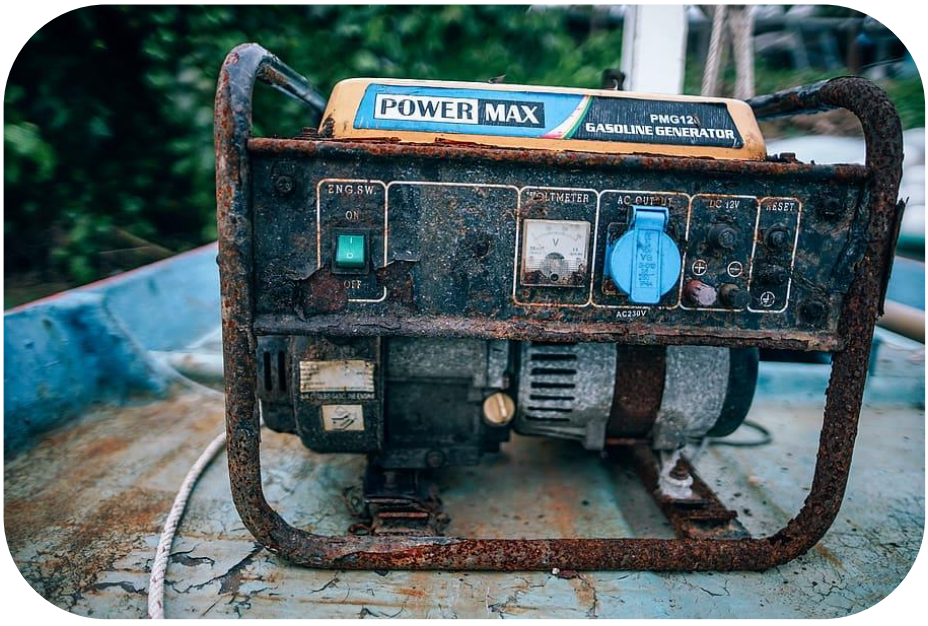
Hidden Grid: More Than Eight Gigawatts of Fossil Fueled Back-Up Generators Located in Just Five California Districts



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M3 POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS
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Introduction

California is a global leader in the development of distributed energy resources (DER): generation, energy efficiency, storage, electric vehicles, and demand response technologies. In 2013, Assembly Bill (AB) 327 required the reform of utility distribution planning, investment, and operations to "minimize overall system cost and maximize ratepayer benefits from investments in preferred resources," while advancing time- and location-variant pricing and incentives to support DERs. The California Public Utilities Commission's (CPUC) resulting *DER Action Plan* is intended to advance affordability, environmental sustainability, and economic prosperity.[1][2]

An oft overlooked DER, most of which were installed well before AB 327 passage, are back-up and emergency generators, which are typically powered by fossil fuels, primarily diesel. With clean energy resources increasingly affordable, and pressing needs to address polluting air emissions, it is time to assess the population, implications, and opportunities associated with California's BUG fleet.

Data and Methodology

Overview

For this initial analysis, five of California's 35 air quality management districts were selected to explore the distribution and concentration of back-up generators(**Figure 1**):

- South Coast Air Quality Management District (SCAQMD)
- Bay Area Air Quality Management District (BAAQMD)
- Eastern Kern County Air Pollution Control District (EKCAPCD)
- San Joaquin Valley Air Pollution Control District (SJVAPCD)
- Ventura County Air Pollution Control District (VCAPCD)

1 CPUC, California's Distributed Energy Resources Action Plan: Aligning Vision and Action, May 3, 2017, http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Organization/Commissioners/Michael_J._Picker/DER%20Action%20Plan%20(5-3-17)%20CLEAN.pdf

2 Next10, The Growth of Distributed Energy: Implications for California's Grid; Available at: https://www.next10.org/publications/grid-der

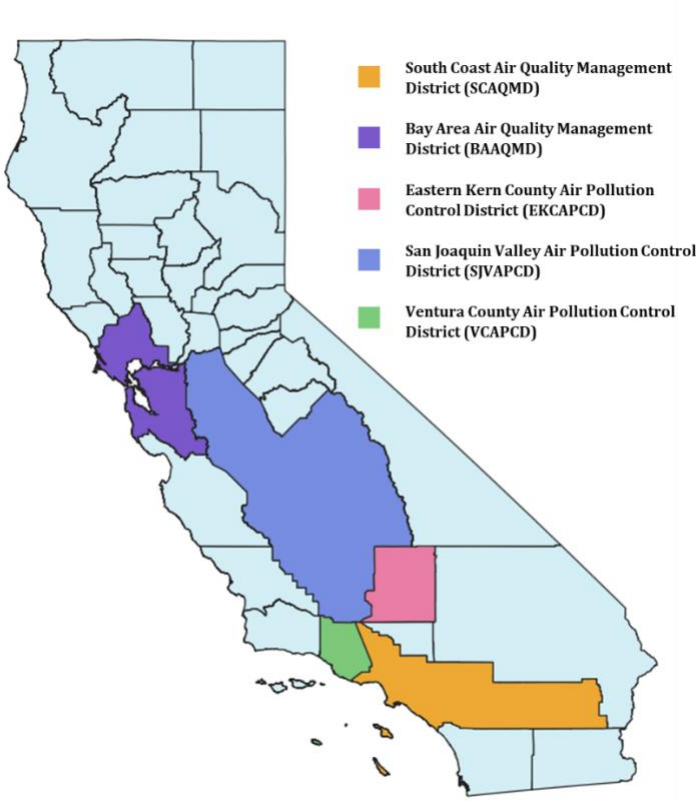

Figure 1: California Air Districts

Permit information for back up and emergency generators in individual air districts was collected through public information requests. The datasets received varied significantly in detail and consistency, as indicated in **Table 1**.

Table 1: Overview of District Data Received

District	Facility Info	Permit Date (Startup / Expire)	Equipment Details	Size	Permitted Use	Estimated Usage / Fuel Consumption
SCAQMD	Facility name; geography; facility representative	Permit issue date	BCAT number and generic BCAT equipment description	Ranges (50-500 bhp; >500 bhp)	Blanket permit of less than 200 hours	Not included
BAAQMD	Geography; facility name; facility owner	Initial issue date and current expiration	Detailed breakdowns including manufacturers, model numbers, serial numbers, and CARB class	Individual bhp figures	Individual hour/day, day/week, week/year permits	Estimate usage and fuel consumption (self-reported)
EKCAPCD	Facility name; geography	Permit issue date	General equipment specification	Individual bhp figures	Not included	Not included
SJVAPCD	Facility name; geography	Not included	Detailed equipment description including	Individual bhp figures	Individual hourly permits with	Not included

			manufacturer and serial number		description for use cases	
VCAPCD	Facility name; geography	Not included	Detailed equipment description with manufacturer and model	Individual bhp figures	MT permitted limit	Not included

Aggregated Dataset

Given data variability across the five districts, a simplified aggregated dataset was compiled with available information on location, equipment, capacity, permitted use, and fuel type. Most of the address and latitude/longitude data provided was digitized into GIS layers. As can be seen on the map in the results section, some of the addresses or locations given were for areas outside of district boundaries. Most of these cases are because the contact address is used, which can sometimes be associated with the managing entity.

For the aggregated data, capacity was estimated based on provided generator sizes (hp). Using an assumed 1.341 horsepower (hp) per kilowatt (kw), the generators' sizes were multiplied by 0.7457 and divided by 1,000 to yield megawatts. For SCAQMD, generator sizes were given in ranges (50 – 500; >500), so default values of 200 hp, based on average sizes for other districts and 500 hp, to be conservative, were selected.

Permitted use, when available, was generally provided for maximum allowed operational hours. These values were multiplied by capacity values to estimate maximum allowable MWh of electricity generation. Most of the units were permitted to run below 500 hours per year. It is unclear from the datasets exactly how much individual units are actually run.

Fuel types were standardized to include natural gas, diesel, oil, gasoline, LPG, and other[3] values based on the initial classifications from the air districts. These fuels were assigned an emissions factor based on U.S. EPA AP 42 documentation per **Table 2** below. From these values, high-level estimates of CO_2 emissions from maximum permitted use were calculated. These figures vary significantly depending on such factors as engine size, temperature, load operation, fuel content, control devices, etc. Accordingly, CO_2 values reflect orders of magnitude approximations.

Table 2: Emissions Factors by Fuel Type

Fuel	Emissions (lbs./hp-hr)	Notes	Source
Diesel	1.15	High load operation	AP 42 Vol 1 3.1: Gasoline and Diesel Industrial Engines https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s03.pdf
Natural Gas	0.77	Based on 110 lbs./MMBTU and an average brake specific fuel consumption (BSCF) of 7000 BTU/hp-hr	AP 42 Vol 1 3.1: Natural Gas Reciprocating Engines https://www3.epa.gov/ttn/chief/ap42/ch03/final/c03s02.pdf AP 42 Vol 1 3.1: Stationary Gas Turbines https://www3.epa.gov/ttn/chief/ap42/ch03/final/c03s01.pdf
Gasoline	1.08	High load operation	AP 42 Vol 1 3.1: Gasoline and Diesel Industrial Engines https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s03.pdf
Oil	1.099	Based on 157 lbs./MMBTU and an average brake specific fuel	AP 42 Vol 1 3.1: Natural Gas Reciprocating Engines https://www3.epa.gov/ttn/chief/ap42/ch03/final/c03s02.pdf

[3] Other fuels included oil, propane, lpg, biogas, landfill gas, biofuel, methanol, etc. depending on the district

		consumption (BSCF) of 7000 BTU/hp-hr	AP 42 Vol 1 3.1: Stationary Gas Turbines https://www3.epa.gov/ttn/chief/ap42/ch03/final/c03s01.pdf
LPG	0.639	Based on 12,500 lbs. CO2/1000 gallons, an average brake specific fuel consumption (BSCF) of 7000 BTU/hp-hr	AP42 Section 1.5 LPG Combustion https://www3.epa.gov/ttn/chief/ap42/ch01/final/c01s05.pdf
Other	0.85	Without information on the distribution of specific fuel types, a central value in between the above values was selected	

Results

Across the five districts there were 24,403[4] back-up and emergency generators, with an estimated 8.3 gigawatts of capacity. In 2018, California had an estimated 80,000 MW of generation capacity statewide.[5] This suggests that the state has approximately 10 percent back-up capacity from distributed fossil resources in just five of the 35 air districts. Notably missing from this estimate as the key population centers of San Diego, Sacramento, and the Central Coast (**Figure 2**).

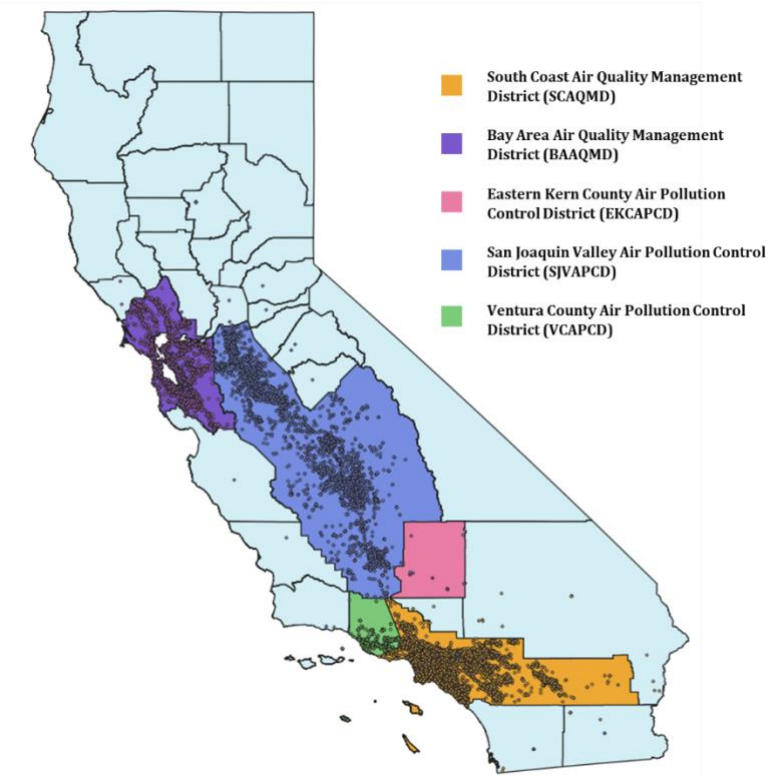

Figure 2: Back-up Generators in Target California Air Districts

The units were permitted to produce a maximum estimated 874 GWh of electricity. This represents a permitted value; actual runtimes and production were not included in the public datasets. Further, important

[4] Note that this is significantly higher than the 15,000 estimated in the Next10 report.

[5] CEC, California Energy Almanac; Available at: https://ww2.energy.ca.gov/almanac/electricity_data/total_system_power.html

variables, like engine size, temperature, load operation, fuel content, and control devices were excluded. With those caveats in mind, the 874 GWh of electricity could represent an estimated 562,000 metric tons (MT) of CO_2/year.

Diesel fuel generators made up approximately 89 percent of all units and accounted for 95 percent of estimated capacity in the five districts (**Table 3**). South Coast accounts for nearly 50 percent of back up and emergency generators included in the aggregated datasets, followed by BAAQMD, with 27 percent, and SJVAPCD, with 21 percent. (**Table 4**).

Table 3: Back-Up Generators by Fuel Type

Fuel Type	Number of Units	Total Capacity (MW)	Total Permitted MWh	Total Estimated Permitted CO_2 (MT)
Diesel	21,659	7,946.91	632,133.26	442,248.20
Gasoline	102	14.19	2,629.23	1,727.48
LPG	562	47.63	4,555.34	1,770.85
Natural Gas	1,633	255.62	119,957.79	56,338.61
Natural Gas / LPG	278	42.59	8,158.88	3,831.85
Oil	90	19.35	3,482.03	2,328.04
Other	79	25.02	103,738.46	53,643.74
Total	**24,403**	**8,351.32**	**874,654.98**	**561,888.76**

Table 4: Back-up Generators by Air District

District	Number of Units	Total Capacity (MW)	Total Permitted Operation (MWh)	Total Estimated Permitted CO_2 (MT)
BAAQMD	6,496	3,810.45	240,530.27	129,700.08
EKCAPCD	15	6.44	0.00[6]	0.00*
SCAQMD	12,104	2,697.13	539,426.69	368,227.37
SJVAPCD	5,106	1,528.14	86,363.70	58,131.29
VCAPCD	682	309.15	8,334.33	5,830.03
Total	**24,403**	**8,351.32**	**874,654.98**	**561,888.76**

Limitations

This analysis has a number of limitations, including:

- **Missing Air Districts** – With only five of 35 air districts the analysis does not reflect a statewide picture for back-up generation capacity, particularly with significant population centers missing.
- **Varying Level of Detail Across Datasets** – While most districts included the same general parameters (**Table 1**) there was substantial variation in details provided, particularly for fuel type and permitted use.

[6] The values for permitted MWh/MT for Kern County are 0 because of missing data

- **Generator Operating Parameters** – Information on operating load, temperature, fuel content, and control devices for the permitted generators was limited in the available datasets. These variables play a critical part in calculating potential emissions and air quality impacts.
- **Actual vs. Permitted Generator Use** – Most of the districts only provided permitted use data excluding information on historic utilization.
- **Emissions Methodology** – The air districts generally utilize some combination of California Air Resources Board and EPA AP-42 methodologies to calculate emissions, but the overall AP-42 methodologies utilized for this analysis likely do not account for the granularity and nuances of specific CARB methodologies for different engine classes. Given available information, the high-level AP-42 were utilized as a simplifying assumption.

Discussion and Future Research

This initial analysis highlights several key issues that warrant further discussion and research:

Portfolio of Back-up Generators – To fully understand the magnitude of back-up generation capacity and identify opportunities to develop alternatives to replace fossil fuels, an analysis of the full portfolio of state back-up generators should be developed. There does not appear to be a publicly accessible statewide database of these generators. Instead individual public data requests for each of the districts must be compiled, as has been done here. These datasets should be created and added to the state GIS resources at the California Energy Commission to provide a basis for a more iterative and dynamic management of the portfolio of back-up generators in individual air districts.

Clustering of Back-up Capacity – Leveraging a full portfolio of back-up capacity would allow for a more extensive analysis of clustering patterns for the generators and associated air quality impacts. Critical in this effort is analyzing the distribution of back-up capacity in low-income communities and near vulnerable populations, particularly schools. The geospatial data for back-up capacity, and particularly the actual utilization and emissions from that capacity, should be integrated into CalEnviroScreen and other assessment tools to help guide policy making.

Closer Integration of BUG Capacity Considerations into DER Planning – There is an opportunity to integrate back-up generation capacity, both individually and at a portfolio level, to planning and policy making for DERs, including related to wildfire risk mitigation. BUGs are generally omitted from distributed generation and reliability considerations in various California proceedings, including whether fossil fueled BUGS might be affordably and beneficially replaced with cleaner resources. There may be opportunities to proactively engage customers with older BUGs as targets for new investments in DER capacity as part of reliability/resiliency efforts.

Permitting of Fossil Back-up Capacity – A broader question for the state and air districts is how to transition away from fossil fuel back-ups in the context of long-term clean energy goals. The permit renewal process for these back-up generators does not leverage opportunities to create pathways to economic or environmental sustainability. Instead, older back-up generation systems are being granted permit renewals despite state mandates to invest in clean energy resources.