Considering Gas Capacity Upgrades to Address Reliability Risk in Integrated Resource Planning

CPUC STAFF PAPER

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Contents

1. Background

Whether and how to pursue gas power plant capacity upgrades is one of the key remaining questions from the Commission's examination of mid-term reliability needs in its Integrated Resource Planning (IRP) proceeding in the first half of 2021. This Staff Paper summarizes findings from the California Energy Commission (CEC) Midterm Reliability Analysis, the state of CAISO's gas fleet today and resource retention considerations, the potential for upgrades at existing gas plants, and the estimated cost and emissions impacts of any such upgrades. New RESOLVE capacity expansion analysis by Commission staff is presented, including the resource portfolio changes, cost impacts, and greenhouse gas (GHG) emissions impacts associated with scenarios that allow the new candidate resource of gas capacity upgrades to compete to meet reliability needs, with a focus on the mid-term (2024-2026). Additional key considerations for gas capacity upgrades are discussed for future study, followed by conclusions.

This work is intended to be viewed in parallel with the Midterm Reliability Analysis conducted by the California Energy Commission (CEC) and adopted in September 2021.

2. Findings from the CEC Midterm Reliability Analysis

The CEC also performed analysis intended to help inform the CPUC's decision-making for the Preferred System Plan, as discussed in the Mid-Term Reliability (MTR) Decision (D.21-06-035). The CEC's report, adopted on September 30, 2021, analyzes reliability in 2023-2026 through loss of load expectation modeling, assessment of risks to reliability from a growing amount of battery energy storage system resources on the grid, and an evaluation of additional thermal generation resources' ability to support reliability.[1] The report found the system to be reliable in the mid-term period when procurement requirements associated with D.21-06-035 are met. The report found that relying on non-emitting resources like renewable generation and energy storage did not diminish reliability compared to portfolios that contained differing or additional amounts of thermal resources.

The report also addresses the performance of batteries on the system, potential battery deployment challenges, and potential reliability impacts. This analysis is crucial as the modeling for the recently proposed IRP Preferred System Plan[2] highlighted that meeting mid-term reliability needs (without gas capacity upgrade options) will require nearly 28 gigawatts (GW) of new nameplate capacity by 2025, roughly half of which is modeled to be battery storage. The ability to scale battery storage from only ~2 GW in summer 2021 to over 12.5 GW by summer 2025 represents a singular challenge with a host of risks. While meeting these build outs will be challenging, CEC's analysis found that as much as 20% of the projected battery procurement being delayed by up to one year would not constitute a threat to system reliability. Further, the CEC found that battery performance in 2020 and 2021 supported meeting the net peak load and therefore does not indicate cause for reliability concerns thus far.[3]

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[1] CEC. Midterm Reliability Analysis. https://www.energy.ca.gov/sites/default/files/2021-09/CEC-200-2021-009.pdf
[2] Proposed Preferred System Plan Ruling and Materials. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2019-2020-irp-events-and-materials/ruling_proposed-psp.pdf
[3] CEC Midterm Reliability Analysis. https://www.energy.ca.gov/sites/default/files/2021-09/CEC-200-2021-009.pdf

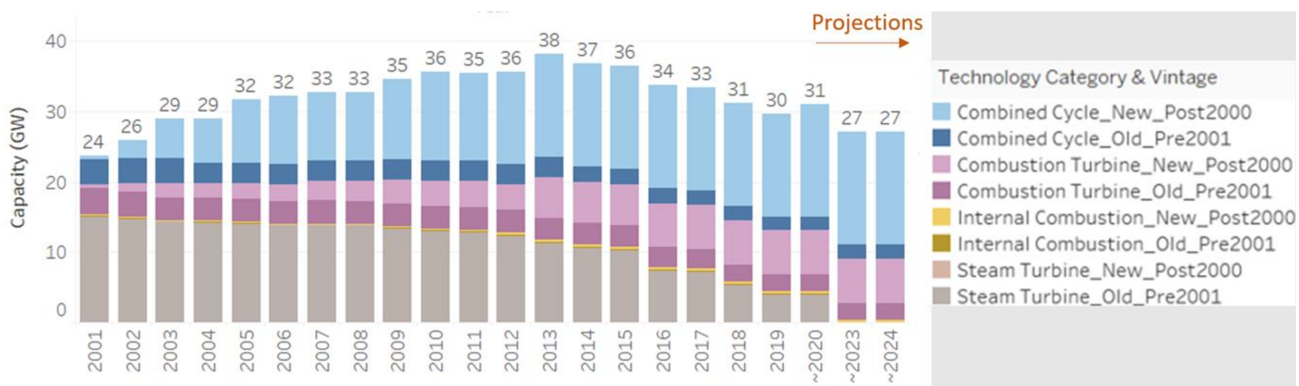
3. State of the CAISO Gas Fleet

3.1 The Gas Fleet Today

The CAISO gas power plant fleet has changed significantly over the last twenty years. Though the fleet is projected by the mid-2020s to be roughly the same size as the 2001 fleet, its composition is changing as newer, more efficient units were permitted and built under stricter environmental standards. Figure 1 shows that by 2023, after the remaining once-through cooling (OTC) steam units retire, the gas fleet will primarily be composed of newer combined cycle and combustion turbine units built since 2001.

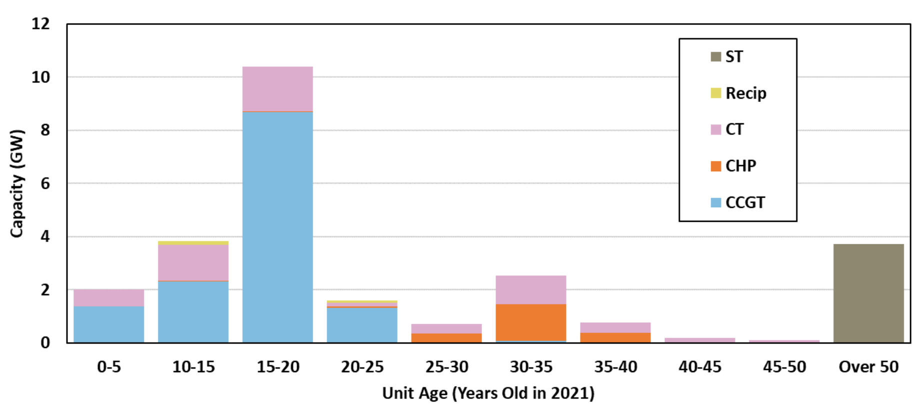
Figure 2 shows the age of the gas fleet in 2021, highlighting that nearly all the combined cycle units are less than 20 years old, 80 percent of the combined heat and power (CHP) units are over 30 years old, and all the steam turbine units (the retiring OTC units) are over 50 years old.[4]

Figure 1. CAISO Gas Capacity Changes, 2001-2024



Data source: CPUC staff analysis using CEC and EIA data.

Figure 2. CAISO Gas Capacity (GW) Unit Age in 2021

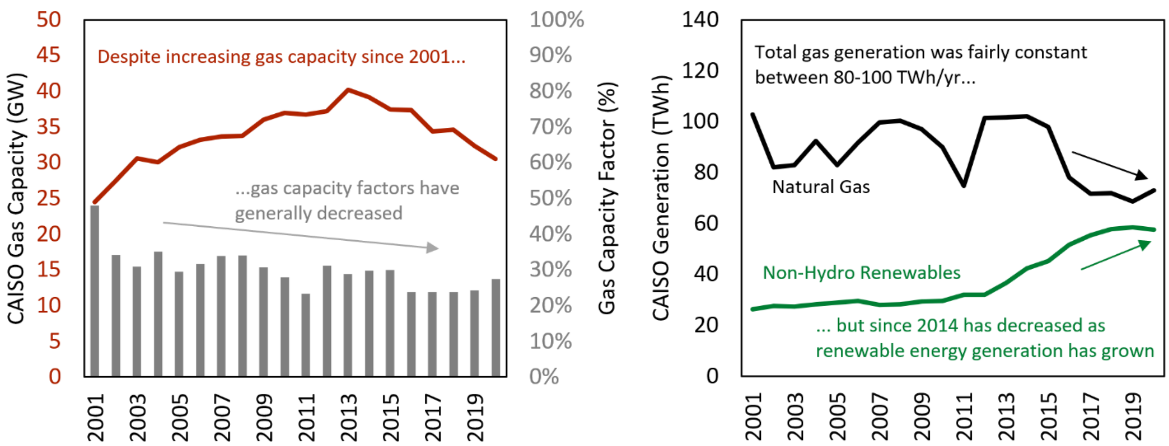


[4] For the PSP, RESOLVE assumed thermal units retired after 40 years. See Preferred System Plan RESOLVE Updates documentation: ftp://ftp.cpuc.ca.gov/energy/modeling/PSP%20RESOLVE%20Updates.pdf

Data source: CPUC staff analysis using the 2019 IRP RESOLVE/SERVM Baseline Generator List.[5]

Generation output from the CAISO gas fleet, and the associated greenhouse gas emissions, have decreased since 2001. Figure 3 shows the trends in gas capacity, gas generation, and non-hydro renewable output between 2001 and 2018. California gas generation is subject to annual variations in energy demand, hydroelectric power output, and the availability and cost of imported power. Since 2001, gas capacity increased while gas generation has fluctuated between and 80 and 100 TWh/yr, which combined indicates a significant decline in the gas fleet's overall capacity factor.[6] Since 2014, gas generation has been displaced by growing renewable energy output. Fifty percent of the decline in California's electric sector GHG emissions since 2000 is attributable to the increased efficiency and decreased GWh output in the gas fleet.[7]

Figure 3. CAISO Gas Capacity and Generation, 2001-2020



Data source: CPUC staff analysis using CEC data.

3.2 Risk of Early Gas Fleet Retirement

One key consideration regarding the state of the CAISO gas fleet is potential reliability risk from early retirement of the aging gas fleet, including older combustion turbines and CHP units rolling off long-term qualifying facility (QF) settlements. The CAISO has increasingly used its reliability must-run (RMR) backstop procurement process, with five plants currently under RMR designation including three CHP plants seeking retirement but retained for system reliability purposes; the CAISO is proposing to extend these RMR designations through 2022.[8] The Commission's mid-term reliability need determination assumed 1 GW (nameplate) of gas plants retire by 2026, but even more units may seek retirement due to economics, age, ongoing maintenance or capital expenses, or – for CHP units – the loss of a thermal host and/or expiring long-term QF contract. Some older

[5] Unabbreviated legend: Steam Turbine (ST), Reciprocating Engine (Recip), Combustion Turbine (CT), Combined Heat and Power (CHP), Combined Cycle Gas Turbine (CCGT)

[6] CEC Staff Paper, *Thermal Efficiency of Natural Gas-Fired Generation in California 2019 Update*. Table 2. https://efiling.energy.ca.gov/GetDocument.aspx?tn=233380&DocumentContentId=65895

[7] Data source: CPUC staff analysis, 2019. Uses CEC and EIA data. In-State Generation in CAISO area only. Statewide data available from CEC: https://www.energy.ca.gpv/data-reports/energy-almanac

[8] The three CHP plants under system RMR designation are: Channel Islands Power, Midway Sunset Cogen Units A-C, and Kingsburg Cogen. http://www.caiso.com/Documents/Decision-Conditional-Approval-Extend-RMR-Contracts-Presentation-Sep-2021.pdf#search=rmr

CHP units may not be eligible for RMR designations, even if determined necessary for system reliability purposes, if they did not undertake QF conversions to become participating generators. From a long-term decarbonization perspective, it may be beneficial to allow older, inefficient power plants to retire (especially inflexible cogeneration plants) while upgrading the capacity at newer, efficient plants that can flexibly integrate growing renewable penetrations with lower emissions rates. However, in the near- and mid-term, analysis shows that nearly all of the gas fleet is retained to meet system reliability needs. The potential for gas plant upgrades, discussed next, is one option for responding to this reliability risk within the CAISO gas fleet.

3.3 The Potential for Gas Plant Upgrades

The CPUC, the CEC, and the CAISO have identified significant system reliability concerns related to resource adequacy in the near-term. The CAISO system faced two consecutive days of involuntary rotating outages in August 2020. Following this, the CPUC instituted an emergency reliability proceeding to secure additional resources for 2021 and Governor Newsom issued an Emergency Proclamation to accelerate new resource deployment and take other aggressive actions to avoid system reliability events.[9] Thus far, no involuntary rotating outages have been required in 2021 due to multiple factors including aggressive state action to deploy new resources rapidly and lower demand in the most critical hours, as well as weather conditions. However, one Stage 2 Alert, eight Flex Alerts and nineteen restricted maintenance alerts, were called in 2021 due to continued tight system conditions.[10] Ongoing efforts, including the Emergency Reliability (R.20-11-003) proceeding, are examining 2022 and 2023 system reliability and further resource procurement and retention to ensure reliable operations in those years. Additionally, the Commission, in its Integrated Resource Planning proceeding, recently initiated one of the largest reliability procurement orders in history by ordering load serving entities to secure 11.5 GW of new NQC between 2023 and 2026.[11]

An option for helping to address reliability is increasing gas plant capacity through one or more of the following methods:

- **Efficiency improvements and equipment upgrades**: Efficiency improvements can reduce plant heat rates and may provide modest increases in net qualifying capacity (NQC). Generally low-cost equipment upgrades increase plant NQC by replacing or adding key plant components. Equipment upgrades may also include the addition of hybrid battery storage resources to plants with spare interconnection capacity. Upgrades can be low to moderate cost.
- **Repowering**: replacement of major equipment (typically gas turbines) in operating or mothballed units that generally are higher cost but have good potential to increase NQC and plant efficiency.
- **Expansion**: construction of additional power plant units at existing plants. These are generally higher cost but can add significant new capacity.
- **Greenfield new unit construction**: construction of additional power plant units at greenfield sites. These have the highest cost of the options but provide the most significant opportunity for adding new capacity. Greenfield unit construction is not being considered by

[9] Proclamation of a State of Emergency (7/30/21). https://www.gov.ca.gov/wp-content/uploads/2021/07/Energy-Emergency-Proc-7-30-21.pdf
[10] CAISO. AWE Grid History Report. http://www.caiso.com/Documents/AWE-Grid-History-Report-1998-Present.pdf#search=Stage%20alerts%202021
[11] D.21-06-035. Requiring Procurement to Address Mid-Term Reliability (2023-2026).

the Commission when examining opportunities to expand gas plant capacity for mid-term reliability in IRP at this stage.

For the Commission's first IRP procurement order (D.19-11-016), gas capacity procurement by Load-Serving Entities (LSEs) was allowed, and LSEs did contract for gas capacity at the Sutter power plant. Sutter was considered incremental new capacity because of how its unique interconnection to the CAISO was modified around that same time. However, no LSE opted to contract for expansion or repowering of any existing gas sites. Expanding capacity at existing units was explicitly authorized by the Commission in its 2021 Emergency Procurement Decision (D.21-03-056), which ordered IOUs to procure additional resources for summer 2021 reliability to meet at least a 17.5% planning reserve margin (PRM). "Upgrades resulting in increased efficiency of existing generation resources" were allowed while "contracts for fossil-fuel development at new sites or for redevelopment or full repowering at existing or mothballed electric generation sites" were disallowed.[12] Since November 2020, 136 MW of additional NQC have been achieved through efficiency and equipment upgrades at existing power plants for summer 2021 reliability.[13] The CEC has identified another 200 MW of additional gas capacity that could potentially come online in 2022 or 2023 via efficiency and equipment upgrades if various procurement and permitting issues could be addressed. There is also 1,200 MW of potential capacity in California from four gas power plant expansion projects that have been permitted but not built.[14]

In addition to upgrades at in-state gas plants, there may be additional regional opportunities outside the CAISO footprint to contract with existing gas capacity, with gas repowering projects at retiring coal plants, or with gas plant upgrade projects. These out of state gas resources could make up, in part, for the reduced availability of imports, due to thermal retirements in other states, which is a key driver of California's need for new capacity. However, out of state gas plants must have firm import contracts and represent incremental (newly built or repowered capacity) to provide new firm capacity to CAISO.

[12] D.21-03-056, Attachment 1, Section 6.
[13] CEC 8/30/21 workshop presentation, slide 75. https://efiling.energy.ca.gov/GetDocument.aspx?tn=239554&DocumentContentId=72991
[14] Ibid, p. 83.

4. Capacity Expansion Analysis

CPUC staff conducted capacity expansion in the CPUC IRP RESOLVE model to consider the system costs and benefits of allowing gas capacity upgrades (efficiency and equipment upgrades, or repowering) across a range of costs and potential.

4.1 Inputs and Methodology

All inputs to RESOLVE except for the gas capacity upgrade cost and potential are consistent with the proposed Preferred System Plan (PSP) modeling released via an ALJ ruling in the IRP proceeding in Summer 2021.[15] All scenarios were run using the 38 MMT GHG target and the LSE planned additions consistent with the proposed PSP. Additional inputs were developed for the cost and potential of gas plant upgrades based on data provided by the CEC in May 2021. This confidential data was based on completed or in-progress gas plant upgrades, including the facility, upgrade cost, and upgrade capacity (MW) at 7 facilities for a total sample of 122 MW of upgrades.[16] This data was used to derive high-level estimates of cost and potential across the fleet.

Table 1. Gas Upgrade Cost ($/kW-yr) Scenarios Considered

Scenario	Cost ($/kW-yr)	Source
Low Cost	$12	Low end of CEC data range
High Cost	$43	High end of CEC data range
Very High Cost	$85	Double the high end of CEC data range

Table 2. Gas Upgrade Potential (MW) Scenarios Considered

Scenario	Potential (MW)	Source
Low Potential	122	Upgrade potential consistent with 2021 increase achieved
High Potential	880	Assumes that full CAISO CCGT fleet could increase capacity proportional to the increased capacity at the plants in the CEC's dataset

The low potential MW quantity was chosen based on the seven studied projects. The high potential MW quantity was derived by assuming the full CAISO (combined cycle gas turbine) CCGT fleet could increase capacity proportional to the studied upgrades. Note that it is not likely all plants could complete similar upgrades, but there are also additional unaccounted for opportunities to increase gas capacity such as the 1,200MW of permitted but unbuilt expansions referenced above.

These costs and capacity potential were input into RESOLVE as a new candidate resource with similar characteristics to the lower efficiency combined cycle unit RESOLVE resource class ("CCGT2"). This simplified approach does not consider unit-level operational changes due to the upgrades (such as heat rate changes associated with plant upgrades). Table 3 describes additional assumptions used to develop this new candidate resource in RESOLVE.

[15] Proposed Preferred System Plan Ruling and Materials. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2019-2020-irp-events-and-materials/ruling_proposed-psp.pdf

[16] Data for this study was only available from 122MW of upgrades, however there are a total of 136MW of in-progress or complete upgrades.

Table 3. Additional Assumptions used for the Gas Capacity Upgrades Candidate Resource

Input	Value
Discount Rate	5%
Financing Lifetime	25 years
Plant Type	CC
RESOLVE Resource Type	CAISO_CCGT2
Heat Rate at Pmax	8.4 MMBtu/MWh
NQC %	99%
First Year Available	2022

NOTE: heat rate and NQC % values based on the existing RESOLVE "CAISO_CCGT2" resource.

Given that financing lifetimes are uncertain for gas plant upgrades and that 25 years may be considered too long for some gas assets, the upgrade costs across different financing lifetimes were calculated and broadly covered by the range of cost scenarios analyzed. As shown in Figure 4, with the "very high" cost sensitivity added, the range of costs modeled in RESOLVE cover the range of CEC upgrade costs associated with 10–25-year financing lifetimes; only the CEC's high cost estimate recovered within 5 years is higher than the range considered in this analysis.

Figure 4. Annualized Cost Impact of Shorter Financing Lifetimes

Shorter financing periods increase $/kW-yr costs

$/kW-yr	Financing Lifetime (years)			
Scenario	5	10	15	25
high	*$ 138.58*	$ 77.70	$ 57.81	$ 42.57
low	$ 38.50	$ 21.58	$ 16.06	$ 11.83

Higher than the cost range studied

Within the cost range studied

4.2 Scenarios

To capture a range of cost and potential for gas upgrades, multiple scenarios were analyzed. A sensitivity was also considered whereby the planning reserve margin in RESOLVE was increased from approximately 15% to 17.5% in 2022 and 2023 – as opposed to waiting to increase the PRM in 2024 as was done for the proposed PSP – to determine whether the gas upgrades would be selected in those years under higher reserve margin needs.

Table 4. Scenarios Modeled in RESOLVE

Scenario	Cost ($/kW-yr)	Potential (MW)	Additional Changes
Low Upgrade Cost	$12	122	
High Upgrade Cost	$43	122	
High Upgrade Cost, High Potential	$43	880	
Very High Upgrade Cost, High Potential	$85	880	
Higher Near-Term PRM	$43	880	Increased 2022 and 2023 PRM from ~15% to 17.5%

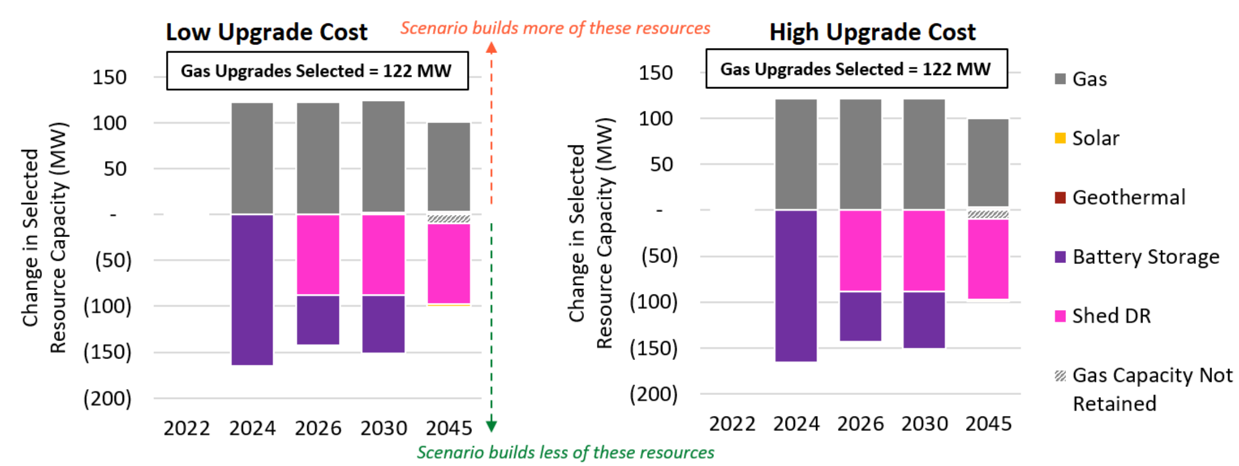
4.3 Results

RESOLVE modeling results were analyzed based on the following key questions:

1. Are gas upgrades economic in RESOLVE for the cost/potential scenarios considered?
2. When selected, what resources do gas upgrades replace?
3. What are the cost impacts of allowing gas upgrades?
4. What are the GHG impacts of allowing gas upgrades?

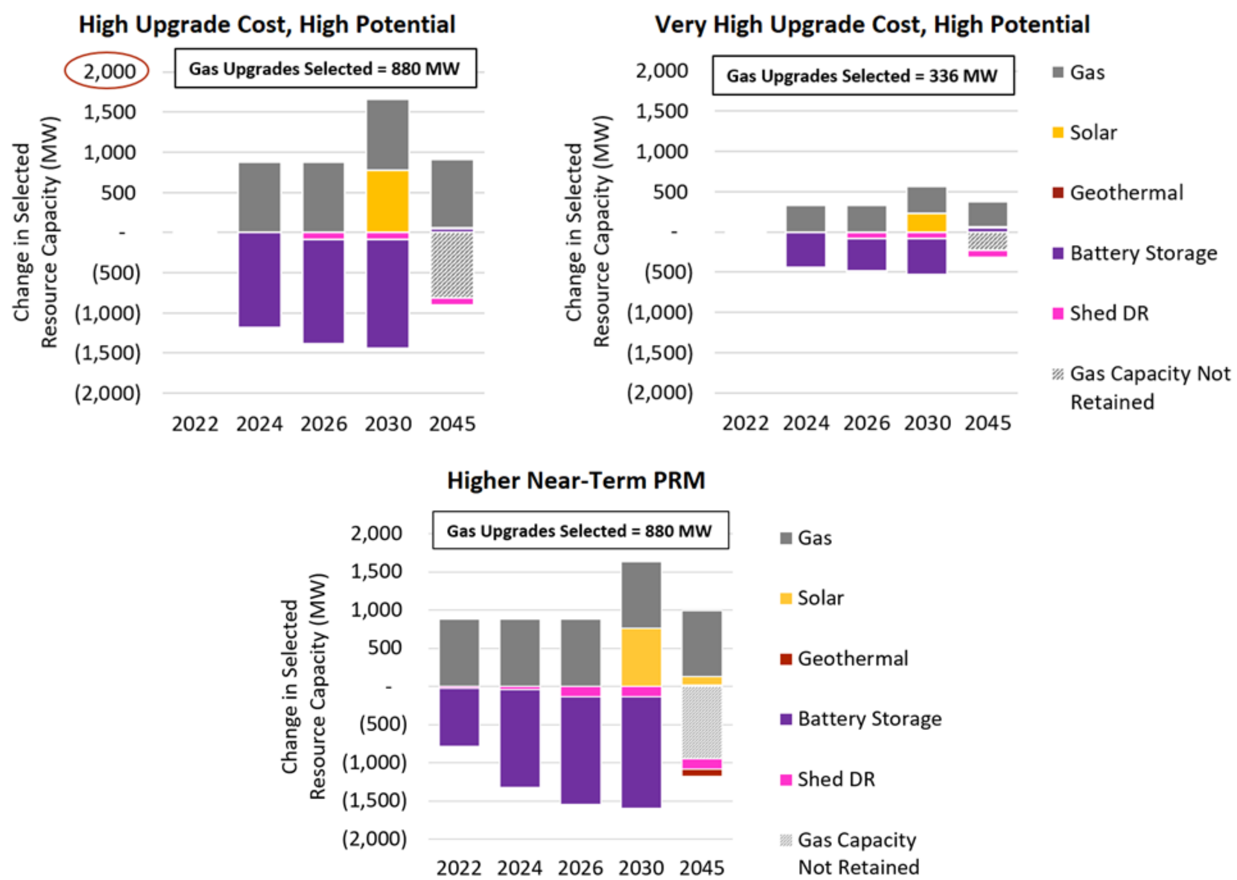
Questions 1 and 2 are addressed in Figure 5 and Figure 6, which show RESOLVE portfolio changes in select years relative to the Proposed PSP base case, which did not allow these types of gas capacity upgrades to be selected. Positive values show additional capacity in the gas upgrade runs compared to the baseline runs, while negative values show the capacity build avoided by allowing the gas upgrades. In "Low Upgrade Cost" and the "High Upgrade Cost" scenario, all 122 MW of gas upgrade potential is selected, offsetting energy storage and demand response resources. Cumulatively by 2045, the storage build is unchanged while the model does permanently avoid a small amount of demand response. Starting in 2035, approximately 10 MW of gas capacity is not retained in these cases. While energy storage is often the primary resource avoided/deferred by gas capacity upgrades, all cases still show at least 11,000 MW of new battery storage by 2025.

Figure 5. RESOLVE Modeling Results: "Low Upgrade Cost" and "High Upgrade Cost" Scenarios (select years)



When additional upgrade potential is made available, RESOLVE selects 100% (880 MW) of that potential in the high upgrade cost scenario at $43/kW-yr but selects only 38% (336 MW) of the total potential made available when costs are increased to $85/kW-yr. This indicates that up to 880 MW of gas upgrades are economic at ~$43/kW-yr, while approximately 300 MW of upgrades are still economic even at $85/kW-yr. Resources replaced follow similar trends to the lower potential cases, just with higher displacement of battery storage capacity and higher gas capacity not retained starting in 2035. The gas capacity not retained indicates that RESOLVE finds it economic to invest in upgrading efficient plants in 2024, while allowing less efficient plants to retire after 2030. Upgrades are modeled as combined cycle gas plants while gas capacity not retained are less efficient combustion turbines, which RESOLVE finds less desirable as the need for GHG reduction increases through 2045. Additional solar is selected in 2030 (i.e. future solar is selected earlier) to substitute for the greenhouse gas reductions benefits of the energy storage avoided through gas capacity upgrades. The "Higher Near-Term PRM" scenario follows the "High Upgrade Cost, High Potential" scenario results, except that the gas upgrades are selected in 2022 and offset approximately 800 MW of storage that was selected by RESOLVE to fill 2022 reliability needs under a higher PRM.[17]

Figure 6. RESOLVE Modeling Results: "High Upgrade Cost, High Potential", "Very High Upgrade Cost, High Potential", and "Higher Near-Term PRM" Scenarios (select years)



Cost impacts are shown in Figure 7 and Figure 8. Allowing gas upgrades lowers CAISO system costs in all scenarios, consistent with their selection by RESOLVE's least-cost optimization. The high upgrade cost, high potential scenario showed that the maximum system benefit modeled ranged from ~$75M/yr in the mid-term, to ~$200M/yr in 2030, and declining to ~$23M/yr in 2045. Higher costs in the "very high upgrade cost, high potential" scenario show that system benefits still remain at $85/kW-yr gas upgrades but are reduced compared to lower cost cases (reaching only ~$15-50 M/yr). Overall, the system cost reduction remains relatively small compared to total resource costs (for instance, up to ~$200 million savings equals <0.5% of the total ~$44 billion total resource cost in the proposed PSP in 2030). However, the relatively small cost impact is expected given the relative magnitude of these resources (880 MW) to the total system (129,000 MW nameplate in 2030). Net Present Value (NPV) cost savings range from $87 million to over $900

17 The "Higher Near-Term PRM" results are compared against an updated proposed PSP baseline case with a higher near-term PRM but without gas capacity upgrades available.

million in the "Higher Near-term PRM" scenario, where gas upgrades offset significantly more expensive battery additions RESOLVE selected in 2022.

Figure 7. Annual System Cost Impacts of Gas Capacity Upgrade Scenarios

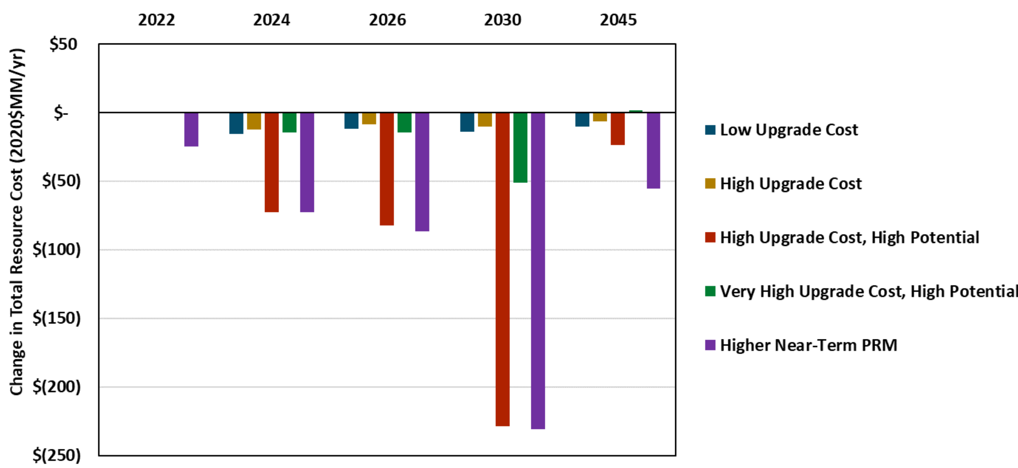
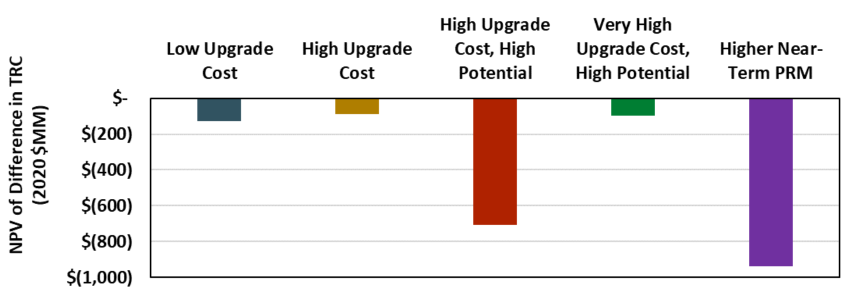


Figure 8. NPV Cost Impacts of Gas Capacity Upgrade Scenarios

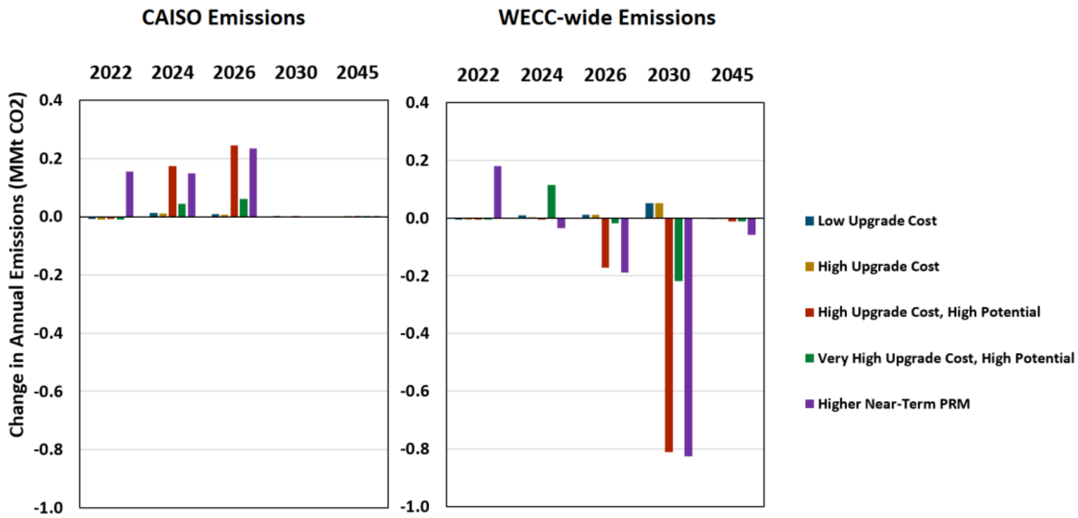


Greenhouse gas emissions are impacted by gas upgrades in two distinct ways. First, by upgrading the capacity of any gas plant more efficient than the least efficient plant, system operators have additional capacity with reduced emissions rates from which to derive more efficient optimal dispatch with lower costs and lower emissions. All else equal, adding capacity to relatively efficient gas plants should reduce greenhouse gas emissions, since their generation will offset the generation from less efficient units when not all capacity is needed. However, there are second order effects associated with reducing energy storage built for reliability purposes (because this storage also provides greenhouse gas reduction benefits) and other portfolio changes (such as the higher 2030 solar build out in some of the scenarios analyzed). Figure 11 shows the greenhouse gas reduction impacts of allowing gas upgrades. Allowing gas upgrades slightly increases CAISO GHG emissions in the mid-term (between 0 – 0.7% of annual CAISO emissions or less than .25 million metric tons (MMT) of 35MMT annual CAISO GHG emissions), while there is no change once the GHG constraint binds by 2030 and beyond. However, even if emissions increase in California, total WECC[18] emissions may decrease in some cases due to more efficient WECC-wide dispatch. Because

[18] The Western Electricity Coordinating Council (WECC) represents the Western Interconnection. The specific geography is described here: https://www.wecc.org/Pages/home.aspx.

this analysis did not assume any heat rate changes as part of gas capacity expansions, it does not account for the impact of those potential changes on GHG emissions.

Figure 9. Greenhouse Gas Impacts of Gas Capacity Upgrade Scenarios (CAISO and WECC)



The types of upgrades specifically modeled in RESOLVE were efficiency or equipment upgrades at existing combined cycle gas turbines. The analysis was intended to represent a broad range of costs to determine at what cost gas capacity upgrades remain cost-effective for mid-term reliability procurement. Further analysis may be warranted if upgrades carry significantly different operational impacts or have significantly different cost drivers, such as requirements for hydrogen use that would entail additional costs for hydrogen production, storage, and equipment upgrades to allow hydrogen fuel blending.

5. Key Considerations for Future Analysis

Capacity expansion modeling shows the impacts on system resources needs, costs, and greenhouse gas emissions when gas upgrades are allowed. These are crucial factors for the Commission's consideration of gas capacity expansion. However, there are additional key qualitative factors not captured within the RESOLVE modeling framework that must also be studied.

5.1 Mid-term Reliability Risk

The Commission's Mid-term Reliability ("MTR") decision, D.21-06-035, used a higher planning reserve margin to assess additional new resource procurement needs amidst planned resource retirements between 2024-2026. Using the more conservative "high need" scenario, the Commission ordered 11.5 GW NQC additional capacity to be added between 2023-2026. While the MTR decision and PSP modeling used lower imports (4 GW unspecified) and included an extra ~1 GW nameplate of unplanned retirements, this may understate future risk regarding import availability and thermal retirements, as discussed earlier in this paper.

5.1.1 Risk of Overreliance on Batteries

Additionally, while battery performance has been positive thus far, data is limited, so further tracking and analysis is warranted. The threat of supply chain disruptions leading to delayed battery deployment also merits further research. While LSEs successfully contracted for cumulatively sufficient capacity to meet D.19-11-016 procurement requirements of 3,300MW NQC, some portion of this capacity is delayed and did not meet the August 1, 2021 online date requirement.[19] CEC's Midterm Reliability Analysis similarly cited supply chain difficulties as an obstacle to bringing new resources online.[20]

5.1.2 Risk of Early Gas Fleet Retirement

One additional mid-term reliability risk, discussed earlier, is the potential early retirement of the aging gas fleet, including older combustion turbines and CHP units rolling off long-term qualifying facility settlements. The Commission's mid-term reliability need determination assumed 1 GW (nameplate) of gas plants retire by 2026, but even more units may seek retirement due to economics, age, ongoing maintenance or capital expenses, or – for CHP units – the loss of a thermal host and/or expiring long-term QF contract. From a long-term decarbonization perspective, it may be beneficial to allow older, inefficient power plants to retire (especially inflexible cogeneration plants) while upgrading the capacity at newer, efficient plants that can flexibly integrate growing renewable

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[19] CPUC. Procurement in Compliance with D.19-11-016 per February 1, 2021 Filings. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/ed_staff_review_of_feb2021_data_in_compliance_with_d1911016.pdf

[20] CEC Midterm Reliability Analysis. https://www.energy.ca.gov/sites/default/files/2021-09/CEC-200-2021-009.pdf

penetrations with lower emissions rates. However, in the near- and mid-term, analysis shows that nearly all of the gas fleet is retained to meet system reliability needs. Future analysis may need to further consider and quantify the risk of early retirement to better inform decision-making regarding system reliability.

5.2 Procurement Process

Determining whether to allow or to require some volume of gas capacity upgrades for reliability is a critical step that will determine what additional procurement process steps the Commission needs to develop.

If the Commission opts to allow rather than require gas capacity upgrades then this can likely be administered as part of the existing mid-term reliability procurement order in a relatively straightforward fashion. The Commission would need to formally allow the upgrades to be eligible resources, potentially to count towards the 7,000 MW NQC portion of the order that is not subject to specific requirements (long-duration storage, etc.). The counting rule for the resource type would also need to be set. Whether the Commission should set a cap on allowable gas upgrades is another important consideration, likely needing allocation among LSEs and possibly having other impacts on procurement process steps. However, setting a cap may not be necessary due to the relatively small resource potential for upgrades at existing sites.

Requiring (rather than allowing) gas capacity upgrades would likely involve a much more involved effort of procurement process development.

Any potential relationship of proposed upgrades to procurement from other CPUC proceedings, such as the Emergency Reliability proceeding (R.20-11-003), would also need to be determined.

5.3 Other Areas for Further Analysis

The following topics should be further studied to support decision-making regarding system reliability and the future of the thermal fleet in California.

- Cost: RESOLVE analysis found that the upgrades modeled were cost-effective based on estimated cost and potential. However, this will be dependent on real market conditions as well as whether LSEs have flexibility to pursue the available upgrades, or are required to.
- Greenhouse Gas Emissions: The RESOLVE modeling found potential small impacts on greenhouse gas emissions in CAISO and there is potential for decreased emissions when taking a WECC-wide perspective. Future analysis should consider GHG emission impacts further and incorporate the impact of upgrades on plant heat rates.
- Air Quality: Beyond the system level considerations discussed thus far, gas plants provide local grid benefits (through Local RA provision) while also having local impacts on surrounding communities through their emission of criteria pollutants like nitrous oxides and particulate matter. Further analysis is needed on the impact of potential gas capacity increases on air quality, particularly in Disadvantaged Communities. While some plant efficiency improvements may decrease the rate of criteria pollutant emissions, it is possible that increased plant dispatch could lead to overall greater emissions.

- Long-Term Asset Risk: The risk of stranded investments associated with mid-term capacity expansions to existing gas power plants is a key consideration for Commission decision-making. This investment risk exists in cases where gas upgrades are valuable over the mid-term but may cease to be economic prior to their expected financing or cost recovery timeline.
- Use of Zero-Carbon Fuels: A key question posed in the mid-term reliability decision-making process was whether gas capacity upgrades should be required to make additional investments that would allow them to operate on zero-carbon fuels such as green hydrogen. Requiring the use of green hydrogen at upgraded plants provides several benefits, including greenhouse gas reduction through use of zero-carbon fuels, encouraging the development of the hydrogen power market in California, and mitigating against long-term asset risk. However, requiring turbine modification to enable hydrogen blending, producing hydrogen fuel via new electrolyzers, and adding hydrogen on-site storage and/or transportation infrastructure all add significant costs and development risks to gas capacity upgrades. It will be helpful to have more analysis on the cost, potential, and use cases for zero carbon fuels like green hydrogen in decarbonizing California's economy.

6. Summary of Findings and Next Steps

The analysis and key considerations outlined above cover a wide range of benefits and risks of allowing gas capacity expansions to fulfill reliability needs. RESOLVE modeling demonstrates that upgrades appear cost-effective for reliability needs starting in 2024, and in the near-term to meet a higher PRM in 2022 or 2023. This conclusion holds across a range of cost scenarios considered at least up to $85/kW-yr. Potential CAISO GHG emission impacts are unchanged or increase slightly and regional emissions may even slightly decrease if expanded capacity occurs on more efficient gas units. If the Commission opts to allow any gas upgrades, a procurement process and determination of potential relationship to D.21-06-035 and procurement from other CPUC proceedings would likely need to be established.

Further, to shed light on related, long-term questions regarding the CAISO gas fleet, the next IRP cycle could study the existing fleet and emerging technologies in more detail. This could provide more insight into the appropriate role of the gas fleet in moving towards a decarbonized electricity system. As one example of potential work to support this, IRP could explore an expansion of its system and local reliability modeling capabilities to further consider when storage technologies or emerging technology resources may economically displace gas generators from their local capacity provision. This may also allow for analysis of the relationship between other infrastructure, such as the Aliso Canyon storage facility, and the existing gas fleet. In addition, the existing plans in both the RA[21] and IRP[22] proceedings to conduct reliability modeling and reassess current reliability standards will likely need to be coordinated with any further analysis regarding the gas fleet.

21 D.20-06-031
22 D.21-06-035