DOCKETED	
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Project Title:	SB 100 Joint Agency Report: Charting a path to a 100% Clean Energy Future
TN #:	229640
Document Title:	Calif. for Green Nuclear Power, Inc. Comment Appendix In Response to ALJ Fitch's Proposed Decision Filed With The CPUC 2-11-16
Description:	CPUC Intervenor Californians for Green Nuclear Power, Inc. (CGNP) submits this CPUC filing in R.16-02-007 as one of eight exhibits supporting the continued safe operation of Diablo Canyon Power Plant (DCPP) beyond 2025 as an essential component of California's Path to a 100% Clean Energy Future. Diablo Canyon's pair of safe, reliable, cost-effective, and zero-emissions power reactors are California's largest generation plant by far, producing about 9% of California's in-state generation - the equivalent of more than 5 (five) Hoover Dams annually. In 2010, the California Energy Commission (CEC) commissioned the California Science and Technology Commission (CSTC) to prepare a pair of reports regarding the path to a 100% Clean Energy Future. The CSTC's report conclusions were clear. The safe and cost-effective solution was a dramatic expansion beyond the four commercial nuclear power reactors then in operation. The eminent CSTC scientists and engineers concluded California would require about 30 such reactors
Filer:	Gene Nelson, Ph.D.
Organization:	Californians for Green Nuclear Power, Inc.
Submitter Role:	Intervenor
Submission Date:	9/3/2019 10:24:02 PM
Docketed Date:	9/3/2019

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements	**R.16-02-007** (Filed 02/11/2016*)*

CALIFORNIANS FOR GREEN NUCLEAR POWER, INC. COMMENTS APPENDIX IN RESPONSE TO ALJ FITCH'S PROPOSED DECISION DATED MARCH 18, 2019 RE ADOPTING PREFERRED SYSTEM PORTFOLIO FOR 2017-2018 INTEGRATED RESOURCE PLAN

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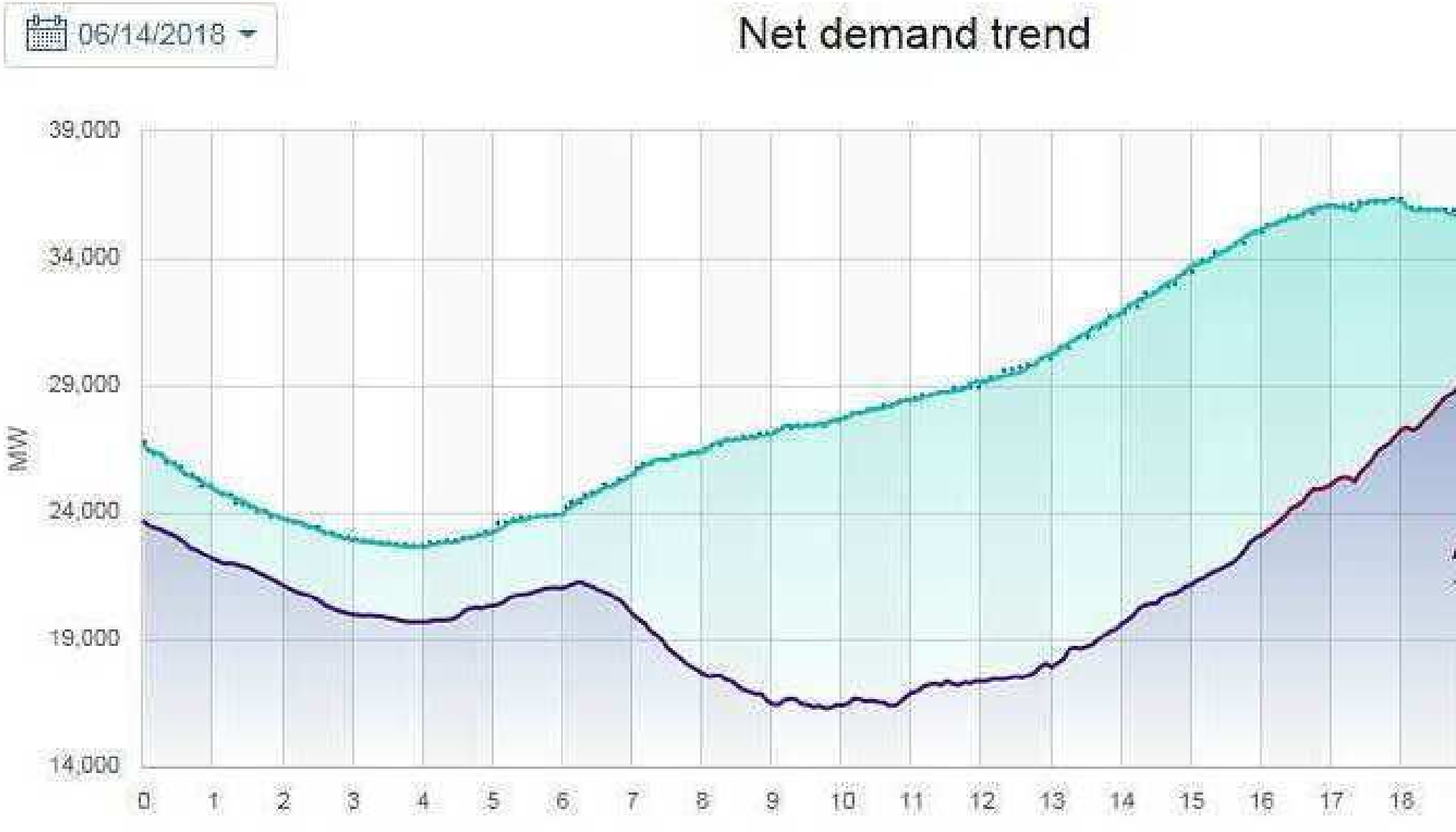
March 31, 2019

06/14/2018


Net demand trend
39,000
34,000
29,000
24,000
19,000
14,000
MW
0
1
2
3
4
5
6
7
8
9
10
11
12
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17
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Exhibit B

California's Energy Future - Powering California with Nuclear Energy

California Council on Science and Technology
Burton Richter, Robert Budnitz, Jane Long, Per Peterson, and Jan Schori
July 2011

California's Energy Future - Powering California with Nuclear Energy

California Council on Science and Technology
Burton Richter, Robert Budnitz,
Jane Long, Per Peterson, and Jan Schori
July, 2011

LEGAL NOTICE

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We would also like to thank the Stephen Bechtel Fund and the California Energy Commision for their contributions to the underwriting of this project. We would also like to thank the California Air Resources Board for their continued support and Lawrence Livermore National Laboratory for underwriting the leadership of this effort.

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Letter from CCST

CCST is pleased to present the results of an analysis of the future of nuclear power in California. This study is part of the California's Energy Future (CEF) project, which was undertaken to help inform California state and local governments of the scale and timing of decisions that must be made in order to achieve the state's goals of significantly reducing total greenhouse gas emissions over the next four decades.

California's Global Warming Solutions Act of 2006 (AB32) and Executive Order S-3-05 set strict standards for the state to meet. In order to comply, California needs to reduce its greenhouse gas emissions to 80% below 1990 levels by 2050 while accommodating projected growth in its economy and population. This will likely require a doubling of electricity production with nearly zero emissions. Nuclear power could be an important component in strategies for meeting these standards. This report is a summary of the realistic potential of nuclear power for California and presents an analysis of technological readiness, safety, fuel supply, costs, and siting.

As this report was nearing completion, the nuclear power accidents that resulted from an earthquake and tsunami in Fukushima, Japan were unfolding. Consequently, this report also includes some preliminary observations about Fukushima relevant to California. As the Fukushima events unfold and we learn more about exactly what happened and why, it will be worth revisiting the meaning of Fukushima for California in more depth.

We believe that the CEF nuclear power report presents valuable insights into the possibilities and realities of meeting California's electricity needs and emissions standards over the decades to come, and hope that you will find it useful.

Jane C.S. Long
California's Energy Future
Committee, Co-chair

Miriam John
California's Energy Future
Committee, Co-chair

Burton Richter
California's Energy Future
Committee

I. Introduction and Conclusions

This report is aimed at examining the potential of nuclear energy to meet California's electricity demand in the year 2050. The main focus of our analysis is on the CCST Realistic Model (described in detail elsewhere) which assumes that total electricity demand in California in the year 2050 amounts to 510 terawatt-hours per year (TWh/y). Since nuclear electricity is capital intensive, it is most economically used as baseload power where the plants run at their maximum output all of the time and that is what we assume here. We also assume that nuclear plants have a 90% capacity factor and that baseload power represents 67% of total electricity demand (adjusting the baseload fraction up or down does not affect the conclusions reached herein), the rest being supplied by renewables as mandated by California's law AB32. This requires about 44 gigawatts (GW) of nuclear electricity capacity. This scenario and one scenario where nuclear electricity is deployed on a much larger scale (call the Stress Test) are described in section III. We also assume that a large scale growth in nuclear energy in California will be part of a large scale growth worldwide which affects infrastructure and work force requirements as discussed below. Consequently, our analysis assumes that California only gets its fair share of resources needed to scale up, but an expanding nuclear industry results in economies-of-scale which makes nuclear power less expensive for California.[1]

Some of the scenarios used in the full report include use of hydrogen as a fuel. Hydrogen can be produced using nuclear reactors though doing so efficiently requires a new generation of nuclear plants.[2] Requirements for hydrogen production are also briefly discussed in Section III.

While reactor technology is certain to evolve over the period of interest, we are assuming for this study that for electricity production these future reactors will have characteristics similar to the new generation of large, advanced, light-water reactors (LWR), known as GEN III+ that are now under review by the U.S. Nuclear Regulatory Commission for deployment in the next decade. This allows us to say something about costs since these are under construction in Asia and Europe, and a larger number of similar systems have been built in Asia recently. We comment later on the potential of new and improved designs. Our main conclusions on technical issues are as follows:

- There are no technical barriers to large-scale deployment of nuclear power in California. There are, however, legislative barriers and public acceptance barriers that have to be overcome to implement a scenario that includes a large number of new nuclear reactors.
- The cost of electricity from new nuclear power plants is uncertain. No new ones have been built in decades, though 104 generating plants are operating in the U.S. today. Thus, operations, maintenance and fuel costs are known well, but the dominant cost, the amortization of construction costs, is uncertain. Estimates of electricity costs from new plants range from 6 to 8¢ per kilowatt hour (KW-hr) up to 18¢ per KW-hr with most estimates at the lower end of the range. Our conclusion is that 6 to 8¢ per KW-hr is the best estimate today. This is discussed in more detail in section II.

1 The scale-up of nuclear power in California could occur whether or not the world develops an expanded role for nuclear power. Although there are no non-proliferation issues with expanding nuclear power in California, we note that nuclear nonproliferation will be an issue for global scale up and if nuclear power is to fulfill its potential as a global carbon-free energy resource, expansion must be accompanied by dramatic increases in cooperation among national governments to strengthen the Nuclear Nonproliferation Treaty, the IAEA system of safeguards against diversion of civilian nuclear programs to any military purpose, and the physical security of nuclear fuel cycle facilities against attack by terrorist groups and theft of weapon-grade materials by terrorist or other criminal groups.

2 The favored method of hydrogen production requires reactors that operate at much higher temperatures than occur in the present generation of power reactors in order to achieve reasonably high efficiency. These high temperatures raise new materials problems and a major R&D effort will be required to solve them. R&D has begun, but it is not possible as yet to say how long it will take to solve the problems.

- Loan guarantees for nuclear power will be required until the financial sector is convinced that the days of large delays and construction cost overruns are over. Continuation of the Price-Anderson act is assumed.
- Nuclear electricity costs will be much lower than solar for some time. There is insufficient information on wind costs yet to allow a comparison, particularly when costs to back up wind power are included.
- Cooling water availability in California is not a problem. Reactors can be cooled with reclaimed water or with forced air, though air cooling is less efficient and would increase nuclear electricity prices by 5% to 10%.
- There should be no problem with uranium availability for the foreseeable future and even large increases in uranium costs have only a small effect on nuclear power costs. There may be shortages of natural uranium in the long term, but there are ways to get around them.
- While there are manufacturing bottlenecks now, these should disappear over the next 10 to 15 years if nuclear power facilities world-wide grow as expected.
- There are benefits to the localities where nuclear plants are sited. Tax rates in California are set by the State Board of Equalization, typically at 1% of the cost of the plant, and collected locally. By current estimates this would amount to $50 million per year per gigawatt of electrical capacity (GWe). In addition, about 500 permanent jobs are created per GWe.
- The events at Fukushima, Japan where a number of boiling water reactors (BWR) were damaged in a major earthquake and tsunami will trigger review and evalution of safety in design, operation and mangement. The information gained during the Fukushima review and any recommendations made should be factored into decisions about the potential future use of nuclear reactor technologies in California.

Section II of this report looks at costs; section III focuses on the realistic and extreme scenarios; section IV examines fuel availability; section V looks at site issues; section VI discusses the spent fuel problem; and section VII briefly touches on weapons proliferation. Section VIII is a story line; what has to be done on the State, Federal, and industrial levels to make this kind of nuclear expansion possible. Section IX gives some preliminary comments on the nuclear accidents at Fukushima nuclear power plants in Japan which were triggered by a massive earthquake and tsunami. Appendices 1-3 go further into fuel availability, waste disposal, and future options (including fusion).

Exhibit C

11 Jan 2018 – NECG Commentary #[19]
https://nuclear-economics.com/wp-content/uploads/2018/01/2018-01-11-DCPP-1.pdf
Published (and Archived by Gene A. Nelson, Ph.D.) 01 11 18.

https://tinyurl.com/Wind-And-Solar-Scam

Diablo Canyon retirement

This is a guest post by Gene A. Nelson, Ph.D., Central Coast Government Liaison with Californians for Green Nuclear Power, Inc. (CGNP.) CGNP is a strong advocate for the continued operation of PG&E's Diablo Canyon Power Plant (DCPP).

DCPP owner PG&E has requested permission from the California Public Utilities Commission (CPUC) to close DCPP in 2024/2025 at the end of the initial 40-year NRC operating license for each unit.

A CPUC decision on this is expected today

Background

On 8 Nov 2017, an Administrative Law Judge (Peter V. Allen) with the California Public Utilities Commission (CPUC) issued a "Proposed Decision" related to Application 16-08-006.[1]

This proposed decision includes the following items (and more):

1. Pacific Gas and Electric Company's proposal to retire Diablo Canyon Unit 1 by 2024 and Unit 2 by 2025 is approved.

2. Pacific Gas and Electric Company's "Tranche 1" proposal to procure 2,000 gigawatt hours of energy efficiency is not approved.

3. Pacific Gas and Electric Company's withdrawn "Tranche 2" and "Tranche 3" replacement procurement proposals are not approved.

4. Replacement procurement will be addressed in the Integrated Resource Planning proceeding or a proceeding designated by the Integrated Resource Planning proceeding.

5. Efforts to avoid an increase in greenhouse gas emissions relating to the retirement of Diablo Canyon, including any replacement procurement, will be addressed in the Integrated Resource Planning proceeding or a proceeding designated by the Integrated Resource Planning proceeding.

6. Pacific Gas and Electric Company should be prepared to present scenarios for Diablo Canyon retirement in the Integrated Resource Planning proceeding that demonstrate no more than a de minimis increase in the GHG emissions of its electric portfolio.

The proposed Decision approves early retirement of Diablo Canyon in 2024/2025, before the implications of this early retirement[2] for the California long-term integrated resource plan or on California greenhouse gas emissions were determined.

Final Oral arguments were held on 28 Nov 2017 at the CPUC headquarters, with comments due on 29 Nov 2017 and reply comments due on 4 Dec 2017.

A 14 December 2017 vote on the Proposed Decision at the CPUC Public Meeting at CPUC headquarters in San Francisco was postponed to 11 January 2018 at the last-minute at the request of at least one of the Commissioners.

There have been some changes to reduce short-term ratepayer obligations. Those changes include that the annual payouts of the "Employee Retention Program" have been reduced from

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1 Application 16-08-006 - 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).

2 While the closure in 2024/2025 is consistent with the original NRC operating license, virtually all U.S. nuclear power plants applied for a 20-year license renewal and these applications were approved.

25% of their salary to 15%. The $85 million "Community Impacts Mitigation Program will not be funded by ratepayers.

CGNP

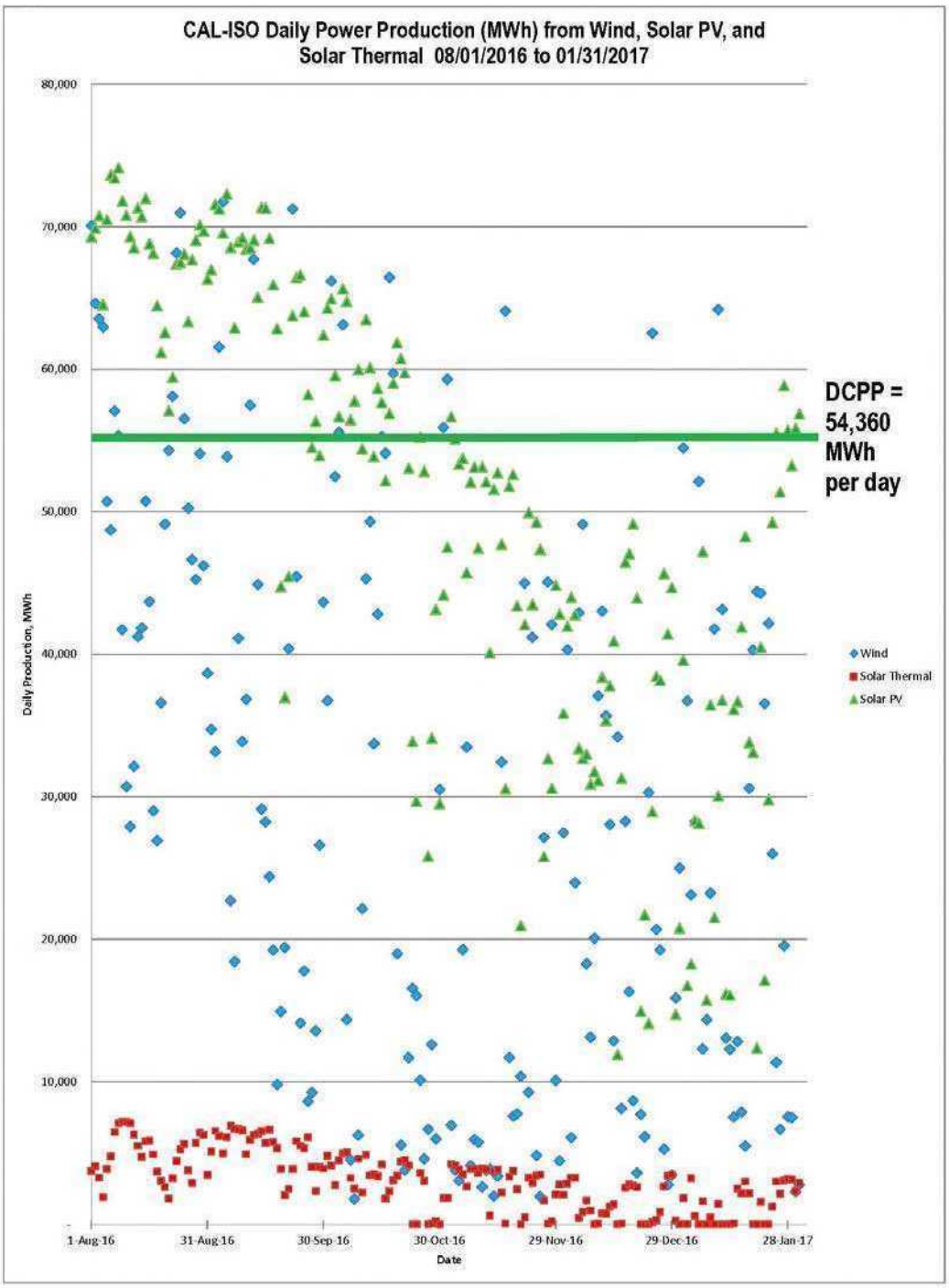
Californians for Green Nuclear Power, Inc. (CGNP) is a nonprofit California educational corporation established in 2013. Gene Nelson, Ph.D. serves as their government liaison in a volunteer capacity. His Ph.D. is in a field relevant to commercial nuclear power generation, as are the Ph.D.s of CGNP's three other volunteer technical authors. CGNP is also being advised by some extremely well-qualified environmental attorneys.

CGNP is **the** advocate for keeping DCPP operating beyond 2025.

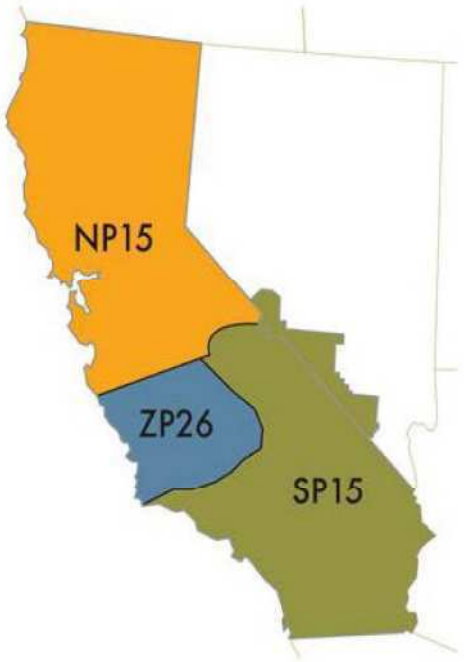
CGNP is the lone adversarial Intervenor (of about 50) in the above Application A.16-08-006. CGNP has researched and authored voluminous, carefully written testimony and vigorously participated during all the oral phases of A16-08-006. CGNP's advocacy on the behalf of the environment and the California ratepayer has already yielded significant beneficial changes in the contours of the Proposed Decision. CGNP has also participated as a nuclear power advocate in some recent FERC Proceedings related to commercial nuclear power.

Core issues

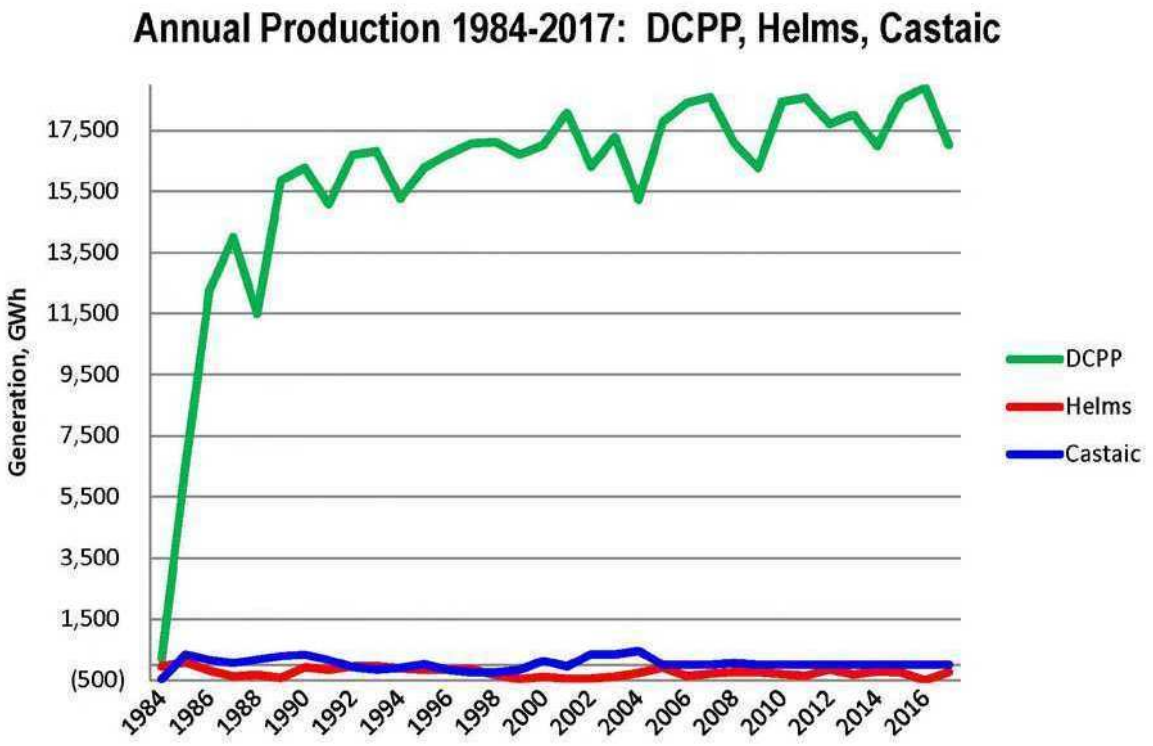
California state policy-makers appear to fail to understand the implications of the 20% statewide capacity factor observed for both California wind and California solar that CGNP obtained by tabulating day-by-day generation by source from the official records of the California Independent System Operator (CAISO) during the half-year period that ended on January 31, 2017. These policy-makers also appear to fail to understand that in comparison, zero-carbon DCPP generated about **108**% of ALL of California's 10,000 MW (nameplate) of solar Photovoltaic power **or** about **180**% of ALL of California's 6,000 MW(nameplate) of wind generation during that half-year interval. Thus, shutting down DCPP will cause significant California environmental harms. Here is a scatter-plot from one of CGNP's CPUC A.16-08-006 filings that shows the random day-to-day daily generation of California solar PV, California wind, California solar thermal (Ivanpah – which also burns about a billion cubic feet of natural gas annually) and DCPP. Clearly, significant (and costly) grid interventions are required to deal with the random variations of solar and wind relative to DCPP's steady – and necessary - power output. (See scatter-plot on the next page.)


CAL-ISO Daily Power Production (MWh) from Wind, Solar PV, and Solar Thermal 08/01/2016 to 01/31/2017
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Daily Production, MWh
1-Aug-16
31-Aug-16
30-Sep-16
30-Oct-16
29-Nov-16
29-Dec-16
28-Jan-17
Date
DCPP = 54,360 MWh per day
Wind
Solar Thermal
Solar PV

CGNP also learned that grid-scale energy storage is not used in California, perhaps as a consequence of California electricity market design. The two utility-scale California pumped storage facilities (Helms Pumped Storage [Helms] and Castaic pumped storage) show modest annual production, per the U.S. EIA, perhaps because they receive more market compensation for providing voltage and frequency support (which DCPP is apparently excluded from receiving, despite providing considerable voltage and frequency stability to CAISO Sub LAP ZP26 shown on the California map to the left. DCPP's location is near the southwest corner of ZP26.) Helms is located in the Sierra foothills, about 50 miles east of Fresno CA in NP15 (North of Path 15.) CAISO recently began tabulating California battery-based storage daily performance on their website. However, current battery-based energy storage systems are too small by three or four orders of magnitude relative to California's huge energy demands as the world's sixth largest economy, with a growing population nearing 40 million.



While Helms has a nameplate capacity of 1,212 MW (more than half of DCPP's nameplate capacity of 2,240 MW) the graph "Annual Production 1984-2017: DCPP, Helms, Castaic" shows the minuscule annual power production of Helms relative to the nominal 18,000 GWh of DCPP. Intervenor CGNP made a formal data query in A.16-08-006 to Helms owner PG&E regarding the reasons for the modest use of Helms during the course of the above CPUC proceeding. CGNP's data query was rebuffed by PG&E.



Both national and state energy policies have provided incentives for the substitution of huge quantities of **low-quality** non-dispatchable solar and wind generation backed up with thermal generation which adds millions of tons of emissions annually to the environment - initially for the 18 million high-quality emission-free and dispatchable megawatt-hours that San Onofre Nuclear Generating Station (SONGS) was generating annually until January, 2012.

Now, the post-2025 plan is to do the same for DCPP's dispatchable 18 million megawatt-hours of annual production. Recently, DCPP had an annual capacity factor in excess of 100%. DCPP provides safe, reliable, durable, cost-effective and emission-free generation. NECG provided inputs for the 2016 Idaho National Laboratory's nuclear power cost study showing that DCPP's generation cost was about $27.10/MWh, about a tenth of the long-term supply contract that the operators of Ivanpah solar thermal plant have with PG&E for $200.00/MWh.

"Back-Down Mode"

As a consequence of the performance documented above, California Solar and wind are backed with thermal generation to provide power for the approximately 80% of the time that they are not generating power. Much of this thermal generation is operated in "back down mode" (or hot-ready mode) so that the thermal generation is ready to generate power at a moment's notice, since both wind and solar are subject to rapid-onset diminution of output power on a random basis. The result is that despite the large installed capacity of solar and wind in California, there is **almost no emissions reductions** relative to 16,000 MW of pure natural-gas-fired generation. Emissions reductions relative to thermal generation are the highly-promoted rationale for employing solar and wind generation.

Perhaps solar and wind generation are valued by operators of thermal generators because of the public believes that there are benefits of capital-intensive solar and wind (that are not supported by the actual performance data shown above.)

Conclusion – Next Steps

In this brief article, summary information regarding the environmental benefits - and ratepayer benefits - of the continued safe operation of DCPP as an example nuclear power plant have been provided. For those readers that wish additional technical details, please contact Gene Nelson at the email address below to obtain links to a number of CGNP's filings in A.16-08-006.

The nuclear power plants in other parts of the country is likely to be experiencing similar pressures. CGNP believes that there are benefits from disseminating information regarding successful citizen advocacy campaigns, such as the initiatives to continue the safe operation of Energy Northwest's Columbia Generating Station. This information exchange would be analogous to how nuclear plant operators exchange information regarding "best operational practices." CGNP gratefully receives such information. CGNP would like to become an information clearinghouse regarding nuclear power advocacy.

In the event that the CPUC chooses to approve A.16-08-006 (i.e., approve retirement of Diablo Canyon in 2024/2025), CGNP intends to challenge that decision on a number of grounds that have already been documented in earlier filings. CGNP will keep NECG readers informed regarding our progress. Any assistance in challenging the CPUC decision will also be gratefully received by CGNP.

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Exhibit D

The Washington Post

Turns out wind and solar have a secret friend: Natural gas

By Chris Mooney

Chris Mooney
Reporter covering climate change, energy and the environment.
Email Christopher.Mooney@Washpost.com

August 11, 2016

https://www.washingtonpost.com/news/energy-environment/wp/2016/08/11/turns-out-wind-and-solar-have-a-secret-friend-natural-gas/
http://tinyurl.com/Natural-Gas-Secret

In this Feb. 25, 2015 photo, a gas flare is seen at a natural gas processing facility near Williston, N.D. (AP Photo/Matthew Brown)

We're at a time of deeply ambitious plans for clean energy growth. Two of the U.S.'s largest states by population, California and New York, have both mandated that power companies get fully 50 percent of their electricity from renewable sources by the year 2030.

Only, there's a problem: Because of the particular nature of clean energy sources like solar and wind, you can't simply add them to the grid in large volumes and think that's the end of the story. Rather, because these sources of electricity generation are "intermittent" — solar fluctuates with weather and the daily cycle, wind fluctuates with the wind — there has to be some means of continuing to provide electricity even when they go dark. And the more renewables you have, the bigger this problem can be.

Now, a new study suggests that at least so far, solving that problem has ironically involved more fossil fuels — and more particularly, installing a large number of fast-ramping natural gas plants, which can fill in quickly whenever renewable generation slips.

The new research, published recently as a working paper by the National Bureau of Economic Research, was conducted by Elena Verdolini of the Euro-Mediterranean Center on Climate Change and the Fondazione Eni Enrico Mattei in Milan, Italy, along with colleagues from Syracuse University and the French Economic Observatory.

In the study, the researchers took a broad look at the erection of wind, solar, and other renewable energy plants (not including large hydropower or biomass projects) across 26 countries that are members of an international council known as the Organisation for Economic Co-operation and Development over the period between the

year 1990 and 2013. **And they found a surprisingly tight relationship between renewables on the one hand, and gas on the other.**

"All other things equal, a 1% percent increase in the share of fast reacting fossil technologies is associated with a 0.88% percent increase in renewable generation capacity in the long term," the study reports. Again, this is over 26 separate countries, and more than two decades.

"Our paper calls attention to the fact that renewables and fast-reacting fossil technologies appear as highly complementary and that they should be jointly installed to meet the goals of cutting emissions and ensuring a stable supply," the paper adds.

The type of "fast-reacting fossil technologies" being referred to here is natural gas plants that fire up quickly. For example, General Electric and EDF Energy currently feature a natural gas plant in France that "is capable of reaching full power in less than 30 minutes." Full power, in this case, means rapidly adding over 600 megawatts, or million watts, of electricity to the grid.

"This allows partners to respond quickly to grid demand fluctuations, integrating renewables as necessary," note the companies.

"When people assume that we can switch from fossil fuels to renewables they assume we can completely switch out of one path, to another path," says Verdolini. But, she adds, the study suggests otherwise.

Verdolini emphasized this merely describes the past — not necessarily the future. That's a critical distinction, because the study also notes that if we reach a time when fast-responding energy storage is prevalent — when, say**, large-scale grid batteries store solar or wind-generated energy and can discharge it instantaneously when there's a need** — then the reliance on gas may no longer be so prevalent.

Other recent research has suggested that precisely because of this overlap between fast-firing natural gas plants and grid scale batteries — because they can play many of the same roles — extremely cheap natural gas prices have helped the industry out-compete the storage sector and slowed its growth.

Two other researchers contacted for reactions to Verdolini's study largely agreed with its findings.

"I think policymakers haven't really grasped what 50 percent renewables really means in a system, without at least cheap batteries available," says Christopher Knittel, who directs the Center for Energy and Environmental Policy Research at MIT, and who said he found the study's results quite plausible.

"It's certainly true that as one adds more renewables, the value of flexible generation increases, and so I would expect to see some correlation as they found," added Eric Hittinger, an energy system researcher at the Rochester Institute of Technology who like Knittel was not involved in the study.

Hittinger and Knittel agreed that adding flexible natural gas alongside renewable projects is not a major climate change concern because the gas plants wouldn't be running all the time — so it's not like

adding coal plants. The emissions would be real, but considerably more limited. However, they said, the principal issue is that the research suggests renewable plants are more costly to build, because of the added backup requirement.

“It’s a reality check now,” said Knittel of the study. “I think it’s potentially bad news as we start to get higher and higher penetration levels of renewables.”

The study also lends some credence to the widespread description of natural gas as a so-called “bridge fuel” that allows for a transition into a world of more renewables, as it is both flexible and also contributes less carbon dioxide emissions than does coal, per unit of energy generated by burning the fuel. (Environmentalists like to point out that if there are enough methane leaks from the process of drilling for and transporting natural gas, this edge could be canceled out.)

Hittinger also questioned what the correlation found in the study actually means — does it mean that natural gas *spurs on* the development of more solar and wind, or vice versa?

Verdolini said the study implies that the causation occurs with gas plants being added first, which then makes renewable projects more easy to integrate. “It’s an enabling factor,” she said, although she cautioned that the study cannot fully demonstrate causation.

Verdolini agreed that the findings are something that decision-makers hoping to add more clean energy to the grid will have to take into account.

“If you have an electric car, you don’t need a diesel car in your garage sitting there,” said Verdolini. “But in the case of renewables, it’s different, because if you have renewable electricity and that fails, then you need the fast acting gas sitting in your garage, so to speak.”

Exhibit E

MIT Technology Review

The $2.5 trillion reason we can't rely on batteries to clean up the grid

Fluctuating solar and wind power require lots of energy storage, and lithium-ion batteries seem like the obvious choice—but they are far too expensive to play a major role.

by James Temple
July 27, 2018
https://www.technologyreview.com/s/611683/the-25-trillion-reason-we-cant-rely-on-batteries-to-clean-up-the-grid/

https://tinyurl.com/Battery-Boondoggle

A pair of 500-foot smokestacks rise from a natural-gas power plant on the harbor of Moss Landing, California, casting an industrial pall over the pretty seaside town. Credit: Hugo | Flickr

If state regulators sign off, however, it could be the site of the world's largest lithium-ion battery project by late 2020, helping to balance fluctuating wind and solar energy on the California grid.

The 300-megawatt facility is one of four giant lithium-ion storage projects that Pacific Gas and Electric, California's largest utility, asked the California Public Utilities Commission to approve in late June. Collectively, they would add enough storage capacity to the grid to supply about 2,700 homes for a month (or to store about .0009 percent of the electricity the state uses each year).

The California projects are among a growing number of efforts around the world, including Tesla's 100-megawatt battery array in South Australia, to build ever larger lithium-ion storage systems as prices decline and renewable generation increases. They're fueling growing optimism that these giant batteries will allow wind and solar power to displace a growing share of fossil-fuel plants.

But there's a problem with this rosy scenario. These batteries are far too expensive and don't last nearly long enough, limiting the role they can play on the grid, experts say. If we plan to rely on them for massive amounts of storage as more renewables come online—rather than turning to a broader mix of low-carbon sources like nuclear and natural gas with carbon capture technology—we could be headed down a dangerously unaffordable path.

Small doses

Today's battery storage technology works best in a limited role, as a substitute for "peaking" power plants, according to a 2016 analysis by researchers at MIT and Argonne National Lab. These are smaller facilities, frequently fueled by natural gas today, that can afford to operate infrequently, firing up quickly when prices and demand are high.

Lithium-ion batteries could compete economically with these natural-gas peakers within the next five years, says Marco Ferrara, a cofounder of Form Energy, an MIT spinout developing grid storage batteries.

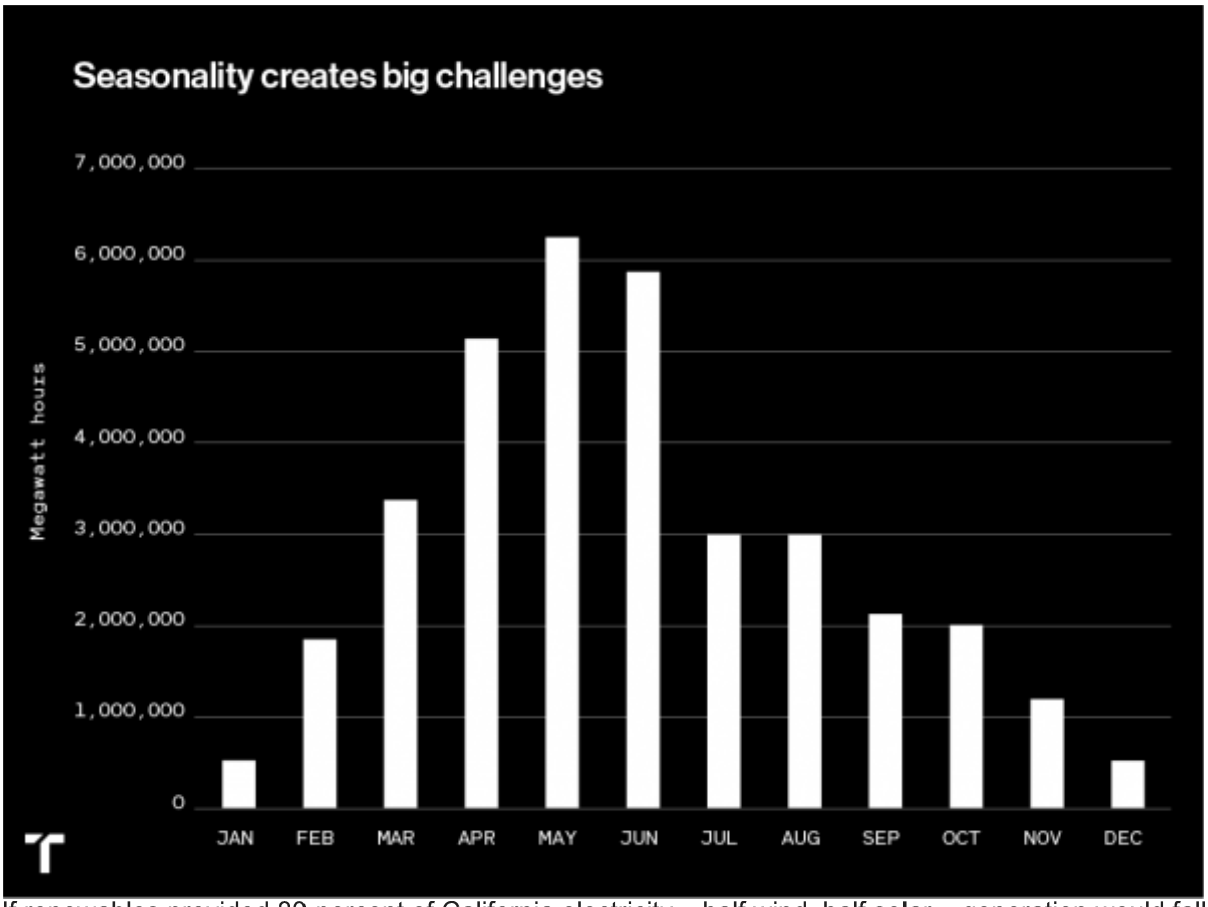
"The gas peaker business is pretty close to ending, and lithium-ion is a great replacement," he says.

This peaker role is precisely the one that most of the new and forthcoming lithium-ion battery projects are designed to fill. Indeed, the California storage projects could eventually replace three natural-gas facilities in the region, two of which are peaker plants.

But much beyond this role, batteries run into real problems. The authors of the 2016 study found steeply diminishing returns when a lot of battery storage is added to the grid. They concluded that coupling battery storage with renewable plants is a "weak substitute" for large, flexible coal or natural-gas combined-cycle plants, the type that can be tapped at any time, run continuously, and vary output levels to meet shifting demand throughout the day.

Not only is lithium-ion technology too expensive for this role, but limited battery life means it's not well suited to filling gaps during the days, weeks, and even months when wind and solar generation flags.

This problem is particularly acute in California, where both wind and solar fall off precipitously during the fall and winter months. Here's what the seasonal pattern looks like:



If renewables provided 80 percent of California electricity – half wind, half solar – generation would fall precipitously beginning in the late summer.
CLEAN AIR TASK FORCE ANALYSIS OF CAISO DATA

This leads to a critical problem: when renewables reach high levels on the grid, you need far, far more wind and solar plants to crank out enough excess power during peak times to keep the grid operating through those long seasonal dips, says Jesse Jenkins, a coauthor of the study and an energy systems researcher. That, in turn, requires banks upon banks of batteries that can store it all away until it's needed.

And that ends up being astronomically expensive.

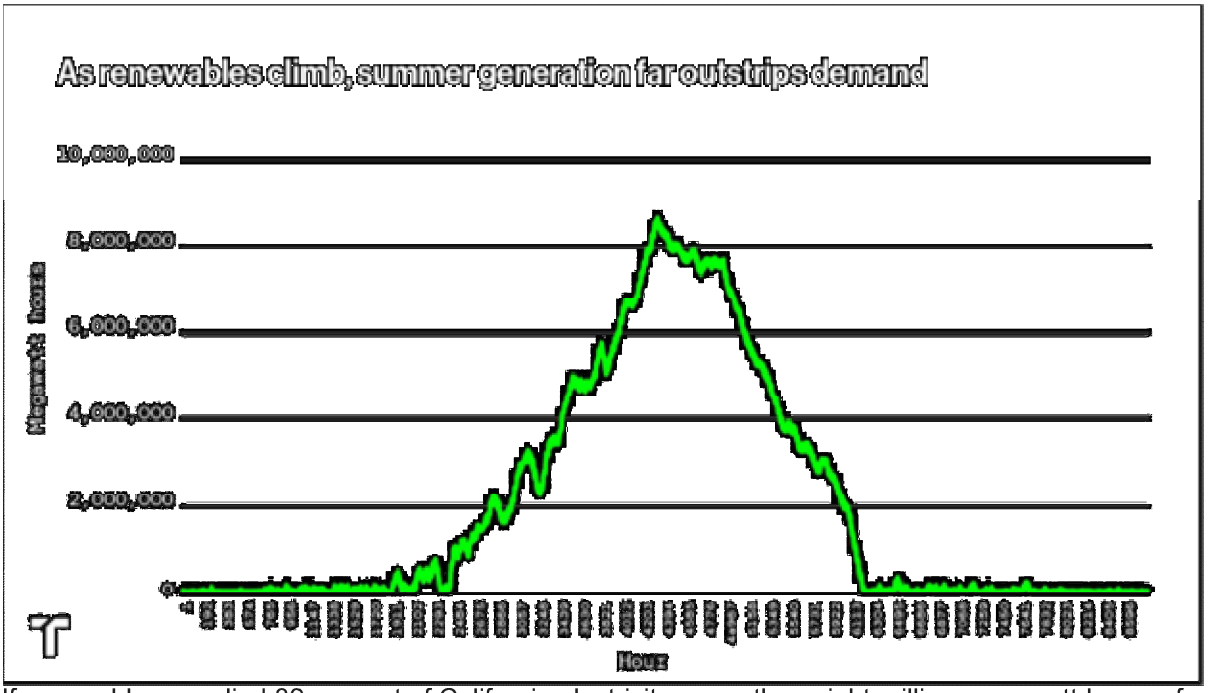
California dreaming

There are issues California can't afford to ignore for long. The state is already on track to get 50 percent of its electricity from clean sources by 2020, and the legislature is once again considering a bill that would require it to reach 100 percent by 2045. **To complicate things, regulators voted in January to close**

the state's last nuclear plant, a carbon-free source that provides 24 percent of PG&E's energy. That will leave California heavily reliant on renewable sources to meet its goals.

The Clean Air Task Force, a Boston-based energy policy think tank, recently found that reaching the 80 percent mark for renewables in California would mean massive amounts of surplus generation during the summer months, requiring 9.6 million megawatt-hours of energy storage. Achieving 100 percent would require 36.3 million.

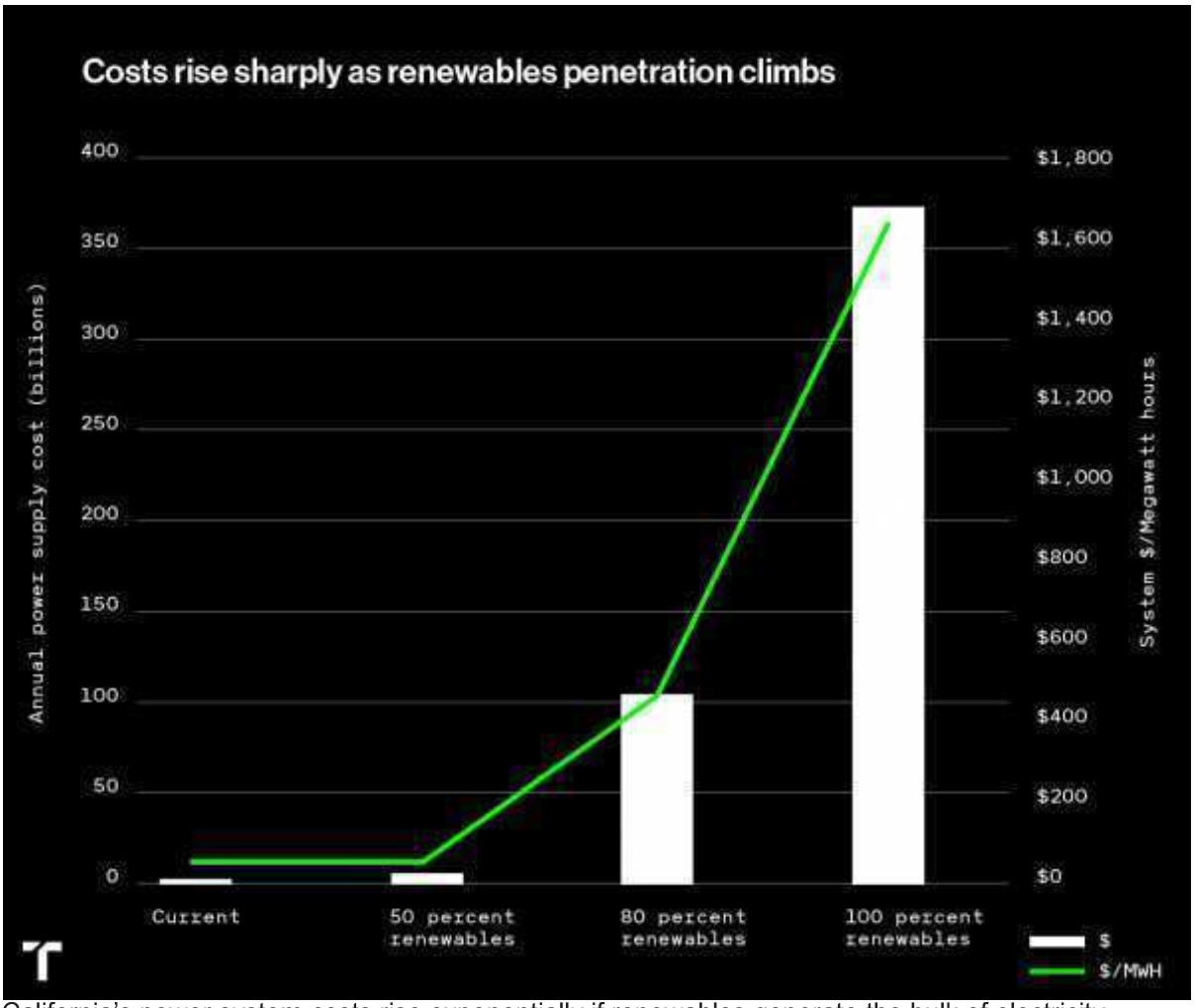
The state currently has 150,000 megawatt-hours of energy storage in total. (That's mainly pumped hydroelectric storage, with a small share of batteries.)



If renewables supplied 80 percent of California electricity, more than eight million megawatt-hours of surplus energy would be generated during summer peaks.
CLEAN AIR TASK FORCE ANALYSIS OF CAISO DATA.

Building the level of renewable generation and storage necessary to reach the state's goals would drive up costs exponentially, from $49 per megawatt-hour of generation at 50 percent to $1,612 at 100 percent.

And that's assuming lithium-ion batteries will cost roughly a third what they do now.



California's power system costs rise exponentially if renewables generate the bulk of electricity.
CLEAN AIR TASK FORCE ANALYSIS OF CAISO DATA.

"The system becomes completely dominated by the cost of storage," says Steve Brick, a senior advisor for the Clean Air Task Force. "**You build this enormous storage machine that you fill up by midyear and then just dissipate it. It's a massive capital investment that gets utilized very little.**"

These forces would dramatically increase electricity costs for consumers.

"You have to pause and ask yourself: 'Is there any way the public would stand for that?'" Brick says.

Similarly, a study earlier this year in *Energy & Environmental Science* found that meeting 80 percent of US electricity demand with wind and solar would require either a nationwide high-speed transmission system, which can balance

renewable generation over hundreds of miles, or 12 hours of electricity storage for the whole system (see "Relying on renewables alone significantly inflates the cost of overhauling energy").

At current prices, a battery storage system of that size would cost more than $2.5 trillion.

A scary price tag

Of course, cheaper and better grid storage is possible, and researchers and startups are exploring various possibilities. Form Energy, which recently secured funding from Bill Gates's Breakthrough Energy Ventures, is trying to develop aqueous sulfur flow batteries with far longer duration, at a fifth the cost where lithium-ion batteries are likely to land.

Ferrara's modeling has found that such a battery could make it possible for renewables to provide 90 percent of electricity needs for most grids, for just marginally higher costs than today's.

But it's dangerous to bank on those kinds of battery breakthroughs—and even if Form Energy or some other company does pull it off, costs would still rise exponentially beyond the 90 percent threshold, Ferrara says.

"The risk," Jenkins says, "is we drive up the cost of deep decarbonization in the power sector to the point where the public decides it's simply unaffordable to continue toward zero carbon."

Graphics Captions

If renewables provided 80 percent of California electricity – half wind, half solar – generation would fall precipitously beginning in the late summer.
Clean Air Task Force analysis of CAISO data

If renewables supplied 80 percent of California electricity, more than eight million megawatt-hours of surplus energy would be generated during summer peaks.
Clean Air Task Force analysis of CAISO data.

California's power system costs rise exponentially if renewables generate the bulk of electricity.
Clean Air Task Force analysis of CAISO data.

Tagged

California, batteries, clean energy, battery storage, climate change, lithium-ion, storage

James Temple Senior Editor, Energy
I am the senior editor for energy at *MIT Technology Review*. I'm focused on renewable energy and the use of technology to combat climate change. Previously, I was a senior director at the *Verge*, deputy managing editor at *Recode*,… More

_____

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27 August 2018

Dear Steve:

Californians for Green Nuclear Power, Inc. (CGNP) is a California Public Utilities Commission (CPUC) Adverse Intervenor in the A.16-08-006 Proceeding now before them, which is PG&E's Application to voluntarily retire Diablo Canyon Power Plant (DCPP) in 2025.

I read with interest the attached 27 July 2018 ***Technology Review*** article which references a CATF study of California Independent System Operator (CAISO) data establishing the economic infeasibility of battery-based bulk power storage. I'm unable to locate the study at the CATF website and would appreciate receiving a copy of it.

The attached CGNP 2018 ANS-UWC package includes a 1-page summary of CGNP's advocacy that was part of my recent presentation at the 2018 American Nuclear Society Utility Working Conference (ANS-UWC). My prepared comments are also included. I expanded on these themes during my participation in the Q&A section of the Tuesday and Wednesday Plenary Sessions. This package includes CGNP's recent analysis for the Nuclear Economics Consulting Group (NECG) of CAISO data regarding the performance of California solar and wind for the half year period ending 31 January 2017 and a pair of CGNP's published "OpEds."

The information is included in the approximately 1,500 pages of written CGNP filings in A.16-08-006. CGNP would be pleased to share our filings with you and the CATF as a "case study" of the advocacy of an independent citizen group for nuclear power.

CGNP also participated vigorously in all oral phases of the CPUC Proceeding.

Thank you in advance for any assistance that you are able to provide.

Gene Nelson, Ph.D. Legal Assistant and Government Liaison
Californians for Green Nuclear Power, Inc. (CGNP)
Arroyo Grande, CA
(805) 363 - 4697 cell
Government@CGNP.org email

Attached: CGNP 2018 ANS-UWC Package and a copy of this article.

_____

After this email "bounced" on 08 30 18 I called
Chicago Council on Global Affairs
Prudential Plaza
Office: 180 N. Stetson Ave., Suite 1400, Chicago, IL 60601
Conference Center: 130 E. Randolph St., Chicago, IL 60601

312.726.3860 and learned that Steve is apparently no longer associated with the Council.

After conducting additional research, I was able to talk with Steve Brick, Ph.D. in Wisconsin on 30 August 2018.

Exhibit F

CGNP's Summary Responses to other Parties December 7, 2018

Here Are important sections for the CPUC and Joint Parties' responses, and a suggested response follows. All responses are supported by material in the record.
- Marty Marinak, Ph.D. and Gene Nelson, Ph.D.

Comments on CPUC response

CPUC claim pp. 20 "Petitioner contends that PG&E's withdrawal of support for replacement procurement was really an amendment to its application and that under the Commission's rules the deadline for filing amendments had passed. As discussed above, P&E did not amend its application. PG&E's replacement procurement request remained an issue in the proceeding."

A: It is sophistry for the CPUC to argue its ALJ could approve PG&E's decision to move its consideration of any replacement procurement to another proceeding, but that this was not an amendment. Even the Joint Parties' response contradicts CPUC's assertion. On pp. 14 of the Joint Parties' response they state: "After protests and testimony by other parties in opposition to the three-tranche procurement proposal were submitted, in March 2017 the Joint Parties agreed to a revised approach, which was memorialized in a **'First Amendment'** to the Joint Proposal. Under the **First Amendment to the Joint Proposal**, **only one of the original three tranches** – a proposal for a package of energy efficiency resources, referred to as "Tranche 1" – **was left in play in the Diablo Canyon docket**. It was proposed that all other issues regarding replacement procurement be deferred to the IRP proceeding." This illustrates how PG&E's amendment fundamentally altered the proceeding. It supports CGNP's contention that it's due process rights were violated when PG&E's unilateral amendment removed tranches 2 and 3 from play in the Diablo Canyon docket.

CPUC Claim pp. 31 "Given the time between now and 2024 and 2025, the rapid changes in the California electricity market, and the growth of renewable generation and CCAs, however, it is not clear based on the limited record in this proceeding what level of GHG-free procurement (if any) may be needed to offset the retirement of Diablo Canyon."

A: **Base-load sources – such as nuclear, natural gas and coal – are essential to maintaining the grid's stable, reliable and economical operation.** When asked, **"Are you aware of any large electric grid, anywhere in the world that operates without a substantial continual supply of electricity from base-load sources?" PG&E witness Frazier-Hampton, who performed their needs analysis, was unable to identify such a grid anywhere.**[1] Under PG&E's proposal, CAISO would continue to obtain base-load electricity from **coal** (mostly imports from Intermountain and impots in the "other" category) and **natural-gas** plants (mostly in-state.) Even if one assumes that CAISO will experience some reduction in the need for base-load capacity, **closing zero-GHG emitting Diablo first, among all of CAISO's base-load sources is indefensibl**e. Closing Diablo would result in about 9 million metric tons more GHG emissions per year generated by CAISO base-

[1] **A.16-08-006 Oral Evidentiary Hearing Transcript, April 26, 2017, PG&E, Frazier-Hampton, pp. 946, line 6**.

load sources[2] compared to that case of continued operation. This would violate the Public Utilities Code which requires "[t]he portfolio shall rely upon zero carbon-emitting resources to the maximum extent reasonable and be designed to achieve any state wide greenhouse gas emissions limit." *See Cal. Pub. Util. Code* § 454.51(a). PG&E has not demonstrated specific new reliable GHG-free sources that could replace Diablo's output and firm, round the clock generating capacity.[3] In fact PG&E's 2010 comprehensive study of possible replacement sources concluded with this strong admonishment:[4]

> Based on these evaluations, **PG&E determined that the only viable alternative generation technology to replace Diablo power is natural gas-fired generation.**

It also warned[5]

> **PG&E is undertaking every effort to meet the state's long term, low-carbon energy requirements. The ability to meet these requirements in the time frame required and at a reasonable cost to PG&E's customers will be severely handicapped without renewal of Diablo's operating licenses.**

CPUC's response further quotes from the Decision:

pp. 31 "In short, the IRP has the ability to look at a bigger picture than this proceeding, and can better analyze the potential impacts of the retirement of Diablo Canyon and its interaction with other dynamics in the electricity markets in a manner consistent with state policies."

A: **The quote above from CPUC's decision is precisely the argument for why the decision on whether to retire Diablo must be considered within the context of the IRP.** If you analyze the potential impacts after approving final shut down then it is too late to correct a mistake. As we stated, if the future proceeding determines available replacements would **increase overall emissions, degrade reliability, increase cost, or deliver inadequate generation capacity** – it would be too late to correct this final Decision.

Comments on Joint Parties response

If Joint Parties can introduce new laws into the argument ex post facto (SB1090), are we free to refer to SB100 which will require 100% carbon free electricity? Nuclear energy will be essential to achieve this requirement. Perhaps SB100 could be mentioned in an amicus brief?

Joint Parties claim pp. 14 "An important and innovative aspect of the Joint Proposal was its commitment to replace the output of the Diablo Canyon generating units with GHG-free resources, to avoid an increase in GHG emissions as a consequence of the units' retirement. As initially executed in June 2016, the Joint Proposal included three proposed "tranches" of

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2 CGNP ex-3, pp. 1-3, line 1.
3 Transcript, PG&E, Frazier-Hampton, pp. 940, line 20.
4 CGNP ex-4, pp. 7.2-2. PG&E's sworn filings were from CPUC A.10-01-022
5 CGNP ex-3, pp. 1-3, line 10.

replacement resources for immediate approval by the Commission, while deferring most of the replacement procurement issues to the broader IRP proceeding."

A: False - The joint proposal never proposed to replace any more than a modest fraction of DCPP output with GHG-free resources. **PG&E proposed to abandon DCPP, an 18,000 GWh per year, zero GHG-emitting reliable resource in favor of 4,300 GWh per year of intermittent resources. Then PG&E's amendment unilaterally withdrew all of the proposed replacement procurement from the proceeding.**

Joint Parties claim pp. 20 regarding SB1090 "It also expressly required that the Commission in the IRP proceeding "ensure that integrated resource plans are designed to avoid any increase in emissions of greenhouse gases as a result of the retirement of the Diablo Canyon Units 1 and 2 powerplant."

A: The bill's operative section only requires "**plans"** that are "**designed** to **avoid**" increased emissions. It does not require anyone to show that Diablo **will** be replaced with clean power and possible clean storage. SB 1090 will just result in **shuffling** existing GHG-free sources and improper reliance on CCAs. Unlike solar and wind, Diablo Canyon is a **reliable** supply of **essential** baseload power. Taking Diablo offline **would result** in the burning of **more** fossil fuels to meet that need. This **would result** in **9 million tons** more CO2 emissions annually than if Diablo continued operating. That is over 100 million tons in increased greenhouse gas emissions during the 20 year relicensing period. PG&E testified that much of replacement power for DCPP would be generated by **unregulated** Community Choice Aggregators, but there is no way for CPUC to **enforce** that **they** would meet the **enormous** challenge of constructing **new** GHG-free sources to replace Diablo. Also since CCAs are not required to audit their sources, there is no mechanism to verify any claim made regarding the content of power they sell. All of this casts great doubt upon the ability of SB1090's provision to ensure that replacement power would actually come from new GHG-free sources.

Joint Parties claim pp. 27: The legislature has validated Joint Proposal making the issue moot and prohibiting the court from acting.

A: The narrow bill's (SB1090's) operative language only requires full funding for community impact mitigation settlement and employee retention program, and future plans that are *designed to avoid* increased emissions from retirement of DCPP. The legislature enacted these provisions intending to reduce the harmful effects that would result from abandoning DCPP well short of its design lifetime. **All of the operative provisions of SB1090 could be deferred if the retirement of Diablo Canyon was deferred**. ***There is nothing in SB1090 that requires Diablo Canyon be retired.*** SB1090 was in fact silent on large portions of the joint proposal, including all three tranches, and the Clean Energy Charge. SB1090 did not endorse or enact these either. The addition of the aforementioned provisions, retroactively, does not relieve CPUC from the requirement that it honor the existing statutes we have cited. These include using GHG-free sources to the maximum extent reasonable, and performing an integrated analysis to create a diverse balanced system to ensure that the very aggressive mandates to

reduce GHG emissions are actually achieved. **As we have described, the Decision violated these statutory mandates.**

The California Global Warming Solutions Act of 2006 (AB 32) requires reduction of GHG emissions to 1990 levels by 2020. According the Alex's testimony (section 2.2) California law requires a 40% reduction below 1990 levels (date unspecified in testimony). Executive Order S-3-05 (June 5, 2005) calls on the state to further reduce its GHG emissions to 80 percent below 1990 levels by 2050. (CGNP rebuttal testimony/opening testimony). **The IRP has not established it is even possible to meet these requirements without continued operation of DCPP, California's largest zero GHG emitting energy source.**

As pointed out by the Green Power Institute in their opening comments, the current IRP shows greenhouse gas emissions increasing substantially after DCPP closure. This holds true across the spectrum of assumptions considered.

As demonstrated by its own previous testimony, PG&E has not identified new reliable GHG-free sources that could replace Diablo's **capacious output, equal to more than five (5) Hoover Dams** and firm-generating capacity, and therefore the record is undeveloped on this issue.

The Joint Proposal itself has clauses which limit the conditions under which it is binding. On pp. 43, under Scope and Approval, section 7.2 includes the following (emphasis added):

7.2 The Parties intend that CPUC adoption of this Joint Proposal will be binding on the Parties. The Parties agree that, if the CPUC fails to adopt this Joint Proposal and the associated settlement agreement **in its entirety and without modification**, the Parties shall meet and confer as specified in CPUC Rule 12.4 within fifteen (15) days thereof to discuss whether the Joint Proposal and associated settlement agreement should be renegotiated with alternative terms and resubmitted to the Commission for approval. The Parties agree under such circumstances to bargain in good faith to **restore the balance of benefits and burdens** under the Joint Proposal. If the Parties cannot mutually agree to resolve the issues raised by the CPUC's actions, the Joint Proposal and the associated settlement agreement may be rescinded by any Party and the Parties shall be released from their obligations under the Joint Proposal. Thereafter, the Parties may pursue any action they deem appropriate.

And section 7.3 includes the following:

7.3 …PG&E's obligation to withdraw its license renewal application under Section 1.3 shall not become effective or binding until the CPUC's approval of the Joint Proposal Application has become **final and non-appealable.**

Joint Parties claim pp. 24: Having established in its decision here (D.18-01-022) the policy goal of allowing zero increase in GHG emissions as a result of retiring the Diablo Canyon generating units, it was both reasonable and necessary as a practical matter for the Commission to defer to the IRP proceeding the specific actions that will be needed to carry out this policy directive.

A: The Commission has fundamental responsibilities to consider the effect of this proposed action upon **reliability, cost, and greenhouse-gas emissions.** Indeed the scoping memo explicitly requests that all of these issues be addressed in any proposals regarding replacement procurement. Yet PG&E's amendment unilaterally deferred consideration of these essential issues to a separate (IRP) proceeding,

after a decision on Diablo Canyon is already made. The Public Utilities Code directs the commission to "**Identify a diverse and balanced portfolio of resources needed to ensure a reliable electricity supply that provides optimal integration of renewable energy in a cost-effective manner**" and further requires that**"[t]he portfolio shall rely upon zero carbon-emitting resources to the maximum extent reasonable and be designed to achieve any state wide greenhouse gas emissions limit**." See Cal. Pub. Util. Code § 454.51(a). Significantly, the code also requires the Commission to **"[d]irect each electrical corporation to include, as part of its proposed procurement plan, a strategy for procuring best-fit and least-cost resources to satisfy the portfolio needs identified by the commission.**" See id. § 454.51(b). PG&E's amendment to defer consideration of these critical issues to a separate proceeding (after a decision on Diablo Canyon is made) **contravened** those requirements. **It precludes the Commission from developing an optimal, minimum-cost portfolio, which maximizes use of zero carbon emitting resources, as required by law**. If the IRP determines available replacements are more costly, would actually increase overall emissions, degrade reliability, or deliver inadequate firm generation capacity – it would be too late to correct the error. These considerations are especially vital given that Diablo Canyon is established as California's largest, reliable, **cost-effective**, zero-carbon-emitting energy source. **If the PUC moves those critical considerations to the IRP proceeding, it *must* move its decision on the fate of Diablo Canyon to the same.**

PG&E continued to testify in final oral arguments that **closing DCPP before 2025 would result in power shortages, and a large increase in greenhouse gas emissions**. Yet no one has demonstrated any specific actions that occur in 2025 and beyond that would change this outcome. The record shows no credible assurance that there will be 18,000 GWh/year of reliable cost-effective supplies of GHG-free resources at the time of Diablo closure or any time thereafter.

SP1090 simply requests that a plan be made for GHG-free replacements to replace Diablo, to be determined in a future proceeding. Yet PG&E has not demonstrated specific new reliable GHG-free sources that could replace Diablo's output and firm generating capacity on the required time scale. As other parties in A1608006 have noted, unless it is required that newly constructed GHG-free sources be used to replace Diablo output, then it is likely that **existing GHG-free sources would be shuffled (a meaningless bureaucratic exercise)** to satisfy the requirement, and the ultimate result would be increased reliance on GHG-emitting sources arising elsewhere.[6] **The net effect would be equivalent to replacing the abundant, zero-carbon Diablo output with fossil fuel combustion.**

[6] GPI opening brief, pp. 14, discussion of additionality.

Exhibit G

Climate Change Must Guide Utility Plans, Ex-PG&E Boss Says

By **Keith Goldberg**

Law360 (March 26, 2019, 3:55 PM EDT) --
https://www.law360.com/bankruptcy/articles/1142924/climate-change-must-guide-utility-plans-ex-pg-e-boss-says

Geisha Williams (Photo: Bloomberg)

The former CEO of bankrupt Pacific Gas and Electric Co. said Tuesday that electric utilities must adapt to the "new normal" of climate change, starting with how to operate in areas that are increasingly vulnerable to disasters like wildfires and floods.

Geisha Williams, who stepped down in January just before PG&E filed for Chapter 11 **amid crippling California wildfire liability**, said at the Bloomberg New Energy Finance Summit in New York that utilities must figure out how any potential action makes their infrastructure more resilient to extreme weather and other climate-related impacts before taking it.

That makes for some difficult choices when dealing with utility customers in wildfire-prone areas, Williams said.

"I think we need to look at how they're served with energy," she said.

Williams added that there are plenty of resilience tools at a utility's disposal, such as more aggressive vegetation management, tighter building codes and creating more space around utility poles, but cautioned that no single tool will be the solution.

"There's not a silver bullet here," Williams said.

PG&E may be a poster child for climate-related liabilities growing so great that they undermine a utility's ability to operate. When the utility revealed in February that it was likely its equipment that helped ignite last fall's deadly Camp Fire that scorched over 150,000 acres in Northern California, it added $10.5 billion in potential liability to a multibillion-dollar wildfire bill that has PG&E questioning whether it can survive.

The utility's woes have some California officials calling for a transfer of its grid assets to public hands. But a change in ownership won't make the climate risks go away, Williams said.

"I don't think that the infrastructure, whether it's governed by a small utility or a large utility, makes it immune to the ravages of climate change," Williams said.

The uncertain future of PG&E comes at a time when California, given its size, has enacted what may be the most aggressive long-term plans to tackle climate change in the U.S. The Golden State is requiring 60 percent of the state's electricity to come from renewable sources by 2030 and envisioning 100 percent zero-carbon electricity by 2045.

Williams has no problem with states driving the regulatory bus to lowering greenhouse gas emissions, but says they should stop short of dictating the energy mix.

"States have an important role in setting an emissions target. Setting wide and aggressive goals is appropriate," Williams said. **"I think how to get there should be left to system operators ... and not necessarily by a prescriptive mandate that says you must purchase this percentage of electricity from certain technologies."**

In making that point, Williams put in a plug for keeping existing U.S. nuclear power plants and their carbon-free emissions up and running for as long as possible.

"I think that greenhouse gas is the enemy, and we need to decide how we reduce that in the most cost-effective manner," Williams said. "To cast that aside would be pretty irresponsible."

Among the U.S. nuclear plants slated for closure: PG&E's Diablo Canyon plant in California, in 2024.

Williams isn't the only current or former utility executive pushing for keeping the current U.S. nuclear power option afloat.

Duke Energy Corp. CEO Lynn Good said at the BNEF Summit on Monday that there is "a business case under second licensing (e.g. 40 to 60 years - GAN)" of the company's existing nuclear plants, referring to the second renewal of a nuclear reactor's operating license.

--Editing by Orlando Lorenzo.

Exhibit H

The Washington Post

In blow to climate, coal plants emitted more than ever in 2018

"We are headed for disaster, and nobody seems to be able to slow things down," a Stanford University professor said.

https://www.washingtonpost.com/climate-environment/2019/03/26/blow-climate-coal-plants-emitted-more-than-ever

A worker walks past coal piles at a coal coking plant in Yuncheng, Shanxi province, China, in January 2018. (William Hong/Reuters)

By Chris Mooney and

Chris Mooney
Reporter covering climate change, energy and the environment.
Email Bio Follow
Brady Dennis

Brady Dennis
Reporter focusing on environmental policy and public health issues
Email Bio Follow

March 25, 2019

Global energy experts released grim findings Monday, saying that not only are planet-warming carbon-dioxide emissions still increasing, but the world's growing thirst for energy has led to higher emissions from coal-fired power plants than ever before.

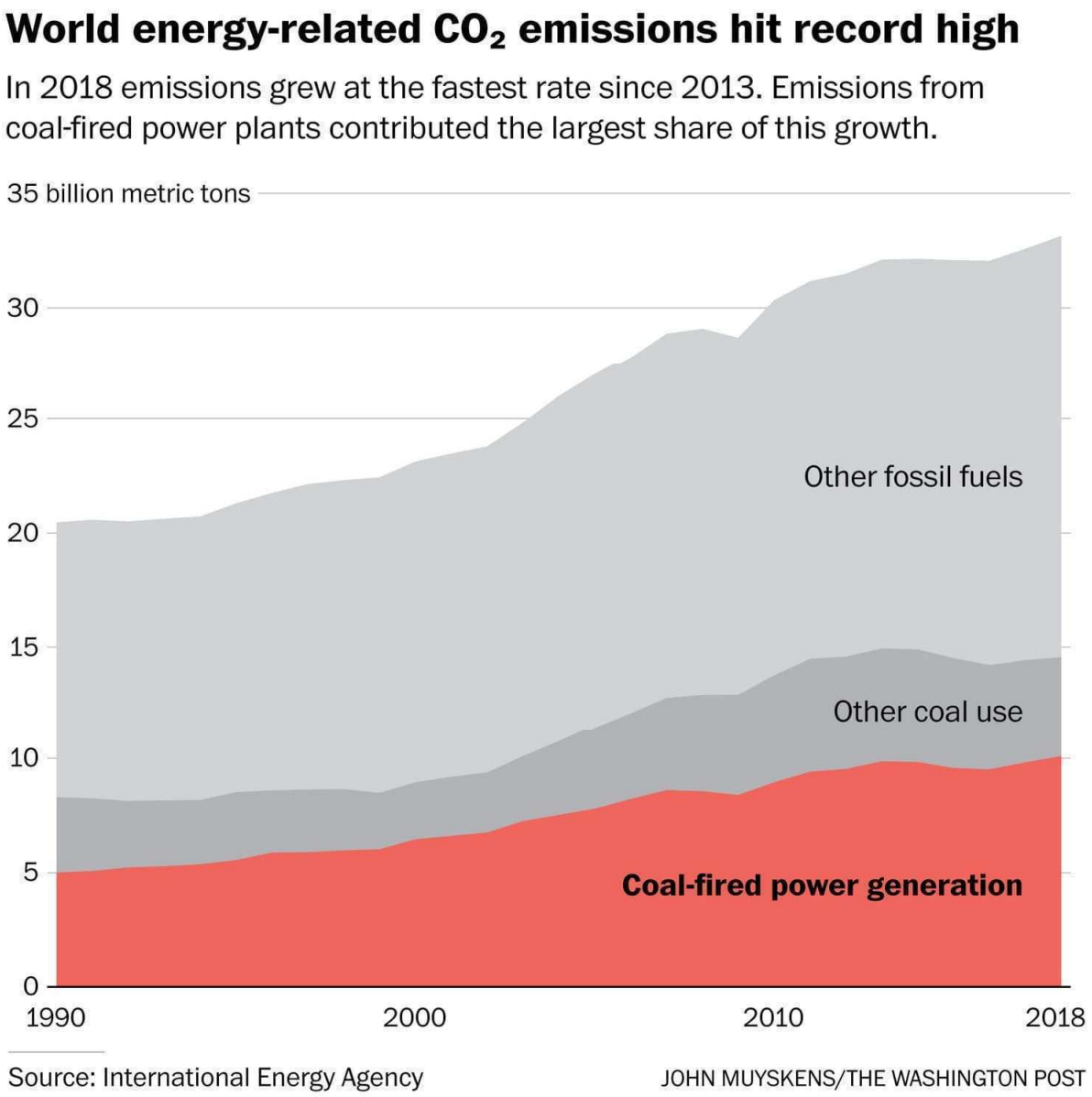
Energy demand around the world grew by 2.3 percent over the past year, marking the most rapid increase in a decade, according to the report from the International Energy Agency. To meet that demand, largely fueled by a booming economy, countries turned to an array of sources, including renewables.

But nothing filled the void quite like fossil fuels, which satisfied nearly 70 percent of the skyrocketing electricity demand, according to the agency, which analyzes energy trends on behalf of 30 member countries, including the United States.

In particular, a fleet of relatively young coal plants located in Asia, with decades to go on their lifetimes, led the way toward a record for emissions from coal fired power plants — exceeding 10 billion tons of carbon dioxide "for the first time," the agency said. In Asia, "average plants are only 12 years old, decades younger than their average economic lifetime of around 40 years," the agency found.

As a result, greenhouse-gas emissions from the use of energy — by far their largest source — surged in 2018, reaching an record high of 33.1 billion tons. Emissions showed 1.7 percent growth, well above the average since 2010. The

growth in global emissions in 2018 alone was “equivalent to the total emissions from international aviation,” the body found.



Monday’s report underscores an unnerving truth about the world’s collective efforts to combat climate change: Even as renewable energy rapidly expands, many countries — including the United States and China — are nevertheless still turning to fossil fuels to satisfy ever-growing energy demand.

“Very worrisome” is how **Michael Mehling, deputy director of the Center for Energy and Environmental Policy Research at the Massachusetts Institute of Technology**, described Monday’s findings.

“To me, all this reflects the fact that climate policies around the globe, despite some limited pockets of progress, remain woefully inadequate,” he said in an email. “They’re not even robust enough to offset the increased emissions from economic expansion, especially in the developing world, let alone to spur decarbonization at levels commensurate with the temperature stabilization goals we’ve committed to under the Paris Agreement.”

Mehling questioned whether the Paris climate agreement — the 2015 global accord in which countries vowed to slash their carbon emissions — has the capacity to compel nations to live up to their promises and ramp up climate action over time.

“This will require overcoming the persistent barriers that have prevented greater progress in the past,” Mehling said.

Why the world still uses coal

Coal is dirty - so why are we still using it for energy? (Jorge Ribas and Julio Negron/The Washington Post)

Overcoming those barriers is complicated, as the agency report makes clear.

China, for instance, satisfied a demand for more energy last year with some new generation from renewables. But it relied far more on natural gas, coal and oil. In India, about half of all new demand was similarly met by coal-fired power plants.

In the United States, by contrast, coal is declining — but most of the increase in demand for energy in this country was nonetheless fueled by the burning of natural gas, rather than renewable energy. Natural gas emits less carbon

dioxide than coal does when it is burned, but it's still a fossil fuel and still causes significant emissions.

Granted, there's some slight good news in the new report, in that as renewables and natural gas have grown, coal has a smaller share of the energy pie overall.

Yet the fact that it's still growing strongly contradicts what scientists have said about what's needed to curb climate warming. In a major report last year the U.N. Intergovernmental Panel on Climate Change found that global emissions would have to be cut nearly in half, by 2030, to preserve a chance of holding the planet's warming to 1.5 degrees Celsius (or 2.7 degrees Fahrenheit).

That would require extremely fast annual reductions in emissions — but instead, the world is still marking record highs.

And when it comes to coal use, that same report found that to limit temperatures to 1.5 degrees C, it would have to decline by as much as 78 percent in just over 10 years. Again, coal emissions are still rising.
Rob Jackson, a professor of Earth system science at Stanford University, said the substantial growth of wind and solar energy detailed in Monday's report was overshadowed by the world's ongoing reliance on fossil fuels.

"The growth in fossils is still greater than all the increases in renewables," Jackson said, adding that few countries are living up to the pledges they made as part of the Paris climate accord. "What's discouraging is that emissions in the U.S. and Europe are going up, too. Someone has to decrease their emissions significantly for us to have any hope of meeting the Paris commitments."

The new results dash earlier hopes that global emissions might be flattening and starting to decline. From 2014 through 2016, they fell slightly, and coal

emissions in particular dipped as well. But with a renewal of growth in 2017 and record highs in 2018, turning the corner on emissions remains nowhere in sight.

As a result, optimism from earlier this decade has largely faded. International efforts to combat climate change have struggled to maintain momentum and the U.S. government has undergone a reversal of priorities.

“We are in deep trouble,” Jackson said of Monday’s findings. “The climate consequences are catastrophic. I don’t use any word like that very often. But we are headed for disaster, and nobody seems to be able to slow things down.”

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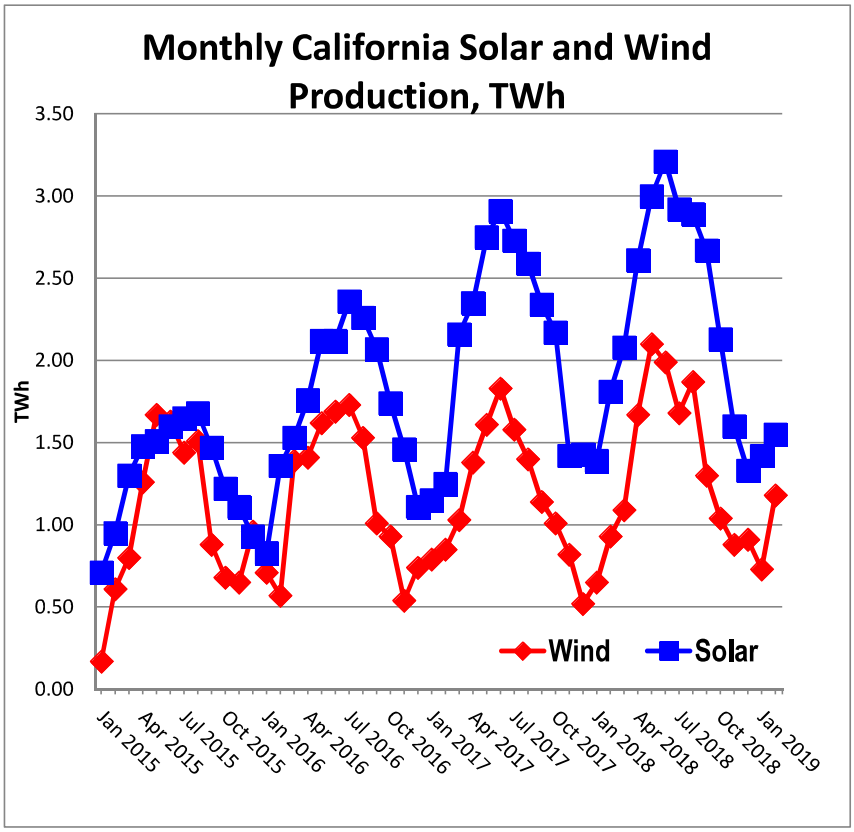
Exhibit I

Month	Wind	Solar
Jan 2015	0.17	0.71
Feb 2015	0.61	0.95
Mar 2015	0.80	1.30
Apr 2015	1.26	1.48
May 2015	1.67	1.51
Jun 2015	1.63	1.60
Jul 2015	1.44	1.65
Aug 2015	1.51	1.68
Sep 2015	0.88	1.47
Oct 2015	0.68	1.22
Nov 2015	0.65	1.11
Dec 2015	0.96	0.93
Jan 2016	0.71	0.83
Feb 2016	0.57	1.36
Mar 2016	1.39	1.53
Apr 2016	1.41	1.76
May 2016	1.62	2.12
Jun 2016	1.69	2.12
Jul 2016	1.73	2.36
Aug 2016	1.53	2.26
Sep 2016	1.01	2.07
Oct 2016	0.93	1.74
Nov 2016	0.54	1.46
Dec 2016	0.74	1.11
Jan 2017	0.79	1.15
Feb 2017	0.85	1.25
Mar 2017	1.03	2.16
Apr 2017	1.38	2.35
May 2017	1.61	2.75
Jun 2017	1.83	2.91
Jul 2017	1.58	2.73
Aug 2017	1.40	2.59
Sep 2017	1.14	2.34
Oct 2017	1.01	2.17
Nov 2017	0.82	1.42
Dec 2017	0.52	1.43
Jan 2018	0.65	1.39
Feb 2018	0.93	1.81
Mar 2018	1.09	2.08
Apr 2018	1.67	2.61
May 2018	2.10	3.00
Jun 2018	1.99	3.21
Jul 2018	1.68	2.92
Aug 2018	1.87	2.89
Sep 2018	1.30	2.67
Oct 2018	1.04	2.13
Nov 2018	0.88	1.60
Dec 2018	0.91	1.33
Jan 2019	0.73	1.42
Feb 2019	1.18	1.55
50-Month Totals (TWh)	**58.11**	**92.19**



Monthly Metered Wind and Solar Generation Jan 2015 - Feb 2019 (TWh)

Source URL: http://www.caiso.com/Documents/MonthlyRenewablesPerformanceReport-Feb2019.html
Archived 03 31 19 by Gene A. Nelson, Ph.D.

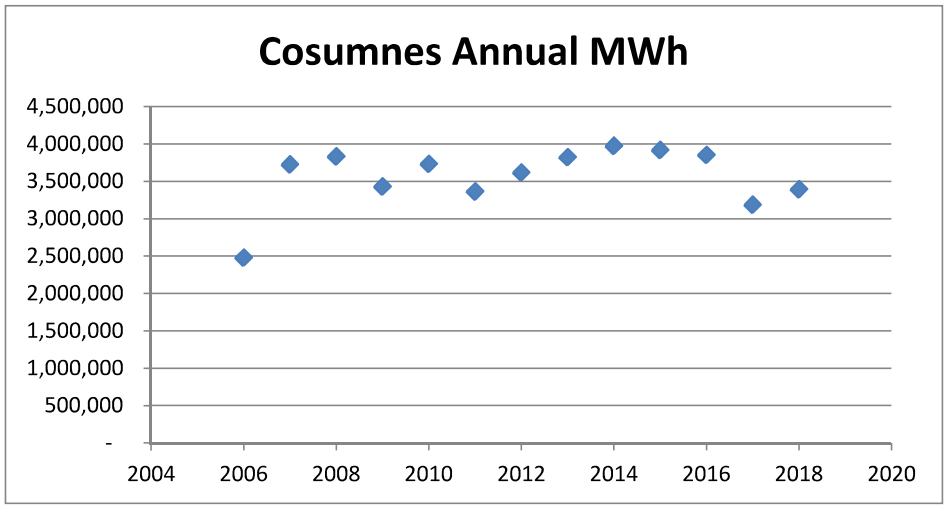
Exhibit J

Plant Name	Nameplate, MW	2018 Production, MWh	2018 Capacity Factor	Emissions	2018 Heat Rate MMBTu/MWh	Notes
Diablo Canyon	2,240	18,213,519	92.757%	NONE	N.A.	California's Clean Power Champion
Cosumnes	500	3,398,778	77.500%	LOW	6.755	Natural Gas Baseload - CF was 90.8% in 2014
Mountainview	1,050	2,091,875	22.727%	MEDIUM	7.999	SCE Runs Mountainview as a "Peaker" now.
Barre	45	33,132	8.399%	HIGH	10.169	One of SCE's five "Peakers." 2017 values.

Exhibit K

Net generation Cosumnes (55970) all fuels all primemovers annual
https://www.eia.gov/opendata/qb.php?category=6223&sdid=ELEC.PLANT.GEN.55970-ALL-ALL.A
14:42:58 GMT-0700 (Pacific Daylight Time)
Source: U.S. Energy Information Administration
Year Series ID: ELEC.PLANT.GEN.55970-ALL-ALL.A megawatthours

Year	MWh	MMBTu	CF	MMBTu/ MWh
2018	3,398,778	22,959,001	0.775	**6.755**
2017	3,192,303	21,948,723	0.728	**6.876**
2016	3,859,086	26,419,481	0.880	**6.846**
2015	3,924,276	26,607,071	0.895	**6.780**
2014	3,980,086	26,984,745	0.908	**6.780**
2013	3,828,845	26,054,237	0.874	**6.805**
2012	3,622,730	25,123,687	0.827	**6.935**
2011	3,369,234	23,753,684	0.769	**7.050**
2010	3,738,648	25,992,736	0.853	**6.952**
2009	3,436,323	24,164,354	0.784	**7.032**
2008	3,838,140	27,111,694	0.876	**7.064**
2007	3,731,659	27,439,378	0.851	**7.353**
2006	2,485,381	18,630,693	0.567	**7.496**
100% CF =	4,383,000	MWh		



Net generation Mountainview Generating Station (358) all fuels all primemovers annual
https://www.eia.gov/opendata/qb.php?category=1257&sdid=ELEC.PLANT.GEN.358-ALL-ALL.A
15:02:35 GMT-0700 (Pacific Daylight Time)
Source: U.S. Energy Information Administration
Year Series ID: ELEC.PLANT.GEN.358-ALL-ALL.A megawatthours

Year	MWh	MMBTu	MMBTu/ MWh	CF
2018	2,091,875	16,733,883	7.999	22.727%
2017	4,040,507	31,708,211	7.848	43.898%
2016	4,890,772	37,701,950	7.709	53.136%
2015	5,750,409	44,001,665	7.652	62.475%
2014	6,172,663	46,054,807	7.461	67.063%
2013	5,518,342	40,620,967	7.361	59.954%
2012	6,586,447	48,849,533	7.417	71.558%
2011	4,631,480	34,947,976	7.546	50.319%
2010	6,034,355	45,531,126	7.545	65.560%
2009	5,749,671	43,862,609	7.629	62.467%
2008	**6,691,295**	49,996,825	7.472	**72.697%**
2007	6,308,447	46,499,103	7.371	68.538%
2006	4,866,120	35,309,849	7.256	52.868%
2005	148,559	1,075,351	7.239	1.614%
2002	-	-	-	-
2001	38,269	421,681	11.019	0.416%

100% CF = 9,204,300 MWh

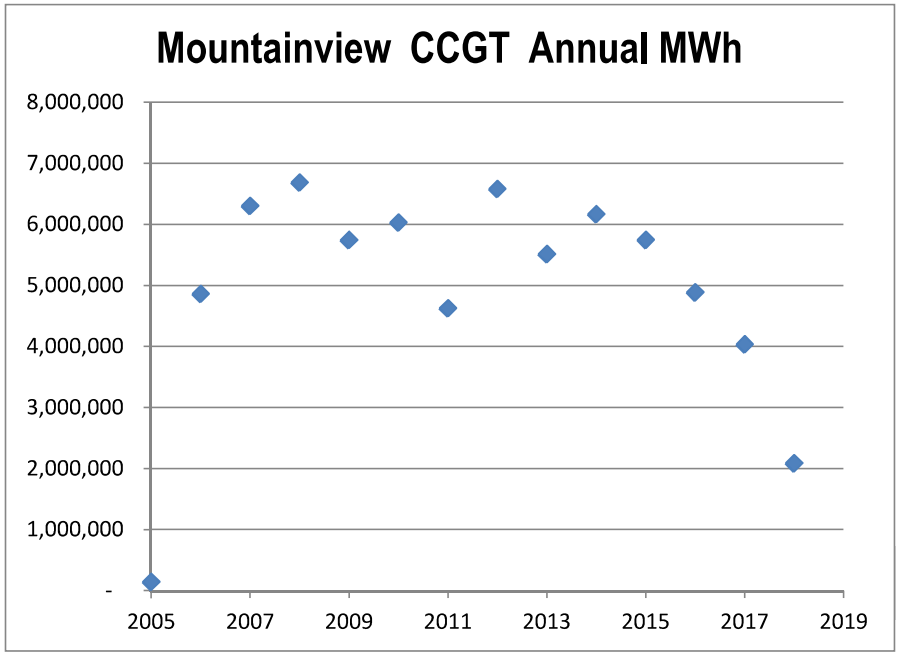


Exhibit L

Exhibit M

Net generation Barre Peaker (56474) all fuels all primemovers annual
https://www.eia.gov/opendata/qb.php?category=6608&sdid=ELEC.PLANT.GEN.56474-ALL-ALL.A
14:23:28 GMT-0700 (Pacific Daylight Time)
Source: U.S. Energy Information Administration
Year Series ID: ELEC.PLANT.GEN.56474-ALL-ALL.A megawatthours

Year	MWh	CF	MMBTU	MMBTU/ MWH
2017	33,132	8.40%	336,913	10.169
2016	28,750	7.29%	295,224	10.269
2015	33,129	8.40%	336,110	10.145
2014	29,409	7.46%	307,394	10.452
2013	16,282	4.13%	175,024	10.750
2012	25,507	6.47%	270,245	10.595
2011	6,191	1.57%	71,151	11.493
2010	6,446	1.63%	74,873	11.615
2009	2,715	0.69%	35,852	13.205
2008	4,727	1.20%	56,982	12.055
2007	9,165	2.32%	107,634	11.744

100% CF = 394,470 MWh