Preliminary Results – Subject to Change

nFRONT CONSULTING LLC
Power Industry Planners • Analysts • Advisors

JEA Electric System Integrated Resource Plan (IRP)

March 21, 2019

Introduction

- Brad Kushner, Executive Consultant, nFront Consulting LLC
  - Prior to nFront, Director of Electric System Resource Planning Services offering for Black & Veatch Management Consulting
  - Provided electric system resource planning services to JEA while with Black & Veatch since early 2000s, including:
    - 2011-2012 JEA Integrated Resource Plan
    - 2004, 2009, 2014, and current Florida Energy Efficiency Conservation Act (“FEECA”)

IRP Process

Establish Process and Assumptions

- Key Assumptions
- Load Forecast / Capacity Requirements
- Fuel Price Projections
- Resource Alternatives Specification
- Scenario / Sensitivity Definition

Modeling and Analysis

- Capacity Expansion and Production Cost Modeling
- Resource Portfolio Development

Reporting

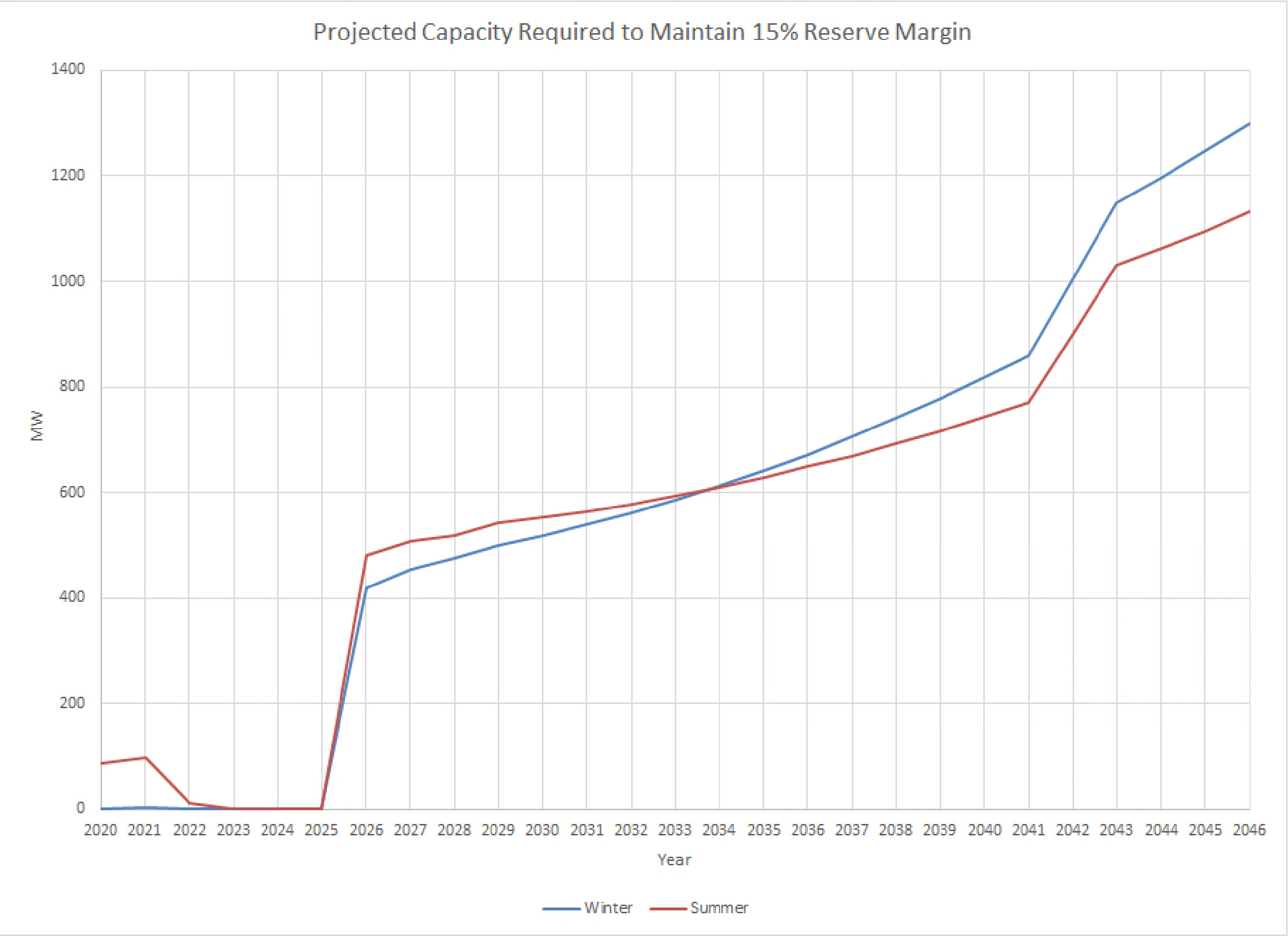
- Presentations
- Final IRP Report

IRP Process

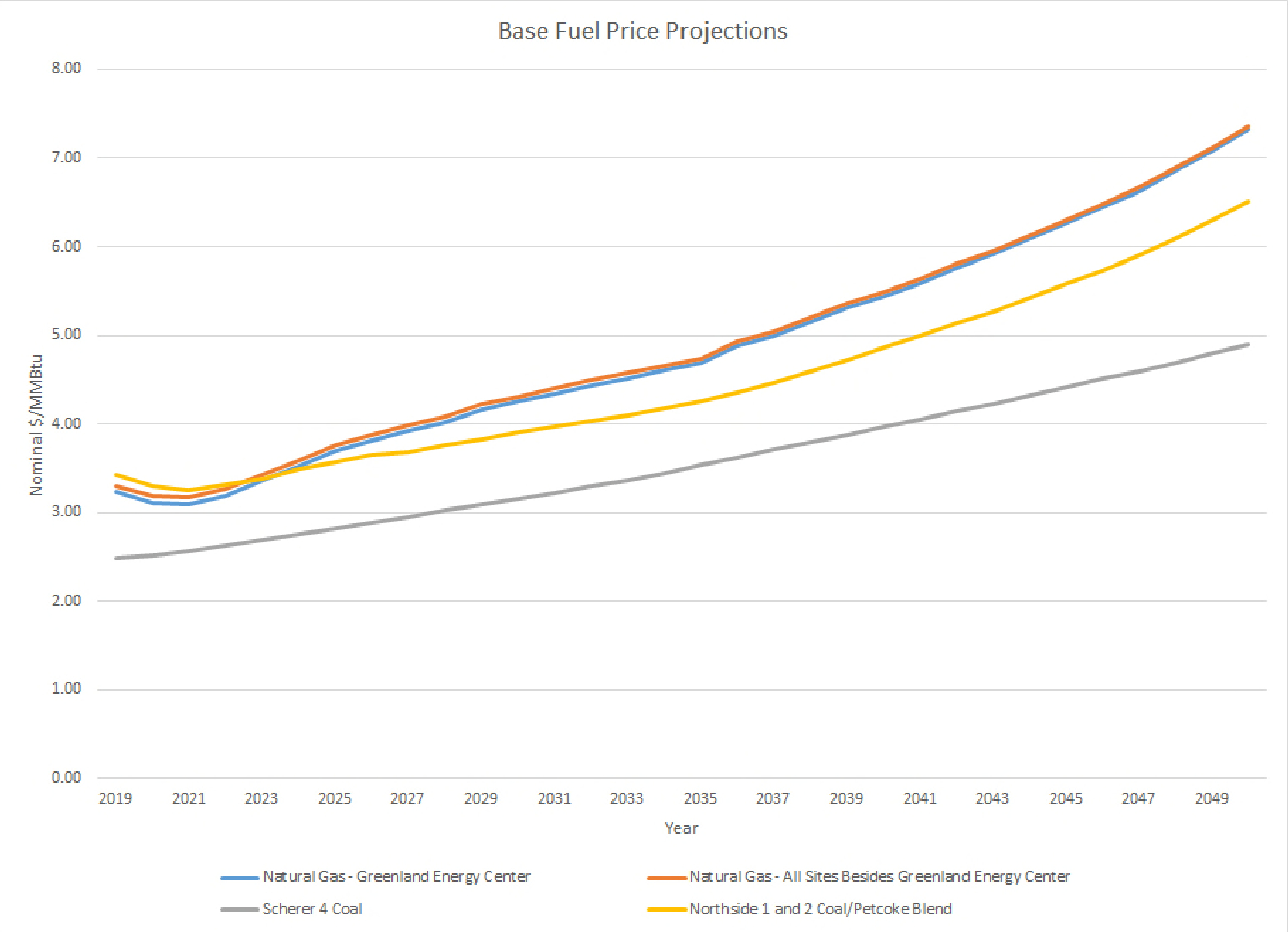
- Development of IRP is a complex process
- Intend to use base IRP expansion plan in current FEECA process
    - FEECA is undertaken every 5 years, and establishes JEA's numeric conservation goals that are approved by the Florida Public Service Commission

Baseline Assumptions

Projected Capacity Requirements



Fuel Price Projections



Supply-Side Options (following LCOE Screening – see subsequent slides)

	Utility Scale Solar PV		Combined Cycles				Reciprocating Engines	Simple Cycle Combustion Turbines		
	Solar PV w/o Storage (Note 1)	Solar PV w/ 4 Hours Storage (Notes 1, 2)	GE 7HA.02 1x1	GE 7FA.05 1x1	Greenland Energy Center 1x1 CC Conversion (Note 3)	Greenland Energy Center 2x1 CC Conversion (Note 3)	Jenbacher 5xJ920	GE LMS100	GE 7FA.05 SCCT	GE 7HA.02 SCCT
Installed Cost ($/kW based on full load average ambient output shown below)										
Capital Cost per kW (2018 $)	723	1,503	893	1,183	1,781	1,594	1,434	1,068	476	485
Average Day Ratings										
Capacity (MW)	75	75	545	350	310	622	45	109	223	342
Heat Rate (HHV, Btu/kWh)	N/A	N/A	6,519	6,843	6,935	6,905	7,962	8,581	9,675	9,079
Summer Ratings										
Capacity (MW)	75	75	508	325	290	582	45	90	207	314
Heat Rate (HHV, Btu/kWh)	N/A	N/A	6,535	6,832	7,021	6,990	7,967	8,897	9,774	9,206
Winter Ratings										
Capacity (MW)	0 (at Winter Peak)	75	559	349	321	644	45	113	232	352
Heat Rate (HHV, Btu/kWh)	N/A	N/A	6,592	6,938	6,977	6,947	7,962	8,472	9,489	8,934
Variable O&M (2018 $/MWh)	0	0	2.26	2.67	2.72	2.64	9.59	4.16	14.92	17.41
Fixed O&M (2018 $/kW-year)	12.00	20.48	6.95	9.90	10.94	6.58	42.11	12.27	8.00	5.64

Notes:

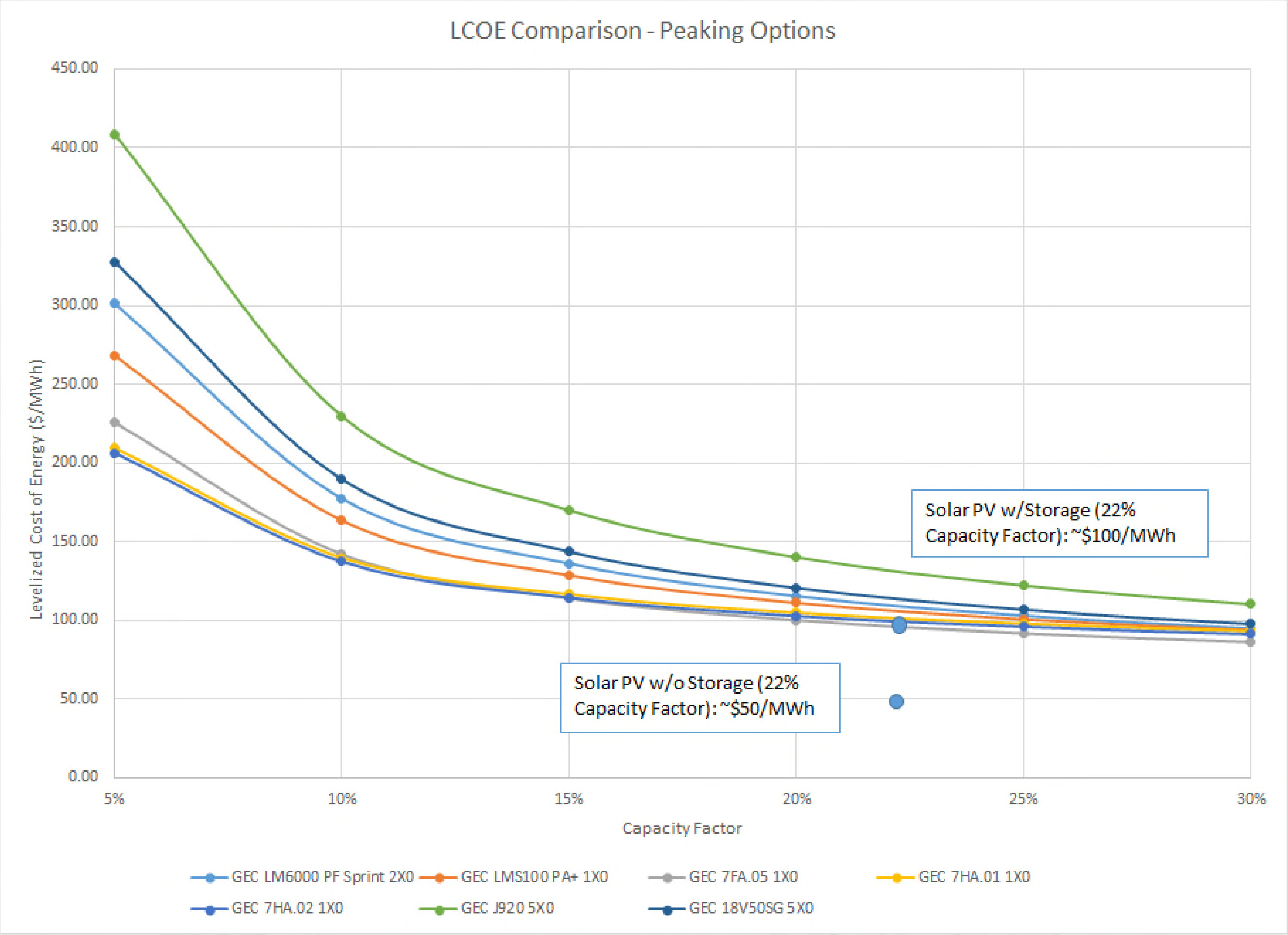
(1). Capital Cost per kW for Solar PV w/o Storage and Solar PV with Storage do not reflect projected decline in costs; assumed to be 6% annually for 5 years. 30% Investment Tax Credit is not reflected but is accounted for in economic analyses.

(2). Solar PV w/Storage does not include costs for battery capacity refreshes, which may be required over time to maintain storage capability.

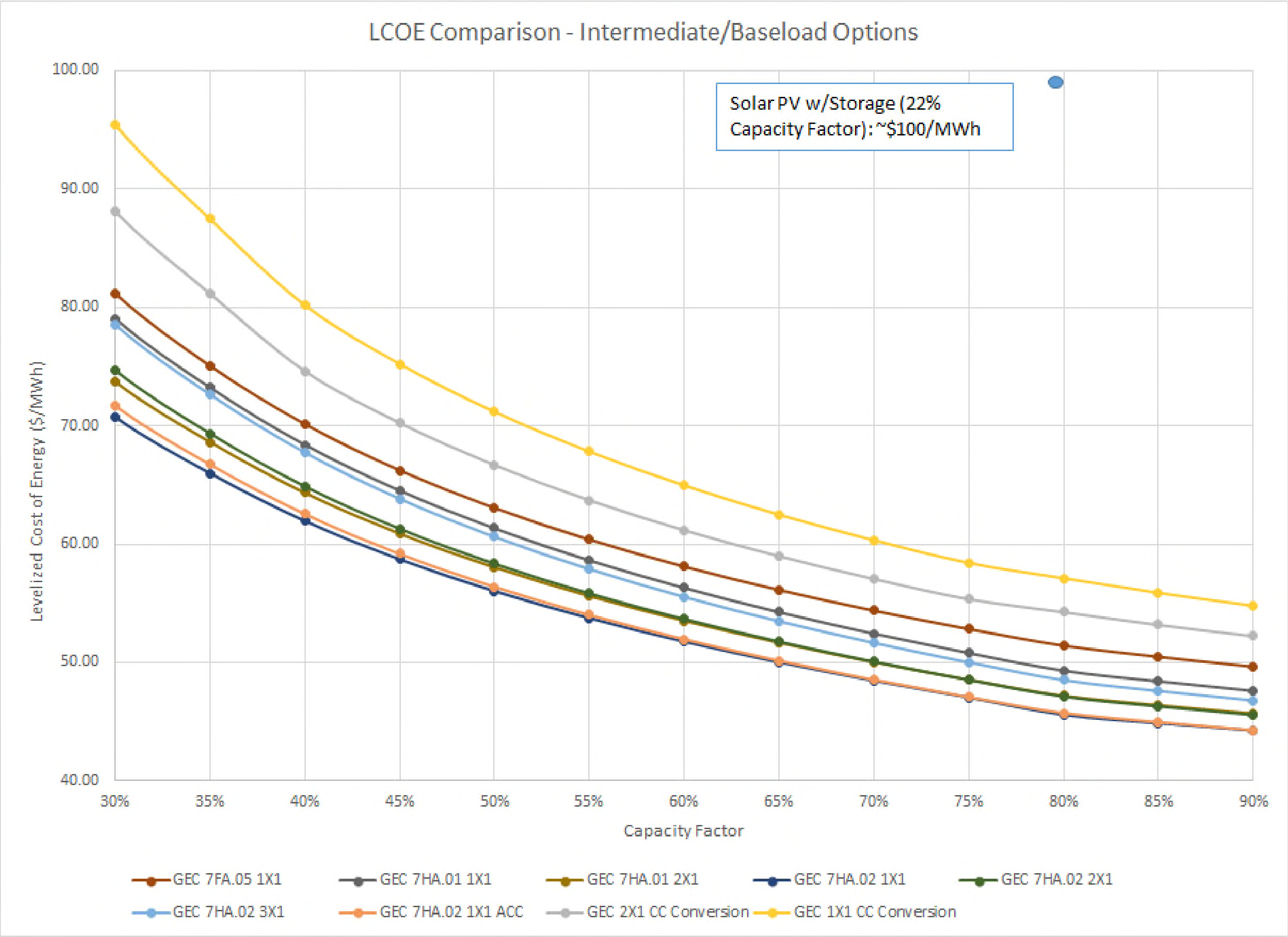
(3). Capital Cost per kW for Greenland Energy Center Combined Cycle Conversions reflect incremental capacity associated with conversions; Capacity and O&M shown reflect entire capacity of converted GEC Combined Cycles

Levelized Cost of Energy and Expansion Planning/Production Cost Modeling

LCOE – Peaking Options



LCOE – Intermediate/Baseload Options



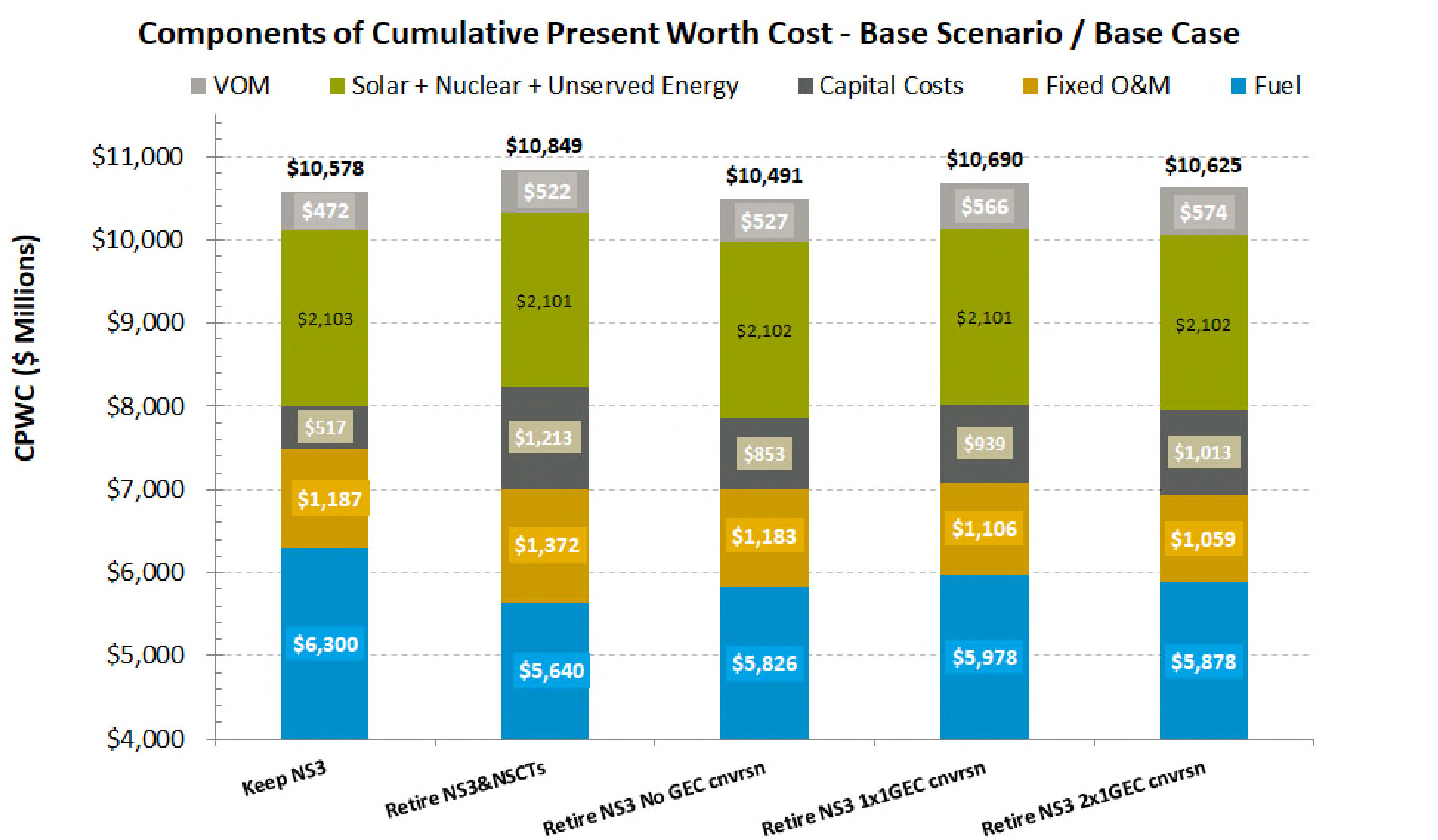
Scenarios and Sensitivities

Scenario Matrix

Area	Metric	Baseline	Load Erosion	Increased Electrfication	Green Economy
Financial	Interest During Construction & Discount Rate	4.50%	6%	4.50%	4.50%
	Escalation Rate	2.00%	3.00%	2.00%	2.00%
Demand	Total Net Energy Requirements Forecast	AAGR: 0.87%	Energy requirements decline by 1.0% /year for 10 years; then no growth	Energy requirements increase at 2.0%/year until achieve +20% over Baseline forecast; then Baseline AAGR of 0.87% thereafter {See Comment}	AAGR: 0.89%
	Net Firm Peak Demand Forecast	AAGR Winter: 0.86% AAGR Summer: 0.70%	Winter and Summer net firm peak demand declines at 1.0% for 10 years; then no growth	Winter and Summer net firm peak demand increase at 2.0%/year until achieve +20% over Baseline forecast; Baseline Winter and Summer AAGR thereafter	AAGR Winter: 1.6% AAGR Summer: 1.6%
	EE/Conservation	Current Portfolio	Embedded in Energy Forecast	Embedded in Energy Forecast	Embedded in Energy Forecast
	Direct Load Control	None	None	None	None
	Interruptible Load	Current Portfolio	Embedded in Peak Demand Forecast	Embedded in Peak Demand Forecast	Embedded in Peak Demand Forecast
	PEV	0.5% by 2027 3.6% by 2046	Embedded in Energy and Peak Demand Forecasts	Embedded in Energy and Peak Demand Forecasts	Embedded in Energy and Peak Demand Forecasts
	Net Metering	Current Portfolio	Embedded in Energy and Peak Demand Forecasts	Embedded in Energy and Peak Demand Forecasts	Embedded in Energy and Peak Demand Forecasts
Environmental Regulations	Carbon Tax Rate	None	None	None	~ $11.50/ton in 2020, increasing at 5% annually
	Clean Energy Standard (CES)	None	None	None	Reflect 30% carbon neutral by 2030
Supply	Fuel Cost & Availability	Gas supply remains adequate with moderate pricing	Gas supply remains adequate with moderate pricing	Gas supply remains adequate with moderate pricing	Gas supply inadequate with high pricing
	Construction Cost	Costs increase at inflation	Costs increase at inflation	Costs increase at inflation	Costs increase at inflation through 2020, inflation + 1% thereafter
	Unit Retirements	Northside 3: 2025; Solid Fuel: none expected	Northside 3: 2025; Solid Fuel: none expected	Northside 3: 2025; Solid Fuel: none expected	Northside 3: 2025; Solid Fuel: 2030

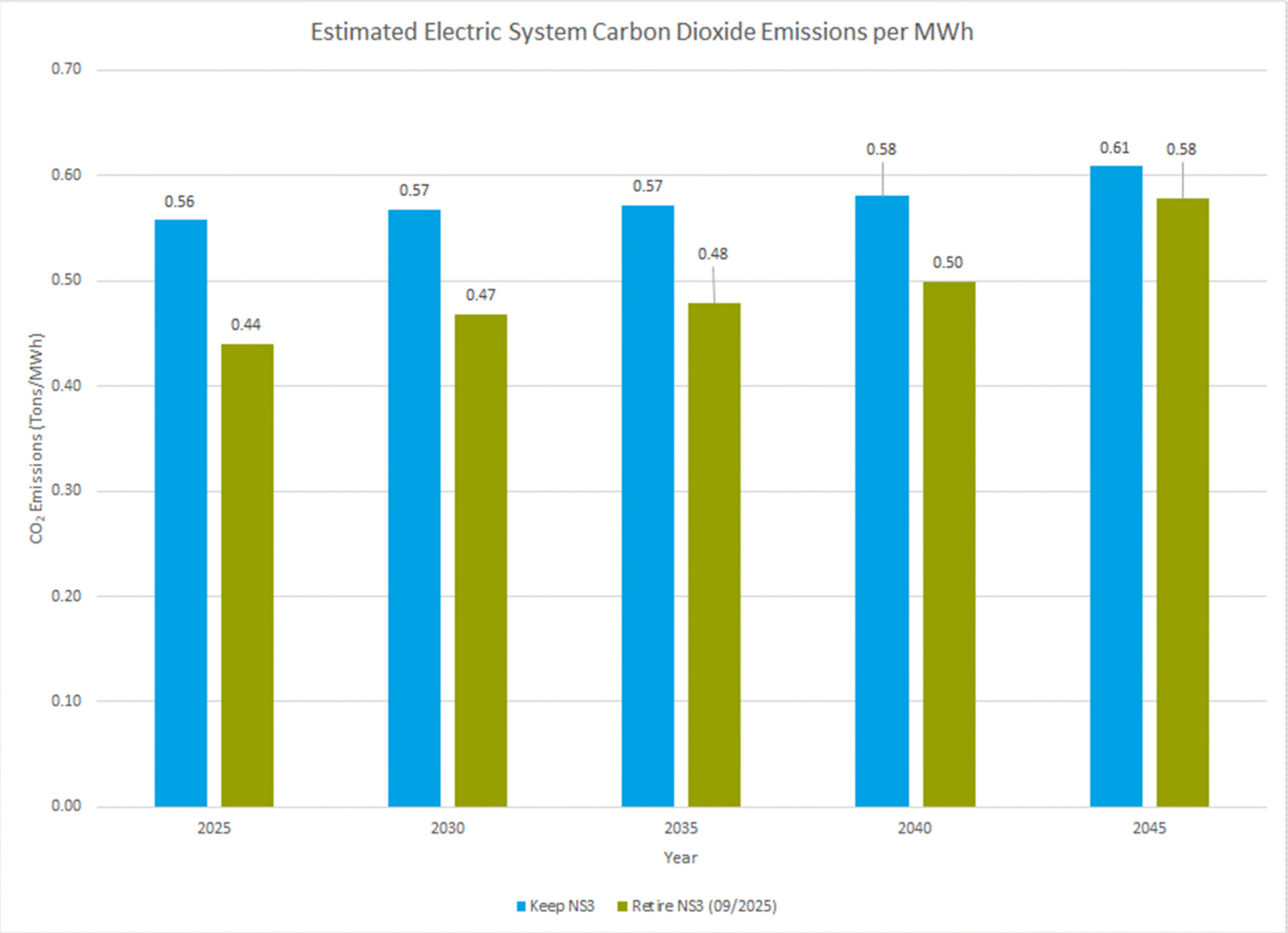
Analysis – Baseline Scenario

CPWC Components – Baseline Analysis



CPWC represents cumulative present worth cost discounted to 2019.

Estimated Carbon Dioxide Emissions per MWh – Baseline Analysis

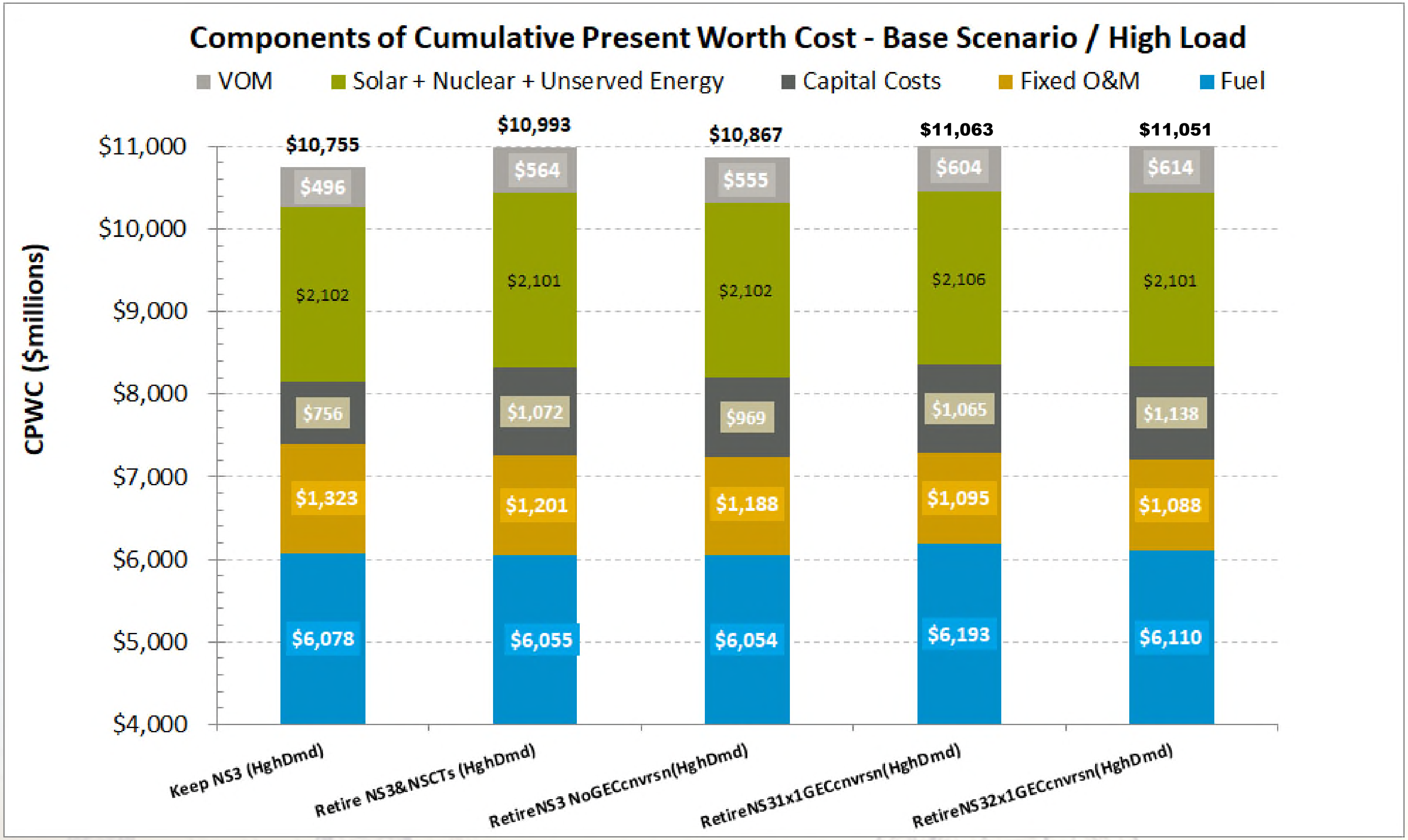


Observations from Expansion Planning and Production Cost Modeling – Baseline Analysis

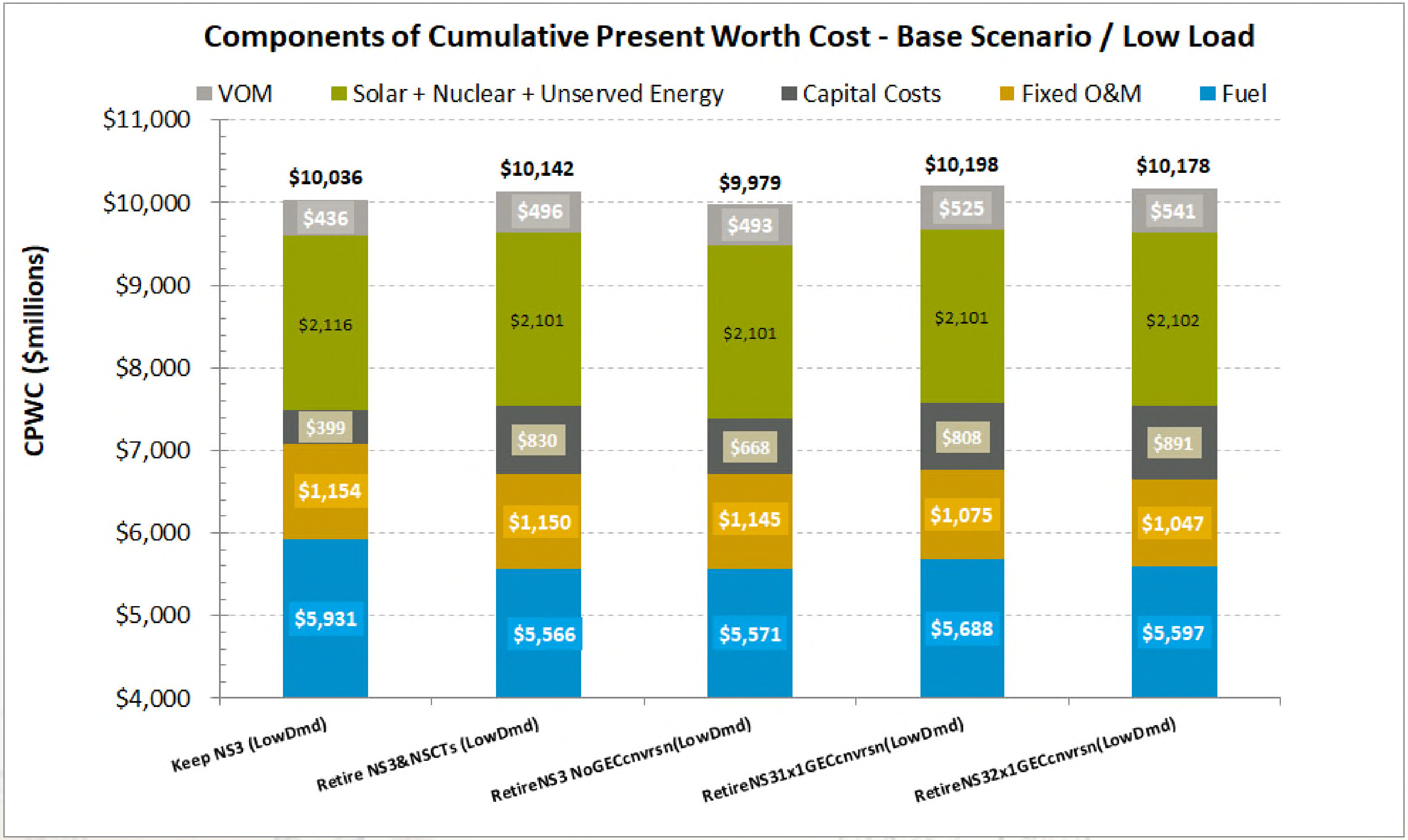
- Preliminary Results of Base Case/Baseline Scenario:
  - CPWC of case that includes retirement of Northside 3 (9/2025) and new 1x1 7HA.02 combined cycle in 2025 is least cost, but other cases are very close
    - CPWC of case with continued operation of Northside 3 (9/2025) is within 1% of CPWC of least cost case
    - CPWC of case with conversion of the existing simple cycle combustion turbines at Greenland Energy Center to combined cycle ("2x1 GEC CC Conversion") in 2025 is ~1.3% higher than least cost case
    - CPWC of case with conversion of one of the existing simple cycle combustion turbines at Greenland Energy Center to combined cycle ("1x1 GEC CC Conversion") in 2025 is ~1.9% higher than least cost case
    - CPWC of case with retirement of Northside 3 and Northside simple cycle CTs is ~3.4% higher than least cost case

Analysis - Sensitivities and Scenarios

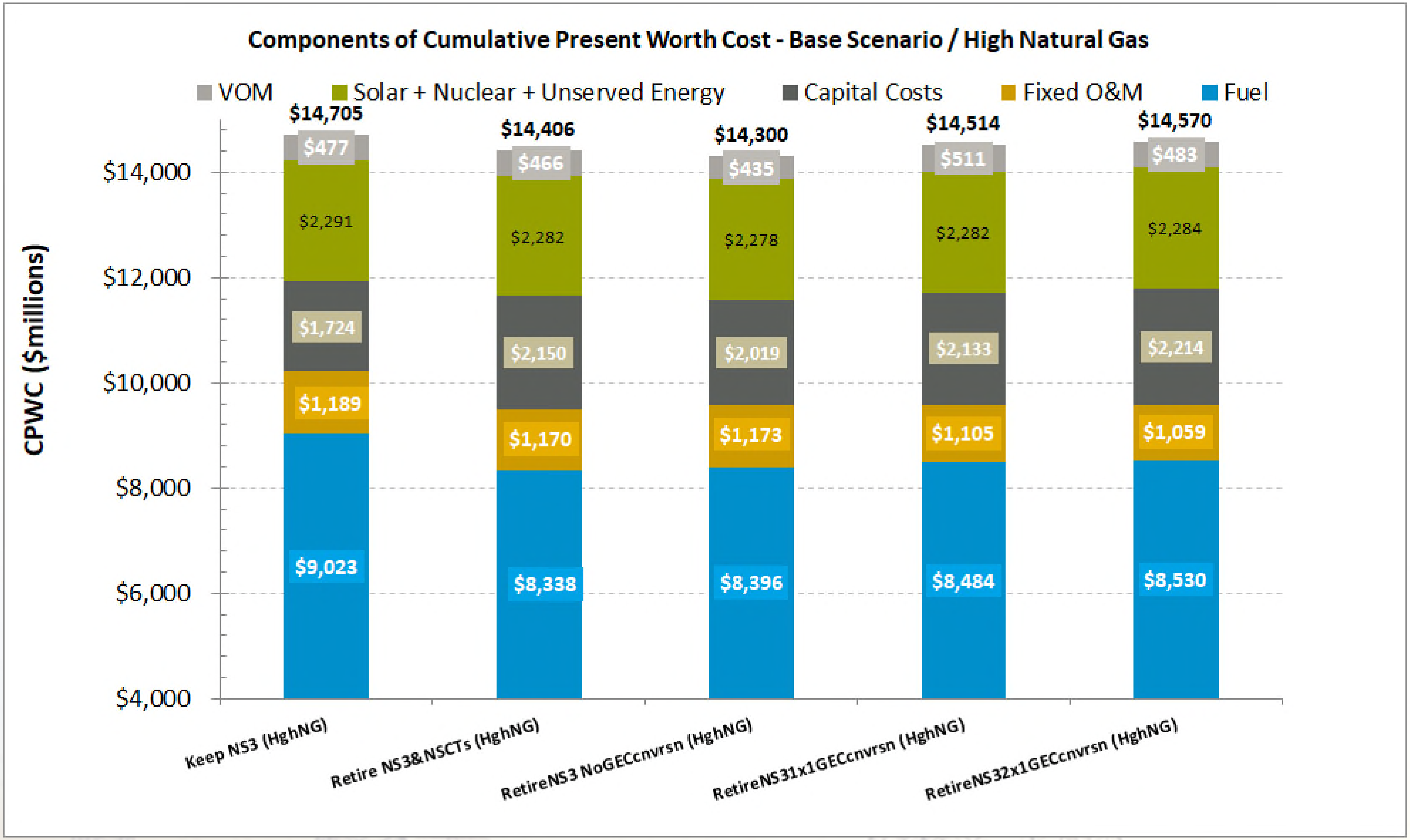
Results of Expansion Planning and Production Cost Modeling – Baseline Scenario/High Load Sensitivity



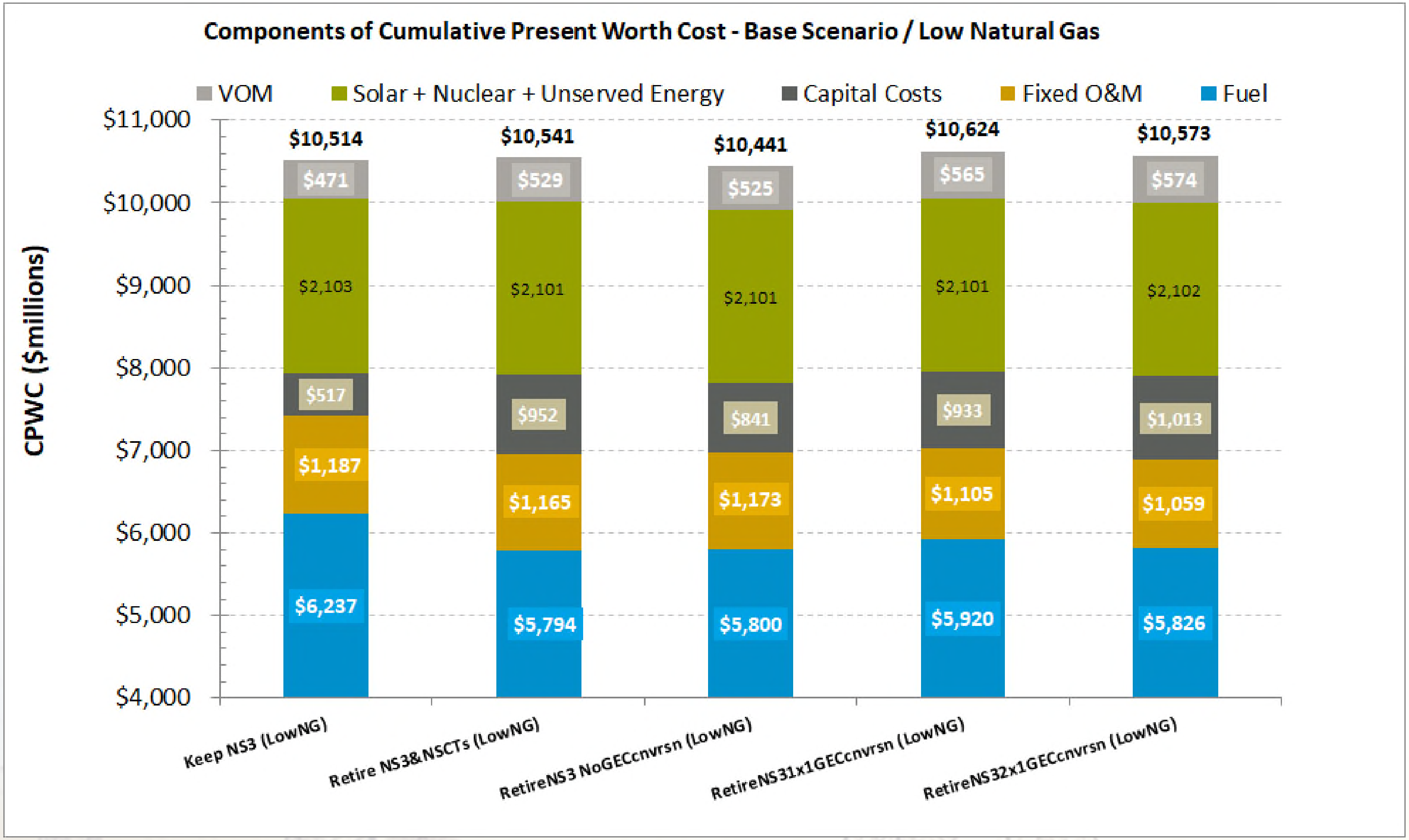
Results of Expansion Planning and Production Cost Modeling – Baseline Scenario/Low Load Sensitivity



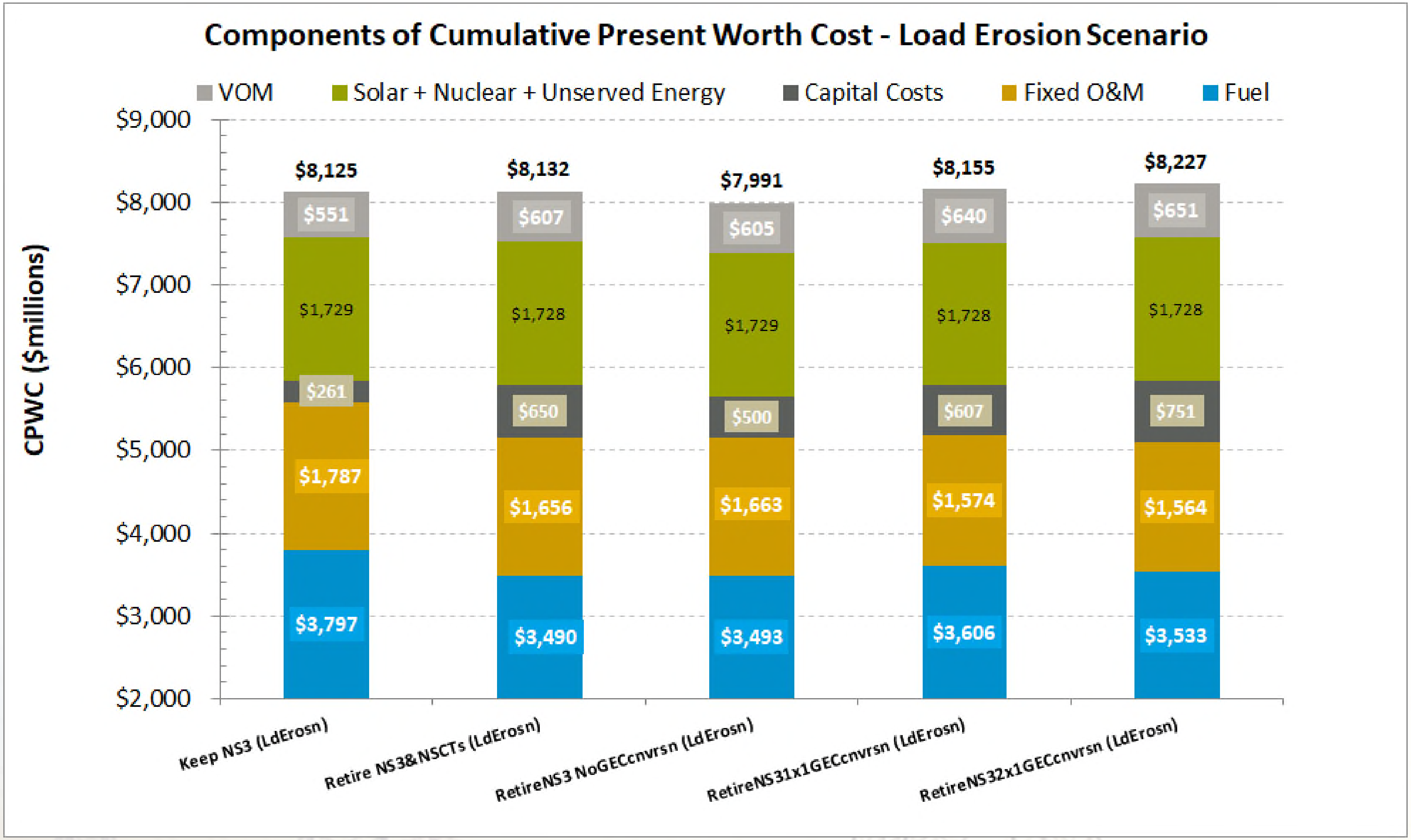
Results of Expansion Planning and Production Cost Modeling – Baseline Scenario/High Natural Gas Sensitivity



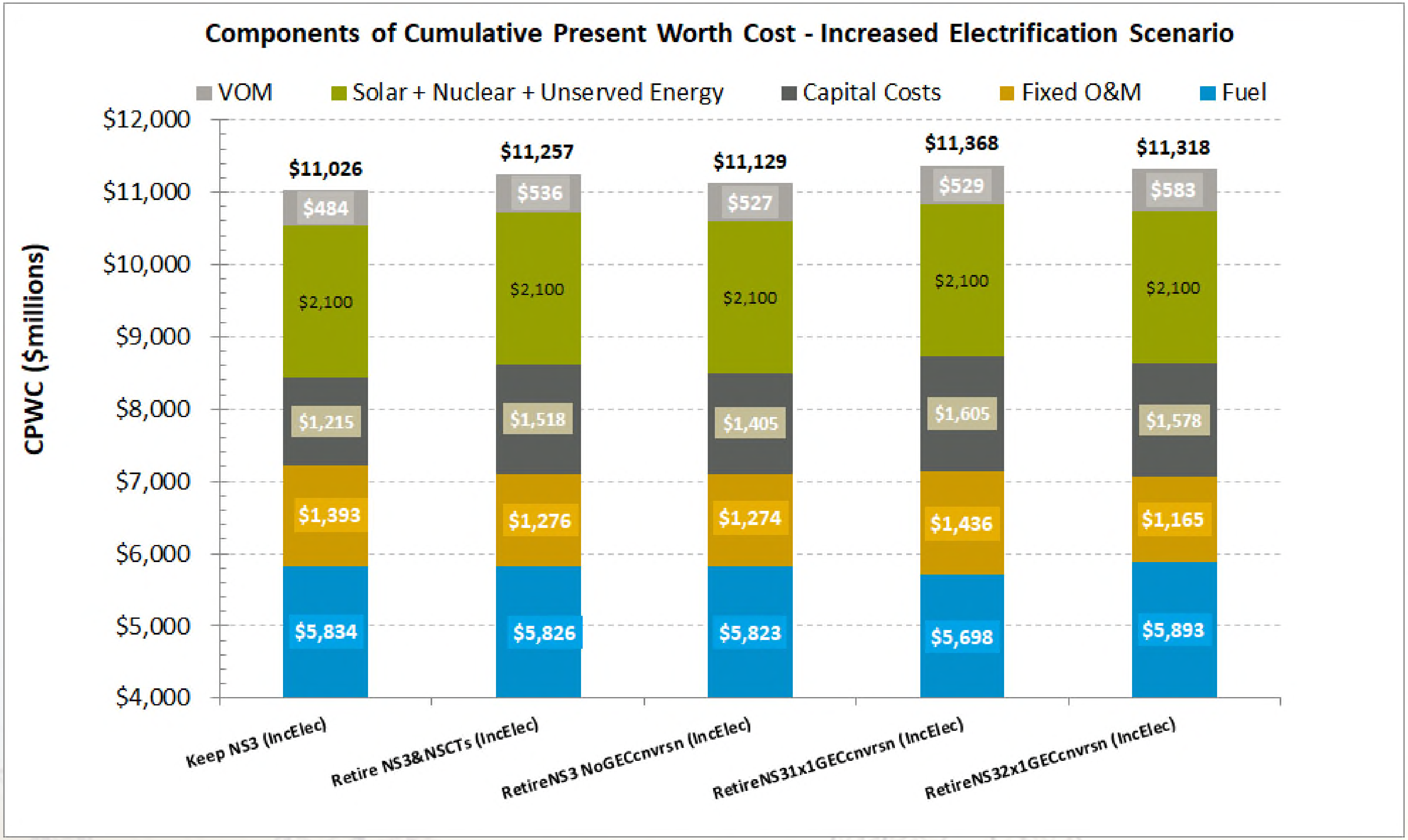
Results of Expansion Planning and Production Cost Modeling – Baseline Scenario/Low Natural Gas Sensitivity



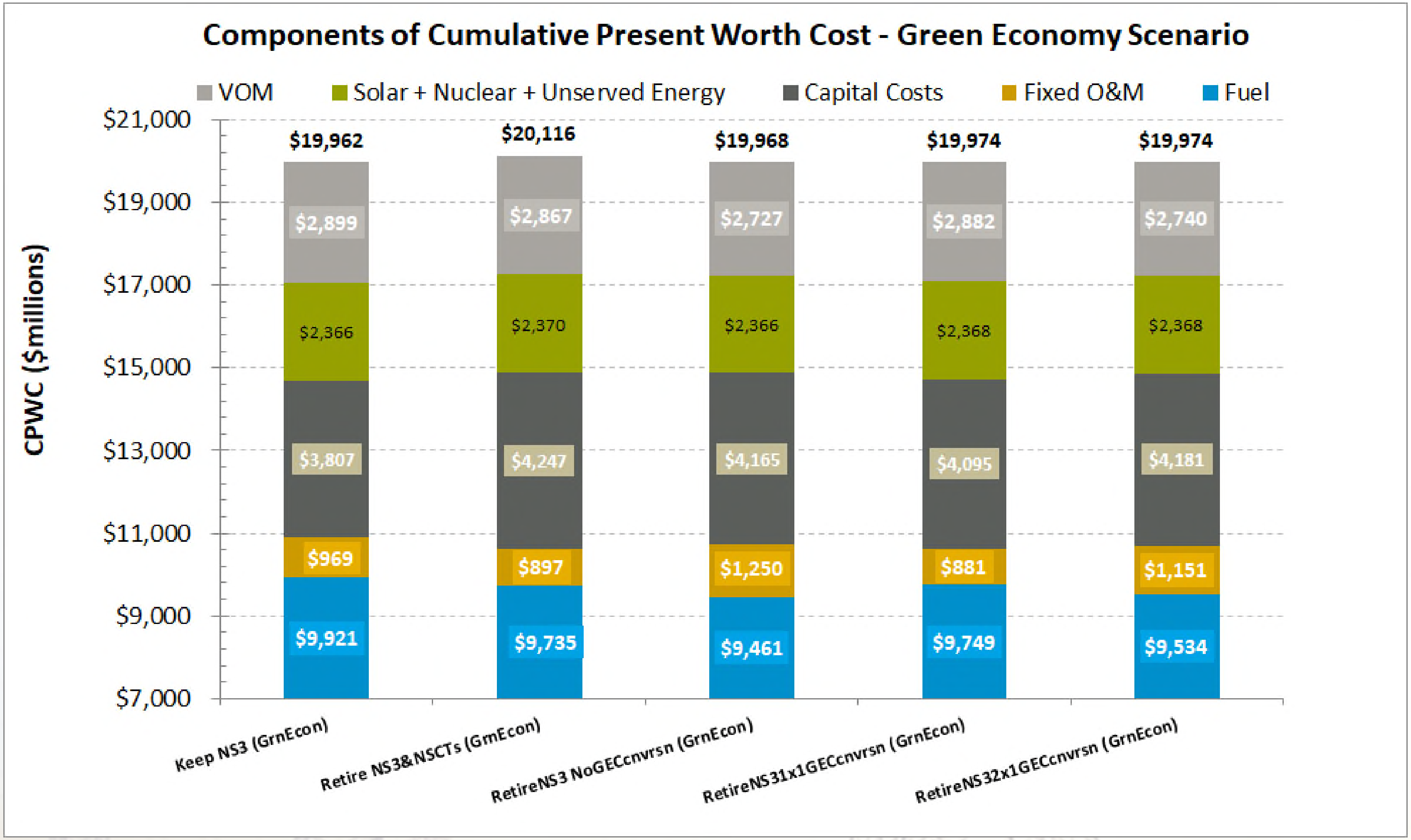
Results of Expansion Planning and Production Cost Modeling – Load Erosion Scenario



Results of Expansion Planning and Production Cost Modeling – Increased Electrification Scenario



Results of Expansion Planning and Production Cost Modeling – Green Economy Scenario



Observations and Next Steps

Overall Observations from Expansion Planning and Production Cost Modeling

- In general, CPWCs of expansion plans are close to one another
  - When comparing plans including continued operation of Northside 3, retirement of Northside 3 (9/2025), and GEC combined cycle conversion:
    - Comparison of CPWCs within each scenario/sensitivity are within ~ 1% to 3% of one another
    - CPWCs are often less than 1% different between expansion plans
    - Plans with retirement of Northside 3 (9/2025) and new combined cycle in 2025 are generally lowest in CPWC; differentials in CPWC are small
- Other considerations beyond CPWC related to Northside 3 retirement and construction of new combined cycle:
  - Condition Assessment
  - Regulations beyond 316(b)
  - Reliability
  - Safety
  - Capital Investment
  - Efficiency
  - Operational Flexibility

Next Steps

- Finalize IRP
- Northside 3 retirement decision
- If move forward with combined cycle (i.e. GEC 1x1 combined cycle or 2x1 combined cycle conversion or new combined cycle):
  - Consider issuing Request for Proposals (RFP) to compare to selected alternative (i.e. GEC CC conversion or new 1x1 combined cycle)
  - New or expansion of existing power plant with 75 MW or more of steam capacity falls under PPSA (see next slide)
  - Other environmental permitting required

PPSA Considerations

- Statutory Criteria and Relevant Considerations:
  - Need for electric system reliability and integrity
    - How does addition of proposed unit help to improve reliability and integrity – for example, can transmission system benefits be quantified
  - Need for adequate electricity at a reasonable cost
    - Is there a "need" for the proposed unit – for example, to maintain reserve margin
  - Need for fuel diversity and supply reliability
    - Would need to demonstrate reliable supply of fuel for proposed unit
  - Whether the proposed plant is the most cost-effective alternative available
    - Consider power supply request for proposals (RFP) to demonstrate cost-effectiveness
  - Whether renewable energy sources and technologies, as well as conservation measures, are utilized to the extent reasonably available
  - Consideration of the conservation measures taken by or reasonably available to the applicant or its members which might mitigate the need for the proposed plant

Reference Material

Levelized Cost of Energy and Expansion Planning/Production Cost Modeling

Levelized Cost of Energy (LCOE)

- The LCOE analysis was developed based on the estimated cost and performance characteristics for the various alternatives
- LCOE provides a single, levelized cost per MWh (or kWh) lifecycle operating cost estimate for each of the supply-side options
- The LCOE analysis was performed at various assumed levels of annual operation (i.e. capacity factor, or amount of energy generated each year) for each supply-side option
- The LCOE analysis considered (as appropriate for each supply-side option) capital costs, operating costs, and fuel costs and expressed the total annual cost and corresponding energy generation on a nominal (current year) and present value basis

Levelized Cost of Energy (LCOE)

- The cumulative present value costs were then divided by the sum of the annual present worth factors to calculate the lifecycle levelized cost of energy for each option
- Such an approach is widely used in comparing the relative economics of various supply-side options to determine if one (or more) option may be consistently more costly than the others across a range of possible capacity factors, allowing an initial list of supply-side options to be reduced to a smaller number to be considered in subsequent evaluations

Expansion Planning and Production Cost Modeling

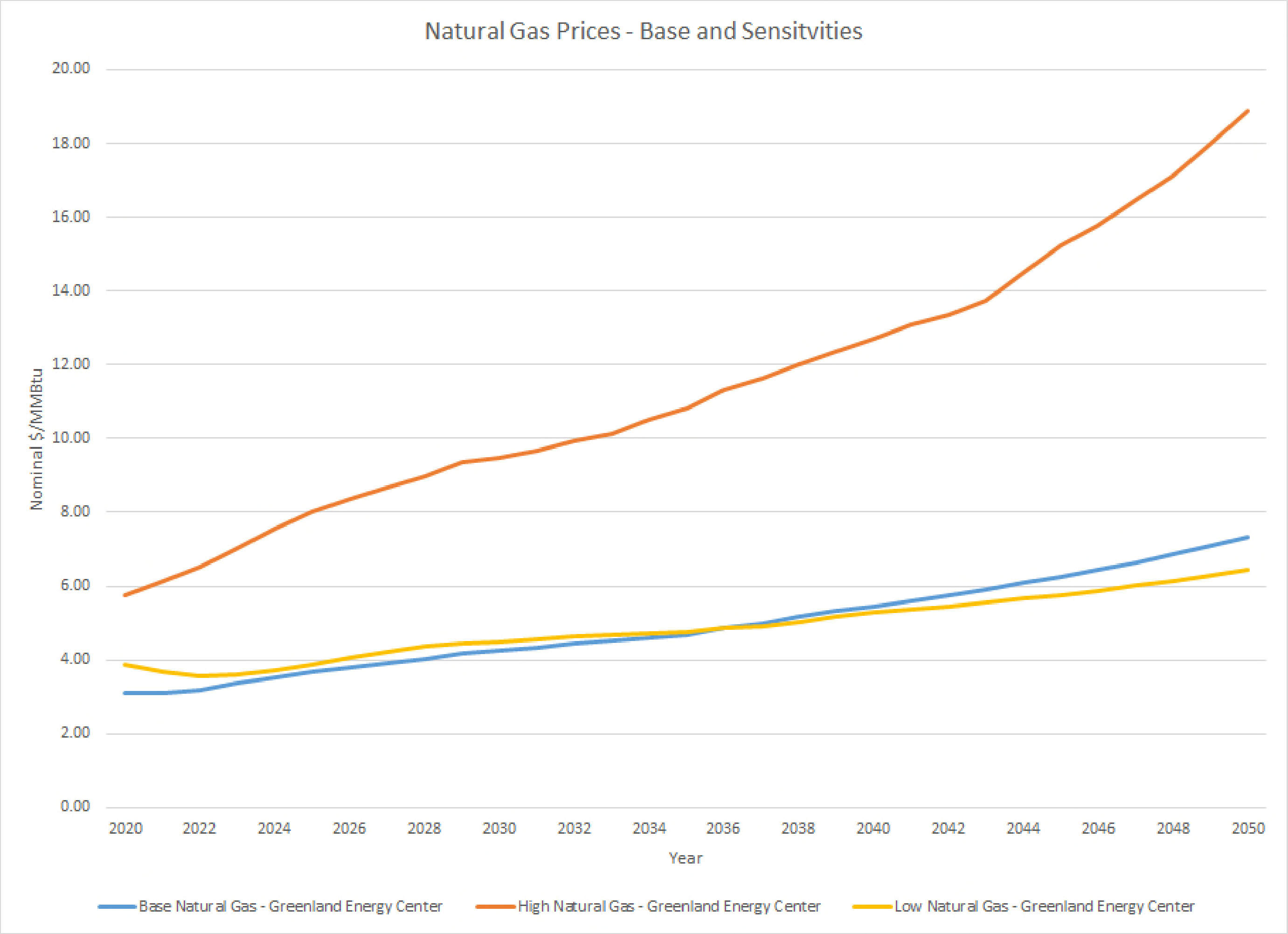
- Expansion planning and production cost modeling was performed to evaluate various resource plans under numerous sensitivities/scenarios
- Used Strategist™ and ProMod™, industry-accepted expansion planning and production cost models licensed by ABB (formerly Ventyx)
- Analyzed cumulative present worth costs (CPWCs), which represent the present value of JEA's system costs over the study period, including variable and fixed O&M costs, capital costs for new unit additions, costs for nuclear and solar purchases, fuel costs, and CO2 emissions costs (for evaluations in which emissions of CO2 are assumed to be regulated)
- Results are presented in subsequent slides

Scenarios and Sensitivities

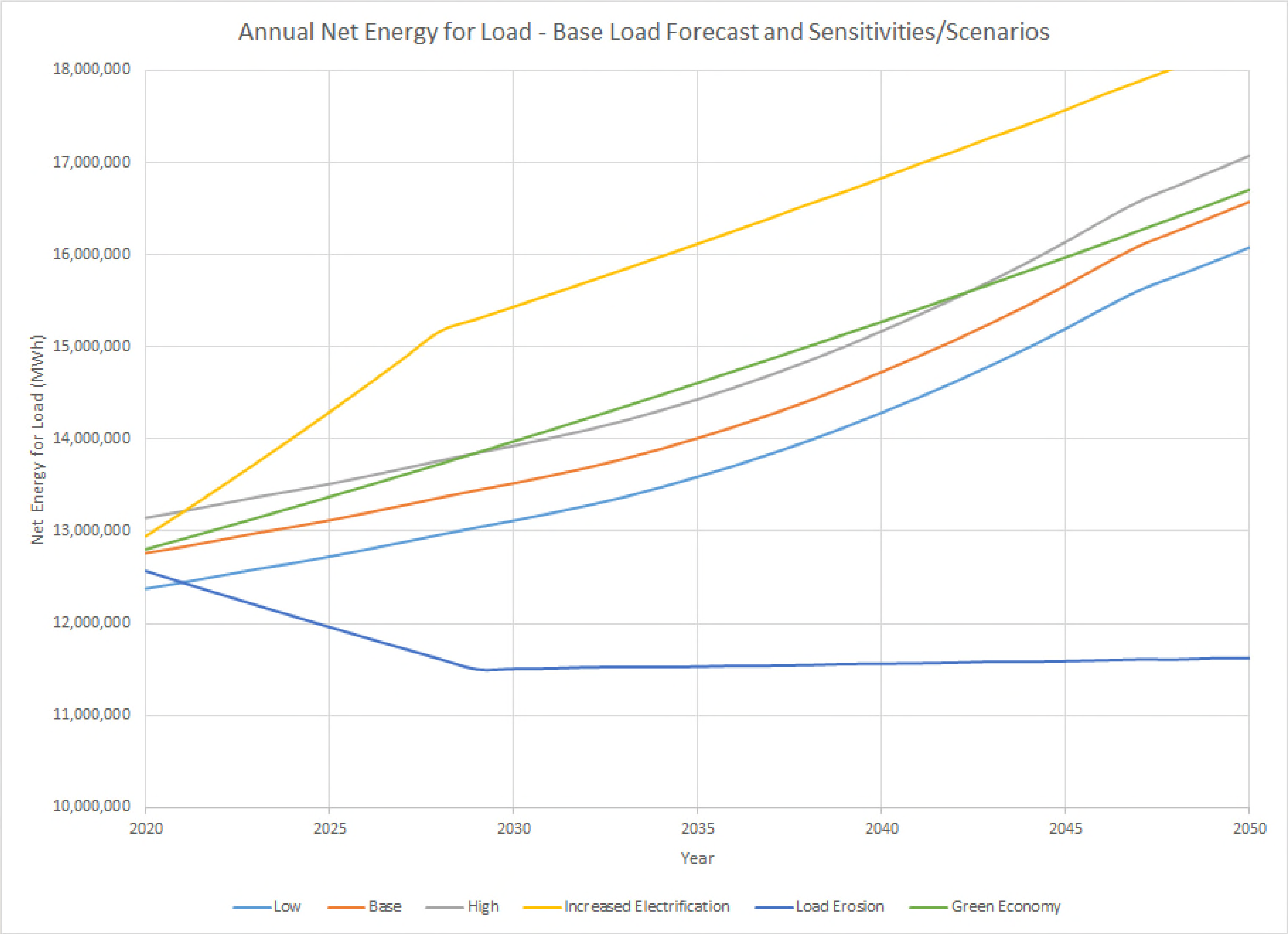
Scenarios and Sensitivities

- Baseline Scenario:
  - Retirement of Northside 3 in 9/2025
  - No carbon dioxide emissions regulations
  - No clean energy/renewable energy standards
  - Baseline load forecast, fuel price projections, capital costs for new construction
- Considerations and Sensitivities under Baseline Scenario:
  - No Northside 3 retirement (analyzed for all sensitivities)
  - Retirement of Northside simple cycles (analyzed for all sensitivities)
  - High and low load sensitivities
  - Natural gas price sensitivities
- Additional Scenarios:
  - Load Erosion
  - Increased Electrification
  - Green Economy

Natural Gas Price Sensitivities



Load Sensitivities and Scenarios



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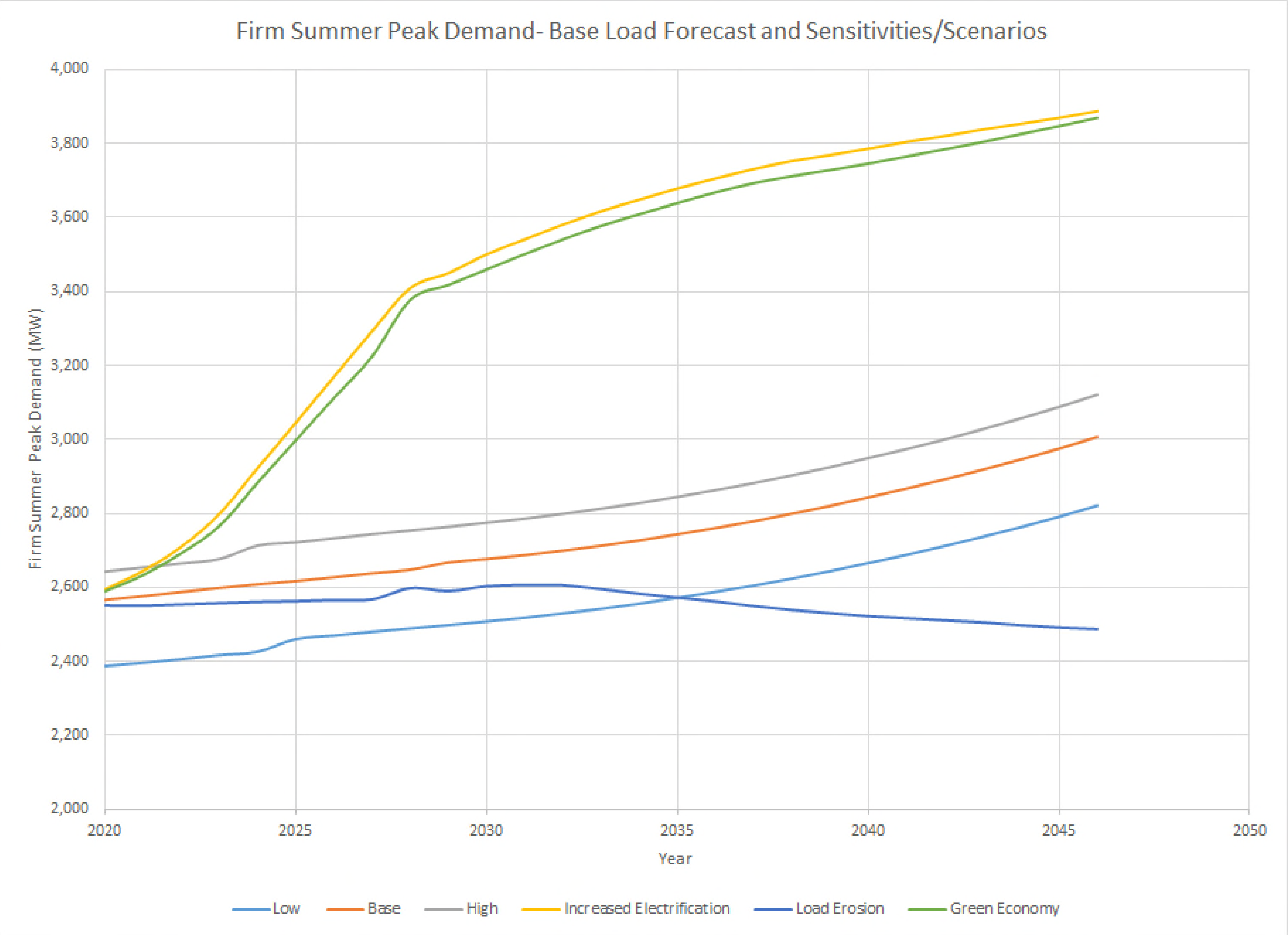
Load Sensitivities and Scenarios



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Observations and Next Steps

Observations from Expansion Planning and Production Cost Modeling – Sensitivity and Scenario Analyses

- High Load Sensitivity
  - Least cost plan includes continued operation of Northside 3 <u>and</u> new 1x1 7HA.02 combined cycle in 2025
  - Plan with retirement of Northside 3 (9/2025) includes new 1x1 7HA.02 combined cycle in 2025; ~ 1% higher in CPWC than least cost plan
  - Plans with retirement of Northside 3 (9/2025) and either 1x1 GEC CC Conversion or 2x1 GEC CC Conversion are ~ 2.7% to 2.8% higher in CPWC than least cost plan
- Low Load Sensitivity
  - Least cost plan includes retirement of Northside 3 (9/2025) and new 1x1 7HA.02 combined cycle in 2025
  - Plan with continued operation of Northside 3 is ~ 0.6% higher in CPWC than least cost plan
  - Plans with retirement of Northside 3 (9/2025) and either 1x1 GEC CC Conversion or 2x1 GEC CC Conversion are ~ 2.0% to 2.2% higher in CPWC than least cost plan

Observations from Expansion Planning and Production Cost Modeling – Sensitivity and Scenario Analyses

- High Natural Gas Sensitivity
  - Least cost plan includes retirement of Northside 3 (9/2025) and new 1x1 7HA.02 combined cycle in 2025
  - Plan with continued operation of Northside 3 is ~ 2.8% higher in CPWC than least cost plan
  - Plans with retirement of Northside 3 (9/2025) and either 1x1 GEC CC Conversion or 2x1 GEC CC Conversion are ~ 1.5% to 1.9% higher in CPWC than least cost plan
- Low Natural Gas Sensitivity
  - Least cost plan includes retirement of Northside 3 (9/2025) and new 1x1 7HA.02 combined cycle in 2025
  - Plan with continued operation of Northside 3 is ~ 0.7% higher in CPWC than least cost plan
  - Plans with retirement of Northside 3 (9/2025) and either 1x1 GEC CC Conversion or 2x1 GEC CC Conversion are ~ 1.3% to 1.8% higher in CPWC than least cost plan

Observations from Expansion Planning and Production Cost Modeling – Sensitivity and Scenario Analyses

- Load Erosion Scenario
  - Least cost plan includes retirement of Northside 3 (9/2025) and new 1x1 7HA.02 combined cycle in 2026
  - Plan with continued operation of Northside 3 is ~ 1.7% higher in CPWC than least cost plan
  - Plans with retirement of Northside 3 (9/2025) and either 1x1 GEC CC Conversion or 2x1 GEC CC Conversion are ~ 2.1% to 3% higher in CPWC than least cost plan
- Increased Electrification Scenario
  - Least cost plan includes continued operation of Northside 3 and new 1x1 7HA.02 combined cycle in 2025
  - Plan with retirement of Northside 3 (9/2025) includes new 1x1 7HA.02 combined cycle in 2025; ~ 1% higher in CPWC than least cost plan
  - Plans with retirement of Northside 3 (9/2025) and either 1x1 GEC CC Conversion or 2x1 GEC CC Conversion are ~ 2.7% to 3.1% higher in CPWC than least cost plan

Observations from Expansion Planning and Production Cost Modeling – Sensitivity and Scenario Analyses

- Green Economy Scenario
  - Least cost plan includes continued operation of Northside 3 <u>and</u> GEC 1x1 combined cycle conversion in 2025
  - Plan with retirement of Northside 3 (9/2025) includes new 1x1 7HA.02 combined cycle in 2025; CPWC is essentially a "break-even" with least cost plan
  - Plans with retirement of Northside 3 (9/2025) and either 1x1 GEC CC Conversion or 2x1 GEC CC Conversion essentially "break-even" with least cost plan

Generation Planning Flow Chart