

The Relevance to Investors of Greenhouse Gas Methane Emissions

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IMAP monthly series

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Plan

- Background
- Data and sample
- Model
- Main results
- Additional findings

Methane

- The second-largest contributor to global warming
 - high heat-trapping power (GWP 25)
 - short lifespan
 - rising amount (1/3 of current warming)
 - 2/3 human induced from energy, landfill, and agriculture industries



Some terms

- CO₂
- CH₄
- CO₂e
- GWP
- Timescale: 100-year, 25-year
- U.S. EPA
- GHGRP

GWP for CO₂, CH₄, and N₂O are 1, 25, and 273 (based on the 100-year timescale), respectively.

A firm emits 1,000 tons CO₂, 20 tons of CH₄, one ton of N₂O, and zero tons of the other gases


Its total GHG emissions, expressed as CO₂e
 $= 1,000 \times 1 + 20 \times 25 + 1 \times 273 = 1,773$

Our early work

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The Relevance to Investors of Greenhouse Gas Emission Disclosures[†]

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This project

- Is methane priced by investors?
- Does the pricing differ from that of CO₂?

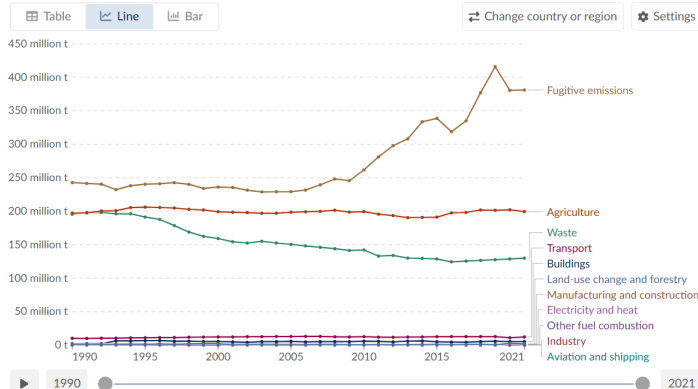
Science & Engineering Controlling Air Pollution from Oil and Natural Gas Operations

- Basic Information
- Actions and Notices

EPA's Final Rule to Reduce Methane and Other Harmful Pollution from Oil and Natural Gas Operations and Related Actions

Methane emissions by sector, United States

Methane (CH₄) emissions are measured in tonnes of carbon dioxide-equivalents.



Data source: Climate Watch (2024) - Learn more about this data
OurWorldInData.org/co2-and-greenhouse-gas-emissions | CC BY

March 13th, 2024 | 6 min read

Methane emissions from U.S. oil and gas operations cost the nation \$10 billion per year

Stanford-led research shows methane emissions from a large share of U.S. oil and gas facilities are three times higher on average than the level predicted by official government estimates.

EPA United States Environmental Protection Agency Search EPA.gov

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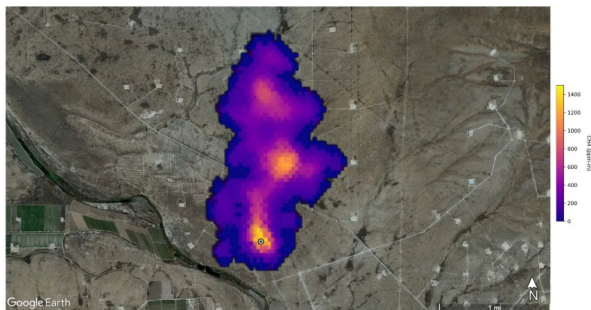
Inflation Reduction Act

Delivering Cleaner Air

Tackling Climate Pollution

Financial Assistance from the Methane Emissions Reduction Program

Methane 'Super-Emitters' Mapped by NASA's New Earth Space Mission



This image shows a methane plume 2 miles (3 kilometers) long that NASA's Earth Surface Mineral Dust Source Investigation mission detected southeast of Carlsbad, New Mexico. Methane is a potent greenhouse gas that is much more effective at trapping heat in the atmosphere than carbon dioxide.

Credits: NASA/JPL-Caltech

Global methane emissions rising at fastest rate in decades, scientists warn

Researchers call for immediate action to reduce methane emissions and avert dangerous escalation in climate crisis

PUBLIC LAW

FIRST EU-WIDE METHANE REGULATION ((EU) 2024/1787) NEW RULES AIM TO CONTROL METHANE EMISSIONS IN THE EU'S ENERGY SECTOR AND FROM ENERGY IMPORTS

How does methane differ from carbon dioxide?

	■ Methane (CH ₄)	■ Carbon Dioxide (CO ₂)
Potency	■ Higher (GWP of 25) in a 100-year horizon	■ GWP of 1 in a 100-year horizon
Life span	■ Shorter (10-12 years)	■ Hundreds to thousands of years
Mitigation/ capturing	■ Tech is less mature	■ More advanced tech
Regulations	■ High uncertainty	■ Already policies to prioritize reductions
Trading scheme	■ Less mature	■ More mature

Methane examined in this paper

- Human induced (~60%)
 - Agriculture (livestock and rice cultivation ~40%)
 - Fossil fuels (oil and gas leaks, coal mines, ~35%)
 - Waste decomposition in landfills (~20%)
 - Others such as land use and forestry (~5%)
- Natural sources (~40%)
 - wetlands and other natural processes
- From facilities that generate more than 25,000 metric tons of CO₂e annually.

Zoom in: EPA facility data

Data Year **2023**

Pfizer
1 BURTT RD.
ANDOVER, MA, 01810



Latitude: 42° 36.85' N
Longitude: 71° 10.17' W

GHGRP Id: 1004343
FRS Id: 110000309648
NAICS Code: 325414

Facility Name: Pfizer
Facility Identifier:
Facility Reporting Year: 2023
Facility Location:
Address: 1 BURTT RD.
City: ANDOVER
State: MA
Postal Code: 01810

Facility Site Details:

CO2 equivalent emissions from facility subparts C-II, SS, and TT (metric tons): 47,362.8
CO2 equivalent emissions from supplier subparts LL-QQ (metric tons):
Biogenic CO2 emissions from facility subparts C-II, SS, and TT (metric tons): 0
Cogeneration Unit Emissions Indicator: Y
GHG Report Start Date: 2023-01-01
GHG Report End Date: 2023-12-31
Description of Changes to Calculation Methodology:
Plant Code Indicator: N
Primary NAICS Code: 325414
Second Primary NAICS Code:

Parent Company Details:

Parent Company Name: PFIZER INC
Address: 235 East 42nd Street, Room 107, New York, NY 10017
Percent Ownership Interest: 100

Facility Information | Facility Emissions by Year

Total Facility Emissions in metric tons CO2 equivalent (mt CO2e) (AR4 GWPs, excluding Biogenic CO2) 47,363

Emissions by Gas in mt CO2e (AR4 GWPs)

Carbon Dioxide (CO2) 47,313
Methane (CH4) 23
Nitrous Oxide (N2O) 27

Emissions by Source/Process in mt CO2e (AR4 GWPs, excluding Biogenic CO2)

Stationary Combustion 47,363

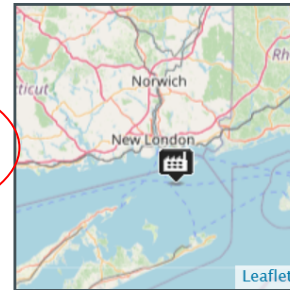
Information on Stationary Combustion

Types of Fuels Used Distillate Fuel Oil No. 2, Natural Gas
Measurement Methods Used Mass Balance
Number of equipment groupings 7

Data Year **2023**

Pfizer

445 EASTERN POINT ROAD
GROTON, CT, 06340



Latitude: 41° 19.91' N
Longitude: 72° 04.75' W

GHGRP Id: 1006941
FRS Id: 110000315891
NAICS Code: 541714
Clean Air Markets Division Business
Database Id: 1199

Facility Name: Pfizer
Facility Identifier:
Facility Reporting Year: 2023
Facility Location:
Address: 445 EASTERN POINT ROAD
City: GROTON
State: CT
Postal Code: 06340

Facility Site Details:

CO2 equivalent emissions from facility subparts C-II, SS, and TT (metric tons): 88,454.4
CO2 equivalent emissions from supplier subparts LL-QQ (metric tons):
Biogenic CO2 emissions from facility subparts C-II, SS, and TT (metric tons): 0
Cogeneration Unit Emissions Indicator: Y
GHG Report Start Date: 2023-01-01
GHG Report End Date: 2023-12-31
Description of Changes to Calculation Methodology:
Plant Code Indicator: Y
Primary NAICS Code: 541714
Second Primary NAICS Code: 541715

Parent Company Details:

Parent Company Name: PFIZER INC
Address: 235 East 42nd Street, Room 107, New York, NY 10017
Percent Ownership Interest: 100

Facility Information | Facility Emissions by Year

Total Facility Emissions in metric tons CO2 equivalent (mt CO2e) (AR4 GWPs, excluding Biogenic CO2) 88,454

Emissions by Gas in mt CO2e (AR4 GWPs)

Carbon Dioxide (CO2) 88,356
Methane (CH4) 43
Nitrous Oxide (N2O) 55

Emissions by Source/Process in mt CO2e (AR4 GWPs, excluding Biogenic CO2)

Stationary Combustion 88,454

Information on Stationary Combustion

Types of Fuels Used Distillate Fuel Oil No. 2, Natural Gas, Propane
Measurement Methods Used Mass Balance
Number of equipment groupings 12

Data

- 4,318 observations (571 firms) between 2010 and 2022
- Sample distributed evenly across years

Sector Breakdown	Sample %	Sample N	Mean value of CH4_ps
Consumer Discretionary	4.08%	176	0.03
Consumer Staples	7.06%	305	0.34
Energy	28.83%	1,245	2.11
Financials	1.00%	30	0.33
Health Care	2.69%	116	0.00
Industrials	10.75%	464	2.39
Information Technology	5.58%	241	0.00
Materials	21.63%	934	1.29
Real Estate	1.27%	55	0.69
Utilities	17.11%	739	1.14
All	100%	4,318	1.39

Model

- Ohlson (1985) and Feltham and Ohlson (1985) model

$$prcc_q = \alpha + \beta_1 CH4_ps + \beta_2 CO2_ps + \beta_3 cvce + \beta_4 epspx + \text{Year FE} + \varepsilon$$

- *CO2_ps*: the total CO2 in metric tons / shares outstanding (in thousands)
- *CH4_ps*: the CO2e of total CH4 in metric tons (GWP of 25) / shares outstanding (in thousands)
- *prcc_q*: firm's stock price, measured at the $t+1$ calendar yearend

Main Predictions

- Ohlson (1985) and Feltham and Ohlson (1985) model

$$prcc_q = \alpha + \beta_1 CH4_ps + \beta_2 CO2_ps + \beta_3 cvce + \beta_4 epspx + \text{Year FE} + \varepsilon$$

Prediction 1: $\beta_1 < 0$

Prediction 2:

- $\beta_1 = \beta_2$ if 1 mt CO2 and 1 mt CO2e of CH4 are valued equally
- $\beta_1 < \beta_2$ if CO2e of CH4 are valued more negatively than CO2
 - Have a short-term outlook, the use of GWP = 25 underestimates the emission level
 - Expect higher future mitigation/capturing costs
 - Anticipate rising regulatory costs
 - See greater financial/market risk from immature trading schemes
 - Believe actual CH4 emissions exceed reported levels

Main Results

$$prcc_q = \alpha + \beta_1 CH4_ps + \beta_2 CO2_ps + \beta_3 cvce + \beta_4 epspx + \text{Year FE} + \varepsilon$$

		(1)	(2)
<i>CH4_ps</i>	More than 6 times higher	-0.568***	-0.592*
<i>CO2_ps</i>		-0.083***	-0.080***
<i>cvce</i>		1.464***	1.424***
<i>epspx</i>		4.514***	4.727***
N		4,318	4,318
Adj R2		0.4934	0.5056
FEs		No	Year
SE		Robust	Cluster by firm

Results: GWP of 87 (25-years horizon)

		(1) GWP of 25	(2) GWP of 87	
<i>CH4_ps</i>	more than 6 times higher	-0.568***	-0.163***	closer coeff. after adjusting GWP to 87.
<i>CO2_ps</i>		-0.083***	-0.083***	
<i>cvce</i>		1.464***	1.464***	
<i>epspx</i>		4.514***	4.514***	
N		4,318	4,318	
Adj R2		0.4934	0.4934	

Which component of CH4 drives the pricing effect? Industry vs. firm

$$prcc_q = \alpha + \beta_1 CH4_ps + \beta_2 CO2_ps + \beta_3 cvce + \beta_4 epspx + \beta_5 CH4_ps_Ind + \beta_6 CO2_ps_Ind + \text{Year FE} + \varepsilon$$

- *CH4_ps_Ind*: industry-level *CH4_ps*
- *CO2_ps_Ind*: industry-level *CO2_ps*

Prediction 3:

- $\beta_5 < 0, \beta_6 < 0$, if *CH4_ps_Ind* and *CO2_ps_Ind* are valued negatively
- $\beta_5 < \beta_6$ if *CH4_ps_Ind* is valued more negatively than *CO2_ps_Ind*
- $\beta_1 < 0, \beta_2 < 0$ if investors also value firm-level emissions negatively after controlling for industry-level emissions

Results: Industry-level CH4 and CO2

	(1)	(2)	(3)
<i>CH4_ps</i>	0.252	0.236	0.185
<i>CO2_ps</i>	-0.035**	-0.033	-0.027
<i>CH4_ps_Ind</i>	-2.718***	-2.765***	-2.772***
<i>CO2_ps_Ind</i>	-0.292***	-0.276***	0.443***
<i>cvce</i>	1.486***	1.445***	1.408***
<i>epsp_x</i>	4.360***	4.566***	3.761***
N	4,318	4,318	4,318
Adj R2	0.5034	0.5155	0.6021
FEs	No	Year	Year&Industry
SE	Robust	Cluster by firm	Cluster by firm

Does political environment affect CH4 pricing? Blue vs. Red states

- Blue states - more support of climate policies, higher regulatory costs of emissions

Prediction 4:

Investors for firms in blue states anticipate higher social and regulatory costs of CH4, leading to greater market penalties.

Analysis:

- Partition by **HQ Blue** vs. **HQ Red**
- Construct *Facility_Blue*: % of a firm's facilities located in a blue state

Results: HQ and facility states

	(1) HQ Red	(2) HQ Blue	(3) HQ Red	(4) HQ Blue
<i>CH4_ps_Ind</i>	-2.312***	-1.577*	-1.841***	2.139
<i>Facility_Blue</i>			17.129	8.048
<i>CH4_ps_Ind*</i> <i>Facility_Blue</i>			-1.377	-6.584***
<i>CO2_ps_Ind</i>	-0.231	-0.324***	-0.229	-0.258**
cvce	1.726***	1.063***	1.732***	1.078***
epspx	2.475***	7.266***	2.479***	7.259***
N	2,320	1,998	2,320	1,998
Adj R2	0.4898	0.5992	0.4961	0.6031
FEs	Year	Year	Year	Year
SE	Cluster by firm	Cluster by firm	Cluster by firm	Cluster by firm

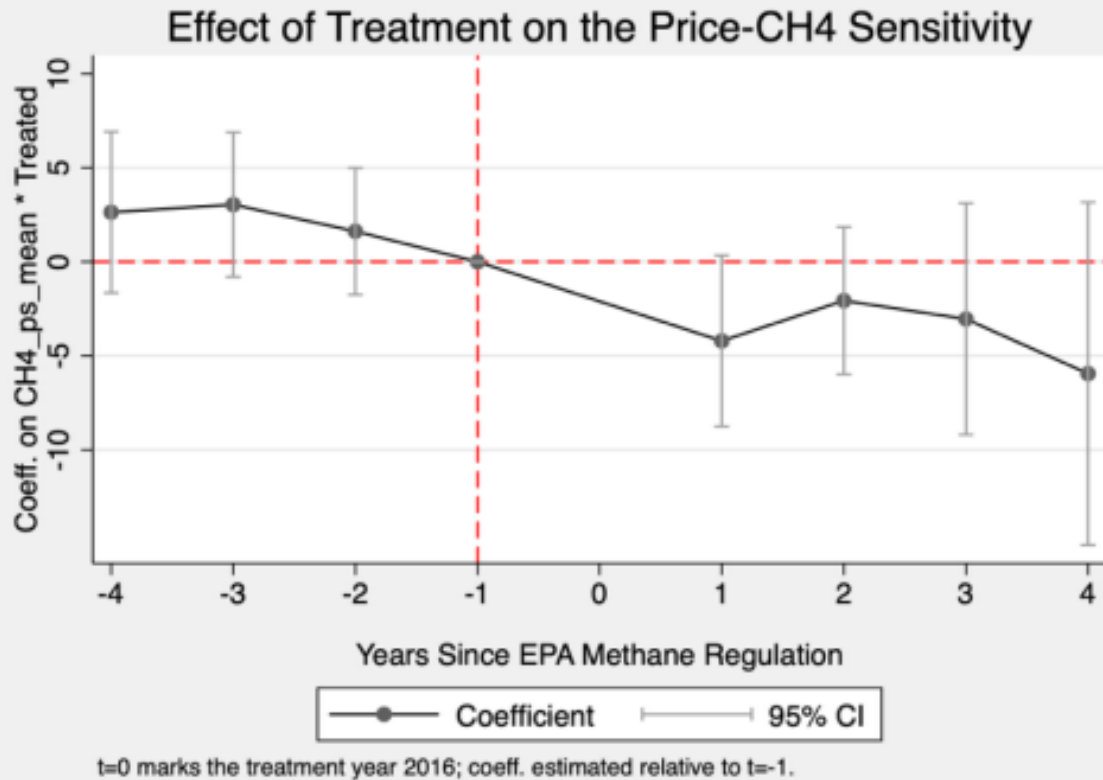
DiD: 2016 EPA methane rules

- June 3 2016: EPA published new source performance standards (NSPS) under the Clean Air Act to regulate methane from various sources in the oil and gas sector
- 2017-2020: delays and rollback
- 2021-2024: reinstate and strengthen rules
- 2025: more withdraws

Treated firms: firms HQ or had majority of facilities in an EPA methane rule supporting states: CA, CT, IL, NM, NY, OR, RI, VT, MA.

Prediction 5: Firm stock price is more negatively associated with CH₄ for firms that supported the 2016 EPA rules than those that did not in the post period of 2016 EPA's methane rules.

Results



Treated firms: firms' HQ or majority of the facilities are in states that supported the EPA's methane reduction rules.

Control firms: other firms

Y0 = 2016, year of publication

Post1 to *Post4* = 2017-2020

Pre4 to *Pre1* = 2012-2015 (2015 is the benchmark year)

Treated firms have more negative methane valuation than the control firms in the post-period.

Zoom in: paper details

- Paper link
- [CH4 Valuation Project](#)

Zoom out: Implications for...

- **Managers**
 - Improve stock price by reducing methane emissions
- **Asset managers**
 - Incorporate methane emissions as a carbon risk factor
- **Policy makers**
 - Continue to fund methane reduction initiatives

Thank you.