



March 30, 2024

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**RE: 2023 Interim Summary 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 ALT FEMP project with the partnership of Qube Technologies. This approval is effective from September 16, 2021, to December 31, 2024, and applies to the 25 facilities listed below:

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

Ember is currently using 60 Qube fixed monitors on these twenty-five LDAR sites. Qube uses 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 receives alarm notifications via email as well as reviews the online Qube dashboard frequently and responds to any events that are outside the setpoints. If the event cannot 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 will be quantified, repaired, and reported as required.

1) *Screening and Survey Details:*

See attached **File: Ember\_Qube\_Alarms\_2023.xlsx** for detailed emission data collected by Qube Technologies. Please also see attached **File: Ember\_Qube\_Volumes\_2023.xlsx** that will provide the total emissions volume collected for each site.

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\_2023.xlsx**.

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

Number of sites emitting - 21 out of 25 sites produced emission data supporting potential fugitive emission events. The remaining 4 sites have quantities of emissions below the Qube leak threshold of 3.6kg/hr.

Number of total emission sources

Detection equipment group	Component type	Total number of sources
<b>Compressor Driver/Engine</b>	Pipe (Union)	1
	Threaded Connection	2
	Pressure Regulator	1
<b>Dehydrator</b>	Pressure Regulator	1
	Other – Moisture Analyzer Inlet Filter	1
<b>Fuel Gas Header</b>	Sampling Connection	1
	Threaded Connection	1
	Valve	1
	Flange	1
<b>Fuel Gas Supply</b>	Pressure Regulator	1

<b>Header</b>	Valve	1
<b>Heater</b>	Connector - Thermostat	1
<b>Pipeline Type – Distribution Main</b>	Threaded Connection	2
<b>Reciprocating compressor</b>	Open-ended line	1
	Other – Discharge Vessel	1
	Valve	1
	Pressure Regulator	1
	Connector - VVP	1
<b>Separator</b>	Flange	1
<b>Vent Stack</b>	Open-ended line	3
	Valve	1

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 5 days.

### *Summary of follow-up surveys*

Ember receives alarm notifications via email as well as monitors the online Qube dashboard and responds to any events that display continuous venting. Qube releases a weekly summary report displaying each site’s trending data for the previous week. Alarm notifications are emailed to Ember when CH<sub>4</sub> site rates are 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 returning 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.

Number of follow-up surveys where a leak was found - 15 surveys identified a leak(s). Note: follow-up surveys completed for the third round of 20% emitters have not been included in this report as they occurred in 2024.

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 – 4 surveys were completed where no leaks were present.

Number of leaks repaired – 23 leaks were found and repaired in 2023.

Number of repairs delayed - 2 leaks have been delayed in 2023 and are awaiting repair. These leak repairs have been delayed due to a required facility outage and PSV turnaround activity.

Average time between survey and repair – the average time between survey and repair was 76 days. A second analysis of survey and repair data was completed where the 3 long terms leak delayed repairs (explained below in emission reduction summary) were excluded. The average time between survey and repair for this analysis was 24 days.

Number of recurring leaks observed – no recurring leaks were observed in 2023. The closest repeat offender was a cold stack found to be venting from different components at separate venting events.

Analysis of trends observed for fugitive leaks – fugitive emission leaks observed were found to be typical when compared to sites not included in the Alt-FEMP 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 (ie, 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 were 2048 emission events which triggered an alarm via continuous monitoring in 2023. The alarm threshold was originally set at of 3.6kg/hr over a sliding window of 1 hour. Commencing June 21, 2023, Qube restructured the alarm threshold to 3.6kg/hr over a sliding window of 24 hours as most alarms were found to be operational events, and non-fugitives therefore, dialing into more accurate potential fugitive emission follow-up.

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\_Qube\_Alarms\_2023.xlsx.**

Number of potential emissions followed up on during the pilot or full-scale program – 1 follow-up survey was initiated based on potential emissions where the emission trending was 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: Qube AltFEMP\_Reduction Summary.xlsx** represents the collective data that was captured from Ember's Qube ALT FEMP Program in 2023. The left-hand column titled UWI lists all 25 sites that are enrolled in the program. The 16 sites that are highlighted in green had no recordable releases or emissions above threshold of 3.6 kg/hr or they were related to an operational venting event. The remaining 9 sites accumulated 25 leaks over the year. Two of those leaks (highlighted yellow) have not been repaired at the time of this report.

### **OGI VS ALT FEMP 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 ALT FEMP program are estimated at 32299.92 kg of methane and estimated emissions from the OGI Directive 060 process was 26080.32 kg of methane. In comparison, the ALT FEMP program shows a potential increase of emissions by 6219.60 kg or -24%. It is important to note that one of the variables considered was the average repair leaks days from 2023 leak analysis. An average repair date of 76 days occurred with all leaks emitting in 2023. Three of the leaks included in this analysis were long term emitters, which greatly increased our average leak repair days. Two leaks of which included cold stack venting where the source could not be identified despite extensive operational troubleshooting. In these cases, one or more PSVs were suspected and a turnaround with PSV service was the next step to rectifying the leak source. Ultrasonic testing technology was utilized to assist in detecting the source at one location and the second vent stack leak was no longer observed at the time of schedule ultrasonic testing as a PSV turnaround had been scheduled and completed prior to testing. The third long term emitter discussed above was due to an inlet filter door seal. A major shutdown was required although a delay in receiving the part was the main reason for the duration of this leak. This was a supply chain issues and therefore outside of the normal repair process.

Considering the above long term leak details that are outside of the normal detection and repair process, we analyzed the emission data again while omitting the three long term leaks from the ALT FEMP fugitive emission data. With the removal of this long-term leak data, an average repair date of 24 days occurred with all leaks emitting in 2023. The total fugitive emissions from the ALT FEMP program were then estimated at 9404.88 kg of methane and estimated for the OGI Directive 060 process was 12664.92 kg of methane. In comparison, our ALT FEMP program shows a decrease of emissions by 3260.04 kg or 26%.

## ALT FEMP Annual Targets vs Actual Targets Obtained

Table 1 below highlights that our ALT FEMP program fell just below the target reduction 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  $8.70 \pm 0.8$  kg per day. LDAR Sim estimates the regulatory triannual OGI program to result in emissions of  $4.66 \pm 0.4$  kg per day, a reduction of ~46%. Emissions from the proposed Qube Alt-FEMP are estimated to be  $3.51 \pm 0.1$  kg per day, or a reduction of 60% from baseline.

We obtained reductions of 67% (OGI) and 59% (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%	2.86 kg/day	67%
Qube Program	3.51 kg/day	60%	3.54 kg/day	59%

**Table 1: ALT FEMP Annual Targets vs Actual Targets Obtained (all leaks considered)**

Table 2 below highlights that our ALT FEMP program exceeded our targets set from the modelling when the long-term leak data was not considered.

We obtained reductions of 84% (OGI) and 88% (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%	1.39 kg/day	84%
Qube Program	3.51 kg/day	60%	1.03 kg/day	88%

**Table 2: ALT FEMP Annual Targets vs Actual Targets Obtained (long term emitters excluded)**

#### 4) *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.

Delayed leak repairs mentioned in this report would likely impact the performance of the program. Three leaks in 2023 were outside of the normal LDAR program as the leak time was beyond our control.

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

Thank you,



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#### **Attached Files:**

Ember\_Qube\_Alarms\_2023.xlsx  
Ember\_Qube\_Volumes\_2023.xlsx  
Survey\_Leak Repair\_2023.xlsx  
Qube AltFEMP\_Reduction Summary.xlsx