Out-of-State Greenhouse Gas Emissions from Loss, Release, and Flaring of Natural Gas Imported to California

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Contents

1 Summary

In 2018, Assembly Bill (AB) 2195 (Chau) was enacted to address emissions associated with natural gas from out-of-state sources. AB 2195 requires the California Air Resources Board (CARB), beginning January 1, 2020, "to quantify and publish annually the amount of greenhouse gas emissions resulting from the loss or release of uncombusted natural gas to the atmosphere and emissions from natural gas flares during all processes associated with the production, processing, and transporting of natural gas imported into the state from out-of-state sources."

This document presents CARB's estimate, including methods and discussion. Table 1 summarizes the greenhouse gas (GHG) emissions estimate calculated later in this report for both 100-yr and 20-yr global warming potential (GWP) time horizons. These data are intended for informational purposes and do not establish any metrics with respect to the greenhouse gas emissions targets promulgated under AB 32.

Table 1 Estimate of 2018 Out-of-State GHG Emissions from Releases of Uncombusted Gas and Flaring Associated with Natural Gas Consumed in California

GWP Time Horizon	2018 GHG Emissions Estimate (MMT CO_2e/yr)
100-yr	9.4
20-yr	25.4

Although these out-of-state emissions are not intended for inventory purposes, comparisons to CARB's Greenhouse Gas Emission Inventory could be useful to convey their general magnitude. All inventory figures are presented in terms of 100-yr GWP. The 2018 in-state GHG emissions from combustion of natural gas totaled 110.9 MMT CO_2e. The 2018 in-state methane emissions from fugitives and venting of natural gas during its transmission and distribution, including post-meter residential gas leaks, totaled 5.0 MMT CO_2e[1].

2 Introduction and Background

The California Air Resources Board developed the Short-Lived Climate Pollutant (SLCP) Reduction Strategy in 2017 to reduce emissions of some particularly potent GHGs (CARB 2017). Among those is methane (CH_4), which is the primary component

[1] Errata: On 11/05/20, the description of processes included in the fugitives and venting comparison was corrected.

of natural gas (NG). Methane is approximately 25 times more effective than carbon dioxide (CO_2) at trapping heat over a 100-year time period. Because CH_4 has a shorter atmospheric lifetime, it is even more potent over shorter periods with approximately 72 times the impact of CO_2 over a 20-year time period[2].

The SLCP Strategy is a roadmap for reducing emissions of short-lived climate pollutants. Among other targets, the plan is designed to reduce methane emissions by 40 percent by 2030 (from 2013 levels). Measures within the plan are intended to be feasible (commercially and technologically), be based on science, maximize pollutant reductions, make use of existing programs and incentives, and be developed with the input of a wide array of stakeholders. The plan focuses on reductions of GHG emissions, but many of the strategies also reduce co-pollutants such as criteria pollutants and toxic air contaminants.

The SLCP Strategy establishes a goal of reducing methane emissions from oil and gas operations by 40 percent by 2025, ramping up to 45 percent by 2030. The plan notes that additional reduction beyond those targets would most feasibly come from reducing in-state demand for oil and natural gas.

Approximately 90 percent of the natural gas used in California is imported from other states or countries (CEC 2018). As with most fossil fuels, the majority of GHG emissions from the natural gas lifecycle occur as CO_2 as a product of combustion. However, upstream releases of uncombusted natural gas are also significant contributors to the total emissions.

When natural gas is imported to California, most of the upstream emissions occur outside of the State. Therefore, that gas is not subject to California regulations or programs, for processes occurring outside of State boundaries. Understanding the emissions associated with that gas could help inform California policies and goals to reduce emissions associated with natural gas use.

The growing interest in emissions associated with out-of-state natural gas have led to policies to better characterize such emissions. AB 1496 (Thurmond) requires CARB to monitor and measure high emission hotspots in the State and carry out a life-cycle GHG emissions analysis of imported natural gas. Additionally, AB 2195 (Chau) mandates that CARB publish an annual estimate of GHG emissions associated with the "loss or release of uncombusted natural gas to the atmosphere and emissions from natural gas flares" for all out-of-state gas that is imported to California. This report describes the methods, calculations, results, and discussion of the value required for AB 2195. It is important to note that this report does not cover all GHG emissions from upstream processes for out-of-state natural gas; excluded are emissions

[2] These figures are based on the IPCC Fourth Assessment Report (AR4) from 2007. Research since then has suggested that the GWP of CH_4 is even higher. The AR4 figures are used herein for easier comparison to other reports and inventories that use AR4 GWPs.

associated with the combustion of fuels used in exploration, production, processing, and transportation.

3 Methods

The sources of data used in this report are summarized in Table 2. Further details are provided in the following sections. For emissions and production datasets, 2018 figures were used as they represented the latest full year of data available across all sources at the time these calculations were performed.

Table 2 Data Sources

Type	Specification	Source	Data Year
US NG production	Gross withdrawals from gas, shale gas, and coalbeds wells	EIA	2018
California NG imports	Total interstate and international receipts	EIA	2018
US NG-related CH_4 emissions	All processes except distribution and LNG	US EPA GHGI	2018
US NG-related CO_2 and N_2O emissions	Flaring processes only (excludes LNG)	US EPA GHGI	2018
Global warming potential	100-yr and 20-yr time horizons	IPCC Fourth Assessment Report (AR4)	2007

Although natural gas has generally small amounts of other GHG constituents, in this report "uncombusted natural gas" is interpreted to mean pure CH_4. Therefore, the usually small amounts of other GHGs, such as CO_2, that are present in some raw natural gas streams are not included for purposes of calculating emissions due to the release of uncombusted natural gas.

3.1 Emissions Data

Emissions data were obtained from the US Environmental Protection Agency (US EPA) *Inventory of Greenhouse Gas Emissions and Sinks* (GHGI) *1990-2018*. Specifically, 2018 process-level emissions data for CH_4, CO_2, and nitrous oxide (N_2O) were obtained from *Annex 3.6: Methodology for Estimating CH_4, CO_2, and N_2O emissions from Natural Gas Systems* (US EPA 2020).

For the purposes of AB 2195, only the following data are considered:

1. CH_4 emissions associated with exploration, production, processing, and transportation of natural gas. This includes transmission and storage, but not distribution[3]. It also includes CH_4 emissions from flaring.
2. CO_2 and N_2O emissions from natural gas flares associated with exploration, production, processing, and transportation of natural gas (Figure 1).

Consistent with the definition of uncombusted natural gas described previously, sources of CO_2 besides flaring (e.g., CO_2 venting from acid gas removal, completions, and workovers) are not included. It is also assumed that there are no out-of-state emissions related to liquefied natural gas (LNG), since EIA (2020a) data show no international imports of LNG to California and interstate imports of natural gas are unlikely to have been previously liquefied.

As mentioned previously, this analysis does not consider emissions associated with the combustion of fuels for exploration, production, processing, and transportation. For example, water may be removed from natural gas in a glycol dehydrator. Regenerating the glycol requires the application of heat and the resulting CO_2 emissions from providing that heat are not included herein.

[3] Distribution was excluded because we interpret AB 2195 as seeking the greenhouse gas emissions associated with imported natural gas that occur outside of California, and distribution occurs within the state. Adding distribution emissions would increase the emissions estimates by 8% and 9% for 100-yr and 20-yr timescales, respectively.

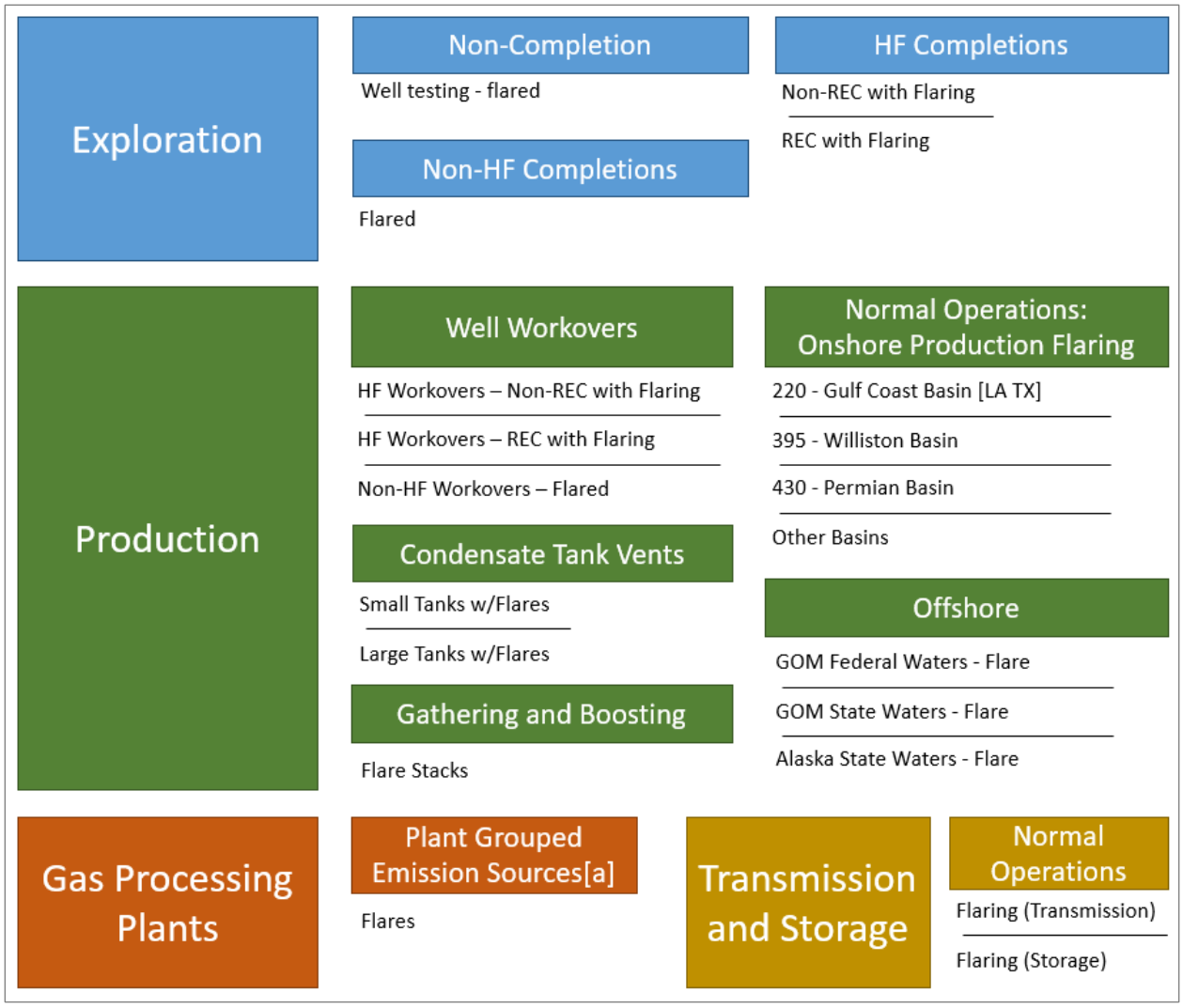

Figure 1 Flaring processes included for CO_2 and N_2O emissions.

3.2 Natural Gas Withdrawals and California Imports

National NG gross withdrawals for 2018 were obtained from the Energy Information Administration (EIA 2020b). For the calculations in this report, the total of gas wells, shale gas wells, and coalbed wells was used. NG production from oil wells was omitted because the emissions estimates from the GHGI only included emissions from wells with a high gas-to-oil ratio (GOR)[4].

[4] The US GHGI uses a GOR of >100 Mcf/bbl in its definition of a natural gas well (versus an oil well). The EIA uses >6 Mcf/bbl in their definition. This definition mismatch results in an underestimation of the carbon intensity of the gas. A rudimentary analysis was performed to estimate the approximate impact of the definition mismatch, and it appears to be in the range of approximately 10-25% of the carbon intensity for processes included in this estimate (venting, fugitives, and flaring emissions only).

Interstate and international movements of natural gas into California in 2018 were obtained from the EIA (2020c). All imports (domestic and international) were summed, without subtracting any exports. The calculations in this report assume the same GHG intensity for all imported gas even though regional and field-specific differences exist in production, processing, and transportation (see Discussion section).

3.3 Global Warming Potentials

Global warming potentials for CH_4 and N_2O were obtained from the Intergovernmental Panel on Climate Change's (IPCC) *Fourth Assessment Report* (AR4). Both 20-year and 100-year time horizons were used, as shown in Table 3 (IPCC 2007).

Table 3 Global Warming Potentials of CH_4 and N_2O

Substance	100-yr GWP (g CO2e/g substance)	20-yr GWP (g CO2e/g substance)
CH_4	25	72
N_2O	298	289

Emissions are reported in both 100-yr and 20-yr GWPs. The figure based on a 100-yr GWP is intended to show relatively long-term impacts, while the 20-yr GWP is meant to depict shorter-term impacts.

4 Calculations and Results

Total CH_4 emissions were calculated as the sum of net emissions from exploration, production, gas processing, and transmission and storage. The total US 2018 emissions were 5,102 kilotonnes (kt) CH_4, which equals 127,539 kt CO_2e on a 100-yr basis or 367,312 kt CO_2e on a 20-yr basis.

Total US 2018 CO_2 emissions from flaring were 14,102 kt CO_2, which requires no adjustment to 100-yr or 20-yr bases because CO_2 is the reference substance. Total US 2018 N_2O emissions from flaring were 0.027 kt N_2O, which equals 8 kt CO_2e on both 100-yr and 20-yr bases.

United States NG production (gross withdrawals from gas, shale gas, and coalbed wells) for 2018 totaled 30,853,661 million standard cubic feet (mmscf). Interstate and international imports of natural gas into California totaled 2,052,635 mmscf in 2018. Below are the calculations for the total out-of-state NG emissions from gas imported

to California from the loss or release of uncombusted NG and from flares in million metric tons (MMT) CO_2e.

Out-of-State Natural Gas GHG Emissions: 100-yr timescale

Based on this analysis, the 2018 annual GHG emissions on a 100-yr GWP timescale are 9.4 MMT CO_2e, calculated as shown below. Of this total, 11% is from flaring processes.

$$\frac{(127{,}539 + 14{,}102 + 8)\ kt\ CO_2e}{30{,}853{,}661\ \ mmscf} * 2{,}052{,}635\ mmscf * \frac{1\ MMT}{10^3\ kt} = 9.4\ MMT\ CO_2e$$

Out-of-State Natural Gas GHG Emissions: 20-yr timescale

The 2018 annual GHG emissions on a 20-yr GWP timescale are 25.4 MMT CO_2e, calculated as shown below. Of this total, 5% is from flaring processes.

$$\frac{(367{,}312 + 14{,}102 + 8)\ kt\ CO_2e}{30{,}853{,}661\ mmscf} * 2{,}052{,}635\ mmscf * \frac{1\ MMT}{10^3\ kt} = 25.4\ MMT\ CO_2$$

5 Discussion

This analysis was intended to capture emissions occurring outside of California. However, based on the emission estimation method used, some of the transmission emissions may occur within the State. This indicates there may be some overlap with CARB's AB 32 GHG inventory. This emissions amount is expected to be small because of the relatively long distances that most imported gas travels before reaching California and because transmission and storage emissions only account for approximately 25 percent of the total calculated out-of-state emissions.

These estimates are based on a nationally consistent data source – the US EPA GHGI. Staff is evaluating other methods to estimate these emissions such as looking at leak detection or remote sensing studies. However, the data from these emerging studies are not robust enough to comprehensively estimate annual emissions on an ongoing basis.

6 References

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