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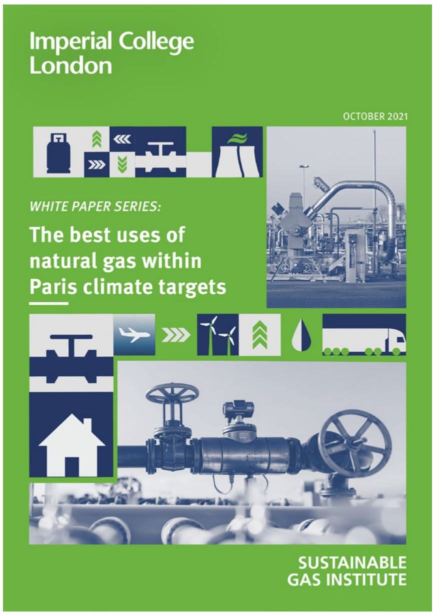
Briefing Note: The best uses of natural gas within Paris climate targets

Can natural gas resources be used without impacting our ability to meet climate change targets? In a world where these resources are abundant, but their unabated combustion is constrained by climate targets, what is the best thing to do with natural gas?

Several uses of gas may be compliant with future climate change targets, including:

- electricity generation with climate capture and storage (CCS);
- hydrogen production with CCS; and,
- constraining unabated gas use in electricity generation, industrial and domestic end uses within the limits set by emissions targets.

However, understanding the best uses is complex, subject to assumptions and often contested. A better understanding of the evidence may help to clarify the extent to which the various options may play a future role.



The Sustainable Gas Institute has conducted a systematic review of the available evidence surrounding the best uses of natural gas to bring clarity to the debate. This white paper presents the findings of that review, exploring the concept of best use, the consensus of the evidence on where natural gas fits in 1.5°C energy scenarios and what key options influence the low carbon use of natural gas.

Key findings

1

Global natural gas use is likely to decline in the future, with half of the Intergovernmental Panel on Climate Change (IPCC) 1.5°C scenarios reducing gas use by at least ~35% by 2050 and by ~70% by 2100 compared to total natural gas use in 2019.

- Due to total primary energy increasing by at least 30% in the majority of IPCC 1.5°C scenarios by 2100, this further reduces the role of natural gas in total primary energy from **23%** in 2019 to **15%** in 2050 and **5%** in 2100.
- However, the range is broad with some extreme scenarios seeing slight increases in natural gas use by 2050 and a return to current natural gas demand by 2100.
- At the other extreme, natural gas use reduces to zero or near zero in 2050 and 2100.
- A significant proportion of future demand includes power generation with CCS (70% of natural gas electricity generation in 2050) and hydrogen production (6.6 exajoules in 2050 or 7.5% of overall natural gas use).

2

The move from a 2°C to a 1.5°C climate target reduces the role of natural gas.

- Under 1.5°C scenarios, natural gas in primary energy is at least **40% lower** in 2050 and **45% lower** in 2100 in half of the IPCC scenarios.
- Under 2°C targets, scenarios are more likely to use slightly more gas in 2050 than current levels. However, by 2100, natural gas use has significantly reduced, with most scenarios at least ~43% lower than natural gas use in 2019.
- This finding demonstrates the significant impact of more stringent targets on natural gas use, particularly in the first half of this century.

Download the full white paper from:
www.imperial.ac.uk/sustainable-gas-institute/white-paper-6-the-best-uses-of-gas-within-paris-climate-targets

For further information on this subject please contact us at SGI@Imperial.ac.uk

The Sustainable Gas Institute at Imperial College London aims to explore the role of natural gas in the world energy mix. Follow us on twitter: **@SGI_London**

3 Key uncertainties influence the use of natural gas in climate scenarios, and the speed and scale of reductions in unabated gas use.

- These uncertainties include:
  - the uptake of coal-to-gas switching;
  - the use of natural gas to produce hydrogen, and balance variable renewables;
  - the ability to reduce methane emissions;
  - the level of uptake of capture rate of carbon capture, utilisation, and storage (CCUS).
- Other technology choices can also influence gas use (e.g., negative emissions technologies, green hydrogen production etc.).

4 There are still 67 exajoules of unabated natural gas in half of scenarios in 2050 and 41 exajoules in 2100. This equates to 7.2% of total energy in 2050.

- Given the reduction in the proportion of gas overall, and the reducing role of unabated natural gas, emissions from natural gas are small relative to the emissions removed by negative emissions technologies.
- Natural gas emissions are likely to be further constrained in response to any tightening of emissions goals in the future, particularly given the climate forcing nature of methane emissions and their impact on warming in the short-term.

5 Natural gas use differs across regions.

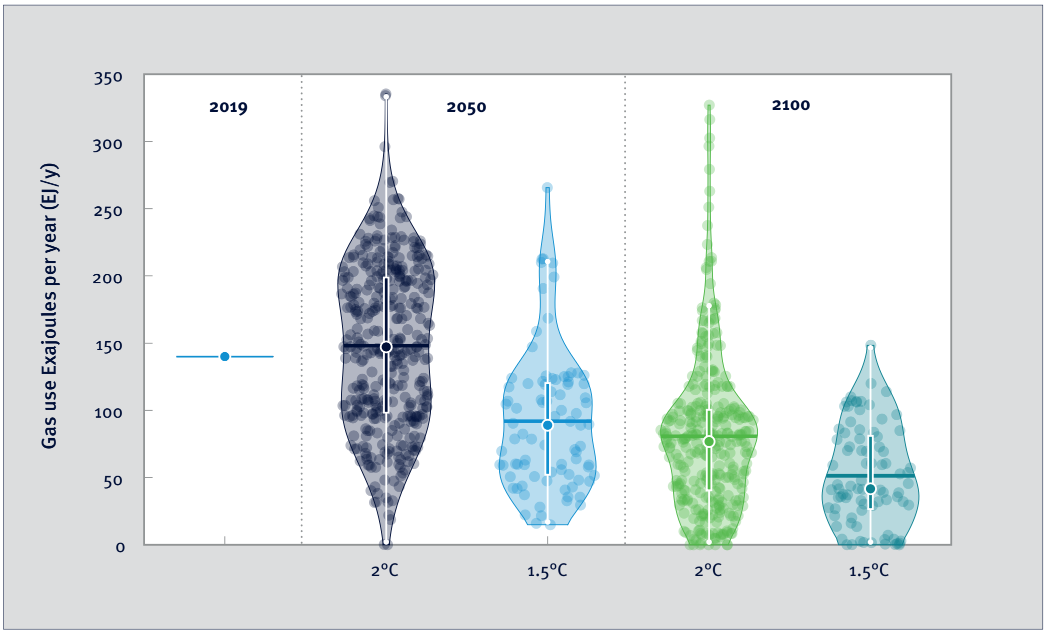
- The USA and Europe both reduce their consumption of natural gas across all sectors in the majority of scenarios due to a reduction in energy consumption, development of hydrogen, CCS and renewable electricity with an increased electrification of end uses.
- Latin America maintains or slightly decreases natural gas use across all sectors with greater electrification.
- India and China have many routes to meet climate targets including increasing natural gas use in the residential and industrial sectors. Natural gas for power may also increase, or reduce only slightly, due to sharp declines in coal use.

6 Carbon capture and storage (CCS) has a vital role in global decarbonisation and in facilitating future natural gas use.

- Scenarios that meet 1.5°C targets maintain a heavy reliance on CCS.
- Bioenergy with carbon capture and storage (BECCS) deployment is typically more rapid under 1.5°C scenarios than 2°C scenarios. The requirement for natural gas with CCS in 1.5°C scenarios is at least ~20% more than 2°C scenarios in 2040 in half the scenarios as more rapid decarbonisation is needed under stricter targets.
- Barriers to CCS need to be overcome including cost and security of investment. However, a carbon price and emerging support mechanisms may stimulate growth.
- Key enablers for the CCS industry include secure economic incentives and a steady regulatory environment. If CCS development is slow, meeting 2050 targets

FIGURE ES1
Natural gas in primary energy in global whole energy system scenarios that meet a 1.5°C warming target.

Note: A 'Violin plot' represents data for a specific moment in time. Each specific scenario is represented by a circle and the density of scenarios in an area is represented by the width of the violin.



becomes more difficult. This has a significant impact for bioenergy power generation with CCS, which is vital in meeting climate targets.

- Support is therefore needed to ensure natural gas power generation is combined with emissions capturing technologies in the future.

7 Low-carbon hydrogen could remove CO_2 from natural gas and replace natural gas in hard to decarbonise sectors.

- Hydrogen requires technological experience and legislative support to make it cost effective.
- Current emissions from hydrogen production are contributing 120 megatonnes (mt) of CO_2 annually.
- Sectors that could benefit from low-carbon hydrogen include transport, domestic heating/ fuel, commercial heat, power, and steelmaking.
- While half of the scenarios include at least 6.6 exajoules of hydrogen from natural gas in 2050, total hydrogen use in 2050 may be significantly greater.
- At the higher end, hydrogen could contribute 24% of global energy demands, or 99 exajoules by 2050.
- While natural gas-based hydrogen production produces emissions, it allows for lower cost hydrogen production and may help drive a hydrogen economy and infrastructure while the costs of green hydrogen fall.

- But when green hydrogen becomes economically competitive, geographic factors, energy security and seasonal effects may still mean that blue hydrogen has a role to play, as seen in the IPCC scenarios up until 2100. It is likely that hydrogen will not be produced from other fossil fuels due to high residual emissions incompatible with climate goals.

8 Our evolving understanding of methane emissions and other factors may disrupt the role of natural gas in the future energy system.

- Improvements in supply chain methane emissions, CCS capture rates and the development of advanced methane using technologies might all contribute to an increase in natural gas use.
- Increasing global warming potentials (GWP) of methane, a new understanding of tipping points and the discovery of higher levels of methane emissions through improved monitoring may decrease the role of natural gas in scenarios.
- These factors emerge over time so revisiting energy systems modelling scenarios regularly is important to help inform the ongoing decisions on climate change mitigation.

9 Policy should:

- Acknowledge the appropriate scale/barriers associated with the development of markets and repurposing of infrastructure needed for hydrogen production and CCS. Measures should be taken to alleviate barriers or conversely to avoid infrastructure lock-in where natural gas use is not compatible with climate targets.
- Encourage the development of support schemes/incentives, and the restructuring of regulations or market mechanisms.
- Remain agile to emerging issues in natural gas use and wider changes in assumptions in energy modelling.
- Foster international gas trade mechanisms for the development of hydrogen and CO_2 markets, which could facilitate flexibility and cost reductions.
- Consider key variables in the future role of natural gas (e.g. CCS capture rates or upstream methane emissions) and to encourage the uptake of beneficial technologies, practices, or support improvements in these variables, thereby reducing the emissions from natural gas use.

10 More research is needed into:

- Examining the extent of natural gas and hydrogen production, transportation, and surrounding infrastructure across regions, over time and under current energy system modelling assumptions. Integrated assessment models (IAM) also need to be updated to be responsive to changes. For example, changes could include mechanisms, assumptions in climate impacts of methane or new/ improving technologies such as hydrogen electrolysis and carbon capture.
- Understanding the methods for reducing natural gas emission from natural gas supply chains (e.g. upstream methane emissions and CCS capture rates may both play a role in reducing emissions from natural gas use).
- Exploring the concept of unburnable carbon under newer 1.5°C climate targets.