KING & SPALDING

What does the accelerating energy transition mean for the LNG business?

IN ASSOCIATION WITH

Petroleum Economist

Gorgon LNG in Australia is one of only two liquefaction projects in the world that captures and stores carbon dioxide from upstream reservoirs. Other producers are beginning to follow this lead, by installing carbon capture and storage (CCS) technology, as international pressure to decarbonise LNG intensifies. (Photo: Chevron)

Foreword

The liquefied natural gas (LNG) industry faces existential uncertainties arising from growing societal pressures for environmental, social and governance (ESG) principles to govern development and investment – not least in energy. Over the past two years ESG has become a political and commercial reality that the LNG business, like other sectors of the energy economy, will have to navigate.

So:

- **What is the outlook for the LNG business over the long term?**
- **How are industry players responding to ESG pressures?**
- **What more can be done to assure LNG's future in an accelerating energy transition?**

OPTIMISTIC OUTLOOK

LNG trade has been growing robustly for decades and the industry consensus is that it will continue to do so, at least for another couple of decades, by some 3.5%/year. If this forecast turns out to be correct, LNG trade will double between now and 2040 to 700 mtpa.

There is, however, acknowledgement that the growing push for humanity to achieve net-zero greenhouse gas (GHG) emissions by 2050 (NZE 2050) – in an ambitious effort to avoid the worst impacts of climate change – will require the industry to adapt in fundamental ways. The latest assessment of the science underlying climate change from the UN's Intergovernmental Panel on Climate Change confirms that the policy landscape will increasingly be impacted by ESG principles. In this context, we consider the outlook for LNG starting on p4.

PROS AND CONS

There is considerable debate about the role of natural gas/LNG along the path to climate neutrality. Unlike other primary energy sources – which tend to divide neatly into heroes and villains – natural gas has advantages and disadvantages in the mitigation of GHG emissions.

It is rich in hydrogen so emits less carbon dioxide than other fossil fuels when burnt. It contains fewer impurities and thus can contribute to improving air quality. But – it is a fossil fuel and the single carbon atom in the methane molecule cannot be ignored. Moreover, methane is a more potent GHG than CO_2, so fugitive emissions along the value chain have become contentious. We look at how the LNG industry is addressing these issues starting on p15.

THE WAY AHEAD?

While the industry has begun to address the disadvantages of natural gas/LNG – by optimising technology and operations, and offsetting unavoidable emissions with carbon credits – these efforts are in their infancy. Starting on p22 we examine what more the industry could and should be doing – to mitigate its own climate impact and to lobby for appropriate policy frameworks so that LNG can continue to play a positive role in the energy transition.

"The energy transition is happening and needs to happen urgently," says Lachlan Clancy, partner in King & Spalding's Corporate, Finance and Investments practice, based in Singapore. "Natural gas has a role to play in that transition but to play that role the industry needs to do everything it can to improve its green credentials on an ESG basis." ■

1 The outlook for LNG

China is well on its way to becoming the world's largest importer and consumer of liquefied natural gas; it is currently overtaking Japan, the largest LNG importer since the mid-1970s. So the surprise announcement at last September's United Nations General Assembly by President Xi Jinping of a net-zero greenhouse gas (GHG) emissions target of 2060 for China was highly significant for the industry.

Perhaps counter-intuitively for some, major industry players welcomed the announcement, predicting that China's climate pledge would drive rather than dampen demand for LNG. This is because of the role that natural gas will need to play in displacing coal from electricity generation and decarbonising hard-to abate sectors, such as buildings, heavy industry, shipping and heavy-duty road transport.

In its influential *LNG Outlook 2021*, Shell – a major producer and trader of LNG, supplying one-fifth of the global market last year – forecasts that Chinese LNG demand will rise to 130 mtpa by 2040, almost double the 67 million tonnes it imported in 2020.

Within weeks of President Xi's announcement, first Japan and then South Korea pledged to reach net-zero emissions by 2050. So by the end of 2020 the world's three largest LNG importers had all made NZE climate pledges – a remarkable development.

"Covid-19 captured the headlines last year," says Shell's Integrated Gas, Renewables and Energy Solutions Director, Maarten Wetselaar, "but another very significant theme was the top-down policy acceleration for decarbonisation. Today, more than a quarter of the world's population and around half of GDP is covered by countries with NZE commitments. Natural gas and LNG have a central role to play in delivering the energy the world needs and helping power progress towards NZE targets."

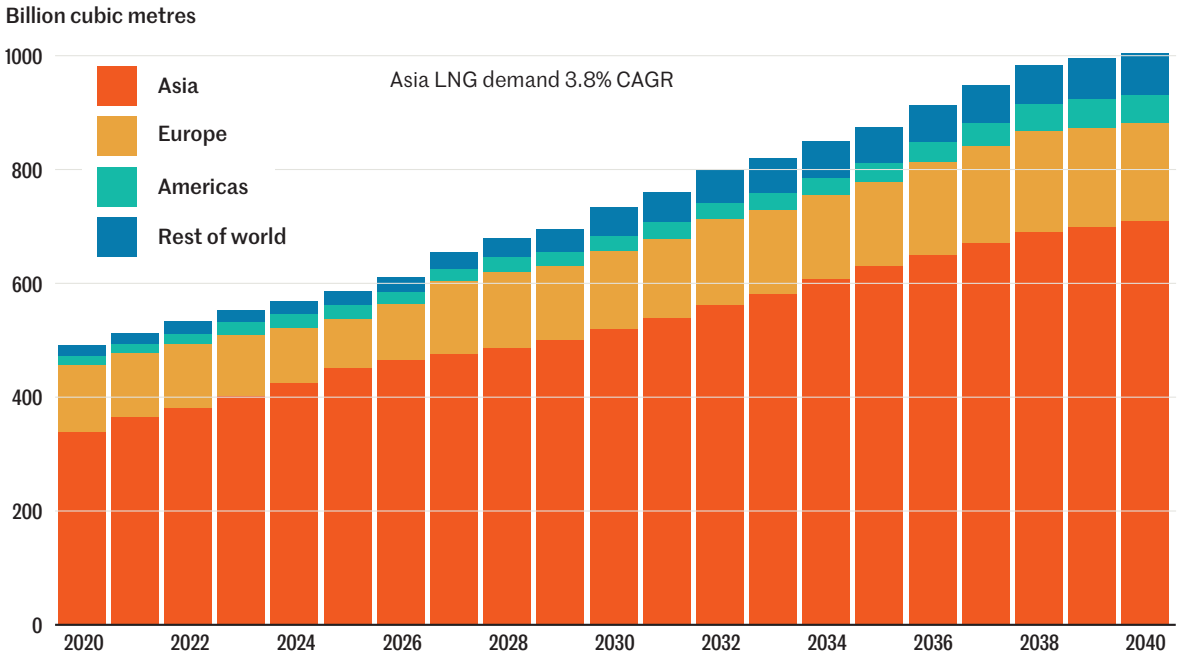
DEMAND TO DOUBLE BY 2040

Over the course of the past year, a consensus has emerged over the future demand trajectory for LNG. Producers such as Shell, Cheniere Energy and newcomer Venture Global are joined by industry associations such as the Gas Exporting Countries Forum (GECF) and the LNG importers' group GIIGNL in their views that demand will double over the coming two decades – going from 360 mt in 2020 to around 700 mt in 2040, a compound annual growth rate (CAGR) of 3.5%.

The GECF forecasts demand of 820 mtpa by 2050, only slightly more than Wood Mackenzie's Director of LNG, Giles Farrer, who expects 800 mtpa by 2050. So it is not just producers and lobbying organisations that are bullish about LNG's outlook; analysts and consultants are too.

Everyone agrees that the lion's share of growth will be in Asia Pacific, as domestic gas production declines in several major economies and as LNG replaces energy sources with higher GHG emissions – tackling air quality concerns and helping to meet emissions targets in climate pledges under the 2015 Paris Agreement, the so-called Nationally Determined Contributions (NDCs). CAGR in Asia Pacific is forecast at 3.8%.

LNG imports by region, 2020-40



Source: Shell LNG Outlook 2021

INVESTMENT TRENDS

Helping to drive this bullish outlook are recent trends in liquefaction investment. While 2020 was a disappointing year for final investment decisions (FIDs) on new LNG supply projects – with only Sempra Energy's 3 mtpa Energía Costa Azul LNG venture getting the green light – 2019 was an all-time record year, with more than 70 mtpa of capacity sanctioned.

As 2020 began, 60 mtpa of capacity was forecast to cross the finishing line but the Covid-19 pandemic led initially to widespread demand destruction and appetite for investment evaporated.

This year will be another bumper year following Qatar's FID on its 32 mtpa North Field East expansion in February. Even if no other projects are sanctioned, 2021 will be "the third-highest level of liquefaction FIDs", according to Terrell Benke, Executive Director for Global Gas and LNG at IHS Markit.

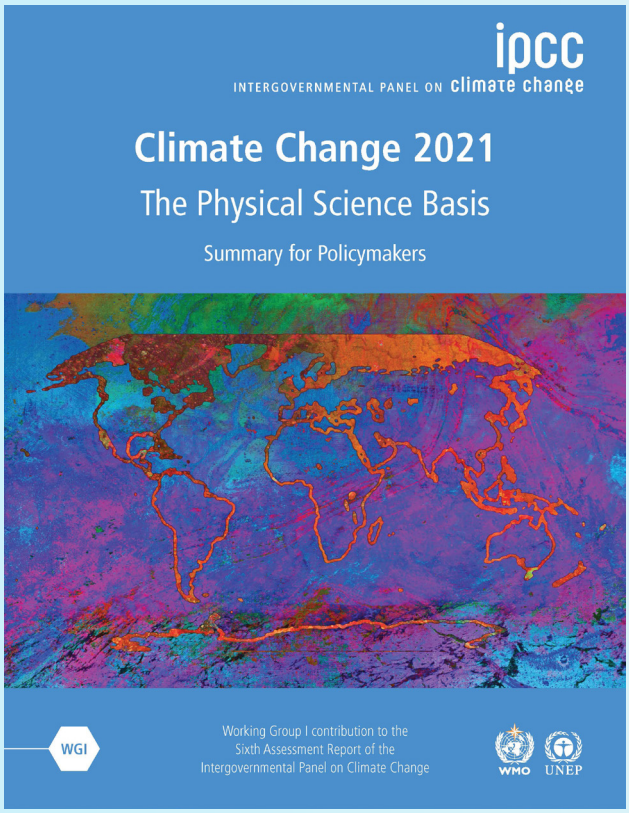
The list of projects striving to reach FID is long – encompassing projects in the US, Africa, the Middle East, Russia and Asia (see map on p12) – but many need long-term offtake contracts to move forward. So the list of contenders for FID this year is short; one possibility, Novatek's 5 mtpa Obskiy LNG, may now become an ammonia plant.

Next year could see more projects move ahead if a tentative resurgence in long-term contracting gathers pace, driven in part by the sky-high prices we have seen in natural gas and LNG markets in recent months – a result of strong demand growth at a time of unplanned outages in liquefaction plants in the US, Australia, Algeria, Norway and Indonesia.

GROWING PRESSURE TO DECARBONISE

However, the optimistic outlook for LNG needs to be seen in the context of the "top-down policy acceleration for decarbonisation" highlighted by Wetselaar. Over the past two years, awareness of the climate emergency has spread widely and rapidly, and the LNG industry faces existential uncertainties as it faces up to growing societal pressure for environmental, social and governance (ESG) principles to govern investment.

These pressures can be expected to intensify over time, given the latest assessment of climate science from the Intergovernmental Panel on Climate Change (see p9), and growing evidence that increasingly common extreme weather events are being driven by global warming.



Human link to climate change and extreme weather 'unequivocal'

IPCC

Any lingering doubt that human activity is severely disrupting the earth's climate was banished in August when the Intergovernmental Panel on Climate Change (IPCC) published its latest assessment of the physical science.

Announcing its findings, the IPCC said: "It is indisputable that human activities are causing climate change, making extreme climate events – including heat waves, heavy rainfall and droughts – more frequent and severe." The report itself uses the word "unequivocal" – a significant departure from previous assessments, the last of which was published in 2013. This is by far the strongest language the Panel has yet used.

The IPCC's Working Group 1 (WG1) report, *Climate Change 2021: the Physical Science Basis*, is the first instalment of the Sixth Assessment Report (AR6), which will be completed next year. Its conclusions are stark:

- **Unless there are "immediate, rapid and large-scale reductions" in greenhouse gas (GHG) emissions, limiting warming to close to 1.5°C or even 2°C – as required by the 2015 Paris Agreement – will be "beyond reach".**
- **GHG emissions from human activities are responsible for "approximately 1.1°C of warming since 1850-1900".**
- **Averaged over the next 20 years, global temperature is "expected to reach or exceed 1.5°C of warming".**
- **Many of the changes observed in the climate are "unprecedented in thousands, if not hundreds of thousands of years" and some of the changes set in motion – such as continued sea level rise – are "irreversible over hundreds to thousands of years".**
- **The report also reflects major advances in the "science of attribution", the role of climate change in intensifying specific weather and climate events, such as extreme heat waves and rainfall.**

REALITY CHECK

"Stabilising the climate will require strong, rapid, and sustained reductions in greenhouse gas emissions, and reaching net-zero CO_2 emissions," says WG1 co-chair Panmao Zhai. "Limiting other GHGs and air pollutants, especially methane, could have benefits both for health and the climate."

The IPCC's conclusions underline the reality of a future policy landscape increasingly impacted by ESG principles, which the LNG industry will have to navigate. How much of a challenge and how much of an opportunity this represents will depend on how effectively the industry communicates the benefits of LNG in achieving rapid and large-scale reductions in GHG emissions, and how quickly and deeply LNG itself can be decarbonised.

LNG producers are consequently coming under increasing pressure to minimise GHG emissions at every link of the value chain, to document the carbon intensity of the LNG they supply, and, increasingly, to provide "carbon-neutral" LNG. There is particular pressure from major LNG buyers – such as gas and electricity utilities – because they in turn are under growing pressure to decarbonise their offerings to end-customers.

CARBON NEUTRALITY CASCADE

LNG players are responding to the growing momentum of the ESG movement, seeking to persuade potential investors and buyers that the industry can decarbonise, at least partially, along the value chain – from the wellhead, through liquefaction, transportation, regasification and even consumption.

Some sellers and buyers have already negotiated for the supply of individual carbon-neutral LNG cargoes and, in one case, even for a term contract; Shell announced in July that it had signed a five-year supply agreement with PetroChina, with lifecycle carbon dioxide equivalent (CO_2e) emissions offset with carbon credits from nature-based projects in China and elsewhere.

PetroChina signed the deal so that it will be able to provide carbon-neutral gas to Chinese businesses and households in line with China's 2060 carbon-neutrality aspirations. This cascade effect will inevitably grow in importance, affecting all players along gas and power value chains.

For example, in October 2019 Tokyo Gas announced a deal to supply Japan's first carbon-neutral city gas to two large customers, for a term of five years, starting in March 2020. In March 2021, Tokyo Gas and 14 other Japanese companies established a Carbon-Neutral LNG Buyers Alliance. In July 2021, Japan's Osaka Gas said it would start supplying carbon-neutral city gas to customers from the start of August. The carbon-neutral city gas being supplied by Tokyo Gas and Osaka Gas has all lifecycle GHG emissions offset with carbon credits.

"Clearly, over time, LNG will have to get to net-zero in its own right," says Maarten Wetselaar, "for which there are several pathways, such as carbon capture and storage (CCS), nature-based solutions, hydrogen blending and biogas."
The view of the LNG importers' group GIIGNL is that: "The environmental case for LNG is not limited to beating the CO_2 emissions performance of burning coal or oil. It is also making sure that its own emissions intensity – in particular regarding methane – is as low as possible." ■

2
Is LNG a climate hero or climate villain?

Along the path to climate neutrality by 2050, the question arises of whether natural gas in general and LNG in particular should be seen as hero or villain. For most primary fuel sources the answer is clear. In simplistic terms[1], coal and oil are climate villains; hydro, wind and solar power are climate heroes. For natural gas the answer is not clear-cut. (Nuclear too is a special case but outside the scope of this report.)

In the race to decarbonise the world's energy economy, natural gas has two advantages and two disadvantages:

RICH IN HYDROGEN

The first advantage is the high hydrogen content of the methane molecule – CH_4 – the primary constituent of natural gas. When methane is burnt, the carbon atom in methane oxidises to form a molecule of CO_2 while the four hydrogen atoms oxidise to form two molecules of harmless water vapour. Both reactions release energy as heat. This means natural gas emits much less carbon dioxide (CO_2) when burnt, per unit of energy generated, than oil and coal.

Oil has about half as much hydrogen per atom of carbon as natural gas while coal consists almost entirely of carbon. This gives gas a vital role in the energy transition as a substitute for these more carbon-intensive fuels, especially coal.

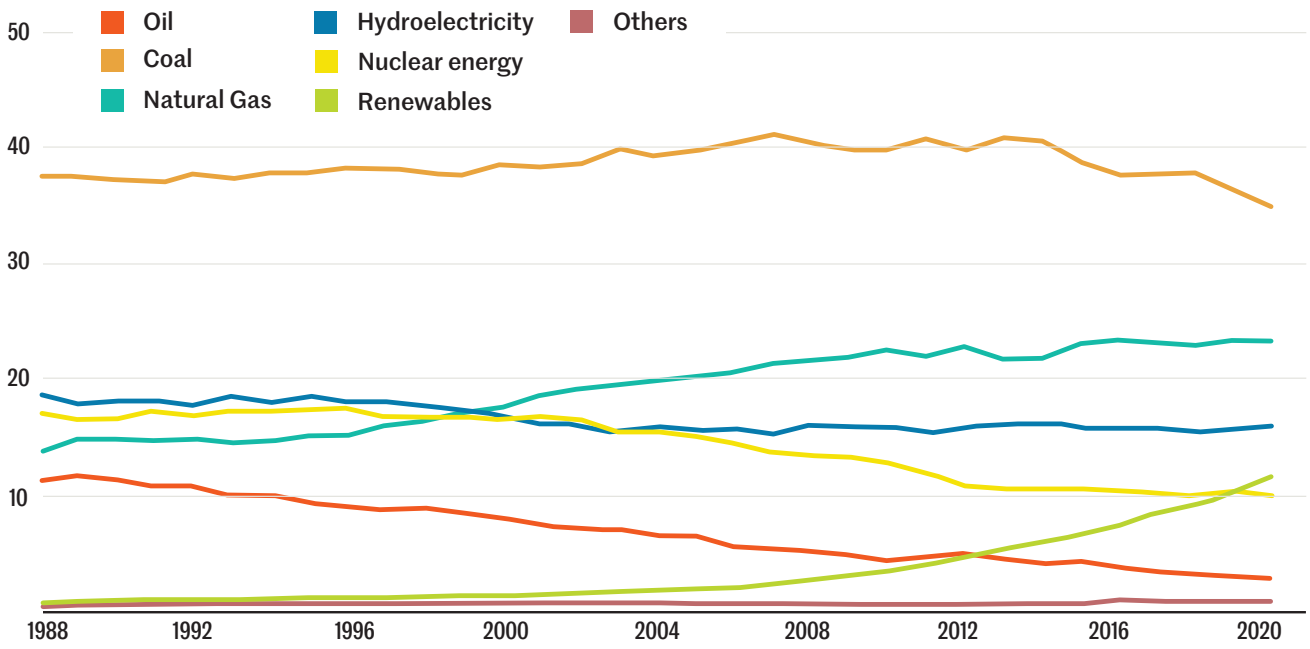
The importance of this role varies regionally. In some developed economies, coal is being pushed out of the electricity generation mix, leaving gas as the main emitter of CO_2. A good example is the UK, where coal consumption has fallen off a cliff, because of the rise of wind and solar power, and because of government policies that have made coal uncompetitive. But while the UK has seen heavy investment in renewable electricity generation, notably offshore wind power, natural gas continues to play a major role, in baseload generation, as back-up for intermittency, and in helping to keep the national power grid stable.

Nevertheless, oil and coal remain the two biggest sources of total global primary energy supply and many large economies remain heavily dependent on coal. Examples include large LNG consumers such as China, Japan, South Korea and India. There is a long road to travel before the potential for gas to reduce greenhouse gas (GHG) emissions through substitution of coal is exhausted. This is true not just in electricity generation but also in other energy-consuming sectors such as industry.

The chart opposite helps illustrate the scale of the challenge involved in eliminating coal from the world's electricity generation systems and the opportunity that this presents to the natural gas/LNG industry. Coal remains by far the most commonly used fuel and its share of the electricity fuel mix has remained remarkably stable over the past three decades, despite the rapid growth of non-hydro renewables over the past two decades. Only in recent years has its share begun to fall noticeably.

1. In certain circumstances – for example, where there is extreme energy poverty – a case can be made even for coal, given the importance of electricity in enabling people to improve their lot, if no alternative is available.

Share of global electricity generation by fuel, 1988-2020 (%)



Source: BP Statistical Review of World Energy, 2021

Substitution of oil is trickier because oil is the primary fuel for transportation, a sector in which gas struggles to compete – though it is starting to make inroads into marine bunkering and heavy-duty transportation. Few countries now burn much oil to generate electricity, as the chart above shows, but gas still has plenty of potential to replace oil use in industrial processes.

A FRESHER BREATH OF AIR

Another advantage of natural gas is that it contains far fewer impurities than coal or oil and so can make a major contribution to improving air quality – significantly reducing emissions of harmful oxides of sulphur and nitrogen and of damaging particulate matter, such as $PM_{2.5}$ (particles with a diameter of less than 2.5 micrometres), which increases age-specific mortality risk, particularly from cardiovascular causes.

The primary factor behind the spectacular growth of LNG imports into China has been President Xi Jinping's "blue skies" policies rather than a specific effort to mitigate GHG emissions. That said, China's NZE 2060 pledge means that in future substitution of coal by natural gas will need to accelerate, to reduce GHG emission and because gas will be needed to facilitate the integration of solar and wind power, which are growing rapidly.

METHANE'S ACHILLES HEEL

One disadvantage of natural gas is that methane is a much more potent GHG than carbon dioxide, and some oil and gas companies have historically been lax about controlling unwanted emissions of methane during the production of oil and gas, and during the transportation and consumption of gas.

The impact of a GHG on global warming is determined by two factors: its ability to absorb energy and the length of time it remains in the atmosphere. Unlike carbon dioxide, which remains in the atmosphere for centuries, methane released into the atmosphere lasts for only 12 years. So, over 100 years methane

The LNG industry has acknowledged that it will need to innovate throughout the value chain to minimise GHG emissions. (Photo: Chevron)

has a global warming potential (GWP) of around 32 times that of carbon dioxide, while over 20 years, its GWP is around 85.

It used to be mainly environmental NGOs that fretted about the oil and gas industry's emissions of methane and their implications for climate change. Then the International Energy Agency shone a spotlight on the problem. Now, concerned investors are insisting on greater disclosure of climate-related risks.

The numbers are shocking. Methane emissions are estimated to be the cause of a quarter of the warming that the planet is experiencing and 60% are anthropogenic. Belatedly, the oil and gas industries have started to devote significant resources to addressing this Achilles heel and thus reducing the climate impact of fugitive methane emissions.

A CARBON ATOM WE CANNOT IGNORE

The second, less tractable, disadvantage is that natural gas is a fossil fuel, with the single carbon atom in the methane molecule contributing to CO_2 emissions when combusted (for more detail on this, see p8). There is also the issue of the energy required to produce, liquefy, regasify and transport LNG and the consequent GHG emissions generated by these processes.

According to the IEA, natural gas accounted for more than one-fifth of global CO_2 emissions in 2020; with the recent recovery of demand, emissions from natural gas consumption are expected to rise by 3% in 2021 to an all-time high of 7.35 Gt (billion tonnes). GHG emissions from LNG supply and end use accounted for an estimated 17% of this.

The LNG industry has acknowledged that it will need to innovate throughout the value chain to lower GHG emissions so that it can continue to play a crucial role in powering hard-to-abate energy-consuming sectors. There is also a move towards the use of offsets to make LNG entirely "carbon-neutral", though so far the amount of LNG sold in this way is a tiny, almost negligible, fraction of the global total.

3
When aspirations collide with reality

While much has been said and written about the urgent need to decarbonise the global energy economy to meet the targets of the 2015 Paris Agreement, there is little consensus about the best way to achieve the target of net-zero emissions by 2050 (NZE 2050) *while at the same time continuing to meet the energy needs of the world's growing population, and giving access to modern energy services to the hundreds of millions of people who still lack them*.

A key element of the Paris Agreement is "to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century". This is what has spurred companies, countries and even continents to make NZE 2050 pledges.

PURISTS VERSUS PRAGMATISTS

Those adopting a primarily aspirational stance argue that investment in fossil fuels (including natural gas) should cease and that the world should aim to depend almost entirely on zero-carbon alternatives such as wind and solar power.

Those adopting a pragmatic stance argue that these aspirations do not reflect the political, economic and technological realities of the world's energy systems and the energy needs of an inexorably growing population.

SUSTAINABLE DEVELOPMENT GOALS

The year 2015 was significant not just for the Paris Agreement on climate change, it was also when governments from around the world, meeting at the United Nations headquarters in New York, signed up to new global Sustainable Development Goals (SDGs) – seeking to build on the Millennium Development Goals and to complete what these had failed to achieve. Of the 17 goals for 2030, SDG 7 covers "access to affordable, reliable, sustainable and modern energy for all".

Specifically it calls for:

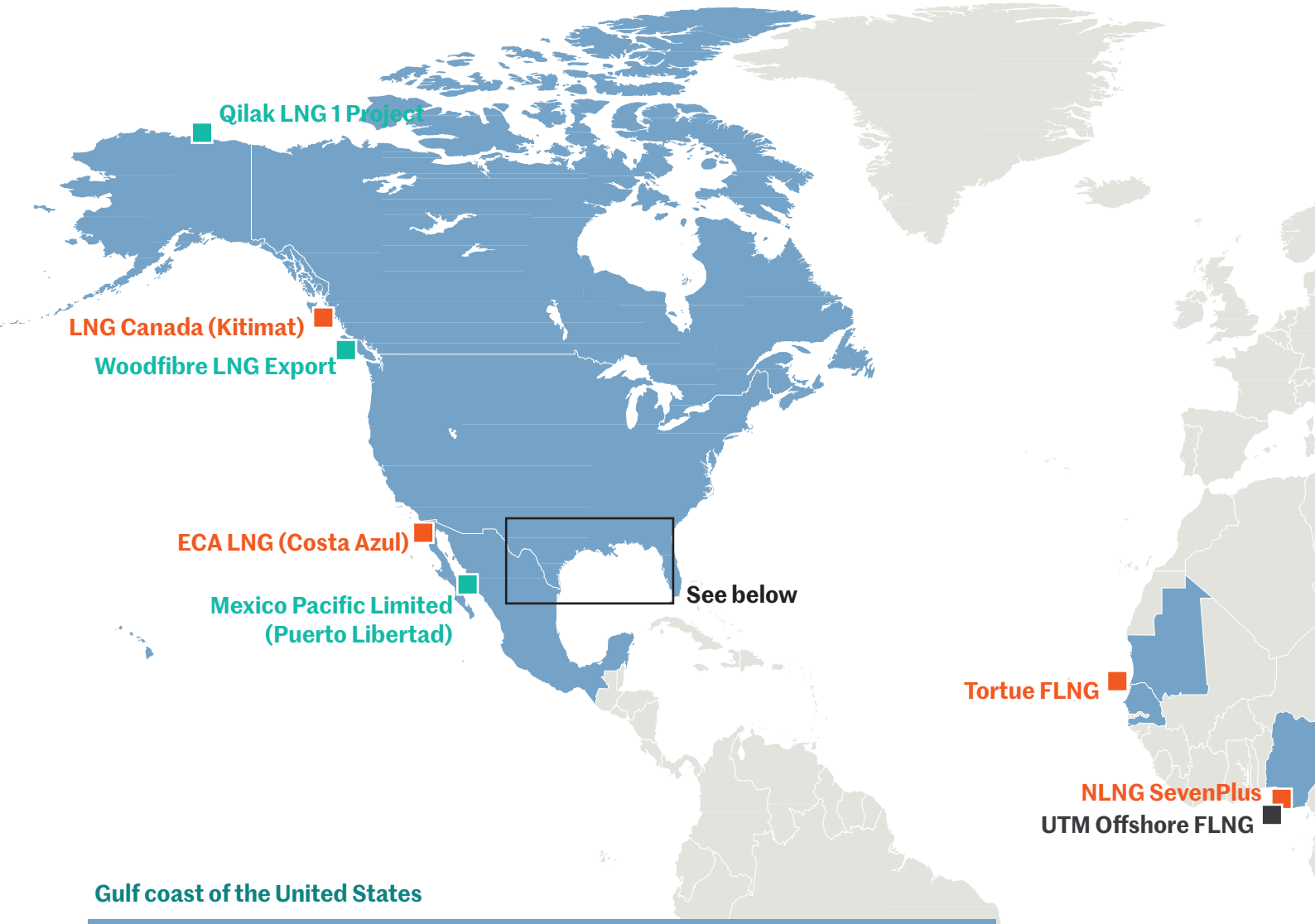
- universal access to affordable, reliable and modern energy services – with a particular emphasis on least-developed countries, small island developing states, and land-locked developing countries;
- a substantial increase in the share of renewable energy in the global energy mix; and
- a doubling of the global rate of improvement in energy efficiency.

NZE 2050 ROADMAP

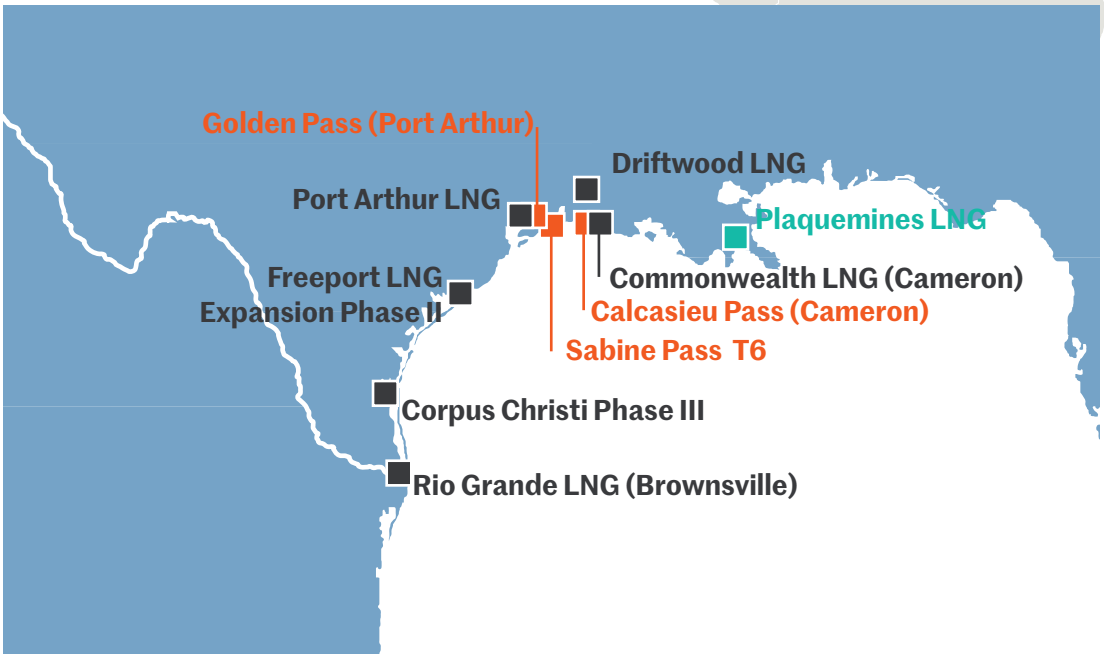
In May, the International Energy Agency (IEA) published a report, *Net Zero by 2050: a Roadmap for the Global Energy Sector*, claimed to be "the world's first comprehensive study of how to transition to a net-zero energy system by 2050 while ensuring stable and affordable energy supplies, providing universal energy access, and enabling robust economic growth".

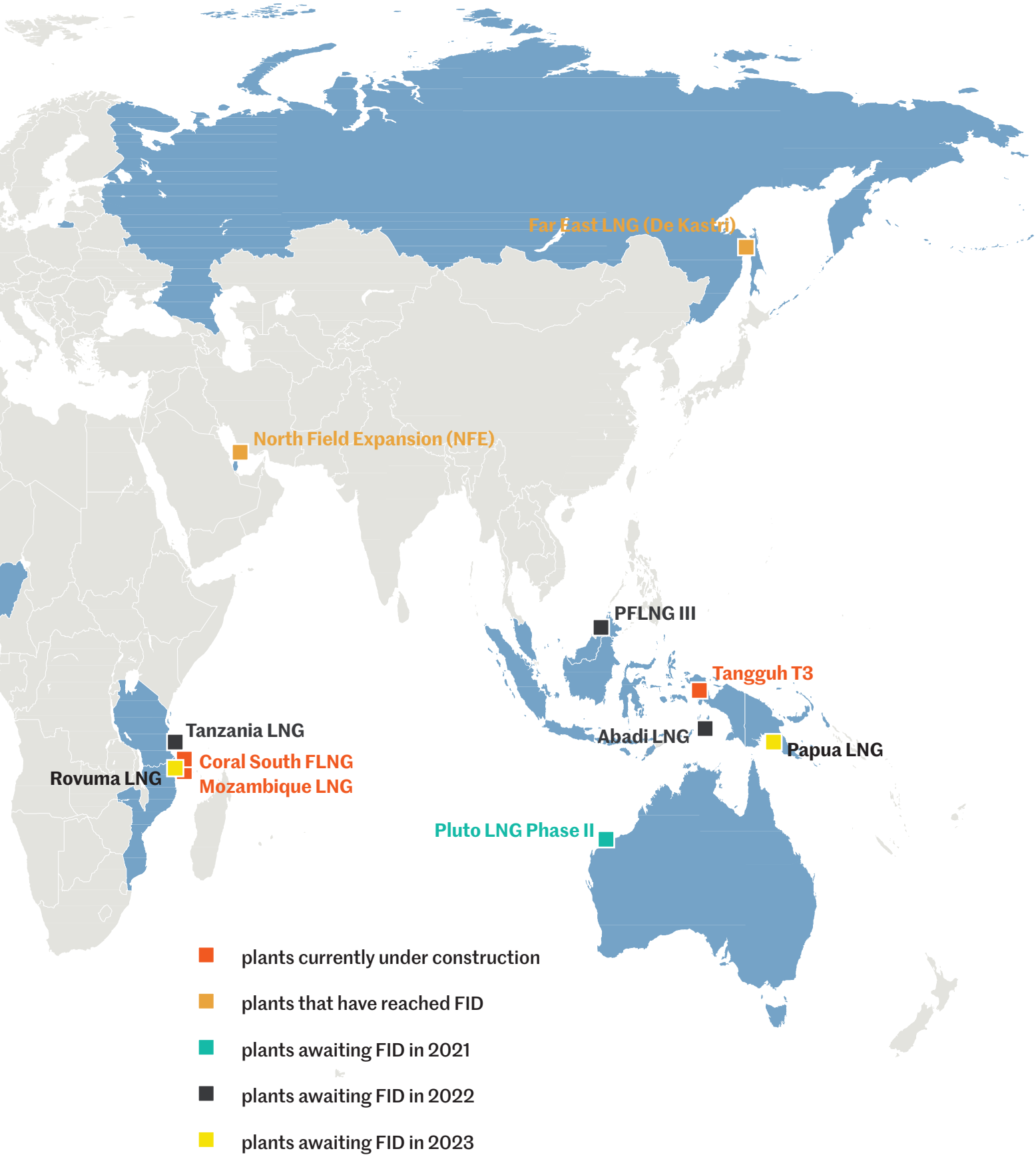
The agency notes that climate pledges made by governments to date – even if fully achieved – "would fall well short of what is required to bring energy-related CO_2 emissions to net zero by 2050". Among its numerous recommendations, it calls for "no investment in new fossil fuel supply projects, and no further final investment decisions for new unabated coal plants".

Global LNG liquefaction projects under construction, reached FID or awaiting FID

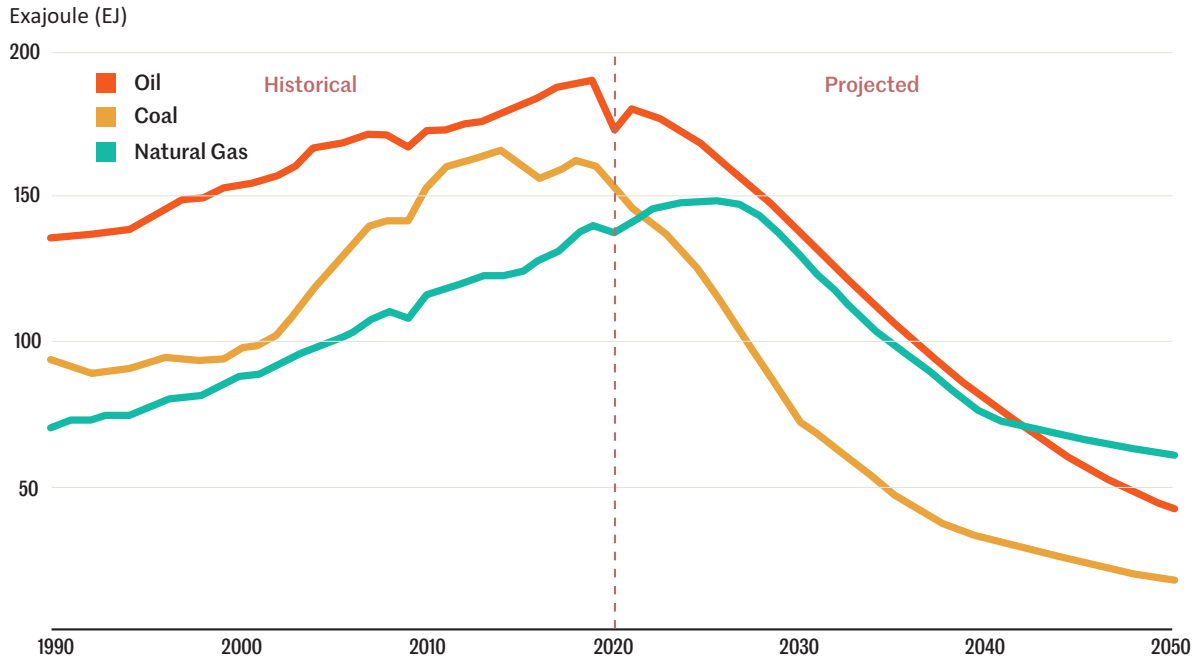


Gulf coast of the United States




Far East LNG (De Kastri)
North Field Expansion (NFE)
PFLNG III
Tangguh T3
Abadi LNG
Papua LNG
Tanzania LNG
Coral South FLNG
Mozambique LNG
Rovuma LNG
Pluto LNG Phase II
plants currently under construction
plants that have reached FID
plants awaiting FID in 2021
plants awaiting FID in 2022
plants awaiting FID in 2023

Coal, oil and natural gas production in the IEA's NZE 2050 scenario



Source: The International Energy Agency

In the near term, the report describes a net-zero pathway that requires "the immediate and massive deployment of all available clean and efficient energy technologies". It goes on to say that most of the global reductions in CO_2 emissions between now and 2030 in the net-zero pathway "come from technologies readily available today" and that by 2050 around half of the reductions will come "from technologies that are currently only at the demonstration or prototype phase".

Yet even in a world where policy-making, technological innovation and behavioural change happen at a scale and at a speed that stretch belief, fossil fuels – especially natural gas – remain significant components of total primary energy supply in the IEA's NZE 2050 scenario, as the chart above illustrates.

More than half of the natural gas used globally in 2050 in the NZE scenario goes to produce hydrogen in facilities equipped with carbon capture, utilisation and storage (CCUS) technology. As from now, no more exploration for natural gas is needed nor any new liquefaction plants beyond those already in operation.

The scenario also assumes that developing economies receive the financing and technological know-how they need to build out their energy systems to meet the needs of expanding populations and economies in a sustainable way. The provision of finance by wealthy industrialised nations to developing nations has long been a sticking point in UN climate negotiations and it remains to be seen how much progress on this will be made at the next major round of talks – the 26th Conference of the Parties (COP 26) of the United Nations Framework Convention on Climate Change in Glasgow in November.

The IEA's special report was indeed requested as input to the negotiations by the UK's COP 26 presidency. It is a laudable exercise, and contains much useful analysis and advice, but more than anything it serves to highlight the gulf that exists between aspirations and reality in climate change mitigation and adaptation.

For the LNG industry, there is one piece of advice that stands out: "Minimising emissions from core oil and gas operations should be a first-order priority for all oil and gas companies . . . Producers that can demonstrate strong and effective action to reduce emissions can credibly argue that their oil and gas resources should be preferred over higher emissions options." ■

4
How the LNG industry is responding

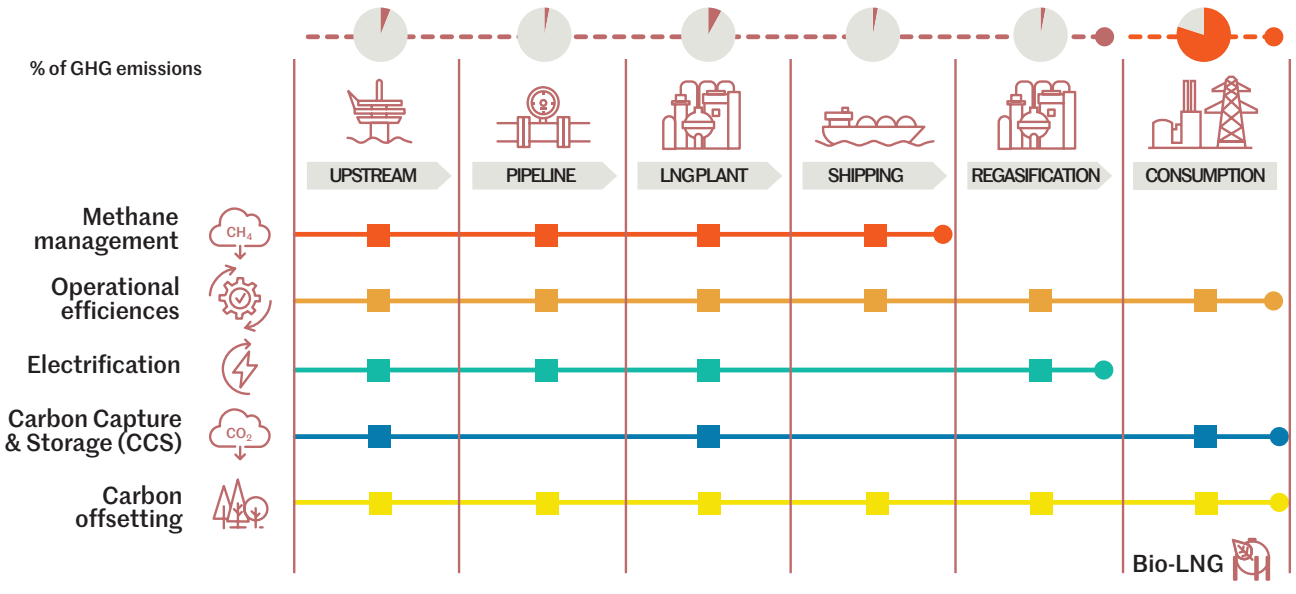
Three years ago – at the World Gas Conference (WGC) in Washington DC – the natural gas industry was just starting to get its head around the need to address the escalating controversy over fugitive emissions of methane in its value chains (see p9). Nothing was said about aspiring to carbon neutrality.

Over the past two years, as awareness of the climate emergency has grown, the LNG industry in particular has had to confront the existential threat of the Paris Agreement, which has prompted the movement towards net-zero GHG missions by 2050. LNG producers are consequently coming under pressure: to minimise emissions at every link of the LNG value chain, especially methane; to document the carbon/GHG intensity of the LNG they supply; and to provide carbon-neutral LNG, especially to utilities facing end-customer demand for net-zero carbon energy.

"What is fundamental now is LNG's role in the energy transition and the efforts that LNG producers and consumers are undertaking to quantify, measure, and verify the GHG emissions associated with the LNG chain and reduce them," says David Lang, partner in King & Spalding's Corporate, Finance and Investments practice, based in Houston.

"We need frameworks in individual countries as well as an international framework that allow that to be done on a consistent basis. We need to work as lawyers to help make that happen as a policy goal."

LNG value chain emissions and mitigation options



Source: Shell LNG Outlook 2021

The LNG Canada project, currently under construction in British Columbia, claims that by combining energy-efficient natural gas turbines and renewable electricity it will emit "less than half the GHG emissions of the average LNG facility currently in operation". (Photo: LNG Canada)

MINIMISING EMISSIONS IN THE VALUE CHAIN

The chart on page 15 – from Shell's *LNG Outlook 2021* – is a concise summary of what can be done to minimise emissions at each link of the LNG value chain. The chart also shows the proportion of emissions that each link in the chain accounts for.

Not surprisingly, by far the largest contribution comes from the consumption of natural gas. But the cumulative impact of emissions in the rest of the chain is far from insignificant, especially in the upstream and in liquefaction. Around a fifth to a quarter of emissions take place before the natural gas is consumed by the customer. There are numerous examples of initiatives already under way in most of these categories – but much remains to be done.

UPSTREAM

Producing natural gas leads to a variety of sources of emissions, some attributable to the energy consumed by the various processes involved – such as production, gathering, processing and transmission by pipeline to the liquefaction plant – and some from the venting to the atmosphere of gases contained in the reservoir, primarily methane and CO_2, or the routine flaring of methane. There are engineering

solutions that can be employed to minimise these emissions, which can account for 10-25% of the well-to-use total.

Fugitive emissions of methane have attracted a lot of controversy – especially when natural gas is produced using fracking techniques, notably in the US – and the gas industry has been responding with numerous alliances and initiatives. Investment is being driven by expectations of tightening regulations and emissions standards.

Some producers have been turning to carbon capture and storage (CCS) to reduce emissions of reservoir CO_2. Currently only the Snøhvit LNG project in Norway and the Gorgon LNG project in Australia are using CCS upstream – and Gorgon has been struggling to get its technology to work as intended. Companies intending or considering to proceed with CCS upstream at LNG projects include Qatar Petroleum, Russia's Novatek, and BP, for its Tangguh project in Indonesia.

LIQUEFACTION

Liquefying natural gas to produce LNG can account for up to 10% of overall emissions and there is plenty of scope for reductions through the use of more energy-efficient equipment, such as specially designed gas turbines, and process electrification using renewable electricity:

- The LNG Canada project claims that by combining energy-efficient natural gas turbines and renewable electricity from BC Hydro, it will emit "less than half the GHG emissions of the average LNG facility currently in operation".

- Another possible approach is to replace gas turbines with electric drives and reduce emissions by supplying the drives with low-carbon electricity. This is what the US company Freeport LNG is doing. It claims that its electric-motor-driven technology not only reduces emissions but is more efficient and extends maintenance intervals, increasing availability.

- Qatar Petroleum plans to add 4 GW of renewable electricity generation capacity by 2030, partly to supply the North Field East expansion project sanctioned in February.

- The US company NextDecade claims that by combining "responsibly sourced gas" with CCS and "net-zero power", its planned Rio Grande LNG project will produce "the lowest lifecycle GHG emissions LNG on a free-on-board basis" – making it "the greenest LNG project in the world".

- Also in the US, Venture Global plans to capture and sequester carbon at its Calcasieu Pass and Plaquemines LNG facilities. It will compress CO_2 at its sites and transport it to subsurface saline aquifers where it will be injected for permanent storage.

SHIPPING

The shipping of LNG across long distances can account for up to 10% of total emissions. The contribution depends on the ship's propulsion system, how well boil-off gas is managed, and the distance travelled. Modern LNG carriers are much more efficient than older steam turbine-driven ships and future developments could include the use of low/zero-carbon fuels such as blue and green ammonia.

REGASIFICATION

Emissions during regasification are the responsibility of the LNG buyer rather than the seller and generally tend be a relatively small fraction of the total, around 1-3%. Nevertheless, here too measures such as better boil-off gas management, the use of low-carbon electricity and elimination of fugitive methane emissions can make a significant difference.

DOCUMENTING THE CARBON INTENSITY OF LNG

If LNG sellers want to be believed when they say their cargoes are less carbon-intensive than those of their competitors, they need to back up these claims with convincing evidence. Indeed, as buyers progressively seek to lower the carbon intensity of their offerings to end-customers, the marketing of LNG will increasingly reflect verifiable environmental performance. Lower emissions profiles are also seen as a natural hedge against regulatory uncertainties, says the IEA.

Two companies setting the pace in this regard are Cheniere Energy in the US and Pavilion Energy in Singapore.

QUANTIFICATION, MONITORING, REPORTING AND VERIFICATION

Cheniere has grown into one of the world's largest LNG producers and is consequently the largest buyer of natural gas in North America. In February, the company announced that from 2022 each LNG cargo supplied from its Sabine Pass and Corpus Christi liquefaction plants would come with GHG data – so-called Cargo Emissions Tags (CE Tags) – quantifying emissions from the wellhead to the cargo delivery point.

"We consider this announcement to be a critical first step for the industry," said CEO Jack Fusco. "Cheniere will continuously work to improve the data incorporated in the CE Tags with the ultimate goal of providing dynamic GHG emissions data. Cheniere is ideally positioned to collaborate with domestic and international value chain participants to provide improved transparency".

In June, the company announced a collaboration with five natural gas producers and several academic institutions to implement quantification, monitoring, reporting and verification (QMRV) of GHG emissions performance at natural gas production sites. The aim is to improve understanding of upstream GHG emissions and advance monitoring technologies and protocols. Multiple ground-

Cheniere Energy, the largest LNG producer in the US, exported its 1000th cargo of LNG in January 2020. Future cargoes will have their GHG emissions quantified. (Photo: Business Wire)

based, drone, aerial, and satellite monitoring technologies will be used to establish baseline emissions levels.

In March 2020, Pavilion Energy launched what it claimed was "the world's first tender with carbon-neutral ambitions" for LNG supply to Singapore. The tender required supply partners to commit to co-operating in the development and implementation of a GHG quantification and reporting methodology.

"The methodology," says Pavilion, "is being developed on the basis of internationally recognised standards, and covers emissions from the well-to-discharge terminal supply chain, including LNG transportation."

Pavilion has since signed a number of sales and purchase agreements (SPAs) under which each cargo will be accompanied by a statement of its GHG emissions, measured from well to discharge port. Counterparties include Qatar Petroleum, Chevron and BP.

Deliveries of carbon/GHG-offset LNG cargoes since 2019

Date	Seller	Buyer	Source	Destination	Volume	Offset scope	Mechanism
Jul 2019	Shell	Tokyo Gas	QC LNG Australia	Japan	1 cargo	CO_2 well-to-wheel	Shell project portfolio
Jul 2019	Shell	GS Energy	QC LNG Australia	South Korea	1 cargo	CO_2 well-to-wheel	Shell project portfolio
Jul 2019	JERA	-	Das Island UAE	India	1 cargo	CO_2 end-use combustion	CER
Mar 2020	Shell	CPC	Sakhalin II Russia	Yung-An Taiwan	1 cargo	CO_2 well-to-wheel	Shell project portfolio
Jun 2020 (announced)	Shell	CNOOC	-	China	2 cargoes	CO_2* well-to-wheel	Shell project portfolio
Oct 2020	TotalEnergies	CNOOC	Ichthys Australia	Dapeng China	1 cargo	CO_2 well-to-wheel	VCS
Nov 2020	Shell	CPC	Bonny Island Nigeria	Yung-An Taiwan	1 cargo	CO_2* well-to-wheel	Shell project portfolio
Mar 2021	Mitsui	Hokkaido Gas	Sakhalin II Russia	Ishikari Japan	1 cargo	CO_2 well-to-wheel	Mitsui portfolio
Mar 2021	Gazprom	Shell	Yamal LNG Russia	Dragon United Kingdom	1 cargo	CO_2 well-to-wheel	VCS
Mar 2021	RWE	Posco	Pluto LNG Australia	Gwangyang South Korea	1 cargo	CO_2 well-to-tank	VER
Apr 2021	Diamond Gas	Toho Gas	Cameron LNG United States	Chita Japan	1 cargo	-	Carbon credits
Apr 2021		Pavilion Energy	Corpus Christi United States	Jurong Singapore	1 cargo	CO_2 well-to-tank	VCS + CCB
Apr 2021	Cheniere	Shell	Sabine Pass United States	United Kingdom	1 cargo	GHG well-to-wheel	Shell project portfolio
Jun 2021	Oman LNG	Shell	Qalhat Oman	-	1 cargo	CO_2 well-to-wheel	Verified Nature-Based Carbon credits

CER: Certified Emission Reduction; VCS: Verified Carbon Standard; VER: Verified Emission Reduction; CCB: Community and Biodiversity Standard.
* CO_2 equivalent. Analysis based on companies' press releases and various news reports

Source: The International Energy Agency

'CARBON-NEUTRAL' LNG

In the hierarchy of GHG emissions mitigation, the avoidance of emissions is generally the preferred strategy. If emissions cannot be avoided entirely, the next best strategy is to reduce them as much as possible, using the kinds of solutions already described under the heading *Minimising emissions in the value chain* on p6. That leaves the question of what to do about emissions that cannot be avoided or reduced, in particular those released when natural gas is consumed. One solution that LNG sellers and buyers have been turning to is the purchase of carbon credits to "offset" GHG emissions.

A report published last year by the imports' group GIIGNL, *LNG carbon offsetting: fleeting trend or sustainable practice?* – which reviewed the main challenges and opportunities associated with offsetting – concluded that: "LNG carbon offsetting is likely to become more widespread and demanded by customers when emissions cannot be directly avoided or reduced."

The scope of offsetting varies from cargo to cargo. In some cases, only the GHG emissions associated with production and transportation are offset; in others, the offsets cover the entire lifecycle emissions, including those produced when the natural gas is consumed by the end-user; in some, only the emissions associated with consumption are offset.

The producer leading this practice to date – starting with the delivery of the first-ever carbon-neutral LNG cargoes in July 2019 to Tokyo Gas and South Korea's GS Energy – has been Shell. Since then more than 15 carbon/GHG-offset LNG cargoes have been delivered, mainly to buyers in Asia, as shown in the

Shell has a global portfolio of GHG emissions-reduction projects that "protect and enhance forests". (Photo: Shell)

table opposite. Shell is also the first producer to sign a term contract for carbon-neutral LNG: a five-year deal with PetroChina (see p7).

"Since delivering the world's first carbon-neutral LNG cargoes in 2019, we have collaborated with producers and buyers across the globe for 13 other carbon-neutral LNG cargoes," says Steve Hill, Executive Vice President Shell Energy. "This first term deal is an important step in scaling up the market for carbon-neutral LNG."

In Shell's case, the carbon credits are purchased from the company's global portfolio of emissions-reduction projects that "protect and enhance forests" in China and other parts of the world. The company's portfolio of natured-based solution (NBS) projects includes the Katingan Peatland Restoration and Conservation Project in Indonesia, the Cordillera Azul National Park Project in Peru and The Form Reforestation Project in Ghana. Shell says these NBSs "protect, transform or restore land and enable nature to add oxygen and absorb more CO_2 emissions from the atmosphere". Each carbon credit represents the avoidance or removal of 1 tonne of CO_2 and is subject to a third-party verification process.

As the table opposite shows, the number of LNG producers supplying carbon-neutral LNG cargoes continues to grow but the use of carbon credits for offsetting GHGs remains controversial – for numerous reasons.

"When you dig beneath the surface it starts to get opaque as to what exactly is going on," says Richard Nelson, head of King & Spalding's international LNG practice. "It seems that it's largely left to the players themselves to make the case that their deliveries are carbon-neutral. There's a plethora of different accreditation mechanisms out there. I'm not sure anyone really understands what tangibly is being done by these players to offset emissions. Increasingly, there are calls for more transparency in the industry and standardisation of offset mechanisms."

As GIIGNL says in its report on this practice: "For both emission reduction and offsetting, a robust monitoring, reporting and verification (MRV) system is a prerequisite to guarantee the effectiveness of each solution." Even that is a challenge the LNG industry is still working on. ■

5
What lies ahead?

As the LNG industry looks to the future, its challenges fall into two main categories: those it can confront on a voluntary basis – for example, to enhance the competitiveness of its offering to the market when compared with other producers, or indeed other energy sources, especially if these receive government subsidies; and those it will have to confront because of the actions of policy-makers or the requirements of regulators. There is, of course, a considerable degree of overlap.

"It's really important with all of the talk and well-intentioned work towards transition – hydrogen and everything else – that people don't forget about the appropriate role of natural gas," says Anthony Patten, partner in King & Spalding's Corporate, Finance and Investments team in Singapore. "Let's not forget that what's been happening in LNG has been cutting edge, dynamic and hugely capital intensive."

MRV

An obvious starting point is to further develop monitoring, reporting and verification (MRV) of GHG emissions. In a speech to last September's LNG Producer-Consumer Conference, the then Chairman of GIIGNL, Jean-Marie Dauger, said:

"There are today wide disparities in terms of emission intensity factors, or reporting and measurement methods. More transparency is needed, more actual data are required. As an industry, we have the opportunity to proactively develop uniform methodologies in order to monitor, report and control emissions from the LNG supply chain."

This, in turn, will throw a spotlight on the different emission profiles of specific value chains and this transparency will highlight the differences between new and old liquefaction plants. The kinds of solutions for emission reduction discussed in the previous section are likely to be economic mainly for newly built plants; retrofits to older plants may not be economic, especially if production is covered by long-term contracts, or indeed feasible. Owners of older plants may find they have to rely more heavily on offsets than owners of new plants.

EMISSIONS REDUCTION

More transparency will boost the incentives for LNG producers to invest in emissions reduction strategies. Section 4 of this report shows that

many companies have embarked or are planning to embark on such strategies – but the industry as a whole has a long way to go to realise the full potential of emissions reduction possibilities.

Carbon management solutions, such as CCS and CCUS, have so far made a negligible impact but will grow in importance, especially if natural gas is to be used for the large-scale production of blue hydrogen. Many see this as an essential first step on the road to building a meaningful green hydrogen economy.

The task is urgent because of the inevitability – given the conclusions of the recent IPCC report on the science of climate change (see p6) – that policies and regulations will progressively tighten over time. For example, in October 2020 the European Commission announced an EU strategy to reduce methane emissions, to be followed up with legislative proposals in 2021. In April of this year, the governments of Canada, Norway, Qatar, Saudi Arabia and the United States established a Net-Zero Producers Forum to develop zero-emission strategies, including the abatement of methane. And this is just the start, with plenty more to come.

MAKING OFFSETS CREDIBLE

The emergence of carbon-neutral LNG cargoes is a fascinating development but we have yet to see whether it will become a widespread practice. So far a negligible amount of LNG has been sold in this way, but these are still early days.

Much will depend on whether international frameworks are developed that sellers, buyers, policy-makers and the public at large find convincing. At present, the initiatives have been developed on a voluntary basis and it remains unclear how much of an impact there will really be on actual GHG emissions.

There are also questions around how the need to purchase offsets in the form of carbon credits may impact the competitiveness of LNG versus other low/zero-carbon energy sources, such as renewables.

DEPLOYING AND INTEGRATING LOW-CARBON GASES

There is a growing realisation that while widespread electrification will help in decarbonising the world's energy economy, we will continue to need molecules as well as electrons on the road to NZE 2050.

The production of low-carbon gases – such as hydrogen, ammonia, biomethane and synthetic methane – is still expensive and their deployment will take decades. However, argues the IEA, "the industry, infrastructure and regulation should begin adapting now to enable their cost-efficient integration into the gas system in the future". It adds that the European Commission plans to publish its hydrogen and clean gas package by the end of 2021.

The overall challenge for the industry is to make the most of the advantages of natural gas/LNG while minimising the impacts of the disadvantages. Doing this successfully matters not just for the future of the LNG industry but also for the achievement of NZE 2050. ■

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