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ABDULLAH BIN HAMAD AL-ATTIYAH INTERNATIONAL FOUNDATION
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Expert energy opinion and insight

Global Gas Demand: What is the Outlook to 2040 and Beyond for New Emerging Markets, Centres of Growth and Sectors?

Natural gas faces a promising but uncertain future. Clean and versatile, it has the best prospects for growth of the three fossil fuels. Asian demand, in particular, is growing strongly, with China's anti-pollution drive. But improvements in renewable energy, growing efficiency, and concern over the greenhouse emissions of natural gas, mean its future is not assured. Major gas exporters face a challenge to balance supply and demand appropriately through major and well-planned investment. Innovations in markets and technology open up new geographies and new sectors for access to gas, given the right price levels, infrastructure, financing and regulation. An active approach has the best chance of allowing the leading gas players to make the most of their resources.

Hassi R'mel gas power plant, Algeria (Magharebia / Wikimedia Commons)

Executive Summary

- Solid growth in global gas demand is expected, despite growing efficiency and the rising competitiveness of renewable energy. However long-term gas demand is quite price-sensitive.
- Global gas resources are adequate to meet even high scenarios for consumption at reasonable costs.
- The gas market is becoming more globalised, creating demand by giving access to new geographies, though some important new pipelines remain stalled by political problems.
- Asia, especially China and later India, is the key centre of gas demand growth. Middle East demand expansion slows down, while Latin America and Africa grow fast, but only from a small base. North America remains a solidly-growing market, while Europe and the former Soviet Union stagnate and then slowly decline.
- Most forecasts show little shift in gas demand between sectors to 2040. Transport will grow fastest but remain minor; gas for petrochemicals and industry is the most promising major use, while residential gas will grow most slowly.

Implications for leading gas exporters

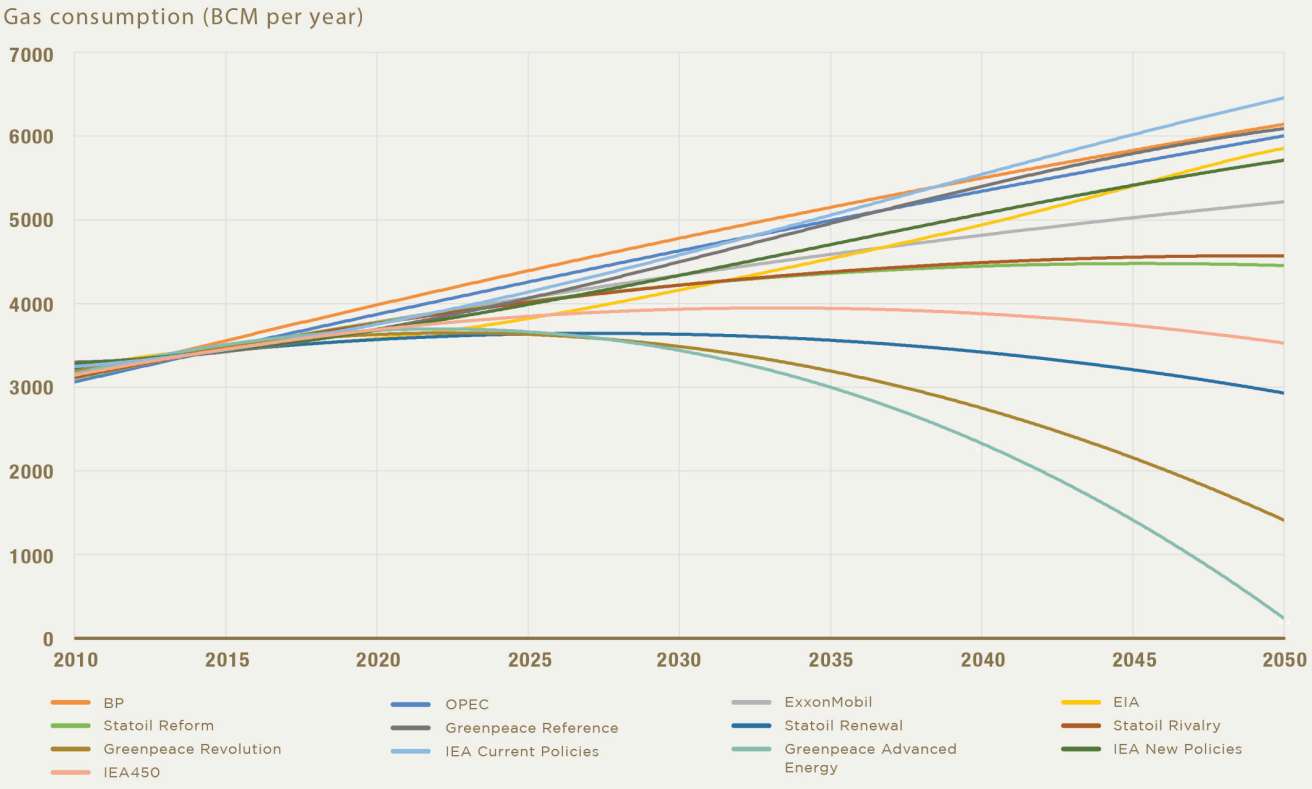
- Gas can capture new markets, but it has to be competitively-priced, and several potential new markets, especially in Africa and emerging Asia, and in LNG ship bunkering, require infrastructure and regulatory development.
- Major producers have to plan expansion carefully, not committing too much capital when there is a risk of demand slowdown, but also avoiding price spikes which would encourage competitors.
- The development of large-scale, cost-competitive carbon capture and storage (CCS) is essential for the long-term future of gas demand.
- New technologies in industry and hydrogen production and use offer a major, if rather speculative, market opportunity for natural gas suppliers.

Most forecasts suggest solid growth in overall gas demand

Most mainstream projections feature continuing growth in gas demand in most regions and sectors (FIGURE 1). Taking a middle-of-the-road forecast, the EIA's shows world gas demand rising from about 3500 BCM per year in 2017 (note: figures are rescaled to match BP statistics for historic years) to 5870 BCM annually in 2050. The annual growth rate is 1.6% in the 2020s, speeds up a little to 1.8% in the 2030s, and slows slightly to 1.7% in the 2040s.

Greenpeace has scenarios with a sharp fall in gas demand beginning around 2025, but these are advocacy rather than analysis, and are unrealistic when combined with a simultaneous drop in oil, coal and nuclear use. Statoil (now Equinor), and the IEA (450 case – meeting climate change goals) also presents scenarios where gas use falls from about 2030, or flattens out from 2040 onwards, with more use of alternative energy and greatly improved efficiency.

FIGURE 01: **FORECASTS FOR WORLD GAS DEMAND**[1]



BP also presents scenarios (not shown on chart) where gas use would be less. Its reference case has 1.6% annual demand growth, going from around 3500 BCM per year in 2016 to about 5200 BCM annually by 2040. In the case of a fast or extra-fast transition to renewables, this could be as low as 3450-4000 BCM by 2040, representing only very limited growth or even a slight drop.

Resources are adequate to meet demand

These forecasts assume that there is no serious limitation in gas use from the resource base or from major political or security problems in major gas exporters such as Russia. While geopolitical problems are always a possibility, global gas resources are of a magnitude to meet future demand.

The highest-demand scenario here, Greenpeace's Reference case (excluding the IEA's Current Policies – since policies will clearly change) consumes about 156 TCM of gas from 2019-2050. Global reserves in 2017 were put at 193.5 (TCM) by BP[2], and increased by 65 TCM since 1997 despite production of 61 TCM since then.

Russia, Iran, Qatar and others have large conventional reserves, while North America has exploited extensive unconventional (shale and tight) resources over the past decade. Major conventional discoveries have been made in recent years in east Africa, deepwater Brazil, the Kurdistan region of Iraq, the eastern Mediterranean and north-west Africa. Mexico, Argentina, China, Australia, Algeria, Oman, the UAE, Saudi Arabia, Russia and others have substantial potential for unconventional gas of various types. Experience so far suggests this gas can be produced at reasonable costs, in the range $2-3 per MMBtu for the US, and perhaps up to $5-7 per MMBtu for Middle Eastern sour gas or more remote resources.

However, the future of gas is uncertain

Despite this promising outlook, future demand for gas faces major uncertainties, that are not captured in the standard forecasts.

Oil has largely a monopoly on transport, at least until electric vehicles take a large market share. Gas, though, faces competition from coal, nuclear power and renewables in power generation, and from oil and coal in industry. Residential gas demand is likely to be less price-sensitive once a network is in place, since it is an essential service and switching is costly.

Typical estimates for long-run price elasticity of oil demand are in the range -0.2 to -0.3 though varying per country[3]. Elasticity for natural gas demand is around -1.25[4]. That is, a 10% increase in price reduces oil demand by 2-3% in the long-term, but reduces gas demand by 12.5%. This reduction occurs by a combination of efficiency (more insulation, more efficient boilers, lighting and so on), behavioural change (such as using less winter heating), and fuel-switching. In the longer term, high gas prices would also inhibit gas from entering new markets, such as LNG for shipping.

Conversely, gas does have the opportunity to create new demand. Compared to oil which is already used virtually everywhere, several important emerging markets have little or no access to gas. New pipelines and, particularly, floating LNG import terminals, have already greatly expanded gas access.

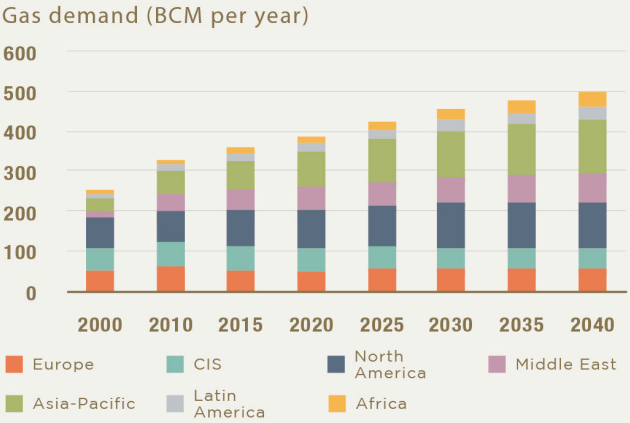
LNG demand is a 'derived demand'. Customers do not generally require LNG; they require gas (which can be delivered as LNG or by pipeline). In fact, they may not even specify gas, if their energy needs can be met by coal, oil or electricity.

Therefore forecasting LNG demand also requires a view on the availability of new supplies within a country, either from domestic production or by pipeline.

Gas demand growth varies greatly by geography

As with most energy sources, Asia is the key locus of growth in natural gas demand (FIGURE 2). China has recently accelerated as a major growth market. By 2040, China is likely to exceed the whole of Europe in demand, and it will be larger than the rest of emerging Asia, including India. Apart from a major economic crisis or geopolitical upheaval, it is hard to see what would derail this trend.

FIGURE 02: **FUTURE GAS DEMAND BY REGION[5]**

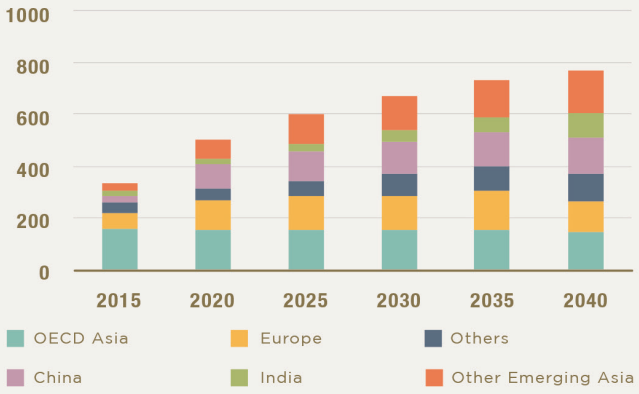


Middle Eastern demand growth remains relatively strong, but is likely to level off due to slower economic growth, efficiency gains, and adoption of alternatives. Efficiency and demographic shrinkage reduces the former Soviet Union's demand, while Europe grows only slightly, even shrinking towards the end of the period. North American demand, though, grows solidly because cheap shale gas encourages industrial use and switching away from coal power. Latin American consumption grows about as quickly in percentage terms as Asia's, but it is a far smaller market.

The potential for African gas demand is possibly underestimated. Demand here is heavily dependent on access to infrastructure, both for importing gas (or distributing local production), and consuming it. In turn, this requires large-scale financing and appropriate regulation.

In line with this pattern of overall gas demand growth, LNG import growth is driven by China and other emerging Asian economies to 2030, then later by India (FIGURE 3). The traditional developed Asian markets (Japan, South Korea, Taiwan) remain flat or decline slightly. Europe increases as its own production falls, but then drops sharply after 2035 as renewables take over.

FIGURE 03: **LNG IMPORT BY REGION**[6]



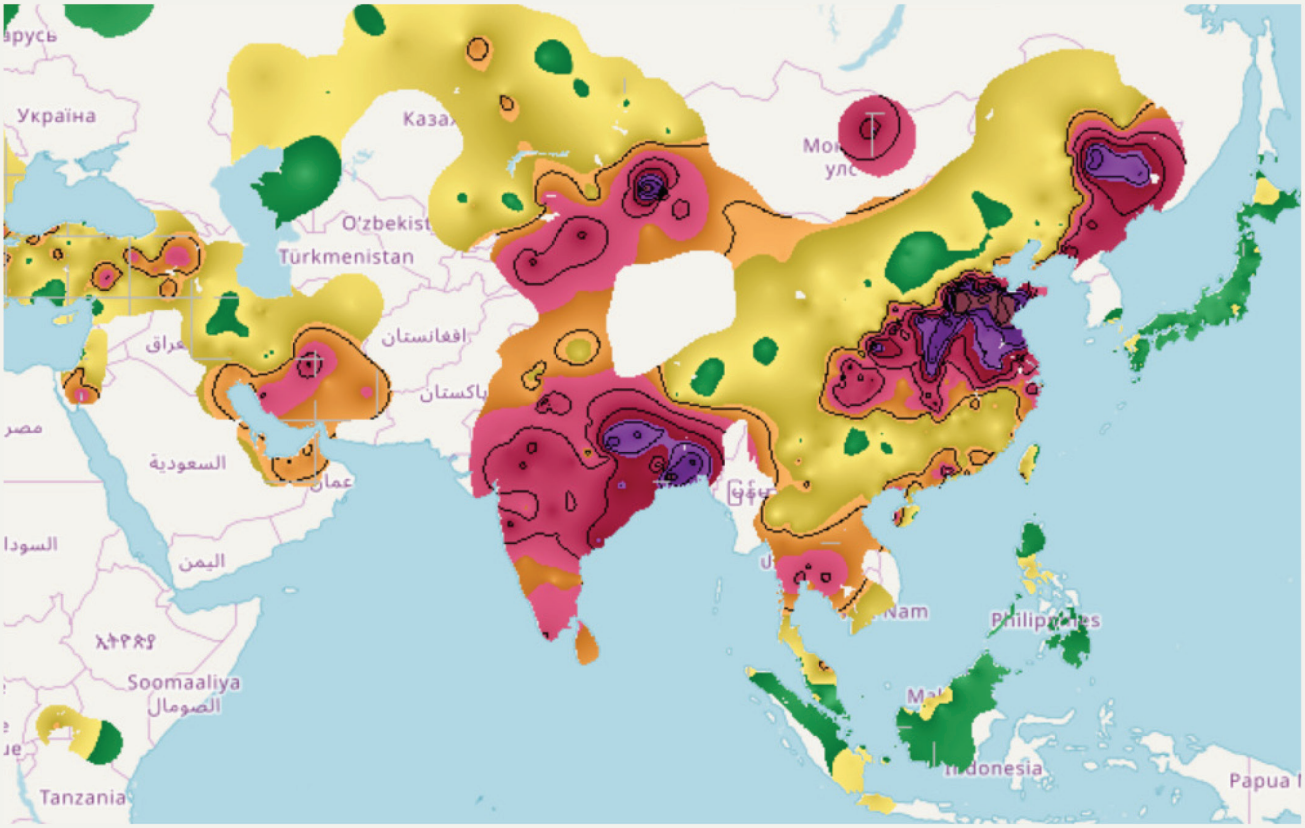
In recent years, a number of new gas importers have emerged via flexible and cost-effective floating storage and regasification units (FSRU). These countries either had no access to gas, or wanted to diversify supplies from pipeline gas only, or had to supplement declining local gas production. They include the UAE, Kuwait, Egypt (which has now become self-sufficient again), Jordan, Lithuania, Malta, Pakistan, Malaysia, Indonesia and Bangladesh. In the near future, others such as Bahrain, Lebanon, Morocco, Sudan, South Africa, Benin, Côte d'Ivoire, Ghana, Panama, Croatia, Germany, Ireland, Vietnam, Burma and the Philippines may join them[7]. Some of these are niche consumers or want FSRUs mainly for security of supply, but several are large countries with the potential to become big gas consumers.

More flexible supply from a wider range of players, shorter-term and smaller contracts, the end of 'destination clauses' restricting resale, and the availability of a wider range of pricing mechanisms, are additional shifts in the LNG market which have opened it up to new importers.

In contrast, new international pipeline developments have been relatively limited, but the Power of Siberia pipeline from Russia to China, and the possible Altai pipeline, are key components of Beijing's drive for gasification, along with the existing pipelines from Central Asia (Turkmenistan and Uzbekistan).

Several major pipelines could contribute in the 2020s or 2030s (but are hampered by political obstacles), such as exports from Iran to its Gulf Arab neighbours and to Pakistan

FIGURE 04: **ASIAN AIR QUALITY**[8]



and India; from the Kurdistan region of Iraq to Turkey; from the Eastern Mediterranean to Turkey and south-eastern Europe, and; from Russia through North Korea to South Korea.

Avoiding pollution will be a major driver of gas adoption, particularly in Asia. FIGURE 4 shows recent air quality in Asia (14th January 2019), with red and purple representing very poor quality, and green good quality. Northern China, northern India and Bangladesh are seen to have serious pollution, as a result of the burning of coal, traditional biomass and waste, and vehicle emissions.

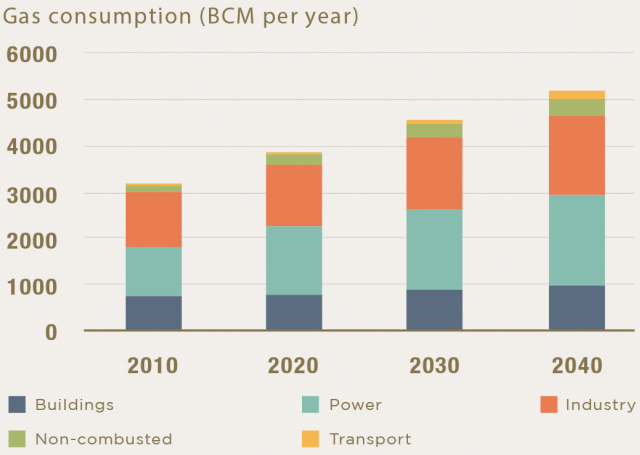
Recent actions by the Chinese government, including conversion of district heating systems and industry from coal to gas, are beginning to yield some improvements, so that air quality in India has recently been worse than in China. China and India are low users of gas: 6.6% of primary energy in China and 6.2% in India, compared to the world average of 23.4%. Even in LNG-dependent Japan, the share is 22%, and it is clear from FIGURE 4 that its air quality is much better.

Gas demand growth varies greatly by sector

Gas is mainly used today in three sectors: power generation (38.5% of consumption in 2016), industry (for self-generation, to provide heat, as a reducing agent, and as a petrochemical feedstock: 33.1% was fuel use and 5.4% feedstock), and residential / commercial (mostly space and water heating, and cooking), amounting to 21.4% in 2016. Gas use in transport (operating pipeline compressors, compressed natural gas (CNG) and LNG vehicles and LNG-fuelled ships) is small, 1.5% of the total.

By 2040, this pattern is expected to have changed little. In BP's view[9], power will amount to 37.9%, industrial fuel to 33.5%, feedstock to 6.6%, buildings to 18.7%, and transport to 3.3% (FIGURE 5).

FIGURE 05: **WORLD GAS CONSUMPTION BY SECTOR**[10]

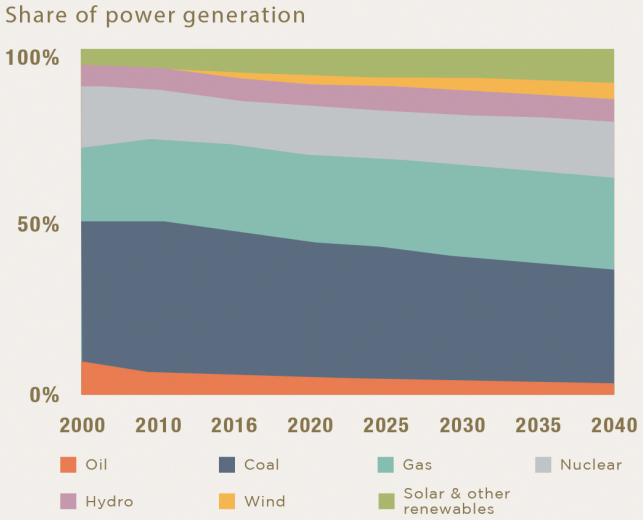


Gas in **power** faces challenges from coal and nuclear, but has advantages over coal in environmental performance, and nuclear in cost, schedule and public acceptance *(see Al Attiyah Foundation Research Series, Issue 28).*

Variable renewable power generation (wind and solar) still requires back-up, likely to be largely from gas. However the falling cost of renewables will make it increasingly popular for wind and solar to replace gas wherever possible, saving on fuel even if gas-fired capacity increases. Cheaper batteries will also enable them to compete with gas in providing peak power.

Electricity demand growth is also expected to slow as economies mature, efficiency improves and electrification of most households is completed. Therefore, increases in the quantity of gas used in power gradually slows down from 2.1% annually in the early 2020s to 1% annually in the late 2030s[11], although this still outpaces the increase in electricity demand. FIGURE 6 shows ExxonMobil's view of power generation market shares, where gas gains from coal and oil while losing to renewables, and overall maintaining almost a constant market share. However, this is a conservative forecast of renewable potential.

FIGURE 06: **POWER GENERATION SHARES BY SOURCE**[12]



In **industry**, gas as a feedstock will grow in line with demand for petrochemicals and fertiliser. The direct reduced iron process, employing gas (or hydrogen) as a reducing agent for iron ore, will likely also grow because of its potential to be low-carbon. However, gas will face competition in petrochemicals from oil, since many of the major national oil companies are targeting this as a key market. If oil is losing ground in transport and its price is reasonable, it will compete as a feedstock because of the greater range of products it yields. yields.

As an industrial fuel, gas faces similar challenges to that in the power sector: it will drive out coal because of its cleanliness, but it will be faced by steady improvements in efficiency, and by competition from electricity in certain applications. Waste heat or renewable (solar) heat could also compete for low-temperature applications such as food processing.

But gas does have the opportunity to make inroads into industry where its availability is currently low because of

inadequate supply and/or pipeline grids. This is particularly the case in China (where the government has recently been encouraging gasification, but pipeline build-out has not kept pace, leading to supply of LNG by trucks). India and various African countries such as Ethiopia and South Africa are also likely contenders.

Residential and commercial gas use can also gain from the extension of grids to areas where it is not yet available. But this is likely to be the slowest-growing sector of gas consumption, as the major markets with cold winters (Canada, US, Europe, Russia, Iran, South Korea, Japan) are already highly gasified, with the exception of northern China.

Efficiency improvements, particularly insulation, better boilers, solar heating, district heating, and heat pumps, are cutting European demand. Germany's 'Passivhaus' standard uses 75-95% less energy for heating than a conventional building. Rising temperatures with global warming can also be expected to cut high-latitude heating demand (though they will increase electrical demand for air-conditioning).

Some climate change policies call for eliminating gas use in residences entirely, and replacing it with electrification, including electrically-driven heat pumps. However, this will be very challenging on a large scale, because of the huge peak in electricity demand it required during a cold winter spell, when solar and wind power may be providing little output. Gas is much easier to store than electricity, and therefore provides a buffer against sudden demand spikes.

Even though the share of gas use devoted to transport is forecast to more than double, it remains relatively small. Increasing gas consumption in transport will be driven mainly by the adoption of LNG in shipping, particularly encouraged by the IMO ruling reducing marine fuels' sulphur content, and likely subsequent action to cut ships' carbon dioxide emissions *(see Al Attiyah Foundation Research Series, Issue 18)*. LNG may be adopted for heavy trucks, and CNG for urban vehicles to improve air quality, as is already popular in Iran, Egypt, India and Pakistan. However, improvements in electric vehicles will probably make them the dominant choice.

New technologies can support gas demand

While gas demand is threatened by the deployment of renewables and batteries, other emerging technologies could boost gas demand directly or indirectly. Or, they can make it more environmentally acceptable and so encourage its continued use.

Complete replacement of oil vehicles with electric would boost gas demand for power by about 20% by 2040, or roughly an additional 300 BCM annually in a world market of approximately 5100 BCM. That assumes that about 25% of the additional electricity required would be supplied by gas, in line with its current market share.

The deployment of CCS would slightly increase gas demand in the power sector by reducing the efficiency of generation. However, new technologies might cut this 'efficiency penalty' to a small level. More importantly, the use of CCS would enable gas to continue being used as a fuel for power and industry while meeting climate targets. This is likely to be increasingly important from the 2030s onwards when, if progress is being made on limiting emissions, coal use will have dropped steeply.

In the long term, synthetic gases could also compete with natural gas: renewable natural gas (RNG) or biogas, produced from waste or plants; synthetic natural gas (SNG), formed by reacting coal or atmospheric carbon dioxide with water, or; hydrogen.

If hydrogen is produced from natural gas via steam methane reforming (SMR), it would add to gas demand. Combined with CCS, this would be a low-carbon energy option. Zero-carbon hydrogen can also be produced by electrolysing water (using renewable or nuclear electricity). But large-scale hydrogen production via SMR plus CCS is likely to remain cheaper than electrolysis for an extended period.

A future energy system might rely heavily on hydrogen for seasonal energy storage, industry (heat, and a reducing agent for iron making), home heating and marine and aviation fuel.

Conclusions: Implications for leading oil and gas producers

Most major forecasts show a solid outlook for gas demand growth. However, some scenarios of strong renewables adoption do suggest a stagnation or fall in gas demand by 2040. This is well within the operating lifetime of a new major gas field, LNG plant or pipeline. This therefore demands careful attention from leading gas producers.

Conversely, gas demand is price-sensitive. Therefore, big exporters have to be careful to avoid underinvestment and price spikes, which would harm future demand. Gas faces significant competition from coal, nuclear and renewables (in power generation) and coal and oil (in industry).

Encouraging new geographic and sectoral markets, by constructing the required infrastructure to import, distribute and consume gas, creates new demand. Developing a market for gas is a much more active process than doing so for oil. China, India, Brazil, Vietnam, Philippines and large parts of sub-Saharan Africa, with large populations and low levels of gasification, are promising for market development.

Widespread adoption of CCS is essential for making gas climate-friendly, and so assuring its long-term future. New technologies, particularly hydrogen, also open up the possibility of large and novel markets for gas.

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