

## Inventory of U.S. Greenhouse Gas Emissions and Sinks: Updating Emissions Estimate for Hydraulically Fractured Gas Well Completions and Workovers

EPA has developed a draft updated methodology for the Inventory estimates for hydraulically fractured gas well completions and workovers that uses information available through the Greenhouse Gas Reporting Program to develop net emission factors to calculate emissions from this source. To develop this draft methodology, EPA reviewed comments on the Inventory and evaluated available data. EPA is now seeking comment on this draft. Summary information on the update is below. Specific questions for stakeholder feedback are listed at the end of this document.

To allow incorporation of feedback into the expert review draft of the 2014 Inventory, EPA is requesting comments by November 22, 2013. Please send comments to [ghginventory@epa.gov](mailto:ghginventory@epa.gov). EPA will also review comments received after the deadline and consider them for the public review draft of the Inventory.

### **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 (CH<sub>4</sub>) 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 (MMTCO<sub>2</sub>e).

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.<sup>1</sup>

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

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

<sup>1</sup> 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](http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_5_Ch5_Timeseries.pdf)

### **2014 Inventory Methodology Under Consideration**

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 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.

Since finalization of the 2013 Inventory, EPA has reviewed 2011 and 2012 data reported to the GHGRP and determined that information available may allow 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 proposed approach are *net emission factors*. Net emission factors are average estimates of the CH<sub>4</sub> 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 under consideration 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 emissions control 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 CH<sub>4</sub>) to be comparable to the EPA potential factor (151 MT CH<sub>4</sub> per completion).<sup>2</sup> 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: Preliminary Results of Update under Consideration 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 preliminary and 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) CO<sub>2</sub>e or more.

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<sup>2</sup> 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.

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

Category	Activity Data (# of completions and workovers in each category)	Emission Factor (MT CH <sub>4</sub> per completion or workover)	National Emissions (MT CH <sub>4</sub> )	National Emissions (MMTCO <sub>2</sub> e)
HF completions and workovers that vent	4,671	41	189,438	4.0
Flared HF completions and workovers	1,384	5	6,908	0.1
HF completions and workovers with RECs	3,884	3	12,490	0.3
HF completions and workovers with RECs that flare	1,295	6	7,651	0.2
<b>Total</b>	<b>11,234</b>	<b>N/A</b>	<b>216,488</b>	<b>4.5</b>

### Updating the 2014 Inventory

Prior to the regular Inventory expert review phase scheduled for December 2013, EPA will review comments received on the approach outlined in this memo. On the basis of this feedback, EPA will prepare an updated time series of emissions for hydraulically fractured gas wells from 1990-2012 as appropriate. Experts will have another opportunity to comment on the draft Inventory results in December, and again as part of the public review in February/March 2014. The final 2014 Inventory will be available in April 2014.

### Questions for Stakeholders

- How will the approach under consideration impact transparency of the Inventory?**  
*EPA is aware of concerns related to the transparency of the Inventory in the past. Will use of the new approach improve the transparency of the Inventory? What information regarding the approach under consideration should be included in the Inventory text?*
- How can EPA apply this approach retroactively?**  
*There are several options for using the approach under consideration to recalculate the time series of emissions from 1990 up to the current Inventory year. How can this approach be used to most accurately and transparently calculate emissions from previous years? Which data sources and methods should be considered to update completions and workover counts for years prior to 2011?*
- Does this approach accurately and transparently characterize and account for emission reductions carried out by industry?**  
*Using the previous methodology, EPA estimated the total amount of reductions from hydraulically fractured well completions and workovers (using industry-reported reductions information from Gas STAR, in addition to information on reductions associated with state regulations). Does this new approach allow for a transparent estimate of the total amount of mitigation taking place each year?*

- **What information available from new studies should be reviewed to assess the quality of, or suggest improvements to, the update under consideration?**

*EPA is aware of new studies that may contain relevant data on this source (e.g., UT Austin/EDF study). EPA is interested in stakeholder feedback on how the results of these studies may be used to update the Inventory. For example, the average emission factor from the 27 wells sampled in the UT Austin/EDF study was 1.7 MT of CH<sub>4</sub>. Can this data be taken into account in the proposed approach, which uses separate factors for various types of controls? EPA will continue to review new data as it becomes available and may update its estimates based on this data.*

- **For years for which GHGRP data are available, which data sources and methods should be considered to estimate completions and workovers that are not reported to GHGRP?**

*The GHGRP will include only completions and workovers activity data for those facilities that meet or exceed the reporting threshold of 25,000 metric tons CO<sub>2</sub>e. GHGRP data do not include completions and workovers for facilities below the reporting threshold and therefore may not necessarily represent national activity.*