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Emission Impact: Additional Generator Usage Associated with Power Outage

January 30, 2020

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Summary

For public safety, it may be necessary for utilities to turn off electricity when gusty winds and dry conditions, combined with a heightened fire risk, are forecasted. This is called a “Public Safety Power Shutoff” or “PSPS”. According to CPUC de-energization report¹, in October 2019, there have been almost 806 PSPS events that have impacted almost 973,000 customers (~7.5% of households in California) of which ~854,000 of them were residential customers, and the rest were commercial/industrial/medical baseline/other customers. Data also indicates that on average each of these customers had about 43 hours of power outage in October 2019.

Following the PSPS events, many households and businesses in California started operating their back-up generators to provide power for their day-to-day operations. Generators used during power outage will increase emissions as compared to an average day. Staff assessment indicated that with 973,000 customers impacted by PSPS events in October 2019, approximately 125,000 back-up generators were used by customers to provide electricity during power outage. Assuming 50 hours of operation per generator during month of October 2019, staff estimated excess emissions from the use of generators which are summarized in Table 1.

Table 1: Population and excess emissions from the use of electricity power generators during October 2019 PSPS events.

Generator Type		NOx (tons)	PM (tons)	Diesel PM (tons)	Additional Generators Running in PSPS
Portable	Gasoline Less than 25 hp	24.3	10.6		122,000
	Diesel above 25 hp <i>Non-Rental Generator</i>	7.3	0.30	0.30	381
	Diesel above 25 hp <i>Rental Generator</i>	9.1	0.30	0.30	582
Permitted Stationary Back-Up Generators (Assuming 30% Load Factor)		125.7	8.3	8.3	1,810
Non-permitted generators ²		N/A	N/A	N/A	N/A
Total		166.4	19.4	8.9	124,774

¹ <https://www.cpuc.ca.gov/deenergization/>

² This analysis does not include emissions estimates from non-permitted generators such as the residential standby natural gas powered generators with power rating of less than 50 hp (e.g, a 22 kW Guardian Series home standby generator by Generac). At this point there is no information available on their population and sales. According to discussion with industry, it is assumed that most of these generator are powered by natural gas.

To put these numbers into context, 9 tons of diesel PM is equivalent to emissions from almost 29,000 heavy duty diesel trucks (above 14,000 lbs.) driving on California roadways for the period of one month (on average each truck drives around 3,000 miles per month).

The calculations described in the rest of the document outlines the assumptions used to estimate potential emissions impact from the use of gasoline and diesel generators during PSPS events.

Small Gasoline Powered Generators (less than 25 hp)

Population

Based on 2018 California State University Fullerton (CSUF) Survey³ for small off-road (SORE) equipment, about one out of 8 households own a generator in California. For a population of 973,000 households, about 122,000 generators will likely to be used to provide additional power during the power shut-off period.

Emission Factors

According to data provided by manufacturers as part of the SORE Evaporative Reporting Requirement⁴, generators have an average horsepower of 3.5 hp of which when combined with a load factor of 0.68, derived from OFFROAD2007⁵, results in an effective power of 2.4 hp. To determine emission factors, we used emissions data from SORE exhaust certification database. Table 2 shows the derived emission factors along with weighted average emission factors across all horsepower bins.

Table 2: Exhaust emission factors (g/bhp-hr) for gasoline powered generator less than 25 hp

Equipment	Tech Type	Horsepower	Percent Population	HC (g/bhp-hr)	NOX (g/bhp-hr)	PM (g/bhp-hr)
Generator Sets	G2-CARB	0 – 2	5%	27.860	0.900	0.600
	G4-CARB	2 – 5	82%	5.634	1.484	0.740
		5 – 15	9%	2.885	1.975	0.140
		15 – 25	3%	3.390	1.422	0.140
	G4-FI	15 – 25	1%	1.074	2.125	0.140
Population Weighted Average				6.296	1.505	0.655

Using the effective power and emission factors described earlier, staff estimated excess emissions as well emissions during 50 hours of generators operation (5 days with 10 hours a day operation). For example, with 122,000 generators operating for 50 hours during power shutoff, staff estimated excess emissions of 24.3 tons of NOx, 101.5 tons of THC, and 10.6 tons of PM. The calculation below outlines the assumptions used for this emissions impact assessment. Obviously, a more refined estimate can be made with additional information.

³ Survey of Small Off-Road Engines (SORE) Operating within California: Results from Surveys with Four Statewide Populations, Submitted May 15, 2019, Prepared by the Social Science Research Center (SSRC) at CSU, Fullerton.

⁴ https://ww3.arb.ca.gov/msprog/mailouts/ecars1805/ecars1805.pdf?_ga=2.15158582.1846785299.1570743950-1632999103.1458687259

⁵ <https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-road-archives>

Portable Diesel Generators (above 25 hp)

Portable diesel generators are generally much larger and supply more power than gasoline generators, and could be used during PSPS events to supply power to larger facilities (such as schools, industrial facilities, or buildings). Table 3 provides CARB's latest population, activity, and emissions associated diesel portable generators registered under CARB's PERP program⁶.

Table 3: Emissions and Population of Diesel portable generators registered under CARB's PERP program

	Population (statewide)	Annual Activity (hours)	NOx (tons/yr)	PM (tons/yr)	PM25 (tons/yr)
Portable Equipment - Non-Rental Generator	5,081	1,299	2,537	99	91
Portable Equipment - Rental Generator	7,764	1,392	3,363	123	113

For assessing the emissions impact associated with this event, this analysis will assume that the percent of businesses that use generators and backup generators that are impacted by the PSPS is roughly proportional to the percent of households impacted (about 973,000 households out of 13,000,000 in California, or about 7.5 percent of the population of generators in the state). Table 4 shows the excess emissions from the use of portable diesel power generators during PSPS events assuming 50 hours of operations.

Table 4: Population and excess emissions from the use of portable diesel powered generators during October 2019 PSPS events

	Additional Generators Running in PSPS	NOx (tons)	PM (tons)	PM2.5 (tons)
Portable Equipment - Non-Rental Generator	381	7.3	0.30	0.30
Portable Equipment - Rental Generator	582	9.1	0.30	0.30
Total	964	16.45	0.61	0.61

Permitted Stationary Back-Up Generators (BUG)

Population

Data on permitted stationary back-up generators were provided to CARB by several air districts. Staff used the facility ID from the districts permit data to find the address of the facility that the stationary BUGs are operating and determined whether those BUGs were impacted by the PSPS events or not. Using this process, staff determined that almost 1,810 stationary BUGs across California were impacted by the October 2019 PSPS events.

Emission Factors

Additionally, using actual emission factors for each diesel BUG engines provided in the districts' stationary BUGs database (i.e., stationary BUGs permit database), staff assumed a work based emission factors of 0.44 g/bhp-hr for PM and 6.7 g/bhp-hr for NOx, based on averaging of a

⁶ <https://ww2.arb.ca.gov/our-work/programs/portable-equipment-registration-program-perp>

sample of permitted diesel powered backup generators in the state. The analysis also indicated that an average permitted back-up generator has a power rating of ~ 627 hp and they can go up as high as 4,400 hp which when combined with a load factor assumption of 30% resulted in an effective power of 188 hp. Table 5 provides a summary of excess emissions associated with the stationary BUGs impacted by the PSPS events.

Table 5: Population and excess emissions from the use of diesel powered stationary back-up generators (BUG) during October 2019 PSPS events

	Additional Generators Running in PSPS	NOx (tons)	PM (tons)	Diesel PM (tons)
Permitted Stationary Back-Up Generators	1,810	126	8.3	8.3

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