Pathway to a Clean and Reliable Grid for California–without Diablo Canyon: Analysis and Recommendations

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The aftermath of two brief outages during an August 2020 heat wave triggered the current political attention to extending Diablo Canyon. A large nuclear power plant is not the right tool to meet our reliability needs because it is inflexible and ordinarily runs all the time at high capacity.

The 2020 event showed a need for flexible electricity resources that can rapidly be brought on-line during a few hours in the early evenings of summer. The proper resources to meet this need are demand response and battery storage.

Demand Response, of the type which rapidly reduces peak demand when the grid operator calls for it during an emergency, could be increased to replace the full capacity of Diablo Canyon at about a tenth of the cost of the nuclear plant.

Only a small amount of utility scale battery storage, about 200 megawatts (MW), had been built in California in August 2020; only two years later in August 2022 there are now thousands of megawatts, which the state grid operator (CAISO) says has already helped avoid power outages. CAISO has called the recent growth of renewable energy and battery storage “dramatic” and “stunning”, which is all the more remarkable because it took place in the pit of the Covid pandemic in spite of supply chain challenges.

This growth has not been an accident; it is the product of years-long planning by multiple agencies, at the state and local level, that support implementation of California’s policies. It is very important that new action by the governor and legislature be carefully directed to support implementation of the state’s clean energy and climate programs, which have been all planned assuming retirement of Diablo Canyon. Continued operation of Diablo Canyon puts this move to cleaner energy resources at risk, and would divert billions of dollars from them.

Governor Newsom, with the support of the state’s energy agencies, is pushing California to make a rushed decision to continue operation of Diablo Canyon, potentially for another 5 to 20 years. This analysis takes a closer look at the circumstances of California’s electricity policies and resources using available data and recommends a set of actions to continue California’s clean energy and climate leadership while ensuring grid reliability–without Diablo Canyon.

Analysis

1. **PROBLEM:** CAISO has and will have more than sufficient resources and reserves to meet normal 1-in-2[1] year peak demand. CAISO is concerned about a reliability gap under low probability[2] extreme demand scenarios during the net peak in the early evening, when solar energy production decreases and the reliability reserve is less than the required margin to meet a temporary shortage that could possibly happen once in 10 years.

2. **OUTAGE DURATION:** The August 2022 heat wave resulted in CAISO calling for customer outages of 1000 MW for 1 hour on August 14th, and 500 MW on the 15th for 20 minutes (3), out of a peak of about 46,000 megawatts. While there are impacts to communities from power outages, a 1 hour power outage every 10 years for a small portion of customers is manageable. Compare this to annual PSPS events that are creating days of power outages for hundreds of thousands of people in California.

3. **LOAD GROWTH:** California Energy Commission's (CEC) peak demand for CAISO is projected to grow slowly, from 46,000[3] MW in 2022 to 50,000 MW in 2030, which is within historical range (4). Contrary to CEC's demand projections, which assume population growth, peak load is likely to grow at an even slower rate, if at all, due to ongoing population decline (8). This potential load growth could be further reduced by recommitting to implement SB350's doubling of energy efficiency (9).

4. **RELIABILITY RESERVE:** CAISO is proposing to dramatically increase reserve margins to cover the very low probability 1-in-10 year peak/net peak load (7). The move from a 17% reserve margin (8,117 MW) to 22.5% (10,744 MW) and even up to 31%(!) reserve margin (14,744 MW more generation than the most likely peak demand) creates the appearance of a significant resource deficit, even though there would be much more available electricity supply resources than would ever likely be needed. This is an extreme and expensive approach that adds reserves on top of reserves and does not match the response to the potential risk.

5. **NEW RESOURCES:** CAISO and others are concerned that supply chain delays will prevent planned resources from coming online in time to replace retiring power plants and meet CAISO's proposed dramatically increased reserve margins. However, 7,621 MW of new resources, including 3,271 MW of dispatchable resources, came online in the midst of the pandemic and supply chain issues (2). While the *total amount* of resources still lags behind what is called for in the CPUC's 2020 Integrated Resource Plan, the new *additions* of battery storage and renewable energy in 2021 to 2022 are rapidly catching up, at a pace described by CAISO as "stunning", "meteoric", and "dramatic" growth (see CAISO's Feb 2022 Blog).

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[1] A 1-in-2 peak demand forecast is the forecast of peak demand that is statistically expected to be reached once every two years. Similarly, a 1-in-5 and 1-in-10 peak demand forecasts are statistically expected to be reached once every five years and once every ten years, respectively.
[2] In 2022, CAISO estimated a 0.003% (3 out of 100,000 hours) -on average once every 3 to 4 years - of hours unserved resulting in a small % of customers experiencing an outage to maintain the 6% WECC reserve margin. The 2022 reliability has dramatically improved, having reduced the number of potentially unserved hours in 2000 modeling scenarios 71% compared to 2021.
[3] While the CEC projected 1005 MW of load growth from 2021 to 2022, CAISO's adopted load growth increase was only 29 MW for a 1-in-2 year peak and 501 MW for a 1-in-10 year peak.

6. **DEMAND RESPONSE:** Based on the August 2020 heat wave outages root causes analysis, CAISO had approx. 750 MW of available emergency demand response resources (RDRR). However, CAISO does not project any growth in RDRR resources in its Diablo Canyon - Reliability Outlook presentation (7). Demand response is an affordable and underutilized resource that is perfectly suited to provide targeted reliability support during extreme-demand, high stress events (6). In fact, demand response was the go-to resource in August 2020 for CAISO during the power emergencies, but is inadequately supported and funded. According to CAISO, there are critical reforms needed to incentivize development and performance of demand response resources (13).

   A CPUC study performed by LBNL and E3 found between 5,000 MW and 13,000 MW of potential demand response in California at a cost of $150 per kilowatt-year or less (6). This means it is possible to increase CAISO's demand response to the total capacity of Diablo Canyon for 1/10 of the cost of Diablo Canyon (6). This is also in alignment with the CPUC's integrated resource plan, which calls for 2400 MW (a Diablo Canyon's worth) of demand response. Additional affordable demand response could entirely close the remaining gap to the 1-in-10 year peak and net/peak reliability criteria.

   CAISO claims demand response will only be brought online over a long period, but the legislature could speed this up by adequate funding and reform requirements for regulatory agencies.

7. **BEHIND-THE-METER BATTERY STORAGE** is growing at a pace of about 250 MW per year and will likely reach 1000 MW total by the end of 2022, and 2000 MW by 2026, adequate to provide 1 hour backup to the grid matching Diablo Canyon's peak capacity. (5) This resource could be integrated as a peak/net peak resource, but requires policies in place to ensure that behind-the-meter batteries are available for this purpose.

8. **OTC GAS PLANTS:** Natural gas power plants that use ocean water for once through cooling were originally planned for closure in 2020, and has been postponed to 2024. These gas plants are limited to meeting reliability requirements during a relatively few hours in the summer[4], which minimizes greenhouse gas emissions, as well as impacts on marine life. They use relatively little ocean water compared to Diablo Canyon operating at nearly 80% capacity factor year round (10).

9. **HYDRO RELIABILITY:** There is concern that hydro resources will be low because of the drought. This is not a novel circumstance since we have been in a drought for most of the past decade. Hydro resources contributing to reliability are already discounted by 30 to 40% based on performance over the last few years. Risk to the overall resource by drought is mitigated to a certain extent by geographic differences in hydro resource locations. In 2021, one of the worst drought years for hydropower in California, hydro still supplied 10% of California's electricity (29,000 gigawatt-hours), approximately half from within CA and half imported from out of state, mostly from the Pacific Northwest.

10. **DIABLO CANYON:** Diablo Canyon, as a large inflexible resource, is poorly suited to serve as a reliability resource during peak and net peak periods. Diablo Canyon has the two largest generators on the CAISO grid, making it one of the highest risks to system reliability. According to

[4] These OTC gas plants have a combined average annual capacity factor of 3%

CAISO's final root causes analysis for the August 2020 heat wave, an unplanned outage at Diablo Canyon during peak/net peak periods is "the most severe single contingency" to the stability of the entire western grid (3).

Diablo Canyon is also expensive. According to PG&E's testimony to the CPUC, and contrary to the flawed MIT/Stanford study, Diablo Canyon costs 7 to 9 cents per kilowatt-hour, which is more than double the cost of replacement energy that would avoid similar greenhouse gas emissions. According to the CPUC report to the legislature, recent renewable energy procurement in the state's RPS program has averaged about 3 to 4 cents per kilowatt-hour (11).

PG&E's testimony in the Diablo Canyon Retirement proceeding made clear that energy from Diablo Canyon is not needed by PG&E, and continued operation of Diablo Canyon limits integration of renewable energy. No one else needs it or wants it either; the CCAs are all pursuing more ambitious targets for renewable energy than the RPS so they have even less room for Diablo Canyon than PG&E. The decline in PG&E's retail sales, combined with increasing renewable energy requirements (RPS of 73% by 2032), leave no room to use the energy that Diablo Canyon normally produces (12). Worse, the fraction of Diablo Canyon that could be used changes seasonally and even from hour to hour, but the nuclear plant cannot change the amount of energy it produces to follow this changing need.

11. **CONCLUSION:** It's reasonable to take into account the actual circumstance of California's electricity policies and resources, which require a more measured, flexible, and cost effective approach to managing California's future grid reliability, than would be possible by relying on continued operation of Diablo Canyon for an additional 5 to 20 years. The pathway forward is to start by implementing the proposed recommendations, which is to support implementation of the CPUC Integrated Resource Plan, developed over the past 5 years under the assumption that Diablo Canyon will be closing by 2025, as the CPUC already decided in 2017.

Recommendations

1. Support the CPUC Integrated Resource Plan for development of demand response, battery storage, RPS renewable energy, and behind the meter resources. Set binding targets in megawatts of demand response and energy storage that align with the planned rate of progress.
2. Leverage available funding to implement mandatory reforms to demand response programs to accelerate development (+1200 MW) and improve performance.
3. Maintain an average pace of 1000 MW to 1500MW per year of additional battery storage resources, and integrate behind the meter batteries as a dispatchable resource.
4. Recommit to the SB350 requirement to doubling of cumulative annual energy efficiency in each year through 2029, with an added focus to reduce peak and net peak loads associated particularly with summer air conditioning loads. Set binding targets with dates to drive incremental progress.
5. Retire OTC gas plants as additional resources come online, pacing these retirements to account for supply chain delay, but also moving forward with replacement resources. Mitigate impacts of continued operation of OTC gas plants on impacted communities and marine resources
6. Shut down Diablo Canyon on schedule.

Supplemental data and associated analysis is available here.

References

1. CPUC 2020 Integrated Resource Plan
2. CAISO 2022 Summer Loads and Resources Assessment
3. Joint- Root Causes Analysis Mid-August 2020 Extreme Heat Wave
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5. California DG Stats
6. LBNL 2025 CA Demand Response Potential Study
7. Joint - 2022 Diablo Canyon Workshop Slides
8. CA Department of Finance May 2022 Population Estimates
9. CEC 2017 SB350: Doubling Energy Efficiency Savings by 2030
10. CEC 2019 OTC Phaseout-Tracking Progress Report
11. CPUC 2022 Padilla Report - RPS
12. CPUC 2021 IRP Preferred System Plan
13. CAISO 2021 CAISO Demand response issues and performance