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Hi Inquiry Panel,

Some interesting reading relevant to the panels efforts.

Attached : Compendium of studies demonstrating the safety and health benefits of fracking



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COMPENDIUM  
OF STUDIES  
DEMONSTRATING THE  
SAFETY AND HEALTH  
BENEFITS OF FRACKING

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## Executive Summary

The United States has made massive improvements in air quality over the past decade and study after study has shown that the increased use of natural gas for electricity generation – made possible by the shale revolution – is the reason we’ve achieved this feat.

This progress is the centerpiece of Energy In Depth’s new report – **Compendium of Studies Demonstrating the Safety and Health Benefits of Fracking** – which includes data from 23 peer-reviewed studies, 17 government health and regulatory agencies and reports from 10 research institutions that clearly demonstrate:

- Increased natural gas use — thanks to hydraulic fracturing — has led to [dramatic declines](#) in air pollution. The United States is the [number one](#) oil and gas producer in the world *and* it has some of the [lowest death rates](#) from air pollution in the world. Numerous studies have shown that pollution has plummeted as natural gas production has soared.
- Emissions from well sites and associated infrastructure are below thresholds regulatory authorities consider to be a threat to public health – that’s the conclusion of multiple studies using air monitors that measure emissions directly.
- There is no credible evidence that fracking causes or exacerbates asthma. In fact, [asthma rates and asthma hospitalizations](#) across the United States have declined as natural gas production has ramped up.
- There is no credible evidence that fracking causes cancer. Studies that have directly measured emissions at fracking sites have found emissions are below the threshold that would be harmful to public health.
- There is no credible evidence that fracking leads to adverse birth outcomes. In fact, adverse birth outcomes have [decreased](#) while life expectancy has increased in areas that are ramping up natural gas use.
- Fracking is not a credible threat to groundwater. Study after study has shown that there are no widespread, systemic impacts to drinking water from hydraulic fracturing.

It is well known that the shale revolution has been a [boon](#) to our nation’s economy, its [geopolitical position](#), and the millions of consumers and manufacturers who continue to benefit from [historically low](#) energy costs. But the case in support of shale’s salubrious effect on air quality and health continues to be an underreported phenomenon – this new report puts the health benefits of our increased use of natural gas in the spotlight.

## TABLE OF CONTENTS

Overview .....	4
Section 1: More Natural Gas, Less Air Pollution .....	7
Section 2: Shale Development Is Protective of Public Health .....	15
Section 3: Asthma Hospitalizations Decline as Natural Gas Use Increases .....	20
Section 4: Life Expectancy and Birth Outcomes Improve as Natural Gas Use Increases .....	22
Section 5: Debunking the Dubious Link between Fracking and Cancer .....	24
Section 6: No Widespread, Systemic Impact to Drinking Water Resources .....	27
Conclusion.....	31

## Overview

The [increased use](#) of natural gas – made possible by hydraulic fracturing – has allowed the United States to make enormous strides in improving air quality.

Not only does natural gas emit far less carbon dioxide than other fossil fuels when burned, it also emits far fewer criteria pollutants. This has had a significant, [positive effect on public health](#).<sup>1</sup> As Dr. Michael Greenstone – an MIT professor of environmental economics – [recently put it](#),

*“There’s a strong case that people in the U.S. are already leading longer lives as a consequence of the fracking revolution.”<sup>2</sup>*

Dr. Daniel Schrag, director of Harvard University’s Center for the Environment, [has said](#),

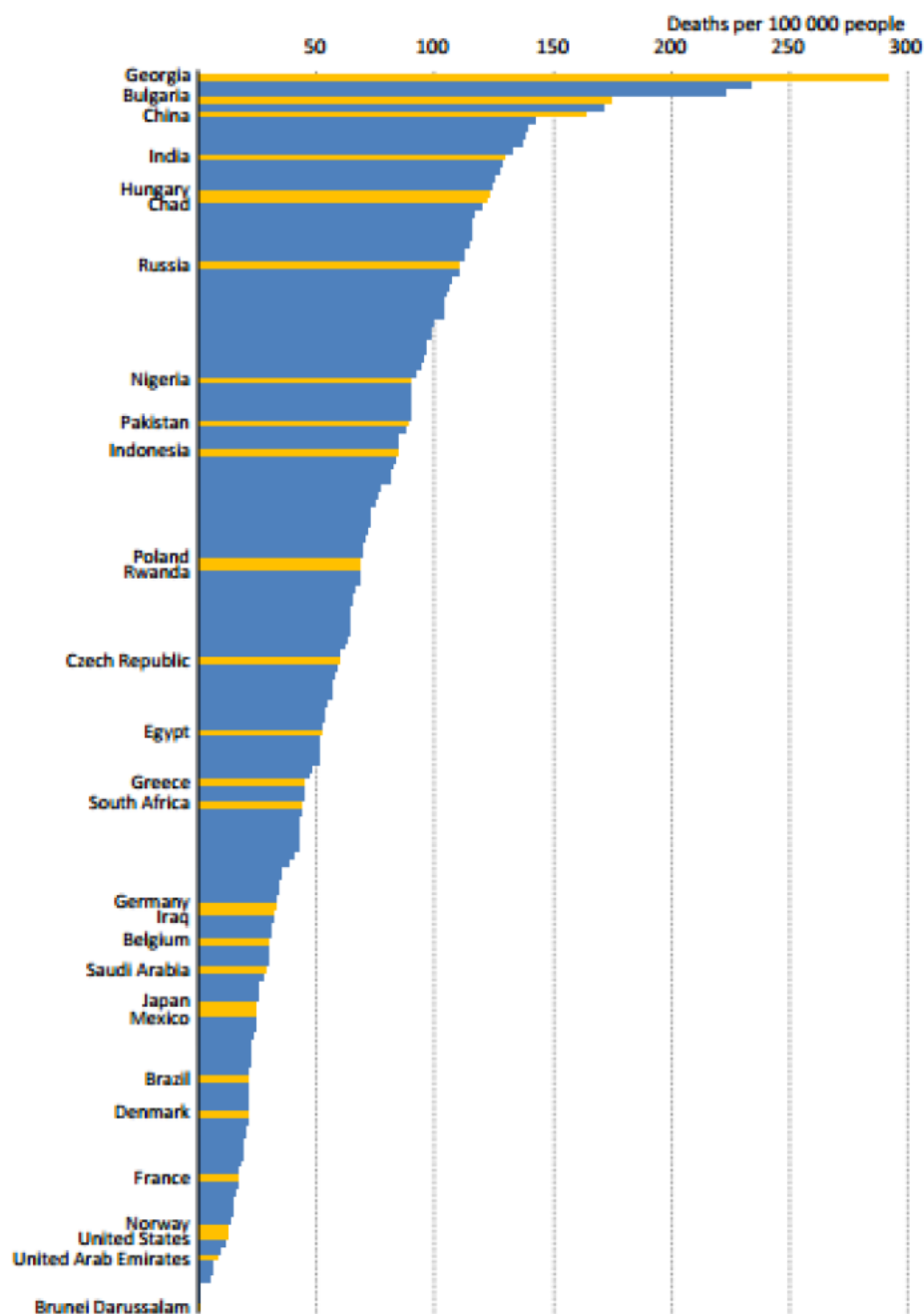
*“With proper regulation and enforcement, gas provides a very substantial health benefit in reducing air pollution.”<sup>3</sup>*

Even former Environmental Protection Agency (EPA) administrator [Gina McCarthy](#) has said,

*“Natural gas has been a game changer with our ability to really move forward with pollution reductions that have been very hard to get our arms around for many decades.”<sup>4</sup>*

The International Energy Agency (IEA) [recently noted](#) that the United States – the number one oil and gas producer in the world – has one of the lowest death rates from air pollution in the world, as this graph demonstrates:<sup>5</sup>

**Figure 1.8 ▶ Mortality rate attributed to air pollution (household and outdoor) by country, 2012**



Note: Only a selection of countries are highlighted.

Sources: WHO (2016b) and IEA analysis.

Over the past few years, anti-fracking activists have tried to convince the public that fracking harms public health. They have attempted to link the process to everything from cancer, premature births, birth defects, asthma and even fatigue and headaches. The Concerned Health Professionals of New York even published a [Compendium of Scientific, Medical and Media Findings Demonstrating Risks and Harms of Fracking](#) — a collection of “studies” intended to influence policymakers to ban or restrict fracking.<sup>6</sup>

For the most part, however, the studies cited lack any such causal evidence, and in many cases their hypotheses have been disproven by empirical research from state health agencies. Most recently, the Colorado Department of Public Health and the Environment (CDPHE) released a [comprehensive report](#) finding a **“low risk of harmful health effects from combined exposure to all substances during oil and gas development.”**<sup>7</sup> Other states, including West Virginia, Pennsylvania, and Texas, have come to similar conclusions.

In order to put the spotlight on the most credible research in the field, Energy In Depth is releasing the first installment of a number of health reports that will be published in the coming months. This initial report, entitled **Compendium of Studies Demonstrating the Safety and Health Benefits of Fracking**, provides the overwhelming scientific evidence that shale production is not a credible threat to public health. In fact, science confirms that natural gas is an environmentally friendly energy source that has helped to improve public health.

## Section 1: More Natural Gas, Less Air Pollution

Electric power plants have traditionally been the top source of emissions of nitrogen oxide (NO<sub>x</sub>) sulfur dioxide (SO<sub>2</sub>), fine particulate matter (PM<sub>2.5</sub>), and mercury. The U.S. EPA has identified SO<sub>2</sub>, nitrogen dioxide (NO<sub>2</sub>) — as well as other nitrogen oxides (NO<sub>x</sub>) — and PM<sub>2.5</sub> as “[criteria pollutants](#)” that “can harm your health and the environment.”<sup>8</sup>

But thanks to the shale revolution, natural gas has been so cheap and abundant that it has become [the top fuel source](#) for electrical generation in the United States.<sup>9</sup> Since natural gas emits far fewer of these pollutants when burned than other fossil fuels, emissions of NO<sub>x</sub>, SO<sub>2</sub>, PM<sub>2.5</sub> and mercury across the United States have [plummeted](#), which has been a boon to public health.<sup>10</sup>

Numerous experts have noted that the reduction in emissions is a direct result of increased natural gas use made possible by fracking. As University of California-Berkeley Professor of Physics Richard Muller has [explained](#),

*“[S]hale gas results in a 400-fold reduction of PM<sub>2.5</sub>, a 4,000-fold reduction in sulfur dioxide (SO<sub>2</sub>), a 70-fold reduction in nitrous oxides (NO<sub>x</sub>), and more than a 30-fold reduction in mercury.”<sup>11</sup>*

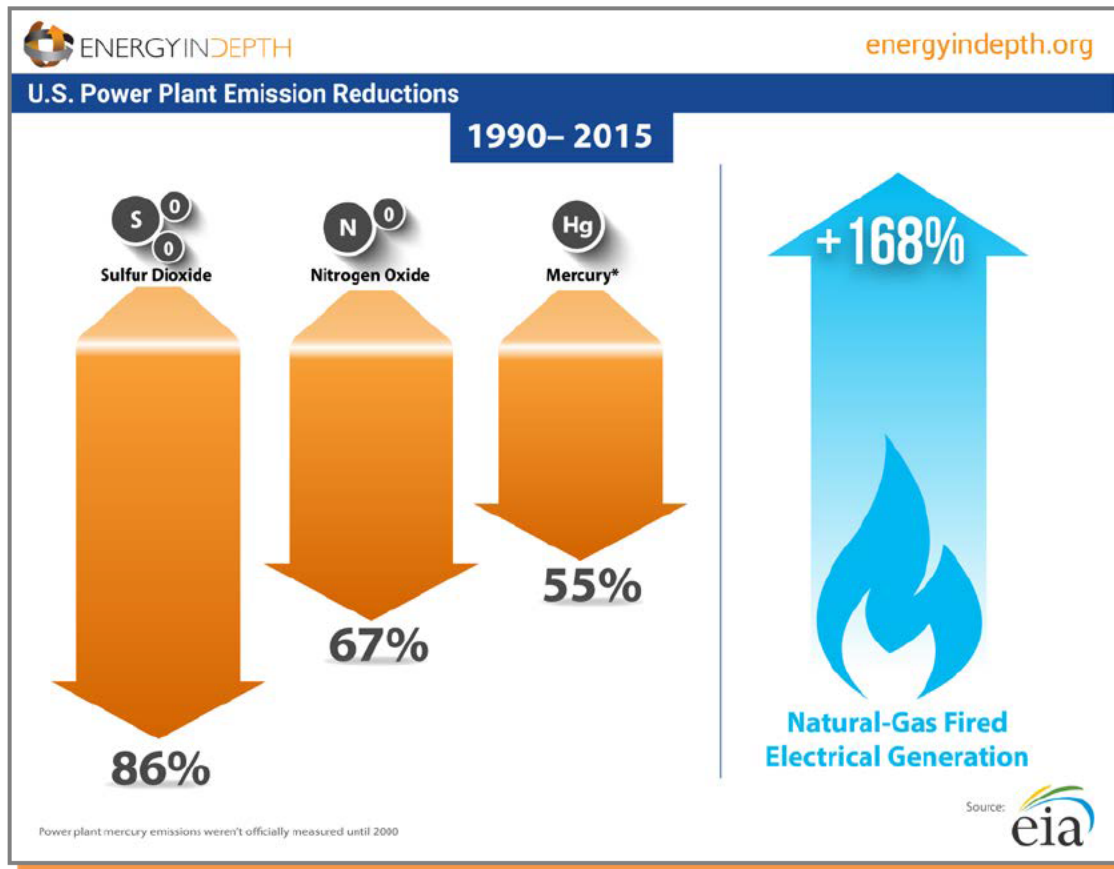
The U.S. Energy Information Administration (EIA) has also [noted](#):

*“In recent years the decreased use of coal for electric power generation because of cheaper natural gas has also played a significant role in the SO<sub>2</sub> and NO<sub>x</sub> emissions declines.”<sup>12</sup>*

The relationship between the increased use of natural gas and the significant decrease in air pollutants is especially apparent in [data from EIA](#).<sup>13</sup> Natural gas’ share of total net electricity generation has [nearly tripled](#) since 1990,<sup>14</sup> while natural gas consumption has increased [43 percent](#) since 1990.<sup>15</sup>

In 2015, power plant SO<sub>2</sub> emissions declined 86 percent from 1990 levels. During that same time period, NO<sub>x</sub> emissions from power plants went down by 67 percent. Power plant mercury emissions have declined 55 percent since 2000. It’s no coincidence that from 1990 to 2015 natural gas use in power plants skyrocketed by 168 percent.





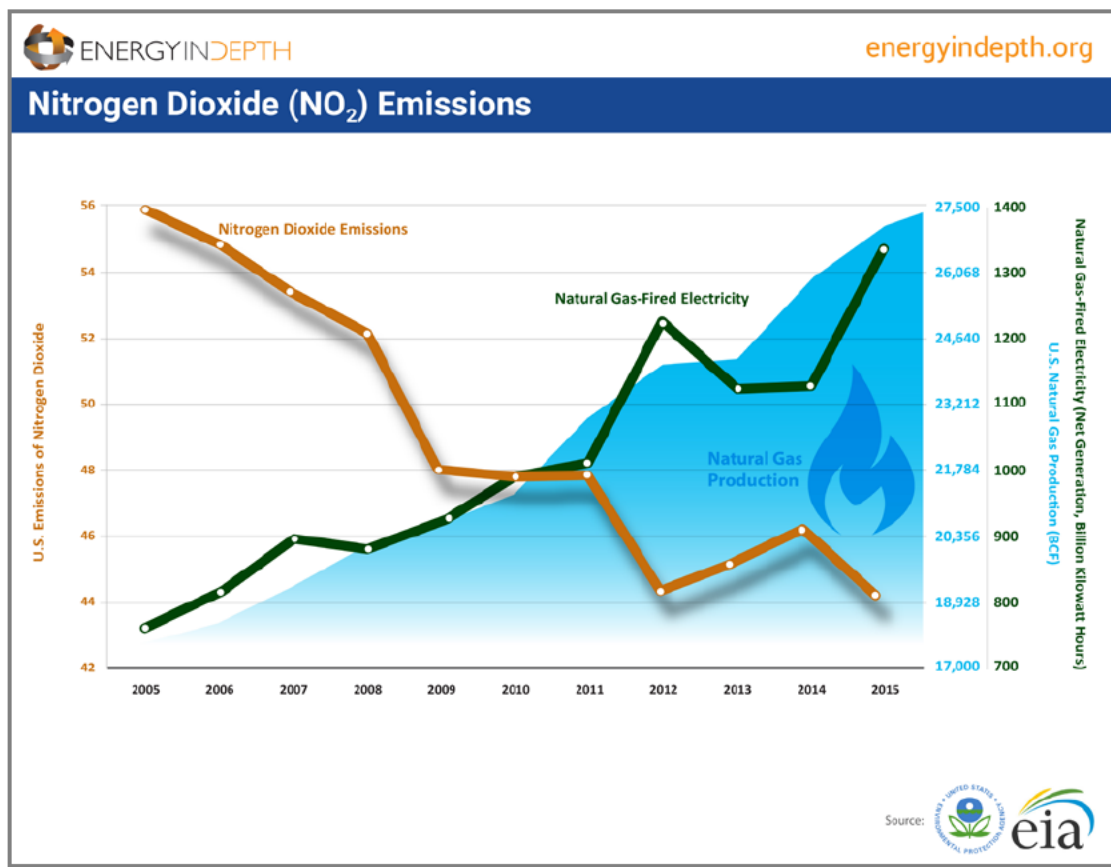
EIA isn't the only agency to release data showing major emission reductions. U.S. EPA data also show how increased natural gas use — particularly for electricity generation — has led to dramatic reductions in these harmful pollutants across the board.

The latest [EPA data](#)<sup>16</sup> show that NO<sub>2</sub> emissions declined [47 percent](#)<sup>17</sup> from 1990 to 2015 and [20 percent](#)<sup>18</sup> from 2005 to 2015, as natural gas use increased by [24 percent](#).<sup>19</sup>

These NO<sub>2</sub> reductions are crucial from a public health perspective, as EPA [explains](#):

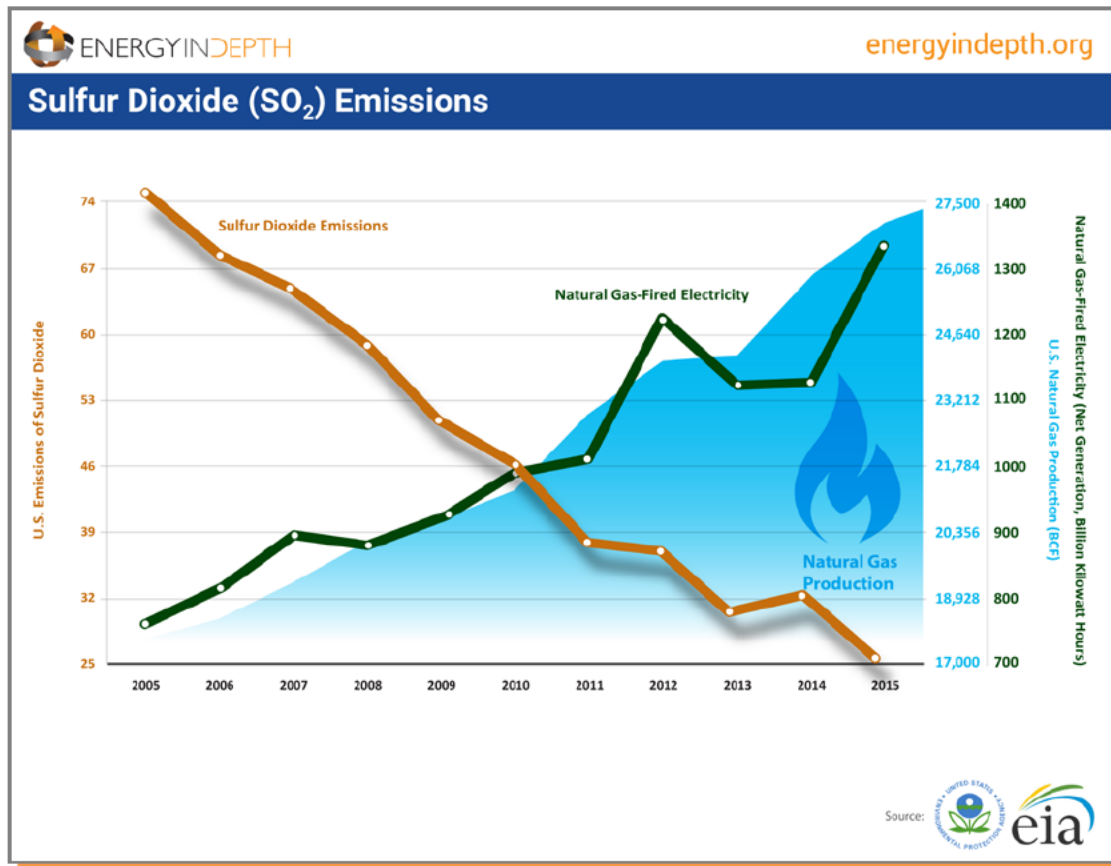
*“Breathing air with a high concentration of NO<sub>2</sub> can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions and visits to emergency rooms. Longer exposures to elevated concentrations of NO<sub>2</sub> may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma, as well as children and the elderly are generally at greater risk for the health effects of NO<sub>2</sub>.”*

The EPA also [notes](#), “NO<sub>2</sub> along with other NO<sub>x</sub> reacts with other chemicals in the air to form both particulate matter and ozone. Both of these are also harmful when inhaled due to effects on the respiratory system.”<sup>20</sup>



The most recent EPA data show U.S. [sulfur dioxide](#) (SO<sub>2</sub>) emissions have declined [81 percent](#) since 1990 and [66 percent](#) from 2005 to 2015,<sup>21</sup> a trend that has been driven largely by increased natural gas use for electricity generation.<sup>22</sup>

These reductions of NO<sub>x</sub> and SO<sub>2</sub> are crucial from a public health perspective because, as EPA [explains](#), acid rain is “caused by a chemical reaction that begins when compounds like sulfur dioxide and nitrogen oxides are released into the air.”<sup>23</sup>



According to the EPA, SO<sub>2</sub> in particular is “[of greatest concern](#)” [because](#).

*“SO<sub>2</sub> emissions that lead to high concentrations of SO<sub>2</sub> in the air generally also lead to the formation of other sulfur oxides (SO<sub>x</sub>). SO<sub>x</sub> can react with other compounds in the atmosphere to form small particles. These particles contribute to particulate matter (PM) pollution: particles may penetrate deeply into sensitive parts of the lungs and cause additional health problems.”<sup>24</sup>*

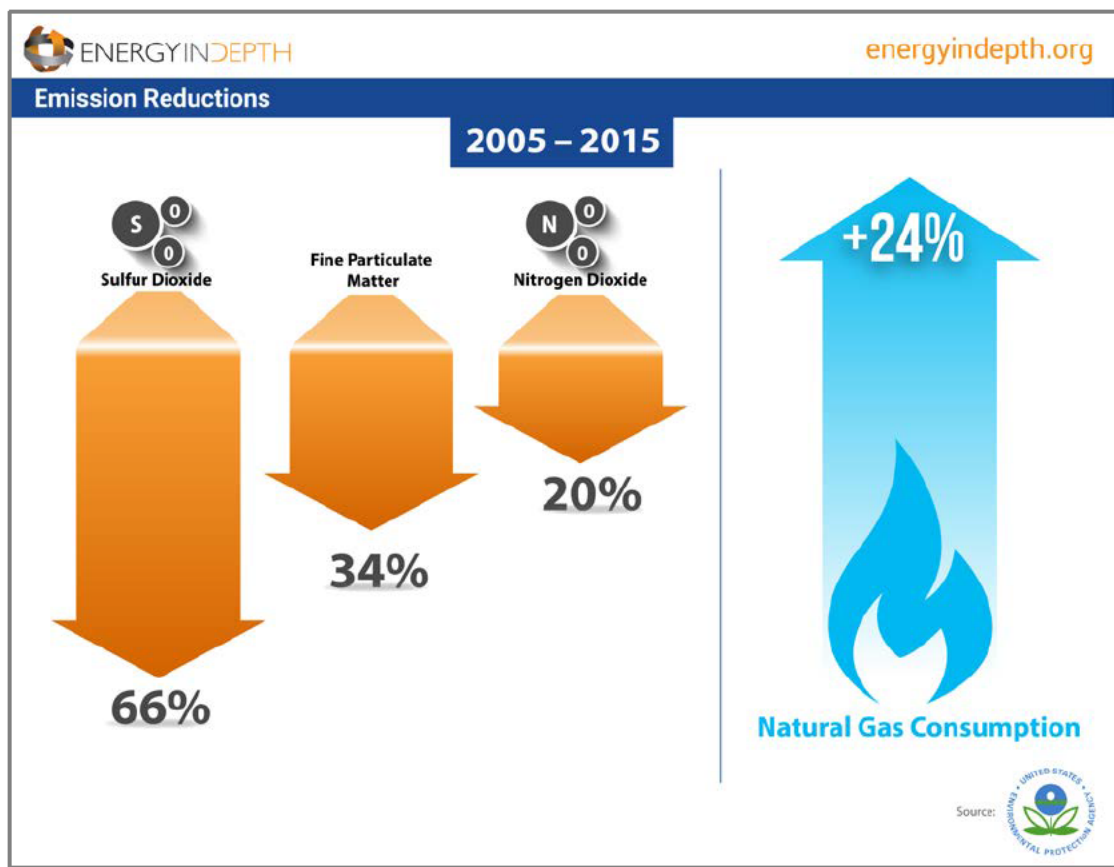
But the increased use of natural gas is rapidly reducing that public health threat. As EPA [puts it](#), “Emissions of sulfur dioxide and mercury compounds from burning natural gas are negligible.”<sup>25</sup>

Fine particulate matter (PM<sub>2.5</sub>) is a byproduct of chemical reactions between a number of pollutants, most notably nitrogen oxides and sulfur dioxide. Because natural gas emits virtually no sulfur dioxide and less than one fourth the nitrogen oxides as coal, it's no surprise the latest EPA data show overall U.S. [fine particulate matter](#)<sup>26</sup> emissions have declined [34 percent](#) from 2005 to 2015.<sup>27</sup>

This is crucial considering EPA has [also found](#) that fine particulate matter can cause early death and cardiovascular or respiratory harm.<sup>28</sup> The World Health Organization's (WHO) [comprehensive database](#), covering 3,000 cities in 103 countries, shows more than [80 percent](#) of people living in urban areas that monitor air pollution worldwide are exposed to PM2.5 concentration levels that exceed WHO standards. In sharp contrast, the WHO data show just 20 percent of people living in urban areas in the U.S. are exposed to PM2.5 levels that exceed WHO standards.<sup>29</sup>

Again, these reductions are thanks in large part to increased natural gas use for electricity generation. Dr. Muller, from Cal-Berkeley, has similarly found that shale gas holds the potential to save millions of lives in the developing world by further reducing PM2.5 emissions, [saying](#).

*"For shale gas is a wonderful gift that has arrived just in time. It can not only reduce greenhouse gas emissions, but also reduce a deadly pollution known as PM2.5 that is currently killing over three million people each year, primarily in the developing world."*<sup>30</sup>



Finally, U.S. mercury emissions have declined 79 percent from 1990 levels. This, too, has been driven by increased use of natural gas for electricity generation. Power plants accounted for nearly half of U.S. mercury emissions as recently as 2011, but mercury emissions from power plants [have decreased](#) 55 percent since 2000 (the first year that mercury emissions were reported by the industry under the Toxics Release Inventory).<sup>31</sup>

Former EPA Administrator Gina McCarthy has also [explained](#), “cheap natural gas—mostly from fracking operations—has improved air quality in the U.S.” by replacing “mercury-laden” emissions from other energy sources.<sup>32</sup>

EIA and EPA data are just the beginning. Numerous independent studies and government reports have come to the same conclusion that increased natural gas use leads to dramatically lower emissions. Here are a few below:

- **de Gouw et al. “Reduced emissions of CO<sub>2</sub>, NO<sub>x</sub> and SO<sub>2</sub> from U.S. power plants owing to switch from coal to natural gas with combined cycle technology,” *Earth's Future*, 2014 ([study link](#)/[EID blog](#)).** This peer-reviewed National Oceanic and Atmospheric Administration (NOAA) study found that “the increased use of natural gas” over the last decade (2004-2014) led to emissions reductions of NO<sub>x</sub> (40%) and SO<sub>2</sub> (44%). The authors also noted: “Further reductions in these emissions can follow by converting a larger fraction of U.S. electric power production to natural gas, and by ensuring that all natural gas power plants are equipped with the latest combined cycle technology.”<sup>33</sup>
- **Leken et al. “The climate and health effects of a USA switch from coal to gas electricity generation,” *Elsevier B.V.*, 2016 ([study link](#)/[EID blog](#)).** This Carnegie Mellon University peer-reviewed study found that increased use of natural gas would result in further sulfur dioxide (SO<sub>2</sub>) reductions from current levels of 90 percent and 60 percent for nitrogen oxide (NO<sub>x</sub>), reducing national annual health damages by \$20-\$50 billion annually.<sup>34</sup>
- **International Energy Agency: “World Energy Outlook Special Report 2016: Energy and Air Pollution,” 2016 ([report link](#)).** This IEA report finds global sulfur dioxide (SO<sub>2</sub>) emissions are projected to fall 20 percent, nitrogen oxide (NO<sub>x</sub>) emissions 10 percent, and particulate matter seven percent by 2040. IEA projects 30 percent of these reductions will be attributable to natural gas, “which emits less air pollution than other fossil fuels or biomass.” The report also notes air pollution is the fourth greatest overall risk factor of human health worldwide, stating that coal use in the power sector is down about 20 percent over the last decade, reflective of the boom in shale gas development, with an associated significant decline in air pollutants. The report forecasts U.S. sulfur dioxide (SO<sub>2</sub>) and nitrogen oxide (NO<sub>x</sub>) emissions each falling another 50 percent by 2040 and PM<sub>2.5</sub> emissions falling 25 percent — with one-quarter of each of the declines

attributable in part to increased natural gas use for power generation. The report projects PM<sub>2.5</sub> emissions from power generation falling 80 percent due to an “increase from natural gas and renewable sources,” adding that power generation will be responsible for just five percent of PM<sub>2.5</sub> emissions in the U.S. by 2040.<sup>35</sup>

- **Ceres: “Benchmarking Air Emissions,” 2016** ([study/EID blog](#)). This report on the 100 biggest U.S. power plants, which account for 85 percent of the country’s electricity, found that SO<sub>2</sub> emissions are down 80 percent, while NO<sub>x</sub> emissions are down 75 percent. It also found that power plant mercury emissions have fallen 44 percent since 1990. The report notes, “Some of the factors driving this trend include energy efficiency improvements and displacement of coal generation by natural gas and renewable energy...”<sup>36</sup>
- **Muller et al., Centre for Policy Studies: “Why Every Serious Environmentalist Should Favour Fracking,” 2013** ([study link](#)). This study finds that shale gas not only reduces greenhouse gas emissions, but also PM<sub>2.5</sub>, which it notes is “killing over three million people each year, primarily in countries like India and China” and “kills more people per year than AIDS, malaria, diabetes or tuberculosis.” The report concludes: “Environmentalists who oppose the development of shale gas and fracking are making a tragic mistake,” and that “shale gas is urgently needed to address the greatest human-caused environmental disaster of our time, rising levels of air pollution, currently causing over three million deaths per year worldwide.”<sup>37</sup>
- **Krotkov et al., “Aura OMI observations of regional SO<sub>2</sub> and NO<sub>2</sub> pollution changes from 2005 to 2015,” *Atmospheric Chemistry and Physics*, 2016** ([study link](#)). This peer-reviewed NASA satellite analysis estimates that sulfur dioxide emissions (SO<sub>2</sub>) in the eastern U.S. decreased 80 percent from 2005 to 2015, noting: “The conversion to natural gas with much less fuel (sulfur) than coal has also contributed to the reduction in SO<sub>2</sub> pollution.”<sup>38</sup>
- **Pennsylvania Department of Environmental Protection: “Unconventional Natural Gas Emissions Inventory,” 2013** ([report link](#)). This report found that over 500 million tons of emissions were removed from the Commonwealth’s air as it increased its natural gas use in 2013. The report explained that “SO<sub>x</sub> emissions have decreased as a result of the installation of control equipment on the electric generating units as well as the conversion to natural gas.”<sup>39</sup>
- **The Breakthrough Institute: “Deadly Air Pollution Declines Thanks to Shale Gas Boom,” 2013** ([report link](#)). This environmental think tank reported that the increased development and utilization of natural gas has been a clear winner for air quality in Pennsylvania, stating, “[N]ew builds in gas-fired power plants and the associated surge in fracking have dramatically reduced emissions across Pennsylvania, including deadly

particulates, heavy metals, and the NO<sub>x</sub> and SO<sub>x</sub> which cause smog, acid rain, and health problems.”<sup>40</sup>

- **Pennsylvania Department of Environmental Protection: “Unconventional Natural Gas Emissions Inventory,” 2012 ([EID blog](#)).** This version of the DEP’s annual inventory highlighted that total Pennsylvania emissions reductions attributable to natural gas represented “between \$14 billion and \$37 billion of annual public health benefits.” In light of these decreases in emissions across the state, Chris Abruzzo, then-Secretary of DEP, pointed out, “It is important to note that across-the-board emission reductions [...] can be attributed to the steady rise in the production and development of natural gas, the greater use of natural gas, lower allowable emissions limits, installation of control technology and the deactivation of certain sources.”<sup>41</sup>



## Section 2: Shale Development Is Protective of Public Health

State health and environmental agencies frequently use air monitoring at well sites to assess health risks. Many have found that emissions levels are below the threshold that would indicate a threat to public health. Here are some of the prominent studies to come out on emissions from well sites and related infrastructure:

- **Colorado Department of Public Health and Environment (CDPHE): “Assessment of Potential Health Effects from Oil and Gas Operations in Colorado,” 2017** ([report link](#)/[EID blog](#)). CDPHE collected over 10,000 air samples in parts of Colorado with “substantial” oil and gas operations. The data indicate that emissions from oil and natural gas operations did not reach levels that would be considered harmful to human health, even when measured against conservative standards intended to protect sensitive individuals. The assessment concluded: “the risk of harmful health effects is low for residents living [near] oil and gas operations,” and that “results from exposure and health effect studies do not indicate the need for immediate public health action.” The assessment also noted that, “All measured air concentrations were below short- and long-term ‘safe’ levels of exposure for non-cancer health effects, even for sensitive populations.”<sup>42</sup>
- **Utah Division of Air Quality/U.S. Environmental Protection Agency Region 8: “2014 Utah Air Agencies O&G Emissions Inventory,” 2016** ([report link](#)/[EID blog](#)). The first phase of this 2016 [report](#) examining air quality in Utah’s Uinta Basin found volatile organic compound (VOC) emissions are significantly less than previously estimated. This report — the outcome of a multi-year collaboration between the Utah Division of Air Quality (UDAQ), Environmental Protection Agency (EPA) Region 8, and the Ute Indian Tribe — shows VOC emissions basin-wide are about half of previous estimates, with a more than 62 percent drop in Duchesne County and about a 34 percent drop in Uintah County.<sup>43</sup>
- **Hildenbrand et al., “Point source attribution of ambient contamination events near unconventional oil and gas development,” *Science of the Total Environment*, 2016** ([study link](#)/[EID blog](#)). This peer-reviewed University of Texas at Arlington [study](#) found that ambient emissions in and around hydraulic fracturing sites in South Texas’ Eagle Ford Shale are within acceptable limits. The authors also determined that the recorded emissions were not inherent to development process overall and were due to mechanical issues that are “not necessarily the inherent nature of the complete UD (unconventional development) process” and are fixable. Focused specifically on levels of ambient BTEX — or benzene, toluene, ethyl benzene, and xylene compounds — near fracking sites in the Eagle Ford, the researchers collected data from over 12,800 mobile mass spectrometry measurements across 13 counties, and the authors determined that while BTEX compounds were registered, the levels were well below federal safety standards. The researchers also note that the levels of ambient toluene



and xylene also did not exceed the federally mandated limits. In fact, the levels tested were *40 and 100 times less*, respectively, than the OSHA and U.S. National Institute for Occupational Safety and Health (NIOSH) limits.<sup>44</sup>

- **Ethridge et al., “The Barnett Shale: From problem formulation to risk management,” *Journal of Unconventional Oil and Gas Resources*, 2015 ([study link](#)).** This peer-reviewed Texas Commission on Environmental Quality (TCEQ) study that found, “Shale gas production activities have not resulted in community-wide exposures to ... VOCs at levels that would pose a health concern.” The Texas Commission on Environmental Quality conducted months of testing in the Barnett Shale area, and its samples collected by state-of-the-art, 24-hour air monitors showed “no levels of concern for any chemicals.” TCEQ added that “there are no immediate health concerns from air quality in the area.” TCEQ’s report included data from more than 560 sites across the region, representing one of the most comprehensive assessments to date.<sup>45</sup>
- **Modern Geosciences: “Air tests of 5 Barnett Shale wells being hydraulically fractured show no harmful emissions,” 2015 ([report link](#)/[EID blog](#)).** This study looked at five Barnett Shale wells in Mansfield, Tex., during both hydraulic fracturing and flowback activities. The report measured volatile organic compounds (VOCs) and other emissions, and concluded “none of the observed VOCs were noted above the comparison criteria,” a reference to scientifically-established public health thresholds. Notably, the Mansfield study found a number of VOCs during its baseline tests, taken in the city before the wells had ever been drilled. Modern Geosciences noted that these emissions “can be found in the urban environment due to both natural and anthropogenic contributions.”<sup>46</sup>
- **Goetz et al., “Atmospheric Emission Characterization of Marcellus Shale Natural Gas Development Sites,” *Environmental Science & Technology*, 2015 ([study link](#)/[EID blog](#)).** This peer-reviewed Drexel University study found low levels of air emissions at well sites in the Marcellus Shale region. As the authors explained, “we did not observe elevated levels of any of the light aromatic compounds (benzene, toluene, etc.)” and “there are few emissions of non-alkane VOCs (as measured by PTR-MS) from Marcellus Shale development.” The Aerodyne Research Inc. Mobile Laboratory (AML) was used during the summer of 2012 to collect ambient air data in two regions of Pennsylvania within the Marcellus Shale Basin. The first campaign took place in northeast Pa., centering on Sullivan and Bradford counties, in August of 2012. The second took place in September 2012 in several southwestern Pa. counties.<sup>47</sup>
- **Professional Service Industries, Inc.: “Atmospheric Emission Characterization of Marcellus Shale Natural Gas Development Sites,” 2015 ([study link](#)/[EID blog](#)).** Commissioned by Union Township in Pennsylvania, this study [found](#): “Airborne gas and TVOC levels appear to have been at or near background levels for the entire monitoring periods in the three locations monitored.” PSI conducted the air quality and noise monitoring at three locations from Feb. 4-9 and March 13-16, 2015, while hydraulic fracturing operations were taking place. The report shows that all levels for all air emissions fall

well below the recommended limit except with one monitor, which picked up above normal levels for airborne particulates. However, according to PSI: “Based on site observations and a review of the data, instrument error was suspected and the area was resampled from March 13-16, 2015. Airborne particulate levels were below applicable levels following the re-sampling, and at the other locations monitored.”<sup>48</sup>

- **Public Health England: “Shale gas extraction: review of the potential public health impacts of exposures to chemical and radioactive pollutants,” 2013 ([study link](#)/[EID blog](#)).** Conducted by an executive agency within UK’s Department of Health, this study concluded: “The currently available evidence indicates that the potential risks to public health from exposure to the emissions associated with shale gas extraction are low if the operations are properly run and regulated.” Specifically referencing emissions during shale development, the study finds that “these emissions are relatively small, intermittent and certainly not unique to shale gas extraction and related activities.”<sup>49</sup>
- **Bunch et al. “Evaluation of impact of shale gas operations in the Barnett Shale region on volatile organic compounds in air and potential human health risks,” *Science of the Total Environment*, 2013 ([study link](#)/[EID blog](#)).** This peer-reviewed study of air emissions across the Barnett Shale, conducted by ToxStrategies, concluded that “shale gas activities have not resulted in VOC levels that pose a health concern.” The study found that VOCs associated with shale gas were all below health-based CVs and VOCs associated with shale gas showed acceptable chronic risk and hazard. The study’s abstract states, “The analyses demonstrate that, for the extensive number of VOCs measured, shale gas production activities have not resulted in community-wide exposures to those VOCs at levels that would pose a health concern.” The study’s conclusions were based on Texas Commission on Environmental Quality (TCEQ) data.<sup>50</sup>
- **West Virginia Department of Environmental Protection: “Air Quality Impacts Occurring From Horizontal Well Drilling And Related Activities,” 2013 ([study link](#)/[EID blog](#)).** This study found no major health threat from shale development, concluding, “Based on a review of completed air studies to date, including the results from the well pad development monitoring conducted in West Virginia’s Brooke, Marion, and Wetzel Counties, no additional legislative rules establishing special requirements need to be promulgated at this time.”<sup>51</sup>
- **ChemRisk: “Air monitoring of volatile organic compounds at relevant receptors during hydraulic fracturing operations in Washington County, Pennsylvania,” 2013 ([study link](#)/[EID blog](#)).** Commissioned by the Fort Cherry School District in Pennsylvania, this study included data from continuous air monitoring at Fort Cherry School District and found: “The results of the fracking and flaring sampling periods were similar to the results obtained from the baseline monitoring period and likewise, did not show anything remarkable with respect to chemicals detected in the ambient air. When volatile compounds were detected, they were consistent with background levels measured at the school and in other areas in Washington County. Furthermore, a basic yet

conservative screening level evaluation shows that the detected volatile compounds were below health-protective levels.” The study took continuous air measurements at the school and a residence — both located 900 meters from the drilling site — before, during and after fracking operations over a three-month timespan in 2011 and 2012, concluding, “The primary finding of this study was that the presence and operation of a hydraulic fracturing well pad in Washington County, PA, did not substantially affect local air concentrations of total and individual VOCs...”<sup>52</sup>

- **West Virginia Department of Environmental Protection: “Air, Noise, and Light Monitoring Plan For Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations,” 2012** ([study link](#)). This School of Public Health at West Virginia University (WVU)-led study evaluated the noise, light, dust and volatile organic compounds from horizontal wells. The study found that “there are no indications of a public health emergency or threat.”<sup>53</sup>
- **Colorado Department of Public Health: “Air Emissions Case Study Related to Oil and Gas Development in Erie, Colorado,” 2012** ([study link](#)). For this study, researchers installed air-quality monitors at a well site that activists complained about. Based on the data collected, the research team concluded: “The monitored concentrations of benzene, one of the major risk driving chemicals, are well within acceptable limits to protect public health, as determined by the U.S. Environmental Protection Agency. The concentrations of various compounds are comparatively low and are not likely to raise significant health issues of concern.”<sup>54</sup>
- **Pennsylvania Department of Environmental Protection: “Northeastern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report,” 2011** ([report link](#)). This was a short-term (three month) study of ambient air quality near Marcellus Shale development in the northeastern region of Pennsylvania, specifically in Susquehanna County. While this was not a cumulative or comprehensive study of emissions, it did provide a snapshot of area specific air quality near natural gas operations and noted: “Results of the limited ambient air sampling initiative in the northeast region did not identify concentrations of any compound that would likely trigger air-related health issues associated with Marcellus Shale drilling activities.”<sup>55</sup>
- **TechLaw and Environmental Protection Agency Region 3: “Skyview Elementary School Site, Morgantown, Monongalia County, West Virginia,” 2011** ([study link](#)/[EID blog](#)). This study monitored air quality at Skyview Elementary School in Morgantown and found “[e]xtremely low concentrations of carbonyls, volatile organic compounds, and hydrogen sulfide,” adding that “no indications of public health impacts related to hydraulic fracturing were found.” EPA performed three sets of air quality tests at Skyview Elementary, two before and one during fracking. The former baseline testing “did not show any levels of concern” and the latter also “did not identify any levels of concern or air problems,” according to Region 3 spokesman Roy Seneca.<sup>56</sup>

- **Eastern Research Group Inc.: “City of Fort Worth Natural Gas Air Quality Study,” 2011** ([study link/EID blog](#)). This study evaluated air emissions associated with natural gas development from the Barnett Shale near Ft. Worth, Tex., and “did not reveal any significant health threats.” The study also found that though five sites exceeded regulatory emission thresholds, the study “did not reveal any significant health threats” to residents.<sup>57</sup>
- **Pennsylvania Department of Environmental Protection: “Southwestern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report,” 2010** ([report link](#)). This study did not identify concentrations of any compound that would likely trigger air-related health issues associated with Marcellus Shale drilling activities. Sampling for carbon monoxide, nitrogen dioxide and ozone, researchers did not detect levels above National Ambient Air Quality Standards at any of the sampling sites.<sup>58</sup>

### Section 3: Asthma Hospitalizations Decline as Natural Gas Use Increases

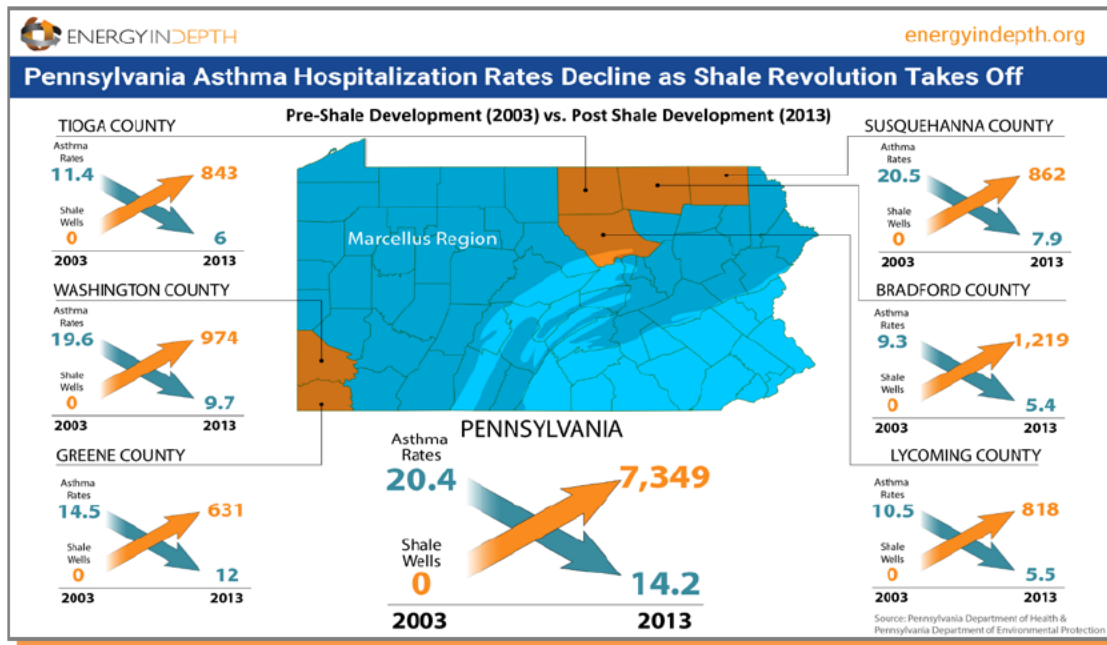
Since the shale revolution took hold, and air pollution has dropped over the past few years, Americans are suffering fewer asthma attacks. The reason: natural gas. The evidence is so overwhelming that even the presidential campaign of Hillary Clinton endorsed natural gas use by stating increased use of the fuel has “yielded significant public health benefits, avoiding thousands of premature deaths and more than 100,000 asthma attacks in 2015 alone...”<sup>59</sup>

According to the Centers for Disease Control and Prevention (CDC) data from 2015:

- The national prevalence of asthma attacks went from [51.5 percent](#) in 2010 to [46.9 percent](#) in 2015.<sup>60</sup>
- Asthma prevalence rates [dropped](#) to from 8.4 percent in 2010 to [7.8 percent](#) in 2015.<sup>61</sup>
- Asthma mortality rates went from [1.1 in 100,000](#) in 2010 to [1.03 in 100,000](#) in 2015.<sup>62</sup>
- Texas, the nation’s top producing oil and gas state, has the [lowest adult asthma prevalence rate](#) (6.7 percent) in the continental United States.

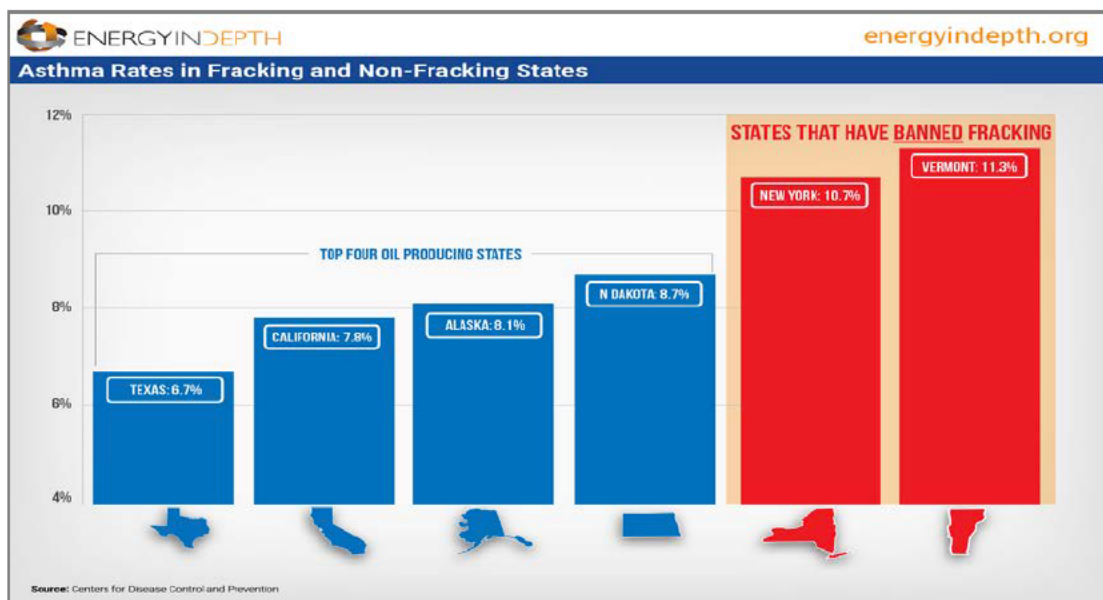
Activist researchers have published a number of [reports](#) claiming that shale development in the Marcellus region in Pennsylvania either causes asthma or exacerbates asthma flare-ups by increasing ozone, despite a complete lack of evidence to support that claim. Meanwhile, data from the Pennsylvania Department of Health (PaDOH) shows that asthma hospitalization rates in some of the top shale counties in the state have dramatically decreased as shale production has increased.

PaDOH’s [database](#) shows the rates of asthma hospitalizations across Pennsylvania decreased 30 percent from 2003 to 2013 (from 20.4 percent to 14.2 percent) at the same time the number of shale wells in the state increased from zero wells to 7,439 wells.<sup>63</sup>



As the graphic above shows, PaDOH [data](#) also reveal asthma hospitalizations rates have fallen at the same time Marcellus development has skyrocketed in the top five shale producing counties in the state: Susquehanna, Bradford, Lycoming, Greene, Washington and Tioga counties.<sup>64</sup>

To further illustrate that point, Texas, California, Alaska and North Dakota — the top four oil producing states in the U.S. — [have lower asthma rates](#) than two states that have banned fracking, New York and Vermont, which both have double-digit asthma rates. Massachusetts' asthma rate is 12 percent despite having no oil and gas production, while the District of Columbia's is 11.5 percent and Rhode Island's is 11.5 percent.<sup>65</sup>



## Section 4: Life Expectancy and Birth Outcomes Improve as Natural Gas Use Increases

If natural gas is a boon to public health, it only follows that it would help increase life expectancy in adults and newborns. Unsurprisingly, that is the conclusion of two National Bureau of Economic Research (NBER) studies. Meanwhile, data from the Centers for Disease Control and Prevention show that low birth weights and infant mortality rates have significantly declined during the years that shale gas has ramped up.

Both of the NBER studies focus on Turkey due to the fact that the country has experienced a large shift towards natural gas use in the last few decades, but the study's lead author was very clear that this research can be applied to other locations as well. As he [said](#), "[T]here is no reason to think that the overall pattern in the relationship might differ much between the two contexts, especially for areas in the United States where there is widespread use of coal and the air quality is poor."<sup>66</sup>

- **National Bureau of Economic Research: "Can Natural Gas Save Lives? Evidence from the Deployment of a Fuel Delivery System in a Developing Country," 2016** ([study link](#)/[EID blog](#)). This study examines the relationship between an increase in natural gas use and adult and elderly mortality rates. The study finds, "the expansion of natural gas services has caused significant reductions in the both the adult and the elderly mortality rates." The paper focuses on 81 Turkish provinces, 71 of which have switched from a coal based fuel delivery system to natural gas over the last two decades. The study shows that when a natural gas network is deployed in a province, air quality improves compared to those provinces without an access to natural gas, and subsequently the rates of mortality go down for all age groups including infants, adults, and the elderly. Furthermore, the study finds that the mortality gains are primarily driven by reductions in cardio-respiratory deaths, which are more likely to be due to conditions caused or exacerbated by air pollution.<sup>67</sup>
- **National Bureau of Economic Research: "Air Pollution and Infant Mortality: Evidence From the Expansion of Natural Gas Infrastructure," 2013** ([study link](#)). This study found increased natural gas infrastructure in Turkey has resulted in a significant decrease in the rate of infant mortality, stating, "Specifically, a one-percentage point increase in natural gas intensity — measured by the rate of subscriptions to natural gas services — would cause the infant mortality rate to decrease by 3.9 percent, which would translate into approximately 340 infant lives saved in 2011 alone."
- **Centers of Disease Control and Prevention:** Data from the CDC [show](#) that from 2007 to 2014, incidences of low birth weight (less than 5 ½ pounds) are currently down [three percent](#) from a 2006 high of 8.26 percent.<sup>68</sup> Notably, the highest percentage of low

birth rates found in a recent University of Pittsburgh [study](#) claiming fracking causes low birth rates (6.5 percent) is still well below the national average.<sup>69</sup> The U.S. infant mortality rate has [dropped](#) 13 percent (5.96 in 1,000 from 6.86) since 2005, falling in prominent oil and gas producing states such as Texas, Colorado, Pennsylvania, Ohio, California and Oklahoma.<sup>70</sup>



## Section 5: Debunking the Dubious Link between Fracking and Cancer

Many activist-backed health studies either specifically claim fracking causes cancer, or insinuate it can cause cancer, despite having [no evidence](#) to support such claims.<sup>71</sup> In almost every instance, the researchers suggest the mere *presence* of certain chemicals pose a threat. This willful misrepresentation of reality ignores the fact that dose and exposure levels are the most relevant factors in determining risks, particularly as it relates to cancer.

Dr. Mike Van Dyke, head of environmental epidemiology at the Colorado Department of Public Health and Environment (CDPHE) has [discussed](#) this fact, saying, “What’s important in terms of exposure to these hazardous substances is how much you’re exposed to.” Van Dyke has also noted cancer-causing substances associated with oil and natural gas development — including benzene, ethylbenzene, formaldehyde and acetaldehyde — are also components of (or emitted by) sources other than oil and natural gas development, [including](#) vehicle traffic and consumer products such as nail polish, detergents, sealants, aerosol antiperspirants and deodorants. As Van Dyke has [noted](#), “Each can be a health concern at some level of exposure.”<sup>72</sup>

In addition to the numerous studies using air measurements taken from well sites that show the public is not exposed to chemical concentrations high enough to pose a health risk, here are some studies that focus on cancer specifically. They find no elevated cancer risk.

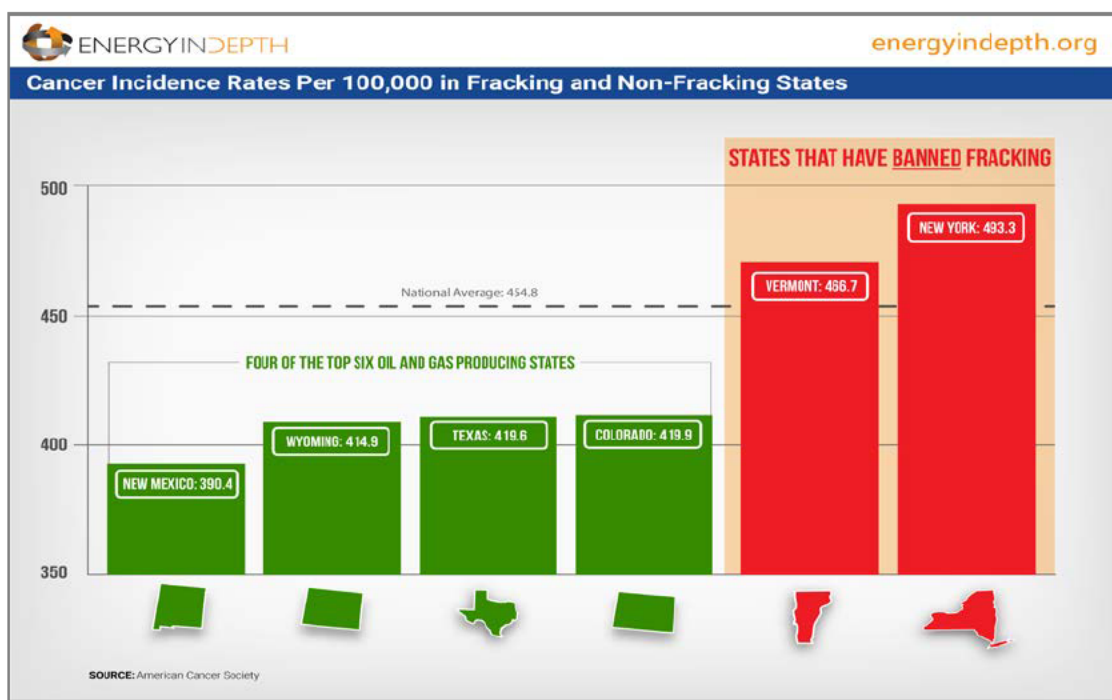
- **Colorado Department of Public Health and Environment (CDPHE): “Assessment of Potential Health Effects from Oil and Gas Operations in Colorado,” 2017** ([report link](#)/[EID blog](#)). In addition to finding that emissions are low, this assessment also found that “available air monitoring data suggest low risk of harmful health effects from combined exposure to all substances,” and **“All four cancer-causing substances (benzene, ethylbenzene, formaldehyde and acetaldehyde) were within acceptable risk range, even for combined exposures.”**<sup>73</sup> (emphasis added)
- **Mitchell et al., “Lung Cancer Risk from Radon in Marcellus Shale Gas in Northeast U.S. Homes,” *US National Library of Medicine National Institutes of Health*, 2016** ([study link](#)/[EID blog](#)). This peer-reviewed Carnegie Mellon University study concluded that “there is no support” to back up activists’ claims about cancer risks from Marcellus shale gas. This study specifically debunked the work of [Dr. Marvin Resnikoff](#), who raised concerns about radon from the Marcellus Shale. The report found that Dr. Resnikoff “provided insufficient documentation of the methodology used” and “[a]t this time there is no support for the high mortality argument offered by Resnikoff.” The researchers found that the difference between radon levels in the average American home compared to a home using Marcellus natural gas is “insignificant.” They add that the lung cancer risk

- to those using Marcellus natural gas “is not high enough to cause a measureable change” in the number of people who are likely to develop the disease in the region.<sup>74</sup>
- **Paulik et al., “Impact of Natural Gas Extraction on PAH Levels in Ambient Air,” *Environmental Science & Technology*, 2015** ([study link](#)/[EID blog](#)/[retraction link](#)). Researchers from the University of Cincinnati and Oregon State University originally claimed to find elevated cancer risks near natural gas wells in Carroll County, Ohio.<sup>75</sup> But the study was retracted in 2016 after the authors revealed that “honest calculation errors” led to an exaggeration in the cancer risk from polycyclic aromatic hydrocarbon (PAH) emissions by an astounding 7,250 times what the corrected study shows they actually are.<sup>76</sup> **The corrected study<sup>77</sup> shows that PAH emission levels are well below the level the U.S. EPA says would increase the risk of cancer.**<sup>78</sup> (emphasis added)
  - **Ministry of Health British Columbia: “Detailed Human Health Risk Assessment of Oil and Gas Activities in Northeastern British Columbia,” 2015** ([study link](#)/[EID blog](#)). The second phase of a Human Health Risk Assessment (HHRA) of oil and gas activities in the area, this study concluded in part: “The overall findings of the detailed HHRA of oil and gas activity in NE BC suggest that, while there is some possibility for elevated COPC [chemicals of potential concern] concentrations to occur at some locations, the probability that adverse health impacts would occur in association with these exposures is considered to be low.” The B.C. study evaluated continuous air emissions from gas processing plants and production facilities in three regions. The 150 km by 176 km area was chosen to include the largest area of oil and gas development and the most densely populated areas in the region. It encompassed 26 locations, including Fort St. John Dawson Creek and Chetwynd, along with smaller communities and First Nation lands. The study also included non-oil and gas emitters in the area that could contribute to the air quality of the area and took into consideration populations with sensitive health, age and other external parameters. It looked at both long-term and short-term health risks, and compared those with exposure limits from various authorities such as the World Health Organization, Health Canada, and U.S. EPA.<sup>79</sup>
  - **Texas Department of State Health Services (DSHS): “Updated Summary Report: Occurrence of Cancer,” 2014** ([study link](#)/[EID blog](#)). The final version of [three studies](#) conducted from [2010 to 2014](#) found no evidence of a “cancer cluster” near shale development in Flower Mound, Texas. DSHS did not find elevated numbers of leukemia, brain or liver cancers in children, or leukemia and non-Hodgkin’s lymphoma in males or females. Researchers collected blood and urine samples from residents in and around the town of DISH, which is located over the Barnett Shale, and found, “Although a number of VOCs were detected in some of the blood samples, the pattern of VOC values was not consistent with a community-wide exposure to airborne contaminants, such as those that might be associated with natural gas drilling operations.” DSHS concluded that the sources of exposure were likely tobacco (all those who recorded elevated levels of benzene were smokers); public drinking water systems, which include disinfectant byproducts; and common consumer products such as cleaners and lubricants. DSHS

did note some limitations (including the fact that VOCs only stay in the body for a relatively short period of time), but nonetheless concluded that their assessment “did not indicate that community-wide exposures from gas wells or compressor stations were occurring in the sample population.”<sup>80</sup>

- **Fryzek et al. “Childhood Cancer Incidence in Pennsylvania Counties in Relation to Living in Counties With Hydraulic Fracturing Sites,” *Journal of Occupational & Environmental Medicine*, 2013** ([study link](#)/[EID blog](#)). This Epidstat Institute and David Garabrandt PLLC peer-reviewed study examined cancer incidence rates in several Pennsylvania counties before and after oil and natural gas operations and found **“no evidence that childhood leukemia was elevated in any county after [hydraulic fracturing] commenced.”**<sup>81</sup> (emphasis added)
- **Cardno Entrix: “Inglewood Oil Field (CA) Study,” 2012** ([study link](#)). This study – the result of a settlement agreement with Culver City, Calif., and environmental groups – concluded: “Public health trends in the area surrounding the field were consistent with public health trends throughout the L.A. Basin. It is reasonable to conclude that the conduct of hydraulic fracturing during the analyzed period did not contribute or create abnormal health risks.”<sup>82</sup>

The latest [American Cancer Society](#) data<sup>83</sup>, spanning 2009 to 2013, show cancer incidence rates are below the national average (**454.8 per 100,000**) in four of the top six oil and gas producing states — New Mexico (390.4), Wyoming (414.9), Texas (419.6) and Colorado (419.9).<sup>84</sup> By comparison, cancer incidence rates are higher than the national average in two states where fracking has been banned — New York (493.3) and Vermont (466.7) as the following graph demonstrates:



## Section 6: No Widespread, Systemic Impact to Drinking Water Resources

There is little to no evidence of significant, negative health effects linked to contaminated water from fracking. This is chiefly because hydraulic fracturing itself does not pose a credible risk of groundwater contamination.

Click [here](#) to watch:



Here are the most prominent studies showing fracking is not a serious threat to drinking water.

- U.S. Environmental Protection Agency (EPA): "Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States," 2016** ([study link](#)/[EID blog](#)). EPA's six-year study found nothing to suggest that fracking is a serious risk to groundwater<sup>85</sup>. While the agency made some wording changes to its previous topline finding that fracking has not caused "widespread, systemic" impacts to groundwater<sup>86</sup>, the data in the report did not change from the draft version.<sup>87</sup> EPA Deputy Assistant Administrator Thomas Burke also [told CBS This Morning](#) that **"the overall incidence of impacts is low."** Last year, EPA characterized its draft report as the "most complete compilation of scientific data to date." EPA spent six years and at least [\\$33 million](#) in taxpayer dollars on this study. It identified 4,100 scientific data sources and scientific studies applicable to this topic.<sup>88</sup>
- Wyoming Department of Environmental Quality: "Pavillion, Wyoming Area Domestic Water Wells Draft Final Report and Palatability Study," 2016** ([study link](#)/[EID blog](#)). This 30-

month investigation into water contamination in Pavillion concluded that “Evidence suggests that upward **gas seepage (or gas charging of shallow sands) was happening naturally before gas well development.**” The report also stressed: “Evidence does not indicate that hydraulic fracturing fluids have risen to shallow depths intersected by water-supply wells.”<sup>89</sup>

- **Townsend et al., “Elevated Methane Levels from Biogenic Coalbed Gas in Ohio Drinking Water Wells Near Shale Gas Extraction,” 2016** ([study abstract link](#)/[EID blog](#)). This to-be-published University of Cincinnati study<sup>90</sup> found that water quality has not been impacted by natural gas drilling, or fracking. Lead researcher Dr. Amy Townsend Small of the [University of Cincinnati](#)<sup>91</sup> has said, “We never saw a significant increase in methane concentration after (the) fracking well was drilled.”<sup>92</sup>
- **Ladage et al. “Schieferöl und Schiefergas in Deutschland - Potenziale und Umweltaspekte,” Bundesanstalt für Geowissenschaften und Rohstoffe (BGR),” *German Federal Institute for Geosciences and Natural Resources*, 2016** ([study link](#)/[EID blog](#)). In this Federal Institute for Geosciences and Natural Resources study, geologists used computer simulations to study what would happen to frack fluids when injected into the bedrock of the North German basin and found “... that the injected fluids did not move upwards into layers carrying drinking-water.”<sup>93</sup>
- **Bureau of Economic Geology, University of Texas at Austin: “Understanding and Managing Environmental Roadblocks to Shale Gas Development: An Analysis of Shallow Gas, NORM, and Trace Metals,” 2016** ([study link](#)/[EID blog](#)). This study of 784 freshwater wells in the Barnett, Haynesville, Eagle Ford and Delaware Basin shale plays in Texas found the presence of high dissolved methane concentrations in the wells “are likely natural” and not related to fracking.<sup>94</sup>
- **Siegel et al., “Dissolved methane in shallow groundwater of the Appalachian Basin: Results from the Chesapeake Energy predrilling geochemical database,” *Environmental Science & Technology*, 2016** ([study link](#)/[EID blog](#)). This Syracuse University study’s data set included groundwater data from private water wells in Ohio and is “the most comprehensive to date for this part of the Appalachian Basin.” The study specifically examined the issue of preexisting methane in groundwater and, through an analysis of 19,278 predrilling groundwater samples, reinforces a University of Cincinnati study’s findings ([EID blog](#)) regarding preexisting methane in groundwater. As the study rightly points out: “Without a proper understanding of preexisting methane occurrence in groundwater, investigations may incorrectly conclude that unconventional hydrocarbon development and production has altered shallow groundwater quality when it has not (i.e. a false positive).”<sup>95</sup>

- **Jackson et al., “The Depths of Hydraulic Fracturing and Accompanying Water Use Across the United States,” *Environmental Science & Technology*, 2015 ([study link](#)/[EID blog](#)).** The researchers of this Stanford University study found no evidence of hydraulic fracturing contaminating water. According the report’s press release, “Using innovative techniques such as isotopic ‘tracer’ compounds that distinguish the source of chemicals in well water, Jackson has not found evidence that frack water contaminants seep upward to drinking-water aquifers from deep underground.”<sup>96</sup>
- **Drollette et al. “Elevated levels of diesel range organic compounds in groundwater near Marcellus gas operations are derived from surface activities,” *Proceedings of National Academy of Sciences*, 2015 ([study link](#)/[EID blog](#)).** This Yale University study found no indication of contamination from the fracking process itself. As the researchers explain, “We found no evidence for direct communication with shallow drinking water wells due to upward migration from shale horizons.”<sup>97</sup>
- **Siegel et al., “Methane Concentrations in Water Wells Unrelated to Proximity to Existing Oil and Gas Wells in Northeastern Pennsylvania,” *Environmental Science & Technology*, 2015 ([study link](#)/[EID blog](#)).** This peer-reviewed Syracuse University study looked at thousands of randomly selected baseline samples from water wells throughout Pennsylvania and concluded: “There is no significant correlation between dissolved methane concentrations in groundwater and proximity to nearby oil/gas wells.”<sup>98</sup>
- **Birkholzer et al., “An Independent Scientific Assessment of Well Stimulation in California,” 2015 ([study link](#)).** This peer-reviewed independent study by the California Council on Science and Technology and Lawrence Berkeley National Laboratory concluded: “We found no documented instance of hydraulic fracturing or acid stimulations directly causing groundwater contamination in California.”<sup>99</sup>
- **Hammack et al., “An Evaluation of Fracture Growth and Gas/Fluid Migration as Horizontal Marcellus Shale Gas Wells are Hydraulically Fractured in Greene County, Pennsylvania,” U.S. Department of Energy, National Energy Technology Laboratory, 2014 ([study link](#)/[EID blog](#)).** In what the Associated Press called a “[landmark study](#),” NETL researchers injected tracers into the hydraulic fracturing fluid in a well in Greene County, Pa., to track for any signs of possible migration. After 12 months of monitoring, the researchers found no signs of this happening. The report concluded: “Current findings are: 1) no evidence of gas migration from the Marcellus Shale; and 2) no evidence of brine migration from the Marcellus Shale.”<sup>100</sup>
- **Kresse et al., “Shallow Groundwater Quality and Geochemistry in the Fayetteville Shale Gas-Production Area, North-Central Arkansas, 2011,” *United States Geological Survey*, 2013 ([study link](#)/[EID blog](#)).** This U.S. Geological Survey (USGS) study examined the water quality of 127 shallow domestic wells in the Fayetteville Shale and found no evidence of



contamination, concluding: “This new study is important in terms of finding no significant effects on groundwater quality from shale gas development within the area of sampling.”<sup>101</sup>

- **Flewwelling et al., “Constraints on Upward Migration of Hydraulic Fracturing Brine and Fluid,” *Groundwater and Geophysical Research Letters*, 2013.** ([study link](#)/[EID blog](#)). Researchers at Gradient released two peer-reviewed studies finding no impacts from shale development. The first study explained that “Overall, the rapid upward migration scenarios that have been recently suggested (Rozell and Reaven 2012; Myers 2012; Warner et al. 2012) are not physically plausible.” In a second paper, Gradient’s team found, “It is not physically plausible for induced fractures to create a hydraulic connection between deep black shale and other tight formations to overlying potable aquifers, based on the limited amount of height growth at depth and the rotation of the least principal stress to the vertical direction at shallow depths.”<sup>102</sup>
- **Molofsky et al., “Evaluation of Methane Sources in Groundwater in Northeastern Pennsylvania,” *Groundwater*, 2013** ([study link](#)/[EID blog](#)). This National Groundwater Association peer-reviewed study tested 1,701 water wells in northeastern Pennsylvania and found that “methane is ubiquitous in groundwater indicating that, on a regional scale, methane concentrations are not correlated to shale-gas extraction.”<sup>103</sup>
- **U.S. Government Accountability Office: “Information on Shale Resources, Development, and Environmental Risks,” 2012** ([report link](#)/[EID blog](#)). The U.S. GAO consulted regulatory officials in eight states who explained, based on their own state investigations, that “the hydraulic fracturing process has not been identified as a cause of groundwater contamination within their states.”<sup>104</sup>
- **Cardno Entrix: “Hydraulic Fracturing Study PXP Inglewood Oil Field,” 2012** ([study link](#)). This study, focusing on water wells in the Inglewood, Calif., oil field concluded, “Before-and-after monitoring of groundwater quality in monitor wells did not show impacts from high-volume hydraulic fracturing and high-rate gravel packing.”<sup>105</sup>
- **Massachusetts Institute of Technology Energy Initiative, 2010** ([study link](#)). This study concludes, “[B]ased on over sixty years of practical application and a lack of evidence to the contrary, there is nothing to indicate that when coupled with appropriate well construction; the practice of hydraulic fracturing in deep formations endangers ground water. There is also a lack of demonstrated evidence that hydraulic fracturing conducted in many shallower formations presents a substantial risk of endangerment to ground water.”<sup>106</sup>

## Conclusion

To be clear, no form of energy development, whether we're talking about fossil fuels or renewables, is risk free. But the data clearly show, time and time again, that emissions from fracking are not a credible risk to public health.

In fact, the data show that enormous reductions in pollution across the board are attributable to the significant increases in natural gas consumption that hydraulic fracturing has made possible.

They show power plant emissions of SO<sub>2</sub> declining by 86 percent, emissions of NO<sub>x</sub> declining by 67 percent, and emissions of mercury by 55 percent. They also show hospitalizations for asthma declining as natural gas ramps up. At the same time life expectancy and birth outcomes have improved.

And, of course, all these positive health outcomes can be largely traced back to significantly cleaner air, thanks to fracking.

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<sup>1</sup> “[New Working Paper Finds Expanded Use of Natural Gas Saves Lives](https://energyindepth.org/national/new-working-paper-finds-expanded-use-of-natural-gas-saves-lives/),” Energy In Depth, August, 2016: <https://energyindepth.org/national/new-working-paper-finds-expanded-use-of-natural-gas-saves-lives/>

<sup>2</sup> “[Fracking health projects puts numbers to debate](http://www.cleveland.com/nation/index.ssf/2013/08/fracking_health_project_puts_n.html),” The Associated Press, August, 2013: [http://www.cleveland.com/nation/index.ssf/2013/08/fracking\\_health\\_project\\_puts\\_n.html](http://www.cleveland.com/nation/index.ssf/2013/08/fracking_health_project_puts_n.html)

<sup>3</sup> “[Celebrity 'fractivists': True advocates or NIMBYs?](http://www.sandiegouniontribune.com/sdut-celebrity-fractivists-true-advocates-or-nimbys-2013mar05-story,amp.html),” The Associated Press, March, 2013: <http://www.sandiegouniontribune.com/sdut-celebrity-fractivists-true-advocates-or-nimbys-2013mar05-story,amp.html>

<sup>4</sup> “[EPA Administrator Gina McCarthy Defends Natural Gas](https://www.forbes.com/sites/jeffmcmahon/2014/09/25/mccarthy-defends-natural-gas/#3c1ba9744068),” Forbes, September, 2014: <https://www.forbes.com/sites/jeffmcmahon/2014/09/25/mccarthy-defends-natural-gas/#3c1ba9744068>

<sup>5</sup> “World Energy Outlook Special Report 2016: Energy and Air Pollution,” International Energy Agency, 2016: <https://www.iea.org/publications/freepublications/publication/weo-2016-special-report-energy-and-air-pollution.html>

<sup>6</sup> “[Compendium of Scientific, Medical and Media Findings Demonstrating Risks and Harms of Fracking](http://concernedhealthny.org/compendium/),” Concerned Health Professionals of New York, 2016: <http://concernedhealthny.org/compendium/>



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- <sup>7</sup> “[Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado](#),” Colorado Department of Public Health & Environment, February 2017: <https://drive.google.com/file/d/0B0tmPQ67k3NVQ3hFTIBVZndxZFU/view>
- <sup>8</sup> “Criteria Air Pollutants,” United States Environmental Protection Agency, <https://www.epa.gov/criteria-air-pollutants#self>
- <sup>9</sup> “[Natural gas surpasses coal as fuel for power production](#),” Houston Chronicle,” January 2017: <http://www.houstonchronicle.com/business/article/Natural-gas-surpasses-coal-as-fuel-for-power-10861176.php>
- <sup>10</sup> “[Report: Data Indicate that Massive Improvements in Air Quality, Health a Direct Function of Shale](#),” Energy In Depth, September, 2015: <https://energyindepth.org/national/report-data-indicate-that-massive-improvements-in-air-quality-health-a-direct-function-of-shale/>
- <sup>11</sup> “[Why Every Serious Environmentalist Should Favor Fracking](#),” Richard A. Muller and Elizabeth A. Muller, Centre for Policy Studies, 2013: [www.cps.org.uk/files/reports/original/131202135150-WhyEverySeriousEnvironmentalistShouldFavourFracking.pdf](http://www.cps.org.uk/files/reports/original/131202135150-WhyEverySeriousEnvironmentalistShouldFavourFracking.pdf)
- <sup>12</sup> “[Power plant emissions of sulfur dioxide and nitrogen oxides continue to decline in 2012](#),” Energy Information Administration, February, 2013: <https://www.eia.gov/todayinenergy/detail.php?id=10151>
- <sup>13</sup> “[Emissions from Energy Consumption at Conventional Power Plants and Combined-Heat-and-Power-Plants](#),” Energy Information Administration, 2016: [https://www.eia.gov/electricity/annual/html/epa\\_09\\_01.html](https://www.eia.gov/electricity/annual/html/epa_09_01.html)
- <sup>14</sup> “[ELECTRICITY](#),” Energy Information Administration, 2016: <https://www.eia.gov/electricity/data.cfm#generation>
- <sup>15</sup> “[U.S. Natural Gas Total Consumption](#),” Energy Information Administration, 2017: <https://www.eia.gov/dnav/ng/hist/n9140us2A.htm>
- <sup>16</sup> “[EPA’s Report on the Environment](#),” United States Environmental Protection Agency, 2017: <https://cfpub.epa.gov/roe/chapter/air/index.cfm>
- <sup>17</sup> “[Nitrogen Dioxide Trends](#),” United States Environmental Protection Agency, 2017: <https://www.epa.gov/air-trends/nitrogen-dioxide-trends>
- <sup>18</sup> “[National Trends in Nitrogen Dioxide Concentrations in 1980 – 2015](#),” United States Environmental Protection Agency, 2017: [https://www3.epa.gov/cgi-bin/broker?\\_service=data&\\_program=dataprog.aqplot\\_data\\_2015.sas&parm=42602&stat=P98V&styear=1980&endyear=2015&pre=val&region=99](https://www3.epa.gov/cgi-bin/broker?_service=data&_program=dataprog.aqplot_data_2015.sas&parm=42602&stat=P98V&styear=1980&endyear=2015&pre=val&region=99)
- <sup>19</sup> “[U.S. Natural Gas Total Consumption](#),” Energy Information Administration, 2017: <https://www.eia.gov/dnav/ng/hist/n9140us2A.htm>
- <sup>20</sup> “[Effects of NO<sub>2</sub>](#),” United States Environmental Protection Agency, 2017: <https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects>

- 
- <sup>21</sup> “[Sulfur Dioxide Trends](https://www.epa.gov/air-trends/sulfur-dioxide-trends),” United States Environmental Protection Agency, 2017: <https://www.epa.gov/air-trends/sulfur-dioxide-trends>
- <sup>22</sup> “[National Trends in Sulfur Dioxide Concentrations in 1990 – 2015](https://www3.epa.gov/cgi-bin/broker?_service=data&_program=dataprog._aqplot_data_2015.sas&parm=42401&stat=P99V&styear=1990&endyear=2015&pre=val&region=99),” United States Environmental Protection Agency, 2017: [https://www3.epa.gov/cgi-bin/broker?\\_service=data&\\_program=dataprog.\\_aqplot\\_data\\_2015.sas&parm=42401&stat=P99V&styear=1990&endyear=2015&pre=val&region=99](https://www3.epa.gov/cgi-bin/broker?_service=data&_program=dataprog._aqplot_data_2015.sas&parm=42401&stat=P99V&styear=1990&endyear=2015&pre=val&region=99)
- <sup>23</sup> “[What is Acid Rain](https://www.epa.gov/acidrain/what-acid-rain),” United States Environmental Protection Agency, 2017: <https://www.epa.gov/acidrain/what-acid-rain>
- <sup>24</sup> “[Sulfur Dioxide \(SO<sub>2</sub>\) Pollution](https://www.epa.gov/so2-pollution/sulfur-dioxide-basics#what%20is%20so2),” United States Environmental Protection Agency, 2017: <https://www.epa.gov/so2-pollution/sulfur-dioxide-basics#what%20is%20so2>
- <sup>25</sup> “[Energy and the Environment](https://www.epa.gov/energy),” United States Environmental Protection Agency, 2017: <https://www.epa.gov/energy>
- <sup>26</sup> “[EPA’s Report on the Environment](https://cfpub.epa.gov/roe/chapter/air/index.cfm),” United States Environmental Protection Agency, 2017: <https://cfpub.epa.gov/roe/chapter/air/index.cfm>
- <sup>27</sup> “[National Trends in PM<sub>2.5</sub> Concentrations in 2000 – 2015](https://cfpub.epa.gov/ncea/risk/recorddisplay.cfm?deid=216546&CFID=90288400&CFTOKEN=26004742#Download),” United States Environmental Protection Agency, 2017: <https://cfpub.epa.gov/ncea/risk/recorddisplay.cfm?deid=216546&CFID=90288400&CFTOKEN=26004742#Download>
- <sup>28</sup> “[Integrated Science Assessment \(ISA\) for Particulate Matter](https://cfpub.epa.gov/ncea/risk/recorddisplay.cfm?deid=216546&CFID=90288400&CFTOKEN=26004742#Download),” United States Environmental Protection Agency, 2009: <https://cfpub.epa.gov/ncea/risk/recorddisplay.cfm?deid=216546&CFID=90288400&CFTOKEN=26004742#Download>
- <sup>29</sup> “[WHO’s Urban Ambient Air Pollution database - Update 2016](http://www.who.int/phe/health_topics/outdoorair/databases/AAP_database_summary_results_2016_v02.pdf?ua=1),” World Health Organization, 2016: [www.who.int/phe/health\\_topics/outdoorair/databases/AAP\\_database\\_summary\\_results\\_2016\\_v02.pdf?ua=1](http://www.who.int/phe/health_topics/outdoorair/databases/AAP_database_summary_results_2016_v02.pdf?ua=1)
- <sup>30</sup> “[Why Every Serious Environmentalist Should Favor Fracking](http://www.cps.org.uk/files/reports/original/131202135150-WhyEverySeriousEnvironmentalistShouldFavourFracking.pdf),” Richard A. Muller and Elizabeth A. Muller, Centre for Policy Studies, 2013: [www.cps.org.uk/files/reports/original/131202135150-WhyEverySeriousEnvironmentalistShouldFavourFracking.pdf](http://www.cps.org.uk/files/reports/original/131202135150-WhyEverySeriousEnvironmentalistShouldFavourFracking.pdf)
- <sup>31</sup> “[Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States 2016](http://www.ceres.org/resources/reports/benchmarking-air-emissions-of-the-100-largest-electric-power-producers-in-the-united-states-2016/view),” Ceres, 2016: <http://www.ceres.org/resources/reports/benchmarking-air-emissions-of-the-100-largest-electric-power-producers-in-the-united-states-2016/view>
- <sup>32</sup> “[EPA Administrator Gina McCarthy Defends Natural Gas](https://www.forbes.com/sites/jeffmcmahon/2014/09/25/mccarthy-defends-natural-gas/#3c1ba9744068),” Forbes, September, 2014: <https://www.forbes.com/sites/jeffmcmahon/2014/09/25/mccarthy-defends-natural-gas/#3c1ba9744068>
- <sup>33</sup> “[New findings shows U.S. power plant emissions are down](https://www.esrl.noaa.gov/csd/news/2014/148_0109.html),” Earth System Research Laboratory, January, 2014: [https://www.esrl.noaa.gov/csd/news/2014/148\\_0109.html](https://www.esrl.noaa.gov/csd/news/2014/148_0109.html)

- 
- <sup>34</sup> [“The climate and health effects of a USA switch from coal to gas electricity generation,”](#) *Elsevier B. V.*, 2016: <http://www.sciencedirect.com/science/article/pii/S036054421630322X>
- <sup>35</sup> [“World Energy Outlook Special Report 2016: Energy and Air Pollution,”](#) International Energy Agency, 2016: <https://www.iea.org/publications/freepublications/publication/weo-2016-special-report-energy-and-air-pollution.html>
- <sup>36</sup> [“Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States 2016,”](#) Ceres, 2016: <http://www.ceres.org/resources/reports/benchmarking-air-emissions-of-the-100-largest-electric-power-producers-in-the-united-states-2016/view>
- <sup>37</sup> [“Why Every Serious Environmentalist Should Favor Fracking,”](#) Richard A. Muller and Elizabeth A. Muller, Centre for Policy Studies, 2013: [www.cps.org.uk/files/reports/original/131202135150-WhyEverySeriousEnvironmentalistShouldFavourFracking.pdf](http://www.cps.org.uk/files/reports/original/131202135150-WhyEverySeriousEnvironmentalistShouldFavourFracking.pdf)
- <sup>38</sup> [“Aura OMI observations of regional SO<sub>2</sub> and NO<sub>2</sub> pollution changes from 2005 to 2015,”](#) *Atmospheric Chemistry and Physics*, 2016: [www.atmos-chem-phys.net/16/4605/2016/acp-16-4605-2016.pdf](http://www.atmos-chem-phys.net/16/4605/2016/acp-16-4605-2016.pdf)
- <sup>39</sup> [“Unconventional Natural Gas Emissions Inventory,”](#) Pennsylvania Department of Environmental Protection, 2013: [https://www.eenews.net/assets/2013/02/04/document\\_ew\\_01.pdf](https://www.eenews.net/assets/2013/02/04/document_ew_01.pdf)
- <sup>40</sup> [“Deadly Air Pollution Declines Thanks to Shale Gas Boom,”](#) The Breakthrough Institute, 2013: <https://thebreakthrough.org/index.php/programs/energy-and-climate/deadly-air-pollution-declines-thanks-to-gas-boom>
- <sup>41</sup> [“State Regulators Credit Marcellus Shale for Declining Air Emissions,”](#) Energy In Depth, April, 2014: <https://energyindepth.org/marcellus/state-regulators-credit-marcellus-shale-declining-air-emissions/>
- <sup>42</sup> [“Assessment of Potential Health Effects from Oil and Gas Operations in Colorado,”](#) Colorado Department of Public Health and Environment, 2017: <https://drive.google.com/file/d/OB0tmPQ67k3NVQ3hFTIBVZndxZFU/view>
- <sup>43</sup> [“2014 Utah Air Agencies O&G Emissions Inventory,”](#) Utah Division of Air Quality/U.S. Environmental Protection Agency Region 8, 2017: [https://cdn.westernenergyalliance.org/sites/default/files/2014%20Utah%20Air%20Agencies%20O\\_G%20Emissions%20Inventory\\_v3.pdf](https://cdn.westernenergyalliance.org/sites/default/files/2014%20Utah%20Air%20Agencies%20O_G%20Emissions%20Inventory_v3.pdf)
- <sup>44</sup> [“Point source attribution of ambient contamination events near unconventional oil and gas development,”](#) *Science of the Total Environment*, 2016: <http://www.sciencedirect.com/science/article/pii/S0048969716318150>
- <sup>45</sup> [“The Barnett Shale: From problem formulation to risk management,”](#) *Journal of Unconventional Oil and Gas Resources*, 2015: <http://www.sciencedirect.com/science/article/pii/S2213397615000270>
- <sup>46</sup> [“Air tests of 5 Barnett Shale wells being hydraulically fractured show no harmful emissions,”](#) Modern Geosciences, 2015: [http://www.bseec.org/air\\_tests\\_of\\_5\\_barnett\\_shale\\_wells\\_being\\_hydraulically\\_fractured\\_show\\_no\\_harmful\\_emissions](http://www.bseec.org/air_tests_of_5_barnett_shale_wells_being_hydraulically_fractured_show_no_harmful_emissions)

- 
- <sup>47</sup> ["Atmospheric Emission Characterization of Marcellus Shale Natural Gas Development Sites,"](#) *Environmental Science & Technology*, 2015: <http://pubs.acs.org/doi/ipdf/10.1021/acs.est.5b00452>
- <sup>48</sup> ["Atmospheric Emission Characterization of Marcellus Shale Natural Gas Development Sites,"](#) Professional Service Industries, Inc., 2015: <http://pubs.acs.org/doi/ipdf/10.1021/acs.est.5b00452>
- <sup>49</sup> ["Shale gas extraction: review of the potential public health impacts of exposures to chemical and radioactive pollutants,"](#) Public Health England, 2013. <https://www.gov.uk/government/publications/shale-gas-extraction-review-of-the-potential-public-health-impacts-of-exposures-to-chemical-and-radioactive-pollutants-draft-for-comment>
- <sup>50</sup> ["Evaluation of impact of shale gas operations in the Barnett Shale region on volatile organic compounds in air and potential human health risks,"](#) *Science of the Total Environment*, 2013: [www.sciencedirect.com/science/article/pii/S0048969713010073](http://www.sciencedirect.com/science/article/pii/S0048969713010073)
- <sup>51</sup> ["Air Quality Impacts Occurring From Horizontal Well Drilling And Related Activities,"](#) West Virginia Department of Environmental Protection, 2013: <http://www.dep.wv.gov/oil-and-gas/HorizontalPermits/Documents/Final%20Air%20Quality%20Report%20June%2028,%202013.pdf>
- <sup>52</sup> ["Air monitoring of volatile organic compounds at relevant receptors during hydraulic fracturing operations in Washington County, Pennsylvania,"](#) ChemRisk, 2013: <https://www.ncbi.nlm.nih.gov/pubmed/27312253>
- <sup>53</sup> ["Air, Noise, and Light Monitoring Plan For Assessing Environmental Impacts of Horizontal Gas Well Drilling Operations,"](#) West Virginia Department of Environmental Protection, 2012: [www.wvri.org/wp-content/uploads/2013/10/A-N-L-Final-Report-FOR-WEB.pdf](http://www.wvri.org/wp-content/uploads/2013/10/A-N-L-Final-Report-FOR-WEB.pdf)
- <sup>54</sup> ["Air Emissions Case Study Related to Oil and Gas Development in Erie, Colorado,"](#) Colorado Department of Public Health, 2012: [http://www.colorado.gov/airquality/tech\\_doc\\_repository.aspx?action=open&file=Erie+Air+Emissions+Case+Study+2012+-+revised+11252014.pdf](http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=Erie+Air+Emissions+Case+Study+2012+-+revised+11252014.pdf)
- <sup>55</sup> ["Northeastern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report,"](#) Pennsylvania Department of Environmental Protection, 2011: [www.dep.state.pa.us/dep/deputate/airwaste/aq/aqm/docs/Marcellus\\_NE\\_01-12-11.pdf](http://www.dep.state.pa.us/dep/deputate/airwaste/aq/aqm/docs/Marcellus_NE_01-12-11.pdf)
- <sup>56</sup> ["Skyview Elementary School Site, Morgantown, Monongalia County, West Virginia,"](#) TechLaw and Environmental Protection Agency Region 3, 2011: [www.dep.wv.gov/oil-and-gas/Horizontal-Permits/Documents/Final%20Air%20Quality%20Report%20June%2028,%202013.pdf](http://www.dep.wv.gov/oil-and-gas/Horizontal-Permits/Documents/Final%20Air%20Quality%20Report%20June%2028,%202013.pdf)
- <sup>57</sup> ["City of Fort Worth Natural Gas Air Quality Study,"](#) Eastern Research Group Inc., 2011: [fortworthtexas.gov/uploadedFiles/Gas\\_Wells/AirQualityStudy\\_final.pdf](http://fortworthtexas.gov/uploadedFiles/Gas_Wells/AirQualityStudy_final.pdf)
- <sup>58</sup> ["Southwestern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report,"](#) Pennsylvania Department of Environmental Protection, 2010: [www.dep.state.pa.us/dep/deputate/airwaste/aq/aqm/docs/Marcellus\\_SW\\_11-01-10.pdf](http://www.dep.state.pa.us/dep/deputate/airwaste/aq/aqm/docs/Marcellus_SW_11-01-10.pdf)
- <sup>59</sup> ["Hillary Clinton's Plan for Ensuring Safe and Responsible Natural Gas Production,"](#) The Briefing, February, 2016:

---

<https://www.hillaryclinton.com/briefing/factsheets/2016/02/12/hillary-clintons-plan-for-ensuring-safe-and-responsible-natural-gas-production/>

<sup>60</sup> [Centers for Disease Control and Prevention Morbidity and Mortality Weekly Report](#) (November 2013) and [Centers for Disease Control and Prevention: Most Recent Asthma Data](#), February, 2017:  
[https://www.cdc.gov/mmwr/preview/mmwrhtml/su6203a16.htm?s\\_cid=su6203a16\\_e#Tab1](https://www.cdc.gov/mmwr/preview/mmwrhtml/su6203a16.htm?s_cid=su6203a16_e#Tab1)

<sup>61</sup> [Centers for Disease Control and Prevention: Most Recent Asthma Data](#), February, 2017:  
<https://www.cdc.gov/nchs/fastats/asthma.htm>

<sup>62</sup> [Centers for Disease Control and Prevention: Asthma](#), 2017:  
<https://www.cdc.gov/nchs/fastats/asthma.htm>

<sup>63</sup> [Pennsylvania Department of Public Health: Asthma](#), 2017: <http://www.health.pa.gov/My%20Health/School%20Health/Pages/Quick%20Links/Chronic%20Disease/Asthma.aspx#.WOGlwoVieN0>

<sup>64</sup> [Pennsylvania Department of Public Health Asthma Focus Report](#), 2015:  
[www.health.pa.gov/My%20Health/Diseases%20and%20Conditions/A-D/Asthma/Documents/2015%20PENNSYLVANIA%20ASTHMA%20FOCUS%20REPORT%202009-2013%20INPATIENT%20%20HOSPITALIZATIONS%20WITH%20ASTHMA%20AS%20THE%20PRIMARY%20DISCHARGE%20DIAGNOSIS.pdf](http://www.health.pa.gov/My%20Health/Diseases%20and%20Conditions/A-D/Asthma/Documents/2015%20PENNSYLVANIA%20ASTHMA%20FOCUS%20REPORT%202009-2013%20INPATIENT%20%20HOSPITALIZATIONS%20WITH%20ASTHMA%20AS%20THE%20PRIMARY%20DISCHARGE%20DIAGNOSIS.pdf)

<sup>65</sup> [Centers for Disease Control and Prevention: Most Recent Asthma Data](#), February, 2017:  
<https://energyindepth.org/national/new-working-paper-finds-expanded-use-of-natural-gas-saves-lives/>

<sup>66</sup> [“New Working Paper Finds Expanded Use of Natural Gas Saves Lives.”](#) Energy In Depth, August, 2016: <http://www.nber.org/papers/w22522>

<sup>67</sup> [“Can Natural Gas Save Lives? Evidence from the Deployment of a Fuel Delivery System in a Developing Country.”](#) National Bureau of Economic Research, 2016: [www.nber.org/papers/w18736.pdf](http://www.nber.org/papers/w18736.pdf)

<sup>68</sup> [Department of Health and Human Services National Vital Statistics Report, Births, Final Data for 2014](#): [https://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64\\_12.pdf](https://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_12.pdf)

<sup>69</sup> [“Top Seven Facts on a New Univ. of Pitt. Infant Birth Weight Study.”](#) Energy In Depth, August, 2015: <https://www.energyindepth.org/marcellus/top-seven-facts-on-a-new-univ-of-pitt-infant-birth-weight-study/>

<sup>70</sup> [Department of Health and Human Services National Vital Statistics Report, Births, Final Data for 2014](#): [https://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64\\_12.pdf](https://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_12.pdf)

<sup>71</sup> [“Experts: Some fracking critics use bad science.”](#) Associated Press, July, 2012:  
<https://www.yahoo.com/news/experts-fracking-critics-bad-science-161628123--finance.html>

<sup>72</sup> [“State Health Officials: ‘Risk of Harmful Health Effects Is Low’ for Residents Living Near Oil & Gas Operations.”](#) Energy In Depth, February, 2017:  
[onlinelibrary.wiley.com/doi/10.1111/risa.12570/abstract](http://onlinelibrary.wiley.com/doi/10.1111/risa.12570/abstract)

- 
- <sup>73</sup> [“State Health Officials: ‘Risk of Harmful Health Effects Is Low’ for Residents Living Near Oil & Gas Operations.”](https://energyindepth.org/mtn-states/state-health-officials-risk-of-harmful-health-effects-is-low-for-residents-living-near-oil-gas-operations/) Energy In Depth, February, 2017: <https://energyindepth.org/mtn-states/state-health-officials-risk-of-harmful-health-effects-is-low-for-residents-living-near-oil-gas-operations/>
- <sup>74</sup> [“Lung Cancer Risk from Radon in Marcellus Shale Gas in Northeast U.S. Homes,”](http://onlinelibrary.wiley.com/doi/10.1111/risa.12570/abstract) US National Library of Medicine National Institutes of Health, 2016. <http://onlinelibrary.wiley.com/doi/10.1111/risa.12570/abstract>
- <sup>75</sup> [“Impact of Natural Gas Extraction on PAH Levels in Ambient Air,”](http://pubs.acs.org/doi/ipdf/10.1021/es506095e) Environmental Science & Technology, 2015. <http://pubs.acs.org/doi/ipdf/10.1021/es506095e>
- <sup>76</sup> [“UC Study Claiming Air Pollution from Fracking Quietly Retracted Due to Bad Data,”](https://www.energyindepth.org/ohio/uc-study-claiming-air-pollution-from-fracking-quietly-retracted-due-to-bad-data/) Energy In Depth, July, 2016: <https://www.energyindepth.org/ohio/uc-study-claiming-air-pollution-from-fracking-quietly-retracted-due-to-bad-data/>
- <sup>77</sup> [“Retraction of ‘Impact of Natural Gas Extraction on PAH Levels in Ambient Air,’”](http://pubs.acs.org/doi/ipdf/10.1021/acs.est.6b02342) Environmental Science & Technology, 2016: <http://pubs.acs.org/doi/ipdf/10.1021/acs.est.6b02342>
- <sup>78</sup> [“Corrected UC Fracking Study Shows Retracted Original Exaggerated Cancer Risk by 725,000 Percent,”](https://energyindepth.org/ohio/corrected-uc-fracking-study-shows-retracted-original-exaggerated-cancer-risk-725000-percent/) Energy In Depth, July, 2016: <https://energyindepth.org/ohio/corrected-uc-fracking-study-shows-retracted-original-exaggerated-cancer-risk-725000-percent/>
- <sup>79</sup> [“New Study Finds Low Public Health Risk from Oil and Gas Development,”](https://energyindepth.org/national/new-study-finds-low-public-health-risk-from-oil-and-gas-development/) Energy In Depth, March, 2015: <https://energyindepth.org/national/new-study-finds-low-public-health-risk-from-oil-and-gas-development/>
- <sup>80</sup> [“Updated Summary Report: Occurrence of Cancer,”](https://www.scribd.com/document/235472973/Texas-2014-Flower-Mound-Cancer-Study) Texas Department of State Health Services, 2014: <https://www.scribd.com/document/235472973/Texas-2014-Flower-Mound-Cancer-Study>
- <sup>81</sup> [“Childhood Cancer Incidence in Pennsylvania Counties in Relation to Living in Counties With Hydraulic Fracturing Sites,”](http://journals.lww.com/joem/Abstract/2013/07000/Childhood_Cancer_Incidence_in_Pennsylvania.12.aspx) Journal of Occupational & Environmental Medicine, 2013: [http://journals.lww.com/joem/Abstract/2013/07000/Childhood\\_Cancer\\_Incidence\\_in\\_Pennsylvania.12.aspx](http://journals.lww.com/joem/Abstract/2013/07000/Childhood_Cancer_Incidence_in_Pennsylvania.12.aspx)
- <sup>82</sup> [“Inglewood Oil Field \(CA\) Study,”](http://www.inglewoodoilfield.com/res/docs/102012study/Hydraulic%20Fracturing%20Study%20Inglewood%20Field10102012.pdf) Cardno Entrix, 2012: [www.inglewoodoilfield.com/res/docs/102012study/Hydraulic%20Fracturing%20Study%20Inglewood%20Field10102012.pdf](http://www.inglewoodoilfield.com/res/docs/102012study/Hydraulic%20Fracturing%20Study%20Inglewood%20Field10102012.pdf)
- <sup>83</sup> [American Cancer Society Cancer Statistics Center, 2017: <https://cancerstatisticscenter.cancer.org/#/>](https://cancerstatisticscenter.cancer.org/#/)
- <sup>84</sup> [National Cancer Institute: Cancer Statistics, 2017: <https://www.cancer.gov/about-cancer/understanding/statistics>](https://www.cancer.gov/about-cancer/understanding/statistics)
- <sup>85</sup> [“Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States,”](https://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=332990) Environmental Protection Agency, 2016: <https://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=332990>
- <sup>86</sup> [“EPA Finalized Groundwater Report Reinforces No Widespread, Systemic Impacts from Fracking,”](https://energyindepth.org/national/epa-finalized-groundwater-report-reinforces-no-widespread-systemic-impacts-from-fracking/) Energy In Depth, December, 2016: <https://energyindepth.org/national/epa-finalized-groundwater-report-reinforces-no-widespread-systemic-impacts-from-fracking/>

- <sup>87</sup> [“Ten Facts About EPA’s Final Drinking Water Report That Prove it Did Not ‘Reverse Course,’”](https://energyindepth.org/national/no-epa-did-not-reverse-course-ten-things-to-know-about-finalized-groundwater-report/) Energy In Depth, December, 2016: <https://energyindepth.org/national/no-epa-did-not-reverse-course-ten-things-to-know-about-finalized-groundwater-report/>
- <sup>88</sup> [“EPA study finds no widespread harm to US drinking water from fracking, but warns of risks,”](https://www.usnews.com/news/politics/articles/2015/06/04/epa-no-widespread-harm-to-drinking-water-from-fracking) U.S. News & World Report, June 4, 2015: <https://www.usnews.com/news/politics/articles/2015/06/04/epa-no-widespread-harm-to-drinking-water-from-fracking>
- <sup>89</sup> [“Pavillion, Wyoming Area Domestic Water Wells Draft Final Report and Palatability Study,”](http://deq.wyoming.gov/media/attachments/Water%20Quality/Pavillion%20Investigation/Draft%20Report/01_Pavillion%20WY%20Area%20Domestic%20Water%20Wells%20Draft%20Final%20Report.pdf) Wyoming Department of Environmental Quality, 2016: [deq.wyoming.gov/media/attachments/Water%20Quality/Pavillion%20Investigation/Draft%20Report/01\\_Pavillion%20WY%20Area%20Domestic%20Water%20Wells%20Draft%20Final%20Report.pdf](http://deq.wyoming.gov/media/attachments/Water%20Quality/Pavillion%20Investigation/Draft%20Report/01_Pavillion%20WY%20Area%20Domestic%20Water%20Wells%20Draft%20Final%20Report.pdf)
- <sup>90</sup> [“Elevated Methane Levels from Biogenic Coalbed Gas in Ohio Drinking Water Wells Near Shale Gas Extraction,”](http://carrollconcernedcitizens.org/uploads/Univ_Cinn_Groundwater_Methane_Study_-_Botner_2015.pdf) University of Cincinnati, 2016: [carrollconcernedcitizens.org/uploads/Univ\\_Cinn\\_Groundwater\\_Methane\\_Study\\_-\\_Botner\\_2015.pdf](http://carrollconcernedcitizens.org/uploads/Univ_Cinn_Groundwater_Methane_Study_-_Botner_2015.pdf)
- <sup>91</sup> [“New UC Water Study Highlighted by EID at SAB Teleconference on Landmark EPA Fracking Report,”](https://energyindepth.org/ohio/new-uc-water-study-highlighted-by-eid-at-sab-teleconference-landmark-epa-fracking-report/) Energy In Depth, March 7, 2016: <https://energyindepth.org/ohio/new-uc-water-study-highlighted-by-eid-at-sab-teleconference-landmark-epa-fracking-report/>
- <sup>92</sup> [“VIDEO: Anti-Drilling Interests ‘Disappointed’ With Study Finding No Water Contamination from Fracking,”](https://energyindepth.org/ohio/new-video-anti-fossil-fuel-funders-disappointed-with-groundbreaking-study-finding-no-water-contamination-from-fracking/) Energy In Depth, February, 2016: <https://energyindepth.org/ohio/new-video-anti-fossil-fuel-funders-disappointed-with-groundbreaking-study-finding-no-water-contamination-from-fracking/>
- <sup>93</sup> [“Schieferöl und Schiefergas in Deutschland - Potenziale und Umweltaspekte,”](http://www.bgr.bund.de/DE/Themen/Energie/Downloads/Abschlussbericht_13MB_Schieferoelgaspotenzial_Deutschland_2016.html) German Federal Institute for Geosciences and Natural Resources, 2016: [http://www.bgr.bund.de/DE/Themen/Energie/Downloads/Abschlussbericht\\_13MB\\_Schieferoelgaspotenzial\\_Deutschland\\_2016.html](http://www.bgr.bund.de/DE/Themen/Energie/Downloads/Abschlussbericht_13MB_Schieferoelgaspotenzial_Deutschland_2016.html)
- <sup>94</sup> [“Understanding and Managing Environmental Roadblocks to Shale Gas Development: An Analysis of Shallow Gas, NORM, and Trace Metals,”](http://www.rpsea.org/media/files/project/338e578b/11122-56-FR-Shale_Gas_Development_Texas_Analysis_Shallow_NORMs_Trace_Metals-11-11-15_P.pdf) Bureau of Economic Geology, University of Texas at Austin, 2016: [www.rpsea.org/media/files/project/338e578b/11122-56-FR-Shale\\_Gas\\_Development\\_Texas\\_Analysis\\_Shallow\\_NORMs\\_Trace\\_Metals-11-11-15\\_P.pdf](http://www.rpsea.org/media/files/project/338e578b/11122-56-FR-Shale_Gas_Development_Texas_Analysis_Shallow_NORMs_Trace_Metals-11-11-15_P.pdf)
- <sup>95</sup> [“Dissolved methane in shallow groundwater of the Appalachian Basin: Results from the Chesapeake Energy predrilling geochemical database,”](http://eg.geoscienceworld.org/content/23/1/1) Syracuse University, 2016: <http://eg.geoscienceworld.org/content/23/1/1>
- <sup>96</sup> [“The Depths of Hydraulic Fracturing and Accompanying Water Use Across the United States,”](http://pubs.acs.org/doi/abs/10.1021/acs.est.5b01228) *Environmental Science & Technology*, 2015: <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b01228>
- <sup>97</sup> [“Elevated levels of diesel range organic compounds in groundwater near Marcellus gas operations are derived from surface activities,”](http://www.pnas.org/content/112/43/13184.abstract) *Proceedings of National Academy of Sciences*, 2015: <http://www.pnas.org/content/112/43/13184.abstract>
- <sup>98</sup> [“Methane Concentrations in Water Wells Unrelated to Proximity to Existing Oil and Gas Wells in Northeastern Pennsylvania,”](http://pubs.acs.org/doi/abs/10.1021/acs.est.5b01228) *Environmental Science & Technology*, 2015:



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[http://pubs.acs.org/  
doi/abs/10.1021/es505775c](http://pubs.acs.org/doi/abs/10.1021/es505775c)

<sup>99</sup> [“An Independent Scientific Assessment of Well Stimulation in California.”](#) California Council on Science and Technology and Lawrence Berkeley National Laboratory. 2015:

[https://ccst.us/  
publications/2015/2015SB4-v2ES.pdf](https://ccst.us/publications/2015/2015SB4-v2ES.pdf)

<sup>100</sup> [“An Evaluation of Fracture Growth and Gas/Fluid Migration as Horizontal Marcellus Shale Gas Wells are Hydraulically Fractured in Greene County, Pennsylvania.”](#) U.S. Department of Energy, National Energy Technology Laboratory, 2014:

[https://hero.epa.gov/hero/index.cfm/reference/  
details/reference\\_id/2711918](https://hero.epa.gov/hero/index.cfm/reference/details/reference_id/2711918)

<sup>101</sup> [“Shallow Groundwater Quality and Geochemistry in the Fayetteville Shale Gas-Production Area, North-Central Arkansas, 2011.”](#) United States Geological Survey, 2013:

[https://pubs.usgs.gov/  
sir/2012/5273/sir2012-5273.pdf](https://pubs.usgs.gov/sir/2012/5273/sir2012-5273.pdf)

<sup>102</sup> [“Constraints on Upward Migration of Hydraulic Fracturing Brine and Fluid.”](#) *Groundwater and Geophysical Research Letters*, 2013:

<http://onlinelibrary.wiley.com/doi/10.1111/gwat.12095/full>

<sup>103</sup> “Evaluation of Methane Sources in Groundwater in Northeastern Pennsylvania,” *Groundwater*, 2013: <http://onlinelibrary.wiley.com/doi/10.1111/gwat.12056/abstract>

<sup>104</sup> [“Information on Shale Resources, Development, and Environmental Risks.”](#) U.S. Government Accountability Office, 2012: [www.gao.gov/assets/650/647791.pdf](http://www.gao.gov/assets/650/647791.pdf)

<sup>105</sup> [“Hydraulic Fracturing Study PXP Inglewood Oil Field.”](#) Cardno Entrix 2012:

[www.eenews.net/  
assets/2012/10/11/document\\_ew\\_01.pdf](http://www.eenews.net/assets/2012/10/11/document_ew_01.pdf)

<sup>106</sup> [Massachusetts Institute of Technology Energy Initiative](#), 2010: <http://ceepr.mit.edu/>