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Why natural gas has an uncertain future

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A B S T R A C T

Until recently, most environmental groups viewed natural gas favorably in facilitating the transition to a low-carbon environment. Today, these groups as well as others have radically changed their perspective by opposing natural gas for electric generation. They also advocate 'electricification,' where fossil-fuel customers convert to electricity for water and space heating, and transportation. This article examines their arguments and policy recommendations.

1. Consensus on the benefits from natural gas

The U.S. natural gas industry has enjoyed a great run over the past eight years. It has contributed to the economy by creating new jobs and significantly reducing households' and businesses' energy bills. This was particularly crucial during the Great Recession, when a boost from a major industry alleviated a further downward spiral of the economy.

Natural gas also benefited the environment by accelerating the retirement of coal plants. The shift from coal to natural gas was a major factor in lowering U.S. energy-related CO_2 emissions by 12% between 2005 and 2015.[1] Even after accounting for methane emissions, the most credible studies have shown that switching from coal to natural gas has mitigated global warming. As an added premuim, natural gas emits lower amounts of air pollutants, like sulfur-dioxide, mercury, and nitrogen oxide, than coal.

Because of its abundance of shale gas, the U.S. expects to be a net exporter of natural gas. Until this decade, the worry was that the country would be importing increasing amounts of natural gas from vulnerable areas of the world.

Overall, because of the development of natural gas resources from advanced technology for hydrocarbon extraction, especially 3D seismic, horizontal drilling, and hydraulic-fracturing stimulation, natural gas appears to have a bright future.[2] About 50% of U.S. natural gas production comes from "fracking" techniques applied in shale formations, whereas just 10 years ago this percentage was virtually zero.

2. Recent opposition to natural gas

We have seen a two-prong attack on natural gas. The first is the opposition to natural gas as a bridge fuel in electricity generation. The second, so far only at a preliminary stage, is what industry observers call "electrification," where customers switch from natural gas and other fossil fuels to electricity for direct use (e.g., transportation, water and space heating). Promoters of electrification contend that it is imperative for meeting stringent GHG-emissions targets.[3]

2.1. A major shift from a few years ago

Up until the last few years, most environmental groups viewed natural gas favorably in facilitating the transition to a low-carbon environment. One 2013 study describes the wide support for natural gas as a bridge fuel:

> Environmental experts and advocates have long viewed natural gas as a critical driver of the shift from coal toward lower-carbon energy sources. Widely referred to as a "bridge fuel," natural gas proponents argue it is one of the lowest-cost and most easily substitutable alternatives to coal. Because it produces roughly half the CO_2 emissions of coal, natural gas has been embraced as a bridge fuel to zero-carbon energy supplies by Al Gore, the Sierra Club, the Natural Resources Defense Council (NRDC), Resources for the Future, former Environmental Protection Agency head and Obama climate

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[1] According to the U.S. Energy Information Administration: Energy-related CO_2 emissions can be reduced by consuming less petroleum, coal, and natural gas, or by switching from more carbon-intensive fuels to less carbon-intensive fuels. Many of the changes in energy-related CO_2 emissions in recent history have occurred in the electric power sector because of the decreased use of coal and the increased use of natural gas for electricity generation. [https://www.eia.gov/todayinenergy/detail.php?id = 26152]

[2] According to a February 2016 study, IHS Energy calculated a 66% increase since 2010 in potential natural gas recoverable at a break-even Henry Hub price of $4/MMBTU or less. [http://news.ihsmarkit.com/press-release/north-americas-unconventional-natural-gas-resource-base-continues-expand-volume-and-de.]

[3] The rationale for reducing the role of natural gas in households, businesses, and industries is that, if the U.S. commits to about an 80% or higher CO_2 emissions reduction by 2050, it would not only have to reduce natural gas usage for electricity production but also for water and space heating. Unless something dramatic occurs in transportation, little room exists for reducing emissions in other sectors. This means that natural gas consumption would have to drastically decline in the future to meet the stringent targets.

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chief Carol Browner, and energy experts across the political spectrum.[4]

A "bridge fuel" is a fuel source of electricity generation relied on until zero-carbon energy like renewable energy evolves more economically and feasibly (in terms of operability and system reliability) to be the major source of electricity generation. Natural gas accompanies growth in renewable energy for some time (i.e., the "bridge" span) but then declines as renewable energy assumes a more dominant role.[5]

Today, these groups as well as others have radically changed their perspective of natural gas. The Sierra Club warns that:

> If America is to meet its climate commitments and prevent further climate disruption, we must reject a massive new gas infrastructure expansion. The only solution for preventing further climate disruption is to redirect the proposed fossil fuel investment into accelerating our transition to 100% clean, renewable energy like wind and solar, and keep as much of the dirty fuels in the ground as possible.[6]

They now see natural gas as a barrier to achieving climate-change targets that will help assure against catastrophes.[7] They propose to phase out, as quickly as possible, the use of natural gas in electricity generation and to include in the dialogue the idea of residential and business customers switching their consumption of natural gas and other fossil fuels for space heating, water heating, and other end uses to electricity (i.e., "electrification").[8]

In sum, the consensus until recently has been that natural gas could serve the beneficial role of a "bridge fuel" smoothing the transition of the electricity sector from fossil fuels to zero-carbon energy by hastening the decline in coal use. Natural gas would buy time before the country is able to rely on zero-carbon technologies to play a prominent role in fueling the electric supply system.

2.2. Recap of anti-gas arguments

Many climate advocates contend that renewable energy has become so compelling that we should phase out natural gas in the shortest time possible. One of their arguments is that governmental policy can assist in replacing coal with renewable energy, at reasonable cost, and slash U.S. GHG emissions without the problems of "fracking," and CO_2 and methane emissions.[9]

Climate advocates warn that by sinking hundreds of billions of dollars into new natural-gas infrastructure instead of expanding renewable power, the U.S. could lock itself into a carbon-based future.[10] This would delay the time before zero-carbon energy would eventually dominate the market.

Perhaps most damning is the assertion that because natural gas systems leak methane– a potent greenhouse gas– a shift from coal to natural gas could actually increase global warming.[11] Climate benefits from natural gas use therefore depend on system leakage rates. Although natural gas is generally regarded as the cleanest fossil fuel, it is debatable for certain uses if actual methane emissions are on the high side of estimates. One rule of thumb developed by the Environmental Defense Fund is that, at a 3.2% leakage rate in the natural gas system, coal and natural gas (used as boiler fuel) have an equivalent effect on global warming.[12]

Whether any of these arguments has validity is questionable. We should not ignore methane emissions, for example, in the natural gas system. On balance, however, studies on methane leaks have shown that leak rates in the natural-gas supply system, while in some instances higher than U.S. EPA estimates, are well below levels that would negate the benefits of switching from coal to natural gas on climate change.[13]

3. Natural gas should continue as a bridge fuel

3.1. Pro-gas arguments

Advocates of natural gas can point to a number of positive developments over the past several years that made this energy source highly beneficial to society. First, cleaner energy sources like natural gas along with zero-emitting sources like renewable energy have increasingly displaced the use of dirtier fossil-fuel sources.[14] The shift from coal to

[4] Alex Trembath et al., "Coal Killer: How Natural Gas Fuels the Clean Energy Revolution," paper prepared by the Breakthrough Institute, June 2013, 11.

[5] Another definition of the word "bridge" depicts a scenario in which natural gas demand rises in the future from current levels before declining. In some analyses, the "bridge" period would extend to 2030 or sooner. As such, natural gas would act as a short-term stopgap (i.e., bridge) until zero-carbon energy sources become more dominant.

[6] Sierra Club, "The Gas Rush: Locking America into Another Fossil Fuel for Decades," report, Jan. 26, 2017, 1.

[7] According to some climate-change activists, the safe level of carbon dioxide in the atmosphere is 350 parts per million. The only path to achieve that goal is to immediately transition the global economy away from fossil fuels. Reaching such a stringent target is effectively already impossible, according to most experts, without large-scale carbon removal. Even aggressive scenarios (for example, 1.5° C warming targets) still have over 400 ppm. Reaching even a 400–450 ppm target (which some experts argue is also unattainable) would require the U.S. to reduce its CO_2 emissions by 80% between now and 2050, which means an extremely short bridge for natural gas.

[8] The rationale for reducing the role of natural gas in households, businesses and industries is that, if the U.S. commits to about an 80% or higher CO_2 emissions reduction by 2050, it would not only have to reduce natural gas usage for electricity production but also for water and space heating. Unless something dramatic occurs in transportation, little room exists for reducing emissions in other sectors. This means that natural gas consumption would have to drastically decline in the future.

[9] A study by the National Renewable Energy Laboratory, for example, showed that currently available renewable technologies can affordably and reliably provide 80% of U.S. electricity needs by 2050. [Maureen M. Hand et al., "Renewable Electricity Futures Study," report by the National Renewable Energy Laboratory, Vols. 1–4, 2012.] Other analyses have come to similar conclusions. [*See*, for example, "100% Renewable Energy Vision," *The Solutions Project* at http://thesolutionsproject.org/.] The policy implication is

(*footnote continued*)
that over the next 20 to 30 years, the U.S. can pretty much phase out natural gas for electricity generation to be displaced by renewable energy with minimal effect on costs and reliability.

[10] As argued, one problem with switching from coal to natural gas is that owners of new gas-fired power plants and other gas facilities will be reluctant to shut down those facilities in 10 or 15 years' time, when we need to move to more aggressive greenhouse-gas controls that would eliminate fossil fuels from the energy mix. It will prolong, in other words, the use of natural gas beyond the time required to keep climate change to a non-catastrophic level.

[11] Every greenhouse gas (GHG) has a global warming potential (GWP) – the measure of its ability to trap heat in the atmosphere relative to carbon dioxide (CO_2). Scientists consider methane as a potent GHG because, according to the U.S .EPA, it has a GWP of 34: When integrated over 100 years, methane is over 34 times more effective (per metric ton) than CO_2 at trapping heat in the atmosphere. That is, pound for pound, methane emissions are 34 times more potent in their effect on global warming than CO_2 over the period of 100 years after emission. Methane has a relatively short atmospheric lifetime of 10 to12 years, however, which means it has a minor effect on long-term peak temperatures.Methane emissions in the natural-gas supply system originate from two major sources: (a) venting (intentional releasing of excess gas), and (b) leaks (the top source of methane emissions, which largely occur on the pipeline and distribution components).

[12] Other studies have shown a threshold in the range of 3.5 to 4.0 percent, depending on several factors. *See* Gavin Bade, "On Earth Day, Natural Gas is the Power Sector's Biggest Environmental Problem," *Utility Dive*, April 22, 2016.One study concluded that at somewhere between 3% and 4% leakage, there is some brief period in the next 20 years in which natural gas would have a greater climate impact than coal. Averaged over the 100-year period, however, the leakage rate would have to be around 9% in a new gas vs. existing coal scenario. [Zeke Hausfather, "Bounding the Climate Viability of Natural Gas as a Bridge Fuel to Displace Coal," *Energy Policy*, Vol. 86 (November 2015): 286-94.]

[13] One widely cited study argues that the EPA underestimates methane leakage and the leakage rate is probably in the 2–4% range. [Adam R. Brandt et al., "Methane Leaks from North American Natural Gas Systems," *Science*, Vol. 343, no.6172 (Feb. 14, 2014): 733-35.]. *See* also Michael Levi, "Climate Consequences of Natural Gas as a Bridge Fuel," *Climatic Change*, Vol. 118, Issue 3 (June 2013): 609-23.

[14] Some observers have labeled natural gas a "coal killer because of its low natural gas price. Over the past few years, the Mercury and Air Toxics rule, the Regional Haze rule, the Cross-State Air Pollution rule, the Effluent Limitation Guidelines, however, have significantly increased the cost of operating coal plants.The primary argument in support of natural gas is the fact that it is cleaner than coal and can be conveniently and cost