LNG: POWERING PROGRESS IN AND EVOLVING INDUSTRY

Jefferson Edwards
Shell Energy, Royal Dutch Shell

The objective of this paper is to assess the policy and market factors which support demand growth and will allow the LNG industry to fulfill its long-term growth potential. The LNG industry has been growing at sustained rates for the past 15 years, driven by its ability to guarantee secure energy supply and responsiveness to rising environmental concerns.

Growth has been characterized by periods of increased investments in capacity additions, followed by market adjustments and demand growth. Increasingly, demand is driven not only by underlying economic and industrial growth, but also by the need to improve air quality and reduce carbon emissions.

Following recent major capacity additions, LNG trade is set to double by 2020, compared to 2015 levels. Beyond 2020, and with the energy transition under way, gas will continue to support renewables in power generation and to provide cleaner energy supply in non-power sectors.

Global gas demand is expected to grow at a compounded average annual rate (CAGR) of 1.7%. The LNG industry is expected to capture a sizeable part of the gas growth and increase its size at a 4% CAGR. Despite this outlook, the promise of growth will be fulfilled only if the LNG industry remains resilient in a fast-changing environment. Starting from a market fundamentals perspective, this paper will analyse what will drive LNG growth in the 2020’s.
LNG: Powering Progress in and Evolving Industry

Energy powers progress. Meeting increasing global demand while minimising negative impacts on the planet and the air we breathe is one of the greatest challenges of the 21st century. A transformation of the global energy system is needed. It will take place at different paces in different countries, depending on factors such as available natural resources and national policies designed to address climate change and local air quality.

Natural gas will be a critical component of this energy transition — to generate electricity, provide heat for essential industrial processes, heat or cool homes, and transport people and goods over long distances. LNG, as the fastest growing source of natural gas supply globally, is playing an increasingly important role in meeting energy needs.

Switching from higher emitting fuels such as coal to cleaner-burning natural gas is significantly reducing greenhouse gas emissions and air pollution today. The flexibility of natural gas will continue to support the integration of variable renewable electricity, cost-effectively responding to increases in demand and drops in supply from solar, wind and hydro.

Electricity generation is expected to increase from a fifth of energy use today to 50% by 2050. As the share of renewable electricity increases, the flexibility of natural gas will make it increasingly competitive with other thermal power generation. Natural gas will also be vital in parts of the economy that are more difficult to electrify, including industrial processes and freight transport.

Economics, government policies, market regulation and an evolving industry structure will shape the future role of LNG in the global energy industry. The economics will become more competitive as government policies consider not only the cost of purchasing and using fuel, but also the anticipated costs associated with the impacts on the environment and human health.

Government policies that put a price on carbon emissions can help reduce emissions and encourage investment in cleaner energy sources. Likewise, government-led emissions standards can drive investment and accelerate emissions reductions.

While demand for LNG continues to grow, anticipated at an approximately 4% global growth rate to 2035, winds of change are impacting the shape of the industry. As domestic production declines or grows slowly in many key markets, LNG is playing an increasingly important role in meeting gas demand in both Asia and Europe. The emergence of the United States as a major source of LNG supply, while Australia reaches its long-anticipated potential as an LNG exporter, is reshaping the trade flows for gas globally.

At the same time, the LNG market structure is evolving. Floating regassification and storage units (FSRU), which can provide greater financial and operational flexibility than traditional onshore terminals in some cases, have been critical to opening emerging markets. New markets for LNG are also emerging – particularly in the transport sector. The spot market for LNG continues to expand strongly, while new pricing benchmarks such as the Japan Korea Marker (JKM) have emerged. New players have emerged pursuing unconventional business models, as suppliers, traders and buyers of LNG.

Growing global demand for energy

The world will need more energy as populations grow. By 2070, the global population could reach 10 billion. That is 2.5 billion more people than today, which is equivalent to the combined populations of China and India, the two most populous countries in the world.

An increase in energy demand will also be driven by economic growth, and as people seek to improve their quality of life. That could mean lighting a home at night, running a refrigerator to store food or medicines, growing a business, or fuelling a car. Even assuming significant future energy efficiency gains, global energy demand is expected to grow by 30% between 2015 and 2040, according to the International Energy Agency (IEA) New Policies Scenario.

Reflecting economic growth, increases in future energy demand are likely to be concentrated in China, India, Africa, the Middle East and South-East Asia. In Asia, energy demand is expected to increase by 50% by the middle of the century, as the number of people in the region grows by 900 million. Demand for energy will also increase significantly in Africa.
Today, cities consume about three-quarters of global primary energy and emit more than half of the world’s total greenhouse gases, according to the UN. Around two thirds of the world’s population are expected to live in cities by 2050, up from around half today. This reflects population growth and migration trends. It will require building the equivalent of a new city of more than 1 million people every week for the next three decades.

The greatest growth is expected in China, India, the USA and Sub-Saharan Africa. In China, around 1 billion people are expected to live in cities by the middle of the century – 350 million more than today and the equivalent of 40 new cities, each the size of Greater London. In India alone, more than 300 million people are expected to move to cities over the next 25 years. The use of energy and other resources such as water will increase considerably, as increased productivity, economic development and rising incomes drive up demand.

Natural Gas and LNG: Providing more and cleaner energy
Providing access to energy, while minimising negative impacts on the planet and the air we breathe, is one of the greatest challenges of the 21st century. In 2015, the UN adopted 17 Sustainable Development Goals. These goals seek to tackle some of the world’s greatest challenges by 2030. Goal 7 aims to "ensure access to affordable, reliable, sustainable and modern energy for all". This is an ambition that implies changes in the way energy is produced, accessed and used.

The challenge of climate change
Since the start of the Industrial Revolution, human activities have significantly raised the concentration of greenhouse gases in the atmosphere; mainly carbon dioxide (CO2), methane and nitrous oxide. In 2014, the 5th Assessment Report of the UN Intergovernmental Panel on Climate Change (IPCC) concluded that it is "extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century". Today, energy is responsible for two-thirds of global greenhouse gas emissions. Oil (32%), natural gas (21%) and coal (29%) together make up 82% of the world’s energy mix, according to the IEA. The remaining fifth comes from biomass (including wood, peat and dung), waste, nuclear, hydropower, and other renewables (such as solar and wind). More energy from the current mix means more greenhouse gases, which leads to further climate change.

The world currently emits 32 billion tonnes of energy related CO2 each year. To limit the rise in global temperature to 2°C, the IEA has calculated that energy related CO2 emissions need to fall to around 18 billion tonnes a year by 2040. This poses a significant challenge. To put it in context, removing around 200 million cars from the road (equal to every car in Europe) would save just 1 billion tonnes each year.

Improving air quality
Today’s energy mix also has a significant impact on air quality, particularly in densely populated urban areas. In the energy system, most air emissions occur because of the combustion of fuels such as coal and diesel. There is broad consensus that air pollution affects millions of people around the world. It leads to early deaths and productivity loss due to lung and heart diseases.

Although developed countries have seen improvements, many developing countries with rapidly growing economies are experiencing worse air quality. The World Bank estimates that more than half of the burden falls on China, India and other economies in Asia. In China, air pollution associated with burning coal results in costs estimated at around $73 billion, or about 6.6% of gross domestic product, according to a study by the consultancy PwC Strategy&, which specialises in tax, audits and assurance. It represents one-third of China’s annual public spending and 300% of public spending on pollution and health. This study shows that, in line with the government’s target, increasing the share of natural gas in the energy mix from 6% today to 10% in 2020 could reduce costs related to air pollution by around $12.5 billion – $3 billion for every additional percentage increase in gas’ share.

The role of natural gas and LNG in the energy transition
Natural gas, often delivered as LNG, is a critical component of the energy transition – helping to meet increasing demand while lowering greenhouse gas emissions and improving air quality. It is one of the few energy sources that can be used across all sectors of the global economy. It is used to generate electricity, provide heat for essential industrial processes, heat homes and fuel the transport of people and goods.

Natural gas emits between 45% and 55% lower greenhouse gas emissions than coal when used to generate electricity, according to IEA data. Today, coal-fired power stations produce around 40% of the world’s electricity, which represents more than two-thirds of global CO2 emissions from electricity generation. Using natural gas
instead of coal to generate electricity can significantly reduce air pollution. Compared to coal-fired power plants, modern natural gas-fired power plants emit less than one tenth of the pollutants.

Despite the significant role of renewables, they cannot provide all the world’s energy needs today. Renewables chiefly power electricity, which only meets around a fifth of global energy demand. For renewables to have a bigger impact, electricity must play a larger part in other key sectors of the economy. As the role of electricity grows, the world will increasingly rely on the electricity supply being reliable and affordable, as well as sustainable. Natural gas supports the integration of variable renewable electricity generation because it can quickly compensate for dips in solar or wind power supply and rapidly respond to sudden increases in demand. Natural gas is a good partner for hydropower, providing a secure electricity supply when there is insufficient rainfall.

Natural gas will have a central role in the energy transition in the industrial sector. In light industry, such as textiles, switching from coal to gas boilers can make a significant contribution to cost reductions, lower greenhouse gas emissions and improved air quality. Likewise, in heavy industries such as iron, steel, cement and chemicals, switching from coal to gas to produce the intense heat required in furnaces can significantly reduce emissions. Natural gas will continue to be a central component to produce everyday products such as plastics and fertilisers.

Increasing use of cleaner-burning natural gas in industry, where it displaces coal and oil, offers the potential to significantly reduce greenhouse gas emissions and air pollution today. These benefits are being recognised by policymakers, particularly in rapidly growing economies such as China. In Northeast China, industrial coal to gas switching is estimated to have added around 17 billion cubic metres to overall gas consumption in 2017, driven largely by policies to reduce air emissions. That is enough gas to supply Belgium for a year. According to the consultancy Wood Mackenzie, global industrial gas demand is likely to increase by 45.5% between 2015 and 2035, with growth of 107% in China and 108% in India. Demand is expected to rise significantly in the chemicals sector, with growth in the need for everything from food packaging to car parts.

Lanzhou is the capital of Gansu, a province in Northwest China. Until 2013, Lanzhou was one of the country’s most polluted cities, largely because of emissions from industry. Residents referred to it as a ‘city which could not be seen on a satellite’. Following a three-year programme to reduce air pollution, focused on switching from coal to natural gas, emissions were significantly reduced. This resulted in a 40% decrease in hospital admissions related to respiratory conditions, a 68% decrease in associated medical costs and an 18% increase in GDP. Visitor numbers have also increased and, in 2015, Lanzhou won the ‘Today’s Revolution and Advancement Award’ at the UN Paris Climate Conference in recognition of this achievement.

Natural gas is playing a significant part supporting the energy transition in the built environment as well. In developing economies, it will replace traditional biomass in heating and cooking, helping to reduce the health impacts of localised emissions from other fuels. In developed countries, planning that incorporates infrastructure to accommodate an increasing share of highly efficient, distributed gas-fired combined heat and power (CHP) systems will help to reduce emissions of greenhouse gases and air pollution, particularly where they replace electricity and heat generated from coal or diesel. The use of natural gas-fired CHPs can also support the integration of low-emissions sources of energy, including geothermal heat and power, solar, wind and batteries.

Where gas infrastructure is in place, replacing conventional natural gas-fired boilers with highly efficient natural gas-fired condensing boilers today represents a fast and cost-effective way to improve energy efficiency and reduce emissions from the use of energy in buildings. In the EU, for example, heating accounts for 27% of total energy consumption (including in houses, offices and public spaces), with gas accounting for 46% of supply.

According to a Burgeap Report for trade association Eurogas in 2014, if all existing conventional gas boilers were replaced with high-efficiency condensing boilers, the EU member states could reduce CO2 emissions from heating by as much as 7%. In countries with existing gas infrastructure, gas can also be a cheaper source of heating than electricity. For example, in the UK gas costs up to three times less per kilowatt hour than electricity.

Highly efficient gas boilers can also support the integration of renewable energy sources, such as heat pumps, by meeting any shortfalls in demand for heat on very cold days. Such hybrid systems allow consumers to access the lowest-cost energy available. Longer term, these systems will also allow the integration of decarbonised gas, such as biogas or hydrogen.

Natural gas is playing an important role in the energy transition in the transport sector, as part of a mosaic of fuel and engine solutions. Liquefied natural gas (LNG) is helping diversify the fuel mix and reduce air pollution as a fuel
for heavy-duty road transport and shipping. Natural gas is also converted into high-quality cleaner burning gas-to-liquids (GTL) fuels for heavy-duty vehicles, inland and seagoing marine vessels.

Energy use in transport is expected to increase most in long-distance transport modes between 2015 and 2060, according to the IEA. In ships and trucks – where the size, weight and range of batteries currently limit their potential, natural gas could be an effective way to reduce air pollution and greenhouse gas emissions. The IEA estimates that use of natural gas for transportation could grow by as much as 14% between 2016 and 2022.

Around 80% of world trade in goods is by ship. This trade is expected to increase by nearly 50%, between 2017 and 2030. Today, there are limited alternatives to hydrocarbons to fuel ships, which still mainly run on heavy fuel oil and diesel. The global shipping fleet produces air pollution, which impacts the environment and human health. Around 70% of these emissions occur within 400 kilometres of coastal communities – mainly in East Asia, South Asia and Europe.

The International Maritime Organization has made progress in agreeing to limit sulphur oxide and nitrogen oxide emissions from ships. LNG fuel can help ship operators meet these requirements. Compared to heavy fuel oil, natural gas combustion produces up to 80% less nitrogen oxides, which can help reduce smog formation. Natural gas emits virtually no sulphur dioxide, so using more natural gas as fuel would emit less of the pollutants that cause acid rain. LNG also has a lower unit cost compared with low-sulphur heavy fuel oil or low-sulphur diesel fuel.

Shipping also produces greenhouse gas emissions. Although it is an efficient means to transport cargo over long distances, the scale of activity generates significant total emissions, with more than 50,000 merchant ships operating internationally. Switching from heavy fuel oil to LNG can reduce greenhouse emissions by up to 21% in a two-stroke engine with high-pressure injection and by 11% in a four-stroke engine, according to the Thinkstep study. This may become an increasingly important consideration for ship operators with the development of more stringent international emissions standards over the next decade.

Gas becomes increasingly competitive with other fossil fuels when all costs are considered. These include the costs associated with purchasing and using the fuel, as well as the anticipated costs associated with the resulting greenhouse gas emissions and negative impacts of air pollution on the environment and human health.

In the UK, a government-led “carbon price” floor of £18 per tonne introduced in April 2015, contributed to a 56% increase in demand for natural gas in the power sector and a 73% decrease in demand for coal-fired electricity generation in the first half of 2016, according to Aurora Energy Research. As a result, CO2 emissions from the UK power sector decreased by 24%. In April 2017, the UK went a day without using any coal to generate electricity for the first time since 1882.

**LNG Reaches Its Full Potential as a Critical Source of Gas Supply**

Natural gas’ environmental and operational benefits ensure that it will play an important role in the energy system for decades to come, growing at a 2% annual rate to 2035. Within the gas industry, the fastest growing source of supply will be LNG, which is anticipated to grow at approximately 4% annually over the same period. LNG provides a flexible energy solution which meets many countries needs and has the unique potential to connect gas supply sources to gas demand centres which are separated by great distances.

At the same time, the LNG industry is being reshaped by a range of factors. New sources of supply are emerging in the Americas and Africa. New technologies are increasing the penetration of LNG into emerging markets and deepening of the market in major developing markets such as China and India. Buyers in mature markets are reconsidering the balance between long-term and shorter term contracts, with the spot market growing rapidly in concert. An increasing share of contracts are linked to hub-based pricing. As a reflection of these driving forces in the industry, new business models are emerging as well, with new players entering various points in the LNG supply chain.

There has been rapid growth in the number of countries supplying LNG, almost doubling between the start of the century and 2018. This has significantly increased the flexibility and security of gas supply options for importing countries. For example, in 2018 China imported natural gas from more than 20 countries, via a combination of both pipelines and as LNG. In 2018, delivered volumes reached 319 MT, nearly doubled in the last 10 years. Once all current construction is finished by 2020, the liquefaction capacity will have doubled from its 2015 level.
Liquefaction capacity addition picked in 2018 at 37 MT. LNG supply is expected to grow by 35 MT and 29 MT in 2019 and 2020 respectively. 60% of this supply growth is going to come from the US projects alone as 35 MT of new US liquefaction capacity comes online between 2019 and 2020. However, capacity additions are expected to slow down rapidly as the 30% of the remaining projects under construction come online over the next 2-3 years.

At the same time, the number of countries importing LNG has quadrupled, with LNG trade increasing from 100 million tonnes in 2000 to 319 million tonnes in 2018, according to IHS Markit. China LNG imports grew at phenomenal 40% rate three years in a row. China alone represented 60% of the global growth in the LNG market in 2018 primarily driven by coal to gas switching program in the industrial and res/com sectors.

Despite the strength of the Chinese market, the LNG trade has proven to be both flexible and resilient, able to adapt quickly to shifting trade patterns, market factors and policy changes. For example, Korea hit its record high LNG imports of 44 MT in 2018 due both to a a record breaking heat wave during summer months, low nuclear utilization and policy-driven constraints on coal-fired generation to improve air quality.

Demand strength will continue as gas import and transmission infrastructure continues to pick up pace. China’s regas capacity is expected to continue to increase, from the current 70 MT to more than double in 5 year. Currently, India has four regas terminals in operation with effective capacity of little less than 30 MT with operating at relatively high levels of utilization of about 75-80% as of today. With six projects under construction currently, the regas capacity is expected to double in three years' time. This expansion in import capacity will be matched by significant increase in gas transportation and distribution within India in the coming decade. Currently there are approximately 4,000 km of trunk pipelines under construction, while the government licensed 86 new areas for city gas distribution in 2018 alone in areas which have historically had no access to natural gas.

Floating storage and regasification units (FSRUs), which present a fast, flexible and economically competitive option for countries looking to import LNG, have made a significant impact on accessing new markets. These vessels can be docked in a port to regasify LNG and feed gas into a transmission or distribution network. FSRUs also offer benefits to countries looking to replace or complement existing gas supplies, or to balance seasonal variations in hydropower. Currently, there are over 20 FSRU terminals in operation worldwide and many more under construction, according to the International Gas Union.

The current wave of investment that underpinned today’s 70% expansion in LNG capacity across the global LNG market expected to support the demand growth over the next few years. However, robust demand growth across time horizon requires continued investments in the new projects now to meet this growing demand by the middle of next decade.

As well, the global LNG market continues to develop its flexibility and responsiveness to buyers’ needs. The LNG spot trade accounted for almost 30% of the global market in 2018, with ~1,500 spot cargoes traded. The growth of spot supply in recent years has come largely from uncontracted supply from Russia and the US. The inherent flexibility of U.S. supply and the country’s capacity growth over the next few years will keep it at the forefront of incremental spot supply growth.

Historically, around half of all spot supplies go into North Asia, where one cargo a day is traded. But the regional diversity of spot buying is growing, with Europe emerging as the largest buyer. It is expected that the European market will play a pivotal role for spot market development, growth and depth in the coming years.

The growth of the spot market has also supported the emergence of alternative pricing benchmarks, most notably the Japan Korea Market (JKM) LNG benchmark price assessment for spot cargoes. Increased spot trade in Asia enables confidence in the use of JKM as a benchmark. More physical spot trading will likely be followed by a financial market to management risk. Activity in the JKM swaps futures market increased its percentage versus the physical market, getting to just over 10% last year. This compares to 2017 when the LNG derivatives market only covered ~3% of the physical market. Liquidity in the financial Asian LNG spot markets continues to reflect to rising number of participants in the physical and financial markets but also the increasing confidence to transact on an index that tracks the supply and demand fundamentals of the LNG market.

A Bright Future for LNG

Energy powers progress. Meeting increasing global demand while minimising negative impacts on the planet and the air we breathe is one of the greatest challenges of the 21st century.
A transformation of the global energy system is needed. It will take place at different paces in different countries, depending on factors such as available natural resources and national policies designed to address climate change and local air quality.

Natural gas will be a critical component of this energy transition – to generate electricity, provide heat for essential industrial processes, heat or cool homes, and transport people and goods over long distances. LNG will play a prominent role in this transition, enhancing global energy security by connecting remote sources of supply with demand centres in a flexible, secure manner.

Switching from coal to cleaner-burning natural gas is significantly reducing greenhouse gas emissions and air pollution today. The flexibility of natural gas will continue to support the integration of variable renewable electricity, cost-effectively responding to increases in demand and drops in supply from solar, wind and hydro.

Natural gas will also be vital in parts of the economy that are more difficult to electrify, including industrial processes and freight transport.

Economics, government policies and relative environmental benefits will shape the future role of natural gas. The economics will become more competitive when government policies consider not only the cost of purchasing and using fuel, but also the anticipated costs associated with the impacts on the environment and human health. Government policies that put a price on carbon emissions can help reduce emissions and encourage investment in cleaner energy sources. Likewise, government-led emissions standards can drive investment and accelerate emissions reductions.

The rapid growth of LNG is playing an important role in increasing energy supply, security, diversity and flexibility. LNG is available during gas market uncertainties (supply and demand). Some examples where LNG provides energy security: Declining domestic production; Pipeline disruptions; Falling nuclear utilisation and reliability; Hydroelectric seasonality; renewable intermittency; and weather disruptions.

Strategic trends will continue to reshape the structure of the LNG industry. The opening up of new markets through the use of FLNG technology, the increased scale of the traded spot market for LNG and the growing linkage to hub-based pricing will allow for new business models to emerge and a more flexible and robust LNG market to continue to grow.