UCS Position on Natural Gas Extraction and Use for Electricity and Transportation in the United States

Summary Position Statement: To avoid the worst consequences of climate change, the United States must transition to low- and zero-carbon energy sources over the next 40 years. Natural gas is a fossil fuel whose emissions contribute to global warming, making it a far less attractive climate solution than lower- and zero-carbon alternatives such as energy efficiency and renewable energy.

Furthermore, new research suggests that methane leakage during the extraction and distribution of natural gas may be undermining the potential to reduce global warming emissions by using natural gas in place of higher-carbon fossil fuels such as coal and oil. And new horizontal drilling and hydraulic fracturing (or "fracking") techniques that have allowed domestic gas and oil production to expand rapidly over the past decade have raised new questions about the impacts that natural gas extraction and use will have on climate change, public health and safety, land and water resources, and people. This expansion is currently outpacing our capacity to understand and manage the attendant risks.

During our nation's transition to a low-carbon energy future, natural gas can play an important but limited role in the electricity and transportation sectors—*if* policies sufficient to minimize emissions and protect communities and public health are put in place.

Specifically, the Union of Concerned Scientists (UCS) recommends that:

- Policy makers at all levels of government should prioritize the use of cleaner and safer strategies such as renewable energy and energy efficiency in all sectors of the economy
- Stronger federal and state regulations are needed to reduce global warming emissions from the extraction, distribution, and use of natural gas
- Better information and stronger regulations are needed to understand and reduce the potential environmental and public health risks associated with fracking
- A local or statewide moratorium or ban on fracking may be appropriate in cases where there is a substantial risk of significant harm to the environment or public health, or where reliable scientific data on such risks are lacking

Introduction

Advances in horizontal drilling and hydraulic fracturing techniques have resulted in a significant increase in natural gas produced from U.S. shale formations over the past decade. The Energy Information Administration (EIA) projects shale gas will grow from about one-third of total U.S. natural gas production in 2012 to nearly half by 2040 (EIA 2013). While most of the initial growth in shale gas production occurred in Arkansas, Louisiana, Oklahoma, and Texas, much of the recent growth has been concentrated in the Northeast, Mid-Atlantic, and upper Midwest.

This boom in production, combined with the recent recession and other factors, has contributed to a significant decline in natural gas prices: according to the EIA, wholesale prices declined from a peak of more than $12 per million British thermal units (MMBtu) in June 2008 to less than $2/MMBtu in April 2012. This resulted in significant fuel switching from coal to natural gas in the electricity sector, increased natural gas use in the industrial sector, and lower energy bills for consumers. It has also increased natural gas exports to Canada and Mexico, and sparked significant interest in building terminals for the purpose of exporting liquefied natural gas overseas.

During the past year, however, natural gas prices more than doubled, leading to some fuel switching back to coal in the power sector. The EIA projects wholesale prices will steadily rise over time, reaching nearly $8/MMBtu by 2040 (EIA 2013).

The Union of Concerned Scientists (UCS) has long supported a role for natural gas as part of a transition away from an electric grid dominated by coal to one that relies on cleaner, renewable energy sources. UCS has also supported a role for natural gas in transportation to reduce air pollution and shift toward hydrogen fuel cell vehicles. However, new research suggests that methane leakage during the extraction and distribution of natural gas may be undermining the potential to reduce global warming emissions by using natural gas in place of coal or oil. New horizontal drilling and hydraulic fracturing techniques have also raised new questions about the impacts that natural gas extraction and use will have on climate change, public health and safety, land and water resources, and people.

Natural Gas and Climate Change

Over the past few years, a switch away from coal to natural gas in the U.S. power sector has been an important driver for reducing U.S. carbon emissions. As natural gas will likely play an important role as part of our energy mix for the next few decades, new policies and regulations will be needed to ensure that the natural gas industry takes responsibility for all its emissions and does its part to reduce its contribution to global warming.

Natural gas is a fossil fuel that emits 50 to 60 percent less carbon dioxide (CO_2) when combusted in a new, efficient natural gas power plant compared with emissions from a typical new coal plant (NETL 2010). Considering only tailpipe emissions, natural gas also emits 15 to 20 percent less heat-trapping gases than gasoline when burned in today's typical vehicle (FuelEconomy.gov 2013; ANL 2012). Nevertheless, those emissions do contribute to global warming, making natural gas less attractive from a climate standpoint than lower- and zero-carbon alternatives like energy efficiency and renewable energy.

A 2011 study by the International Energy Agency (IEA) found that a large global shift to natural gas would still put us on an emissions trajectory (based on energy-related CO_2 emissions) toward a long-term global average temperature increase of more than 6°F—a level of warming associated with a high risk of catastrophic environmental and economic consequences (IEA 2011). The study also found that limiting temperature increases to lower levels would require a greater shift to low-carbon energy sources, increased energy efficiency, and deployment of new technologies such as carbon capture and storage. With Canada, China, Mexico, Russia, and several other European nations also exploiting their shale gas reserves, it is clear that expanded natural gas extraction is a global phenomenon with global implications.

Emissions from smokestacks and tailpipes, however, do not tell the full story. The drilling and extraction of natural gas from wells, and its transportation in pipelines, results in the leakage of methane, a far more potent global warming gas than CO_2. Preliminary studies and field measurements show that these so-called "fugitive" methane emissions range from 1 to 9 percent of total natural gas production (Tollefson 2013; Cathles et al. 2012; Howarth et al. 2012; Petron et al. 2012; Skone 2012; Weber and Clavin 2012).

Whether natural gas has lower life cycle greenhouse gas emissions than coal and oil depends on the assumed leakage rate, the global warming potential of methane over different time frames, the energy conversion efficiency, and other factors (Bradbury et al. 2013). One recent study found that methane losses must be kept below 3.2 percent for natural gas power plants to have lower life cycle emissions than new coal plants over short time frames of 20 years or fewer (Alvarez et al. 2012). And if burning natural gas in vehicles is to deliver even marginal benefits, methane losses must be kept below 1 percent and 1.6 percent compared with diesel fuel and gasoline, respectively. However, if considered over longer time frames of 100 years—as is used in many Intergovernmental Panel on Climate Change (IPCC) assessments—natural gas production could experience methane losses much higher than these examples and still have net climate benefits compared with coal and oil. Technologies are available to reduce much of the leaking methane, but deploying such technology would require new policies and investments (Bradbury et al. 2013; Harvey, Gowrishankar, and Singer 2012; IEA 2012).

To ensure that natural gas and other fossil fuels compete on a level playing field with zero- and near-zero-carbon resources, the United States should set limits that will reduce heat-trapping emissions at least 80 percent below 2005 levels by 2050, and put a price on carbon. The U.S. Environmental Protection Agency (EPA) should require the natural gas industry to deploy technologies and practices that significantly reduce methane losses from natural gas drilling and pipelines. In addition, both the federal government and industry should increase research and development (R&D) funding for low-carbon technologies such as renewable energy, energy efficiency, and carbon capture and storage.

The Role of Natural Gas in the Electricity Sector

Low natural gas prices and recent increases in the cost of generating electricity from coal have resulted in a significant shift from coal to natural gas over the past few years. Compared with coal, natural gas has much lower levels of harmful air emissions and corresponding local health impacts. Unlike coal and nuclear plants, natural gas plants can be ramped up or down quickly, providing important flexibility to the grid and making it easier to integrate variable resources like wind and solar power. Natural gas can also play an important role in meeting peak electricity demand and fueling highly efficient technologies that provide both heat and power in the commercial and industrial sectors.

However, continued increases in natural gas demand for electricity and other uses could result in shortages and significant price increases in the future, similar to what the United States experienced in the past decade (after the last major natural gas power plant construction boom). And with no long-term national policy support, cheap natural gas could crowd renewable energy out of the power market in the near term. Scaling up energy efficiency and renewable energy sources now is critical to further reducing their costs, encouraging innovation, and transitioning rapidly to a low-carbon energy system (NREL 2012; Cleetus, Clemmer, and Friedman 2009). By diversifying the electricity mix, renewables and efficiency can also provide an important hedge against future natural gas price increases (Bolinger 2013).

UCS advocates prioritizing renewable energy and energy efficiency over natural gas and other fossil fuels when adding new electricity supply or replacing old, dirty plants. This is critical for achieving a more sustainable, low-carbon energy future. UCS also supports a goal of increasing renewable electricity to 25 percent of U.S. electricity use by 2025 and 80 percent by 2050. Policy makers at all levels of government should adopt strong policies and programs to ensure the timely expansion of renewable energy and energy efficiency. In addition, the U.S. EPA should adopt strong standards and regulations to reduce CO_2 *and other harmful emissions from new and existing power plants.*

The Role of Natural Gas in Cars and Trucks

Natural gas can play a limited role in fueling cars and trucks, but it is not a good candidate for directly replacing gasoline or diesel at a large scale. The best application for natural gas in cars and trucks is as a resource to produce electricity or hydrogen for electric vehicles.

As a vehicle fuel, natural gas is currently less expensive than gasoline and diesel (AFDC 2013a), but the costs of the high-pressure onboard storage tank and of building up fueling infrastructure can wipe out some or all of the lifetime cost advantages (AFDC 2013b). The greatest potential economic benefit from using natural gas is in larger vehicles that use a lot of fuel and those that regularly travel great distances. Centrally fueled fleet applications can avoid the expense of an extensive infrastructure and deliver some cost savings, but that is more difficult for individual vehicle owners. While the cost of natural gas vehicles is likely to come down, natural gas prices are likely to rise with its increased use in electricity, transportation, and exports, undermining its potential to deliver a significant economic advantage when used in vehicles (EIA 2013).

Most importantly, the emissions benefits of burning natural gas in a car or truck are limited, raising further concerns about making investments in large-scale natural gas vehicle and infrastructure deployment. Modern gasoline and diesel emissions controls have significantly reduced the advantages natural gas cars and trucks have historically held in terms of smog-producing and particulate emissions (Gautam et al. 2011). In addition, when all emissions (i.e., from fuel extraction to use) are considered, natural gas vehicles provide little or no significant reduction in global warming emission compared with gasoline or diesel (FuelEconomy.gov 2013; ANL 2012). Global warming emissions savings on the order of 40 percent can be achieved by using natural gas in an efficient power plant to generate electricity for a plug-in hybrid or battery-electric vehicle, or by using natural gas to generate hydrogen for a fuel cell vehicle (ANL 2012). If methane leakage is minimized, both applications could cut the global warming emissions of today’s typical conventional car by about half (Anair and Mahmassani 2012).

To ensure that natural gas plays an appropriate role as the nation moves toward a lower-carbon transportation system, the United States should strengthen global warming pollution standards for cars and trucks, and account for all emissions from the full fuel cycle of natural gas and other fuels. State and federal incentives and R&D funding for vehicles, fuels, and fueling infrastructure should also be based on full fuel cycle climate and local air quality performance, and should therefore prioritize efficiency, electricity, hydrogen, and low-carbon biofuels over natural gas.

Hydraulic Fracturing

Recent advances in drilling technology are enabling the widespread use of hydraulic fracturing (or "fracking"), leading to the recent expansion in natural gas and oil production from U.S. shale deposits. The technology and its application are expanding at a dizzying speed, with thousands of new fracking wells drilled each year across the nation.

The process of shale oil and natural gas extraction, from exploration to the drilling and fracking of a well to the transportation of the fuel to its destination, involves a range of technological advances and major environmental, economic, and social challenges and opportunities. The challenges include the largely unknown composition of fracking fluid, the fate and disposal of waste fluid, high levels of freshwater use, industrialization of rural landscapes, increased traffic and air pollution, and the impacts of mining the sand needed for fracking. These impacts raise questions of environmental justice for disadvantaged communities in areas both where fracking is occurring and where natural gas is processed.

The expansion of U.S. shale oil and natural gas extraction requires a comprehensive approach to risk management, including the monitoring, evaluation, and mitigation of potential risk factors related to public health and safety, as well as broader environmental, economic, and social impacts. Managing risk requires not only good information, but also making sure this information is openly available to decision makers and the public. It also requires the regulation and implementation of best practices, mitigation measures, and ongoing monitoring to ensure that risk factors are continuously updated, evaluated, and minimized. Unfortunately, although important scientific issues related to the risks of fracking have not been fully evaluated, exploration, drilling, and production are proceeding rapidly—outpacing our capacity to understand and mitigate the attendant risks.

Shale oil and gas extraction is currently regulated through a patchwork of state and federal efforts, with the federal government having the lead on federal lands and the states on private or state lands. Recent reviews have called into serious question the adequacy of both the scope and implementation of such a regulatory structure to protect public health and well-being from the potential risks of fracking-related operations (RFF 2012; DOE 2011). In addition, federal legislation has exempted fracking activities from some key provisions of major national environmental statutes, undermining our ability to apply the best science-based analysis and regulations in reducing health, safety, and environmental risks. Although local conditions for fracking may present the need for a tailored approach to some practices and mitigation measures, there are a core set of risks that need to be managed across locales and should be addressed with a consistent, overarching framework at the federal level.

Such a framework must include a system for acquiring, disseminating, and continuously updating information about all the risk factors that can be identified. The public has a right to know about both the risks and benefits of any public policy that has the potential to affect our health and well-being.

Stronger state and federal laws and regulations are needed to better understand and reduce the environmental and public health risks of hydraulic fracturing. Consistent with the recommendations of a recent U.S. Department of Energy report (DOE 2011), these include:

- *Requiring improved disclosure of the chemical composition, volume, and concentration of all fracking fluids before drilling can begin*
- *Requiring careful monitoring and control of the discharge and disposal of fracking wastewater*
- *Ensuring that federal and state regulation of the shale gas and oil industry works in a complementary and comprehensive fashion*
- *Ensuring dissemination of comprehensive information to the public on both the risks and benefits of fracking at local, state, regional, and federal levels*
- *Fast-tracking critical scientific research on the risks shale gas and oil extraction pose to people, communities, agriculture, and the environment*

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