THE ROLE OF NATURAL GAS IN EUROPE TOWARDS 2050

BRIEF

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BRIEF

The role of natural gas in the global energy mix towards 2050 is robust, but crucially hinges on the successful implementation of carbon capture and storage (CCS) at large scale and use of H_2 as fuel and feedstock to reduce the carbon footprint in transport and industrial processes. Availability of natural gas globally is not a constraint and most projections foresee an increasing number of LNG exports globally. The role of natural gas will hence depend on the ability to decarbonize the resource or compensate by decarbonizing or avoiding use of other fossil fuels. How quickly society is able to shift towards a low-carbon energy mix is a key element in this analysis, hence determining how much natural gas that can be recovered before the energy system needs to become emission-free in 2050, or how quickly CCS and hydrogen technologies can be implemented.

CCS plays a critical role in almost all enabling pathways consistent with Paris goals. When CCS is unavailable, only pathways that include large-scale global afforestation and energy demand reductions reach the Paris target. If CCS is available, our studies show that natural gas markets continue to expand throughout the period of analysis. However, when CCS is unavailable and the world is on a trajectory leading to a 2°C increase in average Earth temperature, the natural gas market peaks and declines as soon as the world increases ambition towards the Paris goals.

In Europe, model studies show that the demand for natural gas will probably decline in any case, and Europe will become a less important consumer of natural gas. European natural gas demand varies between the studies, but the trend is clear and in many studies dramatic. Major factors that could influence the role of natural gas in Europe are the availability of CCS as a commercial and cost-efficient technology and the role of hydrogen in transport and industry.

People clearly see natural gas as a fossil fuel with the according negative impacts on climate change, but also with a clearly better profile than coal or oil. People's relation to natural gas is to a large extent a question of worldviews and beliefs, strongly linked also to political preferences. When natural gas production or infrastructure enters the picture, public resistance may occur, especially when people feel that the decision procedures are unfair and they do not benefit from the infrastructure. The public has considerably lower trust levels in CCS than researchers, NGOs, or governmental actors. Fairness considerations regarding procedures for decision-making and distribution of benefits and costs have been shown to increase acceptance in the few studies that are found on this topic. These conclude that risks, benefits, and trust in the actors' ability to operate and control the technology are decisive for acceptance, and that the social context of the project site is important for blooming of resistance or support.

The long-term role of natural gas in different sectors

We present some long-term studies of the role of natural gas to illustrate the points above. The main analyzes are performed using the Global Change Assessment Model (GCAM). It is an integrated tool for exploring the dynamics of the coupled human-Earth system and the response of this system to global changes. GCAM is a global model that represents the behavior of, and interactions between five systems: the energy system, water, agriculture and land use, the economy, and the climate. Our *Reference* takes as the starting point IPCC´s "Middle of the Road" scenario and is thus comparable to a wide range of other open literature scenarios. The reference world also produces almost 50 billion tons of CO_2 per year in 2050. Extending the scenario to 2100 produces an increase in average Earth temperature relative to pre-industrial of roughly 3.5°C.

Our Paris Policies scenario *(NDC 2C no CCS)* assumes that in the period to 2030 nations successfully implement their Nationally Determined Contributions (NDCs) according to the Paris agreement. Subsequent to 2030, we assume that the world moves to both comprehensive coverage of emissions and a common carbon price, limiting climate change to 2°C . In this scenario, CCS is not available.

Next, we look at an extension to the Paris Policy scenario assuming that CCS is available worldwide *(NDC 2C CCS).*

To explore the implications of an advanced fuel cell (FCEV), we construct a scenario with CCS and FCEV to study a last scenario that hypothesizes the development of a hydrogen fuel cell that is more efficient than those available today.

The results of our analyses show that production and consumption of natural gas continue to expand globally in all examined scenarios except for one—the Paris Policy Scenario without CCS (Scenario 2) (Figure 1). If CCS is available, then natural gas markets continue to expand throughout the period of analysis. However, when CCS is unavailable and the world is on a trajectory leading through NDCs to 2°C, the natural gas market peaks and declines as soon as the world increases ambition towards the Paris goals.

In sum, these scenarios show a robust future for natural gas globally, even if Paris goals are pursued, as long as the CCS technology can be deployed at scale.

When CCS is available, its use expands with the scale of the carbon price. Figure 2 (Panel A) shows that when driven by a rapidly rising common carbon price that the technology deploys rapidly throughout the world. Panel B in Figure 2 shows the sectors using the technology. Power generation accounts for more than half. Note that the use of CCS with natural gas power production is the largest application of CCS among sectors globally. Over time, use of CCS with natural gas has a comparative advantage over use with other fossil fuels because where capture is incomplete and carbon prices are high, the uncaptured portion of the emissions stream becomes an increasing burden on the system. CCS in combination with bioenergy power production is a major use of CCS technology as it produces power with negative emissions. Note also the growing use of CCS in hydrogen (H_2) production using natural gas feedstocks and the use of CCS in refining, including bioenergy refining. Finally, CCS use in conjunction with cement manufacture grows steadily.

Energy system model outlooks can deliver more specific details. We present results for forecasted natural gas demand by 2050 in Figure 3, illustrating that the overwhelming majority of these outlooks envisage a relatively robust share of 20-25% for natural gas in the global primary energy demand by mid-century, while some of them suggest demand as low as but as low as 2-3% in Europe. Globally, the only drastically deviating scenarios are deliberately “green” (renewable-intensive) scenarios such the green cooperation scenario of DIW-REM or the most recent Sky 1.5-scenario from Shell (2021).

Some outlooks, like NetZero (BP) or Green Cooperation (DIW-REM) foresee a share of natural gas of around 12% globally but as low as 7,8% and 0,6% in Europe. This is a substantial reduction. Taken together, the majority of these scenarios indicate a growing demand for natural gas globally with Europe potentially becoming a less important consumer. This in fact heavily relies on the available production technology (competitiveness of CCUS compared to energy systems based on renewable energy sources) and the development path of hydrogen.

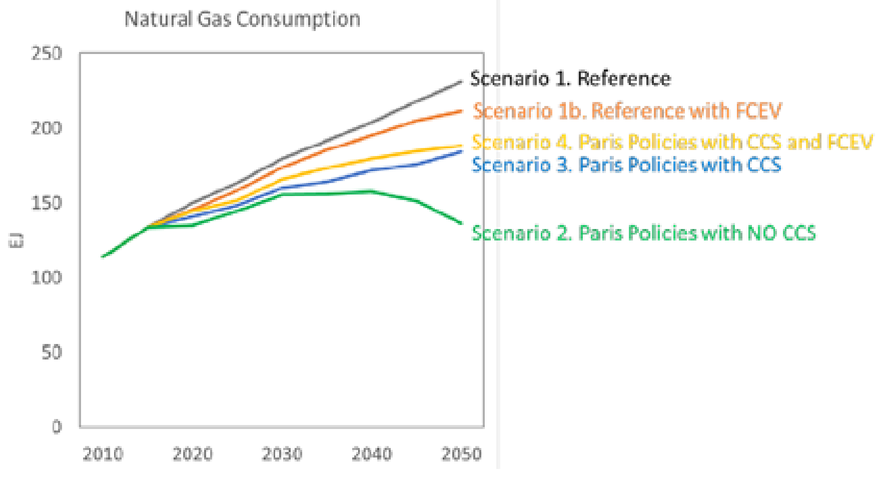

Figure 1: Natural gas consumption across scenarios (GCAM)

Panel A **Panel B**

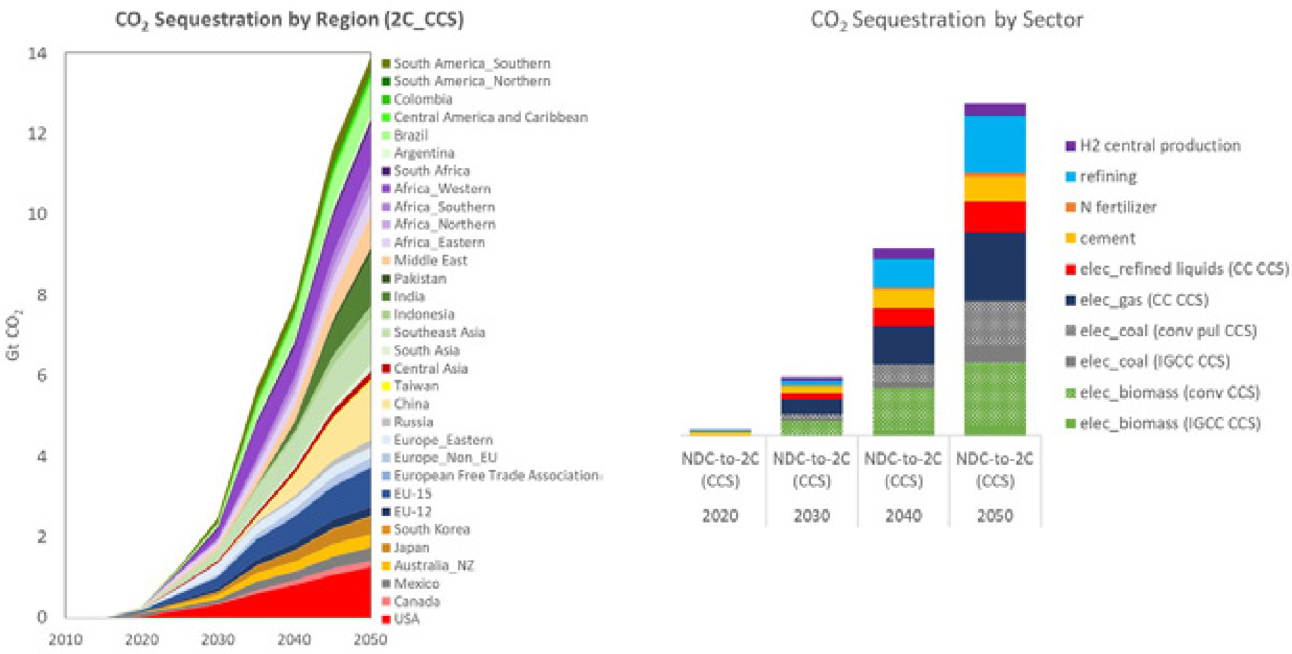

Figure 2: CCS in the Paris Policy Scenario by region and sector to 2050, Scenario 3 (GCAM)

Power: With growing electrification across Europe substantial cost reductions in renewable power generation put natural gas at a disadvantage. International carbon pricing will also impact the future of natural gas in electricity production. In the power sector, use of CCS with natural gas has a comparative advantage over use of CCS with other fossil fuels because where capture is incomplete and carbon prices are high, the uncaptured portion of the emissions stream becomes an increasing burden on the system. CCS in combination with bioenergy power production is a major use of CCS technology as it produces power with negative emissions.

Transport: In the transportation sector (individual mobility, freight transport and maritime shipping) CNG/LNG may be an option but it would not suffice to meet sectoral emission reduction targets in the future. Bio-based synthetic gas and hydrogen also with CCS are potential other forms of gas that could be future technologies in a decarbonized Europe. However, substantial cost reductions are required (for hydrogen use), competition for biomass needs to take into account other Sustainability Development Goals (SDG) (food-water-energy nexus) and the development of CCTS infrastructure (transport and storage) needs to be financed.

Heating: Currently, natural gas is the primary source of energy in the building sector in Europe and the main responsible of its CO_2 footprint. The substitution of natural gas by biofuels or biomass is the most direct approach to reduce CO_2 emissions. This would allow preserving the current infrastructure and hence minimizing the changes required in the sector. However, even if demand from other sectors is not considered, biofuels and biomass might not supply all the energy demand from the building sector. Hydrogen could be an alternative clean fuel if produced from electrolysis of water or natural gas reforming with CCS. Nevertheless, a hydrogen infrastructure and economy would be required. Thus, hydrogen can be considered as a possible long-term solution to decarbonize the building sector, with electrification being the alternative.

Industry: Industry is likely to be an important driver of natural gas demand since it is an essential input for production of cement or steel. The interplay between CCS, hydrogen and natu-

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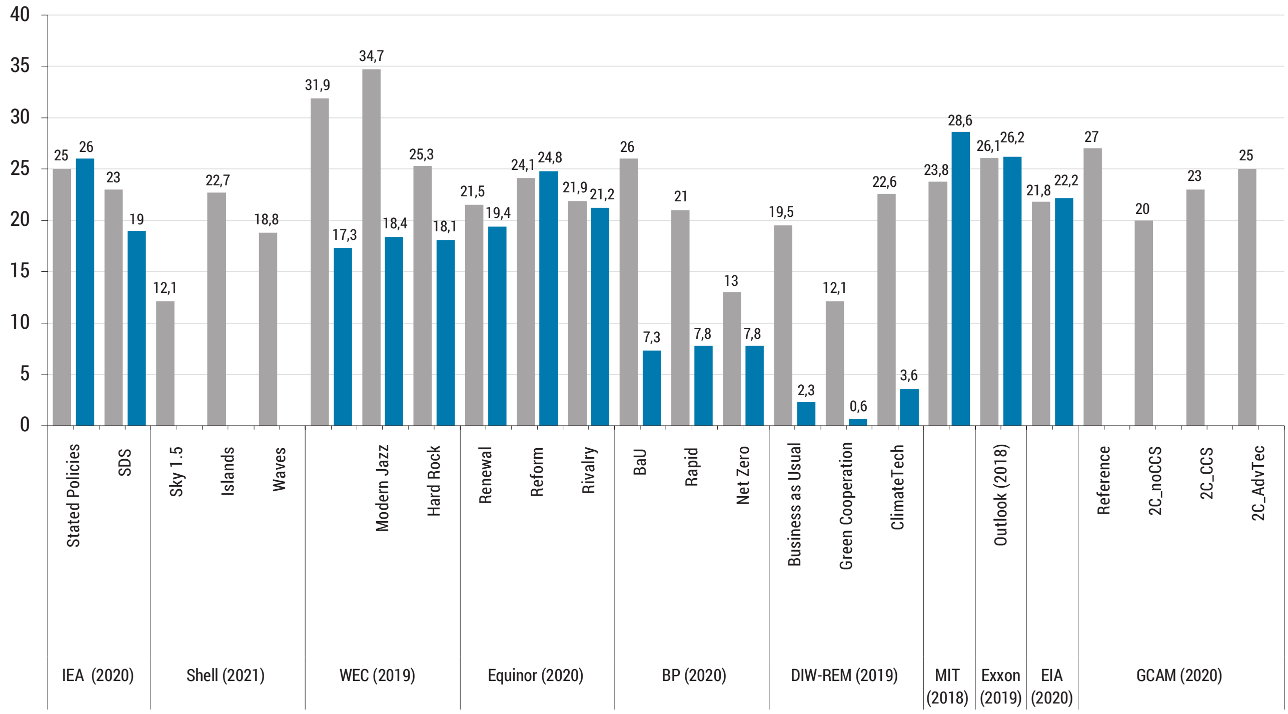

Note: IEA, BP, and ExxonMobil numbers are for 2040, DIW-REM numbers are for 2055.For all scenarios, we note that the definition of "gas" or "natural gas" is not clear. The regional disaggregation also differs across outlooks, hence what is considered as "Europe" in Figure 12 might not be consistent. For the overall findings, however, this does not weigh in for this report. ExxonMobil's outlook stops in 2040 thereby avoiding the question of complying with the Paris Agreement, which set 2050 as target date. Others go to 2060 (World Energy Council) or even 2100 (Shell) which allows them to allocate the bulk of the decarbonization efforts to later periods after 2050.

Figure 3: Share of natural gas in primary energy demand in percentage (%) in various outlooks by 2050 for the world (grey) and Europe (blue)

ral gas has the potential to play a role in industry. The growing use of CCS in hydrogen production using natural gas feedstocks and CCS in refining, including bioenergy refining is one example. Scenarios for industrial use of natural gas are mainly distinguished by the deployment of CCS and the development of new processes and techniques, which strongly depend on the type of industry and its energy intensity.

Recommendations

In Europe, the role of natural gas in the energy transition is under pressure. Below we list what we find to be the main areas that will have a high impact for the role of natural gas as a relevant and sustainable bridging fuel in Europe:

- Market design for providing sustainable and cost-efficient flexibility into power systems with an increasing share of intermittent renewables;
- Development of a European infrastructure for CO_2 transport and storage;
- Non-discriminating market design for hydrogen in Europe where clean hydrogen is defined by its carbon footprint;
- The future cost and efficiency of hydrogen fuel cells with applications in transport;
- Development of a European infrastructure for H_2 production, storage and transport.

The above are also areas where research is required to improve the knowledge base for future decisions. CCS and the market penetration of hydrogen are probably the two single factors with the highest impact on the role of natural gas in Europe. Both of these technologies are immature in terms of commercialization and there is a need for more research on business models and how to build markets for these technologies.

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