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The role of natural gas in energy transition

The role of natural gas in energy transition has long been debated. Although a fossil fuel, it emits significantly less carbon dioxide and air pollutants than coal and oil. In this regard, many consider it as an intermediate source of energy helping to shift from the world of hydrocarbons to renewables. Others question the role of natural gas in a transition to net zero energy systems as they believe it hinders the decarbonization effort through carbon lock-in and stranded assets. Moreover, there is a belief that investments in natural gas might crowd out investments in renewable alternatives.

The current global energy crisis, to a large extent caused by delayed maintenance of oil and gas fields and underinvestment during the pandemic period, and exacerbated by the war in Ukraine, has brought the issue of natural gas consumption into the spotlight again. Furthermore, the decision of the European Union lawmakers in July 2022 to vote in favour of calling natural gas (and nuclear power) a "green" and "sustainable" source of energy has spurred another wave of discussion regarding the role of natural gas in the global energy transition.[1] Such labelling essentially paves the way for potentially billions of euros of funding from investors for the development of natural gas projects. Remarkably, Brussels's position towards natural gas does not fit well into the policy recommendations of the International Energy Agency (IEA), which stated in its "Net Zero by 2050" roadmap in May 2021[2] that there should be no investments in new gas, oil, or coal production if the world is to meet the Paris Agreement targets. The European Union (EU) is a global leader in the field of green energy and sustainable development, and Brussels's decisions regarding the classification

1 Abnett, K. (2022). EU parliament backs labelling gas and nuclear investments as green. *Reuters*, 7 July. Available: https://www.reuters.com/business/sustainable-business/eu-parliament-vote-green-gas-nuclear-rules-2022-07-06/

2 International Energy Agency (2021). Net Zero by 2050: A Roadmap for the Global Energy Sector. International Energy Agency, May 2021. Available: https://www.iea.org/reports/net-zero-by-2050

of environmentally sustainable economic activities, known as the EU taxonomy, will have a significant impact on decarbonization policies in other jurisdictions around the world.

The thesis that the world can quickly transit to renewables without natural gas certainly does not hold water. However, the statement that natural gas will play a dominant role in global decarbonization efforts is equally questionable. The truth is somewhere in between. As it was mentioned in a report on natural gas by the Centre for Strategic and International Studies (CSIS), "gas does different things in different markets and at different costs, so broad statements about how gas will fare in the future are unhelpful."[3] Indeed, in some cases sticking to natural gas would bring about more harm than benefit to the environment, while in other cases using more gas could help to decarbonize the global economy. The paper seeks to analyse the potential role of natural gas in energy transition, understand its various uses, and how those uses might evolve under a decarbonization scenario.

1. Current state of the natural gas market

Natural gas, accounting for a quarter of global energy consumption, is the third largest source of energy after crude and coal. Consumption of natural gas increased dramatically in the past decade, accounting for almost one-third of total energy demand growth, more than any other fossil fuel.[4] In 2021, global natural gas consumption increased by 4.5%. This is more than twice the equivalent of the decline experienced in 2020 and the third strongest year since 2000, after 2010 and 2018 (which grew by 7.8% and 5.2% respectively).[5] The strong growth is a result of the global economic recovery after the pandemic-induced constraints coupled with a higher demand for power and heating needs due to the extreme weather conditions of 2020.

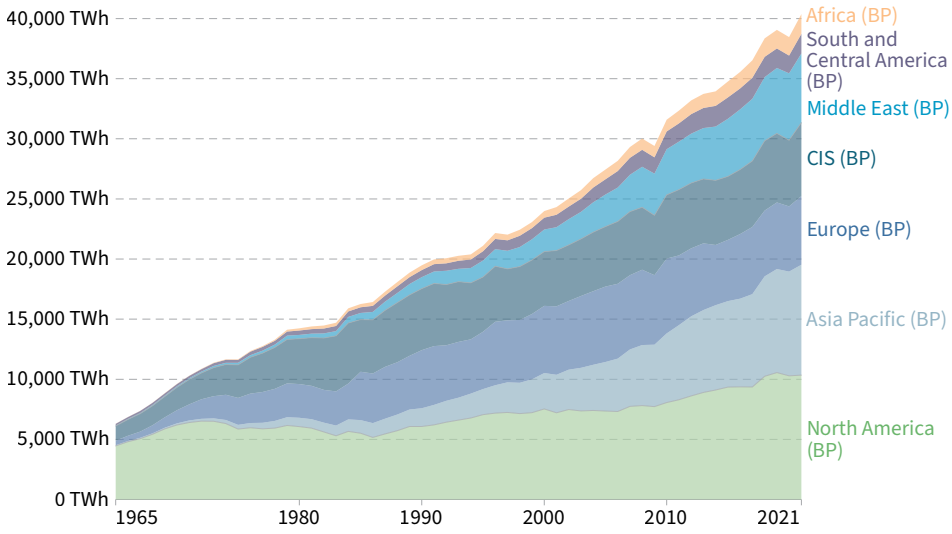
The rapid economic recovery in the second half of 2021 amid limited energy supplies sent natural gas prices soaring. The beginning of the war in Ukraine in February 2022 further exacerbated the situation, causing fuel switching and demand destruction. Current record high prices and supply disruptions negatively impact the image of natural gas as a reliable and affordable energy source, generating mistrust towards the fuel's future, especially in developing countries

3 Tsafos, N. (2020). How Will Natural Gas Fare in the Energy Transition? Center for Strategic and International Studies, 14 January. Available: https://www.csis.org/analysis/how-will-natural-gas-fare-energy-transition

4 Gas. International Energy Agency, 2022. Available: https://www.iea.org/fuels-and-technologies/gas

5 International Energy (2021). Agency Gas Market Report, Q2-2022, including Global Gas Review. Available: https://iea.blob.core.windows.net/assets/cfd2441e-cd24-413f-bc9f-eb5ab7d82076/GasMarketReport%2CQ2-2022.pdf

Picture. **Gas consumption by region. Annual natural gas consumption, measured in terawatt-hour (TWh) equivalents**



Source: https://ourworldindata.org/grapher/natural-gas-consumption-by-region

where it was supposed to play a leading role in meeting rising energy demand and decarbonization ambitions. As a result, global natural gas consumption is expected to contract in 2022, with limited growth until 2025, adding around 140 billion cubic meters (bcm) between 2021 and 2025, a significant decrease from the previous forecasts.[6]

Asia Pacific, the second largest consumer of natural gas accounting for 23% of the fuel's global consumption in 2021, is expected to be the driving force behind natural gas consumption growth in the next 3 years, adding around half of the global consumption gains accounting for 70% of the net demand increase. The potential increase in demand, however, remains limited due to high prices and weakening economic growth. China is expected to experience the largest increase in natural gas demand, accounting for more than 75% of Asia Pacific's growth in gas consumption during the 2021–2025 period. India, too, will be a major contributor to an increase in natural gas demand, owing to the residential and transport sectors in the country's fast-growing city gas segment. After Asia Pacific,

6 International Energy (2021). Agency Gas Market Report, Q2-2022, including Global Gas Review. Available: https://iea.blob.core.windows.net/assets/cfd2441e-cd24-413f-bc9f-eb5ab7d82076/GasMarketReport%2CQ2-2022.pdf

the Middle East is the second largest contributor to global gas demand growth, mainly driven by the increasing domestic supply of fuel in both the power and industrial sectors. In North America, currently the largest consumer of natural gas accounting for a quarter of the fuel's global consumption in 2021, demand is steadily growing. Europe, by contrast, experiences direct demand destruction because of the war in Ukraine and record high gas prices.[7]

According to the Annual Short Term Gas Market Report 2021 of the Gas Exporting Countries Forum (GECF), the power sector is the largest consumer of gas, accounting for 40% of the global natural gas consumption.[8] The residential and commercial sector is another significant consumer accounting for 22%, while the industrial sector accounts for 19% of the total gas consumption. The fuel does not play an important role in the transportation sector where it accounts for just 2% of gas consumption.

2. The role of gas in improving access to electricity, clean cooking, and heating

Despite the efforts to provide access to electricity globally, more than 700 million people remain cut off from electric power. In Africa alone, around 600 million people, representing

43% of the continent's population, have no access to electricity.[9] Although the continent possesses 60% of the world's best solar resources, Africa generates only 1% of electricity from solar photovoltaic (PV) panels.[10] At the same time, around 2.6 billion people are deprived of clean cooking methods, which is one-third of the global population.[11] As a result, millions of deaths from inhaling indoor cooking smoke occur annually. Similar to the electricity problem, most people without access to clean cooking reside in sub-Saharan Africa.

7 International Energy (2021). Agency Gas Market Report, Q2-2022, including Global Gas Review. Available: https://iea.blob.core.windows.net/assets/cfd2441e-cd24-413f-bc9f-eb5ab7d82076/GasMarketReport%2CQ2-2022.pdf

8 Gas Exporting Countries Forum (2021). GECF's Annual Short Term Gas Market Report. Gas Exporting Countries Forum. Available: https://www.gecf.org/_resources/files/pages/gecf-annual-short-term-gas-market-report/gecf-annual-short-term-gas-market-report-2021.pdf

9 International Energy Agency (2022). Africa Energy Outlook. Key findings. International Energy Agency. Available: https://www.iea.org/reports/africa-energy-outlook-2022/key-findings

10 Ibid.

11 World Bank (2021). Report: Universal Access to Sustainable Energy Will Remain Elusive Without Addressing Inequalities. 7 June. Available: https://www.worldbank.org/en/news/press-release/2021/06/07/report-universal-access-to-sustainable-energy-will-remain-elusive-without-addressing-inequalities

Natural gas has great potential to help with energy poverty alleviation. It is a versatile fuel that can be used for improving access to electricity, clean cooking, and heating. Natural gas has already helped to improve access to electricity for millions of people, in some cases by replacing more polluting coal and crude oil. Today, gas already accounts for about a quarter of global electricity generation, and it can play a particularly important role to play in Africa. While in the West electricity consumption may be plateauing, Africa's demand will at least double (or possibly triple) by 2040 due to population growth and rapid urbanization.[12] Currently, renewables alone will not be able to do that because of several technical and financial reasons. Besides, there are significant gas deposits in Africa, including in Algeria, Egypt, Ghana, Nigeria, Mozambique, and Senegal. Moreover, an increase in their consumption will not lead to a notable increase in greenhouse gases due to extremely low energy use and emissions base.

In addition, gas can help address the indoor air pollution problem, associated with 1.6 million premature deaths a year. Switching from solid fuels such as wood charcoal biomass and kerosene to gas for cooking and heating homes – piped gas in urban areas or, more commonly, liquefied petroleum gas (LPG) delivered in cylinders – has considerably helped to lessen indoor air pollution in China, India, Brazil, and Indonesia. It can do the same in many other countries and regions globally. The creation of the LPG infrastructure is also relatively affordable for developing countries and the timelines are much shorter than any form of grid energy.[13]

In some cases, however, renewables would be technically and financially a better option. The cost of solar and wind has decreased substantially over the past decade, making them competitive with fossil fuels for generating electricity in many countries. Since 2010, the price of solar power has decreased by over 80%. As a result, renewables have recently become the most popular source of energy for new capacity additions globally. More than 80% of all new electricity capacity added in 2020 was renewable, with solar and wind accounting for 91% of new renewables, thus exceeding expansion in 2019 by close to 50 percent.[14] In rural areas, where most people rely on solid fuels for cooking and heating, decentralized renewable energy systems (along with LPG for cleaner cooking and heating) could

12 World Economic Forum (2020). 12 reasons why gas should be part of Africa's clean energy future. 23 July. Available: https://www.weforum.org/agenda/2020/07/12-reasons-gas-africas-renewable-energy-future/

13 Kelly, M. (2020). Why is the switch to gas for cooking still so slow in Africa? *New African Magazine*, 12 October. Available: https://newafricanmagazine.com/24602/

14 International Renewable Energy Agency (2021). World Adds Record New Renewable Energy Capacity in 2020. 5 April. Available: https://www.irena.org/newsroom/pressreleases/2021/Apr/World-Adds-Record-New-Renewable-Energy-Capacity-in-2020

be a better and cheaper option for electrification instead of expanding long and expansive natural gas pipelines to remote consumers.

3. Coal-to-gas switching in the power sector

Coal is the dirtiest fossil fuel releasing the largest amount of greenhouse gases when burned. Natural gas, by contrast, is relatively the cleanest fossil fuel, emitting 30% less CO_2 than oil, and around 50% less CO_2 than coal. Replacing coal with natural gas in power generation can, therefore, deliver significant environmental gains. The United States is a good example of where this strategy has worked well. The share of coal in the US power production decreased from 50% in 2005 to 23% in 2019.[15] Simultaneously, the share of natural gas in the US electricity generation increased from 19% to 38% for the same period. As a result, the electricity sector in the United States produced 1,724 million metric tons (MMmt) of CO_2 in 2019, 32% less than the 2.544 MMmt produced in 2005, largely due to coal-to-gas switching but also an increase in deployment of renewables.[16] According to the International Energy Agency (IEA), coal-to-gas switching decreased CO_2 emissions by about 500 million tonnes between 2010 and 2018.[17]

Despite the significant environmental benefits, coal-to-gas switching in the power sector is not a frequent phenomenon. To a large extent, such a switch does not happen due to the wider availability of coal globally and its lower price. The latter has become the major reason for an increase in coal consumption to generate electricity amid the current high natural gas prices. In 2021, the costs of operating gas-fired power plants in many countries were often notably more expensive than operating coal power plants. As a result, for example, coal power emissions increased by 16% in the United States and by 20% in the European Union. In total, coal's share in the global power mix rebounded above 36%, reaching an all-time high and further distancing the world from reaching the Paris Agreement targets.[18]

The current high gas price environment and inability to compete in some power generation markets with coal and renewables might become a problem for

15 US Energy Information Administration (2021). Electric power sector CO2 emissions drop as generation mix shifts from coal to natural gas. 9 June. Available: https://www.eia.gov/todayinenergy/detail.php?id=48296

16 Ibid.

17 Ranney, K., Mukati, M. (2020). The Role of Natural Gas in Energy Transition. *Sustainalytics*, August. Available: https://connect.sustainalytics.com/hubfs/SFS/SFS%20-%20Transition%20Bonds/The%20Role%20of%20Natural%20Gas%20in%20the%20Energy%20Transition.pdf

18 International Energy Agency (2022). Coal-Fired Electricity. September. Available: https://www.iea.org/reports/coal-fired-electricity

the expansion of the natural gas industry. The power sector has been the primary area for the expansion of natural gas since the 1970s, accounting for almost half the growth in gas demand for the period. Losing the ability to compete in the electricity generation segment, traditionally its largest market, might jeopardize the future of natural gas. The IEA already states that industry is the key sector for natural gas expansion, not the power market. Another important trend that might curb the natural gas demand is the electrification of energy systems, especially in buildings and transportation. As the global economy becomes increasingly electrified and the cost of renewable power generation decreases, natural gas's ability to compete will be more challenging.

The soaring price of carbon emissions might also become an enabler for an increase in the natural gas demand. Carbon pricing, also known as cap and trade (CAT) or emissions trading scheme (ETS), is a policy instrument that uses market mechanisms to pass the cost of emitting on to emitters. An increase in carbon pricing would therefore make more-carbon intensive sources of energy, including coal, less competitive than natural gas. As for now, however, relatively low prices of carbon have not contributed to a massive switch from coal to gas.

4. Natural gas as an enabler and backup fuel to renewables

While natural gas might directly compete with renewables for a share in the electricity market, the growing wind and solar power capacity can also promote gas use globally. Intermittency is the major problem associated with the development of wind and solar energy. The sun is not shining all the time, and the wind is not blowing all the time. The limited weather conditions mean that the intermittent solar and wind power capacity should be backed up by a baseload power source as currently there is no large-scale and cost-effective way to store electricity for future consumption. In these circumstances, natural gas can provide a relatively low carbon backup at peak energy demand times when the power generation capacity from renewables is limited. Unlike wind and solar, gas can be stored, and can provide flexibility, since gas-based power production can be adjusted according to hourly, daily or seasonal demand.

There is also a concern that much of the necessary infrastructure for producing and transporting natural gas, taking years to develop, can lock in countries into an emissions pathway that derails them from reaching Paris Agreement commitments. In addition, some industry experts believe that pushing forward fossil fuel projects, including in natural gas, crowd out renewable alternatives. Since public and private funds are limited, their commitment to the development of natural gas projects to some extent can curb the penetration of renewables. In Africa alone, around $132 billion in lending and underwriting

went into 964 gas, oil and coal projects since the adoption of the Paris Agreement in 2016.[19] A fraction of these funds, according to some critics, could have gone to financing renewables.

5. Methane leaks, flaring and venting

Scientists and policymakers are increasingly recognizing the problems of methane leaks, flaring, and venting, which can undermine the environmental case for switching to natural gas. Methane, the major component of natural gas, has a greater warming effect than carbon dioxide (CO_2), although it releases lower volumes of emissions which break down in the atmosphere sooner. Depending on the timescale of the assessment, methane's warming potential can be up to 90 times stronger than that of CO_2. After agriculture, the energy industry is the second largest contributor to the release of methane into the atmosphere, accounting for around 40% of total methane emissions globally.[20] Of the 135 million tonnes of methane emissions produced by the energy sector, around a third is coming from extracting, processing, and transporting natural gas.[21] Furthermore, some recent studies suggest that the environmental impact of methane emissions could be much worse than previously considered.[22] The problem seems to be especially acute given the current tightness of energy markets and high prices for natural gas. If captured and marketed, methane leaks in 2021 could have provided an additional 180 billion cubic meters (bcm) of gas for consumption, which is equivalent to Europe's current power sector demand.[23] Such volumes could have helped to address today's energy crisis on the continent.

The criticism of the gas industry has been also on the rise due to its highly visible gas flaring activity as well as gas venting. Gas flaring is the burning of natural gas associated with oil extraction. If the gas extracted during the production of crude oil cannot be consumed or marketed, either because of poor planning, a lack of infrastructure, incentives, or appropriate regulations, then

19 Oil Change International (2022). New Report: At least $132 billion in finance for fossil fuels is locking Africa out of a Just Transition. 3 March. Available: https://priceofoil.org/2022/03/03/new-report-at-least-132-billion-in-finance-for-fossil-fuels-is-locking-africa-out-of-a-just-transition/

20 International Energy Agency (2022). Global Methane Tracker 2022. September. Available: https://www.iea.org/reports/global-methane-tracker-2022/overview

21 Ibid.

22 Ivanova, I. (2021). Methane emissions from oil and gas may be even worse than previously thought. *MoneyWatch*, 18 August. Available: https://www.cbsnews.com/news/methane-emissions-oil-gas-geofinancial-analytics/

23 International Energy Agency (2022). Global Methane Tracker 2022. September. Available: https://www.iea.org/reports/global-methane-tracker-2022/overview

this gas – known as "associated gas" – can end up being flared or (even worse from an environmental perspective) vented into the atmosphere. A recent IEA analysis suggests that 25% of associated gas produced globally is wasted, totalling 205 bcm in 2019. Of that volume, around 150 bcm was flared and the remaining 55 bcm was released as methane into the atmosphere. Besides being a problem of significant economic waste, studies increasingly suggest that the environmental impact of gas flaring is probably worse than commonly thought as a result of incomplete combustion. According to the IEA, the 150 bcm of flared gas in 2019 contributed to around 300 million tonnes of CO_2 ($MtCO_2$), roughly the same as annual emissions of Italy.[24]

6. Green gas: biomethane and hydrogen

While natural gas has low air pollutant emissions in comparison with coal and crude oil, switching between the unabated combustion of fossil fuels, on its own, is not going to help with deep decarbonization and reaching the Paris Agreement goals. The future of natural gas depends on its ability to evolve into a cleaner/greener gas, a low-carbon substitute for conventional methane. Currently, there are several ways to decarbonize gas consumption, including biomethane made of waste products and agricultural residues, green hydrogen generated by renewables, and blue hydrogen produced with natural gas and supported by carbon capture, utilization, and storage (CCUS). Each of the methods can help to preserve the role of natural gas in the global energy industry. With the production of blue hydrogen, the natural gas industry could even expand into new hard-to-abate sectors like aviation or trucking.

Biomethane, also known as renewable natural gas or green gas, is a naturally occurring gas produced by the anaerobic digestion of organic matter, such as landfill gas, animal manure, and other agricultural waste products, in an oxygen-free environment. It can be derived either by upgrading biogas in a process that eliminates carbon dioxide and other contaminants in the biogas or through the gasification of solid biomass followed by methanation.[25] The chemical content of biomethane is identical to natural gas. Unlike gas, however, biomethane is defined as a green source of energy due to its negligible carbon footprint. Given the similar chemical content, methane can be supplied to stored and supplied to consumers using the existing natural gas infrastructure. Similarly to natural

24 International Energy Agency (2022). Global Methane Tracker 2022. September. Available: https://www.iea.org/reports/global-methane-tracker-2022/overview

25 International Energy Agency (2022). Outlook for biogas and biomethane: Prospects for organic growth. Available: https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth/an-introduction-to-biogas-and-biomethane

gas, biomethane can be used in power generation, industrial processes, cooking, heating, and transportation in the form of bio-CNG (compressed natural gas) and bio-LNG (liquified natural gas). Currently, biomethane represents only about 0.1% of natural gas demand, as green gas has been limited due to land and feedstock availability issues as well as underdeveloped regulatory framework and financial constraints.[26] However, the important role of biomethane in deep decarbonization is increasingly acknowledged globally. According to the World Biogas Association, the use of biogas and biomethane can help to achieve climate neutrality by 2050, as well as to decrease greenhouse gas emissions by 10–13%.[27]

Hydrogen is the simplest and most abundant element on earth, which can store and deliver energy. The current demand for hydrogen is based on several important characteristics: it is light, storable, reactive, and has high energy content per unit mass. Not occurring naturally, it must be derived from compounds that contain it. Around 95% of all hydrogen today is produced from fossil fuels. However, with technological improvements and reductions in costs, hydrogen will be increasingly produced from renewables or natural gas with CCUS. Low-carbon hydrogen options – whether from green hydrogen produced by renewables or blue hydrogen derived with the help of natural gas and supported by CCUS – have a great potential to decarbonize the gas supply chain via hydrogen blending in existing natural gas uses. Moreover, hydrogen can help to decarbonize traditionally hard-to-abate industries like shipping, steel production, and even transport.

While green or blue hydrogen might bring significant economic and environmental benefits, there are still many unknowns about the potential integration of hydrogen into the global economy. New studies suggest that the environmental impacts from hydrogen technologies – even their greenest forms – could be substantially underestimated.[28] Hydrogen's supply chain can be more susceptible to leakage than methane. Although less harmful than methane, hydrogen is an indirect greenhouse gas having a 6 times stronger climate impact than carbon dioxide.[29] Finally, hydrogen's lower density complicates its blending

26 International Energy Agency (2022). Outlook for biogas and biomethane: Prospects for organic growth. Available: https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth/an-introduction-to-biogas-and-biomethane

27 European Biogas Association (2020). The contribution of the biogas and biomethane industries to medium-term greenhouse gas reduction targets and climate neutrality by 2050. Background Paper. April. Available: https://www.europeanbiogas.eu/wp-content/uploads/2020/04/20200419-Background-paper_final.pdf

28 Ocko, I. B., Hamburg, S. P. (2022). Climate consequences of hydrogen emissions. *Atmospheric Chemistry and Physics Magazine*, 20 July. https://doi.org/10.5194/acp-22-9349-2022

29 Derwent, R., Simmonds, P., O'Doherty, S., Manning, A., Collins, W., Stevenson, D. (2006). Global environmental impacts of the hydrogen economy. *International Journal of Nuclear Hydrogen Production and Applications*, 22 May. DOI:10.1504/IJNHPA.2006.009869Corpus ID: 97001798

with the gas stream and necessitates additional costs and equipment upgrades along the natural gas value chain.

7. Natural gas in the industry

Industry uses natural gas as a fuel for process heating, in combined heat and power systems, as a feedstock to produce chemicals, fertilizer, and hydrogen, and as lease and plant fuel. According to the IEA, the industrial use of gas will be a major source of anticipated growth in gas demand globally.[30] Even in a low-carbon future, gas consumption in petrochemicals is expected to grow, with the fuel continuing to be a key component in producing everyday products such as plastics and fertilizers. Switching from coal to gas in light industries, including textiles, such as food and textiles, may bring significant environmental benefits. Natural gas also has a stronger competitive advantage in industrial processes, where it can displace more expensive oil products.

Replacing natural gas will be especially challenging in heavy industry, which is operating under extremely high temperatures to produce iron, steel, or cement. Indeed, as a study on low-carbon heat options for industry suggests, "unlike the power sector and light-duty vehicles, the operational requirements of temperature, quality, flux, and high-capacity place stringent constraints on viable options."[31] Eventually, the industrial use of natural gas should rely on a mix of CCUS, hydrogen, and bioenergy, which would allow using the fuel without emitting greenhouse gases into the atmosphere.

8. Natural gas in buildings

Currently, the building sector uses natural gas mostly for space heating. The market, however, remains quite concentrated geographically. Nearly three-fourths of the gas used in the building sector comes from 10 countries, with four of them accounting for half of the total: the United States, Russia, China, and

30 International Energy Agency (2019). The Role of Gas in Today's Energy Transitions. Available: https://iea.blob.core.windows.net/assets/cc35f20f-7a94-44dc-a750-41c117517e93/TheRoleofGas.pdf

31 Friedmann, J. Fan, A., Tang, K. (2019). Low-Carbon Heat Solutions for Heavy Industry: Sources, Options, and Costs Today. Center for Global Energy Policy, 7 October. Available: https://www.energypolicy.columbia.edu/research/report/low-carbon-heat-solutions-heavy-industry-sources-options-and-costs-today

Iran.[32] Many of the countries using gas in buildings have significant indigenous resource bases allowing to support the role of natural gas in the sector. However, the prospects of expanding natural gas use in space heating are limited and are increasingly challenged by alternative sources. The main competitors of gas in buildings will be coming from an increase in electrification with clean energy sources, the direct use of renewables, heat pumps, and energy efficiency gains. Biomethane, or renewable gas, and hydrogen can also compete with gas for a market share in buildings in the mid and long-term perspective when technological improvements will help to reduce costs.

Competition for the building sector is increasingly fierce, as the sector is expected to experience the most significant carbon dioxide emissions reductions in the Faster Transition Scenario by the IEA. Energy efficiency gains will contribute to global average energy savings of 500 million tonnes of oil equivalent (Mtoe) annually in buildings between 2020 and 2050.[33] High-performance building construction and energy renovations will decrease energy consumption in buildings by around 30% by 2050, even as floor area doubles globally. The share of electricity in energy use in buildings will increase from 33% in 2017 to around 55% in 2050, thus further squeezing the share of natural gas in the sector. In addition, energy efficiency gains will decrease electricity demand in buildings by around 300 million tonnes of oil equivalent (Mtoe) lower in 2050, which also implies a reduction in demand for gas. Substantial improvements in air conditioner performance will further reduce energy demand, as 1.5 billion households are expected to get access to cooling comfort. Finally, heat pumps will help to save four times more energy for heating, while solar thermal will provide carbon-free heat to nearly 3 billion people in buildings by 2050. In total, multiple cost-effective and green technologies along with electrification and energy efficiency gains will lead to lower demand for natural gas in buildings.

The future of gas in new buildings is indeed challenging. Currently, energy demand is shifting towards Asia and Africa, where electrification will lead the building sector. Furthermore, there are not many countries developing new gas networks, let alone starting new gasification programs. There are few countries that have managed to incorporate gas into buildings for the past two decades, thus suggesting a limited growth trajectory of gas in the future. Therefore, while natural gas can increase its share in some markets, it will not be able to expand in buildings

32 Tsafos, N. (2020). How Will Natural Gas Fare in the Energy Transition? Center for Strategic and International Studies, 14 January. Available: https://www.csis.org/analysis/how-will-natural-gas-fare-energy-transition

33 International Energy Agency (2019). The Critical Role of Buildings: Perspectives for the Clean Energy Transition. April. Available: https://www.iea.org/reports/the-critical-role-of-buildings

dramatically. Nonetheless, natural gas will likely preserve its market share against an increasingly challenging array of alternatives.

9. Natural gas in transportation

The use of natural gas in the transportation sector accounts for just 1.4% of its global consumption.[34] Almost all of it is used in road transport thanks to the development of compressed natural gas (CNG) vehicles for passenger cars or short-haul trucks or liquefied natural gas (LNG) for commercial trucks, collectively known as natural gas vehicles (NGVs). NGVs can play an important role in the global energy transition as they emit substantially less greenhouse gas emissions compared to traditional gasoline and diesel vehicles, dominating the global vehicle market today. According to a report by the Organization for Economic Cooperation and Development (OECD), NGVs emit on average 80% fewer ozone-forming emissions – i.e. carbon dioxide (CO_2) and nitrogen oxide (NOx) – than petrol-powered vehicles.[35]

Currently, around 2 million NGVs are sold annually. As of the beginning of 2020, 28.5 million NGVs were on the roads globally, with more than 70% of them concentrated in Asia Pacific.[36] Three countries – China, India, and Iran – accounted for the bulk of the growth in gas used for road transport. Expensive fuel storage tanks used for CNG vehicles have been a key barrier to the wide deployment of CNG as a fuel. The shortage of fuelling infrastructure also impedes the development of CNG and LNG-fuelled vehicles globally. In addition, the current energy crisis and high prices for natural gas have dramatically lowered the price competitiveness of the vehicles running on CNG and LNG compared to gasoline and diesel-powered vehicles, while lower gas prices along with the environmental benefits have always been regarded as the main advantage of NGVs.

Hydrogen fuel cell electric vehicles (FCEVs), such as light- and heavy-duty vehicles, trains, ships, planes, and drones, are expected to play an increased role in the transportation sector soon. Next to FCEVs, hydrogen or ammonia can be mixed in diesel engine fuels and gas turbines for planes, as a transition step to fuel cells. Another important aspect is hydrogen transport, which can be done in

34 Tsafos, N. (2020). How Will Natural Gas Fare in the Energy Transition? Center for Strategic and International Studies, 14 January. Available: https://www.csis.org/analysis/how-will-natural-gas-fare-energy-transition

35 Organisation for Economic Cooperation and Development (2019). Annex A. Overview of clean technologies and fuels in the transport sector. https://www.oecd-ilibrary.org/sites/baf3778b-en/index.html?itemId=/content/component/baf3778b-en

36 Gas Exporting Countries Forum (2021). GECF's Annual Short Term Gas Market Report. Available: https://www.gecf.org/_resources/files/pages/gecf-annual-short-term-gas-market-report/gecf-annual-short-term-gas-market-report-2021.pdf

different forms, such as liquid, compressed gas, or liquid organic hydrogen carriers (LOHCs) like ammonia.

Blue or green hydrogen can also play an important role in the transportation sector. Hydrogen fuel cell electric vehicles (FCEVs), such as light- and heavy-duty vehicles, trains, ships, planes, and drones, are expected to play an increased role in the transportation sector in the upcoming years. Hydrogen's contribution can be especially strong in hard-to-abate heavy-duty transport – trucking, shipping, and aviation. Along with the industrial production of steel, cement, and plastics, heavy-duty transport account today for 40% of carbon emissions from energy systems today and is expected to increase further in the future.

The major challenge for the expansion of natural gas vehicles is stemming from the electrification of the transportation sector. The sales of electric vehicles (EVs) have been on the rise as the world is looking at them to replace traditional gasoline and diesel vehicles to slow climate change. Global EV sales doubled year over year in 2021 to 6.6 million, from 3.2 million in 2020.[37] EV sales accounted for almost 10% of global car sales in 2021, four times the market share in 2019.[38] There are 16.5 million EVs on the road worldwide in 2021, triple the amount in 2018, according to the Global EV Outlook 2022 by the IEA.[39] Given the current growth trajectory of EVs, their market share will continue growing and suppress NGVs sales, which otherwise would replace internal combustion engine vehicles. On the other hand, the increasing electricity consumption to charge EVs could also be met with gas-fired power plants, thus potentially contributing to some increase in natural gas demand globally.

Conclusion

The global energy transition should be based on finding a balance between the achievement of climate goals, economic growth, and energy security. Natural gas can play an important role in shaping such a balance. First, it can be a key tool in fighting energy poverty by providing relatively clean and affordable access to electricity, cooking, and heating. Switching from solid fuels such as wood charcoal biomass and kerosene to gas for cooking and heating homes – piped gas in urban areas or, more commonly, liquefied petroleum gas (LPG) delivered

37 Rives, K. (2022). Global electric vehicle sales doubled; US made EV comeback in 2021. SP Global, 24 May. Available: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/global-electric-vehicle-sales-doubled-us-made-ev-comeback-in-2021-70489884#:~:text=Worldwide%20EV%20sales%20doubled%20year,2.3%20million%20EVs%20were%20sold.

38 Ibid.

39 International Energy Agency (2022). Global EV Outlook 2022. May Available: https://www.iea.org/reports/global-ev-outlook-2022

in cylinders – has considerably helped to lessen indoor air pollution in many countries. Second, natural gas can help to reduce emissions when it replaces coal and diesel, especially in electricity generation. Third, gas-fired power plants can also be a reliable partner for intermittent solar and wind energy sources by quickly compensating for their volatility and responding to sudden increases in demand. While several options exist for addressing the intermittency and dispatchability problems of wind and solar, none of them are commercially feasible and available at the required scale to meet the huge flexibility requirements. Finally, gas can play a major role in the sectors which are hard to electrify, including industrial processes and freight transport.

To be able to compete in the long run, however, natural gas should be able to decarbonize and evolve into a greener gas. Currently, there are several ways to decarbonize natural gas, including biomethane made of waste products and agricultural residues, green hydrogen generated by renewables, and blue hydrogen produced with natural gas and supported by carbon capture, utilization, and storage (CCUS). Each of the methods can help to preserve the role of natural gas in the global energy industry. In addition, methane leaks, flaring, and venting issues, currently undermining the environmental case for natural gas, should be addressed. With the production of blue hydrogen, the natural gas industry could even expand into new hard-to-abate sectors like aviation or trucking. If the industry manages to bring down the costs of CCUS and scale up its application amid the utilization of hydrogen as feedstock to reduce the environmental impact in industrial processes, the role of natural gas in the 2050 global energy mix could be quite robust.