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NATURAL GAS

FLIPPING THE SWITCH

DAWN OF A NEW ERA





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CONTENTS

4

NATURAL GAS: THE BASICS

A Brief History: How Our Lives are Shaped by Natural Gas
Infographic: The LNG Process
Infographic: History of Natural Gas
What is the Future of Natural Gas in Malaysia?

12

SNAPSHOT: THE MALAYSIAN GAS INDUSTRY

Trends and Outlook for the Malaysian Gas Industry
Infographic: Malaysia's Natural Gas Industry
Infographic: Major Players in the Natural Gas Industry
Benefits of the Natural Gas Industry to Malaysia's Economy

21

THE CHANGE IN TREND TO NATURAL GAS ADVOCATED

Trends and Projections in the Region
Infographic: Proven Natural Gas Reserves in ASEAN
Global Country Trends for Natural Gas

29

THE TURNING OF THE TIDE:

TRENDS AND DEVELOPMENT IN THE WORLD OF ENERGY

Market-Driven Factors
Infographic: The Demise of Coal
Government-Driven Factors

35

SUSTAINABILITY, LIVABILITY, VIABILITY

Natural Gas vs. Coal: A Fiery Debate Over the Future Dominance of Fuel
The Claim for Coal
Natural Gas: Complementary Fuel for a Low Carbon Future
Health Effects of Pollutants from Coal and Oil-Burning Plants
Infographic: Malaysia by the Numbers
Case Study: Beijing's Coal Plants Goes Silent

44

21st CENTURY SOLUTIONS:

TRENDS AND DEVELOPMENT IN THE WORLD OF ENERGY

Infographic: A Compelling Combustible
How Innovation and Technology Evolve Natural Gas
Natural Gas Takes Off in Transportation
Infographic: Companies that are Paving the Way
Infographic: The Petronas FLNG


53

CONCLUSION


EXECUTIVE SUMMARY




What industry employs hundreds of thousands of Malaysians, built Malaysia's most iconic landmark, and is a prime driver of technology and innovation? The title of this report might be a dead give-away...




From the dinosaurs to the smart phone: How natural gas has shaped our history, and how it will mold our future.




There's a troubling energy trend taking grip in Southeast Asia. Is ASEAN sinking into the doldrums of the past while the rest of world speeds into the future?



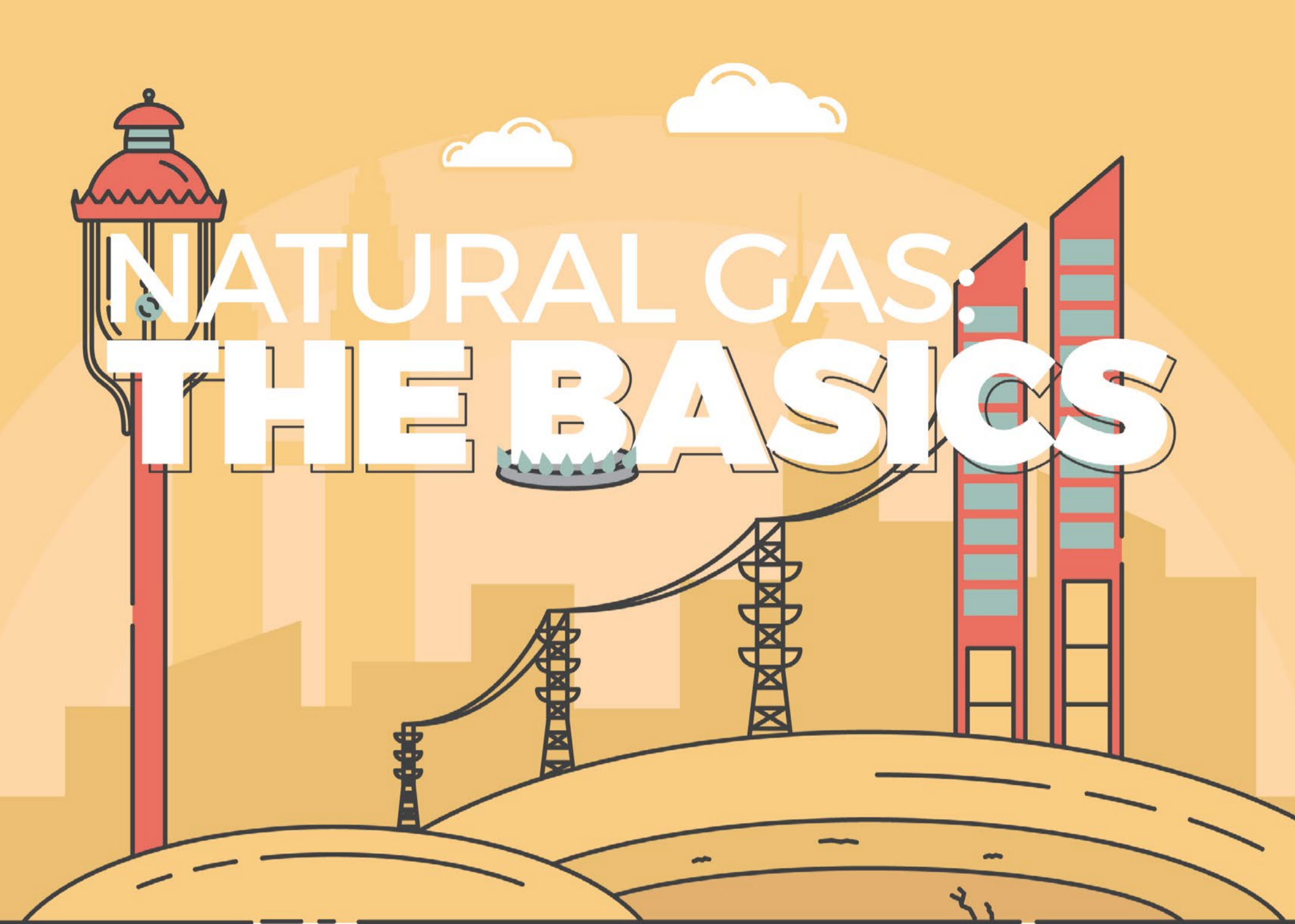
It's good to know what is happening right now, but wouldn't it be better to know what's going to happen next? Trends and developments in the world of energy.



Is the air your breathing poisoning you? If you live in ASEAN, most likely. Read to find out what's responsible.



Cars, planes, and ships only run on diesel and petrol right? Not for long, get used to the idea of gas and GTLs powering your next journey.



NATURAL GAS: THE BASICS

The global natural gas market is going through an unprecedented transformation. Gas is playing a huge role in the transition to a low-carbon world. It is also rapidly becoming a global commodity as its price crumbles on the open market.



A large part of the renewed interest in natural gas is driven by global environmental initiatives like the 2015 Paris Climate Conference, at which international leaders pledged to curtail carbon emissions growth to stem global warming. Because natural gas emits about 50 per cent less CO₂ than coal and about 30 per cent less than oil, it is viewed as an attractive transition fuel, a placeholder until renewable options are perfected and become more cost-effective. In fact, with this goal in mind, electric utilities worldwide – and particularly in less developed areas – are already becoming major purchasers of natural gas.

ADRIAN DEL MAESTRO

Oil and gas analyst for Strategy & the Strategy Consulting Unit of PwC

A BRIEF HISTORY: HOW OUR LIVES ARE SHAPED BY NATURAL GAS

The American portrait painter Rembrandt Peale is responsible for how we collectively imagine the proud and stoic face of General George Washington. Peale's iconic depiction of the first president of the United States, which today hangs in the Oval Office, is but one of his many famous paintings that have been indelibly carved into our consciousness, but less known is how Peale's portraits played a catalytic role to an energy revolution that still burns brightly to this day.

In 1814, Peale was in search of a way to light his newly inaugurated museum in Baltimore, Maryland, the first dedicated museum in the country, and subsequently acquired a patent to burn an odourless methane-based fuel, today known as natural gas. The innovative form of lighting impressed the gallery's attendees, and soon Peale began work to establish the Baltimore Gas and Electric Company, which began its commercial operation in 1816 by powering the first gas-lit lamps in the world on the streets of Baltimore.

In the 200 years since Peale transformed naturally occurring gas into an electricity-producing utility, scientific breakthroughs in the natural gas industry have made the energy source cleaner, lighter and more versatile. The invention of the modern internal combustion engine in 1876 by German engineer Nikolaus Otto forever cemented natural gas as the cleanest burning of the fossil fuels by reducing its emissions of pollutants into the atmosphere. Greater technological advancements in the combustion engine then reduced the most noxious of the polluting byproducts, nitrogen oxide, resulting in the blue flame that is now commonly seen when natural gas is lit, which signifies the success of an ultra-clean combustion process.

A condensing and cooling process first commercially employed in the US in 1918 revolutionized how natural gas was commoditized. Engineers realised that when the temperature of the gaseous-state compound is reduced to minus 162 Celsius to form a liquid, it could be stored more easily, and thus become instantly more transportable and tradable. Indeed, the volume of natural gas is reduced by 615 times

when transformed into its liquid form, known today as liquefied natural gas (LNG). Liquefaction had the pleasant effect of making natural gas a cost-efficient energy source because it was no longer confined to pipelines; instead, it could be contained, loaded to a vehicle and moved over land or sea. Today, LNG is mostly transported through cryogenic sea vessels known as LNG carriers, a rapidly growing segment of the global energy industry, or cryogenic truck tankers.

Even on our modern roadways, the versatile natural gas has found its fold. There are over 22 million road vehicles worldwide that run on natural gas as a fuel, the majority of which are being powered in China and Iran. These alternative fuel vehicles are engineered to burn natural gas in a compressed or liquefied state, including cars, buses, taxis, and trucks, and are widely considered to be much safer than gasoline-powered vehicles. Major car manufacturers have



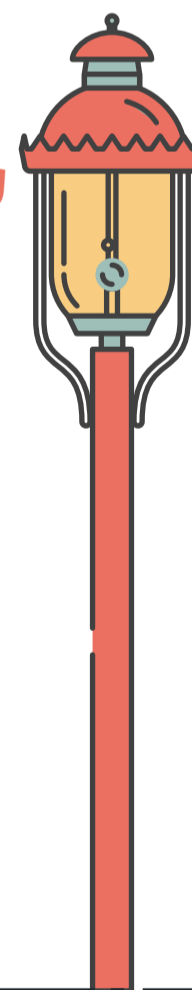
begun offering bi-fuel cars, whereby the vehicle is able to run on either compressed natural gas or gasoline. Retrofitting has also become popular, with some car owners around the globe choosing to convert their vehicle's fuel tank to run on compressed natural gas or LNG. Many cars and trucks across Southeast Asia today run on natural gas thanks to Honda, which manufactured thousands of taxis and commercial-use vehicles that were sold across the region.

Perhaps even now the electricity powering your lights are being run on natural gas, an integral part of today's global energy mix. Together with other fossil fuels and alternative energy sources, natural gas-fired power plants light our homes, hospitals and highways, and have become a backbone of urban energy planning systems. Industries that are either energy intensive and/or lighter in consumption utilise natural gas as a feedstock or a fuel to produce everything from plastic to steel. Some homeowners even make the conscious decision to switch their power supply from oil to natural gas, eliminating oil storage tanks that pose a threat of oil spills through tank corrosion or mishandling.

Such a decision may have seemed common sense to the attendees of Rembrandt Peale's art gallery, but the blessings of this benign fuel source can be obscured amid the complexity and competitiveness of the global energy market. Today, natural gas continues to face challenges versus other fossil fuels that benefit from lower costs and existing infrastructure. Yet, the convenient, clean-burning and safe natural gas should remain an engine to any modern economy.

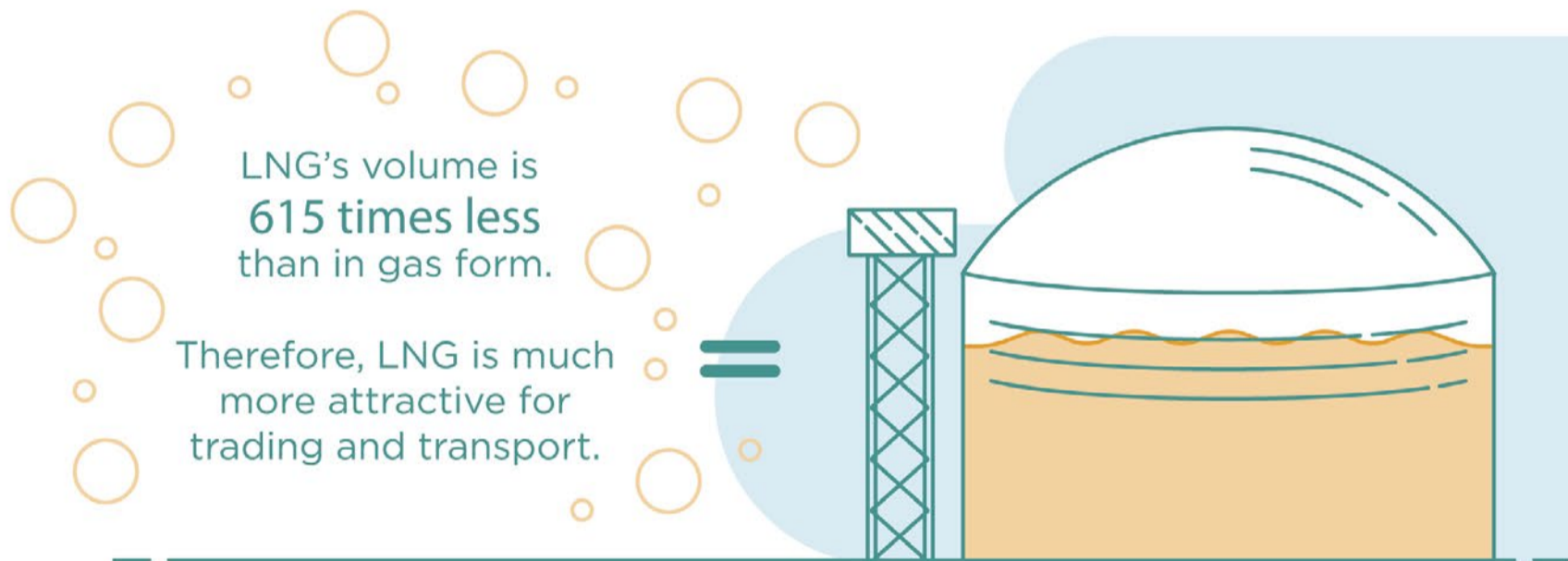
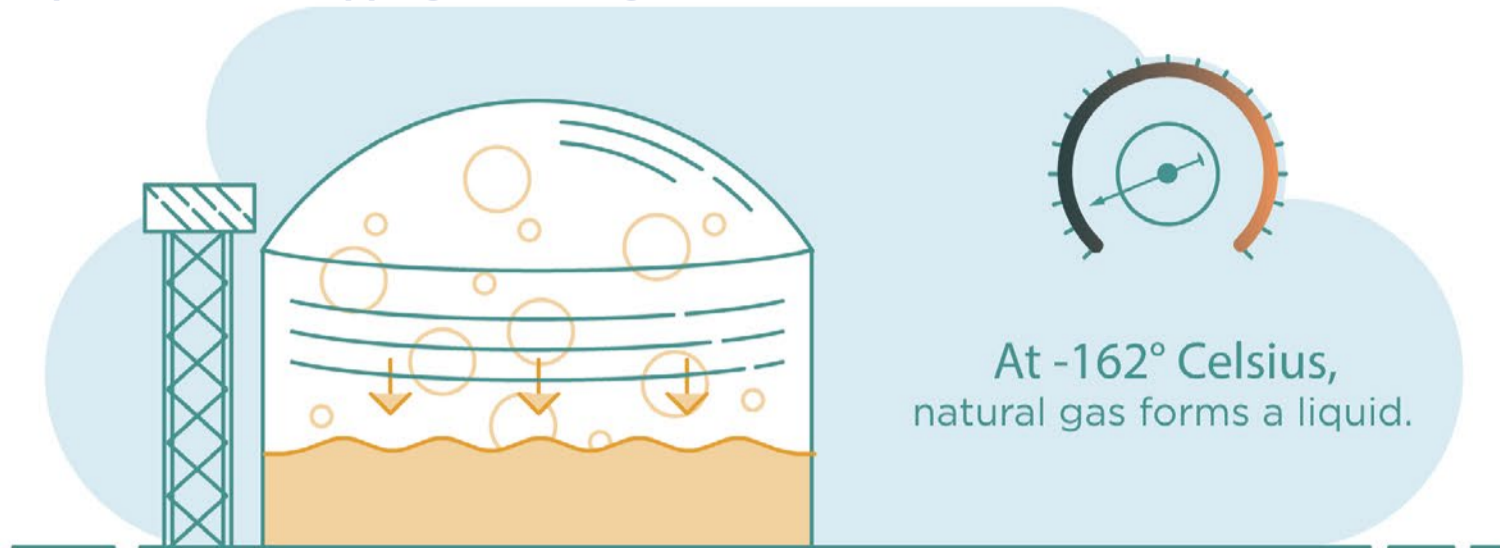


Together with other fossil fuels and alternative energy sources, natural gas-fired power plants light our homes, hospitals and highways, and have become a backbone of urban energy planning systems.

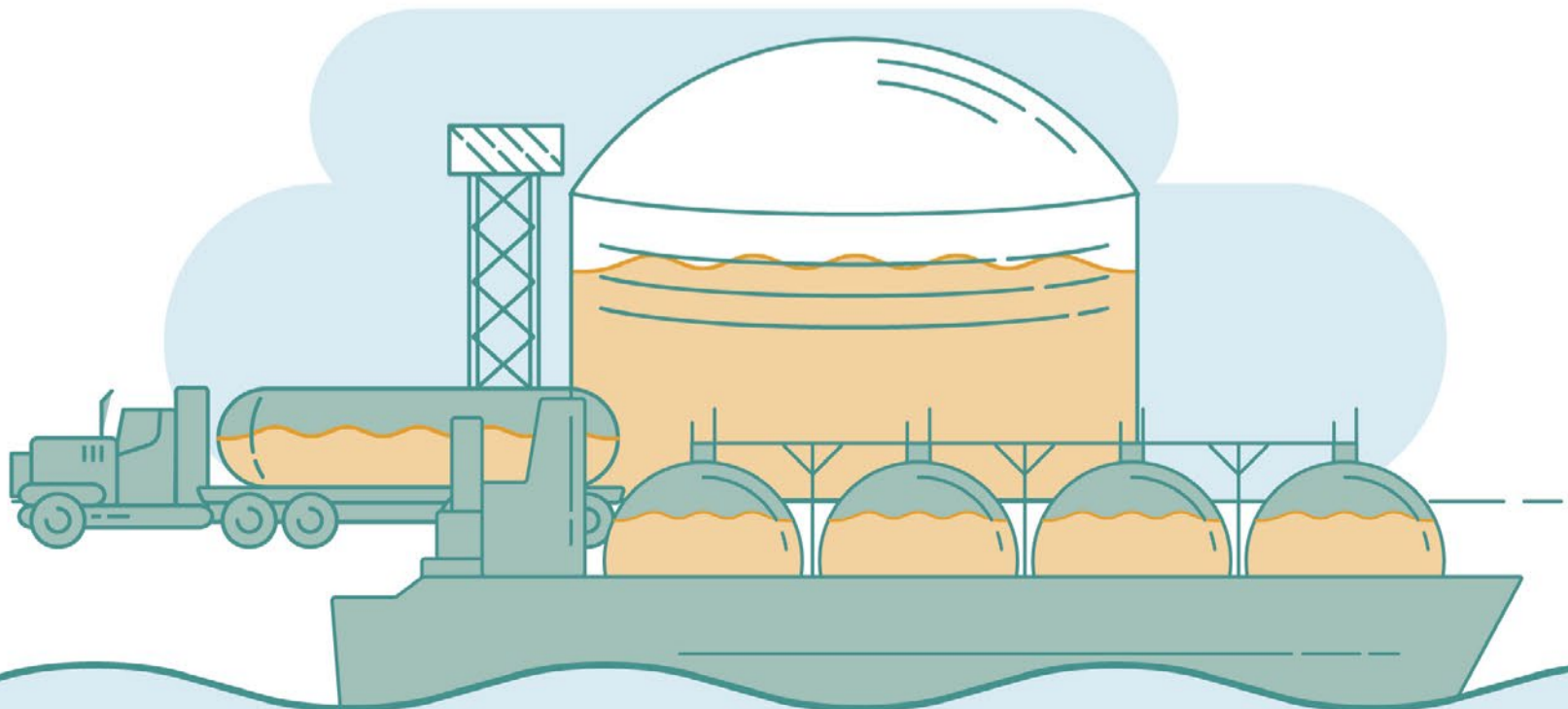


THE LNG PROCESS

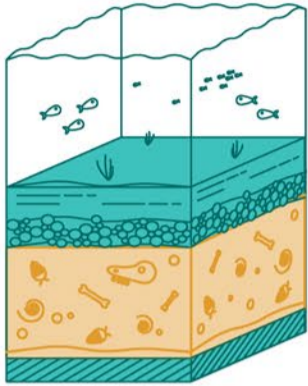
Energy explained - Liquefied Natural Gas (LNG) is natural gas that has been cooled to a liquid state, for shipping and storage



Cryogenic sea vessels and trucks then ship the LNG to buyers.



THE HISTORY OF NATURAL GAS



100 million BC

After hundreds of millions of years, tremendous heat and pressure caused plant and animal matter to form into what we now know as natural gas and oil.



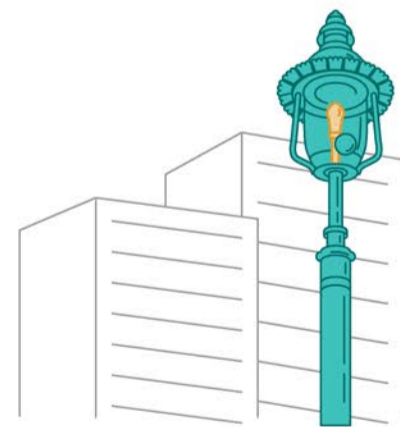
500 BC

The Chinese used crude bamboo 'pipelines' to transport gas that seeped to the surface, using the gas to boil sea water in order to produce drinkable water.



1000 BC

One of the first mentions of natural gas was from the famous Oracle at Delphi, in ancient Greece, where natural gas seeped from the ground into a flame.



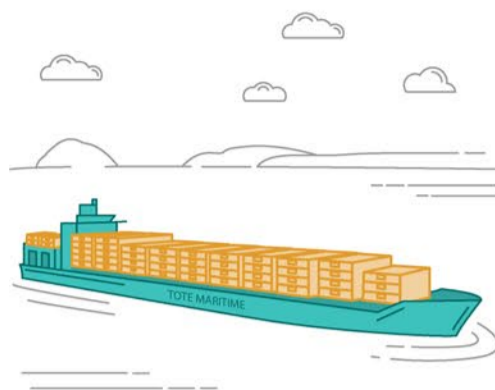
1816

Baltimore, Maryland became the first city in the United States to light its streets using natural gas.



1885

Robert Bunsen invented what is known as the Bunsen Burner, opening vast opportunities for the use of natural gas. Before 1885, natural gas was used primarily as a light source.



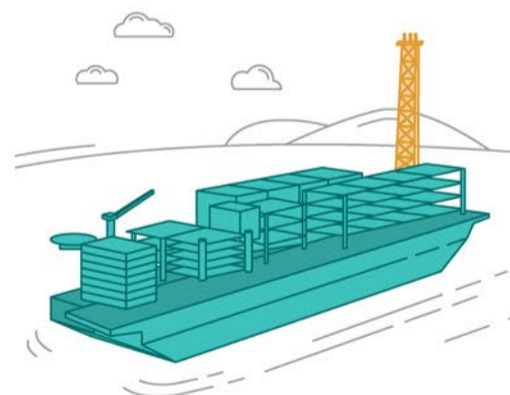
2015

Tote Maritime launched the world's first LNG-powered container ship. Its reduced emissions are equivalent to taking 15,700 gasoline powered cars off the road.



Mid-20th Century

The mid-20th century saw a major boom in natural gas pipeline infrastructure. This allowed for new applications of gas, such as cooking, heating, manufacturing, and electrification.



2016

PETRONAS launches the world's first Floating Liquefied Natural Gas platform, a resounding leap forward in the natural gas industry. The FLNG allows for natural gas to be liquefied at or near the well site. Therefore it doesn't have to be piped to shore to be liquefied, saving time and money.

WHAT'S THE FUTURE OF NATURAL GAS IN MALAYSIA?

In Malaysia, now seems an apt time to reflect on why natural gas should remain the core source of the country's energy security strategy and fuel mix. Starting in 2009, the Malaysian government began a program to "rationalize" natural gas prices by gradually slashing away at a long-implemented subsidy. The program has by and large been a success, slowly weaning the economy off of the subsidies, seen by many economists as an inefficient use of the natural resource, as well as a deleterious one that incentivises excess and waste.

Malaysia's first rendezvous with natural gas occurred about 33 years ago, when an earlier developmental roadmap kicked into place a project to build a gas transmission grid for Peninsular Malaysia, known as the Peninsular Gas Utilisation (PGU) project. The completion of this transformative PGU project coincided with the advent of industrialization in 1990, and has since propelled natural gas to become the most important source of energy for Malaysia, reshaping the country's energy and economic landscape. Today, natural gas consumption in Malaysia accounts for 44 percent of total power generation, as well as 45 percent of total demand for the industrial sector. The PGU system also gave rise to petrochemical hubs on the east coast and encouraged gas-fired power plants to be built along this route, especially along the south and west coast of the peninsula.

Recent discoveries of gas deposits in Sarawak promise to keep natural gas a competitive option due to its natural indigenous abundance while providing added encouragement for further upstream exploration, with total recoverable reserves being boosted from 88.6 tscf in 2010 to 100.7 tscf in 2014. Moreover, investors in exploration will be further attracted to a market that is priced for natural gas at market value rather than being subsidised. Yet, today there is already an immediately observable moderation in natural gas usage in Malaysia, which has reacted to the rationalisation of gas subsidies at a quickening pace over the past few years. While this juncture has arrived as expected, there are several unfortunate side effects that have manifested alongside. "For the power sector, gas is now more expensive than coal, and, hence, there has

been downward trend in the consumption of gas for power generation," the Malaysia Gas Association has observed. "As the government tries to keep the electricity tariff affordable, coal contribution in power generation fuel mix is expected to increase further in the mid-term. However, for the industrial sector, gas will continue to be the fuel of choice. Even at market price, gas is still very competitive compared to other fuels such as diesel, fuel oil or LPG, with the exception of coal. Despite its lower cost, coal is not a viable option for many industries except the power sector. Hence, gas demand from the industrial sector has proven fairly resilient."

The rise of coal consumption for feedstock into power generation across Malaysia is inconsistent with the goals outlined by Putrajaya to cut CO2 emissions by 45 percent compared to 2005 levels by 2030 if they are to be more than just dreams on paper. In truth, the slide back into carbon-intensive power supplies has already begun. At peak usage in 2000, three years after the government decided to regulate



The rise of coal consumption for feedstock into power generation across Malaysia is inconsistent with the goals outlined by Putrajaya to cut CO2 emissions by 45 percent compared to 2005 levels by 2030 if they are to be more than just dreams on paper.



the gas price market, natural gas accounted for a whopping 78 percent of the country's electricity generation mix. However, fuel diversification policies in the 1990s, coupled with the gradual removal of gas subsidies have seen coal-fired plants mushrooming across the nation. "In 2006, natural gas accounted for almost 53 percent of Malaysia's primary energy supply," the Malaysia Gas Association has commented. "However, the share of natural gas in Malaysia's primary energy mix has since dropped to about 43 percent in 2014, with coal meeting the country's incremental energy demand. By 2020, coal-fired power plants will make up 65 percent of total installed capacity compared to 45 percent in 2014."

There are clear environmental and socio-economic benefits to ensuring that other fossil fuels do not crowd out natural gas usage. Proponents of natural gas comment that when a government factors in the rising cost of healthcare that can be expected from a substantial uptick in emissions contributed by coal and oil, the cost of natural gas then becomes more attractive. Indeed, the legacy of PGU in Malaysia also means that the gas industry has become a mainstay of the economy and, thus, a large job creator. When job losses, balance of payments, and supply security impact associated with more fuel imports are considered in the equation, natural gas can be a cost-competitive choice; one simply needs to calculate the hidden costs.

Malaysia has made a conscious acknowledgement in their '11th Malaysia Plan' that green growth must be an imperative of Malaysia if it hopes to rise into developed nation status. With this in mind, there has been a shift in policymaking away from the industrialists' mantra of "grow first, cleanup later" towards a more sustainable trajectory that accounts for social well-being, environmental value to society and promotes an evolutionary conduit to ensure posterity has a cleaner energy mix.

Natural gas is abundant and will continue to be an integral part of humanity's quest for energy. In the global arena, Malaysia's pioneering role in developing LNG and its well-instituted system of gas infrastructure make it a role model and

bellwether for the global industry, and thus a nation that should be watched carefully. Currently, Malaysia is the third largest LNG exporter after Qatar and Australia. It also held the Presidency of International Gas Union (IGU) for the triennium 2009-2012 and hosted the World Gas Conference in Kuala Lumpur in 2012. The reputation of natural gas as a clean, efficient, and cost effective fuel are indisputable. As a gas rich nation, Malaysia should position natural gas to play a key role in the transition to a lower carbon world, while offering a faster solution to meeting Malaysia's commitment to the Paris Agreement.



SNAPSHOT: THE MALAYSIAN GAS INDUSTRY



Natural gas will continue to be an important energy source for many years to come.

Firstly, natural gas is abundance.

Secondly, the credentials of natural gas as a clean, efficient and cost effective fuel are indisputable.

Even though renewable energy is the most environmentally friendly energy source, renewables have their limitations and challenges such as high costs, large land areas, geographic restrictions, accessibility to the power grid and supply reliability arising from intermittency issues among others. The current reality is that renewable energy can only supplement conventional energy production using fossil fuels. Majority of global energy requirement will continue to be met by conventional fossil fuels. Of all fossil fuels around, natural gas is the greenest and cleanest due to its lowest GHG emissions. thus it is an excellent complement to renewable energy in a low carbon energy future.

HAZLI SHAM KASSIM
President Malaysian Gas Association

TRENDS AND OUTLOOK FOR THE MALAYSIAN GAS INDUSTRY

Malaysia's natural gas production is on an upward trend, while consumption and utilisation of natural gas for energy generation is not. This is the main issue that the industry has to tackle, in addition to rising exploration costs and the necessity to balance its strategy for natural gas in terms of sustainable demand, discovery of new sources, a clear and consistent energy mix policy, as well as market-based pricing which includes a phase-out of the government's subsidy policy.

This is crucial since the energy sector in Malaysia plays a critical role in the economic growth of the country, making up about 20 per cent of total gross domestic product. With regards to natural gas, Malaysia's total resources are estimated to be 100.7 trillion standard cubic feet which ranks Malaysia among the top 15 countries worldwide by proven natural gas reserves and the third-largest in the Asia Pacific region behind China and Indonesia. Based on the current production rate, and if no large new discoveries are made in the period, resources should last up to 40 years. This brings with it the challenge of finding a long-term strategy for utilizing natural gas to the benefit of Malaysia's economy, as well as finding a way to feature it prominently in the nation's energy supply in the coming decades.

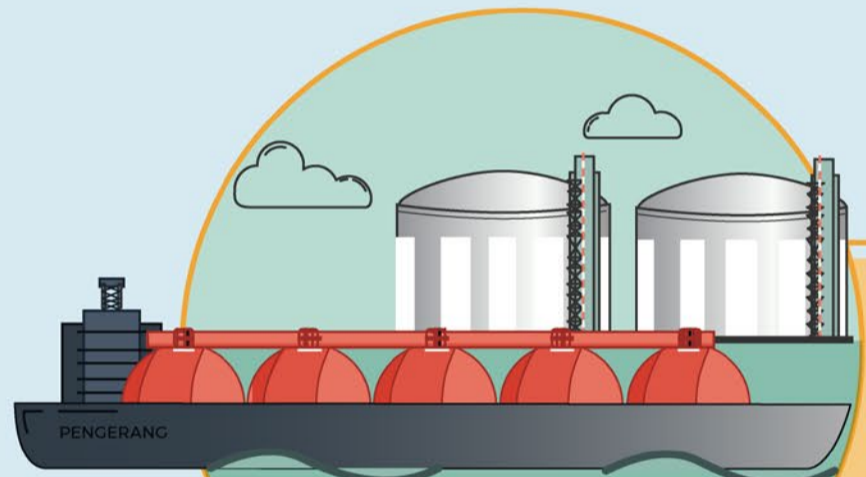
However, Malaysia's natural gas industry faces obstacles from inconsistent implementation of government policies. On the one hand, the government has expressed its commitment to reduce Malaysia's carbon footprint which would include using fuel sources that emit less carbon dioxide such as natural gas as compared to coal. On the other hand, and according to Malaysia's energy policy roadmap, it seems that coal usage will dominate the power generation sector due to its price advantage. Current trends show a reducing dependency on natural gas, primarily due to the retirement of gas turbine units, as well as developments of new coal power plants. However, natural gas output from 2017 increased, with new discoveries and new projects coming online up to 2019 - almost all of them offshore Sarawak which will boost liquefied natural gas (LNG) production growth at Petronas' LNG complex in Bintulu.





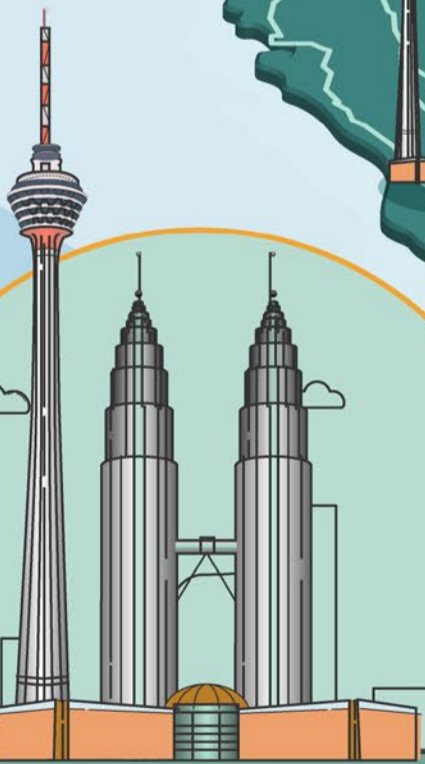
MALAYSIA-THAILAND JDA

Established in 1979, the 7,250 sq km area is jointly developed for natural gas resources. It supplies both Malaysia and Thailand, and contains an estimated 10 trillion cubic feet of natural gas reserves. Malaysia also has a joint development area with Vietnam.



PENERANG INTEGRATED COMPLEX

This \$27 billion project covers 20,000 acres, and includes liquefaction terminals, LNG, petrochemical and petrochemical facilities. The project is slated to be finished by 2019, and it is already changing the dynamic of Malaysia's downstream industry.



DEMAND

81% of domestic natural gas demand comes from Peninsular Malaysia. With the majority of gas coming from hundreds, if not thousands of kilometers away from major population centers, superb infrastructure has been the key to keeping up with consumer demands

MALAYSIA'S NATURAL GAS INDUSTRY

A MAINSTAY OF MALAYSIA'S ECONOMIC STRENGTH

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PETRONAS LNG COMPLEX, BINTULU

The PETRONAS LNG Complex in Bintulu, operated by Malaysia LNG, is the world's largest LNG center. It is used for production, storage, and export.

Continued from page 13

According to the U.S. Energy Information Administration, Malaysia's natural gas production between now and up to 2020 will be between 177 per cent and 187 per cent of domestic consumption. In particular, the gas demand from the power sector is projected to decrease from 1,285 million standard cubic feet of gas per day in 2015 to 980 million scf per day in 2020. In how far this surplus production could be offset by LNG exports depends very much on the global price development of the resource. Exports are expected to decline from 1.06 trillion cubic feet in 2015 to 999 billion cubic feet annually in 2020 owing to the highly competitive LNG environment in Asia, but could rebound to 1.17 trillion cubic feet by 2024 due to increased regional demand.

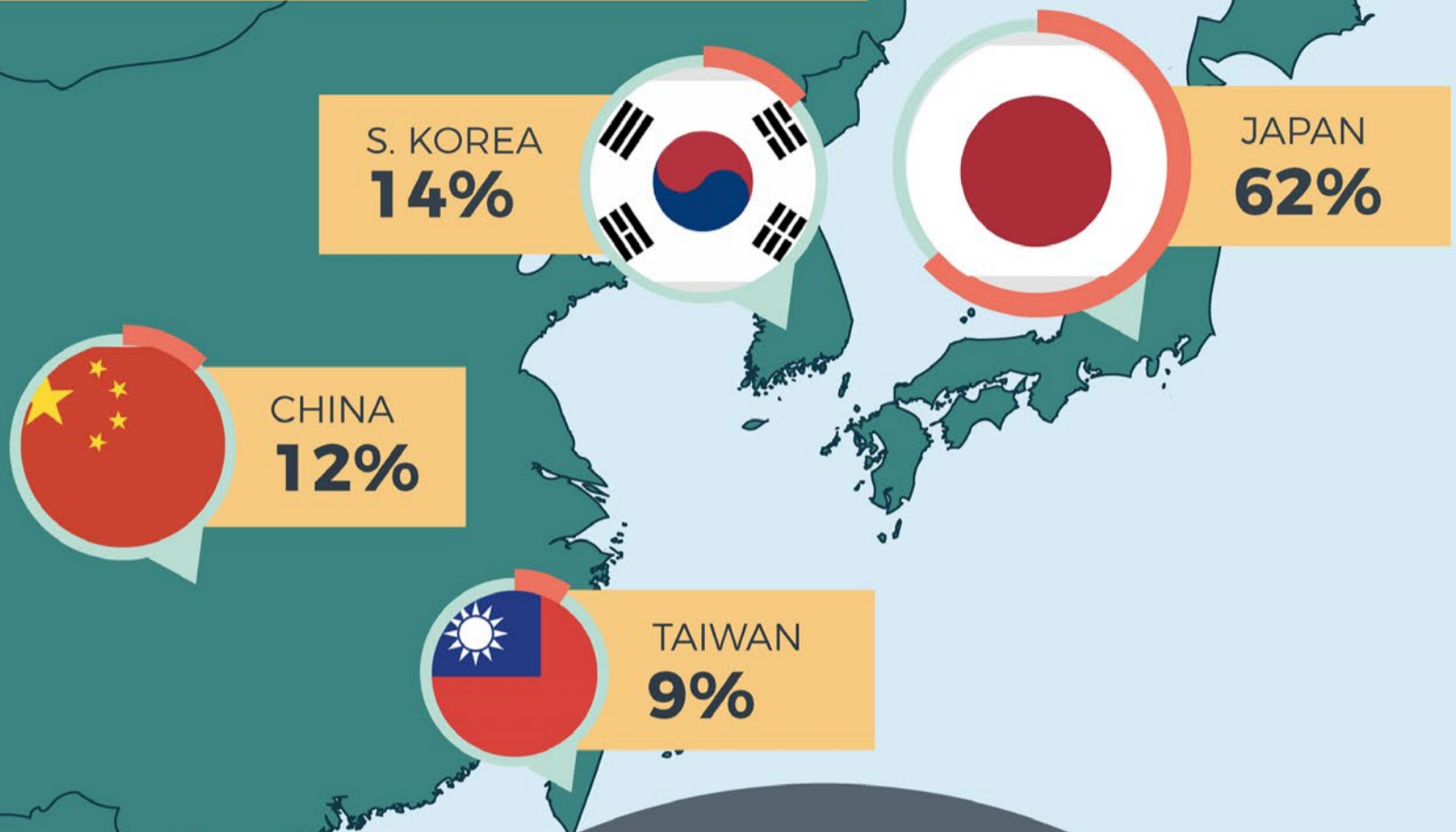
Looking ahead, there are certain significant trends in Malaysia's natural gas industry. On the one hand, the industry will come under pressure in terms of utilisation of natural gas due to the government's strategy of increasing the share of coal in the fuel mix for electricity generation in Malaysia from 47 per cent to 65 per cent by 2020, reducing domestic demand from the power sector for natural gas significantly. Thus, new applications for natural gas have to be developed, such as complementing renewable energy projects and as alternative fuel for vehicles. One good example is the commercial production of palm oil-based biogas compressed natural gas (CNG) by a Gas Malaysia-Sime Darby joint venture which began production in 2016.

The other significant trend is the gradual phase-out of the gas subsidy policy of the Malaysian government to remove this significant burden on gas industry players and the national budget and eventually enable a competitive and liberalized natural gas market which is also in line with Putrajaya's New Economic Model, the 10th and 11th Malaysia Plans, as well as the Economic Transformation Program. From a national perspective, natural gas subsidies have proven to be inefficient and unsustainable and a distortion of prices which has pushed the government to move away from subsidies. Instead, it turned to incentivize future upstream developments.



Malaysia's natural gas production between 2017 and up to 2020 will be between 177 per cent and 187 per cent of domestic consumption.

TOP EXPORT MARKETS FOR MALAYSIAN LNG



MAJOR PLAYERS IN MALAYSIAN GAS INDUSTRY



BENEFITS OF THE NATURAL GAS INDUSTRY TO MALAYSIA'S ECONOMY

Looking back in history, it can be seen how important natural gas is for Malaysia. The industry's contribution to Malaysia's economy peaked during the 1997/98 Asian financial crisis, when the country generated more than 70 per cent of its power demand from natural gas. Strong domestic supply drastically reduced the need for imports and avoided the full brunt of the devaluation of the ringgit at that time. The government could maintain the domestic power tariff at a fairly low rate, which supported local industries and enabled the country as one of the earliest in the region to recover from a very serious economic recession.

And the contribution of natural gas to Malaysia's economy remains large. As per latest figures of 2015, total revenue from natural gas sales to the domestic market at regulated prices in Malaysia was \$2.45 billion, of which \$1.24 billion or 50.5 per cent was purchased by the power sector and the remainder by the non-power sectors, namely industrial, commercial and residential users, as well as NGVs. Cumulative sales revenue since 1997 has reached \$53.55 billion.

In terms of exports, LNG shipments were valued \$10.56 billion in 2015, a decrease from \$14.38 billion in 2014 due to lower volume and lower prices that were indexed to crude prices. In 2015, more than 9,000 LNG cargoes have been exported to buyers across the globe.

In general, the natural gas industry generates significant contributions to Malaysia's economy by way of export income, tens of thousands of jobs depending on it, the taxes and royalties it yields and the technological progress it sparks. Its use in the non-power sector, for example for manufacturing plants, district cooling or as vehicle fuel, also reduced Malaysia's dependence on fuel oil imports. As of now, the number of NGV vehicles in Malaysia has reached approximately 80,000. The industry is, in fact, one of the core enablers for the nation to reach its vision of a developed nation by 2020.

However, Malaysia's natural gas industry is also clearly undergoing a transformation away from a highly regulated,

subsidised and distorted market environment towards a competitive and more sustainable multiple supplier and multiple buyer model. To achieve this, the action plan needs to include three core measures: A phase-out of the subsidies model, investment incentives for development of natural gas related to technological and environmental expertise, as well as developmental support of new industrial and consumer applications for natural gas and derived products.

The first process, the abolishment of subsidies, is already ongoing. Being a legacy of the Asian financial crisis, natural gas subsidies have been in place since 1997 despite clear indicators that they were neither effective nor sustainable. In 2008, first steps were undertaken to phase out subsidies for piped gas, and in 2010, the Malaysian government launched the Subsidy Rationalisation Program which set a timeline for price hikes for natural gas through the gradual elimination of subsidies. The latest timeline for an increase in natural gas prices in the non-power sector was released in December 2016 and sets a gradual increase of prices of average base tariffs every six months from January 2017 to December 2019 on its way to reach market parity. At that point, and as part of Malaysia's Economic Transformation Program, the government is expected to put in place necessary legal and regulatory frameworks for the liberalisation of the natural gas market by giving third parties access to it.

The second process, investment incentives for technological innovation in natural gas production and incentives for its production and utilisation in order to reduce greenhouse gas emissions should be a logical route to follow. Back in 2009, Malaysia set itself a voluntary target of reducing greenhouse gas emissions intensity of GDP by 40 per cent from the 2005 level up to 2020, later this was revised to 45 per cent up to 2030. Natural gas, being the cleanest burning fossil fuel, would be a big contributor to help the country to achieve these targets, in addition to renewable energy sources. However, analysts and sector experts note that with the Malaysian power administration's plans to install larger coal units for base load operations in order to lower



IMPACT OF NATURAL GAS ON THE MALAYSIAN ECONOMY



\$24.94 BILLION

Combined LNG Exports in 2014 & 2015



\$2.45 BILLION

Domestic Gas Sales in 2015



\$53.55 BILLION

Cumulative Domestic Sales Revenue since 1997



4.2 %

Contribution of Natural Gas to Malaysian GDP

NATURAL GAS

is a feedstock for many key industries in Malaysia such as:



Petrochemicals



Fertilizers



Rubber

Hydrogen



Plastics



6%

LNG accounts for 6% of Malaysian Exports

(Harvard Atlas of Economic Complexity)
5th largest export, exceeding other commodities like wood, rubber and plastics

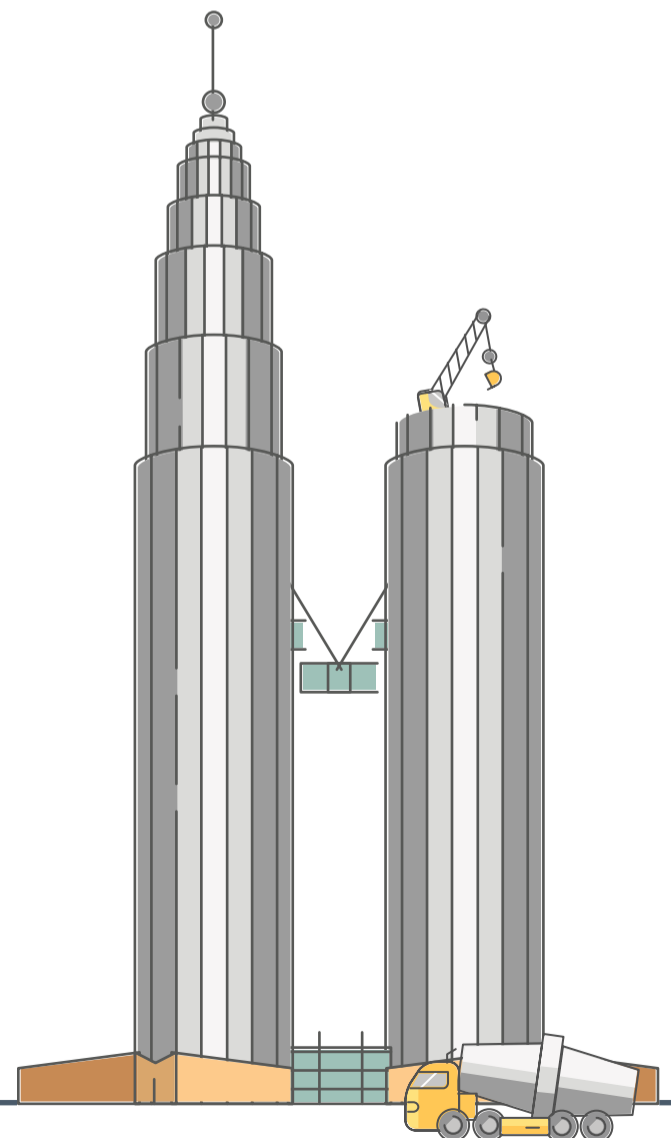


75%

Natural Gas constitutes 75% of Malaysia's Indigenous Oil and Gas Reserves

40 YEARS

Currently discovered gas reserves will last at least 40 years, oil reserves only last 20.





Natural gas vehicles emit up to 90 per cent less smog producing pollutants and up to 40 per cent less greenhouse gas emissions.



electricity production cost and tariffs is contrary to this commitment and should be revised. With fuel choice driven largely by marginal energy cost, further policy steps have to be undertaken to promote the use of natural gas in Malaysia.

One such step, and the third measure, is the development and deployment of new industrial and consumer options for natural gas utilisation. This includes the expansion of the above-mentioned bio-CNG production which started in 2016, but also a variety of other applications since natural gas has many other uses which comes a surprise to most people who learn about it. For industrial utilisation, natural gas can be an ingredient to make fertilizer, antifreeze, plastics, pharmaceuticals and fabrics. It is also used to produce a number of chemicals such as ammonia, methanol, hydrogen, butane, ethane, propane and acetic acid. It can also be used as a heat source for making glass, steel, cement, bricks, ceramics, tile, paper, food products and many other commodities. Natural gas is also used at many industrial facilities for incineration, heating and cooling, and power co-generation. Natural gas is also used to support distributed energy systems, increasing resiliency and efficiency. Furthermore, natural gas has significant potential for increased use as a vehicle fuel in form of CNG, LNG trucks, and marine vehicles, particularly when the necessary infrastructure has been set up – which is another government policy issue. Natural gas vehicles emit up to 90 per cent less smog producing pollutants and up to 40 per cent less greenhouse gas emissions. And by using domestically produced natural gas, costs for oil imports also drop.

All this, and particularly the benefits of natural gas over coal, should be taken into account when formulating a future energy roadmap for Malaysia.

SOURCES:

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Malaysia Oil and Gas Report BMI Research Q1/2016
The Malaysian Oil and Gas Industry PwC May 2016

CHANGE IN TREND TO NATURAL GAS ADVOCATED



“ Countries that import natural gas should anticipate more competing sources of it, which will lower prices and reduce concerns about the security of the gas supply. No longer, it seems, will the world be dependent on a few nations— Iran, Qatar, Russia, Saudi Arabia, and Turkmenistan—that control the bulk of conventional natural gas reserves. Countries that produce natural gas will need to adjust to lower revenues from natural gas exports; for some of them, the adjustment may be quite severe and potentially destabilizing. As gas acts as a substitute for oil, demand for oil will fall, putting downward pressure on oil prices. This will lessen, but certainly not eliminate, the geopolitical influence that major oil-exporting countries enjoy today. It is perhaps a permissible exaggeration to claim a natural gas revolution. But like all revolutions, whether and to what extent the benefits are realised will depend on how rapidly the economic and political systems adapt to the change.

JOHN DEUTCH

Institute Professor of Chemistry, Massachusetts Institute of Technology
Former Director of the CIA

TRENDS AND PROJECTIONS IN THE REGION

Southeast Asia has been a region of steady economic growth and robust demographic development over the past decades. As a result, energy demand increased by over 150 per cent since 1990, from 233 million tonnes of oil equivalent (mtoe) in 1990 to 624 mtoe in 2015, according to the International Energy Agency, with the five biggest energy consumers being Indonesia, Thailand, Malaysia, Vietnam and the Philippines. Together, the five countries account for 90 per cent of the region's energy demand, while the other five ASEAN nations consume just 10 per cent. Traditionally, primary energy supply relied heavily on fossil fuels, and they still represent around 75 per cent of the combined fuel mix today. Besides oil, natural gas demand also expanded rapidly in the 1990s. Mainly fueled by domestic gas production, most Southeast Asian countries built natural gas power generation plants which resulted in a boost for the fuel to about 20 per cent share in the overall fuel mix after the year 2000.

The region is also a prominent LNG producer, with Malaysia ranking third worldwide in LNG exports just after Qatar and Australia, and regionally first ahead of Indonesia and Brunei. And although the market price for LNG dipped in the recent past, primary producer PETRONAS emphasized its long-term view and said it will continue to invest as it still sees sizeable potential for LNG both on the world and the East Asian market. In turn, Malaysia's main regional rival Indonesia will be not so much of a threat in the export business in the years ahead. Rapidly growing demand on Indonesia's domestic market will effectively transform it into a net importer of LNG, which represents even more of an opportunity for Malaysia to maintain the upper hand in ASEAN and to capitalise on its abundant resources.

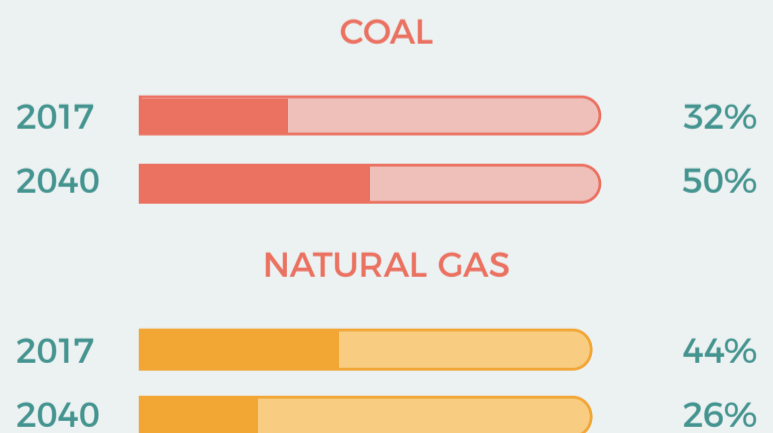
However, some countries began shifting to coal as power companies across the region started tapping into the abundant and cheap domestic resources to generate electricity, a move that has turned out to be detrimental to demand growth for natural gas.

"Electricity is increasing its share in total energy consumption and coal is increasing its share in power generation in

Southeast Asia," says Laszlo Varro, Chief Economist of the International Energy Agency, noting that there is now a long pipeline of coal-fired power plants in the region, while gas-fired plants have been put on the backburner.

Some 40 per cent of the 400 gigawatts in generation capacity to be added in Southeast Asia by 2040 could likely be coal-fired, the International Energy Agency says. That would raise coal's share in the Southeast Asian power market to 50 per cent from 32 per cent, while natural gas could decline to 26 from 44 per cent if governments don't develop strategies and policies that advocate the use of natural gas.

PROJECTION OF COAL'S AND NATURAL GAS' SHARE OF THE ASEAN POWER MARKET



This trend is due to low coal prices, and concerns over natural gas supply.



HOW A COAL-DOMINATED ENERGY MARKET WILL AFFECT THE REGION

This development is somewhat alarming. While it is true that coal is more widely available at lower cost than natural gas in the region which means a budgetary relief for energy producers, there remain societal side-effects and macro-economic considerations. Firstly, natural gas-fired power plants are generally cheaper and quicker to build than coal-fired power plants. They also tend to have higher cycle efficiencies and greater operational flexibility, making gas plants a sounder investment than coal plants. From an environmental standpoint, current coal plants can be equipped with environmental control systems that reduce their significant environmental footprint. These controls attempt to diminish the hazardous emissions of nitrous oxide, sulphur oxide, particulates and carbons. However, such filtering systems come with a hefty price tag and would not be needed to such an extent for a natural gas plant.

With regards to societal costs, health consequences also have to be taken into account. Although natural gas is a fossil fuel, the emissions from its combustion and residues that can directly affect the human body are much lower than those from coal. Natural gas emits 50 to 60 per cent less carbon dioxide when combusted in a new, efficient natural gas power plant compared to emissions from a typical coal plant even if the latter is equipped with the latest filtering techniques. The combustion of natural gas produces negligible amounts of sulphur, mercury and particulates, while one of the biggest problems with burning coal remains the emittance of particulate matter.

A Harvard University-led research study published in January 2017 analyzed the health impacts of existing and planned coal-fired power plants in Southeast Asia, South Korea, Japan and Taiwan and came to the conclusion that air pollution from coal-fired power plants in the areas of the research currently causes around 20,000 premature deaths per year, with Indonesia, Vietnam, China and Myanmar being the most affected countries. Furthermore, if plans are realised to construct hundreds of coal-fired power plants in the region, the fatalities could rise to 70,000 regionally, with 24,400 excess deaths per year by 2030 in Indonesia alone.

Increased coal burning will mean increased emissions of:

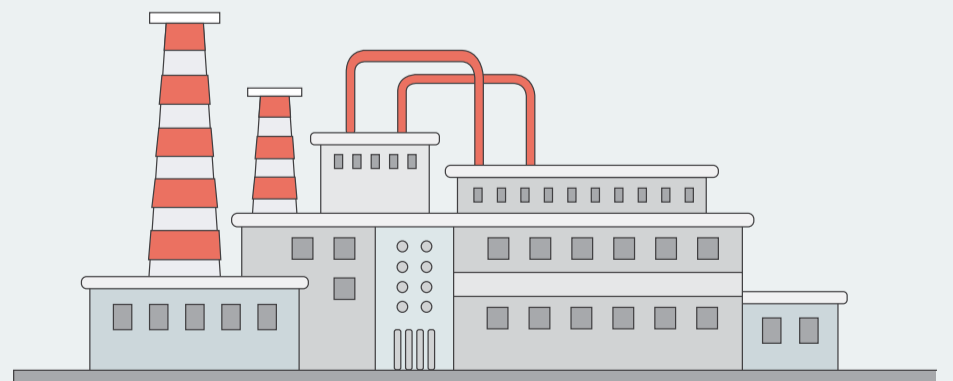
- CO2
- Nitrous Oxide
- Sulphur Oxide
- Particulate Matter

According to Harvard University, emissions from coal plants are currently responsible for

20,000 DEATHS REGIONALLY

If coal consumption in the region expands as predicted, that number will reach

70,000 BY 2030



PROVEN NATURAL GAS RESERVES IN

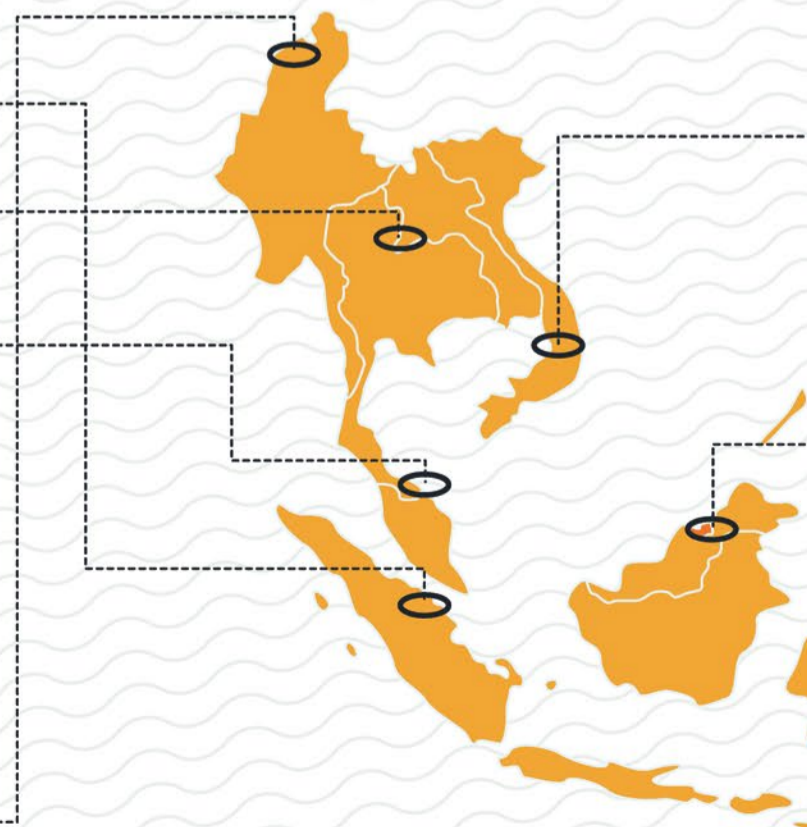


NATURAL GAS PRICES

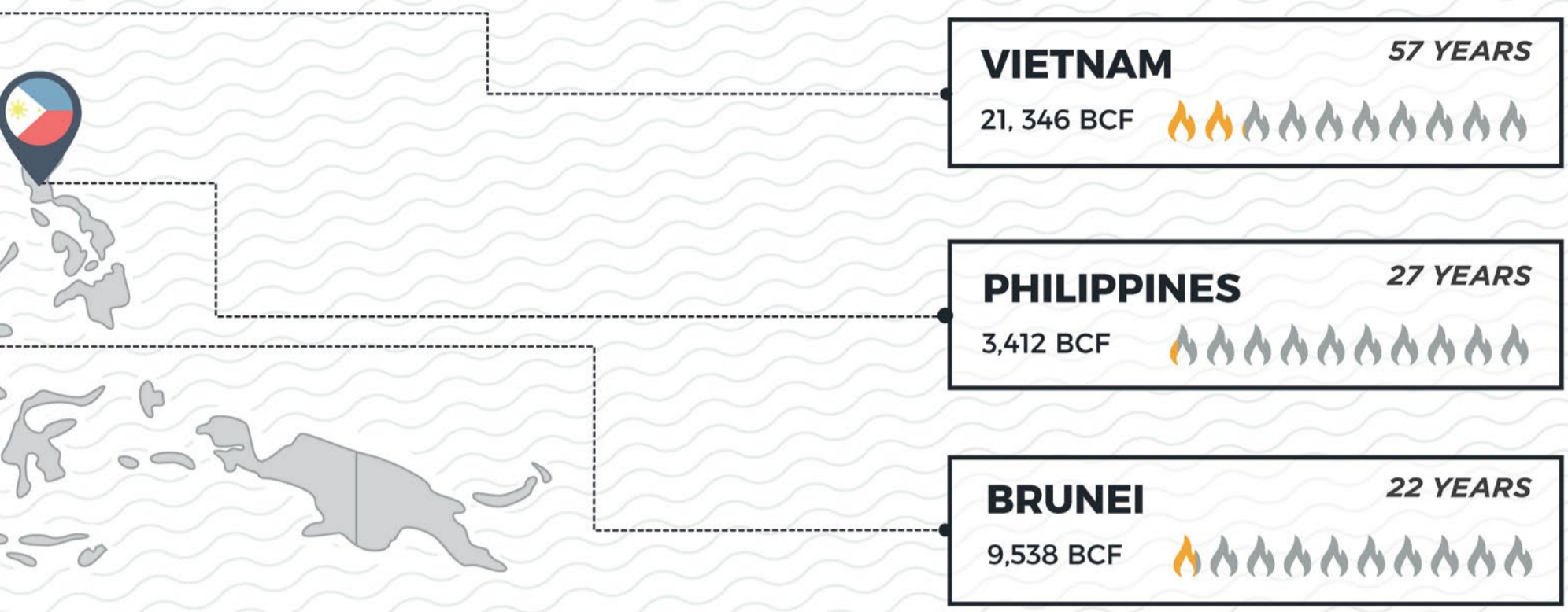
(average price for end-users as of FX rate on March 17, 2017)



ANNUAL NATURAL GAS PRODUCTION



ASEAN (with years of reserves remaining):

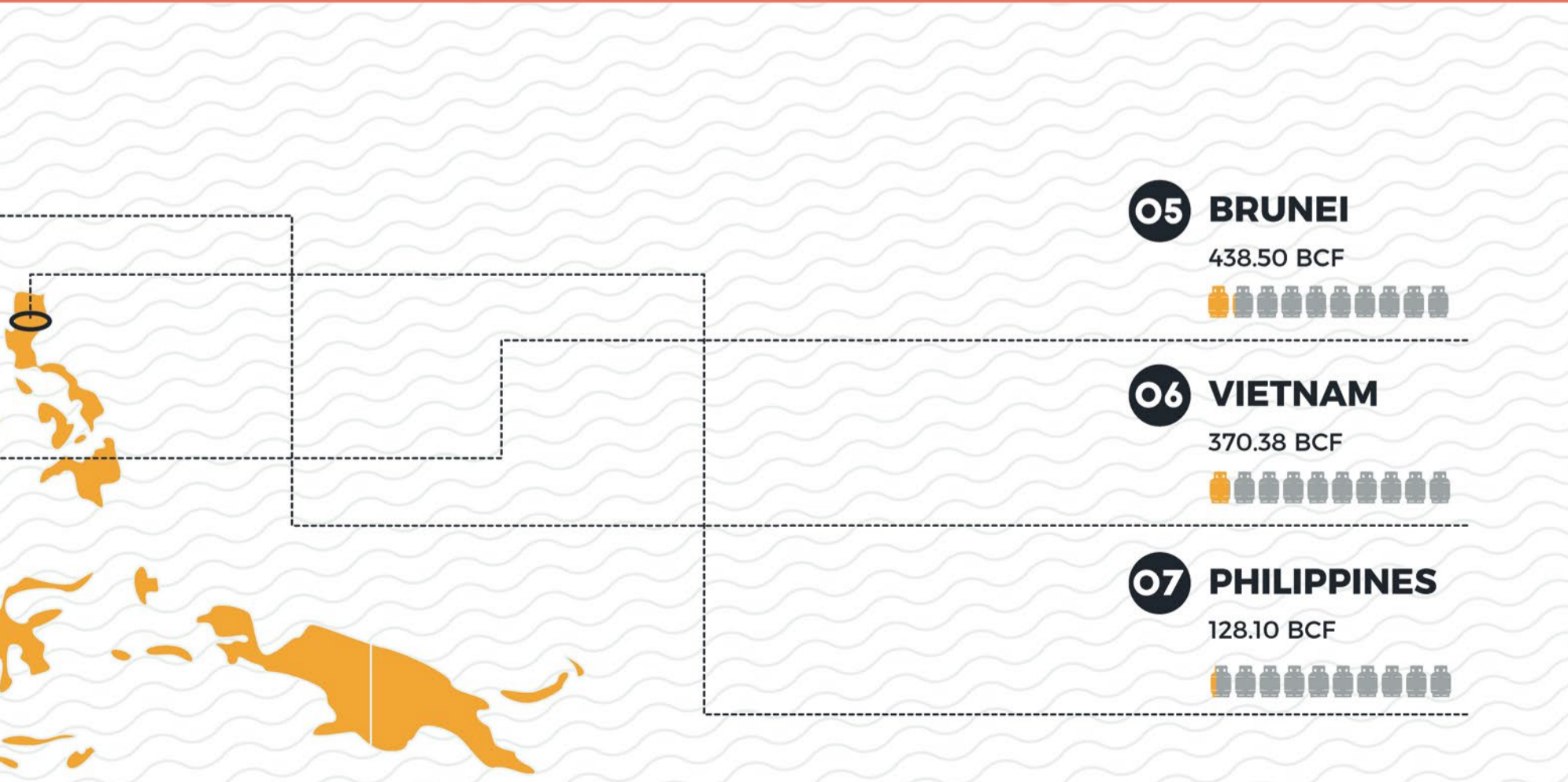


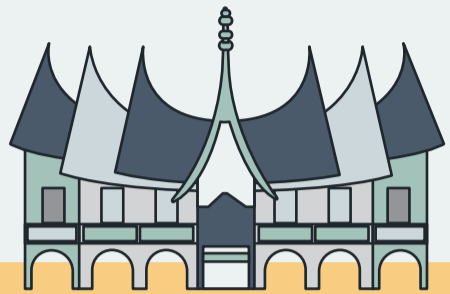
PRICES IN SOUTHEAST ASIA:

(in US Dollars per one million British Thermal Units, mbtu):



PRODUCTION PER COUNTRY (2015):





COUNTRY SNAPSHOT

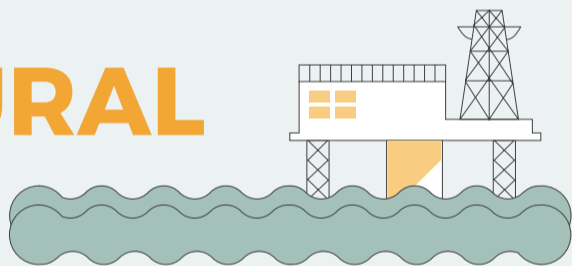
INDONESIA

Despite 2,500+ mtoe of natural gas reserves, Indonesia has ramped up coal production



COAL

NATURAL GAS

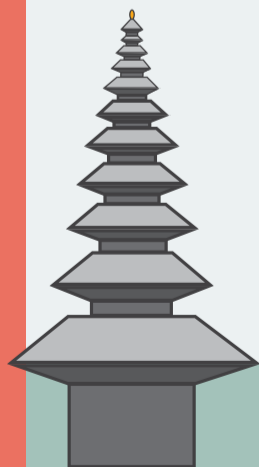
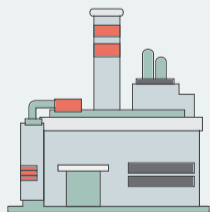


To account for energy shortages, Indonesia aims to build



300 COAL POWER PLANTS by 2019

6 NATURAL GAS POWER PLANTS by 2019



As a result,

24,400

people will die every year

Continued from page 23

Indonesia has a particularly unbalanced system of power generation. While it is the country with the largest natural gas reserves in Southeast Asia, production has been declining since 2010 after it reached an annual record of 85.7 billion cubic meters. At the same time, coal production in Indonesia has been rising rapidly in the recent years, not just for export, but also for increasing domestic use. This year, Indonesia will produce about 489 million metric tonnes of coal, a whopping 18 per cent above the government-mandated target, according to energy ministry forecasts, and up from the 2016 output of about 434 million metric tonnes. The government intends to utilize the surplus production to develop more power-generating capacity in a plan up to 2019 and aims to build nearly 300 power plants, most of them coal-fired, to overcome endemic shortages across the nation.

Natural gas in Indonesia is in abundance and the fuel is indeed acknowledged as a cleaner source of energy. However, exploration, production and deployment of infrastructure in the form of pipelines and gas distribution networks are being choked off by the reluctance, particularly from foreign investors, to go ahead with projects owing to legal and regulatory problems and a lack of investment security. Indonesia's National Infrastructure Development Plan 2016 aims at adding just six natural gas infrastructure projects up to 2018.

Vietnam, which due to its rapid economic development turned into a net electricity importer in 2015, also wants to add additional coal capacity, but not as excessively as Indonesia due to its unique power policy. Firstly, there are widely developed renewable energy solutions such as hydropower deployed throughout the country. Secondly, Vietnam seems more committed to climate change goals, namely those formulated at the 2015 United Nations Climate Change Conference, or COP21, in Paris, after which the government in Hanoi announced its intention to review the development plans of all coal plants, making the previously planned coal boom uncertain. The country primarily produces anthracite which has high ash content when fired, and many communities are not willing to deal with such coal plants in their vicinity. As a result, coal production in Vietnam stagnated in recent years and is projected to continue to remain relatively flat.

Vietnam's natural gas production is also projected to remain stable, but the sector is challenging and expensive to develop due to the high concentration of carbon dioxide and hydrogen sulfide in Vietnam's gas resources. Much depends on whether territorial disputes can be resolved in the South China Sea, where most of Vietnam's natural gas resources are situated.

Thailand is somewhat of a poster child when it comes to commercial and consumer use of natural gas in transport and individual traffic. The country shows how a policy of providing infrastructure for natural gas use can pay off. In terms of energy production, the country utilizes significant natural gas resources from the Malaysia-Thailand Joint Development Area in the Gulf of Thailand, mainly for its energy-starved southern regions. However, an inconsistent energy roadmap due to constant policy changes, varying levels of government competence to tackle energy issues, and no clear indications for the sector over the longer term have reduced the attractiveness of the upstream gas sector for foreign investors. With more than 65 per cent of Thailand's natural gas production concessions expiring in 2023, Thailand's gas output is expected to steadily decline, and a scenario that coal plants would have to be used in order to offset decline in natural gas production is likely. Thailand has significant reserves of brown coal, estimated at 1.1 billion metric tonnes. The country is also importing rising quantities of hard coal, primarily sourced from Indonesia and Australia, to fuel its power stations in coastal areas where it is, in turn, increasingly faced with local opposition against new coal plants. A massive protest against a new, large coal-fired power station in Krabi in February 2017 and angry comments in leading media led eventually to its suspension.

"In pushing for a massive coal-fired power plant in the South, the junta-led government is not only defying the global trend towards sustainable development - it is also putting the health of our next generation at risk," an editorial in Thailand's The Nation newspaper read.

Overall, natural gas production in Southeast Asia is forecast to grow slowly from 214 billion cubic meters in 2013 to around 260 billion cubic meters in 2040, led almost entirely by Indonesia and through higher output in underexplored

Myanmar. Utilisation will meet challenges, though, since domestic consumption will heavily rely on non-power use of natural gas. There is potential for higher domestic consumption and for regional export of LNG. And there are also more applications for natural gas as its use grows in the transportation sector and in some industries. It could also be used as fuel for smaller power units in rural and remote areas off the power grid in developing countries.



MALAYSIA

The world's 3rd largest exporter of LNG, behind Qatar and Australia.

MALAYSIA is the leading exporter in ASEAN, and is primed to stay ahead with brilliant technologies like the world's first FLNG.

GLOBAL COUNTRY TRENDS FOR NATURAL GAS

The basic question for energy policy in Southeast Asia is whether the region can really decouple itself from the policies of a number of trendsetting developed nations to turn to natural gas as a dominant power production and consumption resource.

A major factor influencing global natural gas use is the energy policy in the U.S. Since 2000, the country experienced a boom in natural gas production and use, particularly since shale gas has become a key source of natural gas in the U.S. In 2015, natural gas became the largest source of power generation in the country. Technically recoverable resources are estimated at about 2,474 trillion cubic feet, which means that, at the current rate of consumption, the U.S. has enough natural gas to last about 93 years.

The use of natural gas in the U.S. for power generation and, increasingly, in form of compressed natural gas, liquefied natural gas or liquefied petroleum gas as cheaper fuel for vehicles, had an overall positive effect of reducing air pollution. And it worked all without state subsidies or price controls since all remaining price controls on natural gas in the U.S. were eliminated by Congress as of January 1, 1993.

China is another nation that has strong preferences to promote natural gas use over coal. Development of the country's natural gas industry is one of Beijing's strategic energy policies in order to secure supplies and to achieve environmental targets for its often heavily polluted metropolitan areas.

Although starting from a low level, natural gas share in China's energy mix has been rapidly increasing in the past years, and the government has set the target to raise the share in the fuel mix to ten per cent from eight per cent by 2020 and push down the share of coal to below 58 per cent from 62 per cent. To reach that goal, Beijing is not only pushing the construction of gas-fired power plants, but also the replacement of oil-based vehicle fuels with gas.

In the European Union, targets have been set to dramatically reduce dependency on oil, cut carbon emissions and improve

air quality. To that end, the European Commission has developed a roadmap for the EU's energy supply from natural gas for the coming two decades and beyond. This is expected to trigger billions of euros of investment in infrastructure, including new cross-border pipelines, and the development of terminals for the import of liquefied natural gas which has been identified as strategic alternative to replace oil-derived fuels for vehicles, a crucial strategy since transport accounts for one third of total energy use in the EU.

Malaysia can learn from these strategic developments in power supply and fuel strategies on its quest to deploy a more sustainable power policy according to the national development plan.

SOURCES:

ASEAN Energy Outlook Platts 2016
Asia/World Energy Outlook IEE Japan 2016
PTT presentation natural gas in Thailand May 2016



THE TURNING OF THE TIDE:

TRENDS AND DEVELOPMENTS IN THE WORLD OF ENERGY

The global natural gas market has progressively transformed in the past few decades - quadrupling in size, doubling its share of global natural gas trade and emerging as one of the fastest growing segments in the energy industry.

This is expected to remain so, with natural gas delivery in prime position to take a big part of this growth, serving markets with little access to indigenous gas resources. The long-term trend towards lowering the carbon intensity of the world's economies should enable natural gas to remain on a favourable growth trajectory as it can play an important role in lowering carbon dioxide emissions.

This is particularly relevant as it displaces coal in power generation and provides an additional source of balancing capacity as intermittent renewable generation sources grow. New markets and applications continue to open up, providing more growth opportunities for natural gas as a fuel, and for new and different types of companies to participate in growth up and down the value chain.

ANDREW SLAUGHTER

Executive Director, Center for Energy Solutions , Deloitte

MARKET-DRIVEN FACTORS

We've pointed out that natural gas causes fewer emissions and has higher energy efficiency than coal. It needs less pollutant controls which means that natural gas plants can be built cheaper and also have a higher and quicker return on investment than coal and oil plants, which simply makes natural gas more competitive.

This has an immense impact on the future structure of the energy market. A number of project reports and surveys by global energy organizations found that, in fact, natural gas power plants always return a higher value than coal power plants, leading to the recommendation that natural gas-fired power plants should naturally be favoured over coal plants if infrastructure allows it. Most experts and researchers take the standpoint that it is not recommended to even construct a coal-fired power plant in major world economies anymore because they will most likely break even much later than a natural gas plant or not at all especially as the world moves towards natural gas.

In short: The strongest market-driven factor for natural gas-based power production is that it is fundamentally a much sounder investment.

According to Steve Piper, director of energy research at S&P Global Market Intelligence, for that reason power generation from coal will dip to 28 per cent of total market share by 2022 compared to 34 per cent in 2017, while gas is expected to climb to 37 per cent of power generation by 2022 from 31 per cent in 2017. By comparison, in 2010, coal-based generation was 46 per cent while gas generation was 25 per cent globally.

The trend towards natural gas can be witnessed in many regions; driven by falling coal demand by the largest consumers, emerging economies, increasing investments and growing populations. Particularly, ample opportunities are there for the natural gas market as demand for more efficient energy production is increasing at a healthy rate in Asia-Pacific countries, particularly China.

Looking at the large markets, in the US, power generation has

seen a significant transformation from coal to natural gas in the last few years. According to the Energy Information Administration (EIA), coal-fired generating capacity in the US has fallen by 15 per cent over the last six years to 276 gigawatts in 2016. Forecasts suggest that US coal consumption would be almost 25 per cent lower by 2040 than today.

In Europe, power production by coal is largely stable, with the main reason being that Germany, the largest coal consumer, fills a part of the supply gap left by a nuclear power phase-out with coal-generated power. But after 2025, the expansion of renewable power and natural gas-fired plant will inevitably lead to a gradual decline in coal-fired plants all over the continent.

In Asia, India and China are the largest consumers. After rapid growth from 2003 to 2011, China's coal consumption began to slow in 2012. According to the EIA, the slowing trend is expected to continue as the country's economy and energy system undergo structural changes. India will, however, stick a little longer to coal since it adapts market-driven changes at a much slower pace and also suffers from a lack of infrastructure and investment readiness. The lack of CO2 constraints in Japan has resulted in proposals for 17 GW of coal plants, should they be built it would result in an increase of coal capacity by 50% from 2017.

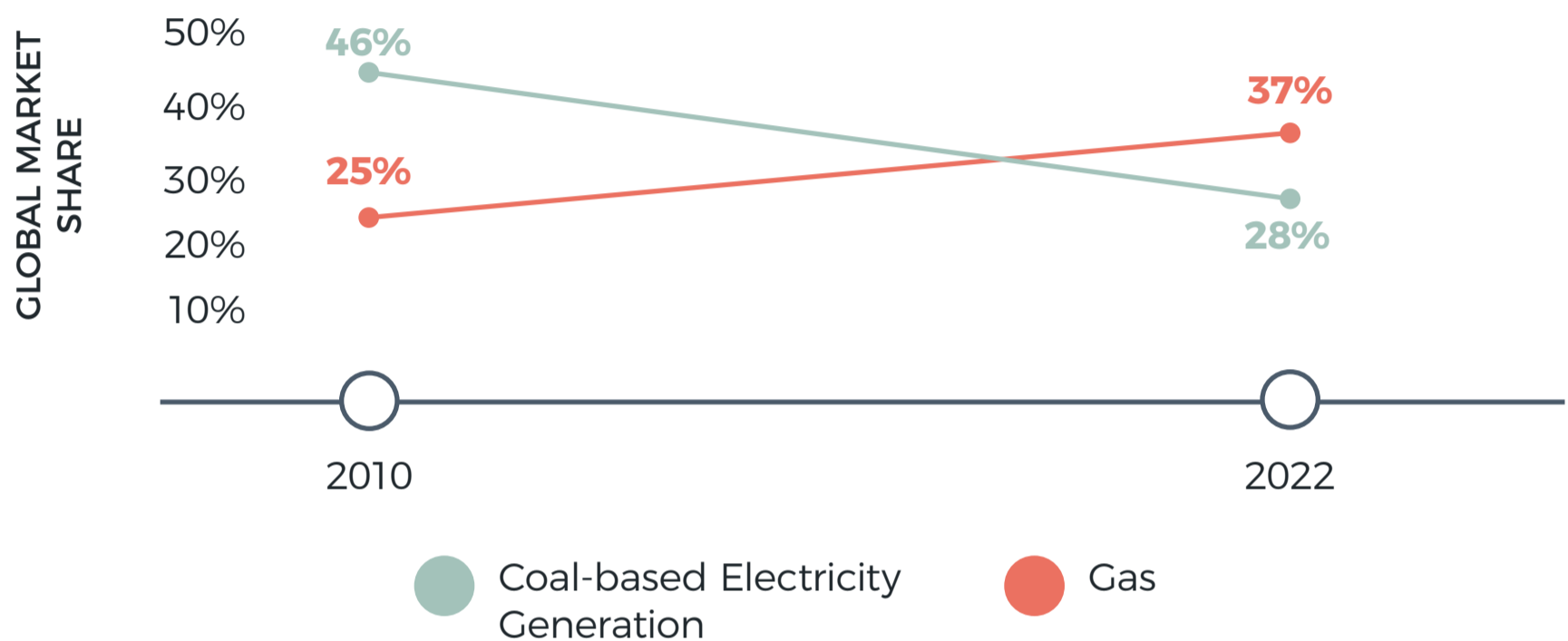
According to the BP Energy Outlook 2017, coal consumption is expected to peak in the mid-2020s globally and its share in the world's fuel mix will shrink consistently afterwards, with natural gas and renewables taking the place. In China alone, growth in gas consumption will increase the share of imported gas to nearly 40 per cent by 2035, up from 30 per cent in 2015.

Natural gas as a cheaper source of energy production also allows suppliers to venture into smaller, so-called second-tier markets. This is being enabled by cheaper transport costs than coal, easier storage and increasingly flexible trade finance.

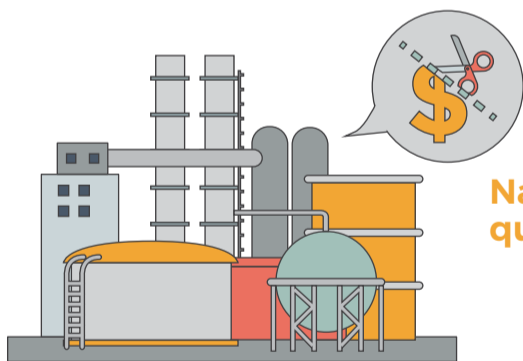


THE DEMISE OF COAL

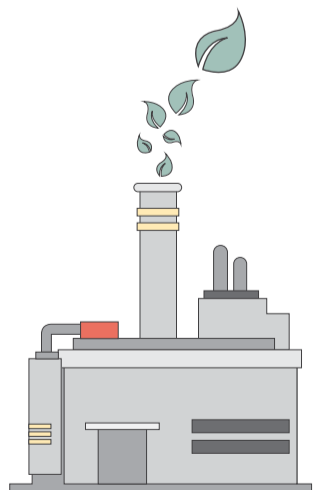
Coal is not the energy giant it once was. By 2022, natural gas will be the leading source of fuel for electricity generation.



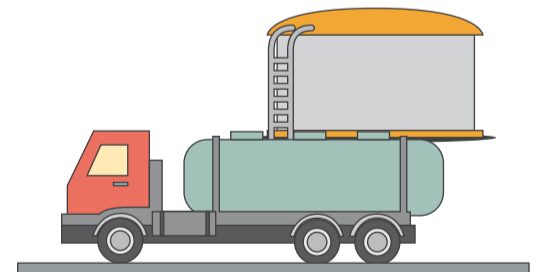
The reasons for this are **GOVERNMENTAL**, **ECONOMICAL** and **ENVIRONMENTAL**. Below, we dive into some specifics:



Natural gas plants are cheaper, and have higher and quicker return on investment than coal and oil plants.



Many governments view natural gas as a bridge fuel that serves as a transition to a greener and low-carbon future. Many countries have introduced a carbon tax, such as countries in the EU, Australia, and India. Thus making coal a much less attractive option.



Technologies like LNG have made transport and storage cheaper and more efficient.

GOVERNMENT-DRIVEN FACTORS

The biggest government-driven factor for support of natural gas-based power generation and consumption are of course its higher energy efficiency and its lower emissions. This means for a government that economic growth can be achieved with less energy inputs than it was the case in the past and without compromising on environmental sustainability. A focus on natural gas also positions and equips governments to better manage the transition to a low-carbon economy, which is the target of most, if not all countries and the reason why they should incentivise and advocate for natural gas rather than coal.

On the government level and apart from higher efficiency, it is also important that natural gas power plants are, as mentioned above, more competitive because this has a direct effect on the willingness of foreign investors to enter new natural gas markets, particularly in emerging economies. Globally, there is a lengthy list of planned new projects, both in development or as approved foreign direct investment projects, with several projects in Southeast Asia, East Africa, the Middle East and North America under consideration.

That said, Malaysia has a history of granting incentives for upstream oil and gas producers and also has outlined a plan as early as 2005 to reduce its carbon emissions by 45 per cent by 2030. The government also imposed incentive-based regulations for the gas sector aimed at incentivising utility companies to reach better performance, and in the future regulations will also be placed on PETRONAS Gas Berhad, the transmission & regasification infrastructure company, a public-listed company owned by energy colossus PETRONAS. Under the current framework, the Malaysian Government is regulating natural gas tariff to commercial and industrial customers, as well as electricity tariffs, which allows distributor Gas Malaysia, and the largest power utility, Tenaga Nasional, to pass on the fluctuations in input costs to consumers.

However, Malaysia is currently burning more coal than ever and seems determined to continue to do so, a policy that analysts have criticised as diametrically opposed to its climate goals as it increases the country's carbon footprint instead of

supporting a low-carbon future. Malaysia has significant gas potential and its domestic gas supply could jump by 25 per cent over the next five years, but with the fuel losing market share to coal in the power mix, the challenge will be finding a use for it. Estimations are that coal will increase its share of the fuel mix for power in Malaysia from 47 per cent to 65 per cent by 2020, according to Edi Saputra, a specialist on Southeast Asian gas and power at energy research company Wood Mackenzie, which, by all means, runs counter to the global trend.

This development is also contrary to energy specialists' recommendations that the use of natural gas would make the energy-producing process easier and cheaper for Malaysia and all other emerging economies, for that matter. For example, power-generating gas units are considered to be more flexible than steam turbines for coal. They can ramp their output up and down more easily, and their start-up and shutdown procedures involve less time and expenses.

Regulation is often the determining factor for future energy developments. The interaction of fuel prices and environmental rules is a key element in coal plant retirements. Higher coal prices, lower wholesale electricity prices, mostly tied to natural gas prices, and reduced use make investment in environmental equipment for coal plants, such as desulphurisation tools, uneconomical compared to natural gas plants. Adding to that, a number of governments mainly in the European Union, but also in countries such as Norway, Switzerland, some Canadian states, Australia, Singapore and India, have introduced carbon tax legislation in the recent past. Taxes are high enough that it is forcing coal plants to switch off and, together with incentives for natural gas use, supports coal to natural gas fuel switching and with it carbon dioxide emissions reduction.

A key future consideration for a government to support and incentivise natural gas is also far lower logistics and transport costs, as well as access to new consumer markets for natural gas. Charter rates for specialised natural gas transporting vessels, along with fuel consumption, comprise a

significant amount of the delivery cost of natural gas. Reducing shipping rates and distances can therefore be an important factor as reducing liquefaction costs is improving the competitive economics of natural gas. Furthermore, with regards to new consumers and end-users, natural gas opens a wide field for marketers. New technology, economic factors and environmental regulations are boosting interest in new applications for natural gas around the world, for example as transport fuel in heavy-duty trucks, rail locomotives, barges and large ships, as well as a fuel source for distributed power generation in markets undersupplied with energy. Experts expect that, while these new consumer markets will take time to build up momentum, over time they could develop into significant new sources of natural gas demand.

In a nutshell, there is ample opportunity in natural gas, and the growth trajectory in the future is clearly visible. However, to benefit from that potential and tap significant opportunities, governments, market players and decision makers need to rethink the dominant energy generating and consumption models of the past, and that includes a revamp of the utilisation and the role in the fuel mix of oil and, particularly coal.

SOURCES:

World LNG Report International Gas Union 2016
International Energy Outlook US Energy Information Administration 2016
World Energy Outlook International Energy Agency 2016
Navigating the new world of LNG Deloitte January 2017
BP Energy Outlook 2017 Edition
Smith School
AT Kearney

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Malaysia is currently burning more coal than ever and seems determined to continue to do so, a policy that analysts have criticised as diametrically opposed to its climate goals as it increases the country's carbon footprint instead of supporting a low-carbon future.



IN 2005

MALAYSIA SET THE GOAL OF

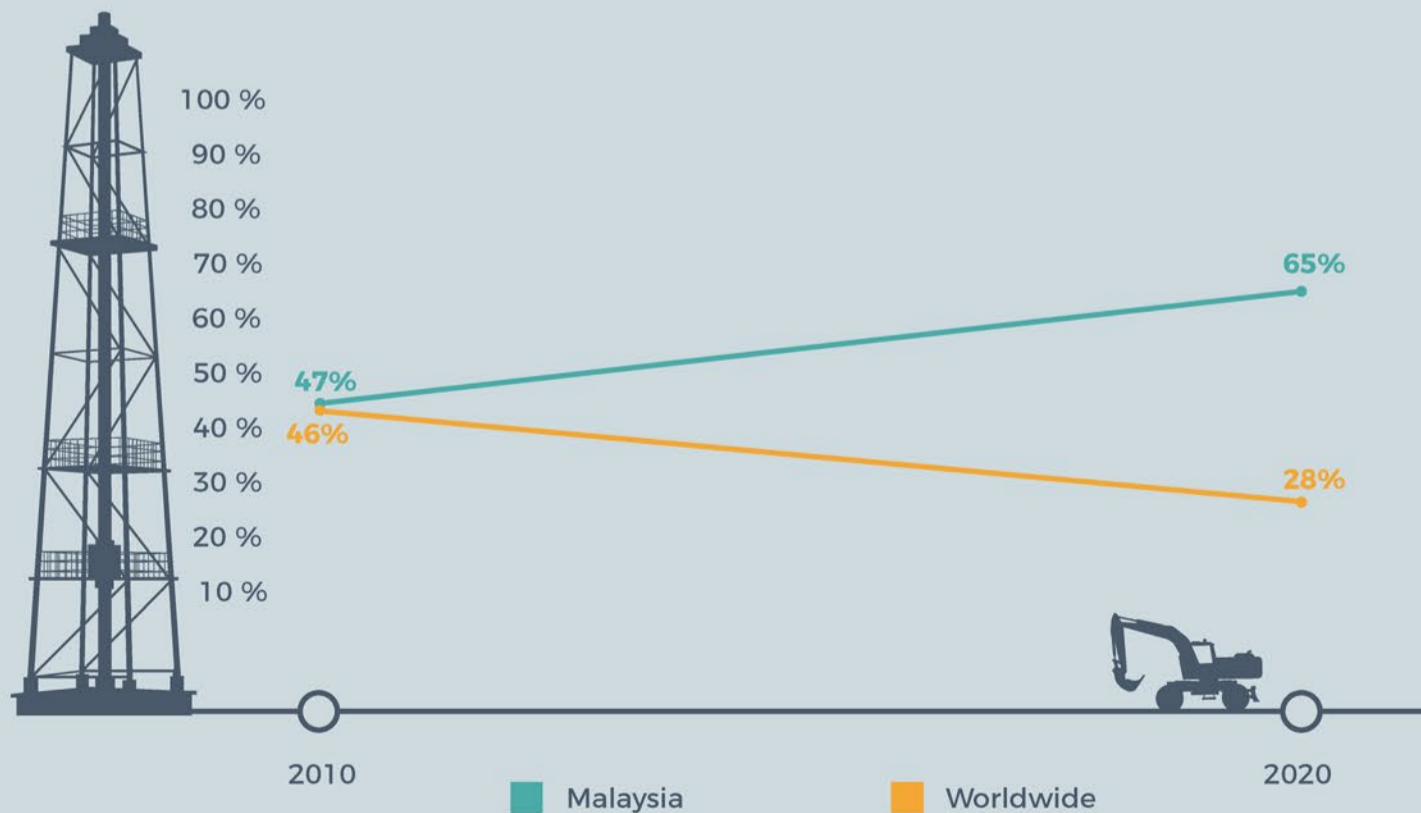
REDUCING ITS CARBON EMISSIONS

BY 40%

BY 2020

*The target has since been revised to 45% cut by 2030.

However, coal will increase its share of the power generation mix to 65% by 2020, up from 47% presently, running counter to the global trend.



FURTHERMORE

Malaysia's domestic gas supply will jump by 25% over the next five years, proving to be an ample source.



SUSTAINABILITY, LIVABILITY, VIABILITY



It is all about really moving away from dirty fossil fuels and into clean renewable energy. So, if we look in the past, a lot of base load power really came from coal as well as oil, but as we are looking at a future where you're looking at zero carbon emissions from solar and from wind.

But to get there is difficult today as we cannot completely switch our industries to using renewables. And that is where gas really comes in as a bridging fuel. It is clean and it can provide base load power.

CHONG ZHI XIN

Principal Analyst at Wood Mackenzie

NATURAL GAS VS. COAL: A FIERY DEBATE OVER THE FUTURE DOMINANCE OF FUEL

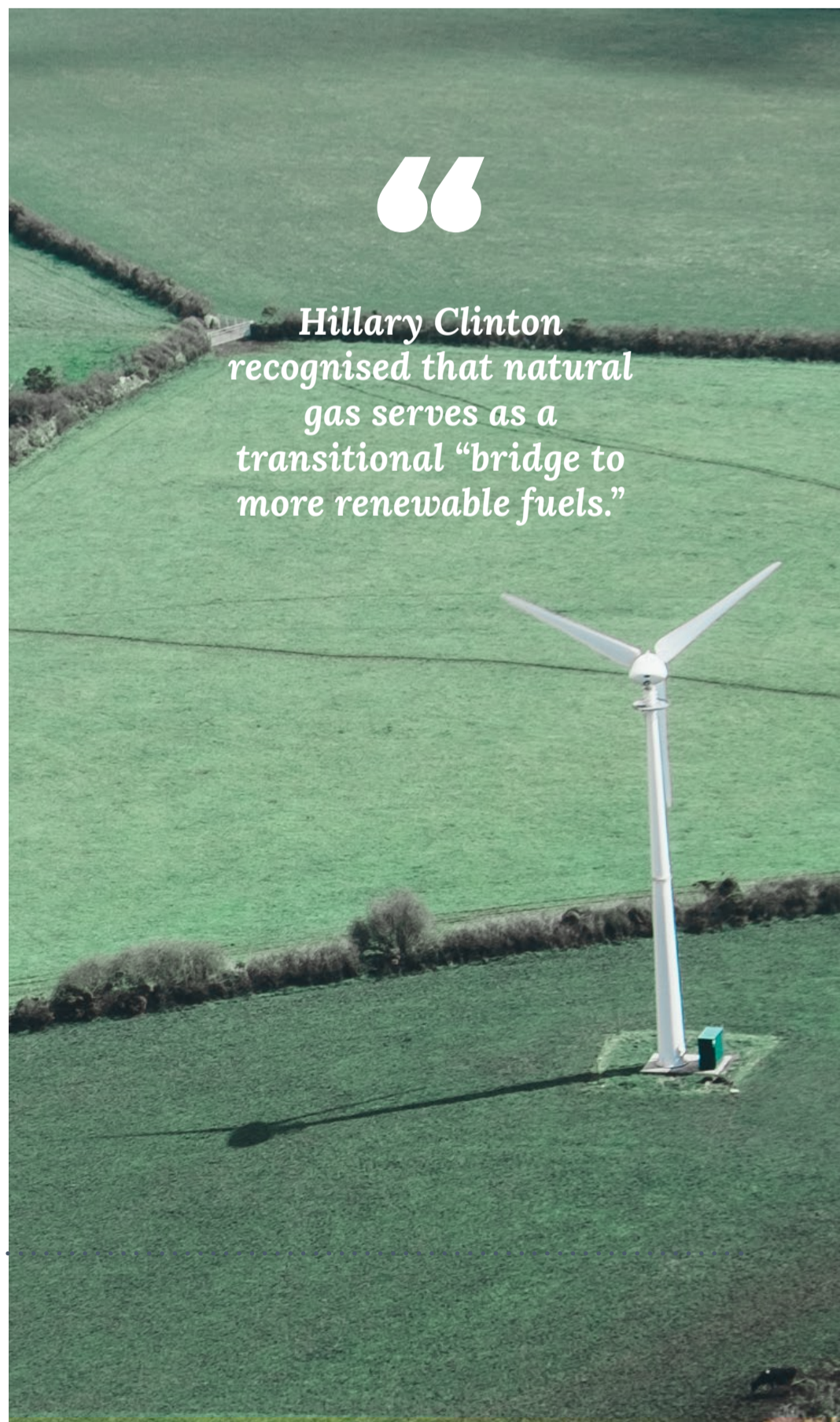
In April 2015, the world's second largest energy consumer crossed a critical threshold that signaled a new era in global power consumption. Long seen as the second fiddle in electricity generation behind coal, natural gas has since taken the lead as the primary fuel source in the United States, and continues to do so. Last year, natural gas is expected to have overtaken coal as the dominant fuel used in US power generation, the US Energy Information Administration predicts. Counting the first six months of 2016 alone, this is already the case: Natural gas-fired generation accounted for 36% of the US's total electricity needs during that period, compared to 31% for coal.

The US's record-level usage of natural gas has been ushered in by more cost efficient means of production, a revolution in oil shale extraction, as well as a political push towards the cleaner cousin of the world's two most predominantly occurring fuel sources. Yet, a fiery debate still roars on over whether natural gas or coal should remain the majority feedstock of the global powerhouse.

During the 2016 US Presidential campaign, Hillary Clinton recognised that natural gas serves as a transitional "bridge to more renewable fuels." This ethos upholds that natural gas will serve in bringing us towards a post-carbon future, given that gas-fired power plants emit about half the amount of carbon dioxide when compared to coal plants. Moreover, fuel switching is also considered a primary tool to combating climate change, and there is persuasive evidence to suggest the switch would be a global boon. "Greenhouse gas emissions from the energy supply can be reduced significantly by replacing current world average coal-fired power plants with modern, highly efficient natural gas combined-cycle power plants or combined heat and power plants, provided that natural gas is available and the fugitive emissions associated with extraction and supply are low or mitigated," a report from the Intergovernmental Panel on Climate Change, an international body supported by the United Nations, concluded. The last part of this statement is particularly important to the debate, and an underlining piece of logic for pro-coal lobbies.



*Hillary Clinton
recognised that natural
gas serves as a
transitional "bridge to
more renewable fuels."*



THE CLAIM FOR COAL

Natural gas is a fossil fuel and while CO2 emissions are drastically lower compared to those of coal-fired plants, this single metric does not tell the whole story. Drilling and extraction of natural gas results in what is known as fugitive emissions, the leakage of methane through transportation pipelines, the drilling site and across other infrastructure. Methane that is released into the atmosphere has deleterious effects on our planet because this primary component of natural gas is 34 times stronger than CO2 at trapping heat over a 100-year period of time, and 86 times stronger over 20 years. If a natural gas extraction site isn't well maintained, then drilling can result in the leakage of these so-called fugitive methane gases, in turn having tremendous unexpected impacts on our environment, effectively negating any climate change mediation.

This is a particularly damaging critique when we look at unconventional extraction methods, namely hydraulic fracturing, also known as fracking, which is the process of pumping high-powered liquids deep into the ground to break apart shale rock deposits to extract natural gas or oil. These deposits are abundant and are ultimately expected to prove a transformative role in buttressing the growing dominance of natural gas in the global energy supply, but extracting this fuel source results in numerous negative repercussions, such as groundwater pollution, seismicity and socioeconomic disruptions.

Across the world, fracking has already proven revolutionary, and shows little sign of abating in growth; the technological breakthrough transformed the US from a net importer of energy to a net exporter. Yet, beyond the polluting byproducts of this extraction method, which also bears a high price for production, the fugitive methane gases that are emitted in larger quantities than we previously thought can further undermine natural gases' utilisation as a "bridge" fuel source, recent studies have found.

Measuring methane leakage isn't easy, because in oil, natural gas and coal extraction, similar byproducts are released, albeit in different quantities. However, researchers have honed

in on just how much methane is being emitted during natural gas drilling, discovering that the extraction process on typical sites have a potential leakage rate of two to four percent, with spikes up to ten percent. This discovery is possibly earth shattering for natural gas backers because a



Experts use the term radiative forcing (RF), to classify the capacity of a gas to trap a gas in the earth's atmosphere.

three percent methane leakage rate would prove to be enough to negate any climate change benefits that natural gas would have over coal during a 20-year period. The findings that natural gas emits two to four percent of methane as fugitive gas would thus be enough to call into question the conventional wisdom that natural gas is more environmentally friendly than coal or, its close relative in the fossil fuel family tree, oil and petroleum-related products.

However, according to data released from the US Environmental Protection Agency, methane leakage rates in the US are sufficiently low that gas maintains approximately 50% lower CO2 equivalent emissions when used in power generation, even when accounting for such methane leakage. When natural gas is burnt efficiently, methane should not be emitted. The main greenhouse gas emission on burning natural gas is CO2. Although natural gas emits much less CO2 than coal when burnt for electricity, this environmental benefit is reduced if high levels of methane are emitted.

Fugitive gas is but one of the central bullet points upheld by the pro-coal lobby worldwide as to why natural gas shouldn't be used to switch off coal plants, but the true foundation behind this platform is the adoption of so-called clean coal-burning technologies to meet a perceived interminable growth in global energy demand. While "clean coal" has no globally accepted definition, it is widely understood as a range of technological advancements to trap and store carbon during the coal combustion process in sources such as power plants. The coal lobby posits further that clean coal advancements would enable an abundant and cheap fuel source to produce electricity via a more sustainable power generation method. This tows in line with the idea that only a widely available and inexpensive fuel source will be able to guarantee future energy security as our planet's population approaches 9.3 billion by the year 2050. Although clean coal technology is still far away from achieving a globally understood consensus on its benefits, and being that the very idea of attaching the word "clean" to the largest source of carbon emissions is often derided as a chimera, the pro-coal lobby is dedicated to claiming that clean coal would be a cheaper way to lower carbon emissions compared to renewable resources, if you see the debate through



The pro-coal lobby is dedicated to claiming that clean coal would be a cheaper way to lower carbon emissions compared to renewable resources.

the "apple for apple" argument. The costs for maintaining batteries to power solar and wind farms to provide a sustainable energy output, pro-coal proponents claim, would cost much more than clean coal, and thus are not the panaceas to energy security as many would like to believe.

NATURAL GAS: ENABLER TO A LOWER CARBON FUTURE

Natural gas proponents tend to have a more Cornucopian outlook than the coal lobby. They see the world as an ever-evolving state where mankind's technological breakthroughs will eventually be able to progress towards a post-carbon future, with natural gas playing an irrefutable role as a "bridge fuel."

To backers of natural gas, a cleaner future is inextricably linked to the dominance of natural gas in the global energy supply. As the cleanest burning of the fossil fuels, natural gas produces only negligible amounts of sulphur oxides, mercury and heavy air particulates when compared to oil- or coal-burning power plants. Moreover, while natural gas combustion does produce nitrogen oxide, the base component to creating smog, it does so at a much lower level than the burning of coal, gasoline or diesel fuels. The societal benefits of switching to natural gas are thus immense: Reduction in these emissions translates into huge public health benefits, as these pollutants have been linked with problems such as asthma, bronchitis, lung cancer and heart disease, health researchers in California have concluded.

The World Health Organization has found that outdoor air pollution in both cities and rural areas is estimated to cause some 3 million premature deaths a year worldwide.

Premature deaths due to air pollution are costing the global economy \$5.1trillion annually, or roughly twice the economic output of the UK. More than half of that burden falls on China and other developing economies in Asia, according to a study released by the World Bank in September 2016.

Gas is the cleanest-burning hydrocarbon, producing around half the greenhouse gas emissions that coal does when burnt to generate electricity.

Although the global economy continued to grow, global energy-related carbon dioxide emissions were flat for a third straight year in 2016, according to the IEA. Switches from coal to gas played a big part, not just in the US, but also the UK and China.

At COP 21, the world reached a historic UN deal on climate change. The Paris Agreement focuses on keeping the global average temperature to below 2°C above what it was in pre-industrial times. Today, the world is already around 1°C above that level.

When the benefits of natural gas versus other fossil fuels are honestly debated, the type of natural gas production must be considered. Undoubtedly, highly efficient natural gas-powered stations produce about 50% less of climate-change incurring carbon dioxide when compared to black coal-powered stations – even if we compare those equipped with the latest technology. The most efficient natural gas stations are combined-cycle plants, which are today widely used across the US and quickly being adopted globally. This type of gas-fired station produces the least CO2 emissions, and efficiently recycles steam produced by a heat recovery system to power gas turbine generators that make additional electricity. In natural gas combined-cycle plants, electricity generation produces half as much carbon dioxide, less than a third as much nitrogen oxide, and one percent as much sulphur dioxide and particulate matter as coal-fired plants.

Coal is not alone in this ignominious category. According to the Natural Resources Defense Council, the most toxic types of air pollution found on the planet today can be traced back to both coal- and oil-fired power plants. Coal and oil contain typically 0.5% to 3% of sulphur by weight, which, during combustion produce, combine with oxygen in the air to produce sulphur dioxide, the most important ingredient to creating acid rain. Making matters worse, many other materials found in coal and oil are not combustible, including carbon. During the combustion process, these materials are released into the air in small solid particulates, which contain toxic materials, such as arsenic and lead, and result in numerous harmful effects to human health.

HEALTH EFFECTS OF POLLUTANTS FROM COAL- AND OIL-BURNING PLANTS

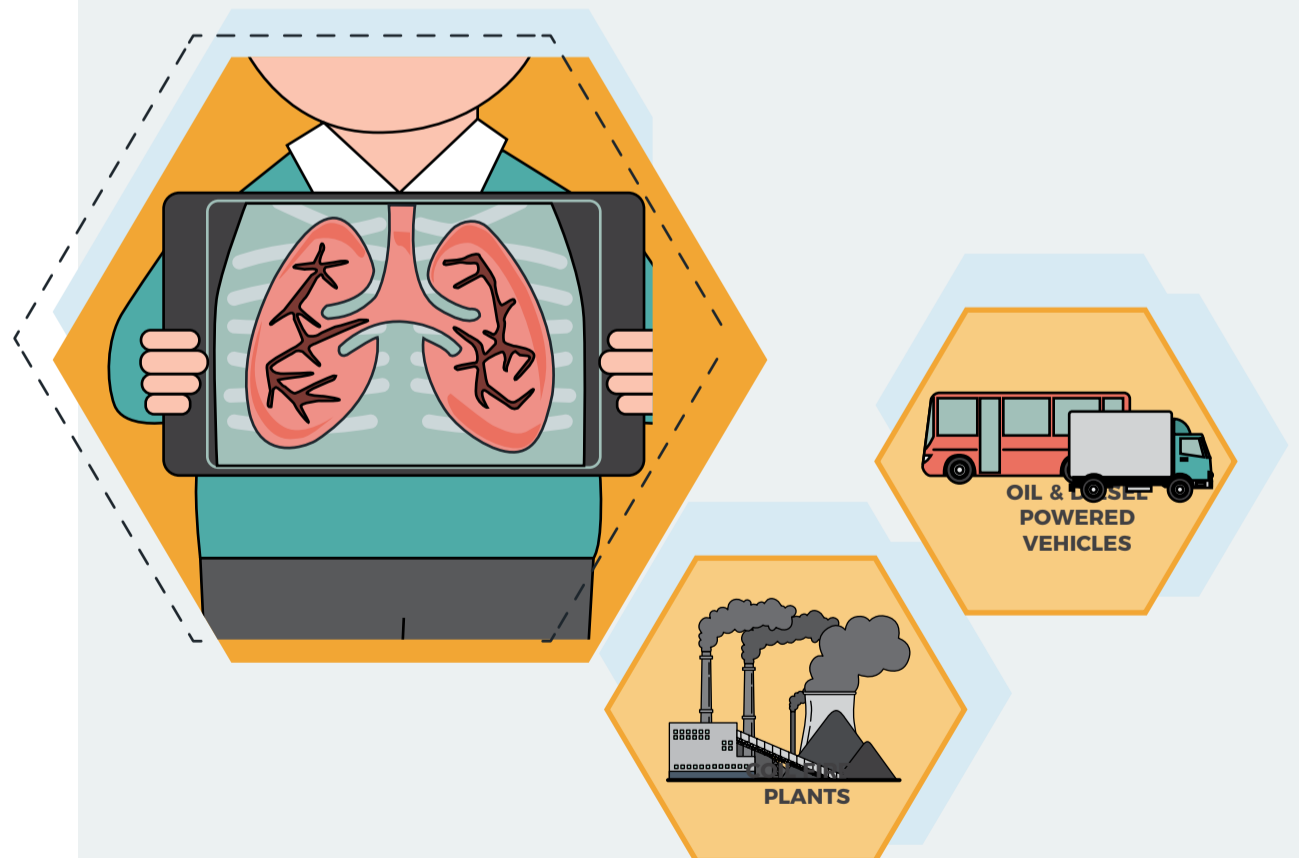
Ultimately, how well natural gas producers manage their fugitive emissions also defines just how valuable of a resource gas can be, and this depends highly on the producer's extraction, treatment and transportation methods. Yet, the full impact fugitive gas leakage may have on the environment may be misrepresented. According to a study conducted by Berkeley, methane leakage rates would have to be 4.8 percent to 9.3 percent to create a stronger trapping power than coal over the next 100 years. This ability for gas to trap heat is called radiative forcing (RF), which is the common measurement of quantifying greenhouse gas emissions. Both carbon dioxide and methane emitted by the production of coal and natural gas have the same net radiative force over the first decade of emission into the atmosphere. However, the Berkeley researchers endorse that there is a noticeably large increase in divergence of radiative force emitted by natural gas production compared to coal in the atmospheric half-life of the fugitive methane gas. While coal and oil proponents may be able to claim that fugitive methane that escapes from natural gas production negates the environmental blessings of production, over the long term this argument holds little sway. "Natural gas can serve a viable bridge away from coal-based generation if avoiding longer-term climate impacts is prioritized and fugitive methane emissions are minimized, reducing radiative forcing by up to 56 percent over the next 100 years compared to conventional coal," the research concludes.

Partnering with renewables

Another argument that is often made is that the utilisation of natural gas as a "comple-

WHAT IS PARTICULATE MATTER?

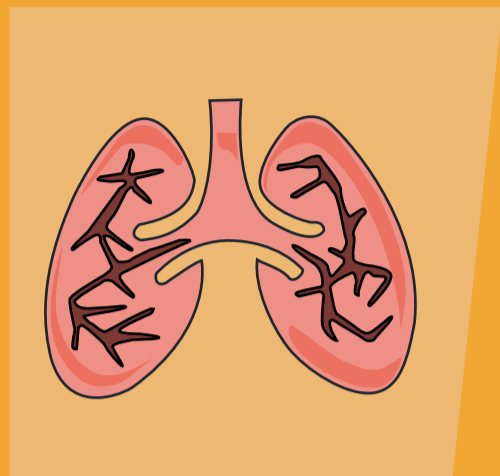
A mixture of soot, smoke, and tiny particles formed in the atmosphere from sulphur dioxide, nitrogen oxides, and ammonia. Particulates are generally formed from coal-fired plants and oil & diesel powered trucks, buses, and cars.



Particles are less than one-hundredth of the width of a human hair, thus bypassing the human lungs' natural defenses, and allowing it to be inhaled deeply.

HEALTH EFFECTS

FROM COAL AND OIL-BURNING PLANTS



- Asthma
- Bronchitis
- Emphysema



SULFUR DIOXIDE



- Pneumonia
- Influenza
- Pulmonary Edema



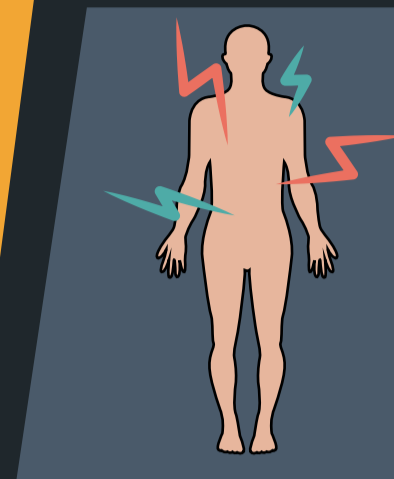
NITROGEN OXIDE



- Exacerbates heart disease
- Asthma
- Bronchitis
- Emphysema



CARBON MONOXIDE



- Damage to the nervous, digestive and immune systems



MERCURY

mentary fuel” towards renewable energy sources is counter-intuitive because it steals the limelight of investment away from wind and solar while placing undue emphasis on natural gas. This view is too zero-sum for the world we live in, and takes out of consideration that natural gas must and will be part of a multi-prong solution to energy security and greenhouse gas reduction. The stark reality is that exploding populations across Asia will continue to pressure energy demand in developing nations; renewable energy development simply will not be able to keep up. Even as the world approaches peak population, estimated to arrive in 2050 at 9.3 billion people, when population growth begins to move towards stability, the world still must prepare for an unending thrust towards modernization, especially across what today is concerned the developing world. Indeed, the bulk of the growth in the world’s middle class will be in Asia, where by 2030 66% of the globe’s middle class population will reside, compared to just 28% back in 2009, according to the OECD. Today, the world’s largest middle class is emerging in China, where more and more people are setting their hands on white goods for the first time. Over the coming decades, that many more refrigerators, toasters and washing machines will incite a spike in energy like the world has never seen.

Yet, if natural gases’ true power as a bridge fuel is to be realised, it must be employed as a complementary energy solution to a supportive renewable energy policy. And, unlike iron-cast activists of renewable energy would have us believe, natural gas cannot be simply replaced wholesale with zero-carbon fuels; the foreseeable global energy needs of our rapidly modernizing world will be too great.

Natural gas has significant advantages when used alongside renewable sources of energy, such as wind and solar, which will play a central role in helping meet the UN climate target.

Modern gas-fired power plants take less than a third of the time a coal plant needs to ramp up to full operation. That means they can quickly respond to an increase in demand for electricity or when the sun does not shine and there is limited wind.

In Brazil, the electricity sector is driven by hydropower. In years when there is enough rain, consumers do not need LNG. But when it does not rain, they need large volumes.

In 2011, 90% of Brazil’s electricity was powered by hydroelectric power plants. By 2015, this had dropped to around 70% because the country suffered a severe drought and the country relied largely on gas to meet demand for power. During those four years, imports of LNG increased 800%.

No current storage solution can adequately manage such seasonal swings today, so gas is best positioned to play that role.

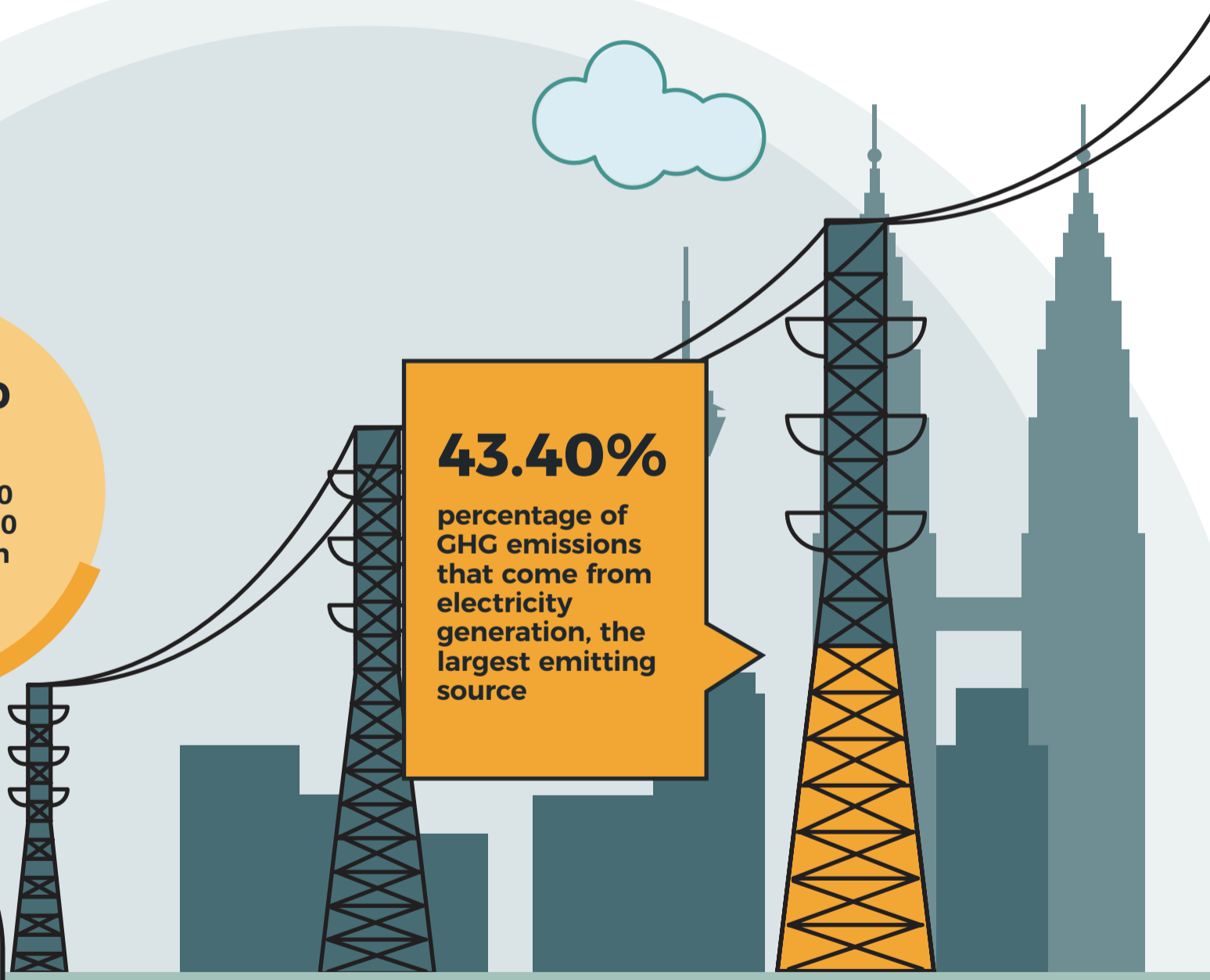
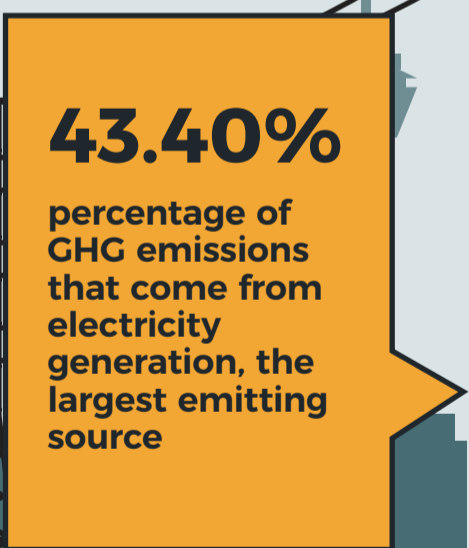
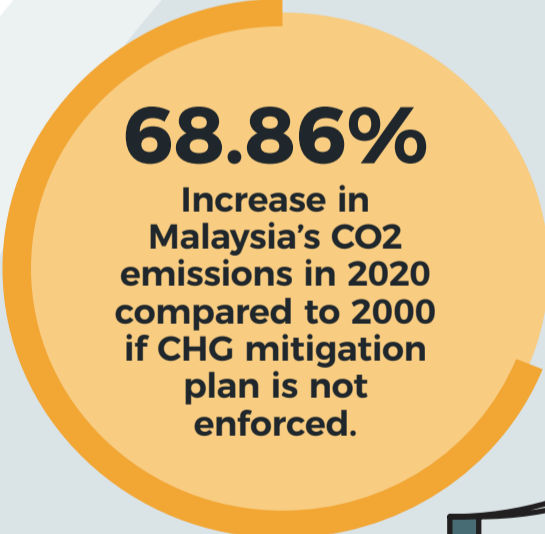
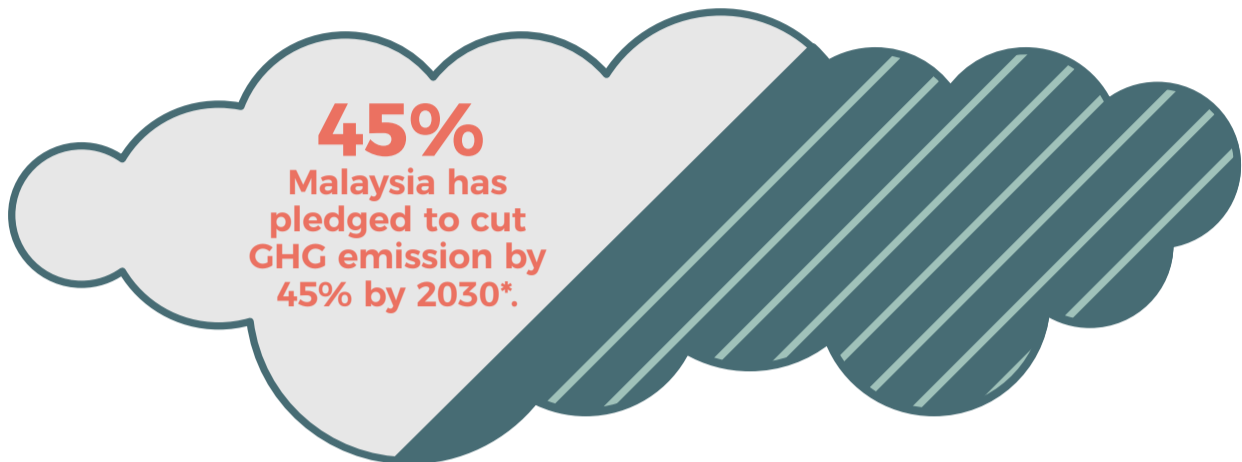
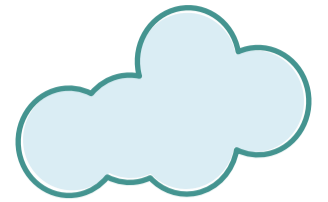
Despite the critical role of renewables, they cannot provide all the world’s energy needs. Renewables chiefly power electricity, which only meets around 20% of global energy demand.

So for renewables to have a bigger impact, electricity has to play a large part in other key sectors of the economy.

For some sectors, such as the manufacture of clothes and food, it will be relatively straightforward to switch to using re-

renewable-powered electricity. But other sectors will not be able to use electricity for the foreseeable future.

In all cases, natural gas will continue to be more preferable to coal as the world's bridge fuel to clean energy, and governments can ensure that the displacement of dirtier coal- and oil-fired plants with natural gas-fired generation doesn't delay renewable resource development by employing forward-thinking policies. Without a doubt, avoiding the opportunity to replace coal with natural gas "due to concerns about short-term warming may inadvertently commit the world to a longer-term warming future," the Berkeley researchers advise. The switch towards natural gas - not away - is in the interest of us all.



MALAYSIA BY THE NUMBERS

*Earlier targeted 40% cut by 2020 compared with 2005 levels

CASE STUDY: BEIJING'S COAL PLANTS GO SILENT

The Chinese capital of Beijing has become synonymous with apocalyptic air pollution. Videos of blinding smog choking the lungs of its citizens, as well as countless channels on YouTube, as netizens have taken to recording the sickeningly fascinating decline of their city's livability in greater numbers over the past years.

But there may be some respite ahead for one of the most polluted cities in the world. In March 2017, the Beijing authorities shuttered the last coal-fired plant in the city, which now depends on generating the vast majority of its electricity from natural gas. Beijing is the first city in China to have taken such a dramatic turn of the leaf in energy policy, which began planning in 2013 as part of the city's five-year environmental and clean air action plan.

At its worst, the amount of PM 2.5 – or tiny air particles considered harmful to our lungs – per cubic meter reached 400 micrograms. The WHO identifies a safe level of air quality as containing 10 to 25 micrograms. The week after Beijing's last coal plant was closed, the PM 2.5 concentrations hovered between 50 and 60, though one day a level of 200 micrograms was recorded.

While it is hard to accurately quantify the environmental impact so soon, academic specialists on the subject say that if data is looked at over a wider scale, positive effects can be attributed to Beijing's ongoing policy on penalizing polluting businesses, reducing vehicle emissions and switching to cleaner fuel sources.

The last of Beijing's coal plants, Huangneng's closure culminated the objective of the five-year plan set out in 2013, effectively reducing 10 million tonnes of coal emission annually. While Shanghai and Guangzhou, China's next largest cities, are ahead in cutting carbon emissions compared to Beijing, the capital's vanguard role in closing coal plants will be used as an example to other city's that also commonly experience "air apocalypses" in the north, such as Tianjin and Hebei.

Indeed, Beijing's clean air action policy is one of the driving forces that have led to China being recognised as one of the few countries in the world that has been making breakneck progress in reducing air and water pollution, the World Bank has acknowledged.



21ST CENTURY SOLUTIONS

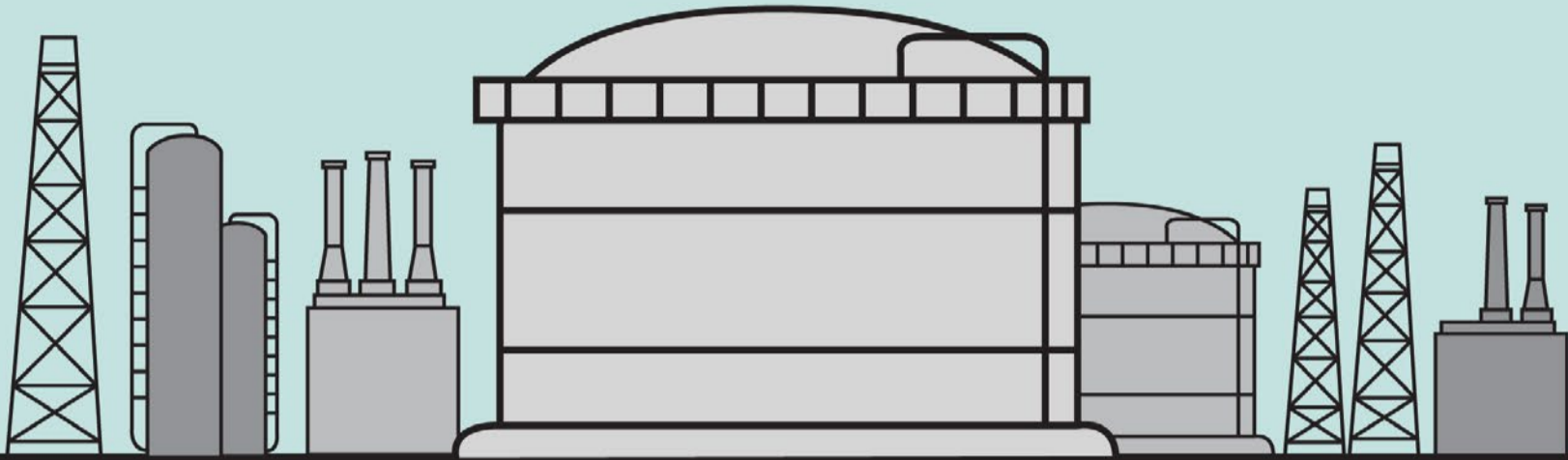
INNOVATION AND PROGRESS
IN THE WORLD OF NATURAL GAS



Learning and innovation go hand in hand. The arrogance of success is to think that what you did yesterday will be sufficient for tomorrow.

WILLIAM POLLARD

COMPELLING COMBUSTIBLE



Across the worldwide domain of transportation, the dynamic properties of natural gas are sparking revolutionary new technologies that utilize CNG and LNG.

Reduced carbon emissions, coupled with economic incentives such as low prices and high efficiency, are pushing governments, airlines, shipbuilders, and others to produce natural gas compatible aircraft, vehicles, vessels, and more.



AIRCRAFT

Using natural gas to produce special gas-to-liquid fuels, aircraft can use GTL which lacks the impurities found in crude oil based jet fuel.



GTL JET FUEL



TRADITIONAL JET FUEL

GTL jet fuel also has more energy per pound than traditional jet fuel, giving it better fuel economy.



SEA VESSELS

LNG-POWERED SEA VESSELS

are expected to see the greatest market penetration in the gas-powered transportation sector.

Traditional diesel powered vessels will be phased out as the International Maritime Organization ensures that industry and government reduce shipping-related emissions.



VEHICLES

Cars, trucks, and busses can contribute up to

50-90% OF AIR POLLUTION

in urban centers. NGV vehicles can provide an immediate solution to stifling emissions from gasoline and diesel powered vehicles.

NGVs reduce GHG emissions from between 20-30% on average, while NGV vehicles that run on fuels such as biomethane can reduce GHG emissions by up to 90%.



HOW INNOVATION AND TECHNOLOGY EVOLVE NATURAL GAS

When the impasses of industry spring up, technological advancement has always been the salve that saves the day, and in the case of natural gas this is no exception. Today, the world has woken up to the dawn of a new era in clean-burning fuel, led by emerging technologies that have made it easier to locate and extract natural gas, further securing that this most-clean of fossil fuels remains cheap and abundant for centuries to come. In turn, the increased supply of natural gas has inspired the adoption of the fuel to replace traditional fossil fuels in global transportation, among the world's largest creators of CO2 emissions.

Last year, Malaysia launched its first floating LNG facility, located hundreds of kilometers off the coast of Sarawak at the Kanowit offshore gas field, which produced its first drop of the cryogenically stored natural gas last December. The facility, dubbed the PETRONAS FLNG Satu, is a revolution in and of itself for Malaysia's energy industry, bringing previously stranded gas fields once considered uneconomically viable enough to explore directly into the nation's energy supply. Moreover, the platform is technologically designed to last up to 20 years without dry-docking, and has an installed production capacity of 1.2 million tonnes of LNG per year.

The PFLNG Satu marks a pioneering moment in the global natural gas industry, while placing Malaysia at the forefront of extraction innovation by becoming the world's first nation to make a floating LNG facility operational. (Shell had designed blueprints for such a platform as early as 2011, but PETRONAS has ultimately come out ahead.) "We have come a long way with our partners to deliver a game changer in the global LNG business. The shared vision for PFLNG SATU to monetise gas resources uneconomical to develop via conventional means is an achievement all can be proud of," said Adnan Zainal Abidin, PETRONAS' Acting Vice President LNG Assets, Development & Production. PETRONAS is not stopping here, either. The Malaysian energy company quickly followed up the successful launch of PFLNG Satu by developing a second FLNG unit to be constructed in South Korea by the Samsung Heavy Industry shipyard. In all, the new supplies waiting beneath these 365-meter-long platforms will complement the future of

natural gas in Malaysia's portfolio.

Natural gas has also proven to be amazingly adaptable. Here, innovation has taken the application of the fossil fuel into industrial heartlands across the globe, where manufacturers utilize it for feedstock, or the raw base material in an industrial process, to create a host of products that we use on a daily basis. Natural gas liquids, namely ethane, propane, butane and methane, are the main sources of these industrial processes. In this way, natural gas is used as a chemical feedstock, founding the production for plastics, ammonia for fertilizers, hydrocarbons and lubricants, rubber, hydrogen and more. Breakthroughs in the treatment and processing of natural gas liquids has also spawned advanced petrochemicals, the most notable of which being ethylene. Natural gas is also used to provide heat and steam in industries and used in homes for cooking and heating.



NATURAL GAS TAKES OFF IN TRANSPORTATION

Truly, the wheels of progress are only just beginning to speed up. In the world of transportation, from automobiles to trucks to airplanes to shipping vessels, natural gas is increasingly being viewed as a next-generation alternative to fossil fuel-powered vehicular engines. The trick, any industry expert will tell you, is incentivising the purchase of next-generation vehicles with the capacity to accommodate natural gas engines, usually in LNG or CNG forms, or retrofitting old vehicles, both of which can carry a heavy cost, for governments and individuals.

First-movers in the new generation of gas-powered vehicles have thus had to lay down some impressive capital in product design and research. It should be no surprise that this group includes the likes of Royal Dutch Shell, which is today, along with PETRONAS, among the leaders in natural gas design and application innovation. In looking for a partner to develop emerging natural gas technologies, Shell found one in Qatar, a small Gulf nation that has relatively little oil reserves, but vast

deposits of indigenous natural gas. Not long ago, an idea was hatched to power Qatar's national airline, Qatar Airways, with the nation's abundant fossil fuel source. In 2012, Shell opened up the \$18 billion Pearl gas-to-liquid (GTL) plant in Qatar's Ras Laffan Industrial City, making this corner of Qatar the world's largest source of GTL, capable of producing 140,000 barrels of GTL products each day. The plant also produces 120,000 barrels per day of natural gas liquids and ethane, data from Shell shows.

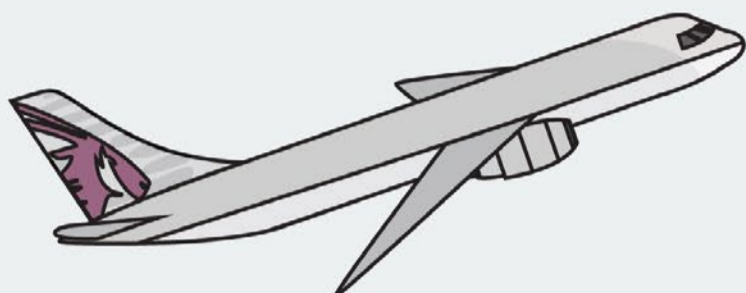
The inauguration of the Pearl GTL plant kick started a global trend in aviation that has gathered momentum. Today, aviation firms looking to jump into the vanguard of alternative fuel development, namely Aviat Aircraft and Chromarat (both from the US), have joined Qatar Airways. The implementation of natural gas in a major airline also had knock-on effects to incite adoption by others vertically integrated into their maintenance and repair chain. For example, Qatar Airways' aircraft utilise Rolls Royce and General Electric engines, garnering approval for GTL from both companies, the New York Times reported.

Because Qatar has the largest recoverable natural gas deposits known in the world, it feels of little surprise to have witnessed such a powerful urge to innovate the fuel source there. But there are countless other benefits that natural gas usage in aircraft present. Due to its very low density, CNG is about 20 percent lighter than conventional jet fuel, yet provides the same amount of power. By employing CNG in their aircraft, airlines are thus increasing the amount of energy that can be stored on a plane while saving space that allows the company to spend less on jet fuel. Greater supply of natural gas also makes it a cheaper option compared to jet fuel. When we factor in for the cost of the infrastructure and delivery system, CNG ends up being half the price.

Last year, a new edition to the world of gas-powered vehicles was committed to be manufactured. Carnival Corporation, the Miami-based cruise company, signed an agreement to construct three large-scale entertainment cruise ships that will be completely powered by liquefied natural gas. While the first

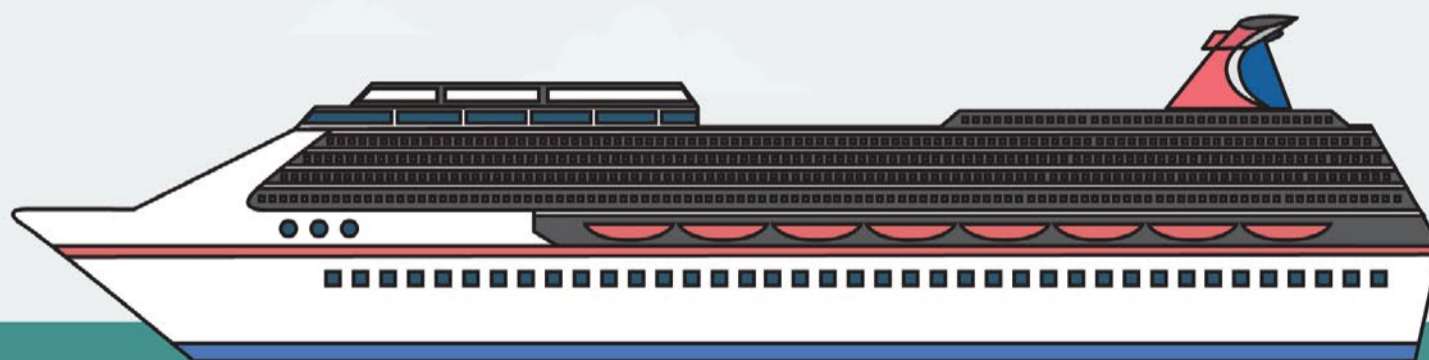


COMPANIES THAT ARE PAVING THE WAY

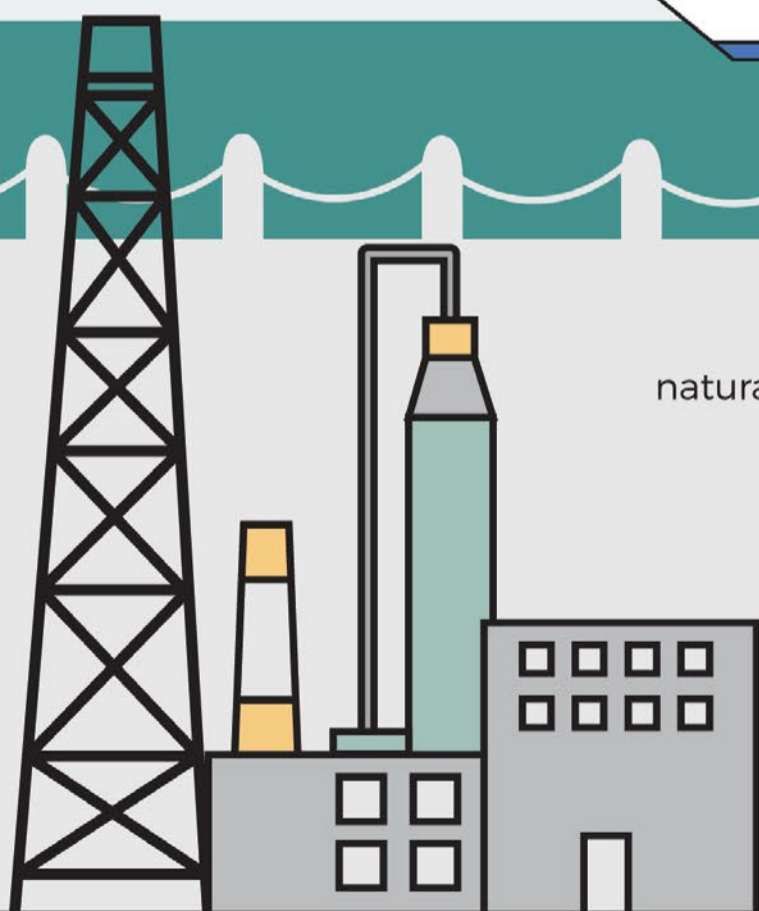


Shell is a pioneer of a new age of gas-powered aircraft, ships, and vehicles. Partnering with Qatar Airways and cruise liner giant Carnival Corporation, Shell will be providing GTL (gas-to-liquid) and LNG fueling solutions to these large companies.

Carnival has ordered
7 LNG
powered cruise ships,
with the first slated to
roll out in 2019.



Shell's ground-breaking Pearl GTL plant in Qatar uses natural gas to produce a cleaner-burning jet fuel. Jet engine manufacturers GE and Rolls Royce have approved the use of GTL fuel in their engines.



Liquid Natural Gas has made big headways in the world of long-haul trucking. LNG has proven to be more efficient and cheaper than its popular counterpart, diesel. LNG is popular for trucking due to its density, meaning less refueling stops.

Continued from page 47

vessel is due to be rolled out in 2019, the American entertainment company has already doubled down on their gambit in LNG, placing orders for more gas-powered ships to arrive down the road. In total, the company now has agreements in place to build seven LNG-powered cruise ships across four of its 10 cruise brands in coming years, World Maritime News has reported.

It may not be immediately obvious to the layman's eye, but a look at our highways presents a chance to spot another trend in the adoption of natural gas to our transportation system. Natural gas vehicles (NGV) have rolled out across the globe, with as many as 23 million in operation today, mostly in Asia. Indeed, China, Iran, Pakistan and India lead the pack for vehicle adoption of the alternative fuel, with approximately 4.4 million, 4 million, 3.7 million and 1.8 million NGVs on the road, respectively. Malaysia has also taken up a penchant for adoption of NGVs, and today has 77,000 models in operation, most of which are taxis, but also include some private cars and public bus systems. However, a lack of policymaking support has all but put an early end to NGV. "PETRONAS NGV Sdn. Bhd. (PNGV) is the only supplier of NGV in the country," the Malaysian Gas Association (MGA) has commented. "They have remained the sole supplier because of a negative margin created by a low-regulated NGV pump price, which has discouraged the entry of other [NGV] suppliers. Hence, this segment of the gas industry is not expected to grow in the near future."

Where NGV has failed (mostly due to poor political will to regulate where needed), another alternative fuel opportunities arise. "There is potential for using LNG as fuel for long-haul trucks, as has been seen in China and US," the MGA declares. "Using LNG gives the trucks a long range of up to 800 kilometers. However, the LNG must be sold at market price to encourage multiple [NGV] suppliers to enter the market, as well as create investment in infrastructures. Even at market parity, LNG would still be cheaper than diesel."

Indeed, LNG is the undoubtedly cheaper alternative than diesel as fuel for trucks. Based on a study conducted in February by the Malaysia Gas Association, LNG prices stood at RM45.50/mmbtu, compared to RM65.95/mmbtu for diesel. "Natural gas (CNG or LNG) is also much friendlier to the environment. When used as fuel in vehicles, the emissions (in gram/100 km) travelled are 16,275 grams for natural gas, com-

pared to 22,200 grams for gasoline, 21,000 grams for diesel and 18,200 grams for LPG," the MGA study revealed. (see table below)

	Natural Gas	Gasoline	Diesel	LPG
Carbon Dioxide	16,275	22,200	21,000	18,200
Carbon Monoxide	22	634	106	168
Sulphur Oxide	0.15	8.3	21	0.38
Nitrogen Monoxide	26	78	108	37

Adopting natural gas as the to-go fuel for the transportation sector, the largest source of CO2 emissions in Malaysia, would give birth to a great deal of positive side effects for the environment, as well as the greater general socio-economic good of the country. Once again, however, it will all come down to how willing and able a government can employ the legislative support needed to transform the way we transport. "Some incentives may be needed, at least in the initial stage, to encourage truck owners to convert from diesel to LNG," the MGA says. "Currently, the costs to convert existing diesel trucks to LNG-fueled trucks are quite high, falling between RM100,000 to RM120,000. Getting truck fleet owners to convert may be challenging, but we are looking at ways how to get the government to support this initiative, at least at the initial stage until we reach critical mass."

In the US, NGV adoption faces myriad hurdles as well, chief among them being the continued affordable competition presented at the pump by diesel and gasoline, which remain low enough to discourage buyers from switching to their more eco-friendly cousin. Yet, where the US has succeeded the most is with its ability to press for adoption of alternative transport fuels through state-level legislation, which remains unaffected by recent backpedals in environmental policy made by the Trump administration. California, with its strict environmental regulations, has lead the way in the country by offering incentives to induce purchases of green trucks, followed by New York and Chicago. In today's political climate, the ability of individual states to mobilize grants greatly outweighs federal input, which allocates green truck incentives

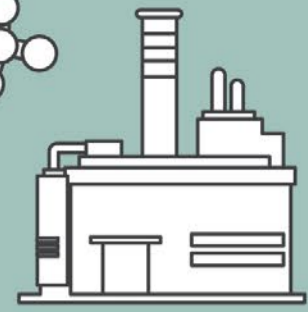
that amount to just one-tenth of the level of what California has budgeted. Indeed, under the Californian Hybrid Vehicle Incentive Program, truck buyers can receive vouchers to offset the price of a Peterbilt truck, vehicles which are outfitted with a Cummins near-zero emissions natural gas engine, such as \$8,695 for a 2017 Model 320, \$8,694 for the 2017 Model 520 and \$8,400 for the 2018 Model 567. All the trucks must have Cummins' ISL-G engine to be eligible for the rebate.

We should not be daunted. Now more than ever, the technological zeitgeist has provided more grist for the innovation mill, enabling industry and individual the capacity to switch on to natural gas - and for all the right reasons. Emerging instruments in 3D and 4D sonar mapping are making it yet simpler to locate deep, hidden deposits of natural gas. Once thought inaccessible, great titans of technology have brought us the likes of the PETRONAS FLNG Satu with which to extract and inject more natural gas into our global supply. Regasification terminals have sprung up everywhere from Jordan to the Philippines, making LNG that much more a globally viable and tradable commodity. All we truly lack is the courage to make the change.

SOURCES:

Petronas Official
Financial Times
Petronas
#PETRONAS FLNG SATU - Youtube
Well Said Cabot
Shell
World Maritime News
New York Times

NATURAL GAS AS A FEEDSTOCK



Natural Gas Liquids (or NGLs) are derived from various natural gas liquids and gases, such as:



NGL's, along with naphtha, are the main **feedstocks** for several industries.

FEEDSTOCK:

Raw material to supply or fuel a machine or industrial process.

These NGLs are necessary in the production of several by-products, such as:



AMMONIA (FOR FERTILIZERS)



HYDROCARBONS AND LUBRICANTS

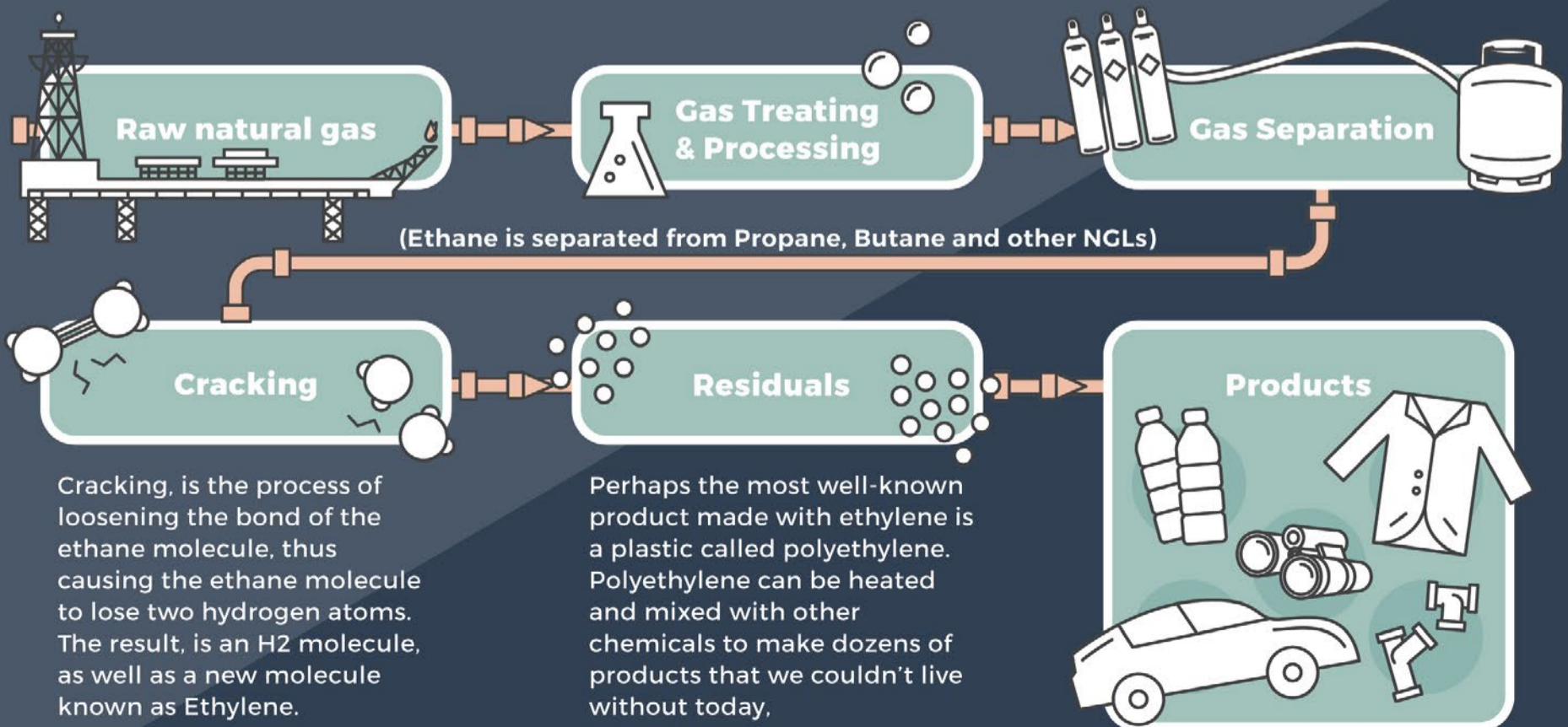


RUBBER



HYDROGEN

ETHYLENE: Perhaps the World's Most Important Petrochemical



Cracking, is the process of loosening the bond of the ethane molecule, thus causing the ethane molecule to lose two hydrogen atoms. The result, is an H₂ molecule, as well as a new molecule known as Ethylene.

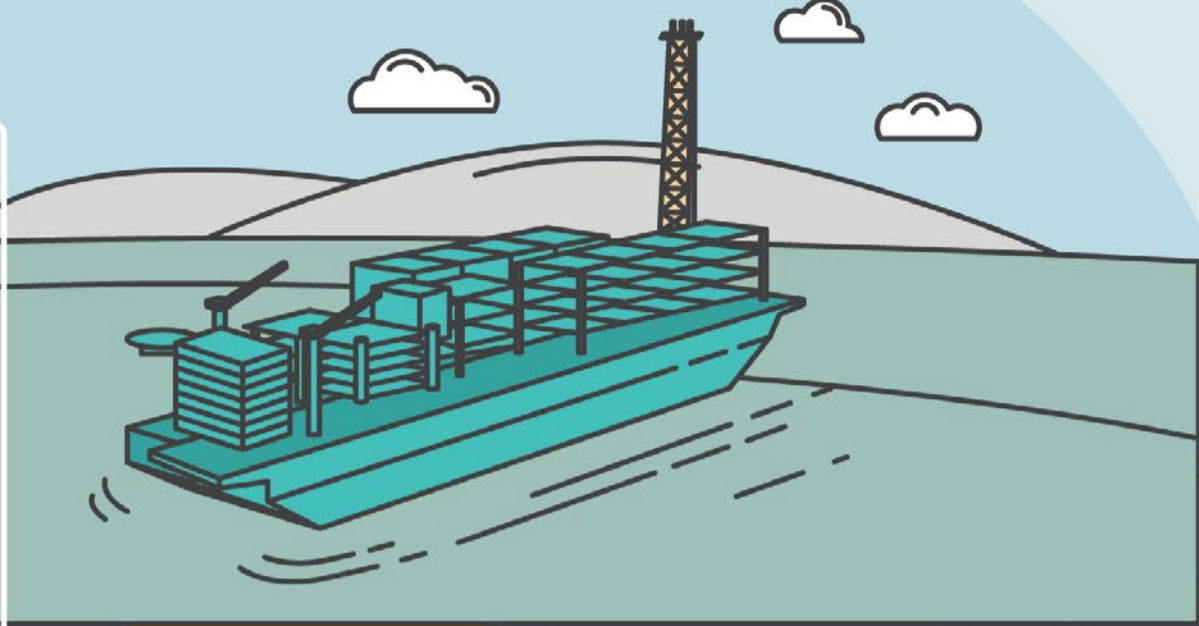
Perhaps the most well-known product made with ethylene is a plastic called polyethylene. Polyethylene can be heated and mixed with other chemicals to make dozens of products that we couldn't live without today.

THE PETRONAS FLNG

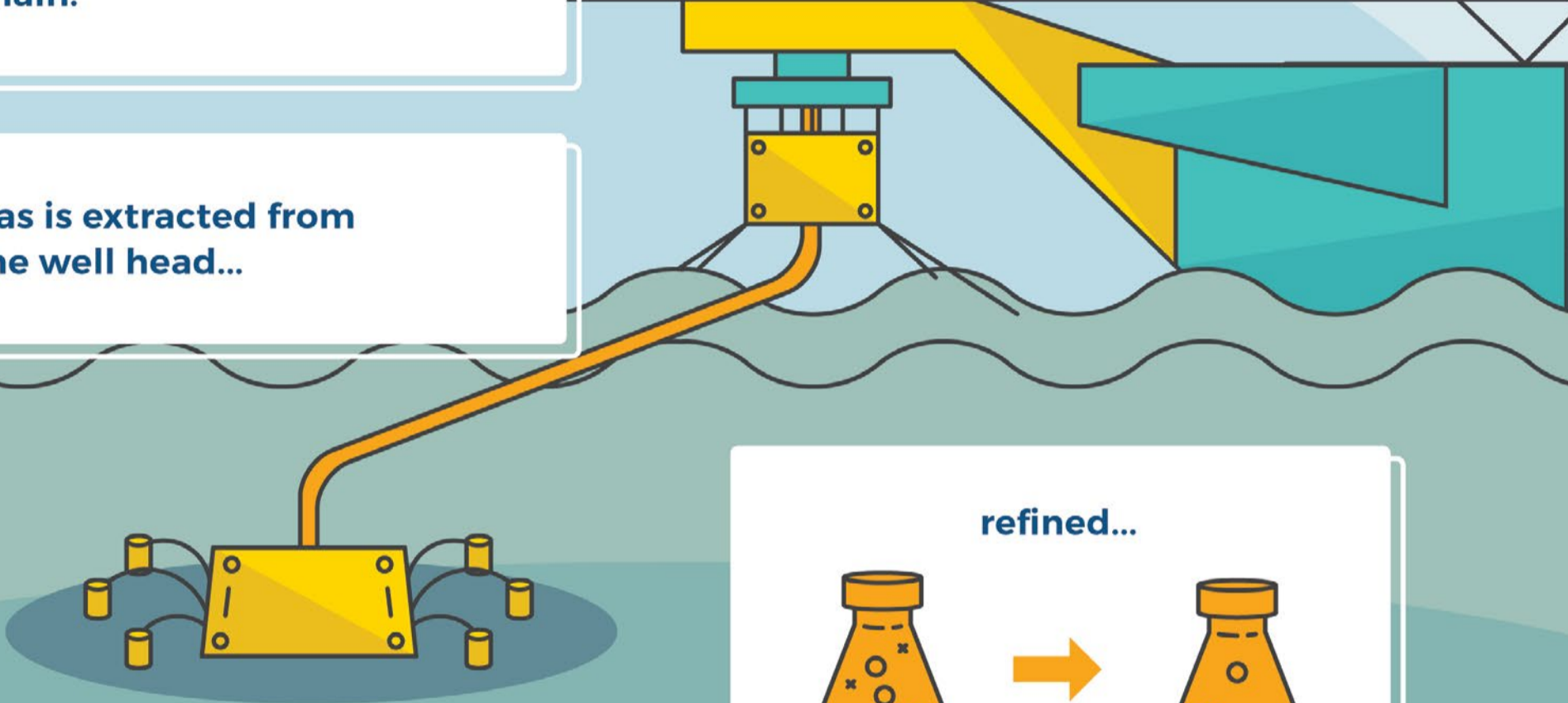
In 2016,

Petronas made history by launching the world's first Floating Natural Gas Platform.

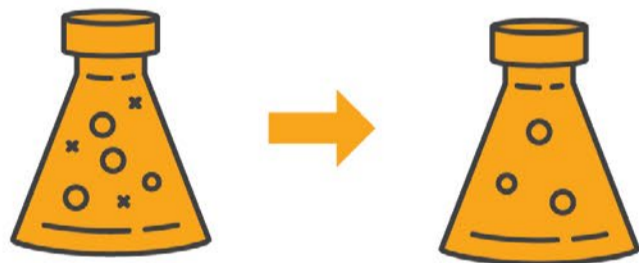
The FLNG eliminates costly and timely steps in the value chain.



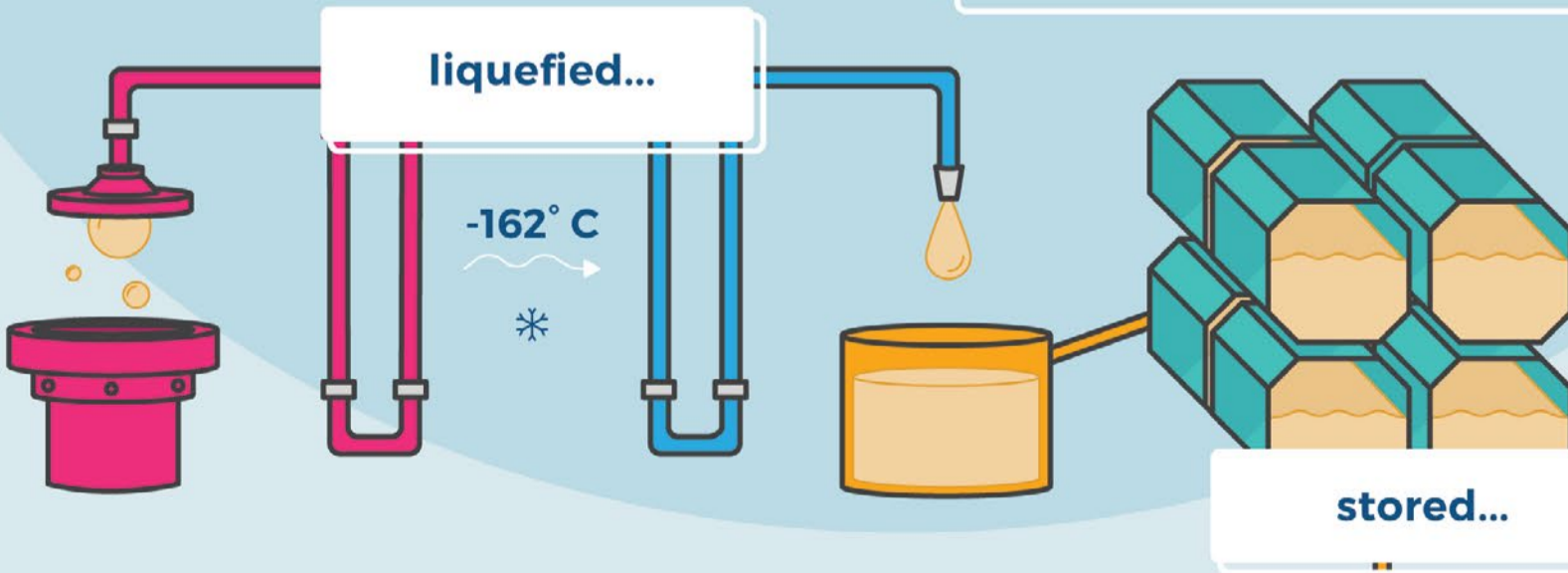
Gas is extracted from the well head...



refined...

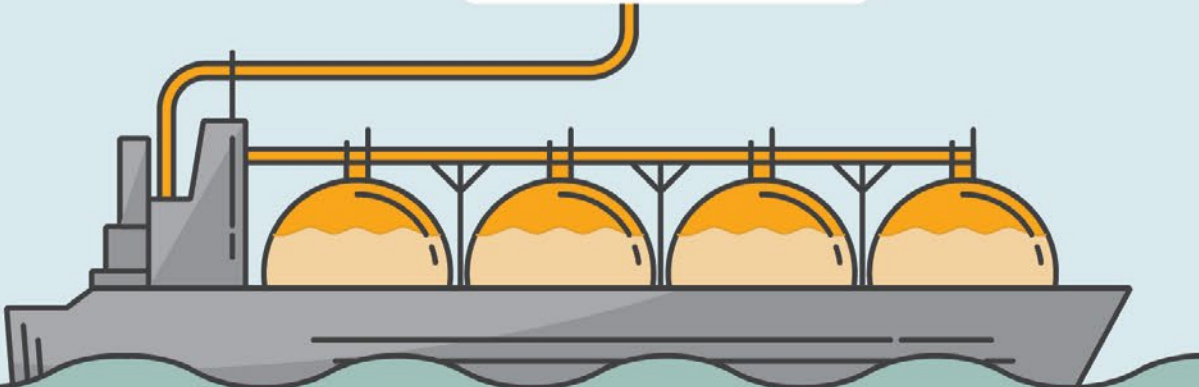


liquefied...



stored...

...and offloaded for immediate export.





CON CLU SION

In late 2015, the world came together in Paris for the United Nations Climate Change Conference, or COP 21, a moment hitherto thought impossible. With every major economy represented in the room, an unprecedented show of unity was broadcast across the planet that, without doubt, the needs of the global community were greater than that of the nation state. The resulting agreement committed signatory nations to drive down the use of high carbon-emission electricity sources, and once and for all acknowledge that our current means of energy generation are simply not sustainable.

This event set the tempo for where we have come today. We seek new solutions to age-old problems and have the technology and capital at our disposal to do so. Yet, the willpower of politics and big business don't instantaneously sync with this lofty agenda, even with the backing of so many power players having committed promises to paper, and we are left pondering what may be next.

Oil- and coal-burning power generation must be dismissed from our repertoire as a viable energy resource and finally downgraded to a tool of the past if this planet is to be able to sustainably carry the

weight of a growing human population; we know this axiomatically today. While still a classified fossil fuel, natural gas emits nowhere near the amount of environmental- and health-damaging pollutants as its dirtier cousins. We now know that half of the carbon dioxide that comes from coal plants is emitted from those that run on natural gas, and that when burnt, natural gas produces only a fraction of the harmful byproducts that toxify our lakes and lungs.

This is evident in the role of natural gas has taken up as a “complementing fuel,” whereby global objectives to transition to zero-carbon energy generation can be met through natural gas as we slowly weaning ourselves off of our fossil fuel-addicted supplies.

It’s more than just a dream; this transition has to materialize. At this point in time, the world cannot simply jump to renewable energy for all of its electricity needs. The human population is growing at its fastest rate in recorded history. This is no where more observable than in Asia, where the world’s largest nouveau middle class is rising out of agriculture-based backgrounds with the ambition of owning shiny new appliances. It will take a plentiful and cheap energy resource to fuel this momentous transition in history, and natural gas, with its naturally occurring abundance and already-established networks of infrastructure, will be the most ideal source to boost this next generation of consumers, as well as power their toasters.

Still, the mission of obtaining our lower-carbon future is by no way guaranteed. Indeed, it still remains beyond numerous hurdles, elevated further away by trends in the global economy that favor the continued usage of cheap and dirty fuel. In Southeast Asia, we have seen that some 40 per cent of the new power capacity that will be added by 2040 will likely be from coal, raising coal’s share of the power market to 50 per cent from 32 per cent, while natural gas could decline to 26 from 44 per cent.

This trend does not need to become a reality. Many regions worldwide have been witnessing a drop in the demand for coal, not only the world’s largest consumers of energy, but also

emerging markets, as more health-conscious policymakers met the needs of a population literally sick of dirty energy production. This miraculous shift can be witnessed particularly in China, which long has suffered from one of the worst air pollution blights in the world, but is now making major progress to shut down coal plants and replace them with natural gas-fueled ones.

The distribution and generation networks for natural gas are by and large already in place, making the usage of the energy all that more convenient. This fact has not gone unnoticed by the global transport industry, which has in turn experimented with new forms of utilizing natural gas as a fuel to replace petroleum and diesel. Airlines, cruise fleets, taxi systems and long-haul truckers have all today used natural gas to move their precious cargo. For many, these innovations in fuel are incipient, and mark a generation of companies that have awoken to the benefits natural gas can present today. But while the private sector may once and a while muster up the guts to retrofit or completely redesign the mechanics of their industry to make the clear shift to natural gas, this shift should be provided with additional support.

Governments across the globe need to start in earnest to develop strategies and policies that advocate the use of natural gas. Much of big business, especially in Asia, will continue to rely on coal- and oil-powered electricity if incentives are provided to encourage the switch, or hybridization, of energy fuel mixes. In California, such a political boost was provided for natural gas trucks, which are costly to add to long-haul truck fleets. To encourage the truck companies, California provided an incentive grant program, offering a rebate for truckers that switch to natural gas engines instead of diesel.

It is clear that this type of mentality cannot be solely the domain of the Californians. If the agreement that was hatched at Paris almost two years ago is to bear any fruit, governments must begin advocating for a cleaner future powered by environmentally aware decisions that we all hope our posterity will inherit.







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