



# Methane Research: The 16 Study Series

## AN UNPRECEDENTED LOOK AT METHANE FROM THE NATURAL GAS SYSTEM

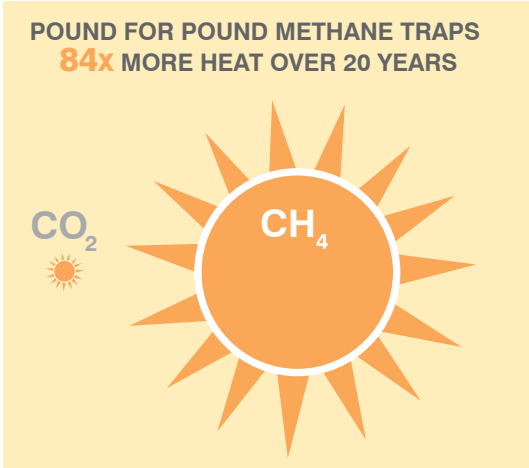
Methane (CH<sub>4</sub>) is a growing environmental concern. Methane is a potent greenhouse gas that is contributing to climate change. Science confirms methane is a problem that requires urgent attention. Reducing emissions of both methane and carbon dioxide is critical to slowing the rate of earth’s warming and limiting peak warming.

### Why methane matters

Methane is the primary component of natural gas, and the oil and gas industry is the nation’s largest industrial source of methane emissions. Methane escaping during the production, delivery and use of natural gas can undermine the climate benefit natural gas has over other fossil fuels because methane traps heat in the atmosphere much more effectively relative to carbon dioxide, especially over the short term. In fact, it is 84 times more potent than CO<sub>2</sub> in the first 20 years after it is released.

Methane emissions represent a threat to our climate but also a waste of natural gas, a valuable energy resource -- enough natural gas is lost each year to fuel 6 million homes. Additionally, the gas lost in the U.S. last year had the same negative impact on the climate as the annual carbon emissions of 117 million cars, or roughly half the cars in the United States.

Reducing methane emissions is critical to reducing our overall GHG emissions, and new scientific insights provide more information for crafting effective mitigation strategies. However, there are important actions that can and should be taken today even as the science evolves.



In 2012, Environmental Defense Fund spearheaded its largest scientific project to date to better understand from where and how much methane is lost across today's U.S. natural gas supply chain, including production, gathering and processing facilities, gas transmission and storage, local utility distribution, as well as end users utilizing natural gas commercial trucks and refueling stations. Insights from this effort will help inform policies and opportunities to minimize these emissions.

This collaborative effort involves partnerships with about 100 universities, research institutions and companies. It is divided into 16 distinct projects that range in their scope from estimating methane emissions in a given geographical area or from specific pieces of equipment across the country. A variety of sophisticated scientific techniques and methodologies--including top-down, bottom up and mobile measuring devices --were deployed across the various projects; no individual method can provide all the answers. Our series was designed to help combine, compare or contrast methods to increase precision, instead of confusion. In many cases, the measurement techniques are paired to provide greater insight and certainty.

Of the 16 studies, data from 12 studies have been published in close to 25 papers with the remaining studies expected to be published or submitted in the coming weeks.

## Production Studies

### 1) Production Study: Phase I

University of Texas at Austin

This study measured methane emissions at natural gas production sites—including some of the first measurements ever collected from hydraulically fractured wells. Diverse methods were used to directly measure methane emissions at well pads operated by nine cooperating U.S. natural gas companies. The study found that methane emissions from equipment leaks and pneumatic devices were larger than previously thought. The study also found that techniques to reduce emissions from well completions are effective at capturing 99% of the methane that was previously vented to the atmosphere, providing a data-based example of EPA regulations working.

#### Resources:

- Published in *Proceedings of the National Academy of Sciences* (Sept. 2013)
- Unprecedented Measurements Provide Better Understanding of Methane Emissions During Natural Gas Production
- A New Study Measures Methane Leaks in the Natural Gas Industry
- Frequently Asked Questions

### 2) Production Study: Phase II

University of Texas at Austin

This study expands on results from the first UT study by collecting additional data from two important emission sources associated with natural gas production: 1) liquid unloadings, when producing wells are cleared of water and other liquids inhibiting the flow of gas, and 2) pneumatic controllers used to regulate routine functions at well sites. UT coordinated with 10 natural gas companies on this effort. The study found that emissions from two sources--pneumatic s and liquids unloadings--were responsible for a significant portion of methane emissions from the production sector.

#### Resources:

- Pneumatics paper published in *Environmental Science and Technology* (Dec. 2014)
- Liquids Unloadings paper published in *Environmental Science and Technology* (Dec. 2014)
- New Study Measures Methane Emissions from Natural Gas Production and Offers Insights into Two Large Sources
- New Study Confirms the Need for National Methane Policy

### 3) Production Data Analysis

Houston Advanced Research Center (HARC), U.S. Environmental Protection Agency (EPA)

EPA's Office of Research and Development has collected fence line data on methane emissions at well production sites over several years EPA, HARC, and EDF, worked together to analyze the data further to investigate trends in production emissions. The report includes measurements from 210 production sites in the Barnett Shale and Eagle Ford regions of Texas, Colorado's Denver-Julesburg Basin, and the Upper Green River Basin gas fields surrounding Pinedale, Wyoming from 2010 to 2013. A statistical analysis of this data suggests unpredictable events, such as malfunctions and maintenance, have a strong influence on emission rates.

#### Resources:

- Published in *Environmental Science and Technology* (Nov. 2014)
- What We Can't See Can Hurt Us: New Study Provides Insights to Find, Fix Oil and Gas Pollution

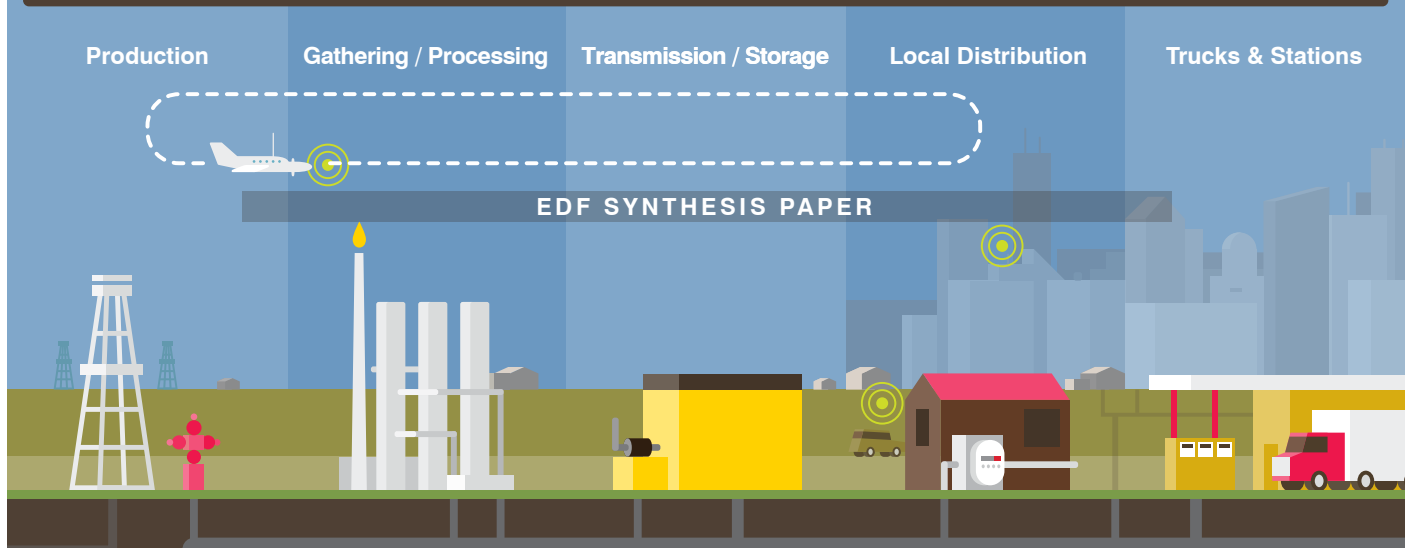
## Midstream Studies

### 4) Gathering and Processing Study

Colorado State University

CSU's Engines and Energy Conversion Laboratory led an effort to quantify national methane emissions associated with the natural gas industry's gathering infrastructure and gas processing facilities. Researchers worked with six industry companies and used tracer gas releases to quantify methane emissions from this sector. . The study found methane leakage from gathering

## EDF STUDIES BY NATURAL GAS SUPPLY CHAIN SEGMENT



activities is 8 times larger than official estimates. Researchers with the study suggest leak detection and repair policies can be effective at minimizing emissions. Researchers with the study suggest leak detection and repair policies can be effective at minimizing emissions from these sources.

### Resources:

- Published in *Environmental Science and Technology* (Feb. 2015)
- Modeling Paper published in *Environmental Science and Technology* (Aug. 2015)
- [Study Reveals Vast Unrecorded Oil and Gas Industry Methane Emissions](#)

### 5) Transmission and Storage Study

Colorado State University, Carnegie Mellon University, Aerodyne Research

This study estimates the amount of methane lost during long-distance transportation and storage of natural gas as it moves across the country in cooperation with seven industry partners. The initial measurements paper used downwind tracer gas methods paired with direct on site measurements to report variable emissions data from site to site. The paper confirms compressors and equipment leaks are two primary sources for the sector's methane emissions. Researchers also developed a model to combine their measurements with data from EPA's Greenhouse Gas Reporting Program to derive a national emissions estimate for this industry segment.

### Resources:

- Published in *Environmental Science and Technology* (Feb. 2015)
- Modeling paper published in *Environmental Science and Technology* (June 2015)
- [New Study Emphasizes Need to Find and Fix Methane Leaks; Reveals Limits of Voluntary Action](#)

## Local Distribution Studies

### 6) Multi-city Local Distribution Study

Washington State University

WSU's Laboratory for Atmospheric Research led a nationwide field study to better characterize and understand methane emissions

associated with the delivery of natural gas. Researchers quantified methane emissions from facilities and pipes operated by 13 utilities in various regions. The data will be used to estimate emissions from distribution systems nationally. The study shows that methane emissions from local natural gas distribution systems are significant, especially in regions such as the Northeast where distribution infrastructure is older, but that progress is being made in reducing emissions from these systems, mainly through regulation and investment by utilities.

### Resources:

- Published in *Environmental Science and Technology* (March, 2015)
- [Study Shows Utilities and Regulators Making Progress on Methane Leaks, but a Major Emissions Problem Remains](#)

### 7) Boston Study

Harvard, Boston and Duke universities with Aerodyne Research and Atmospheric and Environmental Research

University scientists developed an innovative tower-based quantitative technique for use in the urban environment. The study found Boston's methane emissions are more than two times higher than inventory data suggests, with a yearly average loss rate between 2.1 and 3.3- percent.

### Resources:

- Published in *Proceedings of the National Academy of Sciences* (Jan. 2015)
- [From Boston, More Troubling News About Methane Emissions](#)

### 8) Indianapolis Study

Washington State University

To gain further regional insights of urban methane emissions, WSU coordinated with the National Institute of Standards and Technology to measure methane emissions in Indianapolis, which is part of a broader NIST project.

### 9) Methane Mapping

Colorado State University

Using mobile methane sensors, EDF partnered with Google to map methane emissions from pipelines under city streets. Led by

# CLIMATE



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researchers at Colorado State University, this method quantifies methane leaks from local distribution systems that utilities could use to identify and prioritize repair or replacement of leaky pipelines, not otherwise addressed as an immediate public safety risk.

#### Resources:

- [edf.org/methanemaps](http://edf.org/methanemaps)
- [Using Google Street View in Our Fight Against Climate Change](#)

### Basin Specific Studies

#### 10) Flyover study: Denver-Julesburg Basin

National Oceanic Atmospheric Administration and University of Colorado at Boulder

Researchers measured methane emissions from Colorado's most active oil and gas field using data gathered by aircrafts and compared the differences in atmospheric concentrations of hydrocarbons upwind and downwind of production areas. The study estimated methane emissions that were three times higher than estimates derived from EPA data. The study also found that levels of smog-forming VOCs were twice as high as EPA estimates, and Benzene levels were 7 times higher than previously estimated.

#### Resources:

- Published in *Journal of Geophysical Research: Atmospheres* (May 2014)
- [CIRES, NOAA study finds more methane, ozone precursors and benzene than estimated by regulators](#)
- [New Methane Study Demonstrates Urgent Need for Regulatory Action](#)
- [Frequently Asked Questions](#)

#### 11) Barnett study - Coordinated campaign

EDF convened 12 diverse research teams in October 2013 to measure methane emissions in the Barnett Shale in Texas. This campaign used a variety of aircraft, vehicle and ground-based measurements to quantify methane emitted across the natural gas supply chain. A preliminary study estimated regional methane emissions to be 50 percent higher than emission estimates in EPA's Greenhouse Gas Inventory, with subsequent research estimating emissions could be as much as 90 percent higher

#### Resources

- Published in *Environmental Science and Technology* (July 2015)
- Synthesis published in *Proceedings of the National Academy of Sciences* (Dec. 2015)
- [New Research Finds Higher Methane Emissions, Reduction Opportunities in Texas' Barnett Shale Region](#)
- [New Study Finds Oil & Gas Methane Emissions in the Barnett Shale Almost Twice What Official Estimates Suggest](#)

#### 12) Flyover Study: Barnett Shale - National Oceanic and Atmospheric Administration, University of Colorado at Boulder, University of Michigan

As part of a broader project (No. 11), scientists with NOAA and UC-Boulder's Cooperative Institute for Research in Environmental Sciences are measuring atmospheric concentrations of hydrocarbons in order to quantify and allocate regional methane emissions in an active oil-and gas basin that includes infrastructure

### Other Studies

#### 13) Pump-to-wheels Study

West Virginia University

WVU's Center for Alternative Fuels, Engines and Emissions, in cooperation with 10 companies and research organizations, led a study to directly measure methane emissions from the operation of natural gas fueled medium- and heavy duty vehicles, as well as CNG and LNG refueling and maintenance facilities. The study includes modeling emissions from this sector under differing growth scenarios.

#### 14) Pilot Projects

Three initial projects helped build the foundation for some of this research.

University of Texas-Arlington collected methane data using mobile methane-sensing technology that helped inform the first UT study (No.1), as well as the Coordinated Campaign (No. 11 & No. 12), and the methane mapping.

Harvard, Duke and Boston University researchers experimented with tower-based sensing systems for making methane emissions estimates in an urban environment. This work led to the larger Boston study (No. 7).

University of Colorado-Boulder scientists conducted research to identify elevated levels of methane and hydrogen sulfide that provided insights for subsequent overflight work (No. 10 & No. 11).

#### 15) Filling Gaps, Including Super Emitters

The main objective of this effort is to address knowledge gaps not addressed by the other studies, including whether "superemitting" sites or sources produce a large share of emissions. Field work for this study was undertaken in late 2013.

#### 16) Project Synthesis

After the series of EDF-initiated studies are completed, EDF will engage stakeholders from across the projects to develop an integrated understanding of what was learned, including the development of an overall methane emissions rate across the natural gas supply chain.

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