



March 31, 2025

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**RE: 2024 Final Performance Report
EMBER RESOURCES ALTERNATIVE FUGITIVE EMISSION MANAGEMENT PROGRAM
Partnership with Qube Technologies Inc.**

Program Overview

Ember Resources received approval from the AER on September 16, 2021, for our proposed AltFEMP project with the partnership of Qube Technologies. This approval was effective from September 16, 2021, to December 31, 2024, and applied to the 25 facilities listed below:

01-08-027-23W4	03-14-026-24W4	07-19-027-25W4	10-31-026-23W4	13-33-033-20W4
01-22-027-25W4	04-10-026-23W4	09-27-024-25W4	11-08-031-27W4	14-26-024-26W4
01-24-028-24W4	06-28-023-25W4	10-12-025-26W4	11-21-033-27W4	14-35-029-24W4
02-15-025-26W4	07-07-032-27W4	10-22-027-27W4	12-35-026-25W4	16-08-031-27W4
02-29-031-28W4	07-16-023-27W4	10-31-025-24W4	13-13-024-27W4	16-18-031-26W4

Results and applicable data utilized in this report were obtained from Qube devices and surveys/screenings completed in the year 2024 (January 1 – December 31). Ember utilized 60 Qube fixed monitors on these twenty-five LDAR sites. Qube used fixed metal oxide sensors (Axon devices) that continuously monitor for methane and environmental conditions such as wind direction, wind speed, temperature, pressure, and humidity through an Industrial Internet of Things (IIoT) device. Qube’s system measures gas concentration and uses analytics and machine learning to detect where vent occurs, localize the source of a potential leak, and quantify the size of emission. The Qube system does not determine whether a leak is fugitive or vented.

Leaks that are found in real-time can be fixed faster, leading to increased methane reductions compared to traditional OGI survey methods that are intermittent by nature. All data is visualized and reported on a web-based dashboard that enables operators to make actionable insights to reduce methane emissions and meet regulations for reduction targets through continuous monitoring.

Ember received alarm notifications via email as well as reviewed the online Qube dashboard frequently and responded to any events that were outside the setpoints. If the event could not be rationalized by an operational upset or shut down, a site visit is initiated for either GreenPath Energy or Ember’s Regulatory Coordinator to troubleshoot the site with our OGI camera. In the event of a found fugitive emission it was quantified, repaired, and reported as required. As of October 17, 2024, Ember Resources updated the work practice and adopted the AER’s Work Practice for Stationary Monitors outlined in Section 3.2 of the AER’s revised “Alternative Methane Detection Technologies Evaluation September 2024” report. Under the large emitter emission follow-up work practice, Ember Resources configured the Qube Technologies alarm

management system to alert key Ember Resources stakeholders if an emission event or emission events exceed 500m³/d above site-specific baseline for a 24-hour period. For each site after the appropriate time period (annual or triannual), the detected emission rate was compared to the site baseline to examine for sustained deviations from the site baseline. Qube Technologies has an independently verified Minimum Detection Threshold (90% Probability of Detection) of 1.5kg/h or 54.0m³/d. Site baseline was calculated as a 90-day rolling average detected emission rate with known fugitive emission or non-routine venting events removed from the calculation.

1) Screening and Survey Details:

See attached **File: Ember_Alt-FEMP_Qube_Data_2024.xlsx** for detailed emission data collected by Qube Technologies.

Type of screening – continuous monitoring (continuous screening) conducted on 25 sites. 60 fixed monitors deployed within the 25 sites included in the project. Sensor devices and installation locations are labeled within each site map on the Qube Data Dashboard.

Date of screenings and summary of data can be found on the **File: Screening_Leak Repair_2024.xlsx**.

Number of sites screened – 25 sites included in continuous monitoring program.

Number of total emission sources

Detection equipment group	Component type	Total number of sources
Reciprocating Compressor	Connector	3
	Threaded Connection	6
	Pressure Regulator	2
	Valve	5
	Open Ended Line	1
Dehydrator / Refrigeration	Threaded Connection	2
Header	Flange	1
	Threaded Connection	1
	Valve	2
Meter	Connector	1
Uncontrolled Tank	Open-ended line	1

Vent Stack	Open-ended line	1
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Average time between detection (truck, aerial or continuous) and follow-up survey – average time between detection believed to be a leak and follow-up survey was 6 days.

Summary of follow-up surveys

Ember received alarm notifications via email as well as monitored the online Qube dashboard and responded to any events that displayed continuous venting. Alarm notifications were sent when CH₄ site rates were found to be valued over the average of 3.6kg/h threshold over a sliding window of 24 hours. If analysis of the emission trending revealed the baseline returned to normal, a follow-up survey was not completed. Surveys were conducted every four months on the top 20% emitting sites as per the AltFEMP approval. In October 2024, Ember Resources updated the work practice and adopted Work Practice for Stationary Monitors outlined in Section 3.2 of the AER’s revised “Alternative Methane Detection Technologies Evaluation September 2024” report as discussed under the Program Overview section of this report.

Number of follow-up surveys where a leak was found - 15 surveys identified a leak(s).

Number of follow-up surveys where a vent was found – routine venting was observed during follow-up surveys but not specifically recorded as the surveys focused on fugitives. Sources of venting observed was through compressor seals, dehydrator still columns, produced water tanks, and pneumatic instrumentation. If venting was found to be operationally out of the ordinary, a fugitive repair work order was created to define the leak parameters (emission rate, equipment details, etc).

Number of follow-up surveys where no leaks or vents were found – 6 surveys were completed where no leaks were present.

Number of leaks repaired – 26 leaks were found and repaired in 2024.

Number of repairs delayed - 1 leak was delayed past the D060 30-day repair requirement. This was due to the requirement of a major shutdown.

Average time between survey and repair – the average time between survey and repair was 21 days.

Number of recurring leaks observed – no recurring leaks were observed in 2024.

Analysis of trends observed for fugitive leaks – fugitive emission leaks observed were found to be typical when compared to sites not included in the AltFEMP program. Typical leaking equipment was found to be irregular tank venting (scrubber dump valves passing to production tanks), control valves and/or PSV’s leaking to site cold stack, fuel line threaded connections or components, instrumentation leaks (i.e., regulators, unions of fuel gas lines, etc).

2) *Continuous Survey Additional Information:*

Total number of follow-up potential emissions found during the pilot or full-scale program

There was a total of 206 emission events which triggered an alarm via continuous monitoring in 2024. The alarm threshold was set at of 3.6kg/hr over a sliding window of 24 hour as most alarms were found to be operational events, and non-fugitives therefore, dialing into more accurate potential fugitive emission follow-up. Following the adoption of the AER's Work Practice of Stationary Monitors for large emitter emission detection follow-up in October 2024, five emission events were triggered.

It is important to note that following further review and investigation of alarms via the Qube dashboard, most events returned to baseline and therefore deemed operational, eliminating the requirement of a follow up screening. If the baseline returned to normal, a follow-up survey was not initiated. Comments pertaining to each alarm are included on **File:**

Ember_AltFEMP_Qube_Data_2024.xlsx.

Number of potential emissions followed up on during the pilot or full-scale program – 2 follow-up surveys were initiated based on potential emissions where the emission trend was consistent and found to be abnormal (outside of baseline).

Number of potential emissions not followed up on during the pilot of full-scale program, with an explanation – with careful analysis of trending data, sites where baseline returned to normal, a potential fugitive was not investigated. Potential fugitives that were found to be irregular to a site were investigated and/or closely monitored to ensure an actual leak wasn't present.

3) *Emission Reduction Summary*

File: 2024 Qube AltFEMP_Reduction Summary.xlsx represents the collective data that was captured from Ember's Qube AltFEMP Program in 2024. The left-hand column titled UWI lists all 25 sites that are enrolled in the program. The 16 sites highlighted in green had no recordable releases or emissions above the threshold of 3.6 kg/hr / applied baseline, or they were related to an operational venting event. The remaining 9 sites accumulated 26 leaks over the year.

OGI VS AltFEMP Comparison

Even though our triannual OGI surveys occurred over two to three weeks during the year we selected a midpoint of March 15, August 15 and November 15 for obtaining Survey and Previous Survey dates to estimate the OGI equivalent emissions.

The total fugitive emissions from the AltFEMP program are estimated at 15465.78 kg of methane and estimated emissions from the OGI Directive 060 process was 20907.72 kg of methane. In comparison, the AltFEMP program shows a decrease of emissions by 5442.54 kg or 26.03%.

AltFEMP Annual Targets vs Actual Targets Obtained

Table 1 below highlights that the AltFEMP program exceeded our targets set from the modelling. Target values listed in Table 1 were taken from section 5.3.2 Alternative Fugitive Emissions Management Program Proposal; the Qube program is expected to be even lower than emissions expected under triannual OGI. Overall, our simulations estimate that baseline median fugitive emissions in the absence of LDAR are expected to be 8.70 ± 0.8 kg per day. LDAR Sim estimates the regulatory triannual OGI program to result in emissions of 4.66 ± 0.4 kg per day, a reduction of ~46%. Emissions from the proposed Qube AltFEMP are estimated to be 3.51 ± 0.1 kg per day, or a reduction of 60% from baseline.

We obtained reductions of **74%** (OGI) and **80%** (Qube) compared to the targets of 46% and 60% respectively, using the estimate of 8.70 kg/day for baseline.

	Model Targets	Target Reductions	Actuals	Actual Reductions
No LDAR	8.70 kg/day			
OGI Program	4.66 kg/day	46%	2.29 kg/day	74%
Qube Program	3.51 kg/day	60%	1.69 kg/day	81%

Table 1: 2024 AltFEMP Annual Targets vs Actual Targets Obtained

4) Technology Limitations

The continuous monitoring devices functioned well throughout the AltFEMP. Average device uptime was typically in the 90 percentile, with exception associated to cold weather months. Environmental challenges in Alberta tested the device functionality, proving robust technology of the equipment installed on site.

5) Success of the AltFEMP

The Pilot AltFEMP Program was designed to combine continuous measurement with optical gas imaging (OGI) and be conducted over the final quarter of 2021 through to the 2024 compliance year. Emissions from the Qube AltFEMP were estimated to be 3.51 ± 0.1 kg per day, or a reduction of 60% from baseline. Given that the Qube program resulted in greater emissions reductions than the regulatory OGI program, we believe that the proposed AltFEMP met and exceeded the criteria of equivalence.

6) Nonperforming Program Elements

For the first half of 2023, Qube Technologies was utilizing the leak threshold over a sliding window of one hour. This workflow created numerous nuisance alarms as most alarms were

found to be due to operational events, non-fugitives. As of June 2023, Qube restructured the alarm threshold to over a sliding window of 24 hours so that the focus was on finding larger vent activity that would potentially occur outside of operational venting. Additional enhancement to the leak threshold was incorporated once Ember adopted AER's Work Practice for Stationary Monitor, designed to compare large emitter site baselines for deviations. Most importantly, the alarm management system alerted key Ember Resources stakeholders if an emission event or emission events exceeded 500m³/d above site-specific baseline for a 24-hour period.

7) Additional Control Measures

Throughout the AltFEMP pilot program, we did not determine any additional control measures.

8) Additional Information

No additional information to report for this section.

9) Key Performance Indicators

The proposal estimated that emissions reductions of the program will be as good as or better than the prescribed requirements. This was justified through a comprehensive third-party modelling evaluation and discussed throughout this report.

If you require any further information do not hesitate to contact me directly.

Thank you,



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Attached Files:

Ember_Alt-FEMP_Qube_Data_2024.xlsx
Screening_Leak Repair_2024.xlsx
2024 Qube AltFEMP_Reduction Summary.xlsx