DOCKETED	
Docket Number:	21-ESR-01
Project Title:	Energy System Reliability
TN #:	251367
Document Title:	Diablo Canyon Power Plant Operations Assessment Report
Description:	CEC Staff Report: Diablo Canyon Power Plant Operations Assessment Report
Filer:	susan fleming
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	7/28/2023 2:37:34 PM
Docketed Date:	7/28/2023

CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

STAFF REPORT

Diablo Canyon Power Plant Operations Assessment Report

July 2023 | CEC-700-2023-005

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ABSTRACT

The *Diablo Canyon Power Plant Operation Assessment* report addresses a requirement in Senate Bill 846 (Dodd, Chapter 239, Statutes of 2022) for the California Energy Commission, in coordination with the California Public Utilities Commission and the California Independent System Operator, to publish an assessment of the operation of the Diablo Canyon Power Plant that includes outage information, power plant operational costs, average revenues from electricity sales, worker attrition, and the power plant's contribution to resource adequacy requirements.

Keywords: Diablo Canyon, operations assessment, Senate Bill No. 846, outage, refueling, operational costs, worker attrition, resource adequacy

Turner, Michael. 2023. *Diablo Canyon Power Plant Operations Assessment Report, Senate Bill 846*. California Energy Commission. Publication Number: CEC-700-2023-005.

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EXECUTIVE SUMMARY

The Diablo Canyon Power Plant in San Luis Obispo County is owned and operated by Pacific Gas and Electric and, as of 2012, is the last operating nuclear power plant in California. The Diablo Canyon Power Plant consists of two nuclear reactors (Units 1 and 2) that began operation in May 1985 and March 1986, respectively. The Diablo Canyon Power Plant produces about 18,000 gigawatt-hours of electricity annually, which is about 9 percent of California's annual in-state electricity generation. The Diablo Canyon Power Plant's original operating licenses issued by the U.S. Nuclear Regulatory Commission expire November 2024 for Unit 1 and August 2025 for Unit 2.

Climate change is causing substantial variability in weather patterns and an increase in climate-driven natural disasters, resulting in more challenges to grid reliability. In 2020, a west coast-wide heat event resulted in rotating outages on August 14 and 15. In 2021, dry conditions resulted in a wildfire in Oregon that impacted transmission lines that are a key pathway for bringing energy into California. The fire resulted in a loss of 3,000 megawatts of imported electricity to the California Independent System Operator territory and 4,000 megawatts of overall import capacity to the state. In 2022, California experienced record-high temperatures between August 31 and September 9. On September 6, 2022, the California Independent System Operator recorded a new record peak load at 52,061 megawatts, nearly 2,000 megawatts higher than the previous record, despite significant efforts to reduce load during this peak period.

Climate change-related events will likely continue to become more frequent, catastrophic, and costly. Moving to a clean electric grid is a foundational step that will unlock and support economywide opportunities to achieve carbon neutrality and address the most catastrophic impacts of climate change. The 100 Percent Clean Energy Act of 2018 (Senate Bill 100, De León, Chapter 312, Statutes of 2018) establishes a target for eligible renewable energy and zero-carbon resources, as defined, to supply 100 percent of retail sales and electricity procured to serve all state agencies by 2045. Thus, implementation of the Act would help decarbonize the electric grid to achieve economywide carbon neutrality.

The actions to achieve the goals of Senate Bill 100 are resulting in the addition of unprecedented quantities of clean energy resources, primarily solar and energy storage at utility scale. However, supply chain issues and delays in interconnection and permitting pose risks to the timely buildout of these resources. The Clean Energy, Jobs, and Affordability Act of 2022 (Senate Bill 1020, Laird, Chapter 361, Statutes of 2022), supplements SB 100 and established interim targets to the statewide 100 percent clean energy policy and requires state agencies to accelerate their 100 percent clean energy goal by 15 years. The Diablo Canyon Power Plant provides roughly 2,280 megawatts of capacity at peak and net peak times. Senate Bill 846 (Dodd, Chapter 239, Statutes of 2022) was passed to provide a path to extend Diablo Canyon Power Plant operations beyond 2025 if it is needed to support grid reliability. Senate Bill 846 also directs the California Energy Commission to determine whether the state's electricity forecasts for 2024 through 2030 show potential for reliability deficiencies if Diablo

Canyon Power Plant operations are not extended beyond 2025. The bill also directs the California Energy Commission to determine whether extending operations to at least 2030 is prudent to ensure reliability and consistency with the state's emission reduction goals. The California Energy Commission published the *Diablo Canyon Power Plant Extension, CEC Analysis of Need to Support Reliability* in March 2023 to address these directives.

Based on a thorough analysis, the California Energy Commission determined that it is prudent for the state to pursue extension of the Diablo Canyon Power Plant. This determination is driven by the risk that sufficient clean electricity resources may not be built in time to meet the ordered procurement deadlines and to address potential grid demands in extreme heat events associated with climate change.

The *Diablo Canyon Power Plant Operation Assessment* report addresses a requirement in Senate Bill 846 for the California Energy Commission, in coordination with the California Public Utilities Commission and the California Independent System Operator, to publish an assessment of the operation of the Diablo Canyon Power Plant that includes outage information, power plant operational costs, average revenues from electricity sales, worker attrition, and the power plant's contribution to resource adequacy requirements.

This report also identifies state legislation associated with the potential operating extension of the Diablo Canyon Power Plant and discusses the funding mechanisms authorized to support the potential extension of operations.

CHAPTER 1: Introduction

The Diablo Canyon Power Plant (DCPP) near San Luis Obispo is owned and operated by Pacific Gas and Electric Company (PG&E). DCPP produces about 18,000 gigawatt-hours (GWh) of electricity annually, which is about 9 percent of California's in-state generation. The two reactor units are licensed by the U.S. Nuclear Regulatory Commission (NRC) to operate until November 2, 2024 (Unit 1), and August 26, 2025 (Unit 2).[1]

Figure 1: Diablo Canyon Power Plant

Photo Credit: Pacific Gas and Electric Company

1 California Energy Commission staff. 2023. *Final Commission Report, Diablo Canyon Power Plant Extension, CEC Analysis of Need to Support Reliability.* Publication Number: CEC-200-2023-004. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-ESR-01.

In 2022, Senate Bill 846 (SB 846, Dodd, Chapter 239, Statutes of 2022)[2] was enacted. SB 846 added Section 25233.2(d) of the Public Resource Code to state:

> On or before July 1, 2023, and on July 1 of each year thereafter until 2031, the commission, in coordination with the Public Utilities Commission [CPUC] and the Independent System Operator [California ISO], shall publish on its internet website in a new report, or as part of another report, an assessment of the operation of the Diablo Canyon power plant [DCPP]. The report shall include, but not be limited to, outage information, power plant operational costs, average revenues from electricity sales, worker attrition, and the power plant's contribution to resource adequacy requirements.

This document provides a detailed assessment of DCPP operations and includes:

- Outage information.
- Power plant operational costs.
- Revenues from electricity sales.
- Worker attrition.
- Contribution to resource adequacy.

This report also identifies state legislation associated with the potential operating extension of DCPP and funding mechanisms, and includes a brief history of nuclear energy in the United States and California, including power generating facilities in California and related decommissioning activities in Appendix B.

2 Dodd, Bill. 2002. California Senate Bill No. 846, Diablo Canyon Power Plant: Extension of Operations. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220SB846.

CHAPTER 2:
Tribal Historical Homeland Acknowledgement

The operating license extension of DCPP has tribal implications for the Chumash as it is in an area that is part of their historical homelands.

The Chumash historically occupied an area from Paso Robles/Morro Bay to the north, Malibu to the south, Tejon Pass to the east, and the four Northern Channel Islands for more than 8,000 years. Before the European colonization of California, Chumash territory encompassed some 7,000 square miles and included several hundred early Chumash villages and towns, seasonal encampments, rock art sites, shrines, gathering places, and water sources. Several such Chumash places are recorded as cultural resources within and surrounding the DCPP property, including the Rancho Cañada de los Osos y Pecha y lslay Archaeological District.

The Chumash numbered more than 25,000 people on the eve of the first Spanish land expedition in 1769 led by Gaspar de Portolá. This expedition led to the founding of five Catholic missions in the Chumash territory between 1772 and 1804.

The once thriving population of 25,000 Chumash drastically declined to only a few hundred native Americans. With the secularization of the missions and California statehood, the remaining Chumash population found refuge in remote inland valleys including the Zanja de Cota riverbed near the modern town of Santa Ynez.[3]

Today the Chumash are represented by numerous local tribes, including the:

- Yak Titʸu Titʸu Yak Tiłhini Northern Chumash Tribe[4].
- Northern Chumash Tribal Council.
- San Luis Obispo County Chumash Council.
- Santa Ynez Band of Chumash Indians.
- Barbareno/Ventureno Band of Mission Indians.
- Coastal Band of the Chumash Nation.

3 Santa Ynez Band of Chumash. 2023. *SB 846 (Dodd 2022) Tribal Consultation Response letter.* Santa Ynez Band of Chumash. https://chumash.gov/the-santa-ynez-reservation#reservation

4 Yak Tityu Tityu Yak Tiłhini Northern Chumash Tribe. https://www.youtube.com/watch?v=YOsraznCVb4

CHAPTER 3:
Diablo Canyon Power Plant License Extension

California has one operating nuclear power plant, DCPP. DCPP consists of two units. Unit 1 was originally estimated as a nominal 1,073-megawatt (MW) pressurized water reactor (PWR), which began commercial operation in May 1985, while Unit 2 was originally estimated as a nominal 1,087-MW PWR, which began commercial operation in March 1986.[5] Today, the two reactors each produce about 1,140 MW and combined produce about 18,000 GWh of electricity annually, which is about 9 percent of California's in-state generation.[6]

DCPP has two Westinghouse-designed four-loop PWRs. The once-through cooling system of the facility draws water from the Pacific Ocean to condense steam that is used to drive the turbine systems.

On June 21, 2016, PG&E announced a joint proposal with labor and environmental organizations to increase investment in energy efficiency, renewables, and storage, while phasing out nuclear power. The proposal indicated that the operating licenses for Diablo Canyon Units 1 and 2 would not be renewed when they were to expire November 2, 2024, and August 26, 2025, respectively. PG&E's application to close DCPP was approved by the CPUC in January 2018. In February 2018, PG&E withdrew its application from the NRC for a 20-year licensing extension beyond 2024 and 2025.

On September 2, 2022, Governor Newsom approved SB 846, which authorized steps to preserve the option to extend operation of DCPP beyond the current expiration dates, up to five additional years (no later than 2029 and 2030, respectively), under specified conditions.[7] Additional details on SB 846 are discussed below in the subsection titled "License Extension."

Safety of Operations and Seismic Studies Oversight

The Diablo Canyon Independent Safety Committee (DCISC) and the Diablo Canyon Independent Peer Review Panel (IPRP) review and make recommendations concerning the operations at DCPP.

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5 California Energy Commission Staff. 2020. *Nuclear Power Reactors in California*. https://www.energy.ca.gov/sites/default/files/2020-03/Nuclear_Power_Reactors_in_California_ada.pdf

6 California Energy Commission Staff. 2023. *Final Commission Report, Diablo Canyon Power Plant Extension, CEC Analysis of Need to Support Reliability*. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-ESR-01

7 Dodd, Bill. 2002. *California Senate Bill No. 846, Diablo Canyon Power Plant: Extension of Operations*. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220SB846

Diablo Canyon Independent Safety Committee DCISC was established as part of a settlement agreement in June 1988 between the CPUC Division of Ratepayer Advocates, the Attorney General for the State of California, and PG&E. DCISC is a three-person committee charged with reviewing and making recommendations concerning the safety of operations at DCPP. DCISC conducts fact-finding visits to DCPP and associated facilities, meets with DCPP personnel, holds public meetings, and produces an annual report on the safety of DCPP operations.[8]

Diablo Canyon Independent Peer Review Panel IPRP is composed of technical experts from the California Energy Commission (CEC), California Geological Survey, California Coastal Commission, California Seismic Safety Commission, and the County of San Luis Obispo. PG&E submits its seismic studies to IPRP for review. Following submission of these studies, IPRP convenes for public meetings to review and discuss the results. The findings and recommendations are published in annual reports.

Under SB 846, DCISC is to consult with and incorporate into its assessments and recommendations IPRP findings.[9]

License Extension

Climate change is causing substantial variability in weather patterns and an increase in climate-driven natural disasters, resulting in more challenges to grid reliability. In 2020, a west coast-wide heat event resulted in rotating outages on August 14 and 15. In 2021, dry conditions resulted in a wildfire in Oregon that impacted transmission lines that California depends on for reliability. The fire resulted in a loss of 3,000 megawatts of imported electricity to California ISO territory and 4,000 megawatts of overall import capacity to the state. In 2022, California experienced record-high temperatures between August 31 and September 9. On September 6, 2022, California ISO recorded a new record peak load at 52,061 megawatts, nearly 2,000 megawatts higher than the previous record, despite significant efforts to reduce load during this peak period.

Even with near-term mitigation measures, climate change-related events will likely continue to become more frequent, catastrophic, and costly. Moving to a clean electric grid is a foundational step that could unlock and support economywide opportunities to achieve carbon neutrality and address the most catastrophic impacts of climate change.

The 100 Percent Clean Energy Act of 2018 (SB 100, De León, Chapter 312, Statutes of 2018) was initiated to establish a target for renewable and zero-carbon resources to supply 100

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8 California Energy Commission staff. 2020. *Nuclear Power Reactors in California*, https://www.energy.ca.gov/sites/default/files/2020-03/Nuclear_Power_Reactors_in_California_ada.pdf. Diablo Canyon Independent Safety Committee. 2023. Website, https://www.dcisc.org/.

9 California Energy Commission staff. 2020. *Nuclear Power Reactors in California,* https://www.energy.ca.gov/sites/default/files/2020-03/Nuclear_Power_Reactors_in_California_ada.pdf. Dodd, Bill. 2002. *California Senate Bill No. 846, Diablo Canyon Power Plant: Extension of Operations,* https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220SB846.

percent of retail sales and electricity procured to serve all state agencies by 2045. Thus, the state would decarbonize the electric grid to achieve economywide carbon neutrality. The actions to achieve the goals of SB 100 are resulting in the addition of unprecedented quantities of clean energy resources, primarily solar and energy storage at utility scale. The California Legislature passed SB 846, which authorized steps to preserve the option to extend DCPP operations beyond the current expiration dates (2024 for Unit 1 and 2025 for Unit 2), for up to five additional years. If certain criteria are met, this legislation would allow the state to retain the roughly 2,280 MW of capacity from DCPP for a short period of time while new clean energy projects are developed.

California Senate Bill 846

SB 846 authorized a loan of $1.4 billion from California to PG&E, the operator of DCPP, to facilitate extension of plant operations. An initial appropriation of $600 million was transferred from the state's general fund to the Diablo Canyon Extension Fund. SB 846 also provides expedited state actions to facilitate possible relicensing of DCPP, including:

- Limiting state agency review of applications related to DCPP extension to 180 days.
- Deeming DCPP subject to only existing exemptions under the California Environmental Quality Act (CEQA) for purposes of state and local agency actions needed for extended operations.

  Authorizing explicit collections from electric ratepayers (both customers of PG&E and those of other electricity providers) for ongoing costs.

Loans, Grants, and Credit Awards

SB 846 $1.4 Billion Loan

SB 846 states the intent of the Legislature to make available to the Department of Water Resources (DWR) a total principal amount not to exceed $1.4 billion for being loaned out to facilitate the extension of DCPP operations. The bill established the Diablo Canyon Extension Fund in the State Treasury.

The Department of Finance allocated up to $600 million under Section 25548.3 of Division 15 of the Public Resource Code from the general fund as loans to DWR for deposit into the Diablo Canyon Extension Fund. DWR may disburse money from the Diablo Canyon Extension Fund to the operator of DCPP under a loan agreement following Section 25548.3. At the direction of DWR, the Controller shall draw a warrant for this purpose.

To date, $350 million of the $600 million authorized as part of the 2022-2023 State Budget has been disbursed to PG&E, subject to cost verification from DWR. DWR will need to request a release of the remaining $250 million from the Joint Legislative Budget Committee before the next disbursement. Of the remainder of the $1.4 billion ($800 million), $400 million was

authorized as part of the 2023-2024 state budget and the remaining $400 million loan needs further Legislative approval.[10]

United States Department of Energy $1.1 Billion Credit Award

PG&E applied to participate in the Civil Nuclear Credit (CNC) Program through the U.S. Department of Energy to use any credit award to repay the funds appropriated from the SB 846 $1.4 billion loan discussed above. In November 2022, the Biden-Harris administration conditionally selected DCPP to receive the first round of funding from the CNC Program.[11]

The finalization of the credit award is contingent on completion of an environmental review and finalization of terms in the Credit Award and Redemption Agreement (CARA) acceptable to the United States Department of Energy. The CARA will include the terms for adjustment of the award; details regarding annual reporting, specifically matters related to workforce and labor considerations and community engagement; and contract terms around license renewal activities.[12]

AB 180 $75 Million Grant

Assembly Bill No. 180 (AB 180) (Ting, Chapter 44, Statutes of 2021) was signed by the Governor on June 30, 2022, as part of the Budget Act of 2021. The Budget Act of 2021 made appropriations for the support of state government for the 2021–2022 fiscal year. AB 180 amended the Budget Act of 2021 by amending, adding, and repealing items of appropriation.

Section 23, Provision 3(e) of AB 180 authorized the DWR to use up to $75 million to support contracts with the owners of electric generating plants pending retirement. The funds could be used to reimburse or compensate the owners for any costs, expenses, or financial commitments incurred to retain the future availability of such generating facilities pending further legislation.

The DWR entered an agreement with PG&E to provide $75M in funding to retain the future availability of DCPP past the current closure dates. The funding is provided and tracked through DWR's Electricity Supply Strategic Reliability Reserve Program and coordinated with the California ISO and state agencies: California Air Resources Board, CEC, CPUC, and State Water Resources Control Board.[13]Reporting Requirements

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10 Ibid.

11 United States Department of Energy staff. 2022. *Biden-Harris Administration Announces Major Investment to Preserve America's Clean Nuclear Energy Infrastructure.* https://www.energy.gov/articles/biden-harris-administration-announces-major-investment-preserve-americas-clean-nuclear

12 United States Department of Energy staff. *Frequently Asked Questions on the Civil Nuclear Credit Program*. https://www.energy.gov/gdo/frequently-asked-questions-civil-nuclear-credit-program#:~:text=The%20finalization%20of%20the%20award%20is%20contingent%20on,engagement%3B%20and%20contract%20terms%20around%20license%20renewal%20activities

13 Ting, Phillip. 2021. *California Assembly Bill No. 180, Budget Act of 2021,* https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220AB180.

SB 846 requires various reports be prepared related to California's energy supply and reliability. These include:[14]

- *Joint Agency Reliability Planning Assessment* - Addresses requirements for electricity reliability reporting in SB 846 and Assembly Bill 205 (Committee on Budget, Chapter 61, Statutes of 2022). The report provides the first quarterly review of the demand forecast, the supply forecast, and potential high, medium, and low risks to reliability in California ISO territory from 2023 to 2032, as required by SB 846. The report also provides an evaluation of summer 2022 reliability and the magnitude of reliability problems for 2023–2026, as required by AB 205. The CEC this first quarterly report to the California legislature on February 2, 2023 and it will be updated and submitted to the California Legislature quarterly. *Clean Energy Reliability Investment Plan (CERIP)* – This plan addresses a requirement in SB 846 for the CEC to develop a $1 billion investment plan for clean energy resources. This plan provides justification and recommendations for clean energy investments that accelerate the deployment of clean energy resources, support demand response, assist ratepayers, and increase energy reliability. The plan considers California's anticipated supply and demand needs for near-term and mid-term reliability, advancement of the state's policies towards 100 percent zero-carbon and renewable energy resources by 2045, and the state's greenhouse gas emissions reduction targets for the electricity sector.[15] The CEC submitted the CERIP report to the California Legislature on March 1, 2023.
- *Diablo Canyon Power Plant Extension, CEC Analysis of Need to Support Reliability* – Prepared as part of a public hearing, this report addresses a requirement in SB 846 for the CEC to determine the need to extend the operation of the DCPP for 2024–2030. The analysis is based on a CEC assessment of the state's electricity reliability based on forecasted demand and supply for that period. Based on the CEC's analysis, CEC staff recommends that the CEC determine that it is prudent for the state to pursue extension of DCPP. This determination is driven by the risk that sufficient electricity resources may not be built in time to reach the ordered procurement and to address potential grid demands in extreme heat events associated with climate change. [16] The CEC submitted the report to the California Legislature on March 1, 2023.
- *Joint Agency Reliability Planning Assessment – Second Quarterly Report* - prepared by CPUC and CEC. This report addresses requirements for electric system reliability reporting in SB 846. The report provides the second quarterly review of the demand

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14 Dodd, Bill. 2022. *California Senate Bill No. 846, Diablo Canyon Power Plant: Extension of Operations,* https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220SB846.

15 California Energy Commission Staff. 2023. *Clean Energy Reliability Investment Plan.* https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-ESR-01

16 California Energy Commission Staff. 2023. *Diablo Canyon Power Plant Extension, CEC Analysis of Need to Support Reliability.* https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-ESR-01

forecast, supply forecast, and risks to reliability in California ISO territory from 2023 to 2032, as required by SB 846. The report includes an updated analysis for summer 2023. .[17] The CEC published the *Joint Agency Reliability Planning Assessment SB 846 Second Quarterly Report* and submitted to the California Legislature on May 16, 2023.

- *Load Shift Goal Report* – Prepared by the CEC, this report addresses a requirement in Senate Bill 846 (Dodd, Chapter 239, Statutes of 2022) for CEC to develop a statewide goal for load shifting to reduce net peak electrical demand. The report outlines the approach used to develop a load-shift goal in consultation with CPUC and the California ISO and consider research conducted by Lawrence Berkeley National Laboratory as required by SB 846. The report also discusses the current landscape of demand response and load shifting in California and suggests policies to increase demand response and load shifting without increasing greenhouse gas emissions or increasing electric rates.[18] The CEC submitted the *Senate Bill 846 Load-Shift Goal Report* to the California legislature June 1, 2023.
- *DCPP Cost Comparison* - A comparison of the costs of extended DCPP operation against a portfolio of other energy resources and reevaluate prolonged operation if costs exceed the loan agreement with the DWR.

  With respect to the DWR $1.4 billion loan, if the costs of the extension of operations exceed limits provided for in the loan agreement at any time, the CEC is required to reevaluate the cost-effectiveness of prolonging power plant operations. [19] This report will be published in September 2023, and on July 1 of each year thereafter.
- *DCPP Operations Assessment Report* – An assessment of the operation of DCPP in coordination with CPUC and California ISO. The report shall include, but not be limited to, outage information, power plant operational costs, average revenues from electricity sales, worker attrition, and the power plant contribution to resource adequacy requirements.[20] This report is encapsulated in these pages and will be published on or before July 1, 2023, and by July 1 in subsequent years until 2031.
- *Annual Report on Status of New Resource Additions* – The CPUC, in coordination with the CEC and DWR, must submit a report to the California Legislature each year on the status of new resource additions and revisions to the state's electric demand forecast.

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17 California Energy Commission Staff. 2023. *Joint Agency Reliability Planning Assessment SB 846 Second Quarterly Report.* https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-ESR-01

18 California Energy Commission Staff. 2023. *Senate Bill 846 Load-Shift Goal Report* https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-ESR-01

19 Dodd, Bill. 2002. *California Senate Bill No. 846, Diablo Canyon Power Plant: Extension of Operations.* https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220SB846.

20 Ibid.

The report shall include the impact of these updates on the need for keeping DCPP on-line.[21]

21 Ibid.

CHAPTER 4:
Diablo Canyon Power Plant Operations Assessment

Outage Information

DCPP schedules outages to permit refueling of the reactors, along with maintenance, inspections, and modifications. However, on occasion, a forced outage (manual maintenance outage) is required when a system is operating outside acceptable limits or leaks are detected in various systems. These are discussed below.

Refueling Outages

A refueling outage is a normal shutdown of a nuclear power unit to permit refueling of the reactor, along with maintenance, inspections, and modifications. Typical DCPP refueling outages occur about every 18 to 20 months and last about two months. The outages are numbered by unit number (1 or 2), "R," and the consecutive outage number. For example, "1R5" is the fifth refueling outage for Unit 1 since start-up. The outages are scheduled to occur in the spring and fall, preferably April and October, to avoid peak energy demand periods. The unit not undergoing the scheduled refueling outage will continue to safely generate electricity while the other unit is offline.[22]

During the planned outages, PG&E employees and temporary workers will replace a portion of the reactor fuel, conduct maintenance, and test systems and components that are not accessible during regular plant operations. It is estimated that more than 250,000 person-hours are required to complete the tasks required for each outage, which can be composed of upwards of 10 other major projects simultaneously. The intent is to minimize down time for the offline reactor.

Since DCISC began its review of refueling outages in 1990, outage management performance has steadily improved. Since 1990, refueling outages have lasted between 29 and 87 days, with the longest outage being 2R21 in September 2019, which was extended because the Unit 2 generator was rebuilt. This project was not related to nuclear fuel but to upgrades to the generator.

Unit 2 recently completed refueling outage 2R23 in October 2022, the results of which were presented at the February 15 and 16, 2023, DCISC public meeting held in Avila Beach. Refueling outage 1R24 is planned for Unit 1 in October 2024.

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22 Diablo Canyon Independent Safety Committee staff. 2022. *Thirty-Second Annual Report on the Safety of Diablo Canyon Nuclear Power Plant Operations, July 1, 2021—June 30, 2022,* https://www.dcisc.org/download/library/annual-reports/32nd-annual-report-51.pdf.

Maintenance and Forced Outages

Maintenance of the reactor systems which support the reactor are typically planned to occur during refueling outages to minimize the time the reactors are offline. However, on occasion, a forced outage (manual maintenance outage) is required when a system is operating outside acceptable limits or leaks are detected in various systems. A curtailment (reduction) in power production may be required for minor maintenance.

DCISC's thirty-first and thirty-second annual reports[23] for plant operating periods July 1, 2020, through June 30, 2021, and July 1, 2021, through June 30, 2022, provide the following information regarding refueling, maintenance, and forced outages.

Table 1: Power Generation-Impacting Events July 2020 –June 2022

Unit	Date	Type	Reduced to Power Level	Event
1	10/3/20 -11/2/20	Refueling Outage	Offline	1R21 Refueling Outage - 29.9 days
1	4/26/21 - 4/27/21	Curtailment	50%	Main condenser pick and dredge of marine growth and debris - 2 days
1	5/27/21 - 5/28/21	Curtailment	50%	Main condenser salt-water leak - 2 days
2	7/17/20 - 8/2/20	Manual Maintenance Outage	Off-line	Generator Hydrogen Leak - 15.9 days (Including a 6-hour restart delay due to the Creston Pond Fire)
2	10/15/20 - 11/28/20	Manual Maintenance Outage	Off-line	Generator Hydrogen Leak - 45.2 days

23 Diablo Canyon Independent Safety Committee staff. 2021. *Thirty-First Annual Report on the Safety of Diablo Canyon Nuclear Power Plant Operations, July 1, 2020—June 30, 2021,* https://www.dcisc.org/download/library/annual-reports/31st-annual-report-48.pdf. *Thirty-Second Annual Report on the Safety of Diablo Canyon Nuclear Power Plant Operations, July 1, 2021—June 30, 2022,* https://www.dcisc.org/download/library/annual-reports/32nd-annual-report-51.pdf.

Unit	Date	Type	Reduced to Power Level	Event
2	12/2/20 - 1/12/21	Manual Maintenance Outage	Off-line	Generator Hydrogen Leak - 40.8 days
2	1/26/21 - 2/3/21	Curtailment	80%	Vibrations in the Main Generator associated with the Main Generator Hydrogen Leak - 7.7 days
2	2/3/21- 3/13/21	Manual Maintenance Outage	Off-line	Hydrogen Leak - 13.8 days
2	3/13/21- 4/17/21	Refueling Outage	Off-line	2R22 Refueling Outage - 34.6 days
2	4/19/21 - 4/29/21	Manual Maintenance Outage	Off-line	Generator stator cooling water hose configuration - 9.9 days
1	10/25/21 - 10/27/21	Curtailment	50%	Main condenser pick and dredge of marine growth due to high sea swells - 3 days
1	2/23/22 - 2/25/22	Curtailment	50%	Main condenser pick and dredge of marine growth and debris - 3 days
1	3/26/22 - 4/22/22	Refueling Outage	Off-line	1R22 Refueling Outage - 26.6 days
1	4/22/22 - 4/26/22	Outage	2%	Steam Generator Blowdown Relief Valve failure - 5 days
2	10/17/21 - 11/3/21	Manual Maintenance Outage	Off-line	Feedwater heater 2-5B tube leak - 17.5 days
2	11/15/21 - 11/21/21	Curtailment	50%	Main condenser pick and dredge of marine

Unit	Date	Type	Reduced to Power Level	Event
				growth and debris - 7 days
2	4/26/22 - 4/30/22	Manual Maintenance Outage	98%	Steam leak on a Feedwater heater 1-1A valve – 5 days

Source: DCISC's thirty-second annual report, *Diablo Canyon Independent Safety Committee Thirty-Second Annual Report on the Safety of Diablo Canyon Nuclear Power Plant Operations July 1, 2021—June 30, 2022*

Outage Filings With the NRC

PG&E files outage reports with NRC. The outage reports include descriptions of violations and associated corrective actions taken by PG&E. [24] Violations are summarized in Quarterly Performance Reports[25] and Biennial Problem Identification and Resolution Inspection Reports[26]. Additional details are discussed below under the subsection titled Corrective Action Program.

Outage Mitigation, Auditing, Processes, and Controls

PG&E has in place a comprehensive management structure, with internal controls, to prudently oversee the operation of its utility-owned generation facilities. These controls include system management, a corrective action program, outage planning and scheduling processes, project management, and a quality assurance (QA) program.[27] PG&E's internal management controls are discussed in detail below.

Procedures

Procedures cover virtually all aspects of safety, operations, maintenance, planning, environmental compliance, regulatory compliance, emergency planning, work management, inspection, and testing. Each procedure describes the purpose of the document, the details of

24 United States Nuclear Regulatory Agency staff. 2020. *Enforcement Program Overview* https://www.nrc.gov/about-nrc/regulatory/enforcement/program-overview.html

25 United States Nuclear Regulatory Agency staff. 2022. *Diablo Canyon 1, Quarterly Performance Summary, Q1/2023 Performance Indicators.* https://www.nrc.gov/reactors/operating/oversight/docket-chart.html?docket=diab1. *Diablo Canyon 2, Quarterly Performance Summary, Q1/2023 Performance Indicators*. https://www.nrc.gov/reactors/operating/oversight/docket-chart.html?docket=diab2

26 United States Nuclear Regulatory Agency staff. 2023. *Inspection Reports*. https://www.nrc.gov/reactors/operating/oversight/listofrpts-body.html#diab

27 Pacific Gas and Electric Company. 2022. Chapter 4, Utility-Owned Generation: Nuclear. Pacific Gas and Electric staff. 2021. 2021 Energy Resource Recovery Account Compliance Application 22-02-XXX Data Response, Question 22. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=22-MISC-01

the actions or processes or both covered by the document, management's roles and responsibilities, and the date the document became effective.[28]

Corrective Action Program

Required by NRC regulations, the corrective action program is the main process that DCPP uses to identify, analyze, and resolve plant problems. Elements of the program include issue identification, issue significance reviews, various levels of cause analysis up to root cause analysis, corrective action development and implementation, and performance trending and monitoring. The program is used to develop corrective actions to prevent recurrence of problems.[29]

PG&E's corrective action program is conducted in coordination with NRC's enforcement and inspection program. The goals of NRC's enforcement and inspection program are to emphasize the importance of compliance with regulatory requirements, and to encourage prompt identification, and prompt, comprehensive correction of violations. Violations are identified through inspections and investigations and summarized in Quarterly Performance Reports[30] and Biennial Problem Identification and Resolution Inspection Reports[31]. Any violations identified are subject to civil enforcement action and may also be subject to criminal prosecution. After an apparent violation is identified, it is assessed in accordance with NRC's enforcement policy.[32]

Outage Planning and Scheduling Process

As discussed above in the section on Outage Information, nuclear generating units must be shut down periodically to be refueled. Every refueling outage has work activities that are similar in scope and length, including:

- Shutdown and cool down of the reactor.
- Disassembly of the reactor vessel.
- Fuel replacement.

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28 Pacific Gas and Electric Company. 2022. Chapter 4, Utility-Owned Generation: Nuclear.

29 Ibid.

30 United States Nuclear Regulatory Agency staff. 2022. *Diablo Canyon 1, Quarterly Performance Summary, Q1/2023 Performance Indicators.* https://www.nrc.gov/reactors/operating/oversight/docket-chart.html?docket=diab1. United States Nuclear Regulatory Agency staff. 2022. *Diablo Canyon 2, Quarterly Performance Summary, Q1/2023 Performance Indicators*. https://www.nrc.gov/reactors/operating/oversight/docket-chart.html?docket=diab2

31 United States Nuclear Regulatory Agency staff. 2023. *Inspection Reports*. https://www.nrc.gov/reactors/operating/oversight/listofrpts-body.html#diab

32 United States Nuclear Regulatory Agency staff. 2022. *Enforcement Program Overview* https://www.nrc.gov/about-nrc/regulatory/enforcement/program-overview.html

- Reassembly of the reactor vessel.
- Heat up and startup of the unit.

During these refueling periods, scheduled maintenance is conducted, surveillance tests are performed, and plant modifications are completed. Because DCPP Units 1 and 2 do not routinely shut down at other times, a great deal of maintenance is planned to be performed during these refueling outages.

PG&E develops the initial start time for future outages years in advance of the outage start. Outage start dates are typically in the spring or fall when energy demand is lower so that operation during the higher-demand summer months is not interrupted. Outage start dates are coordinated with reactor fuel core cycle length. The outage initial start date is then coordinated through PG&E's Energy Policy and Procurement organization in advance of the actual outage start date.

The DCPP refueling outage planning process is governed by a system of milestones. The outage is broken down into steps to allow a logical process for developing a schedule and monitoring outage preparation. Each outage has a set of milestones and due dates. The milestones are consistent for all outages. PG&E monitors completion of the milestones to ensure the organization is prepared for the upcoming outage.

The outage preparation milestones begin with a review of the long-range outage plan by nuclear work management, about 24 months before the outage start date. Nuclear work management, through the milestone structure, identifies most of the outage design scope (including major and minor items) about 22 months before the outage starts. This scope is reviewed and approved by station leadership and finalized 20 months before the outage starts.

Required preventive maintenance items are identified and approved by Engineering Services 12 months before the outage starts. Preventive maintenance items are items that are needed on a recurring frequency to ensure a safe and reliable plant. Examples of preventive maintenance include motor overhauls, valve refurbishments, and instrument calibrations.

Other significant milestones include issuance of the initial schedule about 11 months before the outage starts and an outage scope freeze about 10 months before the outage starts. The initial schedule undergoes two additional revisions before the outage starts to incorporate activity logic ties and resource availability. An additional review of the outage safety plan and the outage safety schedule is performed by the Plant Staff Review Committee before the outage starts. The final schedule is normally issued two weeks before the outage starts.

Some "float" hours are included in the outage schedule to accommodate any minor issues that arise during the outage. The float hours ensure that the unit is returned to service as planned in the outage schedule.

Once the outage scope milestone is completed, there is a process for incorporating late scope changes. For significant changes to scope items and depending upon magnitude, approval of

the changes is escalated to increasing senior leadership levels. These items are presented and either approved as scope addition or rejected. This process is used for all refueling outages at DCPP.[33]

Quality Assurance Program

Quality assurance (QA) audits, assessments, reviews, and inspections are required by NRC. These processes evaluate DCPP activities to ensure they are being performed in accordance with NRC QA program requirements and the applicable sections of the Code of Federal Regulations (CFR).

Quality oversight activities at DCPP are performed in accordance with Appendix B to Title 10, CFR, Part 50. The appendix discusses quality assurance criteria for nuclear power plants. Nuclear power plants include structures, systems, and components that prevent or address the consequences of postulated accidents that could cause undue risk to the health and safety of the public. This appendix establishes quality assurance requirements for the design, manufacture, construction, and operation of those structures, systems, and components. The pertinent requirements of this appendix apply to all activities affecting the safety-related functions of those structures, systems, and components. These activities include designing, purchasing, fabricating, welding, heat treating, handling, shipping, storing, cleaning, erecting, installing, inspecting, testing, operating, maintaining, repairing, and refueling.[34]

Appendix B to 10 CFR Part 50 also requires that the quality assurance program provide indoctrination and training of personnel performing activities affecting quality as necessary to ensure that quality assurance personnel achieve and maintain suitable proficiency.[35]

Director of Quality Verification

The director of quality verification (QV) has overall responsibility for independent quality oversight of DCPP operations including plant operations, maintenance, radiation protection, chemistry, emergency planning, environmental protection plan, fitness for duty, engineering, design, procurement, outage management, work control, and strategic projects. The work performed by the QV section includes independent QA audits, assessments, reviews, quality control inspections, welding nondestructive examinations, source assessments, and supplier audits.[36]

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33 Ibid.

34 United States Nuclear Regulatory Commission staff. 2021. "Appendix B to Part 50," https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-appb.html.

35 United States Nuclear Regulatory Commission staff. 1980. *NRC Regulatory Guide 1.58, Revision 1.* https://www.nrc.gov/docs/ML1221/ML12216A006.pdf. United States Nuclear Regulatory Commission staff. 1991. *Federal Register, Vol. 56 No. 147, July 31, 1991, Notices, 36175.* https://www.nrc.gov/docs/ML1306/ML13066A531.pdf.

36 Pacific Gas and Electric Company. 2022. *Chapter 4, Utility-Owned Generation: Nuclear.*

Operational Costs

Operational costs subcategories and methodology listed below were developed by PG&E and intended to align with those used for the Electric Utility Cost Group[37] (EUCG) survey.

- Engineering: costs for technical work associated with study, design, implementation of plant modifications, and monitoring and testing for standards compliance.
- Loss Prevention: costs for providing site security and access control, safety, emergency preparedness, and related costs.
- Materials and Services: costs arising from inventory planning, control, optimization, and procedures.
- Fuel Management: costs of managing fuel procurement, conversion, enrichment, and fabrication not captured in the fuel costs.
- Operations: costs from using equipment, chemistry and environmental monitoring and controls, radiation protection, and processing of low-level waste.
- Support Services: costs for business services such as human resources, pensions and benefits, payroll taxes, nuclear officers and executives, and employee incentives.
- Training: costs arising for development and implementation of training programs.
- Work Management: costs for planned, periodic, preventive maintenance of structures, systems, and components.

Historical operating costs as percentages of total annual expenses are summarized in the table below.

Table 2: Operating Costs as Percentages of Total Expenses

	2020	2021	2022
Engineering (%)	11.7	10.3	10.9
Fuel Management (%)	0.1	0.2	0.2
Loss Prevention (%)	19.7	18.9	19.0
Materials and Services (%)	1.2	1.3	1.9
Operations (%)	17.8	18.6	18.7
Support Services (%)	20.0	21.1	20.6
Work Management (%)	26.6	27.2	26.5
Training - Develop and Conduct (%)	2.9	2.4	2.2

Source: Pacific Gas and Electric Company staff. 2023.

Operational expenses for 2020 through 2022 are summarized in the table below. This data represents general rate case (GRC) information approved by CPUC. GRCs are proceedings used to address the costs of operating and maintaining the utility system and the allocation of

37 Electric Utility Cost Group. https://www.eucg.org/

those costs among customer classes. For California's three large IOUs, the GRCs are parsed into two phases. Phase I of a GRC determines the total amount the utility is authorized to collect, while Phase II determines the share of the cost each customer class is responsible for the rate schedules for each class. Each of those IOUs file a GRC application every three to four years.

CPUC reviews detailed cost data for various areas of utility operations and approves a budget for the first year (test year) of the GRC cycle. For years 2, 3, and 4 (post-test years) the GRC decision prescribes how to adjust the test year budget for inflation and other factors that may affect costs, such as additional capital projects between test years.[38]

The GRC for the years 2023 through 2026 is still pending final CPUC approval and will be provided during the next annual submittal of this operation assessment report. Additionally, the GRC does not include nuclear fuel costs. These costs are addressed in an annual Energy Resource Recovery Account proceeding.[39]

Table 3: Operating Expenses

	2020	2021	2022
Total Operating Expenses	$1,094,915,000	$1,078,665,000	$1,068,689,000

Source: California Public Utilities Commission staff. 2023.

Revenues From Electricity Sales

DCPP earns revenue from various types of electricity sales. Most of DCPP's electricity sales revenue comes from sales into organized markets, like the California ISO. These market sales are generally wholesale, and the electricity can be sold to the California ISO or another electric utility. DCPP's second largest source of capacity revenue comes from sales to residential and commercial retail customers. These two sources, market sales and retail customers, make up more than 90 percent of DCPP's electricity sales revenue. The remaining 10 percent DCPP earns is from allowing spare capacity to be dispatched to meet load demands. The table below summarizes the annual revenues from 2020 through 2022.

38 California Public Utilities Commission staff. 2023. *What is a General Rate Case (GRC)?* https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-rates/general-rate-case. *Pacific Gas and Electric (PG&E) GRC Proceedings (Phase I).* https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-rates/general-rate-case/pacific-gas-and-electric-grc-proceedings

39 California Public Utilities Commission staff. 2023. *What is an Energy Resource Recovery Account (ERRA) Proceeding?* https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-costs/what-is-an-energy-resource-recovery-account-proceeding#:~:text=Energy%20Resource%20Recovery%20Account%20%28ERRA%29%20proceedings%20are%20used,The%20costs%20are%20forecast%20for%20the%20year%20ahead

Table 4: Annual Revenues from DCPP for 2020–2022

Year	2020	2021	2022
Electricity Sales into Organized Markets	$475,048, 391	$819,754, 590	$1,485,696,233
$/MWh	$29.16	$49.68	$84.38
Capacity Revenues	$125,582, 400	$142,272, 000	---
$/kW-yr	$55.08	$62.40	---
Retail Rates or Amounts Collected Through Cost-of-Service Rate Recovery	$1,246,934,873	$1,212,227,360	$1,181,608,028

Source: Pacific Gas and Electric Company. 2023. *TN249963_20230503T105701_Redacted- DCPP Historic Annual Operating Conditions (DOE)*. The 2022 data calculations are underway and will be updated when available.

Worker Attrition

Attrition Through 2024–2025 Decommissioning

On January 16, 2018, CPUC issued Decision (D.)18-01-022, approving PG&E's proposal to retire Units 1 and 2 of DCPP by 2024 and 2025, respectively. The decision also authorized up to $211.3 million for DCPP employee retention programs. On September 19, 2018, Governor Edmund G. Brown Jr. signed Senate Bill 1090 (Monning, Chapter 561, Statutes of 2018), which approved an additional $85 million to pay for community impact mitigation programs in the San Luis Obispo region, and another $140.8 million for DCPP employee retention. CPUC enacted the rate changes ordered in SB 1090 when it issued D.18-11-024 on December 7, 2018. Collectively, D.18-01-022, SB 1090, and D.18-11-024 authorized up to $363.4 million for Diablo Canyon employee retention and retraining programs and $85 million for community impact mitigation programs.[40]

PG&E initially proposed to pay retention bonuses to every employee of the plant who continues to work through specified periods. PG&E proposed two tiers of retention payments. Tier 1 would run from September 1, 2016, through August 31, 2020, and provided a retention payment to each employee of 25 percent of the employee's base salary at the end of each of the four years. This plan was estimated to cost $191.6 million. Tier 2 would run from September 1, 2020, through August 31, 2023, and provide a retention payment to each employee of 25 percent of the employee's base salary at the end of each of the three years

40 California Public Utilities Commission staff. 2019. *Prospective Closure of the Diablo Canyon Nuclear Power Plant, Economic Impact Assessment,* https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/electric-costs/decommissioning/final_cpuc-ucb_dcpp_eia_v2.pdf

and would cost $160.5 million. PG&E estimated a $352.1 million cost for the retention plan, assuming that about 1,500 employees would be retained until August 31, 2023.[41]

CPUC's Office of Ratepayer Advocates (ORA) and Californians for Green Nuclear Power (CGNP) opposed PG&E's employee retention program as proposed. ORA argued that ratepayers should not pay for the $191.6 million cost of Tier 1 but generally supported rate recovery for the $160.5 million cost of Tier 2. CGNP argued that the entire retention program is unnecessary but noted that retention payments may be necessary for a very limited set of hard-to-fill positions.

In the end, CPUC's Decision 18-01-022 authorized PG&E's proposed employee retention program but at an annual payment level of 15 percent rather than 25 percent. This decision resulted in a maximum cost of $115 million for Tier 1 and a maximum cost of $96.3 million for Tier 2 for a total cost of $211.3 million. PG&E was authorized to receive rate recovery of up to $211.3 million for its employee retention program.

On May 22, 2018, DCISC sent a letter supporting those aspects of SB 1090 regarding appropriate funding for the Employee Retention Program to Senator Monning and expressed its opinion that a well-designed and appropriately funded employee retention incentive program was essential to the safe operation of Diablo Canyon until retirement. While the DCISC did not suggest what precise funding level was appropriate, the 15 percent proposal seemed inadequate based on the committee members' interactions with the plant staff.

On November 29, 2018, CPUC approved decision D.18-01-022 which implements Senate Bill 1090 by adding Section 712.7 to the Public Utilities Code. Section 712.7 directs the CPUC to approve full funding for the community impact mitigation program and the employee retention program. This decision modifies in part the outcome of CPUC's Decision D. 18-01-022, which authorized the retirement of the DCPP. In compliance with the new Public Utilities Code Section 712.7, PG&E is authorized to collect an additional $225.8 million in rates over the amounts authorized in D.18-01-022.

PG&E also implemented a companywide voluntary severance program, and DCPP senior management opted to include DCPP employees. The voluntary severance program is targeted to individuals with a certain number of years of experience. At DCPP, the program has been offered to specific groups. About 22 individuals have opted for voluntary severance and were to separate from PG&E at the end of June 2022.

41 California Public Utilities Commission staff. 2018. Decision 18-01-022, *Application of Pacific Gas and Electric Company for Approval of the Retirement of Diablo Canyon Power Plant, Implementation of the Joint Proposal, And Recovery of Associated Costs Through Proposed Ratemaking Mechanisms (U39E)*, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M205/K423/205423920.PDF

DCISC concluded in the thirty-second annual report[42] covering plant operations between July 1, 2021, and June 30, 2022, that:

> "The DCPP Employee Retention Program was proceeding generally as planned. Most operators and instrumentation and controls technicians, who are especially needed through the end of generation, remained. Planning for the decommissioning of DCPP was proceeding well, and the Decommissioning Engagement Panel was serving well to represent the interests of the community and other stakeholders."

Attrition Through Continued Operation

The employee retention program discussed above and authorized by (D.)18-01-022 is set to expire at the end of 2023. However, SB 846 in PUC 712.8(f)(2) directs the CPUC to fund an extended program to support worker retention. The PUC 712.8(f)(2) text is provided below.

> "The commission shall continue to fund the employee retention program approved in Decision 18-11-024 (December 2, 2018) Decision Implementing Senate Bill 1090 and Modifying Decision 18-01-22, as modified to incorporate 2024, 2025, and additional years of extended operations, on an ongoing basis until the end of operations of both units with program costs tracked under subdivision (e) and fully recovered in rates. Any additional funding for the employee retention program beyond what was already approved in commission Decision 18-11-024 shall be submitted by the operator in an application for review by the commission."

PG&E is finalizing an application for an updated retention program that will apply through the end of extended operations.

Contribution to Resource Adequacy Requirements

Resource Adequacy Program

The Resource Adequacy (RA) program was developed by CPUC in response to the 2001 energy crisis. The program's goal is to ensure that load-serving entities (LSEs) have sufficient capacity to meet their expected peak load plus an additional planning reserve margin (PRM).

The RA program began implementation in 2006 and provides the energy market with adequate forward capacity to meet peak demand and integrate renewables. This capacity includes system RA, local RA, and flexible RA, all of which are measured in megawatts. CPUC sets the annual and monthly system, local, and flexible RA requirements for CPUC-jurisdictional LSEs.[43]

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42 Diablo Canyon Independent Safety Committee staff. 2022. *Thirty-Second Annual Report on the Safety of Diablo Canyon Nuclear Power Plant Operations July 1, 2021—June 30, 2022,* https://www.dcisc.org/download/library/annual-reports/32nd-annual-report-51.pdf.

43 California Public Utilities Commission staff. 2023. *2021 Resource Adequacy Report.* https://www.publicadvocates.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/resource-adequacy-homepage/2021_ra_report.pdf

System RA requirements are determined based on each LSE's CEC-adjusted electricity forecast plus the current PRM. Local RA requirements are determined based on an annual California ISO study using a 1-10 weather year and an N-1-1 contingency. Flexible RA requirements are based on an annual California ISO study that looks at the largest three-hour ramp for each month needed to run the system reliably.[44]

The PRM is the extra generating capacity that acts as a buffer to ensure there is enough electricity available to meet the demand in unexpected situations. The current PRM for 2023 is 16 percent. In Decision 22-06-050,[45] CPUC adopted a minimum of 17 percent PRM for 2024 and stated that this PRM may be revised in a June 2023 decision after a review of CPUC Energy Division's updates to the loss of load expectation modeling. On May 25, 2023, Administrative Law Judges' Debbie Chiv and Shannon O'Rourke proposed agenda ID #21633 to be heard at CPUC's June 29, 2023 Business Meeting recommending maintaining the status quo at 17 percent PRM for 2024 and extending the effective PRM through 2025.

Diablo Canyon's Contribution to Resource Adequacy

DCPP accounts for 2,280 MW total (1,140 MW per unit) of system RA. As discussed above, each unit at DCPP undergoes a planned refueling outage roughly every 18 months. The planned outages for each unit are staggered such that only one unit is in a planned outage at a time. During planned refueling outages, PG&E is obligated to ensure that adequate replacement RA resources are available to meet PG&E's RA obligations during the outage period. As refueling outage timing and duration are scheduled far in advance, PG&E plans its portfolio so that it continues to meet its RA obligations and appropriately contributes to overall grid reliability during planned outages.

A 48- to 52-GW statewide load forecast through 2030 translates to a 56- to 60-GW RA need based on the projected PRMs. However, the roughly 2,280 MW of system RA of DCPP cannot be used in any future RA forecasts due to SB 846.

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44 California Public Utilities Commission staff. 2021. "Resource Adequacy Homepage," https://www.publicadvocates.cpuc.ca.gov/ra.aspx#:~:text=While%20the%20long-term%20planning%20process%20focuses%20on%20a,contracts%20for%20electricity%20capacity%20at%20least%20one-year%20ahead

45 California Public Utilities Commission staff. 2022. *Decision 22-06-050, Decision Adopting Local Capacity Obligations for 2023–2025, Flexible Capacity Obligations for 2023,* https://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=488540634

CHAPTER 5: Conclusions

The DCPP Operation Assessment report addresses a requirement in Senate Bill 846 for the CEC, in coordination with the CPUC and the California ISO, to provide an assessment of the operation of DCPP that includes outage information, power plant operational costs, average revenues from electricity sales, worker attrition, and the contribution of the power plant to resource adequacy requirements.

This report also includes tribal recognition, identifies California legislation associated with the potential operating extension of DCPP, and discusses the funding mechanisms authorized to support the potential extension of operations.

CEC staff prepared this operation assessment to provide the state Legislature an understanding of the current conditions of operations at DCPP. The operation assessment report will be updated and submitted to the legislature on July 1 of each year thereafter until 2031 and will include updated analyses and assessments of DCPP operations.

GLOSSARY

CLIMATE CHANGE — Climate change refers to a change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean or the variability of its properties or both and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. Anthropogenic climate change is defined by the human impact on Earth's climate while natural climate change are the natural climate cycles that have been and continue to occur throughout Earth's history. Anthropogenic climate change is directly linked to the amount of fossil fuels burned, aerosol releases, and land alteration from agriculture and deforestation.

DEMAND RESPONSE — Demand response (DR) refers to providing wholesale and retail electricity customers with the ability to choose to respond to time-based prices and other incentives by reducing or shifting electricity use, particularly during peak demand periods, so that changes in customer demand become a viable option for addressing pricing, system operations and reliability, infrastructure planning, operation and deferral, and other issues. It has been used traditionally to shed load in emergencies. It also could be used as a low-greenhouse gas, low-cost, price-responsive option to help integrate renewable energy and provide grid-stabilizing services, especially when several distributed energy resources are used in combination and opportunities to earn income make the investment worthwhile.

ELECTRICITY SUPPLY STRATEGIC RELIABILITY RESERVE PROGRAM — The Electricity Supply Strategic Reliability Reserve Program (ESSRRP) is a program that funds the Department of Water Resources (DWR) to secure additional electricity resources to help ensure summer electric reliability. These activities include extending the life of gas-fired power plants that were scheduled to retire and procuring temporary diesel power generators and new energy storage. ESSRRP provided between 554 megawatts (MW) and 1,416 MW of energy during September 2022’s extreme heat wave. For context, the rotating outages in 2020 were caused by a shortfall of about 500 MW.

FUEL CYCLE FACILITIES — According to the NRC Commission fuel cycle facilities are licensed by NRC to process and handle special nuclear material, source material, or both. These forms of nuclear material are highly regulated to ensure the safe use and enhanced security. The NRC Division of Fuel Management is responsible for the effective regulation of operational fuel facilities and the licensing of new facilities.

INTEGRATED ENERGY POLICY REPORT — Senate Bill 1389 (Bowen, Chapter 568, Statutes of 2002) requires the California Energy Commission to prepare a biennial integrated energy policy report (IEPR). The report, which is crafted in collaboration with a range of stakeholders, contains an integrated assessment of major energy trends and issues facing California’s electricity, natural gas, and transportation fuel sectors. The report provides policy recommendations to conserve resources, protect the environment, ensure reliable, secure, and diverse energy supplies, enhance the state’s economy, and protect public health and safety.

LOSS OF LOAD EXPECTATION — The expected number of days per year for which the available generation capacity is insufficient to serve the demand at least once in that day.

California has a planning target of expecting no more than one day with an outage every 10 years. Assessments of the loss of load expectation (LOLE) for a system use hundreds or thousands of potential combinations of system, weather, and resource supply conditions for a single year. The LOLE is then determined by dividing the number of days with an outage by the total number of simulated years. If the result is not greater than 0.1, the planning target has been met even if all the days with an outage occurred in a single simulated year.

ONCE-THROUGH COOLING — Once-through cooling (OTC) technologies draw ocean water to cool the steam that is used to spin turbines for electricity generation. The technologies allow the steam to be reused, and the ocean water that was used for cooling becomes warmer and is then discharged back into the ocean. The intake and discharge can have negative impacts on marine and estuarine environments.

PLANNING RESERVE MARGIN — Planning reserve margin (PRM) is used in resource planning to estimate the generation capacity needed to maintain reliability given uncertainty in demand and unexpected capacity outages. A typical PRM is 15 percent above the forecasted 1-in-2 weather year peak load, although it can vary by planning area. The California Public Utilities Commission's resource adequacy program is increasing the PRM requirement to 16 percent minimum for 2023, and 17 percent minimum for 2024 and beyond.

RESOURCE ADEQUACY — The Resource Adequacy (RA) program ensures that adequate physical generating capacity dedicated to serving all load requirements is available to meet peak demand and planning and operating reserves, at or deliverable to locations and at times as may be necessary to ensure local area reliability and system reliability.

SCENARIO — A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (for example, rate of technological change, prices) and relationships. Note that Scenarios are neither predictions nor forecasts but are used to provide a view of the implications of developments and actions.

APPENDIX A:
Acronyms and Abbreviations

AB — Assembly Bill

AEC — Atomic Energy Commission

ANSI — American National Standard Institute

ASM — additional security measures

California ISO — California Independent System Operator

CEC — California Energy Commission

CEQA — California Environmental Quality Act

CGNP — Californians for Green Nuclear Power

CNC — Civil Nuclear Credit Program

CPEs — central procurement entities

CPUC — California Public Utilities Commission

DCISC — Diablo Canyon Independent Safety Committee

DCPP — Diablo Canyon Power Plant

DOE — U.S. Department of Energy

DWR — Department of Water Resources

ESSRRP — Electricity Supply Strategic Reliability Reserve Program

GW — gigawatt

GWh — gigawatt-hour

HBPP — Humboldt Bay Nuclear Power Plant

ISFSI — Independent Spent Fuel Storage Installation

IPRP - Diablo Canyon Nuclear Power Plant Independent Peer Review Panel

LOLE — Loss of Load Expectation modeling

LSE – load-serving entities

MW – megawatt

MWh – megawatt-hour

NRC — Nuclear Regulatory Commission

ORA — CPUC's Office of Ratepayer Advocates

PG&E — Pacific Gas and Electric Company

PWR — pressurized water reactor

QA — quality assurance

QV — PG&E's director of quality verification

RA — resource adequacy

SB — Senate bill

SCE — Southern California Edison

SMUD — Sacramento Municipal Utility District

SONGS — San Onofre Nuclear Generating Station

SSC — Alfred E. Alquist Seismic Safety Commission

STEP — California Energy Commission, Siting, Transmission, and Environmental Protection Division

APPENDIX B:
Nuclear Energy in the United States and California

United States

Atomic Energy Commission

Before NRC was created, nuclear regulation was the responsibility of the Atomic Energy Commission (AEC), which Congress established in the Atomic Energy Act of 1946. Eight years later, Congress amended that law with the Atomic Energy Act of 1954, which allowed the development of commercial nuclear power. The act assigned AEC the functions of promoting the use of nuclear power and regulating the safety of nuclear power. AEC sought to ensure public health and safety from the hazards of nuclear power without imposing excessive requirements that would inhibit the growth of the industry. This was a difficult balance to achieve and within a short time AEC stirred considerable controversy. An increasing number of critics during the 1960s charged that AEC regulations were insufficiently rigorous in several important areas, including radiation protection standards, reactor safety, plant siting, and environmental protection. [46]

Nuclear Regulatory Commission

By 1974, AEC's regulatory programs had come under such strong attack that Congress decided to abolish the agency. Supporters and critics of nuclear power agreed that the promotional and regulatory duties of AEC should be assigned to different agencies. The Energy Reorganization Act of 1974 placed AEC's weapons and energy development programs under the jurisdiction of an agency that later became the Department of Energy. Congress created the NRC to regulate the civilian nuclear power industry. NRC began operations January 19, 1975. NRC focused its attention on several broad issues that were essential to protecting public health and safety. These issues included radiation protection, reactor safety, and regulation of nuclear materials.[47]

Radiation Protection

The primary danger of the use of nuclear materials for electrical power production, as well as a variety of industrial, medical, and research applications, is that workers or the public could be exposed to hazardous levels of radiation. AEC and NRC published standards that were intended to provide an ample margin of safety from radiation generated by the activities of its

46 United States Regulatory Commission. 2021. *About the NRC.* https://www.nrc.gov/about-nrc.html

47 Ibid

licensees. These radiation standards were based on available scientific information and the judgment of leading authorities in the field at the time.[48]

Radiation standards are continually updated as new data emerge. NRC ensures that users of radioactive materials keep radiation exposures within the agency's specified dose limits and as low as reasonably achievable. Users of radioactive materials must obtain a license from NRC and be inspected to ensure that they are following the agency's latest regulations and safety practices. Nuclear power plants emit minute quantities of radioactive gases and liquids to the environment under controlled and monitored conditions during normal plant operations. Because these radioactive discharges can have environmental impacts on humans and the environment, NRC requires licensees to monitor the discharges and analyze nearby environmental samples to ensure that the impacts of plant operations are minimized.[49]

NRC assists States expressing interest in establishing programs to assume NRC regulatory authority under the Atomic Energy Act of 1954, as amended. Section 274 of the Act provides a statutory basis under which NRC relinquishes to the States portions of its regulatory authority to license and regulate byproduct materials (radioisotopes); source materials (uranium and thorium); and certain quantities of special nuclear materials. Additional details About the NRC Agreement State Program can be found on the NRC website.[50] California is an Agreement State with the California Department of Public Health Division of Radiation Safety and Environmental Management serving as the state regulator.

Reactor Safety

The focus of AEC and NRC regulatory programs was to prevent a major reactor accident from occurring that would threaten public health and safety. Both agencies issued a series of requirements designed to ensure that a power reactor would not release a massive amount of radiation. As the number and size of nuclear power plants being built rapidly increased during the late 1960s and early 1970s, reactor safety became a hotly debated and enormously complex public policy issue. Often bitter debates over the reliability of emergency core cooling systems, pressure vessel integrity, quality assurance, the probability of a major accident, and other questions received a great deal of attention from AEC, NRC, Congress, the nuclear industry, environmentalists, and the news media.

On March 28, 1979, the debate over nuclear power safety moved from the hypothetical to reality. An accident at Unit 2 of the Three Mile Island plant in Pennsylvania melted about half of the reactor core and generated fear that widespread radioactive contamination would result. The crisis ended without a major release of radiation or a need to order a general

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48 Ibid

49 United States Regulatory Commission. 2022. https://www.nrc.gov/about-nrc/radiation/protects-you.html

50 United States Regulatory Commission. 2022. *Agreement State Program*. https://www.nrc.gov/about-nrc/state-tribal/agreement-states.html

evacuation, but it underscored that new approaches to nuclear regulation were essential. The accident demonstrated that even a seemingly small equipment failure could lead to a serious nuclear incident and highlighted the importance of operator training, emergency planning, and other "human factors" in ensuring the safe operation of nuclear power plants.[51]

Regulation of Nuclear Materials

NRC devotes substantial resources to a variety of complex questions in nuclear materials safety. One such issue was the protection of nuclear materials from theft or diversion. This issue became a prominent question after the 1970s in response to growing concern that nuclear materials could be obtained by terrorists or nations seeking to build atomic weapons. NRC devotes a great deal of attention to the safety of managing high-level and low-level radioactive waste, which remains a matter of public fear and political controversy today.

Regulatory Activities

NRC's regulatory activities are focused on:

- Inspections.
- Security and safeguards.
- Plant licensing.
- Operator licensing.

Inspections

NRC conducts inspections to ensure that licensees meet NRC's regulatory requirements. These inspections include licensed nuclear power plants, fuel cycle facilities, and radioactive materials activities and operations. There are roughly 1,000 inspections conducted a year that cover areas such as training of personnel who use materials, radiation protection programs, radiation patient dose records, and security of nuclear materials.[52] Inspectors follow guidance in the NRC Inspection Manual,[53] which contains objectives and procedures to use for each type of inspection. If an inspection shows that a licensee is not safely conducting an activity or safely operating a facility, the plant is informed. NRC will continue to inspect that activity or facility until the problems are corrected.

In addition to region-based inspectors, NRC has resident inspectors at each of the nation's operating nuclear plants and fuel cycle facilities to carry out the inspection program on a day-to-day basis. DCPP has two full-time on-site NRC inspectors.

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51 United States Regulatory Commission. 2022. *About the NRC.* https://www.nrc.gov/about-nrc.html

52 United States Regulatory Commission. 2020. *Inspections. https://www.nrc.gov/about-nrc/regulatory/safety-oversight.html*

53 United States Regulatory Commission. 2023. *Inspection Manual.* https://www.nrc.gov/reading-rm/doc-collections/insp-manual/index.html

Security and Safeguards

NRC has instituted programs that protect public health and safety by promoting the common defense and security of the DCPP and guarding against theft and sabotage. NRC reviews and approves licensees' security programs and contingency plans dealing with threats, thefts, and sabotage relating to special nuclear material, high-level radioactive wastes, nuclear facilities, and other radioactive materials and activities. NRC also ensures safeguards and security by regulating licensees' accounting systems for special nuclear and source materials and security programs and contingency plans. NRC security and safeguard responsibilities include:

- Domestic safeguards, which are aimed at ensuring that special nuclear material within the United States is not stolen or otherwise diverted from civilian facilities for possible use in clandestine fissile explosives and does not pose an unreasonable risk owing to radiological sabotage.
- Information security, which is the protection of classified and sensitive unclassified non safeguards information related to U.S. government programs for the physical protection and safeguarding of nuclear materials or facilities against unauthorized disclosure.
- Cybersecurity, which is composed of establishing and maintaining an effective cybersecurity program. Digital systems are increasingly used in nuclear power plants to maximize productivity. In response to the cybersecurity challenges facing nuclear power plants, the NRC has implemented infrastructure changes, enhanced interagency interfaces, performed enhanced inspections, and developed a cybersecurity roadmap.
- Radioactive material security, aimed at regulating the use of radioactive material to protect people and the environment.
- Required reporting for clearance holders, which is oversight of the reporting requirements for NRC employees and NRC contractors, as well as cleared licensee personnel, cleared licensee contractors, and others who hold national security clearances issued by NRC.
- Insider threat program for licensees. Executive Order 13587 required all federal agencies to establish and implement an insider threat program to cover contractors and licensees who have exposure to classified information.
- Licensee criminal history records and firearms background checks.[54]

Plant Licensing

Through the licensing process, NRC authorizes an applicant to conduct any or all of the following activities:

- Construct, operate, and decommission commercial reactors and fuel cycle facilities.
- Possess, use, process, export and import nuclear materials and waste, and handle certain aspects of their transportation.
- Site, design, construct, operate, and close waste disposal sites.

54 United States Regulatory Commission. 2021. *Security.* https://www.nrc.gov/security.html

To become licensed for any of these activities (or to amend, renew, or transfer an existing license), an entity or individual applies to NRC. NRC staff reviews the submission, using standard review plans, to ensure that the applicant's assumptions are technically correct and that the proposed activities will not adversely impact the environment.[55]

Operator Licensing

NRC regulations in 10 CFR Part 55 require personnel who operate a reactor to have either a reactor operator or a senior operator license issued by NRC. Reactor operators are licensed to operate the reactor under most routine conditions without supervision, such as start-up and shutdown of the reactor, along with monitoring reactor parameters. However, a senior operator must be present to supervise operation of the reactor during some nonroutine plant conditions such as performing fuel movement, making reactor core alterations within the reactor vessel, and overseeing plant operations during emergencies.

To ensure that these operators have the required knowledge, skills, and abilities to control the reactor during routine processes and emergencies, NRC staff prepares and administers a comprehensive written examination and a hands-on operating test to all candidates for a new reactor operator or senior operator license. These examinations, developed from NRC regulations, are designed to measure the candidate's qualifications to operate the reactor. NRC licenses are valid for six years.

Once licensed, operators and senior operators are required to maintain their expertise. Each facility is required to maintain an operator training and requalification program, covering refresher training (material covered during initial licensing) and training on recently changed systems. The operator training and requalification program must be submitted to NRC for approval. The training program is divided into two-year cycles and requires a comprehensive written examination and an annual operating test. These examinations are administered by the facility staff. At the end of the six-year period, operators and senior operators are required to submit a renewal application to renew their licenses. As part of the application, the applicant must certify satisfactory participation in the Operator Training and Requalification Program.[56]

California

As of mid-2012, California has one operating nuclear power plant, DCPP, owned by PG&E. DCPP consists of two units. Unit 1 was originally estimated as a nominal 1,073-MW PWRs, which began commercial operation in May 1985, while Unit 2 was originally estimated as a

55 United States Regulatory Commission. 2021. *Licensing.* *https://www.nrc.gov/about-nrc/regulatory/licensing.html*

56 United States Regulatory Commission. 2022. *Licensing Process for Operators.* https://www.nrc.gov/reactors/operator-licensing/licensing-process.html

nominal 1,087-MW PWR, which began commercial operation in March 1986.[57] Today, the two reactors each produce about 1,140 MW and combined produce about 18,000 GWh of electricity annually, which is about 9 percent of California's in-state generation. [58]

DCPP has two Westinghouse-designed four-loop PWRs. The once-through cooling system of the facility draws water from the Pacific Ocean to condense steam that is used to drive the turbine systems.

On June 21, 2016, PG&E announced a joint proposal with labor and environmental organizations to increase investment in energy efficiency, renewables, and storage, while phasing out nuclear power. The proposal indicated that the operating licenses for Diablo Canyon Units 1 and 2 would not be renewed when they were to expire November 2, 2024, and August 26, 2025. PG&E's application to close DCPP was approved by the CPUC in January 2018. In February 2018, PG&E withdrew its application from NRC for a 20-year licensing extension beyond 2024 and 2025.

On September 2, 2022, the Governor approved SB 846, which authorized the extension of operating DCPP beyond the current expiration dates, up to five additional years (no later than 2029 and 2030, respectively), under specified conditions.[59]

Power Reactor Decommissioning

California hosts three commercial nuclear power reactor facilities in various stages of decommissioning or are decommissioned: the Humboldt Bay Nuclear Power Plant near Eureka, the Rancho Seco Nuclear Power Plant near Sacramento, and the San Onofre Nuclear Generating Station south of San Clemente.

Under all NRC operating licenses, once a nuclear plant ceases reactor operations, it must be decommissioned. Decommissioning is defined by federal regulation (10 CFR 50.2) as the safe removal of a facility from service along with the reduction of residual radioactivity to a level that permits termination of NRC operating license. In preparation for the eventual decommissioning of a plant, nuclear plant owners must maintain trust funds while the plants are in operation to ensure sufficient funding will be available to decommission their facilities and manage the spent nuclear fuel.

In general, spent fuel can be either reprocessed to recover usable uranium and plutonium or managed as a waste for long-term ultimate disposal. Since fuel reprocessing is not

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57 California Energy Commission Staff. 2020. *Nuclear Power Reactors in California*. https://www.energy.ca.gov/sites/default/files/2020-03/Nuclear_Power_Reactors_in_California_ada.pdf

58 California Energy Commission Staff. 2023. *Final Commission Report, Diablo Canyon Power Plant Extension, CEC Analysis of Need to Support Reliability*. https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-ESR-01

59 Dodd, Bill. 2002. *California Senate Bill No. 846, Diablo Canyon Power Plant: Extension of Operations*. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202120220SB846

commercially available in the United States, spent fuel is held in temporary storage at reactor sites until a permanent long-term waste disposal option becomes available.

Because of the lack of permanent long-term waste disposal options in the United States, in 1976 the California placed a moratorium (Chapters 194 and 196, Statutes of 1976) on the construction and licensing of new nuclear reactors until the CEC determines that the federal government has identified and approved a demonstrated technology for:

- The construction and operation of nuclear fuel rod reprocessing plants.
- The permanent disposal of high-level nuclear waste.

In effect, these two conditions halted the construction of new nuclear power plants in California. Accordingly, no new nuclear power plants have been constructed in California since 1976.

The three commercial nuclear power reactor facilities in various stages of decommissioning or are decommissioned are discussed below.

Humboldt Bay Nuclear Power Plant

Humboldt Bay Nuclear Power Plant (HBPP), Unit 3, was a roughly 65 MW boiling water nuclear reactor, owned by PG&E that operated from August 1963 to July 1976. HBPP Units 1 and 2 were fossil fuel steam plants built in 1956 and 1958, respectively. Unit 3 was shut down in 1976 for refueling and seismic upgrades. Repairs subsequently extended the planned shutdown period, and in that interval, significant regulatory changes were made for reactor operation and design. As such, PG&E decided to not restart Unit 3.[60]

In 1983, PG&E announced plans to close the plant permanently and in 1988 placed the plant in SAFSTOR inactive status. SAFSTOR is an NRC facility decommissioning program considered "deferred dismantling," where a nuclear facility is maintained and monitored in a condition that allows the radioactivity to decay; afterward, the plant is dismantled, and the property decontaminated. The other available NRC decommissioning program is called DECON and is considered "immediate dismantling" where soon after the nuclear facility closes, equipment, structures, and portions of the facility containing radioactive contaminants are removed or decontaminated to a level that permits the release of the property and termination of the NRC license.[61]

In 2003, PG&E formally submitted a license application to NRC for approval of a dry-cask Independent Spent Fuel Storage Installation (ISFSI) at the Humboldt Bay site. A license and safety evaluation for the Humboldt Bay ISFSI were issued on November 17, 2005. The transfer

60 Pacific Gas and Electric. 2023. *Humboldt Bay Power Plant.* https://www.pge.com/en_US/about-pge/environment/what-we-are-doing/buildings-and-operations/humboldt-bay-power-plant.page

61 California Energy Commission staff. 2020. *Nuclear Reactors in California.* https://www.energy.ca.gov/sites/default/files/2020-03/Nuclear_Power_Reactors_in_California_ada.pdf

of spent fuel from the fuel storage pool to the ISFSI was completed in December 2008 and decontamination and dismantlement of HBPP decommissioning commenced.[62]

NRC has granted Part 50 termination of the HBPP, Unit 3 apart from the ISFSI on November 18, 2021, and is considered decommissioned.[63]

Rancho Seco Nuclear Power Plant

The Rancho Seco Nuclear Power Plant, located about 25 miles south of Sacramento, is owned by the Sacramento Municipal Utility District (SMUD). The unit approximately 913 MW PWR, was operational from April 1975 to June 1989. It was closed by public referendum.

In 1996, NRC approved the decommissioning plan for the Rancho Seco Nuclear Power Plant. The spent fuel produced during operation remains onsite in protective dry storage.

All power-generating equipment has been removed from the plant except the now-empty cooling towers. In October 2009, NRC released most of the site for unrestricted public use.[64]

San Onofre Nuclear Generating Station

The San Onofre Nuclear Generating Station (SONGS), operated by majority owner Southern California Edison (SCE), is midway between Los Angeles and San Diego and contained three units. The first unit, Unit 1, was in operation from 1968 to 1992, when it was shut down and placed in SAFSTOR inactive status. Unit 1 was a Westinghouse three-loop about 450-megawatts equivalent (Mwe) PWR.[65]

Units 2 and 3 were Combustion Engineering two-loop roughly 1,110-MWe PWRs. Unit 2 began operation in 1983, and Unit 3 began operation in 1984.

Unit 2 was shut down in early January 2012 for routine refueling and replacement of the reactor vessel head. On January 31, 2012, Unit 3 suffered a radioactive leak largely inside the containment shell, with a release to the environment below allowable limits, and the reactor was shut down per standard procedure. On investigation, the replacement steam generators from 2011 in both units were found to show premature wear on over 3,000 tubes, in 15,000 places. In March 2012, NRC forbade the plant to be reopened until the causes of equipment problems were thoroughly understood and fixed. Subsequently, plant owners announced in

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62 Pacific Gas and Electric. 2023. *Humboldt Bay Power Plant.* https://www.pge.com/en_US/about-pge/environment/what-we-are-doing/buildings-and-operations/humboldt-bay-power-plant.page

63 Ibid

64 California Energy Commission staff. 2020. *Nuclear Reactors in California.* https://www.energy.ca.gov/sites/default/files/2020-03/Nuclear_Power_Reactors_in_California_ada.pdf

65 United States Nuclear Regulatory Commission staff. 2023. *San Onofre.* https://www.nrc.gov/info-finder/decommissioning/power-reactor/san-onofre-unit-1.html

June 2013 that the remaining Units 2 and 3 would be permanently retired and would enter decommissioning.[66]

66 California Energy Commission staff. 2020. *Nuclear Reactors in California.* https://www.energy.ca.gov/sites/default/files/2020-03/Nuclear_Power_Reactors_in_California_ada.pdf