Joint Proposal for the Orderly Replacement of Diablo Canyon Power Plant with Energy Efficiency and Renewables

JUNE 21, 2016

Executive Summary

Pacific Gas & Electric (PG&E), International Brotherhood of Electrical Workers Local 1245, Coalition of California Utility Employees, Friends of the Earth, Natural Resources Defense Council, Environment California, and Alliance for Nuclear Responsibility (together, the parties) have developed a joint proposal to retire PG&E's Diablo Canyon Power Plant at the close of its current operating license period and replace it with a portfolio of greenhouse gas (GHG)-free resources. The joint proposal:

- ensures the cost-effective and orderly replacement of Diablo Canyon with GHG-free resources;
- provides a responsible and supportive transition for Diablo Canyon employees and the community;
- facilitates renewables integration through a reliable and more flexible resource mix; and
- greatly diminishes Diablo Canyon impacts on fishery resources at the end of the current license period, avoiding the need to install cooling towers under California's once-through-cooling policy.

Under the joint proposal, PG&E will continue to operate Diablo Canyon at current levels through the current license period. In 2024, PG&E will retire Unit 1, and in 2025 will retire Unit 2. To ensure the orderly replacement of Diablo Canyon with GHG-free resources, the settlement lays out specific procurement requirements starting in 2018 and continuing through 2031. PG&E will procure 2,000 GWh of new energy efficiency projects and programs to be installed from 2018 to 2024. As a second step, PG&E will procure another 2,000 GWh of energy efficiency or GHG-free energy to be initiated between 2025 through 2030. Finally, PG&E commits to procure the necessary levels of renewables to meet a 55 percent Renewables Portfolio Standard by 2031. In addition to these procurement targets, parties agree to support (before the California Public Utilities Commission and the California Independent System Operator) the use of GHG-free resources, including but not limited to pumped hydroelectric storage, for additional reliability and resource integration solutions which may be required to replace Diablo Canyon.

Diablo Canyon has reliably served the electricity needs of PG&E's customers since 1985. However, California's electric grid is in the midst of a significant shift that creates challenges for the facility in the coming decades. Changes in state policies, the electric generation fleet, and market conditions combine to reduce the need for large, inflexible baseload power plants. These forces reduce the need for Diablo Canyon's output beyond the current license period. PG&E is faced with four primary planning challenges associated with operating Diablo Canyon beyond the current license period:

1. *Uncertain PG&E Electricity Supply Needs:* Three key trends have significantly reduced PG&E's electricity sales in recent years and will likely have even greater impacts in the future.[1] This downward pressure on sales is reducing the need for electricity from Diablo Canyon. First, ongoing and aggressive energy efficiency policies are projected to reduce overall electricity consumption. Second, customers are likely to increase the amount of electricity generated through distributed generation (DG), especially privately-owned solar resources. Finally, PG&E's bundled customer base is likely to decrease as some households and businesses choose to buy their generation from alternative providers, either through Direct Access or Community Choice Aggregation. The precise impact each of these factors will have on PG&E's electricity supply needs is not certain, though they combine to support a clear downward trend on PG&E electricity sales.

2. *Decreasing Need for Baseload Generation:* As the electric grid in California continues to evolve, so too will the character of resources needed to operate the California electric system reliably. Given California's energy goals that require increasing reliance on renewables – at least 50 percent by 2030 – the California electric system will need more flexible resources while the need for baseload electricity supply will decrease. PG&E will need less non-renewable baseload generation to supply its electricity customers. Hence the need for baseload power from the large Diablo Canyon Power Plant will decrease in the post 2025 timeframe.

3. *Challenges with Renewable Overgeneration:* Another aspect of this changing California electric system is the prospect of mounting "overgeneration" conditions. As more solar generation comes on line over time and when its output is at peak supply (e.g., in the middle of the day), there is less room on the electric system for energy from inflexible and large baseload resources such as the Diablo Canyon Power Plant. Overgeneration conditions can force the system operator to take action to curtail generation (e.g., dispatch generators down, or even disconnect supply from the grid) in order to maintain electric system reliability. Retirement of Diablo Canyon on the timeframe agreed to in the joint proposal will allow for increased flexibility for the California electric system so as to help maximize the value of solar and other variable resources that will be a crucial part of meeting PG&E's renewable targets and California's renewable and GHG emissions goals.

4. *Ongoing Costs for Diablo Canyon:* Diablo Canyon has served as a valuable resource providing reliable electricity for decades. However, future operating costs are uncertain due to a variety of potential regulatory and other factors and could increase as the facility ages. California's environmental protection regulations and other state and federal requirements may increase future costs beyond 2025. These include, for example, any environmental mitigation or compliance measures required by California resource agencies, retrofits to comply with the State Water Control Board's Cooling Water Intake Structures regulation, or additional regulations or orders from the Nuclear Regulatory Commission in response to federal regulatory or legislative changes either currently under consideration or in the future. Additionally, due to expected overgeneration throughout parts of the year, Diablo Canyon may contribute to higher system costs as its current generation profile causes challenges for efficiently integrating

[1] Throughout this report, "PG&E electricity sales" refers to PG&E's bundled retail sales (i.e., "bundled" electricity, transmission and distribution services).

renewable resources. Therefore, if Diablo Canyon were not relicensed, the cost to integrate renewables could be lower.

The joint proposal would benefit PG&E customers and the state of California by reducing emissions, supporting a reliable and cost-effective electric system, and supporting PG&E employees and the community PG&E serves.

- *Lowering GHG emissions*: PG&E's portfolio has long been one of the lowest emitting in the country. Half or more of its procured electricity is consistently GHG-free, and renewable procurement has more than doubled in the last seven years. Under the joint proposal, PG&E commits to reaching 55 percent renewable deliveries, representing nearly a doubling of today's renewable procurement and a 10 percent increase over state regulatory requirements for 2030. Combined with existing policies and the joint proposal's energy efficiency measures, this will contribute to a significant decrease in GHG emissions.

- *Maintaining reliability*: The parties are confident that Diablo Canyon can be retired while continuing to maintain a cost-effective PG&E electric system. Numerous studies have shown that Diablo Canyon could be removed from the California electric system without harming reliability; indeed, PG&E's transmission system has been maintained and designed in order to withstand the loss of both Diablo Canyon units. Furthermore, the joint proposal provides for a deliberate and orderly phase out of Diablo Canyon, allowing time to replace the facility with GHG-free resources and to ensure the transition occurs while maintaining reliability.

- *Maintaining cost-effective electricity service*: GHG-free replacement resources will be procured through California Public Utility Commission-approved competitive bidding processes, which will ensure that the lowest-cost clean resources are used to replace Diablo Canyon, and that the relevant stakeholders are involved in monitoring and assisting the procurement process. A number of studies have demonstrated that Diablo Canyon generation could be cost-effectively replaced by GHG-free resources.

- *Continuing commitment to PG&E employees and community*: Key provisions of the agreement reflect the fact that PG&E depends upon and has been committed to its employees and the communities in which the utility operates and serves customers. Under the joint proposal, it will be critical to retain existing employees, who are highly qualified and will drive continued safe and reliable operations. PG&E will provide a generous retention program and severance payments upon completion of employment. PG&E will help employees transition to new positions through a retraining and development program to facilitate redeployment of a portion of plant personnel to the decommissioning project. Additionally, the Diablo Canyon Power Plant is one of the largest employers, taxpayers, and charitable contributors in the San Luis Obispo County area. In order to further support this local community, PG&E proposes to continue providing funding to San Luis Obispo at current property tax levels through 2025.

Introduction

Pacific Gas & Electric (PG&E), International Brotherhood of Electrical Workers Local 1245, Coalition of California Utility Employees, Friends of the Earth, Natural Resources Defense Council, Environment California, and Alliance for Nuclear Responsibility (together, the parties) have developed a joint proposal to phase out PG&E's Diablo Canyon Power Plant by 2025 and replace it with a portfolio of greenhouse gas (GHG)-free resources. The joint proposal:

- ensures the cost-effective and orderly replacement of Diablo Canyon with GHG-free resources;
- provides a responsible and supportive transition for Diablo Canyon employees and the community;
- facilitates renewables integration through a reliable and more flexible resource mix; and
- greatly diminishes Diablo Canyon impacts on fishery resources at the end of the current license period, avoiding the need to install cooling towers under California's once-through-cooling policy.

The joint proposal is rooted in California's unique energy and policy landscape. California is in the midst of a significant shift in the character of its electric system, and is on its way toward achieving aggressive and critical environmental targets. The parties' joint proposal recognizes these goals. It builds upon them and offers additional commitments for energy efficiency and renewables that go beyond existing requirements to help further California environmental objectives and invest in the state's energy future. Further, the joint proposal recognizes the realities of a changing electricity landscape in the state, one that includes increasing levels of self-generation, community choice aggregation, and renewable energy resources, all of which decrease PG&E's need for other sources of generation.

California's Goals	Joint Proposal
50% renewables by 2030	55% renewables by 2031 (PG&E electricity sales*)
Double energy efficiency savings by 2030	Implement additional energy efficiency programs between 2018-2024
Optimal integration of renewables	More flexible generation mix to integrate renewables
80% decline in greenhouse gases by 2050	Facilitates California's climate goals

*Electricity sales refers to PG&E's bundled retail sales (i.e., "bundled" electricity, transmission and distribution services).

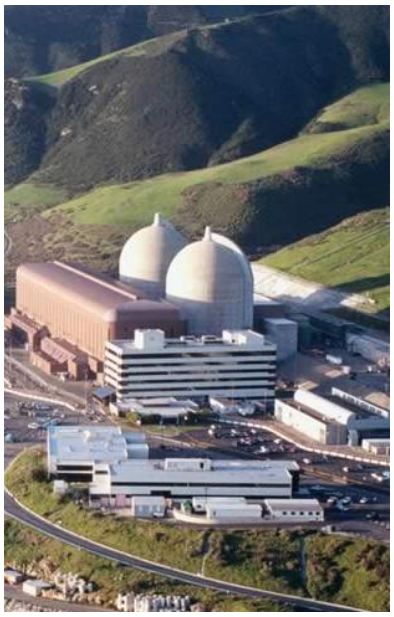
Under the joint proposal, the parties agree to a deliberate and orderly transition away from Diablo Canyon. PG&E would retire both units at Diablo Canyon at the end of their current license period and replace it with a portfolio of GHG-free resources to continue to provide clean, reliable, and cost-effective service to customers. In the next two years, PG&E will prepare a site-specific decommissioning plan for Diablo Canyon following the joint proposal schedule. Key aspects of the joint proposal map directly to California's energy and climate goals:

- PG&E commits to achieve 55 percent renewable generation by 2031, representing an increase over current state targets that require 50 percent by 2030;
- PG&E will procure at least 2,000 gigawatt-hours (GWh) of additional energy efficiency projects and programs, which will increase energy savings, building on California's nation-leading targets;
- PG&E will facilitate more renewables integration and California's GHG reduction goals through the specific energy efficiency and renewables targets in the joint proposal and by procuring additional GHG-free resources that may be needed.

On behalf of the parties to the joint proposal, M.J. Bradley & Associates (MJB&A) was retained to assess and explain the main components of the proposed agreement and the key considerations and analyses that support the plan. This document begins with an overview of how California's changing electric grid poses significant challenges for large, inflexible baseload resources. These market forces are reducing the long-term need for Diablo Canyon's output. The second section summarizes the key provisions included in the joint proposal, including the specific procurement targets for energy efficiency and GHG-free energy and PG&E's commitment to achieving a 55 percent Renewables Portfolio Standard (RPS). The final section of the document highlights the outcomes that would be expected if the joint proposal were implemented. This discussion addresses impacts on emissions, grid reliability, customer affordability, employees, and the local community.

Challenges for Long-term Operation of Diablo Canyon

Diablo Canyon has reliably served the electricity needs of PG&E's customers since 1985. However, California's electric grid is in the midst of a significant shift that creates challenges for the facility in the coming decades. Changes in state policies, the electric generation fleet, and market conditions combine to reduce the need for large, inflexible baseload power plants. These forces reduce the need for Diablo Canyon's output beyond the current license period.



Resource Planning Challenges Beyond Current License Period
1. Uncertain Electricity Supply Needs for PG&E
2. Declining Need for Diablo Canyon Generation
3. Challenges with Inflexible Baseload Generation
4. Uncertain Rising Costs for Diablo Canyon

1. Uncertain PG&E Electricity Supply Needs

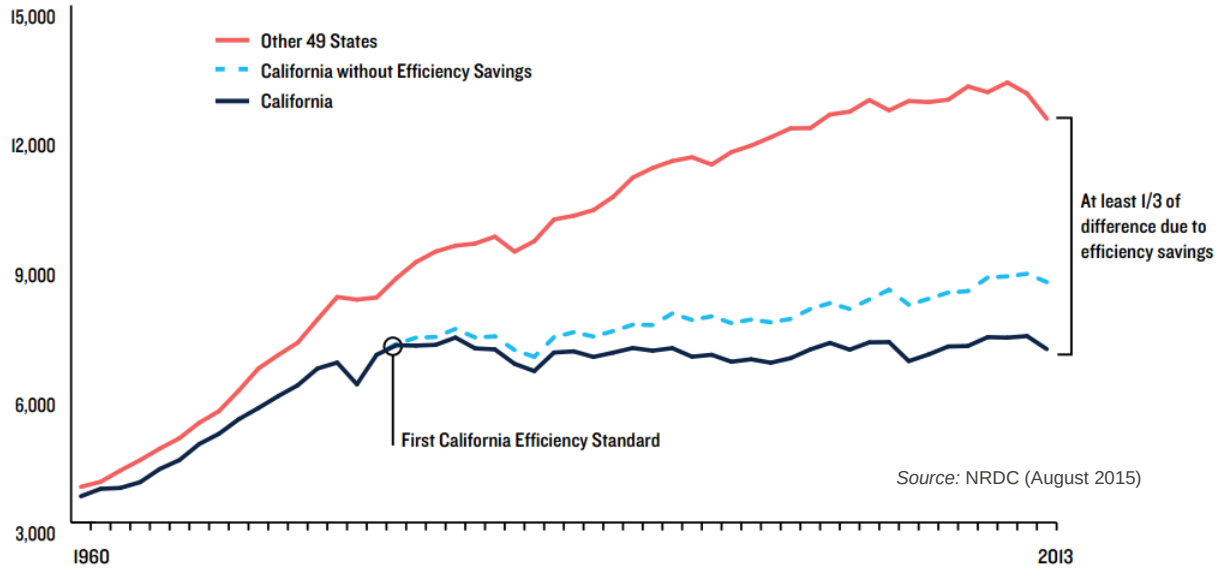
A crucial component of maintaining a safe, reliable, and cost-effective electric system is ensuring that electric supply is balanced with customer demand. Customer demand projection is an inexact science, as many factors out of the control of grid planners (for example, weather or economic activity) can have a large impact on how much electricity will be needed. Despite this inherent uncertainty, three key trends have significantly reduced PG&E's electricity sales in recent years and will likely have even greater impacts in the future. This downward pressure on sales is reducing the need for electricity from Diablo Canyon. First, ongoing and aggressive energy efficiency policies are projected to reduce overall electricity consumption. Second, customers are likely to increase the amount of electricity generated through distributed generation (DG), especially privately-owned solar resources. Finally, PG&E's bundled customer base is likely to decrease as households and businesses instead choose to buy their generation from alternative providers, either through Direct Access (DA) or Community

Choice Aggregation (CCA). The precise impact each of these factors will have on PG&E's electricity supply needs is not certain, though they combine to support a clear downward trend on PG&E electricity sales.

Energy Efficiency

Beginning more than 40 years ago, California has established some of the most aggressive energy efficiency policies in the country. The state began its energy efficiency journey by instituting efficiency standards for appliances in 1977, the first state to do so, followed closely by standards for new buildings in 1978. With the "decoupling" of utility revenues from total electricity sales that began in 1982, California removed barriers and disincentives for investment in energy efficiency by utilities and other parties across the state. As shown in Figure 1, California has put in place dozens of rebate programs, incentives, and standards that have kept California per capita electricity use flat while the rest of the country increased by 50 percent since the 1970s.[2] Since 2003, energy efficiency programs and standards have saved enough electricity to power more than half of California's homes for one year and enough natural gas to serve two million homes annually.[3]

Figure 1. California electricity consumption, per capita (kWh)



The California Energy Commission (CEC) tracks the progress of the collective impact of energy efficiency programs. In a 2015 analysis, it noted that statewide electricity consumption in 2014 grew by less than 1 percent while employment and gross state product grew more than twice as much (2.3 percent). In fact, between 2000 and 2014, California's gross state product grew by 27 percent, which was more than triple the growth in electricity demand.[4] By 2013, efficiency and conservation programs had led to the annual avoidance of nearly 70 terawatt

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2 Natural Resources Defense Council, "California's Golden Energy Efficiency Opportunity: Ramping Up Success to Save Billions and Meet Climate Goals," August 2015, available at https://www.nrdc.org/sites/default/files/ca-energy-efficiency-opportunity-report.pdf

3 Ibid.

4 California Energy Commission, "Tracking Progress – Statewide Energy Demand." Available at http://www.energy.ca.gov/renewables/tracking_progress/documents/statewide_energy_demand.pdf

hours (TWh) of electricity consumption, which is roughly equivalent to one-third of the state's total electric generation.[5,6]

Efficiency savings will only increase in the future. In 2008, California created the Long Term Energy Efficiency Strategic Plan that included the following key goals:

- All new residential construction in California will be zero net energy by 2020.
- All new commercial construction in California will be zero net energy by 2030.
- Heating, ventilation, and air conditioning (HVAC) will be reshaped to ensure optimal performance for California's climate resulting in a 50 percent improvement in efficiency in the HVAC sector by 2020.
- All eligible income-qualified customers will have the opportunity to participate in special energy programs by 2020.
- Existing homes will use 20 percent less energy by 2015 and 40 percent less by 2020.[7]

Recent legislation has codified and further accelerated these goals. Senate Bill 350 requires the CEC to establish annual targets to double statewide energy efficiency savings in electricity and natural gas end uses by January 1, 2030. Assembly Bill 802 requires the California Public Utilities Commission (CPUC) to consider incentives for energy efficiency measures that allow for a broader array of incentive programs with higher potential efficiency savings. In all, the CEC projects that building energy use will be 20 percent below 2014 levels by 2030, even accounting for economic growth and an increase in vehicle electrification.[8]

Customer Distributed and On-site Generation

PG&E customers are increasingly choosing to generate their own electricity, often through privately-owned solar panels, rather than purchase it from PG&E. PG&E must still maintain the transmission and distribution infrastructure required to incorporate this customer-side generation onto the grid and ensure that all customers have access to a reliable electricity source, even when privately-owned generators are not running. However, privately-owned generation decreases overall procurement needs for PG&E, as electricity is now being produced by small customer-side installations throughout its service area.

The rise in privately-owned, customer-side generation has been driven by state policy in combination with the falling cost of distributed generation technologies. One of the first programs of its kind, the California Self-Generation Incentive Program was conceived in 2001. The program provides incentives for the installation of

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5 California Energy Commission, "Tracking Progress – Energy Efficiency" (CEC Tracking Progress - EE). Available at http://www.energy.ca.gov/renewables/tracking_progress/documents/energy_efficiency.pdf

6 One terawatt hour equals 1,000 gigawatt hours.

7 Energy Upgrade California, "Our Energy Efficiency Strategies," available at https://energyupgradeca.org/en/learn/energy-in-california/our-energy-efficiency-strategies

8 CEC Tracking Progress - EE.

small, customer-side wind and cogeneration generators as well as emerging technologies such as energy storage and fuel cells. A total of 252 MW have been brought online under the program.[9]

The largest source of small, privately-owned generation in California is solar installations on the customer-side of the meter at residences and businesses. The California Solar Initiative is a rebate program launched in January of 2007 and provides incentives for privately-owned solar systems installed on existing homes and on commercial, industrial, government, non-profit, and agricultural properties within the service territories of the state's three investor-owned utilities. As of May 2016, there were 1,750 MW installed under the program and another 187 MW of pending projects.[10]

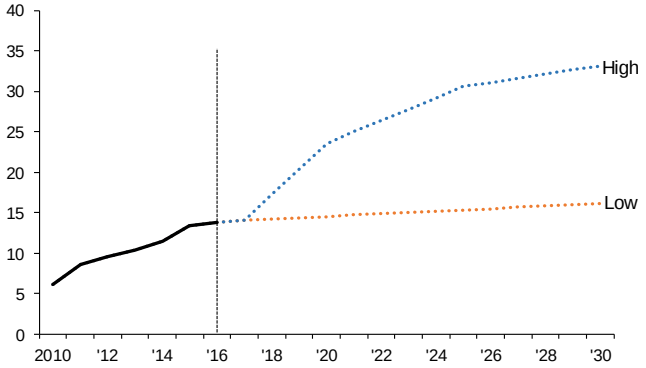
Many of these privately-owned, customer-side solar installations are eligible for California's net energy metering program. Under this program, a meter tracks how much electricity is consumed by the customer and how much is sent from the customer's system back to the grid. Over the course of the year, the customer only pays for the net amount of electricity used from the utility. The number of privately-owned solar installations significantly increased in 2010, as solar leasing companies lessened the up-front cost of investment through new financing mechanisms and favorable state and federal policies.

PG&E has connected more privately-owned solar systems to its grid than any other utility in the country. On-site, privately-owned, grid-connected generation levels increased across PG&E's service territory by more than 170 percent between 2010 and 2015, rising from less than 2 TWh to nearly 5 TWh. Continuing this high growth rate, on-site generation levels are projected to increase another 400 percent above 2015 levels by 2030 (over 23 TWh of total annual output). At this level in 2030, on-site generation would represent over one-fifth of total electricity usage in PG&E's service territory.

Retail Electricity Choice

Starting in the late 1990s, California policies required electric utilities to "unbundle" their electric service into separate generation and delivery components. While PG&E was still required to maintain the electric grid to ensure delivery to all customers in its service area, customers could shop around to have suppliers other that PG&E provide the generation that was delivered. Known as "direct access," this program allowed for a shift away from PG&E-procured energy. However, after the energy crisis in 2000 and 2001, the Commission suspended the direct access program, effectively placing a cap on total generation that could be provided by direct access providers (also called "electric service providers") and restricting new customers from switching to

Figure 2. DA/CCA-served generation in PG&E service territory (TWh)



Source: MJB&A analysis based on data provided by PG&E

[9] California Public Utilities Commission, "About the Self Generation Program." Available at: http://www.cpuc.ca.gov/General.aspx?id=11430

[10] Go Solar California, California Solar Statistics, "Monthly, Quarterly, and Annual Statistics," accessed May 2016. Available at https://www.californiasolarstatistics.ca.gov/reports/monthly_stats/

direct access. The program was re-opened on a limited basis to commercial and industrial customers in 2010. There are currently around 20 active electric service providers in California.[11]

In 2003, the California legislature passed a law that created an exemption to the direct access suspension, by allowing cities and counties to form "community choice aggregators," or CCAs, that would, similar to an energy service provider, provide generation for a distinct set of customers through PG&E's transmission and distribution system. At the start of this year, there were two CCAs operating in PG&E's service area (Marin Clean Energy and Sonoma Clean Power), serving approximately 370,000 customers; a third (CleanPowerSF) has just recently launched.[12]

California-wide, alternative service providers delivered just over 10 percent of the electricity to California customers in 2014.[13] Though direct access participation in PG&E's service area is capped, CCAs are continuing to form within the service area. In addition to the existing CCAs, two additional CCAs in PG&E's service area are expected to become operational in 2016 (Silicon Valley Community Choice Energy Partnership and Peninsula Clean Energy), while another three are in various stages of implementation.[14]

As more customers choose to receive their electricity from CCAs, PG&E's procurement needs for its remaining customers will decrease. Some estimate that up to 60 percent of California residents currently live within the bounds of a community that is pursuing or exploring a CCA program.[15] Though there is uncertainty as to the total generation that may eventually be served by direct access and CCA providers, these programs could cut PG&E electricity sales by 33 TWh by 2030 (See Figure 2).

Implications for PG&E's Electricity Supply Needs

Combined, these three factors point to likely decreases in PG&E's "bundled" retail sales (i.e., electricity sales that are "bundled" with transmission and distribution services), though the exact amount is uncertain. As shown in Figure 3, energy efficiency and departing load due to DG and DA/CCA programs are projected to reduce bundled sales by 5 to 30 percent below current levels (between 3 and 21 TWh). This reduction is equivalent to about 20 percent, if not up to 125 percent, of total generation from Diablo Canyon.

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11 California Energy Almanac, "Electric Load Serving Entities (LSEs) in California, Last Updated February 2015. Available at http://energyalmanac.ca.gov/electricity/utilities.html#200.

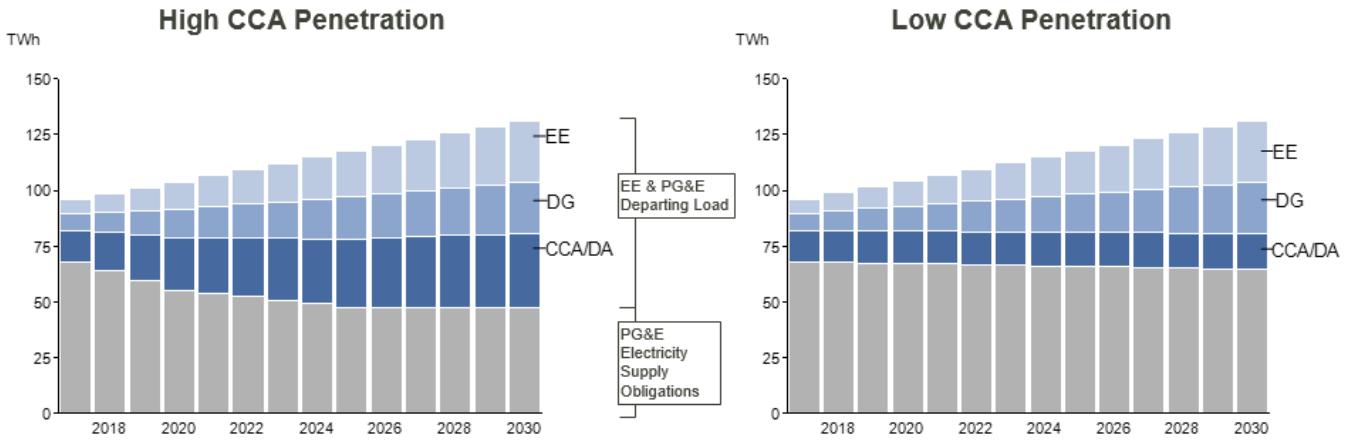
12 Romanow, K. Memo to Transportation and Environment Committee, Attachment A, City of San Jose, CA. January 15, 2016 (Romanow 2016). Available at: http://sanjose.granicus.com/MetaViewer.php?meta_id=554363.

13 Energy Information Administration, "Sales to Ultimate Customers (MWh) by State by Sector by Provider, 1990-2014." Available at https://www.eia.gov/electricity/data/state/sales_annual.xls

14 Romanow 2016.

15 E&E News, "Meet the latest disruption for utilities: community power," June 9, 2016. Available at http://www.eenews.net/energywire/2016/06/09/stories/1060038517.

Figure 3. PG&E electricity supply obligations after accounting for EE, distributed generation, and DA/CCA



Source: MJB&A analysis based on data provided by PG&E

Though projections of electricity needs are always complicated, these trends point to a declining need for Diablo Canyon generation.

2. Decreasing Need for Baseload Generation

As the electric grid in California continues to evolve, so too will the character of resources needed to operate the system reliably. In conjunction with the resources anticipated by Senate Bill 350, which requires PG&E, and other utilities in the state, to supply at least 50 percent of their electricity from qualifying renewable resources by 2030 – the most aggressive renewable standard in the country[16] – there will also need to be other electric resources to synch up with those renewables to assure that the lights stay on even when the wind dies down or when the sun is not shining.

An electric grid with significant generation from non-dispatchable, variable energy resources (wind and solar) will also require a mix of flexible generating facilities and/or storage systems to pair up with them. According to California Independent System Operator (California ISO or CAISO), "[t]o ensure reliability under changing grid conditions, the ISO needs resources with *ramping flexibility and the ability to start and stop multiple times per day*. To ensure supply and demand match at all times, controllable resources will need the flexibility to change output levels and start and stop as dictated by real-time grid conditions."[17]

Recent studies, such as those by the National Renewable Energy Laboratory (NREL), have evaluated the implications of higher solar penetration for grid reliability in California and have emphasized the need for more nimble and complementary resources (e.g., quick-start power plants, demand-control devices, battery storage) that provide the grid operator with a greater degree of control and balance the electric system at all times.[18] In the

16 SB-350 Clean Energy and Pollution Reduction Act of 2015 (Approved by Governor October 7, 2015)

17 CAISO, "Fast Facts: What the Duck Curve Tells Us About Managing a Green Grid," 2016. Available at https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf.

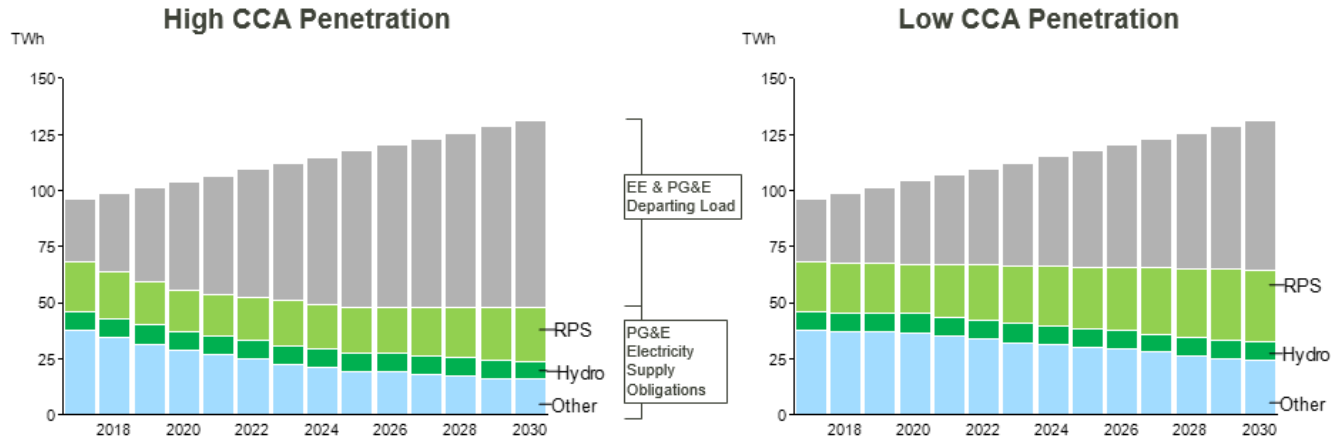
18 Denholm, P., O'Connell, M., Brinkman, G. and Jorgenson, J., National Renewable Energy Laboratory, "Overgeneration from Solar Energy in California: A Field Guide to the Duck Chart," November 2015. Available at http://www.nrel.gov/docs/fy16osti/65023.pdf.

future, there will be less need for very large power stations, like the Diablo Canyon Power Plant, that operate around the clock at a fairly constant rate and have not been designed to ramp their output up and down in short intervals of time (or even over the course of the day). Given California's energy goals that require increasing reliance on renewables, the ISO will need more flexible resources while the need for baseload electricity supply will decrease.

PG&E's own power-resource procurement needs will also evolve in response to the state's policy goals. This will mean that PG&E itself will need fewer conventional baseload power plants to meet the needs of its electricity customers. Over the next 15 years, PG&E is required by SB 350 to increase the amount of renewable energy it procures from the market from 33 to 50 percent. Combined with the outlook for less electricity demand that will result from aggressive installation of energy efficiency measures, lower grid-supplied sales resulting from customers choosing to produce power on their own premises, and continued supply from the company's large fleet of hydroelectric facilities, PG&E has projected that any remaining non-renewable generation needs will decline year over year, reducing the need for market purchases of natural gas-fired generation and for the baseload power from the large Diablo Canyon Power Plant in the post 2025 timeframe.

Simply put, PG&E will continue to deliver power between suppliers and customers, but the character of the power market will change so much that PG&E simply needs less conventional power supply. This outlook is illustrated in the figure below. In Figure 4, the outlook is shown for two potential scenarios: (1) high penetration of CCA/DA and (2) low penetration of CCA/DA. The gray segment at the top of each year's column represents the amount of customer requirements that are either reduced by energy efficiency or provided by customers choosing another source of supply than PG&E (e.g., through self-generation or opting to buy power from another supplier). Figure 5's green-colored segments depict renewable requirements under the RPS and PG&E's hydro resources. In both cases, 50 percent of the company's electricity must come from qualifying renewable energy sources (the light green segment) by 2030, as required by SB 350. The remaining amount ("other," in blue) is the residual resource need to be met with some combination of fossil, nuclear, or additional renewables. This amount declines steadily over time in either scenario, and is reduced to about 16 TWh in 2030 in the High CCA case and 24 TWh in the Low CCA case.

Figure 4. PG&E's projected resource needs: decline in conventional generation



Source: MJB&A analysis based on data provided by PG&E

To put these numbers in perspective, the total output of the Diablo Canyon Power Plant was over 16 TWh in 2015.[19] Thus, its output could exceed the "other" category of resource procurement or be a significant share of that other amount. Notably, Diablo Canyon is a big, two-unit station whose baseload operations make it difficult to ramp up and down within a day or a season, and whose economics make it an unlikely candidate for operating at less than its full output. Its operating profile becomes increasingly incompatible with what California's electric system and PG&E's customers will need in the future. Under either scenario, it will not make sense for Diablo Canyon to supply such a high proportion of the generation that will be needed to balance PG&E's supply and demand profiles. As PG&E increases its reliance on variable renewable resources, it will need increasingly flexible resources to balance its portfolio rather than inflexible, baseload generators such as Diablo Canyon.

3. Challenges with Renewable Overgeneration

Another aspect of this changing electrical system is the potential for California to face the prospect of mounting "overgeneration" conditions, with the need for the system operator to take action to curtail generation (e.g., dispatch generators down, or even disconnect supply from the grid) in order to maintain electric system reliability. As indicated above, many recent studies have evaluated this issue.[20] An electric system's supply and demand must be in balance at all times, and if there's too much supply coming on to the grid relative to customers' demand for power, something has to give. Power plants with operational flexibility can be dispatched or ramped down. Certain generating resources can be turned off (or curtailed). There is less room on the system for large, inflexible baseload resources such as the Diablo Canyon Power Plant, which are operated either all on or all off, as California increases its reliance on renewable resources.

The outlook for overgeneration (and the need to address this condition) results when consumers' electricity demand falls relative to the production output of generating resources, *and* where generation at non-dispatchable renewable facilities and dispatchable conventional power plants cannot be reduced enough due to physically inflexible operations (e.g., at a slow-ramping or baseload generating unit like a nuclear plant) or other "must-run"

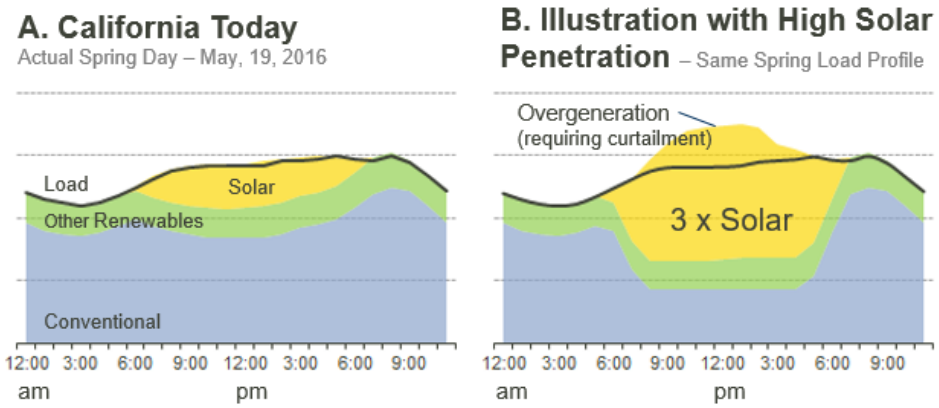
[19] PG&E Corporation. "2015 Joint Annual Report to Shareholders."

[20] See, for example: Denholm, P., O'Connell, M., Brinkman, G. and Jorgenson, J., National Renewable Energy Laboratory, "Overgeneration from Solar Energy in California: A Field Guide to the Duck Chart," November 2015. Available at http://www.nrel.gov/docs/fy16osti/65023.pdf.

concerns (e.g., the need to keep a plant on line for local reliability purpose). Without a reduction in power production to keep the system in balance with demand, the system would overload and potentially cause serious harm to grid reliability. The only solution available to the grid operator at the point of potential overgeneration is to "curtail" output at non-dispatchable wind or solar resources: that is, by temporarily disconnecting or reducing output from solar projects and wind turbines. These resources are the ones curtailed because at that point in system operations, they're the only ones that the operator still can turn up or down fast enough to avoid the overgeneration situation. Such curtailment is thus a technical tool to keep the system in balance and fully operational.

The prospect of overgeneration and curtailment is a particular concern on spring days, when demand for electricity can be relatively modest and when output from solar generation may surge during sunny midday hours. Figure 5 illustrates the load profile in California on a recent spring day (A). This is a plot of actual historic production and load data from CAISO (Renewables Watch website). At current levels of solar power in California, the ratio of solar and conventional resources has generally avoided the need for curtailment, because as solar output increases starting in the morning hours, other resources can be dispatched down sufficiently to avoid overgeneration conditions. The scenario on the right (B) illustrates the profile of a grid with significant, additional solar capacity (it assumes tripling the output reported for May 19, 2016), combined with a significant quantity of inflexible baseload resources. This profile is consistent with projections for the California grid within the next five to ten years if baseload resources are not retired from the system. This combination creates the concern for potential overgeneration conditions and the need for curtailment of solar supply during hours of the spring-time day. Starting at around 9:00 am, the grid operator cannot dispatch down conventional generating resources (the blue bar) enough to avoid pushing total generation over total demand (the black line). To avoid overgeneration at any instant, the grid operator has to act – and curtail whatever resources can be quickly controlled, including wind and solar plants.

Figure 5. Illustration of overgeneration requiring curtailment under a high solar output scenario



Source: Left-hand chart is plot of actual historic production and load data from CAISO (Renewables Watch website). Right-hand chart is an illustrative example assuming 3x increase in May 19, 2016 solar production and minimum baseload. This level of PV is expected in early 2020s.

California will need more flexible supply and load resources to integrate higher levels of solar output and less inflexible baseload generation on the system. The latter raises the specter of unacceptable levels of overgeneration.

Looking ahead, solar generation on PG&E's system and throughout California, is projected to significantly increase due to two trends. First, customers are expected to add increasing amounts of smaller-scale solar systems on their rooftops and land. These will be privately-owned distributed generation solar systems on customers' premises. Additionally, PG&E and other utilities will be procuring increasing amounts of resources from large, "utility-scale" solar projects over time to meet the 50 percent State Renewables Portfolio Standard. This increasing amount of variable solar generation moves California's resource mix in the direction of Scenario B in Figure 5 above.

In fact, under some assumptions about the timing of growth in solar installations, the overgeneration outlook could be even more challenging on the California system. In fact, occasional "overgeneration" events have already occurred. PG&E will need to make substantial changes to its supply-side portfolio to reduce the output from conventional generation that would otherwise result in overgeneration events.

One of these resources is Diablo Canyon, which operates as a "baseload" unit, running around the clock whenever it is operating. Diablo Canyon is not able to vary its output in line with the real-time changes to the generation output on the grid. When more solar generation comes on line over time and when its output is at peak supply (e.g., in the middle of the day) *and* with Diablo Canyon operating at full output, there will be a high likelihood of pushing total generation in excess of demand, leading to the potential curtailment of some of these same solar resources. This would fundamentally make it more difficult to meet California's 50 percent RPS mandate in a cost-effective and efficient manner. Replacing Diablo Canyon with more flexible GHG-free resources and larger scale storage would significantly reduce this effect.

Retirement of Diablo Canyon on the timeframe agreed to in the joint proposal will allow for increased flexibility for the California system, helping to maximize the value of solar and other variable resources that will be a crucial part of meeting PG&E's renewable targets and California's renewable and GHG emissions goals.

4. Ongoing Costs for Diablo Canyon

Diablo Canyon has served as a valuable resource providing reliable electricity for decades. However, future operating costs are uncertain due to a variety of potential regulatory and other factors and could increase as the facility ages. Additionally, due to expected overgeneration throughout parts of the year, Diablo Canyon may contribute to higher system costs as its current generation profile causes challenges for efficiently integrating renewable resources.

Facility Costs

Traditionally, the cost of nuclear generation is largely attributable to initial installation. Once in place, the low fuel costs compared to natural gas and coal facilities offset the more complicated and expensive maintenance and safety operations. However, as facilities age, this maintenance may increase in cost. Additionally, California's environmental protection regulations and other state and federal requirements may increase future costs beyond 2025. These include, for example, any environmental mitigation or compliance measures required by California resource agencies, such as the California Coastal Commission and California State Lands Commission, which must provide discretionary approvals necessary for Diablo Canyon to operate beyond its current Nuclear Regulatory Commission (NRC) operating licenses. Such costs are unclear at this time. Diablo Canyon may also have to undergo costly retrofits to comply with the State Water Control Board's Cooling Water Intake Structures regulation. These are the regulations impacting the amount of water extracted from the Pacific Ocean for cooling

water and other purposes at the facility. Estimates for costs to mitigate impacts associated with this activity have ranged from approximately $1 billion to upwards of $9 billion and could also include operational changes, which would reduce the overall capacity factor of the facility, thereby potentially increasing the production costs of the plant. Finally, the NRC may impose additional regulations or orders in response to federal regulatory or legislative changes either currently under consideration or in the future.

System Costs

In addition, Diablo Canyon will contribute to higher system costs over time due to its non-ramping baseload status. The California power grid is in a period of unprecedented change with growing reliance on renewable resources, which require integrating resources that can ramp up and down quickly in response to changing renewable output on a real-time basis. Relicensing Diablo Canyon at this time would commit PG&E to a large amount of baseload generating capacity that could instead complicate renewable integration and force increased curtailment of renewable resources and additional investment in other resources to manage the operational balance of the overall system. The continued operation of Diablo Canyon past the current license period would likely contribute to the frequency and magnitude of overgeneration events in the future, leading to increased levels of renewables curtailment. This problem contributes to rising system costs in terms of the economic value and environmental value of wasted renewable resources. Therefore, if Diablo Canyon were not relicensed, the cost to integrate renewables could be lower.

Overview of Joint Proposal and Implementation

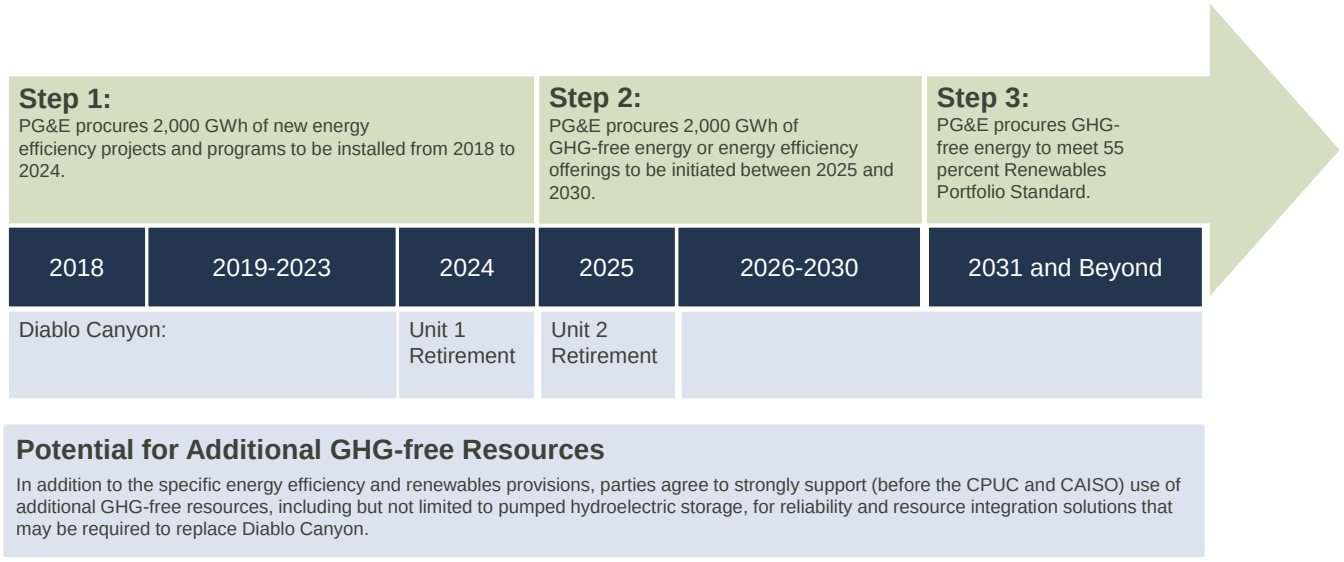
The joint proposal ensures an orderly replacement of Diablo Canyon with energy efficiency and renewable generation. Through the joint proposal, PG&E commits to achieving a 55 percent renewables portfolio through specific procurement provisions while setting a responsible and achievable transition for replacing Diablo Canyon.

Key Components of the Joint Proposal

Under the joint proposal, PG&E will continue to operate Diablo Canyon at current levels through the current license period. In 2024, PG&E will retire Unit 1, and in 2025 will retire Unit 2. To ensure GHG-free replacement of this energy, the settlement lays out procurement requirements starting in 2018 and continuing through 2031. In step 1, PG&E will procure 2,000 GWh of new energy efficiency projects and programs to be installed from 2018 to 2024. In a second step, PG&E would procure another 2,000 GWh of energy efficiency or GHG-free energy to be initiated between 2025 through 2030. As a final step, PG&E commits to procure the necessary levels of additional GHG-free energy required to meet a 55 percent RPS by 2031.

In addition to the specific procurement provisions, parties agree to support (before the CPUC and the CAISO) the use of GHG-free resources, including but not limited to pumped hydroelectric storage, for additional reliability and resource integration solutions which may be required to replace Diablo Canyon.

Figure 6. Joint proposal timeline and key components



Joint Proposal Implementation Considerations

The joint proposal commits PG&E to specific energy efficiency and renewables targets. However, the three steps of resource procurement proposed in the joint proposal are not necessarily intended to capture everything that will be needed to ensure the orderly replacement of Diablo Canyon with GHG-free resources. As discussed earlier, the parties recognize clear trends that are decreasing PG&E's electricity sales due to energy efficiency measures and departing load from privately-owned, distributed generation and CCA programs. However, there remains uncertainty as to the exact level of generation that will be required to serve demand. As such, the joint proposal provides a baseline of renewables and energy efficiency procurement levels, while leaving open flexibility through future procurement proceedings to accommodate market uncertainties.

The full solution for replacing Diablo Canyon and serving customer demand will emerge over the 2024-2045 period, in consultation with many parties and with the oversight of the CPUC, the CAISO, the CEC, the Governor, and the Legislature. The CPUC will play an important role in approving the currently proposed resource procurement and ensuring reasonable cost recovery. Any additional procurement that is needed on a system-wide basis and not specified in the joint proposal would likely be addressed through the CPUC's integrated resource planning process. For example, future studies may show additional resources are needed for the balancing of the electric system and integration of increased levels of renewable resources. As part of this process, the parties have agreed to support the use of GHG-free resource solutions, including additional large pumped storage, to meet future reliability and resource integration needs.

In the next two years, PG&E will prepare a site-specific decommissioning plan for Diablo Canyon. PG&E's plan will complement the joint proposal by following the agreed to schedule and will augment it with additional important detail, such as a schedule for post-shutdown treatment of spent fuel. In this joint proposal, PG&E has committed to pursuing dry cask storage as promptly as is feasible. PG&E will formally withdraw its NRC license renewal application following CPUC approval of the joint proposal.

Joint Proposal Impacts on Emissions, Reliability, Affordability, and the Community

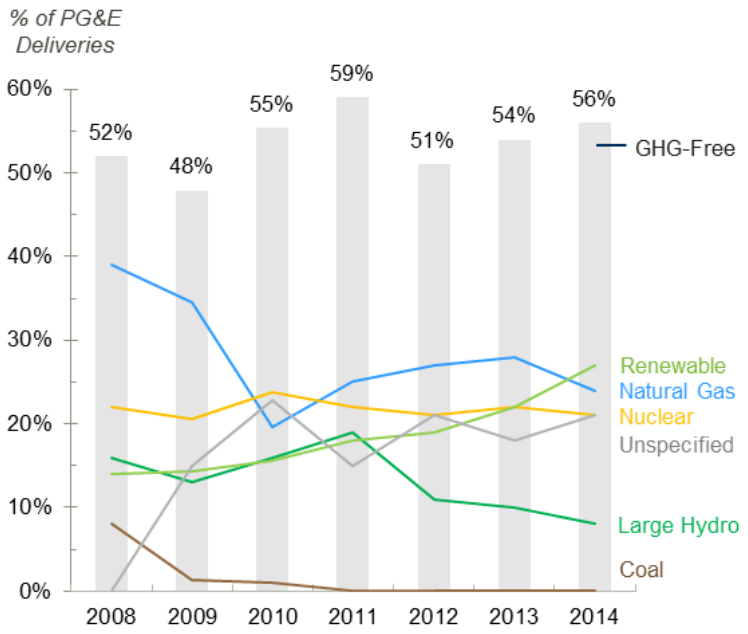
Emissions Impacts of Joint proposal

In total, the joint proposal will contribute to significant and sustained increases in renewables and non-nuclear GHG-free energy in PG&E's portfolio.

PG&E's portfolio has long been one of the lowest emitting in the country. Half or more of its procured electricity is consistently GHG-free, and renewable procurement has more than doubled in the last seven years. According to data gathered by MJB&A that analyzed the 2014 emissions of the top 100 power producers in the country, PG&E's generating fleet had the lowest CO_2 emissions rate of any utility at 116 lb/MWh.[21] In 2014, renewable generation constituted 27 percent of all delivered energy to bundled customers, and 56 percent of all deliveries were GHG-free.

By 2030, PG&E commits to reaching 55 percent renewable deliveries under the joint proposal, representing nearly a doubling of today's renewable procurement and a 10 percent increase over state regulatory requirements. Furthermore, depending on future demand assumptions, including additional energy efficiency procurement and output from PG&E's hydroelectric fleet, PG&E's 2030 bundled portfolio will be anywhere from 72 to 76 percent GHG-free. In all, this will contribute to a significant decrease in GHG emissions associated with PG&E's bundled portfolio, from 35 to 60 percent below 2014 levels.

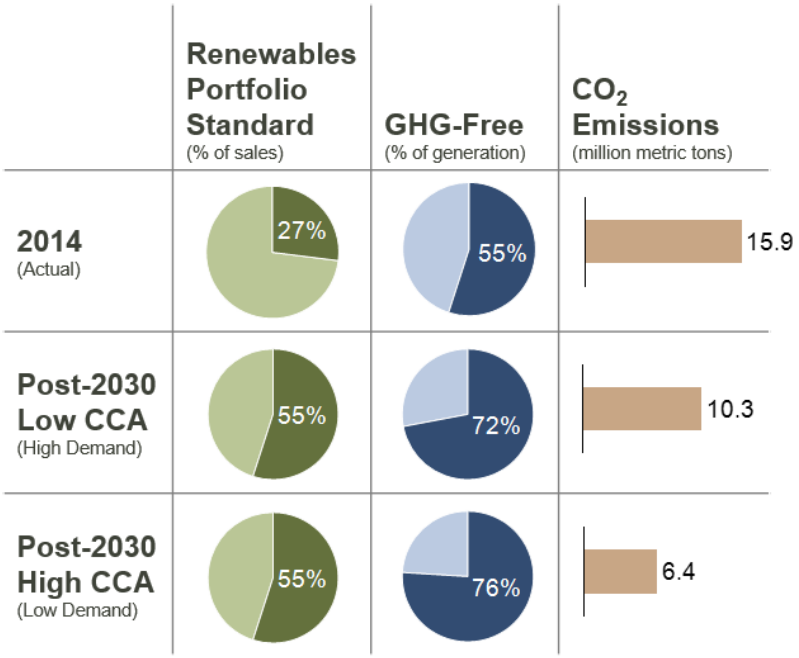
Figure 7. PG&E GHG-free deliveries and deliveries by fuel type



Source: PG&E Power Content Labels

[21] M.J. Bradley & Associates, LLC, "Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States," July 2015. Available at http://www.mjbradley.com/benchmarking-air-emissions.

Figure 8. Projections of renewable and GHG-free energy deliveries and CO_2 emissions under the joint proposal



Source: MJB&A analysis based on data provided by PG&E

Maintaining Reliability

The joint proposal includes a mix of GHG-free resources that facilitate reliability, resource integration, and other long-term cost-effective system benefits. The parties are confident that Diablo Canyon can be retired while continuing to maintain a cost-effective PG&E electric system.

It is of utmost importance that PG&E delivers power safely and reliably to all customers. For decades, Diablo Canyon has contributed to this effort. However, as the facility has approached the end of its current license, numerous agencies have begun to assess what the grid would look like without the contributions of Diablo Canyon. These studies all show that Diablo Canyon could be removed from the California electric system without harming reliability.

The 2011 Integrated Energy Policy Report, released by the CEC in consultation with the CPUC, recommended that the CAISO, "to support long-term energy and contingency planning,…should report to the Energy Commission…on what new generation and/or transmission facilities would be needed to maintain system and/or local reliability in the event of a long-term outage at Diablo Canyon." Accordingly, CAISO conducted two studies as part of their 2012-2013 transmission planning cycle, one addressing the immediate (2017-2018) impacts of removing Diablo Canyon from the system for an "extended outage" and the other assessing the long-term (through 2022) impacts. These studies focused on grid reliability implications for northern California and ISO overall, and were not intended as a basis for a decision to keep or retire the generator.

The CAISO determined that "there was no material mid- or long-term transmission system impacts associated with the absence of Diablo Canyon."[22] Minor thermal overloads were noted to regional transformers and transmission lines, which the ISO recommended could be addressed through upgrades to stretches of lines and the imposition of Special Protection Systems. The study also did not identify any voltage, reactive power, or transient stability issues (with the exception of possible reactive power shortages under extreme and highly unlikely contingency situations).

Indeed, the electric grid is maintained in a manner that ensures that even the loss (temporary or permanent) of a large generator can be absorbed by the system in order to keep electricity flowing even in the case of unanticipated outages. Large power plants like Diablo Canyon are planned for specifically, since at some moments they can provide large portions of the grid's available power. PG&E has noted that, in ensuring that it maintains a reliable system with Diablo Canyon, the utility's transmission system has been maintained and designed in order to withstand the loss of both Diablo Canyon units.[23]

To further prioritize reliability, the joint proposal provides for a deliberate and orderly transition away from Diablo Canyon by beginning planning eight to nine years before the first unit retires. This lead time allows for the orderly and reliable replacement of Diablo Canyon. PG&E will work with regulators and stakeholders to meet the terms of the joint proposal for procuring additional renewable energy and energy efficiency, as well as any other necessary resources and system upgrades, to maintain a reliable electric grid.

Continuing Competitive Procurement and Generation

PG&E will procure GHG-free replacement resources through CPUC-approved competitive bidding processes, which will ensure that the lowest-cost clean resources are used to replace Diablo Canyon, and that the relevant stakeholders are involved in monitoring and assisting the procurement process.

A number of studies help to demonstrate how Diablo Canyon generation could be cost-effectively replaced by GHG-free resources. NREL noted that California's "climate and clean energy goals are technically feasible without significant rate impacts" even without including Diablo Canyon.[24] Additionally, this study emphasizes that although Diablo Canyon does provide GHG-free generation, "the retirement does allow greater flexibility in integrating renewables since the plant provides inflexible baseload energy," which in turn leads to more flexible and cost-effective PG&E procurement.

Similarly, Energy + Environmental Economics showed in their PATHWAYS project that long-term GHG reduction scenarios are possible, even when assuming Diablo Canyon is not part of the electricity mix. Further, this study found that successfully reducing California's greenhouse gas emissions would require significant progress on: (1) increasing the achievement of energy efficiency in buildings and transportation; (2) switching to lower carbon fuel sources in buildings and transportation; (3) producing lower carbon electricity; (4) producing

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22 California Independent System Operator, "Board-Approved 2012-2013 Transmission Plan," March 20, 2013 at p. 162. Available at http://www.caiso.com/Documents/BoardApproved2012-2013TransmissionPlan.pdf

23 PG&E, "Comments of Pacific Gas and Electric Company on the Draft CAISO 2012-2013 Transmission Plan and February 11, 2013 Stakeholder Meeting," February 25 2013 at p. 1. Available at http://www.caiso.com/Documents/PGECommentsDraft2012-2013TransmissionPlan.pdf.

24 NREL's Center for Energy Efficiency and Renewable Technologies, "The Low Carbon Grid Study, Phase II Results," February 2016. Available at http://www.nrel.gov/docs/fy16osti/64884.pdf.

lower carbon liquid or gaseous fuels; and (5) reducing non-energy greenhouse gases. The joint proposal makes significant progress toward each of these electricity-related objectives.[25]

[25] Energy + Environmental Economics, "Summary of the California State Agencies' PATHWAYS Project: Long-term Greenhouse Gas Reduction Scenarios," January 2015. Available at https://ethree.com/documents/E3_Project%20Overview_20150126v2.pdf.

Commitment to PG&E Employees and Community

Key provisions of the agreement reflect the fact that PG&E depends upon and has been committed to its employees and the communities in which the utility operates and serves customers, and the utility and state have benefited from a well-trained, highly skilled and dedicated workforce at Diablo Canyon for its 31 years of operations. Diablo Canyon has provided electricity over 90 percent of the time, only stopping output for planned refueling and maintenance. PG&E employs more than 1,500 workers at the facility, plus additional temporary workers during high activity times such as refueling.

PG&E has committed to continuing the safe and secure operation of Diablo Canyon through its current license period and to provide generous resources and assistance to transitioning workers. Under the joint proposal, it will be critical to retain existing employees, who are highly qualified and will drive continued safe and reliable operations. PG&E will provide a generous retention program and severance payments upon completion of employment. Additionally, PG&E will help employees transition to new positions through a retraining and development program to facilitate redeployment of a portion of plant personnel to the decommissioning project. PG&E has agreed to provide a detailed description and cost estimate of PG&E's retention program for Commission approval in the joint proposal application. The parties support redeployment and training of a portion of current Diablo Canyon employees for the decommissioning project.

The joint proposal also recognizes the place that Diablo Canyon has had in the local economy for the past three decades. The Diablo Canyon Power Plant is one of the largest employers, taxpayers, and charitable contributors in the San Luis Obispo County area. It currently contributes approximately $22 million in annual property taxes to the local community. In order to continue to support this local community even as the facility begins to retire, PG&E proposes to continue to provide funding to San Luis Obispo at current property tax levels through 2025 (as opposed to a typical payment schedule, which would scale them back every year in line with the depreciation schedule of the facility). The payment in lieu of taxes would be recovered through nuclear decommissioning funding. PG&E estimates that the total cost of the Community Impacts Mitigation Program is approximately $50 million.

Conclusion

The joint proposal provides for the orderly replacement of Diablo Canyon Power Plant with GHG-free resources. The proposal builds on the realities of a changing electricity landscape in the state, one that includes increasing levels of self-generation, community choice aggregation, and renewable energy resources, all of which decrease PG&E's need for other sources of generation. These forces reduce the need for Diablo Canyon's output beyond the current license period.

California's path toward achieving aggressive and critical environmental targets is recognized and reflected in the proposal, which builds upon these targets and offers additional commitments for energy efficiency and renewables that go beyond existing requirements. The joint proposal turns toward the procurement of cost-effective GHG-free resources and flexible integrating resources that will be a crucial part of meeting California's renewable and GHG emissions goals. The joint proposal will help California set the stage for even deeper GHG reductions that will be required to meet long-term emissions targets. The proposal also ensures that this transition is conducted while maintaining system reliability and supporting PG&E employees and the local community.

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