CAN International Position: Fossil Gas

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Climate Action Network (CAN) is the world's largest network of civil society organizations working together to promote government action to address the climate crisis, with more than 1500 members in over 130 countries.
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This CAN position paper primarily addresses fossil gas extraction and the phase-out of fossil gas in the electricity sector, where almost half of all fossil gas is used. Alongside scaled-up energy efficiency, increased electrification and, therefore a growing power sector with clean renewables, will be necessary to decarbonize other energy-consuming and fuel-based sectors such as heating in buildings, industry and transport. Hence, phasing-out gas in the power sector now and in future is crucial to meeting the Paris climate objectives[i].

Position Summary

CAN affirms that managing the rapid transition away from fossil fuels to 100% renewable energy and combined with strong energy efficiency no later than 2050 is the most crucial element of achieving the Paris climate goals. This means phasing out all fossil fuels including fossil gas[1]. The role of fossil gas in the transition to 100% renewable energy is limited and does not justify an increase in fossil gas production nor consumption, nor investment in new fossil gas infrastructure. We need a managed phase-out of fossil gas in line with Paris climate goals[2]. CAN opposes CCS in the power sector[3]. Therefore, fossil gas is not a "bridge" fuel.

CAN affirms that fossil gas is not a "low carbon" energy source, but in fact "high carbon" when compared to renewable energy sources like wind, solar and geothermal. And even "very" high carbon when accounting for fugitive methane emissions in its production, which are an often-under-apprehended additional climate impact.

CAN acknowledges that fossil gas production and infrastructure expansion often come at the cost of people's and peoples' rights, and at the expense of biodiversity. Gas production and infrastructure expansion has impacts beyond the climate crisis. The connections between fossil gas production and human rights and Indigenous Peoples rights violations have been well documented. This is especially true with respect to fossil gas megaprojects in some developing states.

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[1] We use the term fossil gas to mean gas produced from fossil fuel sources, instead of using the term 'natural gas'.
[2] CAN, 2018,http://www.climatenetwork.org/sites/default/files/can_position_fossil_fuel_supply_restriction_september_2018.pdf.
[3] CAN, 2021, can_position_carbon_capture_storage_and_utilisation_january_2021.pdf (climatenetwork.org).

CAN confirms that new fossil gas development is incompatible with limiting global warming to 1.5°C: Even if global coal use were phased out immediately, oil and gas reserves in currently-operating and under-construction projects would push the world beyond 1.5°C. There is no room in our global carbon budget to lock in new gas production, nor the infrastructure that enables or stimulates it.

CAN urges that replacing coal with gas cannot cut emissions fast enough or far enough. Even if methane leakage is minimized, the production, processing and combustion of gas emits large amounts of carbon dioxide (CO_2). Replacing one fossil fuel with another cannot reduce emissions at the scale and pace that is required.

CAN recognizes that energy efficiency and low-cost wind and solar can displace both coal and gas in the power sector. Wind and solar now outcompetes gas and coal in most markets for bulk electricity production and is generally the most appropriate means to achieve SDG7's goal of universal access to clean energy, especially where grid infrastructure is not present[4]. Cost is not a prohibitive factor in immediately building out an energy system based on renewable energy.

CAN affirms that gas is not essential for grid reliability and stable load management: Wind and solar require load balancing, but gas is not the only, nor the best resource available for doing so. Managing high levels of wind and solar (both on the local low-voltage distribution as well as the larger high-voltage transmission grid) requires optimizing a wide range of technologies and solutions, and designing energy markets to value and support efficiency and flexible generation, including storage and demand response. The application by grid operators of these technologies have been shown to work in several countries with high wind and solar shares in the power sector, and with low occurrence of black-outs, as well as in the Corona pandemic with highly fluctuating customer demand[5,6].

CAN recognizes that the decarbonization of present non-power sectors like transport requires the full decarbonization of power generation and the electrification of non-power sectors alongside aggressive efficiency improvements. While some non-power sectors, such as certain industrial processes and products or shipping and aviation, are more difficult to decarbonize, this does not provide any justification for decade-long fossil gas continuation or expansion. If fossil gas is phased out in the power sector, and electrification and efficiency are maximised in other sectors, global gas use can only go in one direction: down.

CAN affirms that the development of renewable non-hydrogen gases must be based on sustainable sources, keep methane leaks minimised, and not be dependent on carbon capture and storage (CCS). Hydrogen must be produced with renewable energy to be clean. Gas derived from plant sources may be sustainable in some circumstances, but there are significant problems that must be addressed around this and other forms of bioenergy – including but not limited to issues around food security, biodiversity, and land rights, as well as the direct emissions of burning any such gas.

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4 IRENA, 2020, Renewable Power Generation Costs in 2019 (irena.org).

5 IEA, 2020, Renewables – Global Energy Review 2020 – Analysis - IEA.

6 REN21, 2020, gsr_2020_key_findings_en.pdf (ren21.net).

CAN opposes CCS in the fossil gas sector. We can and must move forward quickly with decarbonization without relying on technologies that are costly and unproven at scale. CCS might have limited use in difficult-to-decarbonize sectors at some point in time in the future once all other decarbonisation options are exhausted, but not in the power sector. It is an unacceptable risk to expand fossil gas production while the practicality and affordability of CCS, as well as the geological permanence of stored CO_2, remain highly uncertain, particularly in the full absence of any liability legislation and independent long-term scientific monitoring.[7]

CAN opposes new gas infrastructure projects that lock in additional carbon emissions. Multibillion-dollar gas infrastructure built today is designed to operate for decades to come. The new Gazprom Nordstream 2 pipeline[8] from Russia to Germany alone with about 55bcm fossil gas will lead to, including fugitive methane[9], about 5% of entire EU CO_2 emissions for many decades. Therefore, it is important to stop building new fossil fuel infrastructure and instead focus on a fossil fuel phase out. The world's existing stock of such infrastructure already locks in enough emissions to push the world above 1.5ºC.[10] The lifetime emissions of new infrastructure cannot be absorbed into a 1.5ºC carbon budget. However, it will be necessary to continue maintenance of existing fossil gas infrastructure as part of a managed phase-out, to address methane leakage and other problems.

CAN opposes international public finance for gas projects. Distributed renewables are a more affordable and cleaner means of providing access to electricity. Very few local jobs are created by fossil gas projects. Governments should not support international fossil gas projects through export credit agencies, development finance agencies or financing provided through Multilateral agreements.

CAN urges that, on the basis of climate justice and capacity to transition, wealthy countries must help poorer countries leapfrog the fossil fuel economy, including fossil gas, by providing adequate climate financing, capacity-building, and technology transfer. Meeting the urgent needs for overcoming energy poverty, clean cooking solutions and affordable and universal access to electricity does not require any expansion in fossil gas production. However, there are still some circumstances where it may be necessary for people in developing countries who face energy poverty and indoor pollution causing high death rates based on traditional but inefficient biomass-based cooking to transition to gas cooking. Even high shares of Liquefied Petroleum Gas (LPG) use in this context would increase global CO_2 emissions negligibly, by far less than 1 percent.[11] There are many other pockets of high CO_2 emissions in wealthier economies that need to be tackled first and cannot be "traded" against immediate human rights

[7] This is set out in detail in CAN's position paper on CCS: https://climatenetwork.org/wp-content/uploads/2021/01/can_position_carbon_capture_storage_and_utilisation_january_2021.pdf.

[8] Gazprom, 2021, Nord Stream 2 (nord-stream2.com).

[9] Reuters, 2020, https://www.reuters.com/article/us-climatechange-methane-satellites-insi-idUSKBN23W3K4.

[10] Dan Tong et al., "Committed emissions from existing energy infrastructure jeopardize 1.5 °C climate target," *Nature* 572, July 2019, 373-377, https://doi.org/10.1038/s41586-019-1364-3.

[11] A 2019 report tracking progress towards ensuring access to affordable and clean energy (Sustainable Development Goal 7), finds that expanded use of LPG to provide 100% access to clean cooking globally by 2030 would account for up to 0.8% of global oil demand in 2030, under a least-cost scenario. *Tracking SDG7: The Energy Progress Report 2019*, The World Bank, the International Energy Agency, the International Renewable Energy Agency, the United Nations Statistics Division and the World Health Organization, 2019, p. 114, 2019THE ENERGY PROGRESS REPORT.

needs for basic safe energy for the super-poor in developing countries. In line with equity and a fair share of carbon pollution, wealthier countries need to phase-out fossil gas earlier than developing ones.

CAN urges that all governments and all companies should conduct a carefully managed phase-out of the fossil fuel industry and ensure a just transition for the workers and communities that depend on it. As such, governments should avoid undue influence from fossil gas industries when creating policies for a green and just transition. Political interference from vested interests prevents measures from being taken to solve the climate crisis and can misinform and redirect policies toward solutions that don't align with science and which undermine ambition.

CAN demands that the plastic crisis is addressed by a continuous reduction and eventual phase out in plastics use and maximization of plastic recycling and reuse, as well as alternative decomposable products. Therefore, the use of the liquid byproducts of gas production for producing plastics feedstocks must be reduced. Demand for plastics is not a reason to maintain gas production.

Background

As the global climate crisis intensifies while the production and consumption of fossil gas soars, it is clearer than ever that fossil gas is not the climate solution that some proponents claim. Global fossil gas production has grown 64% since 2000[12]. The United States has led this growth with the development of hydraulic fracturing (fracking) and horizontal drilling enabling access to hitherto inaccessible shale and tight gas sources. U.S. gas production has grown 70% since 2000[13]. The U.S. in 2019 was producing more than one quarter of all fossil gas worldwide. Unconventional and dirty shale gas was three quarters of all U.S. production[14].

The trend is intensifying. 2018 was a record year for global gas consumption growth. The International Energy Agency (IEA) reported that consumption grew 4.6% in 2018[15]. Gas accounted for 45% of the rise in global primary energy demand in 2018[16]. Presently fossil gas provides almost one quarter of all global primary energy demand and is projected to grow further in most conventional energy scenarios[17].

This aggressive rise in gas consumption has clearly not led to a reduction in emissions. Energy-related CO_2 emissions hit a record in 2018, growing 1.7% to reach almost 33.3 billion tons (Gt) and the same amount in 2019[18].

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[12] Production data from Rystad Energy UCube (August 2019). Global gas production in 2000 was 2,495 billion cubic meters (cm). Estimated 2019 production is 4,092 billion cm.
[13] Production data from Rystad Energy UCube (August 2019). US gas production in 2000 was 542 billion cubic meters (cm). Estimated 2019 production is 919 billion cm.
[14] OECD/IEA 2020, World Energy Outlook 2020, pp 336-337.
[15] OECD/IEA 2019 (1). 'Gas 2019: Analysis and Forecast to 2024. Gas Market Report 2019.'
[16] OECD/IEA 2019 (1).
[17] OECD/IEA 2018 World Energy Outlook 2018.
[18] OECD/IEA 2020, World Energy Outlook 2020, p 344.

Fossil gas CO_2 emissions have grown worldwide by 20% since 2010 to almost 7.3 Gt CO_2 in 2019 and therefore represent about 22% of all global fossil fuel CO_2 emissions[19]. These numbers do not include the large and powerful methane emissions embedded in the entire fossil gas production and transmission supply chain.

The IEA's central energy projection scenario, the New Policies Scenario (NPS), projects a 43% increase in global gas demand from 2017 to 2040. This stands in stark contrast to the trajectory of gas demand in credible pathways to a 1.5ºC limit on global warming (see Figure 2).

These trends signal a need to take a hard look at whether claims that gas can act as a "bridge" or "transition" fuel stand up to scrutiny. It is now clearer than ever that the core concepts used to bolster this idea are false. Gas is neither clean, nor cheap, nor necessary. While fossil gas may still play some role in the next decades, this role is a permanently declining one towards 'zero' and hence this is neither a transition nor a bridge fuel.

Gas Is Not a "Bridge Fuel"

The fallacy around gas being a "cleaner" fossil fuel that can support the transition to clean energy goes back many decades. While burning gas emits less of the pollutants that are hazardous to human health, as well as carbon dioxide, compared to oil and coal, its full emissions profile is far from clean. Even assuming it is possible to eliminate the majority of upstream and midstream emissions associated with fossil gas, climate science and well-established trends in energy technology and policy make it clear that there must be a rapidly diminishing role for fossil gas in our energy future.

Gas Is Not Clean

Methane is the primary component of fossil gas, as well as gas derived from biological sources (e.g., biogas and biomethane). Methane is a super-potent greenhouse gas with a high specific Global Warming Potential. If elevated levels of methane are leaked in the process of producing and delivering gas to consumers, then any emissions advantage gas has over coal or oil is reduced or negated.

In order to compare the global warming impact (also known as radiative forcing) of methane with CO_2, which is the most abundant greenhouse gas, scientists use a Global Warming Potential (GWP) factor. The Intergovernmental Panel on Climate Change (IPCC) states that over a 20-year period, the GWP for methane is 87, meaning the warming impact of a given volume of methane over 20 years is 87 times greater than the same volume of CO_2[20]. Over a 100-year period the GWP is 36. But ongoing research on methane's radiative forcing has recently indicated that it is

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[19] As footnote 17.

[20] Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: 'Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change' [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. (Note that we include the factors for climate carbon feedbacks and oxidation.)

likely underestimated by the IPCC. A recent peer-reviewed paper indicated that the radiative forcing of methane may be at least 14% higher than the IPCC estimate over the 100-year period[21].

The amount of methane leaked in the process of producing, processing and delivering gas is also a source of ongoing study. The IEA recently estimated that the oil and gas supply chain emitted 79 million metric tons of methane in 2018[22]. This may be a very conservative figure. The IEA's estimates are based on flawed U.S. EPA data that has been widely criticised for underestimating methane leakage[23,24]. Whatever the actual rate of methane leakage, which in all likelihood is in constant flux, it is clear that leaking methane from the global oil and gas industry, in particular from shale gas, is a major source of climate and air pollution[25,26].

With methane levels in the atmosphere rising even faster than CO_2 and climate impacts accelerating,[27] there is no doubt about the importance of reducing methane leakage from existing oil and gas operations and distribution networks. But methane leakage is not the sole determinant of whether gas causes net harm to the climate.

New Gas Breaks the Carbon Budget

An analysis of global carbon budgets shows that the economically recoverable oil, gas, and coal in the world's currently producing and under-construction extraction projects would take the world far beyond safe climate limits[28]. Further development of untapped gas reserves, including new shale wells, is inconsistent with the climate goals in the Paris Agreement. Even if global coal use were phased out immediately, already-developed reserves of oil and gas would push the world above 1.5°C of warming[29]. There is simply no room for more gas.

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[21] Etminan, M., Myhre, G., Highwood, E. J., and Shine, K. P. (2016), Radiative forcing of carbon dioxide, methane, and nitrous oxide: A significant revision of the methane radiative forcing, Geophys. Res. Lett., 43, 12,614– 12,623, doi:10.1002/2016GL071930.

[22] OECD/IEA Methane Tracker Database. https://www.iea.org/weo/methane/database/

[23] Lorne Stockman, 'The IEA's Misplaced Techno-optimism.' Oil Change International. August 12, 2019. http://priceofoil.org/2019/08/12/the-ieas-misplaced-techno-optimism/

[24] Giorgia Guglielmi, 'Methane leaks from US gas fields dwarf government estimates' International Journal of Science, Nature. June 21, 2018. https://www.nature.com/articles/d41586-018-05517-y

[25] Robert W. Howarth. 'Ideas and perspectives: is shale gas a major driver of recent increase in global atmospheric methane?' August 14, 2019. Biogeosciences, 16, 3033–3046, 2019 https://doi.org/10.5194/bg-16-3033-2019

[26] Carol Rasmussen, 'NASA-led study solves a methane puzzle'. NASA Global Climate Change. Jan. 2, 2018. https://climate.nasa.gov/news/2668/nasa-led-study-solves-amethane-puzzle

[27] Citation: Nisbet, E. G., Manning, M. R., Dlugokencky, E. J., Fisher, R. E., Lowry, D., Michel, S. E., et al. (2019). Very strong atmospheric methane growth in the 4 years 2014–2017: Implications for the Paris Agreement. Global Biogeochemical Cycles, 33, 318–342. https://doi.org/10.1029/2018GB006009

[28] Greg Muttitt, The Sky's Limit: Why the Paris climate goals require a managed decline of fossil fuel production, Oil Change International, September 2016. http://priceofoil.org/2016/09/22/the-skys-limitreport/

[29] This accounts for optimistic estimates of future CO_2 emissions from cement manufacture, a major source of non-energy emissions.

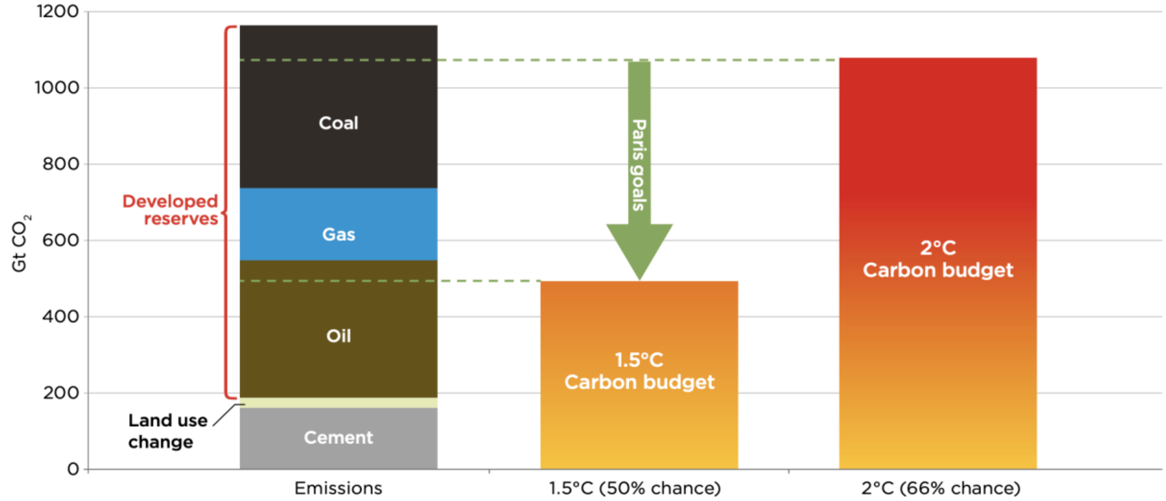

Figure 1: CO_2 From Developed Fossil Fuel Reserves, Compared to Carbon Budgets within Range of Paris Goals.

Sources: Oil Change International analysis based on data from Rystad Energy, IEA, World Energy Council, IPCC and Global Carbon Project.2 Remaining carbon budgets shown are as of 1 January 2020.

Continued Gas Growth Is Not Aligned with Realistic 1.5°C Pathways

The IPCC's 2018 *Special Report on Global Warming of 1.5°C* made clear the critical importance of the 1.5°C threshold[30]. It also made it clear that credible pathways to limiting warming to 1.5°C cannot be achieved by growing gas consumption.

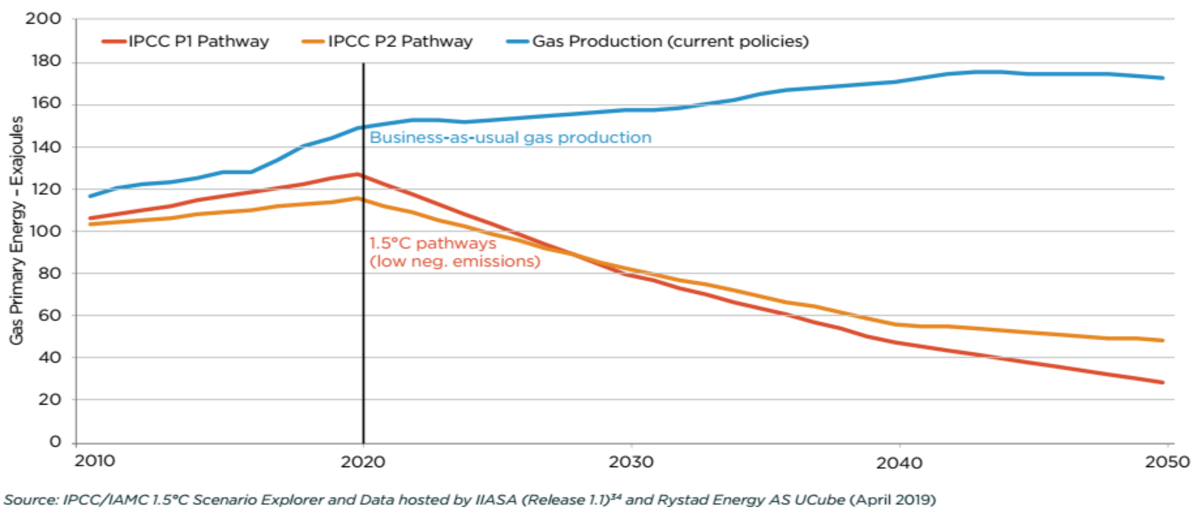

Figure 2: Global Gas Pathways: Business-as-usual extraction vs. demand aligned with 1.5°C

30 IPCC 2018. 'Special Report: Global Warming of 1.5°C' https://www.ipcc.ch/sr15/.

As Figure 2 clearly shows, current business-as-usual projections for gas production are in opposition to trajectories for gas consumption that align with the 1.5°C warming limit and do not rely on unrealistic levels of negative emissions technologies[31].

Coal-to-Gas Switching Doesn't Cut It

Climate goals require the energy sector to be largely decarbonized by mid-century.[32] The IPCC's report on pathways to 1.5°C states that, "[s]ince the electricity sector is completely decarbonized by mid-century in 1.5°C pathways, electrification is the primary means to decarbonize energy end-use sectors."[33] This illustrates the importance of completely decarbonizing the power sector as quickly as possible.

Analysis from Bloomberg New Energy Finance (BNEF) shows that replacing coal plants with new gas plants will not cut CO_2 emissions by nearly enough, even if methane leakage is kept to a minimum. BNEF ran a scenario in which coal is phased out of the power sector by 2035, and replaced with a combination of gas and renewables, based on current energy and climate policies[34]. As Figure 3 shows, emissions in 2050 in the coal phase-out scenario are lower than the business-as-usual (NEO 2019) scenario[35]. But with gas locked in as the primary replacement for phased-out coal, emissions remain substantially above the 1.5°C target.

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[31] The IPCC Special Report on Global Warming of 1.5°C warns that "[Carbon dioxide removal] deployed at scale is unproven, and reliance on such technology is a major risk in the ability to limit warming to 1.5°C" (96). The potentials of these technologies are highly uncertain and limited by sustainability constraints. For example, the other two illustrative pathways not shown in Figure 2, P3 and P4, could respectively require 25 to 46 percent and 47 to 86 percent of the world's arable and permanent cropland to accommodate their assumed levels of bioenergy with carbon capture and storage (Smith et al. 2015).

[32] IPCC 2018.

[33] J. Rogelj, D. Shindell, K. Jiang, S. Fifita, P. Forster, V. Ginzburg, C. Handa et al., "Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development," in Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty, eds. V. Masson-Delmotte,P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani et al. (in press), p. 137.

[34] Bloomberg New Energy Finance, New Energy Outlook 2019.

[35] Emissions are estimated only at the power plant chimney stack, so actual emissions are higher when accounting for methane leakage.

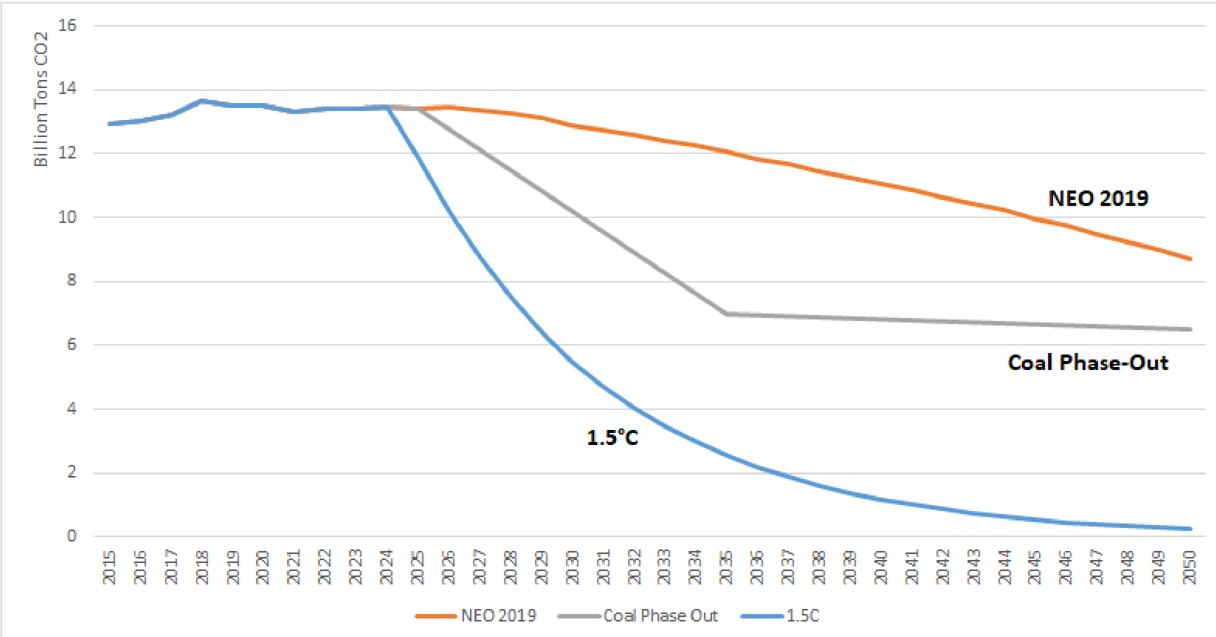

Figure 3: Global Power Sector Emissions in BNEF Scenarios
Source: Oil Change International based on BNEF NEO 2019

The IEA's 2019 special report on gas appears to agree with this and states that, "beating the most carbon-intensive fuel is not in itself a persuasive case for gas if there are lower emissions and lower-cost alternatives to both fuels."[36] The report goes on to warn that, "the increased combustion of natural gas does not provide a long-term pathway to global climate objectives, so policy makers need to be wary about locking in gas-related emissions even as they reduce emissions from coal."[37]

The IEA has also shown that renewables and efficiency play a far bigger role in reducing emissions than coal-to-gas switching. The report provided an analysis of emissions reductions compared to a baseline projection in 2010. It finds that 2018 emissions could have been 7 Gt higher in 2018 if it were not for, "changes in the global economic and energy system since 2010: these include reductions in the energy intensity of the world economy, in part due to greater efficiency, as well as reductions in the carbon intensity of the energy sector related to the rise of renewables and switching to less carbon-intensive fuels." The stated contribution of coal-to-gas switching in this 7 Gt saving is 500 million tons, or about seven percent.

While global CO_2 emissions grew 1.7% year-on-year in 2018, the IEA calculates that both renewables and energy efficiency are playing a far larger role than coal-to-gas switching in preventing even larger emissions increases. According to the IEA's *Global Energy and CO_2 Status Report 2018*, energy efficiency played the largest role in cutting emissions despite a slowdown in energy efficiency policy implementation. Renewables were listed as cutting 215 million tons compared to 95 million tons from coal-to-gas switching.[38]

[36] OECD/IEA 2019 (3) 'The Role of Gas in Today's Energy Transitions.' https://www.iea.org/publications/roleofgas/.
[37] OECD/IEA 2019 (3).
[38] OECD/IEA 2019 (2), pp. 8-9

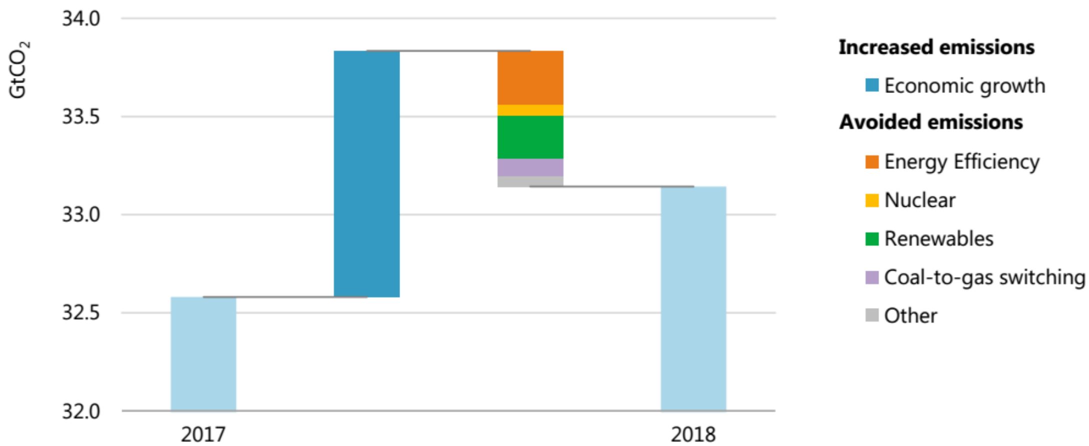

Figure 4: Change in Global Energy Related CO2 Emissions and Avoided Emissions, 2017-18
Source: OECD/IEA, Global Energy and CO_2 Status Report 2018

Gas Is Not Cheap

Low-Cost Renewables Can Displace Both Coal and Gas

The dramatic and ongoing cost declines for wind and solar disrupt the business model for gas in the power sector. Wind and solar are already cheaper to build and operate than coal and gas in most markets, and microgrids powered by renewables can reach many of the nearly 1 billion people, particularly in rural regions in developing countries without access to electricity more cheaply, as they do not require long-distance transmission infrastructure. As these technologies continue to gain from increasing economies of scale and implementation experience, the cost and performance of wind and solar power is only set to improve.[39] This means that renewable energy can and does replace coal as bulk generation while saving consumers money.

As Figure 5 shows, since 2009 the Levelized Cost of Energy (LCOE) for wind and solar have declined 69% and 88% respectively. This reflects the full unsubsidized averaged lifetime cost of financing, building and operating the technologies but does not include any externalities like air pollution, nuclear waste or climate damages. Given the low and still decreasing cost of large-scale wind and solar generation, it is clear that a system based on these clean technologies will reduce energy costs everywhere.

[39] BNEF, NEO 2019.

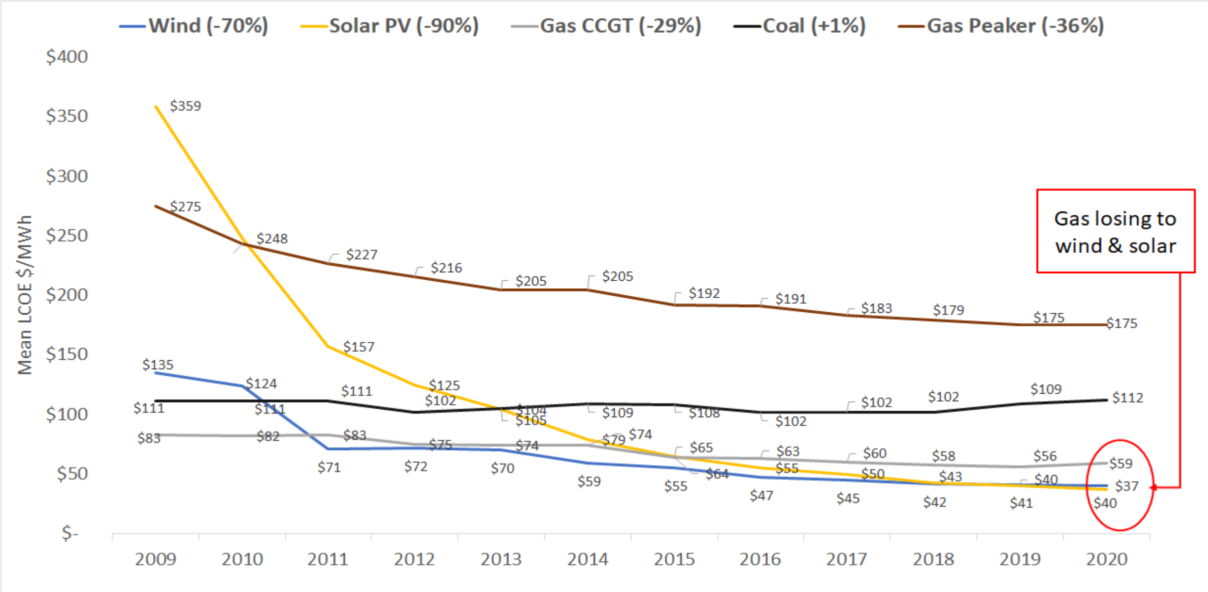

Figure 5: Wind and Solar Are Cheaper than Coal and Gas: Mean Global Levelized Cost of Energy for Select Technologies
Source: Oil Change International based on Lazard.[40]

Gas Is Not Necessary

As renewable energy costs have declined, eroding the economic case for new gas development, gas industry advocates have increasingly emphasized the variability of wind and solar as the reason to build more gas capacity. The sun does not always shine, and the wind does not always blow, and therefore – they argue – gas-fired generation is needed to balance supply and demand. But gas advocates are misleading the public on the role of gas in an electricity system dominated by renewable energy. The reality is that there are many choices for balancing wind and solar on the grid, and gas is losing ground to cheaper, cleaner, and more flexible alternatives.

The average global cost of a utility-scale four-hour battery storage system has declined 83% since 2012, and 55% since 2018. Further cost reductions of around 60% are projected by the 2040s.[41] Wind and solar plants that are coupled with storage are also becoming a competitive "dispatchable" source of energy, with faster response times than so-called gas peakers. But batteries certainly cannot do everything. Managing high levels of wind and solar on the grid requires optimizing a wide range of technologies and solutions, including storage technologies, demand response, and smart transmission. There is no reason to favor gas as a solution[42].

As studies have shown, portfolios of clean energy resources can replace dispatchable fossil fuels. Such portfolios will include the growth of variable renewables, management of flexible load, storage, transmission, low-voltage distribution grids and the gradual electrification of buildings

[40] Lorne Stockman, 'Burning the Gas "Bridge Fuel" Myth: Why Gas is not Clean, Cheap, or Necessary. Oil Change International, 2019. http://priceofoil.org/content/uploads/2019/05/gasBridgeMyth_web-FINAL.pdf Updated with data from Lazard's Levelized Cost of Energy - version 13.0 (Oct. 2020) https://www.lazard.com/media/451419/lazards-levelized-cost-of-energy-version-140.pdf
[41] BloombergNEF, 2H-2020 LCOE Update.
[42] Lorne Stockman, 'Burning the Gas "Bridge Fuel" Myth".

and transportation[43]. Modeling has shown that clean energy portfolios will produce a lower-cost energy system than the status quo gas-dependent system[44].

Carbon Capture & Storage Cannot Justify Growth

The potential of carbon capture and storage (CCS) technology remains highly uncertain and cannot justify continued growth in gas production and consumption.[45] Today's technology ideally captures between 80% and 90% of the CO_2 in the waste stream. Often it is much lower. Combined with the additional fuel needed to run carbon capture equipment, and the additional emissions from producing, processing and delivering gas, the net emissions reduction falls short of any decarbonization goal. In particular, and after two decades of fossil industry advocacy, there is not a single large gas or coal power plant anywhere in the world that commercially captures large parts of the emitted CO_2 reliably and cost-effectively, nor is there any internationally and scientifically agreed, continuously monitored safe carbon storage depository with legal liability requirements.[46]

It is also expensive. One recent study suggests that a CO_2 price of around $140 per tonne would be needed to make retrofitting gas-fired power plants with CCS economic.[47] Bloomberg New Energy Finance recently estimated that combined cycle gas turbine plants with CCS would have a LCOE of between $151 and $480 per MWh.[48] Compare this with the renewable energy LCOE costs in Figure 5 above.

In addition, in a future solar and wind dominated energy system, regularly ramping up and down conventional power plants like gas and coal according to the grid needs, will reduce the carbon capture effectiveness of CCS significantly[49].

[43] https://renewables-grid.eu/about.html.

[44] For an example of how a much more detailed power system model can be used to identify a range of cost-effective pathways for a state to decarbonize, see: Vibrant Clean Energy LLC, "Minnesota's Smarter Grid - Pathways Toward A Clean and Affordable Transportation and Energy System", July 2018, prepared by Vibrant Clean Energy,LLC, for McKnight Foundation and GridLab, available at: https://www.mcknight.org/wp-content/uploads/MNSmarterGrid-VCEFinalVersion-LR-1.pdf.
Also see: Dyson, Mark, Jamil Farbes, and Alexander Engel. "The Economics of Clean Energy Portfolios: How Renewable and Distributed Energy Resources Are Outcompeting and Can Strand Investment
in Natural Gas-Fired Generation." Rocky Mountain Institute, 2018. www.rmi.org/insights/reports/economics-clean-energyportfolios.

[45] The most optimistic scenario by the International Energy Agency – a strong advocate of CCS – projects 8.4 Gt CO2 captured by CCS in 2050. See: IEA, Energy Technology Perspectives 2017. For comparison, carbon dioxide emissions from fossil fuels and industry were 36 Gt in 2017, with gas accounting for 20 percent of that total. Currently, 30 MtCO2 is captured annually in all CCS projects globally, including only two full-scale power projects. The IPCC summarizes that, "The political, economic, social and technical feasibility of solar energy, wind energy and electricity storage technologies has improved dramatically over the past few years, while that of nuclear energy and carbon dioxide capture and storage (CCS) in the electricity sector have not shown similar improvements" (IPCC 2018, 4.3.1). If CCS and related infrastructure were deployed at a meaningful scale, the IPCC finds it could allow gas to provide about 8% of global electricity in 2050, compared to 23% in 2017 (IPCC 2018 C.2.2). The deployment of CCS would still align with an overall decline in gas in the global energy system.

[46] The Global CCS Institute: https://co2re.co/FacilityData.

[47] R.S.Elias, M.I.M.Wahab, L.Fang, 'Retrofitting carbon capture and storage to natural gas-fired power plants: A real-options approach'. Journal of Cleaner Production, Volume 192, 10 August 2018, Pages 722-734. https://doi.org/10.1016/j.jclepro.2018.05.019.

[48] BNEF, NEO 2019.

[49]https://www.researchgate.net/publication/273194020_Operating_Flexibility_of_Power_Plants_with_Carbon_Capture_and_Storage_CCS.

Renewable Gas

The development of renewable gas, for example, green hydrogen, bio-methane, or synthetic fuels produced with electricity, are not the subject of this position paper. Each technology has advantages and disadvantages in addressing hard-to-decarbonize sectors. At this early stage in the development of these technologies, it is difficult to judge the scale at which each will play a role.

However, there are clear principles which must be applied in order to ensure that these new technologies do not undermine the achievement of climate goals. It is also crucial that they do not exacerbate existing, or create new, inequalities, injustices or environmental impacts. Below is a list of guiding principles that must be considered in the development of renewable gases. This is not exhaustive. As we learn more about these and other potential zero carbon technologies, we may also learn more about their utility and impacts.

- Safety, sustainability, and equity must be the guiding principles of any renewable gas development.
- Hydrogen is only a solution if it is produced using 100% renewable energy.
- While hydrogen may be less dangerous than other flammable fuels, safety must be an absolute priority in the transport and storage of hydrogen, particularly where infrastructure is planned close to communities.
- Capturing methane from landfills and agricultural sources may be a sustainable solution for small-scale local use, but its potential to be scaled up is limited. Eventually, the production and combustion of all methane must be phased out.
- Utilising unavoidable household and municipal organic waste for both, composting and biogas production in the context of a circular economy contributes to decarbonisation.
- Manufacturing methane from dedicated biomass at commercial scale threatens food production and biodiversity due to massive land use requirements.
- Using CCS to sequester emissions from biomethane combustion is subject to the same issues discussed in the section above. Cost, efficacy, scale and safety are all restrictive factors that imply a very limited role for such technology.

The potential for hydrogen, or any other genuinely sustainable renewable gas, should not be used as a trojan horse for building out fossil gas infrastructure today. Clearly, decarbonization goals require an unprecedented expansion of renewable energy and massive improvements in energy efficiency, while the best technologies for hard-to-decarbonize sectors are developed in line with the principles outlined above.

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[i] *EDF does not support a categorical prohibition on the use of CCUS in the power sector or in the production of hydrogen, and does not categorically oppose the development of new natural gas infrastructure*