

Petroleum and Natural Gas Systems Greenhouse Gas (GHG) Emissions: Comparison between the GHG Inventory and the GHG Reporting Program

Karin Ritter, API

Miriam Lev-On, The LEVON Group, LLC

Theresa Shires, AECOM Corporation



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Presentation Overview

- Need for methodology update
- Evolution of national greenhouse gas inventory (GHGI)
- Mandatory greenhouse gas reporting program (GHGRP)
- Comparison of GHGI and GHGRP for petroleum and natural gas sector
- Conclusions

Forecast Changes in Petroleum and Natural Gas Production

- EIA forecasts a 56% increase in total natural gas production in the U.S. from 2012 to 2040
 - Mainly due to increased development of shale gas, tight gas, and offshore natural gas resources
- U.S. tight oil production has also increased in the past few years from less than 1 MMbbl/d in 2010 to over 3 MMbbl/d in the second half of 2013

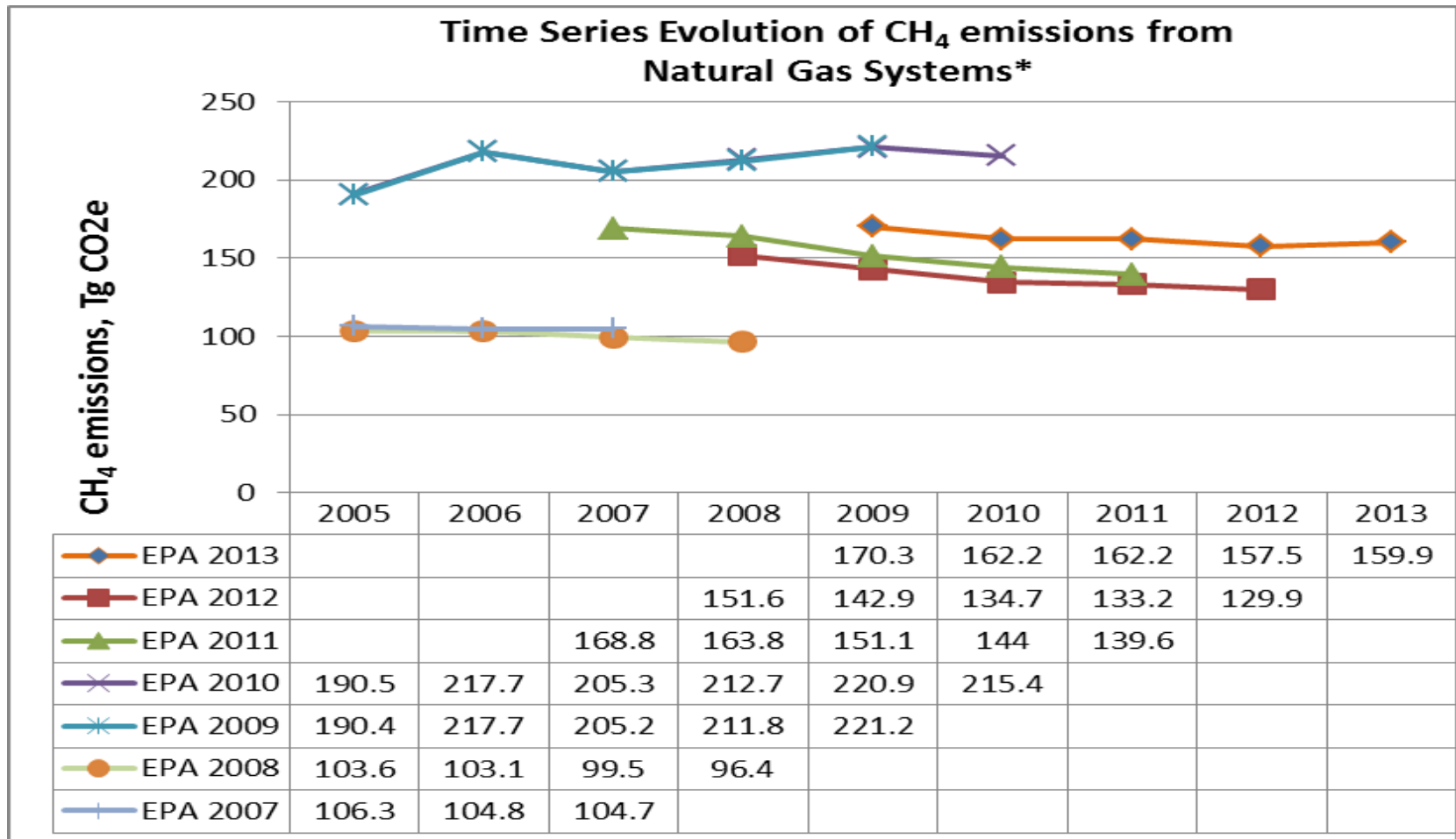
Need for Updated Methodologies

- Increased use of advanced production techniques requires a reexamination of emissions estimation methodology especially for methane emissions
- USEPA engineering estimation for compiling the GHGI requires updating to reflect recent data available from the GHGRP
- There is a need to harmonize the definitions of the sectoral boundaries between the two programs

National Greenhouse Gas Inventory (GHGI)

- USEPA prepares a national GHGI in accordance with the United Nations Framework Convention on Climate Change (UNFCCC)
- According to international practices, methodology changes require a recalculation of the entire time-series to preserve the validity of the trend-line
- Significant step changes occurred in the GHGI for natural gas systems since reporting year 2008
- In accordance with UNFCCC guidance the methane $GWP_{100\text{-yrs}}$ changed from 21 to 25

Evolution of Methane Emissions Time Series for Natural Gas Systems



Inventory and Reporting Boundaries for Petroleum and Natural Gas Segments

GHG Emissions Inventory	EPA GHGRP
<p>Petroleum Systems include:</p> <ul style="list-style-type: none"> ■ Venting, flaring and fugitive emissions from crude oil production, ■ Crude oil transportation, and ■ <i>Crude oil refining</i> <p>Natural Gas Systems include:</p> <ul style="list-style-type: none"> ■ Venting, flaring and fugitive emissions from natural gas production ■ Natural Gas processing ■ Natural Gas transmission and storage ■ Distribution pipelines 	<p>Petroleum and Natural Gas Systems include:</p> <ul style="list-style-type: none"> ■ Venting, flaring and fugitive emissions from onshore and offshore petroleum and natural gas production ■ Natural gas gathering and boosting (proposed 2015) ■ Natural gas processing ■ Natural gas transmission & compression ■ Natural gas distribution ■ Natural gas underground storage ■ LNG storage & import/export terminals

Data Comparison

- The GHGRP provides updated emissions and activity data that could be used to inform the national GHGI
- Will highlight similarities and differences for CH₄ emissions from these two national programs for petroleum and natural gas systems
- Although CO₂ emissions from these sectors are substantial their quantification is a bit more straightforward and not addressed here

Methane Emission Comparison for Onshore Production Sources

	2012 GHGRP (Gg CH ₄)*	2012 National GHG Inventory (Gg CH ₄)*
Pneumatic Controllers	860	770
Natural Gas Driven Pneumatic Pumps	135	115
Dehydrators (includes pumps)	38	470
Well Venting for Liquids Unloading	276	274
Gas Well Completions and Workovers	322	218
Well Testing	14	Not included
Tanks	129	267
Flare Stacks	14	0.118
All Compressors	37	73
Equipment Leaks	364	455

Methane Emissions Comparison for Refinery Emission Sources

	2012 GHGRP (Gg CH ₄)*	2012 National GHG Inventory (Gg CH ₄)*
Combustion Sources	4.84	1.82
Flares	15.1	0.020
Asphalt Blowing Operations	0.284	0.627
Process Vents	5.49	14.44
Uncontrolled Blowdowns	1.58	
Equipment Leaks	2.69	1.672
Storage Tanks	1.59	0.279
Loading Operations	0.221	Not included

Compilation of Updated Emission Factors

- Data comparison and the discrepancies noted above led to further analysis:
 - 2013 GHGRP data released by EPA in September 2014
 - Recent changes noted in the public review draft of the 2013 national GHGI
- The analysis presented aims to show remaining differences in the methane emission factors of select sources when comparing the GHGRP and GHGI for the upstream petroleum and natural gas sector

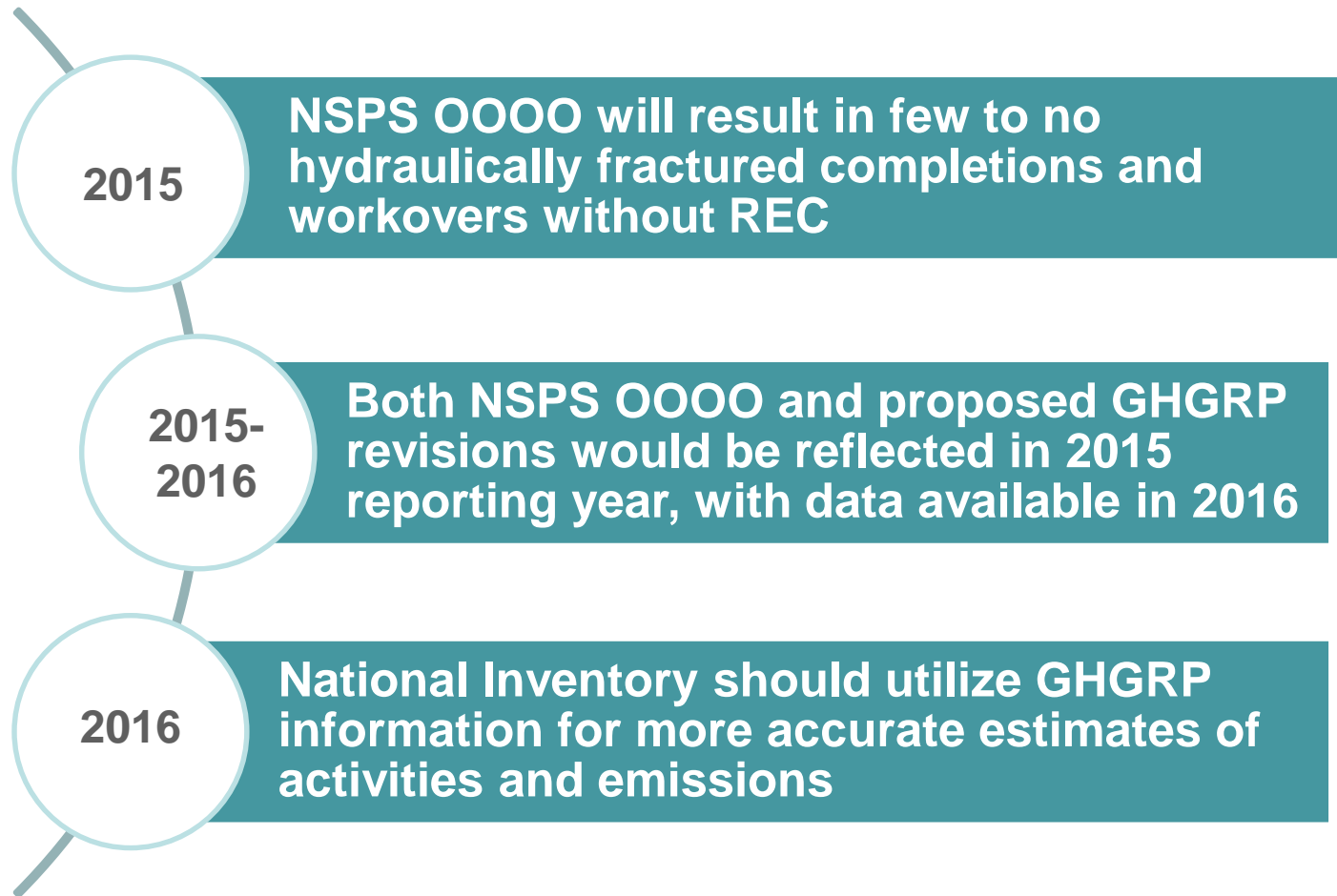
Comparison of Select Emission Factors from Natural Gas Production Operations

	2013 GHG Inventory		GHGRP Measurement/Calculation	
	CH ₄ Emission Factors	Units	CH ₄ Emission Factors	Units
Gas Well HF Completions and Workovers that vent	41	tonnes /event	34.2	tonnes /event
Gas Well HF Completions and Workovers with REC or flare	3-6	tonnes /event	4.1	tonnes /event
Gas Well Completions w/o HF	773.72	scf/completion	3,114	scf /workover
Gas Well Workovers w/out HF	2,624.76	scf/workover		
Liquids unloading with plunger lifts	263,496	scf/well	178,674	scf/well
Liquids unloading without plunger lifts	215,922	scf/well	154,135	scf /well

Comparison of Select Emission Factors from Natural Gas Processing Operations

	2013 GHG Inventory		GHGRP Methods		
	CH ₄ Emission Factors	Units	CH ₄ Emission Factors	Units	Method
Plant Equipment Leaks	7,906	Scfd /plant	5,242	Scfd/plant	“Leaker” EFs
Reciprocating Compressors – Fugitive Emissions	11,196	Scfd/ compressor	3,625	Scfd/ compressor	Measured sub-categories
Centrifugal Comp. (wet seals) – Fugitive Emissions	51,370	Scfd/ compressor	12,381	Scfd/ compressor	Measured sub-categories
Centrifugal Comp (dry seals) – Fugitive Emissions	25,189	Scfd/ compressor	5,762	Scfd/ compressor	Measured sub-categories
Blowdowns/ Venting	4,060	Mscfy/plant	6,521	Mscfy/plant	Volume/event calculation

Anticipated Future Data Revisions



Conclusions

- The comparison between the GHGRP and the GHGI - although not perfect – is instructive
- Consistency of GHGRP data analyzed is enabled by use of uniform methods prescribed by the USEPA for calculating GHG emissions
- The rich database that is becoming available through many studies and the GHGRP would improve understanding of GHG emissions for individual facilities and for the national inventory
- Even while the sector is expanding rapidly, data is reported as absolute emissions which cannot account for increased efficiencies and enhanced operating practices that impact the net GHG emissions per unit of production

Thank you for your attention

Contact Information:

Karin Ritter, API
ritterk@api.org