

## Ember Resources

# Pilot alt-FEMP Program 2024 Performance Report

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## Executive Summary

Ember Resources (Ember) is a Western Canadian coalbed methane producer that owns and operates facilities in Alberta. In 2023, the Alberta Energy Regulator (AER) issued regulatory approval for Ember to implement an alternative Fugitive Emissions Management Program (alt-FEMP) pilot for 153 facilities. The pilot alt-FEMP was issued for two full compliance years (2023 – 2024).

For methane detection, this pilot alt-FEMP utilized GreenPath Energy, now Montrose Environmental Group (Montrose), optical gas imaging cameras (OGI) along with site-level emission-screening by Bridger Photonics, Inc.'s (Bridger) aerial-based technology.

With the Pilot alt-FEMP Program screenings and surveys completed, Ember will continue to use the data collected to track progress towards methane reduction targets and inform areas of improvement. This report summarizes data collected during the alt-FEMP screenings, follow-up OGI surveys, other independent OGI surveys, and Control Region OGI surveys. The schedule of the program was as followed:

<u>Quarter-Year</u>	<u>Site Level Screening</u>	<u>OGI Surveys</u>	<u>Status</u>
<b>Q2 2023</b>		Independent OGI survey by Montrose of all alt-FEMP facilities for fugitive emission localization and repair.	Completed
<b>Q3 2023</b>	Aerial-based, site-level screening by Bridger of alt-FEMP facilities.	Followed by Montrose OGI follow-up surveys at the top 40% of all screened LSDs ranked by total emission rate for fugitive emission localization and repair.	Completed
<b>Q2 2024</b>		Independent OGI survey by Montrose of all alt-FEMP facilities for fugitive emission localization and repair.	Completed
<b>Q3 2024</b>	Aerial-based, site-level screening by Bridger of alt-FEMP facilities.	Followed by Montrose OGI follow-up surveys at the top 40% of all screened LSDs ranked by total emission rate for fugitive emission localization and repair.	Completed
<b>Q4 2024</b>		Independent OGI survey by Montrose of 40 facilities for fugitive emission localization and repair.	Completed

## 1. Screening Data

Table 1 summarizes various statistics regarding the screening campaigns across the alt-FEMP. Please note emissions detected during the screenings can be a combination of fugitive, vented and sporadic operations-related emissions. The detailed screening data is provided in an Excel attachment with this report, and the tables summarizing each site's total and individual emissions detected during each screening are provided in Appendix B and C, respectively.

*Table 1. Combined summary of screening data for 2023 and 2024.*

<u>Parameter</u>	<u>2023</u>	<u>2024</u>
Number of sites screened	137	132
Number of screened sites with detections	65	53
Number of detections during screenings	112	83
Percentage of screened sites with detections (%)	47%	40%
Average emissions per screened site with a detection (m <sup>3</sup> /day)	321	282
Total emission rate identified (m <sup>3</sup> /day)	20 882	14 967
Number of sites followed-up on	55	53
Percentage of sites followed-up on vs. screened (%)	40%	40%
Number of follow-up sites with no screening detections	0	0
Number of follow-up emissions with emission source not detected by the screening technology	0	0
Average time between detection and follow-up to site (days)	53	23
Percentage of follow-up sites that are recurring (%)	N/A	#N/A
Number of emissions from the screenings that were followed-up on	112	83
Number of emissions from the screenings that were followed-up and identified as fugitive emissions	56	37
Total emission rate of fugitives identified and fixed for the calendar year (m <sup>3</sup> /day)	249.2	76

## 2. Follow-up Data

Table 2 summarizes statistics regarding the OGI follow-up surveys of the alt-FEMP region conducted after a screening campaign. The raw detailed follow-up data is provided in an Excel attachment with this report.

OGI has the capability to localize emissions to a source-level. Also, the OGI operator can normally determine the emission type. Table 3 shows the emission source equipment types for all identified emissions including the number and volume for each equipment type.

Table 2. Summary of OGI follow-up data.

Year		2023	2024
Number of sites followed-up on for the year		55	53
Percentage of screened sites followed-up on (%)		40%	40%
Percentage of sites with screening detections followed-up on (%)		65%	100%
Percentage of follow-up sites with OGI detections		65%	87%
Number of follow-up surveys where no emissions were found		19	7
Average time between detection and follow-up to site (days)		53	23
Percentage of follow-up sites that are recurring (for the calendar year – following-up on a site more than once)		N/A	N/A
Identified emission source types per follow-up per screening campaign (vent, fugitive, methane slip, other)		Fugitives and Vents	Fugitives and Vents
Number of detections by emission source type (n)	<b>Fugitives</b>	56	31
	<b>Vents</b>	67	105
	<b>Total</b>	123	136
Volume of detections by emission source type (m <sup>3</sup> /day)	<b>Fugitives</b>	327.9	118
	<b>Vents</b>	263.0	320
	<b>Total</b>	590.9	438

Average emissions per follow-up site (m <sup>3</sup> /day)	10.7	8.2
Identified emission source equipment types per follow-up per screening campaign (e.g., tank, compressor seal)	8	7
Number of recurring leaks observed (if the leak occurred more than once per year)	N/A	4

Table 3. Number and volume (m<sup>3</sup>/d) of emission detections by equipment type.

Identified emission source equipment types	2023		2024	
	Number of detections by equipment type	Volume of detections by equipment type (m <sup>3</sup> /d)	Number of detections by equipment type	Volume of detections by equipment type (m <sup>3</sup> /d)
controlled tank				
dehydrator	6	34.7	8	55.1
flare stack	4	20.4	7	106.4
header	1	4.9		
heater				
meter	3	135.8	3	0
other	1	0	12	20.5
pig sender/receiver				
pipeline - aboveground				
pipeline - buried				
pneumatic instrument				
pneumatic pump				
reciprocating compressor	76	320.4	34	22
screw compressor	23	54.4	26	17.9
separator	9	20.4	12	5.7
surface casing vent				
sweetening process treater				
uncontrolled tank			33	210.0
vent stack				
wellhead			1	0
<b>Total</b>	<b>123</b>	<b>590.9</b>	<b>136</b>	<b>437.6</b>

### 3. Emissions Summary

#### 3.1 Screening Summary

Figure 1 shows the distribution for site-total methane emission rates detected during screening campaigns in 2023 and 2024, capturing all types of methane emissions (fugitives, vents, methane slip and others). The graph allows one to discern how many site-total emission measurements reported emission rates within a certain range (e.g. emissions with rates between 0 and 100 m<sup>3</sup>/day where individual emissions on a single site from one screening are summed).

Figure 2 shows the distribution for individual emission rates detected during the 2023 and 2024 screening campaigns. Screening technologies are generally unable to determine the type of methane emission measured (fugitives, vents, methane slip and others). The graph allows one to discern how many individual emission measurements had an emission rate within a certain range (e.g., emissions with rates between 0 and 100 m<sup>3</sup>/day).

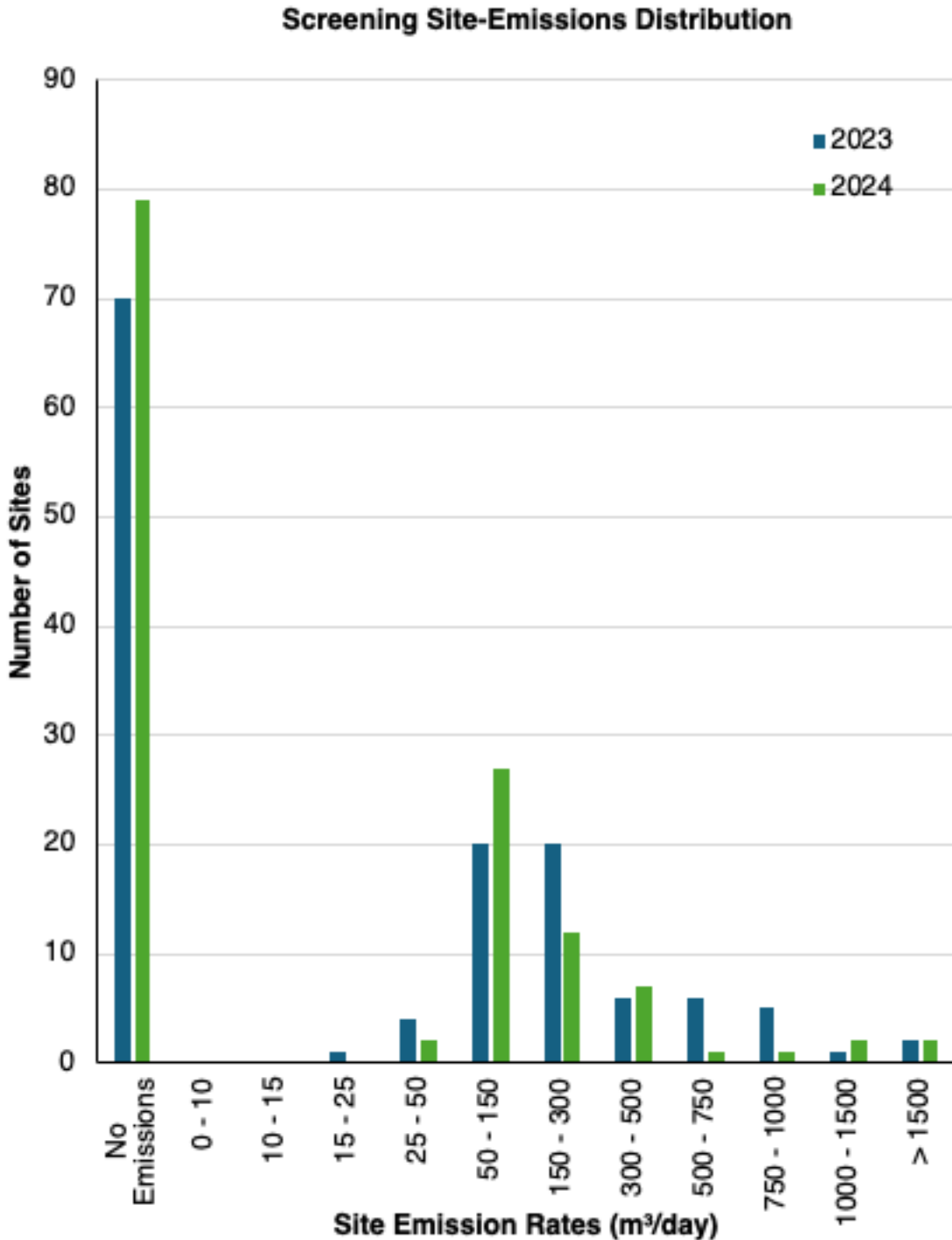


Figure 1: Distribution of site-total emission rates measured during screening campaigns.



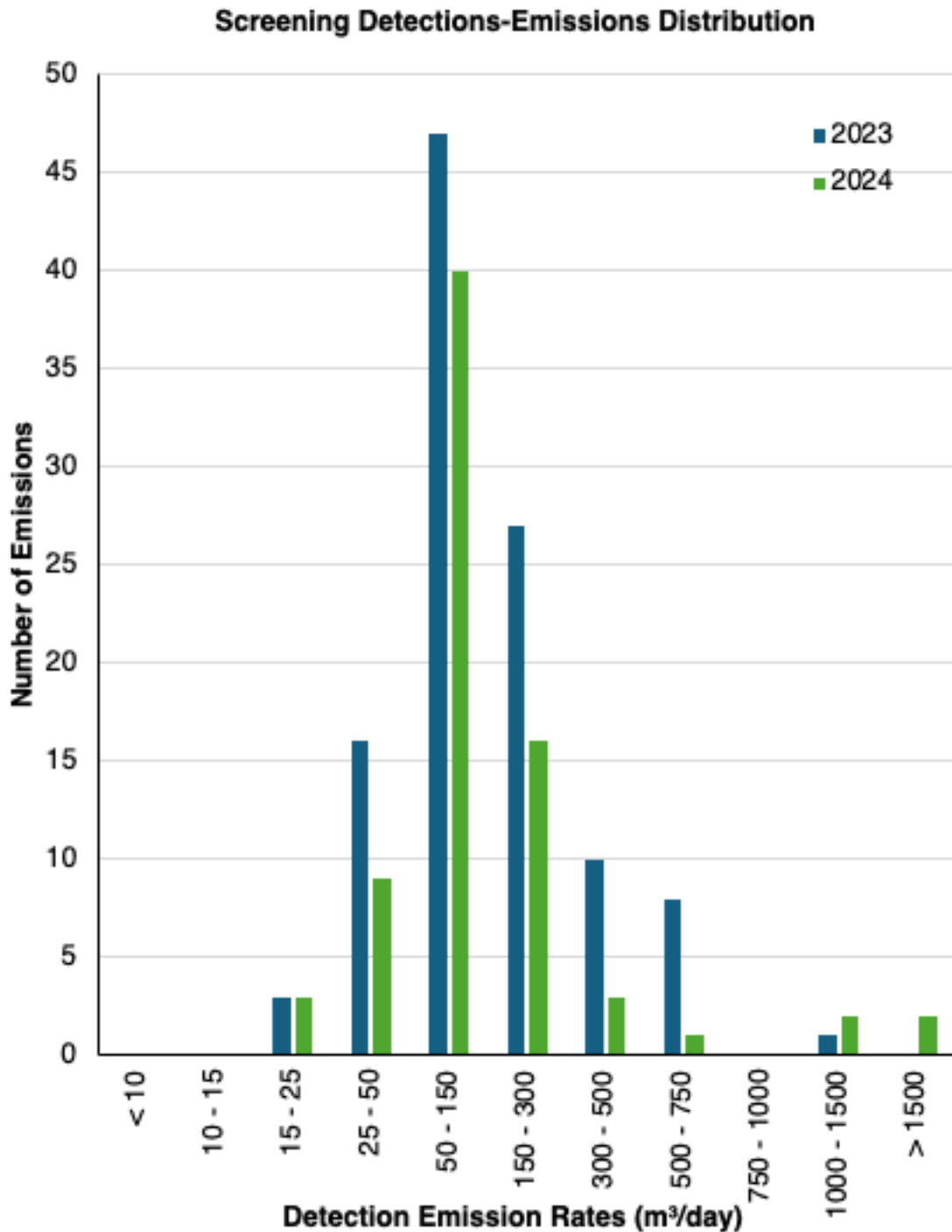


Figure 2: Distribution of individual emissions, by rate, measured during screening campaigns.



In general, screening technologies cannot discern fugitive emissions from other emission types, thus a graph depicting the emissions distribution specifically for fugitives detected during screenings could not be generated.

### **3.2 OGI Survey Summary**

Figure 3 shows the emission rate distribution for site-total emissions detected during OGI survey campaigns of the alt-FEMP region, aggregating all methane emissions measured during that OGI campaign. The graph allows one to discern how many site-total emission measurements, by OGI, reported an emission rate within a certain range.

Figure 4 below shows the emission rate distribution for individual emissions detected during OGI survey campaigns. The graph allows one to discern how many individual OGI measurements had an emission rate within a certain range.

### Survey Site-Emissions Distribution

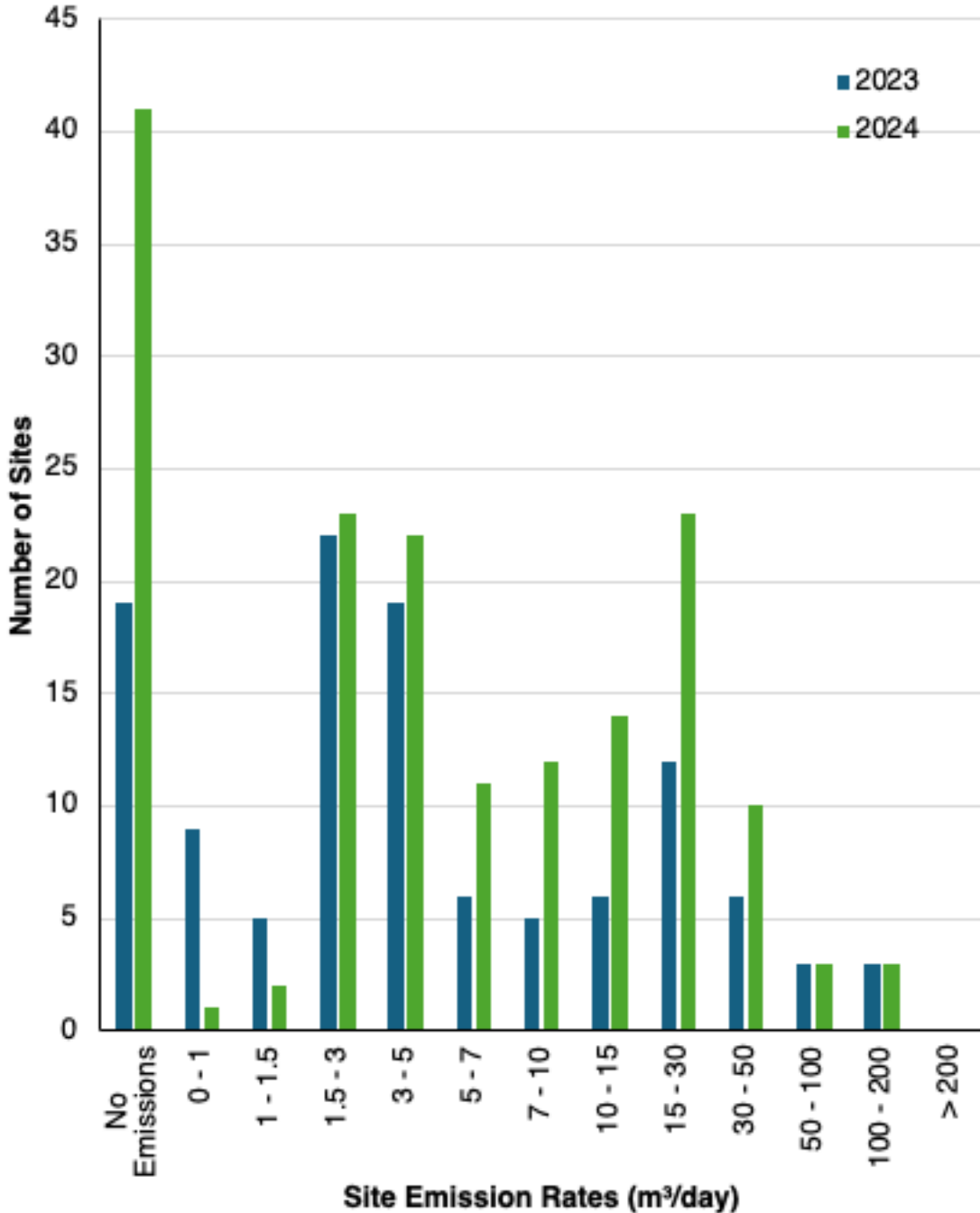


Figure 3: Distribution of site-total emission rates measured during OGI survey campaigns (e.g. follow-up and independent campaigns) of the alt-FEMP region.



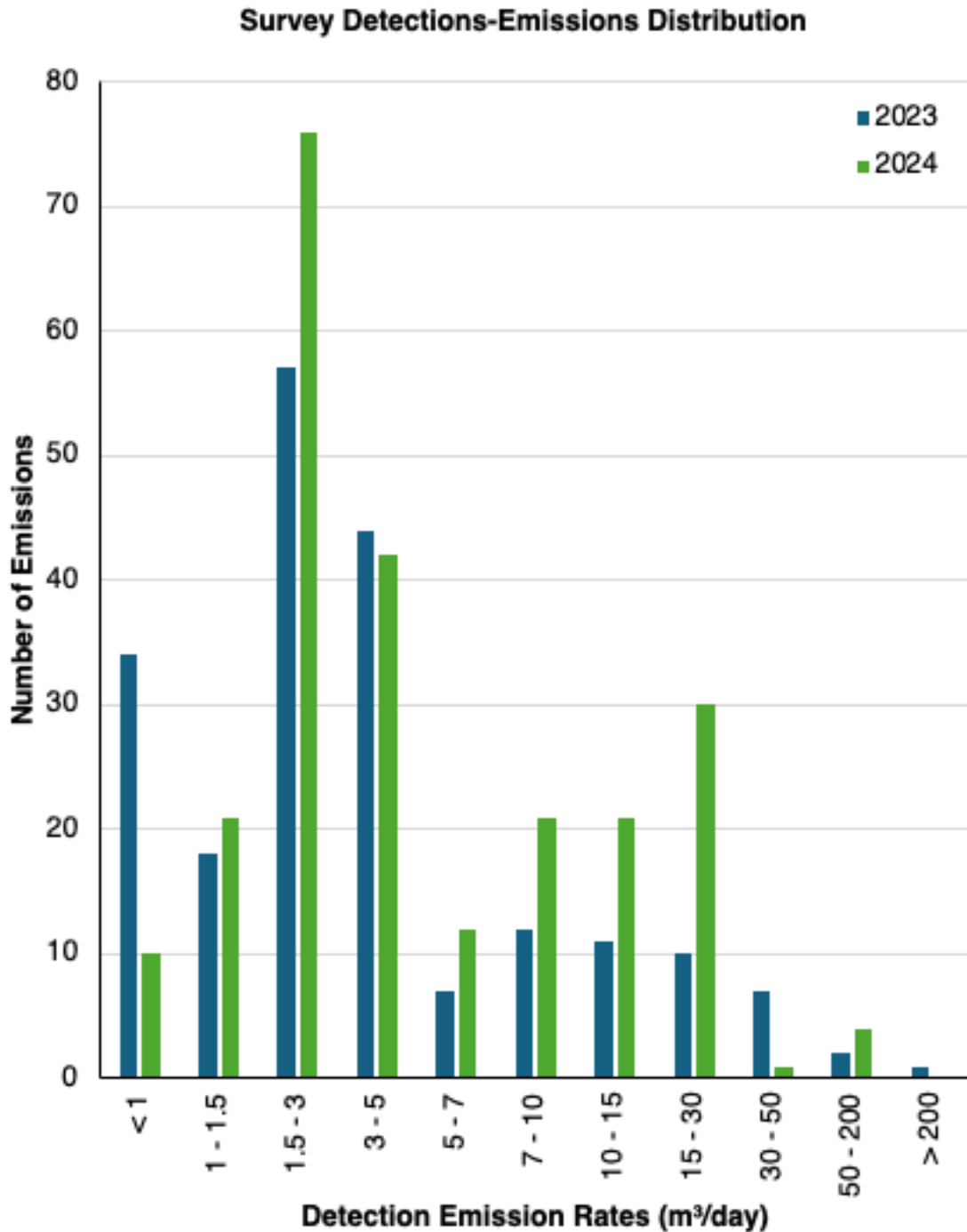


Figure 4: Distribution of individual emissions, by rate, measured during OGI survey campaigns (e.g. follow-up and independent campaigns) of the alt-FEMP region.



Figure 5 below shows the emission rate distribution for individual fugitive emissions detected during OGI survey campaigns. The graph allows one to discern how many individual fugitive emission measurements reported an emission rate within a certain range.

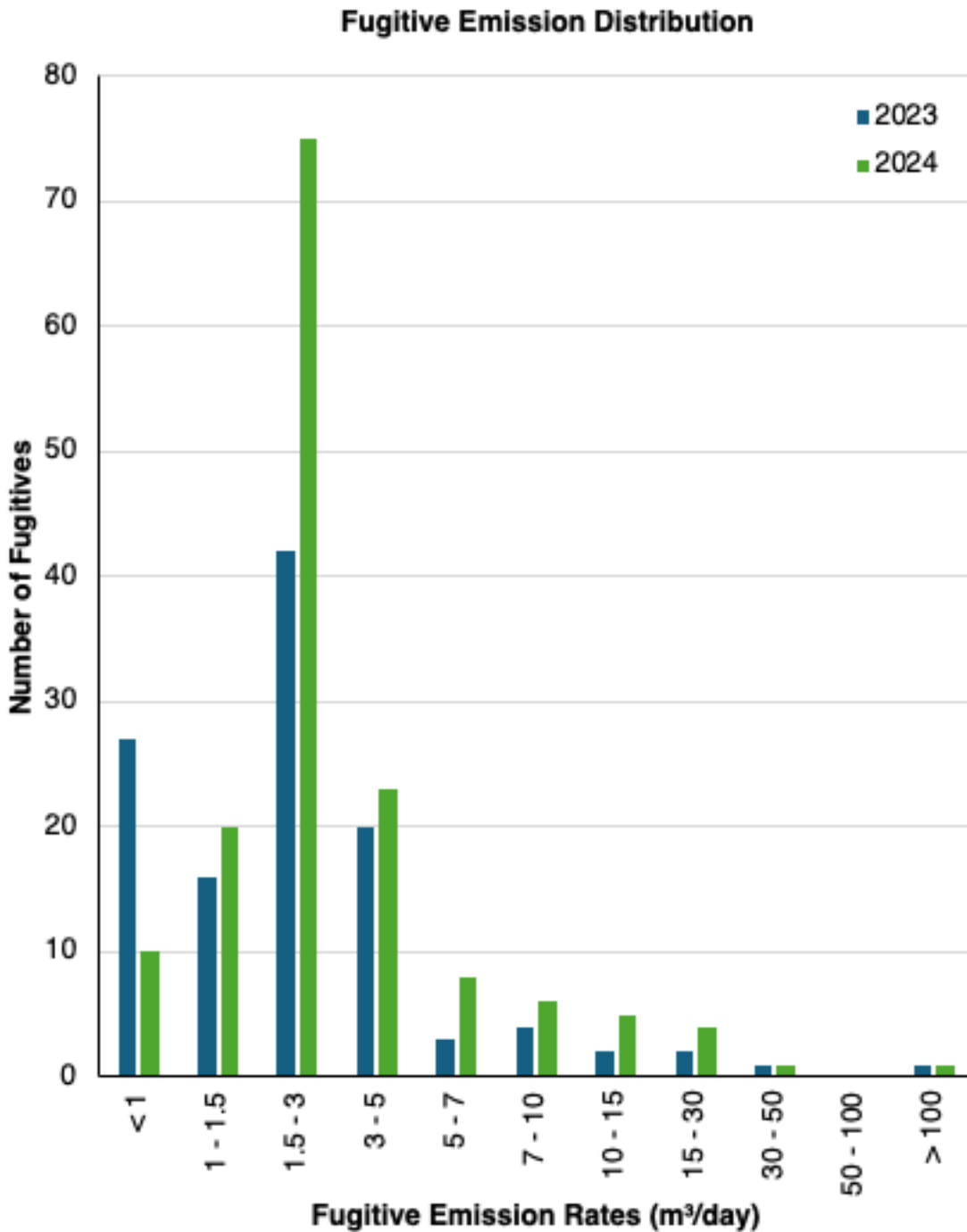


Figure 5: Distribution of fugitive emissions, by rate, measured during OGI survey campaigns (e.g. follow-up) of the alt-FEMP region.



### 3.3 Independent OGI Surveys

As part of the approved pilot alt-FEMP program, independent OGI surveys were completed on top of the normal follow-up campaigns. In 2023 and 2024, all sites had an extra OGI survey. In 2024, a second independent OGI survey was carried out at 40 facilities. The below tables summarize the findings of these campaigns.

*Table 4. Summary of findings during independent OGI campaigns.*

<b>Year</b>		<b>2023</b>	<b>2024</b>
Number of sites followed-up on for the year		137	150
Percentage of sites with detections		53%	83%
Number of follow-up surveys where no emissions were found		64	27
Identified emission source types per follow-up per screening campaign (vent, fugitive, methane slip, other)		Fugitives and Vents	Fugitives and Vents
Number of detections by emission source type (n)	<b>Fugitives</b>	88	163
	<b>Vents</b>	84	183
	<b>Total</b>	172	346
Volume of detections by emission source type (m <sup>3</sup> /day)	<b>Fugitives</b>	140.8	605
	<b>Vents</b>	589.9	957
	<b>Total</b>	730.7	1562
Average emissions per site (m <sup>3</sup> /day)		5.3	10.4

Table 5. Number and volume of emissions detected during independent OGI campaigns sorted by equipment type.

Identified emission source equipment types	2023		2024	
	Number of detections by equipment type	Volume of detections by equipment type (m <sup>3</sup> /d)	Number of detections by equipment type	Volume of detections by equipment type (m <sup>3</sup> /d)
controlled tank				
dehydrator	5	7.3	8	24.0
flare stack				
header	4	4.1		
heater				
meter	3	5.7	7	10.8
other	4	13.0	136	208.2
pig sender/receiver				
pipeline - aboveground				
pipeline - buried				
pneumatic instrument				
pneumatic pump				
reciprocating compressor	92	610.3		
screw compressor	47	70.2		
separator	10	6.1	29	32.6
surface casing vent				
sweetening process				
treater				
uncontrolled tank	2	2.9	141	928.9
vent stack				
wellhead	5	11.0	9	20.2
<b>Total</b>	<b>172</b>	<b>730.6</b>	<b>330</b>	<b>1224.7</b>

### 3.4 Control vs. alt-FEMP Summary

Table 6 compares several metrics related to the sites surveyed and emissions detected via OGI surveys in the alt-FEMP vs. Control regions for 2024. The average rates in the table are calculated per site per survey (e.g. the control site was surveyed six times in the two years and the average of these six was taken).

*Table 6. Comparison of the alt-FEMP and Control regions in 2024.*

<b>Item</b>	<b>alt-FEMP Region</b>	<b>Control Region</b>
Number of Sites Surveyed	53	37
Number of Surveyed Sites with Emissions Detected	46	33
Percentage of Surveyed Sites with Emissions Detected (%)	86.8%	89.2%
Number of Emissions Detected at Surveyed Sites	136	65
Number of Surveyed Sites with Fugitive Emissions Detected	21	11
Percentage of Surveyed Sites with Fugitive Emissions Detected (%)	39.6%	29.7%
Number of Fugitive Emissions Detected	31	14
Number of Vent Emissions Detected	105	51
Total Rate of Emissions Detected (m <sup>3</sup> /day)	438	196
Total Rate of Fugitive Emissions Detected (m <sup>3</sup> /day)	118	50

Total Rate of Vent Emissions Detected (m <sup>3</sup> /day)	320	146
Average Fugitive Rate per Site with Fugitive Emissions Detected (m <sup>3</sup> /day)	9.7	17.8
Average Fugitive Rate for all Fugitive Emissions Detected (m <sup>3</sup> /day)	9.72	6.54
Number of Fugitive Emissions Repaired	24	13
Percentage of Fugitives Repaired (%)	77%	93%
Average time to repair (days)	33	65

#### 4. Emission Reduction Summary

The fugitive emission data collected during the alt-FEMP was used to generate the as-found “measured fugitive emission distribution”. This consisted of all fugitive emissions recorded during surveys of both the alt-FEMP regions. Figure 6 shows a comparison of the as-found “measured fugitive emission distribution” to the “assumed fugitive emission distribution” employed in the modelling initially used to design the approved alt-FEMP. Additionally, the minimum detection limit (MDL) at 90% probability of detection (PoD) for the screening technology is displayed for reference.

A default Directive 060 FEMP program and the executed Ember Resources program were re-modelled using the as-found fugitive distribution using the AroFEMP software (Arolytics). The traditional default FEMP was predicted to have 9.5% less emissions than the alt-FEMP program. The change in performance could be due to the as-found distribution shifting towards smaller emissions.

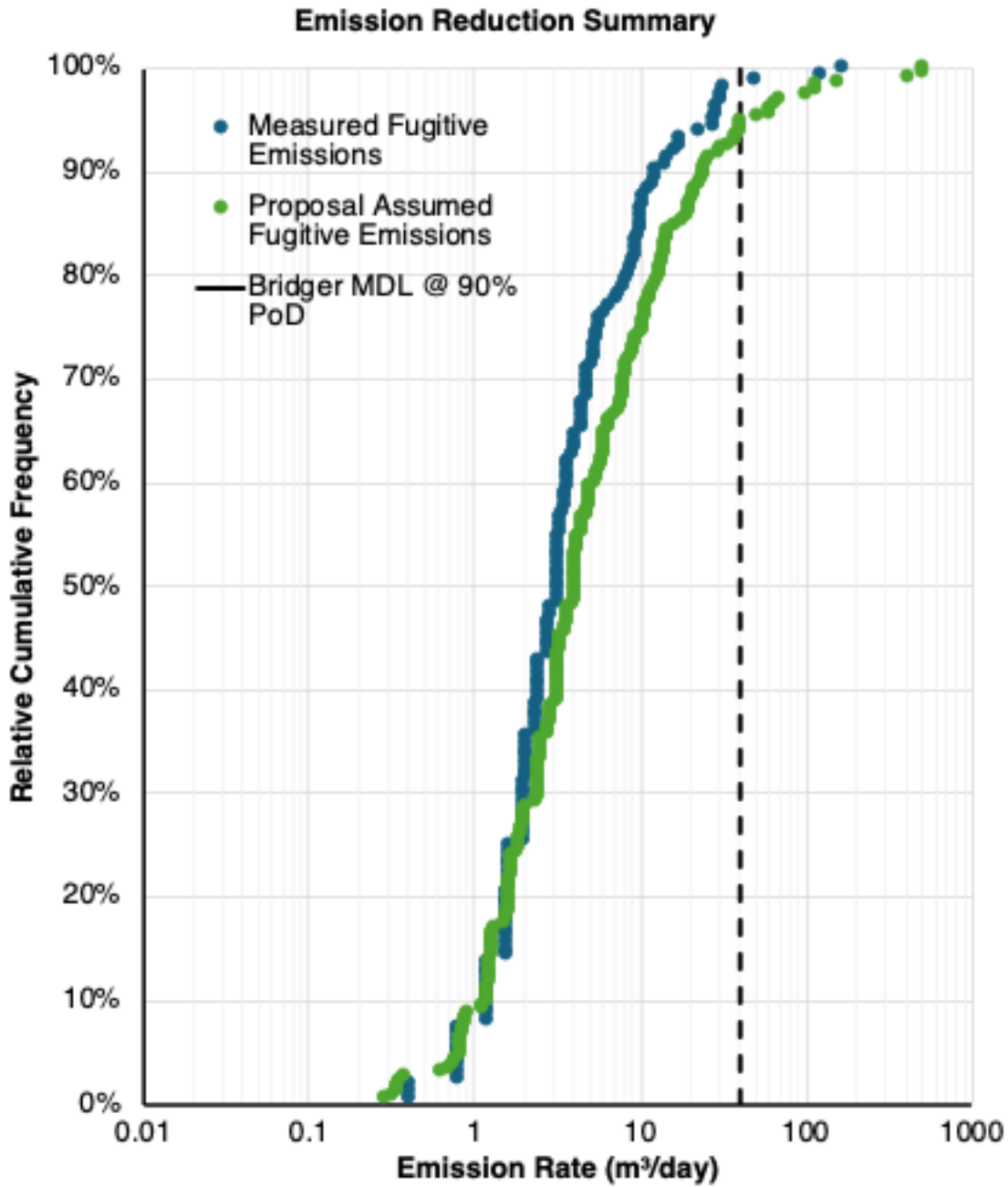


Figure 6. Comparison of relative cumulative frequencies for the “as-found” measured fugitive emissions versus the proposal-assumed fugitive emissions.

## 5. Technology Limitations

Bridger's detection sensitivity depends on factors including flight speed, flight altitude, measurement swath width, and wind speed. Many of these factors can be controlled by Bridger to tighten or loosen the sensitivity as required. Bridger's GML is an active, laser-based system, rather than a passive remote sensor that relies on the environment, so conditions such as cloud cover or shadows that can impair other aerial sensor technologies do not negatively impact GML. Regarding operations at northern latitudes, GML is moderately limited by snow cover and standing water. While GML will detect methane when there is snow on the ground, the detection sensitivity of the data is degraded. With standing water, Bridger's laser 'bounces' off and, as a result, no measurement is made. In several areas of Alberta, the muskeg landscape holds pockets of water in the warmer months. Based on testing and commercial projects completed in Alberta, the muskeg landscape has not negatively impacted Bridger's GML measurements. As a result of high winds rapidly dispersing emissions, Bridger limits its survey operations to ground wind speeds less than or equal to 25 mph. Bridger also implements a wind speed protocol to detect emissions at the lower end of GML's detection sensitivity. To avoid Bridger's limitations in snow, Bridger will only implement GML in snow-free months (between late Spring and early Winter). Bridger will also limit its survey operations to average ground wind speeds less than or equal to 25 mph.

## 6. Success of the alt-FEMP

The Pilot alt-FEMP Program was designed to meet methane emission equivalency to a default FEMP using alternative site screening technologies combined with OGI surveys. The execution of this program has been successfully completed.

## 7. Nonperforming Program Elements

Due to wildfires, the 2023 Bridger screening campaign could not be completed in a single defined time period due to smoke conditions and no-fly zones. Thus, the first part of the screening took place in May to screen all accessible sites while approximately 1 other site was screened in July after the no-fly zones were lifted.

## 8. Additional Control Measures

Any sites that were missed during screenings were automatically added to be followed-up on by OGI survey.

## 9. Additional Information

Note an additional 40-site OGI survey was completed in 2024 as per the approved alt-FEMP schedule. Direct comparison of OGI-detected emissions in 2023 and 2024 within Section 3 above is not accurate without additional analysis.

## 10. Key Performance Indicators

- Ember Resources successfully implemented alternative technologies to conduct LDAR screening, where emissions were detected at 118 of the 269 screened sites.
- In 2023 and 2024, a total of 35 849 m<sup>3</sup>/day of methane was found to be emitting by screening technologies on 195 detections. Of which, 446 m<sup>3</sup>/day was identified as fugitive emissions when followed-up with OGI.
- A comparison of the alt-FEMP and control regions can be found in Table 6 for 2024.
- 77% of fugitive emissions sources were repaired under the alt-FEMP. Some of the remaining are still scheduled to be completed, waiting to be updated into data management platforms, and others are waiting for a shutdown so they can be properly accessed.
- A default D060 program would result in 327 site visits compared to the 203 that were visited with OGI under the alt-FEMP in 2024 showcasing efficient LDAR program execution.
- The average time to repair fugitives was 33 days in the alt-FEMP. The control region saw fugitives repaired after 65 days on average. The longer average control times was heavily skewed by only 6 delayed repairs.

## **Appendix A: Raw Detailed Data**

Please refer to the attached excel file of the raw data collected during the screening and follow-up surveys titled “Ember 2024 femp-screening-data.xlsx”.

## **Appendix B: Screening Data – Site-total Emissions by Campaign**

See attached “Ember AER-altFEMP-PerformanceReport-Appendix.xlsx”. Note that truck screenings are typically just given as a site-total rate and not individual detections.

## **Appendix C: Screening Data – Individual Emissions**

See attached “Ember AER-altFEMP-PerformanceReport-Appendix.xlsx”. Note that truck screenings are typically just given as a site-total rate and not individual detections.