Consumers Energy
Count on Us

November 6, 2025

Ms. Lisa Felice
Executive Secretary
Michigan Public Service Commission
7109 W. Saginaw Hwy., 3rd Floor
Lansing, MI 48917

Re: Case No. U-21870 – In the matter of the application of Consumers Energy Company for authority to increase its rates for the generation and distribution of electricity and for other relief.

Dear Ms. Felice:

Enclosed for electronic filing in the above-captioned case, please find the Redacted Version of **Consumers Energy Company's Supplement to Oral Argument**. A confidential version will be filed with the Executive Secretary under seal.

This is a paperless filing and is therefore being filed only in a PDF. Also included is a Proof of Service showing electronic service upon the persons included in Attachment 1.

Sincerely,

Digitally signed by Bret A. Totoraitis
Date: 2025.11.06 15:15:44 -05'00'

Bret A. Totoraitis
Phone: 517-788-0835
Email: bret.totoraitis@cmsenergy.com

cc: Parties per Attachment 1 to the Proof of Service.

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of **CONSUMERS ENERGY COMPANY** for authority to increase its rates for the generation and distribution of electricity and for other relief.	))))))	Case No. U-21870

SUPPLEMENT TO ORAL ARGUMENT

SUPPLEMENT TO ORAL ARGUMENT

Per ALJ Jonathan F. Thoits' direction during oral arguments at the November 4, 2025 hearing in the above captioned case, attached are Consumers Energy's responses to MEC's discovery requests identified by the Company as U21870-MNSC-CE-0768 and U21870-MNSC-CE-0769. Because these two discovery responses refer to and rely on numerous other materials previously provided to MEC for a complete response to those questions, the pertinent materials referenced in U21870-MNSC-CE-0768 and U21870-MNSC-CE-0769 are also attached.

Broadly speaking, discovery requests U21870-MNSC-CE-0768 and U21870-MNSC-CE-0769 asked for (i) "documents, workpapers, and analyses" used to develop Consumers Energy's rebuttal exhibits A-202 (RTB-24) and A-203 (RTB-25), (ii) "supporting calculations" for the NPV's in those two exhibits, and (iii) "supporting sources" for all assumed and calculated costs and benefits in those exhibits. During oral arguments, counsel for MEC acknowledged that MEC received the discovery responses and claimed they were deficient, in part, because they "[d]id not include access to the model used to create the new analysis." 2 TR 93[1]. However, as the attached discovery materials show, MEC did not request access to the model which the Company could have provided. MEC is aware of this practice as the Company has provided MEC licenses to utilize other third-party modeling software when requested in the past.

The only requested item that the Company was unable to provide was the exact calculation of the NPVs because that calculation is performed by the Copperleaf modeling software, which does not have the capability to display or print the actual calculation. Consumers Energy has no capability to view the exact calculations performed by the software. However, Consumers Energy provided an Excel-based replication of Copperleaf's NPV calculation (see U21870-MNSC-CE-

[1] Citation based on the erroneous volume and page numbering in the transcript filed on November 5, 2025.

0224_ATT_0003) in order to be as responsive as possible given that Consumers Energy does not have possession, custody, or control over Copperleaf's software code. A party has no legal obligation to produce materials over which it has no possession, custody, or control. See *Lancashire v Moynihan*, 218 Mich 16, 19; 187 NW 319 (1922).

With respect to computer models, such as Copperleaf, the Commission has been clear that utilities cannot take a "go buy it yourself" approach, which is why the Company's practice has been to provide limited licenses to intervenors upon request. MPSC Case No. U-17678, June 9, 2016 Order, pages 13-14. However, the Commission has also declined to be "overly prescriptive in recommending a course of action" as it relates to discovery access to third-party modeling software. *Id*. at 14. Instead, the Commission has held that "the company should be prepared with any model to present sensitivity analyses to show the significance of underlying assumptions." *Id*. But, that is exactly what Exhibits A-202 (RTB-24) and A-203 (RTB-25) do. They respond to MEC's claims of inappropriate underlying assumptions in the Company's original modeling[2] by presenting sensitivities consistent with MEC's preferred assumptions. In Case No. U-17678, the Commission stated that it "reinforces the importance of transparency, evidentiary standards, and understanding the impacts of key assumptions for the Commission to assess the reasonableness of the company's . . . decisions." As the attached documents show, the Company has been very transparent and provided as much information as it possesses in its effort to respond to MEC's discovery. The Company's responses have, at all times, been consistent with prior Commission direction regarding the third-party computer models as support in rate proceedings.

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[2] During oral argument, MEC also made much of the fact that the original modeling was performed using the new Copperleaf modeling software, as opposed to the original AURORA modeling software. However, that is simply a function of the fact that Consumers Energy started using Copperleaf in October 2024 for all of this type of modeling.

Respectfully submitted,

CONSUMERS ENERGY COMPANY

Dated: November 6, 2025

By: Bret Totoraitis

Bret A. Totoraitis (P72654)
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Question:

5. Refer to Exhibit No. A-202 (RTB-24).

a. Please provide all supporting documents, workpapers, and analyses used in developing this new concept approval, in electronic format with formulas intact where applicable.

b. Please provide the supporting calculation for all NPVs, in electronic format with formulas intact where applicable.

c. Please provide the supporting sources for all assumed or calculated costs and benefits of each alternative.

d. Please provide support for the calculation of annual capacity value, including the application of probabilities, in electronic format with formulas intact where applicable.

e. Please describe why the probabilities were applied after 2028 and describe how these post-2028 values were used in the calculation.

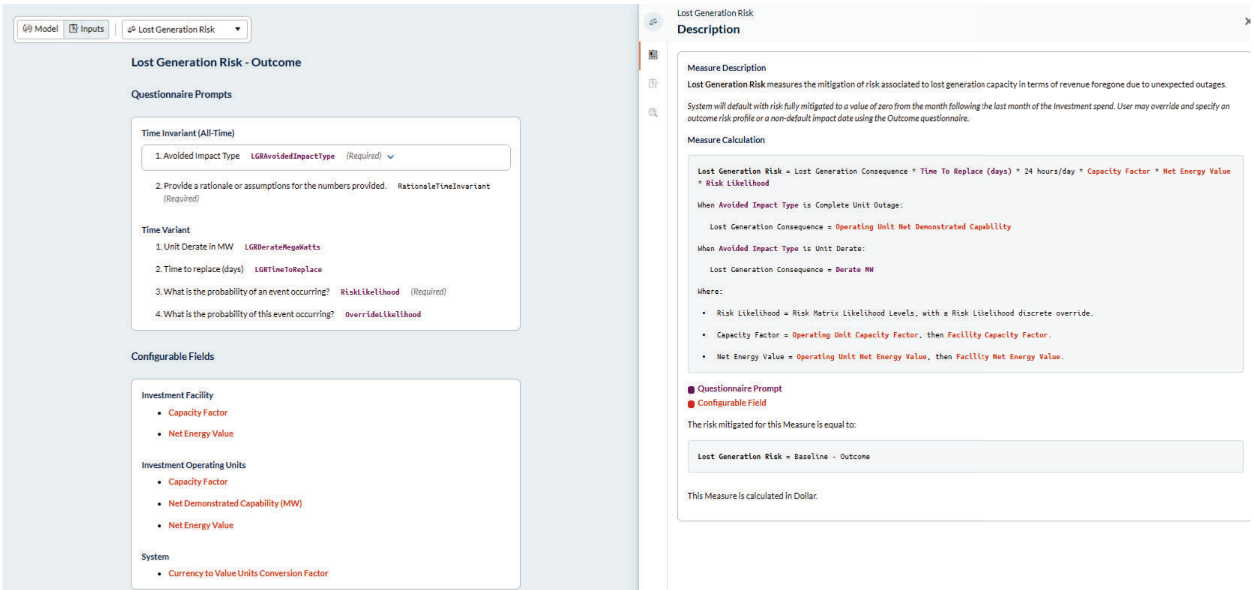
f. Regarding energy value, confirm that even under a 104 MW derate there would be hours of no energy losses because the plant would not be operating at a high level regardless of the derate.

g. Confirm that there is potential for the Company to replace the derated capacity for a three-year period at a cost lower than 75% of CONE. If denied, please explain.

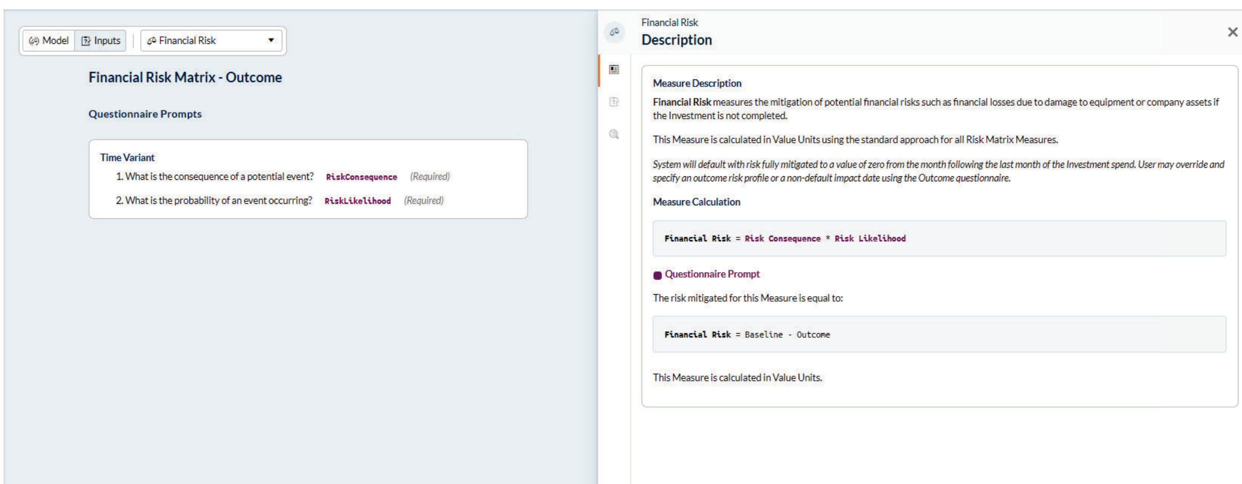
Response:

a. The supporting documentation is reflected in the PSCR case values that are embedded in the Copperleaf models as discussed in prior discovery responses. These values were provided in response to discovery questions U21870-MNSC-CE-071 and U-21870-MNSC-CE-072. The differences between the modeling previously provided and those represented in Exhibit A-202 (RTB-24) are discussed in my rebuttal testimony beginning on page 29. The calculations that the Copperleaf software utilizes are described in the following screen clipping from the software. The assumptions are detailed in the Exhibit. The software provides the results, but it does not have an excel type document that has calculations intact.

Lost Generation Risk



Financial Risk



b. The Company provided examples of the NPV calculations that Copperleaf performs and a document that explains in detail how those are calculated (see Exhibit A-205 (RTB-27)) and example in U21870-MNSC-CE-0224_ATT_0003. See my rebuttal testimony beginning on page 33.

c. See the response to subparts b and d.

d. For annual capacity value and application of probability, the Company provided the generic calculator used for estimating potential capacity lost revenue as well as a document explaining in detail how it works (see Exhibit A-205 (RTB-27)). The probability portion of this question is related to the financial risk model in Copperleaf as captured in subpart a. For the assumed values for Capacity Factor by month see U21870-MNSC-CE-0768_ATT_0001. This document includes all the data for the background calculations for the Jackson site. In row 2 the assumed capacity factors are listed by month starting January 2024 in column O progressing by month moving to the right. These values are the same as the latest approved PSCR case.

e. Copperleaf's valuation methodology begins by establishing a baseline risk scenario—representing the cumulative risk of inaction through 2039. This baseline serves as the foundation for comparison. To determine the value of a proposed project, Copperleaf subtracts both the risk that would be mitigated prior to the project's completion and the associated project costs from the total baseline risk. The result is the net value of the project, expressed as the amount of risk mitigated. Value = Baseline Risk – (Residual Risk + Project Cost)

f. Confirmed. However, the updated calculations include capacity factor projections and therefore are reflected in the new results.

g. The 75% of CONE value is simply a planning assumption and is not a value based on specific market intelligence. I am unable to confirm the availability of capacity, nor the cost of any such capacity.

Witness: RICHARD T. BLUMENSTOCK
Date: October 29, 2025

U21870-MNSC-CE-0768-ATT-0001

Capacity Factor - Jackson	Configurable Field Value	Capacity Factor - Jackson	0	Absolute Calendar Monthly	2024	1	Percent					0.2135005	0.1851007	0.2765036	0.425036	0.6585702	0.6543069	0.8033339	0.6631956	0.4792454	0.5129564	0.5819132	0.5739461	0.232036	0.1811784	0.2762508	0.4246474	0.6579683	0.6697334	0.8222743	0.6788319	0.4838986	0.4721108	0.589456	0.4147103	0.2320445	0.1811784	0.2661513
Fuel Cost $/MMBTU - Jackson	Configurable Field Value	Fuel Cost $/MMBTU - Jackson	0	Absolute Calendar Monthly	2024	1						2.57	2.503011	2.07	1.84	1.94	2.18	2.35	2.413134	2.31	2.39	2.78	3.54	3.42	3.291948	2.97	2.54	2.59	2.86	3.03	3.063979	2.93	2.99	3.28	4	4.26	4.032386	3.51
NDC MW - Jackson	Configurable Field Value	NDC MW - Jackson	0	Absolute Calendar Monthly	2024	1	Megawatt					547	547	547	547	547	547	547	547	547	547	547	547	578.8	578.8	547.5	547.5	547.5	534.4	534.4	534.4	540	540	540	578.8	578.8	578.8	547.5
NetEnergyValue - Jackson	Configurable Field Value	NetEnergyValue - Jackson	0	Absolute Calendar Monthly	2024	1	Dollar				2024	0	0	0	0	0	0	0	0	0	0	0	0	1.124929	5.036391	1.843855	5.332389	5.151049	6.601515	12.06974	9.75506	5.836092	3.412354	2.567774	1.986298	2.059662	2.77725	1.192265

Additional Value 68	Additional Value 69	Additional Value 70	Additional Value 71	Additional Value 72	Additional Value 73	Additional Value 74	Additional Value 75	Additional Value 76	Additional Value 77	Additional Value 78	Additional Value 79	Additional Value 80	Additional Value 81
0.5025396	0.4690971	0.589456	0.2843903	0.22169128	0.17821594	0.26822518	0.32770938	0.58468792	0.66042384	0.8222743	0.66549516	0.4988114	0.48663544
3.16	3.23	3.49	4.2	4.236	4.0234718	3.46	2.772	2.804	3.07	3.24	3.2782572	3.136	3.2
540	540	540	578.8	578.8	578.8	547.5	547.5	547.5	534.4	534.4	534.4	540	540
4.403912	3.612572	2.887255	2.508287	2.1363796	2.956888	1.38600886	3.377885	4.3099632	6.4987262	9.4218026	8.5386518	4.785173	3.4472506

Additional Value 82	Additional Value 83	Additional Value 84	Additional Value 85	Additional Value 86	Additional Value 87	Additional Value 88	Additional Value 89	Additional Value 90	Additional Value 91	Additional Value 92	Additional Value 93	Additional Value 94	Additional Value 95
0.589456	0.29003768	0.22169128	0.17821594	0.26822518	0.32770938	0.58468792	0.66042384	0.8222743	0.66549516	0.4988114	0.48663544	0.589456	0.29003768
3.47	4.184	4.236	4.0234718	3.46	2.772	2.804	3.07	3.24	3.2782572	3.136	3.2	3.47	4.184
540	578.8	578.8	578.8	547.5	547.5	547.5	534.4	534.4	534.4	540	540	540	578.8
2.9496498	2.4671514	2.1363796	2.956888	1.38600886	3.377885	4.3099632	6.4987262	9.4218026	8.5386518	4.785173	3.4472506	2.9496498	2.4671514

Additional Value 96	Additional Value 97	Additional Value 98	Additional Value 99	Additional Value 100	Additional Value 101	Additional Value 102	Additional Value 103	Additional Value 104	Additional Value 105	Additional Value 106	Additional Value 107	Additional Value 108
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

U21870-MNSC-CE-0768-ATT-0001

Additional Value 109	Additional Value 110	Additional Value 111	Additional Value 112	Additional Value 113	Additional Value 114	Additional Value 115	Additional Value 116	Additional Value 117	Additional Value 118	Additional Value 119	Additional Value 120
0.17821594	0.26822518	0.32770938	0.58468792	0.66042384	0.8222743	0.66549516	0.4988114	0.48663544	0.589456	0.29003768	0.221691228
4.0234718	3.46	2.772	2.804	3.07	3.24	3.2782572	3.136	3.2	3.47	4.184	4.236
578.8	547.5	547.5	547.5	534.4	534.4	534.4	540	540	540	578.8	578.8
2.956888	1.38600886	3.377885	4.3099632	6.4987262	9.4218026	8.5386518	4.785173	3.4472506	2.9496498	2.4671514	2.1363796

Additional Value 121	Additional Value 122	Additional Value 123	Additional Value 124	Additional Value 125	Additional Value 126	Additional Value 127	Additional Value 128	Additional Value 129	Additional Value 130	Additional Value 131	Additional Value 132
0.1821594	0.26822518	0.3277093 8	0.58468792	0.66042384	0.8222743	0.66549516	0.4988114	0.486635444	0.589456	0.29003768	0.22169128
4.0234718	3.46	2.772	2.804	3.07	3.24	3.2782572	3.136	3.2	3.47	4.184	4.236
578.8	547.5	547.5	547.5	534.4	534.4	534.4	540	540	540	578.8	578.8
2.956888	1.38600886	3.377885	4.3099632	6.4987262	9.4218026	8.5386518	4.785173	3.4472506	2.9496498	2.4671514	2.1363796

Additional Value 133	Additional Value 134	Additional Value 135	Additional Value 136	Additional Value 137	Additional Value 138	Additional Value 139	Additional Value 140	Additional Value 141	Additional Value 142	Additional Value 143
0.17821594	0.26822518	0.32770938	0.58468792	0.66042384	0.8222743	0.66549516	0.4988114	0.48663544	0.589456	0.29003768
4.0234718	3.46	2.772	2.804	3.07	3.24	3.2782572	3.136	3.2	3.47	4.184
578.8	547.5	547.5	547.5	534.4	534.4	534.4	540	540	540	578.8
2.956888	1.38600886	3.377885	4.3099632	6.4987262	9.4218026	8.5386518	4.785173	3.4472506	2.9496498	2.4671514

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Additional Value 150	Additional Value 151	Additional Value 152	Additional Value 153	Additional Value 154	Additional Value 155	Additional Value 156	Additional Value 157	Additional Value 158	Additional Value 159
0.8222743	0.66549516	0.4988114	0.48663544	0.589456	0.29003768	0.22169128	0.17821594	0.26822518	0.32770938
3.24	3.2782572	3.136	3.2	3.47	4.184	4.236	4.0234718	3.46	2.772
534.4	534.4	540	540	540	578.8	578.8	578.8	547.5	547.5
9.4218026	8.5386518	4.785173	3.4472506	2.9496498	2.4671514	2.1363796	2.956888	1.38600886	3.377885

Additional Value 160	Additional Value 161	Additional Value 162	Additional Value 163	Additional Value 164	Additional Value 165	Additional Value 166	Additional Value 167	Additional Value 168	Additional Value 169
0.58468792	0.66042384	0.8222743	0.66549516	0.4988114	0.48663544	0.589456	0.29003768	0.22169128	0.17821594
2.804	3.07	3.24	3.2782572	3.136	3.2	3.47	4.184	4.236	4.0234718
547.5	534.4	534.4	534.4	540	540	540	578.8	578.8	578.8
4.3099632	6.4987262	9.4218026	8.5386518	4.785173	3.4472506	2.9496498	2.4671514	2.1363796	2.956888

Additional Value 170	Additional Value 171	Additional Value 172	Additional Value 173	Additional Value 174	Additional Value 175	Additional Value 176	Additional Value 177	Additional Value 178	Additional Value 179
0.26822518	0.32770938	0.58468792	0.66042384	0.8222743	0.66549516	0.4988114	0.48663544	0.589456	0.29003768
3.46	2.772	2.804	3.07	3.24	3.2782572	3.136	3.2	3.47	4.184
547.5	547.5	547.5	534.4	534.4	534.4	540	540	540	578.8
1.38600886	3.377885	4.3099632	6.4987262	9.4218026	8.5386518	4.785173	3.4472506	2.9496498	2.4671514

Additional Value 180	Additional Value 181	Additional Value 182	Additional Value 183	Additional Value 184	Additional Value 185	Additional Value 186	Additional Value 187	Additional Value 188	Additional Value 189	Additional Value 190
0.22169128	0.17821594	0.26822518	0.32770938	0.58468792	0.66042384	0.8222743	0.66549516	0.4988114	0.48663544	0.589456
4.236	4.0234718	3.46	2.772	2.804	3.07	3.24	3.2782572	3.136	3.2	3.47
578.8	578.8	547.5	547.5	547.5	534.4	534.4	534.4	540	540	540
2.1363796	2.956888	1.38600886	3.377885	4.3099632	6.4987262	9.4218026	8.5386518	4.785173	3.4472506	2.9496498

U21870-MNSC-CE-0768-ATT-0001

Question:

6. Refer to Exhibit No. A-203 (RTB-25).

   a. Please provide all supporting documents, workpapers, and analyses used in developing this new concept approval, in electronic format with formulas intact where applicable.

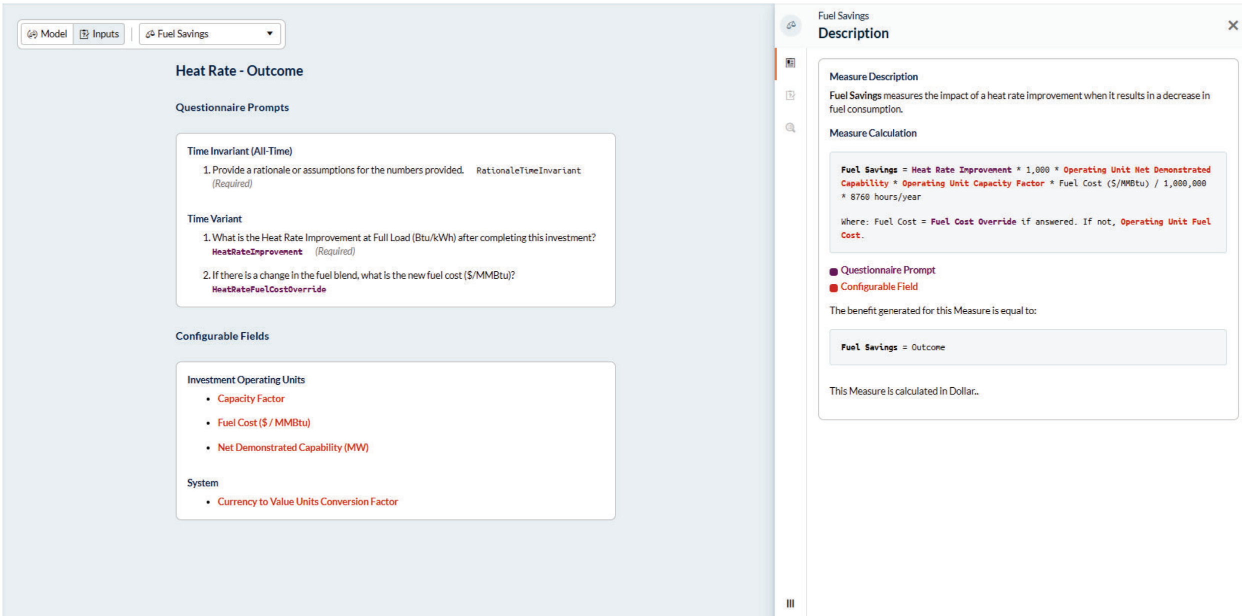
   b. Please provide the supporting calculation for all NPVs, in electronic format with formulas intact where applicable.

   c. Please provide the supporting sources for all assumed or calculated costs and benefits of each alternative, in electronic format with formulas intact where applicable.

Response:

a. For the LM VIGV project benefits (heat rate during duct burning (286 Btu/kWh) and non-duct burning (189 Btu/kWh)), GE provided us with a fact sheet on the VIGV enhancement as well as performance estimate graphs. This simple cycle info was entered into our EBSILON® Professional modeling software program to get the estimated heat rate changes for the JGS combined cycle plant. Attached as U21870-MNSC-CE-0769_ATT_0001, U21870-MNSC-CE-0769_ATT_0002_CONF, and U21870-MNSC-CE-0769_ATT_0003_CONF are copies of the VIGV fact sheet and budgetary estimates/ proposals which have info utilized for modeling, and communication of EBSILON® modeling results. The calculation for Heat Rate that the Copperleaf software utilizes are described in the following screen clipping from the software. The calculations for Lost Generation Risk and Financial Risk are included in U21870-MNSC-CE-0768 part a. The assumptions for each calculation are detailed in the Exhibit. The software provides the results, but it does not have an excel type document that has calculations intact. The Fuel Cost assumptions are included in U21870-MNSC-CE-0768_ATT_0001, row 3.

Heat Rate



b. The concept approval and the NPV calculations are performed in Copperleaf pursuant to the procedure provided in both discovery and as Exhibit A-203 (RTB-25). No other NPV support is available in electronic format other than the detailed discussion of how Copperleaf models NPV as provided in Exhibit A-205 (RTB-27).

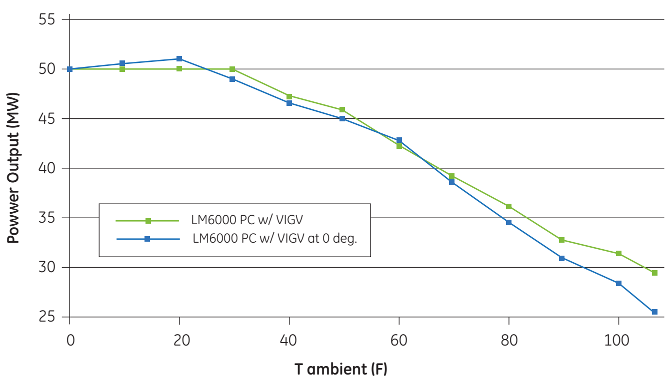
c. Please see attachments U21870-MNSC-CE-0769_ATT_0004_CONF, U21870-MNSC-CE-0769_ATT_0005_CONF, and U21870-MNSC-CE-0769_ATT_0006_CONF, which reflect the costs for the stalled engine. This represents the bulk of the total cost.

Witness: RICHARD T. BLUMENSTOCK
Date: October 27, 2025

Variable Inlet Guide Vane (VIGV)

Product Description

- Variable Inlet Air vanes help guide inlet airflow to maximize engine performance.
- Assembly located in front of Low Pressure Compressor (LPC), consisting of 43 stationary leading-edge vanes and variable trailing flaps (rotate -10 to +60 degrees).
- Variable Differential Transformers (LVDTs) on actuator ring drivetwin hydraulic actuators.
- LVDTs and VIGV positions are controlled by continuous measurement of LPC inlet temperature and HPC discharge static pressure.
- If turbine has Fixed Inlet Guide Vanes, the upgrade involves adding VIGVs, Hydraulic Control Unit (if applicable), off-engine Cables, hydraulic lines and updating the software.



Applicable Units

LM6000*	✓	LM2500	
LMS100		LM5000	
LM1600		TM2500	

* Configured for LM6000 PC units only

Variable Inlet Guide Vanes Assembly

Temp. (F)	Power Increase
70	2.0%
80	5.8%
90	7.2%
100	11.5%
110	13.5%

Customer Benefits

- Increases generator power output by up to 3.25 MW.
- Improves performance for simple and heat recovery cycles at less than full load; reduces engine waste heat.
- Minimizes variable bypass valve (VBV) flow and pressure levels thereby reducing associated flow noise

For LM6000PC SPRINT Gas Turbine with EFS

- Average power increase of 2 MW.
- Greater than 2% fuel efficiency increase at 70% power.
- Exhaust energy increase of 3%.
- Flaps close during large power reductions to quickly reduce LPC flow rate, helping maintain LPC stall margin.

To learn more about this product and its applicability to your gas turbine, please contact your GE Gas Power sales representative.

gepower.com

GEA32093B (07/2021)

Discovery Response U21870-MNSC-CE-0769 Attachments 0002 through 0006 are confidential and being filed Under Seal with the MPSC

Methodology for Quantifying Capital Investment Risk with Copperleaf Value Models – Consumers Energy

Purpose and scope

This document explains how the Company converts engineering and operational risk into dollar-denominated values for investment evaluation. It is intended for the reader to understand the logic behind the results; it does not require access to internal tools or data libraries. The same expected-value reasoning is applied year by year and results are discounted to present value using the Company's approved discount rate.

Model overview

The Company employs multiple model families; this document illustrates three commonly used examples:

1. Financial Risk Matrix — converts the chance of an adverse event and its consequence into an expected annual cost; value equals the risk avoided by the investment.
2. Lost Generation Risk (Energy Only) — quantifies the dollar value of lost energy (MWh) from derates or outages; value equals the avoided energy loss.
3. Financial Benefits & Costs — prices direct financial effects (costs avoided, revenues, and ongoing costs).

Principal value drivers

In practice, the Financial Risk Matrix and Lost Generation Risk models are the most widely used and account for the majority of risk-mitigation value in the Company's Long-Term Financial Plan. Capacity value lost risk is handled within the Financial Risk Matrix to avoid overlap with energy-only valuation.

Common frame (applies to all models)

- Baseline vs With-Project ("Outcome"): Baseline represents conditions if we do nothing; Outcome represents conditions after the investment. Annual value is the difference: Annual Value ($) = Baseline Expected Impact ($) − Outcome Expected Impact ($).
- Expected value: Uncertain events are priced by multiplying their consequence (in $ if they occur) by how likely they are to occur that year. This yields a single expected $ figure for the year.
- Discounting: After computing annual values across the planning horizon, we calculate NPV using a constant discount rate specified by Company finance policy.
- Evidence base (examples): work orders and repair history; outage/derate logs and time-to-restore; unit operating profile and duty cycle; inspection findings and sensor trends; OEM notices; age/obsolescence; supply-chain lead times; peer and industry

experience (including EPRI guidance); and structured SME judgments recorded through Company procedures.

1) Financial Risk Matrix (general risk in dollars)

What it measures: the expected annual cost of a defined hazard (safety, environmental, compliance, or financial), and the amount of that cost the project removes.

How it works, step by step

- Define the hazard and pathway. We state what can go wrong, how it unfolds, and which impact categories it touches. This ensures the risk we price is specific and non-overlapping with other models.
- Monetize the consequence. For each year, we determine the dollar impact if the event occurs in that year. This can include response and repair cost, regulatory or contractual impacts, and business effects appropriate for that hazard. Values are drawn from Company-maintained sources that reflect current costs and obligations.
- Quantify how often it may occur. For each year, we express likelihood as either a frequency (events per year) or a probability for that year. Figures are derived from the evidence base above and recorded through our governance process.
- Convert uncertainty into dollars. Expected annual risk equals consequence × likelihood. This yields a single dollar amount for that year under Baseline.
- Reflect the project's effect. With the project in place, severity and/or frequency typically decline. We determine the with-project consequence and likelihood in the same manner and compute the Outcome expected risk.
- Value created. Annual value is the avoided risk (Baseline minus Outcome). We then discount and sum across years to get NPV.

Capacity value lost risk (handled here)

- Use Capacity Calculator outputs for each year to identify the magnitude and timing of potential capacity exposure relative to accreditation or obligations. These exposure drivers are not re-estimated here.
- Monetize the exposure by applying the Company's capacity valuation parameters for the relevant years (market/regulatory cost components for our jurisdiction and obligations). These parameters are maintained internally and updated on defined cycles as conditions change. The result is a dollar consequence if the exposure materializes in that year.
- Account for chance by assigning, for each year, the likelihood that the exposure will materialize as a dollar impact, consistent with the same evidence base and governance protocols used elsewhere.
- Compute expected annual capacity value loss under Baseline and re-compute under Outcome if the project reduces the exposure (magnitude, timing, or likelihood). The difference is the annual value attributable to mitigating capacity value risk.

2) Lost Generation Risk (energy only)

What it measures: the dollar value of lost energy production due to unit derates or full outages and the portion of that loss the project avoids. This model does not address capacity market value or capacity accreditation.

How it works, step by step

- Describe the operational shortfall for each year: either a derate (the unit can run but at reduced MW) or a complete outage (the unit cannot produce). Specify the MW affected and the expected duration to restore normal operation.
- Translate MW and time into energy. Lost MWh per event equals MW affected × 24 hours × number of days, adjusted for how the unit is expected to operate during that period (capacity factor for the affected window). Operating profiles come from Company-maintained sources that reflect expected duty cycles.
- Monetize the lost energy. Multiply lost MWh by the applicable energy value ($/MWh) for that year (net of costs as appropriate). Energy values are obtained from Company-maintained price/valuation sources refreshed on defined cycles.
- Account for chance. Express how often such a derate/outage is expected in that year (frequency or probability) based on history, condition, and SME protocols, and multiply by the dollar consequence to get the expected annual loss under Baseline.
- Project effect. The project may shorten the duration, reduce the MW affected, reduce the likelihood, or some combination. Recompute the Outcome expected loss with those changes.
- Value created. Annual value is the avoided energy loss; NPV aggregates those annual values.

3) Financial Benefits & Costs

Note: This model does not include capacity value lost risk; those impacts are valued within the Financial Risk Matrix using outputs from the Capacity Calculator.

What it measures: direct financial effects that show up as dollars—costs we avoid, revenues we gain, or ongoing costs attributable to the project.

How it works, step by step

- Identify the financial streams that the project influences (e.g., avoided corrective capex, avoided O&M, incremental revenue, or ongoing costs attributable to the project). Streams are kept distinct to prevent double-counting.
- Size the dollar amounts for each stream by year, using Company-maintained financial and operational sources (e.g., standard labor/material costs, contract terms, or tariff mechanisms).
- Represent uncertainty by assigning a likelihood (0–1) for each stream in each year, following the same governance used elsewhere.

- Compute expected value for each stream and year (amount × likelihood) and sum across streams to obtain the net annual financial effect.
- Value created is the net with-project improvement relative to Baseline, discounted to NPV.

Additional model families employed

- Safety Risk (personnel and public harm, medical/claim costs, and associated operational impacts)
- Regulatory Compliance Risk (violations, penalties, corrective actions, and programmatic impacts)
- Environmental Risk (releases, remediation/response, permitting, and stewardship commitments)
- Other specialized models are applied as warranted by the investment context. All follow the same expected-value logic and governance described in this document.

Relationship to prior business-case practice

- Alignment with prior business-case practice.
    - These value models formalize the same expected-value logic historically used in our narrative business cases (likelihood × impact by year, discounted to present value).
- Structured improvements introduced by Copperleaf.
    - The platform enforces a consistent, systematic structure across all investments: common Baseline vs Outcome framing; governed, Company-maintained input sources updated on defined cycles; a uniform year-by-year treatment of uncertainty; and a single NPV roll-up.
- Implications for portfolio decision-making.
    - This removes variability in author style and assumptions, places projects on a level playing field, enables like-for-like comparison across technologies and sites, and gives leadership a clear portfolio view of risk and value.
- Impact for customers and ratepayers.
    - A more objective, repeatable method for selecting the optimal risk-mitigation portfolio—supporting lower total cost and better reliability outcomes.

Governance, transparency, and QA

- Recorded reference values: For each plant, we keep the values that drive the calculations—Net Energy Value (NEV), Net Demonstrated Capacity (NDC), fuel cost, and capacity factor—and update them on defined cycles as those inputs change. Other supporting engineering context is maintained separately; we don't time-stamp every data point inside the value model.

- Consistency: The same rules are applied to Baseline and Outcome; differences in value come from the project's effect, not from changing the standard.
- Reasonableness checks: Unit consistency (e.g., MW→MWh, $/MWh→$), bounds on probabilities, and year-to-year continuity are verified.
- Change control: When inputs are updated, the prior set and the new set are retained; impacts of changes can be traced year by year.

Question:

2. Refer to Exhibits RTB-5 through RTB-12. Please provide the supporting calculations and analyses used to evaluate the costs and benefits of each project, in Excel format where possible.

Response:

Please see Attachment U21870-MNSC-CE-0071_ATT_0001 which provides a summary table containing relevant modeling information for the eight projects presented in Exhibits RTB-5 through RTB-12. The table provides details regarding the applicable calculation methodology for the net energy value (NEV), the applicable NEV calculation details, the applicable methodology used for capacity losses, and the applicable capacity loss analysis. The Company did not retain the modeled version of the outputs for each project, however the calculator used and the draft procedure for the calculator are provided as Attachments U21870-MNSC-CE-0071_ATT_0002 and U21870-MNSC-CE-0071_ATT_0004 respectively.

Attachments U21870-MNSC-CE-0071_ATT_0003, 0005, and 0006 are also attached and support NEV calculations for several of the projects as referenced in Attachment U21870-MNSC-CE-0071_ATT_0001. Other details are contained in attachments provided in separate discovery response attachments, also as referenced in Attachment U21870-MNSC-CE-0071_ATT_0001.

Witness: RICHARD T. BLUMENSTOCK
Date: July 24, 2025

Status of calculations for business justifications selected Cas

21870-MNSC-CE-0071-Att 0001

project	NEV calculation method	NEV calculation details or location	Capacity losses calc method	Capacity losses analysis Method location
ZGS PH 1/2 turbine upgrades	aurora model and NPV analysis	U21870-ST-CE-0007_ATT_0001_CONF U21870-ST-CE-0007_ATT_0002_CONF	included in formal Analysis	U21870-ST-CE-0007_ATT_0001_CONF U21870-ST-CE-0007_ATT_0002_CONF
Jackson Site spare GSU	aurora model	U21870-MNSC-CE-0071_0003	calculator	U21870-MNSC-CE-0071_0002 U21870-MNSC-CE-0071_0004
Covert Load Commutated Inverter Static Frequency	aurora model	U21870-MNSC-CE-0071_0006	calculator	U21870-MNSC-CE-0071_0002 U21870-MNSC-CE-0071_0004
Covert Site Spare GSU Transformer Concept Approval	PSCR case U-21225, NEV and LPM section, 2025 average	U21870-MNSC-CE-0071_0005 This is a 2023 CA. Prior to Aurora modeling by SME, The reported PSCR plan was used to estimate NEV. The potential NEV losses calculated for this CA were obtained by taking the 3 unit average of the 2025 NEV for the site since the assumption is that the potentially affected unit would not be able to operate for at least a year should the corresponding GSU fail with no spare on site. PSCR results sheet provided.	Manual calculation detailed in CA. Prior to current calculator. Similar inputs and assumptions	U21870-ST-CE-0004_0004
Covert Control System Project Concept Approval	no econ modeling needed, compliance based CA	no econ modeling needed, compliance based CA	no econ modeling needed, compliance based CA	U21870-MNSC-CE-0072_0009
Covert Units 1 through 3 Emerson DCS Evergreen	no econ modeling needed, compliance based CA	no econ modeling needed, compliance based CA	no econ modeling needed, compliance based CA	U21870-MNSC-CE-0072_0008
Karn Unit 4 ID Fan Inlet Damper Replacements	No NEV calc since Karn is assumed to be zero	N/A	calculator	U21870-MNSC-CE-0071_0002 U21870-MNSC-CE-0071_0004
Karn Units 3 & 4 Combustion Air Heater Replacement	No NEV calc since Karn is assumed to be zero	N/A	calculator	U21870-MNSC-CE-0071_0002 U21870-MNSC-CE-0071_0004

	Inputs			
	Unit Name			
ENTER Generator Verification Test capacity	GVTC of Unit (MWs)	1		
ENTER Seasonal accredited Capacity	SAC Value of Unit (ZRC's)	1		
	# of MW derate	1		
	Start Date of de-rate	01/01/25		
	End Date of de-r	01/08/25		

Yearly Inputs (ESO Forecasting team to provide)	
CONE (2025)	$ 130,930

Outputs	
ZRC calculation	100%
SAC Derate	1
Days Offline/Derated	7
Planning Year	2025

Planned (No exemption) /Forced outage (no replacement charges)

	2023	2024	2025	2026	2027	2028
Planned Capacity (ZRCs)	1	1	1	1	1	1
Lost Capacity (ZRCs)	0	0.0	0.0	0.0	0.006392694	0.006392694
Delta Capacity (ZRCs)	1	1.0	1.0	1.0	0.993607306	0.993607306
Loss Capacity Revenue	$ -	$ -	$ 628	$ 628	$ 628	
Total lost capacity revenue						$ 1,883
Total lost capacity revenue for the next three years						$ 1,255

notes:

lost capacity (ZRC) calculation

This formula checks if the outage occurred in any of the three years following the planning year. If it did, it calculates the lost capacity in ZRCs based on the number of days the plant was offline and the seasonal accredited capacity derate. If the outage did not occur in those years, it returns 0.
The formula =IF(OR(C20=($N$5+1),C20=($N$5+2),C20=($N$5+3)),($N$4/365*$N$3)/3,0) is used to calculate the lost capacity in Zonal Resource Credits (ZRCs) for a forced outage at a power plant, without considering replacement charges.

Here's a detailed explanation:

OR(C20=($N$5+1),C20=($N$5+2),C20=($N$5+3)): This part checks if the value in cell C20 matches any of the following conditions: the planning year (N5) plus 1, the planning year plus 2, or the planning year plus 3. If any of these conditions are true, the OR function returns TRUE.

IF(..., ..., 0): The IF function evaluates the result of the OR function. If the result is TRUE, it proceeds to the next part of the formula. If the result is FALSE, it returns 0.

($N$4/365$N$3)/3*: If the OR function returns TRUE, this part of the formula is executed. It calculates the lost capacity in ZRCs by:

Dividing the number of days offline/derated (N4) by 365 to get the fraction of the year the plant was offline.
Multiplying this fraction by the seasonal accredited capacity derate (N3) to get the total derated capacity for the offline period.
Dividing the result by 3 to distribute the lost capacity evenly over the three years.
In summary, this formula checks if the outage occurred in any of the three years following the planning year. If it did, it calculates the lost capacity in ZRCs based on the number of days the plant was offline and the seasonal accredited capacity derate. If the outage did not occur in those years, it returns 0.

Lost Capacity Revenue

this formula checks if the number of days offline is greater than 31 and if the planning year matches the year being calculated. If both conditions are met, it calculates the lost capacity revenue based on the number of days offline beyond the first 31 days and the seasonal accredited capacity derate. If the conditions are not met, it calculates the lost capacity revenue based on the lost capacity in ZRCs, adjusted by a factor of 0.75, and the cost of new entry value.
The formula D24=IF(AND($N$4>31, $N$5=D20),$J$5/365*($N$4-31)*$N$3,D22*0.75*$J$5) calculates the lost capacity revenue for a specific year, considering the cost of new entry (CONE) and the number of days offline.

Here's a detailed explanation:

AND($N$4>31, $N$5=D20): This part checks two conditions:

If the number of days offline/derated (N4) is greater than 31.
If the planning year (N5) is equal to the year being calculated (D20).
If both conditions are true, the AND function returns TRUE.

IF(..., ..., D22*0.75*$J$5): The IF function evaluates the result of the AND function. If the result is TRUE, it proceeds to the next part of the formula. If the result is FALSE, it calculates the lost capacity revenue using the value in cell D22.

$J$5/365*($N$4-31)*$N$3: If the AND function returns TRUE, this part of the formula is executed. It calculates the lost capacity revenue by:

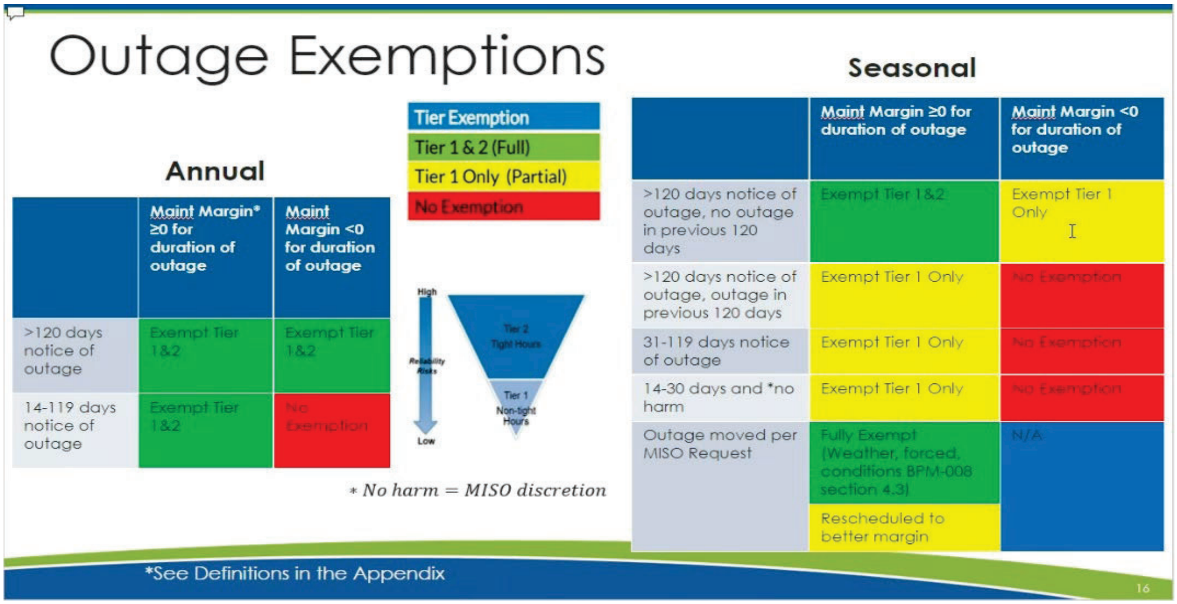
Dividing the cost of new entry value (CONE) for that year (J5) by 365 to get the daily cost.
Subtracting 31 from the number of days offline/derated (N4) to get the number of days beyond the first 31 days.
Multiplying the daily cost by the number of days beyond the first 31 days.
Multiplying the result by the seasonal accredited capacity derate (N3).
D22*0.75*$J$5: If the AND function returns FALSE, this part of the formula is executed. It calculates the lost capacity revenue by:

Multiplying the lost capacity in ZRCs (D22) by 0.75.
Multiplying the result by the cost of new entry value (CONE) for that year (J5).

Owned Capacity Values	Summer		Fall		Winter		Spring				Low Gas					High Gas					
	GVTC	SAC	GVTC	SAC	GVTC	SAC	GVTC	SAC	2025	2026	2027	2028	2029	2025h	2026h	2027h	2028h	2029h	3 yr Historical		
Gratiot Farms Wind Project	150	36.3	150	32.5	150	36.4	150	28.8	(45.45)	(43.63)	(7.11)	(8.99)	(7.91)	(45.36)	(43.62)	(7.11)	(9.04)	(8.00)	24,701,222	74103666.02	
Alcona 1-2	2.7	2.7	2.8	2.8	2.9	2.9	3.7	3.7	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	1,219,261	$3,657,783	
Allegan 1-3	1.2	1.2	0.9	0.9	1.4	1.4	1.9	2	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	-		
Campbell 1	0	0	0	0	0	0	0	0	5.09	-	-	-	-	5.19	-	-	-	-	27,383,910	$82,151,730	
Campbell 2	0	0	0	0	0	0	0	0	5.95	-	-	-	-	6.06	-	-	-	-	20,903,663	$62,710,988	
Campbell 3	0	0	0	0	0	0	0	0	7.15	-	-	-	-	7.26	-	-	-	-	99,663,662	$298,990,986	
Circuit West	0.2	0.2	0.1	0.1	0	0	0.2	0.2	-	-	-	-	-	-	-	-	-	-	-		
Cooke 1	1.6	1.5	1.6	1.5	1.6	1.5	1.6	1.5	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	-		
Cooke 2	2.9	2.7	2.9	2.8	2.9	2.7	2.9	2.7	-	-	-	-	-	-	-	-	-	-	-		
Cooke 3	2.7	2.6	2.7	2.6	2.8	2.6	2.7	2.5	-	-	-	-	-	-	-	-	-	-	-		
Crescent Wind	150	24.4	150	27.6	150	30.4	150	26	(36.43)	(34.31)	(3.11)	(4.99)	(3.91)	(36.34)	(34.30)	(3.11)	(5.04)	(4.00)	22,995,268	$68,985,803	
Cross Winds Phase 1	110.98	25.5	110.98	24.4	110.98	32.2	110.98	26.6	(40.74)	(38.86)	(14.11)	(15.99)	(14.91)	(40.65)	(38.85)	(14.11)	(16.04)	(15.00)	44,951,425	$134,854,274	
Cross Winds Phase 2	43.7	10	43.7	9.6	43.7	12.7	43.7	10.5	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	-		
Cross Winds Phase 3	75.9	17.4	75.9	16.7	75.9	22	75.9	18.2	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	-		
Croton 1-4	2.1	2.1	2.1	2.1	3.7	3.7	3.9	3.9	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	1,260,828	$3,782,484	
Five Channels 1	3.2	3	3.3	3.1	3.3	3	3.2	2.9	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	-		
Five Channels 2	3	2.8	3.1	2.9	3.1	2.8	3	2.8	-	-	-	-	-	-	-	-	-	-	-		
Foote 1-3	2.7	2.8	2.8	2.9	2.9	3	4	4.1	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	-		
GVSU Solar Garden	1.6	1.7	0.8	0.8	0	0	1.3	1.3	-	-	-	-	-	-	-	-	-	-	-		
Hardy 1	10.6	10.3	10.6	10	9.8	9.7	9.8	9.8	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	3,767,600	$11,302,800	
Hardy 2	10.6	10.3	10.6	10	9.8	9.7	9.9	9.9	-	-	-	-	-	-	-	-	-	-	-		
Hardy 3	12.1	11.8	12.1	11.4	11.4	11.3	11.4	11.4	-	-	-	-	-	-	-	-	-	-	-		
Heartland	200	31.5	200	61.4	200	46.7	200	27.3	(24.14)	(22.78)	(12.86)	(14.74)	(13.66)	(24.05)	(22.77)	(12.86)	(14.79)	(13.75)	66,858	$200,574	
Hodenpyl 1-2	4.1	4.1	4.4	4.4	5.1	5.1	6	6	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	1,627,559	$4,882,676	
Jackson Plant	531.1	505.6	536.9	503.6	568.9	575.1	544.9	547.1	17.46	17.64	16.82	14.53	16.83	17.51	17.65	16.71	14.42	16.87	31,819,280	$95,457,840	
Karn 3	602.2	326.9	604.8	225	614.9	322.1	609	177.8	10.75	4.29	1.62	1.61	1.40	10.78	4.33	1.45	1.59	1.41	(1,826,731)	($5,480,193)	432.95
Karn 4	586.7	539	591.4	437.9	615.2	390.8	600.5	374.2	5.21	4.61	-	-	-	5.14	4.60	-	-	-	(2,451,743)	($7,355,228)	
Lake Winds Energy Park	100.8	17.9	100.8	20.9	100.8	25.9	100.8	16.9	(81.94)	(83.36)	(78.72)	(82.72)	(83.84)	(81.84)	(83.34)	(78.72)	(82.77)	(83.93)	10,284,201	$30,852,602	
Loud 1	2.5	2.4	2.5	2.4	2.5	2.3	2.5	2.3	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	-		
Loud 2	2.5	2.4	2.5	2.4	2.5	2.3	2.5	2.3	-	-	-	-	-	-	-	-	-	-	-		
Ludington 1	187.017	185.2	190.179	171	187.68	180.6	187.374	178.2	42.75	47.08	35.75	47.06	48.95	43.06	46.85	35.77	47.18	48.70	(2,837,851)	($8,513,552)	
Ludington 2	186.507	185.4	189.669	172.7	187.17	177.5	186.864	177.4	42.60	48.15	25.82	19.20	48.92	43.20	47.18	25.43	19.33	48.66	(7,984,455)	($23,953,365)	
Ludington 3	185.997	184.6	189.159	161.7	186.66	186.2	186.354	176.2	42.11	36.84	46.39	46.23	48.97	42.10	36.33	46.32	45.91	48.74	(1,725,398)	($5,176,193)	
Ludington 4	187.017	185.4	190.179	146.3	187.68	173.3	187.374	186.7	42.23	20.38	23.24	46.12	48.98	42.18	20.28	23.10	45.82	48.70	(8,392,817)	($25,178,451)	
Ludington 5	187.017	185.4	190.179	172.3	187.68	178.9	187.374	182.5	42.44	46.73	46.65	28.44	12.22	42.79	46.42	47.00	28.50	12.28	(7,971,533)	($23,914,599)	
Ludington 6	185.487	184	188.649	181.4	186.15	179.2	185.844	185.4	42.74	46.94	45.36	31.71	48.91	42.71	46.50	48.10	31.71	48.64	(5,770,942)	($17,312,826)	
Mio 1-2	1.3	1.3	1.5	1.6	1.6	1.6	2	2.1	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	-		
Cadillac Solar Garden	0.2	0.2	0.2	0.2	0	0	0.2	0.2	-	-	-	-	-	-	-	-	-	-	-		
Rogers 1-4	2	2.1	2.6	2.7	2.9	3	3	3.1	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	-		
Tippy 1-3	5.8	5.8	6.2	6.2	6.3	6.3	7	7	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	2,594,075	$7,782,226	
Webber 1-2	1	1	0.9	0.9	1.4	1.4	2.2	2.3	41.57	44.83	44.89	43.01	44.09	41.66	44.84	44.89	42.96	44.00	-		
WMU Solar Garden	0.6	0.6	0.3	0.3	0	0	0.5	0.5	-	-	-	-	-	-	-	-	-	-	-		
Zeeland 1A	157.6	152.4	161.1	106.9	186.1	116.2	167.4	115	16.40	17.01	16.66	15.71	16.55	16.46	17.01	16.64	15.63	16.46	3,450,226	$10,350,677	
Zeeland 1B	156.7	152.1	160.2	166.1	185.1	171.3	166.5	169.4	17.07	17.65	17.43	16.45	17.30	17.13	17.66	17.41	16.38	17.19	4,306,002	$12,918,005	
Zeeland 2A	159.7	155.9	162.5	132.1	189.1	146.4	168.6	172.6	18.39	18.95	18.76	15.80	17.55	18.49	18.97	18.76	15.74	17.46	45,291,698	$135,875,094	
Zeeland 2B	157.3	153.5	160.1	128.6	186.2	144.3	166	170	-	-	-	-	-	-	-	-	-	-	-		
Zeeland 2C	216.8	190.2	219.4	164.3	225.1	185.9	224.2	214.5	-	-	-	-	-	-	-	-	-	-	-		
Covert 1	371.3	323.9	376.8	278.1	429.8	411.5	376.8	340.9	15.97	12.94	15.84	14.85	15.46	16.01	12.91	15.83	14.82	15.44	5,713,843	$17,141,529	
Covert 2	363.9	318.7	370.2	286.2	430.6	417.3	384.9	222.3	12.82	15.62	15.36	15.19	15.13	12.82	15.61	15.34	15.07	15.15	4,241,044	$12,723,131	
Covert 3	364.2	313.8	369.6	378.8	422	414.4	383.3	380.4	15.23	16.92	16.55	15.60	16.27	15.30	16.92	16.54	15.57	16.19	5,731,445	$17,194,334	

Averages

	GVTC	SAC
Gratiot Farms Wind Project	150	33.5
Alcona 1-2	3.025	3.025
Allegan 1-3	1.35	1.375
Campbell 1	0	0
Campbell 2	0	0
Campbell 3	0	0
Circuit West	0.125	0.125
Cooke 1	1.6	1.5
Cooke 2	2.9	2.725
Cooke 3	2.725	2.575
Crescent Wind	150	27.1
Cross Winds Phase 1	110.98	27.175
Cross Winds Phase 2	43.7	10.7
Cross Winds Phase 3	75.9	18.575
Croton 1-4	2.95	2.95
Five Channels 1	3.25	3
Five Channels 2	3.05	2.825
Foote 1-3	3.1	3.2
GVSU Solar Garden	0.925	0.95
Hardy 1	10.2	9.95
Hardy 2	10.225	9.975
Hardy 3	11.75	11.475
Heartland	200	41.725
Hodenpyl 1-2	4.9	4.9
Jackson Plant	545.45	532.85
Karn 3	607.725	262.95
Karn 4	598.45	435.475
Lake Winds Energy Park	100.8	20.4
Loud 1	2.5	2.35
Loud 2	2.5	2.35
Ludington 1	188.0625	178.75
Ludington 2	187.5525	178.25
Ludington 3	187.0425	177.175
Ludington 4	188.0625	172.925
Ludington 5	188.0625	179.775
Ludington 6	186.5325	182.5
Mio 1-2	1.6	1.65
Cadillac Solar Garden	0.15	0.15
Rogers 1-4	2.625	2.725
Tippy 1-3	6.325	6.325
Webber 1-2	1.375	1.4
WMU Solar Garden	0.35	0.35
Zeeland 1A	168.05	122.625
Zeeland 1B	167.125	164.725
Zeeland 2A	169.975	151.75
Zeeland 2B	167.4	149.1
Zeeland 2C	221.375	188.725
Covert 1	388.675	338.6
Covert 2	387.4	311.125
Covert 3	384.775	371.85
ZGS Phase 1 total	335.175	287.35
ZGS Phase 2 total	558.75	489.575



Y filing.

6.4.3 Transfer of Resource Adequacy Requirement and Performance Requirements through ZRC Replacement

ZRC replacement is available for use by Planning Resources that cleared a Season in the Planning Year and that go on suspension, retirement, catastrophic outage, ICAP Deferral, or that experience a Generator Planned Outage or derate greater than 31 days in that Season. In the event of such ZRC Replacement any performance requirements associated with the Resource that is being replaced (e.g., must offer obligation) will be transferred to the substituting Resource(s) for the duration of the ZRC Replacement period. ZRC Replacement is forward looking, MPs cannot replace ZRCs retroactively.

A Resource being used for ZRC replacement must not be on a full or partial Generator Planned Outage during the term of the ZRC replacement and must otherwise meet the applicable performance requirements set forth in section 69.A.3.1.h of Module E-1 of the Tariff.

Jackson Spare Analysis

11/13/2024

The analysis considers two scenarios:
Base: No changes made
90 Day Outage: Jackson has 104 MW on maintenance from June 1st to August 31st, 2025
1080 Day Outage: Jackson has 104 MW on maintenance from June 1st to May 16th, 2028

Values are represented as negative (reduction to customer cost)
Expenses are represented as **positive** (customer expense)

Net Present Value Results	**90 Day Outage**	**1080 Day Outage**
Current Nameplate Capacity (MW)	547	547
Upgraded Capacity (MW)	547	547
Incremental Energy(K$)	$8,809	$79,392
Incremental Capacity Revenue (K$)	$0	$0
Incremental Operating Costs (K$)	($5,694)	($58,142)
Total Value of Phase 2 Upgrade (K$)	**$3,115**	**$21,251**

90 Day Outage

Annual Detailed Results	**Incremental Energy Revenue (K$)**	**Incremental Operating Costs (K$)**
2025	$8,809	($5,694)
2026	$0	$0
2027	$0	$0
2028	$0	$0

1080 Day Outage

Annual Detailed Results	**Incremental Energy Revenue (K$)**	**Incremental Operating Costs (K$)**
2025	$16,863	($11,532)
2026	$28,262	($20,909)
2027	$24,911	($18,217)
2028	$9,357	($7,483)

Helper	Run ID	Year	Name	Capacity	Capacity Factor	Energy Revenue(000s)	Energy Revenue	*Capacity Revenue*	Total Revenue	Total Cost MWh	Total Cost	Total Value	Dispatch Cost	Output (MWh)	Fuel Usage (mmBTU)
Jackson 0 Base-2025-Jackson	Jackson 0 Base	2025	Jackson	547	84%	$ 154,725	$ 154,724,700	*$ 49,029,563*	$ 203,754,263	$ 27	108,129,775.36	95,624,487.16	$ 28	4,008,741	32,593,050
Jackson 0 Base-2026-Jackson	Jackson 0 Base	2026	Jackson	547	72%	$ 139,979	$ 139,978,900	*$ 50,108,213*	$ 190,087,113	$ 30	103,827,654.16	86,259,458.73	$ 30	3,468,329	28,103,600
Jackson 0 Base-2027-Jackson	Jackson 0 Base	2027	Jackson	547	65%	$ 125,390	$ 125,390,200	*$ 51,210,594*	$ 176,600,794	$ 29	91,557,404.67	85,043,388.91	$ 30	3,111,486	25,270,250
Jackson 0 Base-2028-Jackson	Jackson 0 Base	2028	Jackson	547	70%	$ 135,090	$ 135,089,500	*$ 52,337,227*	$ 187,426,727	$ 30	100,619,908.44	86,806,818.20	$ 30	3,356,146	27,230,460
					73%	**$ 555,183**	**$ 555,183,300**	***$ 202,685,596***	**$ 757,868,896**		**$ 404,134,743**	**$ 353,734,153**	**$ 30**	**$ 13,944,702**	**$ 113,197,360**
					NPV	**$472,280**	**$472,280,403**	***$171,319,393***	**$643,599,796**		**$343,243,520**	**$300,356,275**			

Helper	Run ID	Year	Name	Capacity	Capacity Factor	Energy Revenue(000s)	Energy Revenue	*Capacity Revenue*	Total Revenue	Total Cost MWh	Total Cost	Total Value	Dispatch Cost	Output (MWh)	Fuel Usage (mmBTU)
Jackson 90 Days-2025-Jackson	Jackson 90 Days	2025	Jackson	547	79%	$ 145,916	$ 145,915,700	*$ 49,029,563*	$ 194,945,263	$ 27	102,435,926.26	92,509,336.26	$ 28	3,794,699	30,846,050
Jackson 90 Days-2026-Jackson	Jackson 90 Days	2026	Jackson	547	72%	$ 139,979	$ 139,978,900	*$ 50,108,213*	$ 190,087,113	$ 30	103,827,654.16	86,259,458.73	$ 30	3,468,329	28,103,600
Jackson 90 Days-2027-Jackson	Jackson 90 Days	2027	Jackson	547	65%	$ 125,390	$ 125,390,200	*$ 51,210,594*	$ 176,600,794	$ 29	91,557,404.67	85,043,388.91	$ 30	3,111,486	25,270,250
Jackson 90 Days-2028-Jackson	Jackson 90 Days	2028	Jackson	547	70%	$ 135,090	$ 135,089,500	*$ 52,337,227*	$ 187,426,727	$ 30	100,619,908.44	86,806,818.20	$ 30	3,356,146	27,230,460
					72%	**$ 546,374**	**$ 546,374,300**	***$ 202,685,596***	**$ 749,059,896**		**$ 398,440,894**	**$ 350,619,002**	**$ 30**	**$ 13,730,660**	**$ 111,450,360**
					NPV	**$464,048**	**$464,047,692**	***$171,319,393***	**$635,367,085**		**$337,922,166**	**$297,444,919**			

Helper	Run ID	Year	Name	Capacity	Capacity Factor	Energy Revenue(000s)	Energy Revenue	*Capacity Revenue*	Total Revenue	Total Cost MWh	Total Cost	Total Value	Dispatch Cost	Output (MWh)	Fuel Usage (mmBTU)
Jackson 1080 Days-2025-Jackson	Jackson 1080 Days	2025	Jackson	547	75%	$ 137,861	$ 137,861,300	*$ 49,029,563*	$ 186,890,863	$ 27	96,597,504.41	90,293,358.11	$ 28	3,588,960	29,181,050
Jackson 1080 Days-2026-Jackson	Jackson 1080 Days	2026	Jackson	547	58%	$ 111,717	$ 111,717,400	*$ 50,108,213*	$ 161,825,613	$ 30	82,918,538.72	78,907,074.18	$ 30	2,761,890	22,380,420
Jackson 1080 Days-2027-Jackson	Jackson 1080 Days	2027	Jackson	547	52%	$ 100,480	$ 100,479,500	*$ 51,210,594*	$ 151,690,094	$ 29	73,340,078.62	78,350,014.96	$ 30	2,494,032	20,257,700
Jackson 1080 Days-2028-Jackson	Jackson 1080 Days	2028	Jackson	547	65%	$ 125,733	$ 125,732,800	*$ 52,337,227*	$ 178,070,027	$ 30	93,136,830.13	84,933,196.51	$ 30	3,118,555	25,305,690
					62%	**$ 475,791**	**$ 475,791,000**	***$ 202,685,596***	**$ 678,476,596**		**$ 345,992,952**	**$ 332,483,644**	**$ 29**	**$ 11,963,437**	**$ 97,124,860**
					NPV	**$404,363**	**$404,362,794**	***$171,319,393***	**$575,682,187**		**$293,623,297**	**$282,058,890**			

Output DB **2024PriceDispatch JacksonSpare 1080Days 2**

Year	Capacity Price ($/mw-year)
2023	127,135
2024	129,932
2025	132,790
2026	135,712
2027	138,698
2028	141,749
2029	144,867
2030	148,054
2031	151,312
2032	154,640
2033	158,043
2034	161,520
2035	165,073
2036	168,705
2037	172,416
2038	176,209
2039	180,086
2040	184,048

	Capacity (MW)
eFOR	0.9
CONE	75%

Helper Column	Run_ID			Zone	ID	Name	Output	Capability	Capacity									Revenue	
Jackson 1080 Days-2025-Jackson	Jackson 1080 Days	Average	2025	[illegible]	Jackson	Jackson	409.6986	464.1536	547	547	233.33	28.30651	28.026	27.353	8,157	8,131	8,420	######	######
Jackson 1080 Days-2026-Jackson	Jackson 1080 Days	Average	2026	[illegible]	Jackson	Jackson	315.2842	423.065	547	547	212.6748	2.97E+01	29.389	30.556	8,157	8,103	7,863	######	######
Jackson 1080 Days-2027-Jackson	Jackson 1080 Days	Average	2027	[illegible]	Jackson	Jackson	284.7069	423.065	547	547	212.6748	3.00E+01	29.731	31.159	8,157	8,122	7,860	######	######
Jackson 1080 Days-2028-Jackson	Jackson 1080 Days	Average	2028	[illegible]	Jackson	Jackson	355.0268	485.2079	547	547	243.914	2.99E+01	29.576	30.827	8,157	8,115	7,892	######	######
Jackson 0 Base-2025-Jackson	Jackson 0 Base	Average	2025	[illegible]	Jackson	Jackson	457.6188	522.385	547	547	262.6029	2.83E+01	28.041	27.353	8,157	8,130	8,423	######	######
Jackson 0 Base-2026-Jackson	Jackson 0 Base	Average	2026	[illegible]	Jackson	Jackson	395.928	522.385	547	547	262.6029	2.98E+01	29.466	30.556	8,157	8,103	7,886	######	######
Jackson 0 Base-2027-Jackson	Jackson 0 Base	Average	2027	[illegible]	Jackson	Jackson	355.1924	522.385	547	547	262.6029	3.01E+01	29.77	31.159	8,157	8,122	7,870	######	######
Jackson 0 Base-2028-Jackson	Jackson 0 Base	Average	2028	[illegible]	Jackson	Jackson	382.0749	522.385	547	547	262.6029	29.92979	29.633	30.827	8,157	8,114	7,906	######	######
Jackson 90 Days-2025-Jackson	Jackson 90 Days	Average	2025	[illegible]	Jackson	Jackson	433.1848	497.623	547	547	250.1551	2.83E+01	28.041	27.353	8,157	8,129	8,423	######	######
Jackson 90 Days-2026-Jackson	Jackson 90 Days	Average	2026	[illegible]	Jackson	Jackson	395.928	522.385	547	547	262.6029	2.98E+01	29.466	30.556	8,157	8102.9	7,886	139979	139979
Jackson 90 Days-2027-Jackson	Jackson 90 Days	Average	2027	[illegible]	Jackson	Jackson	355.1924	522.385	547	547	262.6029	30.06768	29.77	31.159	8,157	8121.6	7,870	125390	125390
Jackson 90 Days-2028-Jackson	Jackson 90 Days	Average	2028	[illegible]	Jackson	Jackson	382.0749	522.385	547	547	262.6029	2.99E+01	29.633	30.827	8,157	8,114	7,906	######	######

Helper Column																Value								Sec_Fuel
Jackson 1080 Days-2025-Jackson	0	0	537.5	0.9826	0	26.77	0	0	0	0	######	7968.1	0	0	34.608	######	3.0802	######	######	[illegible]	[illegible]	######	-1	0
Jackson 1080 Days-2026-Jackson	0	0	537.5	0.9826	0	29.589	0	0	0	0	######	6274.8	0	0	27.264	######	3.4668	######	######	[illegible]	[illegible]	######	-1	######
Jackson 1080 Days-2027-Jackson	0	0	537.5	0.9826	0	29.08	0	0	0	0	######	5801.2	0	0	25.538	######	3.5342	######	######	[illegible]	[illegible]	######	-1	######
Jackson 1080 Days-2028-Jackson	0	0	537.5	0.9826	0	29.242	0	0	0	0	######	7427.2	0	0	25.684	######	3.4869	######	######	[illegible]	[illegible]	######	-1	######
Jackson 0 Base-2025-Jackson	0	0	537.5	0.9826	0	26.844	0	0	0	0	######	8900.1	0	0	40.525	######	3.0802	######	######	[illegible]	[illegible]	######	-1	######
Jackson 0 Base-2026-Jackson	0	0	537.5	0.9826	0	29.572	0	0	0	0	######	7879.8	0	0	33.873	######	3.4668	######	######	[illegible]	[illegible]	######	-1	######
Jackson 0 Base-2027-Jackson	0	0	537.5	0.9826	0	29.142	0	0	0	0	######	7237.4	0	0	31.538	######	3.5342	######	######	[illegible]	[illegible]	######	-1	######
Jackson 0 Base-2028-Jackson	0	0	537.5	0.9826	0	29.361	0	0	0	0	######	7993	0	0	26.235	######	3.4869	######	######	[illegible]	[illegible]	######	-1	0
Jackson 90 Days-2025-Jackson	0	0	537.5	0.9826	0	26.857	0	0	0	0	######	8424.9	0	0	35.759	######	3.0802	######	######	[illegible]	[illegible]	######	-1	######
Jackson 90 Days-2026-Jackson	0	0	537.5	0.9826	0	29.572	0	0	0	0	7879.8	7879.8	0	0	33.873	36151	3.4668	9465.2	######	[illegible]	[illegible]	######	-1	######
Jackson 90 Days-2027-Jackson	0	0	537.5	0.9826	0	29.142	0	0	0	0	7237.4	7237.4	0	0	31.538	33833	3.5342	8340.6	######	[illegible]	[illegible]	######	-1	0
Jackson 90 Days-2028-Jackson	0	0	537.5	0.9826	0	29.361	0	0	0	0	######	7993	0	0	26.235	######	3.4869	######	######	[illegible]	[illegible]	######	-1	######

Helper Column												Startups																
Jackson 1080 Days-2025-Jackson	-1	######	######	0	######	0	0	26.381	90.126	0	519.82	8	0	0.749	11.497	38.413	26.915	7895	######	######	TRUE	0	0	0	0	0	0	0
Jackson 1080 Days-2026-Jackson	-1	######	######	0	######	0	0	44.886	79.372	0	1195.7	18	0	0.5764	10.427	40.45	30.022	6953	######	######	TRUE	0	0	0	0	0	0	0
Jackson 1080 Days-2027-Jackson	-1	######	######	0	######	0	0	43.231	70.251	0	814.69	12	0	0.5205	10.882	40.288	29.406	6154	######	######	TRUE	0	0	0	0	0	0	0
Jackson 1080 Days-2028-Jackson	-1	######	######	0	######	0	0	44.661	76.389	0	1942.5	28	0	0.649	10.452	40.318	29.865	6710	######	######	TRUE	0	0	0	0	0	0	0
Jackson 0 Base-2025-Jackson	-1	######	######	0	######	0	0	26.495	90.342	0	519.82	8	0	0.8366	11.623	38.597	26.974	7914	######	######	TRUE	0	0	0	0	0	0	0
Jackson 0 Base-2026-Jackson	-1	######	######	0	######	0	0	45.89	80.742	0	1262.2	19	0	0.7238	10.423	40.359	29.936	7073	######	######	TRUE	0	0	0	0	0	0	0
Jackson 0 Base-2027-Jackson	-1	######	######	0	######	0	0	43.539	71.039	0	882.58	13	0	0.6493	10.874	40.299	29.426	6223	######	######	TRUE	0	0	0	0	0	0	0
Jackson 0 Base-2028-Jackson	-1	######	######	0	######	0	0	45.412	77.334	0	2081.3	30	0	0.6985	10.271	40.251	29.981	6793	######	######	TRUE	0	0	0	0	0	0	0
Jackson 90 Days-2025-Jackson	-1	######	######	0	######	0	0	26.495	90.342	0	519.82	8	0	0.7919	11.458	38.453	26.994	7914	######	######	TRUE	0	0	0	0	0	0	0
Jackson 90 Days-2026-Jackson	-1	3E+06	3E+06	0	3E+06	0	0	45.89	80.742	0	1262.2	19	0	0.7238	10.423	40.359	29.936	7073	######	######	TRUE	0	0	0	0	0	0	0
Jackson 90 Days-2027-Jackson	-1	3E+06	3E+06	0	3E+06	0	0	43.539	71.039	0	882.58	13	0	0.6493	10.874	40.299	29.426	6223	######	######	TRUE	0	0	0	0	0	0	0
Jackson 90 Days-2028-Jackson	-1	######	######	0	######	0	0	45.412	77.334	0	2081.3	30	0	0.6985	10.271	40.251	29.981	6793	######	######	TRUE	0	0	0	0	0	0	0

Helper Column										Pool																	Inertia	rpt_PPA	rpt_Zone	rpt_PRM	rpt_RateImpact
Jackson 1080 Days-2025-Jackson	21.871	60.975	0	0	Unit	4	2025	0	0	MISO	[illegible]	660	0	0	0	0	0	130.36	389.46	23718	4E+06	0	88075	0	0	0					
Jackson 1080 Days-2026-Jackson	19.935	104	0	0	Unit	4	2026	0	0	MISO	[illegible]	823	0	0	0	0	0	299.76	895.99	53365	4E+06	0	75421	0	0	0					
Jackson 1080 Days-2027-Jackson	19.935	104	0	0	Unit	4	2027	0	0	MISO	[illegible]	986	0	0	0	0	0	204.24	610.45	35577	4E+06	0	66699	0	0	0					
Jackson 1080 Days-2028-Jackson	22.863	38.929	0	0	Unit	4	2028	0	0	MISO	[illegible]	1149	0	0	0	0	0	487.52	1455	83013	4E+06	0	83741	0	0	0					
Jackson 0 Base-2025-Jackson	24.615	0	0	0	Unit	4	2025	0	0	MISO	[illegible]	1312	0	0	0	0	0	130.36	389.46	23718	5E+06	0	98669	0	0	0					
Jackson 0 Base-2026-Jackson	24.615	0	0	0	Unit	4	2026	0	0	MISO	[illegible]	1475	0	0	0	0	0	316.42	945.76	56330	5E+06	0	94652	0	0	0					
Jackson 0 Base-2027-Jackson	24.615	0	0	0	Unit	4	2027	0	0	MISO	[illegible]	1638	0	0	0	0	0	221.26	661.32	38542	5E+06	0	83406	0	0	0					
Jackson 0 Base-2028-Jackson	24.615	0	0	0	Unit	4	2028	0	0	MISO	[illegible]	1801	0	0	0	0	0	522.34	1559	88942	5E+06	0	90519	0	0	0					
Jackson 90 Days-2025-Jackson	23.448	25.929	0	0	Unit	4	2025	0	0	MISO	[illegible]	8	0	0	0	0	0	130.36	389.46	23718	4E+06	0	93455	0	0	0					
Jackson 90 Days-2026-Jackson	24.615	0	0	0	Unit	4	2026	0	0	MISO	[illegible]	171	0	0	0	0	0	316.42	945.76	56330	5E+06	0	94652	0	0	0					
Jackson 90 Days-2027-Jackson	24.615	0	0	0	Unit	4	2027	0	0	MISO	[illegible]	334	0	0	0	0	0	221.26	661.32	38542	5E+06	0	83406	0	0	0					
Jackson 90 Days-2028-Jackson	24.615	0	0	0	Unit	4	2028	0	0	MISO	[illegible]	497	0	0	0	0	0	522.34	1559	88942	5E+06	0	90519	0	0	0					

Consumers Energy Lost Capacity Calculator – Methodology & Regulatory Notes

Draft workpaper for discussion with Michigan Public Service Commission (MPSC)

Version 1.0 (2025-07-17 build)

Prepared by: Consumers Energy Generation Asset Strategy & Forecasting Teams

Contact: [insert name / email]

1. Purpose

Extended forced outages (or material derates) on generating units can reduce the accredited capacity we rely on to meet MISO Planning Reserve Margin Requirements (PRMR) and to earn capacity revenue. Because actual market outcomes (Planning Resource Auction clearing prices, bilateral forwards, accreditation rules) are uncertain and can span multiple future planning years, we use a streamlined calculator to produce a conservative, internally consistent estimate of the potential capacity value at risk when evaluating investment alternatives and responding to Michigan Public Service Commission (MPSC) data requests.

This document describes the logic in the Lost Capacity Calculator workbook supplied by the Forecasting Team, explains key inputs, shows the Excel formulas, demonstrates a worked example, and identifies the embedded conservatism that makes the results a lower-bound (60–70% view) of potential capacity losses. It is intended to accompany the calculator when provided to MPSC Staff.

2. Overview: Capacity Value Streams & What the Tool Captures

Capacity value at risk from an outage can manifest in several ways:

- Loss or reduction of Zonal Resource Credits (ZRCs) used to meet PRMR compliance.
- Reduced ability to clear ZRCs in the MISO Planning Resource Auction (PRA).
- Lower bilateral capacity revenues or increased replacement capacity purchases.
- Possible penalties / deficiency charges if PRMR not met (not modeled here).

The calculator focuses on two modeled outputs: (1) Lost Capacity in ZRCs and (2) Lost Capacity Revenue in $. It does not attempt to forecast PRA clearing prices or deficiency penalties; instead, it uses a Cost of New Entry (CONE) proxy, with an additional haircut (75% of CONE) where appropriate, to remain conservative.

3. Tool Outputs

3.1 Lost Capacity (ZRCs)

Estimates the reduction in accredited capacity attributable to the outage, expressed in ZRCs, allocated evenly across the three planning years following the Planning Year (Planning Year +1, +2, +3).

3.2 Lost Capacity Revenue ($)

Converts the ZRC impact (or, in one case, outage days) into an estimated $ value. If the outage occurs in the Planning Year being calculated and extends beyond 31 days, the model values the days past 31 at a daily CONE rate times the seasonal factor. In all other cases, the model multiplies the Lost Capacity (ZRCs) by 75% of CONE.

4. Key Inputs & Definitions

Table 1 lists the input fields referenced in the workbook and used in the formulas. Cell references (in parentheses) match the example screenshot you provided; actual cell addresses may differ in your production workbook.

Input / Variable (Excel Ref)	Definition / Notes
Unit Name (E2)	Text label only; identifies the generating unit modeled.
GVTC of Unit (MW) (E3)	Generator Verification Test Capacity (latest tested dependable MW on the GVTC basis). Denominator in the SAC/GVTC ratio: N2 = E4 ÷ E3.
Planning Year (N5)	Forecast planning year for which ZRC accreditation and resource adequacy compliance is being evaluated.
Lost Capacity (ZRCs) row 12	Formula: =IF(OR(Year=N5+1,Year=N5+2,Year=N5+3),(N4/365*N3)/3,0). Books the ZRC impact evenly across the three planning years following the Planning Year; 0 elsewhere.
Planned Capacity (ZRCs) row 11	Baseline accredited capacity with no outage. Formula copies $E$4 (SAC Value) across all year columns for comparison.
SAC Value of Unit (ZRC) (E4)	Seasonal Accredited Capacity for the Planning Year, expressed in Zonal Resource Credits. Also populates the “Planned Capacity (ZRCs)” row across all year columns (row 11).
# of MW derate (E5)	Magnitude of the outage/derate to model in MW on the GVTC basis. Enter full GVTC for a total unit outage; enter expected MW out for a partial derate. Used in N3 = E5 × N2 to convert the MW derate into accredited ZRCs impacted.
Year Being Calculated (C10 row label)	Year for which potential capacity loss is being booked in the model. May equal the Planning Year or Planning Year +1/+2/+3.
Days Offline / Derated (N4)	Outage duration in days. Used in both Lost Capacity (row 12) and Lost Capacity Revenue (row 14) formulas. Threshold: if N4 > 31 and Year = Planning Year, the Planning-Year revenue branch activates.

SAC Derate (ZRCs impacted) (N3) – Derived	Converts the outage magnitude entered in # of MW derate (E5) into accredited capacity (ZRCs) at risk using the unit's Seasonal Accredited Capacity ratio. Calculations: N2 = SAC_ZRC (E4) ÷ GVTC_MW (E3); N3 = MW_derate (E5) × N2. Interprets how many accredited ZRCs are unavailable if the specified MW are out. Full-unit outage ⇒ N3 = unit SAC (ZRCs). Because SAC is usually < GVTC, this translation from MW to ZRCs typically lowers the bookable exposure vs a raw MW × price approach (conservative).
Cost of New Entry – CONE ($/ZRC-Year) (J5)	CONE ($/ZRC-yr) (J5) – Cost of New Entry benchmark used to monetize ZRC impacts. Applied at 100% in the Planning-Year >31-day branch; discounted to 75% (0.75×CONE) in all other years to remain conservative.
Lost Capacity (ZRCs) (D12)	Model output: estimated ZRCs potentially lost due to the outage, averaged across the 3 accreditation years following the Planning Year.
Lost Capacity Revenue ($) (D14)	Model output: estimated $ value of at-risk capacity revenue, using conditional logic (Planning-Year outage >31 days vs all other cases). Formula: =IF(AND(N4>31, N5=Year), J5/365*(N4-31)*N3, LostCapZRC*0.75*J5). Uses daily CONE × days beyond 31 × ZRCs impacted for long Planning-Year outages; otherwise multiplies Lost Capacity (ZRCs) by 0.75 × CONE.

All monetary values are in nominal $ unless noted. 1 ZRC = 1 MW UCAP-Year in MISO terminology.

5. Calculation Logic

The workbook contains two principal formulas: Lost Capacity (ZRCs) and Lost Capacity Revenue ($). Both are wrapped in conditional logic that gates the calculation so we only book losses in the years affected.

5.1 Lost Capacity (ZRCs) Formula

Excel syntax:

```
=IF(OR(C20=($N$5+1),C20=($N$5+2),C20=($N$5+3)),($N$4/365*$N$3)/3,0)
```

Where:

- C20 is the year being calculated.
- $N$5 is the Planning Year (NS).

- $N$4 is Days Offline / Derated.
- $N$3 = SAC Derate (ZRCs impacted) – the number of accredited ZRCs out of service, derived as (# MW derate × SAC_ZRC ÷ GVTC_MW).

Plain-language steps:

1. Check if the year being calculated equals Planning Year +1, +2, or +3.
2. If none match, return 0 (no capacity loss booked in that year).
3. If a match, compute lost ZRCs = (Days Offline / 365) * Seasonal Factor / 3.
4. Dividing by 3 spreads the single outage's effect evenly over the three subsequent accreditation years.

Algebraic form: Lost_ZRC_perYear = ((Days_offline ÷ 365) × Seasonal_Factor) ÷ 3, conditional on Year = PlanningYear +1/+2/+3; else 0.

5.2 Lost Capacity Revenue ($) Formula

Excel syntax:

=IF(AND($N$4>31,$N$5=D20),$J$5/365*($N$4-31)*$N$3,D22*0.75*$J$5)

Where:

- $N$4 is Days Offline / Derated.
- $N$5 is Planning Year (NS).
- D20 is the year being calculated (Planning Year row).
- $J$5 is CONE ($/ZRC-Year).
- $N$3 = SAC Derate (ZRCs impacted) – accredited ZRCs affected by the outage (see Section 4)
- D22 is Lost Capacity (ZRCs) calculated above.

Plain-language steps:

1. Test if two conditions are both TRUE:

   a. Days Offline > 31.
   b. Year being calculated = Planning Year.

2. If BOTH true (Planning-Year outage >31 days):

- Compute daily CONE = CONE / 365.
- Compute Days Beyond 31 = Days Offline - 31.
- Lost Capacity Revenue = (CONE ÷ 365) × Days Beyond 31 × ZRCs impacted (This values the accredited ZRCs out during the extended outage days.).

3. ELSE (all other years / shorter Planning-Year outages):

- Lost Capacity Revenue = Lost Capacity (ZRCs) * 0.75 * CONE.

The 31-day deductible recognizes that short outages inside a Planning Year generally do not reduce the auction-accredited capacity we can count, and it avoids over-stating risk from brief events. Using only 75% of CONE in the ELSE branch is an explicit conservatism that discounts the long-run capacity value proxy.

6. Why Results Are Conservative (Lower-Bound)

Multiple structural and parametric choices bias results low relative to potential market exposure:

1. Only a 60–70% view: Seasonal factors supplied by Forecasting intentionally haircut expected ZRC exposure.
2. Accreditation conversion (SAC ÷ GVTC): We translate MW derates into accredited ZRCs using the unit's SAC/GVTC ratio. Because SAC is typically less than the tested MW capability, this step alone reduces the dollar impact vs valuing the full MW outage. Conservative.
4. Loss spread across 3 years (÷3) dilutes impact vs booking full loss up front.
4. 31-day deductible before valuing Planning-Year outages.
5. 0.75 × CONE multiplier further discounts value in ELSE case.
6. No escalation for scarcity premiums when PRA clears >CONE.
7. Excludes replacement energy purchases, RSG uplift, unit commitment effects, or penalty adders.
8. Does not model correlated fleet outages that could increase zonal tightness.

Taken together, these elements make the calculator a conservative screen; real-world financial exposure could be higher.

7. Appropriate Use Cases & Boundaries

Appropriate:

- Screening capital project justifications and comparing outage-avoidance benefits.
- Internal risk ranking across fleet assets.

Not Intended For:

- Settlements, actual PRA offer strategy, or bilateral contracting decisions.
- Recording GAAP revenues or impairment testing.
- Short-term outage scheduling optimization.

8. Revision History

Date	Version	Author	Key Changes
2025-07-17	1.0	[name]	Initial draft for MPSC discussion.

Appendix A – Detailed Input Field Definitions

Planning Year (NS): Forward compliance year used in resource adequacy planning.

Year Being Calculated: Each row in the model corresponds to a Planning Year or one of the three subsequent years.

Days Offline / Derated: Count of calendar days; if partial derate, convert to equivalent full-derate days (MW-weighted).

SAC Derate (ZRCs impacted): N3. Derived as (# MW derate × SAC_ZRC ÷ GVTC_MW). Represents the accredited capacity (ZRCs) unavailable during the modeled outage. Use full-unit MW if modeling a total outage; otherwise use the expected derated MW.

CONE: Cost of New Entry proxy. Source: Forecasting / MISO data / MPSC filings.

Appendix B – Seasonal Derate Factor Development (Summary)

Forecasting derived N3 factors by mapping historic seasonal PRA accreditation rules and expected zonal reserve margins to quarterly weighting factors. Factors are typically lower in shoulder months and higher in peak summer but always <=1.0 to maintain conservatism. Documentation available on request.

Appendix C – Sensitivity Cases

- - High Case: Replace 0.75*CONE with 1.0*CONE.
- - Peak-Summer Outage: Seasonal Factor = 1.0.
- - Short Outage: Days Offline = 20; demonstrates 31-day deductible effect.
- - Severe Outage Duration Sweep: 30/60/90/180 days.

Appendix D – FAQ for MPSC Staff

Q1. Why not use actual PRA clearing prices?
A1. Forward clearing prices are unknown; CONE provides stable benchmark; 75% haircut keeps results conservative.

Q2. Why spread across 3 years?
A2. Reflects multi-year accreditation effects and avoids double counting; aligns with internal planning horizon.

Q3. What if outage straddles two Planning Years?
A3. Use total equivalent days in each year or model two scenarios; tool is flexible.

Q4. Can Staff change the CONE multiplier?
A4. Yes; cell is unlocked; change 0.75 to 1.0 to view upper bound.

Question:

3. Refer to Company's filing Part III, Attachment 131, for all projects at the Covert, Jackson and Zeeland plants, please provide (where applicable):

a. The earliest and latest project charter.

b. Any economic analysis performed, including present value ratio (PVR) or internal rate of return (IRR) calculations, including all supporting analyses and documentation used in such calculations (preferably in Excel format).

c. Please identify those projects which the Company deems required for safety purposes, including an explanation for why that is the case.

d. Please identify those projects which the Company believes that, if not performed, the unit would not operate, including an explanation for why that is the case.

Response:

a. Per discussion with MNSC council, the Company has provided concept approvals which provide an analysis of the work to be performed, a discussion of alternatives, including doing nothing, and a selected alternative. Attachment U21870-MNSC-CE-0072_ATT_0001 reproduces select fields from Part III Attachment 131 for all projects at the Covert, Jackson, and Zeeland generating stations. This attachment identifies the work type and category, job description, reason for the work to be performed, and the applicable attachment representing the concept approval for the project. 8 other attachments are attached to this response which reflect concept approvals not previously provided in discovery in this proceeding.

   The projected capital investment for certain routine capital projects such as small capital and base outage for each generating station are primarily based upon historical spend. Sheet 2 of this attachment provides 5 years of history of investment for each of these work categories for both the Jackson and Zeeland generating stations and all available investment history for Covert generating station since its acquisition on June 1, 2023.

b. The only projects identified as economic in nature are the Zeeland Phase I and II turbine projects. Please refer to confidential Attachments U21870-ST-CE-0007_ATT_0001_CONF and U21870-ST-CE-0007_ATT_0002_CONF for the economic analysis. Also refer to the Company's response to discovery question U21870-MNSC-CE-0071.

c. None of the projects for the Covert, Jackson, and Zeeland generating stations are being performed based upon safety.

d. Please see concept approval documents identified in Attachment U21870-MNSC-CE-0072_ATT_0001 for the basis for the specific work. Some work is required for warranty such as the LTSAs, some of it is based upon economics (Zeeland Phase I and II), some is performed based on failed equipment, some of it is performed based upon required computer-related equipment upgrades in order to continue to operate the generating units.

Witness: RICHARD T. BLUMENSTOCK
Date: July 24, 2025

PT Number	ProjectID	Work Type (Tier 3)	Site (Tier 2)	Work Category	Title	Funding Type	21870-MNSC-CE-0072	Reason(s) for the work to be performed (for example insurance, aging equipment, warranty, federal/state regulation, etc.).
PP-00524	**12817**	Operations	Covert	Operate	(12817) COVERT - Long Term Service Agreement - Running capital contract	Capital	U21870-ST-CE-0004_0010_CONF	Reliability Maintenance
PP-00579	**13583**	Reliability	Covert	Maintain	(13583) CGS - Netmation (MHPSA Operating System & 4S)- Unit 1-3	Capital	U21870-MNSC-CE-0072_0009	The Covert gas generating station, operational since 2004, faces critical challenges with its outdated control systems. These challenges impact both operational efficiency and cybersecurity, necessitating an urgent upgrade to modern standards.
PP-00545	**13570**	Reliability	Covert	Operate	(13570) Covert - **Unit 2** - Non LTSA Capital - Extras not included in contract	Capital	U21870-ST-CE-0004_ATT_0037	Covert - Unit 2 - Non LTSA Capital - Extras not included in contract
PP-00584	**PP-00584**	Reliability	Covert	Maintain	PP-00584: CGS HRSG Expansion Joint Replacements	Capital	U21870-ST-CE-0004_0034	The expansion joint has a design life of 6-8 yrs, and replacement occurs during the turbine major outages. So the existing expansion joints will be at least 4 years beyond their design if delayed until the next major. Assuming 66%-100% beyond design life, then the probability of a failure would be high. Failure of the joint could start as a tear and found by thermography if it is small. There is no way of expecting a failure will be small or a large rip but the result is that exhaust gasses could bypass the stack and environmental monitoring equipment, exhausting high temp gas inside the building which is a personnel hazard. It is also a significant hit on overall heat rate efficiency that would depend on the unpredictable size of the failure.
PP-00050	**PP-00050**	Reliability	Covert	Maintain	(13618) CGS - LCI Replacements (SFC)	Capital	A-46 (RTB-7)	The Covert Generating Station (CGS) Static Frequency Converter (SFC) Controls Replacement project is essential to address significant operational and reliability issues stemming from the obsolescence of the current SFC controls. This project is critical for maintaining the operational integrity and reliability of the plant's turbine generators, which rely on the SFCs for startup.
PP-00109	**12818**	Operations	Covert	Operate	(12818) Covert -**Unit 1** Non LTSA Capital - Extras not included in contract	Capital	U21870-ST-CE-0004_ATT_0037	Reliability Maintenance
PP-00111	**13571**	Regulatory	Covert	Operate	(13571) Covert - **Unit 3** - Non LTSA Capital - Extras not included in contract	Capital	U21870-ST-CE-0004_ATT_0037	Covert - Unit 3 - Non LTSA Capital - Extras not included in contract
PP-00565	**PP-00565**	Reliability	Covert	Operate	PP-00565: CGS BASE OUTAGE - 2024	Capital	The Company invested $0.789 million in base outage capital during the seven-month period beginning June 1, 2023 and ending December 31, 2023 at Covert. The base outage expenditure for 2024 was $197,942. These figures are consistent with historical spends from the other gas plants and aligned with the normalized forecasted figure of $400k/year.	Outages require funding for site priority #1 work orders, this will cover those issues
PP-00596	**PP-00596**	Reliability	Covert	Maintain	PP-00596: CGS 1 GTG and STG Auto Voltage Regulator	Capital	U21870-MNSC-CE-0072_0002	The excitation system is due for an overhaul
PP-00597	**PP-00597**	Reliability	Covert	Maintain	PP-00597: CGS 3 GTG and STG Auto Voltage Regulator	Capital	U21870-MNSC-CE-0072_0002	The excitation system is due for an overhaul
PP-00589	**13446**	Regulatory	Covert	Comply	(13446) CGS - 1-3 Emerson DCS Evergreen	Capital	U21870-MNSC-CE-0072_0008	The newly acquired gas generation plant at Covert, which started commercial operation in 2004, has many components of its original control system in operation. The Distributed Control System (DCS) that controls all equipment in the plant (along with the Mitsubishi gas turbine controls), is Emerson Ovation DCS. It was upgraded about 10 years ago to the current version. Emerson Ovation version 3.5.1 is no longer supported by Emerson or Microsoft. The Emerson Ovation version 3.5 system entered a retired status in June 2019. The Windows operating systems that are used by this version of Ovation are Windows 7 and Windows Server 2008R2. Microsoft ended extended support of Server 2008R2 in January 2020. The generation plant control systems are an important part of our nation's Critical Infrastructure and fall under NERC Critical Infrastructure Protection (CIP) requirements. To keep our control systems secure, we must patch the operating systems and applications that run our plants. We are no longer able to patch and maintain these operating systems, such as Microsoft Windows, or applications, such as Ovation, when they are no longer supported by the manufacturers. Vulnerabilities may be found in this software that may provide a target for bad actors and nation states to exploit and leave our critical infrastructure vulnerable. Malware protection must be kept up to date and is limited on the older operating systems. The systems at Covert do not meet our corporate cybersecurity standards and are operating with security exception to our standards. The cybersecurity tools (Power & Water Cybersecurity Suite – PWCS) being utilized for the Covert control network device patching and antivirus protection require replacement to allow continued patching and protection with a new DCS version. The current version of PWCS is nearing end of support and requires updating to allow support of the latest Ovation versions. The Balance of Plant (BOP) control is achieved with the Ovation DCS. Its architecture is comprised of controller and operator "drops" (processors and PCs) that provide the control of the equipment with input/output (I/O) modules. Some of these I/O modules are in the same electrical cabinets that contain the "controller drops" (processors). Other I/O is in "remote" electrical cabinets, away from the "controller drops". The existing plant control is comprised of many remote I/O cabinets throughout the site. The communication modules to these cabinets have experienced failures in the past that can trip the generating units offline. Power supplies in the Ovation cabinets have reached the end of their recommend life and need to be replaced. The architecture and components need to be upgraded and replaced with the latest Ovation design. The main controller drop that operates a large part of the BOP equipment has had equipment and data link controls added to it over the years. It controls equipment for all three (3) generating units. The controller drop needs to have part of its I/O and logic split off to new controller drops. The partitioning of I/O to other drops should allow the upgrade and maintenance procedures to occur and
PP-00542	**13573**	Reliability	Covert	Operate	(13573) CGS - Purchase of site spare GSU	Capital	U21870-ST-CE-0004_0004	The Covert Generating Station features a combination of three gas turbine-powered plants and three steam turbine-powered plants, arranged in a one-on-one combined cycle configuration. This setup entails that each gas turbine unit powers the secondary winding of a three-winding transformer (GSU), while the corresponding steam-powered unit powers the tertiary winding. A GSU's failure can lead to significant power generation issues. Specifically, the GSUs at Covert are rated for 500 MVA and are equipped with forced oil and forced air cooling mechanisms. If a GSU were to fail, both the gas and steam turbine units connected to it would be unable to transmit power, leading to a potential loss of up to 400 MVA of generation capacity. This would prevent the generation of market value for Consumers Energy and its customers. Further complicating the situation is the long lead time of 2 to 4 years for procuring a replacement GSU, and the lack of spare units at other facilities. The plant is projected to operating until at least 2040, thus making it crucial to have a reliable GSU ready for replacement.
PP-00577	**13604**	Reliability	Covert	Maintain	(13604) CGS - Cooling Tower Gearboxes	Capital	U21870-MNSC-CE-0072_0003	The Covert Generating Station Cooling Tower Fan Gearbox Replacement Project addresses critical operational issues stemming from the end-of-life status of gearboxes after over 20 years of service. These gearboxes are essential for cooling tower fan operations, affecting the station's overall efficiency and reliability.
PP-00535	**PP-00535**	Regulatory	Covert	Comply	Covert Security and Network	Capital	This project was completed in 2023 and is not included in this rate case. The project is not included in the revenue requirement	Installation of Information Technology room for Corporate systems. The current infrastructure is not in place for connectivity to corporate.
PP-00560	**PP-00560**	Reliability	Covert	Operate	PP-00560: CGS SMALL SITE CAPITAL-2024	Capital	See historical spending for Small site capital. This number typically include Small valves and instrumentation, pumps, motors, and tools. The spending is consistent with the rest of the gas plants figures. CGS Year Investment 2023 $180,071.00 2024 $666,325.00 Average $423,198.00	Multiple small items fail throughout a year. This is to anticipate those failures and reserve budget for them.
PP-00554	**PP-00554**	Reliability	Jackson	Maintain	PP-00554: JGS - 1-6 Feedwater Desuperheater Valve	Capital	U21870-ST-CE-0004_0025	The HRSG 1-6 SH Steam Desuperheater Feedwater valves have had very short life spans since original construction. There are several issues that cause the valves to wear out quickly. The valves inherently cycle frequently open and closed due to the boiler running close to HP Steam Outlet temperature setpoint at gas turbine baseload, without duct firing. This has been reduced recently by a study completed by engineering and GE to allow the HP Steam temperature to be increased from the original 750 deg F up to 770 deg F. This change did cause the valves to cycle open/close less frequently, but it did not result in a substantial improvement in valve life. The brunt of the wear is absorbed by the HP FW Autoblock valve, which when it begins to leak by, causes the SH Steam temperature to fall. The HP FW Control Valve wears out quickly as well. Typically, when this occurs the leak by accelerates quickly to the point which the manual HP FW isolation valve upstream must be closed when the unit is not duct firing in order to maintain adequate superheated steam temperature.
PP-00242	**6006**	Reliability	Jackson	Operate	(6006) Jackson GE Long Term Service Agreement FFH	Capital	U21870-ST-CE-0004_0028-0033_CONF	Reliability Maintenance

PP-00302 PP-00487 PP-00570	5921	Reliability	Jackson	Operate	(5921) Jackson GE LTSA Historical Extra Work Expected	Capital	U21870-ST-CE-0004_0028-0033_CONF	Reliability Maintenance
PP-00568	PP-00568	Infrastructure	Jackson	Operate	PP-00568: JGS 2024 Base Outage	Capital	See historical spending for base outage at this site below. The amount in this rate case is consistent with the required base outage spending needed to safely execute an outage. JGS Year Investment 2018 $437,047.00 2019 $480,062.00 2020 $596,042.00 2021 $477,497.00 2022 $685,888.00 2023 $983,951.00 2024 $738,974.00 Average $628,494.43	Outage work
PP-00166	13478	Reliability	Jackson	Maintain	(13478) JGS - Generator Step Up Transformer (GSU) Site Spare	Capital	U21870-MNSC-CE-0072_0007	During Unit 7 Major Outage GE found cracking within the casing that was acceptable during this interval (Spring '18). Cracking will likely be out of tolerance during the next Hot Gas Path Inspection. GE has recommended replacement be procured.
PP-00178	PP-00178	Reliability	Jackson	Maintain	JGS - LM6000 ESN 191-306 HP Turbine S2 Nozzle replacement	Capital	U21870-ST-CE-0004_0023	During the bi-annual borescope inspection in April 2024 for the LM6000 gas turbines at Jackson Generating Station, damage was identified at the High-Pressure Turbine (HPT) Stage 2 Nozzle (S2N) Impingement Ring of Engine Serial Number (ESN) 191-306. The gas turbine with ESN 191-306 was placed in an 'on watch' period per OEM guidance that results in a 250 running hour inspection frequency to determine if the damage progresses. There is potential for the inspection frequency period to increase based on multiple inspections. Ultimately the S2N assembly of the gas turbine that is damaged needs to be replaced to restore the gas turbine to a serviceable condition.
		Reliability	Jackson	Maintain	JGS - Engine 191-306 Overhaul	Capital	U21870-ST-CE-0004_0024	Reliability Maintenance, discovered during inspections
		Reliability	Jackson	Maintain	JGS - Unit 7 Gas turbine rotor replacement	Capital	U21870-ST-CE-0004_0015	The rotor for a GE 7EA gas turbine has a life limit of either 5000 starts or 250,000 running hours. JGS Unit 7 (GE 7EA GT) gas turbine rotor is expected to hit its limit for starts before hitting its limit for running hours in the year 2032. JGS Unit 7 has planned maintenance intervals, either major overhaul or hot gas path, approximately every 5 years. The next major overhaul is tentatively in 2029 and the next hot gas path tentatively 2034. Based on the running profile of JGS, the unit will not be allowed to operate with the current rotor until 2034, and it would be unwise to take an additional outage between 2029 & 2034 to replace the rotor when it can be done in 2029.
PP-00574	13475	Reliability	Jackson	Operate	(13475) JGS - LM1-6 VIGV(variable inlet guide vane) Project	Capital	U21870-MNSC-CE-0072_0004	Inlet Guide Vanes (IGV's) located in the air intake of the gas turbine are used to direct and control the airflow into the engine. The angle of the IGV's relative to the oncoming flow is a critical driver of performance; opening the IGV's will allow more airflow into the gas turbine and therefore more power. However, opening the IGV's beyond the optimum angle will result in a significant loss in efficiency with minimal increase in power. The setting of the optimum angle is not a constant and is dependent on the corrected speed of the compressor rotor. For this reason, Variable Inlet Guide Vanes (VIGV's) are required to operate at peak power and efficiency over a range of ambient conditions and gas turbine power settings. The VIGV assembly is located at the front of the Low-Pressure Compressor (LPC). It allows flow modulation at partial power, resulting in increased engine efficiency. The VIGV system consists of 43 stationary leading-edge vanes and variable trailing flaps. The variable flaps can be rotated from –10 degrees open to +60 degrees closed by means of an actuation ring, which is driven by twin hydraulic actuators installed at the 3 o'clock and 9 o'clock positions. Both actuators are equipped with Linear Variable Differential Transformers (LVDT's). Normal engine operation is approximately –5 degrees open (full power) to +35 degrees closed (idle power). The flaps will also close during large power reductions to quickly reduce the LPC flow rate in order to maintain the LPC stall margin. An engine stall has the potential to cause catastrophic damage to the gas turbine. The packager-supplied control is designed to provide excitation and signal conditioning for both LVDT's and to control VIGV position by means of closed loop scheduling of VIGV actuator position, based on LPC inlet temperature (T2) and High-Pressure Compressor (HPC) discharge static pressure (PS3) corrected to gas turbine inlet pressure conditions (P0). The VIGV system improves performance for both simple cycle and heat-recovery cycles when operating at less than full load. For LM6000PC SPRINT gas turbines, which Jackson Generating Station has, the VIGV upgrade is expected to yield a significant fuel efficiency improvement at part power. The average fuel efficiency improvement at 70% of maximum power is greater than 2%. The VIGV also helps minimize variable bypass valve (VBV) flow and pressure levels, thereby reducing associated flow noise. The project will look to install new VIGV systems on six LM6000PC engines (S/N's: 191306, 191307, 191312, 191339, 191345, 191351) at Jackson Generating Station. The seventh LM6000PC engine (S/N 185132) has a partial installation already, and the project will look to complete the VIGV system for this engine.
PP-00551	PP-00551	Reliability	Jackson	Operate	PP-00551: JGS Small Site Capital	Capital	See historical spending for Small site capital. This number typically include Small valves and instrumentation, pumps, motors, and tools. The spending is consistent with the rest of the gas plants figures. JGS Year Investment 2020 $289,768.00 2021 $487,796.00 2022 $391,377.00 2023 $637,369.00 2024 $672,338.00 Average $495,729.60	Multiple small items fail throughout a year. This is to anticipate those failures and reserve budget for them.
PP-00507	13499	Reliability	Zeeland	Maintain	(13499) ZGS - 2C GSU Rewind	Capital	U21870-ST-CE-0004_0014	The 2C Generator Step Up Transformer (GSU) which outputs electricity from the generator to the grid is showing signs of imminent failure as indicated by hydrocarbon gasses being continuously generated at rates above Institute of Electrical and Electronics Engineers (IEEE) recommended levels. Time to failure cannot be predicted and could be catastrophic in nature. Previous intrusive internal inspection and testing work in fall of 2022 was able to identify and replace some degraded parts but ultimately not able to locate the source of gas generation.
PP-00488	12833	Reliability	Zeeland	Maintain	(12833) ZGS - Site Spare GSU	Capital	A-47 (RTB-8)	Zeeland Generating Station consists of four gas turbine powered plants and one steam turbine powered plant. The units transmit their power to the grid via Generator Step Up (GSU) transformers. If a GSU were to fail, then the associated turbine would not be able to transmit power and would not be able to generate energy and capacity market value for Consumers Energy and its customers. For Zeeland Phase 2 combined cycle plants, the combustion turbine requires the operation of the steam turbine, therefore the loss of the steam turbine GSU would effectively limit operation of two connected combustion turbine units. The lead time for a GSU is currently 100 weeks and spare units at other facilities typically do not exist. The site is currently projecting retirement in the 2050 timeframe. This project would purchase a spare GSU that is sized to be able to replace any of the existing transformers on site and develop redundancy for any minor power upgrades in the future.
PP-00478	PP-00478	Reliability	Zeeland	Maintain	PP-00478: ZGS-P2 599 699 345kV Breaker Replacement	Capital	U21870-ST-CE-0004_0017	The installed Hitachi HVB breakers have a critical design flaw such that an individual pole or poles may not latch open when required. This has the potential to result in lost generation, loss of power to the entire Zeeland substation, and/or generator damage.
PP-00039 PP-00040 PP-00041	6593	Reliability	Zeeland	Operate	(6593) Zeeland Long Term Service Agreement - Running Capital Contract	Capital	U21870-ST-CE-0004_0028-0033_CONF	Reliability Maintenance
PP-00430	9694	Reliability	Zeeland	Maintain	(9694) ZGS - HRSG Casing Replacement	Capital	U21870-ST-CE-0004_0018	During recent inspections of the heat recovery steam generators (HRSGs) at Zeeland, extensive outer casing corrosion has been identified in particular sections of the units. This condition creates the risk of the studs which hold on the insulation and liner panels breaking loose and liberating both insulation and liner sheets. The insulation then blows downstream and fouls the HRSG tubes, requiring the unit to be shut down and cleaned, then subsequent casing, insulation and liner replacement. The affected areas of casing need to be cut out and replaced with new casing. A study is required to determine the exact scope of repairs, the cost, and the execution schedule.
PP-00426 PP-00023	9943	Reliability	Zeeland	Operate	(9943) ZGS - LTSA - Extras not included in contract (cranes, mobile equipment)	Capital	U21870-ST-CE-0004_0028-0033_CONF	Reliability Maintenance

PP-00517 PP-00564	**6596**	Reliability	Zeeland	Operate	(6596) ZGS Base Outage Capital	Capital	See historical spending for base outage at this site below. The amount in this rate case is consistent with the required base outage spending needed to safely execute an outage. ZGS Year Investment 2018 $2,421,434.00 2019 $341,144.00 2020 $796,316.00 2021 $260,129.00 2022 $522,636.00 2023 $547,912.00 2024 $849,528.00 Average $819,871.29	Outage work
PP-00170	**11712**	Reliability	Zeeland	Maintain	(11712) ZGS - Phase II Turbine Replacements	Capital	U21870-ST-CE-0004_0016	Scheduled Major Inspection outages in 2028 for Phase II turbines.
PP-00171	**13497**	Reliability	Zeeland	Maintain	(13497) ZGS - Phase 2 Gas Turbine Advanced gas path replacement and axial fuel staging	Capital	U21870-ST-CE-0004_0027	Scheduled Major Inspection outages in 2025 for Phase 1 turbines provide a strategic opportunity for substantial improvements through the implementation of Advanced Gas Path (AGP) and Axial Fuel Staging (AFS) technologies. These upgrades aim to boost turbine performance, efficiency, and operational flexibility, aligning with the shift towards a more renewable-centric energy mix.
PP-00562	**PP-00562**	Regulatory	Zeeland	Comply	PP-00562: ZGS - ABB DCS Evergreen	Capital	U21870-MNSC-CE-0072_0005 U21870-MNSC-CE-0072_0006	The Distributed Control System (DCS) must be upgraded at a four to five year upgrade cycle to maintain reliable control and recent operating systems and applications that are patchable. Vendor life cycle for DCS versions is generally a five year cycle. After 5 years they enter a retired state and are no longer patched. Microsoft Operating Systems (O/S) are on a limited life basis and they reach the end of "extended support" and no longer get security patches. Corporate policies require all systems to be patched regularly along with Anti-Virus updates.

base outage

JGS

Year	Investment
2018	$437,047.00
2019	$480,062.00
2020	$596,042.00
2021	$477,497.00
2022	$685,888.00
2023	$983,951.00
2024	$738,974.00
Average	$628,494.43

ZGS

Year	Investment
2018	$2,421,434.00
2019	$341,144.00
2020	$796,316.00
2021	$260,129.00
2022	$522,636.00
2023	$547,912.00
2024	$849,528.00
Average	$819,871.29

CGS

Year	Investment
2023	$789,000.00
2024	$197,942.00
Average	$493,471.00

small capital

JGS

Year	Investment
2020	$289,768.00
2021	$487,796.00
2022	$391,377.00
2023	$637,369.00
2024	$672,338.00
Average	$495,729.60

ZGS

Year	Investment
2020	$194,543.00
2021	$191,168.00
2022	$189,994.00
2023	$136,035.00
2024	$426,391.00
Average	$227,626.20

CGS

Year	Investment
2023	$180,071.00
2024	$666,325.00
Average	$423,198.00

Concept Approval

Jackson Generating Station Variable inlet guide vain upgrade

Date: 10/17/2024

Prepared by: Paul Ohep

Figure 1. Jackson Generating Station.

Executive Summary

The Jackson Generating Station Variable Inlet Guide Vane (VIGV) upgrade project is designed to enhance the efficiency, reliability, and operational performance of six LM6000PC gas turbines. The current fixed Inlet Guide Vanes (IGVs) limit the station's ability to optimize airflow based on varying load conditions, resulting in reduced fuel efficiency, limited power output, and an increased risk of engine stalls. By upgrading to a variable system, the project will enable the turbines to operate more efficiently across a wider range of loads, significantly improving both base load performance and overall station reliability.

Key Drivers for the Upgrade:

- **Shift from Duct Firing to Base Load**: The VIGV upgrade allows for a shift of **12 MW** from duct-fired generation to base load generation plus an increase in exhaust energy resulting in 15MW steam load for an overall base load increase of 27 MW, improving the plant's fuel efficiency and reducing reliance on less efficient duct burners. After the upgrade, the maximum output of the plant will remain **560 MWn**, but the power generation will shift from duct firing to more efficient base load capacity.
- **Improved Fuel Efficiency**: The upgrade is projected to reduce the heat rate by **189 Btu/kWh** during base load operation and 286 Btu/kWh at full duct firing operation, leading to a **2% fuel efficiency improvement at 70% power**. This translates to substantial fuel cost savings and enhanced performance across the plant's operational range.
- **Enhanced Reliability**: The VIGV system will increase the stall margin, reducing the risk of catastrophic engine stalls. This improvement in reliability will minimize the likelihood of unplanned outages and costly repairs, enhancing the station's long-term operational stability.

Economic Impact:

The financial analysis projects a **Net Present Value (NPV) of $29.609 million** in total benefits from the VIGV upgrade. This value is derived from fuel savings, increased base load generation, reduced reliance on duct firing, and the avoidance of potential repair costs due to engine stalls.

Key economic factors include:

- **Fuel Savings**: The reduction in heat rate will lead to significant cost savings in fuel consumption over the lifespan of the turbines.
- **Avoided Repair Costs**: By reducing the risk of engine stalls, the station could avoid up to **$12 million** in repair costs over the next 15 years.

Project Scope and Timeline:

- **Turbine Coverage**: The VIGV system will be installed on six LM6000PC gas turbines and completed on a spare turbine.
- **Implementation Schedule**: The installation is scheduled to occur between 2026 and 2029, aligning with planned maintenance intervals to minimize operational disruption.

Rate Case status:

This Project is included in the 2024 electric rate case.

Financial Summary

Funding Type:	Capital
Estimated Total Cost:	$3,704,350

Proposed Start Implementation Year

First year spend: 2024

Installation year: 2025-2029

Project Span Whole Years

6 Years

Problem Description

The gas turbines at Jackson Generating Station currently use fixed Inlet Guide Vanes (IGVs) that limit their ability to adapt to varying operating conditions. This results in suboptimal performance, reduced efficiency, and increased risks to turbine reliability. The following are the key challenges associated with the current system:

- **Inefficiency of Fixed IGVs**: The fixed angle of the IGVs restricts airflow modulation, preventing the turbines from operating at peak efficiency across different ambient conditions and power settings. This leads to inefficient fuel use, particularly at part load, which is common in load-following operations at Jackson Generating Station.
- **Fuel Consumption and Heat Rate**: Due to the inability of the current system to adjust for optimal airflow, the heat rate of the turbines is higher than necessary, which increases fuel consumption. The inefficiency becomes more pronounced during partial load conditions, where fuel savings are critical for economic operation.
- **Increased Risk of Engine Stall**: Without dynamic control of the IGV angles, the turbines are more susceptible to engine stalls during rapid power reductions or operational fluctuations. An engine stall can cause significant damage to the turbines, resulting in costly repairs and extended downtime.
- **Dependence on Duct Firing**: To meet power demands, the station relies on duct firing, which is less efficient, consumes more fuel, and places additional stress on the system. This dependency results in higher operational costs and increased emissions.

Project Objective

To address these issues, the Jackson LM1-6 Variable Inlet Guide Vane (VIGV) upgrade will replace the fixed IGVs with a variable system, enabling dynamic airflow modulation. This upgrade will:

- **Increase Base Load Output**: The VIGV system will enhance the base load capacity of the gas turbines by 12 MW and contribute to a total site-wide increase of 27 MW when combined with steam turbine improvements. This increase will reduce the reliance on inefficient duct firing.
- **Improve Fuel Efficiency**: The upgrade will improve the baseload heat rate by approximately 189 Btu/kWh (without duct firing) and 286 Btu/kWh (with duct firing).
- **Enhance Stall Margin**: By allowing better airflow control, the VIGV system will improve the stall margin, reducing the risk of turbine failure during rapid load changes and ensuring more reliable operation.

This project is critical for improving the overall performance and efficiency of the turbines, reducing operational costs, and minimizing the risk of unplanned outages due to engine stalls.

Alternative Solutions/Alternatives Considered

1. Do Nothing – Cost: $29.6 million ($29.6M of unrealized value to our customers)

In the "Do Nothing" scenario, Jackson Generating Station would continue to operate with its current fixed Inlet Guide Vane (IGV) system, foregoing the implementation of the Variable Inlet Guide Vane (VIGV) upgrade on the six LM6000PC gas turbines. The consequence of not upgrading the IGV system is the loss of significant operational improvements that would otherwise be realized in efficiency, power output, and reliability. Below is a detailed analysis of the impacts and missed opportunities if the VIGV upgrade is not implemented:

Missed Incremental Power Output

- **Shift from Duct Firing to Base Load**: Without the VIGV upgrade, the station will miss the opportunity to shift **12 MW of capacity** from duct firing to base load generation. The VIGV upgrade does not increase the overall maximum output of the plant but redistributes capacity more efficiently. Currently, with duct burners on, the station reaches a peak output of **546.57 MWn**. With the VIGV upgrade, the plant would be capable of **560 MWn** under the same duct burner conditions, while limiting output to the interconnect constraint during cooler weather by reducing duct burner flow.
- **Improved Base Load Efficiency**: The expected gain of **13.4 MW in base load** would be realized without relying on duct firing, thus increasing the efficiency of base generation. This means that the station would achieve the same overall power output but with a shift of capacity from less efficient duct-fired generation to more efficient base load operation. Without the upgrade, the station will remain dependent on duct firing to achieve higher outputs, losing out on this improved operational profile.

Fuel Efficiency Improvement Missed

- **No Heat Rate Reduction**: Without the upgrade, the station will continue to operate with a heat rate of **8,004 Btu/kWh (LHV)** for each LM6000PC turbine during base load operations. The VIGV upgrade would have reduced this heat rate to **7,958 Btu/kWh (LHV)**, leading to more efficient fuel usage and cost savings.

The following table summarizes the increase in generation and heat rate impacts with and without VIGV:

VIGV	Duct Burner	LM6000 kWg	GT HR LHV Btu/kWh	MWn	NUHR Btu/kWh	∆MW	∆NUHR Btu/kWh
No	Yes	47,321	8,004	546.57	8,928		
Yes	Yes	49,958	7,974	560.00	8,642	13.43	286
No	No	47,321	8,004	427.45	7,951		
Yes	No	50,063	7,958	454.71	7,761	27.26	189

By not upgrading, the plant misses a significant MW improvement in output at lower heat rates without duct burners, and a considerable heat rate improvement of **189 Btu/kWh** across the entire load range. This represents a significant loss in fuel savings and operational efficiency over time.

Increased Risk of Engine Stalls and Repair Costs

- **Stall Risk**: The existing fixed IGV system increases the risk of engine stalls, particularly during rapid load reductions. An engine stall is a critical failure that can lead to catastrophic damage, requiring costly repairs. The estimated cost of an engine stall repair is up to **$4 million per turbine**, with an average stall probability of **one occurrence every five years**. Over the next 15 years, this could result in up to **$12 million** in repair costs that could have been mitigated by the VIGV system.

Economic Losses

The total economic impact of not implementing the VIGV upgrade can be summarized as follows:

- **Value Loss**: The total projected value of the VIGV upgrade, including improved heat rates, increased base load capacity, and reduced reliance on duct firing, has been calculated at **$29.609 million**. By not proceeding with the upgrade, this value will be lost.

Below is a summary of the results from the Aurora economic model used to calculate the economic impact of this upgrade until 2040:

Net Present Value Results	VIGV
Current Nameplate Capacity (MW)	547
Incremental Energy, NPV(K$)	$26,781
Incremental Operating Costs, NPV (K$)	$7,921
Investment Cost, NPV (K$)	($5,093)
Total Value of VIGV Upgrade (K$)	**$29,609**

Table 1. Summary of Aurora model results listing economic impacts of the VIGV upgrade.

By not implementing the VIGV upgrade, Jackson Generating Station will forfeit key operational improvements, including enhanced efficiency, greater base load capacity, and reduced maintenance risks. This "Do Nothing" scenario results in higher operational costs, increased reliance on less efficient duct firing, and greater exposure to potential repair costs from engine stalls.

2. Upgrade gas turbines to Variable inlet guide vane systems -$3.7 Million

Following the analysis of the "Do Nothing" scenario, it is recommended to proceed with the installation of the Variable Inlet Guide Vane (VIGV) system on the six LM6000PC gas turbines at Jackson Generating Station. This upgrade offers clear operational benefits by enabling a shift in capacity from duct firing to base load generation, improving overall efficiency, and reducing operational costs. Below is a picture of the VIGV assembly.

Variable Inlet Guide Vanes Assembly

Scope of the Upgrade:

- **Turbine Coverage**: The VIGV system will be installed on six LM6000PC gas turbines (S/Ns: 191306, 191307, 191312, 191339, 191345, 191351) and completed on the spare engine (S/N: 185132).
- **Installation Schedule**: The work will be scheduled during the turbines' planned maintenance intervals between 2026 and 2029, ensuring minimal impact on normal operations.

Key Benefits of the Upgrade:

- **Capacity Shift**: The primary benefit of the VIGV upgrade is the shift of **13.4 MW** from duct-fired capacity to base load generation. This does not increase the total site output but redistributes capacity more efficiently, improving the station's ability to generate power without relying on duct burners. After the upgrade, the maximum output will remain **560 MWn**, but with reduced dependence on less efficient duct burners.
- **Efficiency Gains**: The upgrade will result in a **189 Btu/kWh heat rate reduction** during base load operations, leading to significant fuel savings.
- **Increased Reliability**: The upgrade will also mitigate the risk of engine stalls by improving the stall margin, thereby reducing the likelihood of costly repairs and unplanned outages. This provides operational stability and long-term cost savings.

Economic Justification:

The economic value of the upgrade has been assessed at **$29.609 million**, considering the efficiency gains, improved base load performance, and avoided repair costs. These benefits will result in long-term fuel savings, enhanced revenue from optimized power generation, and reduced maintenance expenses.

For a full breakdown of the economic analysis, please refer to the preceding section.

Conclusion:

Implementing the VIGV upgrade is the most effective option to enhance the efficiency and reliability of Jackson Generating Station. It optimizes the station's capacity by shifting power generation from duct firing to base load, while reducing operational costs and increasing reliability. The upgrade ensures that the station can meet its future energy needs with improved efficiency and reduced risk of costly repairs.

Funding and Timing

- No funding has been previously committed for this project.
- No outage is required for this project.
- Desired implementation year: First year spend 2024, 2029 final install and spend year.
- Impact if the recommended implementation year is changed:

  If the recommended implementation years for the VIGV upgrade are changed, the project would face several potential negative impacts. Delaying the upgrade could result in missing planned maintenance intervals, leading to increased costs for additional engine swaps outside of these windows. Additionally, the station would continue to operate with less efficiency and higher fuel consumption during the delay, losing out on the projected fuel savings and incremental power gains. Furthermore, the risk of engine stalls would remain elevated, increasing the likelihood of costly unplanned repairs during the extended period without the upgrade.

System Engineer

- System Engineer: Joseph Brooks

Conceptual Estimate

Year	Loaded Cost	Description
2024	**$120,900**	Request for Purchase work, Engineering work, Initial PO creation, Computer hardware & configuration, software design work.
2025	**$970,840**	Milestone payment, Engineering work.
2026	**$1,046,370**	Installation of VIGV upgrade on first two engines 185132, 191307
2027	**$1,107,600**	Installation of VIGV upgrade on next two engines 191345, 191312
2028	**$305,760**	Installation of VIGV upgrade on next two engines 191351, 191306
2029	**$152,880**	Installation of VIGV upgrade on final engine 191339, closeout

Total Cost: $3,704,350

Asset Strategy Approval Comments

The Asset Strategy Group strongly recommends approval based on economic analysis.

Approvals

Title	Approver Name	Date
Generation Planning Manager		
Director of Generation Asset Strategy		
Exec Director of Electric Supply Engineering		
VP of Electric Supply		

Month starts with 24 because benefits start 24

Discount rate (yearly) - update this	7.500%
Discount rate (monthly) - auto-updated	0.006044919

Period (i)

Month (update this with the periods)	24	25	26	27	28	29	30	31	32	33	34	35
Raw (update this with inflated values)	104040	104040	104040	104040	104040	104040	104040	104040	104040	104040	104040	104040
Discounted	90029.205	89488.256	88950.557	88416.089	87884.832	87356.767	86831.876	86310.138	85791.535	85276.048	84763.659	84254.348
Date	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27

Month (update this with the periods)	36	37	38	39	40	41	42	43	44	45	46	47
Raw (update this with inflated values)	106120.8	106120.8	106120.8	106120.8	106120.8	106120.8	106120.8	106120.8	106120.8	106120.8	106120.8	106120.8
Discounted	85423.06	84909.787	84399.598	83892.475	83388.399	82887.351	82389.315	81894.27	81402.201	80913.088	80426.913	79943.661
Date	Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28

Month (update this with the periods)	48	49	50	51	52	53	54	55	56	57	58	59
Raw (update this with inflated values)	108243.22	108243.22	108243.22	108243.22	108243.22	108243.22	108243.22	108243.22	108243.22	108243.22	108243.22	108243.22
Discounted	81052.577	80565.565	80081.479	79600.302	79122.016	78646.603	78174.047	77704.331	77237.437	76773.348	76312.048	75853.52
Date	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29

Month (update this with the periods)	60	61	62	63	64	65	66	67	68	69	70	71
Raw (update this with inflated values)	110408	110408	110408	110408	110408	110408	110408	110408	110408	110408	110408	110408
Discounted	76906	76444	75984	75528	75074	74623	74174	73729	73286	72845	72408	71973
Date	Jan-30	Feb-30	Mar-30	Apr-30	May-30	Jun-30	Jul-30	Aug-30	Sep-30	Oct-30	Nov-30	Dec-30

Month (update this with the periods)	72	73	74	75	76	77	78	79	80	81	82	83
Raw (update this with inflated values)	112616	112616	112616	112616	112616	112616	112616	112616	112616	112616	112616	112616
Discounted	72971	72533	72097	71664	71233	70805	70379	69957	69536	69118	68703	68290
Date	Jan-31	Feb-31	Mar-31	Apr-31	May-31	Jun-31	Jul-31	Aug-31	Sep-31	Oct-31	Nov-31	Dec-31

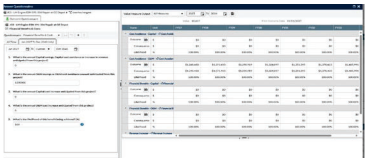
Month (update this with the periods)	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
Raw (update this with inflated values)	114869	114869	114869	114869	114869	114869	114869	114869	114869	114869	114869	114869	117166	117166	117166
Discounted	69238	68822	68408	67997	67588	67182	66779	66377	65979	65582	65188	64796	65695	65300	64908
Date	Jan-32	Feb-32	Mar-32	Apr-32	May-32	Jun-32	Jul-32	Aug-32	Sep-32	Oct-32	Nov-32	Dec-32	Jan-33	Feb-33	Mar-33

Starting from Jan 2025 as '0' $ 10,637,168.61 <-- simulates the Copperleaf calculation

the NPV function in Excel treats the first cashflow amount as month '1', meaning that it discounts it when it shouldn't, but Copperleaf treats the first cashflow as month '0', which creates a different output between them

	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40
Yearly outcome or benefit from Copperleaf	1248480	1273449.6	1298918.6	1324897	1351394.9	1378422.8	1405991.3	1434111.1	1462793.3	1492049.2	1521890.2	1552328	1583374.5	1615042

rationale or assumptions for the numbers provided.
avoid leasing costs for spare. 100% chance of realizing this risk if the project isn't executed.



99	100	101	102	103	104	105	106	107	108	109	110
117166	117166	117166	117166	117166	117166	117166	117166	117166	119509	119509	119509
64518	64130	63745	63362	62981	62603	62227	61853	61481	62334	61960	61587
Apr-33	May-33	Jun-33	Jul-33	Aug-33	Sep-33	Oct-33	Nov-33	Dec-33	Jan-34	Feb-34	Mar-34

111	112	113	114	115	116	117	118	119	120	121	122
119509	119509	119509	119509	119509	119509	119509	119509	119509	121899	121899	121899
61217	60849	60484	60120	59759	59400	59043	58688	58336	59145	58789	58436
Apr-34	May-34	Jun-34	Jul-34	Aug-34	Sep-34	Oct-34	Nov-34	Dec-34	Jan-35	Feb-35	Mar-35

123	124	125	126	127	128	129	130	131	132	133	134
121899	121899	121899	121899	121899	121899	121899	121899	121899	124337	124337	124337
58085	57736	57389	57044	56702	56361	56022	55686	55351	56119	55782	55446
Apr-35	May-35	Jun-35	Jul-35	Aug-35	Sep-35	Oct-35	Nov-35	Dec-35	Jan-36	Feb-36	Mar-36

135	136	137	138	139	140	141	142	143	144	145	146
124337	124337	124337	124337	124337	124337	124337	124337	124337	126824	126824	126824
55113	54782	54453	54126	53801	53477	53156	52837	52519	53248	52928	52610
Apr-36	May-36	Jun-36	Jul-36	Aug-36	Sep-36	Oct-36	Nov-36	Dec-36	Jan-37	Feb-37	Mar-37

147	148	149	150	151	152	153	154	155	156	157	158
126824	126824	126824	126824	126824	126824	126824	126824	126824	129361	129361	129361
52294	51979	51667	51357	51048	50741	50436	50133	49832	50523	50220	49918
Apr-37	May-37	Jun-37	Jul-37	Aug-37	Sep-37	Oct-37	Nov-37	Dec-37	Jan-38	Feb-38	Mar-38

159	160	161	162	163	164	165	166	167	168	169	170
129361	129361	129361	129361	129361	129361	129361	129361	129361	131948	131948	131948
49618	49320	49024	48729	48436	48145	47856	47568	47283	47938	47650	47364
Apr-38	May-38	Jun-38	Jul-38	Aug-38	Sep-38	Oct-38	Nov-38	Dec-38	Jan-39	Feb-39	Mar-39

171	172	173	174	175	176	177	178	179	180	181	182
131948	131948	131948	131948	131948	131948	131948	131948	131948	134587	134587	134587
47079	46797	46515	46236	45958	45682	45407	45135	44863	45486	45212	44941
Apr-39	May-39	Jun-39	Jul-39	Aug-39	Sep-39	Oct-39	Nov-39	Dec-39	Jan-40	Feb-40	Mar-40

183	184	185	186	187	188	189	190	191
134587	134587	134587	134587	134587	134587	134587	134587	134587
44671	44402	44136	43870	43607	43345	43084	42825	42568
Apr-40	May-40	Jun-40	Jul-40	Aug-40	Sep-40	Oct-40	Nov-40	Dec-40

Month starts with 24 because benefits start 24

Discount rate (yearly) - update this	7.500%
Discount rate (monthly) - auto-updated	0.006044919

Period (i)

Month (update this with the periods)	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Raw (update this with inflated values)	6227.5105	6227.5105	6227.5105	6227.5105	6227.5105	6227.5105	6227.5105	6227.5105	6227.5105	6227.5105	6227.5105	6227.5105	5979.057	5979.057	5979.057
Discounted	5388.8679	5356.4884	5324.3034	5292.3118	5260.5124	5228.9041	5197.4857	5166.2561	5135.2142	5104.3588	5073.6887	5043.203	4812.9051	4783.9863	4755.2412
Date	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27	Jan-28	Feb-28	Mar-28

Month (update this with the periods)	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
Raw (update this with inflated values)	5979.057	5979.057	5979.057	5979.057	5979.057	5979.057	5979.057	5979.057	5979.057	5919.1595	5919.1595	5919.1595	5919.1595	5919.1595	5919.1595
Discounted	4726.6689	4698.2683	4670.0383	4641.9779	4614.0861	4586.3619	4558.8043	4531.4123	4504.1849	4432.2698	4405.6381	4379.1664	4352.8537	4326.6992	4300.7018
Date	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28	Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29

Month (update this with the periods)	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
Raw (update this with inflated values)	5919.1595	5919.1595	5919.1595	5919.1595	5919.1595	5919.1595	6585.7	6585.7	6585.7	6585.7	6585.7	6585.7	6585.7	6585.7	6585.7
Discounted	4274.8606	4249.1747	4223.6431	4198.2649	4173.0392	4147.9651	4587.3	4559.8	4532.4	4505.1	4478.1	4451.2	4424.4	4397.8	4371.4
Date	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29	Jan-30	Feb-30	Mar-30	Apr-30	May-30	Jun-30	Jul-30	Aug-30	Sep-30

Month (update this with the periods)	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
Raw (update this with inflated values)	6585.7	6585.7	6585.7	6717.4	6717.4	6717.4	6717.4	6717.4	6717.4	6717.4	6717.4	6717.4	6717.4	6717.4	6717.4
Discounted	4345.1	4319	4293.1	4352.6	4326.5	4300.5	4274.6	4249	4223.4	4198.1	4172.8	4147.8	4122.8	4098.1	4073.4
Date	Oct-30	Nov-30	Dec-30	Jan-31	Feb-31	Mar-31	Apr-31	May-31	Jun-31	Jul-31	Aug-31	Sep-31	Oct-31	Nov-31	Dec-31

Month (update this with the periods)	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
Raw (update this with inflated values)	6851.8	6851.8	6851.8	6851.8	6851.8	6851.8	6851.8	6851.8	6851.8	6851.8	6851.8	6851.8	6988.8	6988.8	6988.8
Discounted	4129.9	4105.1	4080.5	4055.9	4031.6	4007.4	3983.3	3959.3	3935.5	3911.9	3888.4	3865	3918.6	3895.1	3871.7
Date	Jan-32	Feb-32	Mar-32	Apr-32	May-32	Jun-32	Jul-32	Aug-32	Sep-32	Oct-32	Nov-32	Dec-32	Jan-33	Feb-33	Mar-33

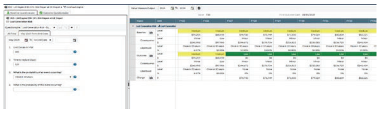
Starting from Jan 2025 as '0' $ 740,585.23 <-- simulates the Copperleaf calculation

the NPV function in Excel treats the first cashflow amount as month '1', meaning that it discounts it when it shouldn't, but Copperleaf treats the first cashflow as month '0', which creates a different output between them

	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48
Yearly outcome or benefit from Copperleaf	74730.126	71748.684	71029.914	79028.633	80609.206	82221.39	83865.818	85543.134	87253.997	88999.077	90779.058	92594.639	94446.532	28290.815	28856.631	29433.764	30022.439	30622.888	31235.346	31860.053	32497.254	33147.199

	FY49	FY50	FY51	FY52	FY53	FY54	FY55	FY56	FY57	FY58	FY59	FY60	FY61	FY62	FY63	FY64	FY65	FY66	FY67	FY68	FY69	FY70
Yearly outcome or benefit from Copperleaf	33810.143	34486.346	35176.073	35879.594	36597.186	37329.13	38075.712	38837.227	39613.971	40406.25	41214.375	42038.663	42879.436	43737.025	44612	45504	46414	47342	48289	49255	50240	51245

rationale or assumptions for the numbers provided.
10% chance that leased engine is recalled and we have no way of operating unit.



99	100	101	102	103	104	105	106	107	108	109	110	111	112
6988.8	6988.8	6988.8	6988.8	6988.8	6988.8	6988.8	6988.8	6988.8	7128.6	7128.6	7128.6	7128.6	7128.6
3848.4	3825.3	3802.3	3779.5	3756.8	3734.2	3711.8	3689.5	3667.3	3718.2	3695.8	3673.6	3651.5	3629.6
Apr-33	May-33	Jun-33	Jul-33	Aug-33	Sep-33	Oct-33	Nov-33	Dec-33	Jan-34	Feb-34	Mar-34	Apr-34	May-34

113	114	115	116	117	118	119	120	121	122	123	124	125	126
7128.6	7128.6	7128.6	7128.6	7128.6	7128.6	7128.6	7271.2	7271.2	7271.2	7271.2	7271.2	7271.2	7271.2
3607.8	3586.1	3564.6	3543.1	3521.9	3500.7	3479.7	3527.9	3506.7	3485.7	3464.7	3443.9	3423.2	3402.6
Jun-34	Jul-34	Aug-34	Sep-34	Oct-34	Nov-34	Dec-34	Jan-35	Feb-35	Mar-35	Apr-35	May-35	Jun-35	Jul-35

127	128	129	130	131	132	133	134	135	136	137	138	139	140
7271.2	7271.2	7271.2	7271.2	7271.2	7416.6	7416.6	7416.6	7416.6	7416.6	7416.6	7416.6	7416.6	7416.6
3382.2	3361.9	3341.7	3321.6	3301.6	3347.4	3327.3	3307.3	3287.4	3267.7	3248.1	3228.5	3209.1	3189.9
Aug-35	Sep-35	Oct-35	Nov-35	Dec-35	Jan-36	Feb-36	Mar-36	Apr-36	May-36	Jun-36	Jul-36	Aug-36	Sep-36

141	142	143	144	145	146	147	148	149	150	151	152	153	154
7416.6	7416.6	7416.6	7564.9	7564.9	7564.9	7564.9	7564.9	7564.9	7564.9	7564.9	7564.9	7564.9	7564.9
3170.7	3151.6	3132.7	3176.2	3157.1	3138.1	3119.3	3100.5	3081.9	3063.4	3045	3026.7	3008.5	2990.4
Oct-36	Nov-36	Dec-36	Jan-37	Feb-37	Mar-37	Apr-37	May-37	Jun-37	Jul-37	Aug-37	Sep-37	Oct-37	Nov-37

155	156	157	158	159	160	161	162	163	164	165	166	167	168
7564.9	7716.2	7716.2	7716.2	7716.2	7716.2	7716.2	7716.2	7716.2	7716.2	7716.2	7716.2	7716.2	7870.5
2972.4	3013.7	2995.6	2977.6	2959.7	2941.9	2924.2	2906.6	2889.2	2871.8	2854.6	2837.4	2820.4	2859.5
Dec-37	Jan-38	Feb-38	Mar-38	Apr-38	May-38	Jun-38	Jul-38	Aug-38	Sep-38	Oct-38	Nov-38	Dec-38	Jan-39

169	170	171	172	173	174	175	176	177	178	179	180	181	182
7870.5	7870.5	7870.5	7870.5	7870.5	7870.5	7870.5	7870.5	7870.5	7870.5	7870.5	2357.6	2357.6	2357.6
2842.3	2825.2	2808.2	2791.4	2774.6	2757.9	2741.4	2724.9	2708.5	2692.2	2676.1	796.78	791.99	787.23
Feb-39	Mar-39	Apr-39	May-39	Jun-39	Jul-39	Aug-39	Sep-39	Oct-39	Nov-39	Dec-39	Jan-40	Feb-40	Mar-40

183	184	185	186	187	188	189	190	191	192	193	194	195	196
2357.6	2357.6	2357.6	2357.6	2357.6	2357.6	2357.6	2357.6	2357.6	2404.7	2404.7	2404.7	2404.7	2404.7
782.5	777.8	773.13	768.48	763.86	759.27	754.71	750.18	745.67	756.01	751.47	746.95	742.47	738.01
Apr-40	May-40	Jun-40	Jul-40	Aug-40	Sep-40	Oct-40	Nov-40	Dec-40	Jan-41	Feb-41	Mar-41	Apr-41	May-41

197	198	199	200	201	202	203	204	205	206	207	208	209	210
2404.7	2404.7	2404.7	2404.7	2404.7	2404.7	2404.7	2452.8	2452.8	2452.8	2452.8	2452.8	2452.8	2452.8
733.57	729.16	724.78	720.43	716.1	711.8	707.52	717.33	713.02	708.74	704.48	700.25	696.04	691.86
Jun-41	Jul-41	Aug-41	Sep-41	Oct-41	Nov-41	Dec-41	Jan-42	Feb-42	Mar-42	Apr-42	May-42	Jun-42	Jul-42

211	212	213	214	215	216	217	218	219	220	221	222	223	224
2452.8	2452.8	2452.8	2452.8	2452.8	2501.9	2501.9	2501.9	2501.9	2501.9	2501.9	2501.9	2501.9	2501.9
687.7	683.57	679.46	675.38	671.32	680.63	676.54	672.48	668.44	664.42	660.43	656.46	652.52	648.59
Aug-42	Sep-42	Oct-42	Nov-42	Dec-42	Jan-43	Feb-43	Mar-43	Apr-43	May-43	Jun-43	Jul-43	Aug-43	Sep-43

225	226	227	228	229	230	231	232	233	234	235	236	237	238
2501.9	2501.9	2501.9	2551.9	2551.9	2551.9	2551.9	2551.9	2551.9	2551.9	2551.9	2551.9	2551.9	2551.9
644.7	640.82	636.97	645.81	641.93	638.07	634.24	630.43	626.64	622.87	619.13	615.41	611.71	608.04
Oct-43	Nov-43	Dec-43	Jan-44	Feb-44	Mar-44	Apr-44	May-44	Jun-44	Jul-44	Aug-44	Sep-44	Oct-44	Nov-44

239	240	241	242	243	244	245	246	247	248	249	250	251	252
2551.9	2602.9	2602.9	2602.9	2602.9	2602.9	2602.9	2602.9	2602.9	2602.9	2602.9	2602.9	2602.9	2655
604.38	612.77	609.09	605.43	601.79	598.17	594.58	591.01	587.45	583.92	580.42	576.93	573.46	581.42
Dec-44	Jan-45	Feb-45	Mar-45	Apr-45	May-45	Jun-45	Jul-45	Aug-45	Sep-45	Oct-45	Nov-45	Dec-45	Jan-46

253	254	255	256	257	258	259	260	261	262	263	264	265	266
2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2655	2708.1	2708.1	2708.1
577.92	574.45	571	567.57	564.16	560.77	557.4	554.05	550.72	547.41	544.12	551.67	548.36	545.06
Feb-46	Mar-46	Apr-46	May-46	Jun-46	Jul-46	Aug-46	Sep-46	Oct-46	Nov-46	Dec-46	Jan-47	Feb-47	Mar-47

267	268	269	270	271	272	273	274	275	276	277	278	279	280
2708.1	2708.1	2708.1	2708.1	2708.1	2708.1	2708.1	2708.1	2708.1	2762.3	2762.3	2762.3	2762.3	2762.3
541.79	538.53	535.29	532.08	528.88	525.7	522.54	519.4	516.28	523.44	520.3	517.17	514.07	510.98
Apr-47	May-47	Jun-47	Jul-47	Aug-47	Sep-47	Oct-47	Nov-47	Dec-47	Jan-48	Feb-48	Mar-48	Apr-48	May-48

281	282	283	284	285	286	287	288	289	290	291	292	293	294
2762.3	2762.3	2762.3	2762.3	2762.3	2762.3	2762.3	2817.5	2817.5	2817.5	2817.5	2817.5	2817.5	2817.5
507.91	504.86	501.82	498.81	495.81	492.83	489.87	496.66	493.68	490.71	487.76	484.83	481.92	479.03
Jun-48	Jul-48	Aug-48	Sep-48	Oct-48	Nov-48	Dec-48	Jan-49	Feb-49	Mar-49	Apr-49	May-49	Jun-49	Jul-49

295	296	297	298	299	300	301	302	303	304	305	306	307	308
2817.5	2817.5	2817.5	2817.5	2817.5	2873.9	2873.9	2873.9	2873.9	2873.9	2873.9	2873.9	2873.9	2873.9
476.15	473.29	470.44	467.62	464.81	471.25	468.42	465.61	462.81	460.03	457.26	454.52	451.79	449.07
Aug-49	Sep-49	Oct-49	Nov-49	Dec-49	Jan-50	Feb-50	Mar-50	Apr-50	May-50	Jun-50	Jul-50	Aug-50	Sep-50

309	310	311	312	313	314	315	316	317	318	319	320	321	322
2873.9	2873.9	2873.9	2931.3	2931.3	2931.3	2931.3	2931.3	2931.3	2931.3	2931.3	2931.3	2931.3	2931.3
446.37	443.69	441.03	447.14	444.46	441.79	439.13	436.49	433.87	431.26	428.67	426.1	423.54	420.99
Oct-50	Nov-50	Dec-50	Jan-51	Feb-51	Mar-51	Apr-51	May-51	Jun-51	Jul-51	Aug-51	Sep-51	Oct-51	Nov-51

323	324	325	326	327	328	329	330	331	332	333	334	335	336
2931.3	2990	2990	2990	2990	2990	2990	2990	2990	2990	2990	2990	2990	3049.8
418.46	424.27	421.72	419.18	416.66	414.16	411.67	409.2	406.74	404.3	401.87	399.45	397.05	402.56
Dec-51	Jan-52	Feb-52	Mar-52	Apr-52	May-52	Jun-52	Jul-52	Aug-52	Sep-52	Oct-52	Nov-52	Dec-52	Jan-53

337	338	339	340	341	342	343	344	345	346	347	348	349	350
3049.8	3049.8	3049.8	3049.8	3049.8	3049.8	3049.8	3049.8	3049.8	3049.8	3049.8	3110.8	3110.8	3110.8
400.14	397.74	395.35	392.97	390.61	388.26	385.93	383.61	381.31	379.01	376.74	381.96	379.67	377.39
Feb-53	Mar-53	Apr-53	May-53	Jun-53	Jul-53	Aug-53	Sep-53	Oct-53	Nov-53	Dec-53	Jan-54	Feb-54	Mar-54

351	352	353	354	355	356	357	358	359	360	361	362	363	364
3110.8	3110.8	3110.8	3110.8	3110.8	3110.8	3110.8	3110.8	3110.8	3173	3173	3173	3173	3173
375.12	372.87	370.62	368.4	366.18	363.98	361.8	359.62	357.46	362.42	360.24	358.08	355.93	353.79
Apr-54	May-54	Jun-54	Jul-54	Aug-54	Sep-54	Oct-54	Nov-54	Dec-54	Jan-55	Feb-55	Mar-55	Apr-55	May-55

365	366	367	368	369	370	371	372	373	374	375	376	377	378
3173	3173	3173	3173	3173	3173	3173	3236.4	3236.4	3236.4	3236.4	3236.4	3236.4	3236.4
351.66	349.55	347.45	345.36	343.29	341.22	339.17	343.88	341.81	339.76	337.72	335.69	333.67	331.67
Jun-55	Jul-55	Aug-55	Sep-55	Oct-55	Nov-55	Dec-55	Jan-56	Feb-56	Mar-56	Apr-56	May-56	Jun-56	Jul-56

379	380	381	382	383	384	385	386	387	388	389	390	391	392
3236.4	3236.4	3236.4	3236.4	3236.4	3301.2	3301.2	3301.2	3301.2	3301.2	3301.2	3301.2	3301.2	3301.2
329.67	327.69	325.72	323.77	321.82	326.28	324.32	322.38	320.44	318.51	316.6	314.7	312.81	310.93
Aug-56	Sep-56	Oct-56	Nov-56	Dec-56	Jan-57	Feb-57	Mar-57	Apr-57	May-57	Jun-57	Jul-57	Aug-57	Sep-57

393	3301.2	309.06	Oct-57
394	3301.2	307.2	Nov-57
395	3301.2	305.36	Dec-57
396	3367.2	309.59	Jan-58
397	3367.2	307.73	Feb-58
398	3367.2	305.88	Mar-58
399	3367.2	304.04	Apr-58
400	3367.2	302.22	May-58
401	3367.2	300.4	Jun-58
402	3367.2	298.6	Jul-58
403	3367.2	296.8	Aug-58
404	3367.2	295.02	Sep-58
405	3367.2	293.25	Oct-58
406	3367.2	291.48	Nov-58
407	3367.2	289.73	Dec-58
408	3434.5	293.75	Jan-59
409	3434.5	291.99	Feb-59
410	3434.5	290.23	Mar-59
411	3434.5	288.49	Apr-59
412	3434.5	286.75	May-59
413	3434.5	285.03	Jun-59
414	3434.5	283.32	Jul-59
415	3434.5	281.62	Aug-59
416	3434.5	279.92	Sep-59
417	3434.5	278.24	Oct-59
418	3434.5	276.57	Nov-59
419	3434.5	274.91	Dec-59
420	3503.2	278.72	Jan-60
421	3503.2	277.05	Feb-60
422	3503.2	275.38	Mar-60
423	3503.2	273.73	Apr-60
424	3503.2	272.08	May-60
425	3503.2	270.45	Jun-60
426	3503.2	268.82	Jul-60
427	3503.2	267.21	Aug-60
428	3503.2	265.6	Sep-60
429	3503.2	264.01	Oct-60
430	3503.2	262.42	Nov-60
431	3503.2	260.84	Dec-60
432	3573.3	264.46	Jan-61
433	3573.3	262.87	Feb-61
434	3573.3	261.29	Mar-61
435	3573.3	259.72	Apr-61
436	3573.3	258.16	May-61
437	3573.3	256.61	Jun-61
438	3573.3	255.07	Jul-61
439	3573.3	253.54	Aug-61
440	3573.3	252.01	Sep-61
441	3573.3	250.5	Oct-61
442	3573.3	248.99	Nov-61
443	3573.3	247.5	Dec-61
444	3644.8	250.93	Jan-62
445	3644.8	249.42	Feb-62
446	3644.8	247.92	Mar-62
447	3644.8	246.44	Apr-62
448	3644.8	244.95	May-62
449	3644.8	243.48	Jun-62
450	3644.8	242.02	Jul-62
451	3644.8	240.57	Aug-62
452	3644.8	239.12	Sep-62
453	3644.8	237.68	Oct-62
454	3644.8	236.26	Nov-62
455	3644.8	234.84	Dec-62
456	3717.6	238.09	Jan-63
457	3717.6	236.66	Feb-63
458	3717.6	235.24	Mar-63
459	3717.6	233.83	Apr-63
460	3717.6	232.42	May-63
461	3717.6	231.03	Jun-63
462	3717.6	229.64	Jul-63
463	3717.6	228.26	Aug-63
464	3717.6	226.89	Sep-63
465	3717.6	225.52	Oct-63
466	3717.6	224.17	Nov-63
467	3717.6	222.82	Dec-63
468	3792	225.91	Jan-64
469	3792	224.55	Feb-64
470	3792	223.2	Mar-64
471	3792	221.86	Apr-64
472	3792	220.53	May-64
473	3792	219.21	Jun-64
474	3792	217.89	Jul-64
475	3792	216.58	Aug-64
476	3792	215.28	Sep-64
477	3792	213.98	Oct-64
478	3792	212.7	Nov-64
479	3792	211.42	Dec-64
480	3867.8	214.35	Jan-65
481	3867.8	213.07	Feb-65
482	3867.8	211.78	Mar-65
483	3867.8	210.51	Apr-65
484	3867.8	209.25	May-65
485	3867.8	207.99	Jun-65
486	3867.8	206.74	Jul-65
487	3867.8	205.5	Aug-65
488	3867.8	204.26	Sep-65
489	3867.8	203.04	Oct-65
490	3867.8	201.82	Nov-65

491	492	493	494	495	496	497	498	499	500	501	502	503	504	505
3867.8	3945.2	3945.2	3945.2	3945.2	3945.2	3945.2	3945.2	3945.2	3945.2	3945.2	3945.2	3945.2	4024.1	4024.1
200.6	203.39	202.16	200.95	199.74	198.54	197.35	196.16	194.98	193.81	192.65	191.49	190.34	192.98	191.82
Dec-65	Jan-66	Feb-66	Mar-66	Apr-66	May-66	Jun-66	Jul-66	Aug-66	Sep-66	Oct-66	Nov-66	Dec-66	Jan-67	Feb-67

506	507	508	509	510	511	512	513	514	515	516	517	518	519	520
4024.1	4024.1	4024.1	4024.1	4024.1	4024.1	4024.1	4024.1	4024.1	4024.1	4104.6	4104.6	4104.6	4104.6	4104.6
190.67	189.52	188.38	187.25	186.13	185.01	183.9	182.79	181.69	180.6	183.11	182.01	180.91	179.83	178.75
Mar-67	Apr-67	May-67	Jun-67	Jul-67	Aug-67	Sep-67	Oct-67	Nov-67	Dec-67	Jan-68	Feb-68	Mar-68	Apr-68	May-68

521	522	523	524	525	526	527	528	529	530	531	532	533	534	535
4104.6	4104.6	4104.6	4104.6	4104.6	4104.6	4104.6	4186.7	4186.7	4186.7	4186.7	4186.7	4186.7	4186.7	4186.7
177.67	176.6	175.54	174.49	173.44	172.4	171.36	173.74	172.69	171.66	170.63	169.6	168.58	167.57	166.56
Jun-68	Jul-68	Aug-68	Sep-68	Oct-68	Nov-68	Dec-68	Jan-69	Feb-69	Mar-69	Apr-69	May-69	Jun-69	Jul-69	Aug-69

536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551
4186.7	4186.7	4186.7	4186.7	4270.4	4270.4	4270.4	4270.4	4270.4	4270.4	4270.4	4270.4	4270.4	4270.4	4270.4	4270.4
165.56	164.57	163.58	162.59	164.85	163.86	162.87	161.9	160.92	159.96	159	158.04	157.09	156.15	155.21	154.28
Sep-69	Oct-69	Nov-69	Dec-69	Jan-70	Feb-70	Mar-70	Apr-70	May-70	Jun-70	Jul-70	Aug-70	Sep-70	Oct-70	Nov-70	Dec-70

Month starts with 12 because Spending starst 12 months after start of current fiscal year

Discount rate (yearly) - update this	7.500%
Discount rate (monthly) - auto-updated	0.006044919

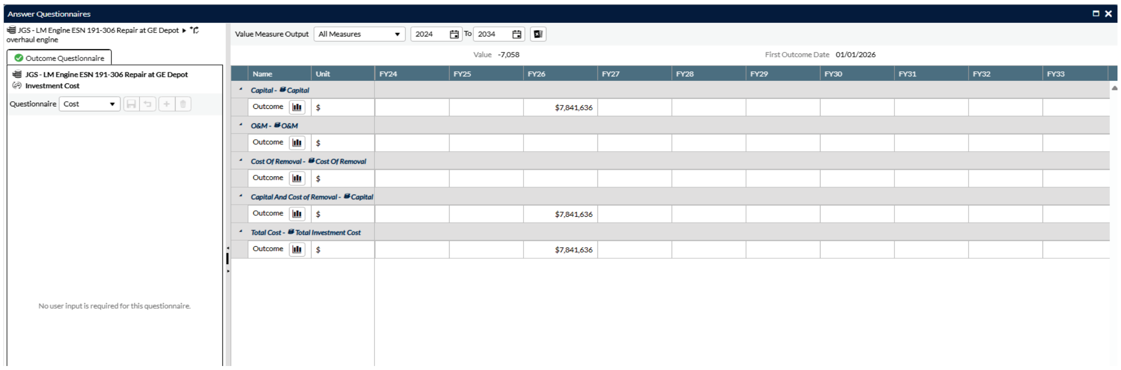
Period (i)

Month (update this with the periods)	12	13	14	15	16	17	18	19	20	21	22	23
Raw (update this with inflated values)	-653469.667	-653469.667	-653469.667	-653469.667	-653469.667	-653469.667	-653469.667	-653469.667	-653469.667	-653469.667	-653469.667	-653469.667
Discounted	-607878.76	-604226.261	-600595.708	-596986.971	-593399.916	-589834.415	-586290.337	-582767.555	-579265.939	-575785.363	-572325.7	-568886.826
Date	Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26

Starting from Jan 2025 as '0' $ (7,058,243.75) <-- simulates the Copperleaf calculation

the NPV function in Excel treats the first cashflow amount as month '1', meaning that it discounts it when it shouldn't, but Copperleaf treats the first cashflow as month '0', which creates a different output between them

	FY26
Total investment cost from Copperleaf	-7841636


Answer Questionnaires

JGS - LM Engine ESN 191-306 Repair at GE Depot ▸ overhaul engine

Outcome Questionnaire

JGS - LM Engine ESN 191-306 Repair at GE Depot
Investment Cost

Questionnaire Cost

No user input is required for this questionnaire.

Value Measure Output All Measures 2024 To 2034

Value -7,058 First Outcome Date 01/01/2026

Name	Unit	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33
Capital - Capital											
Outcome	$			$7,841,636							
O&M - O&M											
Outcome	$										
Cost Of Removal - Cost Of Removal											
Outcome	$										
Capital And Cost of Removal - Capital											
Outcome	$			$7,841,636							
Total Cost - Total Investment Cost											
Outcome	$			$7,841,636							

Investments / JGS - LM Engine ESN 191-306 Repair at GE Depot

Investment Summary

Submit | Initiate Workflow | 4 | Reports | Follow Investment

Overview

JGS - LM Engine ESN 191-306 Repair at GE Depot

Engine ESN 191-306 had a stall event on 02/09/25 while in LM5 package which made it inoperable and later determined to be unserviceable. The engine was removed from its package and a lease engine was installed so the plant could return to full capability. The engine was shipped from JGS to GE Depot (Houston) on 03/03/25.

Owner Cummings, Jeffery (Jeffery.Cummings@cmsenergy.com)

Planning Portfolio Jackson

Stage Initial

Alternatives

Name	Value	Draft Forecast	Spend Date Range
overhaul engine	4,317	$7,841,636	Jan FY26 to Dec FY26

Risks Impacted for overhaul engine

Asset Unique ID	Value Measure	Value Model	Impact Date
	Lost Generation Risk	Lost Generation Risk	01/01/2027

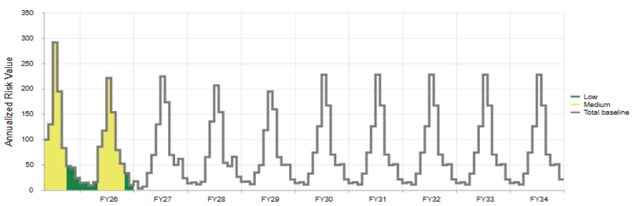
1 | 10 items per page | 1 - 1 of 1 items

Financial Metrics

Metrics	Value
Cost Present Value	$7,058,244
Benefit Present Value	$11,375,002
Net Present Value	$4,316,758
Payback Period	91 months
Internal Rate Of Return	16.14%
Benefit/Cost Ratio	1.61
Value/Cost Ratio	0.61

Annualized Outcome Risks by Risk Level

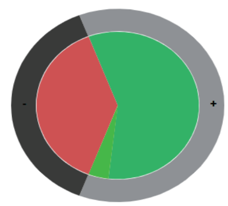
JGS - LM Engine ESN 191-306 Repair at GE Depot



Edit Value for Recommended Alternative

Draft Investment Value

JGS - LM Engine ESN 191-306 Repair at GE Depot



Value Measure	Value	
Cost Avoidance - ...	10,637	
Lost Generation Ri...	738	
Cost Avoidance - C...	0	
Financial Benefits -...	0	
Financial Benefits -...	0	
Revenue Increase	0	
Total Investment C...	-7,058	
Total	**4,317**	

Edit Value for Recommended Alternative

S T A T E O F M I C H I G A N

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of	)	
CONSUMERS ENERGY COMPANY	)	
for authority to increase its rates for	)	Case No. U-21870
the generation and distribution of	)	
electricity and for other relief.	)	
______________________________	)	

PROOF OF SERVICE

STATE OF MICHIGAN)
) SS
COUNTY OF JACKSON)

Melissa K. Harris, being first duly sworn, deposes and says that she is employed in the Legal Department of Consumers Energy Company; that on November 6, 2025, she served an electronic copy of the Redacted Version of **Consumers Energy Company's Supplement to Oral Argument** upon the persons listed in Attachment 1 hereto, at the e-mail addresses listed therein.

Melissa K. Harris

____
Melissa K. Harris

Subscribed and sworn to before me this 6th day of November, 2025.

Crystal L. Chacon

____
Crystal L. Chacon, Notary Public
State of Michigan, County of Eaton
My Commission Expires: 05/25/30
Acting in the County of Jackson

ATTACHMENT 1 TO CASE NO. U-21870

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ATTACHMENT 1 TO CASE NO. U-21870

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