

Overview of Update to Methodology for Hydraulically Fractured Gas Well Completions and Workovers in the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012 (2014 Inventory)

EPA developed an updated methodology for the Inventory estimates for hydraulically fractured gas well completions and workovers that used information available through the Greenhouse Gas Reporting Program to develop net emission factors to calculate emissions from this source. To develop this methodology, EPA reviewed comments on the Inventory and evaluated available data. Background information on the previous methodology (2013 Inventory) and summary information on the updated methodology (2014 Inventory) is below.

Background: 2013 Inventory Methodology for HF Gas Well Completions and Workovers

In the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011, released in April 2013 (2013 Inventory), EPA calculated emissions using a *potential factor*. A potential factor is a national average estimate of the methane (CH₄) that would be released from the completion or workover of a gas well with hydraulic fracturing, in the absence of controls. Potential methane must be adjusted to account for reductions from control technologies.

In the 2013 Inventory, the emissions from this source were calculated in two steps:

- In the first step, potential methane was calculated using a potential factor. The potential factor was applied to all gas well completions and workovers in the United States, a very diverse population in terms of formation types and use of control technologies.
- In the second step, the calculated potential was reduced using information on reductions resulting from state regulations, and information on voluntary reductions (Gas STAR).

This calculation resulted in an emissions estimate of 16.7 million metric tons carbon dioxide equivalent (MMTCO₂e).

The 2013 Inventory approach of calculating potential methane and using a separate calculation for mitigation allows for use of annual data on reductions by industry to more accurately reflect changes in practices and technologies over time. This approach is consistent with the IPCC Guidelines in that it allows for transparent reporting of mitigation over time.¹

Table 1: HF Gas Well Completions and Workovers in the 2013 Inventory

Calculated Potential (MMTCO ₂ e)	Regulatory Reductions (MMTCO ₂ e)	Voluntary Reductions (MMTCO ₂ e)	Emissions (MMTCO ₂ e)
31.2	- 4.5	- 10.0	= 16.7

Updated 2014 Inventory Methodology

A number of stakeholder comments to the 2013 Inventory supported moving away from the approach of using a potential factor, and moving toward use of control technology-specific, net emission factors for HF gas well completions and workovers. Commenters suggested that EPA continue to review data reported to the Greenhouse Gas Reporting Program (GHGRP), and seek other data on emissions from HF gas well completions and workovers to evaluate emission factors and the coverage of the data on reductions from reduced emissions completions (RECs) and flaring.

Taking into account this feedback, EPA noted in the “Planned Improvements” section of the 2013 Inventory that analysis of available data for HF gas well completions and workovers is a priority for the 2014 Inventory, stating that several

¹ See the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 1 General Guidance and Reporting, Chapter 5 Time Series Consistency: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_5_Ch5_Timeseries.pdf

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methods were being considered for estimating well completion emissions reductions to account for RECs and flaring not reported to Gas STAR. EPA stated that alternative methods could potentially involve different emission factors for completions without controls, completions with flaring, and completions with RECs. The 2013 Inventory also noted plans to review 2011 and 2012 GHGRP data from this source, and plans to assess how the data could be best incorporated into the Inventory and how the recent data could best inform emissions calculations throughout the 1990-2012 time series.

In the development of the 2014 Inventory, EPA reviewed 2011 and 2012 data reported to the GHGRP and determined that information available allowed for the development of separate emission factors for the following categories of gas well completions and workovers with HF:

- factor for wells that vent (without flaring or RECs)
- factor for wells that flare
- factor for wells with RECs that do not flare
- factor for wells with RECs that flare

Facilities that report emissions from hydraulically fractured gas well completions and workovers to the GHGRP aggregate emissions according to the following categories:

- venting at completions
- flaring at completions
- venting at workovers
- flaring at workovers

Additionally, facilities report activity data including:

- total number of completions
- number of venting workovers and the number of flaring workovers
- number of completions that employ purposely designed equipment that separates natural gas from the flowback and the number of workovers that employ purposely designed equipment that separates natural gas from the flowback

The emission factors developed and used in the approach are *net emission factors*. Net emission factors are average estimates of the CH₄ emitted from the completion or workover of an HF gas well, used to calculate emissions without the need to deduct reductions. These technology-specific net emission factors would only be applied to wells using the corresponding technology or practice.

The net emission factors in the approach were developed by first selecting the GHGRP facility-level reports for which it is possible to determine emissions from a specific type of completion or workover (i.e., wells that vent (without flaring or RECs), wells that flare, and wells with RECs that do not flare, and wells with RECs that flare). For example, if a facility reported only emissions from venting for completions and reported no emissions from flaring for completions, and reported no completions with separation equipment, it was determined that the emissions represented emissions from a completion with venting and were assigned to that category. Average emissions per completion and workover were calculated for each category by summing the emissions in each category and dividing by the number of completions and workovers in each category.

Potential factors (the approach used for 2013 Inventory) and net emission factors (the new approach under consideration for the 2014 Inventory) are not directly comparable. For example, in the 2013 Inventory, potential methane calculated with the potential factor was reduced using data on emission controls at completions and workovers. Net emission factors are practice-specific and already take any reductions into account. As a result, net emissions factors are lower than potential factors.

GHGRP information is not comparable to the 2013 Inventory potential factor, because GHGRP reporters report net emissions and do not report total potential methane. Therefore, it is not possible to evaluate the potential factor using GHGRP data, or to consider updates to the potential factor based on GHGRP data. However, a recent study by Allen et al. did find average potential methane per completion (124 MT CH₄) to be comparable to the EPA potential factor (151 MT CH₄ per completion).² Additionally, net emissions information submitted by the GHGRP reporters includes periods during which the NSPS OOOO requirements for well completions and workovers were in effect, which would tend to further decrease net emissions below previous EPA estimates.

National Emissions Estimates: Results of Update Based on GHGRP Data

To calculate national emissions using the new approach, the total counts of well completions and workovers in each category of control type were needed. These values are not available directly from GHGRP because of the 33 percent of GHGRP reports that could not be disaggregated into the various control categories for this analysis. To develop these values, the fraction of completions and workovers in each category in the disaggregated data set was applied to the total number of reported completions and workovers.

The values presented below in Table 2 are based on 2011 and 2012 emissions data, and 2011 activity data reported to the GHGRP as of September 1, 2013. EPA notes that the GHGRP does not cover all emissions from this source because facilities in petroleum and natural gas systems are required to submit annual reports to the GHGRP only if the facility emits 25,000 metric tons (MT) CO₂e or more.

Table 2: National Emissions Estimates: Results for 2011 Using Update for HF Gas Well Completions and Workovers

Category	Activity Data (# of completions and workovers in each category)	Emission Factor (MT CH ₄ per completion or workover)	National Emissions (MT CH ₄)	National Emissions (MMT CO ₂ e)
HF completions and workovers that vent	4,678	41	191,798	4.0
Flared HF completions and workovers	1,381	5	6,905	0.1
HF completions and workovers with RECs	3,882	3	11,646	0.2
HF completions and workovers with RECs that flare	1,292	6	7,752	0.2
Total	11,233	N/A	216,488	4.5

² Allen, et al. (2013) *Measurements of methane emissions at natural gas production sites in the United States*. Proceedings of the National Academy of Sciences (PNAS) 110(44): 17768–17773.