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CGNP's Introductory Comments for Six Files - August 17, 2022

R2005003 CAISO's endorsement of PacifiCorp Energy Gateway 10 23 20

This is a convoluted and obscure pair of CAISO filings that establish CAISO's endorsement of PacifiCorp's approximately $20 billion Energy Gateway Project as the solution to connect PacifiCorp's Wyoming coal-fired generation fleet to California's load centers. The Berkshire Hathaway Energy subsidiary NV Energy provides the necessary pair of power corridors that span the state of Nevada.
Please see the notes added to the first page of the CAISO filing.

R2005003 CGNP's Accepted Opening Comments Dated 01 24 22

Attached is CGNP's accepted opening comments in CPUC mid-term reliability Proceeding R2005003. CGNP criticizes the State of California plan to substitute mostly dispatchable coal-fired generation in Wyoming for Diablo Canyon Power Plant's (DCPP's) dispatchable safe, abundant, reliable, cost-effective and emission-free electric power. DCPP's typical annual production is five Hoover Dams of clean power.

Resource Adequacy Means Keeping Diablo Canyon Running

Attached find Californians for Green Nuclear Power, Inc's. (CGNP's) two page essay, "Resource Adequacy Means Keeping Diablo Canyon Running" which was prepared on June 5, 2022. CGNP criticizes the State of California plan in the June 24, 2021 CPUC Decision that relies on large amounts of "shortfall" and "unspecified imports" to maintain a reliable (?) California grid. This plan will yield rolling blackouts. Instead, Diablo Canyon Power Plant should continue to run. This approach is now endorsed by California Governor Gavin Newsom and relevant officials within the Biden Administration.

"Newsom Gets it Right on Diablo Canyon" August 17, 2022 Editorial appearing in at least five California newspapers.

"California unveils proposal to keep Diablo Canyon nuclear plant open with $1.4B loan to PG&E" by Kavya Balaraman, August 16, 2022, *Utility Dive.*

"Who Benefits When Nuclear Plants Close?" by Maxime Robine, August 1, 2022 ***Le Monde Diplomatique***

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Continue Electric Integrated Resource Planning and Related Procurement Processes.	Rulemaking 20-05-003 (Filed May 7, 2020)

COMMENTS OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

In final highlighted paragraph, page 6: Incremental imports could help meet short-term resource needs while resources are planned and constructed to address the 2026 shortfall identified in the CAISO's analysis. Concerns about the lack of resource specificity and potential speculative imports can be addressed via CAISO's proposal submitted to the resource adequacy proceeding. 13

[13] The CAISO's proposal seeks to transition to a resource adequacy import framework that requires resource-specific capacity dedicated solely to California and secured in advance using high priority transmission service to ensure secured power can actually flow to California, particularly during stressed west-wide system conditions. CAISO, Track 3.B Proposals, R.19-11-009, August 7, 2020. Available at: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M344/K841/344841567.PDF

Found on page 20 of 683 (marked page 18) this CAISO passage offers clarification. This prescient CAISO document was filed on August 7, 2020, a week before California's rolling blackouts.

"Furthermore, allowing resource adequacy import energy to flow on hourly non-firm transmission source-to-sink provides inadequate assurance the transmission transfer capability is sufficient to deliver energy to California, even if excess energy is available in the system. Under these circumstances, the Commission should transition to a resource adequacy import framework that requires resource-specific capacity dedicated solely to California and secured in advance using high priority transmission service to ensure secured power can actually flow to California, particularly during stressed west-wide system conditions.

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Dated: October 23, 2020

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BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Continue Electric Integrated Resource Planning and Related Procurement Processes	Rulemaking 20-05-003 (Filed May 7, 2020)

COMMENTS OF THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

I. Introduction

Pursuant to Administrative Law Judge Fitch's October 9, 2020 email ruling inviting initial comments on individual integrated resource plan (IRP) filings, the CAISO submits these comments. The CAISO's comments primarily focus on load serving entities' (LSEs') narratives in Section III.a, regarding the conforming portfolios, and Section IV.e, regarding the portfolios' ability to address retirement of the Diablo Canyon Power Plant (Diablo Canyon). To support these comments, the CAISO provides detailed modeling results from its production cost modeling assessment of the Commission's 38 million metric ton (MMT) greenhouse gas target portfolio, one of the portfolios the Commission provided to LSEs as guidance for developing the individual IRPs.[1] The CAISO provides this analysis for the Commission to consider as it reviews the individual IRPs for aggregation and consideration of the Preferred System Portfolio.

Based on the CAISO's reliability analysis of the 38 MMT Portfolio and comparison to the 46 MMT RSP, the CAISO continues to recommend that the Commission expedite procurement to replace the energy and capacity currently provided by Diablo Canyon as well as ensure progress is made on the boarder portfolio. The CAISO's modeling results shows that incremental resource needs may be much greater than originally anticipated and that the system hits a critical inflection point after Diablo Canyon retires. Under the 38 MMT Portfolio, the CAISO's modeling analysis found a significant resource deficiency—3,493 MW in effective capacity—in 2026. The Commission should coordinate expedited procurement with any contracted for new resources included in the individual LSE IRPs but not delay procurement to wait for planned but unexecuted procurement referenced in

[1] Decision (D.) 20-03-028, p. 104. In these comments, the CAISO refers to this as the 38 MMT Portfolio.

the individual LSE IRPs. The Commission must ensure there are sufficient and diverse resources to meet this post-Diablo Canyon retirement need and reliably decarbonize the grid.

In addition, the CAISO provides comments regarding the need to improve modeling efforts to identify reliability needs, the benefits of resource diversity, and improve resource planning.

The CAISO will make its PLEXOS production cost models available to the public by request.

II. Discussion

A. The Commission Must Ensure that LSEs Procure Resources to Meet 2026 System Needs.

As the CAISO stated in previous comments in this proceeding, the Commission must prioritize authorizing procurement to replace the Diablo Canyon Power Plant (Diablo Canyon), which is scheduled to fully retire before the end of 2025.[2] The individual IRPs filed in this proceeding provide the Commission the opportunity to assess the extent to which LSEs have made progress toward meeting the near-term procurement needs caused by the Diablo Canyon retirement. The Commission's 46 MMT Reference System Portfolio (RSP) and 38 MMT Portfolio—which provided guidance for the individual LSE IRPs—demonstrate the need for significant new resource additions between 2024 and 2026. By 2026, the 46 MMT RSP includes 2,737 MW of new wind generation, 8,000 MW of new solar generation, 6,127 MW of new battery storage, 973 MW of new long-duration pumped storage, and 222 MW of new shed demand response.[3] At the same time, the 46 MMT RSP provides for no new natural gas generation retirement[4] by 2026 and only 30 MW of natural gas generation retirement by 2030. The 38 MMT by 2030 Portfolio indicates the need for even higher levels of total procurement with additional wind, solar, battery storage, and long-duration pumped storage by 2026 with no additional natural gas retirements in that timeframe.[5]

In reviewing the individual IRPs, the Commission should ensure LSEs are not only planning to procure for 2026, but are also actually ***contracting*** for the incremental resources necessary to maintain reliability. As the CAISO details below, it is likely LSEs will need to procure resources in excess of the RSP and the 38 MMT Portfolio to maintain reliability and meet state greenhouse gas reduction goals. As a result, it is imperative LSEs begin contracting for the necessary new resources

[2] See CAISO's July 15, 2020 comments on the preliminary scoping memo (http://www.caiso.com/Documents/Jun15-2020-Comments-PreliminaryScopingMemo-IntegratedResourcePlanning-R20-05-003.pdf) and July 24, 2020 prehearing comments (http://www.caiso.com/Documents/Jul24-2020-ReplyComments-Proposed3YearSchedule-Comments-PrehearingConference-IntegratedResourcePlanning-R20-05-003.pdf).
[3] D.20-03-028, p 41, Table 5.
[4] Outside of once-through-cooling units already scheduled to retire.
[5] D. 20-03-028, p. 46, Table 8.

immediately with a focus on supply diversity. The Commission should develop a reporting and tracking mechanism to transparently show the progress of such contracting.

B. The RSP and the 38 MMT Portfolio Likely Understate 2026 Resource Needs.

Although the RSP and the 38 MMT Portfolio include significant incremental resource additions by 2026, the CAISO's production cost modeling analysis shows they likely underestimate the total quantity of new resources needed to maintain reliability.

Decision (D.) 20-03-028, explained that "Commission staff have not conducted and parties have not vetted a complete reliability assessment of a 38 MMT portfolio."[6] To fill this gap, the CAISO conducted production cost modeling of the 38 MMT Portfolio and includes the results in Attachment A to this filing. To conform to Commission filing requirements for the individual IRPs, the CAISO used the California Energy Commission's (CEC's) 2019 Integrated Energy Policy Report (IEPR) demand forecast, rather than the 2018 IEPR Update used to develop the original portfolios.[7] As in prior processes, the CAISO relied on the PLEXOS model rather than SERVM for the analysis.

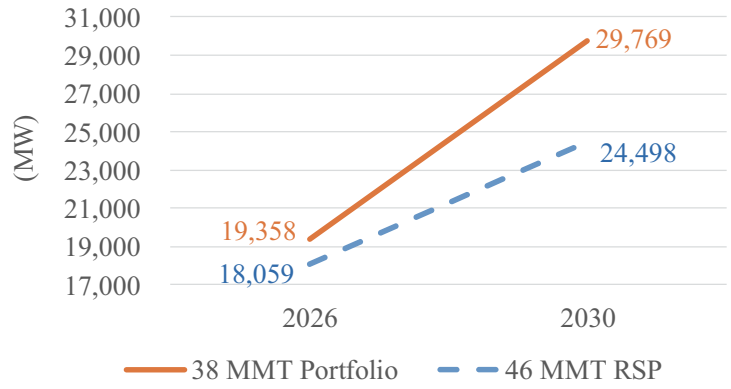
The CAISO's study results show the 38 MMT Portfolio is not reliable in that it does not meet the target loss of load expectation (LOLE) in 2026 or 2030. The CAISO production cost modeling found a 0.890 LOLE in 2026, well in excess of the 0.1, or one day in ten-year LOLE target. The 0.890 LOLE equates to a 3,493 MW shortfall in effective capacity in 2026. Effective capacity is the energy-backed capacity that is available when needed to avoid a loss of load event.[8] For 2030, the CAISO's analysis shows a 0.268 LOLE, which is equivalent to a 1,383 MW shortfall in effective capacity. These results show that system resource needs hit a critical inflection point after Diablo Canyon retirement and the lower 2030 LOLE is likely attributable to the addition of new resources in the RESOLVE model between 2026 and 2030.

The high LOLE found in the CAISO's modeling of the 38 MMT Portfolio raises questions about the Energy Division staff's reliability results under the RSP. In D.20-03-028, the 46 MMT RSP was found to result in a 0.113 LOLE in 2026 and 0.108 LOLE in 2030, slightly in excess of the 0.1 LOLE standard.[9] However, the CAISO notes the 38 MMT Portfolio contains more incremental resource additions than the RSP in terms of both capacity and energy. Specifically, the 38 MMT

[6] D.20-03-028, p. 31.
[7] *Filing Requirements Overview*, June 15, 2020. available at: ftp://ftp.cpuc.ca.gov/energy/modeling/Filing_Requirements_Overview.pdf
[8] Installed capacity may be higher depending on the ability of the resource to address the shortfall.
[9] D.20-03-028, p. 44, Table 7: Key Metrics for New 2019-2020 RSP.

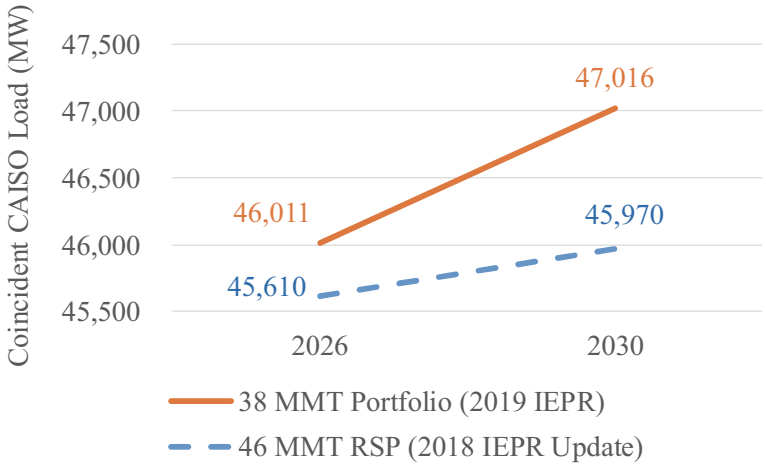
Portfolio added a net 10,411 MW[10] of installed capacity between 2026 and 2030 compared with only 6,439 MW under the 46 MMT RSP. The 38 MMT Portfolio also includes more incremental renewable resources but slightly less storage capacity in 2026 and 2030 than the 46 MMT RSP, as shown in Figure 1 below.

Figure 1: Comparison of Incremental Capacity by Portfolio



Load forecasts, on the other hand, only increased by 401 MW in 2026 and 1,046 MW in 2030 between the 2018 IEPR Update and the 2019 IEPR, as shown in Figure 2.

Figure 2: Comparison of IEPR Load Forecasts



As a result, the CAISO expects that its production cost modeling would show comparable or an even greater LOLE for the RSP compared to the 38 MMT Portfolio. Energy Division staff's SERVM production cost modeling did not show significant resource deficiencies in 2026 or 2030

[10] Net of gas retirements but does not include 327 MW of customer side batteries, which brings the total to 10,738 MW.

with the RSP. Without further extensive benchmarking, it is difficult to precisely account for why the SERVM results differ markedly from the CAISO's production cost modeling, but the 401 MW increase in the 2026 demand forecast does not fully explain the divergence in LOLEs.

The CAISO's production cost modeling results show the period after the Diablo Canyon retirement will be a critical point for system reliability. The Commission should plan accordingly and authorize procurement now to meet the identified needs.

C. The 38 MMT Portfolio Does Not Meet GHG Targets.

In addition to the reliability issues identified, the CAISO's analysis also shows the 38 MMT Portfolio produced 41.2 MMT of CO2 emissions in California, or 3.2 MMT in excess of the 2030 38 MMT target. This means additional and/or different resources will be necessary to meet GHG emissions targets under that portfolio. The CAISO's analysis also shows that given the portfolio and load levels studied, there is no "excess" or oversupplied renewables to charge storage resources. The model results show an increase in thermal generation, and thus CO2 emissions, to ensure battery storage resources are charged to meet the net demand (after sunset) evening ramp.

D. Improvements to Reliability-Based Modeling Are Necessary to Validate Portfolios.

The CAISO's modeling analysis indicates there are significant issues with both the RESOLVE capacity expansion and SERVM production cost modeling used to develop the RSP and 38 MMT Portfolio. The modeling issues produce portfolios that fail to meet reliability needs and GHG reduction goals and fail to produce diversified portfolios. The CAISO discusses these modeling issues in more detail below.

The CAISO's assessment of the 38 MMT Portfolio found a significant capacity shortfall in 2026. This indicates the RESOLVE model did not correctly identify system capacity needs and select sufficient resources to ensure system reliability. In addition, the Commission did not conduct and there was insufficient time for modeling parties to conduct production cost modeling to verify the reliability of the 38 MMT Portfolio prior to providing it as guidance for the individual LSE IRPs. As a general rule the Commission should ensure all portfolios, at minimum, successfully meet a 0.1 LOLE criteria using industry-standard production cost models. Specifically for the RSP and 38 MMT Portfolio, the Commission should evaluate the individual LSE IRPs to ensure collectively there are sufficient resources to cover load growth and replace Diablo Canyon.

Regarding GHG reduction goals, the CAISO's modeling shows RESOLVE understates GHG emissions in the 38 MMT portfolio. Going forward, the Commission should rely on production cost

modeling to validate expected GHG emissions produced in the capacity expansion modeling. The capacity expansion modeling is limited in terms of its study period and its modeling capabilities. Both the CAISO and Energy Division staff production cost modeling demonstrate that expected GHG emissions exceed the targets established in the capacity expansion modeling.

Finally, the simplified RESOLVE capacity expansion model cannot capture the full costs and benefits a particular portfolio will bring to the system. The "least-cost" portfolio, which is based on the input cost parameters in the capacity expansion model, is not necessarily the optimal portfolio from a reliability or prudent resource planning perspective.

Instead, the CAISO recommends the Commission use the RESOLVE capacity expansion model only as a starting tool to create initial portfolios. The Commission should then develop alternative portfolios based on policy guidance as validated by production cost modeling by simulating different sensitivity cases based on the initial portfolio. For example, the least cost constraint in RESOLVE does not seem to reflect the value of diversity upfront. In fact, the RESOLVE model tends to diversify only in later years after less expensive resources have been "exhausted" in earlier years. This approach leads to a less diversified portfolio in the near-term that may be suboptimal to address grid needs. As the CAISO's attached report details, there are numerous system conditions that RESOLVE does not assess—such as ramping needs and multi-day cloud cover events—that would benefit from a more diverse set of resources.[11] As a policy matter, the Commission should seek to "pull in" a greater diversity of resources from later years to mitigate the risks of over-reliance on one or two resource types and to appropriately plan for more complex resource build-outs earlier.

Further, given the potentially large build-out that is needed over the next few years, the Commission should reconsider its limitation on imports that count as incremental capacity to only those imports that are dynamically transferred or pseudo-tied to the CAISO system.[12] Incremental imports could help meet short-term resource needs while resources are planned and constructed to address the 2026 shortfall identified in the CAISO's analysis. Concerns about the lack of resource specificity and potential speculative imports can be addressed via CAISO's proposal submitted to the resource adequacy proceeding.[13]

[11] See Attachment A, pp. 15-17.
[12] D.19-11-016, pp. 31-32.
[13] The CAISO's proposal seeks to transition to a resource adequacy import framework that requires resource-specific capacity dedicated solely to California and secured in advance using high priority transmission service to ensure secured

Lastly, production cost modeling ensures the resulting portfolios meet both the reliability criterion and GHG emission targets. The Commission should then select the RSP from the alternative sensitivity portfolios after comparing the costs and benefits of each based on the production cost modeling results and policy guidance.

III. Conclusion

Both the Commission's RSP and the 38 MMT Portfolio already indicate the need for significant resource additions by 2026. The CAISO's analysis provides evidence that incremental resource needs may be much greater than originally anticipated. In any event, the system will need additional resources by 2030 to meet the increasing demand forecast and long-term GHG goals. The Commission should act now to expedite least regrets resource procurement for 2026. Any over-procurement in the 2026 timeframe will reduce 2030 needs.

The Commission should coordinate this expedited procurement with any contracted for new resources included in the individual LSE IRPs. However, the Commission should not delay procurement to wait for planned but unexecuted procurement referenced in the individual LSE IRPs. Put simply, there is insufficient time to wait for the results of such LSE resource planning exercises and simultaneously ensure LSEs secure sufficient new resources to meet the 2026 needs. The Commission should use its procurement authority to ensure 2026 resource needs are met.

Respectfully submitted

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power can actually flow to California, particularly during stressed west-wide system conditions. CAISO, Track 3.B Proposals, R.19-11-009, August 7, 2020. Available at: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M344/K841/344841567.PDF

Assessment of the CPUC-Selected 38 MMT Integrated Resource Plan Portfolio

October 23, 2020

California Independent System Operator

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1. Executive Summary

The California Public Utilities Commission (CPUC) adopted in Decision (D.) 20-03-028 a 2019-20 Reference System Portfolio (RSP) with a 46 MMT CO2 emission target. The CPUC also provided a second portfolio with a 38 MMT CO2 emission target. CPUC-jurisdictional load serving entities (LSEs) were required to file conforming individual integrated resource plans (IRPs) for both the RSP and the 38 MMT portfolio. D.20-03-028 did not provide complete information about the expected level of reliability or CO2 emission expectations for both portfolios based on production cost modeling. The CAISO has conducted an independent assessment of the 38 MMT portfolio with a focus on assessing levels of reliability and CO2 emissions resulting from the portfolio. Specifically, the CAISO assessment was conducted for 2026 to understand if the portfolio provides sufficient resources to replace the retiring Diablo Canyon Power Plant (Diablo Canyon), and for 2030 to test if the portfolio can meet a 0.1 day loss of load expectation (LOLE) and the 38 MMT CO2 emission target.

The CAISO's assessment used both stochastic and deterministic PLEXOS production cost models with assumptions consistent with the CPUC SERVM model. The CAISO's PLEXOS models, however, have methodologies that differ from the CPUC SERVM model.

The CAISO's assessment found that:

> The 38 MMT portfolio did not meet the 0.1 day per year loss of load expectation reliability criterion[1] in 2026 or in 2030. The portfolio is short of effective capacity to meet that target by 3,493 MW in 2026 and 1,383 MW in 2030.[2]
>
> The 38 MMT portfolio also produced 41.2 MMT CO2 emissions, materially higher than the 38 MMT target.
>
> The high solar and battery storage concentration provided in the 38 MMT portfolio results in the system being heavily dependent on the existing gas generation resources in the summer and winter months. From these results, the CAISO has concluded that diversifying the resource portfolios is more feasible to maintaining system reliability, especially if the majority of the existing gas generation fleet cannot be retained until 2030 and beyond.

2. About the CAISO Assessment

2.1 Purposes

In the CPUC's decision on March 26, 2020 (D.20-03-028), the CPUC released the 2019-20 46 MMT RSP and a 38 MMT scenario portfolio requiring the LSEs to file two individual IRPs conforming with the 46 MMT RSP and 38 MMT portfolio. D.20-03-028 included production cost modeling results about the reliability—from a supply adequacy perspective—and CO2 emission expectations of the 46 MMT RSP. According to the CPUC SERVM production cost modeling results, the 46 MMT RSP was found to marginally meet the loss of load expectation (LOLE)

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[1] For the definition of loss of load expectation criterion, see "Administrative Law Judge Ruling Directing Production Cost Modeling Requirements" and "Unified Resource Adequacy and Integrated Resource Plan Inputs and Assumptions Guidance for Production Cost Modeling and Network Reliability Studies, March 29, 2019" p.12

[2] Effective capacity is the energy-backed capacity that is avaiable when it is needed to avoid loss of load events.

reliability criterion of 0.1 day per year. It produced 50.3 MMT of CO2 emissions, which exceeds the 46 MMT target set in the RESOLVE capacity expansion model.[3] However, D.20-03-028 did not include similar production cost modeling results for the 38 MMT portfolio.

The CAISO conducted an independent assessment of the reliability and CO2 emission expectations of the 38 MMT portfolio for the reasons set out below. The CAISO assessment used PLEXOS production cost simulation models, which use an optimization method different from that of the SERVM model that the CPUC uses in its IRP proceeding. The CAISO PLEXOS models also implement some unique mechanisms to address the special needs for modeling the system with high penetration of renewable and storage resources. The CAISO PLEXOS model methodologies are discussed in Section 3 below.

2.2 Focus of the assessment

As stated in the CPUC decision, the 46 MMT RSP actually produced 50.3 MMT of CO2 emissions in 2030 based on the CPUC SERVM production cost modeling results. Extrapolating those results to the 38 MMT portfolio, this suggests that the 38 MMT portfolio would produce CO2 emissions between 38 and 46 MMT, which is a reasonable intermediate target in order to achieve 100% carbon-emission free electricity in 2045. Therefore, the CAISO used the 38 MMT portfolio as the basis of its assessment.

The CAISO conducted its assessment for years 2026 and 2030. 2026 represents an important inflection point for California's electric system because it is the first year that Diablo Canyon will be fully retired. In 2030, the 38 MMT portfolio should have sufficient resources to meet system load and reserve requirements while also achieving the CO2 emission target set in the definition of the portfolio.

2.3 Production Cost Modeling

The CAISO assessment used both stochastic and deterministic PLEXOS production cost modeling. Stochastic production cost simulation is able to determine the reliability of the portfolio, which is measured as a LOLE of the portfolio less than or equal to 0.1 day per year. The deterministic production cost simulation was used to accurately calculate the CO2 emissions produced by the portfolio.

3. Modeling Methodologies

3.1 Basic methodologies

The production cost modeling methodologies of the assessment are described in detail in the CAISO testimonies filed into the CPUC 2014 long-term procurement plan (LTPP) proceeding.[4] The testimonies covered the specifics of modeling approaches, model structures, assumptions and input parameters, as well as creation of random load, solar and wind generation profile samples for the stochastic models.

The fundamentals of production cost modeling is the optimization method used to solve the models. The CAISO PLEXOS models use a mixed integer programming (MIP) optimization

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[3] See D.20-03-028 p.44

[4] See http://www.caiso.com/Documents/Aug13_2014_InitialTestimony_ShuchengLiu_Phase1A_LTPP_R13-12-010.pdf and http://www.caiso.com/Documents/Nov20_2014_Liu_StochasticStudyTestimony_LTPP_R13-12-010.pdf

method, which is the same method used in the CAISO market clearing/scheduling system. It is, however, different from the optimization method of the SERVM model that the CPUC uses in the CPUC's IRP proceeding.

3.2 Changes to the methodologies in the testimonies

Since filing the LTPP testimonies, some aspects of the modeling methodologies have been updated. The changes improved modeling of resources, system topology and commercial arrangements, and addressed the needs of modeling resource portfolios with a higher penetration of renewable and battery storage resources.

The major changes made to the modeling methodologies since the CAISO filed the testimonies in the 2014 LTPP are set out below.

3.2.1 Dedicated import paths

The CAISO PLEXOS models have virtual dedicated transmission paths for imports from out-of-state renewables that are contracted with the CAISO market participants, and for imports from other generation resources that the CAISO market participants have ownership shares, including Hoover and Palo Verde. The dedicated import paths for the two coal plants Navajo and San Juan have been removed after the expiration of the ownership share contracts.

The dedicated import paths are virtual because they do not exist physically, but are carved out from the physical transmission paths. Each virtual dedicated import path has a dynamic rating equal to the flow of the energy the path was created to transmit. The energy flowing through the dedicated import paths is referred to as dedicated imports. Dedicated imports have scheduling priority over economic imports to ensure the energy of these specific resources is delivered to the CAISO, with or without congestions on the physical import paths. With the dedicated import paths incorporated in the model, the model is able to accurately track CO2 emissions by the imported energy.

3.2.2 Frequency response requirement

As described in the CAISO testimonies, there was a 25% local generation requirement for some zones in California. The local generation requirements for CAISO, SCE and SDG&E are now replaced by a CAISO-wide frequency response requirement in the current model. 50% of the 752 MW CAISO's frequency response obligation is provided by hydro generation resources. It is not modeled explicitly. The other 50% can be provided by combined cycle gas turbines (CCGT) and battery storage resources. Battery storage can meet the frequency response requirement 1 MW-for-1 MW, while CCGT can meet the requirement 1/0.08 = 12.5 MW-for-1 MW with its online installed capacity. The CCGT and battery storage resources to provide frequency response need to have sufficient unused online capacity reserved.

3.2.3 Tiered curtailment prices

In the PLEXOS model, a tiered renewable energy supply curve is implemented. It was developed based on analyses of the CAISO market clearing results. The supply curve is used to decide the curtailment of renewable energy.

Table 1. A Tiered Renewable Energy Supply Curve

	Segment 1	Segment 2	Segment 3	Segment 4
Offer Price ($/MWh)	-15	-25	-50	-150
Segment Capacity (MW)	2,000	5,000	5,000	6,000

3.2.4 Solar and wind providing load-following down

Wind and Solar now can provide load-following down up to 50% of the CAISO total load-following down requirement. Wind and Solar cannot provide any other types of reserves.

3.2.5 Removal of the SCIT constraint

The Southern California Import Transmission (SCIT) constraint has been removed from the model because the CAISO has retired the SCIT nomogram in its market operation.[5] The CAISO simultaneous import limit in the CAISO PLEXOS models is now from the CPUC SERVM model.[6] Specifically, the CAISO simultaneous import limit in the PLEXOS models is 6,500 MW for hour ending (HE)17-22, July through September and 11,665 MW for all other hours.

3.2.6 Look-ahead in simulations

One of the important changes is the introduction of a one day look-ahead feature in the simulations. Specifically, the production cost model simulation optimizes resource commitments and dispatches for two consecutive days each time and keeps the results of the first day only. Then the simulation rolls forward one day, until the end of the year. With one day look-ahead, results of the first day are affected by the load and supply balance situation of the second day. Commitment and dispatch of generation resources with long start-up time and charging and discharging decisions of storage resources are optimized better than without look-ahead.

The look-ahead functionality in simulation is important to accurately modeling battery storage resources. Without it, battery storage resources have no information about the conditions in the upcoming days. As a result, battery storage resources tend to underperform significantly compared to their capabilities. The direct consequence of the underperformance is more renewable energy being curtailed and more CO2 emissions produced.

4. Modeling Assumptions

The CAISO PLEXOS models were set up to be consistent with the assumptions of the CPUC RESOLVE and SERVM models to the extent possible. Differences were mostly due to information availability and confidentiality limitations.

4.1 Assumptions consistent with the CPUC models

Assumptions consistent with the CPUC RESOLVE and SERVM models included:

Existing generation fleet;

Hydro conditions;

CAISO import limits;

Renewable generation shapes; and

New renewable and storage resources.

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[5] See http://www.caiso.mobi/Documents/SouthernCaliforniaImportTransmissionNomogramRetirementScheduledJune1_2018.html

[6] D.20-03-028 at p.39

Table 2. New Resources of the 38 MMT Portfolio

CAISO New Resources Capacity (MW)	2026	2030	Changes 2026 to 2030
Solar	8,684	11,995	3,311
Wind (existing transmission)	3,811	5,279	1,468
Out-of-State Wind (new transmission)	0	3,000	3,000
Battery (4-hour)	5,036	9,714[7]	4,678
Demand Response	222	222	0
Pumped Storage (12-hour)	1,605	1,605	0
Thermal Retirement	0	-2,046	-2,046
Sum	**19,358**	**29,769**	**10,411**

New resources were from the 38 MMT portfolio, as shown in Table 2. From 2026 to 2030, there are 10,738 MW of additional new resources, including the 327 MW customer side battery storage, being selected. This does not include customer solar, which was embedded in the California Energy Commission (CEC) load forecast.

In Table 3 is the list of all the generation, storage and demand response resources by type in the 38 MMT portfolio. Customer Solar is also included in the table. From 2026 to 2030, the installed capacity of the whole portfolio increased by 14,647 MW.

[7] This does not include 327 MW customer side battery storage that is included in the total capacity of the 38 MMT portfolio.

Table 3. Total Resources resulting from the 38 MMT Portfolio

CAISO Total Resources Capacity (MW)	2026	2030	Changes 2026 to 2030
Nuclear	635	635	0
CHP	2,296	2,296	0
Gas	25,113	23,068	-2,046
Coal	0	0	0
Hydro (Large)	7,070	7,070	0
Hydro (NW scheduled imports)	2,852	2,852	0
Biomass	903	901	-2
Geothermal	1,851	1,851	0
Hydro (Small)	974	974	0
Wind (existing transmission)	11,267	12,735	1,468
Out-of-State Wind (new transmission)	0	3,000	3,000
Offshore Wind	0	0	0
Solar	23,571	26,883	3,311
Customer Solar	16,156	20,066	3,911
Battery Storage	7,974	12,978	5,005
Pumped Storage	3,204	3,204	0
Shed DR	2,418	2,418	0
Sum	**106,283**	**120,930**	**14,647**

The 38 MMT portfolio has high concentrations of solar and storage. Solar, including Customer Solar, is 37% and 39% of the installed capacity of the whole portfolio in 2026 and 2030, respectively. Battery and pumped storage together is 11% and 13% in 2026 and 2030, respectively. The share of thermal generation resources dropped from 26% in 2026 to 21% in 2030.

4.2 Assumptions different from the CPUC models

The assumptions that are different from the CPUC models are mostly in the generation resource operation characteristics and the California load forecast.

4.2.1 Operational characteristics

The CPUC SERVM model uses the confidential CAISO Master File data for the operational characteristics of the individual generation resources. The CAISO PLEXOS models do not use confidential data as the CAISO releases its PLEXOS models to the public in the CPUC LTPP and IRP proceedings. The CAISO PLEXOS models rely on publicly availed data. The sources and development of generation resource operation characteristics in the PLEXOS model are discussed in the CAISO testimonies.

4.2.2 Load forecast

The CPUC RESOLVE and SERVM models for developing the 46 MMT RSP and 38 MMT portfolio are based on the CEC 2018 Integrated Energy Policy Report (IEPR) Update load forecast. Since then, the CEC adopted the 2019 IEPR load forecast. The CAISO PLEXOS models are based on the CEC 2019 IEPR load forecast. Table 4compares Managed Load of the 2018 and 2019 IEPR for 2026 and 2030.[8]

The comparison in **Error! Not a valid bookmark self-reference.** 4 shows how much the load forecast has changed from the 2018 IEPR Update to the 2019 IEPR, as well as the differences between the load forecasts for 2026 and 2030.

As stated above, the 46 MMT RSP and 38 MMT portfolio are based on the 2018 IEPR Update load forecast, while the CAISO PLEXOS models use load forecast from the 2019 IEPR. The differences between the 2018 IEPR Update and 2019 IEPR are relatively small. For 2026, the CAISO coincident peak load in the 2019 IEPR is only 401 MW higher than that in 2018 IEPR Update. For 2030, the 2019 IEPR is 1,046 MW higher. This information aids in identifying how much the differences of the IEPR load forecasts contribute to the differences in simulation results of the CPUC RESOLVE and the CAISO PLEXOS models.

Table 4. Comparison of IEPR Load Forecasts for CAISO

CAISO Managed Load (MW)	2018 IEPR Update	2019 IEPR	Changes 2018 to 2019 IEPR
2026 Managed Load			
Coincident Peak Load (MW)	45,610	46,011	**401**
Energy (GWh)	224,426	222,228	**-2,198**
2030 Managed Load			
Coincident Peak Load (MW)	45,970	47,016	**1,046**
Energy (GWh)	220,169	224,222	**4,053**
Changes from 2026 to 2030			
Coincident Peak Load (MW)	**360**	**1,005**	
Energy (GWh)	**-4,257**	**1,994**	

In the 2019 IEPR, the coincident peak load in 2030 is 1,005 MW higher than in 2026, but the 2030 value is only 360 MW higher than the 2026 value in the 2018 IEPR Update. In Table 2, the new resource capacity is 10,738 MW higher in 2030 than in 2026, including 2,959 MW non-renewable capacity.[9] This raised the question of why 10,738 MW of additional resources added between 2026 and 2030 were found to be needed in the 38 MMT portfolio to serve only 360 MW of additional load. This suggests that the resource need is either considerably overstated in 2030, or considerably understated in 2026, which is an issue the CAISO examined in its assessment.

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[8] CEC 2019 IEPR hourly CAISO load forecast, MID-MID case, available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=231555&DocumentContentId=63372

[9] That is 4,678 MW utility scale battery plus 327 MW customer side battery minus 2,046 MW retirement of thermal generation resources. The 1,468 MW in-state and 3,000 MW out-of-state wind resources should also have some generation during the high net load hours.

5. Simulation and Results

5.1 Simulations

Both stochastic and deterministic PLEXOS production cost models were used in the CAISO assessment. Stochastic model simulations determined the level of system adequacy reliability achieved, and capacity shortfalls of the portfolio in meeting the established LOLE criterion. Deterministic model simulations calculated CO2 emissions that the portfolio would produce. The simulations were performed chronologically in hourly intervals for the whole year.

5.1.1 Monte Carlo simulations

The stochastic model captures the possible variations of load, solar and wind generation, and generation unit forced outages. It is for the purpose of testing the sufficiency of resources to meet load and reserve requirements in various circumstances, especially in challenging situations that will occur with small probabilities.

In the CAISO assessment, a 500-iteration Monte Carlo simulations were conducted. The inputs of the stochastic model included 500 sets of hourly profile of load, solar and wind generation, and generation unit forced outages. The 500 load, 500 solar, 500 wind generation profiles, and 500 forced outage profiles were created randomly based on the methodologies described in the CAISO testimonies. Each profile is unique. The results of the Monte Carlo simulations included the LOLE and the shortfall of effective capacity to meet the 0.1 day per year LOLE criterion. Effective capacity is the energy-backed capacity that is available when needed to avoid a loss of load event. Actual installed capacity may be higher than the effective capacity.

5.1.2 Deterministic simulations

The deterministic model includes the entire WECC footprint. It has detailed modeling of load, reserve and load-following requirements, individual generation and storage resources, and transmission paths between the balancing zones. The results of the deterministic simulation included hourly commitment, dispatch, fuel usage and CO2 emissions of each generation resource, the resources used to meet reserve and load-following requirements, imports from CO2-free and CO2-emitting resources, renewable curtailment, and production costs, including CO2 costs, for the resources, for the CAISO and for the whole WECC system.

5.2 Reliability of the 38 MMT portfolio

Based on the results of the 500-iteration Monte Carlo simulations, the 38 MMT portfolio did not meet the targeted LOLE reliability criterion in 2026 or 2030, having LOLE values greater than 0.1 as shown in Table 5.

Table 5. PLEXOS Model Monte Carlo Simulation Results

Cases	2026	2030
Loss of Load Expectation (LOLE)	0.890	0.268
Shortfall of Effective Capacity (MW)	3,493	1,383

The 38 MMT portfolio has a significant deficit between the selected new resources and the need for capacity to cover load growth and to replace Diablo Canyon in 2026. The simulation results provide the answer to the question posed in section 4.2.2 regarding the increase in capacity of 10,738 MW between 2026 and 2030 while there is only a coincident peak load increase of 360 MW over the same period. The significant increase in capacity in 2030 in part served the increased load, but more importantly closed a portion of the deficit found in 2026.

Diablo Canyon is a resource with very high capacity factor and extremely low forced outage rate. It provides large volume of steady and CO2-free energy supply to the system. Replacing it with renewable and battery storage resources is challenging. It needs to be well planned to ensure the system reliability is maintained and CO2 emission reduction is on target. The 38 MMT portfolio falls short in meeting this need. The significant effective capacity shortfall in the 2026 time frame is particularly critical due to the limited time available to address the shortfall between now and 2026.

5.3 CO2 emissions of the 38 MMT portfolio

Deterministic simulations optimize generation, import and export, reserve provision, and renewable curtailment for the whole WECC system, and also calculate CO2 emissions from generation and imports. Some aggregated results of the PLEXOS deterministic simulations and RESOLVE model are provided in Table 6.

The CPUC RESOLVE model was based on the 2018 IEPR Update load forecast and the CAISO PLEXOS model was based on the 2019 IEPR. However, the differences between the two load forecasts are relatively small. Most of the differences in simulation results appear to be because of differences in modeling methodologies and in some data used in the models.

As shown in Table 6 the PLEXOS simulations identified 41.2 MMT state-wide CO2 emission in 2030, while RESOLVE reported 38 MMT. Since RESOLVE is a simplified model for capacity expansion planning purposes, while the CAISO PLEXOS model has detailed modeling of generation resources, transmission paths, import and export, and uses MIP optimization method to solve the model, the CO2 emission result from the PLEXOS model should be more accurate. According to the results, the 38 MMT portfolio did not achieve the 38 MMT CO2 emission target as intended.

Table 6. PLEXOS and RESOLVE Model Deterministic Simulation Results

Simulation Results of the CAISO	2026		2030	
	RESOLVE	PLEXOS	RESOLVE	PLEXOS
CAISO CO2 Emission (MMT)	39.0	38.5	31.1	33.7
CA CO2 Emission (MMT)	47.7	47.0	38.0	41.2
RPS Achieved[10]	65.0%	60.0%	68.2%	71.5%
In-CAISO Generation (GWh)[11]	222,186	192,211	238,699	198,317
Net Import (GWh)	36,484	63,292	25,231	66,066
Renewable Curtailment (GWh)	2,938	821	6,696	1,689
Production Cost ($million)				
CAISO		1,668		1,406
WECC		11,467		11,602

As discussed in section 3.2.6, the one day look-ahead functionality in the simulation allows for better optimization of battery storage performances. With supply and demand information of the next day, PLEXOS simulations are able to make good use of battery storage resources to reduce renewable curtailment. Compared to the results of the RESOLVE model, which simulates 37 discrete days for each year, the renewable curtailment was significantly lower in the PLEXOS simulations. Lower curtailment led to more renewable energy being utilized and lower CO2 emission produced. Even so, the 38 MMT portfolio still produced 3.2 MMT more CO2 emissions than the 38 MMT target in 2030.

The results of the two models also had inconsistent results of the Renewables Portfolio Standard (RPS) achieved. This is because is addition to different renewable curtailments, different values of electricity retail sales were used. The RESOLVE model calculated electricity retail sales using total load, customer solar generation, California Department of Water Resources pump load and transmission/distribution losses. The CAISO PLEXOS model used retails sales values from the CEC 2019 IEPR Form 1.1C.

5.4 Impacts of high concentration of solar and storage in the portfolio

The 38 MMT portfolio has high solar and storage concentrations, as discussed in section 4.1. Solar is heavily favored in the RESOLVE model because it is a low cost renewable resource and is paired with battery storage. This complement works well to achieve the RPS and CO2 emission reduction targets within the model. However, the effectiveness of the pairing starts to diminish when the concentration reaches a certain level.

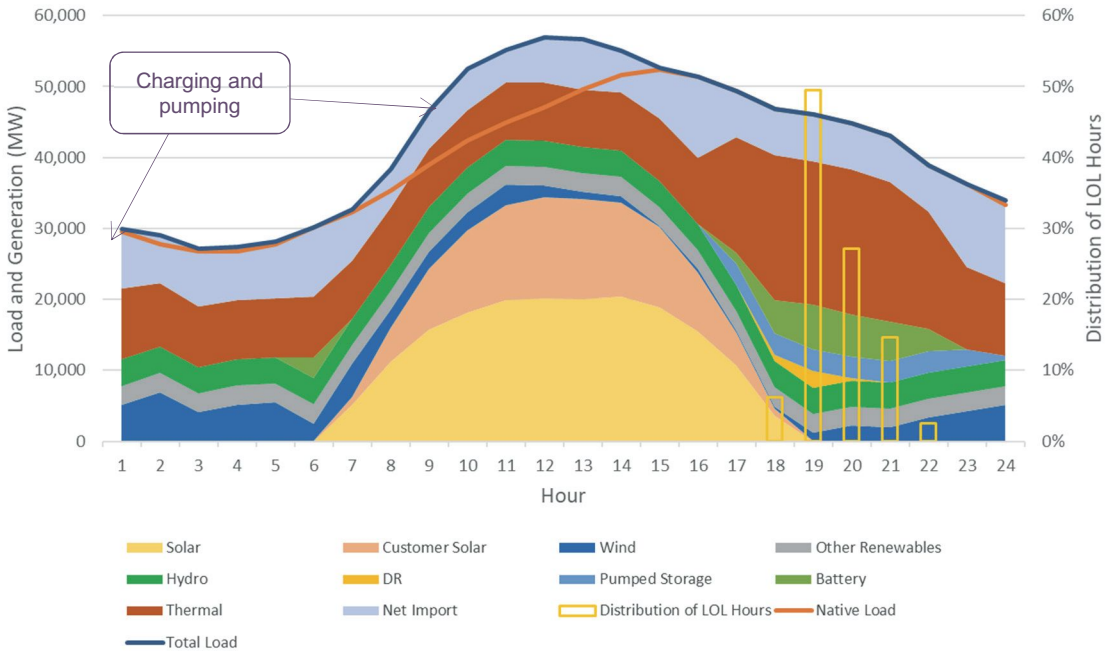
Figure 1 shows the hourly energy balance on a summer high load day in 2026 from the PLEXOS deterministic simulation. On that day, all renewable and hydro energy was fully utilized to serve load. Battery storage resources were charged in the mid-day by thermal generation and imported energy, both of which were assumed to be CO2-emitting resources.

[10] The retail sales values used in the calculation are different. The PLEXOS results use the value from CEC 2019 IEPR Form 1.1C.

[11] Including Customer Solar genreation

In the evening, starting just before sunset, the net load ramped up quickly (see Figure 2). The energy from almost all available resources and imports was needed to serve load and meet reserve requirements. Battery, pumped storage, and demand response resources all responded to the need. Still, the largest portion of energy was from thermal generation resources as imports were limited to 6,500 MW during these hours. All energy discharged from battery and pumped storage resources had CO2 emissions. Further, battery storage resources have round-trip efficiencies between 80% and 85%. It took about 1.2 MWh of thermal generation or imported energy to get 1.0 MWh energy from the storage resources in the evening. While adding more battery storage resources may help recover more renewable energy from curtailment in the spring months, it would actually *increase* thermal generation and CO2 emission in the summer months. This is because on a high demand summer day there is no "excess" or oversupplied renewables to charge the batteries. With the 38 MMT portfolio, retaining most of the existing thermal generation resources until 2030 and beyond becomes the key to integrating the large amount of battery storage resources. The cost of retaining the majority of the thermal fleet until 2030 was not clearly accounted for and explained in the 38 MMT portfolio.

Figure 1. Hourly Energy Balance on a Summer Day in 2026 (version 1)[12]



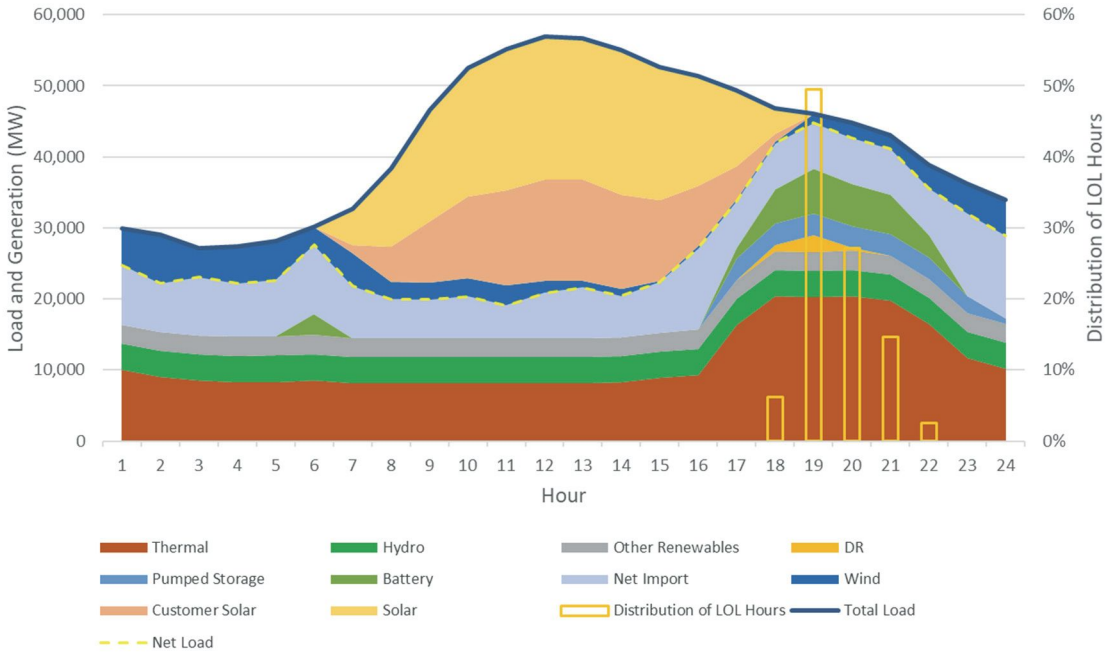
The next part of this analysis looks at the impacts of adding more solar resources to the portfolio. Even though the LOLE definition adopted in the IRP proceeding does not count capacity shortfalls to meet non-spinning reserve and load-following flexibility requirements, it is very important to CAISO system operations to have sufficient flexible capacity to meet non-spinning and load-following requirements all the time.

Figure 2 presents the hourly energy balance of the same day as in Figure 2 but in a different order of stacking up the supply resources. In the chart, the evening net load (total load minus solar, customer solar, and wind generation) experiences a steep upward ramp in late afternoon

[12] "Distribution of LOL Hours" on the right axis of the chart is the frequency distribution of all individual hours with loss of load in the 500-iteration Monte Carlo simulations.

and early evening due to high solar penetration. Securing sufficient flexible capacity to meet energy and reserves requirements during and after the evening ramp is challenging. All of the loss of load events in the Monte Carlo simulations were in the early evening hours and about 50% of them were at HE19 right after sunset. Adding more solar will further depress thermal generation in the mid-day and make the net load ramping situation even more challenging.

Figure 2. Hourly Energy Balance on a Summer Day in 2026 (version 2)



Another challenge is how to maintain system reliability during consecutive cloudy days, especially in the winter months, with a portfolio of high solar and battery concentration. This challenge was not considered in the development of the 38 MMT portfolio as the RESOLVE model simulated 37 discrete days for each year with typical solar and wind generation profiles. The 38 MMT portfolio was also not verified by production cost modeling in the process.

Diversifying the IRP resource portfolios is one option to avoid high solar and battery concentration. Geothermal, out-of-state and offshore wind that have different generation profiles from the California onshore wind, hydrogen for fuel cell batteries, for fuel mix to power existing natural gas generation resources, and for synthetic methane, which could be available in the longer future, should all be considered. These resources may be more expensive than solar and battery, based on the input cost figures in the RESOLVE model. However, RESOLVE is a simplified model. It is not designed to capture all the costs and benefits of different resource portfolios. There should be alternative ways to explore the different portfolios, besides that straight from the RESOLVE model.

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Continue Electric Integrated Resource Planning and Related Procurement Processes.	**R.20-05-003** (Filed May 7, 2020)

COMMENTS OF CALIFORNIANS FOR GREEN NUCLEAR POWER, INC. IN RESPONSE TO THE PROPOSED DECISION OF ALJ FITCH MAILED DECEMBER 22, 2021

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January 14, 2022

BEFORE THE PUBLIC UTILITIES COMMISSION
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I. AUTHOR'S VERIFICATION

The author below affirms under penalty of perjury that the information contained in this written testimony is true and correct, and is given in good faith to their best available knowledge, subject to modifications resulting from new findings.
/s/ Gene Alan Nelson, Ph.D. January 14, 2022

2. INTRODUCTION

Californians for Green Nuclear Power, Inc. (CGNP) is an independent nonprofit California corporation focused on preserving the ratepayer benefits, the environmental benefits, and the public safety benefits of the continued safe operation of Diablo Canyon Power Plant (DCPP) beyond 2025. CGNP believes the DCPP closure plans are motivated by special interests that will profit directly or indirectly from the unnecessary closure of this safe, large, reliable, cost-effective, and emission-free power plant that currently provides the equivalent of five (5) Hoover Dams of clean power each year. CGNP projects the takings from Californians connected with the needless DCPP closure plans to be in the billions of dollars per year. Given these large stakes, the most likely reason for the State of California's harmful actions is the provision of things of value to California governmental decision makers, depriving Californians of honest service by those decision makers.

3. CGNP'S FIRST RECOMMENDED CHANGE TO THE PROPOSED DECISION (PD)

The Commission's PD is to adopt the 2021 Preferred System Plan. Section 4 of the PD is the Preferred System Portfolio (PSP) and GHG Target for 2030. Section 4.1 is the Analysis leading to the PSP Portfolio and GHG Target Recommendation. Section 4.2 is the Discussion, beginning on page 99. The Commission failed to acknowledge any of the

extensive written testimony supplied by CGNP in R.20-05-003 or the related R.20-11-003 Proceeding relating to the PSP and GHG target reductions. Within the Section 4.2 Discussion is the fifth sentence in the first paragraph on page 108 of 185 of the Commission's PD which reads, "Criteria pollutants were counted from generation within California only, and not from unspecified imports." This sentence contravenes the Federal Clean Air Act [1] and California state statutes such as SB 1368 (Perata) 2006 which addresses unspecified imports. [2] This sentence contravenes relevant case law[3] . CGNP's corrected sentence reads, "Criteria pollutants were counted from generation within California, and from all unspecified imports."

4. FACTUAL BACKGROUND FOR CGNP'S FIRST RECOMMENDATION

A summary of some of the controversies surrounding this Proceeding is found in this newspaper article. [4] An in-depth update is found here.[5] Based on CGNP's observations to date, the plan supported by the Commission and at least ten other California executive branch agencies is to keep secret key elements of the plan to replace DCPP's emission-free generation mostly with coal-fired generation located in Wyoming which is owned by PacifiCorp, a subsidiary of Berkshire Hathaway Energy until the 2024-2025 time frame. The Commission's June 24, 2021 Procurement Order in this Proceeding authorizes between 4,000 to 5,000 MW of unspecified imports to be purchased. Unspecified imports are a California legal euphemism mostly applied to out-of-state coal-fired generation. Applying a capacity factor of 90% to this procurement yields a range of 32 - 40 TWh / year, likely the largest procurement in CPUC history.

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[1] 42 U.S.C. §§ 7401 et seq.

[2] PUC §§ 8340 - 8341

[3] *Union Elec. Co. v. EPA*, 427 U.S. 246 (1976)

[4] Gene Nelson, Is California on track to meet clean energy goals without Diablo Canyon? It's doubtful, *SLO Tribune*, 7B, August 22, 2021.

[5] Nathanael Johnson Sr., Save the Nukes, *Grist Magazine*, January 11, 2022, https://grist.org/climate-energy/nuclear-rally-environmentalists-try-to-save-diablo-canyon-power-plant/

Recent events such as ENRON creating California electric power shortages to boost the firm's profits bring into sharp focus that Californians expect a reliable power system [6] [7] for the largest economy in the United States (and the fifth largest in the world.). However, events such as the needless shut down of San Onofre Nuclear Generating Station (SONGS) at the end of January, 2012 decreased California's in-state reliable, emission-free generation by about 18 terawatt-hours (TWh) per year. (A terawatt-hour is a billion kilowatt-hours.)

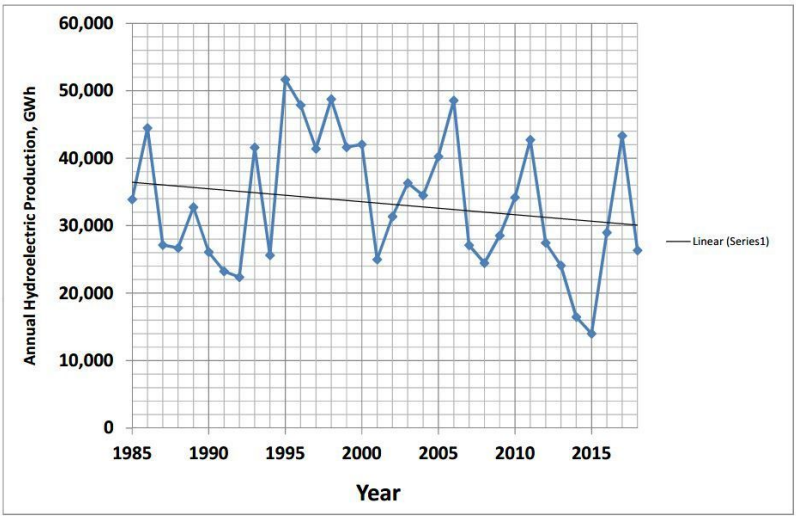
The shutdown of many megawatts of coastal natural gas fired power plants employing once-through cooling has been repeatedly delayed by the Commission in recognition of the important reliability role of those plants to protect California's fragile grid. The alleged benefit to Californians is to protect sea life. However, fishermen on boats know that one of the best fishing spots is near the outfall of power plants employing once-through cooling. Instead of being harmed, ocean fish are attracted to the outfall area since it is slightly warmer. Federal 316(b) regulations involving the waste heat from power plants on inland waterways should not apply to the world's largest heat sink, namely the Pacific Ocean. Daily heat inputs from the Sun dwarf the heat input of California coastal power plants. The solar heat inputs are essential for evaporating sea water to create water vapor which is deposited on California as rain and snow.

SONGS operated from the early 1980s with a variance in which the plant owners paid in the range of $2 million - $3 million annually to construct artificial reefs to remediate any claimed harms to sea life. DCPP has operated with a similar variance since starting operations in 1984 and should continue to operate under a variance. Given that federal 316(b) regulations applicable to DCPP also stipulate that remediation costs must

[6] Eaton Corporation, California Unplugged, *America's Power,* September 25, 2020, https://www.americaspower.org/wp-content/uploads/2020/09/California-Unplugged-Sept-25-2020.pdf

[7] Obstacles To Carbon-Free Electricity By 2035, *America's Power,* May 31, 2021, https://www.americaspower.org/wp-content/uploads/2021/06/Carbon-Free-Electricity-May-31.pdf

not be out of proportion to claimed environmental benefits. On May 1, 2009, the U.S. Supreme Court affirmed this principle. [8]



The scientific consensus is that burning more fossil fuels, particularly coal for electricity generation, is diminishing California snowpack, which decreases California hydroelectric production. The graph to the left based on California Energy Commission data [9] confirms this negative trend. The linear fit line shows a loss of about 6 TWh of California hydroelectric production between 1985 and 2018. The CEC website shows the 2019 California hydroelectric production was 38,494 GWh and the 2020 hydroelectric production dropped to 21,414 GWh, almost a record low. Snowpack in the Rockies is also down, leading to significant water shortages in the Colorado River basin - and the threat of power cutbacks from Hoover Dam and other dams on the Colorado River. [10] Total diminution of emission-free hydroelectric power serving California load in the neighborhood of 10 TWh / year relative to 37 years ago.

[8] Supreme Court Rules that Cost Can be Used to Determine Best Technology Available, *Barclay Damon LLP*, May 5, 2009, https://www.barclaydamon.com/alerts/Supreme-Court-Rules-that-Cost-Can-be-Used-to-Determine-Best-Technology-Available-05-05-2009

[9] 1985-2018 Total Annual Energy, *California Energy Commission*, June, 2021, https://www.energy.ca.gov/sites/default/files/2020-08/1985-2018_Total_Annual_Energy.xlsx

[10] Ian James, 'The pie keeps shrinking': Lake Mead's low level will trigger water cutbacks for Arizona, Nevada, *Arizona Republic*, August 15, 2020. https://www.azcentral.com/story/news/local/arizona-environment/2020/08/15/lake-mead-low-arizona-nevada-water-cutbacks/5584993002/

Finally, there is the unnecessary planned shut down of safe, reliable, cost-effective DCPP electricity production in 2024 and 2025 leading to the loss of another nominal 18 TWh / year. The total above loss of California's electricity is in the neighborhood of 50 TWh / year. The CEC website referenced on the previous page shows recent California electricity consumption approximates 300 TWh / year. California cannot afford to lose 1/6 of its power. After 2025, if DCPP closes, California will have no choice but to accept PacifiCorp's Wyoming coal-fired power to keep the lights on - despite SB 1368 (Perata).

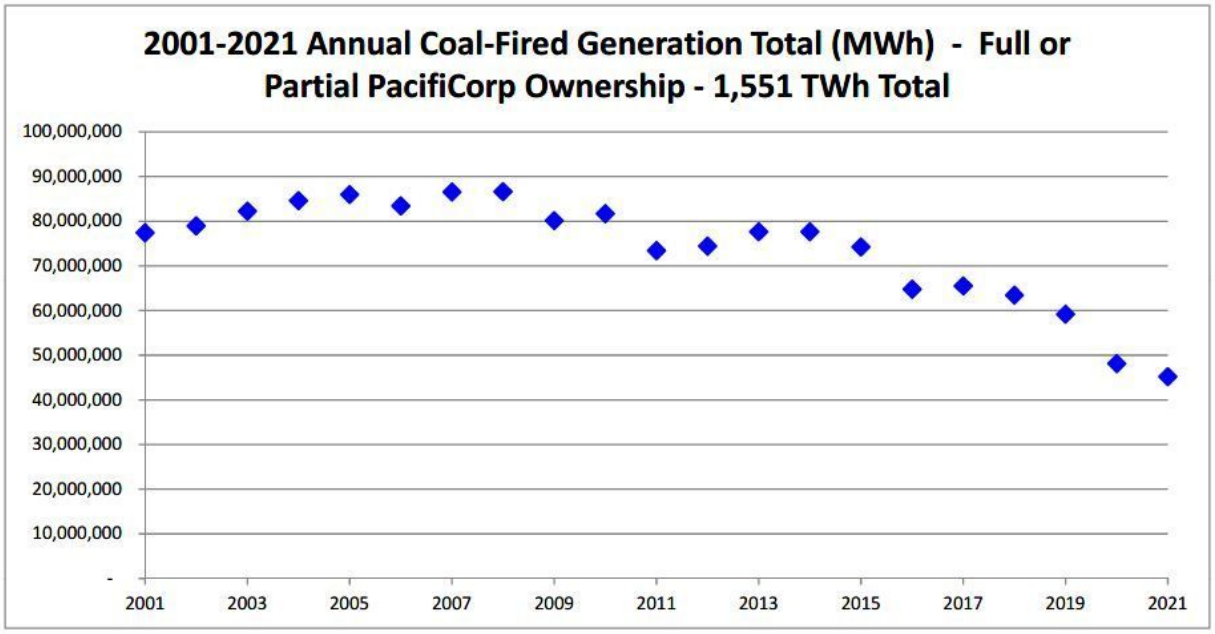
4A. PACIFICORP EMITS SIGNIFICANT AMOUNTS OF CRITERIA POLLUTANTS FROM ITS PRIMARILY COAL-FIRED GENERATION FLEET

Per CARB, PacifiCorp's 2018 CO2 equivalent emissions were 674,176 metric tons. [11] However, PacifiCorp's 2019 reported sustainability metrics[12] show that the firm's total 2017 CO2 equivalents were 41,826,769 metric tons, a factor of 62 larger. This is a significant discrepancy. In addition, PacifiCorp's sustainability metrics show the 2017 emission of 36,327 tons of NOx, 25,861 tons of SO2, and 103 tons of Mercury. CGNP takes sharp exception to the CPUC arbitrarily setting these values to zero. In contrast, DCPP's annual emissions of all of these criteria pollutants was actually zero. PacifiCorp's sustainability metrics show 63% of the firm's net generation was coal-powered, down from 77% in 2005. (In 2006, PacifiCorp was acquired by Berkshire Hathaway Energy for about $6 billion.)

[11] California Air Resources Board, Annual Summary of 2018 Greenhouse Gas Emissions Data, November 4, 2019. https://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/2018-ghg-emissions-2019-11-04-archive.xlsx?_ga=2.214040657.772797513.1626640108-1568542331.1581168515

[12] PacifiCorp 2019 Sustainability Report, https://www.brkenergy.com/assets/pdf/sustainability-pacificorp.pdf (Archived 07 02 21)

Here is a graphic showing the huge amount of PacifiCorp coal-fired generation by year, using EIA reported statistics. PacifiCorp generated close to 50 TWh from coal in 2021.



Here is the 2019 Clean Air Task force tabulation of PacifiCorp coal-fired generation showing the premature deaths of the very old and very young associated with coal-fired power plant emissions.

COAL-FIRED POWER PLANT	State	Capacity, MW	Berkshire Hathaway Energy Ownership Percentage	Annual Deaths from Air Pollution
Colstrip Power Plant	MT	2,094	6.8	48
Craig Station	CO	1,304	12.9	21
Cholla Generating Station	AZ	1,027	36.7	12
North Valmy	NV	522	50.0	21
Hunter Power Plant	UT	1,336	84.7	28
Huntington Power Plant	UT	911	100.0	16
Naughton Power Plant	WY	700	100.0	20
Dave Johnston Power Plant (Ret. 2020	WY	762	100.0	34
Wyodak Power Plant	WY	335	80.0	9
Jim Bridger Power Plant	WY	2,118	66.7	60
Hayden Station	CO	446	17.5	7
Total		**11,555**		**276**

Initial map source: https://tinyurl.com/PacifiCorp-1-Coal Generally, the plant power output was higher
CATF 2019 Updated map source: https://www.tollfromcoal.org/#/map
Archived 06 27 21 by CGNP

TOLL FROM COAL (Statistics before COVID-19 increased death tolls)

Coal-fired power plants are the nation's largest industrial polluter. The air pollutants from power plants—CO2, s particles, mercury, and other air toxics harm public health, causing unhealthy levels of ozone smog and fine par and can shave years off people's lives.

Since the year 2000, the Clean Air Task Force has issued studies based on work by Abt Associates, U.S. EPA's peer-reviewed, published methodology to quantify the deaths and other adverse health effects attributable to th from power plant emissions. Using the most recent emissions data (2019), Clean Air Task Force used the CO-E Impacts Screening and Mapping Tool developed by Abt Associates to estimate the death and disease due to cc that year.

Gene A. Nelson, Ph.D.

Warren Buffet in his 2021 Letter to Berkshire Hathaway shareholders disclosed the total cost of the Energy Gateway Project will be $18 billion by 2030. [13] Given that Washington state and Oregon have already enacted future bans on coal-fired generation,[14] The Energy Gateway will be primarily employed to serve California load.

5. CONCLUSION

PacifiCorp's plan to substitute Wyoming coal - fired generation for emission-free Diablo Canyon Power Plant generation should be rejected for the above reasons. The CPUC should halt the plan to make this substitution by 2025 as not in the public interest. California ratepayers, the environment, and California public safety will all be harmed if the CPUC goes forward with this plan.

Dated: January 14, 2022

Respectfully submitted,

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[13] Berkshire Hathaway Energy Annual Letter to Shareholders, February 21, 2021. https://berkshirehathaway.com/letters/2020ltr.pdf (Archived 01 03 22 by CGNP $18 billion Energy Gateway Project summarized on page 13 of 14, allegedly supporting clean energy.)

[14] Energy News Network, States are banning coal. Will it change the electricity mix?, *E&E Publishing,* LLC, July 21, 2020. https://energynews.us/2020/07/21/states-are-banning-coal-will-it-change-the-electricity-mix/

Resource Adequacy Means Keep Diablo Canyon Running - 06 05 22

Gene Nelson, Ph.D. CGNP Legal Assistant Government@CGNP.org email (805) 363 - 4697 cell

Californians were burned when out-of-state firms such as ENRON gamed the California power grid with energy scarcity, creating rolling blackouts between 2000 - 2001. As the world's fifth-largest economy, we expect the lights to stay on 24/7.

Any plan to replace Diablo Canyon, the state's largest generator by far, must replace Diablo Canyon's 24/7 power with power that has similar reliability. That fact is demonstrated by the **mandated increase in resource adequacy** (RA) in 2024, the year Diablo Canyon starts its planned shut down. CGNP previously explained that neither solar nor wind can add the requisite reliability muscle. Instead, the state uses euphemisms like, "shortfall" and "unspecified imports" to provide the reliability muscle in their procurement plan approved on June 24, 2021. See a picture schematic of the required generation at the top of the second page of the CPUC's 3-page summary at **https://tinyurl.com/D21-06-035** , also shown in the attachment . Unspecified imports, in light tan at 5,000 MW appears near the top of the resource stack shown for each year. Shortfall, which means a lack of reliable power, is shown in salmon. Here's a tabulation including annual summations for possible coal in MW.

Year	2021	2022	2023	2024	2025	2026
Shortfall (MW)	20	246	238	7,361	10,816	11,597
Generic for D.19-11-016		740	1,070	1,627	1,607	1,546
Unspecified Imports	6,000	6,000	6,000	5,000	5,000	5,000
Shortfall + Unspecified Imports (MW)	**6,020**	**6,986**	**7,308**	**13,988**	**17,423**	**18,143**

One possible source could be Berkshire Hathaway Energy's (BHE's) coal fired generation in Wyoming. (Recall that Hoover Dam is 2,078 MW, so the total 18,143 MW in 2026 is nine Hoover Dams.) However, there seem to be permitting delays in completing BHE's Energy Gateway project by 2025

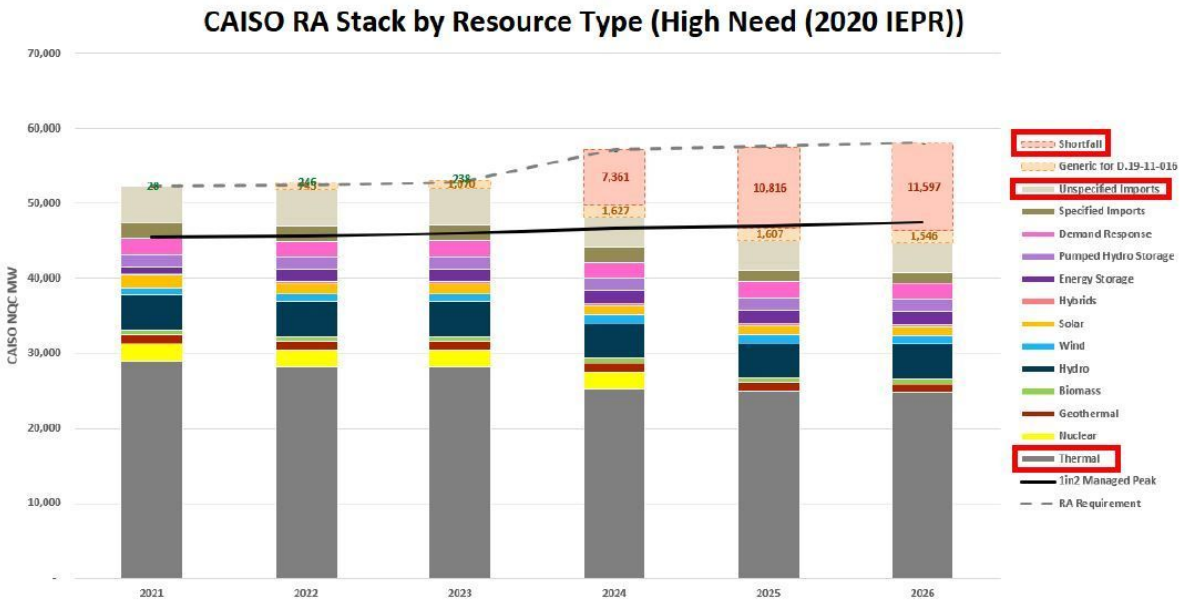
While the CPUC asserts that unspecified imports could be northwest hydroelectricity, that is unlikely, given the northwest soon needs to replace the massive 2,160 MW Colstrip coal-fired power plant in Montana with new, cleaner generation in accord with the upcoming bans on coal-fired imports into Oregon and Washington state. Furthermore, the ongoing western U.S. drought means northwest hydroelectricity isn't available. Any hope that batteries could provide a solution is unlikely, as higher-priority vehicle electrification is projected to require 400,000 MWh in 2022 and 600,000 MWh in 2023, per the April 19, 2022 *Wall Street Journal* article titled, "Rivian CEO Sees a Shortage Of EV Batteries on Horizon." The likely needed quantity of batteries would cost about 100 times the $5.6 billion construction cost of Diablo Canyon.

AB 162 created "unspecified imports" in 2009. Coal was advantaged via AB 1110, passed in 2016, when the default emissions level for unspecified imports was set to about half the actual value for coal-fired generation. Then, the plain language on page 104 of the CPUC's Preferred System Portfolio adopted on Feb. 10, 2022 says, "Criteria pollutants were counted from generation within California only, and not from unspecified imports." Again, the most likely source of unspecified imports is Wyoming coal-fired generation. While BHE's PacifiCorp subsidiary has been building the Energy Gateway, shown ending on the eastern border of Nevada, another BHE subsidiary, NV Energy is completing the pathway from the eastern border of Nevada to connection points to northern and southern California on the western border of Nevada by late 2023. The details are provided in NV Energy's IRPs and summarized in CGNP's CPUC filings. The next phase of BHE's plan would create even stronger links between its Wyoming coal-fired power plants to California. (Search the WECC website for future transmission planning.)

There is a superior solution already providing firm zero-carbon electricity (and resource adequacy) in California. Governor Newsom now agrees. At a minimum, Diablo Canyon's operation should be extended to 2035 to provide reliable, 24/7 power and abundant new desalinated water to the drought-parched Central Coast and points beyond. This cost-effective policy change was recently advocated in a Stanford-MIT paper titled, " An Assessment of the Diablo Canyon Nuclear Plant for Zero-Carbon Electricity, Desalination, and Hydrogen Production." On February 3, 2022, former Energy Secretary Steven Chu was signatory to a letter to Governor Newsom stating, "Considering our climate crisis, closing the plant is not only irresponsible, the consequences could be catastrophic.'

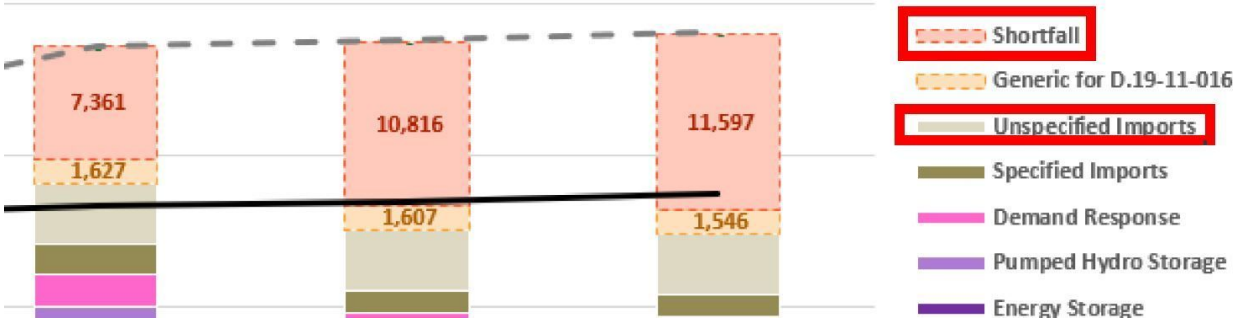
Resource Adequacy Means Keep Diablo Canyon Running - D.21-06-035

by Gene Nelson, Ph.D. 06/05/22



The 11,500 MW NQC ordered in this decision is in addition to the approximately 5,000 MW NQC interconnecting between 2020-2024 from prior CPUC decisions.

This set of Resource Adequacy (RA) stacks is from the second page of the CPUC summary of their June 24, 2021 procurement Decision D.21-06-035. Each resource type is shown in megawatts (MW.) Note the dominance of fossil-fueled thermal generation shown by the grey bars.



Here is an enlargement of the top of the 2024, 2025, and 2026 RA stacks. The State of California plan has one of DCPP's two units shut down in 2024 and the second shut down in late 2025. The most significant item are the large values in 2024, 2025, and 2026 assigned to "Shortfall" to meet the Resource Adequacy requirements after California's 2020 rolling blackouts.

Year	2021	2022	2023	2024	2025	2026
Shortfall (MW)	20	246	238	7,361	10,816	11,597
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Unspecified Imports	6,000	6,000	6,000	5,000	5,000	5,000
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Here is the detailed tabulation from the above Resource Adequacy Stacks. Sums for each year are in the row labeled "Shortfall + Unspecified Imports (MW)" (*Per the legend of the first figure above, here could be 5,000 MW more.)*

Daily News

Newsom gets it right on Diablo Canyon

The Editorial Board
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Categories: Opinion
https://www.dailynews.com/2022/08/17/newsom-gets-it-right-on-diablo-canyon/amp/
https://www.pe.com/2022/08/17/newsom-gets-it-right-on-diablo-canyon/
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https://www.dailybreeze.com/2022/08/17/newsom-gets-it-right-on-diablo-canyon/

California lawmakers may create a way to pay PG&E to ensure that the Diablo Canyon nuclear plant near San Luis Obispo keeps generating power. Avila Beach in 2008. (Michael A. Mariant, AP Photo)

Much to the annoyance of some ideological environmentalists, Gov. Gavin Newsom has proposed keeping open, rather than shutting down, the state's last nuclear power plant. Last week, the governor's office sent draft legislation to help keep the Diablo Canyon nuclear facility in San Luis Obispo County, slated to be shut down in 2025, open.

Under the proposal, Diablo Canyon could be kept open for an additional decade and the state would provide plant-operator PG&E a forgivable loan to cover the cost of the plant's license-renewal process and maintenance.

The governor deserves credit for recognizing the need to be pragmatic about pursuing a greener energy future. The governor has realized that allowing the nuclear plant, which provides about 8% of the state's electricity, to continue operating will do more good than harm at this time and that the planned shutdown of the plant would do more harm than good.

"The governor supports keeping all options on the table as we build out our plan to ensure reliable energy this summer and beyond," Erin Mellin, the governor's spokesperson, told *Politico* on Friday in a statement. "This includes considering a limited term extension of the Diablo Canyon Power Plant, which continues to be an important resource as we transition away from fossil fuel generation to greater amounts of clean energy, with the goal of achieving 100 percent clean electric retail sales by 2045."

There's nothing objectionable about that statement.

Last year, researchers from MIT and Stanford found that "delaying the retirement of Diablo Canyon to 2035 would reduce California power sector carbon emissions by more than 10% from 2017 levels and reduce reliance on gas," as well as save billions of dollars in power system costs.

Yet Newsom's announcement drew anger from enviros at Environment California, Friends of the Earth and the Natural Resources Defense Council, which issued a joint statement denouncing the proposal to keep Diablo Canyon open as "a dangerous and costly distraction."

This sort of hysterical rhetoric should be ignored. If California is going to try and lead the country on renewable energy, there's nothing wrong with buying time as renewable energy technology improves.

UTILITY DIVE DIVE BRIEF

California unveils proposal to keep Diablo Canyon nuclear plant open with $1.4B loan to PG&E

Published Aug. 16, 2022

https://www.utilitydive.com/news/california-diablo-canyon-nuclear-plant-open-newsom-bill/629727/

Kavya BalaramanSenior Reporter

"Diablo Canyon Family Open House" by Tracey Adams is licensed under CC BY 2.0

Dive Brief:

- California Gov. Gavin Newsom, D, is proposing to keep the two units of the Diablo Canyon nuclear plant online until 2029 and 2030 – as opposed to

shuttering the facility entirely by 2025 – while also exploring the option of extending the plant's life through 2035.
- Proposed legislative language released Friday includes a $1.4 billion loan from the state's general fund to Pacific Gas & Electric, the operator of the plant, to cover the cost of relicensing the 2.2 GW nuclear plant. The legislation also outlines the terms of the loan agreement, including the circumstances under which the utility would repay the loan.
- PG&E understands that state leaders' discussions to potentially extend operations at the Diablo Canyon plant are progressing, "and we stand ready to support should there be a change in state policy, to help ensure grid reliability for our customers and all Californians at the lowest possible cost," utility spokesperson Suzanne Hosn said in an emailed statement.

Dive Insight:

California regulators in 2018 approved a plan to retire Diablo Canyon, the state's last nuclear plant, by 2024 and 2025. However, stakeholders have more recently been exploring the potential benefits of keeping the plant open beyond that timeframe – last year, researchers at Stanford University and the Massachusetts Institute of Technology published a report concluding that California could reduce power sector emissions by 10% from 2017 levels and save $2.6 billion by keeping the plant online through 2035.

PG&E Corp. CEO Patti Poppe said during the company's earnings call in late July that the utility was exploring the possibility of keeping the plant operating, but that doing so wouldn't be easy as it would require legislation and navigating a complicated relicensing process.

The draft legislation released last week outlines a pathway for the plant to receive the state and federal regulatory approvals it will require to stay online. **It would direct the California Public Utilities Commission to keep the plant's two units online through Oct. 31, 2029, and Oct. 31, 2030, respectively. By 2026, regulators would need to decide whether to keep the plant open for even longer, but no later than 2035.**

A limited term extension of the Diablo Canyon plant is warranted to ensure reliability as California aims to decarbonize its grid by 2045, the governor's office said in an overview of the proposal. However, extending the life of the plant would not interfere with the state's plans to procure additional clean energy resources, it added. Last summer, the CPUC directed power providers to procure 11.5 GW of new, clean electricity resources to help replace the Diablo Canyon plant as well as a suite of natural gas plants set to retire in the coming years.

"In the face of extreme heat, wildfires, and other extreme events that strain our current electrical system, the state is focused on maintaining energy reliability while accelerating efforts to combat climate change," a spokesperson in the governor's office said in a statement, adding that, "the Governor supports keeping all options on the table as we build out our plan to ensure reliable energy this summer and beyond."

However, the proposal drew criticism from some environmental advocates. Legislators should reject the proposal out of hand, Environment California, Friends of the Earth and the Natural Resources Defense Council said in a statement. The groups said the proposal includes sweeping exemptions from environmental regulations and the $1.4 billion loan to PG&E may never be returned to taxpayers.

“With Governor Newsom and the legislature working to appropriate climate budget funds and advance ambitious climate legislation in the waning days of the legislative session, this proposal is a dangerous and costly distraction,” they added.

Filed Under: **Grid Security & Reliability**

LE MONDE diplomatique

AUGUST 2022 I **LE MONDE DIPLOMATIQUE**

WHO BENEFITS WHEN NUCLEAR POWER PLANTS CLOSE?

The nuclear energy dilemma

Limiting global warming to 1.5°C will mean a growing role for nuclear power. As wildfires burn a parched land, California is rethinking its decision to decommission its last nuclear plant

Maxime Robin Translated by George Miller

CAN YOU BE an environmentalist and also pro-nuclear energy? Heather Hoff is certain you can. To her, they go hand in hand. The 43-year-old mother of two is a keen cyclist and hiker who drives a second-hand electric car and works as a reactor operator and procedure writer at Diablo Canyon, California's last operational nuclear power plant, which the state legislature has committed to shutting down in 2025. Diablo is on the Pacific coast, midway between San Francisco and Los Angeles, set in a vast, rolling landscape where cattle graze. In this picturesque setting, its two reactors generate 10% of California's electricity and more than half its carbon-free energy, on a footprint the size of a large farm.

Hoff says she's the 'ultimate environmentalist', though her campaign to save her workplace — against the advice of her employer Pacific Gas & Electric (PG&E) — and to revive nuclear power in the United States, runs counter to a 50-year-old founding principle of the environmental movement. 'It's the most useful thing I could do for the environment. And it's funny because I grew up always wanting to be saving the whales or [involved] wildlife conservation. But nuclear leads to all those things,' she told me in a bar in downtown San Luis Obispo, the nearest town to the plant. Hoff, who was wearing a pendant around her neck containing thorium, a weakly radioactive, fluorescent metal, always carries homemade stickers for laptops and water bottles with the slogan 'I ♥ U 235' and a drawing of a heart orbited by tiny electrons. **'When nuclear plants close, they're replaced by fossil fuels.** It took me a long time to come to this conclusion'

Diablo Canyon's operating license came up for review in 2016 — normal practice for any plant approaching 40 years of operation. There was widespread surprise when PG&E and the California legislature agreed it would close. Regulations in California give renewable energy priority as a power source, meaning Diablo Canyon could only operate at half-capacity, compromising its profitability, said PG&E, a private company traded on the stock market, which nonetheless has a public service mission. Diablo will be California's second and final nuclear plant closure after San Onofre shut down in 2013. By 2025, the share of nuclear power in the state's

electricity mix is expected to fall from around 10% today to zero; to compensate, the state hopes to triple its renewable capacity. Despite being the home of the highly polluting tech industry' (Apple, Google, Facebook, Uber), California likes to think of itself as in the vanguard of the ecological battle. For several years, it has been trumpeting its intention to withdraw from nuclear power and has set the goal of decarbonising its electricity supply by 2045 — as required by a 2018 California Senate bill — and banning the sale of new vehicles with internal combustion engines from 2035, which will automatically lead to huge additional demand for electricity.

Hardly anyone's fighting to keep the power plants running, least of all environmentalists like us. And yet it's people like us who should care most

Heather Hoff

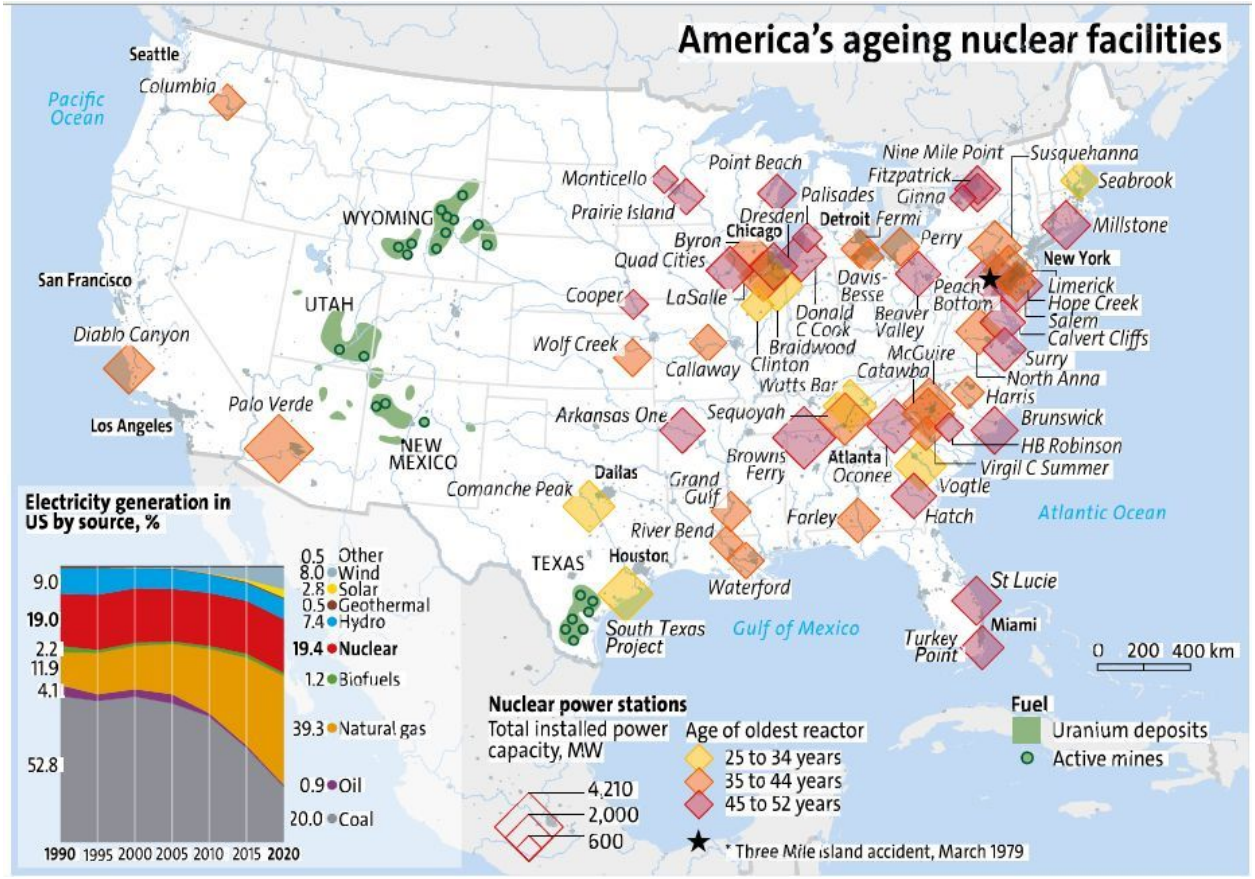
Hoff's conviction that closing the plant was ridiculous, given the need to decarbonise and the rising electricity demand, led her to co-found Mothers for Nuclear with Kristin Zaitz, an engineering manager at the plant, on Earth Day in 2016. The homepage of their website, which they manage in their spare time, shows a gallery of women who share their belief that nuclear energy is essential to fighting global warming and to ensuring a viable future for their children. The website lists nuclear power's benefits — it's a carbon-free, dense and controllable energy source with a tiny footprint —and insists they far outweigh the risks.

'Hardly anyone's fighting to keep the power plants running, least of all environmentalists like us. And yet it's the environmentalists who should care most,' Hoff told me. She sees solar and wind power as allies of nuclear, but on their own they cannot meet present, let alone future, demand because of their low energy density and intermittent supply. 'Wind and solar are great,' acknowledges Jennifer Klay, a group member and physics professor at Cal Poly Tech, 'but they only reduce fossil fuel use when the wind is blowing and the sun is shining. Nuclear power can replace fossil fuels 24/7.' Klay says that closing Diablo Canyon and promising to replace it in the short to medium term with entirely renewable energy is magical thinking. Hoff, for her part, favours a 'strong nuclear base' for California's electricity mix, which could cover all off-peak demand as a minimum. The rest could come from renewables: hydro, solar, wind and geothermal.

Mothers for Nuclear attracted little attention when it was set up; it didn't even receive financial backing from the nuclear industry. **But since then, global warming and the resulting hazards of drought and fire have become the number-one threat in** California. This has shaken confidence that closing Diablo is the right decision, and the group now has strong support.

A joint study published last November by scientists from the Massachusetts Institute of Technology (MIT) and Stanford University was the first major challenge to the closure decision. Its authors suggested that extending Diablo's life by io years would reduce carbon emissions by 10%, and thus California's gas dependence? Keeping it running until 2045 could save up to $21bn in grid costs and spare 364 sq km of land that would otherwise be needed for renewable energy production. The study also recommended using Diablo's energy to power a desalination plant to alleviate California's chronic drinking water shortage.

Underinvestment: a fire caused by ageing energy infrastructure devastated the California town of Paradise, killing 85 people, in 2018



Map sources International Energy Agency (IAE); US Nuclear Regulatory Commission (US NRC)

Then, in early February, 75 scientists (including Nobel prize-winning physicist Steven Chu, Obama's energy secretary) signed a joint letter calling on Democratic governor Gavin Newsom to extend the plant's life: 'The threat of climate change is too real and too pressing to leap before we look,' they wrote; closing Diablo `will increase greenhouse gas emissions, air pollution and make reaching the goal of 100% clean electricity by 2045 much harder and more expensive' The shutdown of San Onofre increased the state's power plant emissions by 35%, according to the California Air Resources Board. Since hydroelectric power could not make up the shortfall because of chronic drought, the slack was largely taken up by gas-fired plants.[3]

Unconventional nuclear lobby

In Washington DC there is an official nuclear lobby, the Nuclear Energy Institute; its members are utilities that own nuclear power plants. But these companies also run gas- and coal-fired plants, 'so they're sometimes a bit ambivalent about being highly focused on nuclear,' says Ed Kee, an expert on the economics of nuclear energy, consultant to governments and private companies, and author of the book *Market Failure.*[4] Rather than a conventional lobby, the US nuclear sector is a group of companies with a variety of different and sometimes conflicting agendas.

Mothers for Nuclear is trying to fill the gap, carving out its own, admittedly modest, patch: six years after its creation, the group has 5,600 Twitter followers. It caught the attention of German environmental activist Britta Augustin, who in September 2020 contacted MEN to propose setting up a European branch. In July 2022, European Mothers for Nuclear went to Strasbourg to support the European Parliament's decision to include nuclear (and gas) activities in the list of 'environmentally sustainable activities' — much to the dismay of most other environmental activists.

Surprisingly, California's green movement has not always been anti-nuclear. In the 1960s it favoured nuclear power over hydroelectric, which was accused of destroying aquatic wildlife and flooding valleys, and considered coal the least bad source of power. But attitudes to nuclear power have varied according to perceived threats at any one time. However, once the case against nuclear power became established, from the 1970s, the support of Californian greens played a decisive role in reducing the size of the sector. (Diablo was originally to have had six reactors, for example.)

In 1981, two years after the accident at Three Mile Island in Pennsylvania, 2,000 people were arrested during a huge demonstration to block the construction of Diablo. It remains the US's largest ever anti-nuclear protest; Buddhist monks came on foot from Santa Barbara. But hard-core anti-nuclear activists are now ageing, as was clear from those who attended an anti-Diablo public meeting at Cal Poly Tech in early April.

California's Central Coast has long been blessed with the kind of Mediterranean microclimate in which lemon trees thrive. In the first half of l9th century, newspaper magnate William Randolph Hearst, an inspiration for Citizen Kane, built his legendary Xanadu Palace here, well away from the sprawl of Los Angeles. But now, in 2022, California is again experiencing a summer drought. The stifling heat has led to spikes in electricity consumption (because of the widespread use of air conditioning), overloading the grid, especially in the evenings, when solar energy does not produce power. This leaves the state with no choice but to burn more fossil fuels to avoid massive power cuts.[5]

Unprecedented water restrictions have been introduced to deal with the 'drought of the millennium', which has in fact been going on for years. The under-maintained power grid, which is ill-suited to such conditions, is starting to cause huge fires. PG&E has admitted responsibility for the so-called Camp Fire, which in 2018 devastated the town of Paradise, killing 85 and destroying 19,000 buildings. In January 2019 the company sought bankruptcy protection after accumulating around $30 billion in liability for fires started by its poorly maintained equipment.[6]

The electricity grid has also proved completely unsuited to diversification of production caused by the development of solar and wind power. Hydropower — 'the backbone of low-carbon electricity generation' along with nuclear, according to the International Energy Agency (IEA) — will not be much help in the future, despite the California legislature's stated intention of relying on it post-Diablo in just three years' time. **Throughout the American West, rivers and dams are drying up. Hydropower output will probably be cut in half this summer, a taste of things to c**ome.

Climate activists often view support for nuclear power as a betrayal, even sacrilege. There is no shortage of arguments against this energy source[7] in campaigning organisations' literature in the US and elsewhere, including the difficulty of managing nuclear waste, the risk of accidents, poor maintenance, ageing infrastructure and problems securing a fuel supply. However, in the absence of viable alternatives, are more and more 'heretics', such as Zion Lights, former spokesperson for Extinction Rebellion, the degrowth movement founded in the UK. Lights gradually found herself out of step with the movement, which she felt 'peddled messages of doomsday gloom' and offered 'little in the way of positive solutions'. She now believes that 'any rational, evidence-based approach shows that a strategy including nuclear energy is the only realistic solution to driving down emissions at the scale and speed required:[8]

In its four main scenarios for limiting global warming to 1.5°C, the Intergovernmental Panel on Climate Change (IPCC) envisages a huge increase in renewable energy, as well as a significant increase in the world's nuclear capacity. Lights denies that this is a U-turn and instead calls it a 'logical next step' in the quest for climate change solutions. In Germany the Greens are engaged in an internal battle over their energy choices of the past 20 years. Historian Anna Veronika Wendland, a leading figure in the German environmentalist movement who once campaigned against nuclear power, now accuses German Greens of an 'irrational fear of the atom'. Although they remain a small minority, these nuclear converts have upset the previous consensus. **And a growing number of Californians, including those concerned about climate change, now wonder whether it's right to close nuclear power plants if they are only going to be replaced by fossil fuels with high CO2 emissions.**

The fracking revolution

The US has no lack of fossil fuels. The fracking revolution boosted production in the late 2000s, making the country the world's largest oil and gas producer. It also made many planned nuclear power plants obsolete over the past 20 years. 'Natural gas is fairly cheap in the US and plentiful,' Kee says, `and [a natural gas plant] ends up being the easier thing to build...We basically met our Paris Accord greenhouse gas emissions targets by doing nothing... Natural gas plants replace coal plants. That causes a big reduction in green house gas emissions without doing anything on the part of the federal government. We've become a bit complacent because of that,' he says. Even in pro-nuclear states, the availability and cheapness of shale gas is discouraging new nuclear plant construction.

With 93 nuclear reactors in operation, the US still has the world's largest nuclear sector, but it's in poor shape. In terms of its share of national electricity production (20%), **American nuclear power is still far behind the world leader, France (over 70%).** The brutal deregulation of the energy market in much of the country has weakened the nuclear sector and expertise is disappearing as reactors are decommissioned and engineers retire. Costs and delays mount daily on the only two reactors currently under construction, Plant Vogtle units 3 and 4 in Georgia.

The only exception is Washington State, which in 2019 passed an environmental law, the Clean Energy Transformation Act, requiring power companies to be carbon neutral by 2030 or face hefty fines. With hydropower output almost at capacity, the state is trying to develop new types of Small Modular Reactors (SMRs), though these come with the known problem of a very high price tag. The first four will be built by the Columbia River. A start-up owned by Bill Gates also plans to build a state-of-the-art power plant in Kemmerer, Wyoming, on the site of a coal-fired plant.

While building a new nuclear power plant is very expensive in the West (it's much less so in Asia), the initial investment in old plants such as Diablo has long since been absorbed. **Even factoring in maintenance costs, established nuclear remains the cheapest source of carbon-free electricity in the US, according to the International Energy Agency (IEA), which includes construction as well as running costs in its calculations.** Next cheapest are solar and onshore wind, then new nuclear, which is significantly more expensive, but still cheaper than offshore wind, the most expensive of all carbon-free sources, according to the IEA.[9] The Biden administration has clearly taken these statistics to heart: in April it offered $ 6bn in aid to extend the life of ageing nuclear plants. Ten days later, California's Democratic governor Gavin Newsom said it would be 'remiss' not to reconsider the closure of Diablo if some of the money was awarded to his state.[10]

Earthquake zone

While the US nuclear sector is largely privatised, managing nuclear waste is the responsibility of the state and managed from Washington. The 1982 Nuclear Waste Policy Act required federal government to provide disposal solutions to private operators of nuclear reactors. In fact, almost no waste has been removed from nuclear plants. For a time, the government considered using an underground facility at Yucca Mountain in Nevada, but the site, a two-hour drive northwest of Las Vegas, has been beset by practical and political problems. So the waste has continued to accumulate at some 6o sites for the past 40 years and the federal government has paid the companies hundreds of millions of dollars annually for breaching its contract, money that the operators are not obliged to spend on storage.

The problem of what to do with the waste is a perennial one, with no obvious long-term solution, but Mothers for Nuclear is blithely optimistic. 'Diablo Canyon stores its own spent fuel on site in dry casks outside and you can stand right next to the canisters and not have any effects of radiation, and you can sleep on top of them, if you wanted to', says Klay. 'They're not dangerous, right?'

The Diablo plant's location, near an earthquake zone, alarms opponents of nuclear power. One of the three fault lines near the plant was not discovered till after it was built. Originally designed to withstand a magnitude 6.5 earthquake, Diablo plant was retrospectively upgraded to withstand a magnitude 7.5 shock. During the last earthquake in the region in San Simeon in 2003 (magnitude 6.5), the plant did not experience problems. But what if there were an earthquake of magnitude 9.1 (as in Fukushima) that precipitated a tsunami? That question remains unanswered.

Former journalist David Weisman is familiar with these issues. For many years he has been the outreach coordinator for the Alliance for Nuclear Responsibility, an organisation campaigning for Diablo Canyon's closure. He lives inside the plant's evacuation zone. In addition to obsolescence and safety issues, Weisman flags up an economic problem: nuclear power is 'too expensive. PG&E says so, not me.' California can get by, he says, with 'energy sobriety' (an idea rarely mentioned in San Luis Obispo) and with new electricity imports from outside the state. He places a lot of hope in wind power from Wyoming, maintaining it could in the future feed into California's grid via a new 1,500-km high-voltage line. The project is being funded by the investor Warren Buffet, the world's eighth richest man, and billionaire Philip Anschutz, an oil and sports events magnate, neither of whom personifies 'energy sobriety'...

'Californians will lose both ways'

Gene Nelson, assistant legal counsel for Californians for Green Nuclear Power (CGNP), says his fellow Californians must believe in Santa Claus if they imagine that this new electricity from Wyoming will be clean. Wind farms are being built on the windy uplands of this sparsely populated state, encouraged by the tax credits introduced by the Obama administration to guarantee a good return on investment, but their total output is small compared to the vast amount of coal Wyoming produces (coal still provides a quarter of total US energy consumed).

While states such as Washington have banned the import of 'dirty' electricity generated from coal, California has not, says Nelson, a retired professor who has made the fighting for the environment and saving nuclear power his life's work. In 2009 the California legislature created a legal loophole, 'unspecified imports', which allows the state to exclude imported energy from its carbon footprint calculations. It's obvious, Nelson thinks, since electricity has no smell, that promises of clean power from Wyoming are just greenwashing. 'Californians will lose both ways: by losing Diablo, they'll pay more for more polluted electricity.'

The Problem of Storage

Underlying the debate about the future electricity mix in California, the world's fifth largest economy, are the difficult trade-offs faced by advanced economies that have invested in intermittent renewables such as solar and wind, but ignored the problem of storage. Surplus electricity produced by the California sun in the middle of the day is frequently sold at a loss to neighbouring states, which are equipping themselves with solar and in turn experiencing the same problems. This is because the expensive lithium storage batteries last only a few hours and have a lifespan of only five to ten years.

There exists the option of pumped-storage facilities, which use excess power to create a temporary artificial lake upstream, which later flows downstream, driving turbines and (re)generating power. California already has two such facilities, at Helms and Castaic, but building more would be huge projects, requiring a large amount of land for relatively modest gains. Other storage options are still on an experimental scale: the sector is in its infancy and suffers from under-investment."

However, California doesn't lack ambition when it comes to renewable energy. A wind farm project was presented to the press and residents of San Luis Obispo this spring. The planned installation would be located about 40km offshore, opposite Diablo, in order to reuse the existing power grid after it is retired. The project is part of the US's first national offshore wind plan. It is huge in every way, with an eventual maximum theoretical capacity of 3GW by 2030 (with actual

power delivery estimated at half that amount due to wind being an intermittent source), almost three times larger than Hornsea 1 in the North Sea, currently the world's largest installation, which has 174 turbines.

A lithium storage plant is also planned, likewise the world's largest, according to its builder, the Texas-based Vistra Corporation. The plant will be at Morro Bay on the Pacific, replacing an old coal-fired power station. With a capacity of 600MW, it is projected to house 180,000 lithium-ion batteries in three huge buildings. The local press is enthusiastic: the project promises jobs and income for a county that will be hard hit by Diablo's closure.

PG&E meanwhile plans to hand the protected natural area around Diablo over to the indigenous Northern Chumash people. Though Diablo's closure sounds like a boon for the community, some here are sceptical. Scott Lathrop, a tribal leader, is in favour of extending the plant's life until something better comes along. He's not impressed by the offshore wind plan.

He says, 'It's a lot cheaper to extend Diablo than to create a whole new industry. The Morro Bay Area is off the coast of our homeland. We're talking like 400 square miles of field and in order to put the turbines together, they have to build a wind port, essentially 100 acres on the waterfront. We would be replacing our cheapest energy source with our most expensive. You realise the amount of area that you need for wind farms and solar and batteries for backup? And it wouldn't even replace all of the power. Why is that a good idea?' **He believes the main beneficiary from a nuclear-free California will be the gas industry•**

Maxime Robin is a journalist

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