

EXHIBIT “A”

TIME

We Only Have 3 Years Left to Prevent a Climate Disaster, Scientists Warn

By **JUSTIN WORLAND**

June 29, 2017

A group of the world's leading thinkers on climate change have issued an urgent call for the world to reach peak greenhouse gas emissions by 2020, as global leaders prepare for a gathering in Germany next month.

The group, led by former United Nations climate chief and Paris Agreement architect Christiana Figueres, warns in a piece published in the journal *Nature* that **the planet could face unsafe — and irreversible — levels of temperature increases if greenhouse gas emissions do not begin to fall by 2020**. The piece calls on energy policymakers to implement policies to move the world to 30% renewable energy by 2020 and stop approving new coal-fired power plants, among other initiatives.

“There will always be those who hide their heads in the sand and ignore the global risks of climate change,” the group writes. “But there are many more of us committed to overcoming this inertia.”

The commentary in *Nature* follows an April report published by the group, which calls itself Mission 2020, showing that the goal of keeping temperatures from rising more than 2°C (3.6°F) by 2100 outlined in the Paris Agreement on climate change would become unattainable if emissions continue to rise or even flatline after 2020 ...

The group of climate change thinkers also emphasized in their commentary that much of the action on climate change will occur beyond national governments and praised cities and municipal governments for committing to take their own action to address the issue ...

EXHIBIT "B"

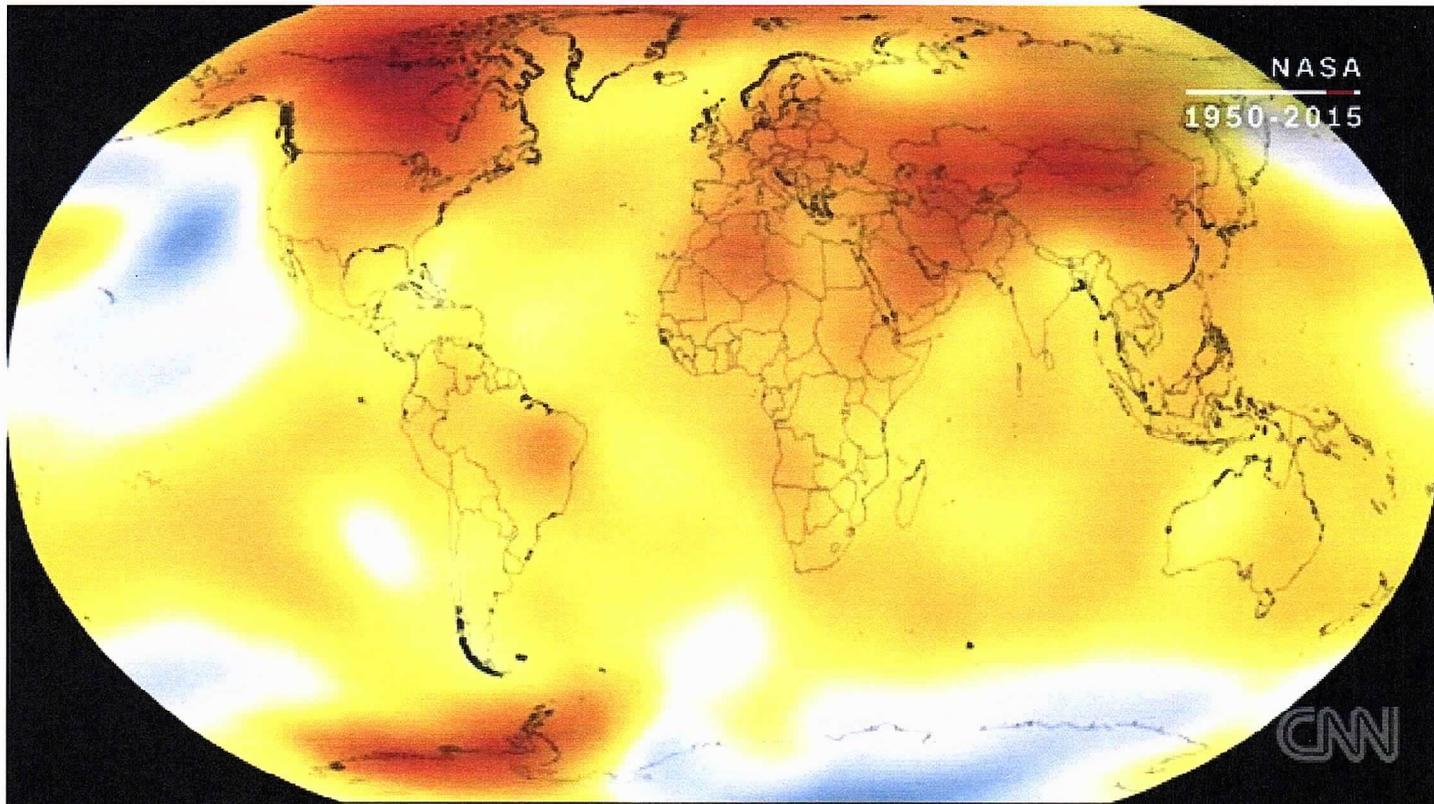
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century, studies say

By **Ashley Strickland, CNN**

🕒 Updated 9:37 PM ET, Mon July 31, 2017



Source: CNN

Undeniable climate change facts 02:24

Story highlights

The Earth's global temperature could rise close to or more than two degrees by 2100, studies say

One study suggests that a global temperature rise of 1.3 degrees may already be "baked in"

[One study](#) used statistical analysis to show that there is a 95% chance that Earth will warm more than 2 degrees at century's end, and a 1% chance that it's below 1.5 C.

Editor's Note: "The Climate Crisis: A CNN Town Hall Event with Al Gore" will air at 9 p.m. ET on Tuesday, August 1, on CNN.

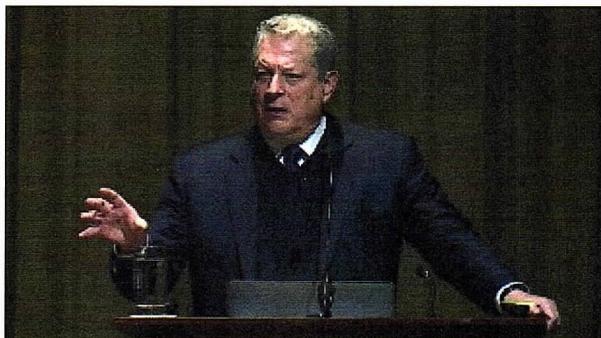
(CNN) — By the end of the century, the global temperature is likely to rise more than 2 degrees Celsius, or 3.6 degrees Fahrenheit.

This rise in temperature is the ominous conclusion reached by two different studies using entirely different methods published in the journal Nature Climate Change on Monday.

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✕ : is 3.2 C,"
ect of existing

emission mitigation policies. Achieving the goal of less than 1.5 C warming will require carbon intensity to decline much faster than in the recent past."



Related Article: Scientists highlight deadly health risks of climate change



Photos: The effects of climate change on the world

The 2 degree mark -- that's a rise of 3.6 degrees Fahrenheit in global temperature -- was set by the 2016 Paris Agreement. It was first proposed as a threshold by Yale economist William Nordhaus in 1977. The climate has been warming since the burning of fossil fuels began in the late 1800s during the Industrial Revolution, researchers say.



Related Content: 2 degrees: key to clim

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The [second study](#) analyzed past emissions of greenhouse gases and the burning of fossil fuels to show that even if humans suddenly stopped burning fossil fuels now, Earth will continue to heat up about two more degrees by 2100. It also concluded that if emissions continue for 15 more years, which is more likely than a sudden stop, Earth's global temperature could rise as much as 3 degrees.

"Even if we would stop burning fossil fuels today, then the Earth would continue to warm slowly," said Thorsten Mauritsen, author of the second study. "It is this committed warming that we estimate."

Taken together, the similar results present a grim reality.

"These studies are part of the emerging scientific understanding that we're in even hotter water than we'd thought," said [Bill McKibben](#), an environmentalist not affiliated with either study. "We're a long ways down the path to disastrous global warming, and the policy response -- especially in the United States -- has been pathetically underwhelming."

Because both studies were completed before the [United States left the Paris Agreement under President Trump](#) earlier this year, that has not been accounted for in either study.

"Clearly the US leaving the Paris Agreement would make the 2 C or 1.5 C targets even harder to achieve than they currently are," said Raftery.

Why two degrees?

If we surpass that mark, it has been estimated by scientists that life on our planet will change as we know it. Rising seas, mass extinctions, super droughts, increased wildfires, intense hurricanes, decreased crops and fresh water and the melting of the Arctic are expected.

The impact on human health would be profound. Rising temperatures and shifts in weather would lead to reduced air quality, food and water contamination, more infections carried by mosquitoes and ticks and stress on mental health, according to a recent report from the [Medical Society Consortium on Climate and Health](#).

Currently, the [World Health Organization estimates](#) that 12.6 million people will die between 2030

and 2050 is expected to cause 250,000 additional global deaths, according to the [WHO](#).

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Our potential future

The first study used population, carbon emission and gross domestic product data from 152 countries (accounting for 98.7% of the world's population as of 2015) over the past 50 years to develop a new statistical model, said Raftery, a professor of statistics and sociology at the University of Washington.

Many studies come from the Intergovernmental Panel on Climate change and use climate model scenarios -- not forecasts -- to use as examples of what might happen, based on specific assumptions about economics, population and carbon emissions in the future.

"This leaves open the question of how likely they are, or whether they cover the range of possibilities," Raftery said. "In contrast, our results are statistically based and probabilistic, in that they aim to cover the range of likely outcomes."



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What Raftery and his colleagues discovered is that population is not a factor.

"This is due to the fact that much of the expected future population growth will be in Africa, in countries whose carbon emissions are currently very low," Raftery said.

The study confirms conclusions of many other studies, said Bill Hare, director and senior scientists of nonprofit Climate

ly.

about where
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Related Article: Where climate change is threatening the health of Americans

ambition of climate and energy policies," Hare said.

The other finding of the study suggests that achieving a goal of less than 1.5 Celsius warming would require carbon intensity to decline faster than it has in the past. "The whole purpose of climate and energy policy is to accelerate decarbonisation and this will necessarily be faster than what we have seen globally," Hare said.

Mauritsen, author of the second study and climate researcher at Max Planck Institute for Meteorology, also shared thoughts on Raftery's findings.

"It seems interesting in that it uses an economic statistical model that accounts for an increasing energy efficiency as societies develop," Mauritsen said. "It shows that the 1.5 to 2 degrees targets will not be met without additional mitigation, and suggests that a focus on energy efficiency is the best way forward."

The impact of our past

By combining observations of past global warming and how much heat and carbon is being captured and taken in by the ocean, Mauritsen and his co-author, Robert Pincus, found that even though CO₂ has an incredibly long lifetime in the atmosphere, the ocean's absorption capacity may reduce estimates of global warming by 0.2 degrees Celsius.

They arrived at the "committed" warming of 1.3 Celsius by 2100, and the estimate including the ocean factor is 1.1 degrees Celsius. But that is still nearly 2 degrees Fahrenheit: 1.8, to be precise.



Related Article: Hail of a forecast: Climate change means fewer hailstorms but bigger hail

"What the study is not concerned with is how future emissions might develop," Mauritsen said. "This is a societal problem where we as physical scientists have fairly little to add. These future emissions will, however, add warming on top of the already committed warming and so our study can act as a baseline for estimating how far we are from reaching various temperature targets."

Hare also found this study to be consistent with previous papers on global temperatures on the rise.

"It shows, in effect, that unless we start reducing emissions quickly -- soon there is a risk that we will overshoot temperature limits like 1.5 or 2 degrees C," Hare said. "It is just another confirmation of how dangerous the present situation is unless CO₂ emissions, which have flatlined in the last few years, really start dropping.

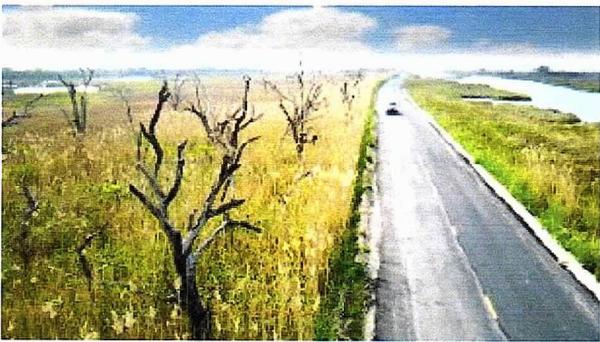
"This addresses a somewhat different question, namely how much warming should we expect if fossil fuel emissions were to suddenly cease," Raftery said. "In contrast, our study tries to assess how much warming we should expect given realistic future trajectories of emissions. Thus the other study provides a lower bound on expected emissions and warming, and this

we would

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What can be done?

Researchers know that if there is any hope of preventing the outcomes they include in their findings, changing public policy is key.

"The next few years are going to be key in the fight against global warming," said Dargan Frierson, co-author of the first study. "Are we going to get to work installing clean energy, or stick to old polluting sources? If we don't act quickly, we better get to work preparing for many severe consequences of a much hotter world."

"There are only two realistic paths toward avoiding long-run disaster: increased financial incentives to avoid greenhouse gas emissions and greatly increased funding for research that will lead to at least partial technological fixes," said Dick Startz, economist and co-author of the second study. "Neither is free. Both are better than the catastrophe at the end of the current path."

Silver linings and hope are hard to find in climate change studies, but they also don't account for every factor.

"The only bright point is that, as the study authors say, they haven't factored in the plummeting cost of solar power," McKibben said. "That's the one way out we still might take -- but only if our governments take full advantage of the breakthroughs our engineers have produced."

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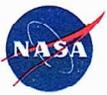


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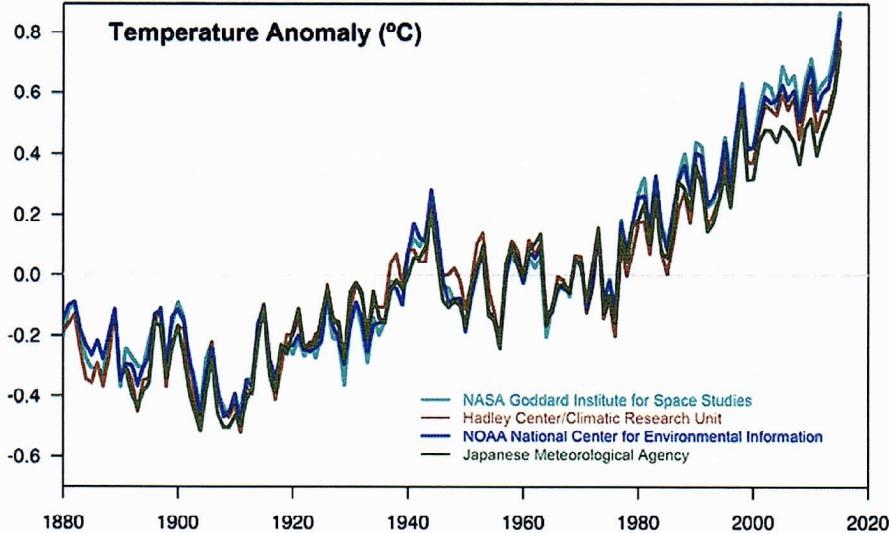
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EXHIBIT "C"



Scientific consensus: Earth's climate is warming



Temperature data from four international science institutions. All show rapid warming in the past few decades and that the last decade has been the warmest on record. Data sources: NASA's Goddard Institute for Space Studies, NOAA National Climatic Data Center, Met Office Hadley Centre/Climatic Research Unit and the Japanese Meteorological Agency.

Multiple studies published in peer-reviewed scientific journals¹ show that 97 percent or more of actively publishing climate scientists agree*: Climate-warming trends over the past century are extremely likely due to human activities. In addition, most of the leading scientific organizations worldwide have issued public statements endorsing this position. The following is a partial list of these organizations, along with links to their published statements and a selection of related resources.

AMERICAN SCIENTIFIC SOCIETIES

Statement on climate change from 18 scientific associations

"Observations throughout the world make it clear that climate change is occurring, and rigorous scientific research demonstrates that the greenhouse gases emitted by human activities are the primary driver." (2009)²

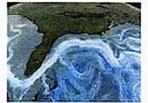
American Association for the Advancement of Science

Latest resources

Video: Greenland's thinning ice



Video: Ocean circulation plays an important role in absorbing carbon from the atmosphere



Video: Annual Arctic sea ice minimum 1979-2016 with area graph

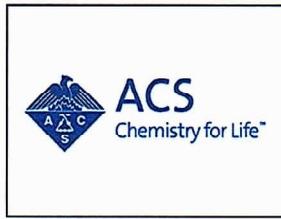


"The scientific evidence is clear: global climate change caused by human activities is occurring now, and it is a growing threat to society." (2006)³



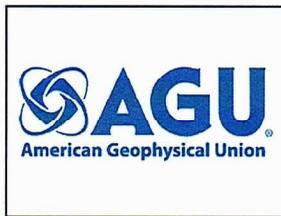
American Chemical Society

"Comprehensive scientific assessments of our current and potential future climates clearly indicate that climate change is real, largely attributable to emissions from human activities, and potentially a very serious problem." (2004)⁴



American Geophysical Union

"Human-induced climate change requires urgent action. Humanity is the major influence on the global climate change observed over the past 50 years. Rapid societal responses can significantly lessen negative outcomes." (Adopted 2003, revised and reaffirmed 2007, 2012, 2013)⁵



American Medical Association

"Our AMA ... supports the findings of the Intergovernmental Panel on Climate Change's fourth assessment report and concurs with the scientific consensus that the Earth is undergoing adverse global climate change and that anthropogenic contributions are significant." (2013)⁶



American Meteorological Society

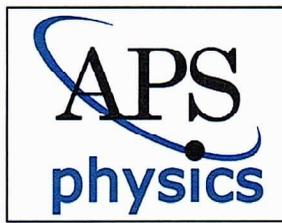
"It is clear from extensive scientific evidence that the dominant cause of the rapid change in climate of the past half century is human-induced increases in the amount of atmospheric greenhouse gases, including carbon dioxide (CO₂), chlorofluorocarbons, methane, and nitrous oxide." (2012)⁷



American Physical Society

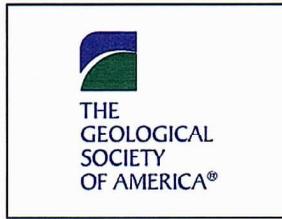
"The evidence is incontrovertible: Global warming is occurring. If no mitigating actions are taken, significant disruptions in the

Earth's physical and ecological systems, social systems, security and human health are likely to occur. We must reduce emissions of greenhouse gases beginning now." (2007)⁸



The Geological Society of America

"The Geological Society of America (GSA) concurs with assessments by the National Academies of Science (2005), the National Research Council (2006), and the Intergovernmental Panel on Climate Change (IPCC, 2007) that global climate has warmed and that human activities (mainly greenhouse-gas emissions) account for most of the warming since the middle 1900s." (2006; revised 2010)⁹



SCIENCE ACADEMIES

International academies: Joint statement

"Climate change is real. There will always be uncertainty in understanding a system as complex as the world's climate. However there is now strong evidence that significant global warming is occurring. The evidence comes from direct measurements of rising surface air temperatures and subsurface ocean temperatures and from phenomena such as increases in average global sea levels, retreating glaciers, and changes to many physical and biological systems. It is likely that most of the warming in recent decades can be attributed to human activities (IPCC 2001)." (2005, 11 international science academies)¹⁰

U.S. National Academy of Sciences

"The scientific understanding of climate change is now sufficiently clear to justify taking steps to reduce the amount of greenhouse gases in the atmosphere." (2005)¹¹



U.S. GOVERNMENT AGENCIES

U.S. Global Change Research Program

"The global warming of the past 50 years is due primarily to human-induced increases in heat-trapping gases. Human 'fingerprints' also have been identified in many other aspects of the climate system, including changes in ocean heat content, precipitation, atmospheric moisture, and Arctic sea ice." (2009, 13 U.S. government departments and agencies)¹²



INTERGOVERNMENTAL BODIES

Intergovernmental Panel on Climate Change

"Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen."¹³



"Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems."¹⁴

OTHER RESOURCES

List of worldwide scientific organizations

The following page lists the nearly 200 worldwide scientific organizations that hold the position that climate change has been caused by human action.

http://opr.ca.gov/s_listoforganizations.php

U.S. agencies

The following page contains information on what federal agencies are doing to adapt to climate change.

<http://www.c2es.org/docUploads/federal-agencies-adaptation.pdf>

**Technically, a “consensus” is a general agreement of opinion, but the scientific method steers us away from this to an objective framework. In science, facts or observations are explained by a hypothesis (a statement of a possible explanation for some natural phenomenon), which can then be tested and retested until it is refuted (or disproved).*

As scientists gather more observations, they will build off one explanation and add details to complete the picture. Eventually, a group of hypotheses might be integrated and generalized into a scientific theory, a scientifically acceptable general principle or body of principles offered to explain phenomena.

References

1. J. Cook, et al, "Consensus on consensus: a synthesis of consensus estimates on human-caused global warming," *Environmental Research Letters* Vol. 11 No. 4, (13 April 2016); DOI:10.1088/1748-9326/11/4/048002

Quotation from page 6: "The number of papers rejecting AGW [Anthropogenic, or human-caused, Global Warming] is a miniscule proportion of the published research, with the percentage slightly decreasing over time. Among papers expressing a position on AGW, an overwhelming percentage (97.2% based on self-ratings, 97.1% based on abstract ratings) endorses the scientific consensus on AGW."

J. Cook, et al, "Quantifying the consensus on anthropogenic global warming in the scientific literature," *Environmental Research Letters* Vol. 8 No. 2, (15 May 2013); DOI:10.1088/1748-9326/8/2/024024

Quotation from page 3: "Among abstracts that expressed a position on AGW, 97.1% endorsed the scientific consensus. Among scientists who expressed a position on AGW in their abstract, 98.4% endorsed the consensus."

W. R. L. Anderegg, "Expert Credibility in Climate Change," *Proceedings of the National Academy of Sciences* Vol. 107 No. 27, 12107-12109 (21 June 2010); DOI: 10.1073/pnas.1003187107.

P. T. Doran & M. K. Zimmerman, "Examining the Scientific Consensus on Climate Change," *Eos Transactions American Geophysical Union* Vol. 90 Issue 3 (2009), 22; DOI: 10.1029/2009EO030002.

N. Oreskes, "Beyond the Ivory Tower: The Scientific Consensus on Climate Change," *Science* Vol. 306 no. 5702, p. 1686 (3 December 2004); DOI: 10.1126/science.1103618.

2. Statement on climate change from 18 scientific associations (2009)
3. AAAS Board Statement on Climate Change (2006)
4. ACS Public Policy Statement: Climate Change (2010-2013)
5. Human-Induced Climate Change Requires Urgent Action (2013)
6. Global Climate Change and Human Health (2013)
7. Climate Change: An Information Statement of the American Meteorological Society (2012)
8. APS National Policy 07.1 Climate Change (2007)
9. GSA Position Statement on Climate Change (2010)
10. Joint science academies' statement: Global response to climate change (2005)
11. Understanding and Responding to Climate Change (2005)
12. Global Climate Change Impacts in the United States (2009)
13. IPCC Fifth Assessment Report, Summary for Policymakers (2014)
14. IPCC Fifth Assessment Report, Summary for Policymakers (2014)

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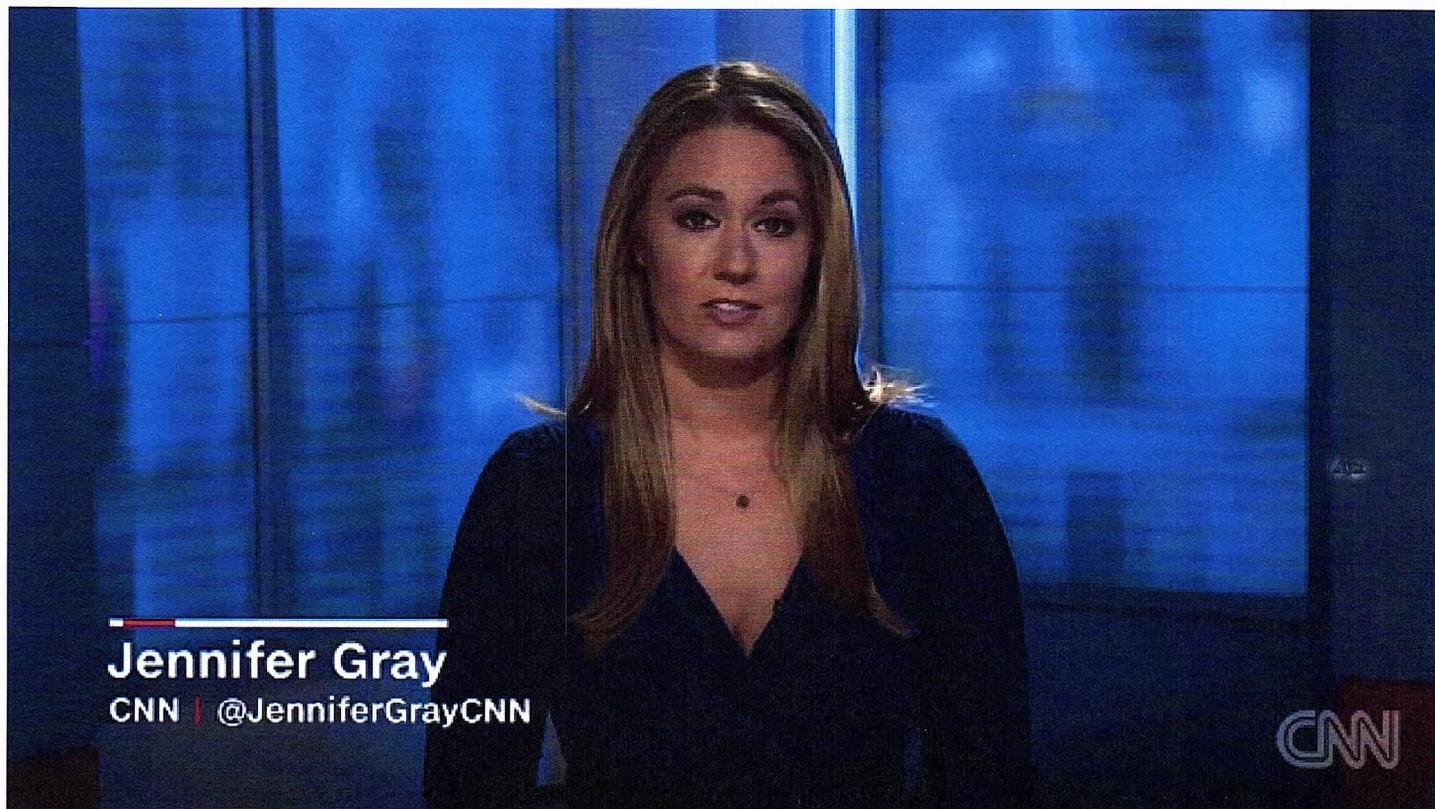
Site last updated: November 14, 2017

EXHIBIT “D”

Trump administration report attributes climate change to 'human activities'

By [Gregory Wallace](#)

Updated 9:30 PM ET, Fri November 3, 2017



Jennifer Gray
CNN | @JenniferGrayCNN

Source: CNN

Undeniable climate change facts 02:24

(CNN) — A significant federal government study released Friday finds "no convincing alternative explanation" for the changing climate other than "human activities, especially emissions of greenhouse gases."

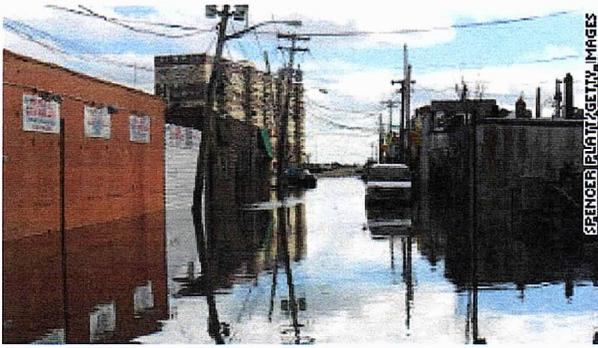
When drafts of the report were circulated earlier this year, some participants voiced concern that President Donald Trump's administration would seek to somehow interfere with the report, due to skepticism from Trump and others in his administration about climate science. Trump has nominated climate skeptics to top [Environmental Protection Agency posts](#), and his administration has actively worked to dismantle climate protections, along with pulling out of the Paris climate accord.

But the study released Friday spoke specifically to the effects and costs of climate change.

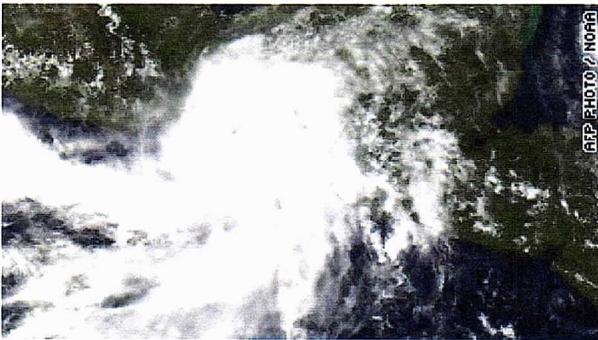
"This assessment concludes, based on extensive evidence, that it is extremely likely that human activities, especially emissions of greenhouse gases, are the dominant cause of

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alternative explanation supported by the extent of the observational evidence," the report said.

Warming temperatures globally, rising sea levels, more frequent heat waves and increased numbers of forest fires are evidence of the changing climate, the report stated.

The Climate Science Special Report is required by federal law and includes contributions from multiple government agencies and non-government academic experts. The report is a component of the Fourth National Climate Assessment.

"The magnitude of climate change beyond the next few decades will depend primarily on the amount of greenhouse gases (especially carbon dioxide) emitted globally," the report said.

The Trump administration has indicated multiple times that climate change is not one of its priorities. Trump has previously labeled climate change a "hoax."

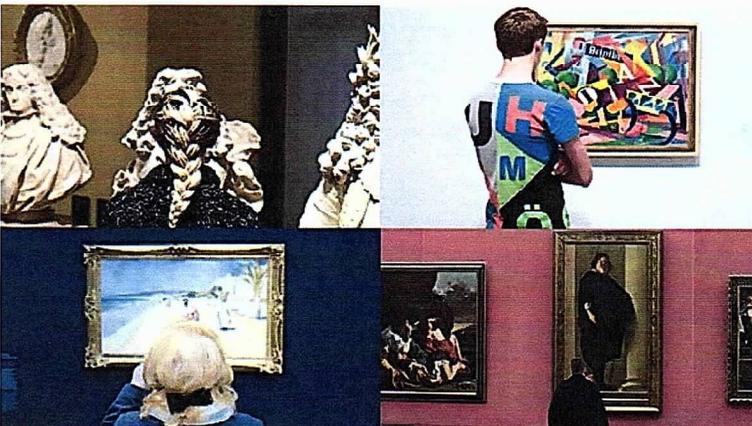
In addition to the administration's withdrawal from the Paris agreement, the EPA did not include climate change in its [recent strategic plan](#), has moved to overturn the landmark Clean Power Plan, and has [dropped experts from advisory panels](#).

EPA Administrator Scott Pruitt has proposed organizing teams to debate climate science.

But the White House said Friday it "supports rigorous scientific analysis and debate."

"The climate has changed and is always changing," spokesman Raj Shah said in a statement. "In the United

States, energy related carbon dioxide emissions have been declining, are expected to remain flat through 2040, and will also continue to decline as a share of world emissions."



Photographer captures people

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EXHIBIT "E"

The New York Times <https://nyti.ms/2vdswoz>

CLIMATE

Scientists Fear Trump Will Dismiss Blunt Climate Report

By LISA FRIEDMAN AUG. 7, 2017

WASHINGTON — The average temperature in the United States has risen rapidly and drastically since 1980, and recent decades have been the warmest of the past 1,500 years, according to a sweeping federal climate change report awaiting approval by the Trump administration.

The draft report by scientists from 13 federal agencies concludes that Americans are feeling the effects of climate change right now. It directly contradicts claims by President Trump and members of his cabinet who say that the human contribution to climate change is uncertain, and that the ability to predict the effects is limited.

“Evidence for a changing climate abounds, from the top of the atmosphere to the depths of the oceans,” a draft of the report states. It was uploaded to a nonprofit internet digital library in January but received little attention until it was published by The New York Times.

The authors note that thousands of studies, conducted by tens of thousands of scientists, have documented climate changes on land and in the air. “Many lines of evidence demonstrate that human activities, especially emissions of greenhouse

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The report was completed this year and is a special science section of the National Climate Assessment, which is congressionally mandated every four years. The National Academy of Sciences has signed off on the draft report, and the authors are awaiting permission from the Trump administration to release it.

One scientist who worked on the report, Katharine Hayhoe, a professor of political science at Texas Tech University, called the conclusions among “the most comprehensive climate science reports” to be published. Another scientist involved in the process, who spoke to The New York Times on the condition of anonymity, said he and others were concerned that it would be suppressed.

The White House and the Environmental Protection Agency did not immediately return calls or respond to emails requesting comment on Monday night.

The report concludes that even if humans immediately stopped emitting greenhouse gases into the atmosphere, the world would still feel at least an additional 0.50 degrees Fahrenheit (0.30 degrees Celsius) of warming over this century compared with today. The projected actual rise, scientists say, will be as much as 2 degrees Celsius.

A small difference in global temperatures can make a big difference in the climate: The difference between a rise in global temperatures of 1.5 degrees Celsius and one of 2 degrees Celsius, for example, could mean longer heat waves, more intense rainstorms and the faster disintegration of coral reefs.

Among the more significant of the study’s findings is that it is possible to attribute some extreme weather to climate change. The field known as “attribution science” has advanced rapidly in response to increasing risks from climate change.

The E.P.A. is one of 13 agencies that must approve the report by Aug. 18. The agency’s administrator, Scott Pruitt, has said he does not believe that carbon dioxide is a primary contributor to global warming.

“It’s a fraught situation,” said Michael Oppenheimer, a professor of geoscience and international affairs at Princeton University who was not involved in the study. “This is the first case in which an analysis of climate change of this scope has come

up in the Trump administration, and scientists will be watching very carefully to see how they handle it.”

Scientists say they fear that the Trump administration could change or suppress the report. But those who challenge scientific data on human-caused climate change say they are equally worried that the draft report, as well as the larger National Climate Assessment, will be publicly released.

The National Climate Assessment “seems to be on autopilot” because of a lack of political direction, said Myron Ebell, a senior fellow at the Competitive Enterprise Institute.

The report says significant advances have been made linking human influence to individual extreme weather events since the last National Climate Assessment was produced in 2014. Still, it notes, crucial uncertainties remain.

It cites the European heat wave of 2003 and the record heat in Australia in 2013 as specific episodes where “relatively strong evidence” showed that a man-made factor contributed to the extreme weather.

In the United States, the authors write, the heat wave that broiled Texas in 2011 was more complicated. That year was Texas’ driest on record, and one study cited in the report said local weather variability and La Niña were the primary causes, with a “relatively small” warming contribution. Another study had concluded that climate change made extreme events 20 times more likely in Texas.

Based on those and other conflicting studies, the federal draft concludes that there was a medium likelihood that climate change played a role in the Texas heat wave. But it avoids assessing other individual weather events for their link to climate change. Generally, the report described linking recent major droughts in the United States to human activity as “complicated,” saying that while many droughts have been long and severe, they have not been unprecedented in the earth’s hydrologic natural variation.

Worldwide, the draft report finds it “extremely likely” that more than half of the global mean temperature increase since 1951 can be linked to human influence.

In the United States, the report concludes with “very high” confidence that the number and severity of cool nights have decreased since the 1960s, while the frequency and severity of warm days have increased. Extreme cold waves, it says, are less common since the 1980s, while extreme heat waves are more common.

The study examines every corner of the United States and finds that all of it was touched by climate change. The average annual temperature in the United States will continue to rise, the authors write, making recent record-setting years “relatively common” in the near future. It projects increases of 5.0 to 7.5 degrees Fahrenheit (2.8 to 4.8 degrees Celsius) by the late century, depending on the level of future emissions.

It says the average annual rainfall across the country has increased by about 4 percent since the beginning of the 20th century. Parts of the West, Southwest and Southeast are drying up, while the Southern Plains and the Midwest are getting wetter.

With a medium degree of confidence, the authors linked the contribution of human-caused warming to rising temperatures over the Western and Northern United States. It found no direct link in the Southeast.

Additionally, the government scientists wrote that surface, air and ground temperatures in Alaska and the Arctic are rising at a frighteningly fast rate — twice as fast as the global average.

“It is very likely that the accelerated rate of Arctic warming will have a significant consequence for the United States due to accelerating land and sea ice melting that is driving changes in the ocean including sea level rise threatening our coastal communities,” the report says.

Human activity, the report goes on to say, is a primary culprit.

The study does not make policy recommendations, but it notes that stabilizing the global mean temperature increase to 2 degrees Celsius — what scientists have referred to as the guardrail beyond which changes become catastrophic — will require significant reductions in global levels of carbon dioxide.

Nearly 200 nations agreed as part of the Paris accords to limit or cut fossil fuel emissions. If countries make good on those promises, the federal report says, that will be a key step toward keeping global warming at manageable levels.

Mr. Trump announced this year that the United States would withdraw from the Paris agreement, saying the deal was bad for America.

Correction: August 9, 2017

An article on Tuesday about a sweeping federal climate change report referred incorrectly to the availability of the report. While it was not widely publicized, the report was uploaded by the nonprofit Internet Archive in January; it was not first made public by The New York Times.

Correction: August 15, 2017

An article last Tuesday about a sweeping federal climate change report misstated the professional credentials of Katharine Hayhoe, who contributed to the report. She is a professor at Texas Tech University, not a government scientist.

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A version of this article appears in print on August 8, 2017, on Page A1 of the New York edition with the headline: Climate Report Full of Warnings Awaits President.

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EXHIBIT “F”

Chemical Composition of Natural Gas

Natural gas is a naturally occurring gas mixture, consisting mainly of methane. The gas supplied to Union Gas comes from western Canada, the United States and Ontario producers. While the gas from these sources has a similar analysis, it is not entirely the same. The table below outlines the typical components of natural gas on the Union Gas system and the typical ranges for these values (allowing for the different sources).

Note that there is no guarantee of the following composition at your location or as an overall system average. Since the different gas supplies enter the Union Gas system at different locations, the exact composition at any site will vary among the different regions and over time. The system average heating value will depend on the mix of gas supplies (which is increasingly controlled by our customers), and therefore can vary from the typical value listed below.

Component	Typical Analysis (mole %)	Range (mole %)
Methane	93.9	87.0 - 97.0
Ethane	4.2	1.5 - 9.0
Propane	0.3	0.1 - 1.5
iso - Butane	0.03	0.01 - 0.3
normal - Butane	0.03	0.01 - 0.3
iso - Pentane	0.01	trace - 0.04
normal - Pentane	0.01	trace - 0.04
Hexanes plus	0.01	trace - 0.06
Nitrogen	1.0	0.2 - 5.5
Carbon Dioxide	0.5	0.05 - 1.0
Oxygen	0.01	trace - 0.1
Hydrogen	trace	trace - 0.02
Specific Gravity	0.59	0.57 - 0.62
Gross Heating Value (MJ/m ³), dry basis *	38.7	36.0 - 40.2
Wobbe Number (MJ/m ³)	50.4	47.5 - 51.5

* The gross heating value is the total heat obtained by complete combustion at constant pressure of a unit volume of gas in air, including the heat released by condensing the water vapour in the combustion products (gas, air, and combustion products taken at standard temperature and pressure).

Sulphur:

In the Union Gas system, the typical sulphur content is 5.5 mg/m³. This includes the 4.9 mg/m³ of sulphur in the odourant (mercaptan) added to gas for safety reasons.

Water:

The water vapour content of natural gas in the Union Gas system is less than 65 mg/m³, and is typically 16 to 32 mg/m³.

Typical Combustion Properties of Natural Gas

Note that there is no guarantee that the combustion properties at your location will be exactly as shown. The properties shown are an overall average on the Union Gas system.

- Ignition Point: 564 °C *
- Flammability Limits: 4% - 15% (volume % in air) *
- Theoretical Flame Temperature (stoichiometric air/fuel ratio): 1953 °C *
- Maximum Flame Velocity: 0.36 m/s *

* Information provided is from the Ortech Report No. 26392, Combustion Property Calculations for a typical Union Gas Composition, 2017.

EXHIBIT “G”

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E&E NEWS

SUSTAINABILITY

How Bad of a Greenhouse Gas Is Methane?

The global warming potential of the gaseous fossil fuel may be consistently underestimated

By Gayathri Vaidyanathan, ClimateWire on December 22, 2015



At present, nations report methane emissions in terms of CO₂ equivalents, using GWP100 as the conversion factor. This allows nations, such as the United States, that use natural gas to generate electricity to present a cleaner façade to the world than they have in reality. *Credit: ©iStock*

SAN FRANCISCO—Environmental advocates are trying to change how policymakers consider the climate impacts of methane, a potent greenhouse gas.

The change, if implemented, could make natural gas a less attractive option for generating electricity in power plants.

At issue is the global warming potential (GWP), a number that allows experts to compare methane with its better-known cousin, carbon dioxide. While CO₂ persists in the atmosphere for centuries, or even millennia, methane warms the planet on steroids for a decade or two before decaying to CO₂.

In those short decades, methane warms the planet by 86 times as much as CO₂, according to the Intergovernmental Panel on Climate Change.

But policymakers typically ignore methane's warming potential over 20 years (GWP₂₀) when assembling a nation's emissions inventory. Instead, they stretch out methane's warming impacts over a century, which makes the gas appear more benign than it is, experts said. The 100-year warming potential (GWP₁₀₀) of methane is 34, according to the IPCC.

There is no scientific reason to prefer a 100-year time horizon over a 20-year time horizon; the choice of GWP₁₀₀ is simply a matter of convention.

The 100-year GWP value underestimates the gas's negative impacts by almost five times, said Ilissa Ocko, a climate scientist at the nonprofit Environmental Defense Fund. The quick warming in the short run catalyzed by methane can affect environmental processes, such as the flowering of plants, she said at the American Geophysical Union meeting last week.

"The short-lived climate pollutants [like methane] that we emit from human activities are basically controlling how fast the warming occurs," she said. "This is because they are very powerful at absorbing radiation."

EDF and some scientists are calling on the United Nations and policymakers to stop relying on GWP₁₀₀. They would instead like experts to use GWP₂₀ and GWP₁₀₀ as a slashed pair.

A push for quicker reductions

"Just like if you were looking at blood pressure and there is only one number, and you'd be like, 'Where is the other one?'" Ocko said.

Ocko and her colleagues will soon publish a peer-reviewed study with this message to get the scientific community on board. Their hope is this convention would be more widely accepted among policymakers.

The effort has gained urgency since the United States has become a large natural-gas-producing nation. Its emissions of methane between 1990 and 2013 have fallen by 15 percent, according to U.S. EPA, though some studies have suggested that methane inventories may be faulty.

If the proposed nomenclature change is adopted by the United Nations, which collects greenhouse gas inventories from nations every year, it could change the optics of the climate change reductions nations are implementing, said Bryce Payne, director of science and technology at Gas Safety Inc., a company that measures methane emissions.

At present, nations report methane emissions in terms of CO₂ equivalents, using GWP₁₀₀ as the conversion factor. This allows nations, such as the United States, that use natural gas to generate electricity to present a cleaner façade to the world than they have in reality, he said.

Payne and two other scientists wrote a letter to the U.S. delegation at the United Nations' climate change summit this month suggesting that the United Nations Framework Convention on Climate Change require nations to use a 10-year global warming potential, or GWP₁₀, in their emissions inventory. This would allow quicker curbs on methane, they wrote.

"Efforts to control methane emissions should be part of a broad effort to reduce, preferably end, anthropogenic [greenhouse gas] emissions at the earliest possible date," he wrote.

EXHIBIT “H”



THE PRESIDENT'S CLIMATE ACTION PLAN

Executive Office of the President

June 2013



building owners and public housing agencies to cut energy waste. In addition, the Administration is launching the Better Buildings Accelerators, a new track that will support and encourage adoption of State and local policies to cut energy waste, building on the momentum of ongoing efforts at that level.

IV. Reducing Other Greenhouse Gas Emissions

Curbing Emissions of Hydrofluorocarbons: Hydrofluorocarbons (HFCs), which are primarily used for refrigeration and air conditioning, are potent greenhouse gases. In the United States, emissions of HFCs are expected to nearly triple by 2030, and double from current levels of 1.5 percent of greenhouse gas emissions to 3 percent by 2020.

To reduce emissions of HFCs, the United States can and will lead both through international diplomacy as well as domestic actions. In fact, the Administration has already acted by including a flexible and powerful incentive in the fuel economy and carbon pollution standards for cars and trucks to encourage automakers to reduce HFC leakage and transition away from the most potent HFCs in vehicle air conditioning systems. Moving forward, the Environmental Protection Agency will use its authority through the Significant New Alternatives Policy Program to encourage private sector investment in low-emissions technology by identifying and approving climate-friendly chemicals while prohibiting certain uses of the most harmful chemical alternatives. In addition, the President has directed his Administration to purchase cleaner alternatives to HFCs whenever feasible and transition over time to equipment that uses safer and more sustainable alternatives.

Reducing Methane Emissions: Curbing emissions of methane is critical to our overall effort to address global climate change. Methane currently accounts for roughly 9 percent of domestic greenhouse gas emissions and has a global warming potential that is more than 20 times greater than carbon dioxide. Notably, since 1990, methane emissions in the United States have decreased by 8 percent. This has occurred in part through partnerships with industry, both at home and abroad, in which we have demonstrated that we have the technology to deliver emissions reductions that benefit both our economy and the environment. To achieve additional progress, the Administration will:

- **Developing an Interagency Methane Strategy:** The Environmental Protection Agency and the Departments of Agriculture, Energy, Interior, Labor, and Transportation will develop a comprehensive, interagency methane strategy. The group will focus on assessing current emissions data, addressing data gaps, identifying technologies and best practices for reducing emissions, and identifying existing authorities and incentive-based opportunities to reduce methane emissions.
- **Pursuing a Collaborative Approach to Reducing Emissions:** Across the economy, there are multiple sectors in which methane emissions can be reduced, from coal mines and landfills to agriculture and oil and gas development. For example, in the agricultural sector, over the last three years, the Environmental Protection Agency and the Department of Agriculture have worked with the dairy industry to increase the adoption of methane digesters through loans, incentives, and other assistance. In addition, when it comes to the oil and gas sector, investments to build and upgrade gas pipelines will not only put more Americans to work, but also reduce emissions and enhance economic productivity. For example, as part of the Administration's effort to improve federal

EXHIBIT "I"

RTAP LIST/FRACKED GAS COMPARISON

22 toxic air pollutants on [RTAP List](#) (beginning at page 15) are associated with fracked gas, either as additives or produced by combustion of this gas (VOCs).

15 of these are Toxicity Class I (most toxic); 6 are Toxicity Class II, 1 is Toxicity Class III.

10 RTAPs - 5 Toxicity Class I, 4 Toxicity Class II, 1 Toxicity Class III - are on EPA list of frequent additives to fracked gas

Sources: [RTAP List](#) (beginning at page 15) and Table 9, at p. 36, of [“Analysis of Hydraulic Fracturing Fluid Data from the FracFocus Chemical Disclosure Registry 1.0,” by the EPA \(March 2015\)](#); *see also* [EPA website](#)

Methanol: RTAP CAS No. 67 – 56 – 1, Toxicity Class II

Ethanol: RTAP CAS No. 64 – 17 – 5, Toxicity Class II

Propargyl alcohol : RTAP CAS No. 107 – 19 – 7, Toxicity Class I

Glutaraldehyde: RTAP CAS No. 111 – 30 – 8, Toxicity Class I

Ethylene glycol (aerosol): RTAP CAS No. 107 – 21 – 1, Toxicity Class II

2-Butoxyethanol: RTAP CAS No. 111 – 76 – 2, Toxicity Class I

Napthalene: RTAP CAS No. 91 – 20 – 3, Toxicity Class I

1,2,4-Trimethylbenzene: RTAP CAS No. 95 – 63 – 6, Toxicity Class II

Dimethylformamide: RTAP CAS No. 68 – 12 – 2, Toxicity Class I

Polyethylene glycol: RTAP CAS No. 25322 – 68 – 3, Toxicity Class III

11 more RTAPs - 9 Toxicity Class I, 2 Toxicity Class II – are identified Table 7 VOCs from fracked gas

Sources: [RTAP List](#) (beginning at page 15) and Table 7, at p. 21, of [“Gas Patch Roulette: How Shale Gas Development Risks Public Health in Pennsylvania,” by Nadia Steinzor, et. al. \(October 2012\)](#)

Acetone: RTAP CAS No. 67 – 64 – 1, Toxicity Class I

1,1,2-Trichloro-1,2,2-Trifluoroethane: RTAP CAS No. 76–13–1 , Toxicity Class II

Carbon tetrachloride: RTAP CAS No. 56 – 23 – 5, Toxicity Class I

Toluene: RTAP CAS No. 108 – 88 – 3, Toxicity Class I

n-Hexane: RTAP CAS No. 110 – 54 – 3, Toxicity Class II

Benzene: RTAP CAS 71 – 43 – 2, Toxicity I

Methylene chloride (dichloromethane): RTAP CAS No. 75 – 09 – 2, Toxicity Class I

Trichloroethylene: RTAP CAS No. 79 – 01 – 6, Toxicity Class I

Xylene m-isomers: RTAP CAS No. 108 – 38 – 3, Toxicity Class I

Xylene p-isomers: RTAP CAS No. 106 – 42 – 3, Toxicity Class I

Xylene o-isomers: RTAP CAS No. 95 – 47 – 6, Toxicity Class I

A 22nd RTAP, the VOC Formaldehyde - Toxicity Class I – is also found in fracked gas

Sources: pp. 18-19 at [“Madison County, New York Department of Health Comments to the Federal Energy Regulatory Committee,” prepared for Madison County Department of Health by Thimble Creek Research \(September 30, 2014\)](#); pp. 26-27 and Appendix B, pp. 2-6 and Table 12 at p. 10, of [ATSDR/CDC Health Consultation Report \(Jan. 29, 2016\)\(asthmatics, elderly and others at risk from compressor stations\)](#); p. 5 and Appendix 1 at p. 19 of [“California’s Fracking Fluids: the Chemical Recipe,” by Tasha Stoiber, et. al. \(EWG; August 2015\)](#)

NOTE: Formaldehyde does not appear in the Table 7 VOC list because sampling for that study was done with Summa canisters. Badges are generally used for formaldehyde monitoring. Formaldehyde is a carcinogen. [Union Leader, December 18, 2015 online article by Meghan Pierce](#)

Compiled by Liz Fletcher for NH Pipeline Health Study Group, May 2016