MYTH BUSTING: Is Fossil Gas Actually "Cleaner"?

by Isabella Suarez, Erika Uusivuori, Ronja Borgmästars, July 2022

Gas is the fastest-growing fossil fuel in the world. Over the last decade, it has accounted for 30% of total energy demand growth, outpacing the growth of both coal and oil. This has been driven in large part by a boost in fossil gas production and supply, which initially drove the cost of gas down in the late 2000s.

With the growing concern for climate, the fossil fuel industry has framed gas as a "transition" or "bridge" fuel towards a low-carbon economy. Hypothetically, in cases of complete uncontrolled combustion, fossil gas may burn cleaner than coal or oil to emit comparatively less carbon and pollution like nitrogen and sulfur oxides.

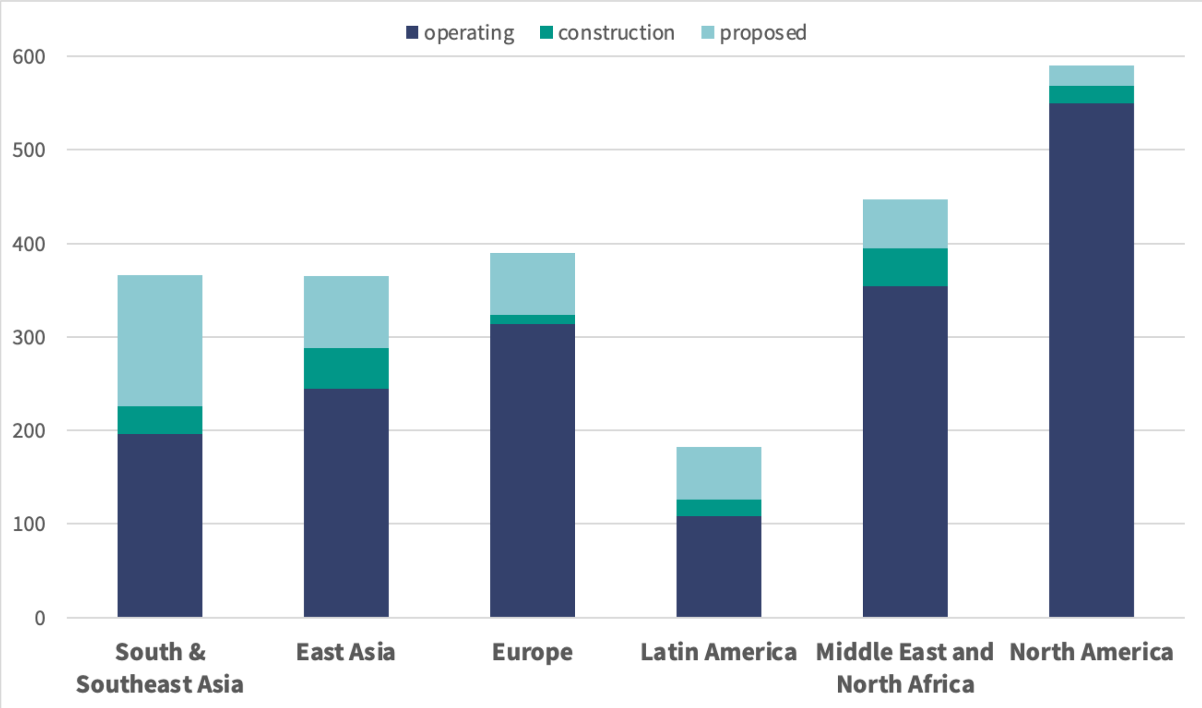
However, the reality is much more complex. The outsized investments into long-lived gas infrastructure are not compatible with the 1.5°C degree Paris Agreement target. CO_2 emissions from fossil gas have nearly doubled in the last 20 years from 1.76 gigatons in 2000 to 3.21 gigatons in 2021. In the power sector alone, gas-fired power plants increased by 30% globally since 2010, with installed capacity totalling 1.8 terawatts (TW) at the end of 2021.

The risks of expanding fossil gas over building out low-carbon technologies have also been highlighted by recent events, such as COVID-19 and the Russian invasion of Ukraine. Supply and production have been disrupted, contributing to markets in flux, and the already volatile prices of gas have been hitting all-time highs at great cost to consumers.

With over 161 GW of gas-fired power plants in construction and another 454 GW proposed globally (GEM, 2021), the health implications of gas-fired power plants must be part of the equation, especially as many are being sited close to densely populated areas. This is especially urgent as policies to control pollution from gas power plants are not well-developed.

More cost-effective and efficient zero-carbon alternatives are also becoming increasingly available for the energy transition, challenging the narrative around the need for gas and its planned expansion scale.

Figure 1. *Total gas-fired power plant capacity and capacity additions (GW)*[1]



Source: Global Energy Monitor, January 2022

This is *Part 1* of our Gas Guide, where we focus on the emissions released during different stages of gas production and the resulting impacts these may have.

Fossil Gas 101

Pollutants of Concern

The perception of gas as a "cleaner" fuel has allowed it to buck attention on its contribution to air pollution. On this front, gas is far from a clean form of fuel and the health impacts of the fuel cannot be considered separately from its contributions to climate.

Significant air pollution is released into the atmosphere during stages of gas production, extraction from wells, storage tanks and pipelines, and processing. Gas flaring and methane leaks are also rampant across the supply chain.

[1] For plants with several years as "start year", research was conducted by CREA to determine the correct start year, and any developments in capacity. For plants where this information was not available, the later year was set as the start date. For plants with "not found" as start date, research was conducted by CREA to determine the correct start year. If information was not available, the plant was assumed to have been operating for the time period of interest (2002-2021).

For power generation, fossil gas combustion emits air pollutants and toxic gasses such as methane, carbon monoxide (CO), nitrous oxides (NO_x), sulfur oxides (SO_x), particulate matter ($PM_{2.5}$ and PM_{10}), and volatile organic compounds (VOCs), as well as heavy metals such as mercury. Methane, NO_x and ammonium sulfate — a byproduct of SO_x — are the main pollutants of concern for gas-fired power plants.

Methane (CH_4), as the primary component of fossil gas, is consequently the main pollutant of concern, and is released in large quantities during production, transmission, and distribution. At gas-fired power plants, methane is released during the start-up or shut-down of a boiler — a common occurrence as gas plants are most needed for "peaking", or when there is a sudden increase in load demand. Not only is methane toxic to health, its 20-year heat trapping impact is 86 times greater than carbon dioxide (CO_2). There is great variation in methane emissions across the supply chain and between countries. Leakage rate — which greatly increases fossil gas' overall emissions — is in the range of 1-10% depending on pipeline quality, method of extraction, and estimation methods across regions. For fossil gas emissions to have environmental savings in the form of reduced greenhouse gasses, the leakage rate needs to be below 4.5-5% in comparison to coal.

Toxic gases like **Nitrogen Oxides** (NO_x) and **Sulfur Oxides** (SO_x) are major pollutants emitted in gas-fired power generation. The concentration of SO_x varies depending on the origin and quality of the fossil gas, but is generally quite low. On the other hand, NO_x is the most significant pollutant emitted in fossil gas electricity generation. Not only does NO_x cause respiratory problems in both adults and children, but NO_x — along with SO_x, VOCs and ammonia emitted throughout the fossil gas supply chain — reacts with other substances in the air to produce particulate matter and ozone.

Particulate Matter (PM) emissions are generally low in initial fossil gas combustion; however, because the pollutants above also contribute to total $PM_{2.5}$ that results from gas, its impacts to human health remain a dangerous consequence of fossil gas. PM emissions may also increase from poor air/fuel mixing or maintenance issues at gas plants.

How do Gas Emissions Compare to Other Emission Sources?

Power generation utilizes different types of natural and synthetic gas.[2] Gas extracted from wells can be processed to remove carbon dioxide, sulfur, and VOCs, and can be processed further into liquefied natural gas (LNG). Shale gas comes from injecting pressurized fluids to shale formation and extracting the released gas. Lastly, synthetic natural gas (SNG) is

[2] Biogas can also be used, but is generally not considered a fossil fuel.

produced from other fossil fuels (e.g. lignite coal) or biofuels by converting these into fossil gas.

Fossil gas emissions vary according to gas types and composition *(Table 1)*. While fossil gas combustion can be controlled in much the same way as coal, a major emerging issue is that pollutant emissions from fossil gas are highly dependent on combustion efficiency and control systems that differ vastly across the world. On top of this, when comparing life-cycle emissions, fossil gas can be higher or equal to those of coal.

Table 1. *Emissions factor comparison of gas and coal production in the United States*

		Combustion		Life-cycle	
Emissions	**Unit**	**Coal**	**Gas**	**Coal**	**Gas**
$PM_{2.5}$		2.8-3.4[3]	0.89	-	-
PM_{10}		6.9-7.9	0.89	-	-
NO_x (minimum)		322.6	15.10	356.6	126
NO_x (maximum)		1,144.10	655.20	1,220.90	1,018.1 (LNG); 1,940.4 (SNG)
SO_x (minimum)		194	0	201.6	5
SO_x (maximum)	g/GJ	3,213	142.4	3,250	187.7
CO_2	kg CO_2 equiv/GJ	264.6	138.6	286	157.5 (Natural gas); 201.6 (LNG); 447.3 (SNG)

Source: Jaramillo et al. 2007

Within the larger context of addressing the climate crisis, the more important comparison is how fossil gas impacts compare to renewable energy alternatives. Increasingly viable technologies like wind and solar, emit no carbon and pollutant emissions to generate power.

Reviewing the Evidence: Health Impacts of Gas Emissions Pile Up

The literature on the health impacts of gas-fired power plants emphasize the lack of proper regulation and safeguards around the technology, as well as highlight the danger in expanding its infrastructure unnecessarily.

[3] The range depends on which type of coal is burned.

In the United States, a study examining mortality caused by outdoor $PM_{2.5}$ from stationary sources, showed that 2017 emissions from gas caused more deaths than coal generation in 19 states. Gas has already displaced coal as the country's main source of power, and the share of gas-related premature deaths has increased from 2008 levels of around 11-14% to 21%. Another health survey found that in Pennsylvania, symptoms such as throat irritation, sinus problems and severe headaches of respondents living near gas developments worsened after shale gas development commenced.

In Iran, a health and economic impact assessment of the Qom gas-fired power plant showed that the prevalent health impact was restricted activity days (RAD), or days spent away from work or school, and days when activity is partially restricted due to sickness, of which nitrate was the primary (96%) contributor. The total costs for all the health impacts — estimated at USD 4.76 million — were primarily split between costs borne from long-term mortality (49%), RAD (27%), and chronic bronchitis (21%).

In Bangladesh, Ashuganj 2 coal-fired plant provides an illustrative comparison of emissions by fuel. A 2020 CREA case study found that the air pollutant emissions from a 1,320 MW Ashuganj 2 coal plant would be responsible for a projected 3,000–6,000 air pollution-related deaths (depending on the exact assumptions of air emission limits and control technology applied in the projects) over a 30-year operating life.

The coal power project was recently canceled and replaced by a proposal for a 3,600 MW LNG-fired power plant project. However, if fully realized, the LNG-fired power plant would still be responsible for a projected 1,500 deaths over its operating life, negating one quarter to a half of the gains from canceling the coal-fired project.

On top of this, the original proposed coal plant would have emitted an estimated 600-800 kg of mercury per year into the air, of which one third would be deposited into land and freshwater ecosystems in Bangladesh. The LNG proposal would reduce projected mercury emissions by only 16%, or 500–720 kg, per year.

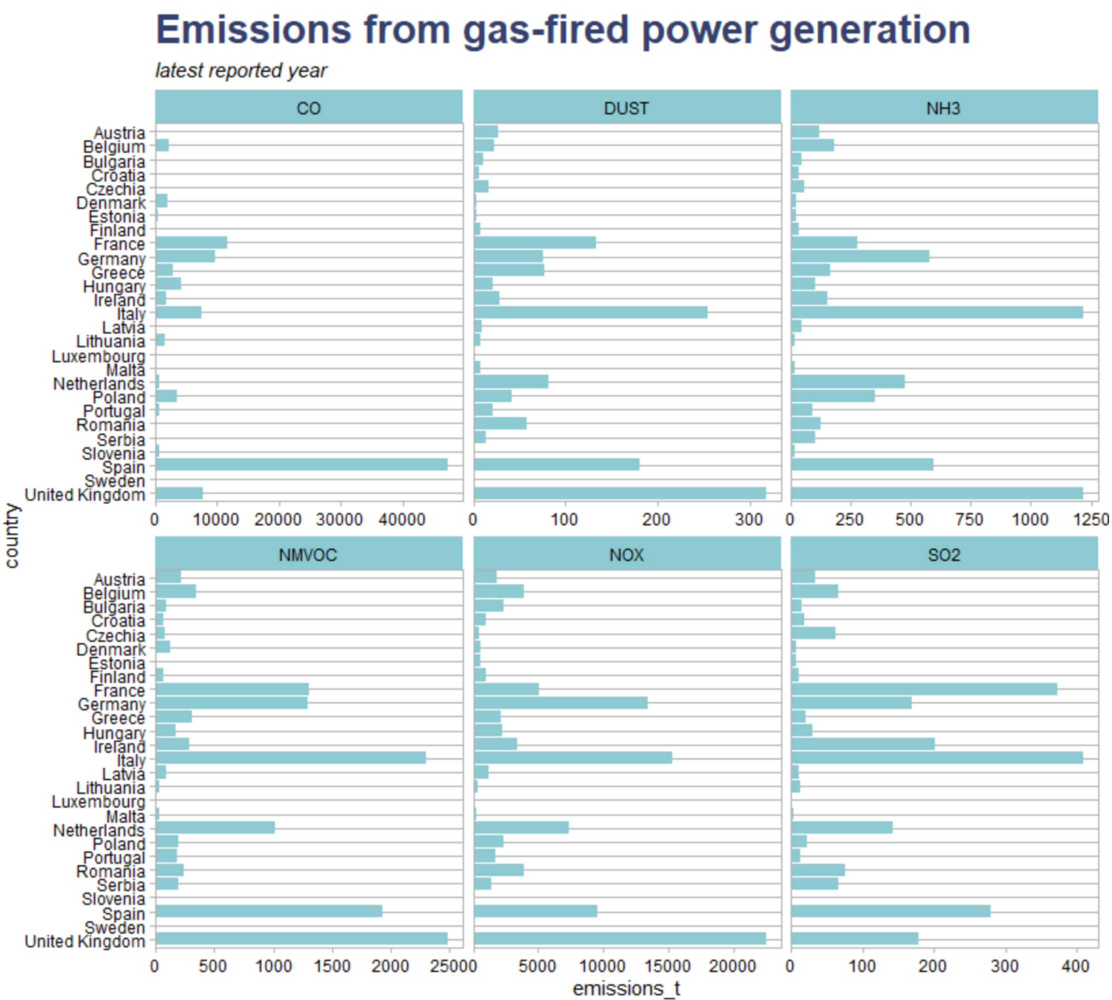
Table 2. *Emissions from proposed coal vs. gas projects in Bangladesh*

		Coal — Ultra-supercritical				Gas — LNG			
Name	Capacity (MW)	SO_2	NO_x	$PM_{2.5}$	Hg	SO_2	NO_x	$PM_{2.5}$	Hg
Payra	1,320	3,383	8,904	305	74	998	5,377	105	0
Ashuganj 1	1,320	3,124	8,595	261	101				
Ashuganj 2	1,320	3,124	8,595	261	101	665	3,585	70	0

Europe is among the world's top consumers of fossil gas, consequently recording high levels of various emissions from gas annually. [A previous CREA study] found that from 2017 to 2020, gas-fired power plants in the EU27 and the UK emitted 100,200 tons of NO_x, 2,100 tons of SO_x and 1,300 tons of dust. On an annual basis, these emissions lead to an estimated 2,100 deaths and cost the countries EUR 6 billion.

Pollutant concentrations differ according to the type of gas burned in each country included in the study, but there were notable gaps in countries' reporting — a clear policy concern around gas. For instance, not all countries reported emissions in 2020, such as Germany which last reported them in 2017. Countries are also not fully monitoring their emissions from gas generation, as some have made premature assumptions that pollutants like NO_x will be minimal.

Figure 2. *Emissions from gas-fired power generation in the EU and UK in 2017-2020, expressed in tons*



Source: EEA IRD

The health saving benefits of going from coal to clean, rather than creating tie-in from gas, are notable. Another CREA study on South Korea found that a “Net-Zero” scenario where gas was phased out by 2035 would avoid 17,840 premature deaths, in comparison to the country’s current plans to increase gas-fired power generation to 59.1 GW. If the gas build out plans go ahead, air pollution from gas power is estimated to cause 23,200 premature deaths on the Korean peninsula, China and Japan until 2064 — which is the assumed retirement year of the plants.

Step on the Breaks, Don’t Let Gas Get Away

The halt in additional fossil gas infrastructure and the phasedown of existing gas use needs to begin urgently.

In recognition of the significant detriment of gas to human health and the environment, as well as its catastrophic contribution to climate change, the transition away from coal ought to be accelerated rapidly towards clean energy, rather than fossil gas.

Misheld assumptions and narratives that fossil gas is a “cleaner” fuel have resulted in regulations to minimize the health and environmental impacts of gas being ill-suited in controlling emissions across the supply chain.

Not only does gas generate more pollution than renewables but investments in fossil gas itself and the infrastructure required to support it are also at high risk of becoming stranded assets. Simply put, stranded assets are assets that turn out to be worth less than originally anticipated due to energy transition changes. Early research estimates that half of the world’s existing fossil fuel assets could become worthless by 2036, leaving USD 11-14 trillion in stranded assets. Large volumes of stranded assets run the risk of further exacerbating the lock-in of fossil fuel dependency, as well as a diversion of financial resources from investment into decarbonisation.

Fossil gas will, in fact, only be a very short “bridge” with its rapidly diminishing role; one that continues to shorten as renewables become more affordable around the world and as the urgency to address the climate crisis deepens. Given both its carbon and pollutant emissions are significant compared to green and renewable energy technologies means that fossil gas is not a viable solution for climate mitigation in the short or long term. Plans to expand fossil gas infrastructure and the policies in place to control their emissions need to be scrutinized, especially given the increasing projected growth in fossil gas generation capacity at a time when the transition should be *away* from fossil fuels.