



# **2021 Methane emissions management from the upstream oil and gas sector in Alberta**

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## Introduction

This report provides details related to mitigating methane emissions from the upstream oil, bitumen and gas sector in Alberta. This includes all facilities licensed or approved by the Alberta Energy Regulator (AER), including, but not limited to, well sites, oil and gas batteries, gas plants, compressor stations, pipelines, gas gathering systems, oil production sites, and other related facilities; it does not include bitumen mining and upgrading.

The Government of Alberta established a target to achieve a 45 per cent reduction in oil and gas methane emissions from a 2014 baseline by 2025. Provincial methane mitigation requirements and programs have set Alberta on the path toward achieving that target.

Alberta and Canada established an equivalency agreement regarding the reduction of methane emissions from the oil and gas sectors. The [Agreement on the Equivalency of Federal and Alberta Regulations Respecting the Release of Methane from the Upstream Oil and Gas Sector in Alberta, 2020](#) (“equivalency agreement”) came into force with the publication of a [final order](#) under section 10(3) of the *Canadian Environmental Protection Act* on October 26, 2020. This report meets Alberta’s annual reporting requirements included in the agreement. Federal Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector) no longer apply in Alberta. Rather, Alberta’s [Methane Emissions Reduction Regulation](#) and [Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting](#) apply.

The 2021 compliance period is the second annual information report for the 2020 equivalency agreement.

**Results from 2021 indicate that Alberta is on track to achieving the 45 per cent reduction target in 2025. Reported and estimated emissions in 2021 show a 44 per cent reduction in methane emissions from 2014 levels. The total methane emissions in 2014 are estimated to be 27 MT CO<sub>2</sub>e and in 2021 are estimated to be 15 MT CO<sub>2</sub>e.**

# Report Information and Structure

The equivalency agreement includes provisions outlining that Alberta provide the following on an annual basis:

- A. the number of existing facilities and wells that are subject to the Methane Emission Reduction Regulation (MERR), disaggregated by well type and facility classification, with the average number of dehydrators and compressors at each facility type
- B. the number of new facility permits and well permits issued, disaggregated by well type and facility classification
- C. the number of closures of facilities and wells, disaggregated by well type and facility classification
- D. information respecting an assessment of the implementation and effectiveness of the MERR in reducing methane emissions (in CO<sub>2</sub>e), including the methodology (by source), analysis undertaken and results of calculations of emission reductions
- E. a summary of compliance verification activities and enforcement or sanctions measures relating to the MERR applied to facilities and wells, segregated by well type and facility classification, including the number of inspections and verifications other than inspections, the number and type of noncompliance events and the orders, penalties, and convictions, and
- F. a summary of the annual reports submitted under the MERR including the number of duty holders who submitted annual reports.

This report is organized to align with sections A to F of the equivalency agreement, referenced above. Parts A, B and C of this report summarize the number of facilities according to A, B and C of the equivalency agreement. Parts D, E and F of this report summarize AER emissions modelling, surveillance program, and OneStop data requirements according to parts D, E and F of the equivalency agreement.

Methane emission reporting to the AER is done using reporting facility identifiers (IDs) that are also used for production volumetric reporting. Facility IDs are characterized by type and sub-type as identified in [Manual 011: How to Submit Volumetric Data to the AER](#). Not all facility IDs are required to report under the MERR and Directive 060 Section 8. Facility subtypes that are required to report are listed in Table 4 of [Manual 015: Estimating Methane Emissions](#). All infrastructure in the upstream oil and gas industry can be delineated to one and only one facility ID.

Facilities, wells and pipelines are authorized for construction and operation through licenses issued by the AER. Some upstream oil and gas sites that do not have wells and do not meet the risk criterion for requiring a facility license may be unlicensed. Pipeline licenses may include multiple installations which have surface equipment. Well licenses and facility licenses may be co-located. Infrastructure capable of emitting methane emissions in the upstream oil and gas industry may be associated with one, multiple or no licenses.

## Part A - Number of Existing Facilities and Wells

The number of active facilities and wells that are subject to the MERR in 2021, disaggregated by well type and facility classification, with the number of dehydrators and compressors at each facility type, are provided in Table 1 and TABLE 2.

**TABLE 1 NUMBER OF ACTIVE FACILITIES, DEHYDRATORS AND COMPRESSORS SUBJECT TO THE MERR IN 2021**

Facility Type	Facilities <sup>1,2</sup>	Dehydrators	Compressors <sup>2</sup>
Crude Bitumen Battery	3,228	4	35
Crude Oil Battery	8,447	64	388
Gas Battery	8,957	211	373
Gas Gathering / Compressor Station	5,855	335	1,435
Gas Plant	511	433	1,260
Other <sup>3</sup>	1,900	4	11
Unknown <sup>4</sup>	0	186	0
<b>Total</b>	<b>28,898</b>	<b>1,237</b>	<b>3,502</b>

**TABLE 2 NUMBER OF ACTIVE WELLS SUBJECT TO THE MERR IN 2021**

Fluid Type	Number of Wells <sup>2</sup>
Coalbed Methane - Shale & Other Sources	30
Coalbed Methane - Coals Only	3,706
Coalbed Methane - Coals & Other Lithology	8,655
Crude Bitumen	3,943
Crude Oil	25,880
Gas	57,788
Helium	2
Shale Gas Only	617
Shale Gas & Other Sources	16
<b>Total</b>	<b>100,637</b>

<sup>1</sup> Includes licensed facilities, licensed wells and unlicensed facilities. A licensed well may consist of more than one well but is counted as one for the purposes of this table.

<sup>2</sup> As of August 2022.

<sup>3</sup> Facility subtypes within the "other" category include meter stations, disposal facilities, pipelines, tank farms, etc.

<sup>4</sup> Dehydrators are reported under Directive 039, which does require an ID, resulting in many unknown facility types.

## Part B - Number of New Facility and Well Permits Issued

The number of new facility and well permits issued, disaggregated by well type and facility classification in 2021, are shown in Table 3 and Table 4.

**TABLE 3 NUMBER OF NEW FACILITY PERMITS ISSUED SUBJECT TO THE MERR IN 2021**

Facility Type	Number of New Facility Permits <sup>1,2</sup>
Crude Bitumen Battery	591
Crude Oil Battery	1,192
Gas Battery	1,160
Gas Gathering / Compressor Station	212
Gas Plant	27
Other <sup>3</sup>	241
<b>Total</b>	<b>3,423</b>

**TABLE 4 NUMBER OF NEW WELL PERMITS SUBJECT TO THE MERR ISSUED IN 2021**

Fluid Type	Number of New Well Permits <sup>2</sup>
Coalbed Methane - Shale & Other Sources	0
Coalbed Methane - Coals Only	23
Coalbed Methane - Coals & Other Lithology	48
Crude Bitumen	437
Crude Oil	1,812
Gas	1,802
Helium	0
Shale Gas Only	28
<b>Total</b>	<b>4,150</b>



# Part C - Number of Closures of Facilities and Wells

The number of closures of facilities and wells, disaggregated by well type and facility classification, are shown in Table 5 and

**TABLE 6.**

**TABLE 5 NUMBER OF FACILITY CLOSURES IN 2021**

<b>Facility Type</b>	<b>Number of Facility Closures<sup>2</sup></b>
Crude Bitumen Battery	27
Crude Oil Battery	30
Gas Battery	44
Gas Gathering / Compressor Station	126
Gas Plant	11
Other <sup>3</sup>	10
<b>Total</b>	<b>248</b>

**TABLE 6 NUMBER OF WELL CLOSURES IN 2021**

<b>Fluid Type</b>	<b>Number of Well Closures<sup>2</sup></b>
Acid Gas	1
Carbon Dioxide	1
Coalbed Methane - Shale & Other Sources	2
Coalbed Methane - Coals Only	258
Coalbed Methane - Coals & Other Lithology	177
Crude Bitumen	408
Crude Oil	2,866
Gas	5,400
Helium	0
Shale Gas Only	4
Solvent	4
Steam	1
Water	460
Not Applicable	128
<b>Total</b>	<b>9,710</b>

## Part D - Implementation and Effectiveness of the MERR

The methane reduction requirements in the AER's *Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting* are summarized in **Error! Reference source not found.**. The 2021 methane emissions in this report include the impacts of two (2) full years of requirements that came into effect on January 1, 2020.

An assessment of the implementation and effectiveness of the MERR was conducted using the Methane Emissions Economic Model of Alberta (MEEMA).

### Methane Emissions Performance

The emission reduction target set by the Government of Alberta is to achieve a 45 per cent reduction in methane emissions from conventional upstream oil and gas from a 2014 baseline by 2025. New methane requirements have set Alberta on the path toward achieving that target. By the end of 2021, a 44 per cent reduction in methane emissions from 2014 levels has been achieved. **Error! Reference source not found.** shows the methane emissions (a combination of reported data and estimates) from 2014 to 2021 and forecasts to 2025. These reductions are the result of the requirements of Directive 060 and include early action through programs like the Alberta Emissions Offset System.

The methane emissions are established through data reported to the AER and estimates. Estimates supplement reported data to allow for an evaluation of the emission reductions achieved to date.

The evaluation excludes oil sands mining and upgrading methane emissions due to the significant difference in sources (primarily mine face and tailings ponds), control measures and abatement costs. Oil sands mining and upgrading methane emissions are regulated through the Technology Innovation and Emission Reduction (TIER) Regulation.

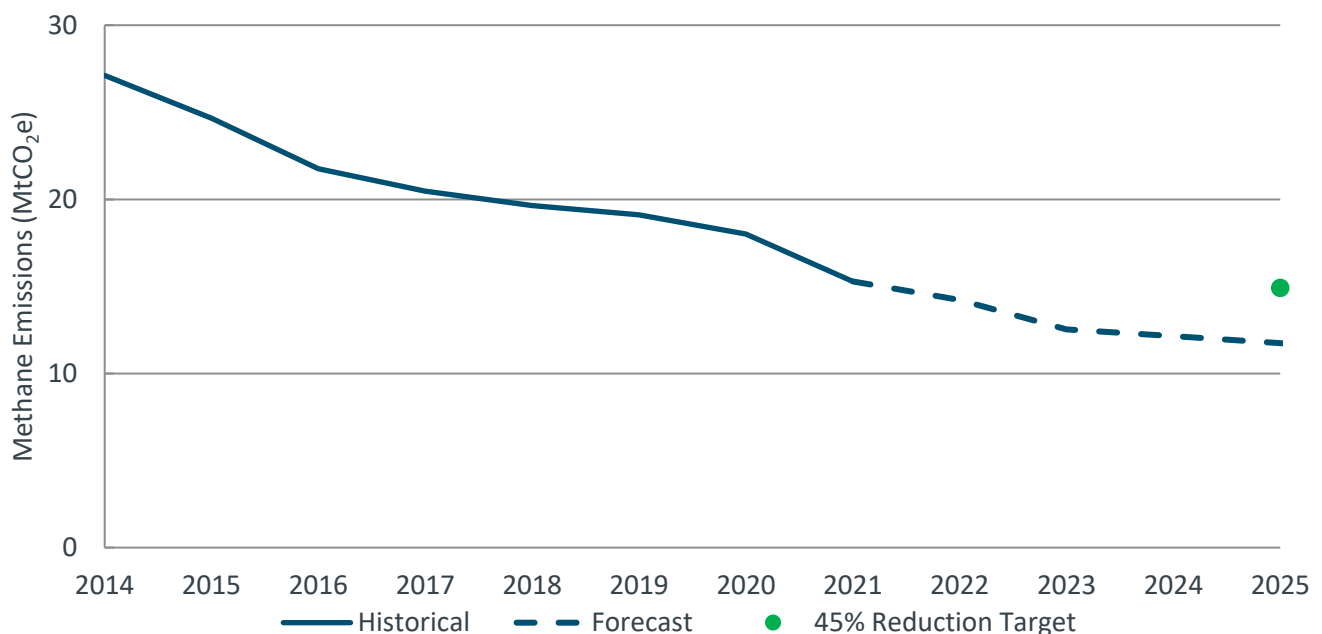


FIGURE 1 METHANE EMISSIONS REDUCTION ESTIMATE AND FORECAST

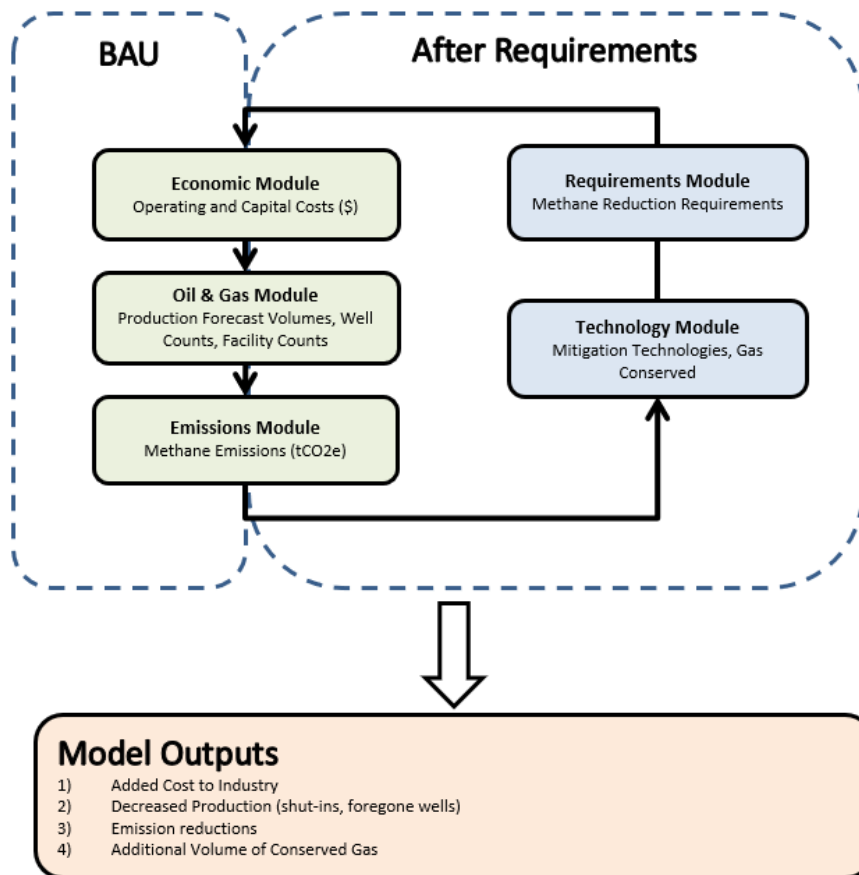
## Methane Emissions Economic Model of Alberta

The Methane Emissions Economic Model of Alberta (MEEMA) was developed to quantify baseline methane emissions from the upstream oil and gas industry and the reductions associated with each requirement. In addition to quantifying emissions, the model quantifies the costs associated with the methane emission reduction requirements, including any measuring, monitoring and reporting (MMR) costs.

The model uses established oil and gas activity modules with customized emissions, technology and requirements modules to estimate methane emissions from Alberta's upstream oil and gas industry.

The model consists of five modules shown in Figure , including:

- Economics module - calculates discounted cash flows and delivers metrics such as net present value, payout, and internal rate of return. The impact of commodity prices on oil and gas drilling activity is implicit in the economics module. The economics module also accounts for additional costs imposed by methane reduction requirements. The cash flows from the economics module inform the oil and gas activity module.
- Oil and gas activity module - simulates industry activity by estimating production forecasts and well counts. There are several parts to industry activity, including activity resulting in new sites, activity of existing sites, and reduced future drilling activities (forgone wells) and shut-in production. The resulting production forecasts and well counts feed into the emissions module to estimate emissions.
- Emissions module - calculates methane emissions from new and existing sources. A 100-year global warming potential of 25 tonnes CO<sub>2</sub>e for 1 tonne of methane is used in the model (IPCC 4th Assessment Report, 2007). Assumptions, source data and methodologies are tailored to each emissions source category as summarized in Annex 1.
- Regulatory requirements module - translates the requirements into formulas to quantify and measure their effect on emission outputs. The requirements module interacts with the technology module since different technologies may be used or purchased to meet the requirements, and these technologies will be deployed differently depending on the stringency of the requirements.
- Technology module - describes the technologies that would be expected to comply with the requirements. Many technologies can be used to mitigate multiple emission source categories, while others are unique to certain emission sources. Different equipment or services may be needed to achieve different levels of emission reduction and costs may vary depending on the equipment or services.



**FIGURE 2 AER MEEMA MODEL STRUCTURE**

The model delivers methane emissions forecasts, volumes of natural gas conserved, lost wells, and production losses. The model also quantifies incremental capital costs, operating costs, and marginal abatement costs (MAC), which describe the average cost of reducing one tonne of carbon dioxide equivalent (CO<sub>2</sub>e).

## Part E - Compliance Verification and Enforcement

The methane reduction requirements are a significant change to how industry manages and reports methane. To improve understanding and ensure compliance, the following activities are carried out:

1. Education - Sending letters to duty holders on the quality of their reported data and suggested follow-up actions.
2. Inspections - Inspecting sites by methane inspectors equipped with optical gas imaging (OGI) cameras and other vent measurement meters. There are currently five field centers in Alberta, all of them with one or two methane inspectors who dedicate about half of their time to methane inspections. There are also two to three methane inspectors based out of the Calgary office.
3. Audits – Conducting desk top exercises that review information submitted by industry through various reporting programs or direct exchanges that result from interaction with duty holders.
4. Aerial Surveillance - Flying over areas of Alberta and scanning sites for methane emissions by a third party.

The results of these activities are summarized below.

### Education

In February to March 2022, the AER issued report cards to all operators active in 2020 with a reporting obligation. Operators were informed if their reported data was satisfactory, or if they had suspected deficiencies. A total of 590 report cards were issued. Sixty-four (64) report cards noted missing reports, insufficient reporting or suspected inaccuracies. The report cards are part of the education component of the compliance assurance program. The AER issued the report cards such that the timing would support improvements to reporting for the 2021 reporting period.

### Inspections

Compliance was the focus for the 2021 inspection season, compared to the education focus during the 2020 season. In 2021, priorities included compliance with fugitive emissions and monitoring, measurement, and reporting requirements. Methane inspectors use various technologies to identify and quantify methane emissions. This includes but not limited to:

1. Optical Gas Imaging (OGI) Cameras
2. Various vent measurement meters
3. Quantitative OGI (QOGI)

A total of 850 methane inspections were conducted in Alberta in 2021. Of these, 224 of the inspections resulted in notices of noncompliance (NNC). Inspection sites were selected based on an assessment of risk for noncompliance considering a number of variables. The noncompliance rates for this population is assumed to be higher than if sites were randomly selected for inspection.

One facility was suspended because total venting at site exceeded the limit of  $15.0 \text{ e}^3 \text{ m}^3/\text{month}$  or  $> 9.0 \text{ e}^3 \text{ kg}$  of methane/month [Directive 060 8.3(1)]. The Licensee is expected to develop, implement, and submit a plan to address the noncompliance and prevent future occurrences.

There were no other orders, penalties or convictions related to enforcement of the MERR, Directive 060 Section 8 or Directive 017 requirements pertaining to methane emission reduction requirements in 2021. Table 7 summarizes the number of inspections by well or facility type.

**TABLE 7 SUMMARY OF INSPECTION ACTIVITY IN 2021**

<b>Facility Sub Type</b>	<b>Total</b>	<b>NNC</b>
Compressor Station	64	26
Crude Bitumen Group	104	7
Crude Bitumen Paper	7	
Crude Bitumen Proration	11	
Crude Bitumen Single	52	10
Crude Oil Group	26	10
Crude Oil Proration	48	15
Crude Oil Single	226	53
Disposal	7	2
Enhanced Recovery Scheme	5	4
Gas Gathering System	51	27
Gas Group	43	12
Gas Plant Sweet	16	9
Gas Proration - S.E.	20	6
Gas Proration Effluent	8	3
Gas Proration Not Sea	17	5
Gas Single	103	27
Gas Test	2	1
Gas plant Acid Gas Flaring	2	2
Gas plant Acid Gas Flaring%		
Unknown	38	5
<b>TOTAL</b>	<b>850</b>	<b>224</b>



## Audits

The AER conducts several different types of methane audits, which are desktop exercises that mainly review information submitted by industry through various reporting programs or direct exchanges that result from interaction with duty holders. A description of the audit types is provided in Table 8.

**TABLE 8 METHANE AUDIT TYPE AND DESCRIPTION**

Audit Type	Description
OneStop Submission	Audits are conducted to ensure duty holders submit the annual methane report to OneStop if a submission is not received by the June 1 deadline. Initial notification is provided to duty holders prior to audits commencing and duty holders who do not respond to the notification and submit the data in an acceptable timeframe may be issued a NNC.
Overall Vent Gas Limit Audits	Overall vent gas (OVG) limit audits are conducted to ensure sites are compliant with the OVG limit of 15 e <sup>3</sup> m <sup>3</sup> per month. Sites are selected based on the highest monthly vent volumes reported to Petrinex and sites over the OVG limit will be issued a notice of noncompliance (NNC).
Fuel Flare Vent and Data Quality Audits	<p>Fuel flare vent (FFV) audits are conducted to ensure accurate reporting of fuel, flare and vent gas volumes to comply with definitions in Directive 060. Audits usually do not result in a noncompliance if the necessary changes are made to comply with Directive 060 or documentation is provided to justify the reported volumes. Facility IDs are chosen based on perceived under-reporting of vent volumes or over-reporting of fuel volumes to identify facilities that may be inconsistent with the updated definitions in Directive 060.</p> <p>Data quality (OneStop) audits are conducted to ensure accurate reporting of annual methane data to OneStop. The scope of these audits also includes requesting the pneumatic inventory to ensure that vent volumes from pneumatic devices are accurate. Audits usually do not result in a noncompliance if the necessary changes are made to comply with Directive 060 or documentation is provided to justify the reported data.</p>
Fugitive Emission Management Plans Audits	Fugitive Emission Management Plans (FEMPs) are documents that duty holders must create and maintain as per requirements in Directive 060. Audits are conducted to ensure duty holders are compliant with the FEMP requirements. Sites that have an alternative FEMP (Alt-FEMP) are excluded. The audit process can serve as an educational component of compliance assurance as well, since the AER may provide feedback as to what deficiencies or gaps may exist in the program prior to it being a noncompliance in the field.
Fugitive Emissions Audits	Fugitive Emissions Audits are conducted to ensure duty holders are compliant with the fugitive survey and screening requirements in <i>Directive 060</i> . Sites are selected based on data in OneStop.
Methane Reduction Retrofit Compliance Plans	Methane reduction retrofit compliance plans (MRRCPs) are documents that duty holders must create and maintain as per requirements in Directive 060. They outline what resources, budget and equipment need to be retrofitted and under what timelines to be compliant with the new equipment requirements of Directive 060. The AER uses management plans such as the MRRCP as a leading indicator of risk for noncompliance related to the equipment vent limit requirements.
Alt FEMP	Audits are conducted to ensure duty holders are compliant with the Alt-FEMP approval requirements. Duty holders with Alt-FEMP approvals may be audited and be required to submit the supporting documentation about the Alt-FEMP performance.
Aerial Surveillance Audits	Audits are conducted to ensure duty holders explain the source of the unreported venting and/or fugitive emissions identified via the AER's aerial surveillance. If reporting errors are identified, duty holders are expected to amend data in OneStop and/or Petrinex and provide a plan to ensure that errors are avoided in the future.

For the 2021 report, audit statistics are presented by the number of audits conducted from January 1 to December 31 in 2021 in Table 9.

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**TABLE 9 SUMMARY OF AUDIT ACTIVITY IN 2021**

<b>Audit Type</b>	<b>Total</b>
OneStop Submission	30
Overall Vent Gas Limit	36
Fuel, Flare, Vent and Data Quality	11
FEMP	5
Fugitives	23
MRRCP	6
Alt FEMP	2
Aerial Surveillance	75

Duty holders who do not submit a satisfactory response to audits may be issued a notice of noncompliance (NNC). For the 2021 report, NNC statistics are presented by the number of NNC's issued from January 1 to December 3 in 2021 in Table 10.

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**TABLE 10 SUMMARY OF NOTICE OF NONCOMPLIANCES (NNC'S) ISSUED IN 2021.**

<b>Audit Type</b>	<b>NNC</b>
OneStop Submission	30
Overall Vent Gas Limit	29
Data Quality	
FEMP	
Fugitives	2
MRRCP	
Alt FEMP	
Aerial Surveillance	

## Aerial Surveillance

The AER methane aerial surveillance program is in its third year and is proving to be a very important compliance tool. Having the ability to view quantified methane plumes on an aerial image is very valuable for prioritizing ground inspections and identifying all sources of methane. Emissions data from the 2021 pilot program were used to evaluate limit exceedances, but they are only snapshot detections in time and are not solely able to confirm a noncompliance.

For the 2021 program, an airplane-mounted methane sensor was used to scan 1,012 facilities to collect site-level methane data primarily within the areas surrounding Grande Prairie and Lloydminster. Of these 1,012 facilities, 64 were identified as having emissions greater than 500 m<sup>3</sup> per day (these emissions include vents, methane slip and fugitives). The AER used the aerial surveillance program results to investigate the majority of the sites in 2021 and 2022, any 2021 findings and NNC's are included in the Inspections section of this report.

The following important lessons were learned from these pilots:

- Remote sensing technologies that can detect emission rates near compliance limits are valuable tools for assessing noncompliance risk as part of Alberta's compliance program.
- The role methane inspectors play in validating aerial surveillance data is critical in getting a more comprehensive picture of the emissions being observed during these screenings.
- It is important that detection technologies undergo robust performance testing so that the capabilities of the technology are well understood.

The AER plans to continue remote sensing campaigns annually to collect compliance data and to help direct where ground-based methane inspections will occur.

## Part F - Summary of Annual Reports

The Methane Emission Reduction Regulation (MERR) stipulate that determination of methane emissions must occur and that reporting of methane emissions must be made to the Director. For the 2021 calendar year, annual methane emission reports were accepted through the AER OneStop reporting system on behalf of the Director and in accordance with Section 8.2 of Directive 060. This data reported by duty holders to the AER is summarized in the following sections.

### OneStop Source Specific Emissions

Emissions data reported to the AER through OneStop, as a requirement of the methane emission reduction requirements, provide detail on the source specific contributions to methane emissions. Table 11 shows data reported in 2021 by source category and facility subtype. This is the second year the AER required reporting of both vent and fugitive emissions data via OneStop. As of August 4, 2022, 424 Duty Holders submitted OneStop reports (92% compliance rate).

**TABLE 11 2021 SOURCE SPECIFIC VOLUMES REPORTED TO ONESTOP BY FACILITY SUBTYPE**

Facility Subtype	Defined Vent Gas	Pneumatic Pumps	Pneumatic Instruments	Compressor Seals	Fugitive Emissions	Glycol Dehydrators
Crude Bitumen Battery (e <sup>6</sup> m <sup>3</sup> )	26.2	0.7	0.3	0.2	6.0	0.0
Crude Oil Battery (e <sup>6</sup> m <sup>3</sup> )	81.2	22.2	26.1	2.9	13.0	0.4
Gas Battery (e <sup>6</sup> m <sup>3</sup> )	49.7	109.9	86.4	2.0	8.6	3.0
Gas Gathering / Compressor Station (e <sup>6</sup> m <sup>3</sup> )	41.5	10.3	17.1	10.0	7.7	9.0
Gas Plant (e <sup>6</sup> m <sup>3</sup> )	16.5	2.1	3.8	12.6	10.4	1.1
Other (e <sup>6</sup> m <sup>3</sup> )	2.7	0.3	0.3	0.1	0.3	0.0
Unknown (e <sup>6</sup> m <sup>3</sup> )						0.4
<b>Total (e<sup>6</sup>m<sup>3</sup>)</b>	<b>217.7</b>	<b>145.5</b>	<b>134.0</b>	<b>27.9</b>	<b>47.2</b>	<b>13.9</b>
<b>Total (MtCO<sub>2</sub>e)</b>	<b>2.9</b>	<b>2.1</b>	<b>2.0</b>	<b>0.4</b>	<b>0.7</b>	<b>0.2</b>

### Defined Vent Gas

Directive 060 includes vent limits for defined vent gas (DVG) that is reported annually to the AER through OneStop. DVG should also be captured within the vent volumes reported to Petrinex.

### Pneumatic Devices

Directive 060 includes vent limits for vent gas from both pneumatic instruments and pumps. Emissions from pneumatic instruments and pumps are estimated based on a comprehensive inventory and are reported annually to the AER through OneStop. These volumes should also be captured within the vent volumes reported to Petrinex. Pneumatic device inventories are not required to be reported to the AER, so comprehensive device counts are not provided

### Compressor Seals

Directive 060 includes testing requirements and vent limits for both reciprocating and centrifugal compressor seals. Emissions tested and estimated from these seals are reported annually to the AER through OneStop. These volumes should also be captured within the vent volumes reported to Petrinex.

Directive 060 requires a comprehensive compressor inventory reported annually to the AER through OneStop. Compressors rated at least 75 KW and pressurized greater than 450 hours must be reported individually. For compressors that do not meet those criteria, their associated emissions are reported to compressor seals for that facility, however not to a specific compressor.

Emissions associated with compressors, such as compressor blowdowns and engine starts, are reported to the Overall Vent Gas (OVG) limit.

### Glycol Dehydrators

Directive 060 includes vent gas limits for glycol dehydrators. Glycol dehydrator emissions must be reported to the AER through OneStop annually. The OneStop reporting requirements for glycol dehydrators differ from all other source categories in that the AER only requires the emissions mass to be reported. The volume should be captured within the vent volumes reported to Petrinex.

Companies are also required to meet the benzene emission requirements for glycol dehydrators (dehydration and refrigeration) set out in Directive 039: Revised Program to Reduce Benzene Emissions from Glycol Dehydrators. Under Directive 039, licensees must complete and submit to the AER an annual dehydrator inventory list that details the emissions from all their glycol dehydrators.

### Fugitive Emissions

Fugitive emissions are unintentional releases of hydrocarbon to the atmosphere and can result from the wear or failure of equipment. Directive 060 includes requirements for screenings and surveys to inspect for and repair fugitive emissions. These emissions are reported to the AER through OneStop annually.

The year 2020 was the first year of implementing prescribed fugitive emission requirements under Directive 060 and the first year for which equipment fugitive emissions data was reported to the AER.

### **Surface Casing Vent Flows and Gas Migration**

A surface casing vent flow (SCVF) is the flow of gas, liquid, or both out of the surface casing or casing annulus of a well. Gas migration (GM) is the flow of detectable gas at the surface outside of the outermost casing string.

Section 8 of Directive 060 now requires increased ongoing fugitive emissions surveys at active sites. This increase will result in more frequent inspections of surface casing vents, as these are identified as mandatory equipment within the scope of a fugitive emission survey.

In 2021, the AER released Directive 087: Well Integrity Management (formerly issued as Interim Directive 2003-01: 1) Isolation Packer Testing, Reporting, and Repair Requirements; 2) Surface Casing Venting Flow (SCVF)/Gas Migration (GM) Testing, Reporting, and Repair Requirements; 3) Casing Failure Reporting and Repair Requirements). Directive 087 complements Directive 060 when it comes to SCVF management. Directive 060 contains ongoing survey requirements while Directive 087 contains testing, reporting, and repair requirements for isolation packers, surface casing vent flows gas migration, and casing failures. This Directive requires companies to report emissions from SCVFs and GM. Over the years, the AER has worked with licensees to ensure proper reporting of SCVFs and GM.

Table 12 shows the number of unresolved wells with SCVF, GM, or both in 2021, along with their respective emissions

**TABLE 12 EMISSIONS FROM SCVFS AND GM AT UNREPAIRED WELLS**

<b>Year</b>	<b>Number of Wells with SCVFs, GM or Both</b>	<b>Annual natural gas emissions (e<sup>6</sup> m<sup>3</sup>)<sup>5, 6,7</sup></b>
2010	8,926	95
2011	9,318	92
2012	9,563	88
2013	9,624	89
2014	9,982	84
2015	10,247	86
2016	9,972	81
2017	10,291	83
2018	10,128	65
2019	10,324	66
2020	10,246	65
2021	10,636	62

<sup>5</sup> For wells that have SCVF flow rates that are too small to measure and wells where a GM flow rate cannot be determined, a flow rate of 1 m<sup>3</sup>/day was used.

<sup>6</sup> The flow rates reported are from a single point in time and are extrapolated to determine annual emissions. Flow rates for SCVFs and GM can fluctuate significantly over a period of time.

<sup>7</sup> If no emissions type (e.g. natural gas, saline water, or nonsaline water) is provided, an SCVF or GM is assumed to be natural gas and have a flow rate equal to the average of all other reported natural gas SCVFs or GM.

# Annex 1 – Summary of Emission Methodologies

**TABLE 13 SUMMARY OF EMISSION METHODOLOGIES**

Emission Source	Methodology	Data Source	Methane Content (vol %)	Methane Content Applicability
Pneumatics	Facility Counts	ST98	92	All
	Component Counts	National Inventory Report (2021), Clearstone (2018) <sup>8</sup>		
	Emission Factors	Clearstone 2018, Prasino 2013, and Van Vilet 2018		
Venting: Routine & Non-Routine (2014 – 2018)	Reported Vent Volume	Petrinex	78	Natural Gas
			74	Crude Oil
			95	Primary Crude Bitumen <sup>9</sup>
			97	Primary Crude Bitumen <sup>10</sup>
Venting: Routine (2019 – 2020)	Reported Vent Volume	OneStop	78	Natural Gas
			74	Crude Oil Battery
			95	Primary Crude Bitumen
			97	Primary Crude Bitumen
Venting: Non-Routine Well Testing	Reported Vent Volume	ST60B	92	All
Venting: Non-Routine Compressor Blowdowns	Equipment Counts	OneStop	89	2014 to 2019
	Emission Factors	Cheremisnoff (2016), Levelton Consultants (2014)	87	2020 onwards
Fugitive Emissions	Facility Counts	Clearstone (2017)	92	Natural Gas (fuel gas)
	Component Counts	Clearstone (2017)	74	Crude Oil
Compressor Seals	Reported Vent Volume	OneStop	0.532 kg CH <sub>4</sub> /m <sup>3</sup>	2014 to 2019
	Facility Counts	ST98	0.585 kg CH <sub>4</sub> /m <sup>3</sup>	2020 onwards
	Equipment Counts	OneStop		
Glycol Dehydrators	Reported Emissions	OneStop	OneStop	Methane Mass is reported to OneStop.
	Equipment Counts	OneStop		

<sup>8</sup> OneStop data was not used because it resulted in values much lower than the National Inventory Report (2021)

<sup>9</sup> Subtypes H-MPB, H-SWB

<sup>10</sup> Subtypes H-Admin, H-MGB

Emission Source	Methodology	Data Source	Methane Content (vol %)	Methane Content Applicability
Methane Slip Fuel	Emission Factors	EPA (Boilers, Turbines), Environ. Sci. Technol. 2021, 55, 1190–1196	92	All
	Equipment Inventory	(Lean Burn Engines), EPA (Rich Burn)		
	Reported Fuel Volume	ECCC Engine Database		
	Fuel Disposition	Petrinex and ST98 Picard and Ross 1999		
Unlit Flares	Combustion Efficiency	Assumes 6% of flares at select sites are unlit	74	Crude Oil Battery
	Flare Inventory	Petrinex	92	Gas Battery
	Reported Flare Volume	Petrinex	95	Crude Bitumen Battery
Surface Casing Vent Flows	Reported Vent Volume	ID 2003-01 Data	85	All
Spills and Ruptures	Reported Vent Volume	AER Incident Release Report	85	All