G20 Saudi Arabia

The Role of Gas Technologies in the Circular Carbon Economy

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The world is currently experiencing a period of dramatic innovation in its energy systems. How energy is supplied and consumed shows significant potential to be disrupted in the coming decades. Indeed, it is essential that such disruption does occur for the world to fulfill the commitment of the Paris Accord and achieve the UN Sustainable Development Goals.

The Paris commitment of limiting the rise in global temperature to well below 2° C before the end of the century, requires a sharp restoration of the global greenhouse gas emissions balance. That balance is currently off by over 20 gigatons of CO2 per year. The IEA analysis demonstrates that current policy commitments will help to avoid more than 6 gigatons (GT) of these emissions through 2040, which still leaves a gap of 18 GT to the 2° target. Closing this gap will be very challenging, even with the use of every policy and technology tool possible, including natural gas. However, with deliberate policy commitments to technology development and innovation, driven by outcomes, and industry stepping up to the challenge when reliable policy signals are in place, this challenge can be turned into an opportunity. An opportunity to redefine energy systems and business models, to apply technological and commercial innovations to create value and minimize, reuse, and recycle waste in a circular and balanced carbon economy.

Cleantech solutions in power generation and electrification of energy consumption are often the focus of discussion on the theme of energy innovation. However, as recent research from the International Gas Union demonstrates, clean technology development and innovation in natural gas value chains are of equal significance and offer the potential for similar transformative impact.

TECHNOLOGY	RECENT TECHNOLOGY DEVELOPMENT	EMERGING TECHNOLOGY TRENDS	ILLUSTRATIVE POTENTIAL IMPROVEMENTS		
		CAPEX	EFFICIENCY	CAPEX	FLEXIBILITY
POWER SWITCHING	• Improving CCGT thermal efficiency • Ramp time reduction	• Improving heat retention during downtime • Equipment flexibility and resilience to better manage intermittency	CCGT thermal efficiency (up to 10%)		Faster start times (1.5-2x)
INDUSTRY SWITCHING	• Efficiency improvements and cost decline • Development of gas burners as a substitute for oil fired burners	• Improved boiler flexibility • Process efficiency improvements in petrochemical applications	Boiler efficiency (10-20%)		
BUILDING SWITCHING	• Boiler efficiency improvements • Adoption of CHP in buildings	• Development of gas hybrid residential heating solutions	Boiler efficiency (10-20%)	Boiler cost declines (0-5%)	
CNG/LNG VEHICLES	• Engine efficiency, torque, and emissions • LNG storage and distribution	• New methods for engine efficiency • Improving control systems, combustion, and catalysts to further reduce emissions	Emissions reductions (15-70%)	Vehicle part cost declines (up to 20%)	
LNG BUNKERING	• Engine scale and efficiency • Ship-to-ship LNG bunkering	• Port-scale distribution infrastructure • Development of smaller membrane fuel tanks	Engine power output (10-25%)	Scale & learning effects (up to 20%)	

Source: Power Engineering Magazine; Power Magazine; Power Engineering International; Lazard; BNEF; Lawrence Berkeley Laboratory; Colpier & Cornland; US EIA, Cummins Westport; SEA LNG; BCG analysis.

Starting with the premise that a wide variety of technologies, applied across all sectors and fuels, will be necessary to achieve the required transition, the analysis focuses on the role that gas cleantech can play. It shows that deploying gas technologies to their full economic potential for fuel switching from coal and oil, while also scaling up low-carbon gas technologies, could enable a reduction in GHG emissions of up to 12 GT by 2040, equivalent to a third of global energy sector GHG emissions in 2019. While gas technologies cannot address the gap in its entirety, the potential for progress is too large to ignore.

Even though gas technologies are already mature in many instances, ongoing advances show potential to reduce the costs of gas combustion by 30% or more, cut the capital investment required to access gas by half, and dramatically improve the flexibility of gas power generation.

Significant innovation is occurring in low carbon gas technologies, including renewable gas, low carbon hydrogen, and carbon capture, utilization, and storage (CCUS). While the costs of these technologies are high today and deployment is limited, a combination of fundamental technology breakthroughs as well and scale and experience driven impacts indicate the potential to cut these costs nearly in half over the next one to two decades.

			ILLUSTRATIVE POTENTIAL IMPROVEMENTS	
TECHNOLOGY	RECENT TECHNOLOGY DEVELOPMENT	EMERGING TECHNOLOGY TRENDS	EFFICIENCY	CAPEX
RENEWABLE NATURAL GAS	• Anaerobic digestion enzyme efficiency improvements	• Production scale • Use of new, lower cost feedstocks • Biomethane upgrading efficiency	Process advances (up to 40%)	Scale & learning effects (40-65%)
HYDROGEN	• Demonstration of SMR with CCUS • Cost reduction of electrolysis	• Methane cracking • Hydrogen blending and system integration cost improvements	Process advances (electrolysis) (5-10%)	Technology maturity (electrolysis) (20-50%)
CCUS	• Application of post combustion capture to new industries • Efficiency improvements in solvent based post-combustion capture	• Development of oxyfuel combustion • Membrane based post combustion capture • Development of utilization technologies	New materials & process (up to 50%)	New technology (electrolysis) (90%)

Source: Navigant, IEA, Global CCS Institute, Energia Procedia, BCG analysis.

As a result of the ongoing and newly emerging developments in gas technologies, the potential market for natural gas can be much greater than it is today. Factoring in these improvements along with the value that gas provides from reducing greenhouse gas emissions and localized pollution relative to other fuels, the IGU and its partners have found that the global market for gas could be 2.5 times its current size today at its maximum economic potential in 2040.

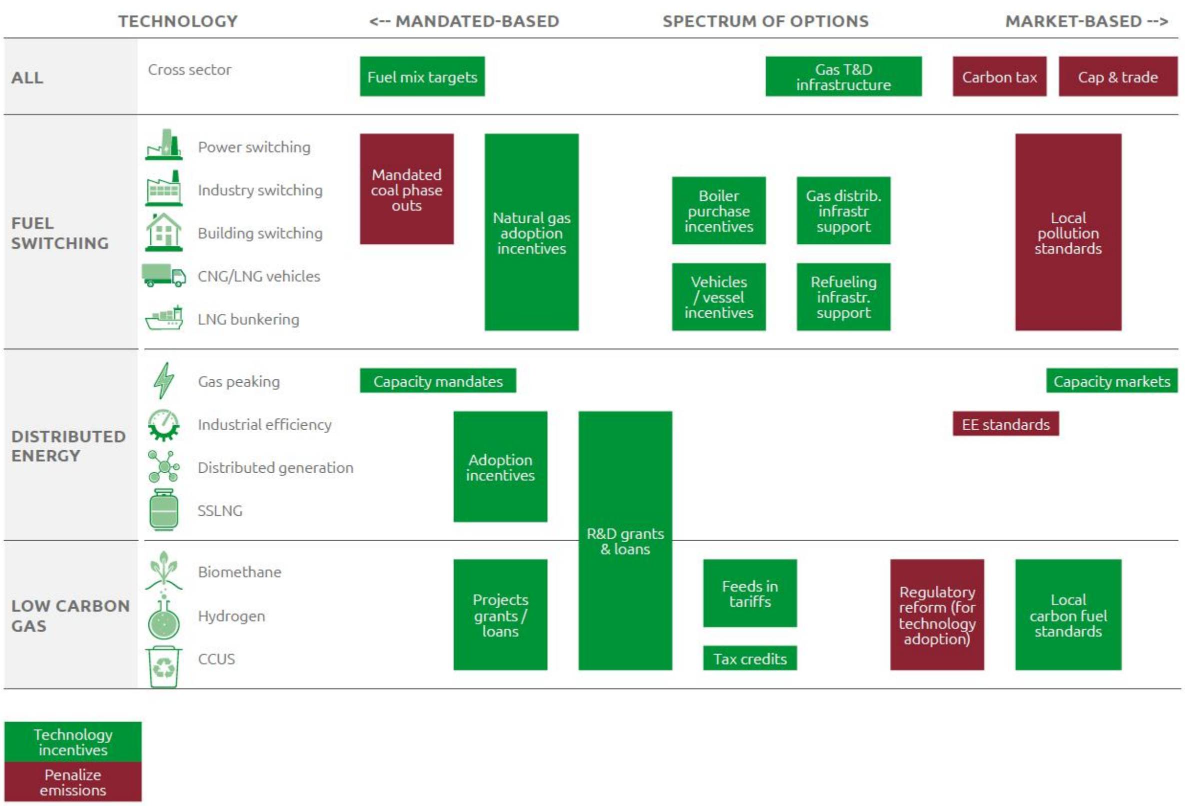
Achieving the maximum economic potential for the adoption of gas technologies would in turn offer substantial environmental and social benefits. Under such a scenario, gas technologies could mitigate up to one third of global energy sector greenhouse gas emissions, reduce emissions of pollutants such as nitrogen oxide by up to 30%, and enable access to clean cooking fuels to 1 billion more people by 2040. And when considering the relative costs of other technologies, gas technologies provide the lowest cost means of reducing emissions in many instances, particularly in the buildings, industry, and transport sectors.

Such an outcome is far from assured, however.

Lessons from the development and adoption of gas technologies in the past, as well as other cleantech solutions, indicate that three drivers are essential for the further development and deployment of gas technologies:

First, government policy support is essential for promoting sustained R&D in gas technologies while ensuring their environmental and social value are reflected, for example through the implementation of carbon price. Second, substantial investment is required to enable access to gas, deploy technologies for gas consumption, and scale up the supply of low carbon gas; achieving the maximum economic potential for gas and the associated benefits would require $400-800 billion of annual investments.

Third, innovation by the gas industry is required, particularly through investment in R&D and early stage deployment while also developing new business models and new applications of technologies to reduce deployment barriers and speed Transforming the global energy system to simultaneously enable action on climate change, promote sustainable cities and communities, and provide access to affordable and clean energy will require sustained innovation across the breadth of energy applications around the world.



Source: BCG analysis

As the IGU and its partners demonstrate, innovation in gas technologies are already enabling these outcomes and offer substantial incremental potential to do so in the coming decades.