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THE ROLE OF NATURAL GAS IN THE ENERGY TRANSITION

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While industry outlooks for natural gas and LNG demand remain buoyant, question marks surround the role of gas in deep decarbonization scenarios consistent with the Paris Agreement's climate goals. The near-term prospects for gas seem strong, for reasons reflecting the fuel's superior air quality attributes in comparison with coal or liquid fuels. However, the credentials of gas as a transition fuel could be undermined if flaring, venting, and fugitive methane emissions along the natural gas supply chain are not significantly addressed. In the long term, the imperative to eliminate most fossil fuel-related greenhouse gas emissions—not just those associated with coal and oil, but also most of those associated with the burning of gas—could pose a profound challenge to the gas business as we know it.

The gas sector has started to embrace the idea of "greening" natural gas in order to reconcile the vision of a decarbonized energy system with projections of continued consumption of the fuel. This can be done by using more biomethane from organic sources or by blending hydrogen—produced either from water using renewable electricity (green hydrogen) or from natural gas combined with CCUS (blue hydrogen)—into existing natural gas networks. Some of these pathways could offer decarbonization at scale, including in hard-to-abate sectors, while extending the use of existing natural gas grids into the future. However, none of these pathways is particularly easy from an energy economics point of view, and by no means are they guaranteed to succeed.

Bridge fuel narrative under fire?

For the past decade or so, the gas industry has made a case that gas can be a critical factor in the ongoing energy transition as a bridge fuel, primarily by replacing more-polluting coal (as well as some oil) in the energy system. Some success stories like the wholesale displacement of coal-fired generation by a combination of gas and renewables in the US and the UK, and the more recent policy-driven coal-to-gas switching in China underscore the environmental benefits of gas as a transition fuel. The IEA recently estimated that coal-to-gas switching globally avoided more than 500 million tons of CO_2 emissions between 2010 and 2018,[1] which is roughly equivalent to the total energy-related emissions of all Central American countries over the same period.

Methane leaks, flaring and venting, which are receiving steadily greater attention in recent years, have the potential to undermine the environmental *bona fides* of natural gas, however.

Methane is a highly potent greenhouse gas with a warming potential that is roughly 30 to 90 times greater than that of CO_2, depending on the timescale of the assessment.[2] While global understanding of the methane leakage problem is still limited, an International Energy Agency study estimates that the methane emissions associated with oil and gas operations worldwide are probably quite significant, totaling about 2.4 billion tons of CO_2 equivalent.[3] At that level, these emissions would be more than the energy-related CO_2 emissions of any country except the US and China. Moreover, a number of recent high-profile academic studies indicate that the environmental impact of oil and gas-related methane emissions could be worse than previously thought.[4]

The gas industry's green credentials are also increasingly called into question due to its highly visible gas flaring activity, which has been growing fastest in the United States. According to the latest World Bank data, US gas flaring activity increased 48 percent from 2017 to 2018 and reached 1.4 Bcf/d last year,[5] roughly equivalent to the total gas consumption of a medium-sized European country like Belgium (1.6 Bcf/d) or Romania (1.1 Bcf/d). Flaring has so far been viewed as a problem of economic waste and seen as less environmentally harmful than methane emissions because it produces CO_2 as a primary greenhouse gas. However, an upcoming paper by CGEP senior scholar Robert Kleinberg finds that the GHG impact of gas flaring in the US is probably worse than commonly assumed as a result of incomplete combustion.[6]

While the best available data on leakage rates globally indicate that the lifecycle GHG footprint of natural gas is probably substantially lower than that of coal,[7] the lack of definitive data has generally not worked in the gas industry's favor. Some environmental activists and academics already assert that natural gas is hardly better than coal from a climate perspective,[8] and certain policy makers and philanthropists are increasingly calling for the elimination of all fossil fuels from the energy mix as soon as possible.[9] The risks of such a policy backlash against gas may intensify as flaring volumes increase in the US, and the extent of the global methane leakage problem is more fully understood.

The challenge of greening natural gas

The longer-term threat to natural gas is that in developed economies the unmitigated burning of all fossil fuels could become increasingly untenable if governments begin to take the objectives of the Paris Agreement—and thus the need for deep decarbonization—seriously.

To safeguard a transition role for natural gas, some in the sector have started to embrace "green" gas—low-carbon substitutes for conventional methane. The most common pathways to decarbonize the gas mix include: biomethane produced from waste products and agricultural residues; "green hydrogen" produced via water electrolysis using renewable electricity; and "blue hydrogen" produced from conventional natural gas via steam methane reforming combined with CCUS. Each of these green gas pathways could help preserve at least part of the existing gas grid and the associated downstream infrastructure. Blue hydrogen could even extend the reach of gas into new hard-to-abate sectors like aviation or trucking, thus reinvigorating gas demand in mature developed economies. However, each of these technological pathways is fraught with difficulties.

Biomethane, which can be produced from landfill gas, animal manure and other agricultural waste products through biogas upgrading has the same characteristics as conventional natural gas minus the carbon footprint. This means that it can be transported, stored and burned using the existing natural gas supply chain with no modification whatsoever. The biomethane production process faces serious scalability constraints, however, due to land and feedstock availability issues and the inherent rate limitations of the anaerobic digestion process, among other factors. Biomethane production itself can be prone to methane leakage, and the lifecycle environmental impacts—including the land-use change effects—of the process are not fully mapped out. Estimates of the sustainable potential of biomethane supply vary enormously, even within specific regions such as Europe,[10] but in all likelihood it is fairly small compared to the scale of the existing natural gas system. The technology of producing biogas and upgrading it to biomethane is relatively well-established, so further cost declines from large-scale deployment are limited. Costs may even go up over time if biomethane gains widespread adoption and producers are gradually forced to utilize more marginal—and expensive—feedstock sources.

Low-carbon hydrogen pathways—whether from renewable electricity or from natural gas combined with CCUS—may not only enable the greening of gas supply via hydrogen blending in existing natural gas applications. They may also spur the development of a future hydrogen economy, eventually opening the possibility for deep decarbonization in hard-to-abate sectors, such as aviation, maritime shipping, long-haul trucking, industrial processes and residential heating. Hydrogen is notoriously difficult to handle, however. Storage and transport over long distances are highly expensive, and hydrogen may be even more susceptible to leakage than methane along the supply chain.[11] While hydrogen is less harmful than methane, it is nonetheless an indirect greenhouse gas with an estimated global warming potential 6 times greater than that of CO_2 over a 100-year time frame (vs. 28-34 for methane).[12] Corrosion, embrittlement and heightened safety risks are also issues that need to be addressed and could add to costs as hydrogen blending gains momentum.[13] The energy density of hydrogen is only about a third of methane,[14] so hydrogen blending into the natural gas stream will result in an inferior product (in terms of energy content) at substantial additional cost. Beyond a relatively low threshold it will also necessitate equipment upgrades on the end-use side. This means that low-carbon hydrogen will have to rely on some form of policy support. While the cost of producing green or blue hydrogen might fall substantially with widespread deployment, system costs can later reflate as the 10 to 20 percent maximum blending threshold for using current infrastructure is surpassed,[15] and substantial upgrades and new infrastructure become necessary.

In addition to these common challenges, green hydrogen requires electrolysis powered by zero-carbon electricity. A dedicated wind or solar power supply would only allow intermittent utilization of highly capital intensive electrolysis plants, however, which could undermine the economics of the process.[16] Blue hydrogen uses natural gas as a feedstock. It could be a real boon for the upstream gas industry, as the process could open up new markets in aviation, shipping, and trucking for natural gas-based hydrogen thanks to the favorable physical properties of the fuel. On the other hand, this pathway would require scaling up not one, but two challenging technologies—CCUS and hydrogen—simultaneously. On the plus side, where geological CO_2 storage is an option, such as in the North Sea or the US Gulf of Mexico, blue hydrogen may prove relatively fast and cheap to deploy. In contrast, not all countries and markets have geological storage options, including large gas consuming nations like Japan and South Korea.

The Way Forward

Natural gas has played a role to date in addressing local air quality problems and reducing carbon dioxide emissions in many jurisdictions around the globe. Coal-to-gas switching can continue to help cut emissions as the energy transition gains momentum. The industry will have to tackle the leakage and flaring problems if gas is to be a viable and low-cost abatement option in the medium term, however. In the longer term, the gas sector will also need a credible decarbonization strategy that addresses the inherent opportunities, challenges and limitations of the current technological pathways on offer.

If the history of environmental progress is any guide, then voluntary action alone will not be enough to clean up the natural gas mix. Given the multitude of market failures and infrastructure challenges standing in the way of decarbonizing gas on a meaningful scale, there will be ample room for smart policy intervention and more forceful regulatory action in the years ahead. Historically, the oil and gas sector has been reluctant to advocate for policies that hasten the energy transition. It may be time to change that and embrace policies and technologies that can help the decarbonization of the natural gas supply chain. Without greater industry leadership and collaboration with governments, green gas may never become a commercial reality, and ultimately there may be little room left for natural gas in low carbon energy systems around the world.

Notes

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