Natural Gas & Petroleum Systems: Updates Under Consideration for 2023 GHGI

Stakeholder Webinar

September 15, 2022

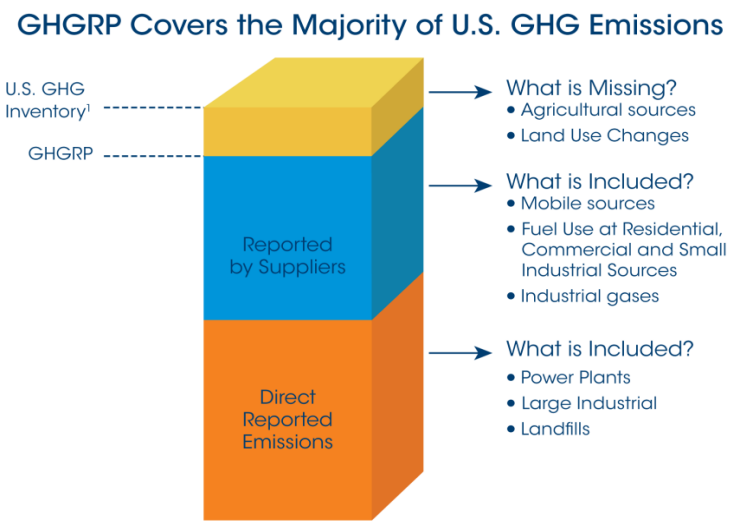
9/15 Stakeholder Webinar Agenda

- GHG Inventory Overview
- Overview of State-level GHGI and Gridded CH_4 GHGI
- Updates Under Consideration for 2023 GHGI
- DOE's Methane Measurement, Monitoring, and Mitigation R&D Program
- BOEM's GHG Inventory and Studies
- Wrap Up

GHG Inventory Overview

EPA GHG Data: U.S. GHG Inventory (GHGI) and GHG Reporting Program (GHGRP)

- Inventory of U.S. Greenhouse Gas Emissions and Sinks (GHGI), the U.S. official GHG Inventory submission to UNFCCC, tracks total annual U.S. emissions across all sectors of the economy, using mostly national-level data
- GHGRP collects detailed emissions data from large greenhouse gas emitting facilities in the United States, as directed by the Clean Air Act
  - GHGRP covers most, but not all, U.S. GHG sources and sinks (i.e., GHGRP does not include agriculture, land use, and small sources)



Task	Inventory of U.S. GHG Emission and Sinks	Greenhouse Gas Reporting Program
Find total U.S. emissions and sinks	✓	
Review trend data for the past 20+ years	✓	
Browse a map to find the largest emitters in your area		✓
Compare facility emissions across an industrial sector		✓
Find state-level data	Total ✓	Reported ✓

GHGI Overview

- **GHGI**
  - Official U.S. Government data on national GHG emissions and sinks over time by gas, source/sink, and economic sector
  - CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and NF_3
  - Fulfills U.S. reporting commitment under the UNFCCC
  - Covers a time series beginning with 1990
- **Oil and Gas in the GHGI**
  - IPCC fugitive emissions category; includes leaks, vents, and flaring emissions
  - Oil and gas in GHGI covers hundreds of types of emission sources
  - Emissions calculated using data from GHGRP, research studies, national level activity data, etc.

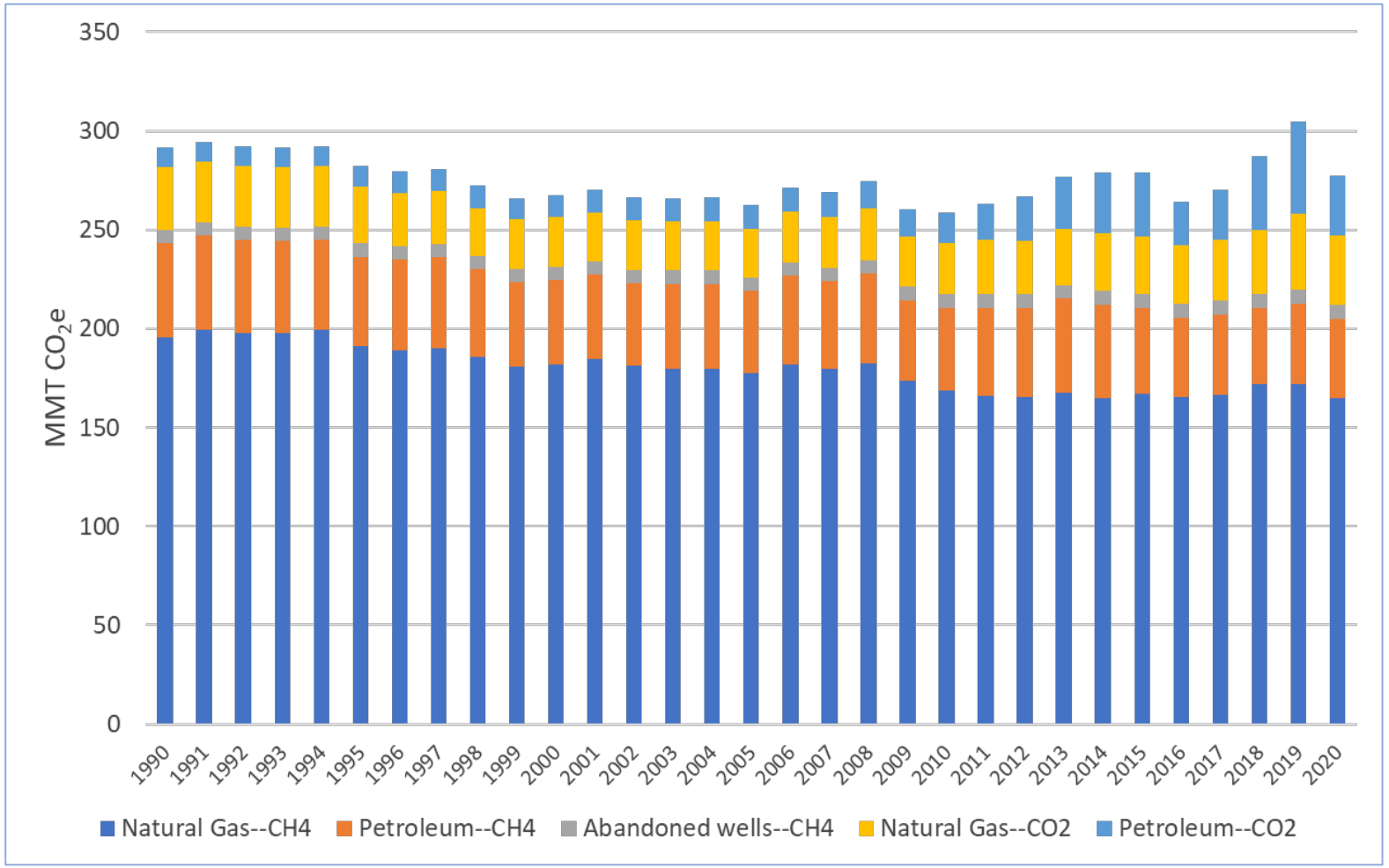
Trends in CH_4 and CO_2 Emissions from Oil and Gas Systems

1990-2020 Trends and Key Drivers

- CH_4-decrease of 15%
  - Distribution (upgrades to pipeline and stations)
  - Transmission and storage (changes in compressor types)
- CO_2-increase of 58%
  - Oil and gas production (increased flaring)

2019-2020 Trends and Key Drivers

- CH_4-decrease of 3%
  - Oil and gas production (decrease in emissions from pneumatic controllers)
- CO_2-decrease of 23%
  - Oil production (decreased flaring of associated gas)



EPA Oil and Gas GHGI Stakeholder Process

- Annual stakeholder process to discuss new data and improvements to GHGI data
- Typically hold two webinars/workshops in the development of each GHGI
- Stakeholder website

  (https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems)
  - Information on workshops and memos on updates under consideration
  - Full time series of data and information on methods

Previous Updates to GHGI

Year	Update
2022	Inclusion of post-meter estimates and large well blowouts, improved estimates for abandoned wells and voluntary reductions
2021	Updated data on customer meters and produced water
2020	Use of research study EFs for G&B equipment, use of BOEM and GHGRP data on offshore
2019	Use of GHGRP data for G&B and transmission pipelines, LNG, HF oil wells, N_2O emissions
2018	Inclusion of abandoned wells estimate, use of GHGRP for CO_2 and year-specific EFs
2017	Inclusion of Aliso Canyon estimate, GHGRP for processing, associated gas venting and flaring,
2016	Update to production (GHGRP), G&B emission estimate, transmission (GHGRP and research study), distribution (GHGRP and research study)
2015	Use of GHGRP for refineries, use of latest BOEM for offshore, update to well data source
2014	Use of GHGRP data for HF gas wells
2013	Use of API/ANGA data on liquids unloading, use of NSPS OOOO analysis for gas wells

Overview of State-level GHGI and Gridded CH_4 GHGI

GHGI State-Level Estimates

- New (first published 2022), fully disaggregated national GHGI across the 50 States for all gases, sectors, and categories
  - Ensure consistency with the national GHGI in terms of emission and removal totals across the time series, from 1990 to the most recent inventory year.
  - Annual updates on a regular schedule
- Support researchers, policymakers, and the general public
- Dataset should not be viewed as official data of any state government

https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals

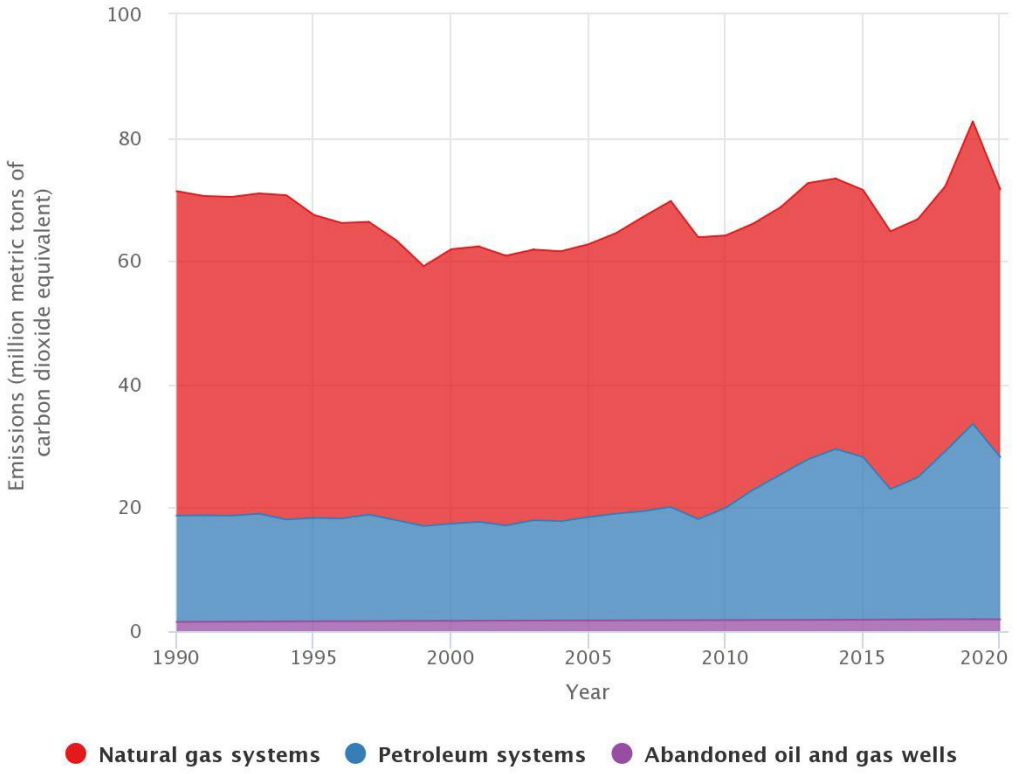
GHG State-Level Estimates for Oil and Gas

Approach to allocate emissions to state-level

- National GHGI emissions are allocated to each state using datasets with state-specific data that are used to represent the relative contributions of state emissions to the national total
  - e.g., state-specific well counts, pipeline miles, production
- Approach reflects state-variations for some sources
  - e.g., pipeline materials, number and types of wells
- Approach does not reflect certain other variation
  - e.g., differences in technologies and practices, impacts of state regulations

Example: Texas

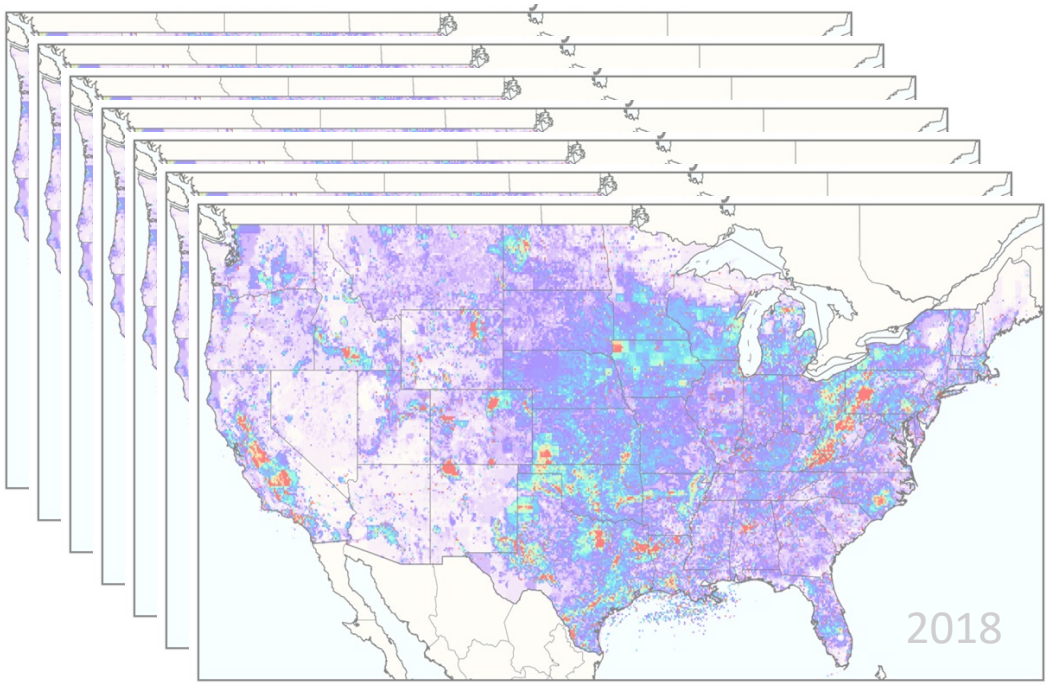
Texas Greenhouse Gas Emissions from Natural Gas and Petroleum Systems, by Category, 1990–2020



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990–2020. https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals

GHGI – Gridded Methane Emissions

- Spatially and temporally disaggregated version (~10 x 10 km, monthly resolution) of all methane emission sources in the GHGI
- Allows for more direct comparison between the GHGI and the time and location of atmospheric methane observations/emission rates
- Is used as a prior estimate for inversions of atmospheric methane



Version 1 – Published 2016

- Emissions for 2012
- Based on 2016 GHGI
- Research study effort

Version 2 – To be finalized 2022

- Timeseries (2012 - 2018)
- Based on 2020 GHGI
- Development of a system to streamline future updates

https://www.epa.gov/ghgemissions/gridded-2012-methane-emissions

IPCC 2019 Procedures for Comparison of Atmospheric Measurements with Inventories – Discrepancies

1. Confirm that the observation-based emission estimates and the inventories represent the same time period, areas
2. Determine what emission dataset was used as a prior, and how it compares to the emission inventory
3. Assess how the estimation procedure treats anthropogenic and natural emissions, to confirm that the estimates compare with anthropogenic and natural emissions included in the inventory
4. Confirm that seasonal variability of the emissions and other effects have been considered in the comparison
5. Assess the uncertainties of the estimated emissions and note whether the discrepancy is statistically significant
6. For sub-national scale regions with the larger discrepancies, determine which emissions activities are occurring there, based on the gridded or regional GHG inventory:
    a. Recheck inventory activity data in that region
    b. Assess factors that may make the regional emission rates different from the national inventory average (e.g., different regulations, different technologies), and assess the extent to which these have been taken into account in the national inventory and in its gridding/disaggregation
7. In the national inventory improvement plan, prioritize emission sources/regions with larger discrepancies

Update Under Consideration for 2023 GHGI: Incorporation of additional Basin- or State-Level data

Context for Update

- O&G GHGI emissions are generally estimated at the national level using emission factors and activity data at the national level
- For certain sources (i.e., associated gas venting and flaring, miscellaneous onshore production flaring), EPA calculates national emissions using basin-specific information
  - Over-representation or under-representation in GHGRP data by geographic regions where these sources occur more or less frequently would disproportionately contribute to national-level factors
- EPA Gridded Inventory and State Inventory generally rely on national-level average activity and emission factors and do not reflect geographic variation due to differences in formation types, technologies and practices, regulations, or voluntary initiatives

Update Overview

- EPA is considering updating the GHGI to develop emissions estimates using basin- or state-specific data from GHGRP subpart W
- Generally not expected to have a large impact on total national emissions
- The incorporation of this data will improve future versions of both the gridded and state-level inventories
- This will allow EPA to use the gridded inventory for improved comparisons with atmospheric observation studies (as regions will reflect the local differences in emissions rates as reported to GHGRP)
- In addition, this will allow the state-level inventory to more closely reflect state-level programs, formation type mixes, and technologies and practices

Details: Update Under Consideration

Incorporating Additional Geographically Disaggregated Data into GHGI

Update under consideration: Where appropriate, incorporate more disaggregated data into GHGI methodologies → develop basin/state emission factors (EFs) and activity factors (AFs) from subpart W data

Approach for each industry segment:

1. Examine the **variability** of the data at basin/state-level
2. Calculate the **coverage** of subpart W data for each basin/state
3. Consider the impacts of coverage and variability on national emissions

Background – Variability

Consideration: For each emission source, to what extent do emissions activities vary from basin-to-basin/state-to-state, such that national-level averages would not capture that variation

Assessment:

- Identified relevant emissions or activity comparisons by emission source to help assess variability in O&G emissions between basins/states
- Performed uniquely for each industry segment and source
- Examples:
  - Production: how do the number of pneumatic controllers per well vary across basins?
  - NG Processing: how do the average emissions per processing plant vary across states?

Background – Coverage

Consideration: Whether basin- or state-level EFs/AFs would more appropriately represent emissions than a national average

- e.g. if only 5% of a basin's activity is reported, would a basin-level EF be appropriate, versus use of a national average for that basin, due to limited data?

Assessment:

- Estimated the % of each region's O&G operations that subpart W represents, for each industry segment
  - Subpart W reporters are a subset of the national population due to reporting threshold

$$\%\ \text{Coverage}_{Region} = \text{Subpart W Activity}_{Region} \div \text{National Dataset Activity}_{Region}$$

  - Used GHGI national dataset, where possible

Background – Coverage (cont.)

- Considering whether to apply a coverage threshold
- E.g., for each emission source, could calculate emissions using:
  1. National-level factors
  2. Basin-/state-level factors for all basins/states
  3. Basin-/state-level factors for basins/states meeting certain coverage threshold and an average factor for others
- For this assessment, used 50% coverage threshold as an example

PRODUCTION

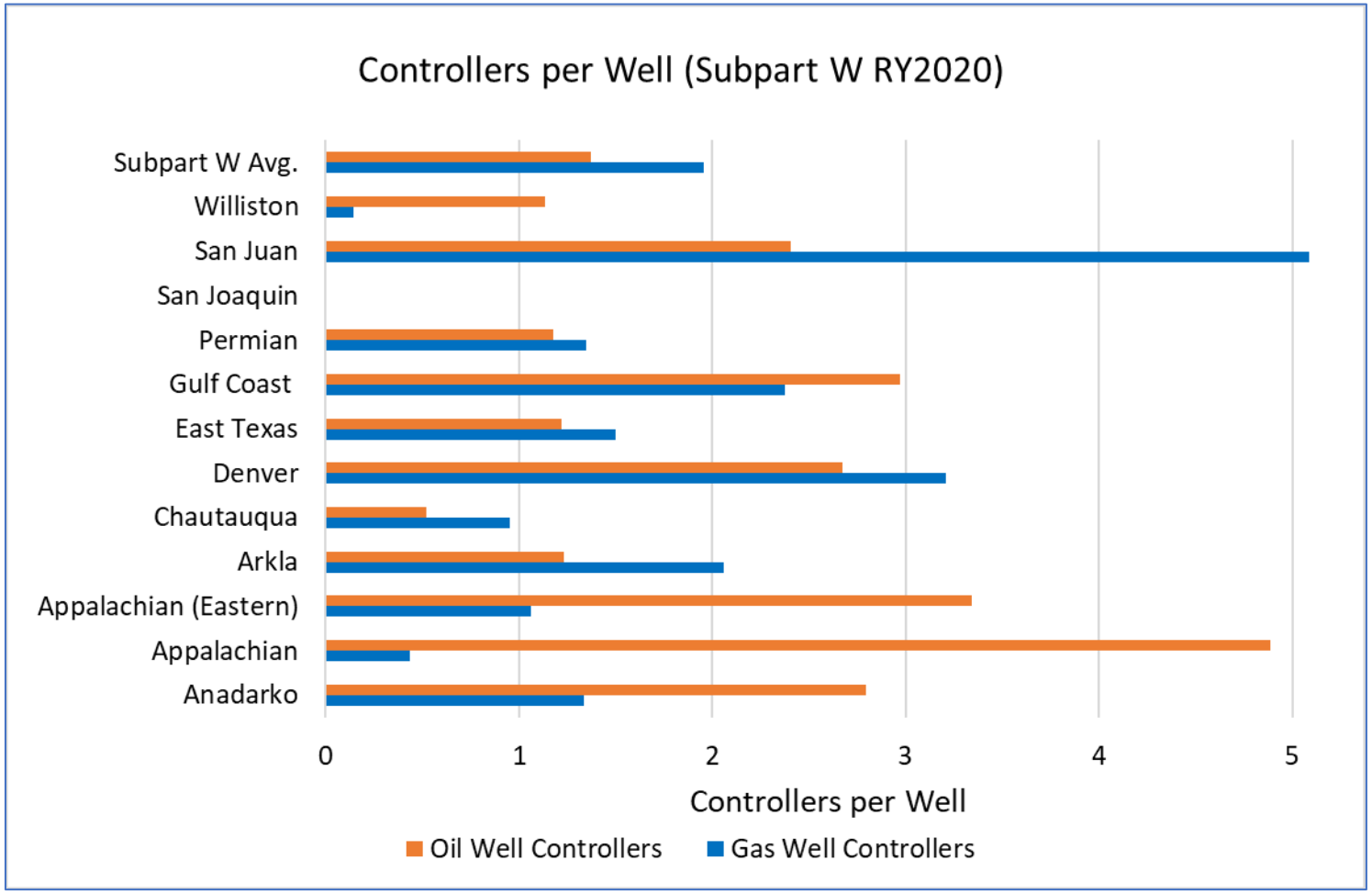
Examples: Pneumatic Controllers, Associated Gas, Equipment Leaks

Pneumatic Controllers Basin-Level Analysis

- Current GHGI methodology for pneumatic controllers
  - Activity: Use of year-specific GHGRP data to calculate fractions of low, high, and intermittent bleed controllers and controllers per well
    - Separate calculations are done for oil and gas well controllers
  - Emission Factor: Use of RY2014 GHGRP emissions per controller type
    - Same EFs applied for oil and gas well controllers
- Assessment of basin-level variability – Considered differences in both activity and emissions. *Controllers per well shown on next slide*

Pneumatic Controllers Basin-Level Analysis – Variability –

- Figure shows 12 basins with >20,000 wells (73% of total wells)
- Number of controllers per well shows significant variability across basins
  - e.g., far more controllers per well for gas wells in San Juan and oil wells in Appalachia
- This variability indicates basin-level calculations would take into account unique configurations of pneumatic controllers



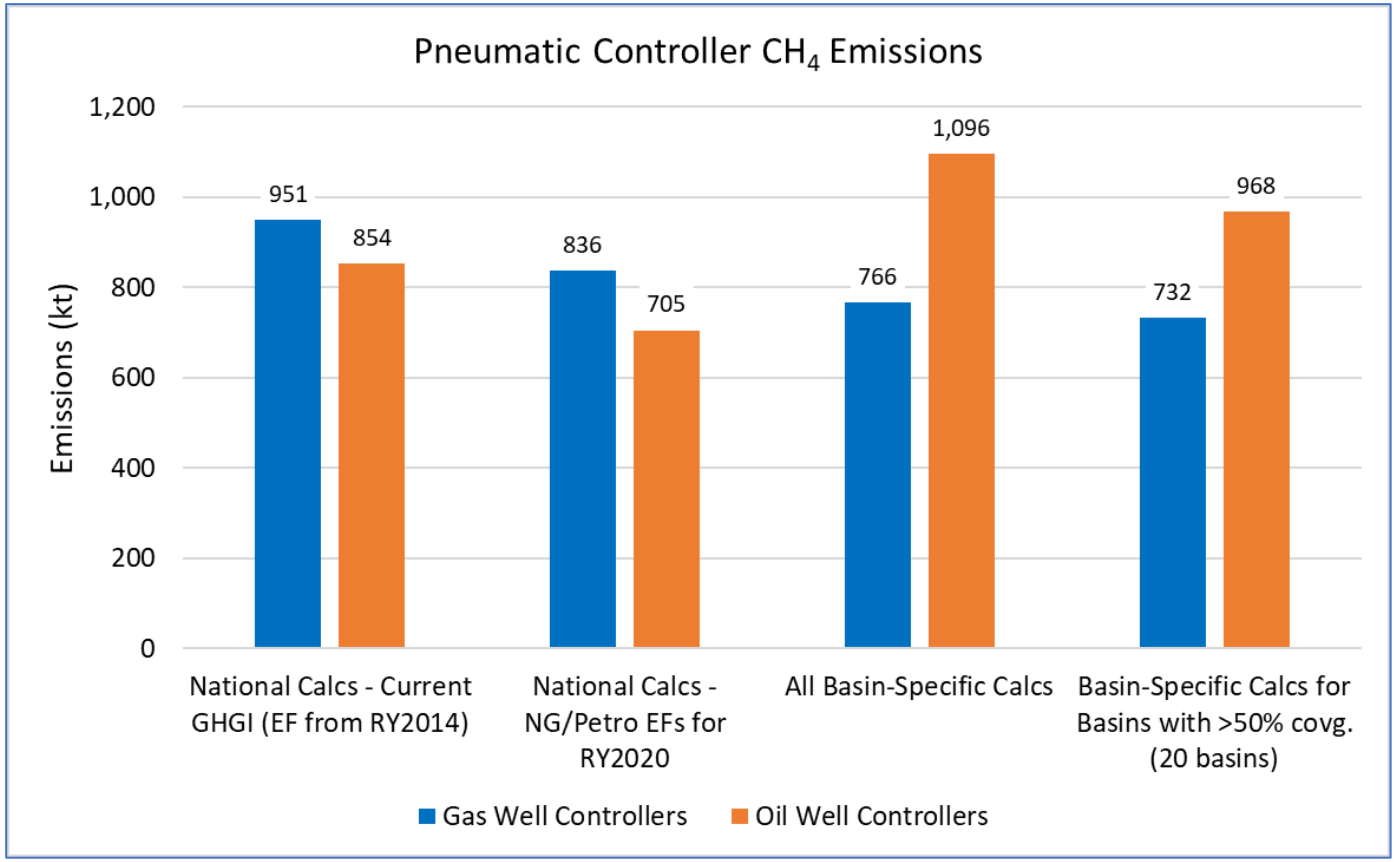
Pneumatic Controllers Basin-Level Analysis – Impact on Calculated Emissions –

Evaluated basin-specific calcs for:

- All basins
- Basins with >50% of total wells reported to subpart W

Compared to national, basin-specific calculations:

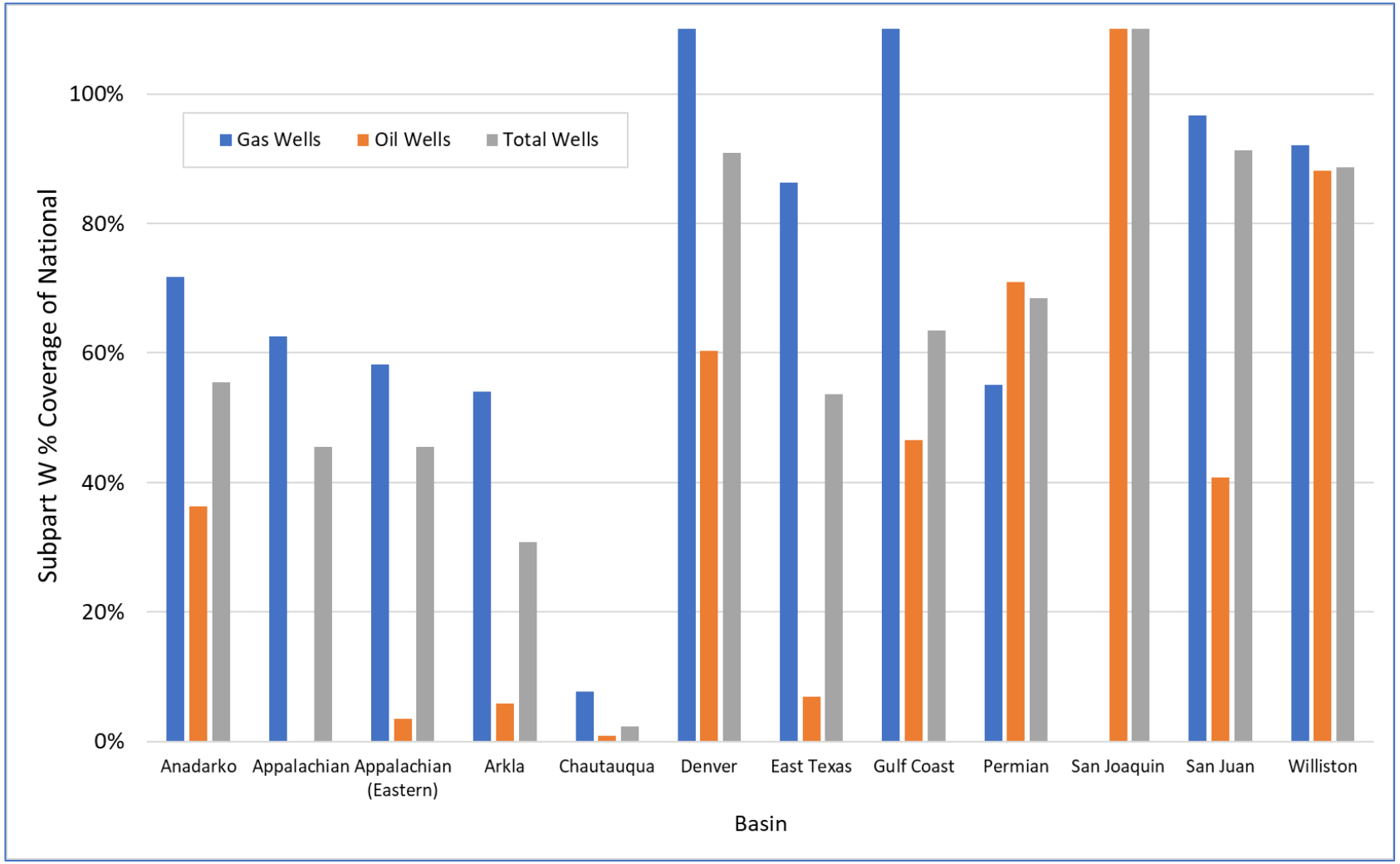
- Decrease gas well controller emissions
- Increase oil well controller emissions



Subpart W Well Coverage for Largest Basins

- Figure shows 12 basins with > 20,000 wells (73% of total wells)

Well Type	# Basins > 50% Covg.
All	8
Oil	4
Gas	10

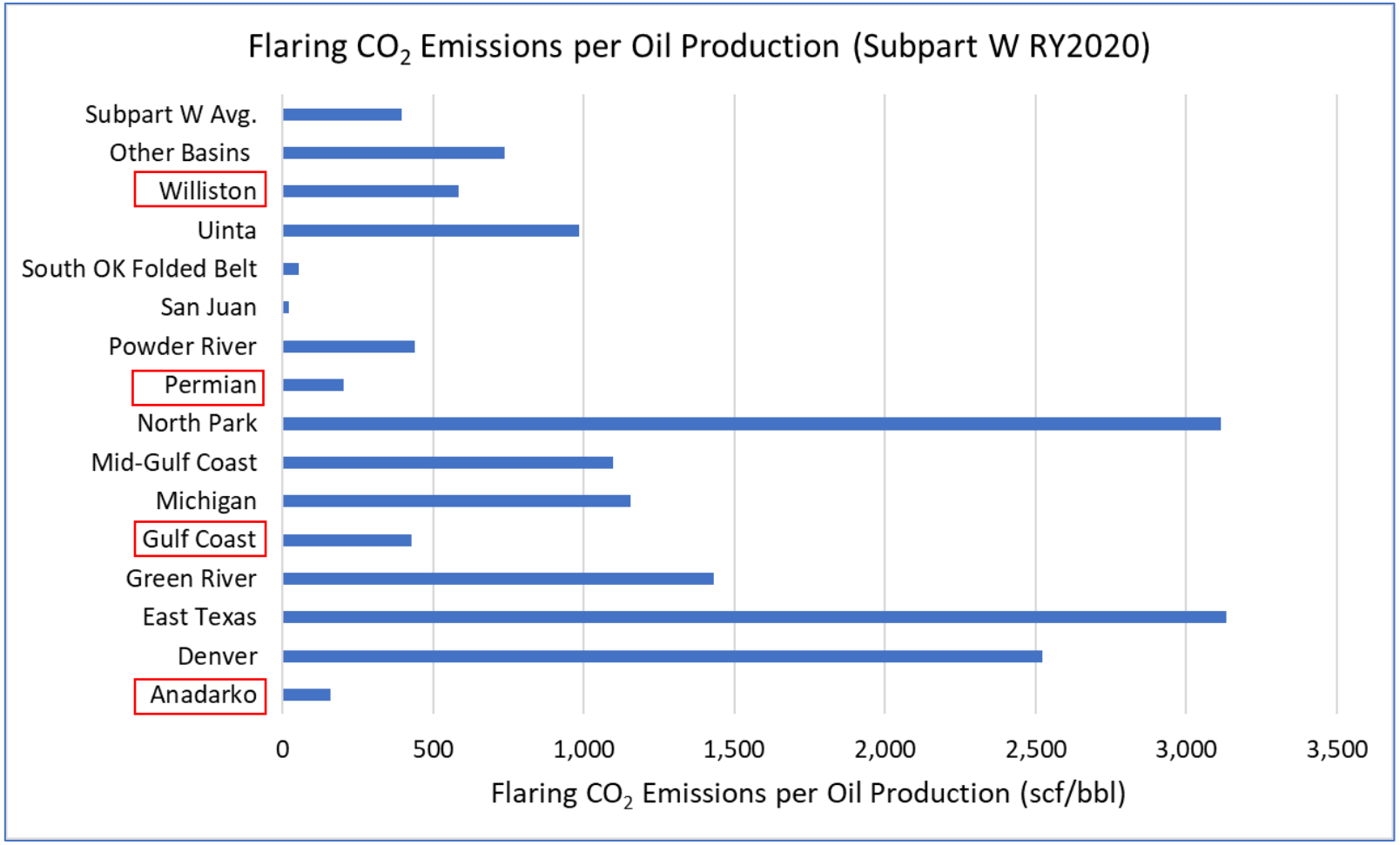


Associated Gas Basin-Level Analysis

- Current GHGI methodology for associated gas venting and flaring uses basin-specific calculations for four basins, and aggregates the remaining basins
  - 4 basins are Anadarko, Gulf Coast, Permian, and Williston
  - These basins each accounted for >10% of subpart W emissions (on a CO_2 eq. basis) in any year from 2011-2020
  - In 2020, cumulatively account for 96% of CO_2 eq. emissions
- Assessment of basin-level variability – Considered differences in flaring CO_2 emissions per oil production, *shown on next slide*

Associated Gas Basin-Level Analysis – Variability –

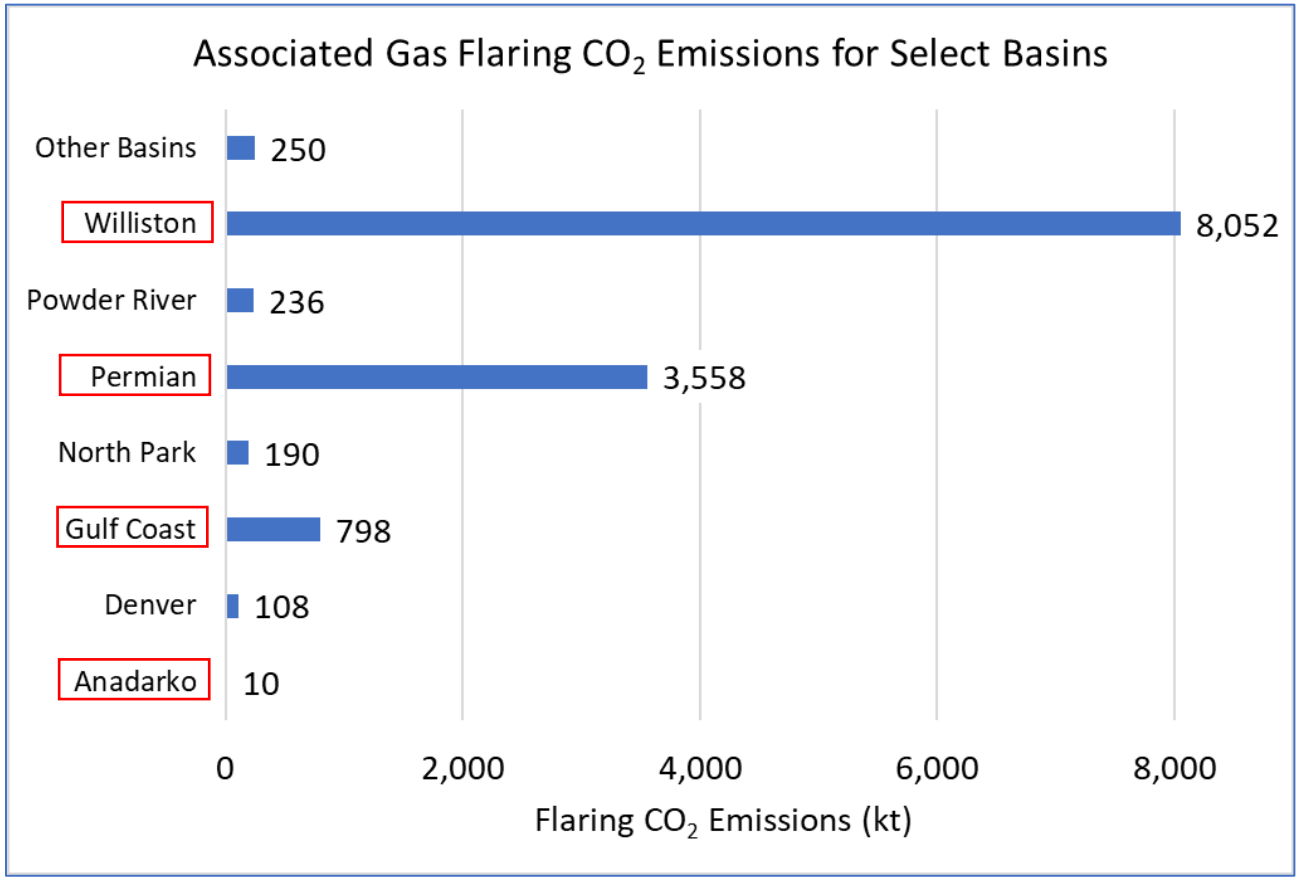
- Emission factor (flaring CO_2 emissions per oil production) shows significant variability across basins
- Activity factors also show variability; basins have very different % of oil production with associated gas
- This variability indicates basin-level calculations take into account unique operations for associated gas venting and flaring



Associated Gas Basin-Level Analysis – Impact on Emissions –

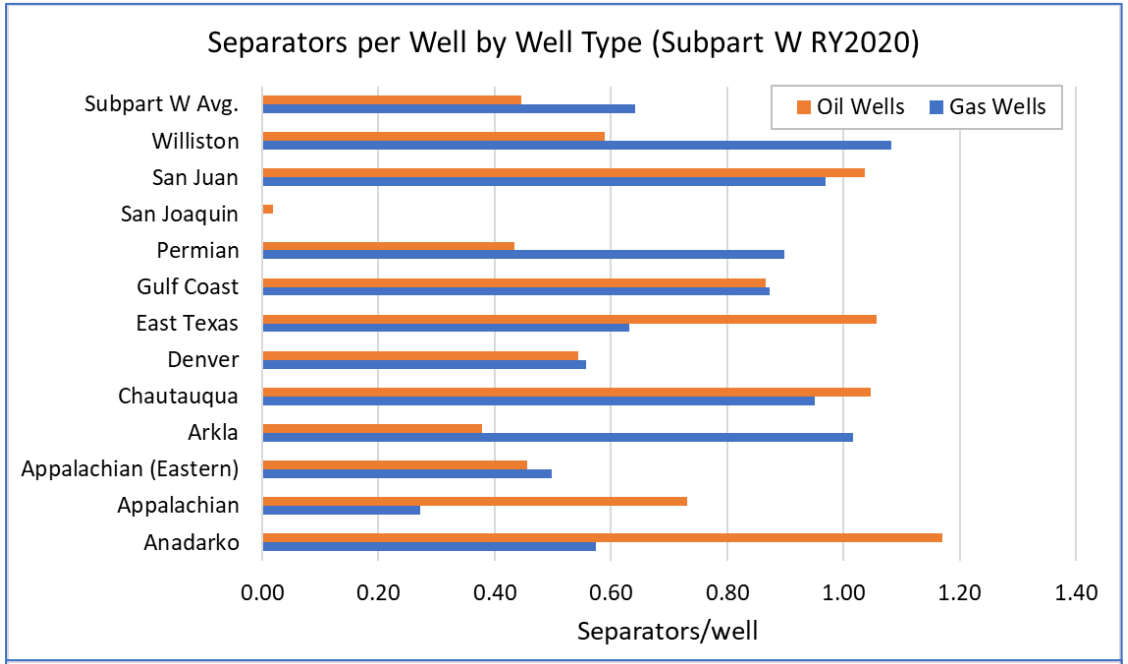
- Minimal impact on national emissions when including additional basins (regardless of coverage)
- Basin-level approach for current GHGI shows impact of regional calcs (i.e., national calcs are higher when all basins assumed to have similar operations)

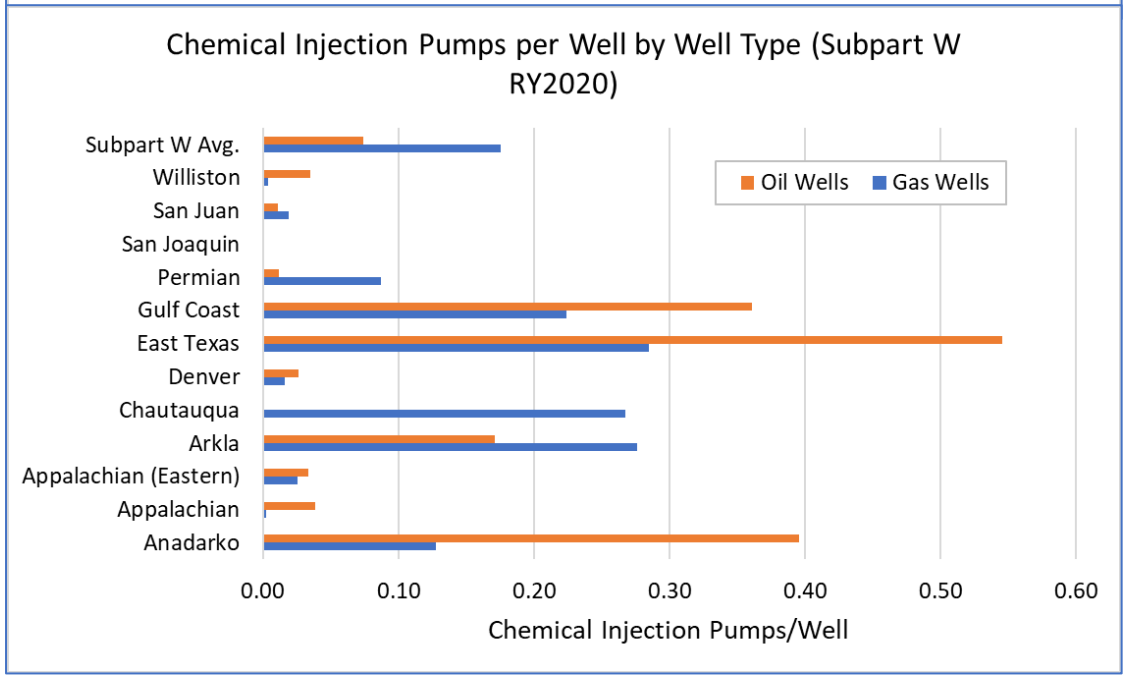
Option	Flaring CO2 Emissions (kt)	% Change from Current GHGI
Current GHGI	13,041	
All Basin-Specific Calcs	13,014	-0.2%
Basin-Specific Calcs for Basins with >50% Covg. (10 Basins)	13,201	1.2%
National-level Calcs	14,613	12%



Equipment Leak Basin-Level Analysis – AF Variability

- Figures shows 12 basins with > 20,000 wells (73% of total wells)
- Equipment counts per well vary across basins and by well type
- This variability indicates basin-level calculations would take into account unique configurations of equipment

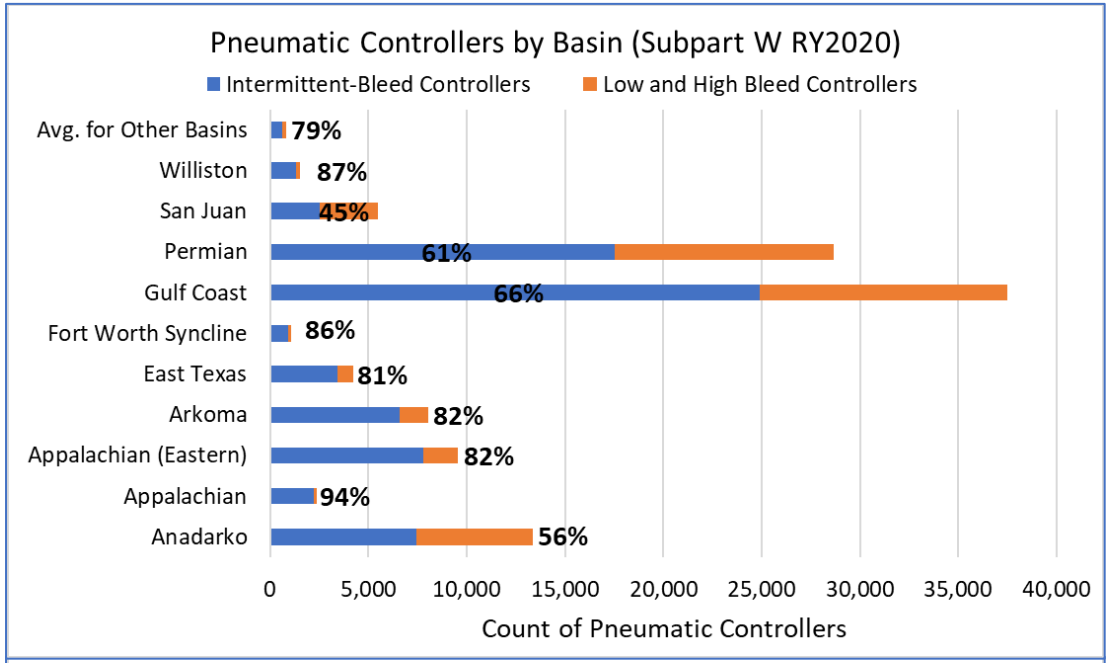


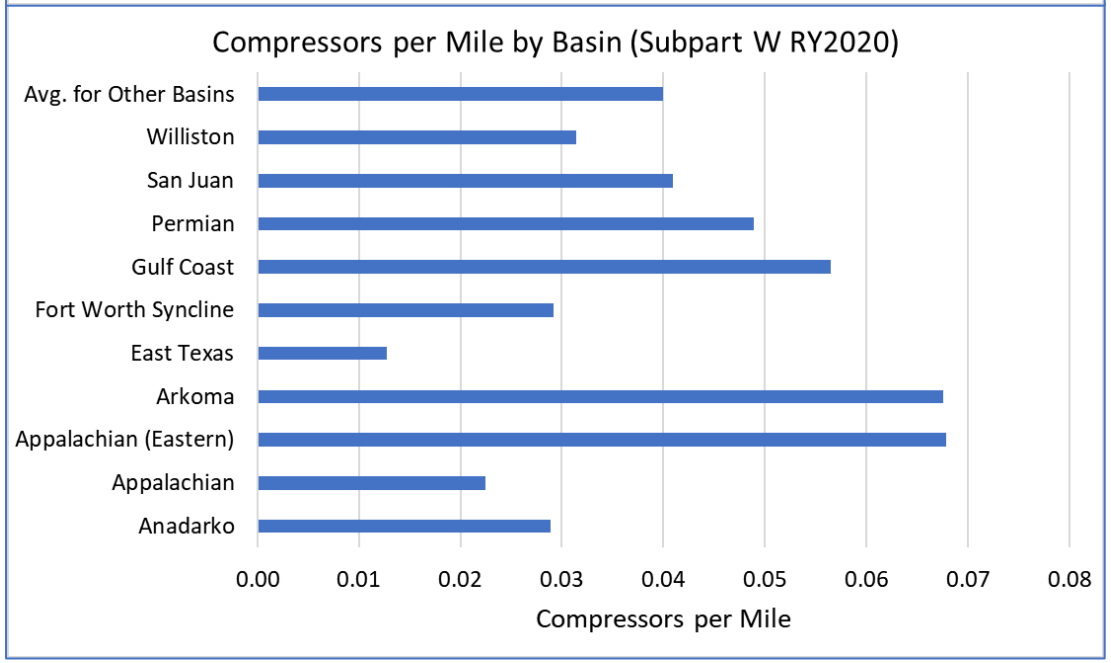


Variability Assessments:
- Gathering and Boosting
- Natural Gas Processing
- Transmission

G&B VARIABILITY

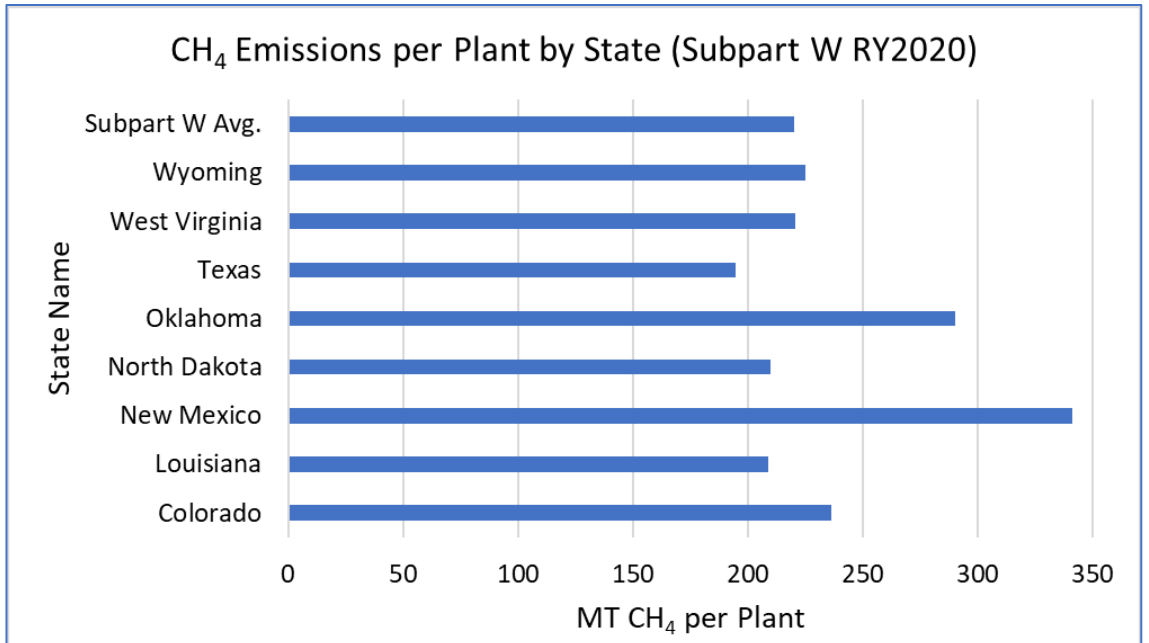
- Figures show 10 basins with most G&B activity
- The % of intermittent controllers varies across basins; range from 45% - 94% of all controllers
- Compressor activity factors (using gathering pipelines as reference) also show variability across basins

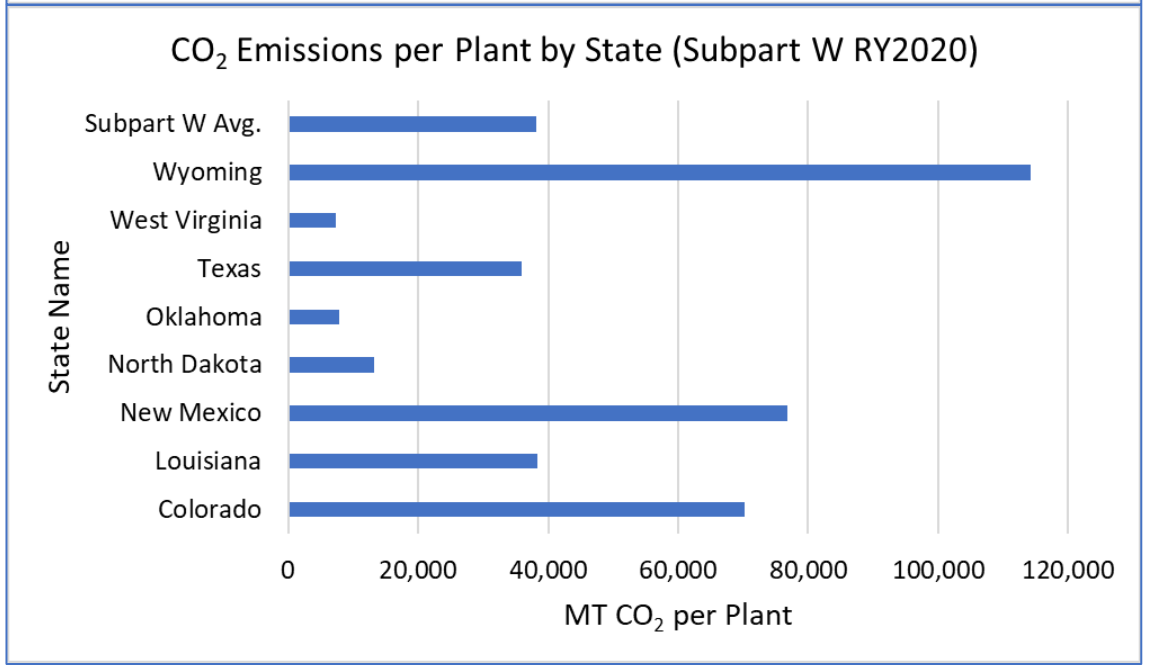




PROCESSING VARIABILITY

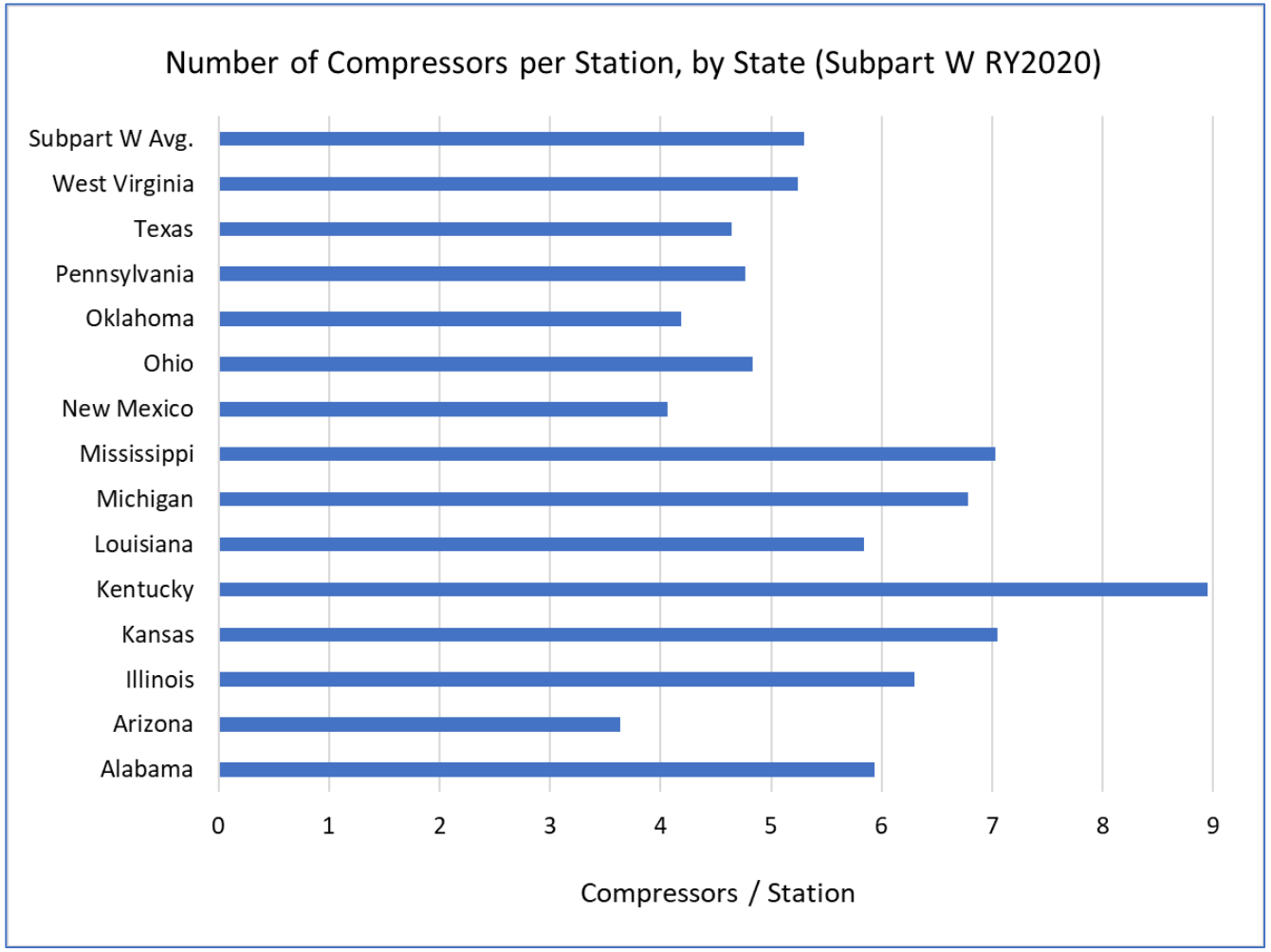
- Figures show 8 states with most plants
- Assessed average emissions per processing plant in GHGRP
- CH_4 emissions have minimal differences amongst states
- CO_2 emissions are highly variable





Transmission Variability

- Compared average number of compressors per station
- Some variability across states, but most states are around subpart W avg.
- Variability is not as significant as other industry segments



Next Steps and Stakeholder Feedback

Next Steps

- Update under consideration would focus on production
  - Would consider expanding to other segments for future GHGIs
- For 2023 GHGI, would assess basin-level calculations for additional production emission sources
- Basin or state-level calculations for other industry segments would be continually evaluated moving forward
  - Would depend on identifying national datasets with relevant regional data

Considerations for Segments Other Than Production

- Exploration—Gridded GHGI and State GHGI reflect region-specific completion and drilling counts, EFs are national
- Gathering and Boosting—GHGI uses national emissions factors; GHGRP activity data
- Processing—Limited variation in CH_4 emissions but significant variation in CO_2 emissions between regions
- Transmission and Storage—Regional EFs unavailable in GHGI data set; lower GHGRP coverage than other segments (limited regional data)
- Distribution—Gridded GHGI and State GHGI reflect region-specific pipeline materials, regional EFs unavailable in GHGI data set for other distribution sources
- Post-meter—Regional EFs unavailable
- Refineries—Gridded GHGI and State GHGI already reflect differences (use GHGRP data directly)

Requests for Stakeholder Feedback

- General feedback on the use of an approach that incorporates additional basin or state-level calculations
- Sources that might be prioritized for moving towards a basin or state-level approach
- Whether a coverage threshold should be considered
- Considerations for basins for which relatively few companies report data to GHGRP
- Approaches for basins with relatively low GHGRP coverage

Wrap-Up

Providing Stakeholder Feedback

- EPA memos will be posted online with additional details and specific stakeholder feedback requests
- https://www.epa.gov/ghgemissions/stakeholder-process-natural-gas-and-petroleum-systems-1990-2021-inventory

- Submit feedback via email: GHGInventory@epa.gov

- Next stakeholder webinar will be held in November
  - EPA invites stakeholders to present on data or other information relevant to the EPA GHG data for oil and gas
  - To request or present at the workshop, please contact ghginventory@epa.gov with information on the topic area for the presentation