



# Methane Emissions in the Natural Gas Life Cycle and Implications for Power Generation

Presentation to WIEB Board of Directors and  
Joint CREPC/SPSC/WIRAB Meeting  
October 20 and 21, 2014

Tom Curry  
[tcurry@mjbradley.com](mailto:tcurry@mjbradley.com)

---

MJB & A

MJB & A

M.J. Bradley & Associates LLC  
(978) 369 5533 / [www.mjbradley.com](http://www.mjbradley.com)

# Project Timeline

---

- April 2014: Presentation of preliminary findings to WIEB Board
- September 2014: Delivery of draft report reviewing bottom-up and top-down studies of fugitive and vented methane emissions
- October 2014: Presentation to WIEB Board and Joint CREPC/SPSC/WIRAB Meeting
- December 2014: Delivery of final report with review of policy scenarios and summary for policymakers*

Draft report with a review of top-down and bottom-up studies will be posted for download from WIEB website

# Key Takeaways

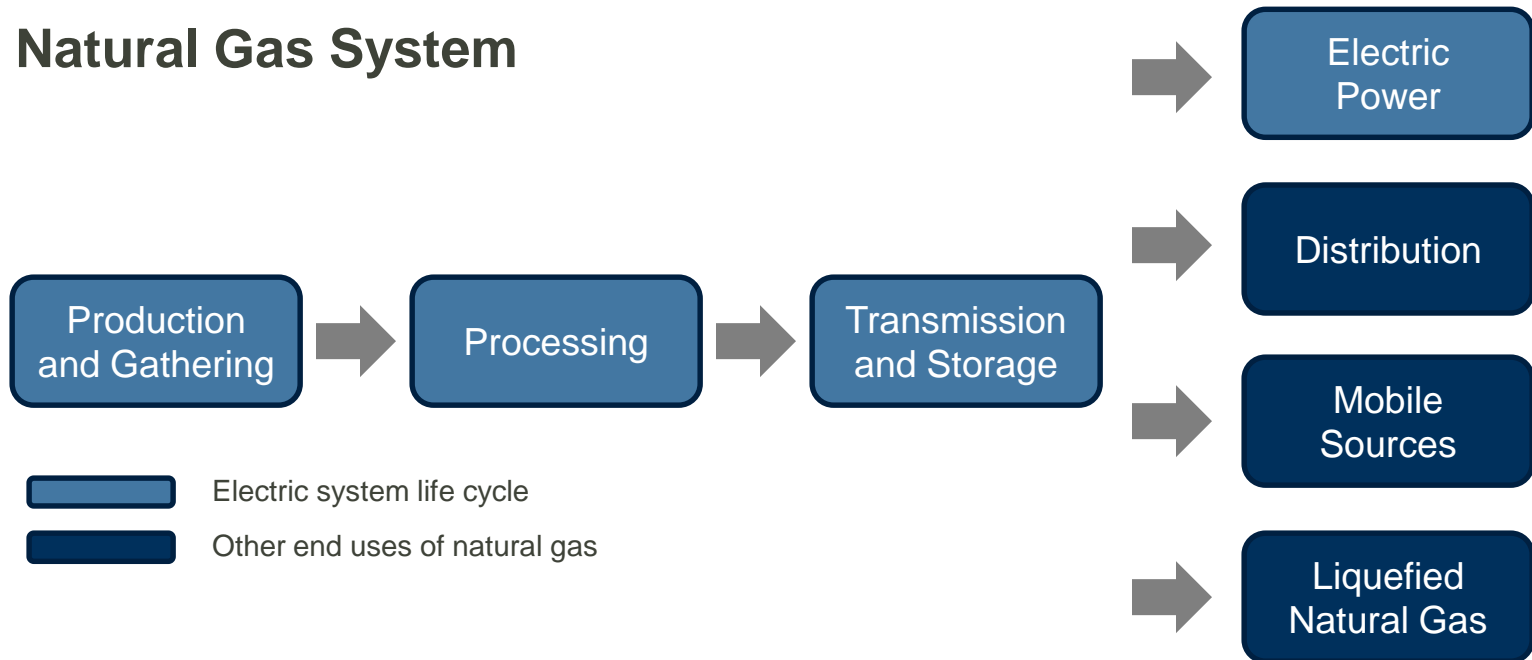
---

- Natural gas combined cycle power plants have about half the life cycle greenhouse gas emissions of coal-fired power plants
  - NGCC's advantage over coal-fired power plants is robust across a range of upstream methane emission scenarios
- Emerging and ongoing research suggests a “fat-tail” issue where a small percentage of sources are responsible for a large percentage of emissions
- Significant actions have been taken by EPA, states, and companies in recent years to reduce emissions associated with the natural gas system
- Discussions continue on ways to address major emission sources, a range of stakeholders are engaged in both regulatory and voluntary activities
  - Anticipate an announcement from EPA on its approach to reduce emissions from natural gas systems by the end of the year

# Scope of Life Cycle Assessments

Greenhouse Gas Emissions  
[Methane (CH<sub>4</sub>), Carbon Dioxide (CO<sub>2</sub>), and Others]

## Natural Gas System



# 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

## Top-down Studies

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

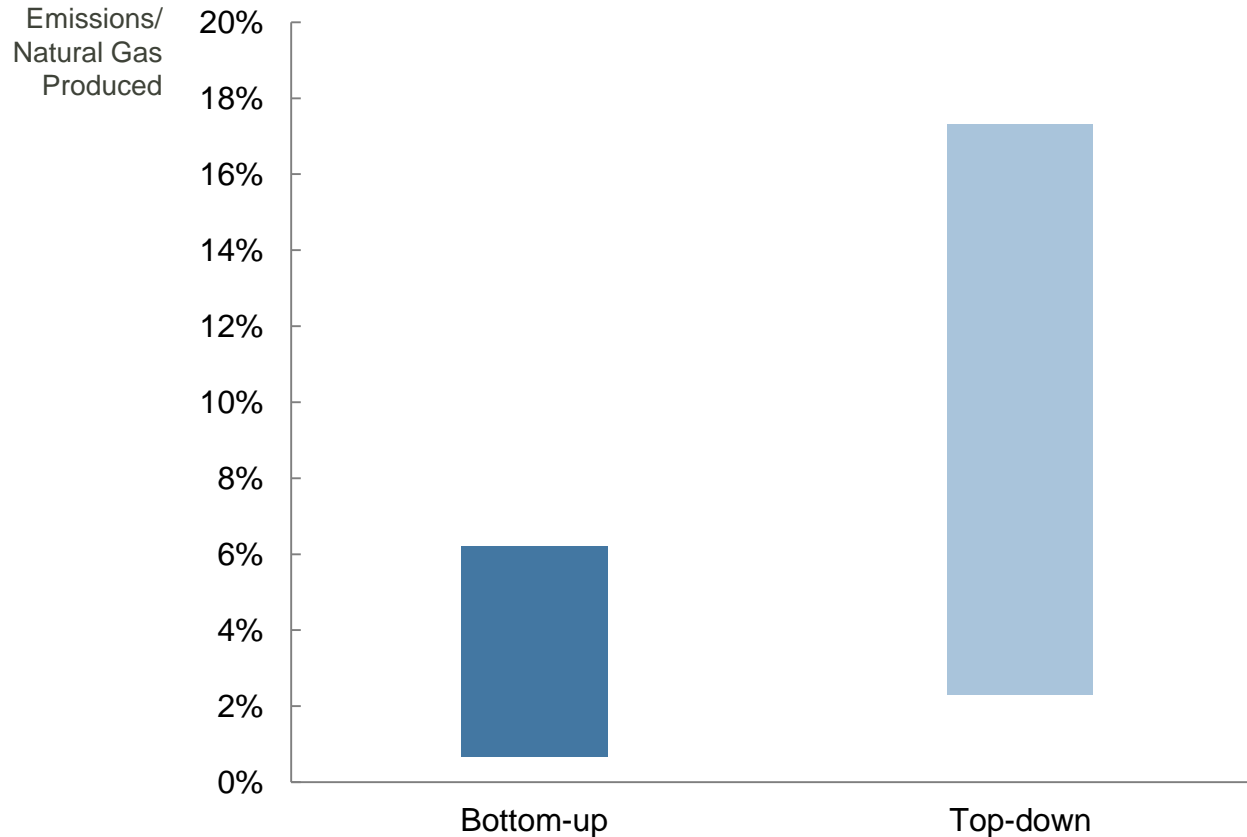


Photo Source: EPA Gas STAR  
(<http://www.epa.gov/gasstar/documents/workshops/buenosaires-2008/dim.pdf>)

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

# Review of Fugitive and Vented Methane Estimates

Range of Methane Emission Rates for Reviewed Studies  
(Normalized Values for Bottom-up Studies, Reported Values for Top-down Studies)



Notes: Bottom-up percentages based on normalized rates in Heath et al. 2014 (values normalized to be based on methane emitted divided by natural gas produced). Top-down percentages as reported by individual studies.

# Study by Brandt et al.

---

ENERGY AND ENVIRONMENT

## Methane Leaks from North American Natural Gas Systems

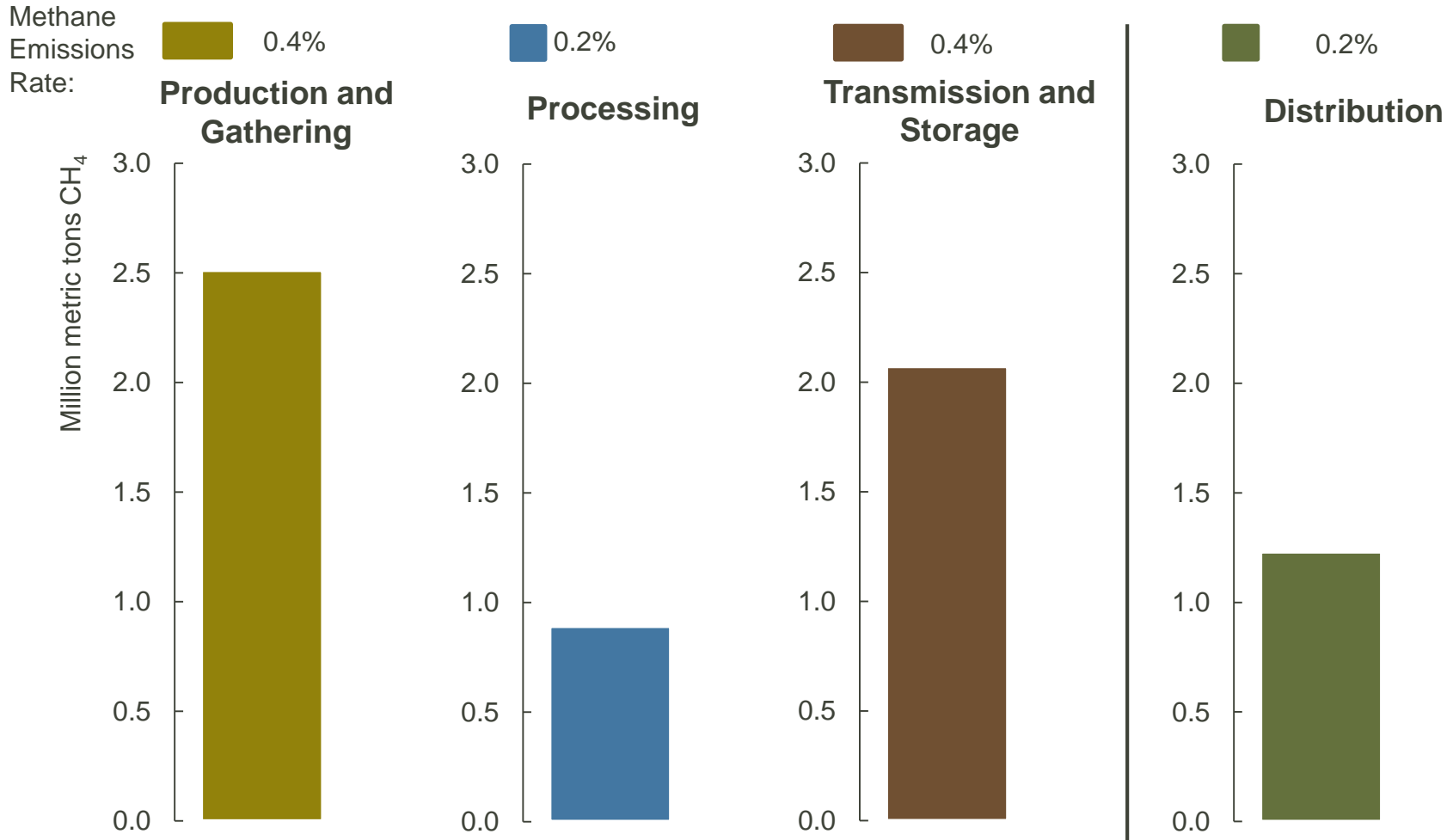
A. R. Brandt,<sup>1\*†</sup> G. A. Heath,<sup>2</sup> E. A. Kort,<sup>3</sup> F. O'Sullivan,<sup>4</sup> G. Pétron,<sup>5,6</sup> S. M. Jordaán,<sup>7</sup> P. Tans,<sup>5</sup> J. Wilcox,<sup>1</sup> A. M. Gopstein,<sup>8†</sup> D. Arent,<sup>2,9</sup> S. Wofsy,<sup>10</sup> N. J. Brown,<sup>11</sup> R. Bradley,<sup>12</sup> G. D. Stucky,<sup>13</sup> D. Eardley,<sup>13</sup> R. Harriss<sup>14</sup>

*Methane emissions from U.S. and Canadian natural gas systems appear larger than official estimates.*

- Examines the relationship between bottom-up and top-down methane studies
- Compares over 200 published methane emissions estimates on a wide range of scales, from emissions measured at individual devices to continental-scale atmospheric emissions readings
- After normalization, national-scale atmospheric measurements typically estimated total national methane emissions to be about 1.5 times greater (based on a range of 1.25 to 1.75 times) than those in the 2013 GHG Inventory
- The study emphasizes that the excess methane detected in atmospheric studies may be attributable to a number of sources, not all of which are related to the natural gas value chain
- Published in Science Magazine February 14, 2014

# Natural Gas System Emission Sources by Segment

2014 EPA GHG Inventory Implied 2012 Methane Emissions Rate (CH<sub>4</sub>/NG Produced): 1.2%

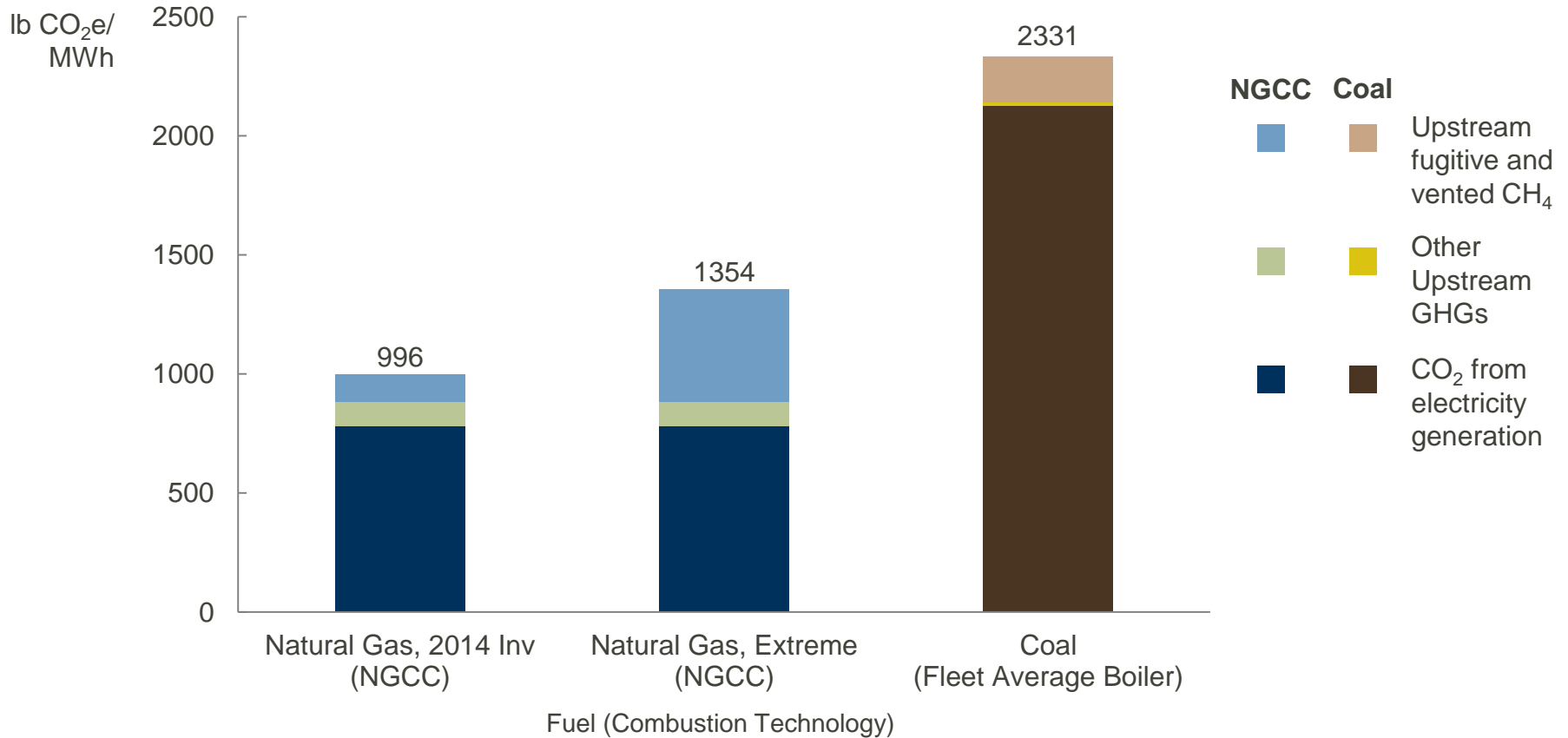


Source: MJB&A analysis, EPA 2014 GHG Inventory, EIA Total U.S. Gross Natural Gas Withdrawals



# MJB&A Life Cycle Assessment

## Estimated Life Cycle Emissions for Natural Gas- and Coal-based Electricity Generation (100-year GWP)

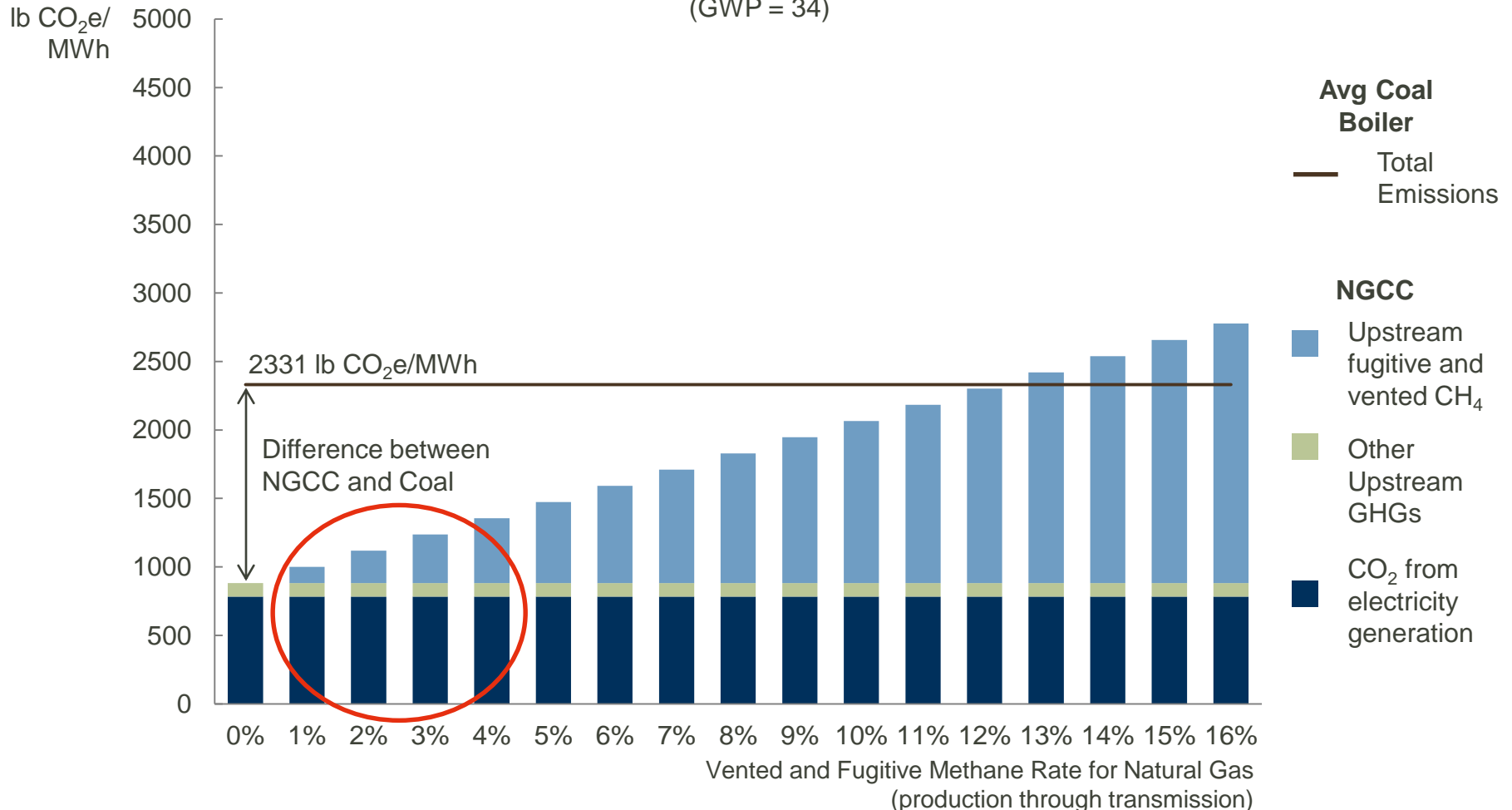


GWP=34; “Natural Gas, 2014 Inv” based on 2014 EPA GHG Inventory less distribution segment emissions. “Natural Gas, Extreme” based on assigning all Brandt et al. identified excess CH<sub>4</sub> to natural gas. Brandt et al. describe such a scenario as implausible.

# Life Cycle Emissions at Different Emission Rates

## 100-year GWP

**Estimated Life Cycle Emissions for Natural Gas- and Coal-based Electricity Generation**  
(GWP = 34)

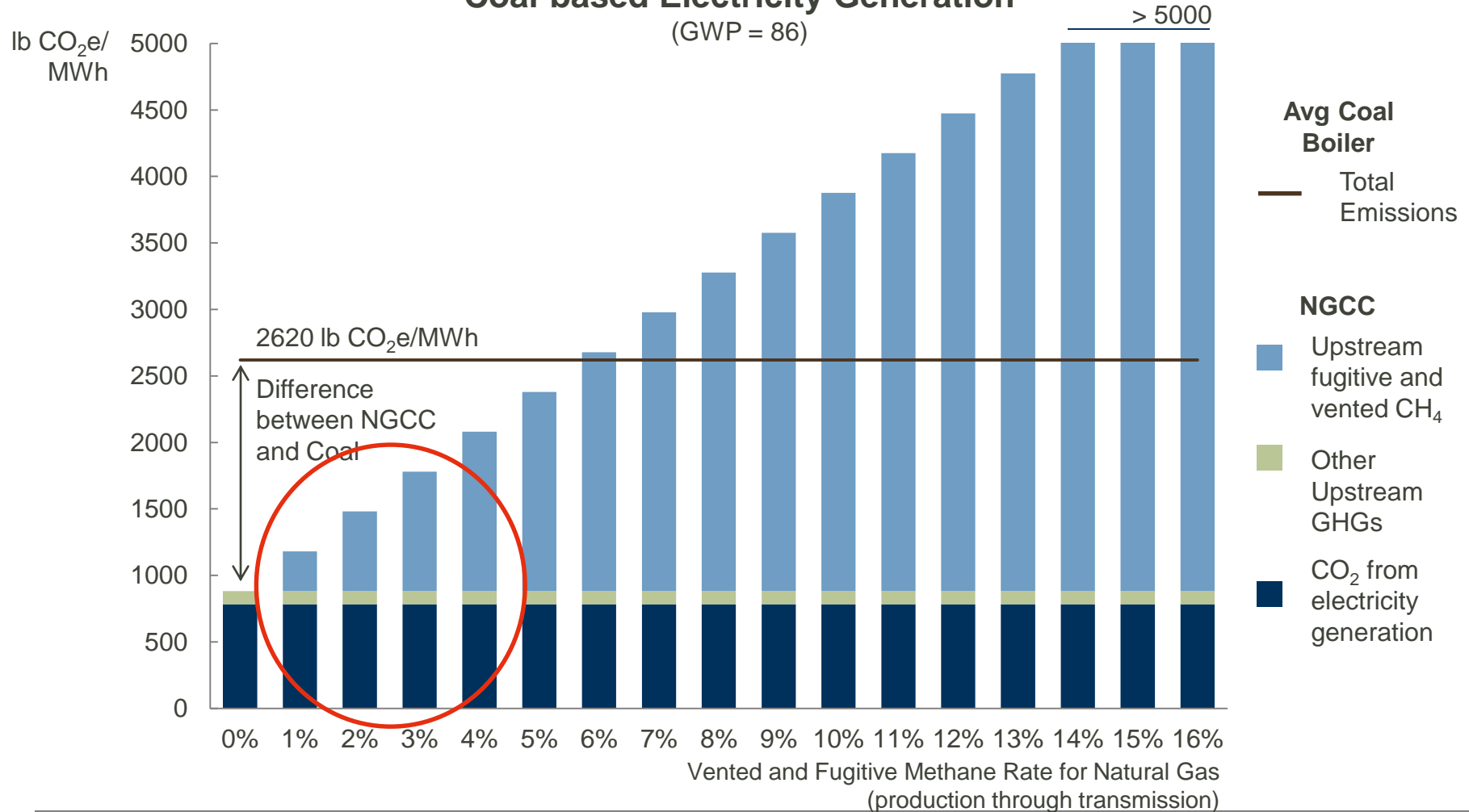


# Life Cycle Emissions at Different Emission Rates

## 20-year GWP

### Estimated Life Cycle Emissions for Natural Gas- and Coal-based Electricity Generation

(GWP = 86)



# Natural Gas System Emission Sources by Segment

2014 EPA GHG Inventory Implied 2012 Methane Emissions Rate (CH<sub>4</sub>/NG Produced): 0.97%  
(1.2% with Distribution)

Methane Emissions Rate:

0.4%

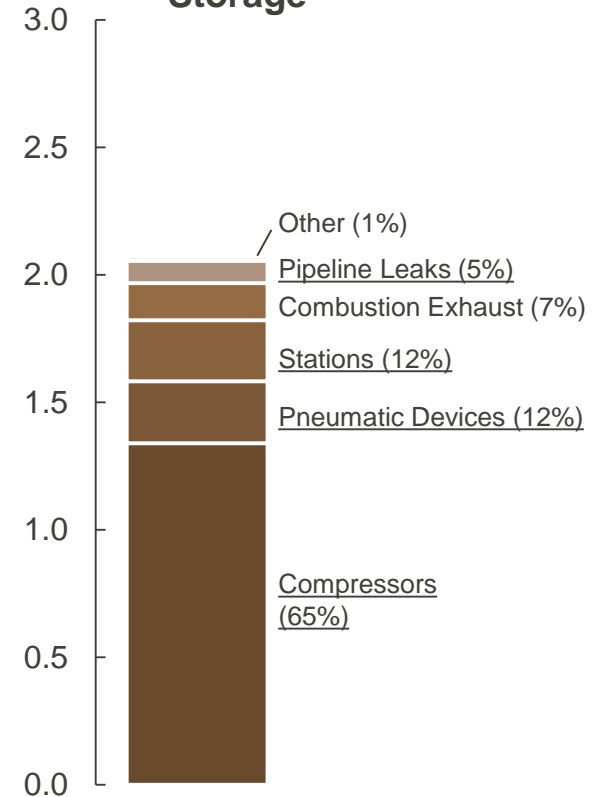
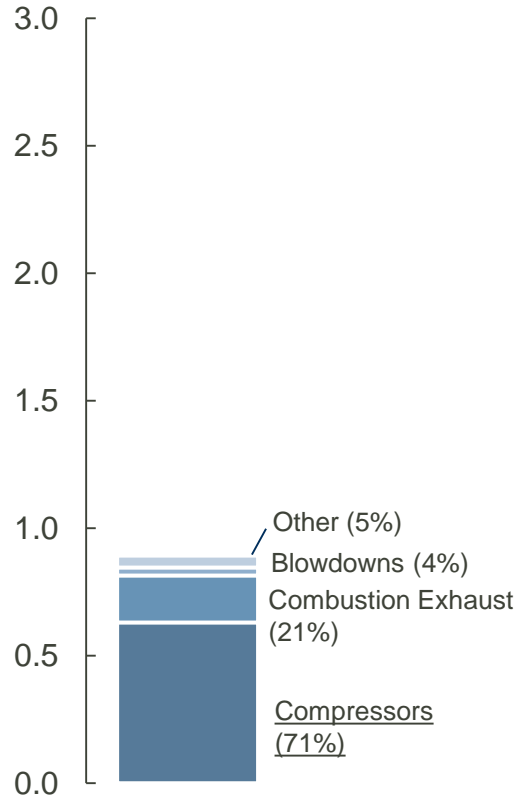
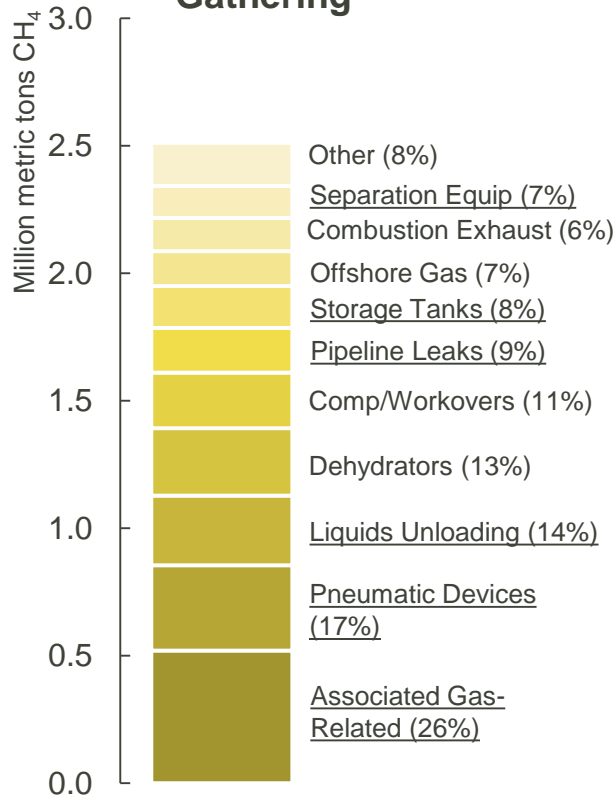
0.2%

0.4%

## Production and Gathering

## Processing

## Transmission and Storage



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

Underlined sources in EPA technical white papers

# Potential Scope of Federal Actions

Under different regulatory frameworks

Segment	Sources	VOC NSPS	NESHAP	GHG NSPS
Production & Gathering	Existing		✓	✓
	New	✓	✓	✓
Processing	Existing		✓	✓
	New	✓	✓	✓
Transmission & Storage	Existing			✓
	New			✓
Distribution	Existing			?
	New			?

- *EPA has not defined the scope of its authority and it could differ from our evaluation.*
- *Parallel to any Federal regulatory approach, EPA is pursuing changes to its successful Natural Gas STAR program to recognize industry leaders in methane reduction.*
- *At the same time, stakeholders are pursuing voluntary initiatives including industry best practices and certification programs.*

# Anticipated Activity on Natural Gas Issues



- Expected to announce strategy for additional reductions by the end of 2014 as described in President's Climate Action Plan
- Continue to refine methodology for annual GHG Inventory
- Collect data from industry through the GHG Reporting Program



- State and regional air emission data collection and modeling efforts
- State efforts to address methane emissions



- Ongoing studies to better understand and quantify emissions
- Voluntary initiatives including industry best practices and certification programs

