Public Service Company of Colorado ERP Phase II: Assessment of Clean Energy Alternatives to New Natural Gas Peaker Resources

Prepared by Strategen for Advanced Energy United
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Executive Summary

In this report, Strategen assesses the proposed resource plan set forth by Public Service Company of Colorado ("PSCo") in Phase II of their 2021 Electric Resource Plan ("ERP"), also known as the 120-Day Report. In this plan, PSCo takes commendable strides towards decarbonization, proposing an 80% reduction in carbon emissions from 2005 levels by 2030 and retiring all coal plants in the process. However, the proposed plan also includes over 600 MW of new natural gas combustion turbine ("CT") peaker plants in operation by 2027, long-term investments that will restrict PSCo's ability to eventually achieve a fully decarbonized system.

Since the completion of Phase I of the ERP, the U.S. Federal Government has passed the Inflation Reduction Act of 2022 ("IRA"), which dramatically reduced the cost of clean energy resources, including battery storage. PSCo incorporated many of the IRA incentives in Phase II to increase the investment in affordable, clean energy, but the low cost of clean energy resources could provide an opportunity to avoid additional natural gas deployment. Strategen analyzed a portfolio of battery storage, solar, and wind resources from the list of publicly available projects in the 2022 All-Source Request for Proposals ("RFP"), and selected projects sized to exceed the capacity of the proposed 400 MW gas peaker, the largest in PSCo's plan. An economic analysis was done to estimate the cost of the gas unit relative to the clean energy portfolio, including the value of energy and the cost of operation.

The modeled clean energy portfolio is more economic than the proposed CT while providing greater capacity. In the first year of operation, the clean energy portfolio would provide savings of $28.9 million, before considering additional factors such as grid services, stranded asset risk, and fuel supply risk. Savings in subsequent years are anticipated to be even greater.

This report is organized into three sections. The first section provides an overview of the PSCo 120-Day Report and a summary of the clean energy benefits included in the IRA. The second section details the case study, describing the utility's proposed natural gas peaker plants, the development of the alternative clean energy portfolio, and the economic analysis performed. This section also includes discussion of additional factors that may further impact the planning decision. Finally, the report concludes with recommendations for PSCo and the Colorado Public Utilities Commission ("PUC").

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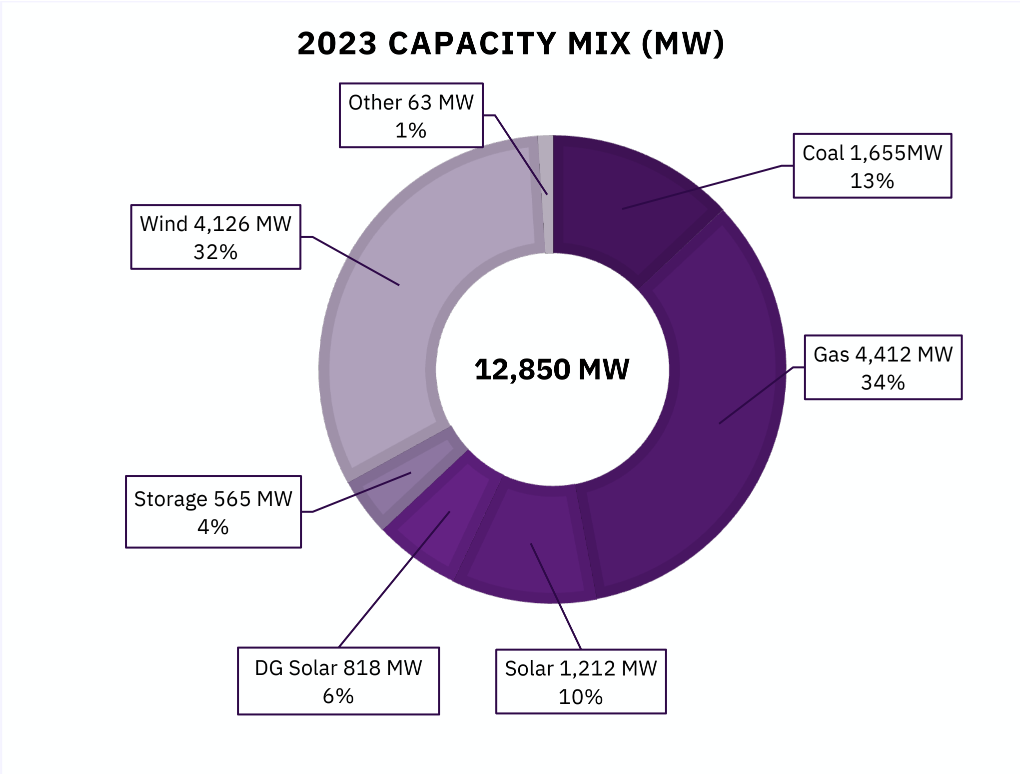
Introduction

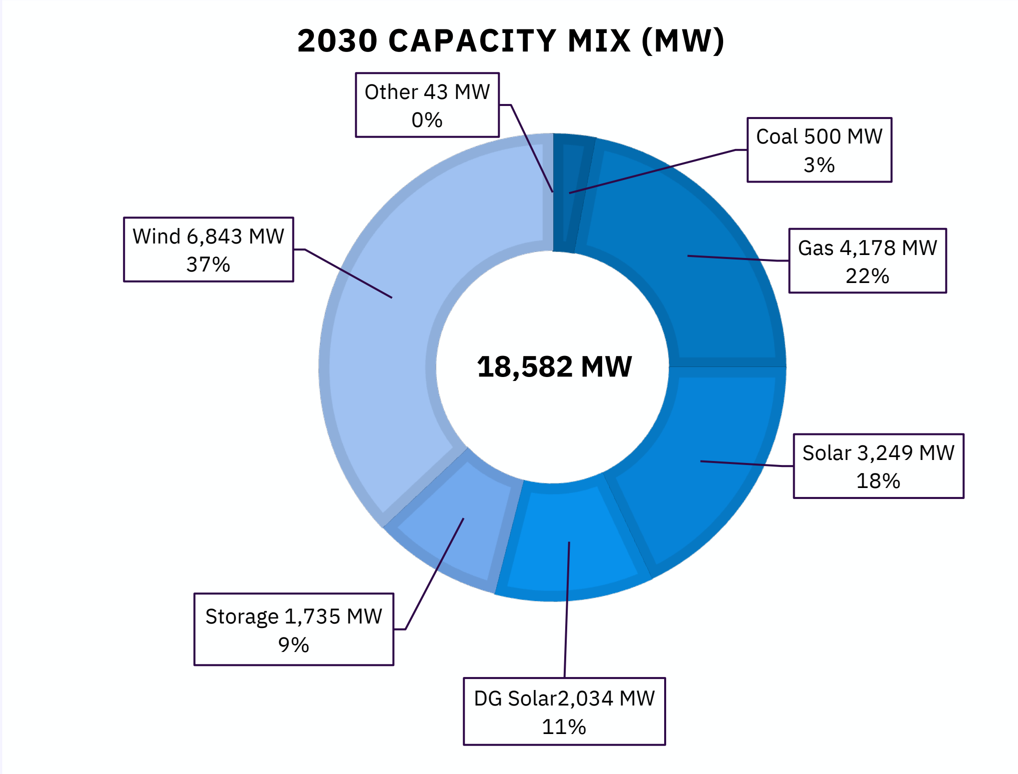
PSCo ERP – Phase II

The PSCo ERP – Phase II, also known as the 120-Day Report,[1] is a commendable advancement towards a decarbonized future, proposing an 80% reduction in carbon emissions from 2005 levels by 2030 and scheduling the retirement of all coal plants by 2031. Despite this progress, PSCo has proposed the construction of three new natural gas combustion turbine ("CT") units to be in service by 2027. The three fossil fuel plants included in the Preferred Portfolio are a 400 MW natural gas CT, a 200 MW natural gas CT, and a 28 MW aeroderivative CT with dual fuel capability, for a total of 628 MW. Including existing resources, natural gas generation will be 22% of the total nameplate capacity in 2030, or approximately 4,178 MW, as shown in Figure .

Figure 1 – PSCo ERP Proposed Capacity Mix of Preferred Portfolio by Fuel Type (Source: PSCo 120-Day Report, Figure 3)

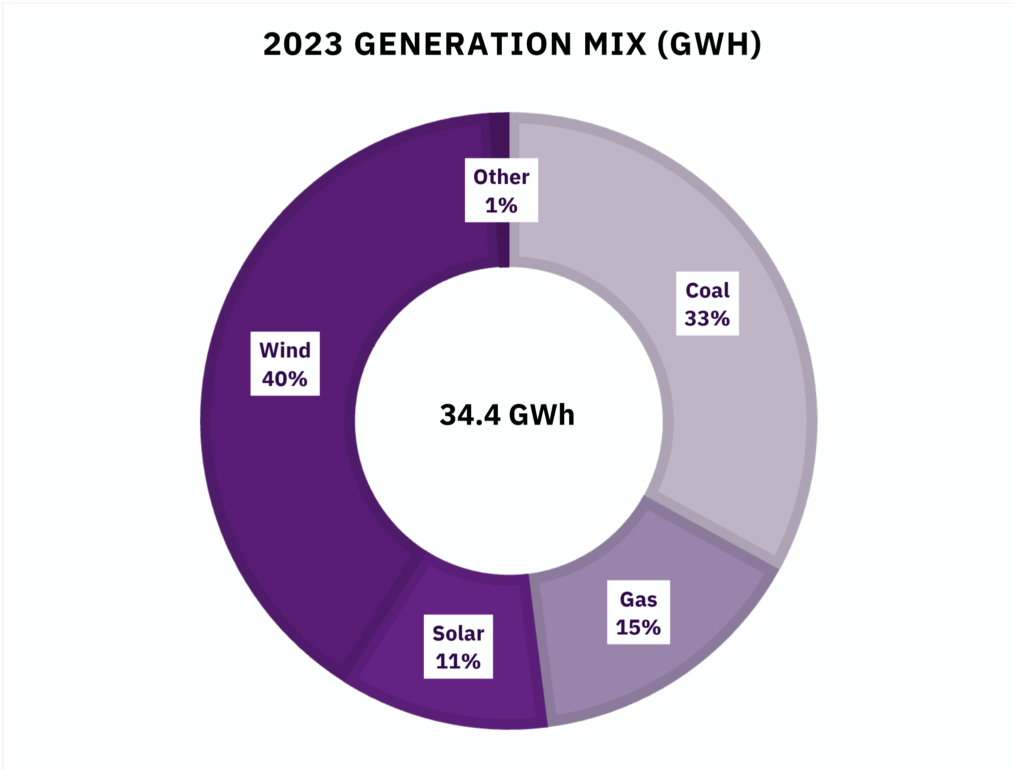


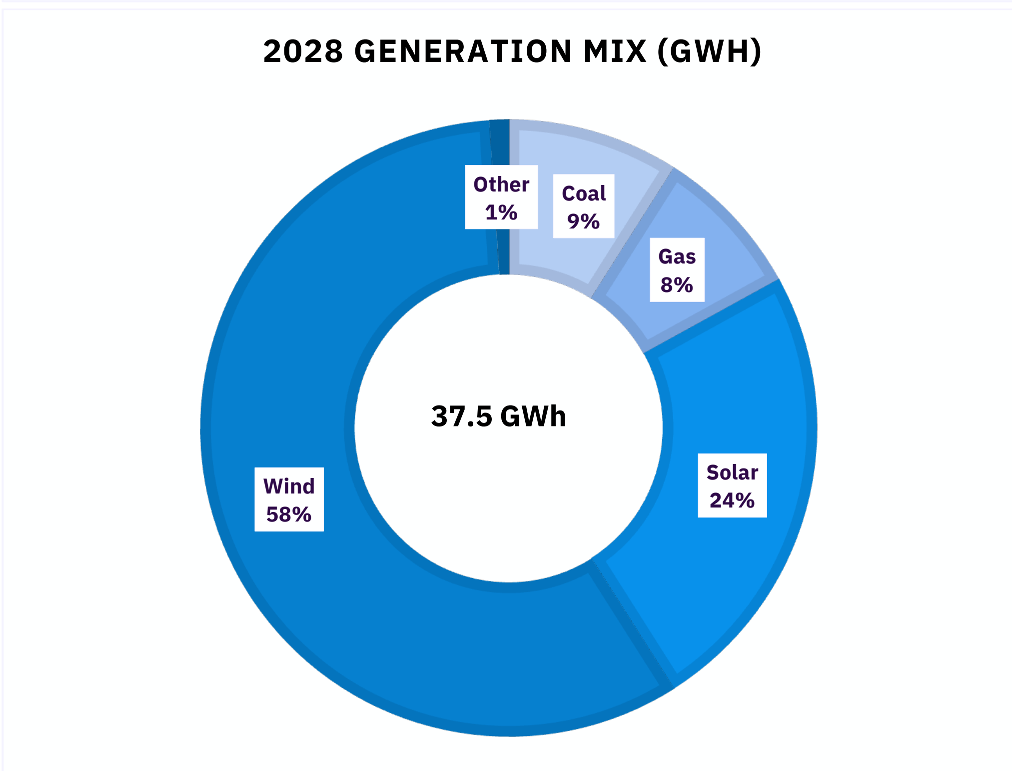
[1] https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/PUBLIC%202021%20ERP%20&%20CEP_120-Day%20Report_FINAL.pdf.



PSCo is also forecasting improvements from an energy perspective. As detailed in the 120-Day Report, 2028 generation will be largely renewable-based, with nine percent of energy generated by coal and eight percent by natural gas as shown in Figure . However, PSCo does not provide detailed generation results for any other year in the 120-Day Report, and thus it is unclear how the generation mix will change when all coal is retired in 2031. Unless more clean energy is procured by 2031, it is likely that the new natural gas CTs will increase their capacity factor to replace the coal-fired energy generation.

Figure 2 – PSCo ERP Proposed Generation Mix of Preferred Portfolio by Fuel Type
(Source: PSCo 120-Day Report, Figure 1)





PSCo developed the Preferred Portfolio using capacity expansion and production cost modeling tools EnCompass and PLEXOS. These are commercially available software platforms that are routinely used in docketed resource planning cases throughout the United States to determine least cost and least risk portfolios in long-term planning. PSCo developed a Least Cost Portfolio using these tools by fixing the retirement dates of resources established in Phase I, and then allowing for the optimal selection of candidate resources using the bids received during their 2022 RFP. Once the Least Cost Portfolio was established, PSCo then made several post-modeling manual adjustments to create the Preferred Portfolio. Notably, there were three dispatchable power plants added:

1. 28 MW aeroderivative CT with dual fuel capability to provide local reliability needs in the San Luis Valley.
2. 200 MW natural gas CT to provide counter flow on the transmission system to increase the import capability of renewable energy into Denver metro area.
3. 19 MW biomass plant to support just transition for employees of the Hayden coal plant which is slated for retirement.

The manual addition of these resources replaced a 219 MW natural gas PPA that was originally included in the Least Cost Portfolio (a net increase of 9 MW). The Preferred Portfolio also reduced the deployment of solar resources by 400 MW and reduced storage by 250 MW, resulting in an overall cost increase of $207 million. The justification provided for reduction in clean energy resources is “the increased firm dispatchable generation from the Alamosa CT (San Luis Valley 28 MW CT)” reduces the need for additional resources, and that “the increased carbon-free energy from the biomass unit” reduces the need for carbon-free energy from other resources.[2]

Both arguments appear to be inadequate. Regarding dispatchable generation, the increase in natural gas and biomass dispatchable generation is only 9 MW compared to the Least Cost Portfolio, while storage is reduced by 250 MW, for an overall reduction of 222 MW of firm dispatchable generation (Table 1). Additionally, the total emissions of the Preferred Portfolio increase by 2.3 million metric tons from 2023-2055 compared to the Least Cost Portfolio. Given the inadequacy of the justifications for PSCo’s final portfolio, it is necessary to assess whether clean energy resources have been overlooked in favor of new natural gas plants.

[2] Xcel 120-Day Report, page 40.

Table 1 – Comparison of Preferred Portfolio and Least Cost Plan (Source: PSCo 120-Day Report)

Nameplate Capacity (MW)	Least Cost Plan (SCC)	Preferred Plan (SCC)	Change From Least Cost Plan
Biomass	-	19	19
Gas	619	628	9
Solar	2,369	1,969	(400)
Storage	1,420	1,170	(250)
Wind	3,406	3,406	0
TOTAL Nameplate Additions (MW)	**7,814**	**7,192**	**(622)**
Emissions 2023-2055 CO2 (M Tons)	*90,731,893*	*93,063,889*	*2,331,996*
Total PVRR ($M)	*$43,984*	*$44,191*	*$207*
Total Present Value Societal Cost (PVSC) ($M)	*$50,197*	*$50,535*	*$338*

Inflation Reduction Act and the Impact on Resource Planning

Between the completion of Phase I of the ERP and the start of Phase II, there was a shift in the energy industry due to the passage of the 2022 Inflation Reduction Act ("IRA"). The IRA includes electricity sector policies and incentives that dramatically reduce the cost of many clean energy resources, including battery storage. This is considered by many to be the most significant U.S. legislation to advance clean energy investment and has already begun altering the economics of utilities' planning decisions.[3]

Passed in August 2022, the IRA provides significant and previously unseen benefits for investments in clean energy technologies, including the following benefits[4]:

- Extension of clean energy tax credits at their full value for at least ten years, providing economic certainty for investors, developers, and utilities.

[3] https://blog.advancedenergyunited.org/as-industrial-policy-the-inflation-reduction-act-will-reshape-the-economy.

[4] *Inflation Reduction Act of 2022: Summary Chart*, Troutman Pepper Hamilton Sanders LLP https://www.troutman.com/images/content/3/1/319248/IRA-Energy-Impact-Summary-August-2022.pdf.

- Technology-neutral tax credits for zero-emission projects, including expansion of the Production Tax Credit ("PTC") to include solar and expansion of the Investment Tax Credit ("ITC") to include standalone energy storage.
- Clean energy ITC rate up to 30% of the basis of qualified energy property for facilities that pay prevailing wages.
- PTC rate of 100% of the inflation-adjusted credit amount.
- Additional tax credits for projects built in energy communities5 or low-income communities (ten percent of PTC credit).
- Additional ten percent of PTC credit for domestic-built content.

According to a recent survey performed by RMI, when full IRA benefits are used (ITC at 50%, PTC at $31.2/MWh by including prevailing wages, domestic content, and energy community bonuses), equivalently sized renewable energy sources are cheaper than 99% of proposed gas plants in the US.[6]

For Phase II, PSCo updated its economic assumptions to account for some of the impacts of the IRA. The generic resource costs for solar and battery storage included the base 30% ITC and a reduction in capital costs, and generic wind resources were modeled with the full PTC. They did not include the additional bonuses for energy or low-income communities or domestic content. PSCo's 120-Day Report highlights the massive impact of the IRA on their plan, including $10 billion in IRA benefits to their customers and the addition of over 6,500 MW of new clean energy resources while maintaining affordable rates. This plan shows promise, but still relies on the buildout of more natural gas generation, potentially limiting the value of these once-in-a-generation incentives.

Peaker Replacement Analysis

Economic Analysis: Combustion Turbine vs. Battery Storage

Strategen conducted analysis to evaluate the feasibility and cost of an alternative clean energy portfolio for PSCo that included greater investments in battery storage, solar, and wind in lieu of a portion of the proposed new natural gas capacity. This analysis focuses specifically on the replacement of the proposed 400 MW natural gas CT (Bid 1000). While the Preferred Plan also includes a 200 MW CT (Bid 0989) and a 28 MW CT (Bid 0986), these two resources were added to the portfolio specifically for their local reliability benefits. Because Strategen only has access to the publicly available bid data and no location-specific data, it was not possible to

[5] U.S. Department of the Treasury has issued guidance defining "energy Communities" as communities with closed coal mines or retired coal-fired power plants https://home.treasury.gov/news/press-releases/jy1269 February 13, 2023.

[6] *The Business Case for New Gas Is Shrinking*, Lauren Shwisberg, Rocky Mountain Institute https://rmi.org/business-case-for-new-gas-is-shrinking/ December 8, 2022.

recommend an alternative resource plan for clean energy projects that may not exist in the required location. Instead, the analysis focuses solely on the 400 MW CT that PSCo's model selected for economic value and compares its net cost against the replacement clean energy resources. However, this analysis may also be applicable to the 200 MW CT, if locational data and local reliability analysis were made available to stakeholders. The following sections describe the analysis, including the inputs, assumptions, and results.

Sizing the Battery Storage

In determining an alternative portfolio without the 400 MW CT, it is necessary to size the replacement resources to meet the equivalent capacity value of the CT. Additionally, for reliability purposes, the sizes of the dispatchable battery storage resources were chosen to roughly match the power output of the CT. The capacity accreditation values were calculated using PSCo's forced outage rate for a generic CT[7] and Effective Load Carrying Capability ("ELCC") values for generic storage, solar, and wind (Table). For illustrative purposes, specific RFP bids have been selected to provide a representative portfolio of resources that can be deployed in 2027 to replace the CT. However, it should be noted that these particular projects may not be suitable for cost, location, or other reasons, in which case other similarly sized projects may be used.

[7] Xcel 120-Day Report, Appendix D, Table 2.14-30.

Table 2 – Clean Energy Portfolio Capacity and Energy Compared to CT

Proposed Resource	Installed Capacity (MW)	Firm Capacity Rating (%)[8]	Capacity Accreditation (MW)	Bid No.
CT	400 MW	96%	384 MW	No. 1000
Clean Energy Alternative Resources	**Installed Capacity (MW)**	**ELCC[9]**	**Capacity Accreditation (MW)**	**Bid No.**
4-hr Battery Storage	399 MW	70%	279.3 MW	No. 0995 | 199 MW No. 0593 | 200 MW
Solar	492 MW	5.4%	26.6 MW	No. 0594 | 250 MW No. 0315 | 242 MW
Wind	1081.5 MW	11.3%	110.3 MW	No. 0010 | 202.5 MW No. 0043 | 375 MW No. 1013 | 504 MW
Total	**1972.5 MW**	**-**	**416.1 MW**	-

Net Cost Comparison

After sizing the clean energy portfolio to provide sufficient firm capacity to replace the CT, the economics of the alternatives were calculated by analyzing the operations of each resource in the first year of operations (2027). The assets were assumed to operate economically based on the Four Corners wholesale power price and Colorado Interstate Gas ("CIG") natural gas price base forecasts defined in Appendix D, Table 2.14-2. The Four Corners 2027 hourly power price was determined by taking the historical hourly price shape from October 20, 2022, through October 19, 2023, and scaling to PSCo's forecasted On- and Off- peak average prices.[10]

[8] CT firm capacity rating calculated as 1-Forced Outage Rate (FOR), where FOR=4% (Xcel 120-Day Report, Appendix D, Table 2.14-30).

[9] Xcel 120-Day Report, Appendix D, Table 2.14-9 (solar), Table 2.14-12 (storage), and Table 2.14-7 (wind). ELCC values assume the final Xcel portfolio includes over 500 MW of total storage and over 2,000 MW of both total solar and wind.

[10] Hourly historical power price sourced from S&P Capital IQ Pro.

Table 3 – 2027 Average Annual Commodity Price Forecasts
(Source: PSCo 120-Day Report, Appendix D)

Scenario	Four Corners On-Peak ($/MWh)	Four Corners Off-Peak ($/MWh)	CIG ($/mmBTu)	SCC ($/ST CO2)
Base	$33.50	$34.75	$4.28	$89.16
Low	$28.76	$29.83	$3.68	$89.16
High	$38.59	$40.03	$4.93	$89.16

The CT was allowed to dispatch economically based on the hourly implied heat rate. The Social Cost of Carbon ("SCC") was not included in the dispatch optimization but was calculated following the model results as a cost based on the annual emissions from the plant. This approach is consistent with PSCo's methodology, as described on page 97 of the 120-Day Report.

The battery was limited to one charge/discharge cycle per day, with cost for charging and revenue for discharging calculated based on the hourly power price. Revenue from solar and wind generation was calculated based on the hourly generation and power price.
Since this analysis is based on the publicly available RFP bid details, the costs were assigned based on the generic costs of the resources found in Appendix D[11], and not the confidential costs associated with the specific RFP bids. These costs defined by PSCo include the annual fixed costs of a generic CT[12], levelized fixed costs of 4-hour duration battery storage,[13] and capital costs of solar and wind.[14] Additionally, PSCo did not include a fixed operations & maintenance ("FOM") for wind and solar energy, so this cost was added from the 2021 NREL ATB.[15] Full cost details are provided in Appendix A – Model Inputs and Detailed Results.
The total net cost of each asset is calculated by subtracting the total costs from the total gross revenue. The asset with the lower net cost provides the necessary capacity at lower cost for the utility and its customers.

[11] Xcel 120-Day Report, Appendix D, Tables 2.14-31 and Table 2.14-32.
[12] Inclusive of initial and ongoing capex, FOM, firm fuel costs, and transmissions interconnection and assumed delivery costs.
[13] NREL 2021 ATB Overnight Capital Costs inflated at 2%/yr from 2019 to the in-service year.
[14] Calculated by Xcel from the 2021 NREL ATB capital costs (with an assumed 11% levelized fixed charge rate) and FOM costs, both inflated at 2%/yr from 2019 to the in-service year. The calculation also assumes that the battery qualifies for a 30% ITC through 2037.
[15] NREL 2021 ATB Fixed O&M Costs for land-based wind and utility-scale solar. 2021 vintage is consistent with Xcel's other generic cost assumptions.

Consistent with the 120-Day Report, the analysis considered three price sensitivity scenarios, with resources dispatched economically. All scenarios include SCC, consistent with the Preferred Portfolio.

1. Econ Dispatch: 2027 Base Forecasted Power/Gas Prices + SCC
2. Econ Dispatch: 2027 Low Forecasted Power/Gas Prices + SCC
3. Econ Dispatch: 2027 High Forecasted Power/Gas Prices + SCC

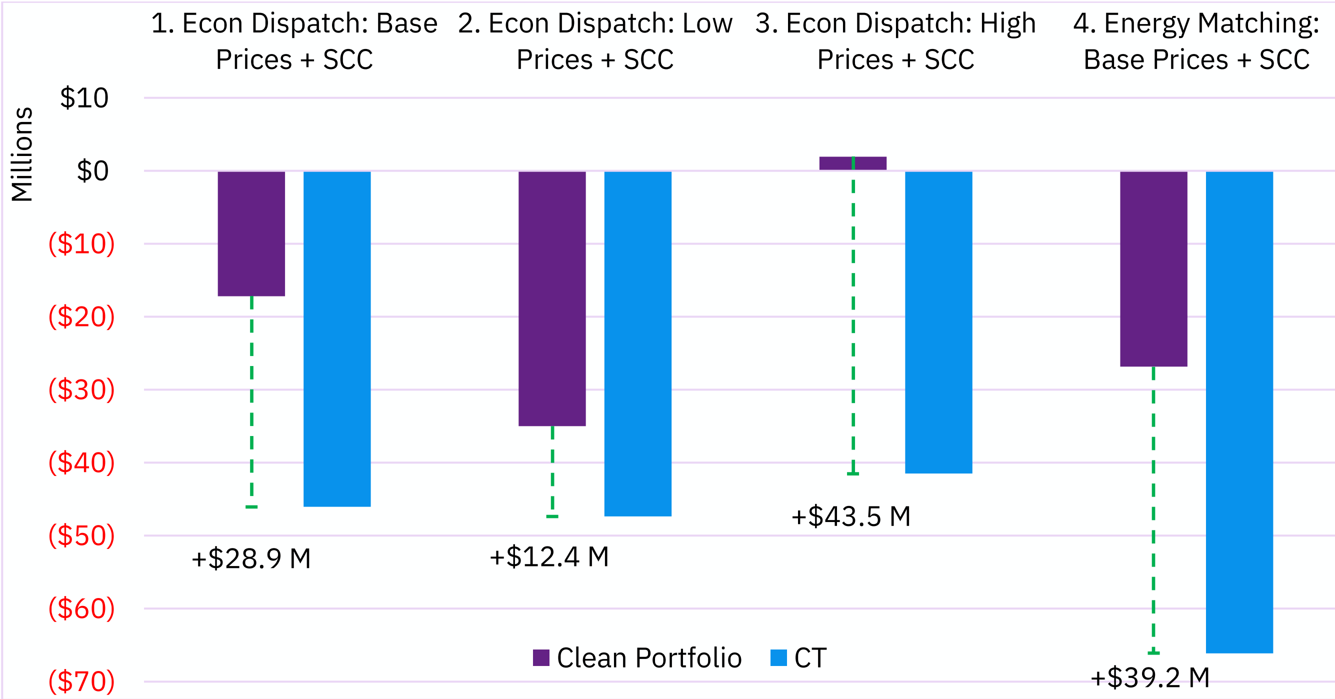
Additionally, a fourth scenario was developed that compared the historical generation of a comparable CT in the region to assess the ability of the clean energy portfolio to provide energy in the same hours as the CT.

4. Energy Matching: 2027 Base Forecasted Power/Gas Prices + SCC

This scenario calculated the total net cost using the same approach as the prior scenarios. If there were any hours where the CT dispatched and the clean energy portfolio was unable to generate an equivalent amount of energy as the CT, that missing energy was considered a cost valued at the hourly power price.

Across the four scenarios, the clean energy portfolio provides an average net benefit of $30.1 million over the CT in 2027. Summarized results for all scenarios are shown in Figure below.

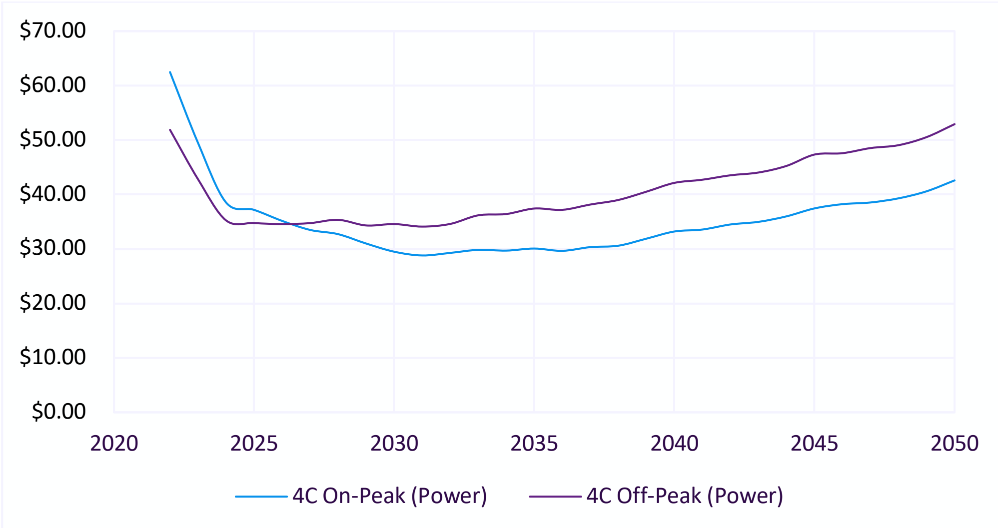
Figure 3 – 2027 Net Cost Across Four Scenarios
(Net Cost Includes Annualized Fixed Costs, Operational Costs, and Energy Revenue)



*Clean Energy Portfolio net savings relative to CT labeled for each scenario.

The analysis focuses on a single year, but net savings for the clean energy portfolio are expected to continue in subsequent years. As intermittent renewable generation increases in PSCo's service territory, the fast charging and discharging capabilities of batteries will provide added value to the system as a flexible asset. Additionally, beginning in 2027 there is an inversion of on-peak and off-peak power prices, as shown in Figure . This gap grows until 2050, indicating that the wind resources, which generate most of their energy at night during off-peak, will only increase in value. Further, the additional storage resources in the alternative portfolio assures that lower midday energy prices driven by solar expansion are captured by lower charging cost. These macro-level trends indicate that the economics of the clean energy portfolio should remain advantageous even beyond the scope of this analysis. The next sections detail the cost breakdown for each of the five scenarios in the first year of operation.

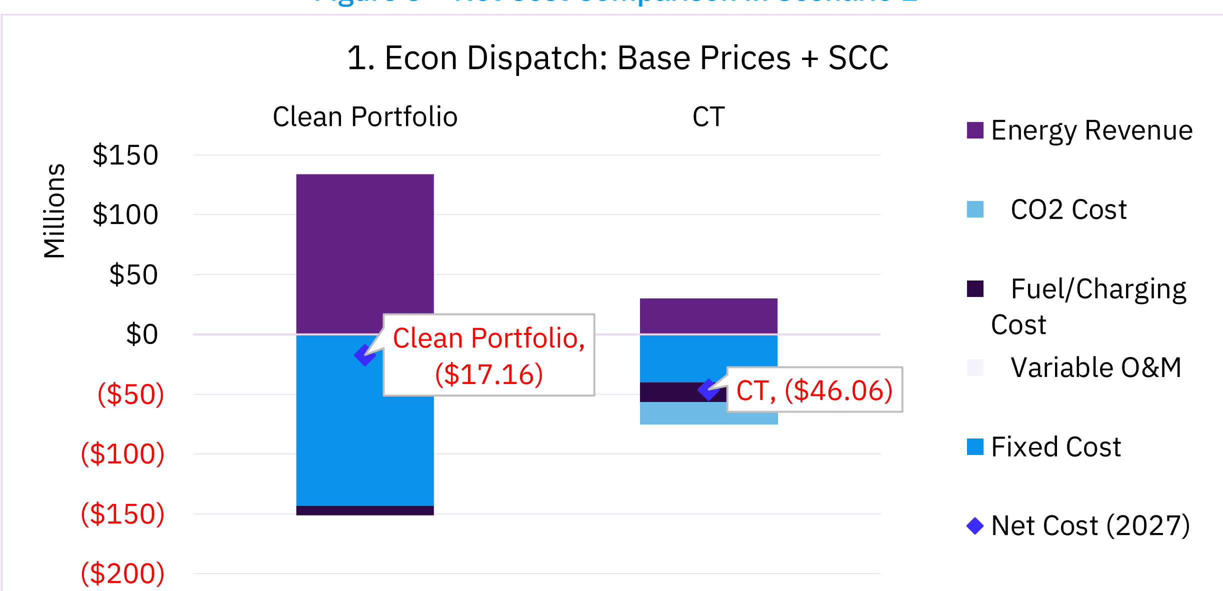
Figure 4 – Forecasted Base Power Prices Through 2050
(Source: PSCo 120-Day Report, Appendix D)



Scenario 1: Econ Dispatch: 2027 Base Forecasted Power/Gas Prices + SCC

In Scenario 1, the Base 2027 gas and power prices were used in addition to the SCC carbon price from PSCo's ERP. This price scenario results in a 10% capacity factor for the CT and an overall net benefit of $28.9 million for the clean portfolio relative to the CT in 2027. Figure details the cost and revenue components that make up the total net cost for the clean energy portfolio and CT in this scenario.

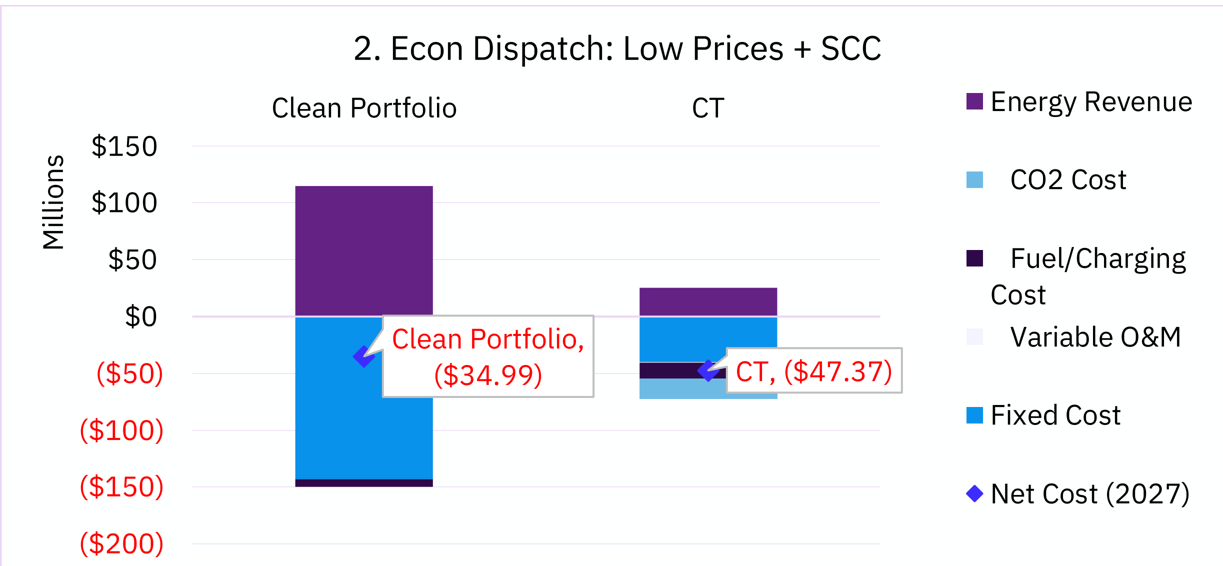
Figure 5 – Net Cost Comparison in Scenario 1



Scenario 2: Econ Dispatch: 2027 Low Forecasted Power/Gas Prices + SCC

Scenario 2 uses the Low 2027 power and gas prices in addition to the SCC carbon price from PSCo's ERP. As a result, the capacity factor of the CT decreased to 9.7%. The decreased production resulted in approximately $1.2 million less revenue for the CT compared to Scenario 1, while the lower power prices also reduced revenue for the clean energy portfolio by $18 million. Still, overall economics remained in favor of the clean energy portfolio with a total net benefit of $12.4 million relative to the CT in 2027. Figure details the cost and revenue components that make up the total net cost for the clean energy portfolio and CT in this scenario.

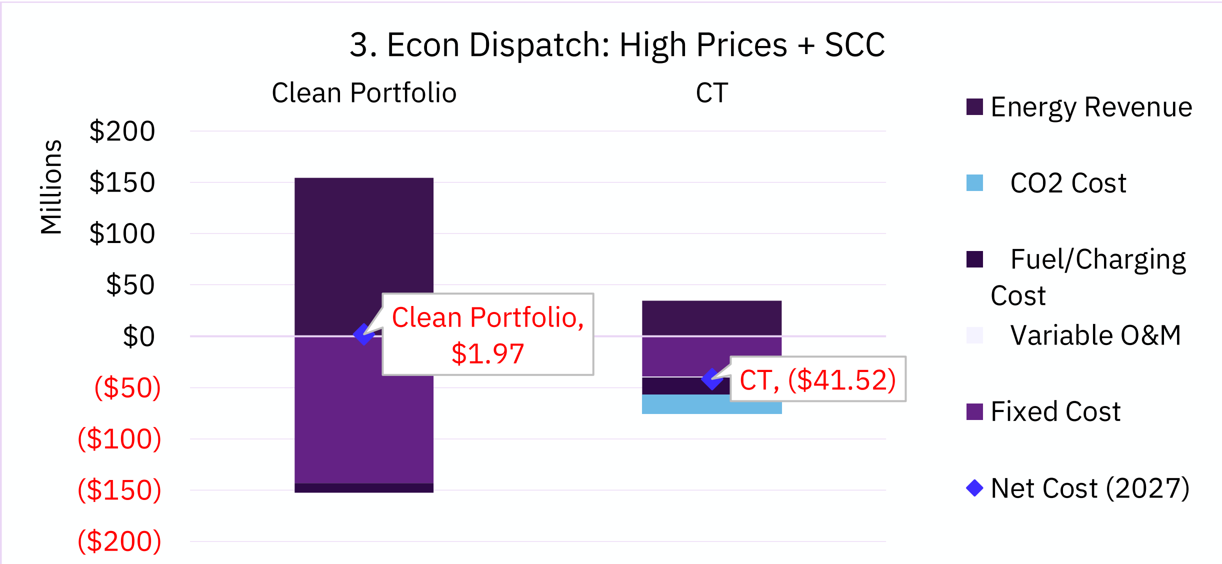
Figure 6 – Net Cost Comparison in Scenario 2



Scenario 3: Econ Dispatch: 2027 High Forecasted Power/Gas Prices + SCC

Scenario 3 used High 2027 Forward prices for power and gas, plus SCC. The CT capacity factor remained similar to Scenario 1 at 10%, but the clean portfolio's revenue increases $19 million relative to Scenario 1. The result is the clean energy portfolio seeing a total net benefit of $43.5 million relative to the CT in 2027. Figure details the cost and revenue components that make up the total net cost for the clean energy portfolio and CT in this scenario.

Figure 7 – Net Cost Comparison in Scenario 3



Scenario 4: Energy Matching: 2027 Base Forecasted Power/Gas Prices + SCC

Instead of simulating economic dispatch as in the prior scenarios, Scenario 4 models the clean energy portfolio to analyze if it has the capability to generate energy during the same hours as the CT. To this end, a historic generation profile of a similar CT[16] was used to simulate when the proposed CT may operate for reliability purposes, as opposed to economic-driven operation. Battery operations were then scheduled to discharge only when the CT would be operating and the renewable energy was insufficient for matching the CT generation. This approach intentionally reduces the economic value of the clean energy portfolio with the intent of showing how clean energy resources may be used for reliability purposes, rather than pure economic operations. This scenario also reduces the economic value of the CT, as it was not optimized to 2027 prices.

In total, there were only 128 hours throughout the year where the clean energy portfolio was not able to fully replace the hourly generation of the CT. This represents 28,741 MWh of energy not served by the clean energy portfolio, equivalent to 0.1% of PSCo's total annual load demand. The clean energy portfolio incurs an additional cost of $1.1 million to replace this unserved energy, representing the cost of increasing generation from another PSCo resource or purchasing energy from a neighboring utility.

[16] Manchief Electric Generating Station Unit 1 in Brush, CO. The Unit has a 150 MW nameplate capacity and operates at an 8% capacity factor. Every hour of dispatch was assumed to be at full capacity. Hourly dispatch was taken from S&P Global.

Even though the battery operations in this scenario were intentionally made sub-optimal from an economic perspective, the net cost analysis still favors the clean energy portfolio with a total net benefit of $39.2 million relative to the CT in 2027. Figure 8 details the cost and revenue components that make up the total net cost for the clean energy portfolio and CT in this scenario, and Figure 9 shows an example three-day period where the clean energy portfolio operates to match the hours of generation from the CT.

Figure 8 – Net Cost Comparison in Scenario 4

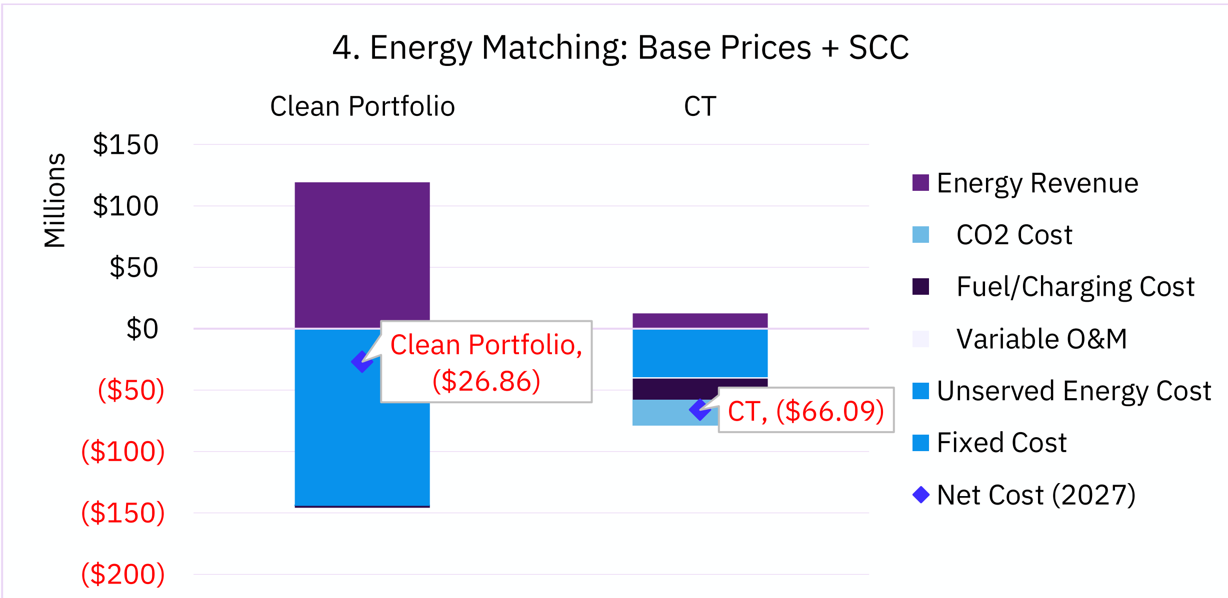
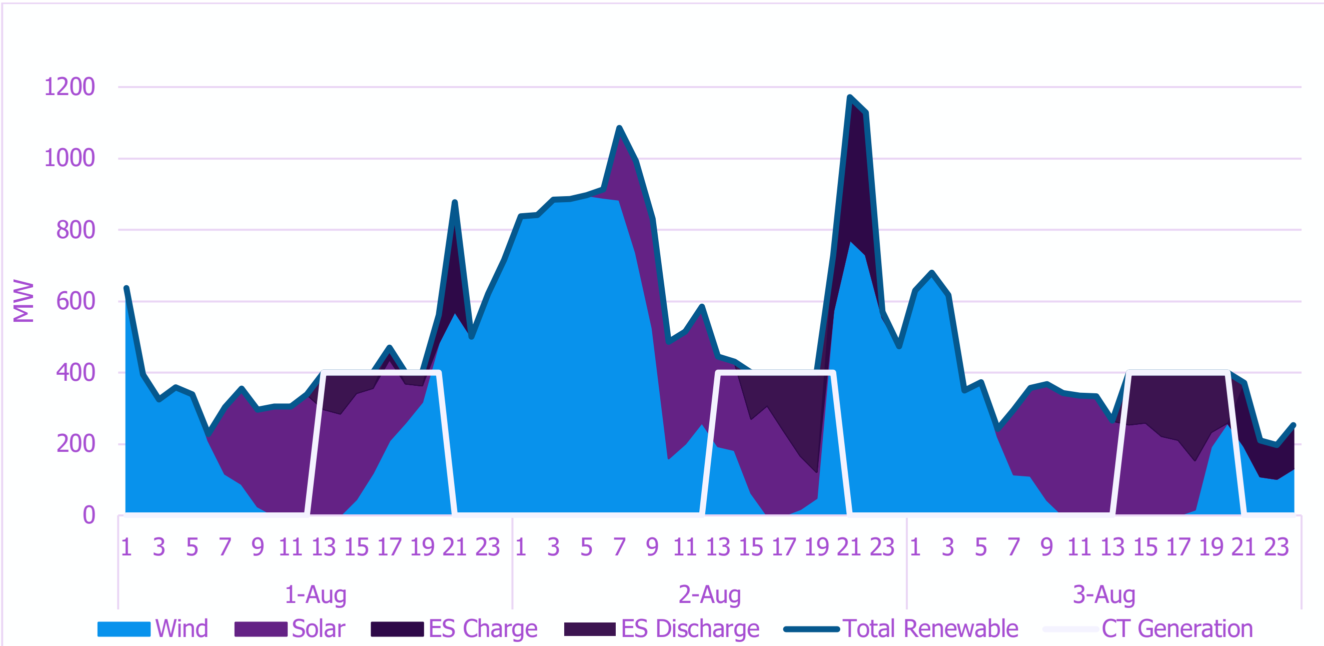


Figure 9 – Hourly Dispatch of Clean Energy Portfolio to Match CT Generation from August 1 to August 3, 2027
(Battery Charges During Periods of Excess Renewable Energy to Ensure Ability to Discharge to Match CT Generation)



Emissions Savings:

Beyond the economic value PSCo would see from the clean energy portfolio, it would also provide environmental benefits by reducing carbon emissions. Between the four scenarios examined in this report, the proposed clean portfolio is projected to abate between 180,000 and 218,000 tons of CO2 per year by removing the fossil fuel resource and replacing with clean energy from wind, solar, and battery storage.[17] Further, this portfolio could potentially provide more savings beyond just the emissions profile of the CT. As shown in Figure 9, there are many hours where the renewable generation exceeds the CT generation. This excess renewable energy could reduce the need for thermal generation elsewhere in PSCo's system. Based on PSCo's projected 2028 generation mix of 9% coal and 8% natural gas (see Figure 2), this excess renewable energy could save an additional 604,396 tons of CO2 per year.

Total Portfolio Cost Considerations: Assessment of PSCo's Alternative Portfolios

In addition to the direct economic comparison between the assets, it is also valuable to assess the overall portfolio impact of replacing the proposed CT with clean energy resources. While there is not an exact portfolio in PSCo's 120-Day Report that matches the proposed scenario,

[17] Annual emissions calculated using the heat rate and CO2 emissions rate for a generic CT defined in Appendix D, Table 2.14-30.

the Lower Dispatchable Plan considers a scenario with less natural gas generation and more solar than the Preferred Portfolio. This alternate portfolio achieves a nearly identical Present Value Revenue Requirement (PVRR) with lower emissions, and when including the SCC, the Present Value Societal Cost (PVSC) is over $100 million cheaper than the Preferred Portfolio (Table 4) This is achieved while still including the projects chosen for local reliability: San Luis Valley natural gas CT (Bid 0986), Denver metro natural gas CT (Bid 0989), and Hayden biomass plant (Bid 1031).

Table 4 – Preferred Portfolio and Lower Dispatchable Plan Comparison (Source: PSCo 120-Day Report, Table 27)

Portfolios' Comparison of Key Characteristics

Nameplate Capacity (MW)	1 - Preferred Plan (SCC)	6 - Lower Dispatchable Plan (SCC)
Biomass	19	19
Gas	628	504
Solar	1,969	2,369
Storage	1,170	1,170
Wind	3,406	3,406
TOTAL Nameplate Additions (MW)	7,192	7,467
Flexible Capacity (MW)	1,817	1,693
Colorado Power Pathway (CPP) Trx Utilization (MW)	4,411	4,811
CPP May Valley-Longhorn Extension Trx Utilization (MW)	1,206	1,206
Accredited Capacity (MW)	1,621	1,545
Section 123 Capacity (MW)	19	19
Owned Capacity (MW)	4,787	4,587
Owned Capacity (%)	66.6%	61.4%
Owned Energy (%)	69.7%	65.7%
Accredited Capacity Position		
2028 Capacity Position Long/(Short) (MW)	100	24
2028 Actual Reserve Margin (%)	19.7%	18.5%
Planning Period Present Value Revenue Requirement (PVRR) ($M)		
NPV Base Portfolio Costs ($M)	$ 41,708	$ 41,682
NPV Trx PO-PF Interconnection Costs ($M)	$ 130	$ 157
NPV Trx Network Upgrades for Delivery ($M)	$ 2,353	$ 2,353
TOTAL PVRR ($M)	$ 44,191	$ 44,192
PVRR Delta vs. Preferred Plan ($M)	$ -	$ 1
Emissions		
2023-2030 CO2 (M Tons)	69,322,272	68,775,275
2023-2055 CO2 (M Tons)	93,063,889	91,044,125
2023-2055 CO2 Delta vs. Preferred Plan (M Tons)	-	(2,019,764)
2030 CO2 Reduction from 2005 (%)	-87.4%	-87.8%
2023-2055 NPV CO2 at SCC ($M)	$ 6,288	$ 6,175
2023-2055 NPV Methane at SCM ($M)	$ 57	$ 54
TOTAL Present Value Societal Cost (PVSC) ($M)	$ 50,535	$ 50,421
PVSC Delta vs. Preferred Plan ($M)	$ -	$ (114)
Other		
2023-2055 Natural Gas Burn (MMBtu)	648,263,108	620,831,187
2028 Renewable Energy MWh (%)	83.0%	83.9%

PSCo's own analysis confirms that solar can affordably replace the capacity of natural gas within the context of the larger portfolio. Based on the analysis described in the prior sections, there is evidence that additional reduction of natural gas and replacement with additional solar, wind, and battery storage can reduce costs for PSCo compared to the Preferred Portfolio.

Additional Considerations

Battery Storage Grid Services

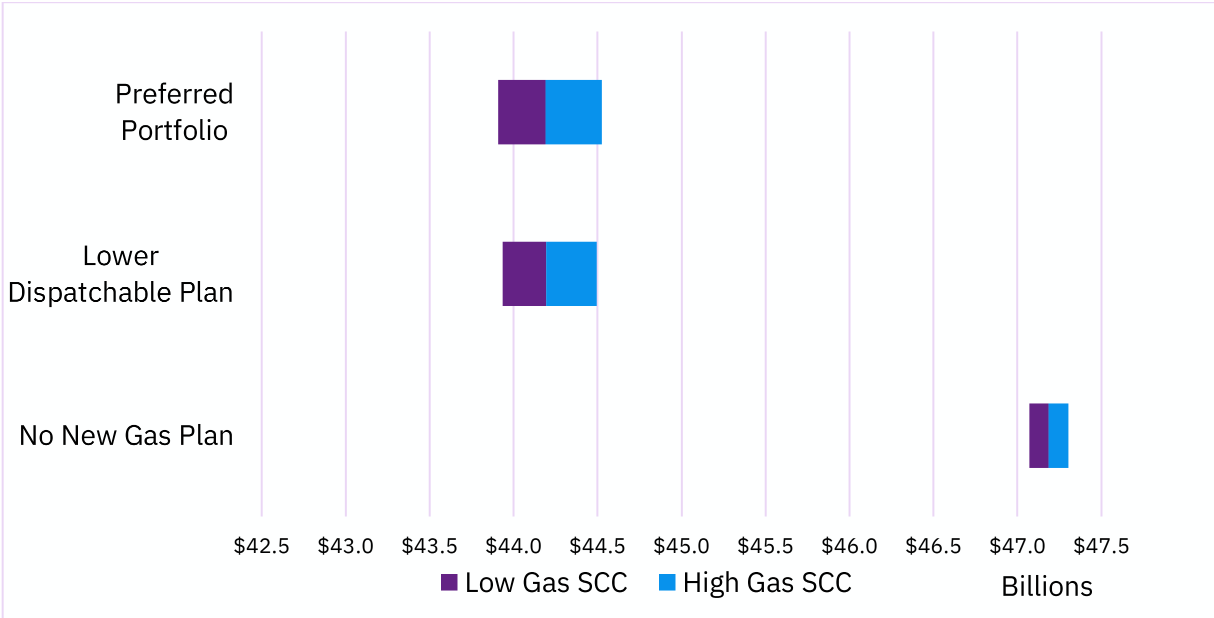
While fossil fuel resources such as CTs are commonly cited in resource planning activities as valuable for their ability to provide reliability and ancillary services to the grid, the instantaneous charging and discharging capabilities of battery storage can often serve the same purpose while adding even more flexibility to grid operators. A recent white paper published by the Western Electricity Coordinating Council ("WECC") showed that battery storage can provide a variety of ancillary services, including frequency control, regulating reserve, flexibility reserve, contingency reserves, load following, ramping, blackstart capability, and voltage support.[18] In addition to ancillary services, batteries can provide energy service products such as load leveling, time shifting, and generating capacity, as well as transmission service products such as transmission deferral, congestion relief, and micro griding. Further explanation of each product is available in WECC's report. The 120-Day Report does not provide details on the grid services provided by the proposed gas CTs, but to the extent they are included in the Preferred Portfolio to meet grid needs beyond energy and capacity, the alternative clean energy portfolio may be able to meet equal or greater capability.

Fuel Price Volatility Risk

While PSCo is progressing toward a portfolio driven by more clean energy, they remain reliant on natural gas resources as the primary source of dispatchable generation. This can present overall economic risk due to the fluctuating price of natural gas. PSCo performed both High Gas Price and Low Gas Price scenarios to assess the elasticity of each portfolio's total PVRR against fuel prices. Figure 10 shows the range of PVRR for the Preferred Portfolio, Lower Dispatchable Plan, and No New Gas Plan across the Base Gas Price, High Gas Price, and Low Gas Price scenarios.

[18] *Energy Storage Services*, WECC Energy Storage Task Force, https://www.wecc.org/Administrative/ES%20Services%20White%20Paper%20Final_final.pdf, February 13, 2023.

Figure 10 – Total PVRR ($B) from 2023-2055 for High and Low Gas Price Scenarios Against Three Portfolios (Source: PSCo 120-Day Report, Appendix S and U)

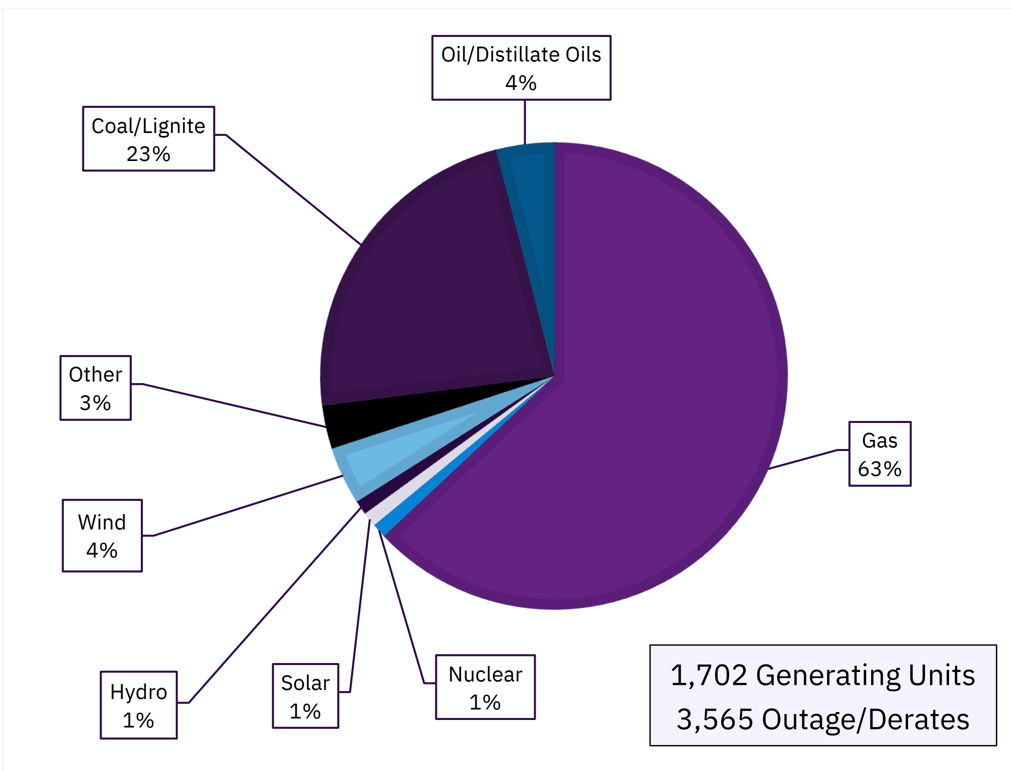


The key takeaway from this plot is the size of the distribution for each portfolio. The Preferred Portfolio has the widest range, meaning this portfolio has the largest fuel volatility risk profile. The Lower Dispatchable Plan, which has less natural gas and more clean energy, has the same PVRR in the Base Gas Price scenario, but in the High Gas Price scenario, it is $30 million cheaper than the Preferred Portfolio. While the No New Gas Plan overall is a higher cost, it also has a much smaller distribution across price scenarios. The No New Gas Plan has a range of $231 million between the Low and High price scenarios, while the Preferred Portfolio's range is nearly three times larger at $615 million. This shows the value of clean energy resources for portfolio risk management and the inherent risk of investment in fossil fuel generation. Furthermore, in each scenario the risk is skewed towards the high gas scenarios, meaning that high gas prices would have a larger negative impact on costs than the potential positive impact of low gas prices. This skewed tail risk is further evidenced in the analysis in Section 2.1. While the clean energy portfolio is more cost-effective in all price scenarios, the High Gas Price scenario increases the cost saving for clean energy by $17.2 million compared to the Base Gas Price scenario, while the Low Gas Price scenario only has a $16.5 million change from the Base.

Fuel Supply Risk and Fossil Fuel Asset Reliability Risk

In recent years, fuel delivery risk has been heightened across the country due to more extreme weather events, in particular winter storms. In the recent 2022 Winter Storm Elliot, several balancing authorities, including PJM, MISO, SPP, and ISO-NE, had significant unplanned outages, largely because of the lack of gas supply availability. As shown in Figure 11, approximately 3,565 outages or derates occurred during the storm, 63% of which were caused by problems with natural gas resources.[19] This type of event has occurred with increased frequency in recent years across the country. Since 2011, four other winter storms have caused at least 15 GW of concurrent forced outages.[20] In 2021, Winter Storm Uri caused over 61 GW of forced outages, leading the Federal Energy Regulatory Commission ("FERC") and the North American Electric Reliability Council ("NERC") to recommend revising power grid and natural gas infrastructure reliability standards due to the extreme levels of outage among natural gas assets.

Figure 11 – FERC Reported Unplanned Outages by Resource Type during Winter Storm Elliot (Percentages by Unavailable MW) (Source: FERC-NERC-Regional Entity Joint Inquiry into Winter Storm Elliott)



While the most recent storms have not directly affected reliability in Colorado, the increase in frequency, magnitude, and geographic diversity of winter storms indicates that it is a matter of

[19] FERC-NERC-Regional Entity Joint Inquiry Into Winter Storm Elliott, https://www.ferc.gov/news-events/news/presentation-ferc-nerc-regional-entity-joint-inquiry-winter-storm-elliott, September 21, 2023.

[20] FERC, NERC and Regional Entity Joint Staff Inquiry, *February 2021 Cold Weather Grid Operations: Preliminary Findings and Recommendations,* October 21, 2021.

when, not if, PSCo will be impacted. Given the fact that winter storms have an outsized impact on the reliability of natural gas assets, PSCo should be looking for all options to replace their proposed natural gas resources with more reliable alternatives.

Stranded Asset Risk

Stranded asset risk is commonly associated with the forced early retirement of an asset, but stranded asset risk can also refer to a risk that the economics of operating an asset may change negatively for the operator. This can cause the asset to run at a significantly lower capacity factor and generate far less revenue than originally projected, even though the asset has not been fully paid off. As renewable costs continue to decline, coupled with the added benefits from the IRA, more clean energy will be built across Colorado and the Western states. Further, PSCo is required under SB-21-072 to join a regional transmission organization by 2030, which can be expected to lower costs further through access to deeper and more liquid energy markets and increased transmission access to low-cost and temporally matched renewable resources elsewhere in the West. This will likely drive down the average cost of energy, leading to more hours where it is uneconomic to run a less efficient plant like a CT. This could be further amplified by high gas prices, as discussed above in the fuel price volatility section.

Another potential driver of stranded asset risk is policy. Colorado Governor Jared Polis has already established a state target of 100% renewable energy by 2040.[21] Additionally, the U.S. Environmental Protection Agency ("EPA") has recently proposed regulations that establish limits on the amount of carbon emissions allowed from power plants.[22] While these proposed rules are still under consideration, there is strong evidence that some level of policy or regulation will be established that could impact the economics of the proposed CT, either by limiting the ability to run or incurring new costs to comply with regulation, potentially accelerating the obsolescence of the plant.

Recommendations

The IRA has dramatically shifted the energy planning space and all utilities should reassess their prior plans in light of its passage. While PSCo did incorporate these cost benefits and accelerated their own clean energy deployment schedule as a result, they may have still left money on the table. There is an opportunity to do even more to give their customers the most competitive rates while also achieving their—and the state's—clean energy and climate goals. Through this analysis, Strategen has identified that battery storage, solar, and wind can

[21] https://energyoffice.colorado.gov/sites/energyoffice/files/documents/ROADMAPTO100%25RENEWABLE.pdf.

[22] https://www.epa.gov/stationary-sources-air-pollution/greenhouse-gas-standards-and-guidelines-fossil-fuel-fired-power.

economically replace PSCo's proposed 400 MW CT, reducing costs to ratepayers and mitigating risks associated with fossil fuel generation.

Not only do the economics favor the clean energy portfolio under all future price scenarios, but the reliability argument for CTs is failing as well. Natural gas peaker plants are historically favored by utilities for their ability to provide power during high load or emergency situations, but the recent poor performance and unavailability of natural gas plants in recent winter storms has been a blight on many markets across the U.S. If CTs cannot be counted on to deliver power during the most crucial hours, their value to the utility and to overall system reliability drops dramatically. At the same time, the flexible operations of battery storage, combined with low-cost energy from wind and solar, can provide exceptional economic and dispatchability value to the utility, while also avoiding fuel price volatility risks and stranded asset risks.

Given the significant benefits shown herein for replacing the CT with clean energy resources under a range of scenarios, along with the other risks associated with natural gas assets, we recommend that the PUC require PSCo to re-evaluate their plan to invest in large fossil fuel assets and consider further investment in clean energy.

Appendix A – Model Inputs and Detailed Results

Asset Configurations & Costs

Table 5 specifies the input configurations and costs for the combustion turbine and the clean energy resources used in the PSCo analysis. All input assumptions are sourced from the PSCo 120-Day Report, Appendix D.

Table 5 – Combustion Turbine and Battery Storage Input Configurations and Costs

General	
Construction Year	2026
Comparison Year	2027
Incentives	Base IRA (30% ITC) as described by PSCo
Weighted average cost of capital	6.42%
Average inflation rate post-2022	2%
Combustion Turbine (CT)	
Accredited Capacity	96%
Nameplate Capacity	400 MW
Annual Generation	339 to 395 GWh, depending on pricing and policy scenario
Annual Fixed Cost	$8.3 / kW-mo
Variable O&M	$1.46 / MWh
4-hour Battery Storage	
Accredited Capacity	70%
Nameplate Capacity	399 MW
Roundtrip Efficiency	85%
Levelized Fixed Cost	$8.66 / kW-mo
Solar	
Accredited Capacity	5.4%

Nameplate Capacity	492 MW
Annual Generation	987 GWh
CapEx	$1,100 / kW
Fixed O&M	$19 / kW-year
Wind	
Accredited Capacity	11.3%
Nameplate Capacity	1,081 MW
Annual Generation	3,593 GWh
CapEx	$1,220 / kW
Fixed O&M	$28 / kW-year

Commodity Price Inputs

Table 6 specifies the power and gas prices used for the analysis. The PSCo 120-Day Report included annual average forecasted prices for CIG Rockies natural gas and Four Corners on- and off-peak power. The hourly power prices were calculated using the latest available year of Four Corners hourly data and scaled to match the average peak period price for 2027.

Table 6 – Power and Gas Prices for PSCo Analysis

General	
2027 Annual Natural Gas Price	CIG natural gas (Source: PSCo 120-Day Report, Appendix D, Table 2.14-2)
2027 Annual Power Price by Peak Period	Four Corners On-Peak and Off-Peak (Source: PSCo 120-Day Report, Appendix D, Table 2.14-2)
2027 Hourly Power Price	Four Corners historical power price, scaled to Forecasted On- and Off-Peak price. (Source: S&P Capital IQ Pro, CAISO Four Corners, Date:10/20/2022-10/18/2023)

Analysis Detailed Results

Scenario 1: Econ Dispatch: 2027 Base Forecasted Power/Gas Prices + SCC

Table 7 – Net Cost Comparison in Scenario 1

All in 2022$ for Year 2027	Clean Energy Portfolio	CT
Fixed Cost	($143,080,747)	($39,840,000)
Variable O&M	$0	$510,416
Fuel or Charging Cost	($7,954,933)	($16,936,080)
CO_2 Cost	$0	($18,574,169)
Total Cost	($151,035,679)	($75,860,665)
Energy Revenue	$133,872,926	$29,804,920
Net Cost (2027)	($17,162,753)	($46,055,745)
Total Net Benefit (2027)	**$28,892,992**	

Scenario 2: Econ Dispatch: 2027 Low Forecasted Power/Gas Prices + SCC

Table 8 – Net Cost Comparison in Scenario 2

All in 2022$ for year 2027	Clean Energy Portfolio	CT
Fixed Cost	($143,080,747)	($39,840,000)
Variable O&M	$0	($494,648)
Fuel or Charging Cost	($6,829,102)	($14,137,406)
CO_2 Cost	$0	($18,000,368)
Total Cost	($149,909,849)	($72,472,421)
Energy Revenue	$114,924,440	$25,103,346
Net Cost (2027)	($34,985,409)	($47,369,075)
Total Net Benefit (2027)	**$12,383,666**	

Scenario 3: Econ Dispatch: 2027 High Forecasted Power/Gas Prices + SCC

Table 9 – Net Cost Comparison in Scenario 3

All in 2022$ for year 2027	Clean Energy Portfolio	CT
Fixed Cost	($143,080,747)	($39,840,000)
Variable O&M	$0	($512,168)
Fuel or Charging Cost	($9,163,614)	($16,936,080)
CO_2 Cost	$0	($18,637,925)
Total Cost	($152,244,360)	($75,926,173)
Energy Revenue	$154,213,773	$34,405,822
Net Cost (2027)	$1,969,412	($41,520,351)
Total Net Benefit (2027)	**$43,489,764**	

Scenario 4: Energy Matching: 2027 Base Forecasted Power/Gas Prices + SCC

Table 10 – Net Cost Comparison in Scenario 4

All in 2022$ for year 2027	Clean Energy Portfolio	CT
Fixed Cost	($143,080,747)	($39,840,000)
Variable O&M	$0	($576,408)
Fuel or Charging Cost	$0	($17,414,250)
CO_2 Cost	$0	($20,975,635)
Unserved Energy Cost	($1,081,208)	$0
Total Cost	($145,934,233)	($78,806,293)
Energy Revenue	$119,078,484	$12,719,286
Net Cost (2027)	($26,855,748)	($66,087,007)
Total Net Benefit (2027)	**$39,231,259**	