

Liquids Unloading

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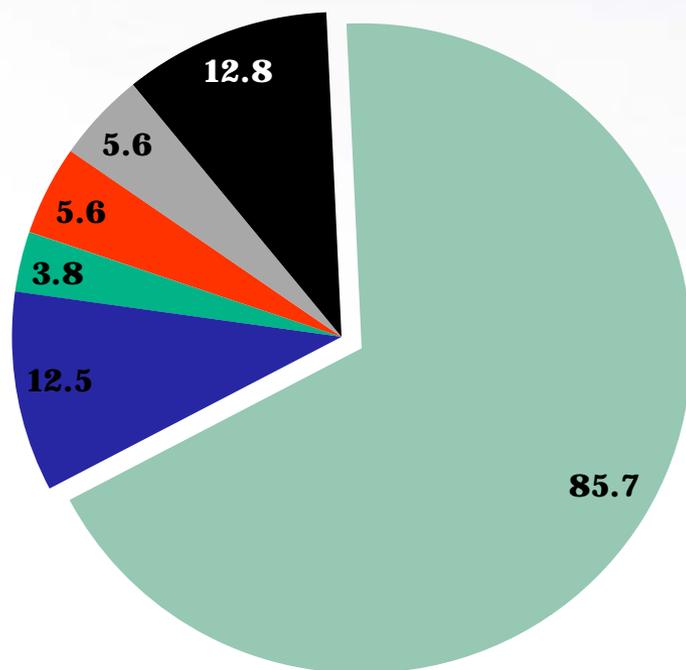


Liquids Unloading



2010 Emissions from Natural Gas Production, MMTCO₂e

- 68.0% of production emissions
- 39.8% of total natural gas systems emissions



- Completions and Workovers with Hydraulic Fracturing
- Shallow water Gas Platforms
- Gas Engines
- Pneumatic Device Vents
- Liquids Unloading
- Other production sources

Background



Liquids Unloading – Removal of accumulated fluids from well bore either by venting (“blowing down”) or using artificial lift techniques (e.g., plunger lifts).

2012 Inventory Liquids Unloading Emissions (MMTCO₂e)

	1990	2000	2010
Calculated Potential	55.7	69.9	95.5
Voluntary Reductions Reported to Gas STAR	N/A	-(1.5)	-(9.9)
Regulatory Reductions	N/A	N/A	N/A
Net Emissions	55.7	68.4	85.7

Methodology Update (2010 to 2011 Inventory)



2010 Methodology:

- EPA/GRI (1996) emission factor (49,570 scf/yr-well)
 - Factor based on assumptions of venting using average gas production rates

2011 Update:

- Updated factor uses engineering calculations and actual well-level production data from the Lasser[®] and GASIS databases
 - Sample of basins nation-wide to calculate NEMS-region specific emission factors
- Updated emission factor by NEMS region (ranging from 690,000 to 2,500,000 scf/year-well)

Current Inventory Method



Step 1. Calculate Potential Methane

- **1a – Activity Data**
 - NEMS regional data
- **1b – Emission Factor**
 - NEMs regional factors

Step 2. Compile Reductions Data

- Voluntary reductions reported to GasSTAR

Step 3. Calculate Net Emissions

Step 1a. Potential Methane Calculations – Activity Data



- The activity data (i.e., number of wells that conduct liquids unloading) is based on the following data and calculation:

$$W_{\text{WO}} \times F_{\text{LU}}$$

W_{WO} = number of wells without hydraulic fracturing
– *As outlined in Well Counts presentation*

F_{LU} = fraction of gas wells conducting liquids unloading (41.3%)
– From the 1996 EPA/GRI study

Example for 2010 (2012 Inventory)

W_{WO}	F_{LU} (%)	# wells requiring LU
434,361	x 0.413	= 179,391

Step 1b. Potential Methane Calculations – Emission Factor



- The liquids unloading emission factor represents the per well blowdown potential emissions per year.
- A factor was developed for each NEMS region, adjusted to reflect the average methane content of each region shown in the table below.
- Factors applied every year of the time series to wells requiring liquids unloading in each NEMS region

Potential Methane Factors for Liquids Unloading (scf CH₄/well)*

NEMS Regions	1990	2000	2010
North East	1,364,054	1,315,230	1,359,535
Mid-Continent	666,452	701,932	703,273
Rocky Mountain	610,744	717,251	690,440
South West	691,827	864,819	864,999
West Coast	1,222,737	1,491,925	1,491,925
Gulf Coast	2,272,696	2,524,927	2,519,264

*CH₄ content updated annually for each NEMS region

Step 1b. Emission Factor

Derivation of NEMS Emission Factors



- **Developed emission factors for a sample of AAPG basins nation-wide using well-level data:**
 - Volume of emissions from well casing (MCF/blowdown) per each sample basin
 - Using the well depth and shut-in pressure (*GASIS and Lasser*®) and 5 inch casing diameter
 - Blowtime of continued venting after liquids have been removed
 - Blowtime (3 hours per well per blowdown)
 - Average gas production rate (Mcf per hour per well) from *Lasser*® for each sample basin
- **Developed basin-level emissions estimates** by applying emission factors to number of blowdowns per year in each basin, calculated with:
 - Estimated blowdowns per year per well (38.73) EPA/GRI (1996)
 - Number of conventional wells for each basin (*GASIS and Lasser*®)
 - Percentage of conventional wells requiring liquids unloading (41.3%) (EPA/GRI 1996)
- **NEMS region-specific emission factors** were developed by summing basin emissions for use with available annual activity data at NEMS region level:
 - Total potential methane release for each sample basin summed across each NEMS region
 - NEMS region-level emissions divided by number of wells requiring liquids unloading in each region

Step 1 Results



- The NEMS-specific well counts and emission factors are used to calculate Region-level emissions
- Potential methane per NEMS region = Wells Conducting Liquids Unloading \times Regional Emission Factor
- Resulting regional potential methane estimates are then summed to the national level

Example of 2010 Potential Methane (2012 Inventory)

Wells with LU	EF (scf/yr-well)	Emissions (MMTCO ₂ e)
179,391	x (Ranges from 690,000 to 2,500,000)	= 95.5 MMTCO ₂ e

Step 2. Reductions Reported to Natural Gas STAR



- Gas STAR Partners report annual liquids unloading emissions reductions associated with artificial lifts
 - Equipment installation: plunger lifts, pumpjacks or rod pumps, velocity tubing strings
 - Operations: pressure swabbing, capillary strings, compression, pumping unit, blowtime reductions

Step 3. Calculate Net Emissions



- Net Annual Emissions = Potential Methane Emissions – Reported Reductions
- In 2010, reductions reported to Natural Gas STAR reduced calculated potential emissions by 9.9 MMTCO₂e, or 10.4%

Example of 2010 Net Emissions (2012 Inventory)

Potential Methane (MMTCO ₂ e)	Voluntary Reductions (MMTCO ₂ e)	Net Emissions (MMT CO ₂ e)
95.5	- 9.9	= 85.7

Updates Under Consideration



Activity Data

- Expanding population of potential wells conducting liquids unloading to include wells in unconventional formations

Emissions Reductions

- Update assumptions on use of artificial lift technologies (e.g., plunger lifts)
 - Vendor information indicating 150,000 plunger lifts are in use (as of 2008)

New Sources of Data

- Review of new reports studies with information on activity data, emission factors or reduction activities

Questions for Stakeholders –



Activity Data:

- Which types of wells practice liquids unloading?
- Is data available on wells conducting liquids unloading in different reservoir types?

Emission Factor:

- Is it reasonable to use a constant whole gas emission factor (from 2006) across the time series?
- Were assumptions used in the development of the emission factor reasonable?
 - 39 blowdowns/well-year
 - Blowtime of 3 hours

Reduction Data:

- Are other sources of data available for reduced emissions from liquids unloading?
- Is it realistic to assume that there were zero plunger lifts in operation prior to 1990?
- Is data available on control efficiency of plunger lifts?