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Bill McKibben's Terrifying Disregard for Fracking Facts

By Isaac Orr*

1. Introduction

"Be afraid. Be very afraid." That is the overriding sentiment of a recent article titled "Global Warming's Terrifying New Chemistry," written by Bill McKibben, an environmental activist and founder of 350.org, an organization dedicated to stopping the use of all fossil fuels.[1,2] McKibben portrays methane, the primary component of natural gas, as a greenhouse gas potentially more dangerous than carbon dioxide because methane is more effective at trapping heat in the atmosphere.

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McKibben claims hydraulic fracturing, commonly referred to as "fracking," is responsible for releasing massive quantities of methane into the atmosphere. He argues fracking could release methane in sufficient quantities that humans' use of natural gas could lead to more intense global warming than our use of coal. Fortunately, he's

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* Isaac Orr is a research fellow for The Heartland Institute. For a more complete bio, see page 28. The author acknowledges and thanks the following persons for reviewing this paper and suggesting revisions: Dr. Calvin Beisner, Dr. John Droz, Dr. Jay Lehr, Mr. Bryan Leyland, Ms. Marita Noon, Dr. Lucian Platt, Mr. Tom Sheahen, and Dr. Willie Soon. Any errors that remain are the sole responsibility of the author.

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[1] Bill McKibben, "Global Warming's Terrifying New Chemistry," The Nation, March 23, 2016, https://www.thenation.com/article/global-warming-terrifying-new-chemistry/.

[2] "Break Free From Fossil Fuels," 350.org, breakfree2016.org, website, last accessed 8/19/2016.

wrong. Acting on his arguments against fracking would actually cause the United States to greatly increase its output of carbon dioxide, which would be the opposite of what environmentalists say they want.

Fracking and the natural gas it produces have been heralded by many experts as reducing greenhouse gas emissions in the United States, primarily because burning natural gas emits half as much carbon dioxide (CO_2) per BtU of energy produced as burning coal.[3] Some life-cycle estimates suggest burning natural gas emits 43 percent less CO_2 per BtU than the burning of coal.

> Using an inaccurate portrayal of methane emissions as a reason to push for a ban on fracking, however, would be bad public policy.

Data from the Energy Information Administration (EIA) show the United States reduced its carbon dioxide emissions by 12 percent between 2005 and 2015. Switching from coal to natural gas in the power sector was responsible for 68 percent of the total energy-related CO_2 reductions during that period (see Figure 1).[4] Burning larger quantities of natural gas for electricity generation is the main reason the United States has reduced its CO_2 emissions more than any other country in the world since 2005, achieving CO_2 emission reductions more than six times greater than in Great Britain and more than 12.5 times greater than in Germany during this time period.[5]

Understanding these tradeoffs is important because in the short term, methane is a more potent greenhouse gas than CO_2. The U.S. Environmental Protection Agency (EPA) estimates that molecule-for-molecule, methane is 25 times more potent than carbon dioxide in the atmosphere but methane is less of a concern over the longer term because methane breaks down naturally in the atmosphere after approximately eight to 12 years. The short lifespan of methane means its warming impact on the climate is short-lived.[6] By contrast, estimates of how long CO_2 can linger in the atmosphere range from five to 200 years before it is absorbed by the ocean or by plants and turned into bio-matter.

There is great value in measuring how much methane is escaping into the atmosphere because understanding where leaks are occurring, and how much is leaking, provides oil and gas operators and regulators with the information they need to reduce them. Using an inaccurate

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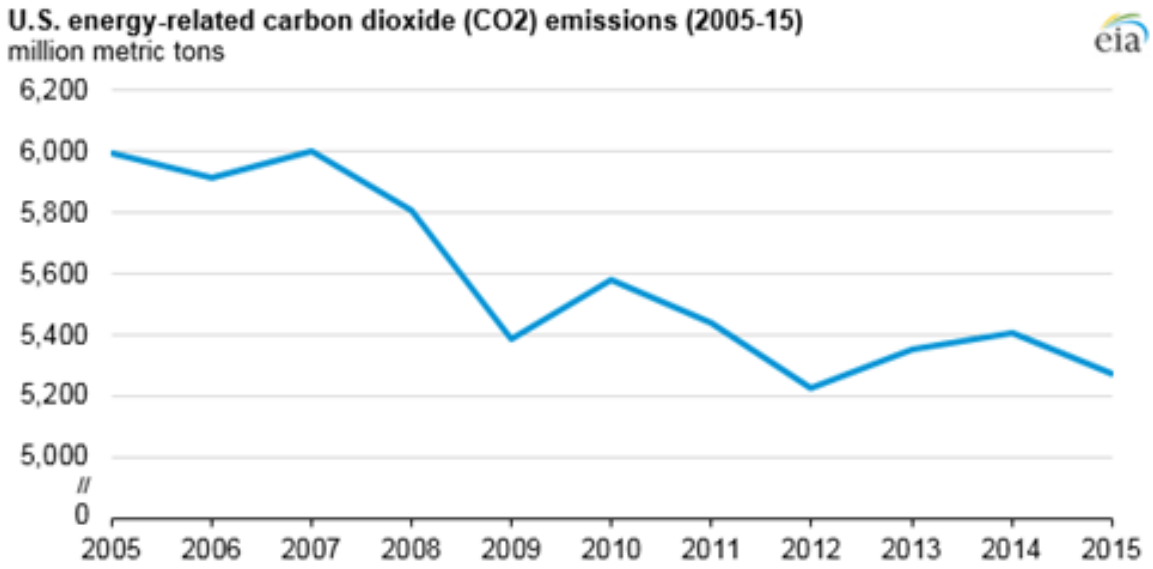
[3] IFC International, "Finding the Facts on Methane Emissions: A Guide to the Literature," April, 2016, http://www.ngsa.org/download/analysis_studies/NGC-Final-Report-4-25.pdf.

[4] Energy Information Administration, "U.S. Energy-Related Carbon Dioxide Emissions in 2015 are 12% Below Their 2005 Levels," *Today in Energy*, May 9, 2016, http://www.eia.gov/todayinenergy/detail.cfm?id=26152.

[5] Simon Evans, "Climate Slowdown: Has the US, UK, or Germany Done More to Cut Emissions?" Carbon Brief, April 10, 2015, https://www.carbonbrief.org/climate-showdown-has-the-us-uk-or-germany-done-more-to-cut-emissions.

[6] Stig B. Dalsøren *et al.*, "Atmospheric Methane Evolution the Last 40 Years," *Atmospheric Chemistry and Physics*, March 9, 2016, http://www.atmos-chem-phys.net/16/3099/2016/acp-16-3099-2016.pdf.

Figure 1
U.S. energy-related carbon dioxide emissions have fallen by 12 percent since 2005



Source: Energy Information Administration, "U.S. Energy-Related Carbon Dioxide Emissions in 2015 are 12% Below Their 2005 Levels," *Today in Energy*, May 9, 2016, http://www.eia.gov/todayinenergy/detail.cfm?id=26152.

portrayal of methane emissions as a reason to push for a ban on fracking, however, would be bad public policy. We need the energy provided by natural gas and oil, as renewable sources cannot meet that demand.

In the end, methane emissions aren't nearly as terrifying as Bill McKibben claims.

Although McKibben – a journalist, not a scientist – accurately identifies methane as being exceptionally good at capturing heat in Earth's atmosphere, his "the-sky-is-falling" analysis is based on cherry-picking data useful to his cause, selectively interpreting the results of other studies, ignoring contradicting data, and failing to acknowledge the real uncertainties in our understanding of how much methane is entering the atmosphere. In the end, methane emissions aren't nearly as terrifying as McKibben claims.

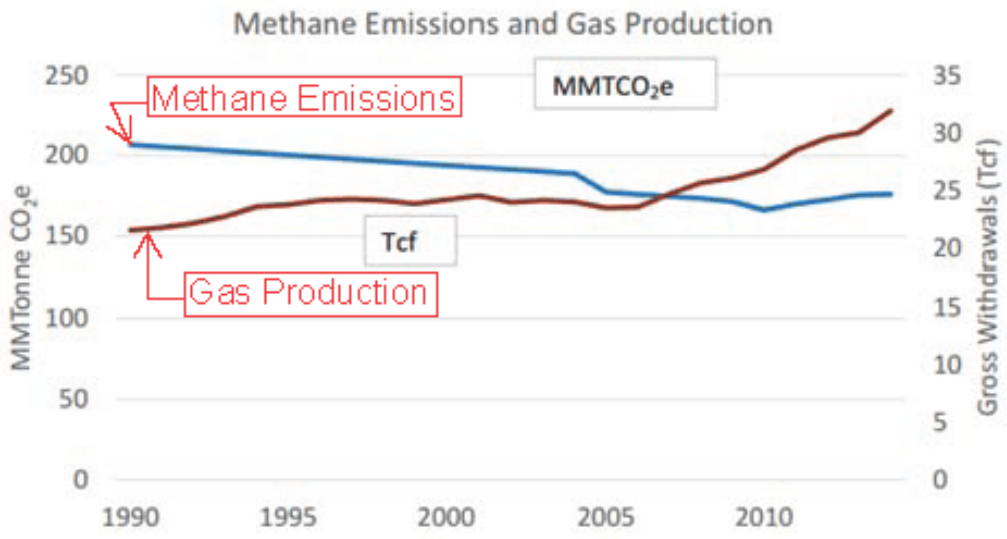
Part 2 of this Heartland Institute *Policy Brief* examines how methane emissions are measured. Part 3 reports the impact those emissions may have on global warming. Part 4 discusses several falsehoods McKibben repeats from the discredited movie *Gasland*. Part 5 considers what alternatives might be available to energy produced by fracking, and finds those alternatives wanting. Part 6 discusses the relatively small impact new methane emissions rules enacted by EPA will have on the global climate. A brief conclusion summarizes my findings.

2. Measuring Methane Emissions

How much methane is emitted by oil and natural gas operations in the United States? This is a question without an easy answer. Tools have been developed only recently to measure accurately methane emissions, with new and better equipment progressively replacing less perfect methods.

According to the EPA Greenhouse Gas Inventory, methane emissions from the natural gas industry have been declining continuously since the early 1990s. Absolute emissions declined between 6 and 15 percent between 1990 and 2014 – a period during which natural gas production increased by more than 53 percent (see Figure 2).[7,8] Methane emissions fell by 43 percent per unit of natural gas produced during this time (see Figure 3).[9]

Figure 2
Natural gas production has grown significantly since 1990 while methane emissions declined



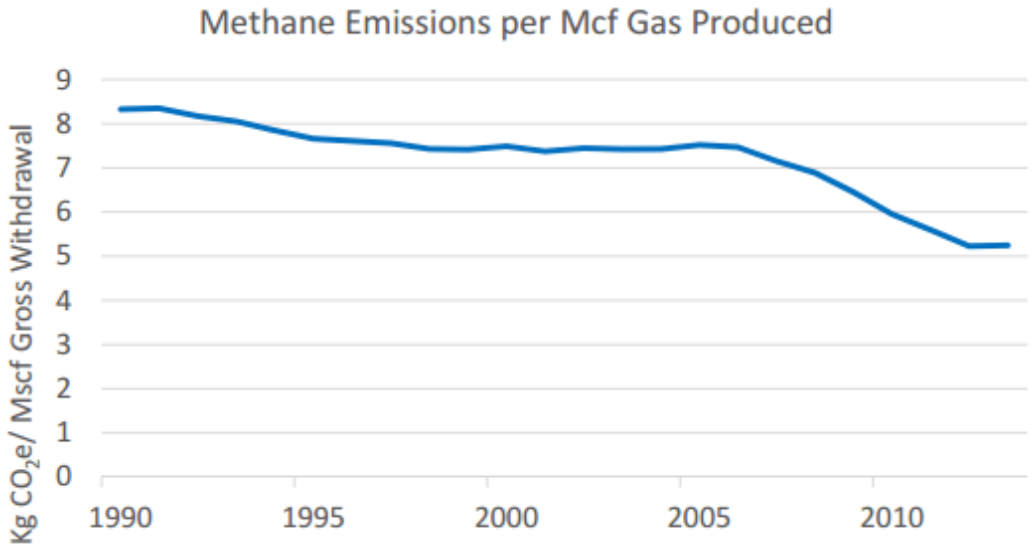
Source: IFC International, "Finding the Facts on Methane Emissions: A Guide to the Literature," April 2016, http://www.ngsa.org/download/analysis_studies/NGC-Final-Report-4-25.pdf. *Data source*: U.S. Energy Information Administration, Greenhouse Gas Inventory Data Explorer, http://www3.epa.gov/climatechange/ghgemissions/inventoryexplorer/#energy/allgas/source/all.

[7] U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emission and Sinks: 1990–2014," April 15, 2016, https://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2016-Main-Text.pdf.

[8] Energy Information Administration, "U.S. Natural Gas Gross Withdrawals," accessed July 27, 2016, http://www.eia.gov/dnav/ng/hist/n9010us2a.htm.

[9] IFC International, *supra* note 3.

Figure 3
The amount of methane emitted into the atmosphere per unit of gas produced has fallen



Source: IFC International, "Finding the Facts on Methane Emissions: A Guide to the Literature," April 2016, http://www.ngsa.org/download/analysis_studies/NGC-Final-Report-4-25.pdf. Data source: U.S. Energy Information Administration, Greenhouse Gas Inventory Data Explorer, http://www3.epa.gov/climatechange/ghgemissions/inventoryexplorer/#energy/allgas/source/all.

Factors contributing to methane emission reductions include equipment turnover and replacement (such as replacing old, leak-prone, cast iron pipes with plastic piping), voluntary reductions of natural gas losses by the gas industry, economic incentives to capture more gas and thus lose less money on unsold product, and recent regulations to limit volatile organic compounds (VOCs), which also reduce methane emissions.[10,11]

Molecule for molecule, methane traps more heat than CO_2 does, but methane accounts for only about 10.6 percent of manmade greenhouse gas emissions (GHGs) in the United States, with methane from the oil and gas industry representing only about 3.4 percent of this total.[12,13] New EPA rules aimed at reducing methane leaks from oil and natural gas production by 40 to 45 percent by 2025 are expected to have no discernible impact on global temperatures,

[10] *Ibid.*

[11] U.S. Environmental Protection Agency, *supra* note 7.

[12] *Ibid.*

[13] Bernard Weinstein, "Tougher Methane Regulations: A Solution In Search of a Problem," *Investor's Business Daily*, April 8, 2016, http://www.investors.com/politics/viewpoint/tougher-methane-regulations-a-solution-in-search-of-a-problem/.

hypothetically reducing global warming by only 0.0047 degrees Celsius by 2100.[14] The United States could cease *all* oil and natural gas production and have no meaningful impact on the environment.

Harvard University Study

New EPA rules aimed at reducing methane leaks from oil and natural gas production are expected to have no discernible impact on global temperatures.

McKibben obviously disagrees with the analysis presented so far. He claims methane emissions have been and continue to be severely underestimated by EPA and others, and he further claims these emissions are having a greater warming impact on the climate than previously thought. McKibben writes,

> In February, Harvard researchers published an explosive paper in *Geophysical Research Letters*. Using satellite data and ground observations, they concluded that the nation as a whole is leaking methane in massive quantities. Between 2002 and 2014, the data showed that US methane emissions increased by more than 30 percent, accounting for 30 to 60 percent of an enormous spike in methane in the entire planet's atmosphere.
>
> To the extent our leaders have cared about climate change, they've fixed on CO_2. Partly as a result, coal-fired power plants have begun to close across the country. They've been replaced mostly with ones that burn natural gas, which is primarily composed of methane. Because burning natural gas releases significantly less carbon dioxide than burning coal, CO_2 emissions have begun to trend slowly downward, allowing politicians to take a bow. But this new Harvard data, which comes on the heels of other aerial surveys showing big methane leakage, suggests that our new natural-gas infrastructure has been bleeding methane into the atmosphere in record quantities. And molecule for molecule, this unburned methane is much, much more efficient at trapping heat than carbon dioxide.

McKibben uses the results of the Harvard researchers' study to imply fracking is responsible for the increase in methane emissions, although he walks back that claim later in the article. But the Harvard study did not attempt to pinpoint the source of methane emissions.[15] Correlation is not causation, and the Harvard researchers did not make that leap:

> Long-term surface observations and satellite retrievals of atmospheric methane, interpreted directly and using inverse methods, point to an increase of more than 30% in U.S. methane emissions over the past decade. The increase is largest in the central part of

[14] *Ibid.*

[15] A.J. Turner *et al.*, "A large increase in U.S. methane emissions over the past decade inferred from satellite data and surface observations," *Geophysical Research Letters*, March 2, 2016, http://onlinelibrary.wiley.com/doi/10.1002/2016GL067987/abstract.

> the country. The U.S. has seen a 20% increase in oil and gas production [US EIA, 2015] and a nine-fold increase in shale gas production from 2002 to 2014, but the spatial pattern of the methane increase seen by GOSAT *does not clearly point to these sources* [emphasis added].[16]

Estimating the contributions from different source types and regions is difficult because there are many different sources of methane, and those sources overlap in the same spatial area. For example, methane is produced naturally in wetlands – and it is worth noting that environmentalists support "restoring" wetlands despite the increases in methane emissions this would cause. Methane also is produced by agriculture through growing rice and raising livestock, fast-growing activities in developing countries. This makes it difficult to calculate exactly where methane is coming from and what sources should be controlled. McKibben's simplistic attribution of these emissions to the oil and gas sector is inappropriate.

Methane is produced naturally in wetlands, by agriculture through growing rice and livestock, and fossil fuel losses, making it difficult to calculate exactly where methane is coming.

Howarth–Ingraffea Study

McKibben attempts to support his assertions with a discussion of fly-over studies, in which researchers fly planes or helicopters equipped with infrared cameras over oil and natural gas fields. He quotes a study conducted in 2011 by anti-fracking activists Anthony Ingraffea and Robert Howarth from Cornell University:[17]

> Howarth and Ingraffea began producing a series of papers claiming that if even a small percentage of the methane leaked – maybe as little as 3 percent – then fracked gas would do more climate damage than coal. And their preliminary data showed that leak rates could be at least that high: that somewhere between 3.6 and 7.9 percent of methane gas from shale-drilling operations actually escapes into the atmosphere.

Citing the Howarth and Ingraffea study is a prime example of the cherry-picking McKibben employs throughout his article. The scientific literature includes more than 75 studies examining methane emissions from oil and gas systems, yet McKibben chose an outdated study that used unrealistic assumptions and reached inaccurate conclusions.

According to the liberal Environmental Defense Fund (EDF), which partnered with several research institutions, including the University of Texas–Austin (UT), to conduct 16 studies monitoring methane emissions from shale gas basins around the country, Howarth and Ingraffea wrongly assumed no green completion technology (to capture emissions) or flaring was used to

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[16] *Ibid.*

[17] Robert Howarth *et al.*, "Methane and the greenhouse-gas footprint of natural gas from shale formations," *Climactic Change*, June 2011, http://link.springer.com/article/10.1007/s10584-011-0061-5.

limit emissions of methane and other volatile organic compounds, instead assuming all methane emissions were vented into the atmosphere, resulting in emissions data that are skewed upward.[18,19]

Natural gas producers have a powerful economic motive to reduce methane leakage and use technologies that capture methane emissions.

Natural gas producers have a powerful economic motive to reduce methane leakage and use technologies that capture methane emissions during the drilling and well completion phase. These technologies, commonly referred to as "Green Completion,"[20] are used across the country to prevent methane from escaping into the atmosphere. The industry also employs flaring to burn excess methane at the wellhead, converting it to CO_2 and water vapor.

Commenting on the Howarth–Ingraffea study, EDF stated:

> While that [venting, rather than capturing or flaring methane] may have been the case several years ago, it isn't the case now, as the evidence from the UT study suggests. Once EPA regulations are fully implemented [*Author's note: Regulations to control volatile organic compounds, which also capture methane, were implemented in January 2015*], all new hydraulically fractured natural gas wells will be required to use green completion technologies. A similarity exists around equipment leaks and routine venting, in which, Howarth *et al.* assumes emissions are between 0.3% and 1.9% of production and the UT study supports the lower end of the range, suggesting the potential use of best available technology and practices at the well sites observed by UT.[21]

In short, EDF found Howarth and Ingraffea used unrealistic assumptions in their research to make their initial calculations, and those assumptions are no longer reasonable or appropriate because economic drivers and EPA regulations require natural gas producers to capture or flare volatile organic compounds, also capturing methane.

Refusing to use realistic assumptions in studies of methane emissions makes as little sense as building a case against cars by telling everyone how dangerous they are, but citing statistics obtained before seatbelts and airbags were installed. Despite the obvious limitations of the Howarth–Ingraffea study, McKibben relies on it heavily, suggesting his real intent may be to push an agenda rather than seeking to inform the public fairly and accurately. McKibben appears to have understood the limitations of the Howarth-Ingraffea study but decided to promote it

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[18] IFC International *supra* note 3.

[19] Environmental Defense Fund, "FAQ About the University of Texas Methane Study Phase 1," https://www.edf.org/sites/default/files/content/ut_study_faq_for_web.pdf.

[20] "Green Completions," International Petroleum Industry Environmental Conservation Association (IPIECA), undated website accessed August 17, 2016, www.ipieca.org/energyefficiency/solutions/78161.

[21] Environmental Defense Fund, *supra* note 19.

anyway, which may be why he portrays anyone who disagreed with the study's findings as an "industry shill" or opportunistic academic seeking to be appointed to a cabinet post. McKibben writes,

> The two scientists [Howarth and Ingraffea] were roundly attacked by the industry; one trade group called their study the "Ivory Tower's latest fact-free assault on shale gas exploration." Most of the energy establishment joined in. An MIT team, for instance, had just finished an industry-funded report that found "the environmental impacts of shale development are challenging but manageable"; one of its lead authors, the ur-establishment energy expert Henry Jacoby, described the Cornell research as "very weak." One of its other authors, Ernest Moniz, would soon become the US secretary of energy; in his nomination hearings in 2013, he lauded the "stunning increase" in natural gas as a "revolution" and pledged to increase its use domestically.

By dismissing dissenting opinions with *ad hominem* attacks, McKibben seems intent on distracting attention from the fact that Howarth and Ingraffea used unrealistic assumptions to "cook the books," so to speak, and produce alarming results.

Despite the obvious limitations of the Howarth–Ingraffea study, McKibben relies on it heavily, suggesting his real intent may be to push an agenda rather than seeking to inform the public fairly and accurately.

Another study cited by McKibben used airplane measurements to estimate methane emissions from oil and gas production in the Uintah Basin in Utah. This aerial survey found high methane emissions, about 8.8 percent of total production, plus or minus 2.6 percent. However, the authors clearly stated the production operations in that region are not representative of national operations. In spite of the original authors' caution, the study is often incorrectly cited as typical and used to justify estimates at the high end of the uncertainty range (11 percent emissions rate).[22]

The Utah study demonstrates some of the challenges associated with measuring methane emissions. There are four commonly used methods of measuring emissions: direct measurements, ambient air monitoring studies, life-cycle analyses, and meta-analyses.

Direct measurement of emissions

Direct measurements take place on-site and identify methane emissions from specific sources. They produce large datasets that can be collected over a period of months or years. Direct-measurement studies have generally found most oil and natural gas facilities have emissions lower than estimates in the EPA Greenhouse Gas Inventory. A small number of sources – referred to as "super emitters" – are responsible for large amounts of emissions, inflating or significantly skewing the emissions profile.

[22] IFC International *supra* note 3.

Direct-measurement studies also show some sources have been underrepresented in the EPA Greenhouse Gas Inventory. That is being addressed in the most recent inventory publication.[23] Direct measurements generally find methane emissions to be lower than aerial surveys.

Ambient Air Monitoring Studies

Ambient air monitoring studies using aerial surveys are helpful because they allow large areas to be surveyed in a relatively short period of time, but the results of such studies are affected by a wide variety of uncertainties, including weather and non-industrial sources of methane, such as wetlands and agricultural emissions.

> Direct-measurement studies have generally found most oil and natural gas facilities have emissions lower than estimates in the EPA Greenhouse Gas Inventory.

Aerial surveys are based on short sampling time periods relative to other air monitoring protocols. For example, EPA requires three years of sampling data for measuring criteria pollutants such as particulate matter, whereas fly-over methane data typically consists of only two or three days of sampling. Aerial surveys cannot provide data over longer timescales or adjust for seasonal or other important variations such as temperature.

As a result of these variables and uncertainties, aerial surveys have found high methane emissions, such as those found in Uintah County, as well as very low methane emissions, as were found in the Haynesville Shale, Fayetteville Shale, and Marcellus Shale, which were lower than EPA estimates in some of those basins (discussed below).[24]

Life-Cycle Analyses

Life-cycle analysis studies, sometimes referred to as "site to source" studies, draw on multiple sources to provide an integrated measure of emissions from the entire natural gas value chain – from facilities that produce, process, transport, and use natural gas – to estimate emissions from "wellhead to burnertip."[25]

Life-cycle emissions are especially important for natural gas because methane is the primary component in natural gas, so any losses of the product along the value chain are sources of GHG

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[23] *Ibid.*

[24] *Ibid.*

[25] National Energy Technology Laboratory, "Life Cycle Greenhouse Gas Inventory of Natural Gas Extraction, Delivery and Electricity Production," 2011, http://netl.doe.gov/research/energy?analysis/publications/details?pub=eaa7f83c?ff41?4712?b53c?52b22a3afa29.

emissions. Methane is also emitted from coal and oil production and processing as well from natural gas, though in lower amounts.[26]

The first life-cycle analysis was conducted in 2011 and found higher upstream greenhouse gas emissions from natural gas, including methane emissions, than coal.[27] Total emissions for natural gas were lower, however, because natural-gas fired power plants are more efficient than coal plants. As a result, this life-cycle analysis showed greenhouse gas emissions from natural gas were 42 to 53 percent lower than coal over a 100-year time-frame. The study also found that natural gas-fired electricity produces greenhouse gas emissions 39 percent lower than coal using the 20-year GWP, even when that natural gas-fired electricity is generated from shale gas sources.

A fly-over study of the Texas, Arkansas, and Pennsylvania shale formations found very low emissions as a percentage of total production in each of these basins.

The most recent and authoritative life-cycle analyses show that the life-cycle emissions of natural gas are 40 to 50 percent lower than coal on a 100-year basis.[28]

Meta-Analyses

Meta-analyses attempt to combine the results of multiple studies using different methodologies or databases to search for overarching trends, recurring facts, and robust findings.[29] Recent meta-analyses attempt to reconcile aerial ambient air monitoring studies and direct-measurement studies to give researchers a more comprehensive estimate of emissions.[30]

A fly-over study of the Haynesville (Texas), Fayetteville (Arkansas), and northeastern Marcellus (Pennsylvania) shale formations found very low emissions as a percentage of total production in each of these basins. Loss rates were estimated to be 1.0 to 2.1 percent of total production from the Haynesville region, 1.0 to 2.8 percent from the Fayetteville region, and 0.18 to 0.41 percent from the northeastern Pennsylvania area of the Marcellus region.[31]

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[26] *Ibid.*

[27] *Ibid.*

[28] IFC International, *supra* note 3.

[29] Diana B. Petitti, *Meta-Analysis, Decision Analysis, And Cost-Effectiveness Analysis: Methods For Quantitative Synthesis In Medicine - methods for quantitative synthesis in medicine* (Oxford, UK: Oxford University Press, 2000).

[30] IFC International, *supra* note 3.

[31] J. Peischl, *et al.*, "Quantifying atmospheric methane emissions from the Haynesville, Fayetteville, and northeastern Marcellus shale gas production regions," *Journal of Geophysical Research: Atmospheres*, March 13, 2015, http://onlinelibrary.wiley.com/doi/10.1002/2014JD022697/pdf.

According to the study – conducted by Jeff Peischl of the Cooperative Institute for Research in Environmental Sciences at the University of Colorado Boulder and colleagues – the climate impact of methane losses from shale gas production depends upon the total leakage from all production regions. The regions investigated by Peischl *et al.* represented more than half of the U.S. shale gas production in 2013. The researchers found generally lower methane loss rates than those reported in other studies covering regions that were responsible for a smaller percentage of total production. Peischl *et al.* conclude the national average methane loss rate from shale gas production may be lower than values extrapolated from earlier studies.[32]

A March 2016 study published in *Science* concluded rising levels of atmospheric methane are most likely due to agricultural practices and natural sources such as wetlands, not fossil fuel production.

Meta-analyses in two studies coordinated by EDF consisted of researchers attempting to reconcile direct measurements and ambient air monitoring measurements in the Barnett shale region in Texas. This effort was coordinated with a detailed inventory and analysis of all of the methane sources in the region (oil, gas, and other). Data from five EDF direct-measurement studies were combined with airplane measurements and ground-based ambient measurements. The researchers were able to reconcile the direct measurements and ambient measurements when they accounted for all of the different methane sources.

Using results from both fly-over and ground-based ambient air monitoring studies, Harriss *et al.* estimated 50 percent greater methane emissions from oil and gas operations in the Barnett shale region than calculated based on the EPA Inventory at that time. The largest contributor to the higher estimate was a much greater number of large gathering system compressors than was estimated in the EPA Inventory. (The revised 2016 EPA Inventory has increased its estimate of emissions from gathering systems, so these estimates are likely more aligned.) Harriss *et al.* also found higher emission factors for gas production sites.

Harriss *et al.* found Barnett shale oil and gas emissions account for 1.2 percent (a range of 1.0 to 1.4 percent) of production volume. When emissions from sites producing oil were excluded, the emissions from sites producing only natural gas fell to 1.1 percent (a range of 1.0 to 1.3 percent) of gas produced.[33]

A study published in March 2016 in the international journal *Science* used carbon isotopes to distinguish between biogenic methane (methane that is natural in origin) and thermogenic methane (methane from oil and gas activities) and concluded fossil fuel production was not the major cause of increasing methane levels in the atmosphere observed since 2007. Instead, the

[32] *Ibid.*

[33] IFC International *supra* note 3.

study concluded increasing levels of methane are most likely due to agricultural practices and natural sources such as wetlands, not fossil fuel production.[34,35]

Several studies have attributed a large share of methane emissions to a small number of well sites and specific equipment in the areas studied. For example, in the Four Corners region, scientists found emissions from pneumatic controllers could be 17 percent higher than the estimate in the 2012 U.S. Greenhouse Gas Inventory.[36] The study also found a small subset of devices (19 percent) accounted for 95 percent of emissions, suggesting fixing existing leaks could result in large reductions in methane emissions. McKibben's call to ban fracking entirely, rather than fixing existing leaks, is not justified by the majority of scientific data.

This survey of the methane emissions literature is not meant to imply emissions are so low there is no need to improve oil and gas production processes, or to imply agriculture is responsible for the entire rise in global methane levels since 2007. But the scientific literature clearly shows great uncertainty about how much methane is entering the atmosphere, how much is produced by oil and natural gas production, and how emissions can be managed in the future.

McKibben's focus on a few, select examples that support his narrative about "terrifying" methane emissions, while glossing over other studies and natural sources of methane, conflicts with well-designed scientific studies conducted in shale basins across the country. While all emissions studies and estimates have limitations, few have more shortcomings than the ones most prominently featured in McKibben's article.

While all methane emissions studies and estimates have limitations, few have more shortcomings than the ones most prominently featured in McKibben's article.

3. Methane and Global Warming

The second pillar of McKibben's argument rests on attributing a very high amount of warming to methane in the atmosphere. McKibben writes,

> If you combine Howarth's estimates of leakage rates and the new standard values for the heat-trapping potential of methane, then the picture of America's total greenhouse gas emissions over the last 15 years looks very different: Instead of peaking in 2007 and then

[34] NIWA, "Scientists Attribute Rising Methane Levels to Agriculture," *Science*, March 11, 2016, http://phys.org/news/2016-03-scientists-attribute-methane-agriculture.html.

[35] Princeton University, "A More Potent Greenhouse Gas Than Carbon Dioxide, Methane Emissions Will Leap As Earth Warms," *Science Daily*, March 27, 2014, https://www.sciencedaily.com/releases/2014/03/140327111724.htm.

[36] David Allen *et al.*, "Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Pneumatic Controllers," *Environmental Science and Technology*, December 2014, http://pubs.acs.org/doi/abs/10.1021/es5040156.

> trending downward, as the EPA has maintained, our combined emissions of methane and carbon dioxide have gone steadily and sharply up during the Obama years, Howarth says.
>
> Under the worst-case scenario – one that assumes that methane is extremely potent and extremely fast-acting – the United States has actually slightly increased its greenhouse-gas emissions from 2005 to 2015.

The problem with this analysis is there is little evidence to suggest the global warming power of methane is as high as Howarth and McKibben claim.

According to a study by the London-based Centre for Policy Studies, claims that methane emission rates of 1 or 2 percent would negate the advantage of methane over coal are incorrect. The study suggests fully 12 percent of produced gas would need to escape into the atmosphere for natural gas to produce more potential future warming than coal over a 100-year timespan.[37]

It is highly unlikely that 12 percent of methane would escape into the atmosphere, because oil and natural gas producers want to sell this product, not vent it. The best current estimates for the average leakage across the supply chain are below 3 percent, according to the Centre (and confirmed by the literature review presented above). At that leakage level, natural gas would produce less than half the warming produced by coal averaged over the 100 years following emission. Half this 100-year average would occur in the first 10 years and three-quarters in the first 20 years. At 100 years, the methane-related warming is almost entirely from the (relatively low) CO_2 produced from burned methane, not from the leaked methane itself.[38]

Another reason methane is unlikely to have a significant long-term impact on global temperatures is because it breaks down quickly in the atmosphere.

Another reason methane is unlikely to have a significant long-term impact on global temperatures is because it breaks down quickly in the atmosphere. EPA estimates it takes approximately 12 years for methane to dissolve in the atmosphere, and further research suggests methane can dissolve faster, in as little as 8.7 years, depending on "methane sinks" such as soil uptake and meteorological conditions (see Figure 4). This suggests that if leaks in oil and natural gas systems are fixed, methane will not have an ongoing effect on temperatures because, while methane is more effective than CO_2 at trapping heat in the short term, methane's fast decomposition will render its climate impacts moot.

Real-world temperature data also suggest methane has less warming impact than McKibben claims. For more than 18 years, between 1998 and early 2016, there had been a global warming hiatus, during which there has been no statistically significant increase in global

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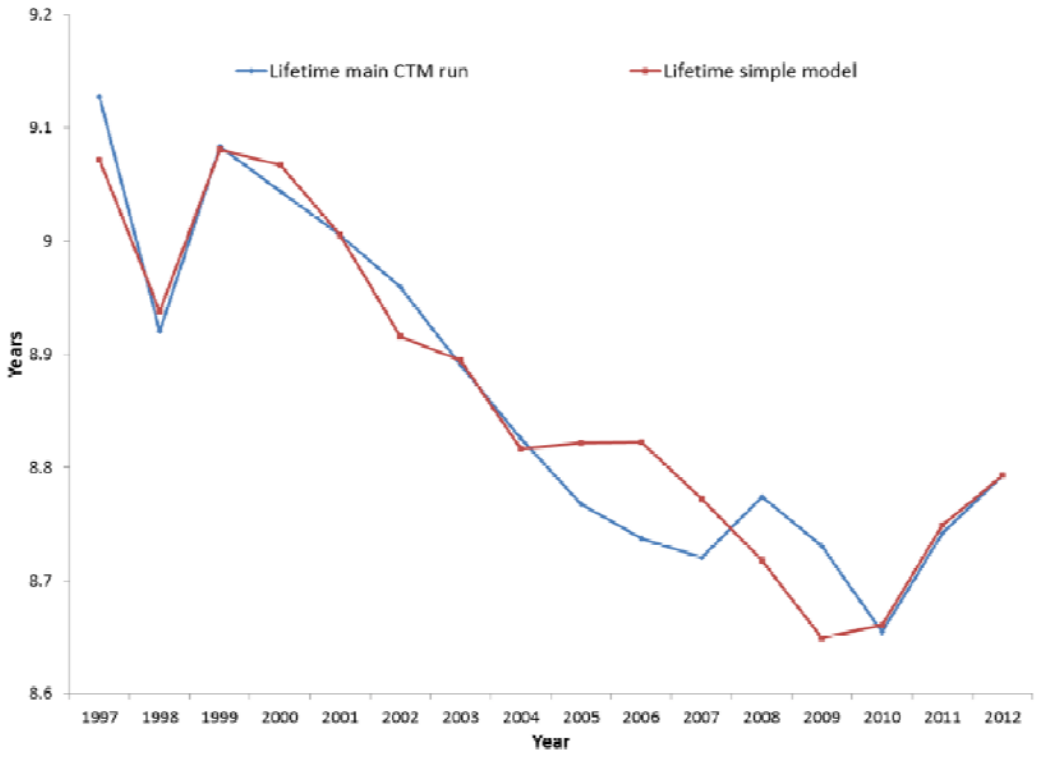
[37] Elizabeth A. Muller and Richard A. Muller, "The Facts About Fugitive Methane," Centre For Policy Studies, October 26, 2015, http://www.cps.org.uk/publications/reports/the-facts-about-fugitive-methane/.

[38] *Ibid.*

Figure 4
The amount of time it takes methane to dissolve in the atmosphere is not constant



Source: Stig B. Dalsøren *et al.*, "Atmospheric Methane Evolution the Last 40 Years," *Atmospheric Chemistry and Physics*, March 9, 2016, http://www.atmos-chem-phys.net/16/3099/2016/acp-16-3099-2016.pdf.

temperatures.[39,40] If not for the record-breaking El Niño experienced in 2015 and 2016, this trend may have continued into the future. It isn't just people skeptical of catastrophic climate change theory who acknowledge global warming has been missing in action for the past 18 years. Even the United Nations' IPCC (cited above) and climate alarmists such as Michael Mann[41] acknowledge global warming has stopped, or at least slowed, during this period.

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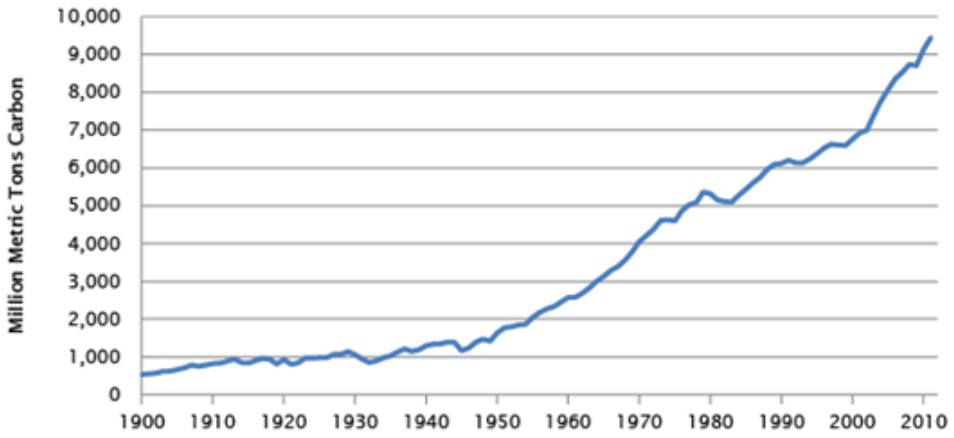
[39] T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley, editors, "Summary for Policymakers," *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK and New York, NY: Cambridge University Press, 2013), p. 3.

[40] University of Alabama Huntsville, "Global Temperature Report," accessed August 11, 2016, http://www.nsstc.uah.edu/climate/index.html.

[41] John C. Fyfe *et al.*, "Making Sense of the early-2000s warming slowdown," *Nature Climate Change*, February 24, 2016, http://www.nature.com/nclimate/journal/v6/n3/full/nclimate2938.html?WT.ec_id=NCLIMATE-201603&spMailingID=50767823&spUserID=MTI0NzgyNDMwMjA2S0&spJobID=862987827&spReportId=ODYyOTg3ODI3S0.

The hiatus occurred despite the 30 percent increase in methane emissions between 2002 and 2014, as noted by the Harvard study cited by McKibben, and a rise in atmospheric carbon dioxide levels. Thirty percent of all the carbon dioxide released into the atmosphere as a result of burning fossil fuels occurred since 1998 (see Figure 5).[42]

Figure 5
Fossil-fuel-related carbon dioxide emissions have increased by roughly a third since 1998, but global temperatures had not risen from 1998 until early 2016



Source: T.A. Boden *et al.*, "Global, Regional, and National Fossil-Fuel CO2 Emissions," Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, 2015, https://www3.epa.gov/climatechange/ghgemissions/global.html.

Increasing atmospheric methane concentrations by even a seemingly large amount, such as the 30 to 60 percent spike reported by McKibben, has little impact on the climate because methane is so rare in the atmosphere. Water vapor, the most common and potent greenhouse gas, is present at about 10,000 parts per million. Carbon dioxide is present at about 400 parts per million. Methane is present at only 1.8 parts per million. Even a 30 to 60 percent spike raises methane's presence in the atmosphere to a still-trivial 2.3 to 2.9 parts per million.

If global temperatures were as sensitive to carbon dioxide and methane as McKibben claims in his article, the increase in methane, in combination with an increase in CO_2, should have resulted in a measurable increase in global temperatures – not a warming hiatus. McKibben assumes a climate sensitivity to greenhouse gases greater than what most scientists now believe to be the most likely range.[43]

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[42] T.A. Boden *et al.*, "Global, Regional, and National Fossil-Fuel CO2 Emissions," Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, 2015, https://www3.epa.gov/climatechange/ghgemissions/global.html.

[43] C. Monckton, W. W-H. Soon, D.R. Legates, and W.M. Briggs, "Keeping It Simple: The Value of an Irreducibly Simply Climate Model," *Science Bulletin* **60** (15): 1378–90, footnotes 7 to 33.

4. Repeating *Gasland* Falsehoods

With only flimsy scientific support for his argument on methane emissions, McKibben turns his attention to other possible environmental impacts of fracking. Here he relies not on scholarly research but on *Gasland*, a documentary film that has been thoroughly discredited.[44,45] McKibben writes:

> The Marcellus Shale, though, underlies densely populated eastern states. It wasn't long before stories about the pollution of farm fields and contamination of drinking water from fracking chemicals began to make their way into the national media. In the Delaware Valley, after a fracking company tried to lease his family's farm, a young filmmaker named Josh Fox produced one of the classic environmental documentaries of all time, Gasland, which became instantly famous for its shot of a man lighting on fire the methane flowing from his water faucet.[46]

Without question, *Gasland* offers the most powerful – and most misleading – anti-fracking imagery to date. The film contains the now-famous scene showing Colorado resident Mike Markham lighting his drinking water on fire, an image intended to lead the viewer to believe fracking was responsible for the methane in his well.

In fact, an analysis by the Colorado Oil and Gas Conservation Commission (COGCC) determined the methane found in Markham's well was biogenic in origin, naturally occurring in the coal formations present within the aquifer supplying his drinking water. Markham's well did not test positive for chemicals used in the fracking process, providing further evidence that oil and gas production was not the cause of contamination.[47] Markham would have had methane in his water even if fracking techniques were never used in the region.

Producer Josh Fox's flair for the dramatic at the expense of the truth is not limited to *Gasland*. The sequel, *Gasland II*, also contained fraudulent claims about flammable water.

Producer Josh Fox's flair for the dramatic at the expense of the truth is not limited to *Gasland*. The sequel, *Gasland II*, also contained fraudulent claims about flammable water. Fox ups the ante in *Gasland II*, and the film portrays a landowner in Parker County, Texas lighting his water hose on fire, implying that was somehow due to fracking in the Barnett Shale area of North Texas.

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[44] Department of Natural Resources, Colorado Oil and Gas Conservation Commission, *Gasland Document*, n.d., http://cogcc.state.co.us/library/GASLAND%20DOC.pdf.

[45] Ronald Bailey, "The Top 5 Lies About Fracking," *Reason*, July 5, 2013, http://reason.com/archives/2013/07/05/the-top-5-lies-about-fracking.

[46] Bill McKibben, *supra* note 1.

[47] Department of Natural Resources, Colorado Oil and Gas Conservation Commission, *supra* note 44.

According to an article in *Forbes*, the flaming hose was determined in a 2012 Texas District Court proceeding to be a fraud. The landowner, working with a local "consultant" who was little more than an anti-natural gas activist, was revealed in court to have "… attach(ed) a garden hose to a gas vent – not to a water line – and then light and burn the gas from the end of the nozzle of the hose. The demonstration was not done for scientific study but to provide local and national news media a deceptive video, calculated to alarm the public into believing the water was burning … [and] alarm the EPA."[48]

Without question, there have been instances across the country where practices associated with oil and natural gas development have resulted in water contamination. Fortunately, such instances are rare. In the most extensive study to date of the impact of hydraulic fracturing on groundwater resources, EPA found no evidence fracking or other activities related to oil and natural gas development have had widespread or systemic impacts on groundwater quality.[49] Although some incidences of contamination have occurred when fracking fluids were spilled at the surface or wells were not properly cased, resulting in some instances of methane entering into water wells, EPA found those incidents to be rare. The locations depicted in the *Gasland* films were not among the sites found by EPA to be contaminated.

It is simply not possible to have an *honest* discussion of the impact of hydraulic fracturing on groundwater resources without citing the EPA study, yet McKibben never mentions it.

In addition to falsely portraying hydraulic fracturing as the culprit for water contamination, it appears the premise of *Gasland* – that a gas company wanted to lease mineral rights from filmmaker Fox – was a fabrication. In *Gasland,* Fox claims a gas company sent him in 2008 a lease offering a $100,000 signing bonus. He also claims he had an agreement not to disclose the name of the company that sent him the lease.[50] Fox's story was proven false in the documentary *FrackNation*. It turns out the lease portrayed in *Gasland* was not from a gas company at all. It was a sample lease from the Northern Wayne Property Owners Alliance (NWPOA), a consortium of more than 1,300 member-families that represents the interest of landowners. This falsehood undermines the entire premise of the film.

It is shameful for McKibben to lend his unqualified support to a film that has been so thoroughly discredited while ignoring or hiding much more credible evidence that undercuts his thesis.

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[48] David Blackmon, "Fiction Masquerading As News In The Oil And Gas Shale World," *Forbes*, June 10, 2013, http://www.forbes.com/sites/davidblackmon/2013/07/10/fiction-masquerading-as-news-in-the-oil-and-gas-shale-world/#3b846a5836b7.

[49] Environmental Protection Agency, "Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources (External Review Draft)," June 5, 2015, https://www.epa.gov/sites/production/files/2015-07/documents/hf_es_erd_jun2015.pdf.

[50] Tom Shepstone, "Josh Fox's Gasland Background Story Completely Collapses," *Natural Gas Now*, August 19, 2013, http://naturalgasnow.org/josh-foxs-gasland-background-story-completely-collapses/.

Doing so reinforces the notion he's more interested in cherry-picking his sources and pushing an agenda than in having an honest debate about the potential environmental impacts of hydraulic fracturing.

5. What's the Fracking Alternative?

With his skewed interpretation of methane emissions data in hand, McKibben concludes it won't be enough to reduce the amount of methane that escapes into the atmosphere by fixing leaks in equipment and developing new technology to minimize emissions in the future. Fracking, he writes, must be stopped entirely:

> With that in mind, the other conclusion from the new data is even more obvious: We need to stop the fracking industry in its tracks, here and abroad. Even with optimistic numbers for all the plausible leaks fixed, Howarth says, methane emissions will keep rising if we keep fracking.

The idea of banning fracking prompts a fundamental question: If McKibben believes we must stop fracking, what viable alternative does he propose for obtaining the energy we need?

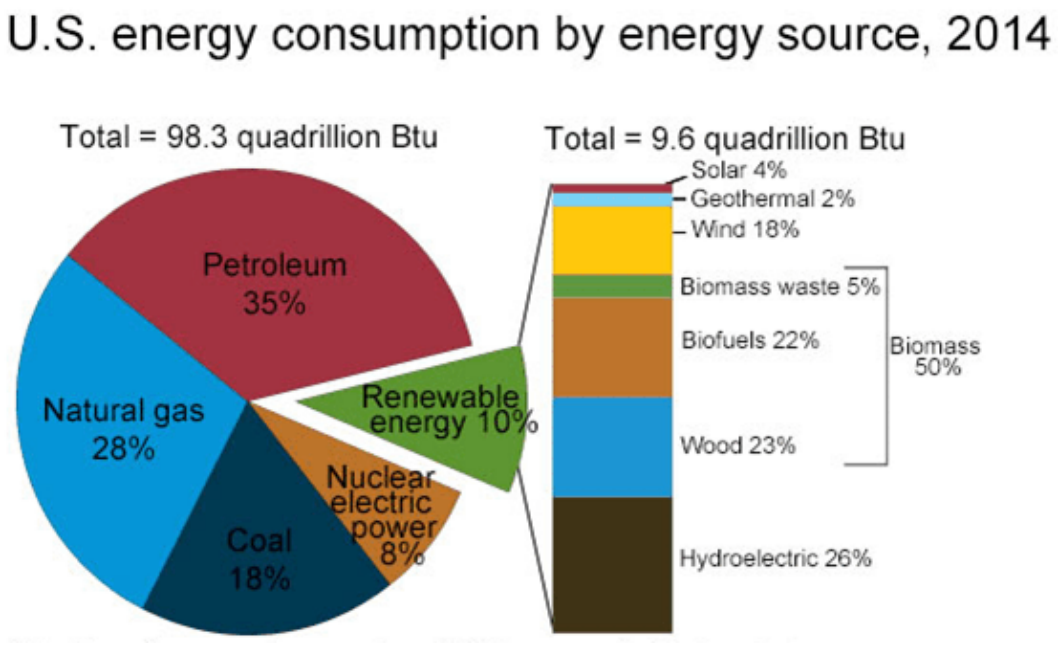
Imagine the battery in your smartphone could be charged to any percentage. What percentage would you want it to be charged to? Most people would like their phone to be charged to 100 percent – frankly, that's the most logical answer.

The idea of banning fracking prompts a fundamental question: If McKibben believes we must stop fracking, what viable alternative does he propose for obtaining the energy we need?

Now imagine that smartphone battery represents all of the energy used in our everyday lives, from the gasoline and diesel fuel that powers our cars, the tractors used to grow our food, and the ambulances rushing us to the hospital in times of emergency, to the natural gas, nuclear power, coal, wind, solar, and hydroelectric power that create the electricity that keeps our lights on, refrigerators running, and schools open.

According to the Energy Information Administration (EIA), the United States gets approximately 0.4 percent of the energy it consumes from solar power (photovoltaics or concentrated solar power). Wind accounts for 1.8 percent. Together, these two sources account for just 2.2 percent of our total energy consumption. We obtain slightly more of our total energy

Figure 6



Source: U.S. Energy Information Administration, *Energy In Brief*, December 29, 2015, http://www.eia.gov/energyexplained/images/charts/energy_consumption_by_source_2014-large.jpg.

from *burning wood* than from wind and solar combined (see Figure 6), even though taxpayers pay billions of dollars every year for subsidies to wind and solar power.[51,52,53]

In terms of charging your smartphone, relying on wind and solar power would mean your phone would be only 2.2 percent charged, enough for only a few minutes of phone conversation or email. After these few minutes, your phone would become an expensive paperweight – not because of some vast Fossil Fuel conspiracy, but because electricity from wind and solar is far more expensive and less reliable than electricity from coal or natural gas.

Hydraulic fracturing produces more than 67 percent of all the natural gas we produce, and oil from fracking operations accounts for 51 percent of domestic oil production. Hydraulic

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[51] U.S. Energy Information Administration, "Monthly Energy Review May 2016," May 25, 2016, http://www.eia.gov/totalenergy/data/monthly/pdf/sec1_7.pdf.

[52] U.S. Energy Information Administration, "What are the major sources and users of energy in the U.S." *Energy in Brief*, December 29, 2015, http://www.eia.gov/energy_in_brief/article/major_energy_sources_and_users.cfm.

[53] Institute for Energy Research, "EIA Report: Subsidies Continue to Roll in for Wind and Solar," March 18, 2015, http://instituteforenergyresearch.org/analysis/eia-subsidy-report-solar-subsidies-increase-389-percent/.

fracturing technology, which has been used safely since 1947, in combination with horizontal drilling, will become even more important in the future because production from conventional sources of oil and natural gas is expected to decline in the future, increasing our need to use these technologies to access oil and gas from unconventional reservoirs.[54]

Hydraulic fracturing has made the United States the largest producer of natural gas in the world and has nearly doubled oil production since 2008. If McKibben wants to ban fracking, which would essentially halt oil and gas production in the United States, what realistic alternative would we have?

Hydroelectric is the largest source of renewable energy, constituting approximately 2.6 percent of U.S. energy consumption. Nuclear energy supplies 8 percent of our total energy consumption, coal 18 percent, natural gas 28 percent, and oil 35 percent. Together, oil and natural gas supply 63 percent of the energy we use. To produce oil and gas resources in the United States, we need to use hydraulic fracturing and horizontal drilling.

Wind and solar are simply far more expensive and less reliable than fossil fuels and face insurmountable barriers to scaling up sufficiently to replace them.

This is where a serious discussion of alternatives to fracking should have taken place in McKibben's essay, but he dodges the question by pretending wind and solar power will be able to fill the void:

> Ten years ago, the realistic choice was between natural gas and coal. But that choice is no longer germane: Over the same 10 years, the price of a solar panel has dropped at least 80 percent. New inventions have come online, such as air-source heat pumps, which use the latent heat in the air to warm and cool houses, and electric storage batteries. We've reached the point where Denmark can generate 42 percent of its power from the wind, and where Bangladesh is planning to solarize every village in the country within the next five years. We've reached the point, that is, where the idea of natural gas as a "bridge fuel" to a renewable future is a marketing slogan, not a realistic claim (even if that's precisely the phrase that Hillary Clinton used to defend fracking in a debate earlier this month).

Remember, in the United States, wind and solar combined produce just 2.2 percent of our total energy consumption. Climate activists often pretend this is because of some vast fossil fuel producers' conspiracy to stifle renewables, but the fact of the matter is wind and solar are simply far more expensive and less reliable than fossil fuels and face insurmountable barriers to scaling up sufficiently to replace them.

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[54] Isaac Orr, "Hydraulic Fracturing a Game-Changer for U.S. Energy and Economies," *Policy Study*, The Heartland Institute, November 18, 2013, https://www.heartland.org/publications-resources/publications/hydraulic-fracturing-a-game-changer-for-us-energy-and-economies.

Although it's true the price of solar panels has fallen considerably in recent years, generating electricity with solar is still far more expensive than using conventional fuels. The Brookings Institution, a left-of-center public policy think tank, concluded the cost of generating energy from a new solar plant is still at least 200 percent greater per kilowatt hour than using coal and gas technologies.[55]

Brookings gives two key reasons why wind and solar cost so much more than conventional fuels. First, the cost of building one megawatt of capacity for a wind or solar plant is quite high (much greater than a gas-fired plant), and the cost per megawatt of solar capacity is especially high. Reductions in the cost of solar-voltaic panels have lowered the cost of building a solar plant, but further reductions are likely to have a diminishing effect because the cost of solar panels is only a fraction of the total cost of an entire utility-scale solar plant.[56]

The average output of a typical solar plant in the United States is only about 15 percent of what it would generate if the plant could operate continuously at full capacity, and a wind plant generates only about 25 percent.

Second, a wind or solar plant operates at full capacity only a fraction of the time, when the wind is blowing or the sun is shining. The average output of a typical solar plant in the United States is only about 15 percent of what it would generate if the plant could operate continuously at full capacity, and a wind plant generates only about 25 percent. The output of both is unpredictable and, in general, low or absent during system peak demand periods.

By contrast, a coal-fired plant averages 90 percent of full capacity and is always available when needed. Brookings estimates it would take at least 7.3 solar plants and 4.3 wind plants to produce the same amount of electricity as a coal or gas plant, even setting aside the unreliability problem.[57]

Frankly, it is *impossible* for wind and solar to provide for all of our energy needs, regardless of cost, because the wind does not always blow and the sun does not always shine. Energy storage systems such as batteries capable of providing energy to the entire grid do not yet exist. No matter how much money is spent subsidizing renewable energy, we will still rely on natural gas and coal to generate the energy we require when we need it.[58]

McKibben claims the days of coal and natural gas are behind us because countries such as Denmark can generate nearly half of their power from wind. It is true the Danish government has

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[55] Charles Frank, "Why the Best Path to a Low-Carbon Future is Not Wind or Solar Power," The Brookings Institution, May 20, 2014, http://www.brookings.edu/blogs/planetpolicy/posts/2014/05/20-low-carbon-wind-solar-power-frank.

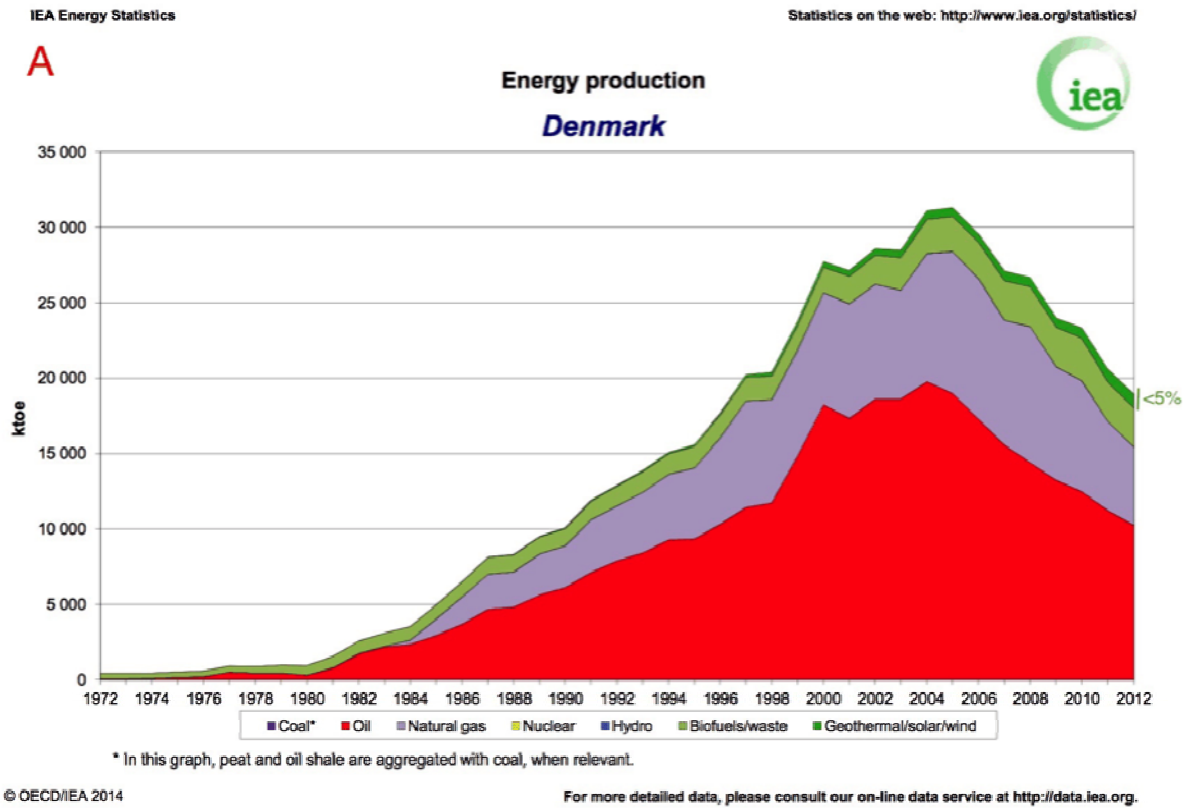
[56] *Ibid.*

[57] *Ibid.*

[58] *Ibid.*

aggressively pursued wind energy and as a result, Denmark produced on average 42 percent of its electricity from wind energy, but this figure is deceptive: It accounts only for electricity, not total energy consumption. Figure 7 below shows the total energy produced in Denmark, in which the dark green area shows wind, geothermal, and solar power accounted for just 5 percent of the energy mix, with the vast majority of Danish energy being produced by oil and natural gas.[59]

Figure 7
Energy Production in Denmark



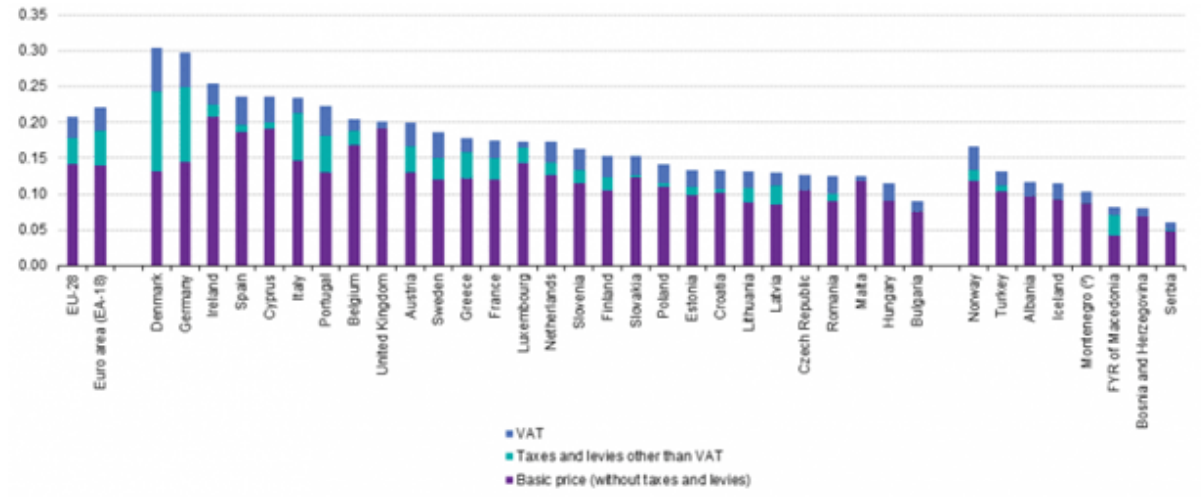
Source: Worldwatch Institute, "Myths about Danish Wind Power: Why 39% is Not Enough," February 7, 2015, http://www.worldwatch-europe.org/sites/default/files/energy%20production%20dk.png. *Data source*: International Energy Agency, *IEA Energy Statistics*, http://www.iea.org/statistics.

Generating 42 percent of the nation's electricity from wind power probably seems like a good thing to the casual observer, but this reliance on wind power has come at great expense to the Danish people. Figure 8 shows electricity prices in Europe. Germany and Denmark, the two

[59] Worldwatch Institute, "Myths about Danish Wind Power: Why 39% is Not Enough," February 7, 2015, http://www.worldwatch-europe.org/sites/default/files/energy%20production%20dk.png.

countries that have most aggressively pursued renewable energy, have the highest-priced electricity on the continent and prices that are far more expensive than in the United States.

Figure 8
Electricity Prices in Europe



Source: Melissa Quinn, "After Receiving $191 Million in Taxpayer-Backed Loans, Spanish Solar Company Files for Bankruptcy," *The Daily Signal*, April 18, 2016, http://dailysignal.com/2016/04/18/after-receiving-191-million-in-taxpayer-backed-loans-spanish-solar-company-files-for-bankruptcy/.

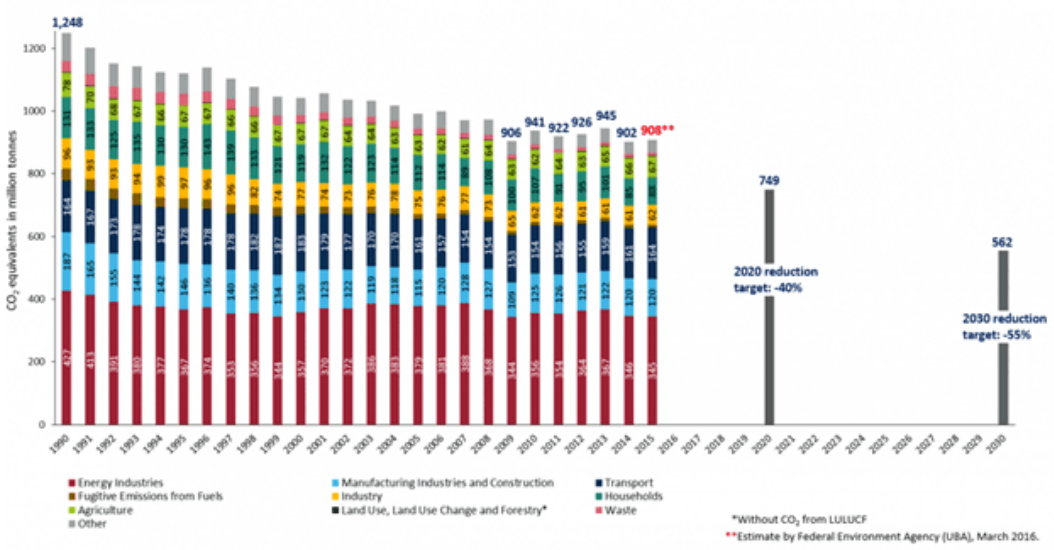
According to EIA, the average sales-weighted retail price for residential energy consumption in Germany was about 35 cents/kWh in 2014, while the average residential retail price in the United States was about 13 cents/kWh, making electricity prices in Germany more than 2.5 times higher than in the United States.[60]

For all the expense, one might expect wind, solar, and other forms of renewable energy would at least provide measurable benefits to the environment. Unfortunately, that's not the case. Data from Germany show greenhouse gas emissions there have been essentially flat, and even increased slightly, since the nation embarked on it ambitious plan to subsidize renewable energy around 2009 (see Figure 9). Electricity prices in Germany have increased by approximately 19 percent since 2009 (Figure 10).[61] Wind and solar energy account for an exceedingly small percentage of total energy consumption in Germany (Figure 11).

[60] Energy Information Administration, "European Residential Electricity Prices Increasing Faster Than Prices in United States," November 18, 2014, http://www.eia.gov/todayinenergy/detail.cfm?id=18851.

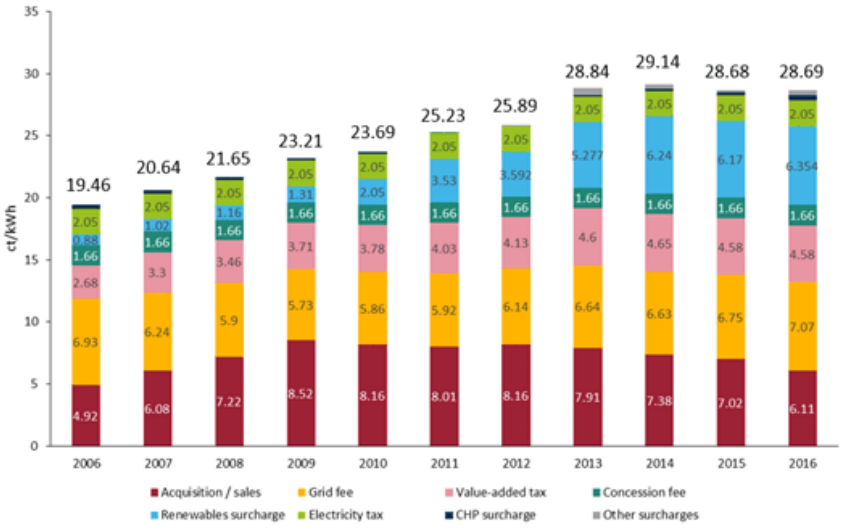
[61] Kerstine Appunn, "Germany's Greenhouse Gas Emissions and Climate Targets," *Clean Energy Wire*, March 17, 2016, https://www.cleanenergywire.org/factsheets/germanys-greenhouse-gas-emissions-and-climate-targets.

Figure 9
Greenhouse Gas Emissions in Germany



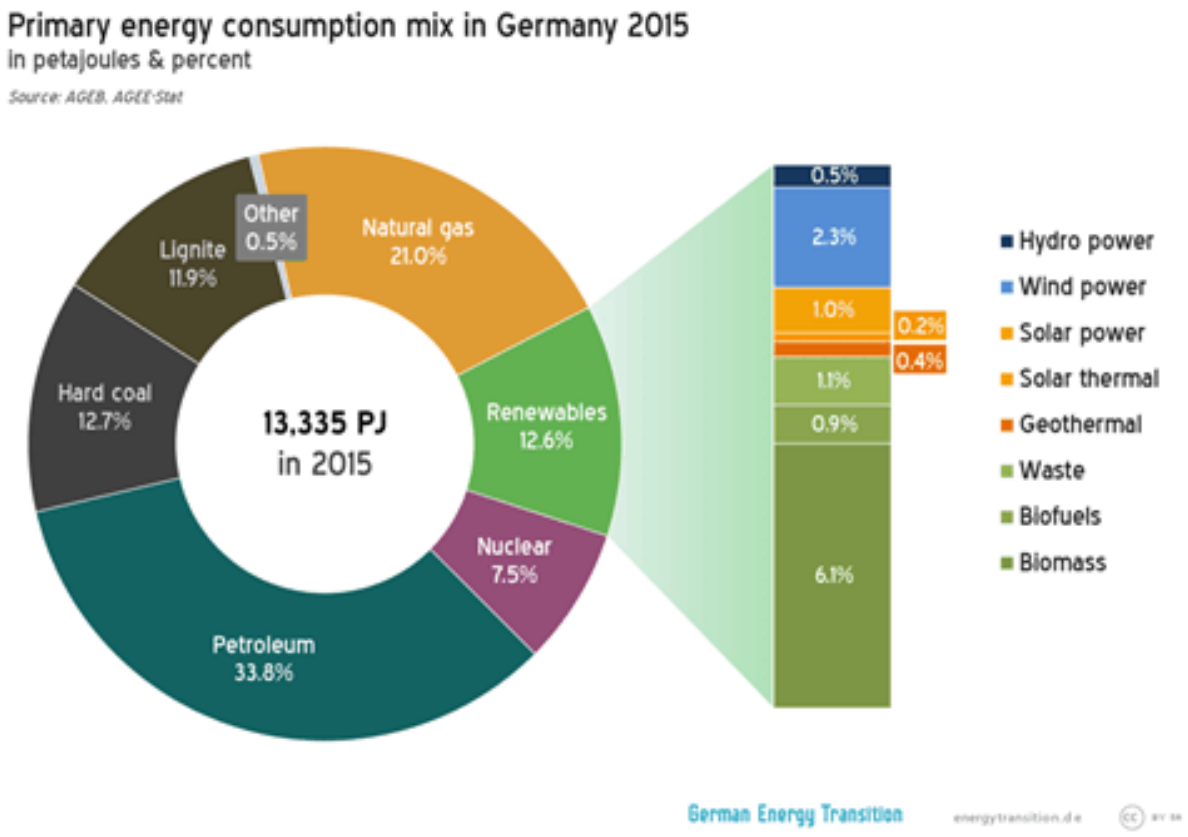
Source: Kerstine Appunn, "Germany's Greenhouse Gas Emissions and Climate Targets," *Clean Energy Wire*, March 17, 2016, https://www.cleanenergywire.org/factsheets/germanys-greenhouse-gas-emissions-and-climate-targets.

Figure 10
Residential Cost of Electricity in Germany (in Euros)



Source: Ellen Thaman, "What German Households Pay for Power," *Clean Energy Wire*, January 22, 2016, https://www.cleanenergywire.org/factsheets/what-german-households-pay-power.

Figure 11



Source: Craig Morris, "Can Germany Reach Its Renewables Target for the Energy Sector for 2020?," *The Energy Transition*, January 14, 2016, http://energytransition.de/2016/01/can-germany-reach-its-renewables-target-for-the-energy-sector-for-2020/.

When presented with these facts, few people are likely to believe Germany's investment in renewable power has been worthwhile.

Higher residential electricity costs coupled with higher greenhouse gas emissions are part of the reason why the German and Spanish governments are rolling back their subsidies for wind and solar providers.[62] Instead of automatically receiving subsidies, German renewable energy installations will now have to compete on the open market. Renewable energy providers will have to bid for subsidies through an auction-based system. In addition, caps have been placed

[62] Dave Keating, "Sea Change to Germany's Energy Transition as it Throws Renewables Into the Open Market," *Deutsche Welle* (DW), July 14, 2016, http://www.dw.com/en/sea-change-to-germanys-energy-transition-as-it-throws-renewables-to-the-open-market/a-19400641.

on the amount of green power eligible for subsidies. In Spain, wind development effectively ceased when the subsidies were withdrawn.[63]

Renewable energy policies come at staggering costs and, as seen with Germany, those policies bring few if any measurable environmental benefits.

Renewable energy advocates often claim renewable sources of energy have become cost-competitive with traditional sources of energy, or they say renewables are *this close* to achieving this feat ... with the help of just a few more subsidies, of course. If renewable energy sources are truly competitive with traditional forms of energy, opening up the energy system to competitive bidding shouldn't be a problem. Yet the leader of Germany's Green Party called this system of competitive bidding a "knockout punch" to the nation's energy transition, and others have argued it will decimate the renewable energy industry.[64]

Renewable energy advocates have every right to argue for their preferred source of energy, but they are wrong to claim these sources of energy will not raise energy costs or even save consumers money "because the wind and sun are free." Renewable energy policies come at staggering costs and, as seen with Germany, those policies bring few if any measurable environmental benefits.

If taxpayers and consumers were informed about the high cost and limited environmental benefits of renewable energy, and still chose freely to support renewables by voluntarily paying taxpayer subsidies and higher electricity bills, that is their right. But they also have a right to an honest and fact-based discussion of the cost and environmental impacts of renewable energy polices. None of this is presented in McKibben's article.

6. Conclusion

The United States obtains 63 percent of its total energy consumption from oil and natural gas – 35 percent and 28 percent, respectively – and this total is likely to grow in the future as natural gas continues to replace coal as the primary means of generating electricity in the United States. Producing oil and natural gas domestically requires the use of hydraulic fracturing and horizontal drilling.

We live in a world where we must make choices based on realistic alternatives. If Americans want to continue to drive their own cars, have smartphones, and live in air-conditioned homes, they need access to plentiful and affordable energy, which ultimately means nuclear power or burning coal, oil, or natural gas.

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[63] Associatión Empresarial Eólica, "Spain does not install a single megawatt wind farm in 2015, which has not happened since the eighties," January 26, 2016, http://www.aeeolica.org/es/new/espana-no-instala-ni-un-solo-megavatio-eolico-en-2015-lo-que-no-ocurria-desde-los-ochenta/.

[64] Dave Keating, *supra* note 62.

Despite staggering investments in renewable energy sources, Denmark and Germany still depend on fossil fuels for the vast majority of their energy, and this is unlikely to change in the coming decades. The International Energy Agency estimates that today about 0.5 percent of global energy comes from solar and wind. In 2040, assuming every country does everything it promised at the Paris climate summit, the world will get only 2.4 percent of its energy from solar and wind.[65]

New EPA rules intended to reduce methane leaks from oil and natural gas production are expected to have no measurable impact on global temperatures.

Molecule for molecule, methane traps more heat than carbon dioxide. But methane accounts for only about 10.6 percent of greenhouse gas emissions in the United States, and methane from the oil and gas industry represents only about 3.4 percent of all U.S.-emitted greenhouse gases.[66,67]

New EPA rules intended to reduce methane leaks from oil and natural gas production by 40 to 45 percent by 2025 are expected to have no measurable impact on global temperatures, hypothetically reducing global warming by only 0.0047 degrees Celsius by 2100. Oil- and natural gas-producing systems are emitting methane, but at rates far below the flawed research cited by McKibben. Simply quantifying methane emissions remains a challenging task.

Aerial air monitoring studies of Arkansas, Pennsylvania, and Texas shale formations found very low emissions as a percentage of total production.[68] Other studies have attributed the biggest share of methane emissions to a small number of well sites and specific equipment at the facilities studied, suggesting better methods of leak detection and corresponding equipment/ operating changes could lead to significant reductions in methane emissions. Other studies suggest agriculture and natural sources have contributed more to rising atmospheric methane levels since 2007 than fossil fuels.

The question of how much methane is being emitted by the oil and gas sector in the United States is largely unresolved at this time. The topic requires a serious discussion and attention to real solutions, neither of which appear in McKibben's article.

In conclusion, the most terrifying aspect of McKibben's piece is his biased selection of flawed supporting documentation and his disregard for the truth about fracking.

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[65] Bjørn Lomborg, "Funding Wind and Solar Energy Is Inefficient," *The Huffington Post*, January 27, 2016, http://www.huffingtonpost.com/bjorn-lomborg/are-wind-and-solar-energy_b_9087586.html.

[66] U.S. Environmental Protection Agency, *supra* note 7.

[67] Bernard Weinstein, *supra* note 13.

[68] J. Peischl, *et al.*, *supra* note 31.

About the Author

Isaac Orr is a research fellow for energy and environment policy at The Heartland Institute. Orr is a speaker, researcher, and writer specializing in hydraulic fracturing, frac sand mining, agricultural, and environmental policy issues. He graduated from the University of Wisconsin Eau Claire with studies in political science and geology, winning awards for his undergraduate geology research before taking a position as an aide in the Wisconsin State Senate, where he served as lead-office writer and as a policy advisor on frac sand mining and agricultural issues.

Since joining Heartland, Orr has written a Heartland *Policy Study* on fracking titled "Hydraulic Fracturing: A Game-Changer for U.S. Energy and Economies," and has coauthored multiple Policy Studies on frac sand mining, including "Environmental Impacts of Industrial Silica Sand (Frac Sand) Mining" and "Economic Impacts of Industrial Silica Sand (Frac Sand) Mining," in addition to his article "Frac Sand Study Lots of Scare, Little Science," published in the *Milwaukee Journal Sentinel* in October 2014.

His work on fracking is featured in the *Alternative Energy and Shale Gas Encyclopedia*, published in April 2016 by John Wiley & Sons, Inc. His writing has appeared in *USA Today*, *Houston Chronicle*, *Washington Times*, *The Hill*, *American Thinker*, *Human Events*, *Milwaukee Journal Sentinel*, and other publications.

Orr has spoken to nearly a dozen audiences and recorded more than two dozen podcasts on energy and environment topics for The Heartland Institute, available on Heartland's YouTube channel at HeartlandTube.

About The Heartland Institute

The Heartland Institute is a national nonprofit research and education organization based in Arlington Heights, Illinois. It is a publicly supported charitable organization and tax-exempt under Section 501(c)(3) of the Internal Revenue Code. It is approximately 6,000 men and women devoted to discovering, developing, and promoting free-market solutions to social and economic problems. They believe ideas matter, and the most important idea in human history is freedom.

Heartland has a full-time staff of 39. Joseph Bast is cofounder, president, and CEO. Dr. Herbert Walberg is chairman of the 10-member Board of Directors. Approximately 250 academics participate in the peer review of its publications and more than 220 elected officials pay annual dues to serve on its Legislative Forum.

Five centers at The Heartland Institute – including the Arthur B. Robinson Center for Climate and Environmental Policy, through which this *Policy Study* is published – conduct original research to find new ways to solve problems, turn good ideas into practical proposals for policy change, and effectively promote those proposals to policymakers and the public.

For more information, visit The Heartland Institute's website at www.heartland.org, call 312/377-4000, or visit 3939 North Wilke Road, Arlington Heights, Illinois.