

Well Completions and Workovers with Hydraulic Fracturing

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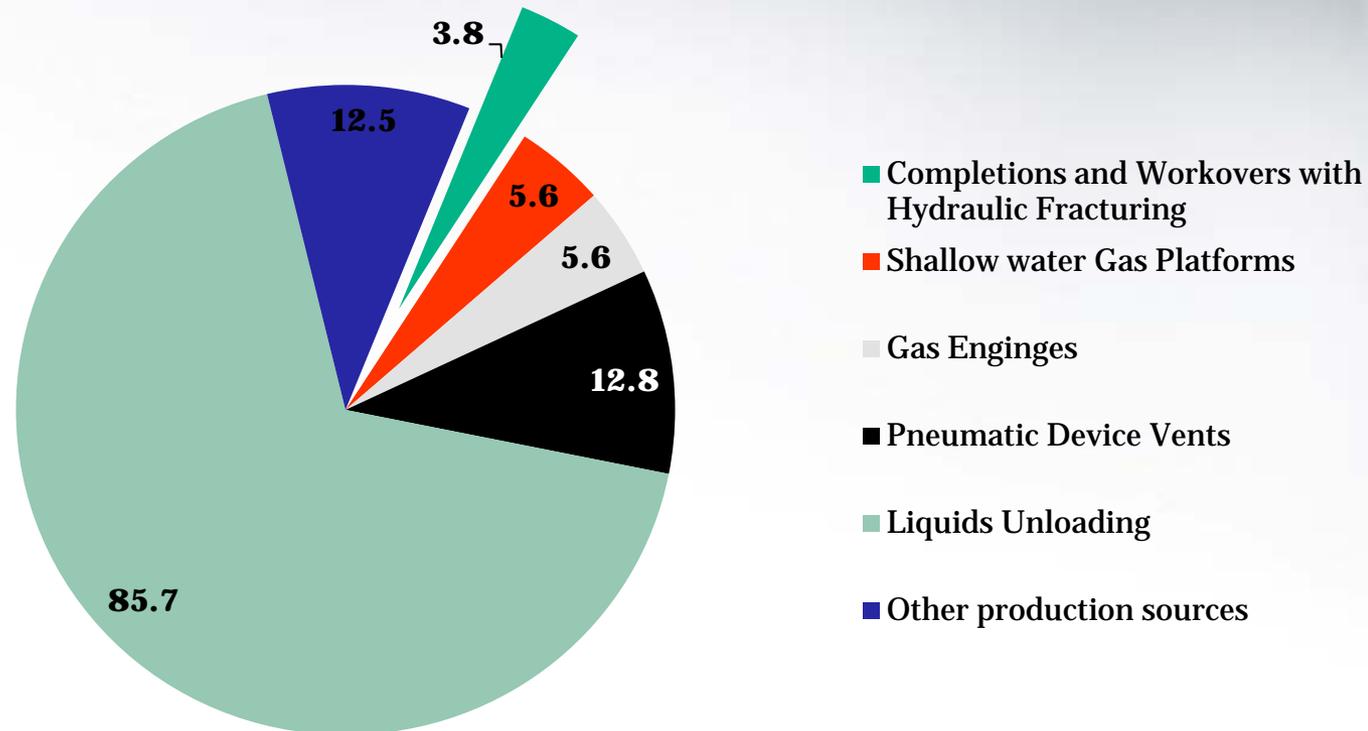


Well Completions and Workovers with Hydraulic Fracturing



2010 Emissions from Natural Gas Production, MMTCO₂e

- 3% of production sector emissions
- 1.8% of total natural gas emissions



Background



- Well Completions – Process of finishing a well so that it is ready to produce natural gas
- Well Workovers – Refracturing a well

Emissions from Completions and Workovers with Hydraulic Fracturing, MMTCO₂e (2012 Inventory)

	1990	2000	2010
Calculated Potential	0.4	10.9	27.6
Regulatory Reductions	-(0.2)	-(5.5)	-(13.9)
Voluntary Reductions	0.0	-(0.2)	-(9.8)
Net Emissions	0.2	5.2	3.8

Methodology prior to 2011

Inventory



- Did not differentiate between completions/workovers with and without hydraulic fracturing
- Completions calculated as difference in total well numbers from year to year
- Workovers calculated as 4.35% of total well number for each year
- Emission factors from EPA/GRI (1996)
 - 733 scf/completion
 - 2,454 scf/workover
- Factors include assumption of 100% flaring, with 98% combustion efficiency (i.e. it is not a potential emission factor)
- 2010 Inventory calculated 0.02 MMTCO₂e CH₄ emissions (year 2008) from completions and workovers combined

Methodological Update (2011)



Inclusion of wells with hydraulic fracturing

- EPA/GRI (1996) study not representative of wells with hydraulic fracturing
- Hydraulically fractured well completions are more emissive than other types of completions
- Hydraulic fracturing increased dramatically since 1992 (30% of completions in 1992 to 85% in 2009)

Update

- Differentiated between wells with and without hydraulic fracturing
- Wells with hydraulic fracturing
 - Used new (9,175 Mcf) emission factor for completions and workovers with hydraulic fracturing
 - Updated workover frequency for wells with HF to 10%

Results

- 2012 Inventory estimated emissions of 3.8 MMTCO₂e (year 2010) from completions and workovers combined

Current Method for Wells with Hydraulic Fracturing



Step 1. Calculate potential methane

- **1a – Activity Data**
- **1b – Emission Factor**

Step 2. Compile reductions data

- **2a – Voluntary Reductions Reported to GasStar**
- **2b – Regulatory Reductions**

Step 3. Calculate Net Emissions

Step 1a. Potential Methane Calculations – Activity Data



- Total hydraulically fractured well count determined from state-level data
- Method for calculating # of completions with hydraulic fracturing
 - Wells with HF in 2010 minus Wells with HF in 2009 = # of completions in 2010
- Method for calculating # of workovers
 - Inventory assumes that 10% of all wells with hydraulic fracturing are worked over each year

Example for 2010 Activity Data (2012 Inventory)

# Completions	# Workovers	# Completions and Workovers
4,196	+ 5,043	= 9,212

Step 1b. Potential Methane Calculations – Emission Factor



- Factor developed from four data sets containing data for over 1,000 well completions
 - Industry data on gas capture from well completions
 - Included wells representative of U.S. formation types where hydraulic fracturing is typical, including shale, tightsands, and coal bed methane wells
 - Best publically available data at the time of development
- Factor of 9,175 Mscf per completion calculated by averaging data sets
- Factor is applied to both well completions and well workovers
- Factor is a potential methane factor--any emissions captured or flared must be deducted to calculate net emissions

Step 1 Results



(# of Completions + # of Workovers) × Emission Factor = Calculated Potential

Example for 2010 Calculated Potential (2012 Inventory)

# of Completions and Workovers	EF (Mscf whole gas/completion or workover)	Regional methane content (%)*	Calculated Potential
9,212	x 9,175	x (Ranges from 78.4% to 91.9%)	= 27.6 MMTCO _{2e}

*Inventory calculated potential is calculated by region, with regional CH₄ content

Step 2a. Reductions



Reductions reported to Natural Gas STAR

- GasSTAR Partners report annual emissions reductions from Reduced Emissions Completions (RECs) and flaring at wells with hydraulic fracturing

State regulatory reductions

- National-level percentage of regulatory reductions applied across all years of Inventory to estimate the percent of emissions controlled due to state regulations
 - Developed single year estimate of regulatory reductions known at the time
 - Estimated based on the share of wells with hydraulic fracturing in Wyoming, only state known to have relevant regulation at the time
 - Requires operators to flare or capture gas produced from gas well completions and workovers
 - EPA calculated percentage of gas wells with hydraulic fracturing in WY as compared to States without regulations (51%)
 - Result is Inventory assumption that 100% of gas is controlled for 51% of calculated potential

Step 3. Calculate Net Emissions



- Potential Methane – Reductions = Emissions
- Emissions presented in the GHG Inventory are net emissions

Example for 2010 Emissions (2012 Inventory)

Calculated Potential (MMTCO ₂ e)	Regulatory Reductions (MMTCO ₂ e)	Voluntary Reductions (MMTCO ₂ e)	Emissions (MMTCO ₂ e)
27.6	- 13.9	- 9.8	= 3.8

Updates Under Consideration



Step 1

- Completions
 - Use NEMS Oil and Gas Supply Module input data file to generate the number of completions, expanding coverage of Inventory for completions and workovers
 - Round emission factor, 9,175 MCF to 9,000 MCF, consistent with final NSPS analysis
- Workovers
 - Replace the current 10% workover rate with a 1% workover rate, consistent with final NSPS analysis

Step 2

- State regulatory reductions
 - Recalculate reductions from state regulations
 - Use updated data to determine the number of completions and workovers occurring in states with regulations
 - Adjust start year for state regulations from 1990 to state-specific start years
 - Investigate additional data on state regulations
- NSPS
 - Consider how to reflect impact of NSPS in future Inventories

Questions for Stakeholders



Feedback on Updates Under Consideration?

- Refracture frequency rate update (10% to 1%)
- Updates to state regulatory reductions
- Are other data available on completions, workovers, or emissions reductions (both voluntary and regulatory)?
- Are there opportunities to generate new well-level data?

Time series

- Are all unconventional wells completed with hydraulic fracturing throughout the 1990-2011 time series?
- Will the workover rate change over time?

Presentation of information in the Inventory

- Options for updated presentation of information in the GHG Inventory?