# Methane Emissions in the Natural Gas Life Cycle and Implications for Power Generation: Update on Emission Studies

Presentation for the Western Interstate Energy Board

March 17, 2015

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# Key Takeaways

- Recent bottom-up studies of emissions from natural gas systems have reinforced the idea of a “fat-tail” issue where a small percentage of sources are responsible for a large percentage of emissions
- EPA continues to refine the GHG Inventory to reflect reported data and recent studies, while source contributions have changed, total emission estimates have remained fairly steady across recent inventories
- Recent top-down studies highlight significant regional variability which could contribute to the disparity between bottom-up approaches and earlier top-down studies
- Natural gas combined cycle power plants have about half the life cycle greenhouse gas emissions of coal-fired power plants

# Estimating Fugitive and Vented Methane Emissions

Bottom-up Studies

- Direct measurements of emissions at the device or facility level are used to develop emission factors
- Inventories based on emission factors and activity data
- Life cycle assessments based on inventories and measurements

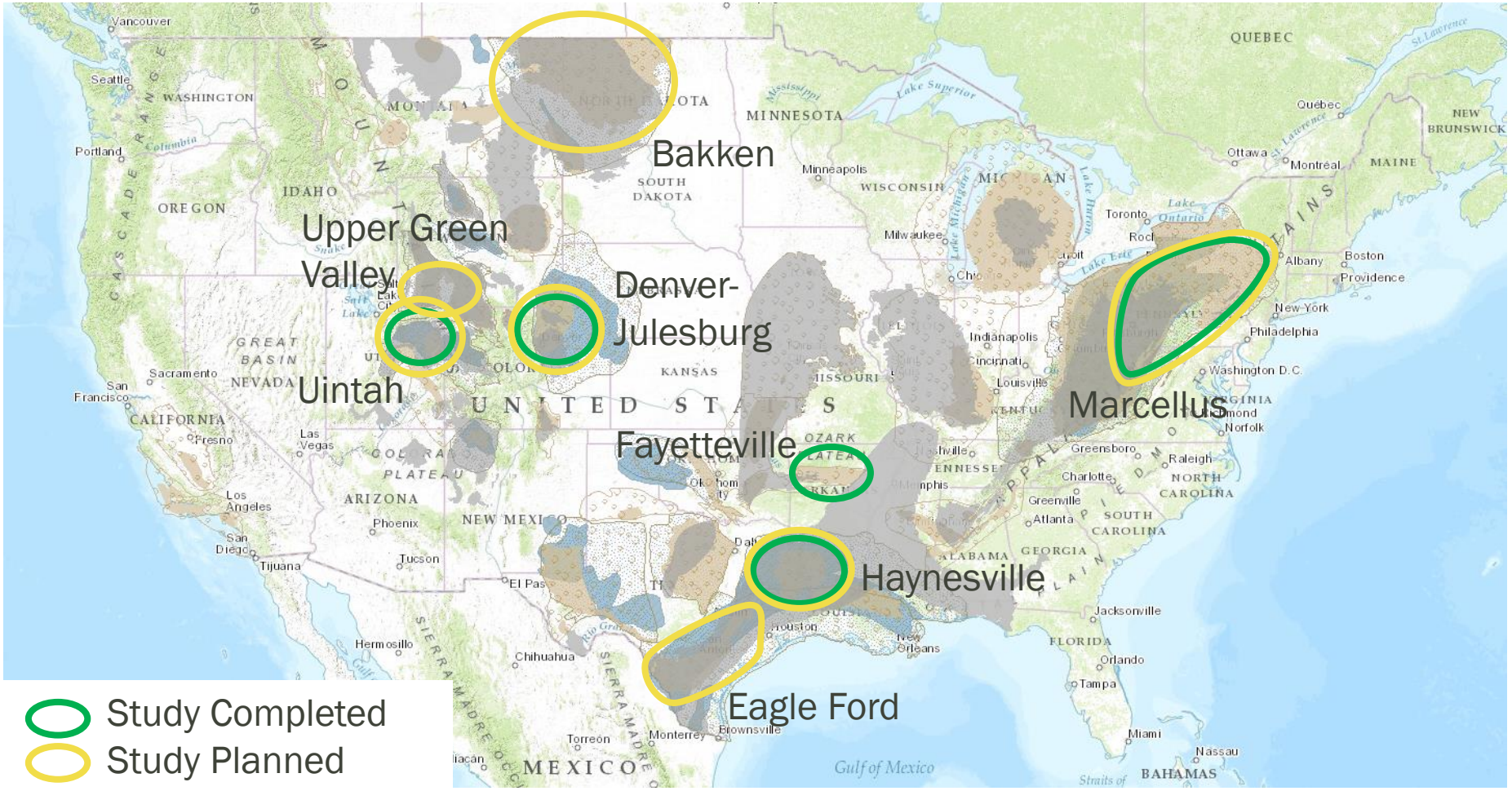
Photo Source: EPA Gas STAR
(http://www.epa.gov/gasstar/documents/workshops/buenosaires-2008/dim.pdf)

Top-down Studies

- Measurements of emissions at facility to national scales, typically take at a location remote from individual pieces of equipment

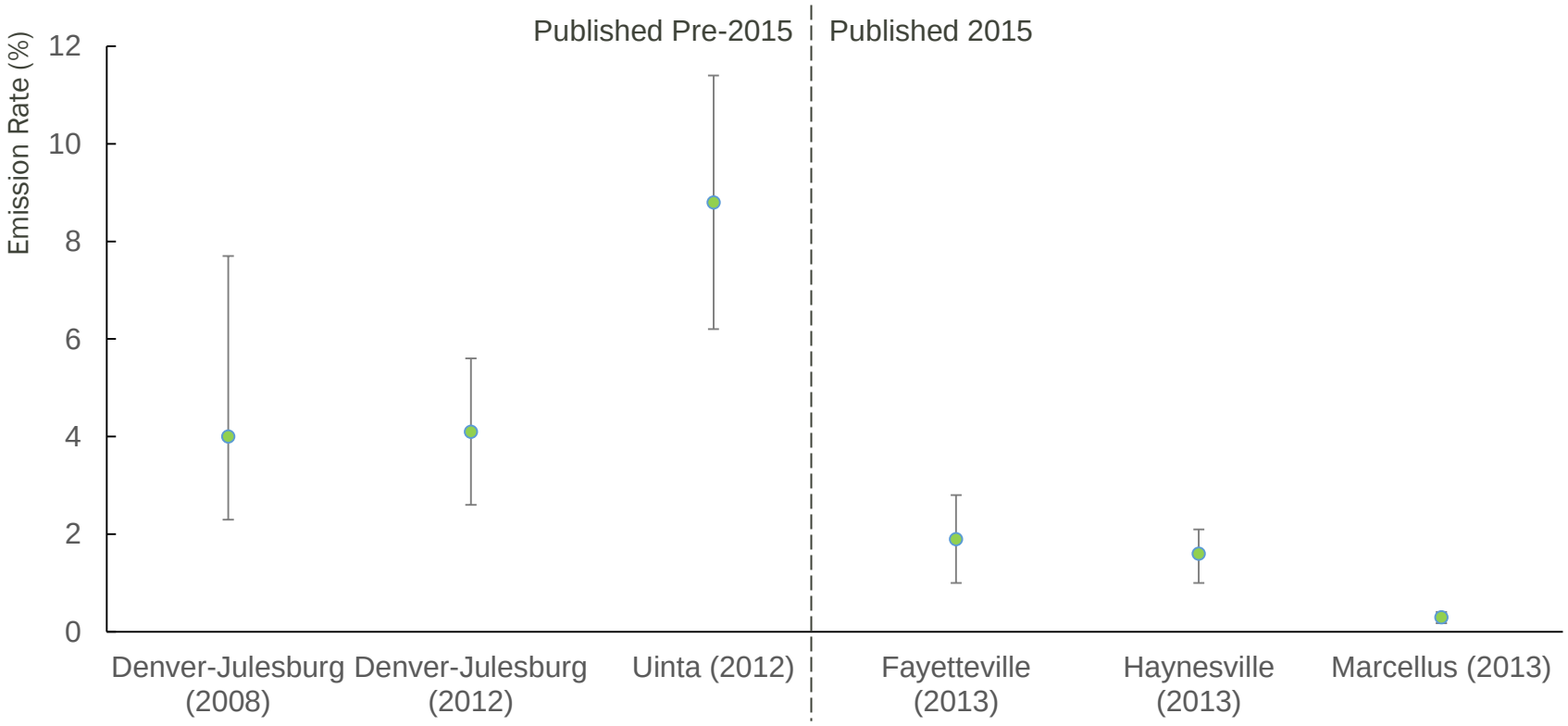
Photo Source: CIRES/NOAA
(http://cires.colorado.edu/news/press/2013/methaneleaks.html)

# NOAA-led Top-down Methane Measurement Studies

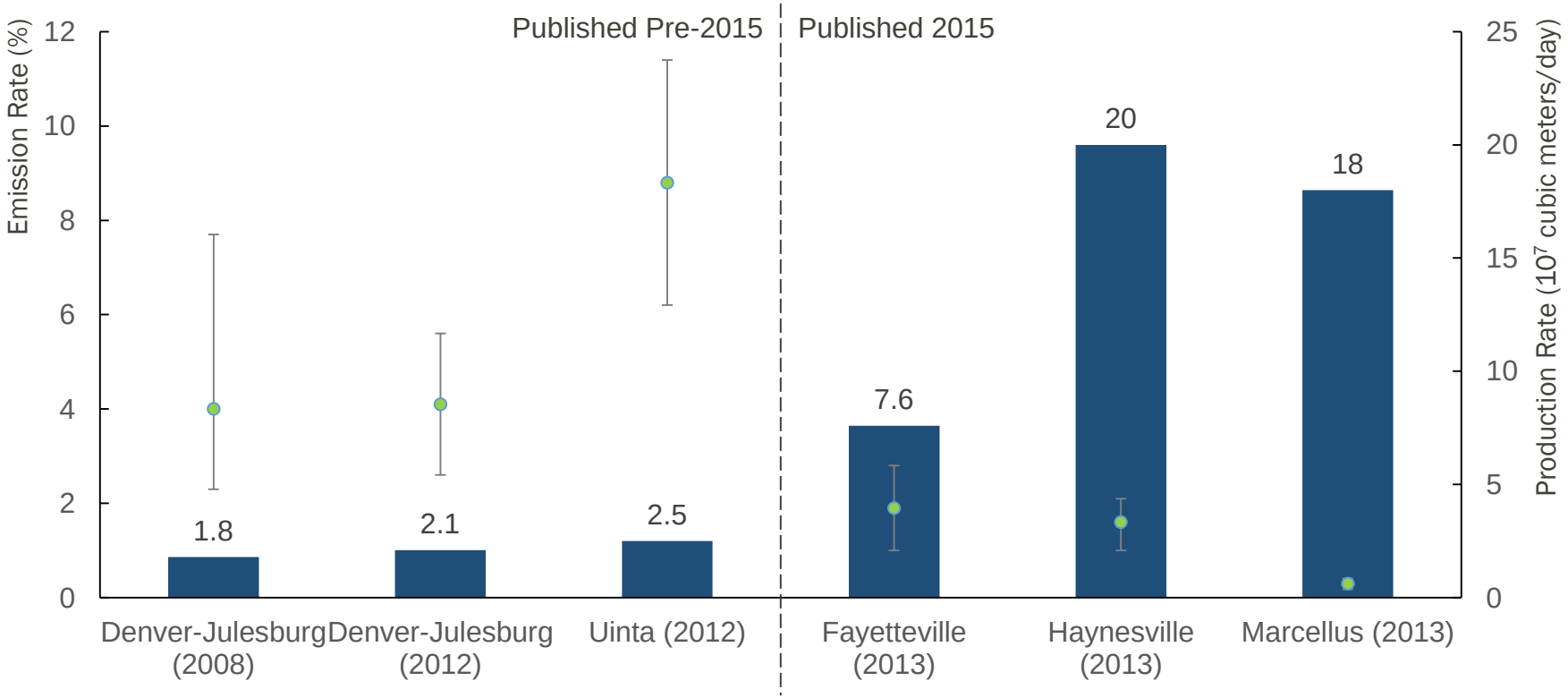



Source: EIA, MJB&A Analysis

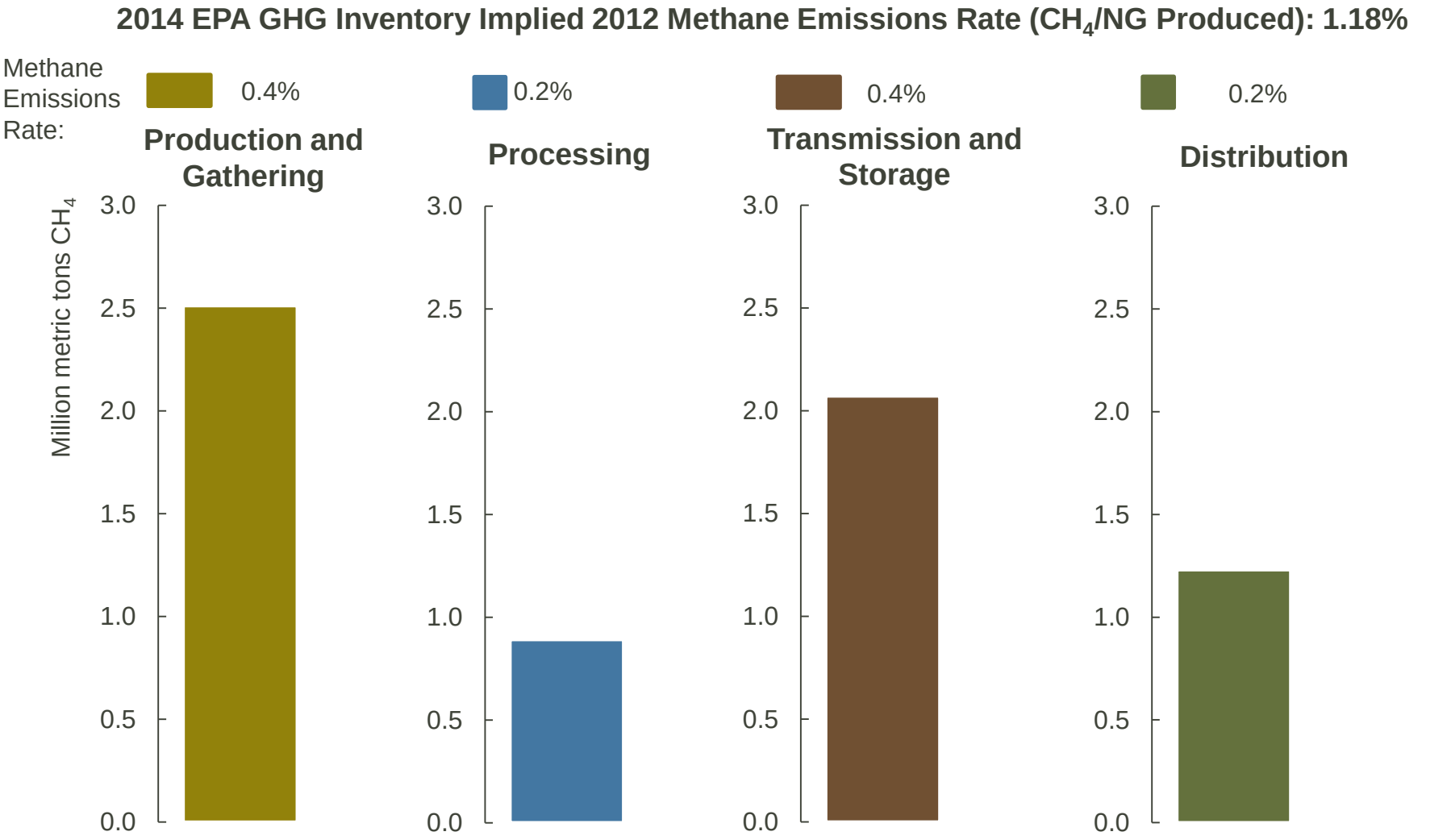
# Top-down Study Estimated Emission Rates



# Basin Emission and Production Rates



# Natural Gas System Emission Sources by Segment




Source: MJB&A analysis, EPA 2014 GHG Inventory, EIA Total U.S. Gross Natural Gas Withdrawals

# Continued Progress on Bottom-Up Studies

| Segment | Component/Activity | Direct Emissions Measurements | Scaled to National Emissions | Notes |
|---|---|---|---|---|
| Production & Gathering | Well completions and workovers | ✓ | ✓ | Allen et al. Phase I |
| | Pumps and other equipment leaks | ✓ | ✓ | Allen et al. Phase I |
| | Pneumatic controllers | ✓ | ✓ | Allen et al. Phase I & II |
| | Liquids Unloading | ✓ | ✓ | Allen et al. Phase I & II |
| | Gathering facilities | ✓ | | National estimate comparison in review |
| Processing | Processing plants | ✓ | | National estimate comparison in review |
| Transmission & Storage | Compressors | ✓ | | National estimate comparison in review |
| Distribution | Distribution networks | | | City mapping data released, direct measurements forthcoming |

✓ = Study published

# Consistent Themes from Bottom-Up Studies

- **Emission factors used by EPA and others should be updated**
  - Some should be adjusted up, others down
  - Despite changes in specific emission factors, overall inventory appears to be consistent with released studies
- **Site-level emission rates are skewed, with a small number of sources contributing a large percentage of overall emissions**
  - Findings of “superemitters” across the studies
- **Evidence of regional variability with sources emitting at different rates in different regions**
- **Accuracy of EPA’s GHG Reporting Program could be improved by increasing direct measurement**

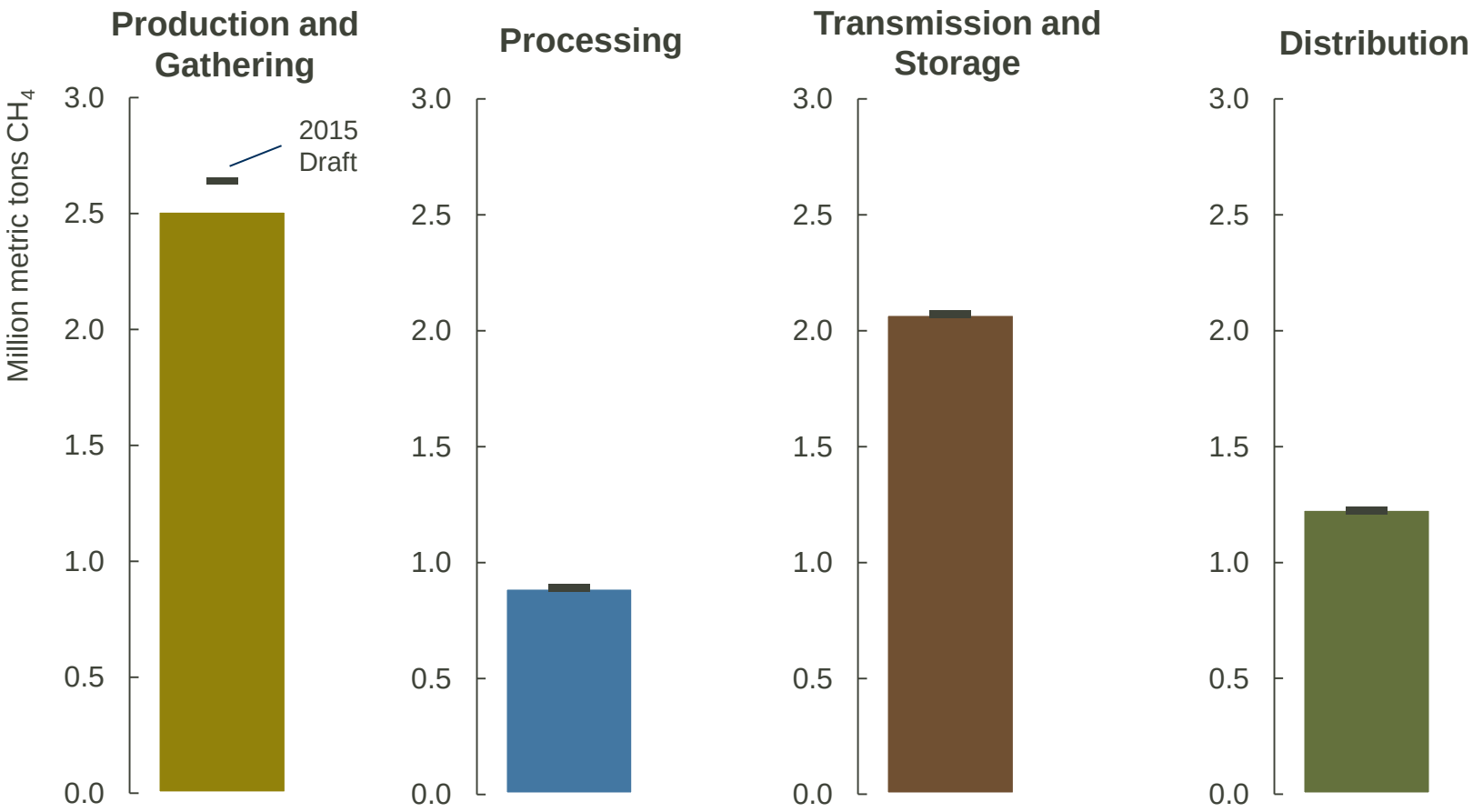
# Recent Production Studies Compared to Inventory

**2012 Production Emissions Across Inventories (thousand metric tons $CH_4$)**

| Emissions Source | UT Austin Studies | 2014 GHG Inventory | 2015 GHG Inventory (Draft) |
|---|---|---|---|
| **Flowback from Hydraulically Fractured Wells** | **24** | **217** | **138** |
| Chemical Pumps | 73 | 65 | 63 |
| **Pneumatic Devices** | **600** | **334** | **653** |
| Liquids Unloading | 270 | 274 | 267 |
| Other Sources | 1,218 | 1,102 | 991 |
| Total EPA Production Emissions | 2,185 | 1,992 | 2,112 |
| **Leak Rate ($CH_4$/ NG produced)** | **0.38%** | **0.35%** | **0.37%** |

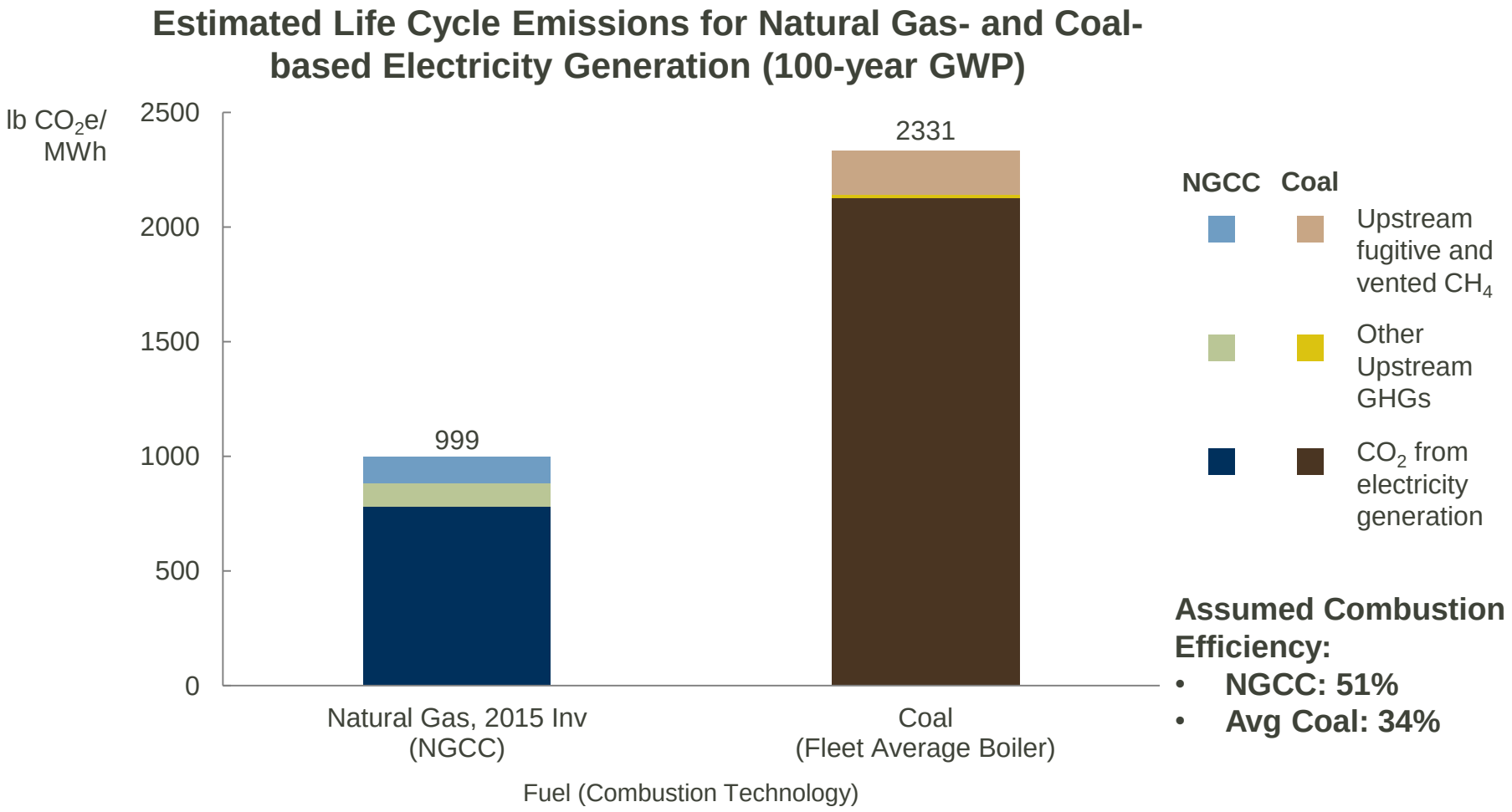
# Natural Gas System Emission Sources by Segment

**2014 EPA GHG Inventory Implied 2012 Methane Emissions Rate ($CH_4$/NG Produced): 1.18%**
**2015 EPA GHG Inventory Implied 2012 Methane Emissions Rate ($CH_4$/NG Produced): 1.20%**




Source: MJB&A analysis, EPA 2014 GHG Inventory, EIA Total U.S. Gross Natural Gas Withdrawals

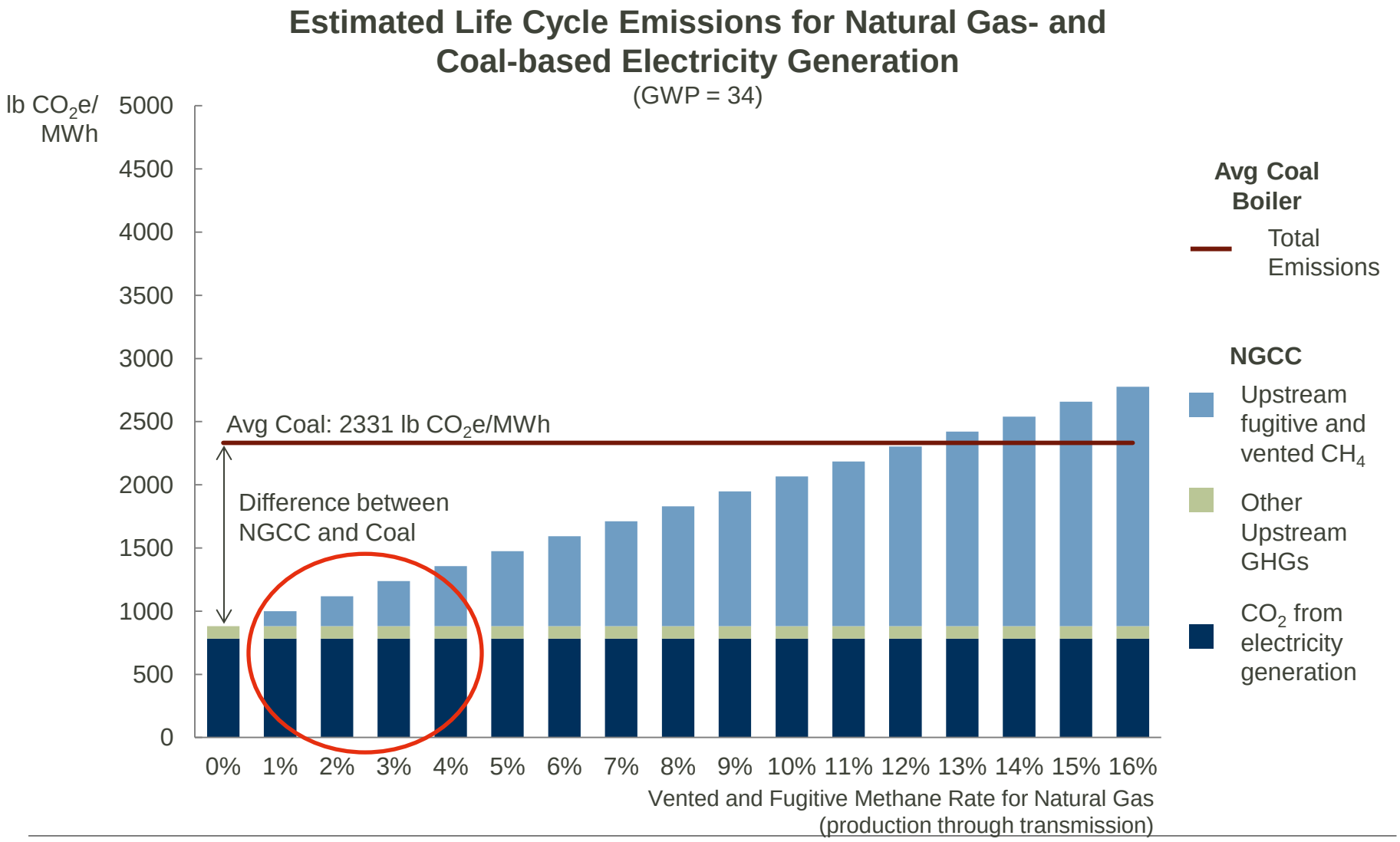
# MJB&A Life Cycle Assessment




GWP=34; "Natural Gas, 2014 Inv" based on 2014 EPA GHG Inventory less distribution segment emissions.

# Life Cycle Emissions at Different Emission Rates

## 100-year GWP



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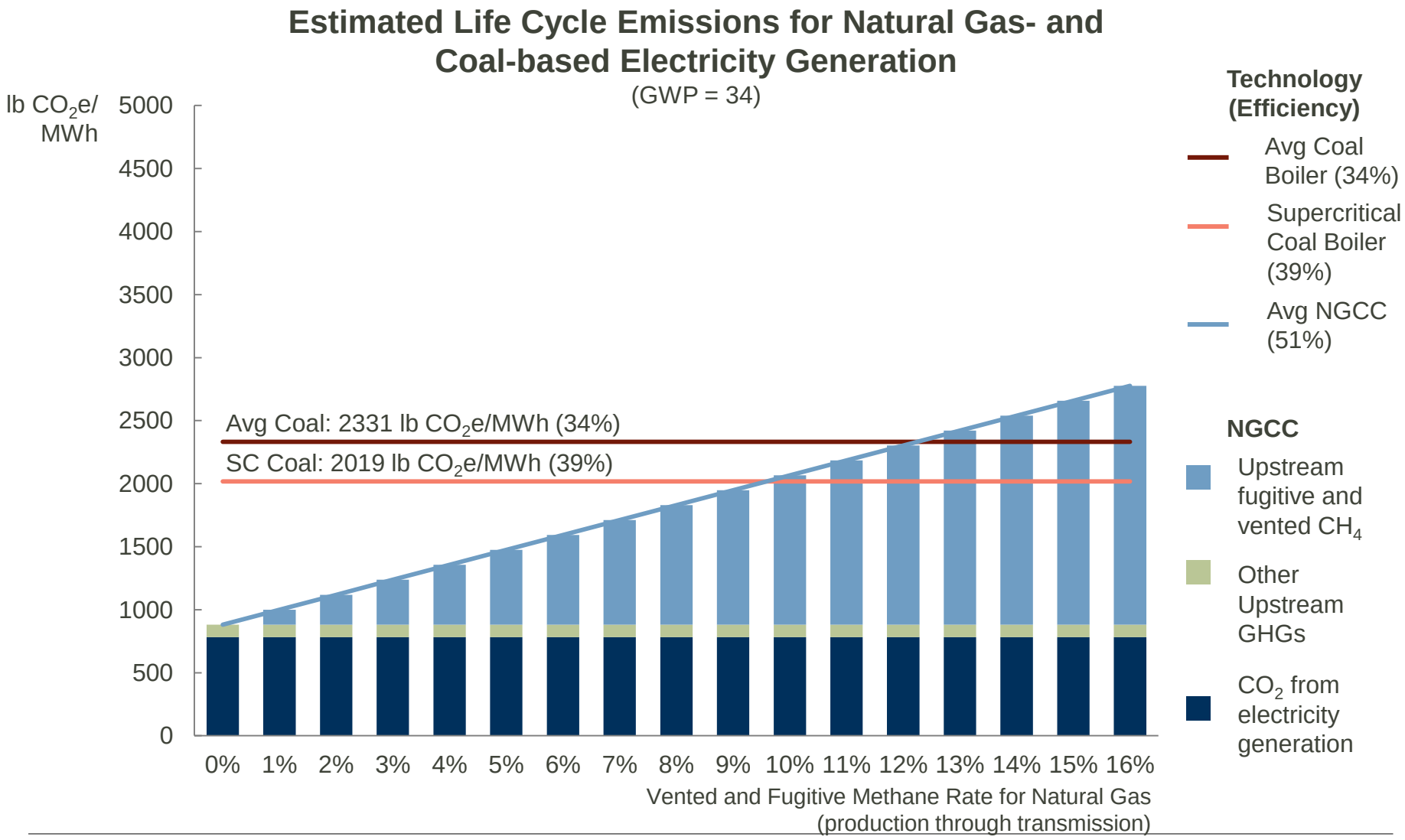
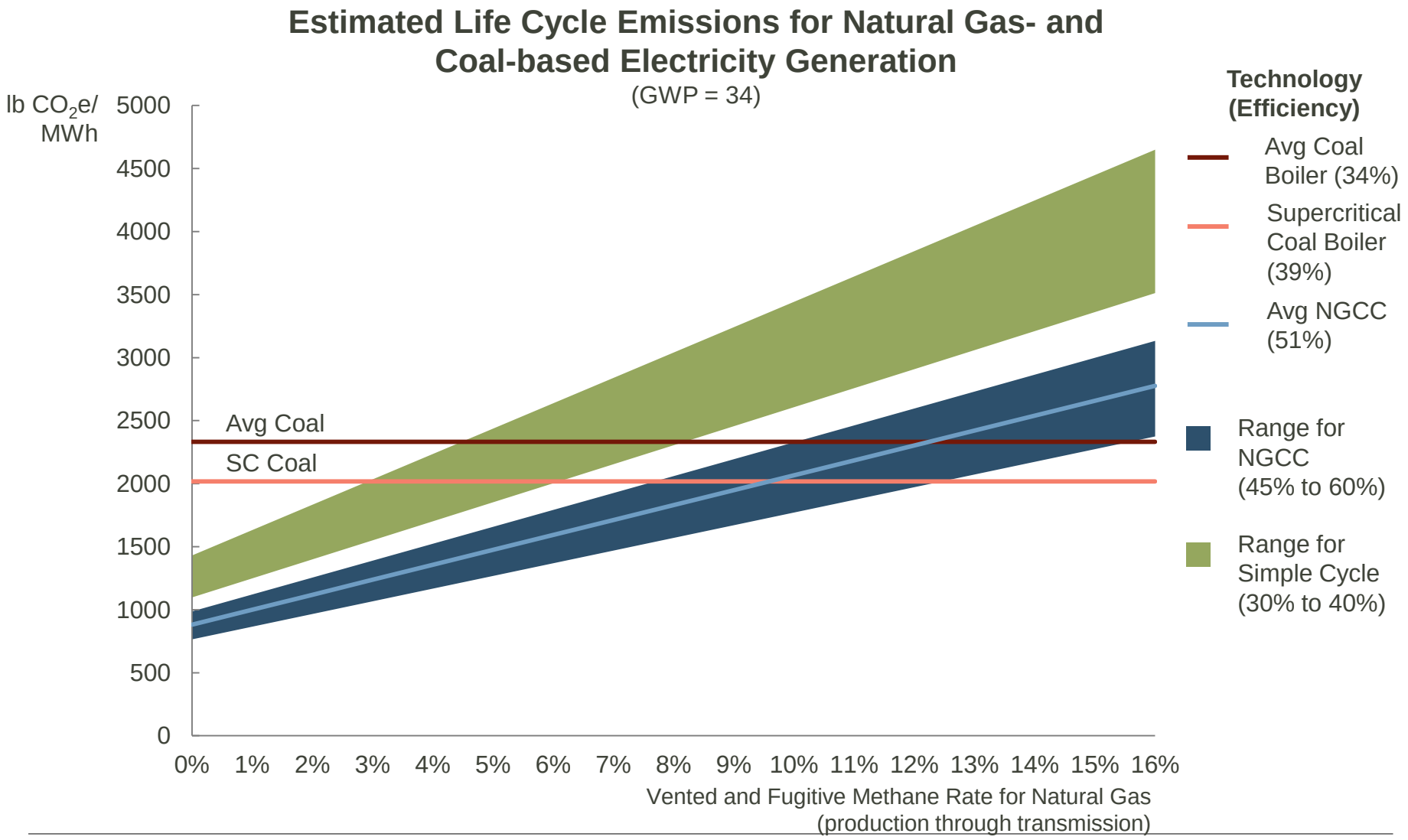


# Life Cycle Emissions at Different Emission Rates

## 100-year GWP (Comparison of Power Plant Efficiency)



# Ongoing Research and Emerging Issues

- **Upcoming bottom-up and top-down studies will provide better understanding of emissions from individual sources and gas production regions**
  - Better account for regional emissions variations and activity data
  - Airborne emissions measurements over western U.S. shale gas and tight oil basin
    - Will also measure emissions from surface coalmines, oil pipelines, coal and gas power plants, and biofuel refineries

- **Updating Inventory methodologies**
  - Regional data from direct measurements to play larger role in estimating national emissions
  - Revisions to the GHG Reporting Program
  - Apportionment studies assigning methane to natural gas production or petroleum production