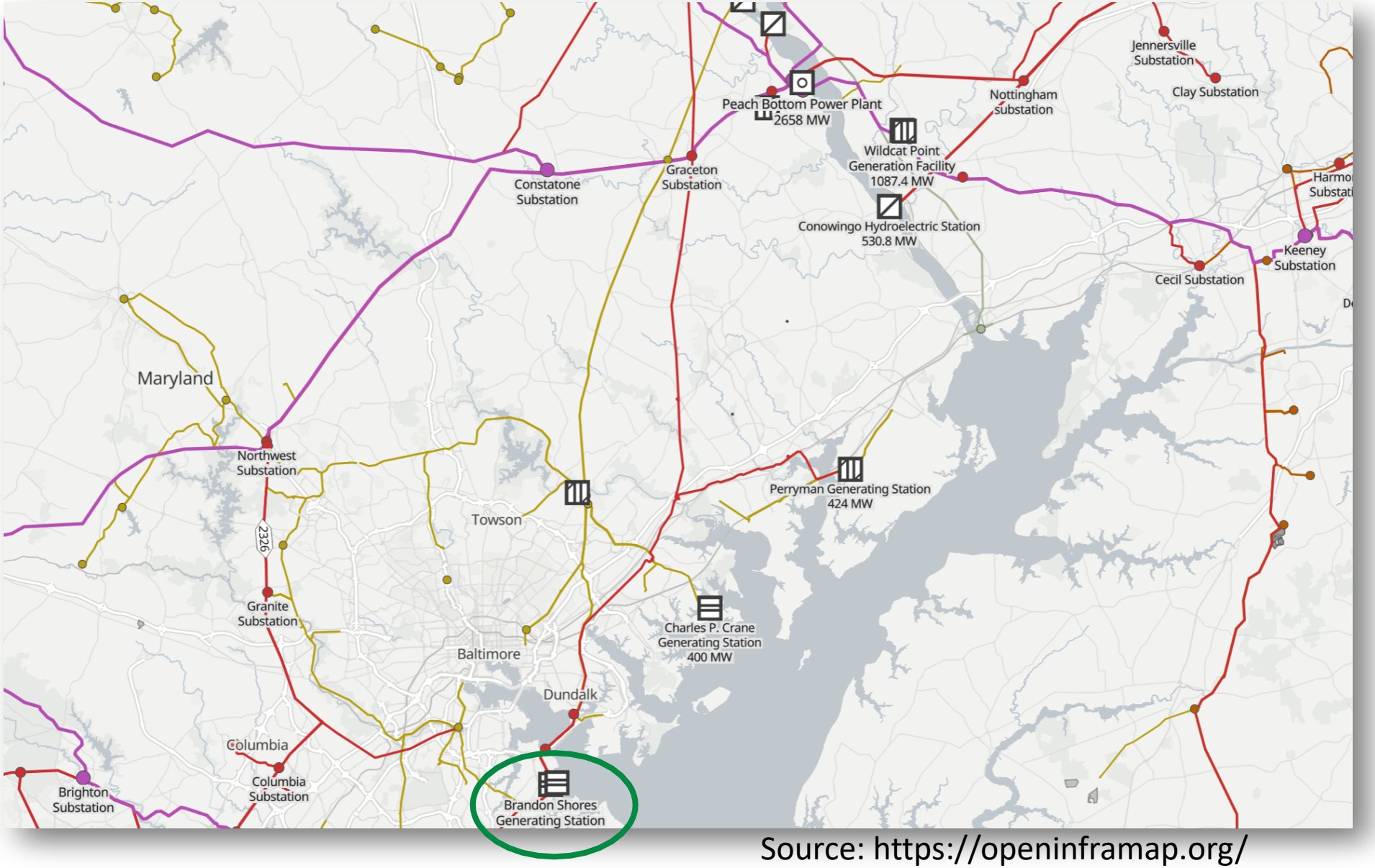
PJM'S Recommended Reinforcements

* Operating measures are not available

- To address these issues, PJM proposed a $780 million package of new transmission including
  - Two new high-voltage (500kV and 230 kV) transmission lines
  - Three new high voltage substations, and two substation expansions
  - Several voltage support devices ("STATCOMs" and "Capacitors")

- PJM is forecasting these upgrades will not be completed until **December 31, 2028**

- Until all upgrades are completed, PJM proposes to retain Brandon Shores from **3.5 years** past its requested retirement date (June 1, 2025), under a **reliability-must-run agreement (RMR).**



Source: https://openinframap.org/

RMR Risks

- A Brandon Shores RMR could cost **$258 million per year.**
- Which could total **$900 million in RMR costs** by the end of 2028.
- Meanwhile, region remains reliant on 33 – 40-year-old resources

This table was prepared by the Independent Market Monitor for PJM. The IMM confirmed the data with PJM.

Table 1 Part V reliability service summary[1 2 3 4]

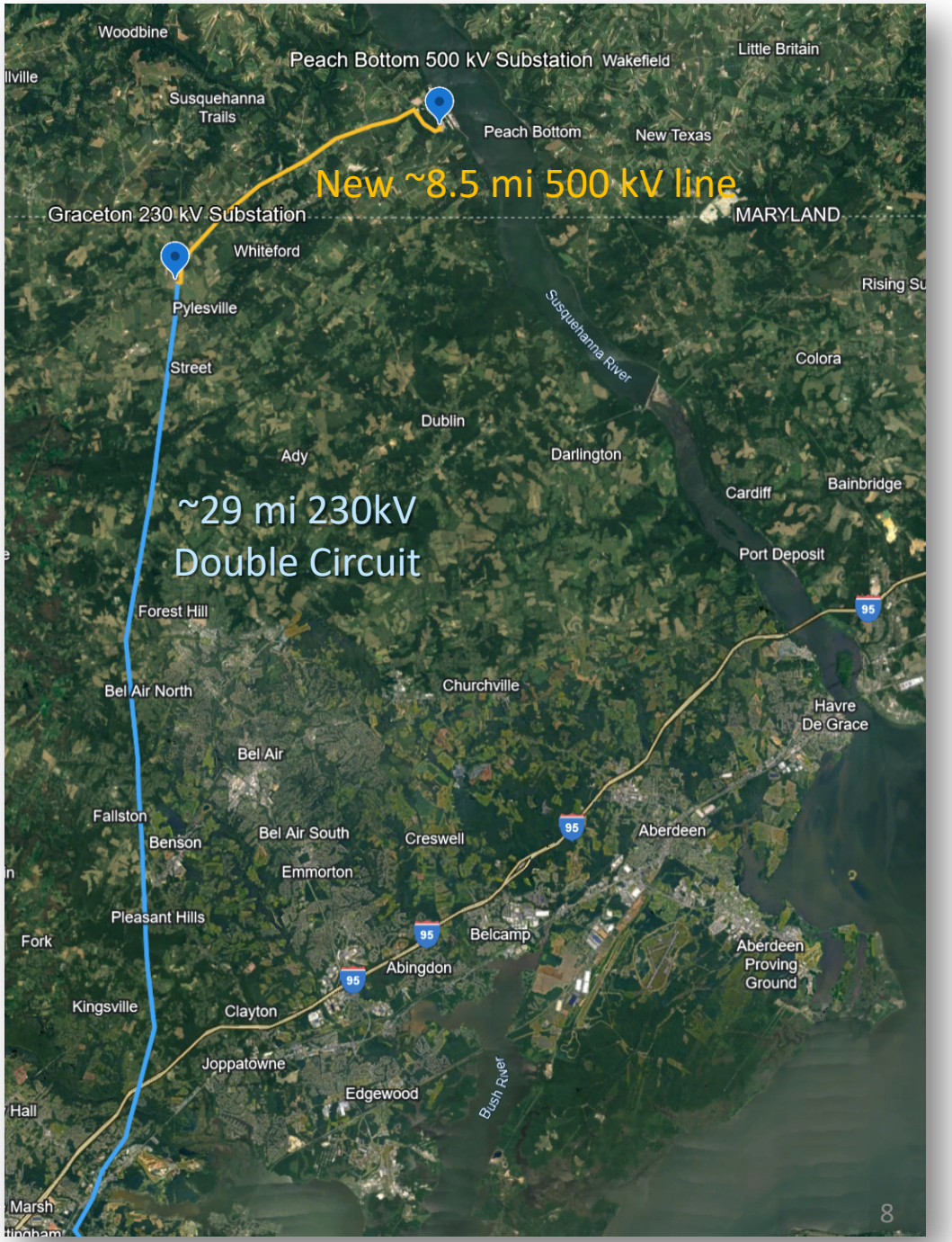
							Initial Filing		Actual	
Unit Names	Owner	ICAP (MW)	Cost Recovery Method	Docket Numbers	Start of Term	End of Term	Total Cost	Cost per MW-day	Total Cost	Cost per MW-day
Indian River 4	NRG Power Marketing LLC	410.0	Cost of Service Recovery Rate	ER22-1539	01-Jun-22	31-Dec-26	$357,065,662	$520.25	$111,081,790	$556.33
B.L. England 2	RC Cape May Holdings, LLC	150.0	Cost of Service Recovery Rate	ER17-1083	01-May-17	01-May-19	$35,953,561	$328.34	$51,779,892	$472.88
Yorktown 1	Dominion Virginia Power	159.0	Deactivation Avoidable Cost Rate	ER17-750	06-Jan-17	13-Mar-18	$9,739,434	$142.12	$8,427,011	$122.97
Yorktown 2	Dominion Virginia Power	164.0	Deactivation Avoidable Cost Rate	ER17-750	06-Jan-17	13-Mar-18	$10,045,705	$142.12	$9,529,149	$134.81
B.L. England 3	RC Cape May Holdings, LLC	148.0	Cost of Service Recovery Rate	ER17-1083	01-May-17	24-Jan-18	$28,710,481	$723.84	$10,058,665	$253.60
Ashtabula	FirstEnergy Service Company	210.0	Deactivation Avoidable Cost Rate	ER12-2710	01-Sep-12	11-Apr-15	$35,236,541	$176.25	$25,177,042	$125.94
Eastlake 1	FirstEnergy Service Company	109.0	Deactivation Avoidable Cost Rate	ER12-2710	01-Sep-12	15-Sep-14	$20,842,416	$257.01	$18,484,399	$227.93
Eastlake 2	FirstEnergy Service Company	109.0	Deactivation Avoidable Cost Rate	ER12-2710	01-Sep-12	15-Sep-14	$20,182,025	$248.87	$17,683,994	$218.06
Eastlake 3	FirstEnergy Service Company	109.0	Deactivation Avoidable Cost Rate	ER12-2710	01-Sep-12	15-Sep-14	$20,192,938	$249.00	$17,391,797	$214.46
Lakeshore	FirstEnergy Service Company	190.0	Deactivation Avoidable Cost Rate	ER12-2710	01-Sep-12	15-Sep-14	$33,993,468	$240.47	$20,532,969	$145.25
Elrama 4	GenOn Power Midwest, LP	171.0	Cost of Service Recovery Rate	ER12-1901	01-Jun-12	01-Oct-12	$15,435,472	$739.88	$7,576,435	$363.17
Niles 1	GenOn Power Midwest, LP	109.0	Cost of Service Recovery Rate	ER12-1901	01-Jun-12	01-Oct-12	$9,510,580	$715.19	$4,829,423	$363.17
Cromby 2 and Diesel	Exelon Generation Company, LLC	203.7	Cost of Service Recovery Rate	ER10-1418	01-Jun-11	01-Jan-12	$20,213,406	$463.70	$17,776,658	$407.80
Eddystone 2	Exelon Generation Company, LLC	309.0	Cost of Service Recovery Rate	ER10-1418	01-Jun-11	01-Jun-12	$165,993,135	$1,467.74	$85,364,570	$754.81
Brunot Island CT 2A, CT 2B, CT 3 and CC4	Orion Power MidWest, L.P.	244.0	Cost of Service Recovery Rate	ER06-993	16-May-06	05-Jul-07	$60,933,986	$601.76	$23,507,795	$232.15
Hudson 1	PSEG Energy Resources & Trade LLC and PSEG Fossil LLC	355.0	Cost of Service Recovery Rate	ER05-644, ER11-2688	25-Feb-05	08-Dec-11	$28,934,341	$32.90	$62,364,359	$70.92
Sewaren 1-4	PSEG Energy Resources & Trade LLC and PSEG Fossil LLC	453.0	Cost of Service Recovery Rate	ER05-644	25-Feb-05	01-Sep-08	$47,633,115	$81.89	$79,580,435	$136.82

Transmission Line Schedule Risks

Can these new transmission lines be permitted, designed, and built in less than 4 years?

Example 500 kV structure

Existing 230 kV corridor



Risks in PJM's Transmission Upgrade Package Schedule

"PJM does not have the authority or ability to assess the local impacts of these routes" – 2022 RTEP Window 3 FAQ

"There are currently long lead times of **two to three years** for all circuit breakers above 115 kV." – PJM RTEP Window 3 Constructability & Financial Analysis Report

STATCOMs being quoted with a **three-year** lead time based on transformer availability

500/230kV Transformers can take **three to four years** to deliver

Proposed Alternative

Technical Feasibility

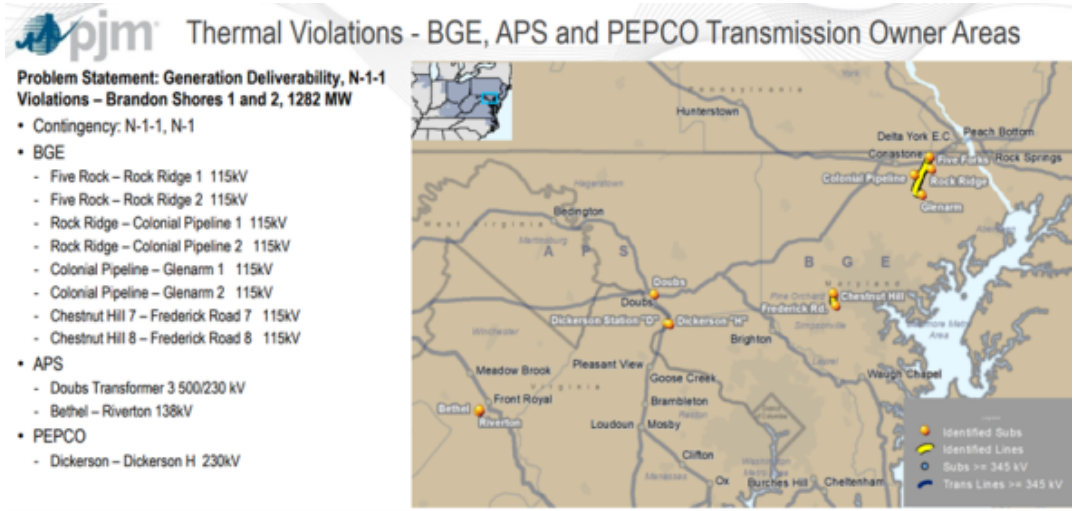
Our Approach

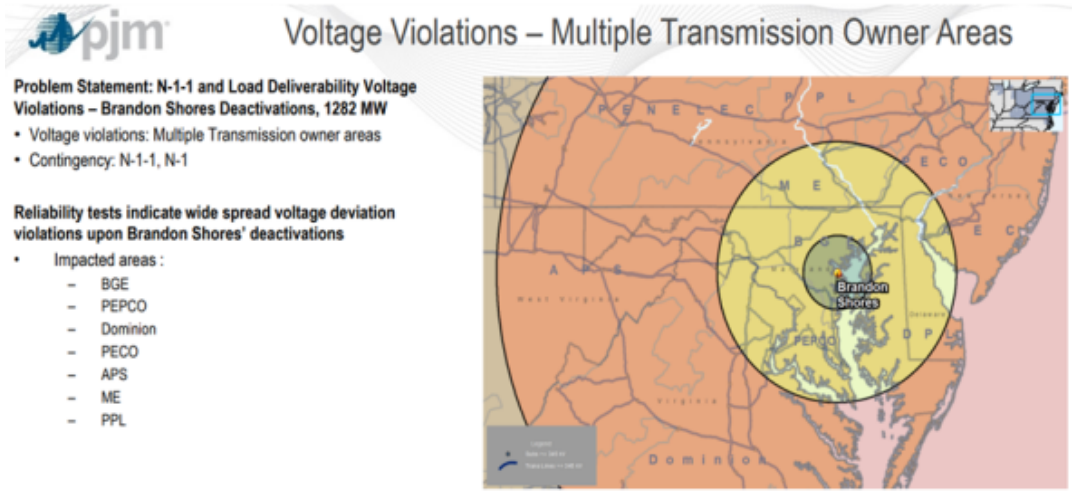
- **Objective:** Identify a set of mitigations to enable the fastest retirement of Brandon Shores (shortest duration of RMR, lowest RMR cost)

- Evaluate a set of models ("cases") representing summer and winter peak demand to understand the grid impact of the Brandon Shores retirement
- Consider the impact of potential alternative mitigations or combinations, including
  - Transmission reinforcements (including, but not limited to PJM's planned upgrades)
  - Synchronous condenser (MVAr only – helps with voltage violations only)
  - Battery energy storage (MVAr and MW – helps with voltage and thermal violations)
  - Long-duration capacity resources
- Evaluate costs of alternative mitigations that could reduce the duration of the Brandon Shores RMR

Key Findings

- Telos, in consultation with PJM, was able to create similar models to PJM and has confirmed that retiring Brandon Shores without mitigations **does cause reliability risks**
- The worst scenario in terms of **transmission line overloads** was summer peak conditions combined with a maintenance outage and unplanned outage (N-1-1)
- The worst scenario in terms of **voltage collapse** was an extended winter peak condition (Winter Storm Elliot) combined with generation outages





Scenario (Brandon Shores Retired)	Type of Analysis	Problem Identified	Alternative Solution
Summer Peak Load	Load Deliverability (An analysis to check the ability to transfer power into a load pocket under stressed conditions)	• **~430 MW of capacity shortfall**	**~600 MW x 4hr battery** at Brandon Shores
Summer Peak Load	Generation Deliverability (An analysis to check the ability to transfer power out of a generation pocket under stressed conditions)	• The power flowing through several 115-230 kV **lines exceed rating** (<10%)	**Reconductor** affected lines
Summer Peak Load	N-1-1 Analysis (a planned maintenance outage plus an additional unplanned outage)	• The power flowing through several 115kV **lines exceed rating** (<10%) • Moderate **voltage violations**	**Reconductor** affected lines Utilize the proposed 600 MW battery at Brandon Shores for simultaneous voltage support
Extended Winter Peak Load (Winter Storm Elliot)	N-1-1 Analysis (a planned maintenance outage plus an additional unplanned outage)	• Large voltage violations/**voltage collapse** when battery is depleted	Add voltage support approved by PJM **(Capacitors and STATCOMS)** & utilize Wagner 3&4 RMR and the 600 MW battery as a STATCOM
Extended Winter Peak Load (Winter Storm Elliot)	Generation Deliverability (An analysis to check the ability to transfer power out of a generation pocket under stressed conditions)	• Thermal violations when battery is depleted	Extended (100+ hour generation) **Wagner 3&4 RMR**

PJM Current Solution

- RMR for entire Brandon Shores plant until $780 million package is complete
- Install voltage support (STATCOMs & Capacitors)
- Construct new 500kV line
- Construct 500 kV and 230 kV system upgrades

Proposed Alternative

- RMR for entire Brandon Shores plant until battery, reconductor, and voltage support projects are complete
- New 600 MW x 4 hr battery at Brandon Shores (20-year life)
- Reconductor lines forecasted to overload
- Install voltage support (STATCOMs & Capacitors)
- Construct new 500kV line as load forecast requires
- Construct 500kV and 230 kV line and system upgrades as load and generation forecast requires

Which option is the lowest **cost** to customers?

Which option is the **quickest** to retire Brandon Shores?

Proposed Alternative

Cost Feasibility

Proposed Portfolio

Transmission

Prioritized Transmission Upgrades	Approved by PJM?	Estimated Cost ($MM)
BGE - Five Forks – Rock Ridge 1 115kV (GD + N-1-1)	No	$8.6
BGE - Five Forks – Rock Ridge 2 115kV (GD + N-1-1)	No	$8.6
BGE - Chestnut Hill 7 – Frederick Road 7 115kV (GD + N-1-1)	No	$4.0
BGE - Chestnut Hill 8 – Frederick Road 8 115kV (GD + N-1-1)	No	$4.0
APS - Bethel – Riverton 138kV (GD + N-1-1)	No	$5.6
APS - Line drops to Doubs Transformer 3 (GD + N-1-1)	Yes	$0.8
PECO - New Conastone Capacitor (N-1-1 Voltage)	Yes	$15.0
PEPCO - Brighton Statcom + Capacitor (N-1-1 Voltage)	Yes	$63.0
PEPCO - Burchess Hill Cap (N-1-1 Voltage)	Yes	$15.0
BGE - Build Solley Road Substation + Statcom (N-1-1 Voltage)	Yes	$109.0
BGE - Build Granite Substation + Statcom (N-1-1 Voltage)	Yes	$91.0

$31MM “New” / Incremental Upgrades

$294MM Short Lead-Time Upgrades already approved by PJM

Battery

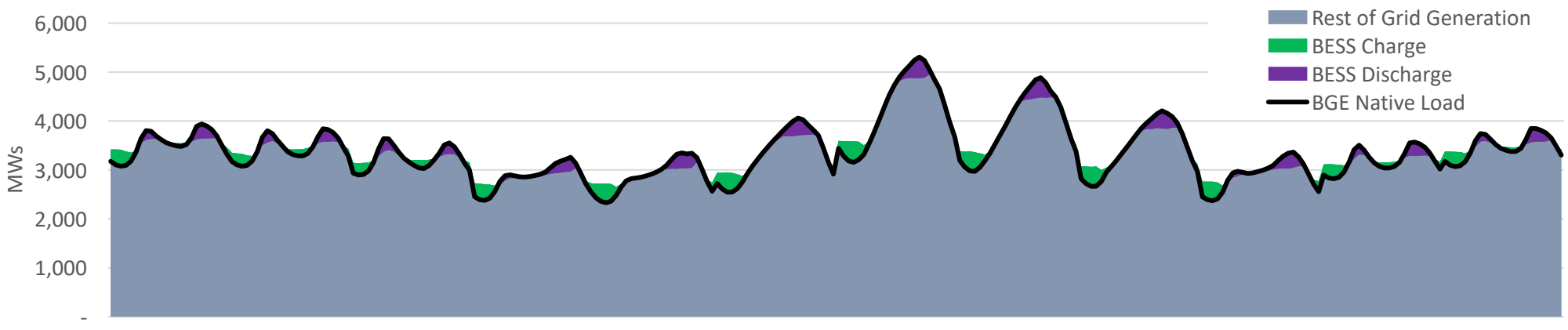
- Battery connected at the Brandon Shores POI (230kV)
- Power Rating: 600 MW / 300 MVAr (670 MVA inverters at 0.90 PF)
- Energy Rating: Assumed 4h

$753 million (before ITC, revenues etc.)
Revenues detailed in the next slides

Battery Operations: Optimized for BGE Peak Shaving

- Battery operations were optimized daily to shave BGE's peak loads – this analysis was performed using BGE's 2023 hourly loads
- This process generated charge, discharge and state of charge (SoC) parameters for the Battery which were used to estimate **revenues** relating to energy arbitrage and reserve provisions

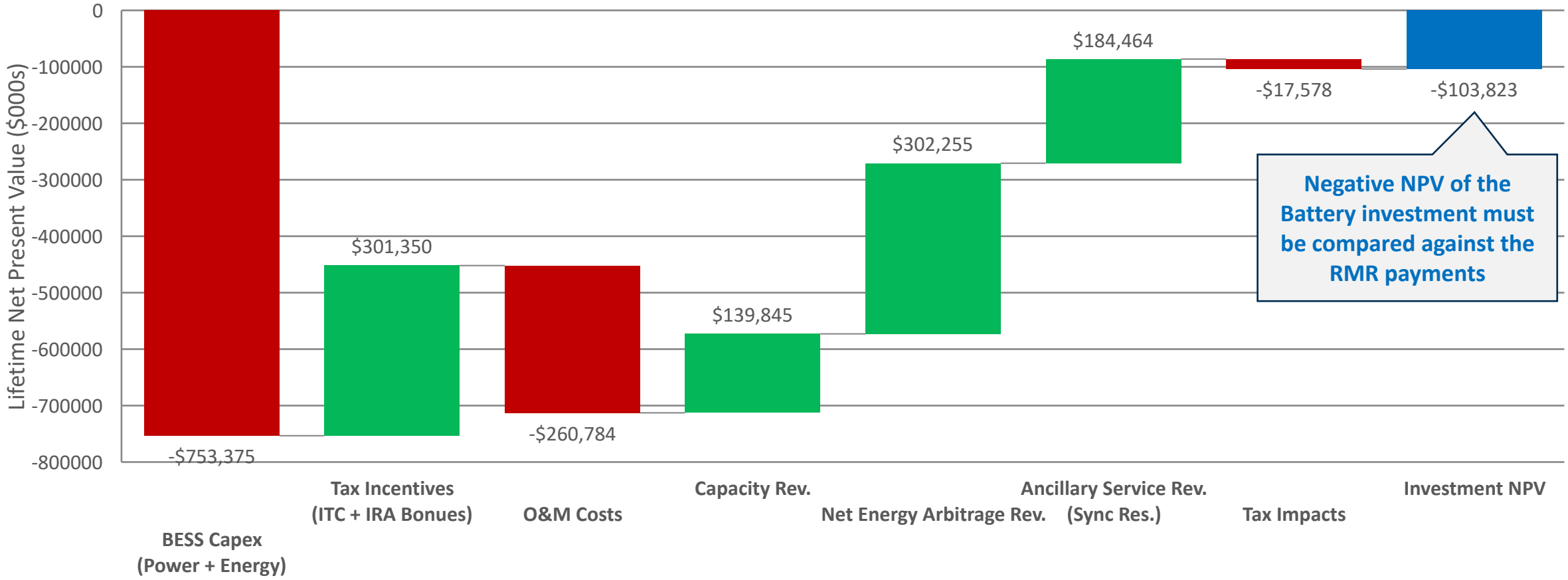
2023 Average Day Per Month Battery Operating Profile



600 MW x 4-hour Battery Investment Net Present Value (NPV) Waterfall

ELCC Capacity Credit 78% = 468 MW

NPV of BESS Investment

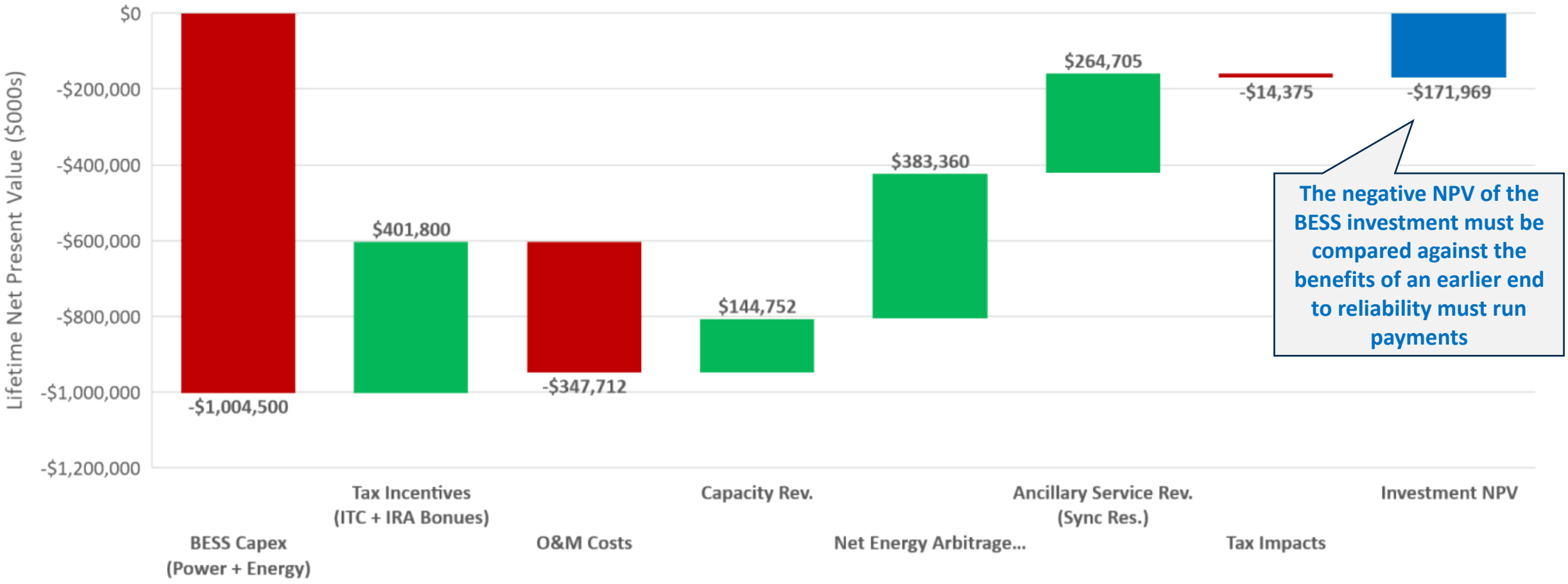


800 MW x 4-hour Battery Investment Net Present Value (NPV) Waterfall

ELCC Capacity Credit 59% = 472 MW

NPV of Standalone BESS Investment

($ in Thousands)



PJM Current Solution

Item	Estimated Cost
Brandon Shores RMR cost per year	$250 million

Proposed Alternative

Item	Estimated Cost
Targeted Reconductoring	$31 million
Battery (Capex – Tax Credits)	$452 - $603 million
20-Year Net Revenues (O&M cost - Revenue)	(-) $348 – $431 million
Total	$135 - $203 million

If the battery alternative can be installed on or before the start date of the RMR, it could solve the problem for **1/6 – 1/4 of the cost**

If the battery alternative can **offset 6 - 12 months of RMR** it could be a cost-effective alternative

The **current RMR is forecasted to be 3.5 years long,** so the sooner the alternative solution can be constructed, the more savings

Summary

Summary

- PJM Reliability Risks were confirmed

- Team studied an alternative solution including:
  - Targeted transmission line reconductoring
  - Installation of a 600 or 800 MW/4 hr. battery (Depending on ELCC Updates)
  - Construction of voltage support projects in RTEP Window 3 projects

- The proposed alternative is technically and highly cost effective

Thank you!

Storage Developers are interested in interconnecting in the area

Storage projects with active interconnection applications, but awaiting study

Project/OASIS ID	Name	State	Status	Transmission Owner	MFO	MW Energy	MW Capacity
Search	brandon shores			Search			
AG2-207	Brandon Shores 230 kV	MD	Active	BGE	275	275	110
AG2-319	Brandon Shores 230 kV	MD	Active	BGE	150	150	150
AG2-225	Wagner 115 kV	MD	Active	BGE	135	115	46
AH2-162	Northeast-CP Crane 115kV	MD	Active	BGE	200	200	200
AI1-130	Northeast-CP Crane 115kV	MD	Active	BGE	75	75	75
AI1-189	Northeast - Windy Edge 115 kV	MD	Active	BGE	110	110	110
AJ1-037	Northeast - CP Crane 115 kV	MD	Active	BGE	500	300	300

Glossary

- **MW –** Megawatt, a unit of electric power. ~1,350 horsepower
- **MWh** – Megawatt-hour, a unit of electric energy. 1 MW delivered for one hour
- **Capacitor –** A device typically installed inside a substation that provides voltage support
- **STATCOM -** A static synchronous compensator (STATCOM) reactive compensation device used on transmission networks. It uses power electronics to support voltage
- **Synchronous Condenser** - A synchronous condenser (also called a synchronous capacitor or synchronous compensator) is a large rotating generator whose shaft is not attached to any driving equipment. This device supports voltage on the transmission system
- **BESS** – Battery Energy Storage System