California Air Resources Board
Oil and Gas Methane Regulation
2021 Annual Leak Detection and Repair (LDAR) Summary

April 2024

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A. Key Findings

- During the fourth year of implementation of CARB's Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities[1] (Oil and Gas Methane Regulation, or Regulation), over 10,000 leaks were identified and repaired during quarterly leak detection and repair (LDAR) surveys of approximately 2.4 million unique components.
- The ratio of leaks to unique components surveyed was 0.44%.
- The natural gas processing plant sector had the largest ratio of leaks to components surveyed (1.02%), but the second fewest number of components surveyed, while the natural gas production sector had the smallest ratio of leaks to components surveyed (0.08%), but the second highest number of components surveyed. The remaining sectors (crude oil production, natural gas storage, natural gas transmission, and natural gas gathering and boosting stations) had ratios of leaks to components surveyed ranging from 0.38% to 0.92%.
- Approximately 10% of the leaks at or above the regulatory threshold of 1,000 ppmv accounted for 50% of the emissions.
- Total emission reductions resulting from corrections made due to LDAR surveys in 2021 were estimated to be approximately 1,600 metric tons methane, or approximately 40,000 metric tons CO_2e.[2]
- LDAR surveys in 2021 resulted in a 16% reduction in emissions from components subject to LDAR in the Regulation.

Table 1 shows a summary comparison of 2021 LDAR data and 2020 LDAR data. A detailed comparison of 2021 and 2020 data is provided in Section D.

[1] California Code of Regulations, Title 17, Division 3, Chapter 1, Subchapter 10 Climate Change, Article 4. Subarticle 13: Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities.

[2] CO_2e was calculated throughout the report using the 100-year global warming potential (GWP) of methane of 25.

Table 1: Comparison of 2021 LDAR to 2020

	2020	2021
Annual Average Total Components in LDAR Program	2,380,049	2,373,178
Number of Leaks	13,594	10,489
Number of Leaks per Component Count in LDAR Program (%)		
Overall	0.57%	0.44%
Crude Oil Production Sector	0.55%	0.46%
Natural Gas Production Sector	0.40%	0.08%
Natural Gas Storage Sector	0.53%	0.52%
Natural Gas Transmission Sector	1.19%	0.92%
Natural Gas Gathering and Boosting Station Sector	0.65%	0.38%
Natural Gas Processing Plant Sector	1.66%	1.02%
% of Leaks that Accounted for 50% of Emissions	~10%	~10%
Total Estimated Emission Reductions (metric tons methane)	2,200	1,600
% Estimated Emission Reductions	23%	16%

B. Background

As an early action measure to achieve the emission reductions required by the California Global Warming Solutions Act (AB 32), CARB adopted the Oil and Gas Methane Regulation to reduce methane emissions from oil and gas production, processing, storage, and transmission compressor stations. CARB's Oil and Gas Methane Regulation was adopted by the Board on March 23, 2017, and went into effect on January 1, 2018. Section 95669 requires owners/operators of oil and natural gas facilities[3] to conduct quarterly LDAR surveys to monitor components for leaks and repair detected leaks within a specified time frame. Quarterly LDAR inspections began on January 1, 2018, and operators are required to submit annual LDAR reports to CARB by July 1 of each calendar year. The following information must be included in operators' annual LDAR reports:

1. Total number of components inspected
2. Total number of leaks identified per leak threshold category (1,000 to 9,999 ppmv, 10,000 to 49,999 ppmv, and 50,000 ppmv or greater)
3. For each leak:
    a. Inspection date
    b. US EPA Method 21 instrument used
    c. US EPA Method 21 instrument calibration date

[3] Including oil and gas production, processing, and storage; natural gas gathering and boosting stations; natural gas underground storage; and natural gas transmission compressor stations.

d. Component type
e. Component ID, if applicable
f. Equipment ID for the equipment the leaking component is on, if applicable
g. Initial leak concentration
h. Repair date
i. Concentration after repair

This Annual LDAR Summary is based on annual reports CARB received from 94 operators for LDAR inspections at 438 facilities during 2021.

The LDAR requirements in CARB's Oil and Gas Methane Regulation do not apply to all components in California; there are two key exemptions. First, components that are subject to local air district LDAR requirements that were in place prior to January 1, 2018 are exempt from LDAR requirements in CARB's Oil and Gas Methane Regulation because the regulation was intended to cover components that were not already subject to district LDAR requirements.[4] Second, components handling crude oil with an API gravity less than 20 are not subject to LDAR requirements due to their very low emissions levels relative to other components found in gas or other liquid service (less than 1% of all emissions from components in the state).[5,6,7,8] Figure 1 shows the fraction of oil and gas components in California that are subject to CARB's regulation, are subject to local air district rules,[9] or handle heavy oil and are exempt from LDAR requirements.[10]

[4] Oil and Gas Methane Regulation, Section 95669(b)(1).
[5] Oil and Gas Methane Regulation, Section 95669(b)(2).
[6] ARB. (2013). Oil and Gas Survey. ARB 2007 Oil and Gas Industry Survey Results, Final Report, revised in October 2013.
[7] CAPCOA. (1999). California Implementation Guidelines for Estimating Mass Emissions of Fugitive Hydrocarbon Leaks at Petroleum Facilities.
[8] 15-Day Notice Attachment 2. https://ww3.arb.ca.gov/regact/2016/oilandgas2016/oilgasatt2.pdf.
[9] There are eight local air districts with LDAR requirements for oil and gas facilities, including Bay Area Air Quality Management District (AQMD), Monterey Bay Air Resources District (ARD), San Joaquin Valley Air Pollution Control District (APCD), San Luis Obispo County APCD, Santa Barbara County APCD, South Coast AQMD, Ventura County APCD, and Yolo-Solano AQMD.
[10] Heavy oil is defined differently in different district rules, e.g., by API gravity, by flash point, by vapor pressure, or by evaporation percentage. For the purposes of Figure 1, heavy oil was defined as < 20 API gravity.

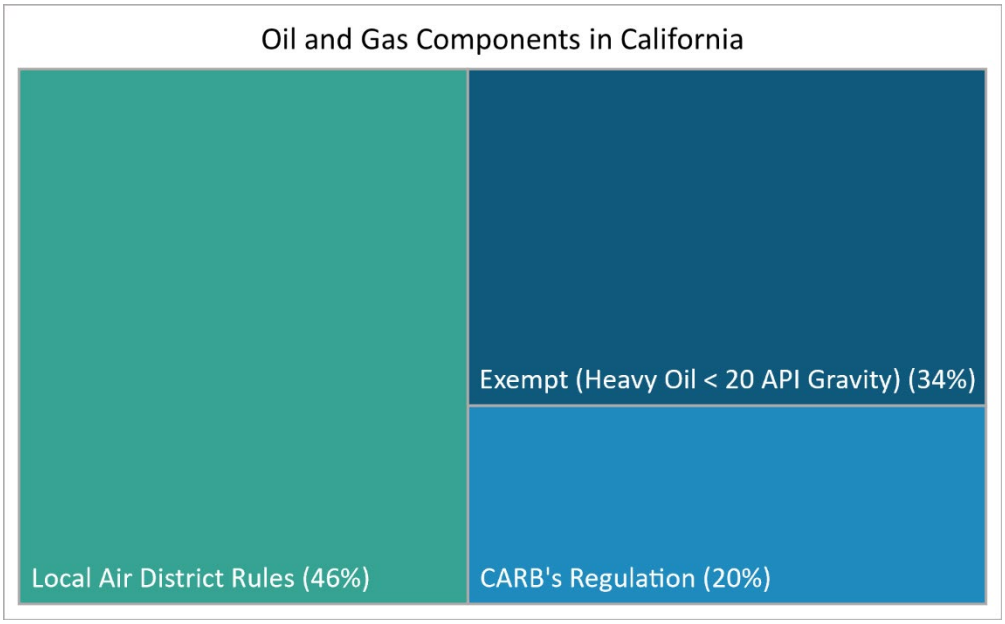


Figure 1: Breakdown of oil and gas components in California. Size of box corresponds to the percent of components in each category (shown in parentheses) based on data from CARB's 2007 oil and gas industry survey and the Oil and Gas Methane Regulation rulemaking. [11,12]

C. Summary of LDAR Data

On average, 2,373,178 unique components were surveyed[13] during 2021 LDAR surveys each quarter, and in total throughout the year 10,489 leaks were identified as greater than or equal to 1,000 ppmv (the ratio of leaks to components surveyed was 0.44%). Of the leaks found during inspections, 10,386 were repaired or a component was replaced, 48 were designated as critical components[14] and were repaired at the next scheduled shutdown or within 12 months, whichever was sooner, and 55 were approved for delays of repair at the time of reporting and were repaired or replaced within 30 calendar days from the allowed repair time period or by the anticipated repair date stated in the operator's approved delay of repair request. Delay of repair approvals are requested by operators who need to order specific parts or equipment to repair leaking components. CARB staff tracks the delay of repair requests to confirm that repairs are completed according to the allowed timeline.[15]

[11] See footnote 6.
[12] See footnote 8.
[13] Component surveys were repeated quarterly for a total of approximately 9.5 million component inspections.
[14] A critical component would require the shutdown of a critical process unit if that component was shutdown.
[15] The 103 critical component and delay of repair leaks were included in this report in Tables 1 and 2 as well as Figures 2 and 3, but not in estimates of emission reductions because those calculations require a concentration after repair that wasn't included at the time annual LDAR reports were submitted.

The validity of the data presented in this report is dependent on the accuracy of the data reported by operators. CARB acknowledges that there are potential limitations with self-reported data; however, CARB staff conducted rigorous quality control checks to ensure the highest level of data integrity possible. CARB staff reviewed the data in the 2021 annual reports and found no widespread issues with operators' reported data. Issues encountered were all associated with data entry and include conflicting inspection dates, conflicting repair dates, conflicting instrument calibration dates, incorrect number of components inspected, incorrect number of leaks found, and incorrect repaired leak concentrations. All discrepancies were corrected by CARB staff after following up with operators. During 2021, 0.25% of the reported leaks had potential errors identified that affected the emissions and emissions reductions calculations and required CARB staff to follow up with operators and make necessary corrections. Of the facilities that reported LDAR data, 7.5% had discrepancies between the number of leaks recorded in the annual LDAR reports' two reporting tables, and 3.1% of all reported quarterly inspections listed incorrect inspection dates (i.e., dates were not in 2021). There was an increase in the number of facilities with reports that had discrepancies between the number of leaks reported in the two reporting tables as well as an increase in the percentage of incorrect inspection dates for reported quarterly LDAR. However, there were fewer issues identified with 2021 LDAR reporting data that affected emissions and emissions reductions calculations compared to 2020. CARB will continue working with reporters to improve initial reporting and limit follow up required to finalize reports.

Table 2 shows the LDAR survey leak distribution for 2021 according to oil and gas sector. The natural gas processing plant sector had the largest ratio of leaks to unique components surveyed, 1.02%, but the second fewest number of components surveyed (18,019). The natural gas production sector had the lowest ratio of leaks to components surveyed, 0.08%, but the second largest number of components surveyed (361,068). The remaining sectors (crude oil production, natural gas storage, natural gas transmission, and natural gas gathering and boosting stations) had ratios of leaks to components surveyed ranging from 0.38% to 0.92%, and crude oil production had the largest number of components surveyed.[16] The natural gas gathering and boosting station sector had the fewest number of components surveyed (3,691).

[16] In general, district LDAR rules cover crude oil production facilities; however, the Oil and Gas Methane Regulation addressed some components that are exempt from district rules, resulting in the large number of components in the crude oil production sector, as shown in Table 2.

Table 2: Components Found Leaking by Sector in 2021

Sector	Total Count of Components in LDAR Program[17]	Number of Leaks in Each Category[18] (Ratio of Leaks to Count of Components in LDAR Program by Sector)			Number of Leaks per Component Count in LDAR Program (%)
		1,000 to 9,999 ppmv	10,000 to 49,999 ppmv	50,000 ppmv or greater	
Crude Oil Production	1,519,578	5,171 (0.34%)	1,559 (0.10%)	300 (0.02%)	0.46%
Natural Gas Production	361,068	217 (0.06%)	63 (0.02%)	19 (0.01%)	0.08%
Natural Gas Storage	344,543	1,176 (0.34%)	449 (0.13%)	172 (0.05%)	0.52%
Natural Gas Transmission	126,279	789 (0.62%)	269 (0.21%)	107 (0.08%)	0.92%
Natural Gas Gathering and Boosting Stations	3,691	2 (0.05%)	9 (0.24%)	3 (0.08%)	0.38%
Natural Gas Processing Plants	18,019	115 (0.64%)	69 (0.38%)	0 (0.00%)	1.02%
Total	2,373,178	7,470 (0.31%)	2,418 (0.10%)	601 (0.03%)	0.44%

Figure 2 shows the number of leaks identified in 2021 by component type; connectors and valves had the most leaks of the component types, 4,286 and 2,853, respectively.

[17] Counts include the physical number of components that were surveyed four times throughout the year.

[18] A component could have been found to be leaking during a quarterly inspection and been repaired or replaced within the required time period, and also may have been measured as leaking again during a subsequent quarterly inspection, resulting in one component accounting for more than one leak.

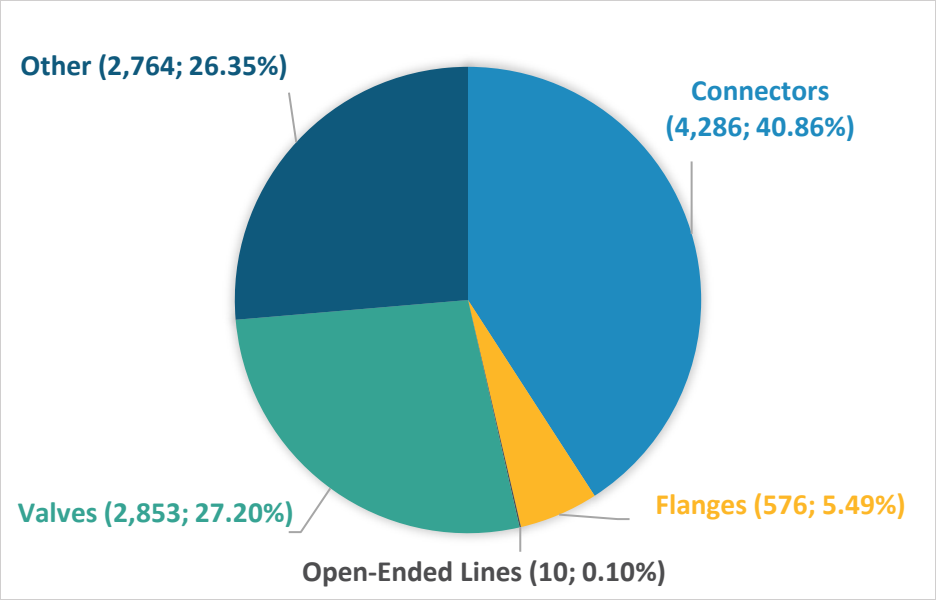


Figure 2: Number of leaks identified in 2021 by component type. The "other" component category includes gas regulators, pressure gauges, pressure relief devices, flow and pressure meter fittings, pneumatic devices, compressor vents, temperature controllers, stuffing boxes, and inactive flare pilots.

CARB staff estimated emissions from the reported leaks using correlation equations developed in the Enhanced Inspection & Maintenance for GHG & VOCs at Upstream Facilities study.[19] Estimated methane leak rate statistics by component type are shown in Table 3. On average, open-ended lines had the highest leak rate, but only accounted for 10 total leaks. The mean leak rate from all components was 0.018 kg CH_4/hr.

[19] Air Resources Board IFB No. 13-414: Enhanced Inspection & Maintenance for GHG & VOCs at Upstream Facilities, Sage ATC Environmental Consulting LLC, revised November 2019.

Table 3: Methane Leak Rate Statistics by Component Type[20]

	All Components	Connector	Flange	Open-Ended Line	Valve	Other
Min (kg CH_4/hr)	0.002	0.002	0.002	0.013	0.003	0.005
Max (kg CH_4/hr)	0.877	0.048	0.037	0.186	0.877	0.267
Mean (kg CH_4/hr)	0.018	0.007	0.007	0.088	0.027	0.028
Median (kg CH_4/hr)	0.008	0.004	0.005	0.081	0.014	0.014

Figure 3 shows the cumulative leak emission distribution from 2021 LDAR data. The distribution shows that approximately 10% of leaks accounted for 50% of estimated emissions from leaking components. The results continue to show that a relatively small number of sources contributed to a significant portion of the emissions, as has been demonstrated in previous studies of oil and gas facilities.[21,22]

[20] Leak rates were converted from total hydrocarbons assuming a methane composition of 89.2% based on data from a CARB-funded 2019 study (see footnote 19).

[21] Allen, D. (2016). Emissions from oil and gas operations in the United States and their air quality implications. *Journal of the Air & Waste Management Association*, 66:6, 549-575. DOI: 10.1080/10962247.2016.1171263.

[22] Brandt et al. 2016. Methane Leaks from Natural Gas Systems Follow Extreme Distributions. *Environmental Science & Technology*, 50:22, 12512-12520. DOI: 10.1021/acs.est.6b04303.

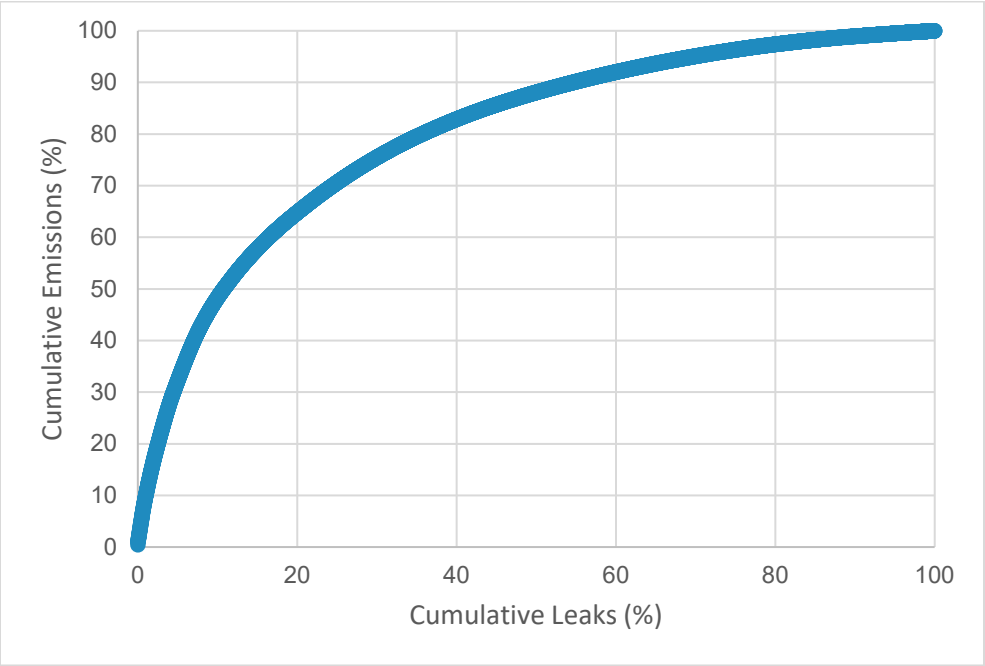


Figure 3: Fraction of cumulative emissions versus cumulative leaks based on LDAR data for 2021.

Emission reductions were estimated by assuming that a leak would have continued unabated for a year without the LDAR program. Total emission reductions from the 2021 LDAR surveys were estimated to be approximately 1,600 metric tons methane, or approximately 40,000 metric tons CO_2e.[23] CARB staff also estimated baseline 2021 emissions from all components subject to LDAR in the regulation in order to evaluate the percent emission reductions from 2021 LDAR surveys. Operators are not required to report concentration data for components measured below the leak threshold (1,000 ppmv); therefore, emissions from these "non-leaking" components were estimated by assuming a leak rate equal to the average post-repair leak rate of all leaking components. Similar to an estimate of emission reductions, baseline emissions from leaks were estimated by assuming that leaks would have persisted for a year without the LDAR program. The combined total baseline emissions from leaking and "non-leaking" components subject to quarterly LDAR surveys for CARB's Oil and Gas Methane Regulation during 2021 was estimated to be approximately 10,000 metric tons methane,[24,25] or approximately 250,000 metric tons CO_2e.[26] Based on these calculations, 2021 LDAR surveys

[23] Approximately 120,000 metric tons CO_2e using the 20-year GWP of methane of 72.
[24] Converted from total hydrocarbons assuming a methane composition of 89.2% based on data from a CARB-funded 2019 study (see footnote 19).
[25] Leaking and "non-leaking" components accounted for approximately 1,600 and approximately 8,300 metric tons methane, respectively.
[26] Approximately 720,000 metric tons CO_2e using the 20-year GWP of methane of 72.

resulted in an estimated 16% reduction in emissions from components subject to LDAR in the Oil and Gas Methane Regulation.

Leak data broken down by local air district and owner/operator are shown in Appendix A. Figures A-1 and A-3 show emission reductions from each sector (crude oil production, natural gas production, natural gas transmission, natural gas storage, natural gas gathering and boosting stations, and natural gas processing plants), and Figures A-2 and A-4 show the ratios of leaks to components surveyed for each sector.[27] San Joaquin Valley Air Pollution Control District (APCD) had the highest emission reductions, with the majority coming from the crude oil production sector (Figure A-1). Excluding Bay Area AQMD and San Joaquin Valley APCD, the transmission sector had the highest ratios of leaks to components surveyed of the six sectors for all local air districts with natural gas transmission facilities (Figure A-2). For Bay Area AQMD and San Joaquin Valley APCD, the highest ratios of leaks to components surveyed came from the crude oil production and natural gas processing plant sectors, respectively. The three highest ratios of leaks to components surveyed based on sector were Lassen County APCD's (3.0%; natural gas transmission), South Coast AQMD's (1.6%; natural gas transmission), and San Joaquin Valley APCD's (1.2%; natural gas processing plant). The owner/operator with the highest emission reductions was Aera, followed by Pacific Gas & Electric and Southern California Gas Company (Figure A-3). The owners/operators with the highest ratios of leaks to components surveyed based on sector were Glendale Oil (4.2%; crude oil production), Pioneer Exploration (3.0%; natural gas production), and Caleco (2.4%; crude oil production); no clear trends were observed across sectors (Figure A-4).

D. Comparison to 2020 Data and Conclusions

In 2021, CARB received annual reports for inspections from 94 operators at 438 facilities, whereas in 2020, 97 operators submitted annual reports for inspections at 437 facilities. During 2021 LDAR surveys, on average, operators inspected fewer unique components (2,373,178 compared to 2,380,049 in 2020) each quarter. Seeing fewer unique components inspected compared to the previous year could be due to portions of facilities being shut down for certain periods of time throughout the year. Although fewer leaks were identified in 2021 (10,489 leaks) compared to 2020 (13,594 leaks), the overall ratio of leaks to unique components surveyed still decreased from 0.57% to 0.44%. Table 4 shows the LDAR survey leak distribution comparison between 2021 and 2020. There was a decrease in leak ratio across all six sectors. The sectors with the largest decrease in leak ratio were the natural gas processing plant sector which decreased from 1.66% to 1.02%, followed by the natural gas transmission and natural gas

[27] The ratio metric in this report should not be compared to the "% of total inspected" metric in Tables 1 and 2 of CARB's Oil and Gas Methane Regulation. Tables 1 and 2 pertain to single inspections of a group of components during district or CARB inspections; the ratios in this report represent four inspections of a group of components during operator inspections. The ratio metric also should not be compared to the loss rate used in Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET).

production sectors, which decreased from 1.29% to 0.92% and from 0.40% to 0.08%, respectively. For the remaining three sectors, natural gas gathering and boosting stations decreased from 0.65% to 0.38%, crude oil production decreased from 0.55% to 0.46%, and natural gas storage decreased from 0.53% to 0.52%.

Table 4: Components Found Leaking by Sector in 2021 and 2020

Sector	Total Count of Components in LDAR Program[28] (2021|2020)	Number of Leaks in Each Category[29] (Ratio of Leaks to Count of Components in LDAR Program by Sector)			Number of Leaks per Component Count in LDAR Program (%) (2021|2020)
		1,000 to 9,999 ppmv (2021|2020)	10,000 to 49,999 ppmv (2021|2020)	50,000 ppmv or greater (2021|2020)	
Crude Oil Production	1,519,578 | 1,454,623	5,171 (0.34%) | 5,847 (0.40%)	1,559 (0.10%) | 1,805 (0.12%)	300 (0.02%) | 375 (0.03%)	0.46% | 0.55%
Natural Gas Production	361,068 | 359,536	217 (0.06%) | 825 (0.23%)	63 (0.02%) | 444 (0.12%)	19 (0.01%) | 171 (0.05%)	0.08% | 0.40%
Natural Gas Storage	344,543[30] | 410,022	1,176 (0.34%) | 1,495 (0.36%)	449 (0.13%) | 474 (0.12%)	172 (0.05%) | 221 (0.05%)	0.52% | 0.53%
Natural Gas Transmission	126,279 | 130,526	789 (0.62%) | 1,091 (0.84%)	269 (0.21%) | 323 (0.25%)	107 (0.08%) | 221 (0.05%)	0.92% | 1.29%
Natural Gas Gathering and Boosting Stations	3,691 | 3,672	2 (0.05%) | 16 (0.44%)	9 (0.24%) | 6 (0.16%)	3 (0.08%) | 139 (0.11%)	0.38% | 0.65%
Natural Gas Processing Plants	18,019 | 21,670	115 (0.64%) | 230 (1.06%)	69 (0.38%) | 130 (0.60%)	0 (0.00%) | 2 (0.05%)	1.02% | 1.66%
Total	2,373,178 | 2,380,049	7,470 (0.31%) | 9,499 (0.40%)	2,418 (0.10%) | 5,738 (0.25%)	601 (0.03%) | 908 (0.04%)	0.44% | 0.57%

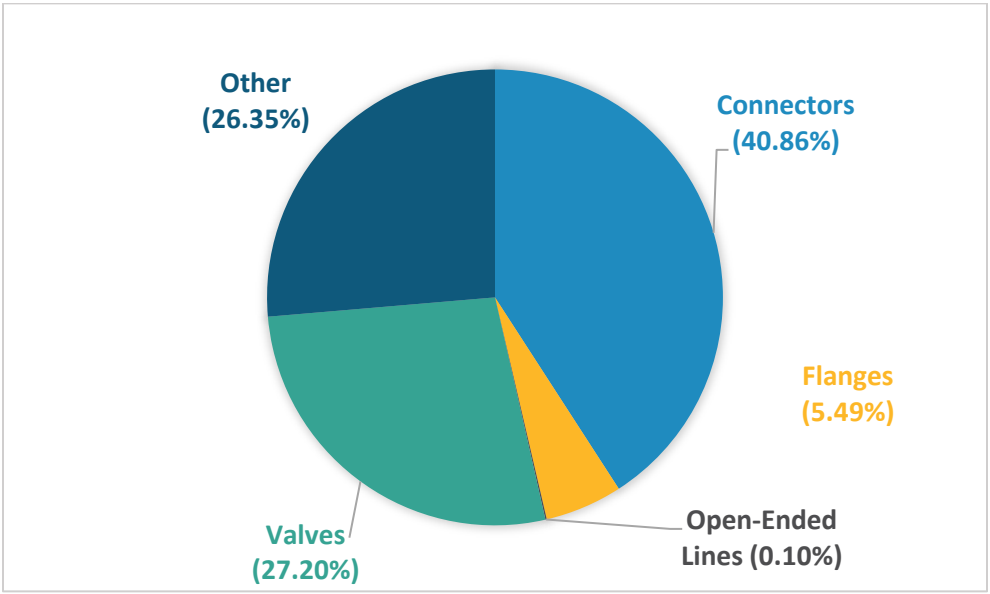
[28] Counts include the physical number of components that were surveyed four times throughout the year.

[29] A component could have been found to be leaking during a quarterly inspection and been repaired or replaced within the required time period, and also may have been measured as leaking again during a subsequent quarterly inspection, resulting in one component accounting for more than one leak.

[30] This value dropped in 2021 because fewer components were inspected that year due to well workovers and due to operators no longer inspecting some components they didn't need to be inspecting in past years.

Leak counts by component type were similar for 2021 and 2020 with connectors and valves having the most leaks, followed by the "other" category. Figure 4 shows the percentage of leaks found by component type in 2021 and 2020. The percentage of leaks found on connectors increased from 39.81% to 40.86%, leaks found on valves decreased from 31.79% to 27.20%, leaks found on components in the "other" category increased from 21.52% to 26.35%, leaks found on flanges decreased from 6.80% to 5.49%, and leaks found on open-ended lines increased from 0.08% to 0.10%.

(a)



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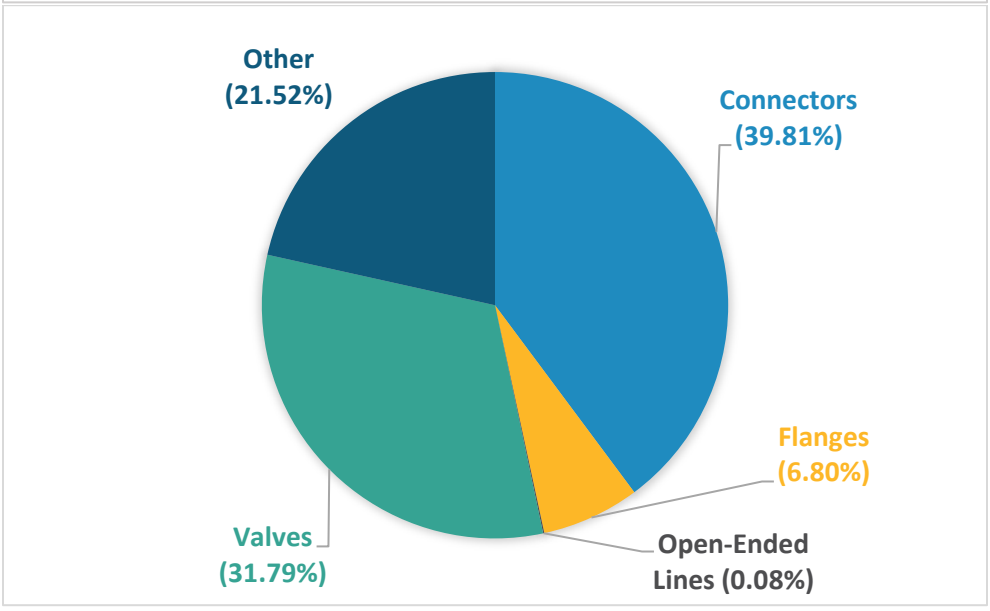

Figure 4: Percentages of leaks identified in 2021 (a) and 2020 (b) by component type.

Table 5 displays the methane leak statistics for leaks in 2021 and 2020. In both years, on average, leaks found on open-ended lines had the highest leak rates but accounted for the fewest leaks total. The mean leak rate from all components decreased from 0.046 kg CH_4/hr to 0.018 CH_4/hr.

Table 5: Methane Leak Rate Statistics by Component Type for Leaks 2021 and 2020[31]

	All Components (2021 | 2020)	Connector (2021 | 2020)	Flange (2021 | 2020)	Open-Ended Line (2021 | 2020)	Valve (2021 | 2020)	Other (2021 | 2020)
Min (kg CH_4/hr)	0.002 | 0.008	0.002 | 0.008	0.002 | 0.008	0.013 | 0.133	0.003 | 0.021	0.005 | 0.029
Max (kg CH_4/hr)	0.877 | 0.500	0.048 | 0.178	0.037 | 0.049	0.186 | 0.275	0.877 | 0.500	0.267 | 0.241
Mean (kg CH_4/hr)	0.018 | 0.046	0.007 | 0.018	0.007 | 0.017	0.088 | 0.171	0.027 | 0.058	0.028 | 0.083
Median (kg CH_4/hr)	0.008 | 0.031	0.004 | 0.016	0.005 | 0.016	0.081 | 0.153	0.014 | 0.050	0.014 | 0.074

Figure 5 shows the cumulative leak distribution in 2021 and 2020. Although there were over 3,000 fewer leaks identified in 2021 (10,386 compared to 13,594 in 2020), the distribution of leaks to emissions remains similar. The distribution of leaks in 2021 continues to illustrate that approximately 10% of leaks accounted for 50% of total emissions.

[31] Leak rates were converted from total hydrocarbons assuming a methane composition of 89.2% based on data from a CARB-funded 2019 study (see footnote 19).

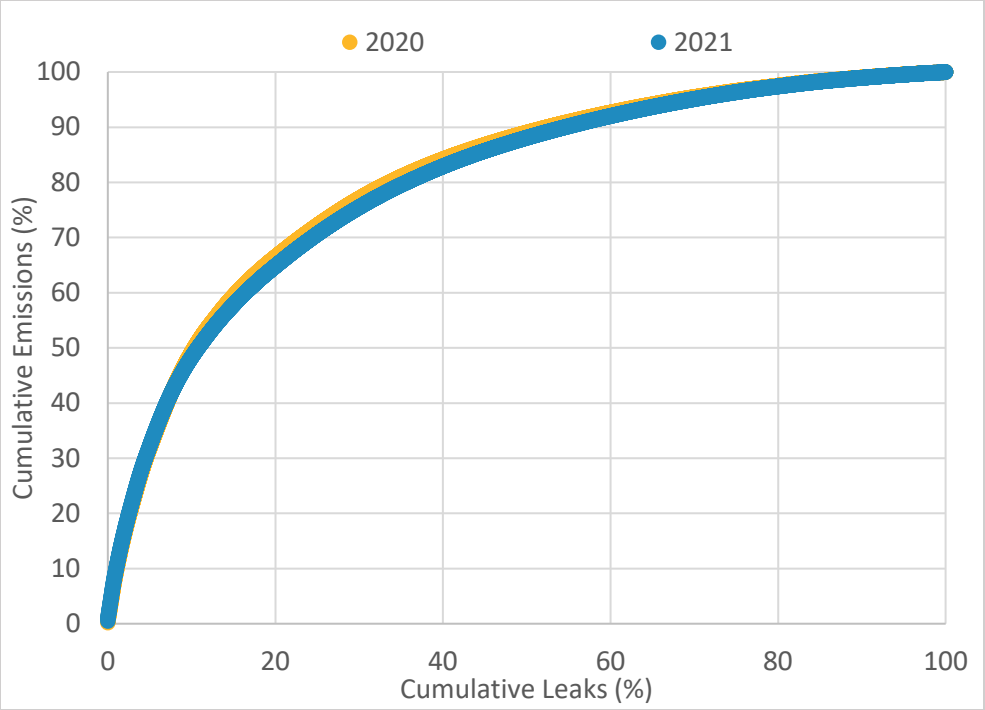

Figure 5: Fraction of cumulative emissions versus cumulative leaks for 2021 and 2020.

Table 6 shows a comparison of LDAR emissions and emission reductions between 2021 and 2020. Emission reductions were less in 2021 than in 2020, with reductions of approximately 1,600 metric tons methane in 2021 compared to approximately 2,200 metric tons methane in 2020. The decrease in emission reductions in 2021 was due to the smaller number of leaks identified compared to 2020. Conversely, baseline emissions from components subject to quarterly LDAR surveys were larger in 2021 relative to 2020 due to the increase in the average post-repair leak rate. LDAR surveys in 2021 resulted in a 16% reduction in emissions from components subject to LDAR in the regulation compared to 23% in 2020. The lower percent reduction was caused by the decrease in emission reductions as well as the increase in baseline emissions.

Table 6: Comparison of LDAR Emissions and Emission Reductions between 2021 and 2020

	2021	2020
Baseline Emissions (metric tons methane; “non-leaking” components)	8,300	7,200
Baseline Emissions (metric tons methane; “leaking” components)	1,600	2,200
Total Baseline Emissions (metric tons methane)	10,000	9,400
Total Emission Reductions (metric tons methane)	1,600	2,200
% Emission Reductions	16%	23%

The decrease in ratio of leaks to unique components surveyed from 2020 to 2021 indicates that implementation of the LDAR program is helpful in reducing the number of leaks over time.

Appendix A: LDAR Data by Local Air District and Owner/Operator

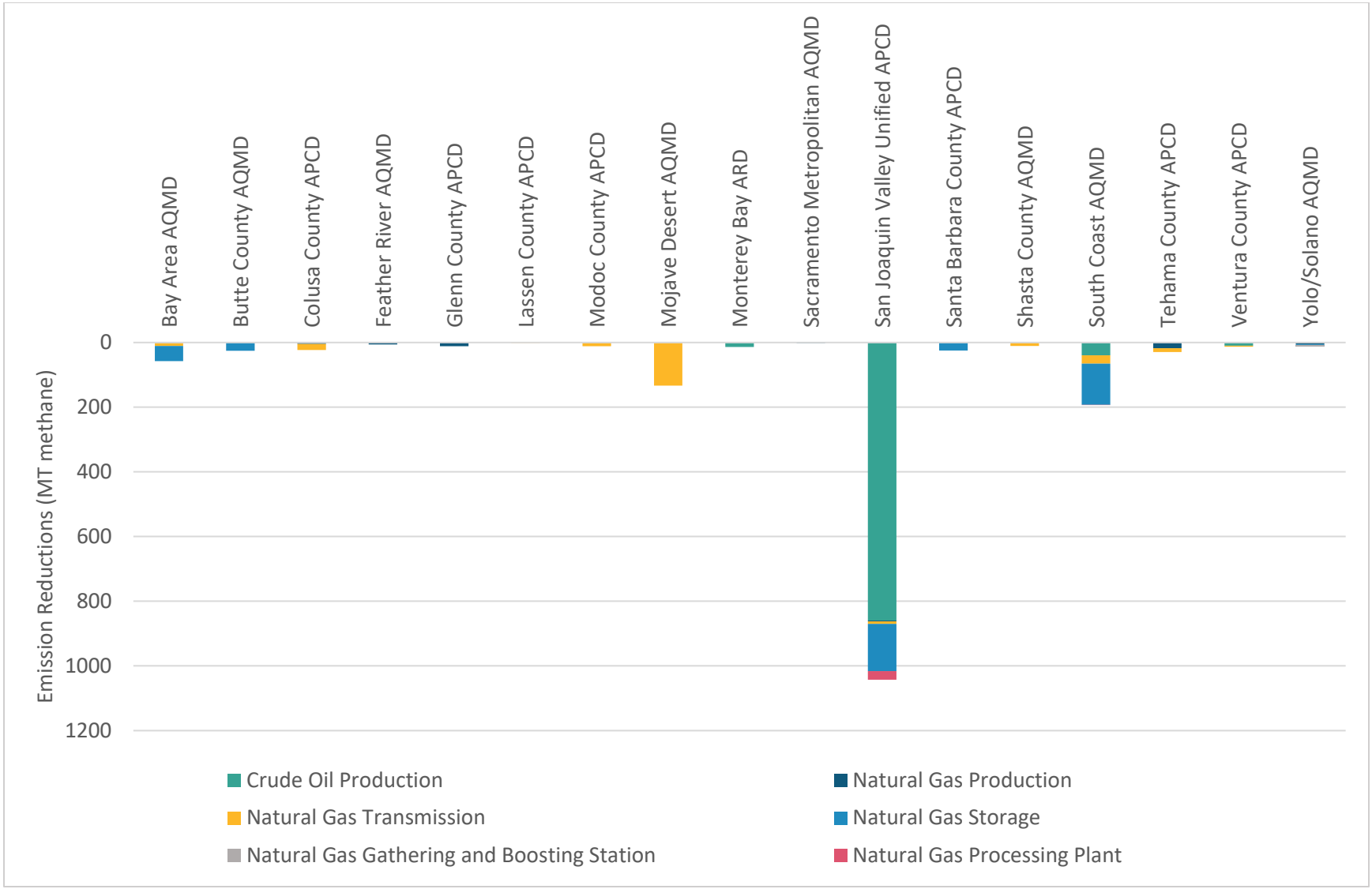

Figure A-1: Emission reductions from each sector by local air district during 2021. No leaks at or above 1,000 ppmv were discovered at the North Coast Unified AQMD in 2021. San Luis Obispo County APCD does not have facilities subject to CARB's Oil and Gas Methane Regulation's LDAR provisions; those facilities report their LDAR data to the District.

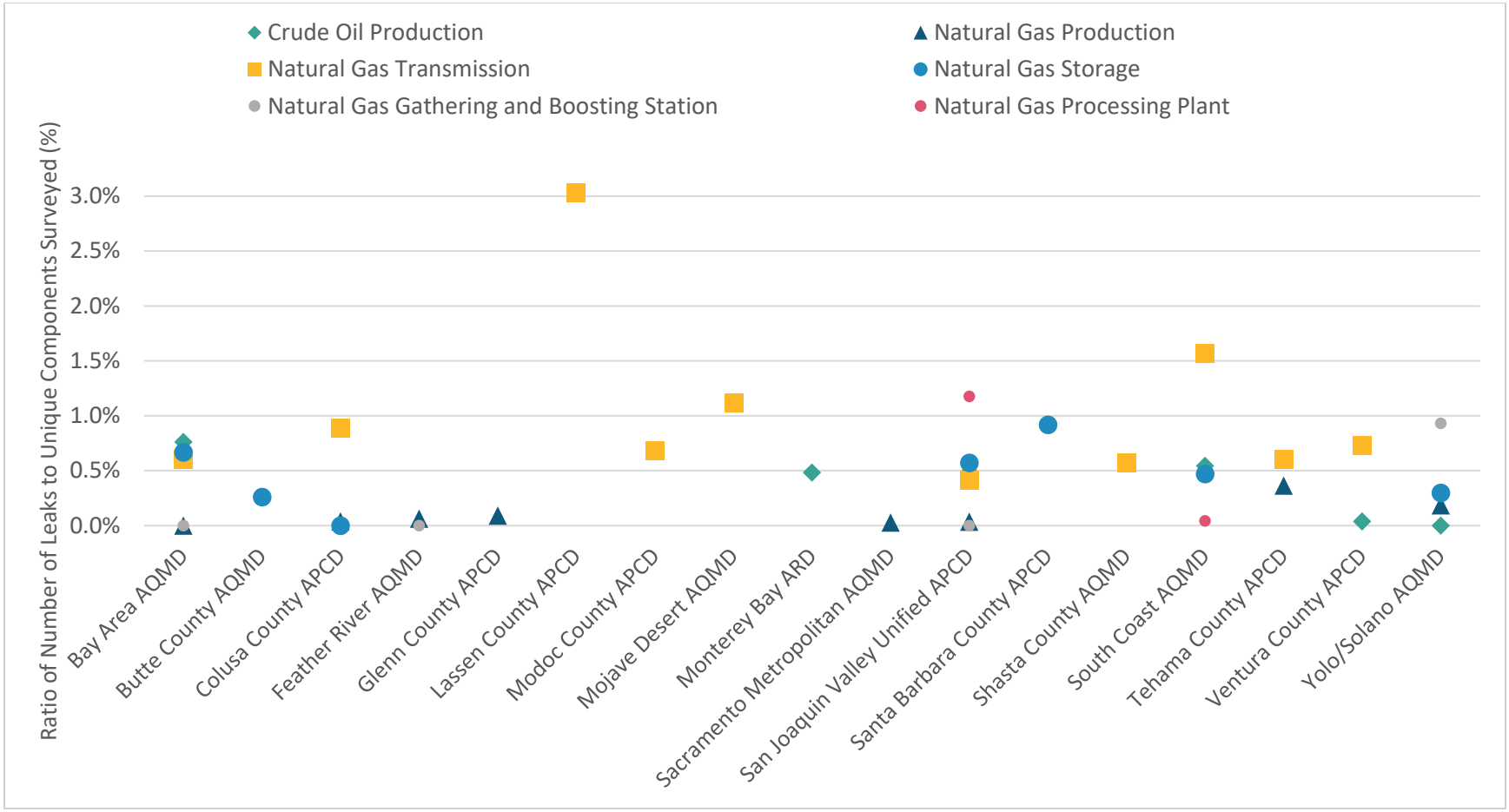

Figure A-2: Ratios of numbers of leaks to numbers of unique components surveyed for each sector by local air district during 2021. Note there are overlapping values: Bay Area AQMD had ratios of 0.00% for both natural gas production and natural gas gathering and boosting stations, Colusa County APCD had ratios of 0.037% and 0.00% for natural gas production and natural gas storage, respecitvely, Feather River AQMD had ratios of 0.064% and 0.00% for natural gas production and natural gas gathering and boosting stations, respectively, and San Joaquin Valley Unified APCD had ratios of 0.036%, 0.00%, 0.42% and 0.49% for natural gas production, natural gas gathering and boosting stations, natural gas transmission, and crude oil production, respectively. No leaks at or above 1,000 ppmv were discovered at the North Coast Unified AQMD in 2021. San Luis Obispo County APCD does not have facilities subject to CARB's Oil and Gas Methane Regulation's LDAR provisions; those facilities report their LDAR data to the District.

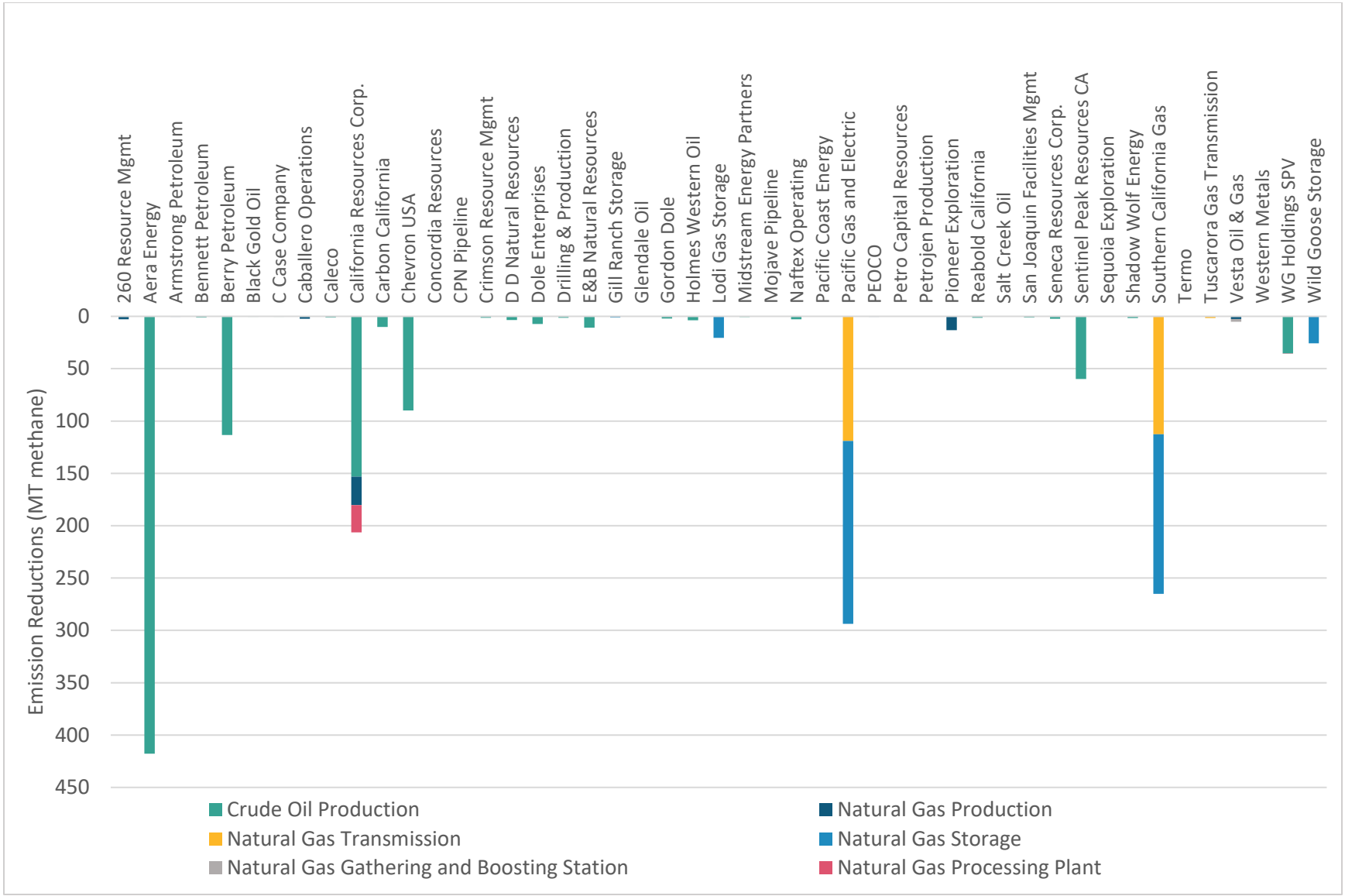

Figure A-3: Emission reductions from each sector by owner/operator during 2021. Of the 94 operators who conducted quarterly LDAR surveys, 47 did not measure any leaks at or above 1,000 ppmv and are therefore not shown here.

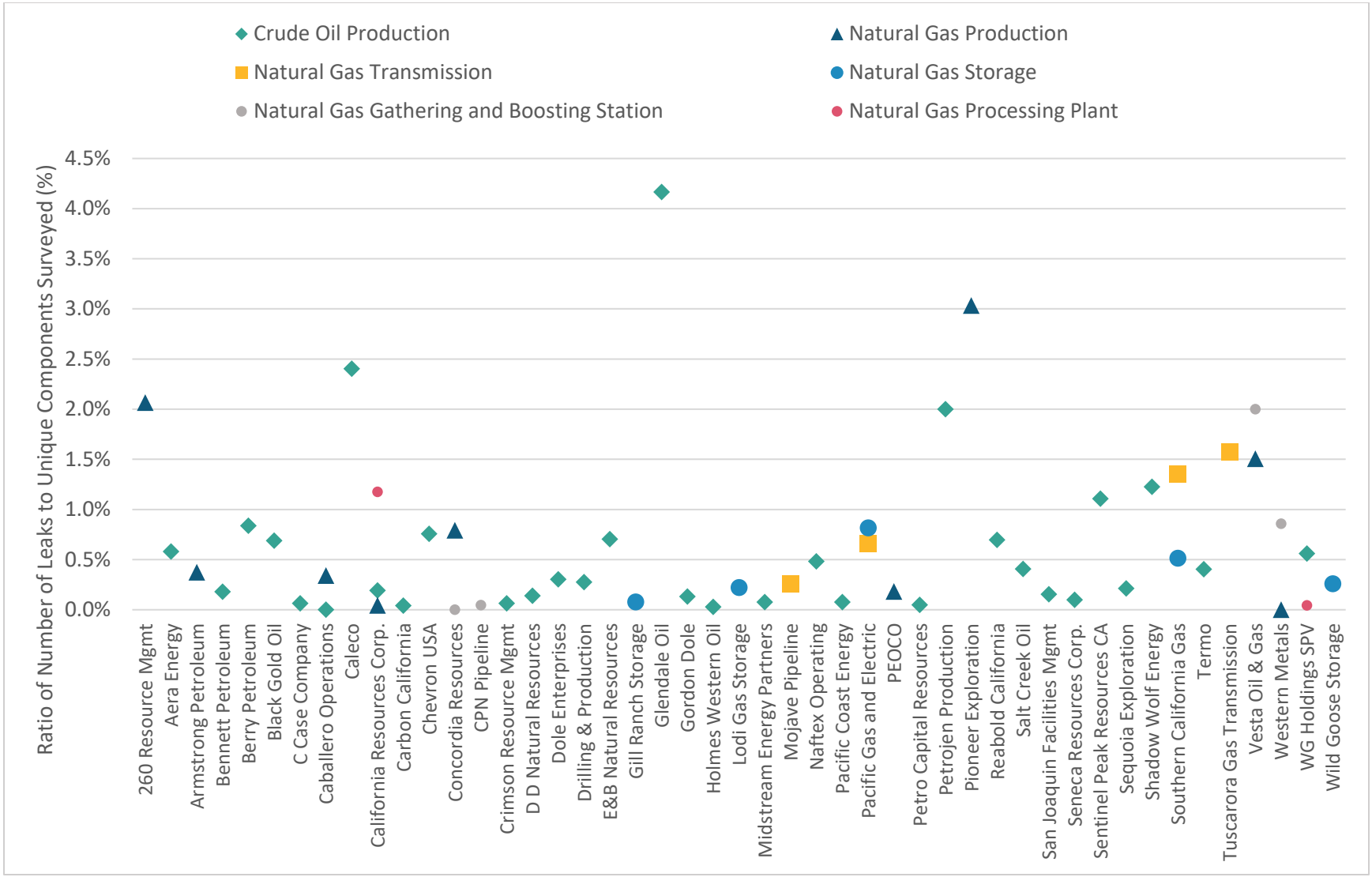

Figure A-4: Ratios of numbers of leaks to numbers of unique components surveyed for each sector by owner/operator during 2021. Of the 94 operators who conducted quarterly LDAR surveys, 47 did not measure any leaks at or above 1,000 ppmv and are therefore not shown here.