Natural Gas & Petroleum Systems: Updates Under Consideration for Gathering & Boosting Station Emissions in 2020 GHGI

Stakeholder Workshop

November 7, 2019

OVERVIEW

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- Current G&B Station GHGI Methodology
- Available Data and Considerations for Use in GHGI
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    2. Zimmerle et al. 2019 Study – CH_4 EFs and Approach to Estimate National Emissions for GHGI
- Regional Variability and Time Series Considerations
- National Emissions for Update Under Consideration
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GHGI G&B Background

- EPA evaluated G&B station and gathering pipeline emissions for 2019 GHGI updates
- Gathering pipelines methodology updated for 2019 GHGI – relies on subpart W data
- G&B station methodology was updated in 2016 GHGI but not updated in the 2019 GHGI based on stakeholder feedback
  - Stakeholders noted upcoming new studies on G&B station emissions

Current G&B Station GHGI Methodology

- G&B station methodology updated in 2016 GHGI
- Incorporated Marchese et al. 2015 study
  - Station-level CH_4 EFs
  - National station count in year 2012
  - Station count scaled by marketed gas production in other years vs. year 2012
- CO_2 emissions
  - Apply a default ratio of CO_2-to-CH_4 gas content
  - Approach does not fully account for CO_2 from sources such as flaring or AGR

Parameter	Value	Units
G&B Station EF	373	mt/yr
G&B Station Episodic Events EF	37	mt/yr
G&B Station Count in Year 2012	4,549	stations

Overview of Recent Available data

GHGRP Subpart W

- Collects annual activity and emissions data for facilities ≥25,000 mt CO_2e
- G&B facility = unique combination of operator and basin
- G&B facilities began reporting in RY16

Zimmerle et al. Study

- Component- and source-level CH_4 measurements at G&B stations during year 2017
  - 180 G&B stations in 11 U.S. states
  - 1,938 major equipment units (compressors, dehys, separators, tanks, AGR, yard piping)
  - Facilities operated by companies representing 35% of G&B compressors reported to subpart W in RY2017
- Note, the Zimmerle et al. study data in this presentation reflects the original study results and does not incorporate data from the October 2019 revision

Subpart W G&B Station Data (RY2017)

Emission Source	Reported Emissions (kt)		Data Used in Update Under Consideration?	
	CH_4	CO_2	Activity	EFs
Pneumatic Controllers	197	15	✓	✓
Equipment Leaks	105	12	✓	
Tanks	92	589	✓	✓ (CO_2, N_2O)
Blowdown Vent Stacks	66	9	✓	✓
Dehydrators	49	699	✓	✓
Centrifugal Compressors	40	5	✓	
Combustion Slip	29	n/a		
Pneumatic Pumps	21	2	✓	✓
Flare Stacks	9	2,143	✓	✓
Recip. Compressors	3	0.4	✓	
AGRUs	n/a	486	✓	✓
G&B Station Total	**610**	**3,959**		
National Total (2019 GHGI)	***2,219***	***239***		

Subpart W G&B Station Data Considerations For Using in the GHGI

- To estimate coverage and to consider an approach for scaling subpart W data to the national level, EPA compared subpart W "gas received" by G&B facilities to national gas production (DrillingInfo data analysis), resulting in a 1.07 scaling factor for RY2017
- Scaling resulted in lower CH_4 emissions than current GHGI
- EPA analyzed emissions data from reciprocating compressor seal and valve leakage and compressor engine exhaust (i.e., combustion slip)
  - Zimmerle et al. 2019 study published measurement data specific to G&B compressors

Zimmerle et al. 2019 Study

- Study produced several products that inform potential GHGI updates:
  - Component-level leaker and population EFs (analogous to GHGRP)
  - Population EFs for major equipment
  - Year 2017 national emissions estimate (from study results and subpart W)
- Zimmerle et al. Approach to Estimating National Emissions
  - Relies on a combination of Zimmerle et al. EFs and subpart W-based EFs
  - Considers subpart W and study partner data to estimate national-level activity

Zimmerle et al. 2019 Study: Emission Factors

- Developed 6 major equipment EFs:
  - Compressors
  - Yard piping
  - Separators
  - Tanks
  - Dehydrators
  - AGRUs
- Major equipment EFs account for the contribution from emissions too large to be measured in the field ("large" or "super" emitters) by referencing emissions data from previous studies and applying a statistical approach
- Study recommends using each of the 6 major equipment EFs to calculate leak and vent emissions for these sources
- Study generally recommends using EFs calculated from reported subpart W data for other sources

Zimmerle et al. 2019 Study: National Activity Data

Study recommends an approach to estimate national activity for each equipment type using subpart W data, with two key steps:

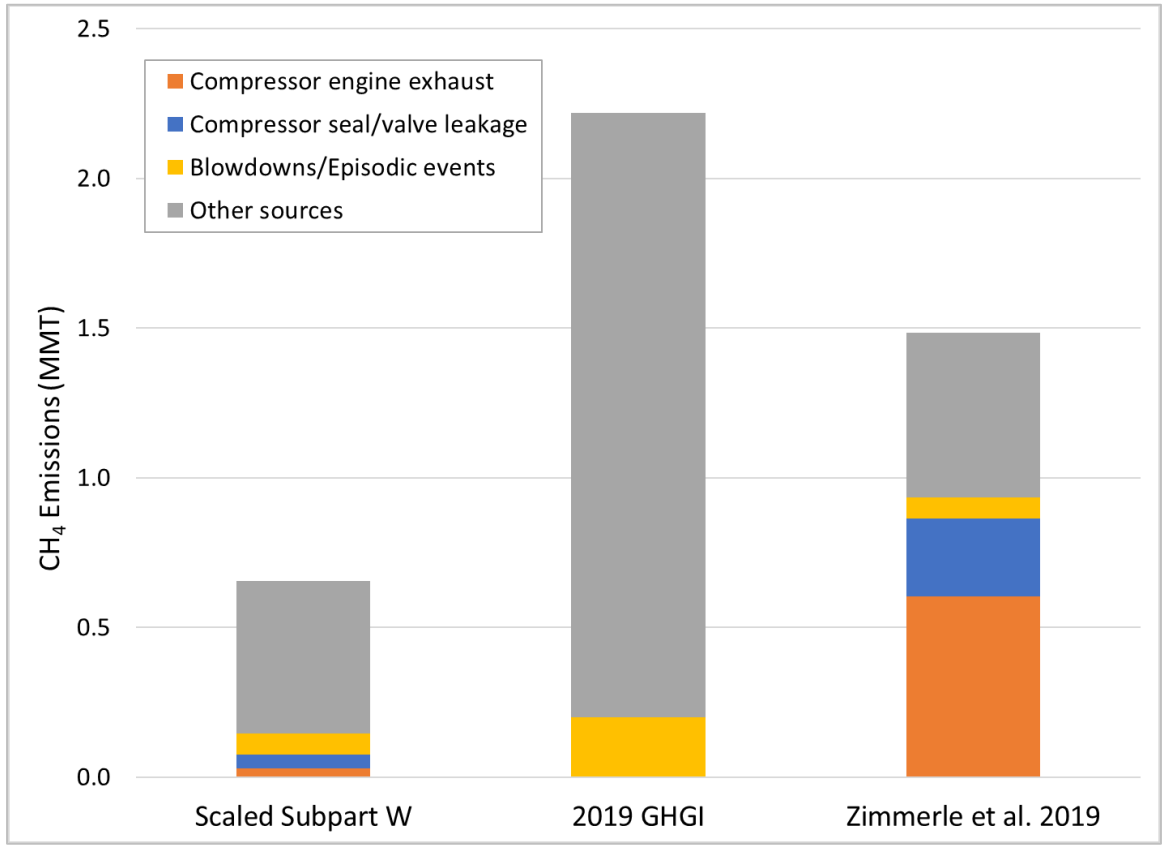
1. Estimating counts of stations and separators
   - Station counts not reported to subpart W
   - Used partner data to develop activity factors of compressors per station and separators per compressor (e.g., national average of 2.8 compressors per station)
2. Scaling reported subpart W equipment counts to national activity
   - Used basin-level production data from subpart W and DrillingInfo to estimate that 7.5% of stations are not reported to subpart W, for a scaling factor of 1.075
     - Scaling factor is similar to that previously developed by EPA (1.07)

Zimmerle et al. 2019 Study: Combustion Slip

- Conducted measurements on 116 reciprocating compressor drivers at 51 G&B stations:
  - 70 four-stroke lean burn engines
  - 46 four-stroke rich burn engines
- Measured emission rates are in general agreement with AP-42 EFs
- Largest source of CH_4 emissions at G&B stations
- Additional work by the study team on combustion slip may provide additional information to assess for use in GHGI updates

Zimmerle et al. 2019 Study: Considerations For Use In GHGI

Comparison of Year 2017 G&B Station CH_4 Emissions by Source



- Largest contributors
  - compressor engine exhaust
  - compressor seal/valve leakage
- Zimmerle et al. emissions are:
  - lower than 2019 GHGI emissions
  - higher than scaled up subpart W emissions

Zimmerle et al. 2019 Study: Considerations For Use In GHGI (cont.)

Zimmerle et al. national emissions are lower than the current GHGI estimate

- Driven by lower station-level emissions (Zimmerle et al. estimates a higher station count than current GHGI)
- Zimmerle et al. suggests the following reasons for differences in emissions, highlighting differences with Marchese et al. study (current GHGI basis)
  - Zimmerle mix of stations is possibly more representative: Marchese evaluated ~700 stations from 4 partner companies vs. >1,700 stations from 9 partner companies
  - Zimmerle accessed GHGRP activity data, which was not available to Marchese
  - The two studies utilized different measurement methods
  - There may have been operational improvements to G&B stations and/or construction of new lower-emitting stations during the four years between studies

Zimmerle et al. 2019 Study: Considerations For Use In GHGI (cont.)

Zimmerle et al. National Estimate and Scaled Subpart W Emissions

Emission Source	Zimmerle CH_4 (kt)	Scaled Subpart W CH_4 (kt)	Factors Driving Differences
Compressor Driver Combustion Slip	605	30	• For natural gas-driven compressor drivers, subpart W uses EF that is more representative of turbines than engines • Engines are the predominant compressor driver in the G&B segment
Compressor Vent & Leak	259	Recip. 3 Cent. 43	• Subpart W reciprocating compressor EF is based on small upstream compressors measured in the 1996 GRI study, whereas G&B compressors can be much larger
Tank Vent & Leak	202	99	• Zimmerle estimated a significant contribution from “large emitters” at tanks

Zimmerle et al. 2019 Study: Considerations For Use In GHGI (cont.)

- **Pneumatic Controllers**: EPA would use EFs calculated from year-specific subpart W data, reflecting gas CH_4 content, operating hours, and year-to-year variation
- **Pneumatic Pumps**: not addressed in Zimmerle et al. study. EPA would use subpart W data to estimate emissions
- **Separators:** EPA would use separator counts reported to subpart W
- **Compressors**: Zimmerle et al. calculated a single leak and vent EF to apply to all compressors
  - Few centrifugal compressors operate within the G&B segment, approximately 1 percent of compressors reporting to subpart W
  - EPA considering whether separate EFs for reciprocating and centrifugal compressors should be applied in the GHGI

Regional Variability Considerations

Station Count Ratio

- Zimmerle developed a compressors per station ratio at the basin-level from partner data
- EPA is considering applying the Zimmerle et al. national average ratio

Scaling Factor

- Zimmerle conducted a detailed, basin-level analysis to develop a scaling factor accounting for:
  - Coverage of subpart W data in basins with GHGRP reporters
  - Basins with no subpart W reporters but some DrillingInfo production
- EPA is considering a simplified, national-level approach to implement the Zimmerle et al. scaling factor

Time Series Considerations

- EPA is considering three options for implementing Zimmerle et al. and subpart W data into the GHGI time series calculations
- Options apply to estimating G&B station counts and applying EFs over the time series
  (1) Use Zimmerle et al. data across the time series
  (2) Use data from both studies (e.g., Marchese et al. data from 1990 – 2013, Zimmerle et al. for 2017 forward, and interpolating between the two for intermediate years)
  (3) Maintain Marchese et al. data (AD and/or EF) across the time series

National Emissions Estimates for Approach Under Consideration (Year 2017)

Emission Source	CH_4 (kt)	CO_2 (kt)	N_2O (kt)
Combustion Slip *	605	n/a	n/a
Compressor L&V *	303	36	n/a
Tank L&V + Flaring *	234	633	0.002
IB Pneumatic Controllers	172	13	n/a
Blowdowns	65	5	n/a
Dehydrator Vents	52	751	0.006
Yard Piping L&V *	52	6	n/a
HB Pneumatic Controllers	33	2	n/a
Pneumatic Pumps	23	2	n/a
Flares	9	2,303	0.004
LB Pneumatic Controllers	6	0.4	n/a
Dehydrator L&V *	2	0.2	n/a
Separator L&V *	3	0.4	n/a
AGRU L&V *	0.1	522	n/a
Total	**1,560**	**4,275**	**0.012**
2019 GHGI Total	***2,219***	***239***	***NE***

* indicates the source of the CH_4 EF was Zimmerle et al. study measurements
NE = Not estimated

- CH_4 emissions calculated by applying the general approach outlined in Zimmerle et al.
  - Relies on a combination of Zimmerle et al. EFs and subpart W-based EFs
- The Zimmerle et al. study did not address CO_2 or N_2O emissions. Emissions were estimated using subpart W data or a CO_2-to-CH_4 gas content ratio as appropriate

Requests for Stakeholder Feedback

1. EPA seeks feedback on applying the general approach outlined in the Zimmerle et al. 2019 study, including:
   - Applying Zimmerle et al. EFs (based on field measurement data and incorporating large emitters)
   - Applying EFs calculated from subpart W data for emission sources that were not included in the Zimmerle et al. study field campaign (e.g., blowdowns)
   - The use of onshore production volumes to determine the coverage of reported subpart W G&B data, used to develop a scaling factor
2. EPA seeks feedback on the appropriateness of a single EF to estimate emissions from reciprocating and centrifugal compressors (as suggested in the Zimmerle et al. study) vs. having separate EFs for each compressor type (as in the GHGRP and as generally used for other GHGI industry segments).
   - If a centrifugal compressor-specific EF is used, what EF should EPA apply (e.g., subpart W EF or an EF from another data source)?

Requests for Stakeholder Feedback (cont.)

3. EPA seeks feedback on how to consider regional variability for G&B stations in the GHGI, including whether to apply a simplified, national-level approach to determine ratios and scaling factors versus a detailed, basin-level approach
4. EPA seeks feedback on how to consider temporal variability for G&B station emissions in the GHGI, including:
   - How to apply the Zimmerle et al. approach versus Marchese et al. EFs (the basis of the current GHGI) over the time series?
   - How to use Zimmerle et al. data versus Marchese et al. data (the basis of the current GHGI) to determine G&B station counts over the time series?
   - How to use subpart W data to estimate flaring emissions over the time series?

Providing Stakeholder Feedback

- EPA will post memo online with additional details and specific stakeholder feedback requests
- https://www.epa.gov/ghgemissions/stakeholder-process-natural-gas-and-petroleum-systems-1990-2018-inventory