Clearing the Air: Natural Gas Improves Air Quality
White Paper, November 2013

Clean air and a healthy environment are important to the oil and natural gas industry, which works hard to improve technology and practices to reduce emissions. Companies have made great strides in reducing emissions and voluntarily add controls and other mitigation measures that go above and beyond what federal and state regulations require.

Clean Air Advantages

Natural gas is playing an increasingly important role for reducing standard air pollutants as well as greenhouse gas emissions. Natural gas produces about 95% fewer emissions of criteria pollutants and 50% fewer carbon emissions than coal. When used for electricity generation, it does not produce the harmful soot, SO_2 and mercury emissions that coal generation does. Natural gas also reduces air emissions when burned in engines in place of gasoline or diesel. Natural gas vehicles reduce carbon monoxide (CO) emissions by 75%, nitrogen oxides (NO_x) by 50%, volatile organic compounds (VOC) by 55%, and particulate matter (PM) by 95% compared to gasoline engines.[1]

Figure 1 shows the amount of air pollutants released per unit of energy produced using coal, oil or natural gas. Natural gas enjoys a significant air quality benefit and replacement of oil and coal with natural gas for our energy needs can further improve our air quality.

Pounds of Air Pollutants Produced per Billion Btu of Energy

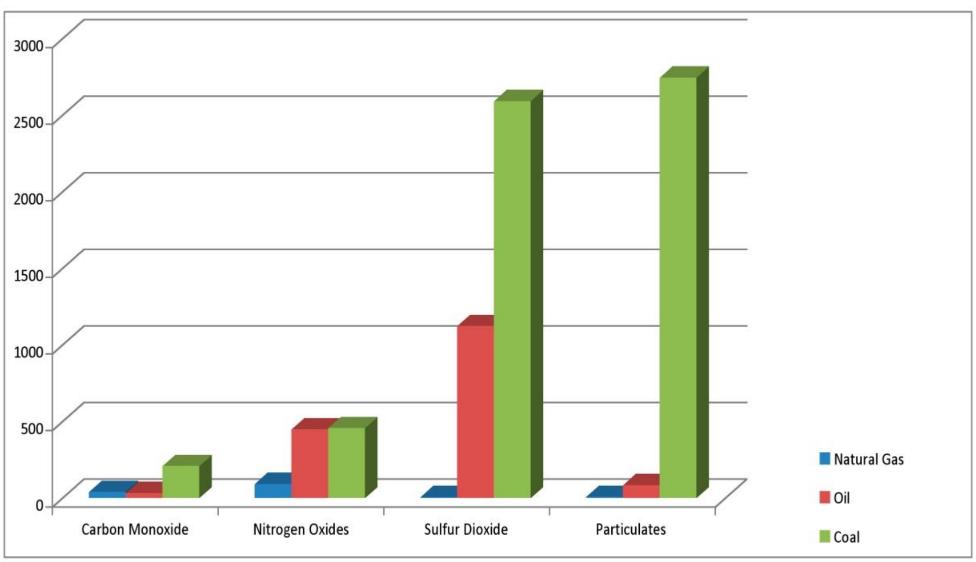

Figure 1. *Air pollutants produced for energy produced for different fuels. Source:* US Energy Information Administration

[1] *A Full Fuel-Cycle Analysis of Energy and Emissions Impacts of Transportation Fuels Produced from Natural Gas*, Argonne National Lab, DOE, December, 1999.

Environmental Protection Agency Air Standards

The U.S. Environmental Protection Agency (EPA) sets National Ambient Air Quality Standards (NAAQS) for six pollutants: CO, lead, NO_x, ozone, SO_2 and PM. America has been able to achieve great success in environmental air quality, with a 67% decrease in emissions since 1980 (see Figure 2).

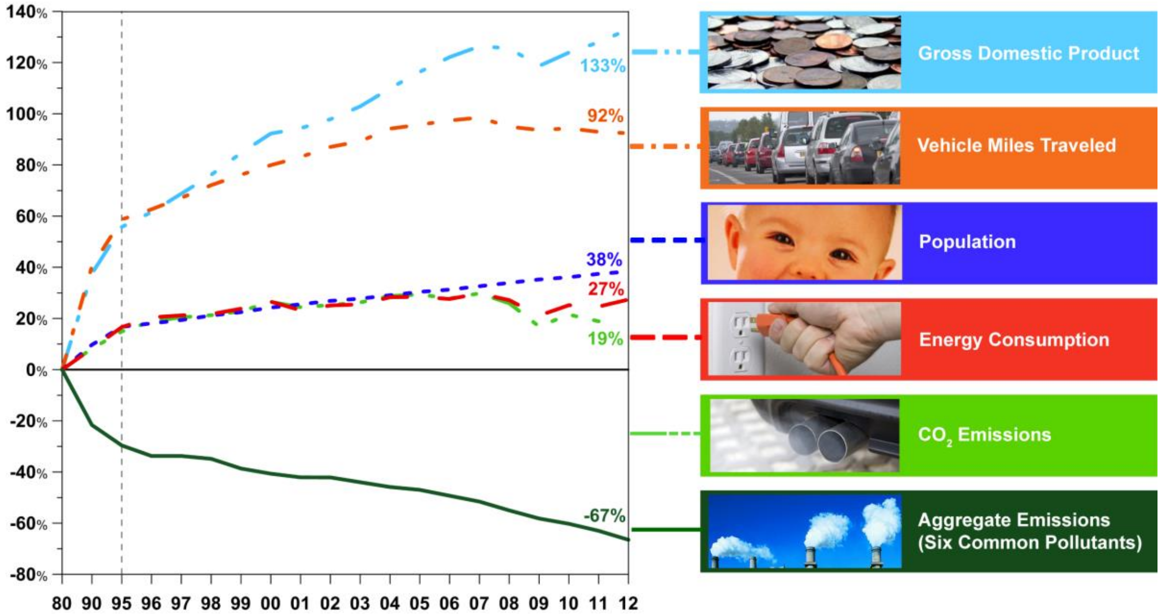

Figure 2. *Air quality has improved 67% at the same time that GDP has increased by 133% and energy consumption has grown by 27%.*[2]

Despite that success, EPA rhetoric continues to center on the need to act quickly to address urgent health concerns from air pollution. EPA continues to ratchet down NAAQS, and the natural gas industry is being asked to comply with an onslaught of new air regulations that provide minimal environmental benefits compared to the significant costs of compliance. EPA actions take billions of dollars from job creation and economic growth and funnel it into regulation.

These regulations are shortsighted, since use of natural gas for electricity, home and industrial heating, and vehicles delivers huge air quality benefits. On balance, production emissions are far outweighed by the benefits from end-use consumption. Yet EPA and other regulators are delaying permits and leases indefinitely across the West because of concerns about air quality. Policies that intentionally place limits on the development of new supplies of American natural gas are counterproductive to the clean air goals of our country. Federal policies that limit public lands access and EPA regulations focused only on emissions from production while ignoring the full lifecycle air quality benefits of natural gas are constraining development.

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[2] *Our Nation's Air: Status and Trends Through 2012*,

Issues Affecting the Western Oil and Natural Gas Industry

Below are some examples of the air quality regulatory issues which could cause a slow-down in oil and natural gas development in the West.

Ozone

Of particular concern in the Western states are ozone concentrations in the lower atmosphere, or troposphere. Ozone protects us from the sun's harmful rays when it's in the upper atmosphere, but ozone is considered a pollutant closer to the ground. Ozone in the troposphere forms from reactions between NO_x and VOCs in the presence of sunlight. Ozone is considered a secondary pollutant because it is not emitted directly to the atmosphere but forms from reactions between these other direct, or primary, emissions.

Elevated ozone is typically monitored during the summer in urban areas which have a great deal of vehicle traffic and heavy industry. Because ozone is formed from complex photochemical reactions from primary emissions, understanding and regulating it requires photochemical models to determine which emissions will lead to a reduction in ozone. Limiting the wrong pollutant can actually increase ozone concentrations, so it is critical to understand the atmospheric chemistry and emissions of a region before imposing emissions reductions.

The current EPA ozone NAAQS requires that the annual fourth highest daily 8-hour ozone concentration, averaged over three years, not exceed 75 parts per billion (ppb). EPA uses data from air quality monitors that measure ozone concentrations in the air. The concentrations are averaged over 8-hour periods, and the fourth highest value for each year is used in a three-year average to determine a regions compliance with the NAAQS.

EPA's Clean Air Scientific Advisory Committee (CASAC) has recommended lowering the ozone standard to between 60 and 70 ppb. These levels are based on health studies of ozone's effect on asthma and other decreased lung function. However, these studies are likely to exaggerate the health effects for a variety of reasons. These studies often do not involve human subjects, or they expose the subjects to unrealistically high ozone concentrations making them poor indicators of how the average human reacts to realistic ozone levels actually experienced by the population.

If EPA reduces the ozone standard, it would negatively impact the West, in particular. Background levels in rural areas with little population or industry frequently approach or exceed 60 ppb because of air transport from Asia and West Coast cities. Typical means to address ozone levels such as stopping industrial development or other human activity will be unsuccessful when the source of the ozone is largely outside the control of local communities. States and communities across the West will be unable to achieve compliance with an ozone standard established at or near the background levels except at great expense and at the loss of local job and economic growth .

Regions with high ozone are usually considered either NO_x limited or VOC limited. In a NO_x limited region, the ozone concentration is controlled by the amount of NO_x emissions, and this is common for rural areas with few automobile emissions and considerable vegetation that emits VOCs. In a VOC limited region, ozone is controlled by VOC emissions, which is typical for urban areas with high vehicle emissions and power generation. In the United States, ozone levels that exceed the NAAQS typically occur in the summer in large cities where there are many cars, many industries and lots of heat to drive the chemical reactions.

Summertime ozone in urban areas has been the focus of regulatory and scientific methods to reduce ozone concentrations for at least the last four decades. These methods are not proving to be effective for rural areas with relatively low levels of ozone from different types of sources. If EPA lowers the ozone NAAQS to that approaching background levels in western rural areas, many western counties will suddenly be in non-attainment, with few effective means to reduce ozone without severely depressing economic activity and job creation.

Winter Ozone

Recently, there have been elevated ozone levels recorded during the winter in two Western basins, the Uinta Basin in Utah and the Upper Green River Basin in Wyoming. The episodes are surprising since ozone has typically been identified as a summer problem in urban areas. EPA and states have spent more than four decades monitoring, modeling, and regulating summer ozone, and only recently bothered to install or operate ozone monitors during the winter.

Both basins contain significant upstream and midstream oil and natural gas activities, which emit both NO_x and VOCs ozone precursors, but do not fully explain the high concentrations. Early studies have indicated that three conditions are required for winter ozone episodes: snowpack on the ground, atmospheric inversions and basin topography.[3] Atmospheric inversions of heavy cold air aloft stagnate air at the surface trap emissions within the bowl-shaped basins. Snowpack on the ground serves two purposes. It forms the inversions and reflects sunlight, which provides the ultraviolet radiation needed to drive ozone chemistry.

Even though it is well known that meteorology and topography are needed to form winter ozone, many questions remain. Episodes in Wyoming last only a few days, while those in the Uinta Basin last for weeks. Scientists also do not know which VOCs are most reactive in such cold temperatures and what compounds lead to the necessary radical formation for ozone production. These and other details will be required to develop a useful photochemical model for each basin before ozone can be successfully regulated.

Western Energy Alliance along with the State of Utah, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA), Uintah and Duchesne counties, Utah State University and other universities are conducting the Uinta Basin Ozone Study (UBOS) to understand the causes of winter ozone formation. High ozone readings were recorded in the Uinta Basin during the winters of 2010, 2011 and 2013, although not in 2012 when there was no snowpack. Because the right weather conditions did not exist during the 2012 winter, ozone

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[3] Conceptual Model of Winter Ozone Episodes in Southwest Wyoming, Wyoming DEQ, *2012 Uintah Basin Winter Ozone & Air Quality Study*, Utah State University, Utah Department of Environmental Quality, February 1, 2013.

levels were extremely low even as oil and natural gas production increased. The 2012 study provided excellent baseline data on air quality conditions in the basin.[4] The 2013 study is now underway, and both years will provide scientific data about the conditions necessary for ozone formation to better inform regulators, public land managers, and the greater scientific community.

Hydraulic Fracturing Air Emissions

During the process of hydraulic fracturing (HF), water, sand and a small amount of chemicals are pumped into an oil or gas well to fracture the rock and release hydrocarbons. After the fracturing process is complete, some of the water and chemicals return to the surface while the sand remains in the rock formation to prop open the fractures. Gradually, oil and natural gas from the well begin to flow back with the HF materials. Once the concentration of oil or natural gas is great enough, it will be sent to tanks or pipelines for sale. During this flowback period, a mixture of methane and VOCs are produced from the well along with water and other hydrocarbons.

Over the last decade, industry has developed green completions technology (also called reduced emissions completions) to capture these VOCs and methane in order to reduce their emissions. The mixture is pumped through a closed-loop system that separates the water, hydrocarbon liquids and gases. The water can be reused for another HF job, and the liquids and gases are sent to sales. Despite this technological development and adoption by industry, EPA decided to promulgate air rules to regulate the HF process and impose regulatory requirements for practices and technology that companies were already adopting.

In October 2012, EPA finalized New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants (NSPS/NESHAP) rules for the oil and natural gas industry. These rules focus on VOC emissions from hydraulic fracturing and storage vessels. EPA claims the rules will reduce VOC emissions by 540,000 tons and air toxics by 38,000 tons. However, by EPA's own data, oil and natural gas production accounts for just a small percentage (2.3%) of U.S. VOC emissions.[5] Even though industry was continuing to adopt green completions technology, EPA has made green completions technology mandatory and thereby claims economic benefits of $45million per year, most of which actually come from the methane captured in the process of controlling VOCs.

The rule implements back-door regulation of the greenhouse gas methane. EPA is using provisions of the Clean Air Act (CAA) for controlling VOCs to control methane emissions. EPA had to overestimate methane emissions by 200% in order to arrive at such a high economic benefit.[6] EPA claims 130 million metric tons of CO_2-equivalent ($mtCO_2e$) are emitted annually

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[4] *2012 Uintah Basin Winter Ozone & Air Quality Study*, Utah State University, Utah Department of Environmental Quality, February 1, 2013.

[5] Calculated from EPA data in *National Air Quality Status and Trends through 2007 (EPA-454/R-08-006 November 2008); National Air Quality and Emissions Trends Report,2003 (EPA-454/R-03-005 September 2003).* For comparison, vehicles account for 38% of US VOC emissions; paints & solvents 27%; agriculture & forest fires 12%; and other industrial processes 14%.

[6] US Environmental Protection Agency, *Greenhouse Gas Emissions Reporting from the Petroleum and Natural Gas Industry: Background Technical Support Document,* 2010.

from gas wells during well completion and flowback, whereas and IHS CERA report estimates 43 $mtCO_2e$ of methane emitted.[7] EPA assumes 49% of gas is vented and 51% flared during flowback nationwide because it assumes that flaring does not take place unless specifically required by the regulating state, which is contrary to industry practice. They also assume the entire amount of methane captured during the green completions process would be vented if green completions were not used, which is also contrary to industry practice. A recent study from the University of Texas and the Environmental Defense Fund measured methane emissions during hydraulic fracturing processes and found EPA overestimated emissions by over 47 times the measured methane.[8] In short, EPA has imposed expensive regulations on the oil and gas industry and justified them with greatly overestimated economic benefits.

Health Impacts – Debunking the Myths

There have been numerous media reports that people living near oil and gas development have suffered negative health impacts from the air quality around them. Everything from nose bleeds, to asthma and even cancer have been blamed on oil and gas development, but only anecdotally without independent verification. The media often accepts wild claims at face value, and fails to explain how oil and natural gas is regulated and the large number of regulations in place to protect air quality and human health. The EPA, Occupational Safety and Health Administration (OSHA), National Institute for Occupational Safety and Health (NIOSH) and the states have a full slate of studies and rules for any chemical that could impact human health.

There have also been dubious studies claiming to link oil and gas development to health impacts. One particularly egregious example is a paper from the Endocrine Disruption Exchange in 2012.[9] The authors present concentrations of various chemicals in the air around Paonia, CO and make veiled references to possible connections to oil and gas activity in the region. However, they took no meteorological measurements to determine the source of the chemicals, they gave no detail of their sampling and measurement methods, they make no effort to measure the background levels of each chemical, and they show a poor understanding of industry activities. They even admit that "The concentrations at which the chemicals were detected in the air are far less than U.S. government safety standards…" Despite the myriad problems with this study, it was widely quoted in the media and is routinely used to show oil and gas development emissions are harmful to public health.

Another widely cited study is from the Colorado School of Public Health, which claims oil and gas development, especially hydraulic fracturing, can have serious health impacts.[10] However, there are several problems with the assumptions made in the paper. Like the previous paper discussed, this study did not adequately take into account background concentrations or

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[7] IHS CERA, *Mismeasuring Methane: Estimating Greenhouse Gas Emissions from Upstream Natural Gas Development,* August 2011.
[8] Measurements of methane emissions at natural gas production sites in the United States, David T. Allen and others, *Proceedings of the National Academies of Science,* 2013.
[9] An Exploratory Study of Air Quality near Natural Gas Operations, Theo Colburn and others, *Human and Ecological Risk Assessment*, 2012.
[10] Human health risk assessment of air emissions from development of unconventional natural gas resources, Lisa McKenzie and others, *Science of the Total Environment,* 2012.

meteorology. By greatly overestimating the time required to drill and complete a well, the authors exaggerate assumed emissions. They assume exposure lasts for 24 hours/day, 365/per year for 70 years, which is unrealistically high since wells take just a matter of months to drill and complete, which limits exposure. Finally, they didn't control for other sources of emissions such as the nearby interstate highway. But the bottom line is they show a risk of cancer in Garfield County, where the study takes place, is actually lower than that for the overall U.S. population.

Activists in Erie, Colorado tried to use atmospheric measurements on a 300 foot tower to say the local population was at serious health risk from oil and gas operations. The Colorado Department of Public Health and Environment (CDPHE) took air samples near an Erie well using proper sampling methods for a health risk assessment and found "no significant concentrations" of chemicals attributed to the well pad. An independent study of the data from the tower and CDPHE found the risk to the Erie population of adverse health effects over a lifetime exposure was low.[11]

Given the controversy over these and other public health studies, the state of Colorado along with Colorado State University has begun a new study of air quality in several drilling areas in Colorado. Western Energy Alliance hopes that robust data and realistic assumptions will be used for this research and that it includes a valid risk assessment of health impacts and detailed examination of plausible exposure pathways from well sites to nearby populations.

Other studies in Fort Worth, TX,[12] Pennsylvania,[13] and Australia[14] that employ the appropriate methods for assessment of health effects have shown that concentrations in the air around oil and gas sites stay well below levels deemed a health risk. Overall, valid health assessment studies demonstrate low risk of adverse impacts from oil and gas operations, and there have been no patterns of impacts to oil and gas workers, who spend much more time at close proximity to well sites.

Western Energy Alliance Leadership on Air Quality

Western Energy Alliance has been a regional leader in air quality for several years, engaging states, federal agencies, counties and academia to provide credible data that advances scientific understanding of air quality and provides regulators with the information they need to sensibly improve air quality. This work includes the Winter Ozone Study in the Uinta Basin and the WRAP Phase III Oil and Gas Inventories

WRAP Phase III is a multi-year project to develop regional criteria pollutant emissions inventories for each major oil and gas production basin across the West. Western Energy Alliance worked with the Western Regional Air Partnership (WRAP), a program of the Western Governors' Association, to develop the inventories and to ensure their credibility. Western

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[11] Town of Erie Air Quality Review, Technical Memorandum to Erie, Colorado, Pinyon Environmental, 2013
[12] Fort Worth Natural Gas Air Quality Study, Pring and Wilhelmi, 2011
[13] Northeastern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report, PA DEP, 2011; Southwestern Pennsylvania Marcellus Shale Short Term Ambient Air Sampling Report, PA DEP, 2010; Northcentral Pennsylvania Marcellus Shale Short-0Term Ambient Air Sampling Report, PA, DEP, 2011
[14] Health Watch, Australian Institute of Petroleum Health Surveillance Program, 2005

Energy Alliance member companies contributed data on their emissions in each production basin to build the inventory to quantify emission inventories from stationary and mobile equipment operated as part of the exploration and production activities.

The inventories are a primary source of information for state regulators, EPA, BLM, NOAA, and academic institutions. Without accurate emissions inventories, permitting and regulating bodies made excessively conservative estimates of potential emissions from oil and gas development. These large emissions were then used in lawsuits aimed at stopping development. Robust inventory data used as the basis for potential emissions provide legal and scientific backing to regulators and permitters.

Western Energy Alliance continues to lead on air quality issues for the oil and gas industry. We monitor and work to improve proposed regulations for air quality and promote the benefits of natural gas for U.S. air quality. Natural is clean, abundant and affordable, which makes it the perfect choice as we search for cleaner energy sources. Natural gas can provide clean, baseload power for electricity, and can dramatically reduce our transportation emissions when used in vehicles. Despite some of the media reports and environmental rhetoric, natural gas has and will continue to lead to improved air quality.