Should Methane Emissions Regulations be Prescriptive or Performance Based?

Robert L. Kleinberg
Columbia University Center on Global Energy Policy
Boston University Institute for Sustainable Energy

Background

In the United States, legal strictures on emissions of air pollutants from crude oil and natural gas production, processing, and transmission systems originated in 2012 with the promulgation of the New Source Performance Standards of 40 CFR 60 Subpart OOOO, which regulated emissions of volatile organic compounds (VOC). This was followed in 2016 by 40 CFR 60 Subpart OOOOa, which regulated emissions of greenhouse gases, including specifically methane. Subparts OOOO and OOOOa imposed similar, though not identical, restrictions on natural gas emissions. The measures in OOOO that limited VOC emissions also reduced methane emissions as a co-benefit.

On 13 August 2020, the U.S. Environmental Protection Agency (EPA) promulgated final rules amending 40 CFR 60 Subpart OOOO and Subpart OOOOa. Policy amendments deregulated methane emissions in the production and processing segments and deregulated both methane and volatile organic compound emissions in the transmission and storage segment. Technical amendments reduced inspection and reporting requirements, and simplified the process of certifying new emission detection technology. The 2020 amendments, while rich in symbolism, are in general less substantive than both proponents and opponents have claimed.

The EPA tracks about 250 distinct sources of methane emissions in petroleum and natural gas systems. Of these, only a fraction are subject to regulatory controls prescribed by 40 CFR 60. While regulated infrastructure are among the largest emission sources, a number of very significant sources are clearly inadequately regulated for environmental protection. [https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3810337]

Devised at a time when the technology for the measurement of natural gas emissions was relatively immature, OOOO and OOOOa regulations are highly prescriptive. Unfortunately, methane reductions resulting from these regulations have been disappointing. In 2016, the Obama administration pledged to reduce methane emission CAGR from the oil and gas sector by 40-45% by 2025, a CAGR of about -6%. However, thae actual methane emissions over the last thirty years has averaged -0.3%, with no perceptible change following the promulgation of the OOOO rules meant to control emissions of natural gas.

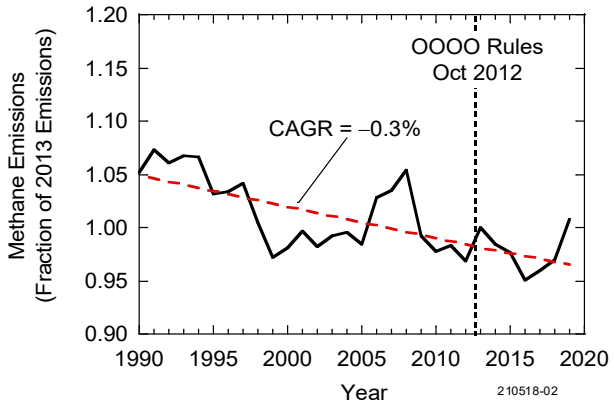

Figure 1. Methane emissions, from emission factor estimates of OOOO and OOOOa regulated segments, 1990-2019, normalized to emissions in 2013. Data: [EPA, Greenhouse Gas Inventory, Additional Information Methodology Annexes]. Further Details: R.L. Kleinberg, Methane Emission Controls: Toward More Effective Regulation, to be published on Social Science Research Network

Observations

- Older and low production facilities cannot be neglected in methane emission control regulations. Both populations (which overlap) are responsible for substantial fractions of total upstream methane emissions. Gathering pipelines, which are not regulated by EPA and inadequately regulated by the Pipeline and

Hazardous Materials Safety Administration (PHMSA), have been found to be the origin of many of the largest leaks associated with the production and processing segments.

- Some very important sources of vented methane have been inadequately mitigated by both Obama- and Trump-era EPA, and by industry. These include routine emissions associated with normal and abnormal operations of pneumatic controllers and oil storage tanks, and malfunctioning and unlit flares. These sources collectively account for roughly a third of the methane emitted by the entire U.S. oil and gas industry.
- The transmission and storage segment is responsible for 14-17% of emissions of the oil and gas industry. Therefore regulation of this segment should be restored and strengthened. Emissions from liquefied natural gas facilities have not been assessed by field measurements. In view of the recent growth of this industry sector, these measurements should be given high priority.

Recommendations

The complexities of oil and gas production do not lend themselves to prescriptive regulation. Current regulations do not pay adequate attention to intentional and unintentional venting occurring in the course of routine operations. Thus, some of the largest emissions are due to unregulated vents. Performance-based regulation would encourage engineers to solve problems using locally-appropriate solutions, rather than relying on a prescriptive check-list approach that cannot anticipate every eventuality.

The key to performance-based regulation is accurate measurement, and this capability has improved rapidly in recent years. Aircraft-based, facility-scale measurements encompassing tens of thousands of facilities spread over tens of thousands of square kilometers are economically viable and increasingly common. However such measurements are not compliant with the current regulatory regime, which focuses on individual components. Therefore the current regulatory regime must be completely rethought.

Very large but intermittent sources play an important role in the total methane emission budget of the oil and gas industry. Pilot studies indicate that whereas occasional surveys of individual facilities are likely to miss large emission events, company-wide surveys may well produce statistically significant data on environmental performance. The more assets a company controls, the more likely this is to be true.

Another solution to the problem of intermittency is the use of ground-based continuous monitoring. Pilot studies of such systems are underway.

Measurements are logically performed by third-party contractors using methods certified by a central authority, such as the Environmental Protection Agency. This service-company model is familiar to the oil and gas industry. Measurements most appropriate for comprehensive measurement – aircraft surveys several times a year and ground-based continuous surveillance sensors – scale well and are economic. In one model, all companies operating in a geographical area pay a proportionate share of survey expense.

At the present commercial level of measurement sensitivity at facility scale, 40-80% of total methane emissions can be found. Measurement precision and accuracy of both occasional aerial and continuous ground-based measurements are expected to improve over the next decade, allowing regulations to become more stringent in future years.

Prescriptive Regulation	Performance Based Regulation
Focus on Components	Focus on Facilities or Companies
Separate Rules for Leaks, Vents, Flares	Unified Target for all Emissions
Regulators Write Rules	Facility Engineers Figure Out How to Hit Target
Measurements Not Required	Accurate Measurements Essential
Compliance Unverified (Honor System)	Compliance Verified by Validated Third Party Measurements
Suppliers Rated Pass/Fail	Suppliers Rated Quantitatively

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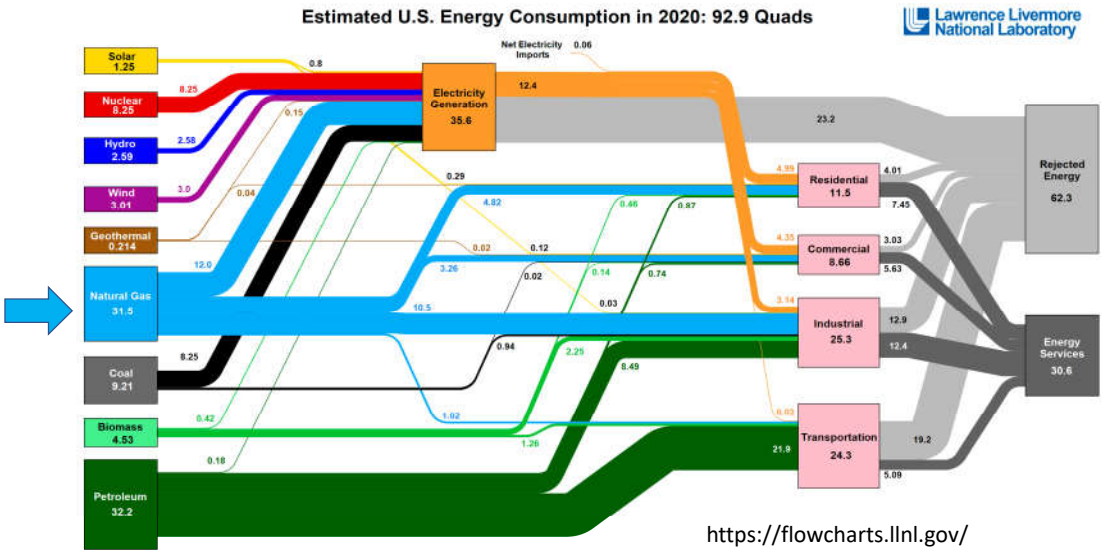
Center on Global Energy Policy

BU Institute for Sustainable Energy

Outline

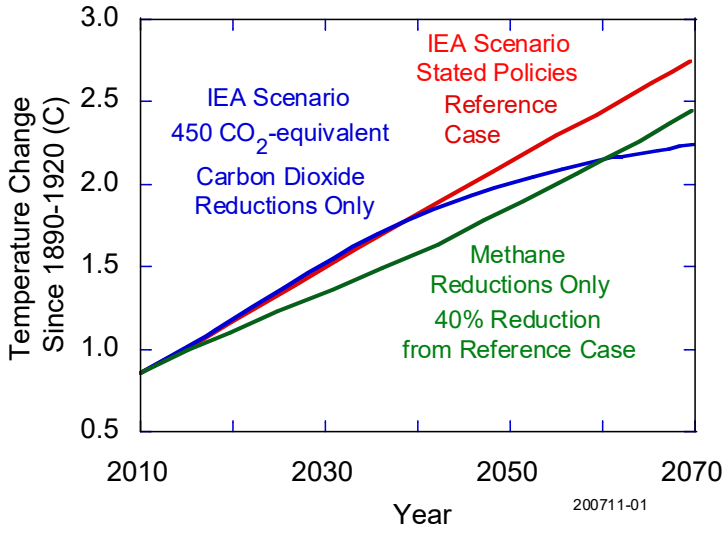
- ❑ Natural gas plays a central role in U.S. and global energy economies
- ❑ Reduction of methane emissions is the quickest way to mitigate climate change
- ❑ U.S. methane emission controls have been ineffective
- ❑ Prescriptive vs performance-based regulation
- ❑ Outlook for Europe (and the Far East?)

Natural Gas is an Important & Versatile Source of Primary Energy



Source: LLNL March, 2021. Data is based on DOE/EIA MER (2020). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

Controlling Methane is the Quickest Way to Mitigate Global Warming

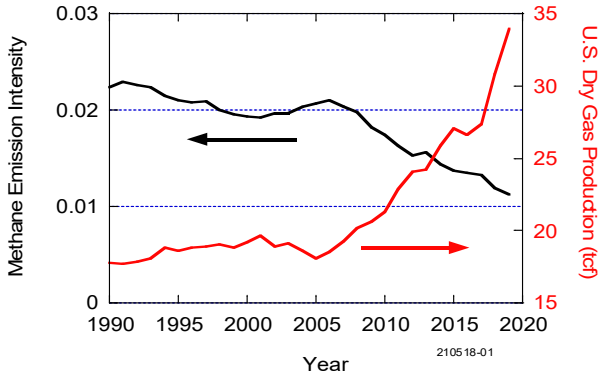


Shindell et al., Science 335, 183-189 (2012)

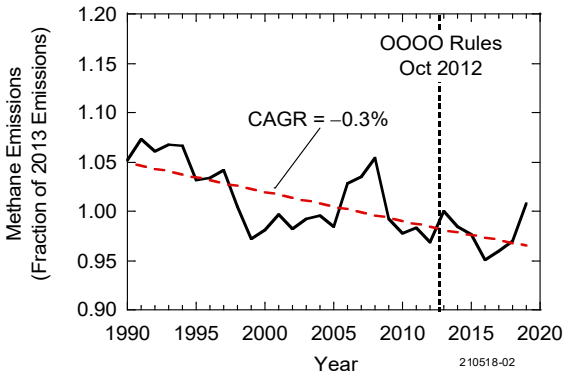
U.S. EPA Natural Gas Emission Regulation: Disappointing Results

EPA Emission Factor Estimates of Regulated Segments

Methane Emission Intensity



Methane Emissions



R.L. Kleinberg, Methane Emission Controls: Toward More Effective Regulation
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Prescriptive Focus on Components Can Lead to Unintended and Undesirable Outcomes

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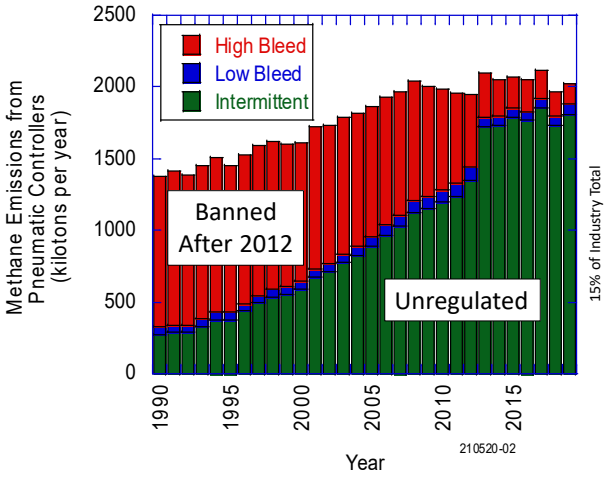

U.S. Inventory of Greenhouse Gas Emissions and Sinks
[EPA, 2020b Data Tables]

Permian Basin Methane Emissions from Flares (tons per year)				
Flare Status	Functioning	Malfunctioning	Unlit	Total
EDF	75,000	30,000	200,000	305,000
EPA	80,000			80,000

Environmental Defense Fund PermianMAP -- Accessed 27 December 2020
https://www.permianmap.org/flaring-emissions/

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- Smoke emission limit
- Pilot light on and monitored
- Upper limit on gas velocity
- Lower limit on heating value
- No requirement to detect unlit flares

Environmental Protection Agency
Flaring Regulation - 40 CFR 60.18

Clean Air Act Regulated Entities are Owners or Operators, Not Components

EDF and commercial entities are already providing company-specific performance data.

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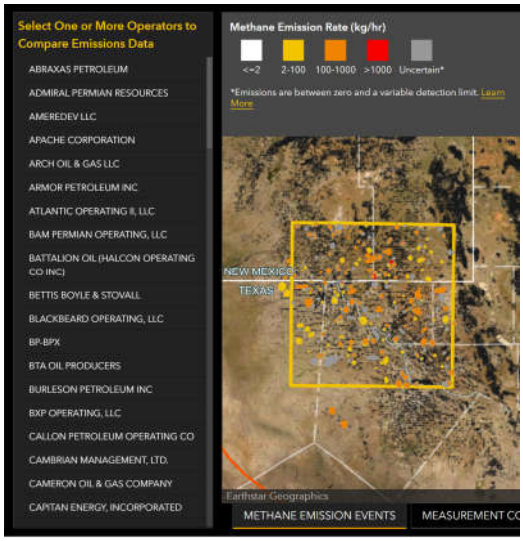

https://data.permianmap.org/pages/operators

Can Facility Emissions be Measured Accurately? Yes

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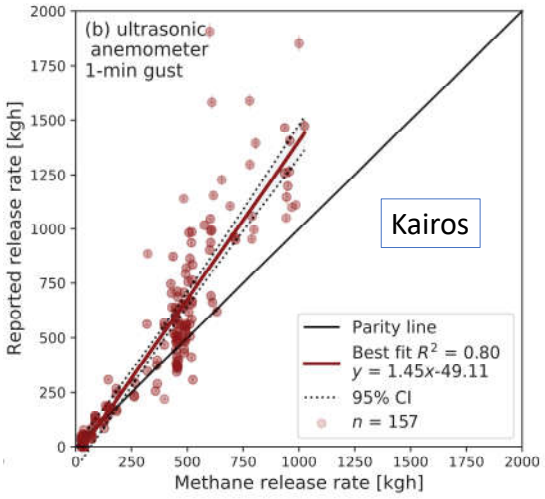

Sherwin, Chen, Ravikumar, Brandt; Elementa, 2021
https://doi.org/10.1525/elementa.2021.00063

Methane: The Big Picture for Europe (and the Far East?)

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"Estimates show . . . the emissions released outside the EU to produce and deliver fossil gas to the EU are between three to eight times the quantity of emissions occurring within the EU."

EU Strategy to Reduce Methane Emissions
14 October 2020

Therefore Europe must influence the behavior of fossil carbon exporters.

A fundamental tenet of the World Trade Organization is that nations or blocs cannot impose rules on exporting nations that they do not impose on their own products.

The EC is presently writing rules for Europe, but they must be applicable to the rest of the world.

It is time for Asian importers to share leadership.

Observations and Recommendations (1)

Modern remote sensing methods do not distinguish between leaks and vents. Event-driven flaring is essentially impossible to regulate prescriptively.

Unify leak, vent, and flare detection, measurement & mitigation requirements under overall emission targets.

Methane reduction targets based on outmoded estimates of past emissions are meaningless.

Base reduction targets on measured baselines using modern methods.

Engineers are really good at complying with the letter of the regulations, at lowest possible cost.

Regulators should ask for exactly what they want (reduced emissions).
Then give operators the flexibility to reduce total emissions
in the best and most economical way for their local circumstances.

Observations and Recommendations (2)

Remote sensing technology (airborne, ground-based continuous) is improving rapidly.

Escalate requirements for emission reduction as remote sensing improves.

Fossil fuel users will look for verifiably reduced environmental impact.
Fossil fuel suppliers will look for verifiable competitive advantage.

Measurements need to be uniform across basins/nations/internationally.
Therefore they need to be made by third party service organizations certified by national or international authorities.

R.L. Kleinberg, Methane Emission Controls: Toward More Effective Regulation to be published on Social Science Research Network

Robert L. Kleinberg, Ph.D.

Senior Fellow
Institute for Sustainable Energy
Boston University

Senior Research Scholar
Center on Global Energy Policy
Columbia University

Implementing Method 21

robert@robertkleinberg.com
http://www.linkedin.com/pub/robert-kleinberg/19/177/131
Member of the National Academy of Engineering

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Center on Global Energy Policy

BU Institute for Sustainable Energy