February 2016

Inventory of U.S. GHG Emissions and Sinks: Revision Under Consideration for Gathering and Boosting Emissions

This memo was posted and open for stakeholder feedback from December 2015-February 2016. Many of the updates discussed in the memos below were implemented in the 2016 Inventory. For information on revisions implemented in the 2016 Inventory, please see Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2014: Revisions to Gathering and Boosting Emissions, *available at* https://www3.epa.gov/climatechange/ghgemissions/usinventoryreport/natural-gas-systems.html.

Substantial new data are available on emissions from gathering and boosting (G&B) emission sources. The EPA is evaluating approaches for incorporating this new data into its emission estimates for the *Inventory of U.S. GHG Emissions and Sinks* (GHGI).

Background on Gathering and Boosting Emissions in the GHGI

The G&B segment of natural gas systems comprises G&B stations (with multiple emission sources on site) and gathering pipelines. G&B stations receive natural gas from production sites and transfer it, via gathering pipelines, to transmission pipelines or processing facilities (custody transfer points are typically used to segregate sources between each segment). G&B emission sources are not reported under a unique segment in the GHGI. Instead, G&B is included within the production sector. While some processes are conducted only at G&B stations, other processes can be conducted at either production facilities or G&B stations. The emission sources that are applicable to G&B are discussed in further detail below and identified in the first column of Table 1.

EPA has reviewed recent studies conducted on G&B station emissions and is considering revising the GHGI methodology to reflect this new information. The GHGRP does not currently collect data from G&B emission sources, but will beginning with the 2016 reporting year. As GHGRP G&B data become available (beginning in 2017), the EPA may again revisit the GHGI methodologies.

Data Sources Available for Potential Revisions

Two recent studies, Mitchell et al.[1] and Marchese et al.,[2] evaluated emissions from G&B sources. Mitchell et al. conducted emissions testing, while Marchese et al. used the Mitchell et al. test data along with additional data from study partners and other sources to estimate national emissions.

Mitchell et al. collected data from 114 G&B stations with various types of equipment on site. Five types of G&B stations were evaluated, to reflect variation in equipment and function. The types of G&B stations included:

- Compression only;
- Compression and dehydration;
- Compression, dehydration, and acid gas removal;

[1] Mitchell, A. L.; Tkacik, D. S.; Roscioli, J. R.; Herndon, S. C.; Yacovitch, T. I.; Martinez, D. M.; Vaughn, T. L.; Williams, L.L.; Sullivan, M.R.; Floerchinger, C.; Omara, M.; Subramanian, R.; Zimmerle, D.; Marchese, A.J.; Robinson, A.L. *Measurements of Methane Emissions from Natural Gas Gathering Facilities and Processing Plants: Measurement Results.* Environmental Science & Technology, 49, 3219−3227. 2015.

[2] Marchese, A. J.; Vaughn, T. L.; Zimmerle, D.J.; Martinez, D.M.; Williams, L. L.; Robinson, A. L.; Mitchell, A. L.; Subramanian, R.; Tkacik, D. S.; Roscioli, J. R.; Herndon, S. C. *Methane Emissions from United States Natural Gas Gathering and Processing*. Environmental Science & Technology, 49, 10718-10727. 2015.

- Dehydration only; and
- Dehydration and acid gas removal.

When performing the emissions testing, rather than determining emissions for specific sources (e.g., dehydrators or compressors), Mitchell et al. estimated station-level emissions with downwind tracer flux measurements. Emission sources that routinely release emissions at G&B stations were included in the station-level estimate. Tracer flux measurements also captured some emissions from non-routine events, such as blowdowns. However, any emissions identified as non-routine were specifically excluded in the Mitchell et al. data analysis. Uncombusted engine exhaust was captured to a very limited extent. Mitchell et al. noted that due to elevated stacks, engine exhaust emissions were underestimated in the station-level estimates. Additionally, gathering pipelines were not included in the emissions data. The fifth column of Table 1 identifies the emission sources included in the Mitchell et al. station-level emissions data.

The G&B station types tested by Mitchell et al. were selected to provide a sufficient test sample in each category, but were not weighted to represent the national mix of station types. Marchese et al. used the measurement data from Mitchell et al. for the five G&B station types along with activity data (AD) by station type from study partners and state permits to estimate national emissions from the national mix of station types using Monte Carlo simulations. The Monte Carlo simulations are described in greater detail below, in the section "G&B Station Emissions Data."

The production segment emission sources in the current GHGI include sources that may be present at both production sites and at G&B stations such as those studied by Mitchell et al. and Marchese et al. In evaluating how these study data may be used to revise current GHGI methodologies, EPA has drawn a distinction between "production activities" and "G&B activities" for purposes of further analysis:

- *Production activities* generally refers to sources on or associated with single well pads; and
- *G&B activities* generally refers to sources serving multiple well pads and facilitating transport to downstream operations, similar to the definition under the recently finalized subpart W rule updates.[3] G&B activities are further identified as activities that occur at G&B stations, including compression, dehydration and/or acid gas removal, and activities that occur outside of the G&B stations such as the gathering pipelines and associated metering/regulating runs.

The second column in Table 1 identifies emission sources in the current GHGI methodology that are associated predominantly with G&B activities, either located at stations or outside of the stations. The third column of Table 1 identifies emission sources in the current GHGI methodology that are present at both G&B and production sites and are calculated as a single combined value. A companion memo titled "Inventory of U.S. Greenhouse Gas Emissions and Sinks: Revisions under Consideration for Natural Gas Production Emissions" (February 2016) discusses potential revisions including updating some of the production emission calculation methodologies based on subpart W data for production-only facilities, which will result in the calculations being applicable to only production sites. Those production site emission sources for which the methodologies would be revised to avoid including G&B station emission

[3] Gathering and boosting definition under 40 CFR 98.230: *gathering pipelines and other equipment used to collect petroleum and/or natural gas from onshore production gas or oil wells and used to compress, dehydrate, sweeten, or transport the petroleum and/or natural gas to a natural gas processing facility, a natural gas transmission pipeline, or a natural gas distribution pipeline. Gathering and boosting equipment includes, but is not limited to, gathering pipelines, separators, compressors, acid gas removal (AGR) units, dehydrators, pneumatic devices/ pumps, storage vessels, engines, boilers, heaters, and flares.*

sources are shown in column 4 of Table 1. The G&B station emission sources that are included in the emissions estimated by Marchese et al. are indicated in column 5 of Table 1.

Table 1. GHGI Production Segment Emission Sources Relevant to G&B Activities

Emission Source	Emissions are Specific to G&B in Current Methodology	G&B and Production Emissions are Combined in Current Methodology	GHGI Revisions Proposed to Make Emissions Applicable to Only Production	Source is Included in Marchese et al. G&B Station Emissions
Field Separation Equipment				
Heaters		●	●	●
Separators		●	●	●
Dehydrators		●	●	●
Meters/Piping		●	●	●
Gathering Compressors				
Small Reciprocating Compressors		●	●	●
Large Reciprocating Compressors	●			●
Large Reciprocating Stations	●			●
Pipeline Leaks	●			
Normal Operations				
Pneumatic Device Vents		●	●	●
Chemical Injection Pumps		●	●	●
Kimray Pumps		●		●
Dehydrator Vents		●		●
Condensate Tank Vents				
Condensate Tanks without Control Devices		●		●
Condensate Tanks with Control Devices		●		●
Compressor Exhaust Vented				
Gas Engines		●		
Blowdowns				
Vessel Blowdowns		●		
Pipeline Blowdowns	●			
Compressor Blowdowns		●		
Compressor Starts		●		
Upsets				
Pressure Relief Valves		●		
Mishaps	●			

As indicated in Table 1, emissions from the “field separation equipment” category are included in the Marchese et al. emissions estimate for G&B stations (column 5) and are also currently being calculated in combination with production site emissions in the current GHGI methodology (column 3). However, the revisions under consideration to update the production emission calculation methodologies based on subpart W data will result in the calculations for these sources being applicable to only production sites (column 4). This will avoid the double counting of emissions for the emission sources in this category. These same proposed updates will also eliminate the double counting of emissions from small reciprocating compressors and pneumatic device (controller) vents.

As indicated in Table 1, emissions from certain emission sources in the "normal operations" category (chemical injection pumps, Kimray pumps, and dehydrator vents) and emissions from condensate tank vents are calculated for combined G&B and production activities in the current GHGI methodology, and are also included in the Marchese et al. emissions estimate for G&B stations. Marchese et al. estimated that the emissions calculated by the current GHGI methodology for these sources are predominantly associated with production activities (over 92%), indicating very little overlap between production sites and G&B stations. Marchese estimates that this overlap accounts for 44 Gg (2% of current GHGI production segment emissions). More information can be found in the companion memo "Inventory of U.S. Greenhouse Gas Emissions and Sinks: Revisions under Consideration for Natural Gas Production Emissions" (February 2016).

Pipeline leaks, blowdown sources, and upset sources are not covered by the Marchese et al. emissions estimate. Therefore, there is no overlap of these sources between the current GHGI methodology and the Marchese et al. emissions estimate. Marchese et al. expects that compressor engine exhaust plumes are largely omitted from their emission measurements as a result of the test method used. Marchese et al. estimated that the portion of the exhaust emissions omitted from their emissions estimate is at least as large as the emissions estimated by the current GHGI methodology, thereby minimizing or eliminating any emission overlap between the current methodology and the Marchese et al. emissions estimate.

The current GHGI methodology for estimating emissions from large reciprocating engines and for large reciprocating engine stations applies to only G&B activities. These combined sources in the GHGI parallel the Marchese et al. G&B stations emissions estimate and therefore could potentially be replaced by emission factors (EFs) and AD derived from the Marchese et al. data.

This memorandum evaluates potential application of available data for G&B station emission in the GHGI and summarizes:

- Activity data;
- Emissions data;
- National estimates under various options;
- Options for developing the time series of emissions estimates from 1990-2014; and
- Approach under Consideration.

At the end of this memorandum, specific requests for stakeholder feedback are outlined.

G&B Station Activity Data

For many sources in the GHGI, direct AD are not available for every year of the time series. For these sources, generally, AD drivers are used to update AD for each year in the GHGI using counts from the year with available data (commonly, 1992), though for some sources data from earlier years are carried forward as a proxy for later years. AD drivers currently used in the GHGI include statistics on gas production, number of wells, system throughput, miles of various types of pipeline, and other statistics that characterize the changes in the U.S. natural gas system infrastructure and operations. For example, the joint Gas Research Institute (GRI)/EPA study published in 1996 estimated 12 large reciprocating stations (an emission source specific to G&B) for year 1992. EPA scales this value to estimate station counts for other years in the time series based on gathering pipeline miles, which are estimated based on count of active gas wells in the given year. The large reciprocating station count estimated in the GRI/EPA report was based on data from the Federal Energy Regulatory Commission (FERC); no specific data on G&B station counts were available to inform the estimate. FERC data showed that there were three stations in the gathering system that contained five or more compressors serving 86,000 miles of

gathering lines operated by transmission companies. There was an average of eight compressors at these three stations. These data were linearly extrapolated to the 340,000 national miles of gathering lines to provide a national estimate of 12 gathering stations with a total of 96 compressors. When the 1992 station count was allocated to the six NEMS regions in the GHGI and rounded to whole numbers, the sum of the six regions was 10 stations containing 80 compressors. Further information on current GHGI AD methodologies are provided in Annex 3 of the 2015 GHGI report.[4]

Marchese et al. first estimated the 2012 G&B station AD for eight states that include a majority of the national G&B stations as well as the majority of the study partner operations. Marchese et al. reviewed permits from each of the eight states to identify G&B stations and to compile the estimated mix of G&B station sizes and types in these states. For this study, a G&B station was a facility owned by a company whose primary function was gathering and not exploration/production or natural gas transmission. Marchese et al. acknowledged that not every G&B station was found in the permit search and increased the G&B station estimate by applying a ratio of the total number of study partner G&B stations to the number of study partner G&B stations with permits. So few partner G&B stations were identified in the Texas permit review that a separate methodology was applied. The number of G&B stations in the Barnett Shale was estimated in a separate study and these data were scaled to a Texas state estimate using the ratio of natural gas production. Marchese et al. then scaled the G&B station count for the eight states to a national 2012 station estimate by assuming a linear relationship between natural gas production and the number of G&B stations.

G&B Station Emissions Data

The current GHGI methods for G&B emission sources largely rely on EFs generated through the 1996 GRI/EPA study which uses 1992 as the base year. This includes the emissions from field separation equipment, gathering compressors and normal operation sources listed in Table 1. While the EFs for field separation equipment and normal operations were developed from tests on field gathering operations, the EFs for large reciprocating compressors and large reciprocating compressor station operations were assumed to be the same as their counterparts in the natural gas transmission segment, so transmission segment EFs were used in place of testing these sources. The current GHGI accounts for advancement in and increased adoption of emission reduction technologies and practices since the GRI/EPA study by subtracting emission reductions reported to the EPA's Gas STAR program from the calculated potential emissions to estimate "net" emissions.

In 2013 and 2014, Mitchell et al. collected emission measurements from 114 G&B stations with various types of equipment (refer to "Data Sources Available for Potential Revisions" above for the five types of stations categorized based on equipment). When performing the emissions testing, rather than determining emissions for specific sources (e.g., dehydrators or compressors), Mitchell et al. estimated station-level emissions during normal operation by obtaining downwind tracer flux measurements. Marchese et al. used Monte Carlo simulations to scale up the emission data from the five station types to a national G&B station emission estimate based on the national profile of station types and sizes. Marchese et al. first developed the type and size profile for the 738 stations operated by the study partners. Then, Marchese et al. developed a station profile for the eight highest natural gas producing states using the station profile from their partner's stations and the station size distributions developed from the eight state permit databases. Marchese et al. then used Monte Carlo simulations to develop the G&B station emissions for the eight states based on the station profiles and the Mitchell et al.

[4] http://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-GHGI-2015-Annex-3-Additional-Source-or-Sink-Categories.pdf

emission data for the various station sizes and types. Marchese et al. scaled the G&B emissions for the eight states to a national estimate using natural gas production data.

National Estimates of G&B Station Emissions

The results from the Marchese et al. study are presented in Table 2.

Table 2. Results of the Marchese et al. Study of G&B Stations, for Year 2012

Data Level	# G&B Stations	CH_4 Emissions (MMT CO_2e)
Total for 8 States Modeled by Marchese et al.	3,797	35.4
Total U.S.	4,549	42.4

Marchese et al. also compared their estimates to the GHGI. As previously noted, certain emission sources are applicable to both G&B and production; thus the GHGI emissions do not allow for straightforward comparison with Marchese et al. However, Marchese et al. used AD from 738 G&B stations owned by the study's partners, scaled to the national estimated 4,549 G&B stations (see Table 2), in addition to the EFs used in the GHGI, to estimate the portion of GHGI emissions due to G&B stations. To make the comparison on an equal basis, Marchese et al. included only the emission sources from the GHGI that were also captured by their emission testing (e.g., wells and completions were excluded as well as non-station G&B sources such as gathering pipelines and intermittent station sources such as blowdowns). This comparison by Marchese et al. is presented in Table 3. The Marchese et al. national G&B station emissions estimate (1,697 Gg) is significantly higher than the Marchese-estimated net GHGI G&B station emissions (226 Gg), which suggests the current GHGI methodology does not capture all G&B station emissions.

Table 3. Comparison of Marchese et al. and GHGI 2012 G&B Station CH_4 Emissions

Data Source	2012 National CH_4 Emissions (Gg)	2012 National CH_4 Emissions (MMT CO_2e)
Marchese et al. G&B Station Emissions	1,697	42.4
GHGI – Net Emissions (G&B stations only)[a]	226	5.7

a. As provided in Marchese et al.; only includes G&B station sources that were likely captured by their testing (e.g., emissions sources specific to production, such as wells and completions are excluded as well as non-station G&B sources such as gathering pipelines and intermittent station sources such as blowdowns).

GHGI Time Series Considerations for G&B Station Emissions

As further detailed below, the EPA is considering using Marchese et al. national estimates of station counts and emissions to develop a station-level EF, and is considering options for incorporating this data. This station-level EF might be considered representative of emissions from G&B stations over all years of the time series unless there have been changing industry trends over time (for example, replacement of continuous high-bleed pneumatic controllers with low- or intermittent-bleed, and vapor controls on storage tanks). Below, the EPA seeks stakeholder feedback on this issue.

If a station-level EF were developed from the Marchese data, the EPA would need to develop associated AD (G&B station counts) for all years of the time series. The current GHGI methodology estimates counts of large reciprocating compressors and stations based on an estimate of gathering compressors and stations in 1992 by the GRI/EPA study and projected to future years based on changes in the population

of non-associated gas wells. To develop station counts that would be appropriate to pair with a Marchese et al. based EF, other types of stations (e.g., dehydration but no compression) should be included. Similar to the approach that Marchese et al. used for scaling estimates to a national level, the EPA is considering using EIA onshore marketed natural gas production as an AD driver. As discussed further in the next section, EPA might use this data to develop AD over the time series. These EIA data are available on a state-by-state basis therefore AD on a NEMS region level can be calculated to be consistent with the organization of the rest of the production segment in the natural gas GHGI. However, the EIA does not publish separate values for the onshore portion of marketed natural gas production prior to 1992, but publishes the onshore portion of gross withdrawals. The EPA could use the relationship of onshore marketed production to onshore gross withdrawals in 1992 to estimate marketed onshore production in 1990 and 1991, based upon onshore gross withdrawals for these two years.

Gas STAR Reductions Considerations

The revisions discussed in this memorandum in conjunction with the revisions outlined in the companion memorandum "Inventory of U.S. Greenhouse Gas Emissions and Sinks: Revisions under Consideration for Natural Gas Production Emissions" (February 2016) would result in G&B station net emissions being directly calculated for every year of the time series. This obviates the need to apply Gas STAR reductions data for G&B station sources. Table 4 below summarizes natural gas production segment Gas STAR reductions by source in the 2015 GHGI. There are significant Gas STAR reductions in the production segment that are not classified as applicable to specific emission sources ("Other voluntary reductions" are 16 MMT CO_2e CH_4 in year 2013). Some portion of the "other voluntary reductions" might apply to the emission sources for which EPA is considering revising the basis to reflect separation between production and G&B segments and/or to reflect net emissions. EPA is investigating potential disaggregation of "other voluntary reductions."

Table 4. Year 2013 Production Segment CH_4 Emissions by Source in the 2015 GHGI Inventory

All Production Emission Sources	Potential Emissions (MT CO_2e)	Reduction (MT CO_2e)	Net Emissions (MT CO_2e)
Pneumatic Controllers	29.0	15.5	13.5
Major Equipment Fugitives	8.6	-	8.6
Chemical Injection Pump Venting	1.6	0.1	1.5
Dehydrator Pumps/Vents	12.2	-	12.2
Compressor Starts	0.2	0.01	0.1
Large Gathering Compressor Station Fugitives	0.4	-	0.4
Gathering Pipeline Leaks	4.2	-	4.2
Gas Engines	6.2	3.5	2.7
Condensate Tanks	7.8	-	7.8
Blowdowns	0.2	-	0.2
Upsets	0.1	-	0.1
Wellpad Fugitives/Venting	11.5	-	11.5
Offshore	3.8	-	3.8
Other Voluntary Reductions	n/a	16.5	n/a
Regulatory Reductions	n/a	3.0[a]	n/a
Total	**85.6**	**38.6**	**47.0**

a. Due to NESHAP regulations addressing condensate storage tanks and dehydrators, in effect for year 1999 forward.

Approach under Consideration for Gathering and Boosting Emissions in the GHGI

The EPA is considering the following approach for revising the current GHGI methodology using data derived from the Marchese et al. estimate of national G&B station emissions.

G&B Station Emission Factor

The EPA is considering deriving a station-level EF from the Marchese et al. estimate of national G&B station emissions to apply for all years of the GHGI time series. Marchese et al. estimated a total G&B station count for the U.S. and their associated emissions; see Table 2. Dividing the emissions by the G&B station count results in a station level EF of 53,253 scfd CH_4 per G&B station. This EF would be used to replace the EF for large gathering reciprocating compressors and for large gathering reciprocating compressor stations in the current methodology.

G&B Station Activity Data

The EPA is considering scaling the 2012 G&B station AD estimated by Marchese et al. to estimate the number of G&B stations for all years in the GHGI time series based on the ratio of natural gas production in a given year to that in year 2012. The EPA considered using the existing GHGI estimate for the base year of 1992 (see section "G&B Station Activity Data" for a description of the current methodology), however the current GHGI methodology for station counts reflects an estimate of only large gathering compressor stations, which is a very small subset of the population of G&B stations that was estimated by Marchese et al. and that EPA aims to capture through a revised GHGI approach.

The US DOE's Energy Information Administration (EIA) publishes current and historical natural gas production information by state. This production information is published on three bases: dry production, gross production, and marketed production. These three bases, as described by EIA, are presented in Table 5. Of the three categories of production data published by EIA, the EPA is considering using the marketed onshore production because it most closely represents the net volume of natural gas passing through G&B stations. Gross withdraws represent all natural gas production, including gas that is reinjected, vented, and flared, thereby overstating the volume of gas that enters the G&B system. Dry natural gas production excludes the gas used at the processing plant, thereby understating the volume of gas passing through G&B stations.

Table 5. Natural Gas Production Data Published by EIA

Production Basis	EIA Description
Dry Natural Gas Production	The process of producing consumer-grade natural gas. Natural gas withdrawn from reservoirs is reduced by volumes used at the production (lease) site and by processing losses. Volumes used at the production site include (1) the volume returned to reservoirs in cycling, repressuring of oil reservoirs, and conservation operations; and (2) gas vented and flared. Processing losses include (1) nonhydrocarbon gases (e.g., water vapor, carbon dioxide, helium, hydrogen sulfide, and nitrogen) removed from the gas stream; and (2) gas converted to liquid form, such as lease condensate and plant liquids. Volumes of dry gas withdrawn from gas storage reservoirs are not considered part of production. Dry natural gas production equals marketed production less extraction loss.
Gross Withdrawals	Full well-stream volume, including all natural gas plant liquids and all nonhydrocarbon gases, but excluding lease condensate. Also includes amounts delivered as royalty payments or consumed in field operations.

Production Basis	EIA Description
Marketed Production	Gross withdrawals less gas used for repressuring, quantities vented and flared, and nonhydrocarbon gases removed in treating or processing operations. Includes all quantities of gas used in field and processing plant operations.

The number of G&B stations estimated for certain years of the GHGI using this approach compared to current GHGI AD are presented in Table 6.

Table 6. G&B Station AD Over the GHGI Time Series

Data Element	1990	1992	1995	2000	2005	2010	2012	2013
Marketed Natural Gas Production (BCF)	13,263	13,526	14,135	14,703	15,355	19,851	23,531	23,995
Revised G&B Station Count	2,564	2,615	2,733	2,842	2,968	3,838	4,549	4,639
Current GHGI G&B Station Count	9	10	11	11	13	16	16	16

G&B Station National Emissions

Applying the 53,253 scfd/station CH_4 EF derived from Marchese et al. to the revised G&B station counts shown in Table 6 results in the national G&B station emission estimates presented below in Table 7.

Table 7. National G&B Station CH_4 Emission Estimates Calculated for Select Years (MMT CO_2e)

Approach	1990	1992	1995	2000	2005	2010	2012	2013
G&B Stations Revision	24	24	25	27	28	36	42	43

Requests for Stakeholder Feedback

Data Availability

1. The EPA is seeking stakeholder feedback on additional data available to consider in revising G&B emission estimates at this time. The EPA seeks stakeholder feedback on the proposed approach to use Marchese et al. estimates for national activity data. Are additional data sources or approaches available to estimate national G&B activity?

2. Replacing current GHGI EFs for large reciprocating compressors and stations with the EF based on Marchese et al. G&B station emissions may introduce double counting of the "mixed category" sources based on current GHGI methodology. The EPA's updates under consideration for the G&B segment (this memorandum) and production segment (*Inventory of U.S. Greenhouse Gas Emissions and Sinks: Revisions under Consideration for Natural Gas Production Emissions* (February 2016)) in combination avoid potential double counting issues by calculating emissions for each as distinct segments. Please comment on the overall approach under consideration for production and G&B.

3. As discussed in this memorandum, G&B data will be available in 2017 through GHGRP. GHGRP data could allow the EPA to calculate emissions for individual equipment types as opposed to using emission factors and activity data at the station level. The EPA seeks stakeholder feedback on the two approaches. The EPA could considering using the station level approach for the 2016 GHGI, and then re-evaluating and potentially revising the approach with new GHGRP data in the

2017 GHGI, or could consider implementing updates to the G&B segments starting with the 2017 GHGI and using GHGRP and/or the Marchese et al. data at that time.

4. The EPA seeks feedback on whether and how to use the Marchese et al. data to reflect geographic variation of activity factors and/or emission factors. In the current GHGI, emissions from G&B sources are calculated separately for six NEMS regions along with production sources. The update under consideration would be applied at the national level. The EPA plans to explore options to reflect geographic variation in future GHG inventories.

Time Series Considerations

5. The EPA seeks feedback on the appropriateness of using the Marchese et al. based G&B station EF across all years of the time series, or whether there are approaches that may be considered for reflecting changing industry trends impacting emissions over time.

6. The EPA seeks stakeholder feedback on the activity driver (volume of marketed onshore gas production) under consideration. Other options for the activity driver could include well count data or other gas production categories. Please comment on which activity driver would be the most appropriate to show trends in G&B.

7. The EPA seeks stakeholder feedback on trends in G&B activity data that would result in more or fewer stations per volume of marketed onshore gas production during any point in the GHGI time series. The EPA requests stakeholder feedback on how upcoming subpart W G&B activity data (available in 2017) could be used to inform the time series activity data to reflect ongoing trends.

8. Since the EIA does not publish separate values for the onshore portion of marketed natural gas production prior to 1992, the EPA is considering using the relationship of onshore marketed production to onshore gross withdrawals in 1992 to estimate marketed onshore production in 1990 and 1991, based upon onshore gross withdrawals for these two years. Are there alternatives to addressing this missing AD?

9. Although it is not possible to directly compare the G&B emissions estimate developed with GRI/EPA study data to the Marchese et al. results, it is evident that the G&B emissions from Marchese et al. are significantly higher than estimates in the current GHGI. The EPA seeks stakeholder comment on this discrepancy.

Marchese et al. Assessment of Gas Processing Plant Emissions

Marchese et al. also measured the methane emissions from 16 natural gas processing plants using a similar approach as described above for G&B stations. 15 of the measured plants were owned by two of the study participants, and 1 plant was owned by a non-participant of the study. The results of the Marchese et al. testing were scaled to the estimated 600 national gas processing plants using a similar Monte Carlo simulation as was used for G&B stations. The results of the Marchese et al. simulation was a national methane emission estimate for gas processing plants of 506 Gg. As with the G&B stations, Marchese et al. estimated that the emission results were biased low for several factors. The brief sampling period did not capture routine maintenance and upset emissions. In addition the sampling method did not capture a significant portion of the compressor exhaust emissions. Marchese et al. compared their findings to the EPA GHGI of 2012 emissions. The net GHGI methane emissions for 2012 from processing plants were 891 Gg. The net GHGI emissions from processing plants, excluding compressor exhaust and blowdown/venting emissions were estimated to be 666 Gg. EPA seeks stakeholder comment on the potential use of Marchese et al. results for the processing segment.