# Targeted policies can reduce reliance on aging peaker plants

*A Comment to the California Air Resources Board*

*Re: The Proposed Strategy for Achieving California's 2030 Greenhouse Gas Target and Draft Environmental Analysis*

Submitted via: https://www.arb.ca.gov/lispub/comm/bclist.php

Andrew Wilson, David Weiskopf (JD, MS)

NextGen Climate America

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**SUMMARY**

NextGen Climate America is grateful for the opportunity to comment on the scoping plan for California's 2030 Greenhouse Gas Target and its associated draft environmental analysis ("scoping plan").

We commend ARB for developing a detailed proposal that takes a comprehensive approach to meeting California's vital 2030 global warming pollution reduction target and for the open and inclusive process that ARB is following to refine the plan. We appreciate ARB's commitment to an integrated strategy that combines direct regulation of key sources with an efficient market-based mechanism to ensure that the overall target is achieved, while prioritizing redressing the burden of environmental pollution on disadvantaged communities.

This comment addresses the need for the scoping plan to fully consider the diversity of emissions sources across California. Based on our analysis, we recommend that ARB consider additional direct regulations and mechanisms in its scoping plan to reduce reliance on aging peaker plants, and more thoroughly analyze how approaches to meeting California's carbon pollution reduction targets during the 2020–2030 compliance period can prioritize displacing pollution from peakers as a means of maximizing health and equity co-benefits.

Four principal findings inform our recommendation:

1. peaker plants have relatively high carbon and copollutant intensity per unit of power generated
2. peaker plants are disproportionately located in disadvantaged communities ("DACs")
3. peaker plants are used disproportionately on poor air quality days
4. non-fossil alternatives to peakers will be increasingly available during the 2020-2030 compliance period.

ARB's proposed cap-and-trade policy does not adequately address the issue of peaker copollutant emissions. Further, given other elements of the scoping plan—such as a stricter Renewable Portfolio Standard ("RPS"), Mobile Source Strategy, and Freight Action Plan—demand for peaker generation is not expected to decline proportional to the declining GHG cap; it may even increase. Because of the equity and public health concerns prolonged reliance on fossil peakers presents, ARB should consider additional direct regulations to reduce peaker demand and how these measures can increase the overall effectiveness and health benefits of a cap and trade system, particularly for residents living in DACs.

### *1. The Role of Peakers[1] in the Electric Power System*

The power system must dynamically adapt to serve fluctuations in energy supply and demand. Most fluctuations in demand originate in people's life patterns; most fluctuations in supply originate in the operational constraints of dedicated electricity generation resources, including renewables and traditional fossil fuel generation.

As existing plants undergo natural obsolescence and depreciation, marginal choices are made to permit and construct new generation facilities. Apart from relevant regulatory frameworks, the key economic measure driving these choices is the projected long-run average cost of the facility.[2] Long-run average cost is calculated as the sum of the initial fixed cost of the facility and its marginal operation and maintenance costs divided by the number of hours the facility is expected to run during its useful life. More efficient and durable facilities (those with a lower marginal cost of generation) are in general more advanced and hence have a higher initial fixed cost of construction; less efficient facilities have in general lower fixed costs but higher variable costs.[3]

Importantly, total energy demand in California is unusually high on summer and winter afternoons when people return home from work and switch on heating and cooling appliances. Energy supply, as California expands its portfolio of renewables, is usually highest during the day, when insolation and wind speeds are higher. Critical mismatches between energy demand and energy supply occur only a handful of hours each year, though other needs of the power system are present daily, including ramping, voltage support, and frequency regulation.

When energy suppliers plan to meet peak demand, they aim to provide generation and ancillary needs at minimum long-run average cost: facilities like peakers that operate a relatively small number of hours each year[4] achieve low long-run average cost when their fixed cost is low relative to their marginal cost of generation.[5] Accordingly, peakers are generally simpler, higher-polluting, and less efficient than other types of generation facilities.

Though peakers have historically been arguably the economically efficient solution to a fundamental challenge of the power system—how to meet recurrent but short periods of very high demand and provide critical ancillary services—they have also had a disproportionate environmental impact. Fortunately, emerging storage and grid interactivity electronic technologies are beginning to offer lower-cost and low-polluting alternatives to legacy fossil peakers.

### *2.Peakers Have Disproportionately Large Environmental and Public Health Impacts*

While emissions of greenhouse gases have a global impact, fossil fuel power plants also emit copollutants that have local environmental and public health impacts, including nitrogen

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[1] This analysis uses primarily data on California natural gas power plants' qualities and emissions from 2014. Very few changes have been made to California's fleet of natural gas-fired plants since this time. A table of summary statistics for the observed power plants is included at the end of this comment.

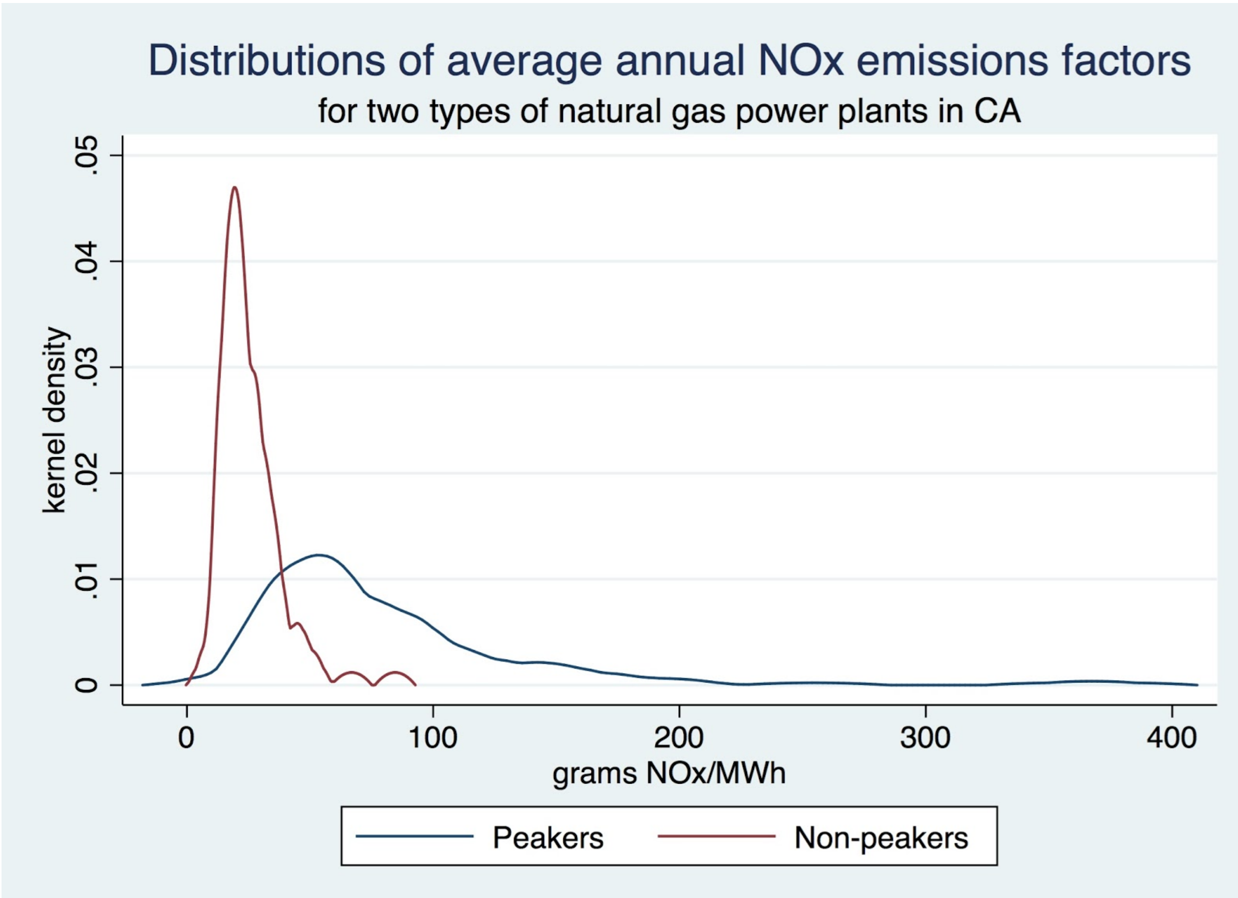
[2] http://www.eei.org/issuesandpolicy/stateregulation/Documents/ResourcePlanningProcurement.pdf

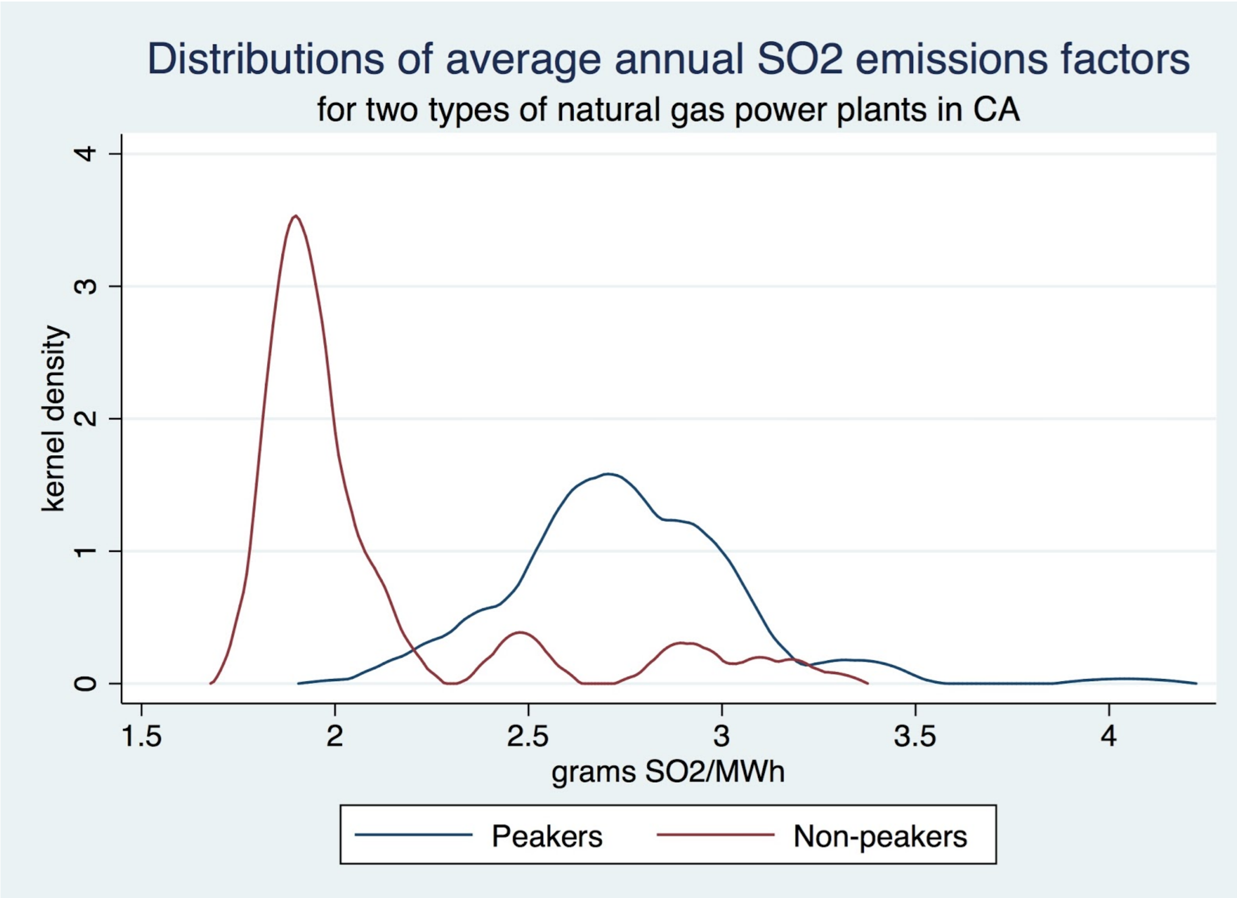
[3] Drbal, Lawrence F., Patricia G. Boston, and Kayla L. Westra. Power Plant Engineering. 2005. p. 820

[4] 10.9% of hours on average in 2014 (EIA)

[5] When assessing a potential peaker installation, a capacity factor of 10–30 percent if typically assumed. See: http://instituteforenergyresearch.org/wp-content/uploads/2015/06/ier_lcoe_2015.pdf

oxides (NOx), sulfur dioxide ($SO_2$), and particulate matter. NOx also serves as a precursor for the formation of ozone and very fine particulate matter ($PM_{2.5}$). Peakers in particular emit high levels of NOx and $SO_2$ per unit of power generated, as shown Figures 1 and 2.






The environmental and public health impact of peakers is disproportionately borne by disadvantaged communities. As Krieger et al. write in a recent article published in *Energy Policy*:

> Short-term and chronic ozone exposure has been found to increase mortality rates, particularly respiratory and pulmonary deaths. High PM2.5 concentrations increase the rate of acute coronary events, particularly in those with underlying disease and the elderly. Some populations are more at risk to exposure than other groups: high 1-h NOx concentrations, 8-h ozone concentrations, and 24-h PM2.5 concentrations are associated with increased asthma-related hospital visits in children; 8-h ozone concentrations are also strongly correlated with negative health impacts on the elderly and those with low employment status, and weakly correlated with impacts on ethnic or racial minority populations, and populations with high poverty rates or low educational status.

While our analysis finds that peakers are located in communities that look in many ways demographically similar to the rest of the state, these communities are also significantly higher concentrations of Latino and Asian American residents and significantly lower concentrations of white residents. We also find that peakers are sited in communities that suffer unusually high environmental burdens. Specifically, California communities within 5 miles of peakers exhibit ambient $PM_{2.5}$ concentrations roughly 56% higher than the state average, diesel PM six times the state average, toxic releases 11-times more frequent than the state average, and traffic levels four times the state average. In all, these communities have state environmental risk scores 22% higher than the average California community. In a separate but related analysis, we find that one's overall proximity to California's peakers is significantly predictive ($p < 0.01$) of a community's environmental quality.

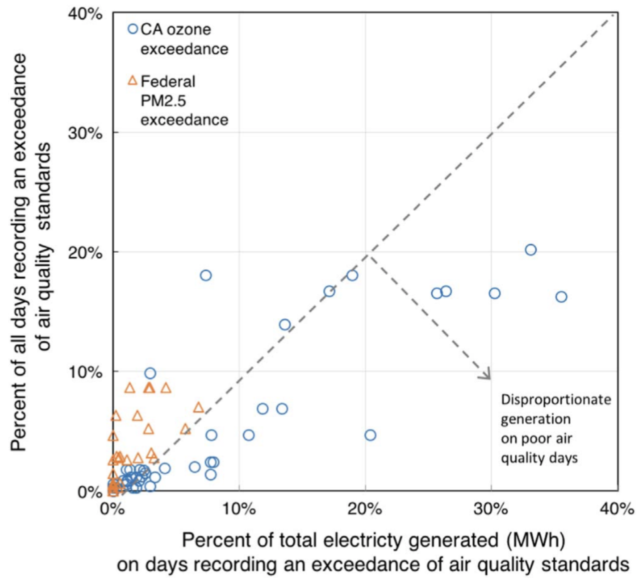
Table 1: Environmental quality

| | |
|---|---|
| Proximity to peakers | -0.961** |
| | (-2.73) |
| Constant | 29.92*** |
| | (39.67) |
| Observations | 8035 |

*t* statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

While we do not imply that peakers are solely responsible for the poor environmental quality of the communities in which they are sited, we note that, as a matter of equity, reductions in peaker pollution would, on average, provide important environmental benefits to communities that currently bear some of the heaviest environmental burdens and to many Californians of color.

Compounding these harms, peaker demand is disproportionately high on days with disproportionately poor air quality; at these times, the acute effects of peaker emissions are magnified. See Figure 3, reproduced from Krieger, et al. (cited above), demonstrating peakers' high levels of activity on ozone exceedance days:




In addition to equity considerations, the potential health benefits of reducing our reliance on fossil peaker plants are substantial: in the 2015 Clean Power Plan, the U.S. EPA estimated the 2020 health benefit of reducing NOx emissions to be highest in California, at \$22,000–49,000/ton $PM_{2.5}$ and \$14,000–59,000/ton ozone.[6]

### *3. The Scoping Plan's Proposed Cap-And-Trade Implementation Insufficiently Incentivizes Reductions In Demand For Peakers—And May Even Increase Demand For Them*

**Senate Bill 350** (SB 350)[7] requires the State to set GHG reduction planning targets both for the electricity sector as a whole and for individual utilities and other electricity providers (collectively known as load serving entities), which will develop strategies to reduce GHG emissions through Integrated Resource Planning. The bill also codifies an increase in the Renewables Portfolio Standard (RPS) to 50 percent by 2030. Most of this increased renewable generation (up from 33 percent by 2020) is expected to be solar and wind. While these resources are generally predictable in their output and allow for a certain degree of dispatchability, variations in power output will occur as a result of fluctuations in insolation and wind speed. These variations must be addressed in order to balance electric supply and demand, and to maximize the efficiency of the electric power system as a whole.

Grid operators currently use three main strategies to balance fluctuating generation throughout a day: curtailment, load shifting, and ramping dispatchable generation sources, including peakers.

The first, curtailment, involves operating renewables below their maximum power output. Though effective, this strategy involves forgoing zero or very low marginal cost and marginal

[6] EPA, 2015. Regulatory impact analysis for the Clean Power Plan final rule. Tech. Rep. EPA 452-R-15–003, U.S. Environmental Protection Agency (August). http://www2.epa.gov/sites/production/files/2015-08/documents/cpp-final-rule-ria.pdf.

[7] De Leon, Chapter 547, Statutes of 2015.

emission generation, increasing costs to consumers and the overall carbon intensity of California's energy system. Further, customer-installed generation—spurred by load-modifying policies such as net energy metering, the California Solar Initiative, the Self-Generation Incentive Program, and the federal Production Tax Credit and Investment Tax Credit—is generally not-dispatchable (cannot be curtailed by CAISO).

The second strategy, load shifting, encompasses a number of tactics, including demand response programs and deploying battery storage arrays. The third strategy includes adjusting output at dispatchable renewable energy sources, such as hydroelectric facilities, but often the default approach of utilities and grid operators is to authorize the construction and use of natural gas plants—often peakers. Indeed, while meeting peak demand is still an important use case for peakers, the increasing flexibility, but relative geographic concentration of large-scale renewable resources has meant that other services provided by peakers—including ramping during non-peak times and ancillary power quality[8] services—have become relatively more important. As renewable generation patterns become increasingly predictable, and to some extent controllable, resources with moderate ramping times will be able to meet more of the need for additional generation when peak demand coincides with reduced output at wind and solar plants, but for outage events and unpredictable weather conditions, fast ramping resources will always be needed. Ancillary services are often needed in geographically-specific load pockets and transmission areas that may be far from large renewable and non-renewable generation sources. Small peakers often provide these services today. If they are replaced by generation or storage resources, these replacement resources must be similarly-sited.

In sum, the increase of renewables in the California power system is expected to increase demand for fast-ramping capability and localized ancillary services for grid stability.[9] It would be a mistake, however, to conflate this need with a need for continued reliance on aging, expensive, and high-polluting peakers.

In addition to market and rate-design tools to incentivize demand response and better alignment of demand and peak supply, both distributed and utility-scale energy storage options offer a cleaner and safer alternative to continued reliance on peakers. Accordingly, ARB should prioritize approaches to Cap and Trade that will incentivize a transition away from these legacy polluters and towards cleaner alternatives.

California's **Mobile Source Strategy** aims to realize 1.5 million zero emission and plug-in hybrid light-duty electric vehicles by 2025 (with up to 4.2 million ZEVs by 2030), with an additional 100 percent of new urban buses and 10 percent of new delivery vehicles also zero-emission by 2030. Depending on the technology installed, these vehicles can reduce and beneficially shape total

[8] Typically defined as load-following, regulation (up and down), contingency reserves (spin and non-spin), frequency response, reactive power (voltage support), and "black start." CAISO currently operates ancillary services markets for only regulation (up and down) and contingency reserves. CAISO is currently considering introducing markets for voltage support, frequency regulation, and a flexible ramping product. See www.caiso.com/informed/Pages/StakeholderProcesses/ReactivePowerRequirements-FinancialCompensation.aspx and www.caiso.com/informed/Pages/StakeholderProcesses/FrequencyResponse.aspx.

[9] Appendix P of the scoping plan notes: "... the variable nature of certain renewables, such as wind and solar, may lessen [the air quality improvements under the cap-and-trade program] and could contribute to localized impacts due to their variable nature and the need to back up the technologies with fossil generation to meet peak demand."

load by aligning charging times with times when renewable resources may otherwise be curtailed with time of use rates or remote dispatchable charging (and discharging).

California's **Sustainable Freight Action Plan** aims to see the deployment of over 100,000 freight vehicles and equipment capable of zero emission operation and maximize near-zero emission freight vehicles and equipment powered by renewable energy by 2030. Integrating this new source of flexible load can also help to reduce our reliance on peakers.

But, despite potential gains from the above policies, the mechanisms by which we will achieve grid benefits of distributed and vehicle-based storage are only beginning to emerge. If millions of EVs are added to our electric power system without smart approaches to how they can help shape load, our peak power ancillary services, and ramping needs may increase, rather than decrease, which could drive additional market pressures towards increased reliance on peakers. ARB should therefore consider both how these resources can best be integrated to maximize the benefits of our Cap and Trade system, and also how direct regulation and market conditions can reduce peaker pollution.

### 4. Better Alternatives to Legacy and New Fossil Peakers Exist

We identify six main technologies that can be deployed to reduce peaker demand: distributed solar with advanced inverters (DSAI), energy storage (ES; many types), synchronous condensers and clutch couplings, demand response (DR; interruptible load, direct load control, and behavioral load shaping), energy efficiency (EE), and advanced electric vehicles (AEVs).

A number of policies are in place to encourage the adoption of distributed solar power. However, most of the installed distributed solar generates energy naively: grid operators have no control over its contributions to overall levels of energy in the grid and the grid's power quality. **Advanced inverters** solve some of these challenges by enabling "more elaborate monitoring and communication of the grid status to the solar unit (and vice versa), the ability to receive operation instructions from a centralized location, and the capability to make autonomous decisions to improve grid stability, support power quality, and provide ancillary services."[10] DSAI does not, however, enhance the power system's ability to meet peak demand beyond what distributed solar may provide in the absence of DSAI. ARB should evaluate how DSAI can help to reduce reliance on peakers and reduce peaker pollution to the extent that DSAI replaces peaker operation for certain ancillary services.

AB 2514 (and subsequent rulemaking by the CPUC, such as D. 13–10–040) established a 1.3 GW **energy storage** target for 2020. The storage target covers a number of diverse technologies, including compressed air storage, battery storage, and small pumped hydro operations (less than 50 MW in total capacity). Between 2020 and 2030, California can and should readily exceed this target many times over. In addition to the development of larger storage resources pursuant to AB 2514, additional EVs, distributed combined solar and storage systems, and improved grid interactivity for EVs as well as home and commercial electric appliances and water heaters are likely to continue to grow significantly in the next 13 years. ARB should accordingly evaluate how these resources can reduce our reliance on peakers for ramping,

[10] National Renewable Energy Laboratory. 2014. Advanced Inverter Functions to Support High Levels of Distributed Solar Power. U.S. Department of Energy.

ancillary services, and meeting peak demand, in addition to reducing curtailment of high levels of renewable energy as we move towards meeting our 50% RPS.

Most peakers can be retrofitted with **synchronous condensers and clutch couplings**, technologies that allow them to be operated without generating solely for the purpose of providing ancillary services. These technologies draw power from the grid in order to power large machinery that feeds voltage into the grid and helps to regulate electric frequency on the grid in much the same manner conventional power plants do. Though a recent economic analysis[11] seems to suggest that these technologies are not profitable additions to peakers as currently operated, they might prove cheaper and simpler to operate than other sources of ancillary services where significant sunk costs and geographic constraints create conditions that incentivize continued utilization of existing peaker pad sites for ancillary services, even where peakers are no longer regularly utilized for generation.

**Demand response** is a broad name for a collection of technologies that achieve load shifting/shaping by centralizing control over energy demand. Some demand response strategies significantly empower power system management authorities: interruptible load grants these authorities the ability to interrupt large sources of industrial or commercial demand; direct load control does the same for consumers. Other systems simply build pathways through which these authorities can send a signal to customers to voluntarily and temporarily reduce their energy use at times when the grid is most burdened. Finally, behavioral load shaping, although currently uncommon in the United States, dynamically delays energy demand of large appliances by small amounts of time to balance total system load in an automated manner. ARB should consider how demand response programs can function within the scoping plan to help reduce reliance on peakers.

**Energy efficiency** technologies reduce the total magnitude of demand at most times by reducing the amount of power needed to perform some function at the point the power is consumed. To the extent that efficiency measures target behaviors and technologies that contribute most to peak load, these technologies can have disproportionately large benefits for peak-shaving and reduced ramping needs. ARB should analyze how utilities increased and increasingly optimized efficiency programs can help to reduce our reliance on fossil peakers between 2020 and 2030.

Finally, **advanced electric vehicles** reduce peaker demand by intelligent scheduling charging or returning power to the grid when necessary (acting, essentially, as distributed energy storage resources). Advanced electric vehicle technology ranges from simple—charging is stopped during very critical periods each year—to complex—fully interactive vehicle batteries that are both charging and returning energy to the grid whenever ideal. More advanced technology, as one might expect, costs more; the rate of battery degradation also increases when batteries are bidirectional. In order to achieve the maximum benefit of two-way grid-interactive EVs (V2G), California should therefore help EV owners to obtain some of the significant financial benefit that two-way charging provides to the electrical system by reducing the need for what is often extraordinarily expensive peak power supplies. Because the development of V2G remains in

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11 http://docketpublic.energy.ca.gov/PublicDocuments/15-AFC-01/TN210450_20160218T120232_Synchronous_Condenser_Analysis.pdf

part contingent on policies that are difficult for ARB to anticipate, ARB should consider EV scenarios that include the potential for grid non-interactive EVs, EVs that function as dispatchable load, and V2G when evaluating how increased EV penetration can help to reduce reliance on legacy fossil peakers.

### 5. Non-Fossil Technologies Can Provide Technically and Economically Feasible Solutions for Peakers' Six Primary Functions

Peakers perform six primary functions for the power system: generating capacity, voltage regulation, frequency regulation, load following, operating reserves, and a 'black start' option. All functions can be provided by a combination of the non-fossil technologies described above.

Peakers provide high-need, flexible **generating capacity** during periods of especially high load. Energy storage technologies can directly provide a form of generating capacity, if charged, and demand response and energy efficiency technologies indirectly provide the equivalent of peak period capacity by reducing demand during these periods.

Power quality, both in the sense of **voltage support** and **frequency regulation**, can be feasibly provided by energy storage technologies and distributed solar with advanced inverters. Energy storage is particularly well-suited to the task, with a number of profitable storage projects already developed specifically to serve these needs.[12]

Demand response and energy storage are capable of **load following**.

Energy storage and demand response can be used to increase supply or reduce demand on the grid in place of central generators that would otherwise be used in case of contingencies. The same technologies can also provide both fast-response **operating reserves** (e.g., spinning reserves) and slower-response reserves (e.g., supplemental reserves).

Finally, energy storage alone is capable of powering a **'black start.'** Many plants today have diesel backups to help with black start, which are tested on a weekly or monthly basis, have lower stacks and much higher emission rates. Batteries could replace these diesel gensets. The co-location of storage and a gas plant could help reduce emissions from ramping, as well.[13]

### 6. Policy Approaches to Spur Deployment of Non-fossil Replacements for Peakers

We identify five policy mechanisms that would decrease demand for peakers during high impact periods by encouraging reliance on the above alternatives: resource loading modification, dynamic emissions pricing, dynamic payment for cleaner generation and ancillary services, deeper integrations in resource planning, and time-of-use pricing. To the extent feasible in the scoping plan, ARB should consider how each of these policies may be

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12 http://www.renewableenergyworld.com/articles/2016/02/fast-responding-energy-storage-digs-into-frequency-regulation-market.html

13 http://www.utilitydive.com/news/aes-to-partially-replace-california-gas-plant-with-300-mw-of-battery-storag/423171/

implemented during the 2020–2030 compliance period. Where ARB does not have sole authority to implement a policy described here, the scoping plan hould describe a process by which ARB may consult with entities including but not limited to CAISO, the California Energy Commission, and the California Public Utilities Commission to further the development of these policies.

First, the **resource loading order** may be modified to prioritize technologies like demand response when demand is projected to cross a certain threshold. Recent research has suggested prioritizing this cleaner loading order on days of disproportionately poor air quality can dramatically improve air quality.[14] [15]

Second, $CO_2$ emissions associated with high levels of co-pollutants (such as the dirtier emissions of peakers), especially in environmentally stressed communities, could be priced in the carbon market in a manner that better reflects their full range of environmental and health burdens or otherwise requires additional demonstrations of environmental co-pollutant compliance before submitting carbon allowances. **Pricing adjustments** like these would reduce emissions-intensive operations over time and favor the development of cleaner generation technologies and the use of more efficient generation to charge grid-scale storage.

Third, resources that provide ancillary services from low- or zero-emissions technologies should receive **financial incentives for ancillary service provision** that better reflect both their grid benefits and their pollution benefits. This is especially pertinent as CAISO considers developing markets for frequency and voltage regulation.

Fourth, the three California power system management authorities should seek to eliminate silos between supply, demand, transmission, and generation planning, more **deeply integrating long-term resource planning**. The grid integration challenge requires that these authorities consider all potential resource types. ARB should evaluate the potential air pollution and health benefits of such coordination, and provide recommendations to the power system management authorities.

Fifth, California should seek to implement **full time-of-use pricing** and develop tariffs to benefit grid interactive distributed storage and EV technologies. By charging lower prices to consumers during off-peak times—or when renewables are available—California can use markets to encourage the adoption of more clean energy resources, relieving strain on the power grid during peak times. ARB should evaluate the potential air pollution and health benefits of such coordination, and provide recommendations to the power system management authorities.

In all, the proposed scoping plan should be intentional and specific about its plans for reducing

[14] Krieger, et al. 2016.
[15] http://www.sciencedirect.com/science/article/pii/S0301421513002346

demand for peakers.[16] Analysis by the UCS estimates that non-fossil solutions to grid flexibility can reduce curtailment by 77 percent, reduce emissions from electricity generation by 27 percent, and reduce the production cost of electricity by 25 percent compared to a 50 percent RPS base with flexibility provided by fossil fuel-driven sources of generation.[17] Our own analysis extends these findings to show that non-fossil grid flexibility would reduce NOx and $SO_2$ emissions, as well, with most of this reduction happening in environmentally stressed communities.

[16] In addition to addressing the public health concerns discussed above, reduced use of peakers may also contribute to achieving SB 1383 (BAAQMD: Reg 11, Rule 18), which targets methane and black carbon.
[17] Nelson, James H., and Laura M. Wisland. August 2015. "Achieving 50 Percent Renewable Electricity in California: The Role of Non-Fossil Flexibility in a Cleaner Electricity Grid." Union of Concerned Scientists.

## Summary statistics for plants analyzed above

| | (1)<br>Non-peaker NG plants | (2)<br>Peakers |
|---|---|---|
| Operating hours/year | 5799.52 | 955.95 |
| | (2176.5) | (973.9) |
| MW generated/year | 1.1e+06 | 48334.08 |
| | (615592.4) | (58832.2) |
| Capacity | 180.01 | 49.78 |
| | (77.08) | (27.35) |
| Year built | 2005 | 2005 |
| | (4.4) | (7.3) |
| *N* | 77 | 113 |

mean coefficients; sd in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$