

# NATURAL GAS & PETROLEUM SYSTEMS: UPDATES UNDER CONSIDERATION FOR 2019 GHGI

Webinar  
June 6, 2018

# OUTLINE

- Summary of updates from 2017 GHGI to 2018 GHGI
- Overview of 2019 GHGI stakeholder process
- Updates under consideration for 2019 GHGI
  - **Topic area 1: Incorporation of GHGRP data**
    - G&B segment
    - HF oil well completions and workovers
    - Other topics
  - **Topic area 2: Improvements to well-related activity data**
    - Well drilling activity
    - Well completions and workovers activity
    - Other topics

# UPDATES FROM 2017 GHGI TO 2018 GHGI

# OVERVIEW OF UPDATES FROM 2017 TO 2018 GHGI

- Updates to incorporate GHGRP data
  - Basin-level, throughput-based EFs for certain sources
  - Year-specific EFs for certain sources
  - CO<sub>2</sub> emissions estimates
- Uncertainty model update
- Abandoned wells estimates
- Reorganization to include a specific exploration segment
- Corrections to Gas STAR reductions

# UPDATES TO INCORPORATE GHGRP DATA

- Basin-level, throughput-based EF development
  - Developed EFs from subpart W data on a throughput basis (e.g., per unit oil production)
  - Developed EFs specific to any basin that contributes  $\geq 10\%$  of total reported source emissions (combine all other basins)
  - Applied for associated gas venting/flaring and miscellaneous production segment flaring in the 2018 GHGI
- Year-specific EF development
  - Developed year-specific EFs from subpart W data (where previously, multiple years were combined)
  - Applied for HF gas well completions/workovers and liquids unloading in the 2018 GHGI

# UPDATES TO INCORPORATE GHGRP DATA (CONT.)

- CO<sub>2</sub> emissions estimates
  - Subpart W data are used in the GHGI to calculate CH<sub>4</sub> emissions for numerous production, processing, and transmission and storage sources
  - To create consistency, EPA applied the existing subpart W-based CH<sub>4</sub> methodology to calculate CO<sub>2</sub> EFs
  - EPA also developed a new methodology to use subpart W data for sources that were not already based on subpart W
  - Largest impact for sources with flaring, and updates resulted in a reallocation of flaring CO<sub>2</sub> emissions from natural gas to petroleum systems

# CO<sub>2</sub> RECALCULATIONS IMPACT

- 15% increase in estimate for year 2015 from 2017 GHGI to 2018 GHGI
  - Due to new flaring estimates

Segment	2017 Final – Year 2015 Estimate (CO <sub>2</sub> )	2018 Final – Year 2015 Estimate (CO <sub>2</sub> )
Production	19.2 MMT (Gas: 18.6 MMT; Oil: 0.6 MMT)	28.4 MMT (Gas: 3.7 MMT; Oil: 24.7 MMT)
Processing	23.7 MMT	21.0 MMT
Transmission and Storage	0.0 MMT	0.1 MMT
Distribution	0.0 MMT	0.0 MMT
Refineries	2.9 MMT	4.0 MMT
<b>Total</b>	<b>46.5 MMT</b>	<b>53.6 MMT</b>

# ABANDONED WELLS UPDATE

- New category for the Inventory
- Developed plugged and unplugged EFs for Appalachia and non-Appalachia regions
- Population of abandoned wells, including split between plugged and unplugged wells, based on Drillinginfo and historical data
- Uncertainty model developed based on study data (EFs) and expert judgment (activity estimates) – results presented in following slide

Year	Abandoned Well Count (millions)			Plugging Status (%)		Population in Each Region (%)	
	Total	Gas	Oil	Unplugged	Plugged	Appalachia	Other
<b>1990</b>	2.37	0.32	2.05	81	19	26	74
<b>2016</b>	3.35	0.72	2.63	69	31	24	76

Regional EFs (g/h/well)	Unplugged	Plugged
Non-Appalachia	10	0.002
Appalachia	23	0.36



# CH<sub>4</sub> RECALCULATIONS IMPACT

- 1% increase in estimate for year 2015 from 2017 Final to 2018 Final

Segment	2017 Final – Year 2015 Estimate (CO <sub>2</sub> e)	2018 Final – Year 2015 Estimate (CO <sub>2</sub> e)
Production	145.6 MMTCO <sub>2</sub> e (Gas: 106.6 MMTCO <sub>2</sub> e; Oil: 39.0 MMTCO <sub>2</sub> e)	146.3 MMTCO <sub>2</sub> e (Gas: 109.1 MMTCO <sub>2</sub> e; Oil: 37.2 MMTCO <sub>2</sub> e)
Processing	11.1 MMTCO <sub>2</sub> e	11.0 MMTCO <sub>2</sub> e
Transmission and Storage	33.7 MMTCO <sub>2</sub> e	34.1 MMTCO <sub>2</sub> e
Distribution	11.0 MMTCO <sub>2</sub> e	12.0 MMTCO <sub>2</sub> e
Refineries and transport	0.8 MMTCO <sub>2</sub> e	0.7 MMTCO <sub>2</sub> e
<b>Total</b>	<b>202.2 MMTCO<sub>2</sub>e</b>	<b>204.4 MMTCO<sub>2</sub>e</b>
Abandoned Wells (separate category)	N/A	7.2 MMTCO <sub>2</sub> e (Gas: 1.4 MMTCO <sub>2</sub> e; Oil: 5.8 MMTCO <sub>2</sub> e)

# UNCERTAINTY MODEL UPDATE

- Performed a detailed uncertainty analysis for sources that contribute 75% of emissions for natural gas and petroleum systems (i.e., modeled sources)
- Performed a detailed uncertainty analysis for abandoned wells
- For each step, Monte Carlo simulations were used (IPCC Approach 2)

Analysis	Natural Gas Systems		Petroleum Systems		Abandoned Wells	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
2011 Analysis	-19%	+30%	-24%	+149%	-	-
<b>2018 Final</b>	<b>-16%</b>	<b>+17%</b>	<b>-30%</b>	<b>+34%</b>	<b>-83%</b>	<b>+215%</b>

# 2019 GHGI STAKEHOLDER PROCESS

# 2019 GHGI STAKEHOLDER PROCESS

- EPA invites stakeholder feedback on potential updates for the 2019 and future GHG inventories
- As in previous years, EPA will hold a series of webinars and workshops on oil and gas in the 2019 GHGI
- Information will be available on our website as webinars/workshops are announced
- Memos on updates under consideration will be posted for stakeholder feedback
- EPA invites stakeholders to present information at webinars/workshops
  - Feedback on options EPA is assessing
  - Other updates that could be considered
- Next few slides will cover updates and data sources that EPA is currently assessing

# UPDATES UNDER CONSIDERATION FOR 2019 GHGI

## TOPIC AREA 1: INCORPORATING GHGRP DATA

# G&B SEGMENT – CURRENT GHGI METHODOLOGY

- Station counts in each year calculated as marketed onshore gas production in the given year (obtained from EIA) divided by the year 2012 throughput per station from the Marchese et al. 2015 study
- Station-level EFs for normal events (documented in the *2016 G&B memo*) and episodic events (documented in the *2017 Production memo*) representing vented and fugitive emissions calculated using data from the Marchese et al. 2015 study
- Pipeline miles in each year calculated as an AF (pipeline miles per well) from the 1996 GRI/EPA study times the total count of gas wells (DrillingInfo) in that year, plus a correction factor from the GRI/EPA study.
- Pipeline CH<sub>4</sub> EF (emissions per mile) representing leaks and blowdowns developed from 1996 GRI/EPA study.
- CO<sub>2</sub> emissions based on CO<sub>2</sub> EFs developed by applying a default production segment ratio of CO<sub>2</sub>-to-CH<sub>4</sub> gas content

# G&B SEGMENT – AVAILABLE DATA

- GHGRP Subpart W
  - G&B segment newly reported under subpart W as of RY2016
  - G&B facilities defined as a unique combination of operator and basin of operation
  - Subpart W does not delineate data for G&B stations versus pipelines
  - However, the data are reported on an emission source level, so each source can be assigned as likely occurring at either G&B stations or pipelines

**G&B Station Emissions Data, Year 2016**

Data Source	Total CH <sub>4</sub> Emissions (mt)	Total CO <sub>2</sub> Emissions (mt)
Subpart W	796,868	5,930,105
2018 GHGI	2,149,065	233,502

**G&B Pipeline Emissions and Mileage Data, Year 2016**

Data Source	Total CH <sub>4</sub> Emissions (mt)	Total CO <sub>2</sub> Emissions (mt)	Pipeline Miles
Subpart W	152,011	8,967	405,174
2018 GHGI	157,798	18,820	398,554

# G&B SEGMENT – AVAILABLE DATA (CONT.)

- Recent Studies

- Vaughn et al. (2017). *Comparing facility-level methane emission rate estimates at natural gas gathering and boosting stations*
- Yacovitch et al. (2017). *Natural gas facility methane emissions: measurements by tracer flux ratio in two US natural gas producing basins*
- Zimmerle et al. (2017). *Gathering pipeline methane emissions in Fayetteville shale pipelines and scoping guidelines for future pipeline measurement campaigns*

Data Source	CH <sub>4</sub> Emission Rate (kg/h)
Current GHGI	43
Vaughn (Fayetteville) (excl. tank venting)	50.4
Vaughn (Fayetteville) (incl. tank venting)	74.5
Yacovitch (Fayetteville)	40
Yacovitch (DJ)	11



# G&B SEGMENT – UPDATES UNDER CONSIDERATION

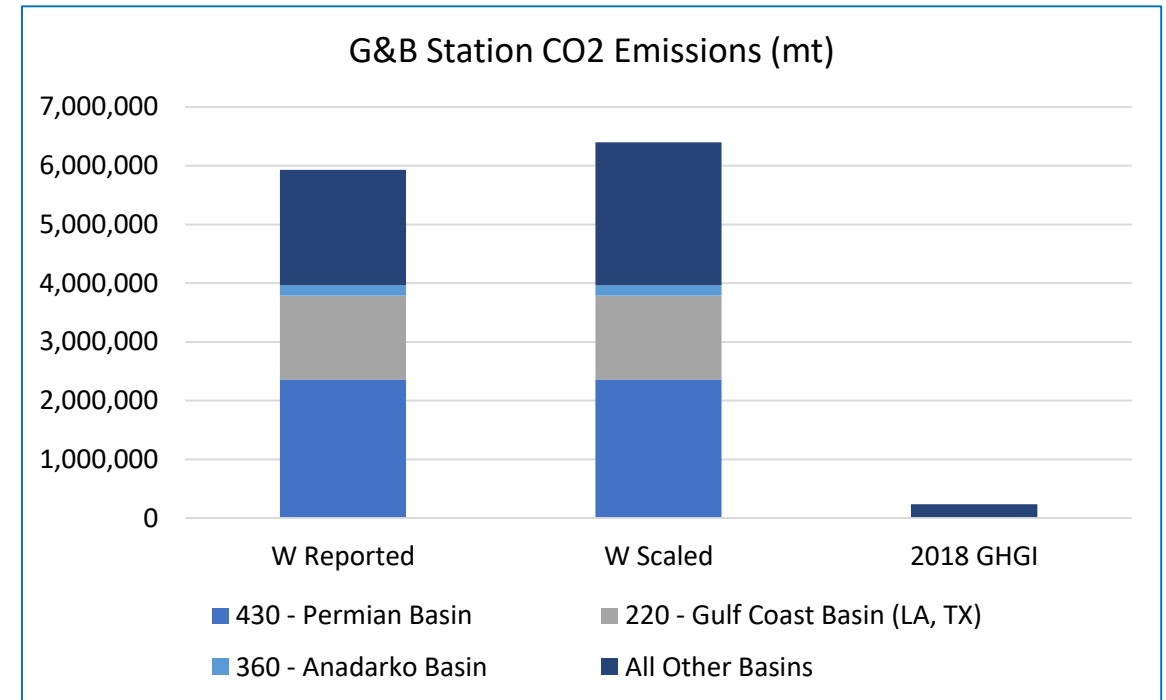
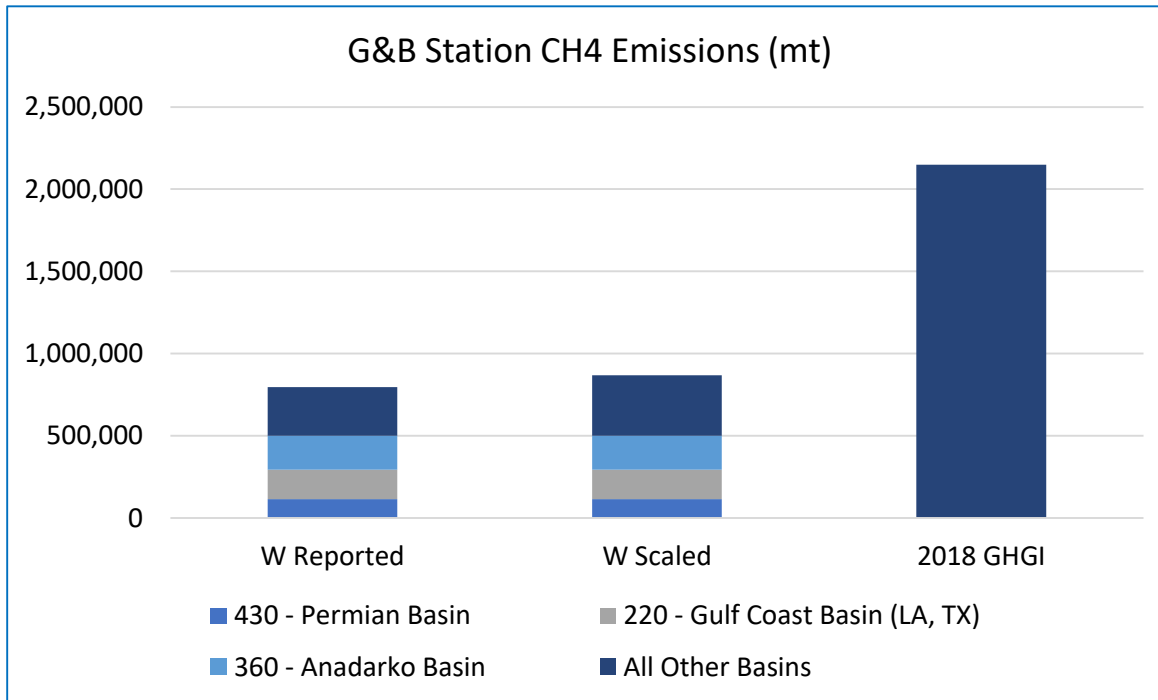
- Consider approaches for incorporation of GHGRP and other data
- Develop activity-based (throughput or mileage) GHGRP reporting coverage estimates
  - Additional details, including preliminary national estimates, shown on following slides
- Consider incorporation of certain GHGRP data
  - Examine at source-level
  - Consider supplementing source-level data with other existing data
- Consider level of aggregation (e.g., source- versus station-level emissions; basin- versus national-level EFs, etc.)
- Consider time series

# G&B SEGMENT – UPDATES UNDER CONSIDERATION (CONT.)

- Incorporating subpart W data via basin-level, throughput-based coverage (stations and pipelines)
  1. Compare the quantity of gas received (reported by subpart W G&B facilities) to the total amount of gas produced from wells (estimated from DrillingInfo)
  2. For the top-emitting basins and the group of all other basins, calculate a scaling factor equal to the gas produced divided by the gas received
  3. For each basin or basin group, apply the scaling factor to reported emissions
- Incorporating subpart W data via mileage-based coverage (pipelines)
  1. Assume subpart W covers 100% of G&B pipelines, based on comparison to current GHGI and other available gathering pipeline mileage data
  2. Use subpart W data as-reported in GHGI

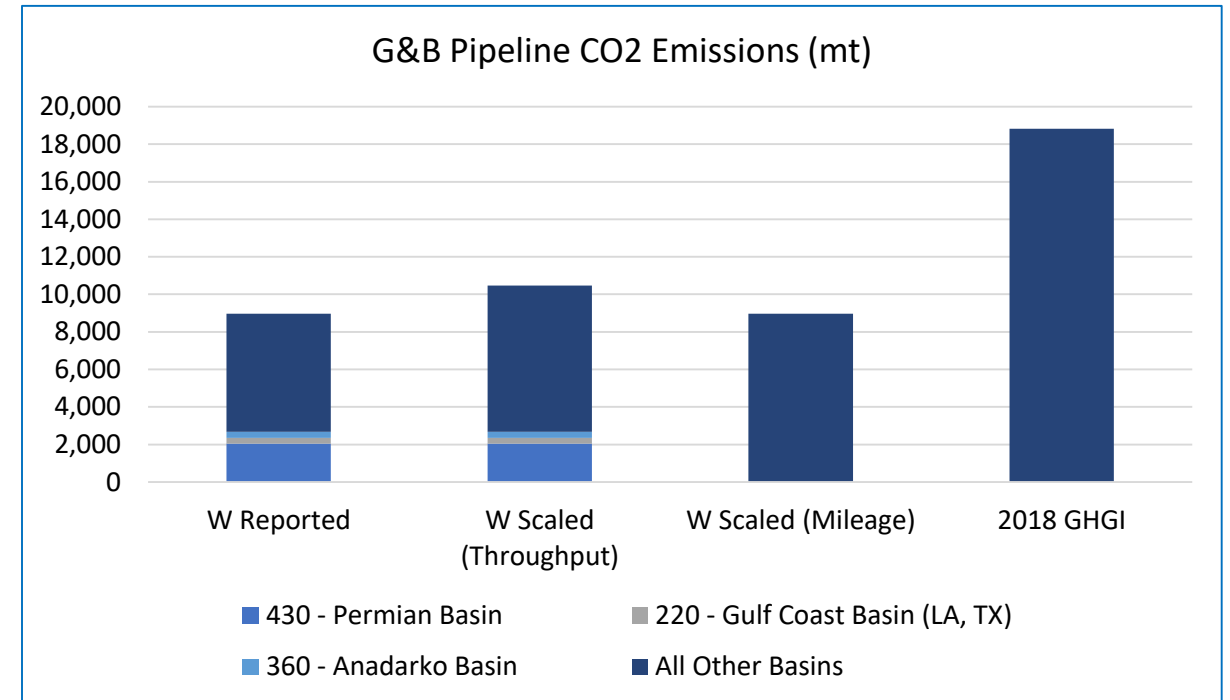
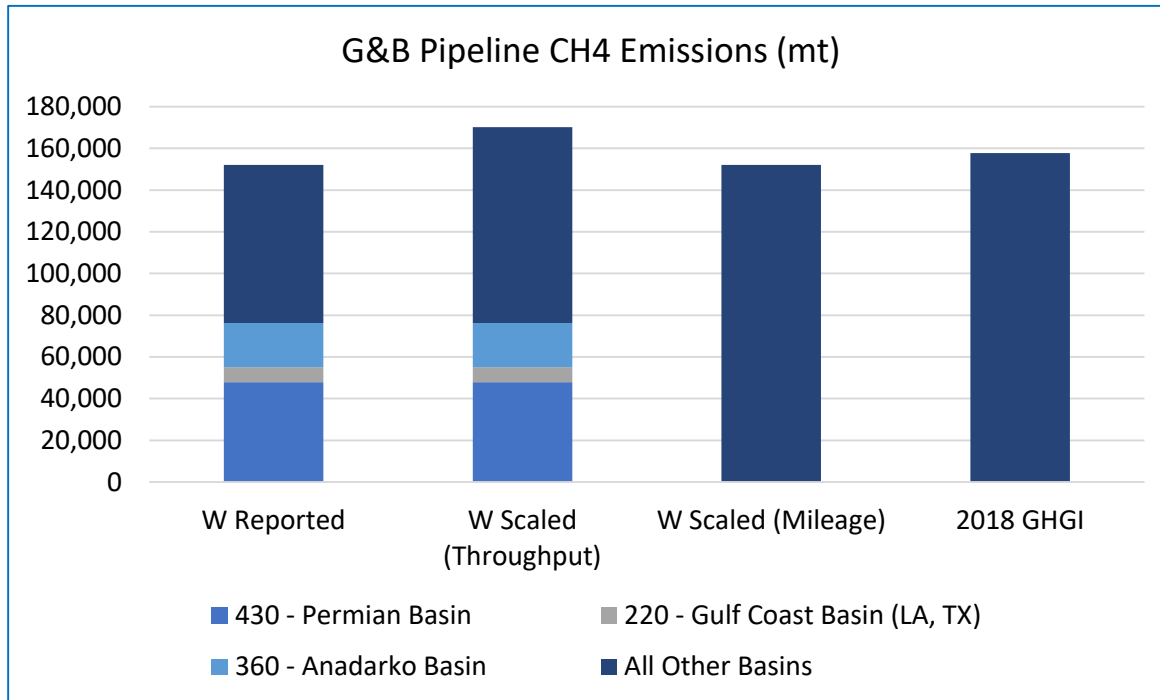
# G&B SEGMENT – UPDATES UNDER CONSIDERATION (CONT.)

- Incorporating GHGRP data via reporting coverage analyses (cont.)



# G&B SEGMENT – UPDATES UNDER CONSIDERATION (CONT.)

- Incorporating GHGRP data via reporting coverage analyses (cont.)



# G&B SEGMENT – STAKEHOLDER FEEDBACK TOPICS

1. Data sources and methodology to consider in revising GHGI
2. How to assess GHGRP reporting coverage
3. How to consider regional and temporal variability in GHGRP data
4. How to consider impacts of the GHGRP G&B facility definition
5. Level of detail to present in the GHGI

***Refer to EPA memo to be posted online for additional detail***

# HF OIL WELL COMPLETIONS & WORKOVERS – CURRENT GHGI METHODOLOGY

- HF Completions
  - Controlled and uncontrolled CH<sub>4</sub> EFs calculated from 2015 NSPS OOOOa data
  - Activity developed by analyzing DrillingInfo data on well-level dates of completion or first reported production
  - Assumptions applied to develop AFs for apportioning total counts into control categories: from 2008 forward, 7% of completions are RECs (based on 2008 CO and WY REC regulations)
- HF Workovers
  - GHGI does not distinguish HF from non-HF, uses an EF developed for conventional wells and an assumption that 7.5% of all oil wells are worked over in each year
- CO<sub>2</sub> emissions based on CO<sub>2</sub> EFs developed by applying a default production segment ratio of CO<sub>2</sub>-to-CH<sub>4</sub> gas content

# HF OIL WELL COMPLETIONS & WORKOVERS – AVAILABLE DATA

- GHGRP
  - HF oil well events newly reported under subpart W as of RY2016
  - 4 control categories (same as those for HF gas well events)
- Subpart W Calculated EFs, Year 2016

Event Type	Control Category	CH <sub>4</sub> EF (mt/event)		CO <sub>2</sub> EF (mt/event)	
		2018 GHGI	Subpart W	2018 GHGI	Subpart W
Non-REC	Vent	6.8	36.0	0.4	0.8
	Flare		1.1		248.8
REC	Vent	0.3	1.3	0.02	0.1
	Flare		2.6		287.1

# HF OIL WELL COMPLETIONS & WORKOVERS – AVAILABLE DATA (CONT.)

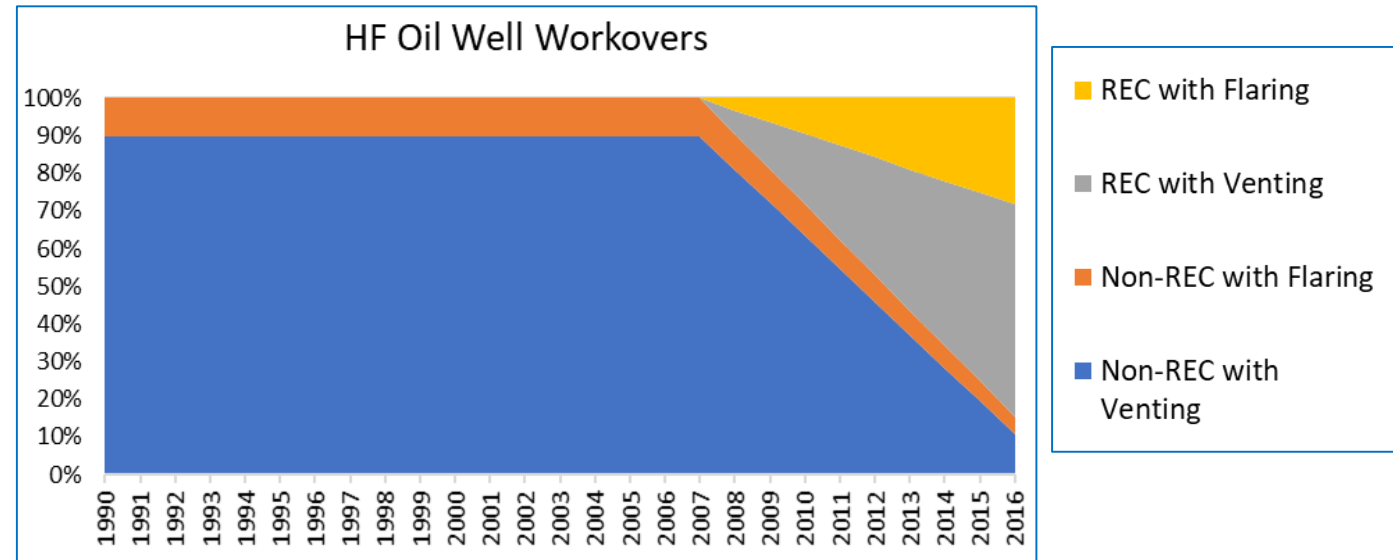
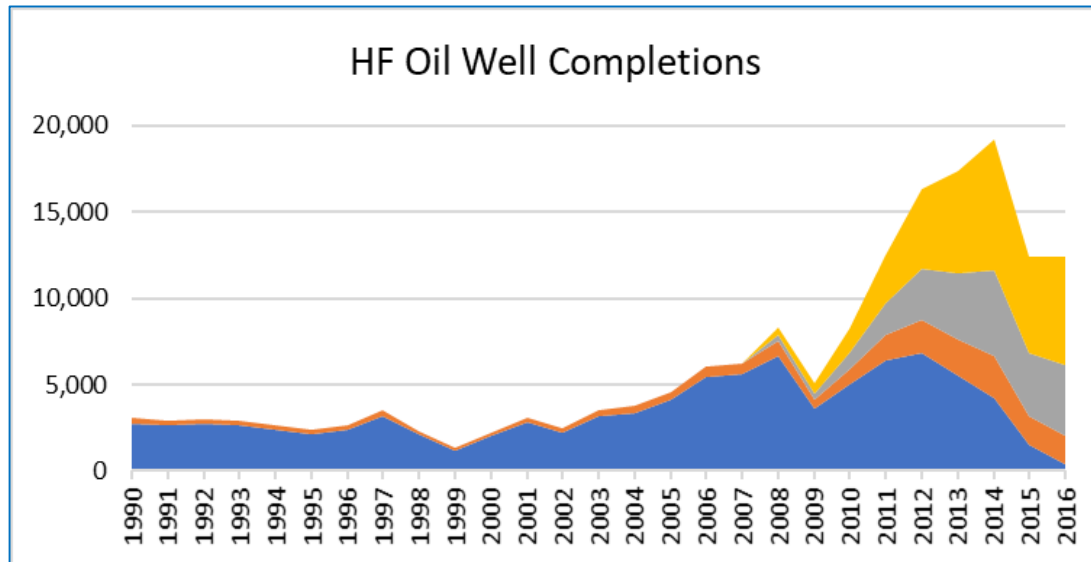
- Subpart W Activity Data, Year 2016

Event Type	Control Category	HF Completions				HF Workovers	
		2018 GHGI		Subpart W		Subpart W	
		# of Events	% of total	# of Events	% of total	# of Events	% of total
Non-REC	Vent	11,567	93%	111	3%	35	11%
	Flare			542	13%	16	5%
REC	Vent	871	7%	1,345	33%	186	56%
	Flare			2,061	51%	93	28%
<b>Total</b>		12,438	100%	4,059	100%	330	100%



# HF OIL WELL COMPLETIONS & WORKOVERS – UPDATES UNDER CONSIDERATION

- Apply parallel approach as used for gas well events in the GHGI
  - Incorporate current HF oil well-specific assumptions for control category split over the time series



- Separately consider improvements to national activity estimates (based on DrillingInfo data)

# HF OIL WELL COMPLETIONS & WORKOVERS – UPDATES UNDER CONSIDERATION (CONT.)

Preliminary National Activity and Emissions Estimates, Select Years

Data Element	1990	2000	2005	2010	2015	2016
HF oil well completions (#)	3,075	2,246	4,594	8,188	12,438	12,438
HF oil well workovers (#)	846	848	947	1,235	1,916	1,884
Total CH <sub>4</sub> emissions (kt)	128	101	180	222	95	46
<i>2018 GHGI CH<sub>4</sub> emissions (kt)</i>	<i>21</i>	<i>15</i>	<i>31</i>	<i>52</i>	<i>79</i>	<i>79</i>
Total CO <sub>2</sub> emissions (kt)	100	79	142	688	2,179	2,402
<i>2018 GHGI CO<sub>2</sub> emissions (kt)</i>	<i>1</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>4</i>

# HF OIL WELL COMPLETIONS & WORKOVERS – STAKEHOLDER FEEDBACK TOPICS

1. Using GHGRP data to develop EFs and AFs
2. How to consider regional and temporal variability in GHGRP data
3. How to establish AFs (control category splits) across the time series
4. How to apportion GHGRP data between gas and oil well events

***Refer to EPA memo to be posted online for additional detail***

# FLARING N<sub>2</sub>O EMISSIONS – UPDATES UNDER CONSIDERATION

- Flaring N<sub>2</sub>O emissions are not currently in GHGI
  - N<sub>2</sub>O from fuel combustion accounted for in the Energy chapter of the GHGI
- EPA is considering applying existing source-specific CH<sub>4</sub> methodologies to develop N<sub>2</sub>O EFs directly from GHGRP data
- EPA is also considering developing source-specific ratios of N<sub>2</sub>O:CO<sub>2</sub> from GHGRP data to estimate national total N<sub>2</sub>O emissions based on national total CO<sub>2</sub> emissions

# OTHER UPDATES UNDER CONSIDERATION

- EPA is reviewing available data including data for other sources to consider updates for the 2019 GHGI
  - Transmission pipeline blowdowns
    - Current methodology based on GRI/EPA 1996 study EFs
    - Newly reported to GHGRP in RY2016
  - LNG facilities
    - Current methodology based on GRI/EPA 1996 study EFs
    - Six years of GHGRP data available, at station- and compressor-level
  - Offshore production platforms
    - Current methodology based on 2011 GOADS data
    - Considering updates to EFs (e.g., using 2014 GOADS data) and activity data
- ***Refer to EPA memos to be posted online for additional details and specific stakeholder feedback requests***

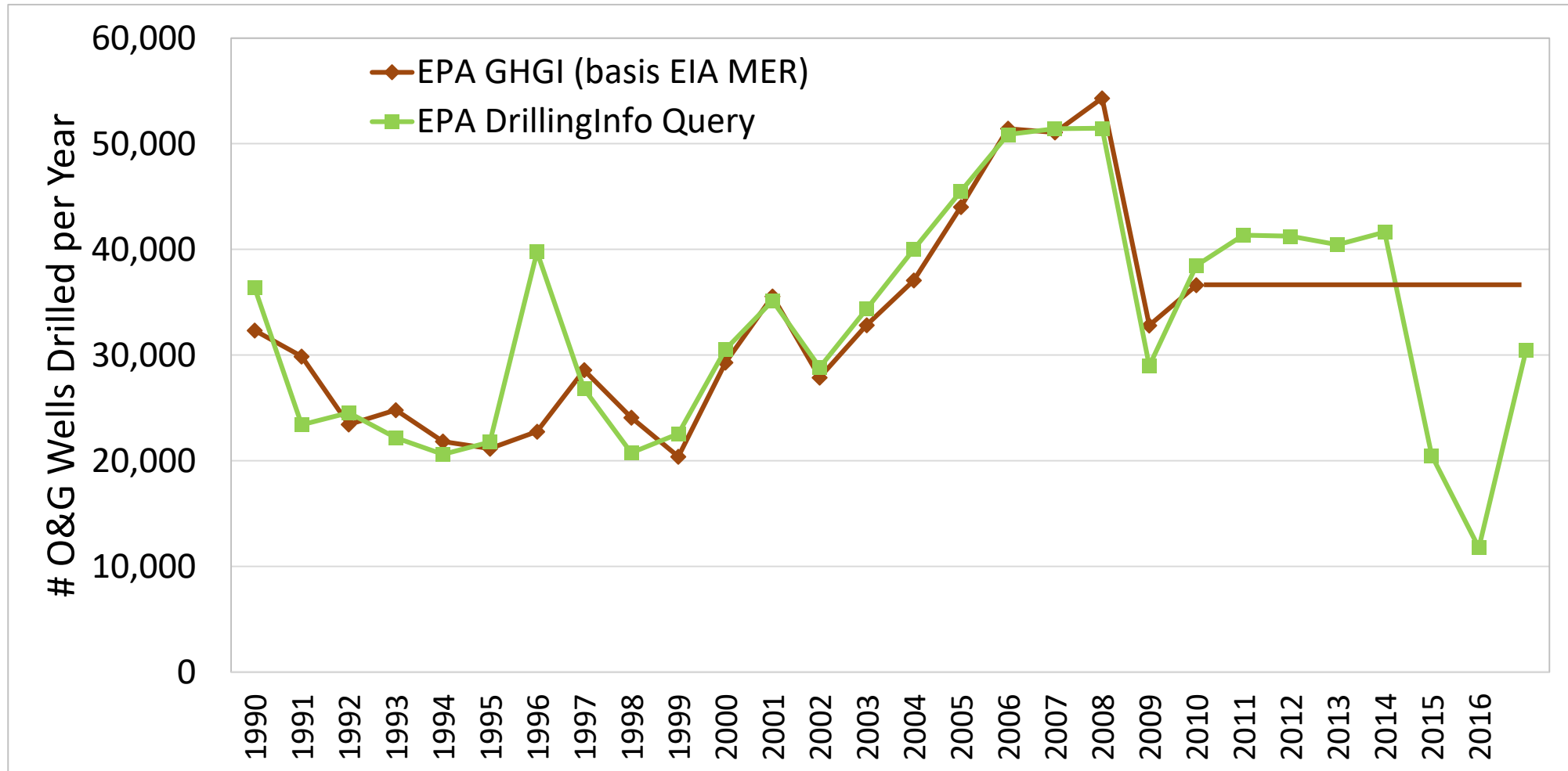
# UPDATES UNDER CONSIDERATION FOR 2019 GHGI

## TOPIC AREA 2: IMPROVING WELL- RELATED ACTIVITY DATA

# WELL DRILLING – UPDATES UNDER CONSIDERATION

- DOE/EIA no longer maintains the well drilling activity data set within its *Monthly Energy Review* publication (only covers through 2010)
- GHGI requires a new data source for the entire time series, or at least 2011 forward
- EPA is reviewing other EIA data sets and developing a methodology for querying the DrillingInfo data set
- DrillingInfo draft methodology: count all wells in time series year “N” with spud date within year “N” **or** blank spud date and first production within year “N+1”

# WELL DRILLING (CONT.) – PRELIMINARY NATIONAL ACTIVITY DATA ESTIMATES





# WELL COMPLETIONS AND WORKOVERS

- EPA is reviewing GHGRP data to consider its use in updated methodologies and/or to inform improvements (e.g., updating the DrillingInfo analysis methodologies)

Activity Data Element	Current Basis
Non-HF gas well completion counts	Scaled from base year 1992 counts (1996 GRI/EPA study)
Non-HF oil well completion counts	#Oil wells drilled (EIA) minus #HF oil well completions (DrillingInfo)
HF gas well completions	Subpart W as-reported counts
HF oil well completions	DrillingInfo analysis
Workover rates	<ul style="list-style-type: none"><li>• 1% for HF wells</li><li>• 4.35% for non-HF gas</li><li>• 7.5% for non-HF oil</li></ul>

# DEFINITION OF OIL VS. GAS WELL

- Current GHGI methodology based on DrillingInfo data analysis:
  - Active gas wells in a given year as any well in the DrillingInfo data set with a gas-to-oil ratio (GOR)  $> 100$  mcf/bbl in that year, and
  - Active oil wells as those with  $\text{GOR} \leq 100$  mcf/bbl
- Other industry data sets use different thresholds for defining oil versus gas wells
  - 6 mcf/bbl is another common threshold (used by EIA), based on energy equivalence (6 mcf  $\sim$  1 BOE)
- EPA is reviewing available data reported under GHGRP subpart W to evaluate how reported GOR values compare to the current GHGI methodology

# HEAVY VS. LIGHT CRUDE EQUIPMENT SERVICE

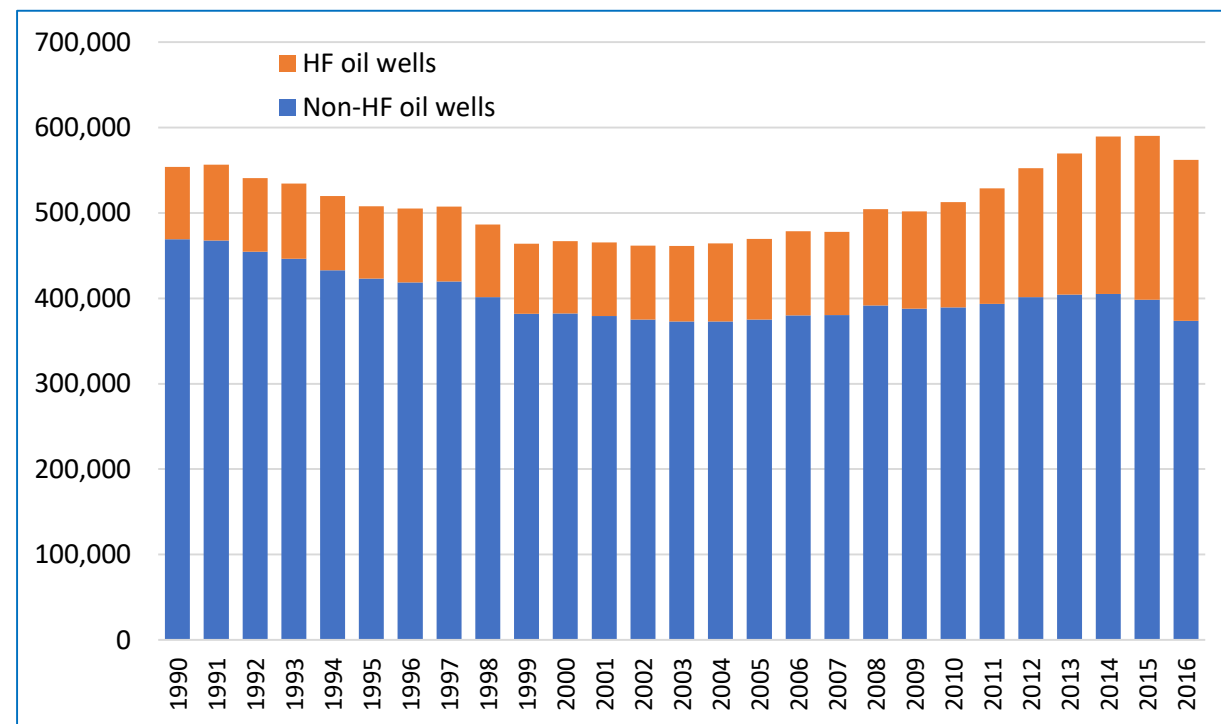
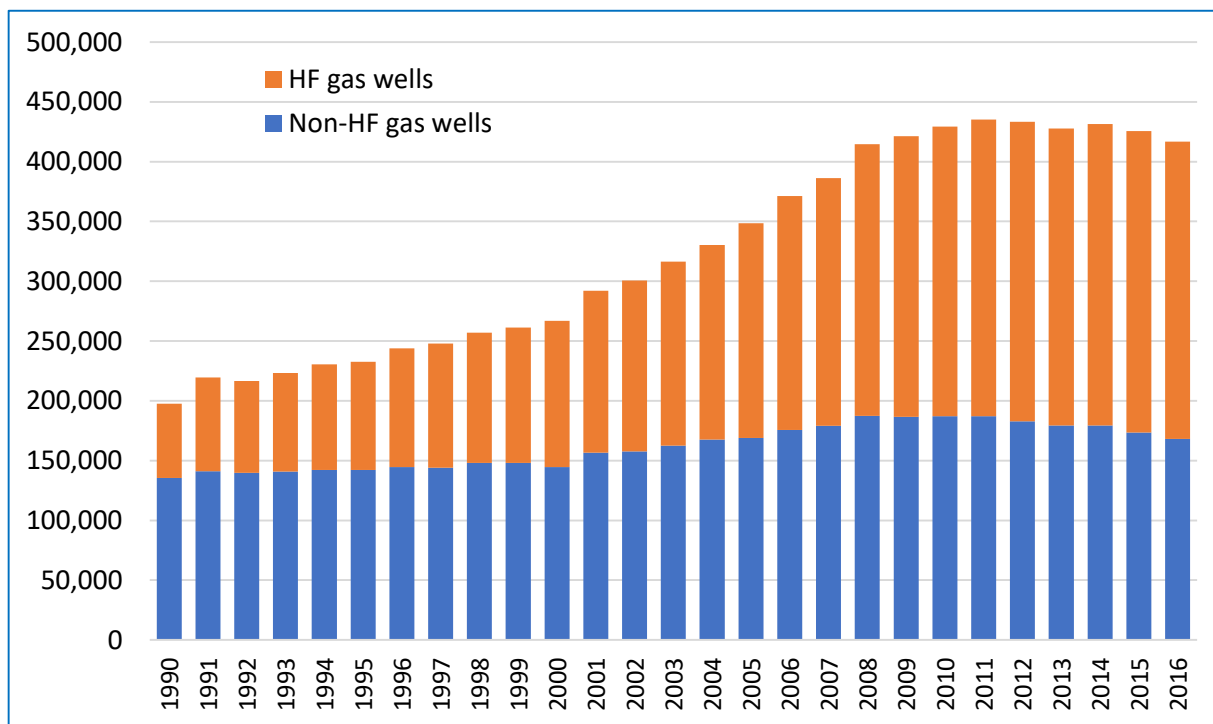
- The current GHGI uses separate EFs and activity data for wellheads, separators, and headers in heavy crude (<20° API gravity) versus light crude service
  - Current assumptions developed in the 1990's
  - 7% of oil wells produce heavy crude; 93% produce light crude
  - 10% of separators in heavy crude service; 90% in light crude service
- EPA is reviewing available subpart W data and considering other methodologies to updating assumptions to account for changing trends over time
  - Subpart W might be used to calculate crude type-specific activity factors (e.g., separators per heavy or light crude wellhead)
  - EPA might also analyze state-level data regarding heavy versus light crude production

# IDENTIFICATION OF HF WELLS

- The current GHGI methodology identifies HF wells as those horizontally drilled (based on DrillingInfo data) and/or located in a shale, low permeability, or coalbed formation
- EPA is identifying options to revise this methodology to improve accuracy and increase transparency
- In year 2016, EIA estimates 670,000 total active HF wells; the current GHGI estimates 440,000 HF wells

# IDENTIFICATION OF HF WELLS (CONT.)

## 2018 GHGI Active Gas & Oil Well Counts



# STAKEHOLDER FEEDBACK REQUESTS

- ***Refer to EPA memos to be posted online for additional details and specific stakeholder feedback requests***
  - Updates Under Consideration for Incorporating GHGRP Data
  - Updates Under Consideration for Improving Well-related Activity Data
- ***Additional stakeholder feedback***
- <https://www.epa.gov/ghgemissions/stakeholder-process-natural-gas-and-petroleum-systems-1990-2017-inventory>