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POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS

M.CUBED

Back-up Generator Populations in Bay Area, South Coast Continue to Grow; San Diego Home to a Significant Number of Generators, Mostly Diesel-Power[1]

December 2022

[1] This analysis is a continuation of work initially conducted pro bono by Steven Moss, M.Cubed Partner and Andy Bilich, Research Associate, who were concerned about what appeared to be rapid increases in diesel BUGs deployment in San Francisco, where in 2017 a generator was sited near the high school that Moss' daughter attended. Bloom Energy funded this update.

Overview

This analysis summarizes the population and characteristics of backup generators (BUGs) permitted in the Bay Area (BAAQMD) and South Coast (SCAQMD) air quality management districts, as well as the San Diego County Air Pollution Control District (SDCAPCD).

In 2022 the three districts were collectively home to 29,217 back-up generators, with a generating capacity of more than 14.2 gigawatts (GW), which emitted an estimated 174,000+ metric tons of carbon dioxide ($MTCO_2$) annually.[2] Almost 90 percent of the generators are diesel fueled.

This analysis replicates 2020[3] and 2021[4] studies conducted in the BAAQMD and SCAQMD service territories. In 2021, the two districts were home to 23,507 BUGs, which had a generating capacity of 12.2 gigawatts (GW). In 2020 there were 18,600 BUGs with 6.5 GW of capacity. The BUG population has grown steadily over the study period, jumping 26 percent in the two districts from 2020 to 2021, with a nine percent increase 2021 to 2022, as shown in Figure 1.[5] SDCAPCD was not included in the earlier investigations.

The sections below explore the BUG portfolios in each of the Air Districts.

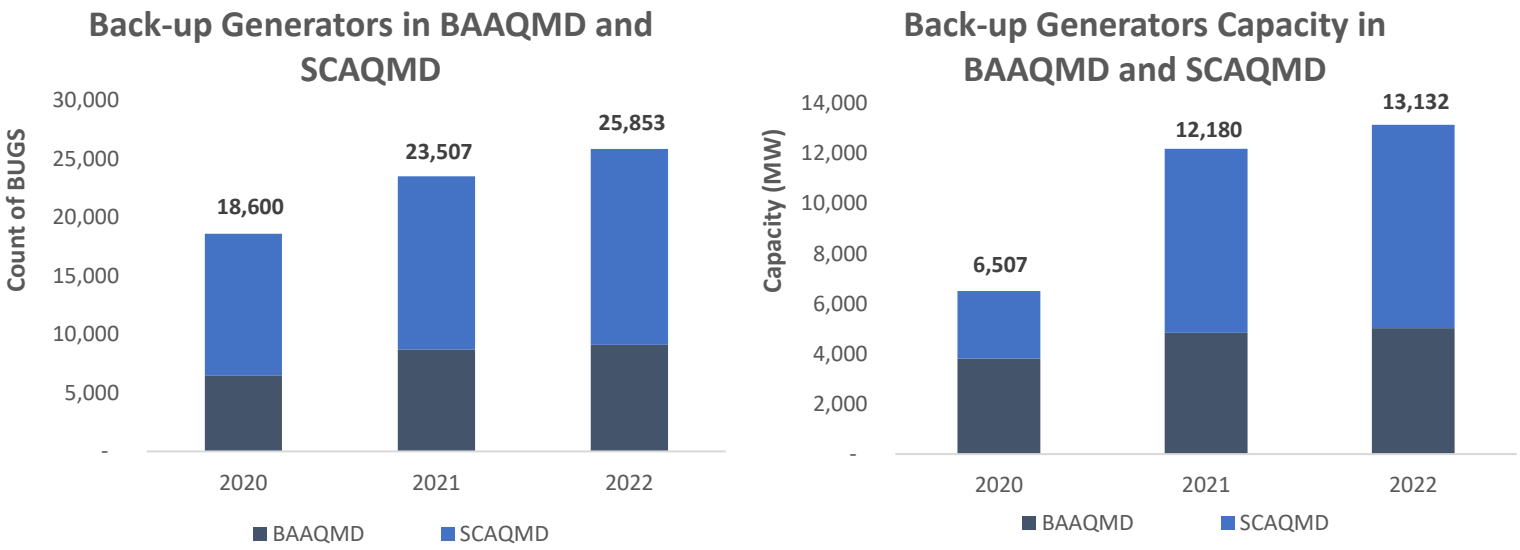


Figure 1: Growth in Back-up Generators in BAAQMD and SCAQMD (Count – Left; Capacity – Right)

[2] Based on data obtained from the districts in May and June 2021.
[3] BUGs-in-5-CA-Air-Districts.pdf (lgsec.org).
[4] https://www.bloomenergy.com/resource/new-study-shows-a-rapid-increase-of-diesel-fueled-backup-generators-across-california/
[5] There is significant uncertainty associated with individual BUG capacities in SCAQMD, as discussed in this report's methodology section.

Bay Area Air Quality Management District

Back-up Generators Portfolio Summary

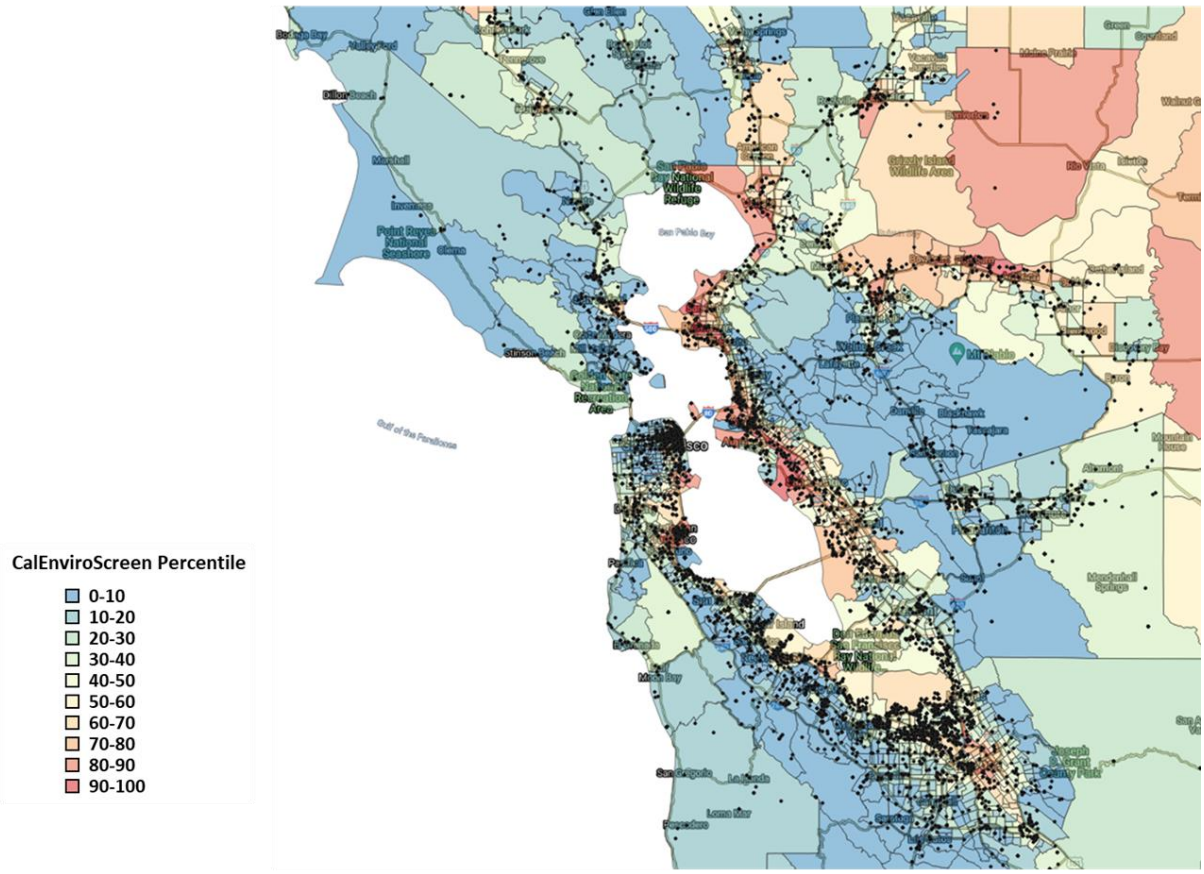
There are 9,121 back-up generators permitted in the Bay Area Air Quality Management District, with a collective capacity of more than five GW. The majority of these gensets are diesel powered, 8,215 gensets or 90% of the portfolio, with methane gas accounting for the second highest subset, 521 gensets or 5.7% of the portfolio (Figure 2, Figure 3, Table 1). Over the past roughly year, these gensets operated more than 271,000 hours, generating in excess of 61.7 GW-hours of power and greater than 43,400 tons of CO_2.

Notably, in the dataset provided by the district, 1,525 gensets, 16.7% of the portfolio, reported 0 operational hours (1,467 gensets) or had redacted hours (58 gensets). Despite these omissions, many of these gensets still indicated CO_2 emissions; 341 gensets show CO_2 releases while reporting 0 or redacted operational hours.

The average genset capacity was 551 kW. This figure varies significantly by fuel type, with diesel BUGs and the undefined gensets having substantially larger capacities than other fuels. Reported operating hours averaged 30 hours across the portfolio, but these also varied substantially with propane and liquified petroleum gas (LPG) gensets operating the longest and diesel gensets averaging just 13 hours of use per year (Table 2).

Ninety-one percent of the gensets, 8,294, were tagged as “electricity generation,” with fire pumps accounting for 538 gensets, 6%, general pumps 216 gensets, 2%, and other applications accounting for 64 gensets (1%).

Bay Area Air Quality Management District Back-up Generators



There are 9,121 gensets operating in the Bay Area totaling over 5 GW of capacity. The map shows the siting of these generators in the context of CalEnviroScreen; red/orange indicate most burdened, vulnerable communities, blue/green the least.

Figure 2: BAAQMD Map of Back-up Generators

Table 1: BAAQMD Back-up Generator Portfolio

Fuel	Count	Capacity (MW)	Reported Hours	Generation (GWh)	CO_2 (tCO_2)
Diesel	8,215	4,909	106,359	47.4	33,128
Natural Gas	521	66	18,067	1.6	1,172
Gasoline	15	1	19,657	1.1	945
LPG	303	26	107,879	9.6	6,523
Propane	22	2	19,147	1.8	1,416
Undefined	45	18	722	0.2	257
Total	9,121	5,023	271,831	61.7	43,441

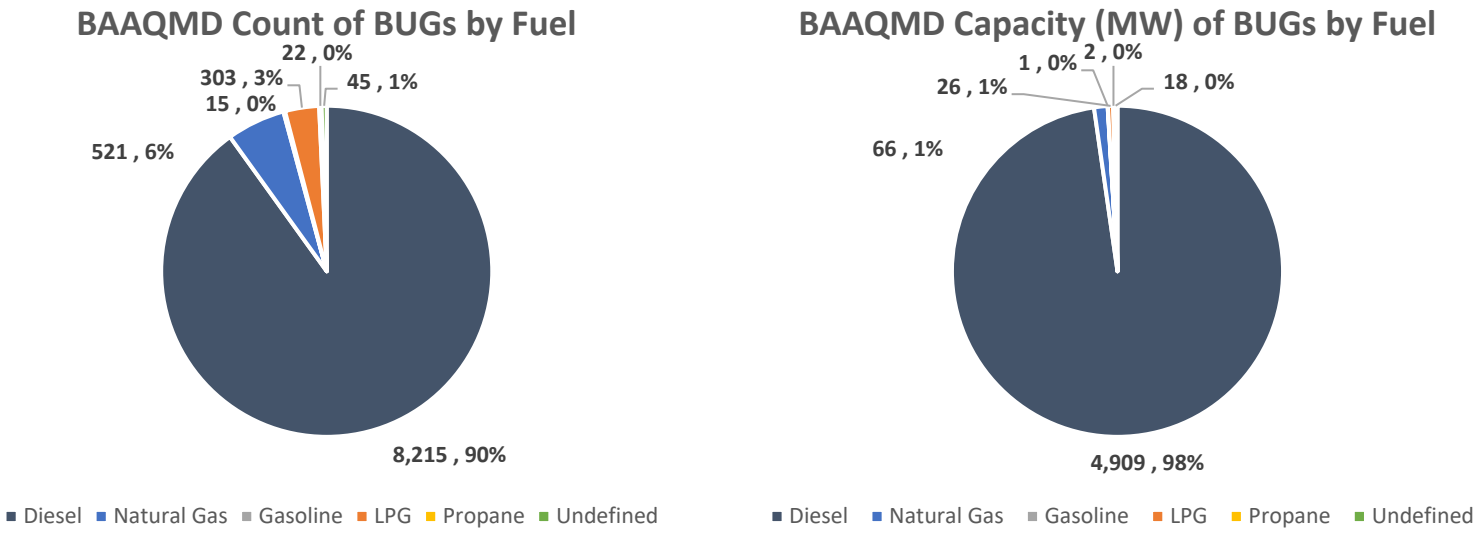


Figure 3: BAAQMD Count (Left) and Capacity (Right) of BUGS by Fuel

Table 2: Average Capacities, Operating Hours, Generation, and Emissions for BAAQMD BUGS Portfolio

Fuel	Capacity (kW)	Reported Hours	Generation (kWh)	CO_2 (tCO_2)
Diesel	598	13	7,779	4
Natural Gas	127	35	4,433	2
Gasoline	90	1,404	126,338	63
LPG	86	356	30,503	22
Propane	97	870	84,823	64
Undefined	409	20	8,209	6
Total	551	30	16,518	5

Since June 28, 2021, the date when the BAAQMD compiled the data for the 2021 Bloom analysis, 7,815 gensets, 85.6% of the portfolio, have been reissued or newly issued operating permits.

Methodology

A public records request to obtain data on the portfolio of permitted backup gensets was filed with BAAQMD on October 26, 2022 and fulfilled by BAAQMD on November 9, 2022. District data included facility information, locations, horsepower (HP), fuels, estimated emissions, and reported operating hours.[6]

Reported runtimes and District-calculated emissions were utilized as the basis for estimates for most assets, with a few observations dropped due to quality issues. BUG owner/operators are supposed to report usage when their permits are renewed, but these data are not always

[6] HP figures were converted to MW by multiplying by 0.7457 and dividing by 1000.

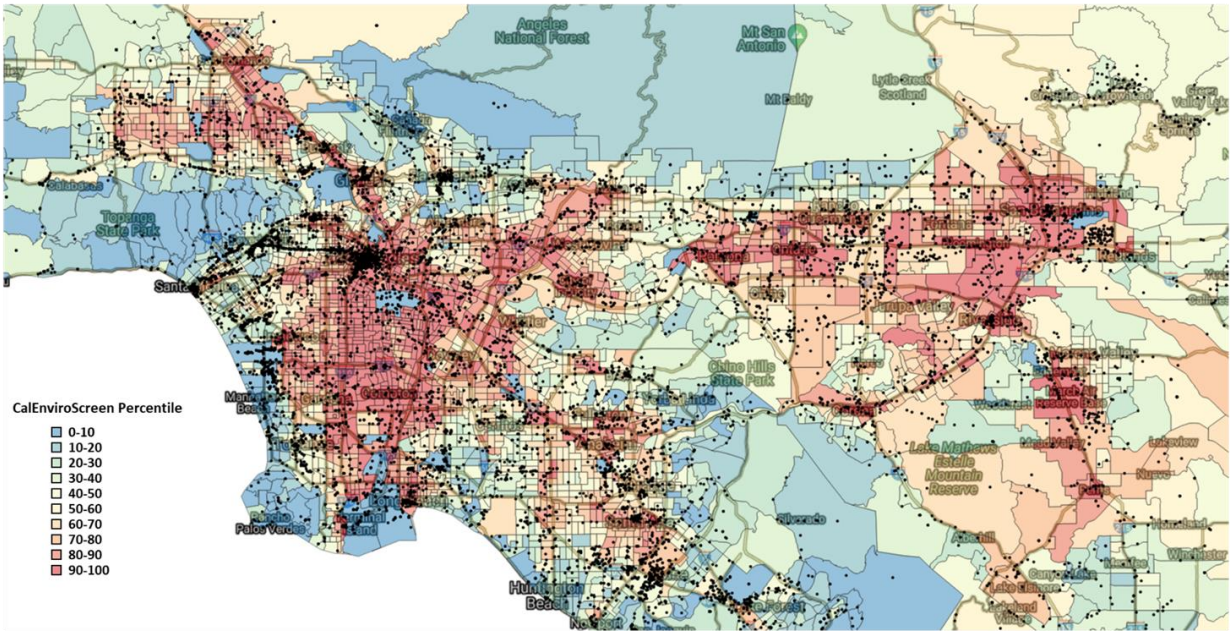
reflected in the database. Altogether, 3,118 gensets – 41 percent of the portfolio – had their last reports from before 2021.[7]

South Coast Air Quality Management District (SCAQMD)

Back-up Generators Portfolio Summary

There are more than 16,732 permitted BUGS with a cumulative capacity of 8.1 GW in the South Coast Air Quality Management District (SCAQMD). Diesel and methane gas systems make up the majority of the portfolio, at 84% and 9%, respectively. If these assets were operated similarly to what was reported in BAAQMD (see methodology section below) they would account for in excess of 135 GWh of generation and be responsible for greater than 123,000 tCO2 (Figure 4, Table 3, Figure 5).

South Coast Air Quality Management District Back-up Generators



There are 16,732 gensets operating in the South Coast District totaling over 8.1 GW of capacity. The map shows the siting of these generators in the context of CalEnviroScreen; red/orange indicate most burdened, vulnerable communities, blue/green the least.

Figure 4: SCAQMD Map of BUGS Portfolio

Table 3: SCAQMD BUGS Portfolio

Fuel	Count	Capacity (MW)	Reported Hours	Generation (GWh)	CO2 (tCO2)
Diesel	14,010	7,455	185,420	82	103,674

[7] While the numbers contained herein are representative of the BAAQMD's BUGs portfolio, the datasets are subject to edit/change by the District, a phenomenon that is extant for all three districts in this study.

Natural Gas	1,438	299	44,254	5	10,641
Gasoline	205	21	287,820	29	1,517
LPG	429	57	139,419	12	3,175
HFO	74	14	52,035	4	548
Other	576	263	11,178	4	4,262
Total	16,732	8,109	720,126	135	123,817

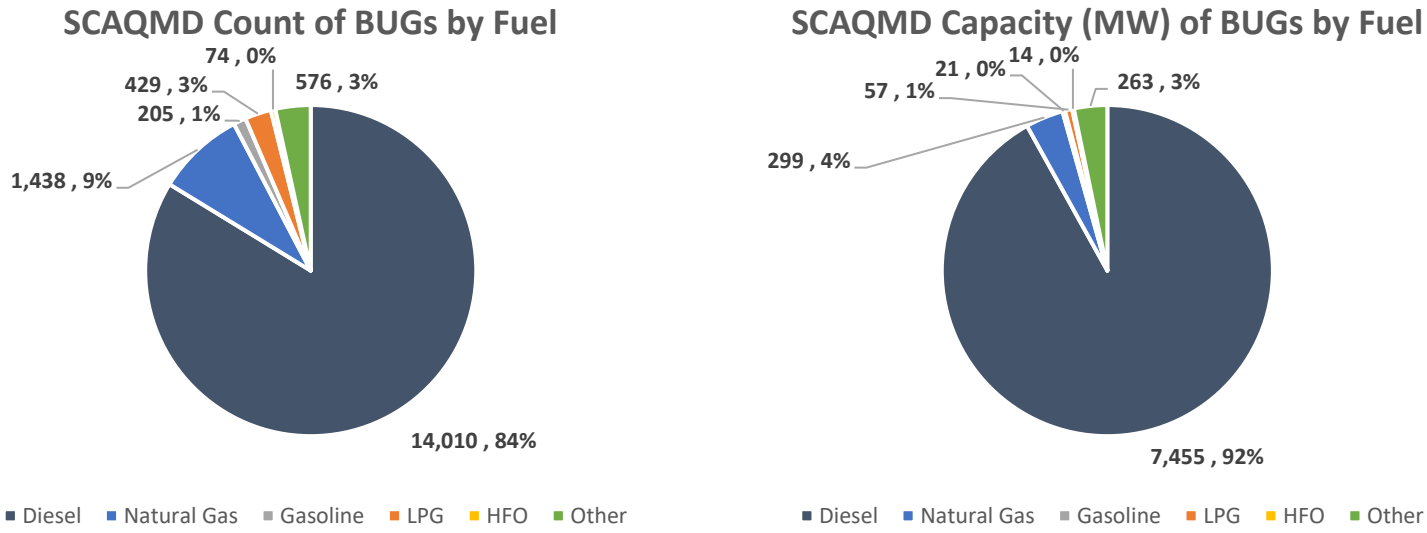


Figure 5: SCAQMD Count (Left) and Capacity (Right) of Back-up Generators by Fuel

Compared to the May 2021 analysis, the back-up generator population in South Coast has significantly expanded over the past year, growing from 14,785 in 2021 to 16,828 today, a 13.8 percent jump.

Methodology

The public data request was filed with SCAQMD on October 25, 2022.[8]

SCAQMD only reports general descriptions for genset sizes (e.g., 50 to 500 horsepower, greater than 500 horsepower, and emergency generators). Different size classifications were assigned a HP value based on the 2022 averages from the genset portfolio located in the Bay Area Air Quality Management District, as shown in Table 4 below.

Operating hours and emissions rates were also estimated based on averages from the BAAQMD portfolio.[9] The accuracy of relying on assumptions derived from the Bay Area is largely unknown. Differences in outage rates, particularly related to Public Safety Power Shutoffs, risk

[8] Public records request #1415085

[9] For the "Emergency" HP class the Diesel >500 HP values were utilized. Where values weren't available for the higher horsepower figures, the lower horsepower averages were utilized.

perceptions, and risk tolerances, especially associated with the reliability needs of distinct economic segments, could influence back-up generator population and working characteristics.

Table 4: Average Horsepower, Operating Hours, and Emissions Figures for SCAQMD based on BAAQMD Portfolio

Fuel	HP Class	Average Horsepower	Operating Hours	MT/op hours
Diesel	50-500 HP	219	15	0.11
Diesel	>500 HP	1620	10	0.74
Gasoline	50-500 HP	121	1404	0.04
Gasoline	>500 HP	1620	1404	0.04
Natural Gas	50-500 HP	128	36	0.06
Natural Gas	>500 HP	1110	2	1.06
HFO	50-500 HP	100	912	0.07
HFO	>500 HP	770	3	0.40
LPG	50-500 HP	113	357	0.06
LPG	>500 HP	770	30	0.31
Diesel	Emergency	1620	10	0.74
Other	50-500 HP	222	24	0.07
Other	>500 HP	1353	10	1.55
Other	Emergency	1620	10	0.74

Notably, average emission factors from the BAAQMD 2021 data were significantly higher than those reported in 2022, particularly for diesel, propane, and LPG gensets. The cause of this deviation is unknown, though careful examination of the District-provided specifications spreadsheet could help clarify underlying trends, particularly related to emission control devices deployed. Possible explanations include inaccurate or inconsistent emissions reporting, different size mixes of generation used year-to-year, loading characteristics and variations in emissions management technology. (Table 8).

Table 5: Average Emissions Factors by Fuel for BAAQMD Portfolio 2022 vs. 2021

Average Emissions Factors	BAAQMD - 2022	BAAQMD - 2021
Diesel	0.699	0.908
Natural Gas	0.735	0.726
Gasoline	0.827	0.795
LPG	0.681	0.993
Propane/HFO	0.769	0.824
Undefined	1.549	-

San Diego Country Air Pollution Control District (SDCAPCD)

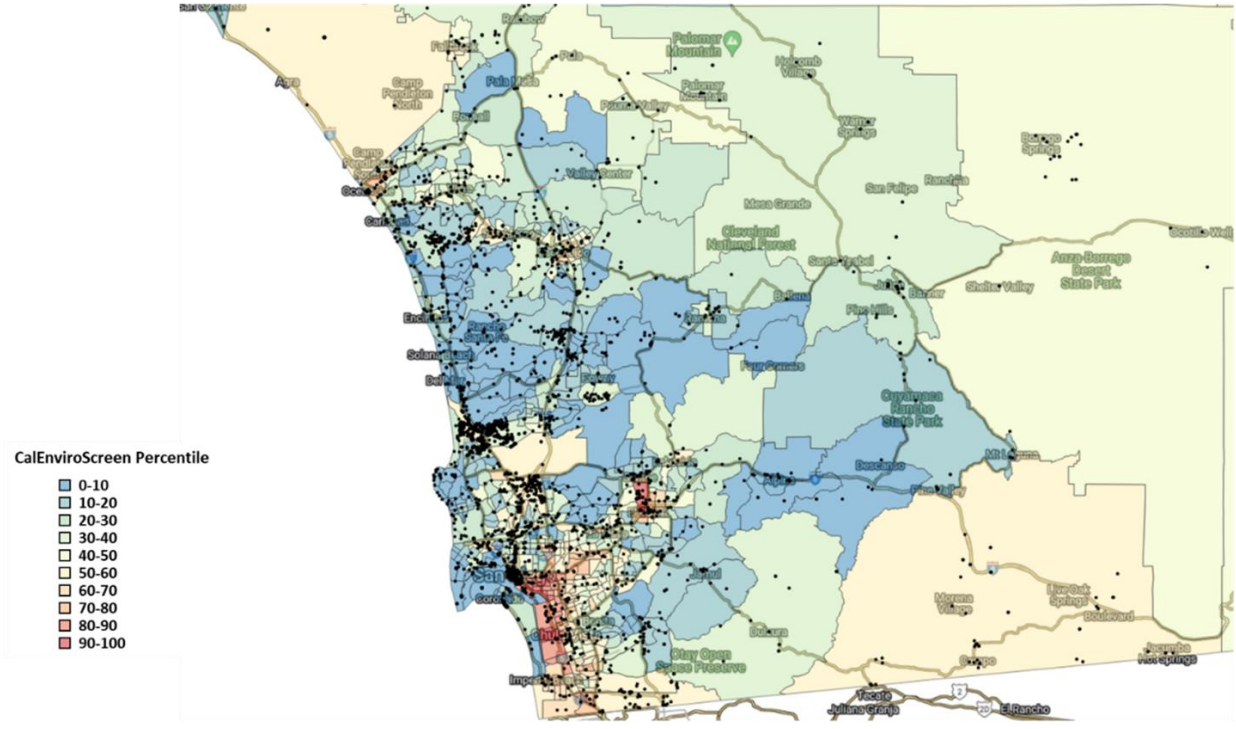
Back-up Generators Portfolio Summary

There are 3,364 BUGs online in the San Diego Country Air Pollution Control District (SDCAPCD), with more than one GW of collective generating capacity. About 85% of these are diesel gensets, with an average capacity of 356 kW. The next largest contributors are methane gas, 7% of portfolio, averaging 121 kW; and propane, 4%, with an average of 77 kW. (Figure 6, Figure 7, Table 6, Table 7).

Over the last year the genset population in the district has collectively operated for more than 31,000 hours, generating more than 10 GWh of power and an estimated 6,800+ tCO2. [10] While at a portfolio level this is significant, most of the assets operate on average just 13 hours per year. The average genset capacity was 325 kW; this figure varies significantly by fuel type, with diesel and undefined gensets having substantially larger capacities than other fuels.

SDCAPCD was not included in the 2021 analysis.

San Diego County Air Pollution Control District Back-up Generators



There are 3,364 gensets operating in San Diego County totaling over 1 GW of capacity. The map shows the siting of these generators in the context of CalEnviroScreen; red/orange indicate most burdened, vulnerable communities, blue/green the least.

[10] About 25% of gensets did not report operating hours in the District's public records request data.

Figure 6: Map of SDCAPCD Back-up Generator Portfolio

Table 6: SDCAPCD Back-up Generator Portfolio

Fuel	Count	Capacity (MW)	Reported Hours	Generation (GWh)	CO_2 (tCO_2)
Diesel	2,874	1,018	25,336	9406	6578
Propane	130	10	2,143	153	118
Natural Gas	228	27	1,919	210	154
LPG	22	1	975	37	25
Gasoline	2	0	56	2	2
Unknown	108	30	783	216	0
Total	3,364	1087	31,211	10,023	6,877

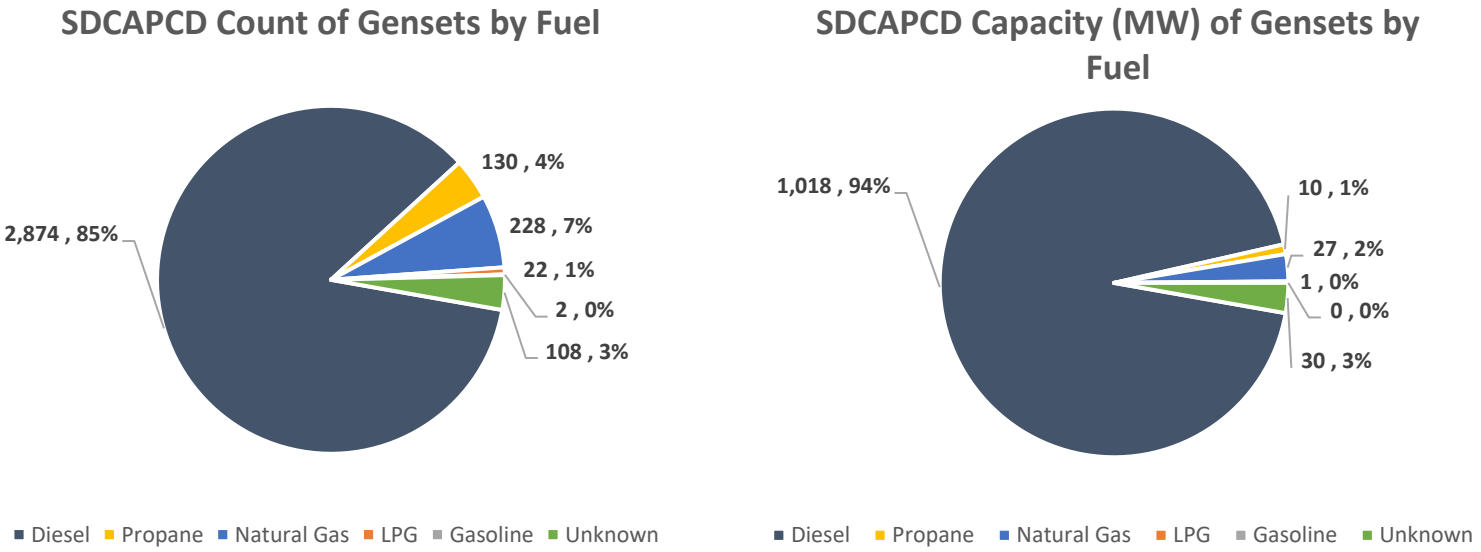


Figure 7: SDCAPCD Count (Left) and Capacity (Right) of Back-up Generators by Fuel

Table 7: Average Capacities, Operating Hours, Generation, and Emissions for SDCAPCD Back-up Generators Portfolio

Fuel	Capacity (kW)	Reported Hours	Generation (kWh)	CO_2 (tCO_2)
Diesel	356	12	4629	4
Propane	77	24	1757	1
Natural Gas	121	12	1296	1
LPG	68	65	2469	2
Gasoline	38	28	1966	2
Unknown	288	11	3082	-
Total	325	13	4,235	4

Methodology

A public records request to obtain data on the portfolio of permitted backup gensets was filed with SDCAPCD in October 2022. District data included facility information, locations, horsepower (HP), fuels, and reported operating hours.[11]

As with SCAQMD, since emissions figures were missing from the dataset, average emissions factors from BAAQMD were utilized to estimate emissions from the SDCAPCD reported runtimes. As highlighted above, there are significant differences in the BAAQMD emissions factors for 2022 compared to 2021; actual emissions values may be much higher (Table 8).

Table 8: Average Emissions Factors by Fuel for BAAQMD Portfolio 2022 vs. 2021

Average Emissions Factors	BAAQMD - 2022	BAAQMD - 2021
Diesel	0.699	0.908
Natural Gas	0.735	0.726
Gasoline	0.827	0.795
LPG	0.681	0.993
Propane	0.769	0.824
Undefined	1.549	-

[11] HP figures were converted to MW by multiplying by 0.7457 and dividing by 1000.

Appendix:
City-Specific BUG Populations

City of Los Angeles

Fuel	Count	Capacity (MW)	Reported Hours	Generation (GWh)	CO2 (tCO2)
Diesel	2,460	1,458	31,845	16	18,204
Natural Gas	107	20	3,410	0	792
Gasoline	28	4	39,312	5	207
LPG	17	1	6,069	1	126
HFO	10	3	5,484	0	74
Other	33	17	624	0	244
Total	2,655	1,502	86,744	22	19,647

City of Milpitas

Fuel	Count	Capacity (MW)	Reported Hours	Generation (MWh)	CO2 (tCO2)
Diesel	109	63	996	429.9	366
Natural Gas	11	1	1,259	192.9	106
Gasoline	-	-	-	-	-
LPG	-	-	-	-	-
Propane	-	-	-	-	-
Undefined	1	0	24	9.6	6
Total	**121**	**65**	**2,280**	**632.4**	**478**

City of Mountain View

Fuel	Count	Capacity (MW)	Reported Hours	Generation (MWh)	CO2 (tCO2)
Diesel	183	95	1,219	659.2	438
Natural Gas	8	1	1,221	56.2	45
Gasoline	1	0	7	0.6	0
LPG	-	-	-	-	-
Propane	-	-	-	-	-
Undefined	-	-	-	-	-
Total	**192**	**96**	**2,447**	**716.0**	**483**

City and County of San Francisco

Fuel	Count	Capacity (MW)	Reported Hours	Generation (MWh)	CO2 (tCO2)
Diesel	1,179	729	12,827	6,372.1	4,357
Natural Gas	23	3	252	26.7	16
Gasoline	1	0	15,778	964.8	834
LPG	2	0	98	8.2	2
Propane	-	-	-	-	-
Undefined	3	4	13	16.4	10
Total	**1,208**	**736**	**28,969**	**7,388.4**	**5,220**

City of San Jose

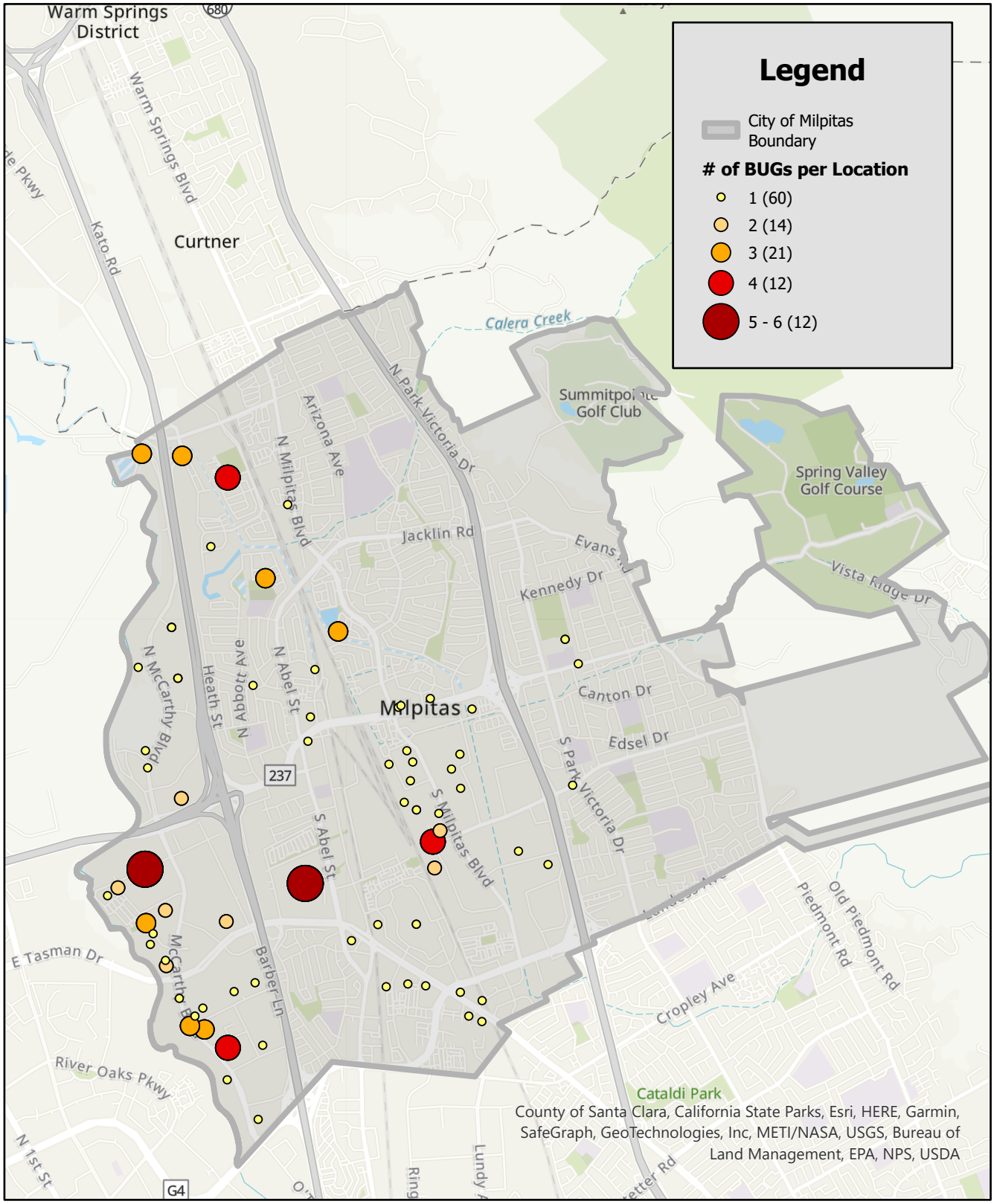
Fuel	Count	Capacity (MW)	Reported Hours	Generation (MWh)	CO2 (tCO2)
Diesel	755	562	6,032	3,773.4	2,616
Natural Gas	39	4	1,491	98.6	71
Gasoline	-	-	-	-	-
LPG	8	0	18,002	888.9	518
Propane	1	0	28	1.3	1
Undefined	2	0	39	2.9	2
Total	**805**	**567**	**25,592**	**4,765.1**	**3,208**

	Diesel
City of Santa Clara	577
Santa Clara County	2,006

Appendix: City-Specific BUG Maps

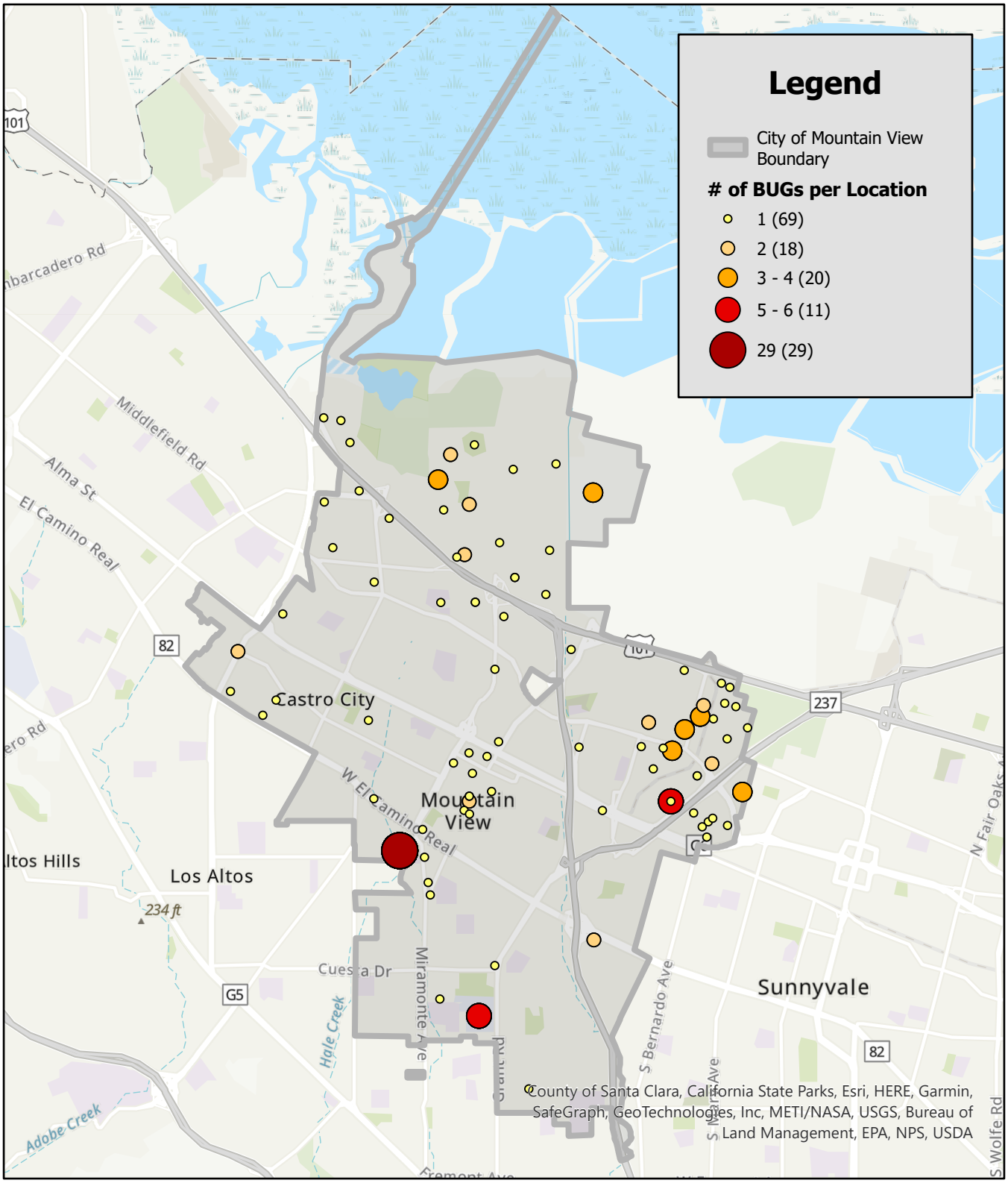
M.Cubed
December 2022

121 Backup Generators Located in the City of Milpitas



Source: Bay Area Air Quality Management District; M.Cubed, 2022

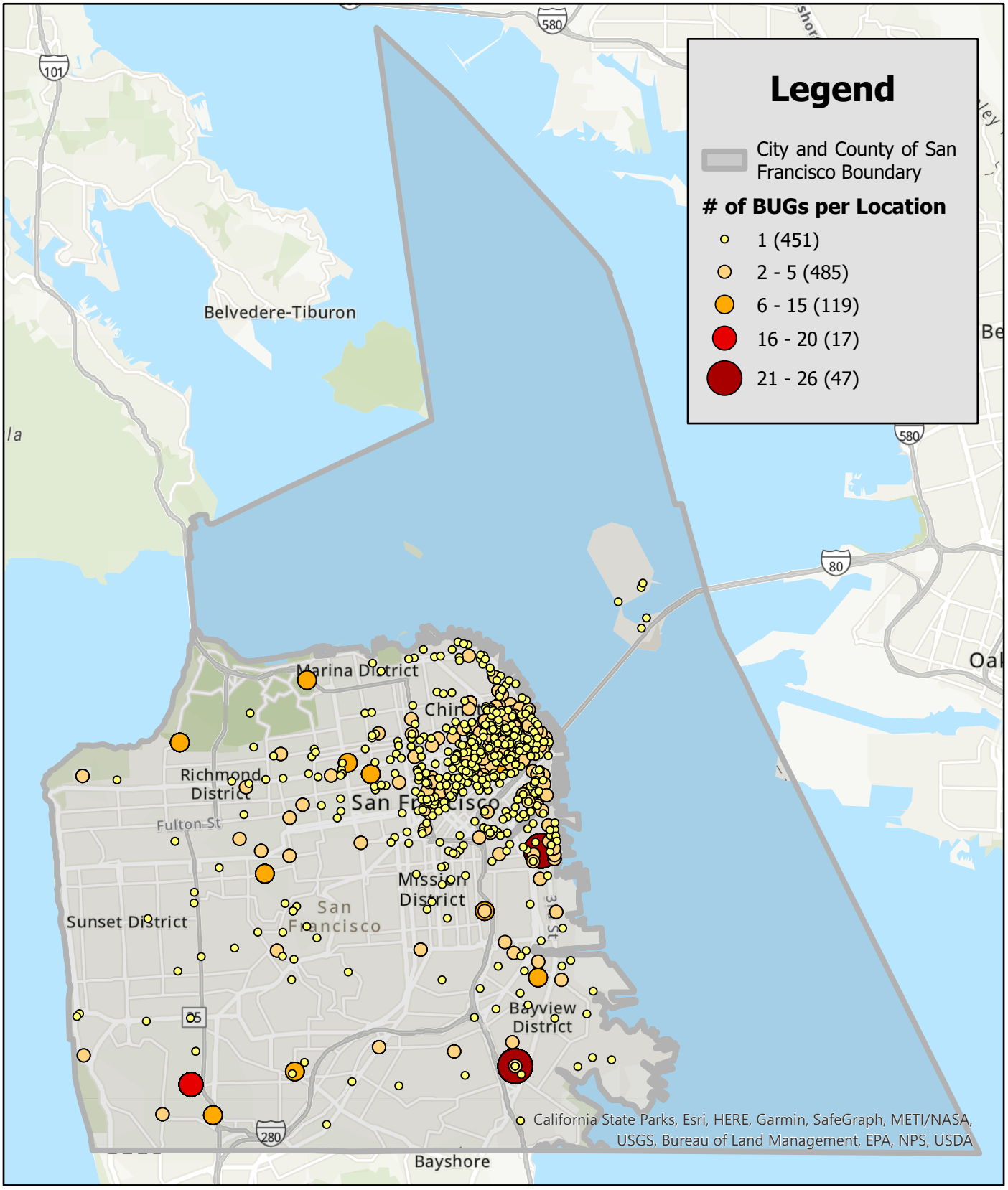
192 Backup Generators Located in the City of Mountain View



*43 additional BUGs are located at the NASA-AMES Research Center and Moffett Field, adjacent to city boundaries.
**2 BUGs were not mapped due to incomplete data.

Source: Bay Area Air Quality Management District; M.Cubed, 2022

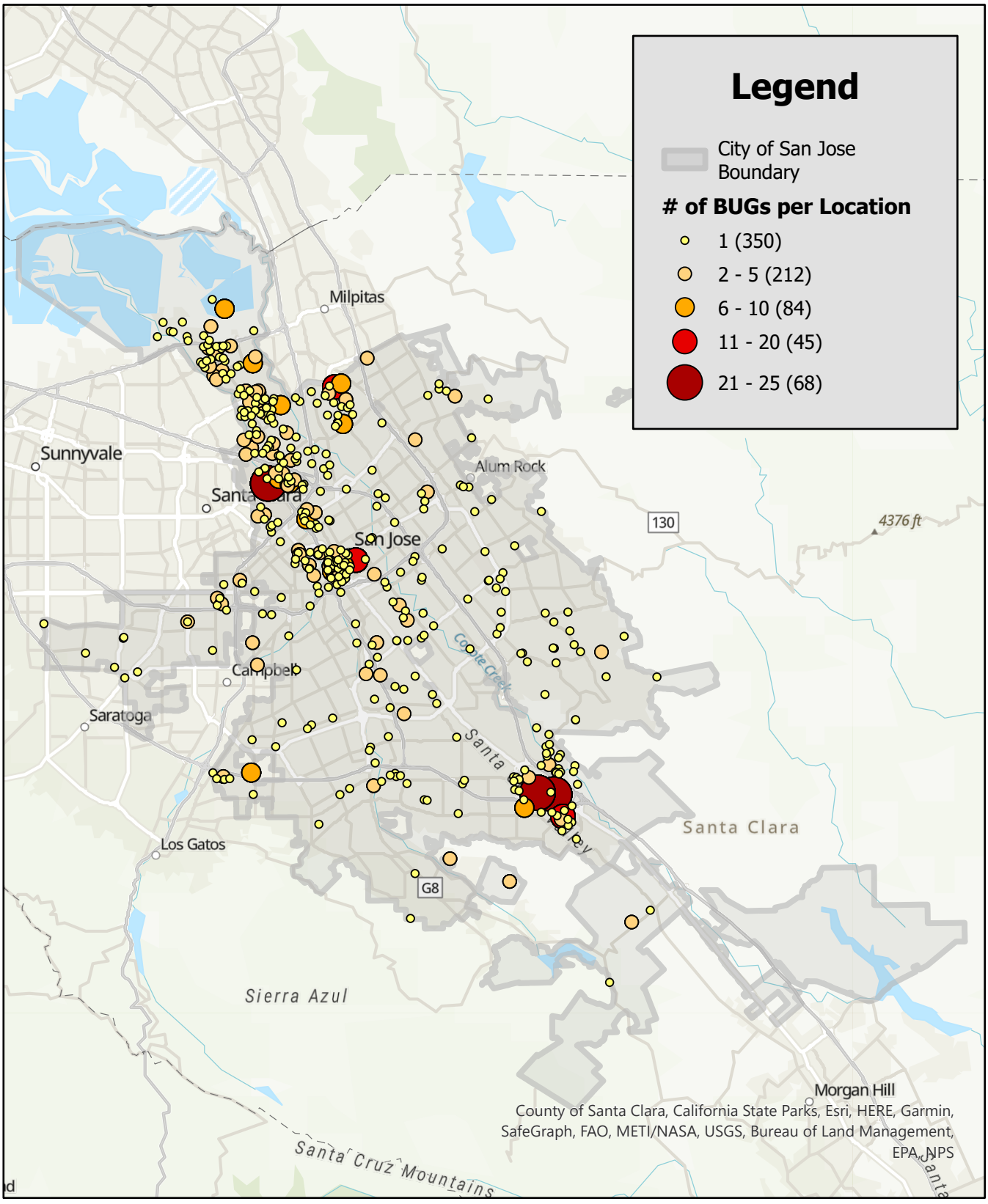
Backup Generator Population in San Francisco Grows to 1,208, Mostly Diesel



*84 additional BUGs are located at the San Francisco International Airport and other unincorporated areas adjacent to city boundaries.
**5 BUGs were not mapped due to incomplete data.

Source: Bay Area Air Quality Management District; M.Cubed, 2022

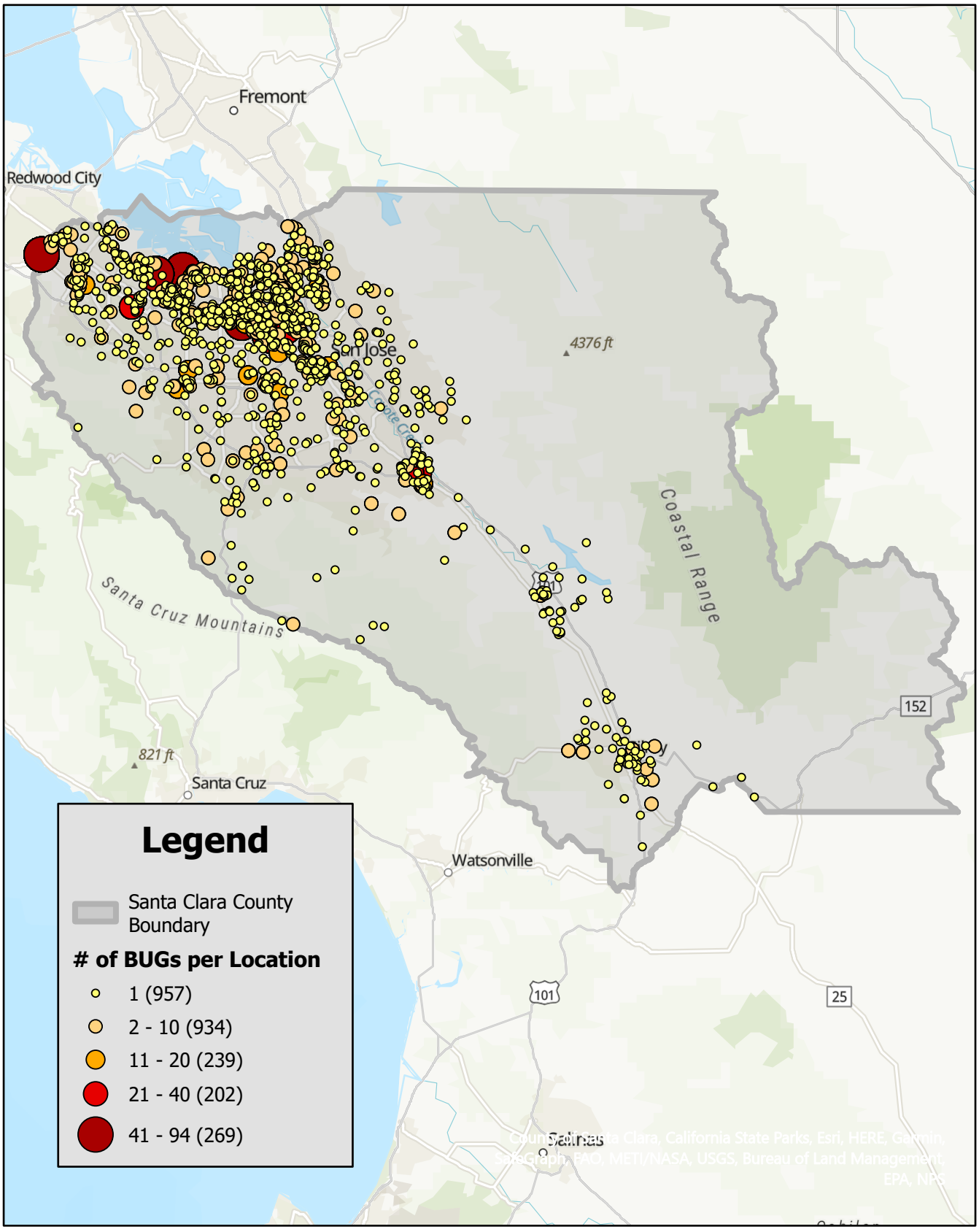
805 Backup Generators Located in the City of San Jose



*18 additional BUGs are located in unincorporated areas adjacent to city boundaries.
**28 BUGs were not mapped due to incomplete data.

Source: Bay Area Air Quality Management District; M.Cubed, 2022

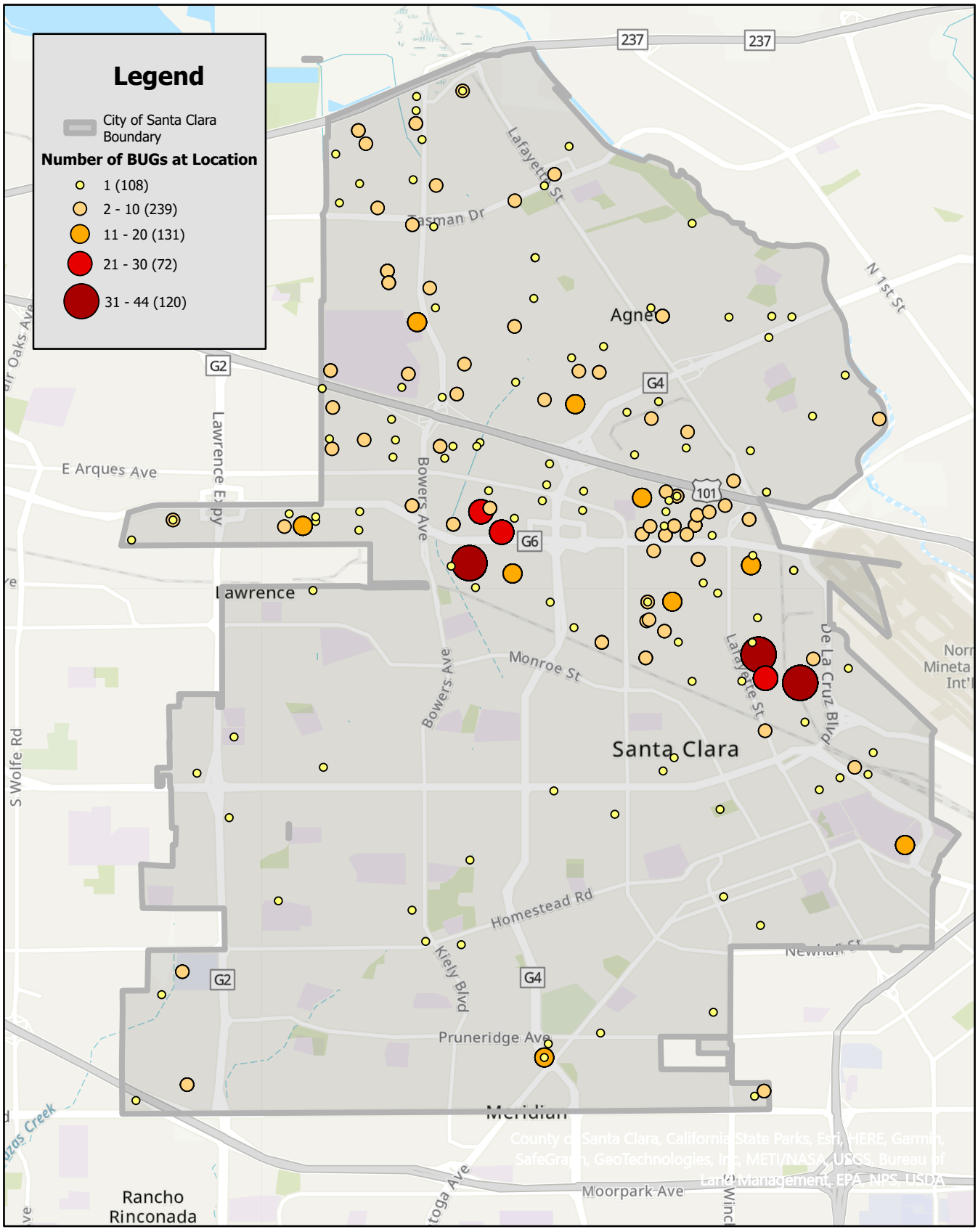
2,638 Backup Generators Located in Santa Clara County



*37 BUGs were not mapped due to incomplete data.

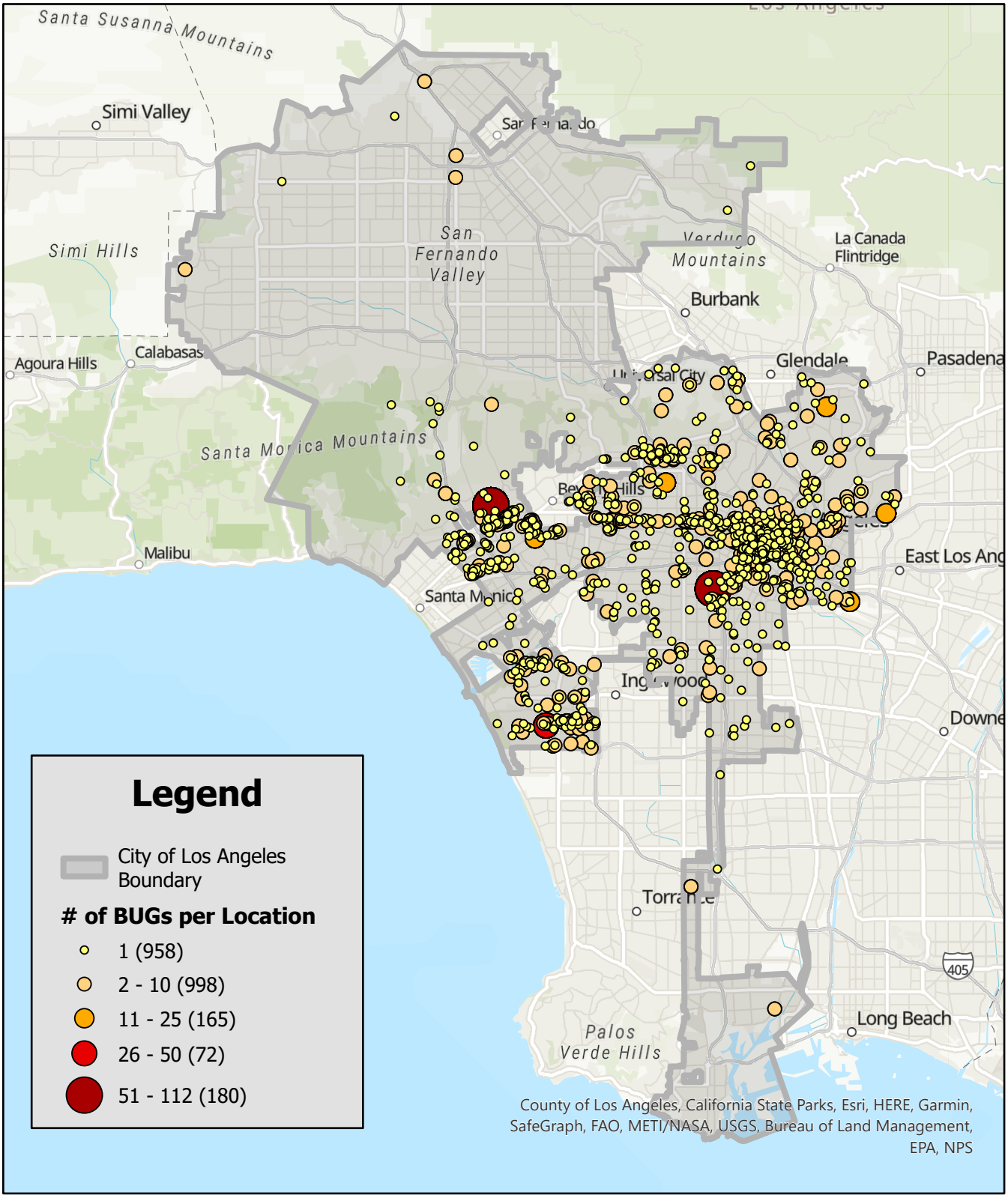
Source: Bay Area Air Quality Management District; M.Cubed, 2022

670 Backup Generators Located in the City of Santa Clara



Source: Bay Area Air Quality Management District; M.Cubed, December 2022

2,655 Backup Generators Located in the City of Los Angeles



*56 BUGs were not mapped due to incomplete data.

Source: South Coast Air Quality Management District
M.Cubed, 2022