California Peaker Power Plants

Energy Storage Replacement Opportunities

Across California, nearly 80 gas-fired power plants help meet statewide peak electric demand. These plants include 65 combustion turbines designed to ramp quickly to meet peak demand, and over ten aging steam and combined cycle turbines now used infrequently to meet peak needs. Half of these facilities are located in areas designated as disadvantaged communities by the state of California due to high cumulative socioeconomic, environmental and health burdens. California peakers also disproportionately operate on days when ozone concentrations exceed federal standards, exacerbating local air quality conditions. A number of the aging plants are poised for retirement, and some of the peakers are kept online only through expensive reliability contracts, suggesting many of these would be prime candidates for replacement. The state has also set numerous targets to support the deployment of renewable energy and energy storage and reduce dependence on fossil fuels, providing an opportunity to replace inefficient, high-emitting peakers plants in vulnerable communities throughout the state with energy storage, solar+storage, demand response, and other clean alternatives.

California Policy and Regulatory Environment

California has enacted numerous policy targets and incentives that could both directly and indirectly facilitate replacement of peakers with solar and storage. Key initiatives include but are not limited to:

- **Ongoing:** Minimum of 35 percent of California Climate Investments (from greenhouse gas cap-and-trade funds) earmarked to reduce emissions and support clean energy in disadvantaged communities.
- **2020:** 1,325 megawatt (MW) energy storage target; additional 500 MW of distributed storage.
- **2020-2025:** Inclusion of equity and resilience carve-out for distributed storage in the Self-Generation Incentive Program.
- **2030:** Phase-out of once-through cooling plants, which are often used to meet peak; 60 percent renewable electricity; recommended guidance to procure 12.1 gigawatts of energy storage by 2030; 46 million metric ton greenhouse gas emission target for the power sector.
- **2045:** Full carbon neutrality.
- **2050:** 100 percent renewable energy; 80 percent reduction in greenhouse gas emissions below 1990 levels.

The majority of the California grid is operated by the California Independent System Operator (CAISO), which identifies resource needs in load zones across the state. CAISO has identified local reliability areas which rely on local generation resources to meet peak demand. Deployment of energy storage and solar in these transmission-
constrained areas may help mitigate need for the peakers currently used to meet local peak demand, including in the Greater Bay Area, Stockton, Fresno, Kern, San Diego and the Los Angeles Basin, part of which is managed by the Los Angeles Department of Water & Power and has significant electricity import constraints. CAISO has also given reliability-must-run contracts to otherwise unprofitable peaker plants, which have the potential to be replaced with energy storage to meet these grid needs.

California Peaker Plants

Peak electricity demand in California is partially met by nearly 80 gas turbines, internal combustion units, and underutilized aging gas steam and combined cycle plants that run at capacity factors less than 15 percent (they generate 15 percent or less of the electricity that they would if they were running constantly at full power all year). Many of these plants are used at capacity factors as low as one percent. Features of these plants suggest that many would be good targets for replacement with energy storage, including:

- **Short runtimes:** Two-thirds of the gas turbines for which we have data (29 of 45) run less than five hours on average every time they are started up, which could likely be met with standalone batteries or solar+storage (see Figure 2).
- **Aging:** The once-through cooling plants are over 40 years old and slated for retirement, providing an opportunity to replace them with energy storage.
- **Infrequently used:** Twenty of the gas turbine peaker plants operate at a capacity factor of 2 percent or less.

California currently has 7.1 gigawatts (GW) of gas turbine or internal combustion peaker plants along with 5.9 GW of once-through cooling plants and 4.3 GW of combined cycle plants currently used as peakers (having capacity factors under 15 percent). Across California, energy storage procurements are beginning to replace fossil-fired power plants. For example, the Oakland Power Plant, an aging facility with a very low capacity factor, is currently facing retirement and will be replaced with a mix of solar and energy storage as part of the Oakland Clean Energy Initiative. Plants with long runtimes may be best replaced with a portfolio mix of multiple resources, such as solar, storage and demand response.

Nearby Populations

Some of California’s peakers serve load pockets in dense urban areas in California, including more than twenty facilities which have more than 100,000 people living within a three-mile radius of the plant. Half of the state’s peakers are lo-

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**Figure 2: Average hourly generation from the CalPeak Power Vaca Dixon plant.** The plant occasionally meets some morning loads and reduces output during peak solar hours, but it is most frequently used to meet peak evening demand. It runs an average of 2.8 hours every time it starts up and has a capacity factor of 2.6 percent. Batteries can serve a similar grid role.
Emissions and the Environment

The plants used to meet peak demand in California are typically less efficient and have higher emission rates of greenhouse gas and criteria pollutants per megawatt-hour of electricity generated than the natural gas-fired combined cycle plants used more frequently to meet load. Most of California is designated as out-of-attainment for federal ozone and fine particulate matter concentration standards; while the source of much of this pollution is transportation, peaker plants often operate on hot summer days to meet air conditioning demands and can exacerbate these poor air quality conditions. California peakers tend to operate disproportionately on high ozone days. For example, in the San Joaquin Valley Air Basin, one-third of days exceed federal ozone standards, but some of the peakers in the Valley generate two-thirds of the electricity they produce on days exceeding these standards. Figure 4 shows the percent of electricity generation on high ozone days and total annual emissions of nitrogen oxides (an ozone precursor) from California peakers. Energy storage, demand response, and other cleaner technologies could be preferentially sited in these areas and dispatched on poor air quality days to reduce reliance on these plants in polluted regions.

Summary

California’s peak electricity demand is met with dozens of power plants across the state, many of which operate at low capacity factors, have short runtimes, or are aging and slated to retire. In addition, many of these plants have high rates of pollutant emissions per megawatt-hour...
of electricity generated as compared with other plants in the state, and they tend to operate disproportionately on days when air quality exceeds federal ozone standards, exacerbating local air quality conditions. Half of California’s peaker plants are also located in areas designated as disadvantaged communities by the state. The state has ambitious energy storage targets as well as funding earmarked for emission reductions and clean energy access in disadvantaged communities. The state’s energy storage deployment goals and clean energy investment incentives provide a clear opportunity to target the more inefficient and polluting facilities for replacement with cleaner alternatives. Clean energy deployment in communities near plants located in transmission-constrained load pockets can help mitigate the need for those plants as well. In the attached table, we provide operational, environmental and demographic data for California peakers and nearby populations. Indicators such as nearby population, rates, heat rate (fuel used per megawatt-hour), operation on poor air quality days, capacity factor, typical run hours, location in an environmental justice community or in an import-constrained load area downstate, can help inform whether a given plant might be a good target for replacement with storage, solar + storage, demand response, or a portfolio of these resources. These data should be accompanied by engagement with affected communities to determine replacement priorities and strategies.

Figure 4: Annual average nitrogen oxide emissions and percent of generation on high ozone days from California peakers. Colors indicate the CalEnviroScreen score of the plant census tract. Energy storage can help replace plants with high emissions or plants that often operate when air quality is poor.
# California Peaker Plant Operational and Demographic Data

For methods see [www.psehealthyenergy.org](http://www.psehealthyenergy.org).

<table>
<thead>
<tr>
<th>Name (EIA ID)</th>
<th>Status</th>
<th>County</th>
<th>Fuel</th>
<th>MW</th>
<th>Local reliability area</th>
<th>Age</th>
<th>Capacity factor</th>
<th>Run hours/ start</th>
<th>Heat rate</th>
<th>CO₂ rate</th>
<th>NOₓ rate</th>
<th>% MWh high ozone days</th>
<th>Pop.</th>
<th>% Non-white</th>
<th>% Poverty</th>
<th>CES score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agua Mansa* (5951)</td>
<td>Operating</td>
<td>San Bernardino</td>
<td>Natural gas</td>
<td>61</td>
<td>LA Basin</td>
<td>16</td>
<td>2%</td>
<td>8</td>
<td>9.8</td>
<td>0.58</td>
<td>0.17</td>
<td>59%</td>
<td>67,236</td>
<td>82%</td>
<td>20%</td>
<td>98*</td>
</tr>
</tbody>
</table>

1. Primary fuel.
2. Installed nameplate capacity (plant size).
3. Local reliability area as designated by CAISO.
5. Percent of time running as compared to running all year at full capacity for 2016-2018.
6. Average number of hours plant runs each time it is turned on. Steam plants are slower to ramp up so tend to run longer.
7. Heat rates are energy burned per unit of electricity generated; high heat rates reflect low efficiency.
8. Direct carbon dioxide emissions per unit of electricity generated; does not include upstream emissions.
9. Nitrogen oxides (NOₓ) emitted per unit of electricity generated; NOₓ contributes to ozone and particulate matter formation.
10. Percent of generation on days nearby monitors record exceedances of federal ozone standards.
11. Percent non-white-only populations.
12. Percent of population below the federal poverty limit.
13. CalEnviroScreen 3.0 Score for plant census tract. *Indicates plant is in a disadvantaged community.