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WIDER Working Paper 2020/48

The energy transition in Asia

Country priorities, fuel types, and energy decisions

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April 2020

United Nations University World Institute for Development Economics Research

wider.unu.edu

Abstract: This paper provides an overview of the energy transition in Asia. It sets out the underlying drivers, and how these set energy transition priorities in China, India, and South East Asia. It particularly describes the role of (liquefied) natural gas in the growing energy demand and changing energy mix. A comparison is then made for each of the three regions on how four main fuel types (coal, oil, natural gas, and renewables) contribute differently to eight energy transition priorities. An analytical model is developed that links a ranking of energy transition priorities to an alignment with the four fuel types. The model determines which fuel types are most aligned with a certain set of energy transition priorities. The predicted alignment with fuel types appear to match the energy investment decisions well for China, India, and South East Asia.

Key words: energy, energy utilities, fuel, gas, renewable resources

JEL classification: Q2, Q4

Note: This study is complemented by another working paper written by the same authors (Romsom and McPhail 2020). The present paper was first written in November 2019.

This is a slightly revised version from that published in April 2020. It includes a new figure and two additional references.

Abbreviations and units at the end.

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This study has been prepared within the UNU-WIDER project Extractives for development (E4D), which is part of a larger research project on Macro-economic management (M-EM).

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ISSN 1798-7237 ISBN 978-92-9256-805-4

https://doi.org/10.35188/UNU-WIDER/2020/805-4

Typescript prepared by Siméon Rapin.

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The Institute is funded through income from an endowment fund with additional contributions to its work programme from Finland, Sweden, and the United Kingdom as well as earmarked contributions for specific projects from a variety of donors.

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1 Introduction

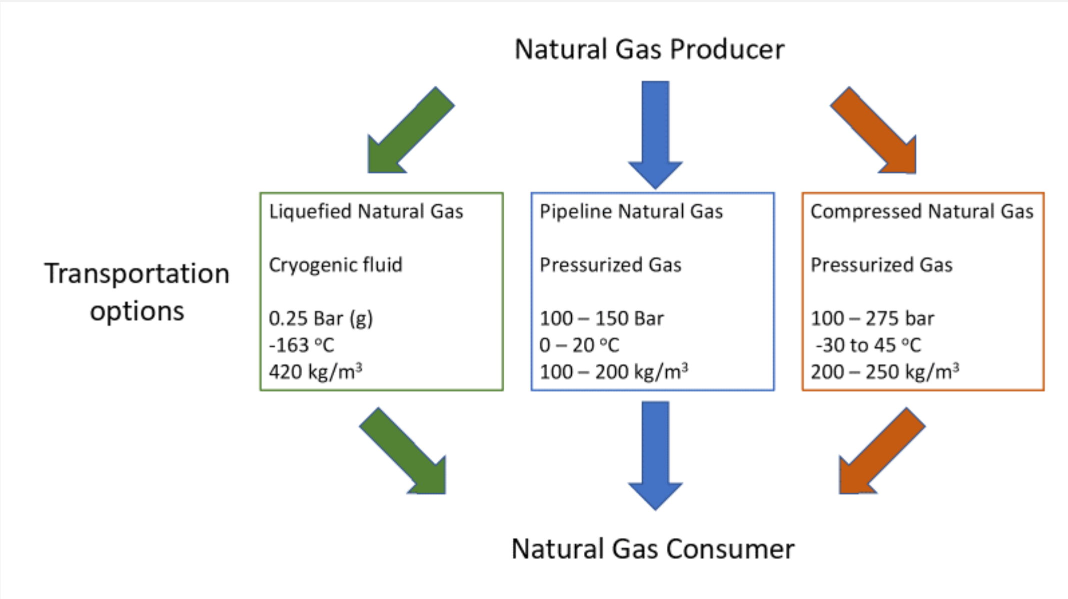
This study aims to provide an overview of the role of natural gas and liquefied natural gas (LNG) in the energy transition in Asia. It describes the underlying drivers for the energy transition and how these provide both challenges and solutions towards a lower carbon future. Asian countries drive the energy transition through eight identified common priorities. The implementation of these priorities determines the energy mix going forward. Because Asian countries differ in their relative ranking of these priorities, each country is driven to a different energy mix that is optimum for their relative priorities. This explains why there is no 'single solution fits all' in determining the optimum energy mix to deliver on the energy transition. Consequently, we see marked differences in the growth of natural gas/ LNG across the Asian region. Also, as the drivers for the growth of natural gas differ among countries, LNG suppliers need to adapt their marketing strategies to tailor their supply opportunities to meeting the countries' energy priorities. Complementary to these developments in the energy transition, we also describe the key reasons why the LNG market is experiencing increasingly fierce competition among suppliers. The diversification of LNG supply sources over time and the liberalisation of the LNG market have caused LNG to become increasingly a buyers' market instead of a sellers' market. The repercussions of the market changes are strongly felt among new greenfield LNG supply sources that are at a relative disadvantage compared to established LNG ventures with expansion capability. This report concludes with an assessment of competitive differentiators for successful LNG projects and how these are different between 'large and strategic' versus 'nimble and flexible' LNG supply opportunities in the Asian markets.

This work is complemented by another report written by the same authors (Romsom and McPhail 2020), first written in November 2018. Whereas the other study emphasizes the changing LNG market as it grows and matures, this report has increased emphasis on the drivers and country priorities in shaping the energy transition, and how natural gas (LNG) plays an instrumental role in energy decision making.

Box A: Liquefied natural gas explained

Liquefied natural gas (LNG) is a condensed, lean, clean natural gas containing predominantly methane and possibly some ethane. Any natural gas contaminants and heavier carbon components are removed as part of the (pre-)processing during the liquefaction process. The purpose of the liquefaction process is to increase the energy density of the natural gas to make it available for economic transport and storage. By cooling natural gas from a gas into a liquid phase at -163 °C (-260 °F), its volume reduces with a factor ~600. This increases the energy density of natural gas to 2.5 times that of compressed natural gas (CNG), comparable to propane and ethanol, and 60 per cent the energy density of diesel. As LNG is a liquid, it can be transported by a variety of means other than pipeline, such as by ship, train or truck, depending on the scale of the demand and distance to market. Another benefit of LNG over natural gas transport by pipeline is that cargos can go to multiple market destinations from its liquefaction point. For purposes of economy of scale, most of the LNG is transported by ship, particularly over large distances (more than 1,000–2,000 nautical miles). Consequently, most LNG capacity (liquefaction and regassification) can be found at coastal locations. In the last few years, technology has also developed to liquefy natural gas offshore, using Floating LNG (FLNG). Similarly, there is a trend to install floating regassification facilities at receiving markets to convert LNG back into a gaseous phase suitable for distribution and use. Another development is to distribute LNG increasingly in its liquid state as a transportation fuel for ships, trains, and trucks. There is no standard for the amount of ethane in LNG and hence the calorific value of LNG can vary, and needs to be matched with downstream consumer needs. It is possible that in the future a fuel standard for LNG emerges, particularly if transport fuel applications mature further (Romsom and McPhail 2020).

Figure 1: Properties of LNG compared with pipeline NG and CNG



Source: authors' illustration.

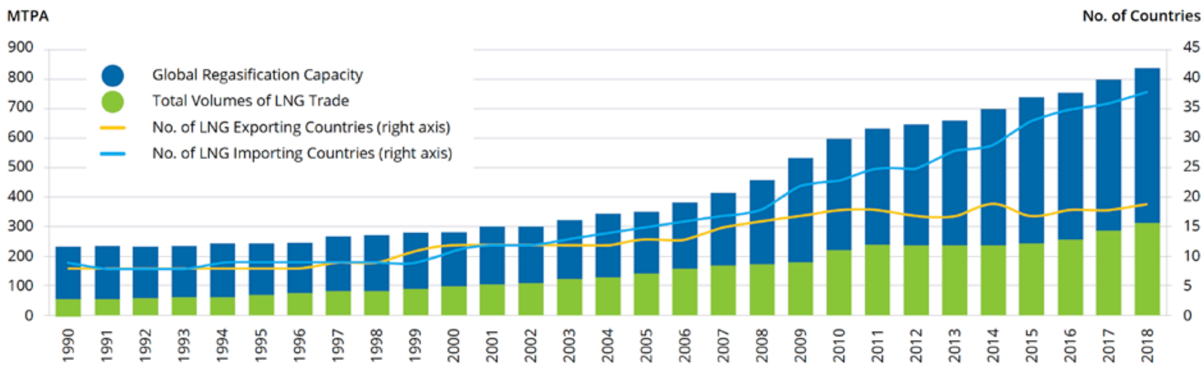
2 The use of natural gas and LNG in Asia

Asia has a long history with LNG, both as a market (starting with Japan) as well as a supply region, with Brunei LNG and Bontang LNG (Indonesia) among the earlier developments. In 2018, Asian countries exported 121.6 million ton per annum (mtpa) of LNG, 38.4 per cent of the 316.5 mtpa globally traded LNG (IGU 2019). As an LNG market, Asia is even more dominant, with 75.6 per cent (239.2 mtpa) of all globally traded LNG imported by Asian countries. Each of the top five LNG importing countries are located in Asia: Japan (83.2 mtpa, 25.4 per cent), China (54.8 mtpa, 16.7 per cent), South Korea (44.5 mtpa, 13.6 per cent), India (23.3 mtpa, 7.1 per cent), and Chinese

Taipei (17.1 mtpa, 5 per cent). These five Asian countries jointly imported 222.9 mtpa of LNG, 67.8 per cent of the globally traded market.

Despite the dominance of Asia LNG, the LNG market is increasingly globally connected and has been growing rapidly (see Figure 2). Large market shares of the earlier LNG exporting countries (Algeria, Trinidad, Indonesia, Malaysia) have gradually been replaced with a growing number of other large exporting countries: Qatar, Australia, USA, Russia, PNG. New large LNG exporters are expected, such as Mozambique. Nevertheless, in 2018 two countries: Qatar (24.9 per cent) and Australia (21.7 per cent) accounted for 46.6 per cent of all global LNG exports.

Figure 2: LNG traded volumes over time



Source: World LNG Report (IGU 2019). Reproduced with permission.

On the LNG import side of the market, there is a similar skew to a few dominant countries as mentioned above, but there is a faster growing tail of smaller scale LNG importers. Among LNG importing countries, 12 imported 5 mtpa or more in 2018, while 26 countries imported less. New LNG markets appear to exhibit an initial gestation period of limited growth. The five new LNG markets that opened in the period 2016–2018 amounted only to 1.3 mtpa incremental growth in 2018, to a total combined LNG import of just 1.8 mtpa. In comparison, the two countries (Pakistan and Poland) that started importing a year earlier in 2015, grew in 2018 with 3.1 mtpa to a total of 9.1 mtpa combined. This split between bulk LNG importing countries and more niche LNG importing countries, as well as the presence of distinct market customers (power, industry, transport) is likely to require tailored commercial strategies to secure long term LNG contracts.

In 2018, globally traded LNG grew by 28.2 mtpa to 316.5 mtpa, a 9.8 per cent growth compared to 2017 and an all-time record. This growth compares with an LNG increase of 35.2 mtpa in 2017 (+13.6 per cent) and 13 mtpa in 2016 (+5.3 per cent) in 2016 (IGU 2017, 2018). Compounded average growth rate (cagr) for LNG has been 6.4 per cent since 2000, much exceeding the growth rate for pipeline exported gas (3.1 per cent cagr) and locally consumed gas (1.8 per cent cagr) during the same period. The outlook is for the LNG market to continue to grow, given the increased liquefaction and regassification capacity not yet utilized, new projects under construction and planned. LNG liquefaction capacity reached 392.9 mtpa as of February 2019 and a further 101.3 mtpa has been sanctioned for development, mostly in the United States.

Despite the stable long-term growth performance of LNG, the capacity additions (and therefore projects and marketing for new LNG contracts) appear to be cyclical, following market prices and availability of investment capital. The current wave of new LNG capacity coming on stream is expected to last into the year 2020 and growth will then take a pause in 202–-2022. This is caused by very few LNG project sanctions during the low oil price period 2015–2017. Project final investment decisions (FIDs) started only to increase again in 2018 with 21.5 mtpa, almost as much as in the three years prior combined. In addition, 2019 is a year of significant FIDs in LNG capacity, targeting to secure a forecasted demand growth by mid-2025. This choppiness of LNG market growth causes periods of fierce competition for LNG supply contracts when many developers are simultaneously eager to sanction their projects.

To protect against delays and the worst effects of price cyclicality, some developers have taken FID without LNG supply contracts secured by taking marketing risk on their own books. Companies with strong balance sheets that they can leverage enjoy greater chances of success in developing a new LNG plant. Some projects, such as LNG Canada, are financed by a group of equity holders, rather than using the traditional model of lining up long-term contracts with buyers. Project partners of LNG Canada will be responsible for recouping their investment by feeding their share of natural gas supplies into the terminal and either using or selling the LNG themselves. This structure gives the partners the option to sell LNG for delivery on the spot market, or to sign long-term contracts with potential buyers when market conditions improve.

Competitive pressures to place new LNG volumes in the market not only advantage those ventures supported by strong balance sheets, they also favour LNG train expansions of existing facilities over new greenfield LNG ventures. The reasons for this are multiple:

- A lower unit development cost (in US$/mtpa) and a smaller capital outlay due to synergies with the existing facilities.
- A lower risk profile as seen by the buyers due to performance track record of the existing venture and reduced technical complexity of an LNG train expansion over a greenfield development.
- Existing supplier-buyer relationships, particularly if buyers have already taken a strategic share interest in the upstream and/or LNG liquefaction venture.

Furthermore, the market is increasingly supplied by shorter-term and spot LNG contracts. These types of contracts provide buyers with increased flexibility with respect to take-or-pay commitments, LNG sourcing, and destination flexibility in case LNG cargos are traded on. In 2018, non-long-term LNG trade grew by 14.5 mtpa to a total of 99 mtpa, 31 per cent of the total volume of LNG traded. It is expected that long-term contracts will continue to be the majority supply option in the market. However, the volume of short-term and spot trades has now reached such a significant liquidity that enhanced terms for buyer flexibility also spill over into new or renegotiated long-term contracts.

The trends shown above indicate that the LNG market is likely to change in the future. Security of supply under long-term contracts remains an important foundation, but as market liquidity and flexibility grow, the price premium for long-term LNG contracts will be driven less by security of supply considerations and more by parties' long-term LNG price outlook. Moreover, trends indicate that new demand enters the market in small volume (mtpa) tranches, with increased market fragmentation in terms of geographies (LNG importing countries/locations), LNG buyers and LNG utilization. Infrastructure financing and sector policy challenges vary between power generation, industry and transportation sectors. All this implies that new LNG suppliers need to carefully design a marketing strategy that is attractive to buyers and competitive in the market.

Although the LNG market has been globalised, each country has its own specific issues and opportunities, and thus the use of natural gas and LNG in Asia must include the local context and perspectives, including energy security, affordability, and consumer demand. In many countries, affordability has been the overriding factor in deciding the supply source in the energy mix. With abundance of low-cost coal, this has become the fuel of choice for electrical power in many Asian countries. However, externalities such as air quality and its impact on health and GDP have for the most part been neglected in decision making on energy investments. The World Health Organisation estimates air pollution kills 4.2 million people each year and is the largest part of cost externalities that are unaccounted for.[1] The share of gas in the energy matrix varies widely in Asia from 75 per cent in Bangladesh to less than 10 per cent in China, India, and the Philippines. However, these shares are subject to dynamic change under the implementation of the energy transition as described in the next sections.

3 The role of LNG in the global energy transition

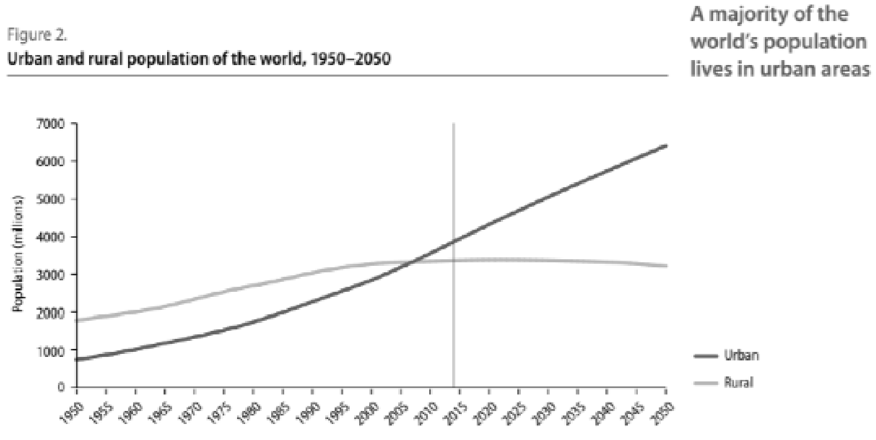
As the LNG market is developing to adjust to a changing world, so is the energy sector at large coming to terms with a transition that will impact all participants and stakeholders. The underlying drivers for the energy transition cover a number of inter-linked dimensions. In this current section of the paper we identify four main drivers of future energy demand. These are rising population; rising living standards and the changing expectations associated with these; various technology advances; and climate change actions. These are discussed in turn below.

3.1 Drivers for the energy transition in Asia

Demographics

More than half of the world's 7 billion people live in Asia and by 2030, two thirds of global middle-class people will be living in India, China, and South East Asia (Kharas 2017). Moreover, continued urbanization will concentrate more people in mostly coastal mega-cities. For the first time in 2018, there are more people in the Asia Pacific region living in urban areas (2.1 billion people) than in rural areas (UNESCAP 2017). This concentration of people to Asian cities poses great challenges and opportunities on infrastructure needs, energy security, logistics, space limitations, and liveability.

Figure 3: Urbanization



Note: since 2010, the majority of the global population lives in cities.

Source: World Urbanization Prospects, 2014 Revision (UN 2014).

[1] Available at: http://www9.who.int/airpollution/en/ (accessed 11 March 2020).

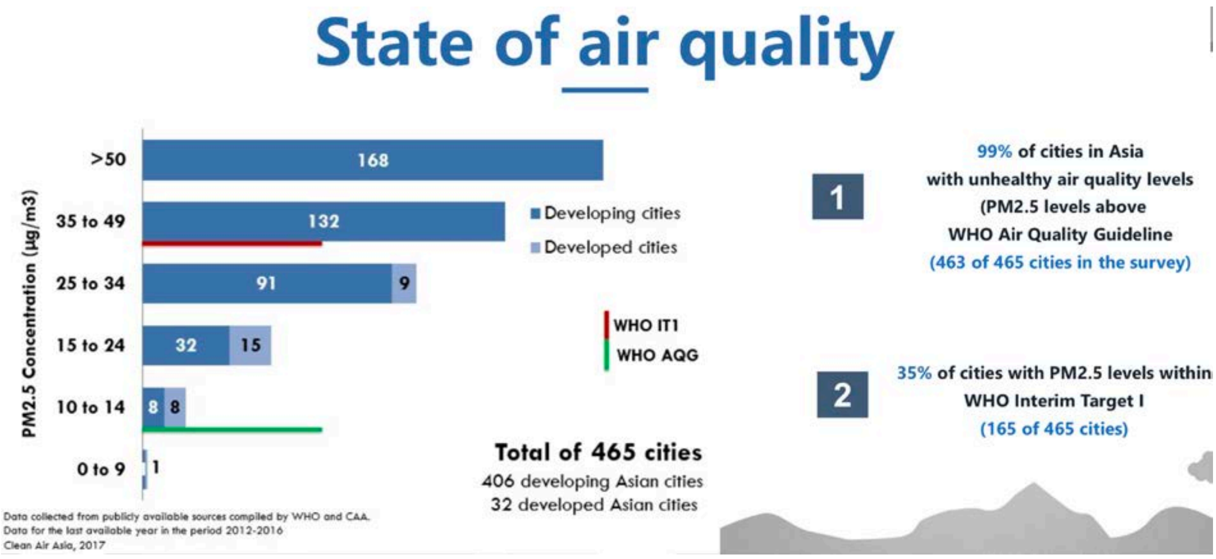
Rising living standards

The rapid increase in middle class populations has major impact on consumer energy demand. Growth in use of household electrical apparatus is one of the main sources of rapidly rising electrical demand. Domestic electrical equipment for cooling, heating, lighting, digital connectivity, food preparation and storage, will all increase with the transition of families into the middle-class economy.

In addition to demand for increased domestic convenience, middle-class people are increasingly intolerant against poor living conditions outside of their homes that are not commensurate with their new wealth. Opposition against pollution, including air pollution, is increasing and spreading also to poorer segments of society. China has been an important example of how intolerance against air pollution achieved a tipping point in 2017, resulting in China banning highly polluting and low efficiency coal boilers and forcing many households to gas, even when there was insufficient gas infrastructure and supply. China understood the wider economic and social implications caused by the pervasive coal pollution. Lower life expectancies, increased medical costs, lower productivity, and a brain-drain fleeing China's economic centres were a direct threat to China's economic success and its further growth of GDP. Moreover, there were indications that the increasingly digitally connected population no longer accepted the status quo and were voicing out their opposition against pollution on social media. In Asia, 99 per cent (or 463) of 465 cities surveyed have unhealthy levels of air quality (PM2.5 levels above WHO Guidelines).[2] There are increasing indications that communities in other countries similarly are becoming more vocal in voicing out against pollution. In July 2019, residents of Jakarta filed a lawsuit against the government over the toxic levels of air pollution in the city, ranked as 'very unhealthy' and higher than readings in New Delhi and Beijing. Nevertheless, real insights and understanding of the impact of pollution on health and GDP is still lacking by decision making authorities. For example, in many countries, decisions on new electrical power plants is made independently by the ministry of energy, without consulting other government departments or bodies. Consequently, the ministry of health has no say when a decision is taken to build another coal-fired power plant on the narrow consideration that 'coal price is cheaper'.

[2] WHO Global Urban Ambient Air Pollution Database (update 2016). Available at: https://www.who.int/phe/health_topics/outdoorair/databases/cities/en/ (accessed February 2020).

Figure 4: Air quality in 465 Asian cities surveyed



Source: Clean Air Asia presentation, World Bank Group internal workshop 2018. Reproduced with permission.

A third element of rising living standards is the growth in the demand for people to be more independently mobile. In many developing economies, public transport is perceived as mobility for the poor and the possession of a private car a demonstration of economic prosperity. This rise in demand for private passenger car transport causes a number of problems: congestion, loss of productivity, and air pollution. The government of Thailand attributed pollution in Bangkok in December 2018 to the fact that almost one million new vehicles were registered in the capital alone last year (Techakitteranum 2019). Electrification of mobility is a global development priority and addresses the air pollution challenge. However, electrical demand management is itself a major challenge when a major source of energy use is expected to switch fuel type.

Technology advancements

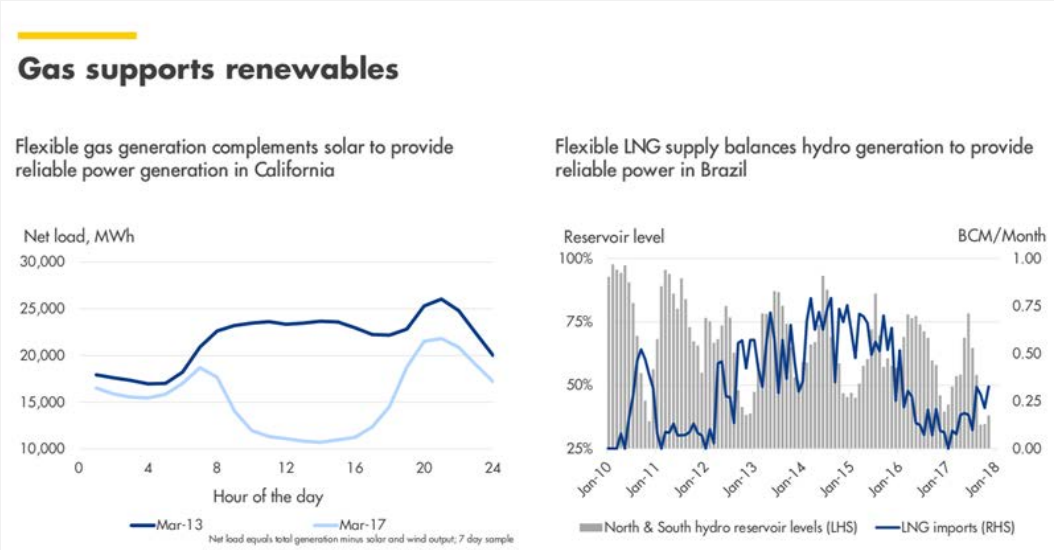
Another driver for the energy transition is the development in technology that presents new opportunities. Energy technology is having a particularly strong impact in two areas: energy diversity and energy efficiency.

(i) Technologies to increase energy diversity

Historically, energy sources have progressed from biofuels (wood) to coal, petroleum, and subsequently diversified to also include gas (LNG), hydro, nuclear, geothermal, and renewables. Energy used to be consumed in proximity to the energy resource. However, transportation, storage, and conversion technologies have significantly increased the flexibility of choice to design the right energy mix between energy sources and carriers. Markets have been created that are efficient and resilient, such that energy security is no longer constrained to domestic energy sources. These developments are expected to continue. In many countries, renewables such as wind and solar energy, are already outcompeting other energy sources on price. This competitive pivot point is expected to expand to many more geographies and to intensify as renewable cost curves continue to decline. Consequentially, financial markets are increasingly concerned about stranded assets, in particular coal. Further advancements in energy technology are ongoing with focus on energy storage (industrial batteries) to address the intermittency of renewables and on new energy carriers, such as LNG as fuel and hydrogen. The full potential of these technologies will take time to develop. However, natural gas (LNG) is greatly positioned as a (transition) fuel to play a pivotal role in these developments.

Box B: Natural gas supports renewables

Figure 5: Natural gas complements intermittent energy supply from renewables



Source: Shell LNG Outlook 2018 (Shell 2018). Shell interpretation of Wood Mackenzie Q4 2017, IHS Markit, and CAISO data. Reproduced with permission.

Gas is a symbiotic fuel to renewables in managing the so-called 'duck curve', i.e. periods of low renewable energy supply. Due to the inherent intermittency of renewable resources, the power-generation mix requires a fast-firing load-balancing fuel to mitigate against the variable supply. The curves in the left side of the figure represent the utilisation of gas power generated at two separate days, March 13 and March 17. The 'duck curve' on March 17 illustrates that when there is deep penetration of weather-dependent renewables into the power-generation mix, the load factors on thermal generation vary quite substantially. The curves on the right side of the figure show another example of the use of LNG in balancing fluctuations in hydropower in Brazil. The example shows a period of a week in January, when LNG supply responded flexibly to adjust for fluctuating levels of water-reservoir storage. LNG is able to back up intermittent or fluctuating renewable energy supply in meeting energy demand. At lower load factors, gas can compete head-to-head with coal on a cost basis. Gas-fired power is also more flexible to adapt to the rapidly changing electricity load. Hence, renewables is the way to back coal out of the system, and gas is a facilitator to enable this. However, the roadmap for how this would happen hasn't really been borne out by the facts. Germany and other European countries show that coal contribution in the power-mix is resilient and its decline slow unless it is actively reduced by regulation. Renewables and gas (LNG) need closer collaboration on this issue.

(ii) Technologies to increase energy efficiency

On the other hand, energy efficiency has been lagging as a focus of attention, but now is considered as one of the big frontiers to optimise energy value chains. Moreover, this is not just a matter of cost reduction and capacity optimisation. With increasing pressures from demographics, living standards, pollution and resource shortage, we have to learn to do more from less. Part of the solution is an increased consciousness of individuals to reduce the negative impact through our choices and habits. Technology can support solutions to reduce, reuse, and recycle. Energy efficient electrical devices and building technologies to reduce heat loss and assist in cooling also have significant further potential.

Other prospective examples are:

- **Electricity 'prosumers'**: while historically electricity was generated centrally and then distributed, the renewable revolution has caused a major change in this setup in some countries. Local wind and solar production for own consumption has changed offtake patterns. Moreover, in many regulatory regimes, unutilised privately produced electricity can be locally sold to the grid. This model of distributed production and distributed consumption has major implications and opportunities for grid management. Add industrial batteries into this equation and the possibilities for energy flexibility are even further increased. Finally, distributed power generation is also expected to have benefits on reduced electricity transportation/distribution costs and on improving resilience of the electricity network.

- **Demand management**: averaging out demand throughout the day is a key opportunity to manage infrastructure capacity costs and peak demand running costs. Incentivising users to schedule their electrical loads at periods of high generation/low demand improves overall efficiency of the system. This is particularly effective if prosumers are incentivised to produce into the grid at periods of low generation/high demand. Also, prosumer battery-stored energy can be part of the value optimisation. Batteries in electrical vehicles (EVs) when connected to the grid are both a source of electrical demand as well as a potential supply source to spike electricity back into the grid when this assists in keeping the grid stable and supplied. Digital connectivity is a key enabler for load scheduling and cost optimisation.
- **Cold energy**: cooling today consumes 17 per cent of the world's electricity and produces 10 per cent of its CO_2 emissions. The demand for cooling is expected to increase significantly. One growing source of cooling demand is the data-centre market. In a conventional data centre, standard air conditioning accounts typically for 40 per cent of the energy bill. The use of cooling towers, which evaporate water to drive the cooling of air, causes another environmental problem: US data centres are estimated to have used about 100 billion litres of water in 2014 (Ristic et al. 2015). Getting rid of compression chillers and cooling towers helps to save both energy and water (Jones 2018). Closed-cycle piped cooling are more efficient than open systems and provide a key opportunity for cold energy from LNG. When LNG is regasified from its cold liquid state into its ambient gas phase, seawater is generally used to heat up LNG prior to distribution and this cold seawater is then generally discarded. Using a closed heat exchange process with a refrigerant can be made 90 per cent efficient and the data centre can be at several kilometres distance from the regassification facility.
- **Electrification of mobility** is a huge opportunity to gain economic efficiency and reduce emissions. Of course, there are many factors that determine the overall cost (including environmental cost) of electrical vehicles (EVs) versus vehicles with combustion engines. The increased use of EVs structurally replaces a key source of demand for oil with large ramifications for a significant part of the energy supply chain, ranging from upstream oil production to pipeline and tanker transport, refinery processes and oil products' distribution. Technology advancement in electrification of mobility offers great potential for energy efficiency and emission reductions, particularly if grid energy is created from a combination of renewables and NG/LNG. Further development in battery technology (both industrial as well as in mobility devices) is likely to further improve the economic case for low-emission electric vehicles.

Climate change

The most significant challenge facing our planet, and that is key to driving the energy transition, is climate change. Emissions of carbon dioxide (CO_2) and other global warming chemicals are consuming the global carbon budget that has been defined as necessary to constrain climate change to within acceptable limits. The 2015 Paris Climate Agreement set out a goal to keep the increase in global average temperatures to 'well below' 2 degrees Celsius above pre-industrial levels. The latest reports from the International Energy Agency however suggest we are heading for at least a 2 ˚C increase in global mean temperatures (IEA 2019a). This is well beyond the 1.5 ˚C now regarded by the Intergovernmental Panel on Climate Change (2018) as the threshold at which a serious impact on climatic conditions is likely. This is despite the success of renewables in growing its market share.

(i) Not on track to reach Paris Climate Agreement

The global carbon budget for a 2 ˚C scenario is 3,700 Gt CO_2-equivalent. Subtracting from this budget 800 Gt CO_2-eq to allow for non-CO_2 related emissions (such as methane) from land use changes, agriculture, or waste provides a CO_2 budget of 2,900 Gt CO_2. DNV GL (2018) forecasts in its Energy Transition Outlook an overshoot of the CO_2 budget by 770 Gt by the year 2100 (DNV GL 2018). BP (2019) finds that carbon emissions in 2018 grew by 2.0 per cent—the fastest growth for seven years. This was a result of a significant increase in energy demand, which grew by 2.9 per cent in 2010, largely fuelled by fossil fuel sources, principally natural gas. Global Energy Monitor similarly found that the total global carbon budget could be consumed by Asia (Shearer 2019). Faster substitution of carbon heavy fuels (coal) for carbon light fuels (including gas) is needed to bring emissions in line with the carbon budget. The IMF (Lagarde and Gaspar 2019) points to the 'growing consensus' that carbon pricing, which is charging for the carbon content of fossil fuels or their emissions, is the single most effective mitigation instrument to achieve the Paris Climate Agreement commitments. It provides incentives to reduce energy consumption, use cleaner fuels and mobilise private finance. There are currently over 50 carbon tax and emissions trading schemes operating at national and sub-national level; however the average global carbon price is US$2 per ton, a small fraction of the estimated US$75 a ton price that is estimated to be consistent with a 2 ˚C warming target (Newburger 2019). Singapore is the first country in South East Asia to introduce a carbon tax from 2019, starting at USS$5 per ton and to be reviewed in 2023.

(ii) Developing Asia likely to use global carbon budget

How will this global carbon budget be utilized across key emitting countries? Forecasts show that developing Asia (China, India, SEA) alone will be responsible for utilizing the bulk of the global CO_2 budget unless there is a major shift in carbon policies. This implies that notwithstanding energy transition efforts in OECD countries, developing countries (in Asia) must also ramp up investment in clean energy. Asia undoubtedly has very considerable opportunities to scale back its use of the carbon budget given its current limited percentage penetration of renewable energies in overall energy use (Box C). In South East Asia, for example, Bloomberg estimates that the share of coal in the region will exceed gas and will continue to rise as the largest source of power generation until 2035. The key competitor to gas-for-power is not renewables but is coal and over time industrial-scale batteries when costs of these decline. ODI reports that between 2014 and 2017, G20 governments halved support for coal mining from US$22 billion to about US$10 billion per annum. In stark contrast to this, there was increased support for coal-fired power plants in countries such as Bangladesh, Indonesia, Pakistan, and Viet Nam from US$17 billion to US$47 billion per annum.

Box C: Accelerating low carbon investments in South East Asia

The Intergovernmental Panel on Climate Change (IPCC) (2018) estimates that around US$2.4 trillion must be invested annually in the energy system until 2035 to support a Paris Climate Agreement 1.5 ˚C ambition. In 2018, of the US$1,800 billion invested in all aspects of the energy sector, around US$300 billion went into renewables. More than 80 per cent of this renewable energy finance is 'domestic', i.e. in-country and often in-developed country. Investors such as pension funds provide less than 5 per cent. Development finance institutions provide about 8 per cent.

In South East Asia, one challenge to scaling up and accelerating low carbon investments is that the risk-adjusted returns are unfavourable when compared with traditional energy sources such as coal. Lack of competitiveness is due to inefficiencies in the value-chain across developers, financiers and service providers.

Large institutional investors seek investments with projects that are largely de-risked, can be benchmarked for consistency and quality, and aggregated and bundled into large funds. There is need for a standardised risk assessment that can benchmark and bundle low carbon projects and assets, and in turn drive down costs and improve returns.

This will require the climate-finance value chain to work cooperatively together and with project developers. Joint industry projects (JIPs) executed by professional third-party institutions are a well-tested vehicle to create the necessary collaborative processes to enable investment aggregation and de-risking. This will improve the risk/return for developers and financiers. JIPs could potentially deliver an accelerated deal flow for low carbon investment.

4 Asia regional priorities in the energy transition

Having discussed above the four key underlying drivers for the energy transition (demographics, rising living standards, technology advancements, and climate change), we will now focus on how these set the priorities in the various regions in Asia. In discussions with stakeholders across the region, we repeatedly noted the following set of energy transition priorities:

- affordability;
- energy security;
- energy access;
- air quality;
- climate change impact;
- continuity of supply (managing intermittency);
- how to balance the grid;
- and diversity of use.

For the purpose of this research, we have compared how the following fuel types: NG/LNG, oil, coal, and renewables would rank against each of these priorities. We have done this in a qualitative manner (relative order) rather than quantitatively as the specifics of each situation could impact the outcome uniquely.

In the present section we introduce the issues associated with each of these eight priorities. In the following sections 5, 6, and 7, we will also evaluate the ranking of energy priorities as these are communicated by China, India, and countries in South East Asia, respectively. Each of these priorities are weighted differently by the various countries/regions, based on their distinctions in local resources, state of economic development, role and efficiency of markets, government direction, and opportunities.

Finally, by comparing the two analyses (by fuel type and by country), we are able to evaluate how the different choices for energy priorities result in an optimum energy mix for each of these countries/regions.

4.1 Affordability

Creating the potential for human development for citizens is a key focus area for Asian governments. Yet, this tends to narrow the decision frame when considering energy solutions. As mentioned in the previous section when discussing pollution, many Asian regional governments restrict the question of affordability to electricity price in local currency/kWh, without consideration for pricing externalities or the impact of subsidies. In context of energy fuel type decisions, this focus translates to a price of local currency/MMBtu. For the purposes of this analysis, affordability is defined in this narrow context. Other priorities mentioned address the other elements of 'affordability'. In Asia, the most affordable fuel (in US$/MMBtu) tends to be coal, with renewables making strong progress in cost reductions, although with much more progress needed in many regions to beat coal on price. LNG/NG is often priced to oil in long-term contracts, with oil having a premium for flexibility, low storage cost and being more commoditised than natural gas. The impact of fossil fuel subsidies and or differential (fuel/sector) taxation regimes further obscures the assessment of affordability. Almost all subsides are aimed at consumers rather than producers (Jewell et a. 2018). While this benefits richer households, who use larger *absolute* amounts of energy, this unintended outcome is often not perceived by governments. This is because energy makes up a larger share of the budgets for poorer households, and so governments often see subsidies as important to protect low income populations. The IMF has reviewed fossil fuel subsidies for 191 countries and estimates that global 'pre-tax' energy subsidies (government funding to reduce the retail price of fuel) is about US$500 billion each year (Coady et al. 2019). The IMF also includes 'post-tax' subsidies, which is largely the difference in failing to price greenhouse gas emissions and other externalities, such as under-pricing of local air pollution. Globally, subsidies remain large: US$4.7 trillion in 2015 and these were expected to rise to US$5.2 trillion in 2017. The IMF estimates that in 2015, China was the largest subsidizer of energy with US$1.4 trillion followed by the United States US$649 billion, Russia US$551 billion, the EU US$289 billion and India US$209 billion. Coal and petroleum together account for 85 per cent of global subsidies (ibid.).

4.2 Energy security

Every government sees it as its duty to protect its citizens from global disruptions in energy supply. Hence, there is a strong preference to be energy independent as much as possible. For those countries that have to rely on imports, fuels that are highly commoditised and available from wide-spread resources are preferred. As renewables are generating energy in-country and, once built, are not dependent on other nations input, these rank highest in terms of energy security (note that intermittency, another dimension of 'energy security', is being addressed by a separate element, 'continuity of supply'). Among the three carbon fuels, NG/LNG requires the most dedicated infrastructure, providing supply from a relatively small number of possible suppliers in a not fully efficient (commoditised market) and is therefore ranked lowest. Both coal and oil are fully commoditised markets, with coal having an edge over oil in terms of energy security due to its prevalence, large volume of reserves and geographical spread. The oil market continues for a large part to be dependent on a relatively small number of producers in the Arabian Gulf.

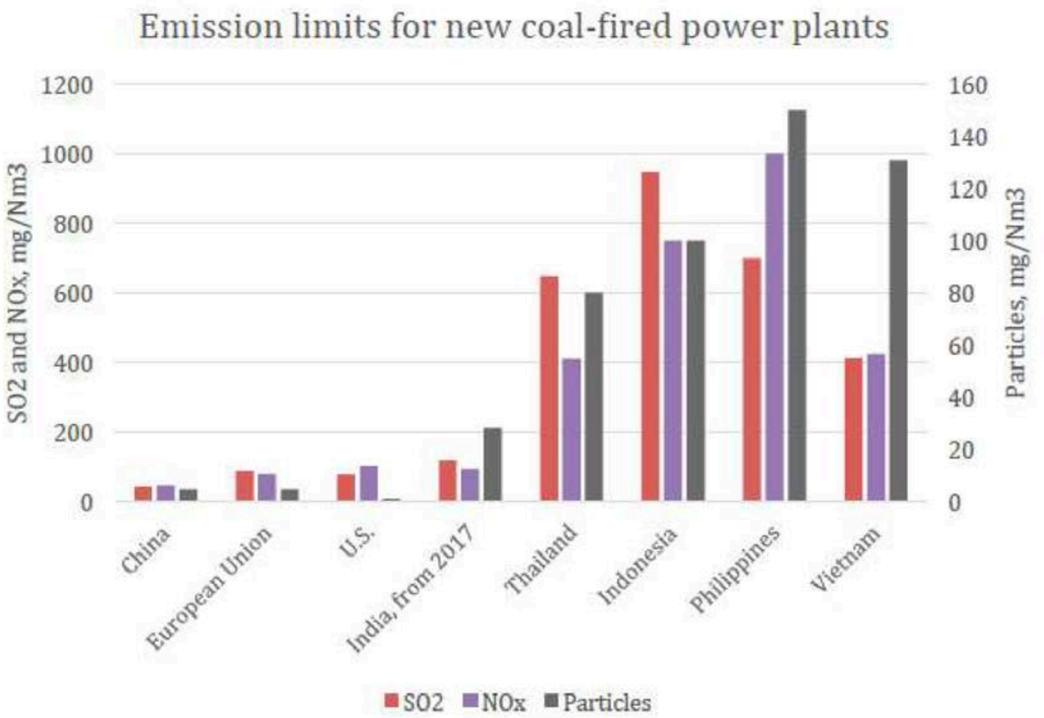
4.3 Energy access

At a global level, about one billion people have no access to electricity. One of the United Nations Sustainable Development Goals, SDG7, specifically addresses the ambition to make electricity available to all, in an effort to spread development and emancipation across all populations, including remote communities. Although investments in energy infrastructure to promote energy access also address large scale solutions such as pipeline infrastructure and gas-distribution grids, many of the solutions sought include small scale and off-grid power systems, such as solar, wind, with storage not connected to the grid. For the 2.6 billion people (IEA 2019d) without access to clean fuels for cooking, the role of natural gas is limited, for example to LPG. Many of these are rural, often widely dispersed populations and so microgrids would be a faster solution for energy poverty. Therefore, renewables combined with batteries are the main choice for energy access, followed by oil because of ease of distribution and storage and prevalence of generators. Increasingly, smaller scale and small-scale LNG applications are maturing, reducing the scale needed for LNG use to become economic. Small coal applications in remote areas are limited to domestic heating and cooking where they cause considerable negative health impact due to air quality concerns.

4.4 Air quality

Emissions that affect air quality are largest for coal among the four energy types, although standards vary across countries. For example, standards for emission limits for new coal fired power plants in South East Asia (SEA) are five to ten times more lenient than those in China, EU or US, see Figure 6 below. Among the countries shown, China has the most stringent emission standards. Burning of oil (and oil products) causes more air quality issues (due to SO_x and NO_x particulates) than natural gas and in particular LNG that is practically pure methane (and possibly a small fraction of ethane). Among these energy sources, renewables are the cleanest with no air emissions.

Figure 6: Country-determined emission limits for new coal-fired power plants



Source: Greenpeace, Southeast Asia (2016).

4.5 Climate change impact

The ranking order of fuel types for climate change impact follows the ranking for **air quality**, although for this evaluation, we address carbon dioxide (CO_2) and other global warming agents (such as methane emissions) that are different from the emissions that impact air quality. Although LNG production per ton is less CO_2 efficient than coal production, LNG has a higher energy density per tonne than coal and emits less CO_2 during power generation. The comparison of the overall CO_2 footprint of these two fuels depends of course on a large number of variables, including the type of power plants. Two parameters that could swing the balance negatively for gas are the CO_2 content of the gas and the energy required to compress and transport the gas to the LNG plant. Unless the CO_2 content in the LNG is captured and sequestered into a disposal reservoir (as is done for the Gorgon LNG development in Australia), any gas fields containing 8–17 per cent CO_2 could cause an additional 50 per cent of CO_2 emissions in the upstream operations and liquefaction processes (e.g. Ichthys LNG development in Australia), compared to fields that have no or negligible CO_2 in their gas content (Reuters 2011). There are also growing concerns about the 'methane slip', i.e. methane losses to the atmosphere along the gas value chain. This puts the focus on producers and transporters to verify and certify the extent of any methane losses. Another element that contributes to climate change is 'black carbon'. These are particulates that enter the atmosphere due to incomplete combustion (e.g. from oil) and are deposited on arctic ice where they absorb heat and contribute to the melting of ice.

4.6 Continuity of supply

Fluctuations in the demand for energy depend on many factors, such as weather, season or time of day. This fluctuation in demand needs to be met by an energy supply that can cope with the variability. Most renewable sources of energy are impacted by external factors such as wind speed or the amount of sunshine. Even hydro is dependent on rainy seasons to fill up supply. Among renewable sources, geothermal is perhaps the most consistent and least variable. In the future, combinations of solar/wind with storage (industrial batteries and hydro) can address some of the short-cycle (day/night) fluctuations. However, the advantage of carbon-based sources is that these have the energy stored inside the fuel and therefore are able to supply continuously for as long as there is fuel stored and available.

4.7 Grid balancer

When energy supply and demand fluctuations increase, i.e. with an increased share of renewable energy in the grid, it becomes increasingly important to be able to balance the grid quickly and efficiently. Battery storage is increasingly becoming more effective (in capacity and cost) but is only partially able to economically address the intermittency of renewable energy sources. Gas fired power can manage supply-demand variations with a higher degree of flexibility than coal. Gas is a fast-firing fuel and therefore a strongly symbiotic to intermittent renewables, much more so than coal. In those cases where renewables provide a larger share of the base load power generation, other fuels have to make up the difference at lower load factors to meet total power demand. Because LNG is on the downstream side of the value chain much more Opex heavy than Capex heavy, it can compete head-to-head with coal on a cost basis at lower load factors. Particularly, in a more distributed and off-grid setting, oil also can be an effective and efficient back-up fuel to renewables.

4.8 Diversity of use

To create economies of scale, to stimulate economic (industrial and employment) activity and to improve economic utilisation of infrastructure, diversity of use is a key source of value creation, whilst creating synergies with, for example power generation. Renewables are typically limited to generating electricity, with hydro being an exception in its potential role in water supply. Much work has been done on the economic and social benefits of low carbon development—valued at US$26 trillion between now and 2030, including the creation of 65 million new jobs in 2030 and 700,000 fewer deaths (GCEC 2018).

The carbon sources differ in their opportunity for multi-purpose use. Among these fuels, NG/LNG is most versatile as an efficient and lower-emitting source of transportation fuel, petrochemical feedstock, chemical feedstock (fertiliser, methanol for biodiesel, plastics), domestic cooking and heating, industrial applications. Among the carbon fuels, coal is the least versatile and efficient. Shifts from coal to NG for both ammonia and methanol production, mainly in China, result in decreases in both process emissions and energy intensity. Chemical sector emissions can be reduced, with coal-to-natural-gas feedstock shifts accounting for 25 per cent of the total reduction. In addition, feedstock shift from naphtha to ethane (NG) further contributes to energy efficiency improvements.

This assessment of the four fuel types across the eight energy transition priorities is summarized in Table 1.

Table 1: Comparison of energy transition priorities with fuel type

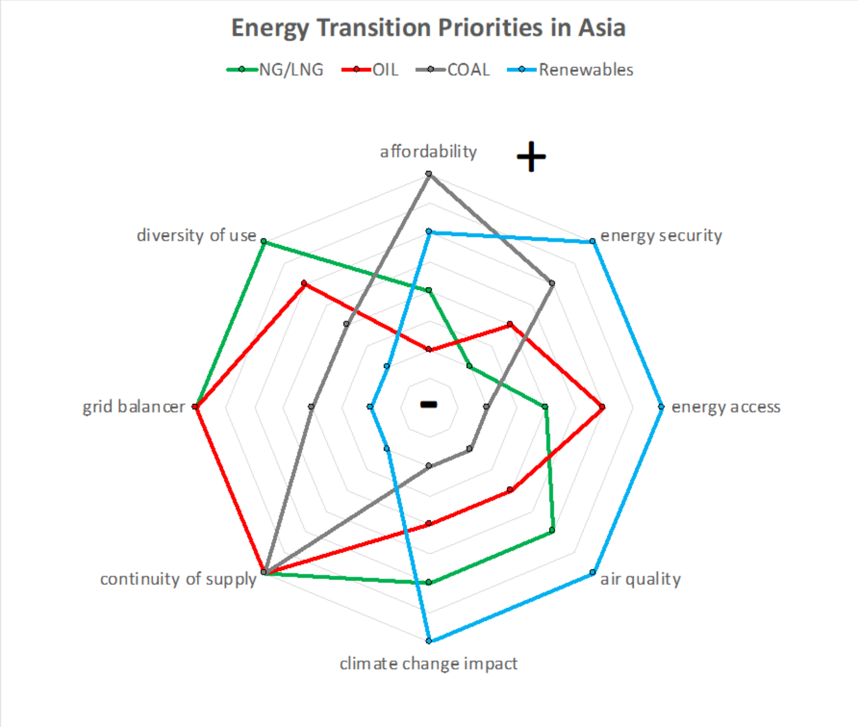
Energy priorities versus fuel type	**Coal**	**Oil**	**NG / LNG**	**Renewables**
Affordability	4	1	2	3
Energy security	3	2	1	4
Energy access	1	3	2	4
Air Quality	1	2	3	4
Climate change impact	1	2	3	4
Continuity of supply	4	4	4	1
Grid balancer	2	4	4	1
Diversity of use	2	3	4	1

Note: table shows a comparative ranking on how each of the fuel types is contributing positively to the priorities mentioned (1 = low, 4 = high).

Source: authors' illustration.

In Figure 7 below, the contents of Table 1 are plotted in the format of a spider diagram. The impact on energy priorities is greater for data points further from the centre of the spider diagram. What is apparent from the figure is that among all the combinations of any two fuel types, the mix of renewables and NG/LNG provides the best coverage against all priorities combined. Among the other carbon fuels, NG/LNG is the most complementary fuel type to renewables.

Figure 7: Spider diagram showing the impact of the four fuel types against energy transition priorities



Source: authors' illustration.

5 The role of LNG in China

5.1 China as a key driver of LNG growth in Asia

In global terms, China is the second largest LNG importing country (54.8mtpa in 2018) and is expected by Wood Mackenzie (2019) to become the global leader with 74.1mtpa imports by 2022. In 2018, LNG import volumes grew faster than other delivery mechanisms (e.g., pipeline, domestic production) at 52 per cent p.a. during Jan–June 2018. Import dependency has been steadily rising, reaching 45 per cent in 2018, versus 5 per cent a decade earlier. Oil import dependency is 70 per cent, up from 50 per cent a decade ago. Increasing domestic output has proved challenging. With gas demand growing, China has been diversifying LNG suppliers (from one in 2006 to 19 in 2017) to increase energy security (O'Sullivan 2019).

Imports of LNG into China began in 2006 with its first LNG regasification terminal and were joined by pipeline gas imports in 2010. LNG now represents almost 60 per cent of China's gas imports, considerably ahead of the volume of pipeline gas imports. By August 2018, China had 20 LNG regasification terminals with total capacity of over 90 bcm per year (Deb 2019).

Following ratification of the Paris Agreement in September 2016, China committed to lowering its carbon emissions by 60–65 per cent per unit of GDP from the 2005 level and to peaking its carbon emissions by 2030. The 13th Five Year Plan (2016–2020) aims at reducing, by 2020, CO_2 intensity per unit of GDP by at least 40 per cent from its 2005 level (OECD 2019). In September 2019, China announced that it had achieved its **carbon reduction** targets two years ahead of schedule: CO_2 intensity per unit of GDP is reduced by 45.8 per cent from 2005 levels and share of non-fossil fuels energy in primary energy has reached 14.3 per cent, versus national target of 15 per cent by 2020.

The 2018 IPCC report (IPCC 2018) found that global GHG emissions must peak by 2020 (not 2030). Global emissions therefore need to adhere to carbon budgets that are set and driven by policies that focus on absolute and not relative targets. The BP Energy Outlook for 2019 (BP 2019) concludes that carbon emissions in China will peak in 2022—eight years before the Paris Climate Agreement, although two years after the IPCC report target.

In 2017, natural gas accounted for about 7 per cent of China's primary energy consumption. More than two thirds of natural gas in China is used in industry and buildings (heating). China's 13th Five-Year Plan calls for natural gas to provide up to 10 per cent of primary energy by 2020 and 15 per cent by 2030 (Sandalow 2018).

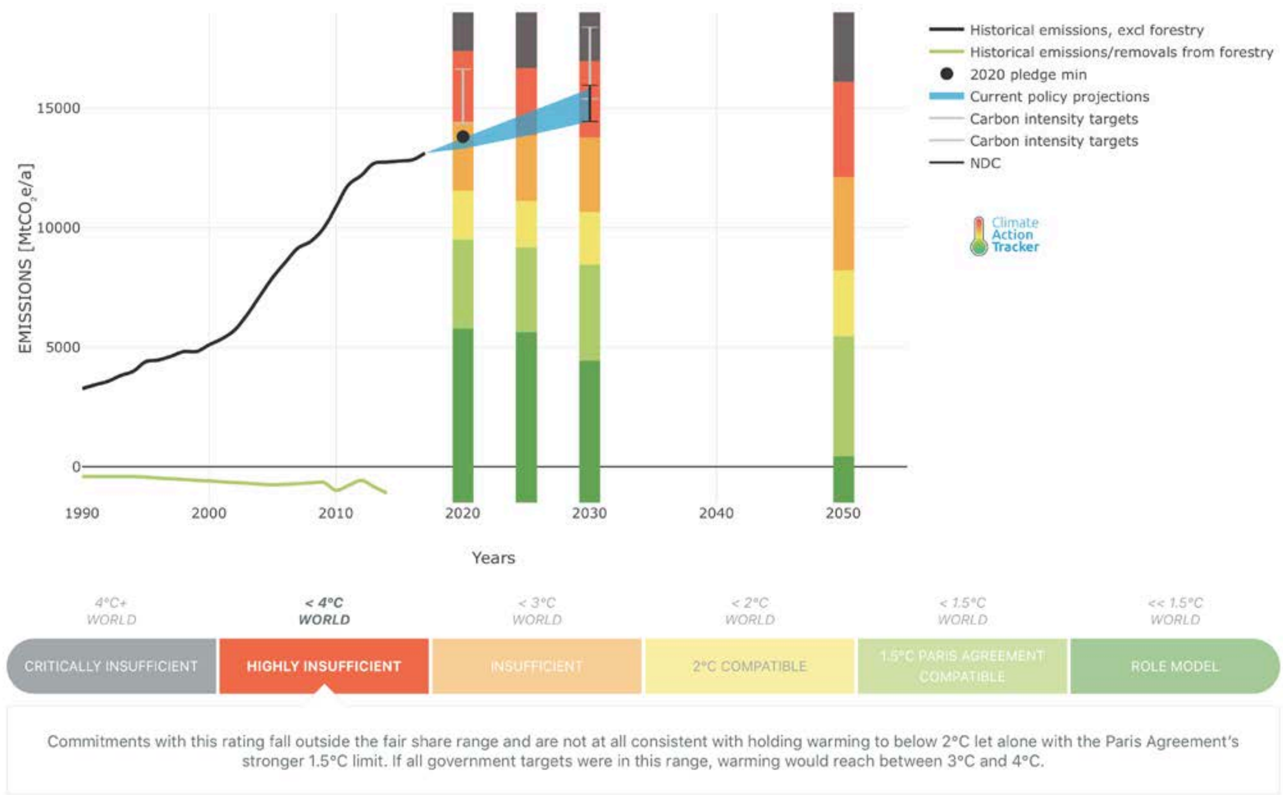
Air quality is an important domestic consideration in the decisions for natural gas. The IMF estimates that mortality rate from pollution related illness in China as 5.3 deaths per 1,000 people (Coady et al. 2019). In January 2013, official Particulate Matter (PM) 2.5 levels exceeded emission standards by a wide margin. This led the government to adopt the National Action Plan on Air Pollution Prevention and Control, September 2013, which focussed solely on reducing levels of PM10 and PM2.5 by switching from coal to gas (Miyamoto and Ishiguro 2018). While some progress was made, in 2016, 66 per cent of China's residents were still exposed to levels of air pollution that significantly exceed the WHO guidelines for PM2.5 (OECD 2019). To achieve the National 2013 Action Plan targets, in 2017, the government required all small coal-fired power plants in 28 cities in Beijing-Tianjin-Hebei region to be closed and replaced with natural gas fired units. China forced through this policy, despite lacking sufficient gas supply and infrastructure. That decision severely disrupted **continuity of supply** in a large number of cities and regions. As part of the 13th Development Plan this was expanded to 300 large cities to limit poor air quality to '20% per cent of the time' by 2020. China is also implementing an emissions trading system, with first trades expected in 2020, and has also announced a mandatory renewable energy certificate scheme that sets targets for renewable energy for each province individually.

BP (2019) finds that gas consumption in China grew by an 'astounding' 18 per cent in 2018. Domestic production grew by 8.5 per cent and imports surged by 27 per cent, with a stronger growth in imports of LNG. The largest growth sector was for city gas. In 2018, consumption increased to 18 per cent, domestic production grew by 4.6 per cent while imports of pipeline gas grew by 24 per cent and LNG by 54 per cent (Miyamoto and Ishiguro 2018). This was driven by the coal-to-gas switching policy in industry and buildings for local air quality and by robust growth in industrial activity.

Coal is the dominant fuel in China. In spite of the rapid growth of gas usage, China is still easily the world's dominant producer and consumer of coal and exceeds India, the US, and Japan by a very large margin. In 2018, coal comprised 59 per cent of China's primary energy consumption, down from 68 per cent in 2000. The 13th Development Plan signalled the need to diversify the country's use of energy sources. BP (2019) estimates coal to further decline to 35 per cent by 2040, with renewables (18 per cent in 2040) and natural gas (14 per cent in 2040) both increasing their share in the energy mix. Coal-fired power plants in China are almost all nearly 300 MW and above super-critical or at super-critical power plants. Few very small power plants (unless Combined Heat and Power (CHP)) remain, as they do in other developing countries. This results in the fact that the overall efficiency of coal-fired power plants in China, especially for those that were commissioned recently, is higher than in the US and Europe (see Figure 6 above). Notwithstanding progress made on energy diversification to rebalance China's energy mix with a smaller percentage of coal, China's increasing needs for energy means that the absolute levels of coal-fired power generation continue to increase, negatively impacting **climate change** efforts. Partly as a consequence of this, China's carbon emissions rose by 2.3 per cent in 2018, the second year of consecutive growth after carbon emission growth stalled between 2014 and 2016.[3] Continued new investment in coal-fired power is more than offsetting carbon reductions from investment into NG/LNG and Renewables. China remains as the world's largest greenhouse gas emitter by volume (although not per capita). But it is important to note that its impact on energy decisions is not just limited to China's domestic needs. Chinese companies are helping or promising to finance at least one in four newly constructed coal fired power plants globally (Brown and Buckley 2019).

China has also been the world's largest investor in renewable energy since 2012 (US$102.9 billion in 2015) or 36 per cent of global investment in renewables (UNEP 2016). By 2017, China accounted remarkably for almost half of the world's investment in renewable energy. Yet by 2017, renewables only comprised 3 per cent (BP 2019) of primary energy consumption in China. Given the intermittency of renewable energy, natural gas can be complementary. Natural gas enables renewable energy to take a bigger role, while growth of renewable energy also requires more flexible energy like gas-fired power to come into the system.

Figure 8: China's carbon emissions



Notes: after several years of stagnating growth of carbon emissions during 2014–2016, China's emissions have increased again in 2017 as well as in 2018. Continued new investment in coal-fired power is more than offsetting carbon reductions from investment into NG/LNG and renewables.

Source: Climate Action Tracker, by Climate Analytics and NewClimate Institute, © 2020.

In parallel, China has provided global leadership in the development of industrial export capacity in solar, wind, and EV technology. The cost of wind power has fallen by 69 per cent over the past decade while solar costs are down by 88 per cent, largely a result of the mass production of turbines

[3] Data retrieved from Climate Action Tracker. Available at: https://climateactiontracker.org/countries/china/ (accessed October 2019).

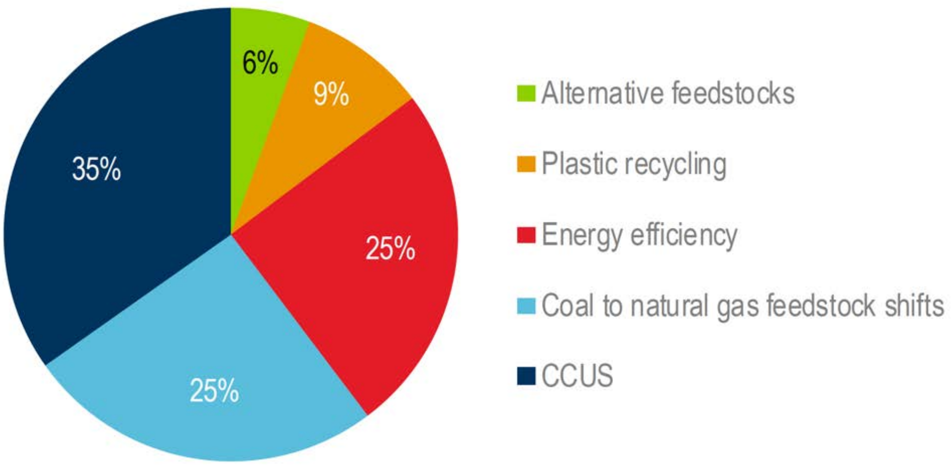
and panels by Chinese companies (Butler 2019). Outbound investment by Chinese private owned enterprises for renewables is discussed in the section on South East Asia below.

Within China, after almost a decade of subsidies to all three industries, solar has become a cheaper alternative to carbon emitting technologies; electricity generated from solar panels now costs less to produce than power from coal fired plants in 11 of China's 31 administrative units in 2019, four years ahead of an official target of 2023 (Johnson 2019). Wind power is expected to follow suit by 2020 and electric vehicles to be more cost efficient than conventional vehicles by 2021. These are all extremely remarkable achievements.

5.2 The greatest opportunity for gas in China

The greatest future opportunity for gas in China is generally regarded to be power generation, also in combination with heat-and-power (CHP) distributed energy centres. This includes the switch from coal to gas and enables increases in energy efficiency. In 2011, coal power plants had 35 per cent thermal efficiency (ABB 2013). However, by moving towards gas-fired CHP, efficiencies of around 80 per cent can be achieved.[4] There are also major opportunities for gas in other industrial applications, such as steam boilers, water boilers, furnaces, kilns, all of which in the past used a lot of coal. For example, opportunity exists to displace coal and naphtha feedstock with NG in the chemical sector. Methanol-to-olefins capacity in China is to nearly double between 2017 and 2025. The sector's clean transition is led by Carbon Capture and Storage (CCUS), catalytic processes, and a shift from coal to NG. Catalytic alternatives to traditional process routes can provide more than 15 per cent of energy savings per unit of production. Shifts from coal to NG for both ammonia and methanol production, mainly in China, result in decreases in both process emissions and energy intensity.

Figure 9: Chemical sector emissions



Notes: chemical sector emissions can be reduced, with coal-to-natural-gas feedstock shifts accounting for 25 per cent of the total reduction. In the energy efficiency component (25 per cent), there is also an element for feedstock shift from naphtha to ethane (NG).

Source: The future of petrochemicals (IEA 2018).

However, in terms of supply, China has few producing gas resources and must rely on gas imports to meet demand. There will be increasing calls in the future for government to control the price

4 See also above section on 'Technologies to increase energy efficiency' for more information on energy efficiency and fuel sources.

for natural gas in the industrial sector. But given the dominance of imports, that is also countered by the rising natural gas supply price from overseas. This imposes a lot of pressure for downstream companies to control costs and overheads, and on the other hand also to persuade customers to change to natural gas. If the economic margins for natural gas are not going up, they will not have an obvious economic driver. Electricity prices in China do not cover costs, so gas is currently not attractive for power producers. Currently, all gas-fired power plants in China are subsidised to ensure that the consumer does not pay a much higher tariff than if coal or other fuels were used. China's process of high-grading its energy mix to higher quality, yet higher cost NG/LNG as fuel, is through managed electricity tariffs to dampen **affordability** impact on its population. Yet, the main sectors for gas demand growth in China are industry, city gas, chemicals (such as fertiliser) that rely on energy efficiency gains of NG/LNG to counter lower fuel cost of coal.

5.3 There are several impediments for gas in China

Increasing domestic production of gas in China has proved challenging. Unconventional production of shale gas has not achieved the ambitious production targets set for it. In addition to affordability, another impediment for gas is how to create a just transition for the people and businesses employed in the coal sector. Millions of people are affected directly and indirectly. This is particularly acute in Northeast China. Government spending is supporting these workers to find alternative jobs, reskill them to improve their capacity or to help them convert to new jobs.

Based on the energy transition priorities described above, and how these effect energy decision-making in China, we have ranked China's energy priorities as follows (from low to high), see Table 2.

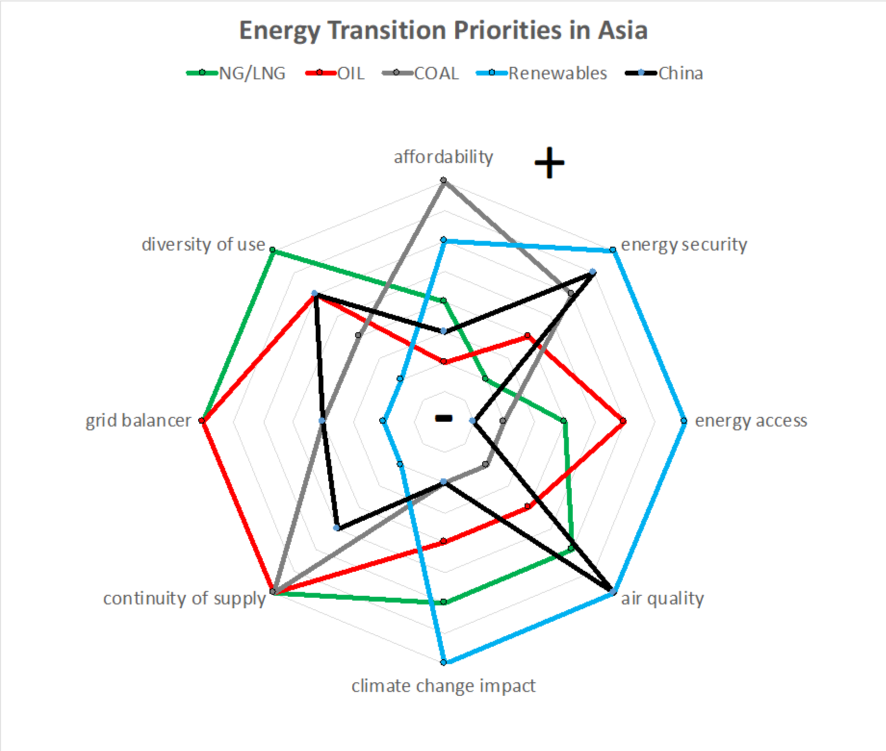
Table 2: Relative ranking of China's energy transition priorities

Energy priorities ranking	**China**
Affordability	3
Energy security	7
Energy access	1
Air Quality	8
Climate change impact	2
Continuity of supply	5
Grid balancer	4
Diversity of use	6

Note: table shows a comparative ranking how each of the priorities is evidenced to contribute in China's energy decision making (1 = low, 8 = high). Access to electricity in China is ranked the lowest since according to World Bank estimates, 100 per cent of the population has access as of 2017.

Source: authors' illustration.

Figure 10: Energy transition priorities in China: a relative ranking



Notes: A spider diagram visualising the relative ranking China's energy transition priorities (in Table 2) and compares how this ranking aligns with each of the four fuel types. Among the three regions, China energy priorities show a stronger alignment with gas, yet also positive for coal (energy security).

Source: author's illustration.

6 The role of LNG in India

6.1 India as a key driver of LNG growth in Asia

India is another of the five countries where LNG imports increased very substantially in Jan–June 2018. In 2016, India LNG imports grew by 4.5 mtpa (second largest growth after China), but slowed in 2017, when imports grew only by 1.5 mtpa (ranked 8th in growth that year) to 20.7 mtpa. In 2018, India imported a total of 23 mtpa of LNG.

Coal is still the dominant fuel in India. In 2017, it accounted for 56 per cent (BP 2019) of India's primary energy consumption, up from 54 per cent in 2008. BP estimates that this will fall to 48 per cent by 2040 with NG/LNG rising modestly from 6 per cent (54 Bcm) to 8 per cent (185 Bcm) over the same period. Hydro will remain unchanged (3–4 per cent), while other renewables (including biofuels) are expected to increase from 3 per cent in 2017 to 16 per cent in 2040. In absolute energy output levels, all these sources of energy-use in India are expected to rise significantly.

India's **climate change** ambitions under the Paris Agreement target involve a reduction of emissions intensity by 33 per cent by 2030 over 2005 and plans to increase India's renewable energy capacity to 175 GW by 2022 and 275 GW by 2027. In September 2019, the government committed to achieve a much higher 450 GW of renewable energy capacity by 2030. For three consecutive years, India's renewable energy investment topped that of fossil fuel-related power investments and in 2018, solar investments exceeded those in coal. But in spite of these positive developments, BP expects India's total net carbon emissions to roughly double to 5GT by 2040, with India's share of global emissions increasing from 7 to 15 per cent.

In 2000, the India Hydrocarbon Vision-2025 (Daniel 2019) projected that gas would account for 20 per cent of total energy supply by 2025. This was reduced to 15 per cent and in December 2018, government announced that the date for achieving that reduced share would be extended forward to 2030.

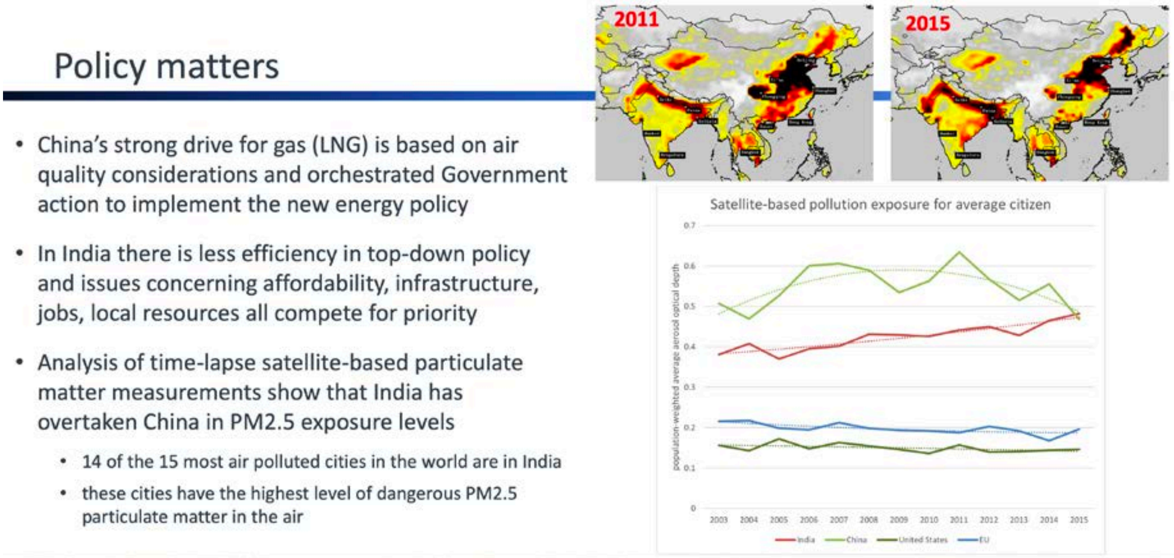
In 2017 a new national draft energy policy was issued, with plans to 2022 and to 2040 (Panda 2019). It was issued by India's premier planning authority which typically coordinates across agencies. The Plan focuses on four areas: electricity at **affordable** prices; improved **energy security** and independence; greater sustainability, and economic growth. The previous integrated energy policy, developed in 2006, was spread among five major ministries. This often led to conflicting ambitions. For example, the Ministry of New and Renewable Energy drove an ambitious renewables support scheme as part of India's national commitments for the Paris Agreement, while the Ministry of Power aimed to double coal production to 1.5 billion tons by 2020.

In 2014, about 21 per cent of India's population (and 30 per cent in rural areas) had no electricity access, government announced a 'power for all' **energy access** plan to connect power to all villages by 2018, covering 300 million people. Government data indicate that the percentage of households in India with electricity is now 99.99 per cent and 25 million households receive free necessary infrastructure, but not all households connected benefit from reliable **continuity of supply** on a sustained basis.

S&P Global Platts (Mohanty et al. 2019) reports that the government aims to raise the share of natural gas in the energy mix from 6 per cent in 2016 to 15 per cent by 2030, well above the BP forecast estimates. Currently half of India's supply of natural gas comes from domestic production and half from imported LNG. After adopting its National Electricity Plan (NEP) in 2018, India remains on track to overachieve its '2 °C compatible' rated Paris Agreement NDC climate action targets. Several utilities have shelved plans to build coal plants as one aspect of this.

Over 50 per cent of power generation is directly owned by central and State governments. However, that strong government intervention from upstream to downstream has prevented market forces from operating effectively (Corbeau et al. 2018; see also section below on the opportunities for gas in India). Unlike in China, India has little coal-to-gas switching potential in residential heating and much of the country's natural gas demand outside the subsidized fertilizer sector is highly price sensitive.

Figure 11: China’s noticeable air quality improvements are not yet a feature in India



Source: authors’ illustration. Images: Greenpeace East Asia (2016).

6.2 The greatest opportunities for gas in India

India’s energy’s growth requirements are such that it needs access to a wide range of possible energy sources, both domestic and imported. Its strong drive to **energy access** implies that **energy security** priorities have to rank a bit lower. India is moving from a scenario where it relies significantly on domestic coal and needs to look at diversifying its energy mix but still ensure **energy security**. This is also to be achieved through developing domestic resources such as oil, gas, coal, and in particular, renewables.

There is a significant role for gas in balancing renewables within the power sector. However, at the same time, natural gas is taxed differently and has a higher tax component than does coal. This makes the use of gas uneconomical in India for power generation and thus opportunities to play a bridging role are limited.

There are also opportunities for gas as a preferential fuel source outside the power sector where polluting fuels are causing issues with the **air quality** in India (see Figure 12 above). More recently, the issue of air quality has gained some resonance with local populations in India. However, unlike in China, this has not yet affected decisions regarding the relative choice of fuels.

Access to electricity, including clean fuels for cooking is a priority. The Indian government is starting to provide alternative cooking fuel through subsidised LPG supply to less well-off Indian communities. Gas is also a source of fuel for electricity and government is working to ensure this can be reliably supplied to domestic consumers with reliable connections.

6.3 The greatest impediments for gas in India

In India there is less government effectiveness and clarity in top-down policy processes and as a result, issues concerning **affordability,** infrastructure, jobs, local resources all compete for priority in this large democratic country. It is invested in quite a static system with domestic coal, while the value chain system relies also heavily on coal. In an energy transition, there will be ‘winners and losers’ including people employed as well as businesses from the banking sector to transportation.

India's legal, regulatory and pricing framework remains unfavourable to gas developments. Inadequate transmission infrastructure has affected achievement of national targets. For example, in 2013, it was expected that operational gas pipelines would more than double over the following five years to 28,000 km. By May 2019, 16,226 km of pipelines were operational, delayed mainly by lack of finance, and access to land issues.

There are six operating regasification LNG terminals. The Kochi terminal located in Kerala state was commissioned in 2013 and the 400 km pipeline from the facility was completed in 2019. But its throughput was limited to less than 10 per cent in 2018. Similarly, the Ratnagiri terminal also built in 2013 operates at one third capacity awaiting construction of a breakwater for the operations during the monsoon. Other terminals have compensated by operating at full capacity. In 2018, the four terminals then operational had more potential capacity than the more than 23 mtpa of LNG that was imported due to lack of gas infrastructure.

The existing City Gas Distribution network covers 11 per cent of India reaching 19 per cent of the population. However, given the likelihood of delays in implementing many networks, it is uncertain how the gas demand from consumers will develop. Recent estimates suggest that if India can successfully address its infrastructure constraints and if the price is right the country could emerge as another engine of global LNG demand (Losz et al. 2019).

Based on the energy transition priorities above, and how these effect energy decision-making in India, we have ranked India's energy priorities as follows (from low to high):

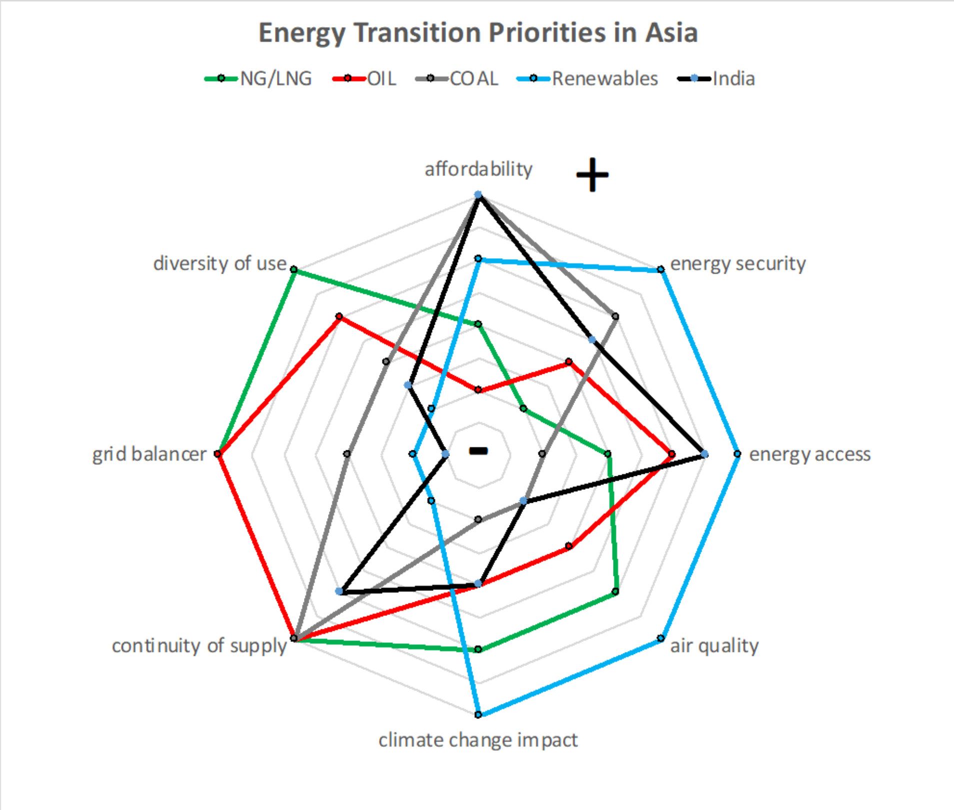
Table 3: Relative ranking of India's energy transition priorities

Energy priorities ranking	**India**
Affordability	8
Energy security	5
Energy access	7
Air Quality	2
Climate change impact	4
Continuity of supply	6
Grid balancer	1
Diversity of use	3

Note: table shows a comparative ranking how each of the priorities is evidenced to contribute in India's energy decision making (1 = low, 8 = high).

Source: authors' illustration.

Figure 12: Energy transition priorities in India



Notes: spider diagram visualising the relative ranking India's energy transition priorities (in Table 3) and compares how this ranking aligns with each of the four fuel types. Among the three regions, India energy priorities show a stronger alignment with coal (affordability) and renewables (affordability and energy access).

Source: authors' illustration.

7 The role of LNG in South East Asia (SEA)

7.1 SEA as a key driver of LNG growth in Asia

SEA is a very heterogeneous region, with a multitude of independent countries at various stages of development and with different levels of natural resources, opportunities and challenges. It is therefore to be expected that there is a significant variety in how NG/LNG is positioned in these markets. For the purpose of this report, we focus particularly on two of the most populous countries in the region: Indonesia and Viet Nam, but will also touch upon other SEA countries when relevant.[5]

Further growth of LNG in SEA is expected, particularly as a replacement for pipeline natural gas where local field resources are declining. Consequently, there is a shift in emphasis in further developments from LNG liquefaction to regasification projects. Due to depleting local gas fields, there is limited opportunity in adding liquefaction trains to existing facilities, although Indonesia (Tangguh and Abadi) and Papua New Guinea (PNG) still have some scope in this respect. As gas

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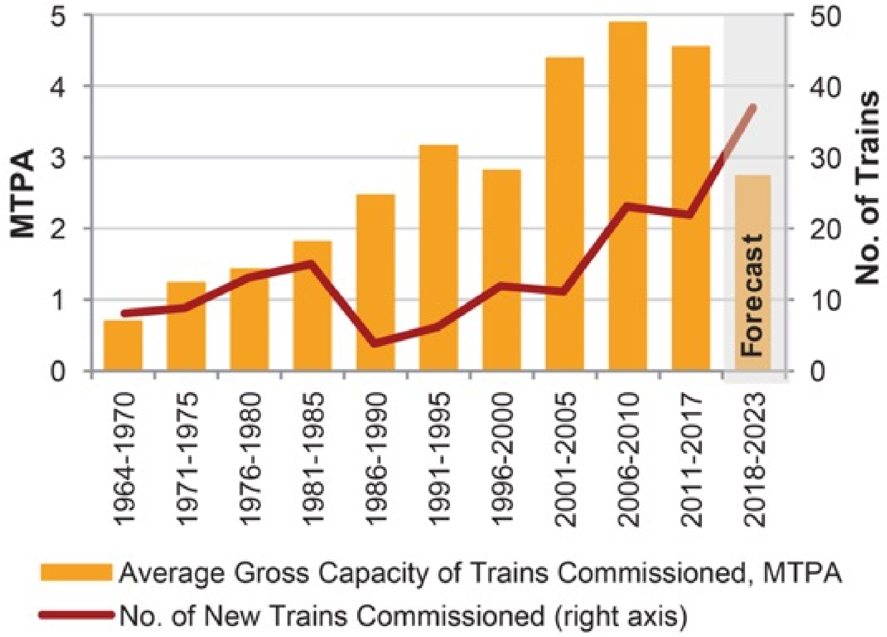
[5] In 2018, the most populous countries in South East Asia are Indonesia (266 million), Bangladesh (166 million), Philippines (106 million), Viet Nam (96 million), and Thailand (69 million). Source: World Population in 2018, freely available at www.ourworldindata.org (accessed February 2020).

resources become smaller and more remote, Floating LNG (FLNG) has become operational as a new technology for LNG supply.

A recent IGU report estimated that close to 50 Floating Storage Regasification Units (FSRU)could be in operation by 2025 with the capacity to import close to 200 mtpa globally. This rapid growth is attributed to the lower cost, faster schedule, and commercial flexibility. In addition to the FSRUs, there are currently four floating storage vessels (FSUs) in operation.

Whereas up to 2010 the trend was in designing and building ever larger LNG trains and projects, recent market demand growth has become more fragmented with smaller volume gas contracts. For operational as well as a commercial flexibility, the preference now is for more standardized (smaller) sized LNG trains for most projects (see Figure 14). This is also driven by smaller sized undeveloped gas fields and more widely distributed demand.

Figure 13: Increasing LNG train sizes are now changing in favour of smaller LNG train sizes



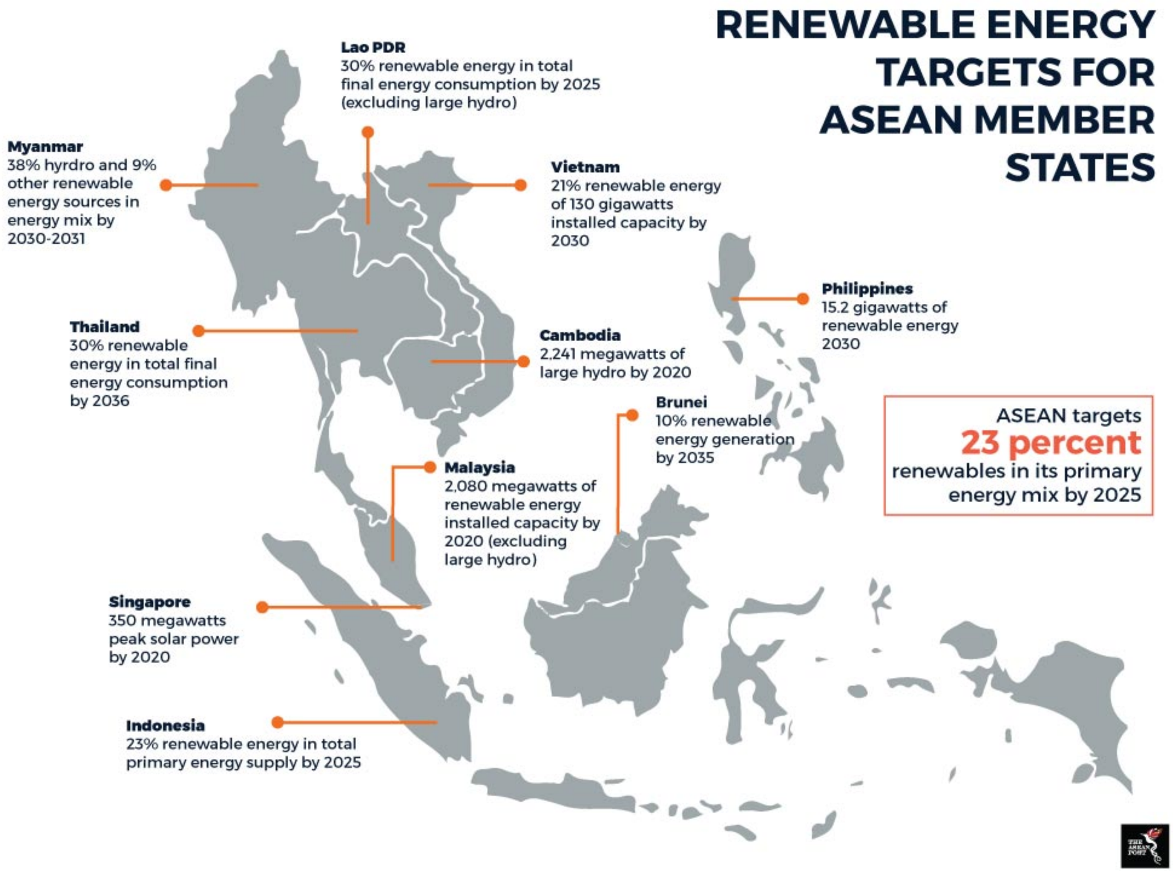
Source: World Gas LNG Report (IGU 2018). Reproduced with permission.

Gas demand in SEA pushes the size envelope even further to small scale LNG and mini-LNG. Local power development projects, such as those by PLN in Indonesia similarly show a distributed demand driven by **energy access**. Such projects are often economically marginal due to the small scale and commercial complexity involved in establishing a full value chain from upstream resource to LNG plant to LNG transportation to LNG receiving terminals to LNG offtake agreements with local power producers. In 2018, the government of Indonesia revised its 2016 plans for additional power capacity of 77.9GW down to 56 GW due to lower electricity demand growth. The largest cut was for gas-fired power plants (PWC 2018) where **affordability** and commercial terms remain challenging.

In 2017, Thailand imported 3.9 mtpa LNG, Singapore 2.3 mtpa, Malaysia 1.4 mtpa. Indonesia LNG regas is supplied solely from domestic LNG resources. Singapore has aspirations to become a global market hub for LNG (pricing and strategic storage, maritime fuel bunkering). SLNG (owned by Singapore's Energy Market Authority) started commercial operations from its US$1.7 billion project on 7 May 2013. The project is the first open-access multi-user terminal in Asia. It is capable of importing LNG and re-exporting it to various suppliers[6]. SLNG has built a fourth LNG tank sized 260,000 m^3, the largest in the world, and able to receive a full cargo load from a Q-Max carrier (which is currently the largest LNG carrier in the world). With this fourth tank the throughput capacity of the terminal will increase from 6 to 9 mtpa.

The Association of Southeast Asian Nations' (ASEAN) Plan for Energy Cooperation 2016–2025 (ASEAN Centre for Energy 2015) in support of the Paris Climate Agreement includes a target to achieve a 23 per cent renewable energy share in the total primary energy mix by 2025, up from 10 per cent in 2014. ASEAN countries' renewable energy targets are presented in Figure 15 and Table 4 below.

Figure 14: ASEAN renewable energy targets



Note: the diversity of renewables targets for ASEAN member states indicates the variability in resources, other than wind and solar. Hydro and geothermal also play a key role in some of these countries.

Source: The ASEAN Post (Gnanasagaran 2019). Reproduced with permission.

[6] See *Hydrocarbons Technology*: 'Singapore LNG Terminal, Jurong Island'. Available at: https://www.hydrocarbons-technology.com/projects/singaporelngterminal/ (accessed November 2018).

Table 4: ASEAN, China, US, and EU national determined contributions (NDCs)

National Determined Contributions to meeting COP21 targets	
ASEAN	
Brunei	10% of electricity from renewables
Cambodia	Reduce carbon emissions by 27% on Business as Usual (BAU) by 2030
Indonesia	Cut GHG by 29% below BAU by 2030
Lao PDR	Increase renewable energy to 30% of energy consumption by 2025
Malaysia	Cut emissions intensity by 35% from 2005 by 2030
Myanmar	38% of electricity from hydro by 2030
Philippines	Cut emissions by 70% below BAU by 2030
Singapore	Cut emissions per unit of GDP by 36% from 2005 by 2030
Thailand	Cut emissions by 20% below BAU by 2030
Viet Nam	Cut GHG by 8% below BAU by 2030
China	Cut emissions per unit of GDP by 60–65% from 2005 by 2030. Renewables and nuclear to be 20% of energy mix by 2030
US	20% of energy from renewables by 2020
EU	20% of energy from renewables by 2020 and 27% by 2030

Note: table sets out the commitments made by each country to reduce national emissions and adapt to the impacts of climate change as set out in their respective national commitments for the Paris Climate Agreement.

Source: authors' illustration, based on Climate Action Tracker.[7]

By 2018, some progress had already been made on delivering on these **renewable energy** targets, but countries are not on track. IRENA estimates that ASEAN countries would most likely reach just under 17 per cent renewables by 2025. Renewable energy currently comprises 14.3 per cent of ASEAN's total primary energy supply, with 26.8 per cent of installed power capacity being from renewable energy (mainly hydropower, bioenergy and geothermal energy). There are limitations to further expand on hydro and therefore much of the renewable energy growth will have to come from other non-hydro renewable sources. Solar PV and onshore wind power have seen significant cost reductions—a 45 per cent decline in installed costs for PV and 11 per cent decline for onshore wind between 2012 and 2016, yet they still only account for a small share of the generation mix.

Renewable investment flows have similarly not increased significantly. In Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam investments in renewables increased from US$1.4 billion in 2006 to US$2.6 billion in 2016, peaking in 2014 at US$3.4 billion and in 2015 at US$3.8 billion p.a. Thailand attracted the largest share of financing, followed by Indonesia. However, analysis has also shown that most NDCs do not include a comprehensive assessment of

[7] Available at: https://climateactiontracker.org/countries (accessed October 2019).

investment opportunities and are not sending sufficiently clear signals to market actors. Access to finance therefore remains a bottleneck. China's Belt and Road Initiative (BRI) has energy and the ASEAN region as focus areas. However, renewable investment in ASEAN appears to be underrepresented in BRI. For example, even for the energy sector, only 55 per cent of countries which have joined the BRI provide quantifiable contributions in their NDCs (Zhou et al. 2018).

In 2013, China launched the BRI to strengthen infrastructure on the westward land route from China through Central Asia to Europe and on the southerly maritime routes from China through Southeast Asia to Africa. In 2017, China issued *Guidelines on Promoting Green Belt and Road* and *The Belt and Road Ecological Cooperation Plan* and at the same time committed US$113 billion in special funds for Chinese financial institutions to support the plan. This is significantly larger than China's Financial outward FDI in 2017, which totalled US$13.9 billion.

The most comprehensive data on outbound Chinese financial flows can be found in a 2018 review (Zhou et al. 2018) undertaken by the World Resources Institute. It analysed whether and how Chinese financial flows align with the mid- to long-term energy and transportation investment priorities that BRI countries have conveyed through their NDCs for the Paris Climate Agreement. In terms of financial flows, there has been a significant increase. Between 2014 and 2017, Chinese energy and transportation investments in 56 BRI countries (including all ASEAN countries) totalled US$287 billion. The data includes ASEAN countries, but these are not separately presented. Consequently, only broad trends can be observed. The data shows that public sector sources of funding (major Chinese banks, China Development Bank, Chinese SOEs) largely financed conventional energy projects. Privately owned enterprises financed mainly low carbon priorities:

- Syndicated bank loans of US$143 billion from six Chinese banks. This funded 165 projects in 32 mainly high-income, BRI countries. Oil, gas, and petrochemical industries comprised US$103 billion. Within the electric power generation and transmission sector ($26 billion), over half financed fossil-fuel power plants, including US$10 billion for coal-fired power plants, and about a third to renewable energy, mainly hydropower (Pakistan), wind power (India), and geothermal power (Indonesia).
- China Development Bank and China Eximbank provided US$44.7 billion of energy sector loans. With their development objectives, funding is mainly to low income BRI countries. The share of lending to energy projects was smaller (43 per cent), and mostly targeting coal fired power generation. In ASEAN, Indonesia received US$2 billion for coal fired power generation; Malaysia US$1 billion for oil, gas, and petrochemical projects. Solar PV and wind power received only 5.3 percent ($2.4 billion) of the two banks' total energy lending.
- Equity investments of US$7 billion. One third for the energy sector (Russia, UAE, Pakistan and Egypt).
- Chinese corporations invested US$72.3 billion in the energy and transportation sectors (Dealogic 2018) with 86 percent in the energy sector; most electric-power generation and transmission. Investment choices of State-Owned Enterprises (SOEs) and Private Owned Enterprises (POEs) vary. SOEs invested overwhelmingly (90 per cent) in fossil-fuel power generation and less than $1 billion in solar PV and wind. In contrast, POEs invested heavily in solar PV and wind power, reaching US$7 billion and US$5.5 billion, respectively, however India and Pakistan (and not ASEAN) were the top investment destinations.

7.2 The greatest opportunity for gas in South East Asia (SEA)

Indonesia is the most populous (after China and India) in a select group of only 23 countries with at least three successive decades of high per capita growth since 1945. Indonesia has been well endowed with resources, including access to affordable energy. This has supported its growth and progress towards human development goals. **Energy access**, which is supported under the Government of Indonesia's 2015–19 Development Plan is a high priority. While the access rate compared with some other countries in Asia is already quite high, given the archipelagic geography, reaching those not currently connected is a huge challenge. Gas has a role to play and this is recognised by the government. Box D illustrates one opportunity to reduce gas flaring from oil production operations and capture the gas for use by these remote communities.

In preparation for the next Five Year Development Plan (2020–2024), Indonesia's Ministry of National Development Planning, known as Bappenas, is now focussed on ambitious climate action—developed under its Low Carbon Development Initiative, as central to put the country on track to meet or exceed its **climate change** goals. This includes less carbon-intensive, more efficient energy systems which can contribute to delivering 6 per cent GDP growth per year until 2045, with continued gains in employment generation, increased incomes, and poverty reduction. This strategy would cut Indonesia's greenhouse gas emissions by nearly 43 per cent by 2030, exceeding the country's NDC target. Actions to achieve this include moving away from coal and increasing renewable energy's share of the power sector to at least 30% per cent by 2045.

Renewable energy is now cheaper than coal in Indonesia, but only when price externalities, such as the costs of air pollution, are included as part of the cost of coal (Garrido et al. 2019). Ensuring a just transition to a low carbon economy will require that those negatively impacted—people and businesses currently employed in fossil fuel industries—can shift to new opportunities in a low carbon economy without sustaining undue losses. Some indication of the challenge of this transition is evident in the 2019 BP Energy Outlook (BP 2019). While coal declined in the energy mix in China over the past decade, in Indonesia it has increased between 2008–2018 from 24 to 33 per cent. This is similar to the situation in India where coal increased from 54 per cent in 2008 to 56 per cent in 2018. Again, and contrary to trends in China, the share of natural gas in Indonesia's energy mix declined from 26 to 18 per cent over the same period. Renewables in power (mainly biomass and geothermal, as well as wind and solar are negligible) are similarly small, comprising 1.8 per cent of primary energy consumption in 2018 versus 3.4 per cent for India.

Box D: Improving energy access by capturing flared gas

The annual volume of natural gas being flared and vented worldwide is currently estimated at about 4 per cent of world yearly gas production. To put this in perspective, globally flared volumes exceed the total combined gas consumption in Africa. This volume is also equivalent to up 360 million tons of CO_2 released into the atmosphere per year, or the yearly CO_2 emissions of 77 million cars -more than the entire fleet of cars in UK, France and Belgium combined. Developing countries account for more than 85 per cent of total gas flared and vented. Yet, these are also the countries where the need for energy access through smaller scale, distributed energy solutions is often highest.

Various small-scale gas processing options exist based on gas-to-gas, gas-to-liquids, gas-to-solids and gas-to-wire technologies. Economically attractive solutions can be developed through Joint Industry Projects (JIPs). These also have the potential to reduce negative environmental and societal impact and provide a more sustainable solution for local communities.

There is opportunity to build on UK DFID-supported work in Nigeria which developed a 'Gas Flare Tracker' and apply this to the Asia region. The Tracker provides improved gas flare emissions data from oil & gas operations. This is achieved through the satellite detection of flares managed by the U.S. National Oceanic and Atmospheric Administration (NOAA) which provides information about every single flare. Overlaying these data with spatial information on oil and gas infrastructure then creates transparency on sources of flares and operating parties.

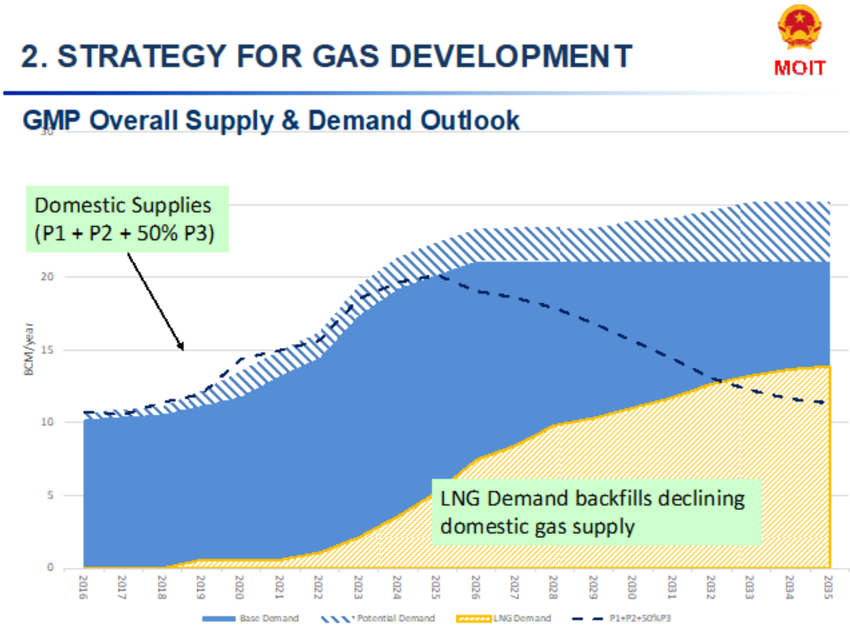
Use of satellite data also resolves constraints and cost for area access to conduct measurements, while it also can be used on a continuous basis to evaluate time-based trends. For example, time lapse satellite data can be used to assist in distinguishing routine from non-routine flaring and venting. Satellite data can be calibrated with reported data to identify anomalies and assist in the further development of quantitative methodologies to measure gas emissions data (including methane) from satellite observations.

With this robust data, it is then possible to develop energy access solutions which are win-win-win: capture unprocessed gas, assess how these resources can be converted, transported and utilised by local communities, reduce GHG emissions and improve air quality.

Industry and transport are significant opportunities for **diversity of use** of natural gas. Indonesia, for example, has tens of gigawatts of inside-the-fence industrial power capacity fuelled by liquid fuels. Increasingly, LNG will be delivered through 'virtual pipelines', meaning trucks and even small ships, allowing smaller industries to move to natural gas. This has already happened in China. Global companies are signing up to RE100, a global corporate leadership initiative committed to 100 per cent renewable electricity. Companies are required to source renewable electricity globally—thus including their supply chain. This will support more natural gas, particularly in the industrial sector. In Indonesia, BP finds that most of the new consumption in the (increased) energy demand is in transportation services – with higher demand for gasoline, diesel and jet fuel.

In Viet Nam, gas development is seen by government as strategic for **energy security** (see Figure 16). In 2012, the Vietnamese government adopted a National Green Growth Strategy and in 2014 a Green Growth Action Plan. However, the cost to implement this is estimated to be at least US$30 billion and requires a significant increase to current financing levels. Viet Nam's GHG inventory (2010) reveals a 602 per cent increase since 1990, with emissions per unit of GDP surpassing all other Asia-Pacific developing countries except for China. **Energy access** is however much less of an issue, with over 98 per cent of the population connected to the grid, although demand will increase by a further 10 per cent a year until 2030.

Figure 15: Viet Nam expected to become a LNG importing country



Source: Ministry of Industry and Trade, Viet Nam, presentation at World Bank Group internal Workshop, 2018. Reproduced with permission.

7.3 What is the greatest impediment for gas in South East Asia

Infrastructure financing for LNG and renewables needs a firm market as well as market access. In Indonesia, the big challenges include the country's geography as an archipelago, technology selection, and demand uncertainties together with land acquisition issues, local permits, and overlapping regulations. Part of the challenge in building a market for LNG is how infrastructure investment can be structured. For Indonesian coal-fired power, it is possible to bring all required infrastructure within the ring fence of the power utility investment. However, for a gas-fired power plant that is to be supplied by LNG, each of the elements of the value chain: jetty, port, storage, transportation, etc. need to be structured as individual commercial entities. This significantly increase the challenge for developing a NG/LNG fired power plant over coal. Nevertheless, as of 2017 Indonesia has four LNG receiving terminals in operation.

In Viet Nam, for example, power customers are dominant in the market. Currently, the industry is driven by coal, which is produced locally, and the cost of natural gas cannot compete. While the Gas Master Plan includes a section on LNG, there is currently no legal framework to accommodate LNG. The aspiration for transition to a gas market by 2030 is identified but the specific steps to achieve this have not been specified. Viet Nam now has an LNG MOU with Shell and Japan, with the first LNG cargo planned for 2021. PetroViet Nam aspires to build four LNG receiving terminals. In 2019, PetroViet Nam Gas announced that construction of one of the country's first LNG terminals will begin in southern Viet Nam in October 2019 and be operational in 2022.

Based on the energy transition priorities above, and how these affect energy decision making in SEA, we have ranked SEA's energy priorities as follows (from low to high):

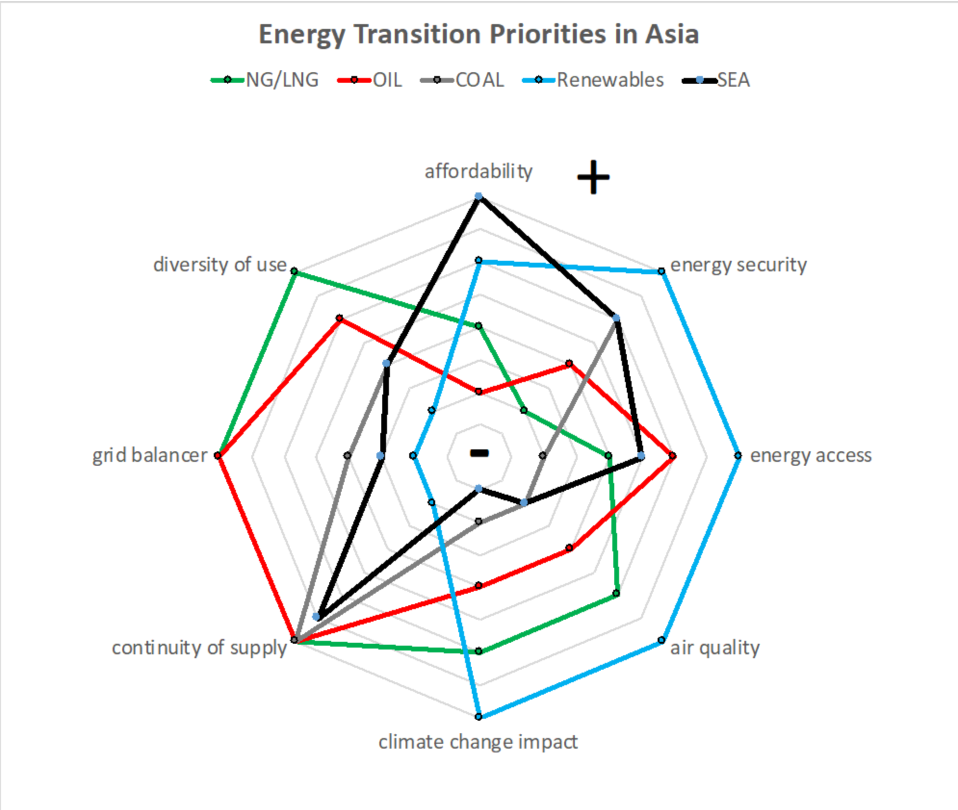
Table 5: Relative ranking of SEA's energy transition priorities

Energy priorities ranking	**SEA**
Affordability	8
Energy security	6
Energy access	5
Air Quality	2
Climate change impact	1
Continuity of supply	7
Grid balancer	3
Diversity of use	4

Note: table shows a comparative ranking how each of the priorities is evidenced to contribute in SEA's energy decision making (1 = low, 8 = high).

Source: authors' illustration.

Figure 16: Energy transition priorities in SEA



Notes: spider diagram visualising the relative ranking SEA's energy transition priorities (in Table 4) and compares how this ranking aligns with each of the four fuel types. Among the three regions, SEA energy priorities show the strongest alignment with coal and for oil. The latter is evidenced by the pervasive use of generator sets for off-grid power generation, or as backup against electricity grid brownouts and blackouts.

Source: authors' illustration.

8 How energy transition priorities affect LNG markets across regions

The previous sections described the role of natural gas and LNG in China, India, and SEA. In India and SEA, market opportunities for NG/LNG are more strongly influenced by energy priorities as evidenced in investment decision-making than on the basis of energy policies. China is an exception, where top-down policymaking is steering Chinese investment decisions and changes in the energy mix. The relative priorities of the energy transition are different for each of these three regions, and consequently the current and future role of gas/LNG in these regions is also likely to differ.

8.1 Comparison of the energy transition priorities across the three regions

Following the regional descriptions in the previous sections, we are now in a position to juxtapose these in a consistent format. Having derived rankings of energy priorities based on evidence from energy investments in each of the regions, we can see some marked differences in priorities (and therefore investments) in China, India, and SEA. Table 6 below shows how these three regions differ in their ranking of energy transition priorities. Figure 18 below further compares these priority rankings in a spider diagram.

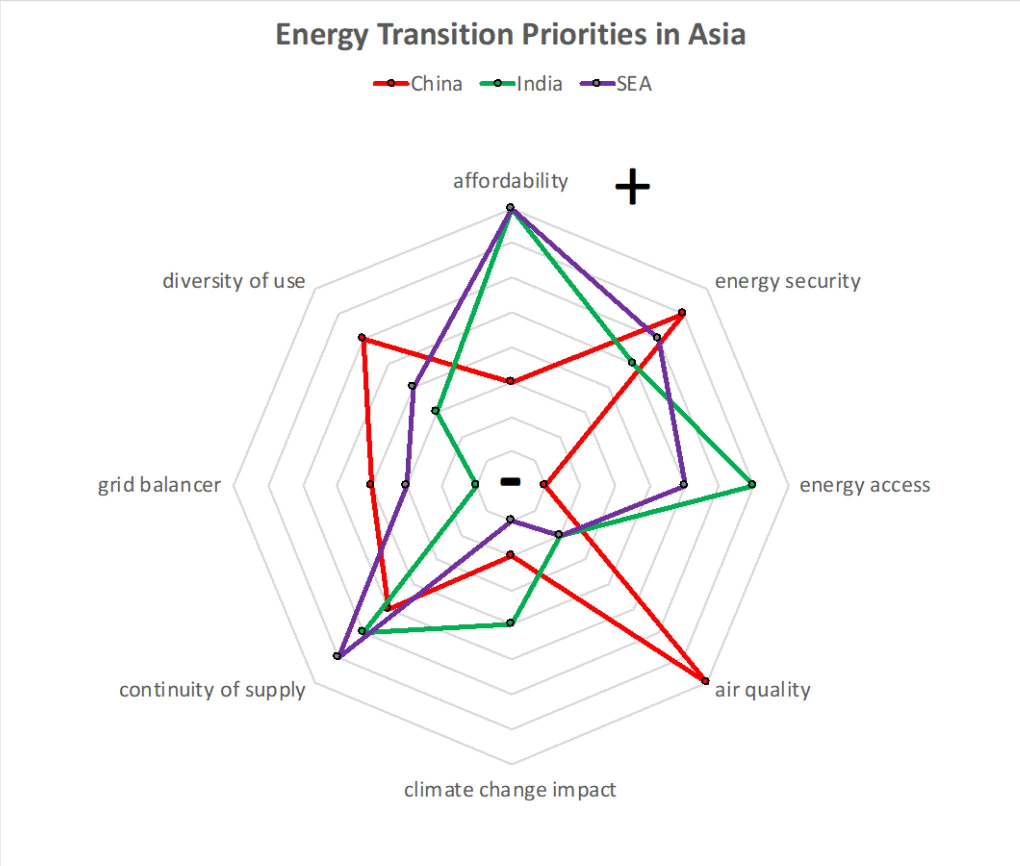
Table 6: A comparison of energy transition priorities across the three regions, summarising the sections above

Energy priorities ranking comparison	**China**	**India**	**SEA**
Affordability	3	8	8
Energy security	7	5	6
Energy access	1	7	5
Air Quality	8	2	2
Climate change impact	2	4	1
Continuity of supply	5	6	7
Grid balancer	4	1	3
Diversity of use	6	3	4

Note: table shows a comparative ranking how each of the regions rank their priorities as evidenced in energy decision making (1 = low, 8 = high).

Source: authors' illustration.

Figure 17: Energy transition priorities in Asia



Note: spider diagram visualising the relative ranking of the energy transition priorities across the three regions China, India, and SEA (as summarised in Table 6).

Source: authors' illustration.

When we normalize the alignment of the region's priority scores against the fuel types, such that:

- zero is indifferent (i.e. the outcome if there was average alignment);
- large positive indicates more than average alignment;
- large negative indicates less than average alignment;

we obtain the qualitative grid presented in Table 7:

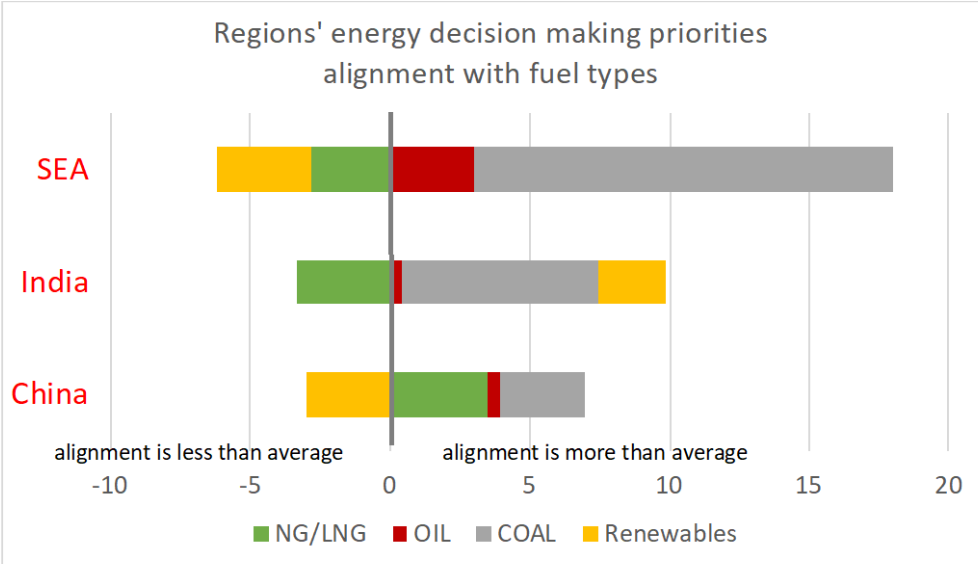
Table 7: Comparison of energy transition priorities with fuel type.

Energy priorities versus fuel type	**Coal**	**Oil**	**NG / LNG**	**Renewables**
China	3	0.4	3.5	-3.0
India	7	0.4	-3.4	2.5
SEA	15	3	-2.8	-3.4

Note: table shows how the fuel type options align with the eight energy transition priorities in each region (zero means that the alignment is average among the priorities).

Source: authors' illustration.

Figure 18: Alignment of the energy transition priorities of China, India, and SEA with the four fuel types



Source: authors' illustration.

The following conclusions can be drawn from the comparative analysis above:

- All three regions have a very strong positive alignment in energy decisions towards coal, with SEA showing the strongest match, followed by India and a more balanced China.
- China is more positively aligned to gas in its energy decisions (at the expense of some of its coal ambitions). SEA and India are less than average aligned towards gas (in a relative sense, i.e. compared to other fuel types), mainly because of dominant priority on **affordability**.
- India is positively aligned towards renewables, for the purpose of **energy access** among its rural population and with less emphasis on **grid balancing** issues (more off grid/local grid solutions).
- With its emphasis on **continuity of supply**, SEA favours oil over small scale gas or renewables. This is evidenced by significant use of oil-fired generators for off-grid power generation (or as backup against brownouts and blackouts).

The analysis further shows than China's push for natural gas at the expense of coal is not merely a correction to replace small, inefficient, and dirty coal boilers with cleaner burning natural gas as fuel. China's positioning for an increased share of gas in its energy mix is supported by a number of strategic priorities in addition to improving **air quality**. We are therefore likely to see a deeper penetration of gas in a number of markets in China (power, industry, transport).

8.2 Different energy priorities of countries drive different marketing approaches by LNG suppliers

In Section 2, we described key reasons why the LNG market is experiencing increasingly fierce competition among suppliers. The diversification of LNG supply sources over time has caused LNG to become increasingly a buyers' market instead of a sellers' market. The repercussions of the market changes are particularly felt among new greenfield LNG supply sources that are at a relative disadvantage compared to established LNG ventures with expansion capability.

LNG contract terms

LNG contracts are generally very detailed documents with a plethora of details aiming to cover for a whole range of eventualities to reduce commercial risk. In general, the following key elements are part of an LNG supply contract:

- **Commitment**: the seller commits to sell and the buyer commits to purchase LNG.
- **Term**: project financed LNG supply ventures need to be under-written by long-term LNG contracts of 20–25 years, for the majority of the LNG plant capacity. Other options for term are shorter-term contracts (5–10 years) and spot (sale of individual cargo or volume without repeat deliveries).
- **Transportation and discharge**: LNG sales are based on the following transfer options:
    - FOB (free on board), with title transfer to the LNG buyer at the loading point and the buyer responsible for the LNG transportation.
    - CIF (cost, insurance, and freight) borne by the LNG supplier, but title and risk still transfers at the LNG loading point.
    - DAT (delivered at terminal) or DAP (delivered at place), with supplier maintaining title and risk up to the point of delivery and responsible for CIF costs.[8]
- **Volume**: the amount of LNG to be delivered over the contract period, usually specified as a volume per calendar year. Other details include scheduling (timings and parcel sizes) and allowable deviations to committed volume (e.g., force majeure, rejected LNG volumes due to off specification).
- **Level of commitment**: a commitment could be 'firm., i.e. a failure to deliver will result in exposure to damages, or on the basis of 'best endeavours' with weaker enforcement. Buyers generally are obligated under 'take or pay' provisions, while sellers are likewise obligated under 'deliver or pay'. Sometimes, there is flexibility to make up missed cargos at a future date, but the common take-or-pay provision is that the buyer is forced to pay even when unable to physically take the cargo. This provision transfers risk to the buyer. A milder form of take-or-pay grants the seller the right to sell missed cargos in the market with the buyer making up for any reductions of price and any additional costs of sale. Similarly, a less onerous deliver-or-pay provision would grant the buyer a percentage of the value of volumes not delivered, either in cash or as a price discount for future cargos. The value of money involved for these contract elements can be highly substantial.
- **Cargo diversions**: seller or buyer may or may not have the right to divert cargos to another market, generally because of an opportunity to attract a higher price. Terms on these conditions include how costs and profits incurred are allocated.
- **Price**: elements include base price, indexation, floor price, ceiling price, inflection points of S-curve pricing formula, conditions for price reviews or price re-openers.[9] Most LNG continues to be oil-price linked, but due to increased LNG supply from the USA, there are more cases of gas-to-gas indexation and mixed price indexation. The deviation from straight-line indexation at low and at high prices (known as S-curve) aims to protect LNG sellers and buyers respectively. See also Figure 20 below.

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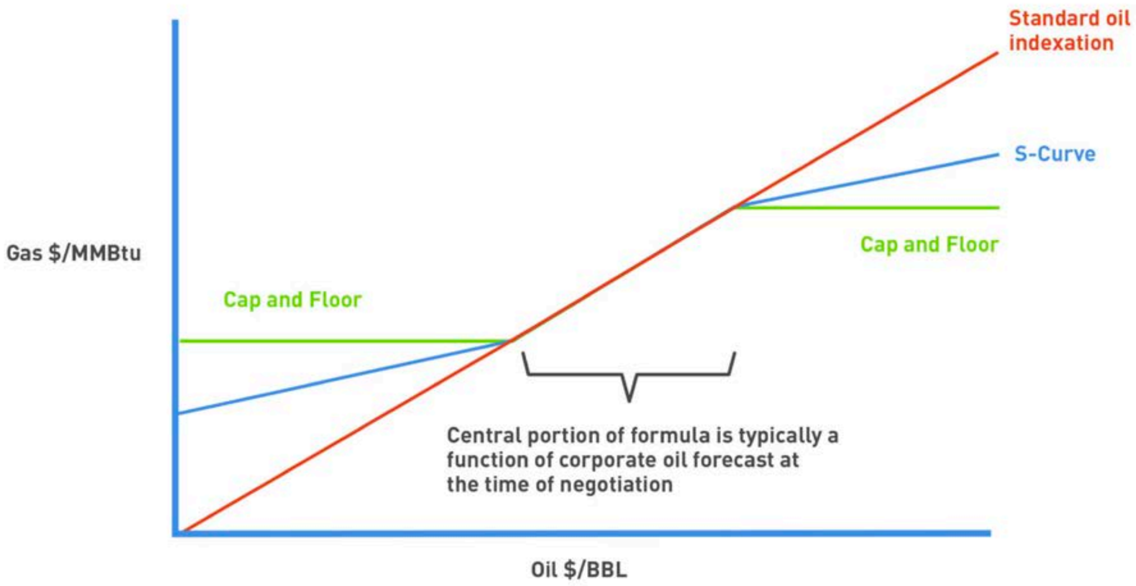
[8] In older terminology, this used to be referred to as 'delivered ex-ship' (DES)

[9] A common formulation for price reviews or re-opener is: *"If . . . economic circumstances in the [buyer's market] . . . have substantially changed as compared to that expected when entering into the contract for reasons beyond the parties' control . . . and the contract price . . . does not reflect the value of natural gas in the [buyer's market] . . . [then the parties may meet to discuss the pricing structure"* (US Department of Energy 2018). However, experience on the use of such clauses now tends to constrain the conditions and the scope more specifically. This is to avoid unintended divergence of long-term interests between LNG buyers and sellers.

- **Technical provisions**: there is no global standard for LNG as fuel. Therefore, LNG specifications can differ between suppliers. On the downstream side, customers can be highly sensitive to deviations in calorific value of natural gas. Consequently, minimum and maximum levels of heating value, ethane content, trace elements, etc. need to be specified. Other technical provisions cover metering, vessel and terminal specifications.
- **Miscellaneous**: cover a large range of terms, including applicable law, dispute resolution, confidentiality, liabilities, payment.

For more information on Global LNG fundamentals, see US Department of Energy (2018).

Figure 19: LNG pricing mechanisms



Source: Global LNG fundamentals, US Department of Energy (2018).

LNG marketing strategy

The negotiation and specification of LNG sales contracts are a protracted, highly specialised, and voluminous affair. The process is a detailed matchmaking process of aligning buyers and seller interests across a broad range of factors. These can generally be clustered into four categories:

- Price
- Flexibility
- Risk
- Performance

Price

The impact of price competition has been described earlier in the report. From a supplier point of view, the ideal timing is when there is a business cycle of less new LNG supply (for example when other suppliers have a shortage of capital to invest, or have less gas-resource volumes matured for sale) and/or a cycle of increased LNG demand (for example, when there is a policy change from a major energy-using country that reduces a certain energy type in favour of LNG, such as in China with coal and Japan during the Fukushima nuclear incident). The negotiation power generally veers towards the party that has the most flexibility regarding the timing a deal needs to be done.

Another mechanism to align buyers and sellers on their different views of value is by taking share interests in each other's ventures, when policies and laws allow. This helps in several ways:

- Value that is shifting from buyer to seller or vice versa is partially mitigated by the cross-holding interest.
- The degree of suspicion and misunderstanding between parties due to the imbalance in information between buyer and seller is (partially) overcome.
- Parties have an opportunity to address issues, such as operational performance, through their cross-representation in the value chain.
- Strategic opportunities may arise for more business in the future.

It is quite common that LNG buyers acquire small stakes (up to ~20 per cent) in the upstream venture and LNG plant as part of a commitment to underwrite a significant volume of LNG under a long-term contract. Similarly, other joint business opportunities could be offered to build trust and to add value for both buyers and sellers.

Risk

The allocation of risk between parties can be seen a somewhat similar to opposing positions in price negotiations. However, while price negotiation is more of a 'zero-sum gain' dilemma, this is not necessarily true in negotiating risk allocation. A certain risk situation can have a much higher impact to either buyer or seller because this party is not able to mitigate the risk, has lack of expertise in managing the risk, cannot offload the risk to another third party, etc. A good understanding between buyer and seller on their ability to manage risk is critical in optimising the value in the total chain. Trading of risks during LNG contract negotiations is a common way to try to optimise risk-based value.

Flexibility

The desire for flexibility is closely linked to risk. However, while risk is generally a transfer or balancing of a potential negative outcome to the party that is best positioned to accommodate or mitigate against that risk, flexibility could be positive for both seller and buyer. For example, LNG destination flexibility can benefit both parties if the incremental value of diverted cargos is shared. Because of changing conditions over time (markets, technologies, policies, tax, etc.), it is recommended to accommodate flexibility as an opportunity for value creation along the value chain that benefit both seller and buyer. Historically, LNG has been a sellers' market and LNG supply ventures (that generally take the biggest value risk across the chain) have been keen to protect their position in limiting any flexibility to the buyer. However, the LNG market has now significantly matured with 30 per cent of LNG traded under shorter term contracts or as spot. Optimisation of LNG (e.g. in transportation routes) is now a key source of potential incremental value. This requires more flexibility to be incorporated into LNG contracts, with benefits for both buyers and sellers.

Performance

Because LNG is a value chain, performance in one part of the chain can have repercussions in other parts of the chain. Performance issues can be accommodated contractually, as for example in take-or-pay or deliver-or-pay provisions, but better yet is to align the value chain such that it positively stimulates performance enhancement, transparency, and trust. It is because of demonstrated track-record that supply from LNG-train expansions have a competitive edge as a supply source over greenfield LNG ventures. Because greenfield LNG does not have this ability to demonstrate reliability, efficiency, timeliness, etc., it has to focus efforts in designing the optimum structure of the value chain and demonstrate its transparency (see Figure 21 below). Moreover, inviting project partners into the venture that have track-record (as well as relations with buyers) can be a valuable conduit to get access to necessary expertise and to build trust with buyers.

Figure 20: Value-chain design optimization

Source: authors' illustration. Image: US Department of Energy and USEA (2017).

Value-chain design optimization is critical for greenfield LNG ventures to demonstrate their ability to drive performance once operational. It is value chain transparency and best practice that helps to build trust from buyers, even in the absence of operational track record.

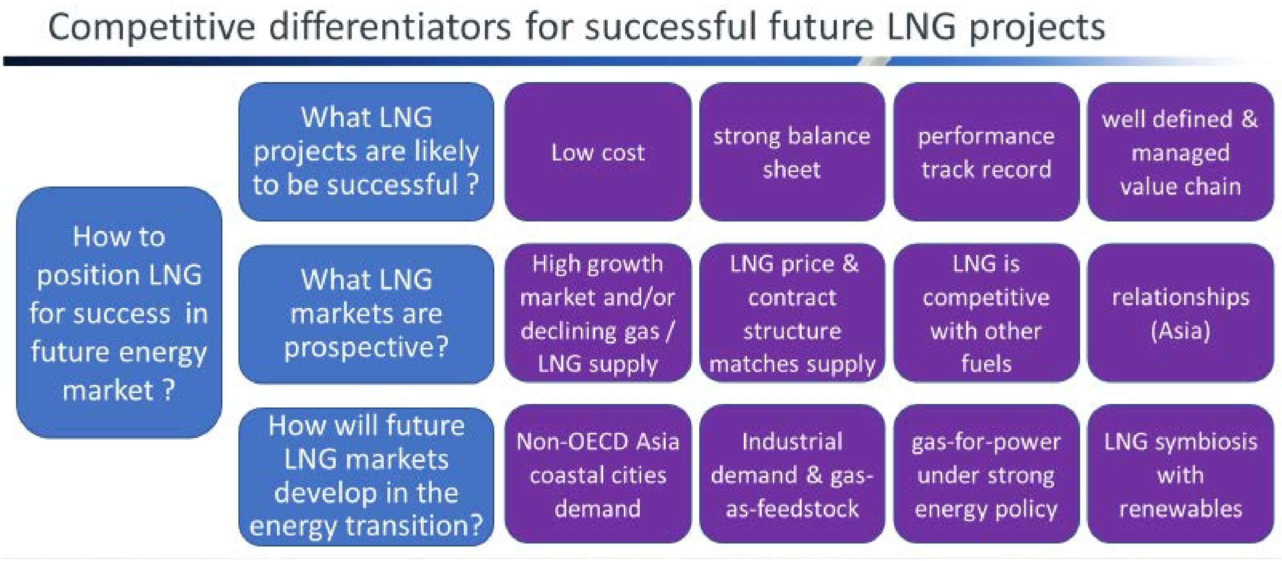
9 The role of African LNG

Key sources of new LNG supply that compete with the potential scale of East African LNG are: USA, Qatar, and to a certain degree Russia. Each source has specific advantages and disadvantages, opportunities and constraints when competing against East African LNG. Understanding how competing suppliers are able to optimize the potential of their own value chains provides insight on which of African LNG key differentiators are truly unique and can be leveraged to greatest extent in securing LNG sales.

New greenfield African LNG supply ventures compete in a quite challenging market to secure long-term sales for large volumes of LNG. It is of great importance that there is good understanding between buyers and sellers on their priorities, abilities, and constraints, to best align LNG contract terms to maximise the value of the value chain. Once the value chain has been optimised in this integrated way, parties (buyers and sellers) can then subsequently focus on the distribution of value between them. There can be the temptation for parties to commence negotiating with an objective of maximising their own position rather than the value of the value chain. Consequently, any concession is then perceived as 'giving up value' to the other party.

Among all the contract terms and parties' concerns described in the previous sections, the most important lever for success is to know how to maximise value in the total LNG value chain. This includes knowing the other party in depth and sharing a degree of openness. All of this can be done in an arms-length transaction that honours competition law issues. In practice, LNG contract negotiations are substantial on detail and technical issues. Yet, to demonstrate the principles described above we have illustrated the process at a conceptual level in the figures below.

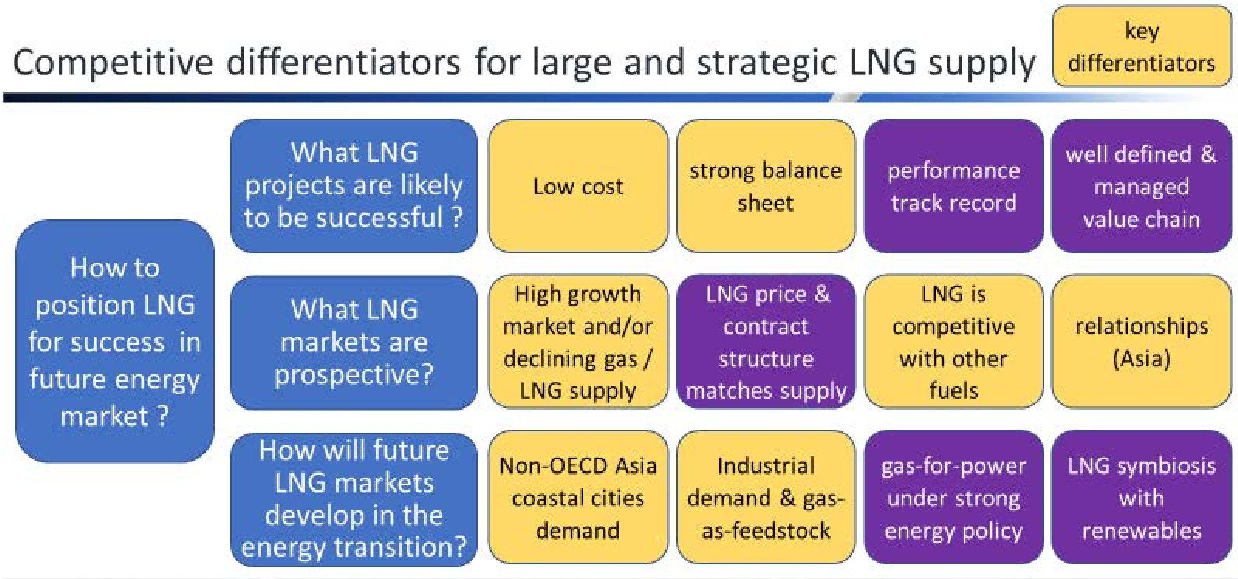
Figure 21: A high level overview of the elements of the LNG value chain, including project (liquefaction, shipping, regassification), market, and (market) opportunities



Source: authors' illustration.

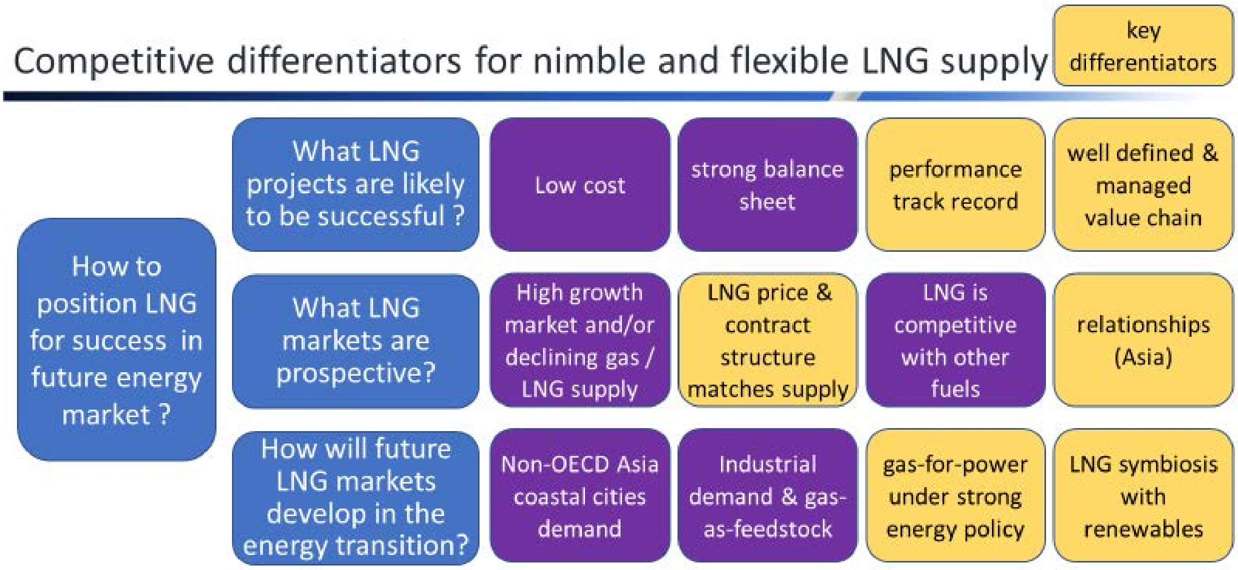
Each of these elements has 'value drivers' that are more or less important depending on the specifics of the LNG value chain. These value drivers can become key differentiators in securing an LNG contract, if their importance in optimizing the value chain is understood and shared among parties.

Figure 22: Key differentiators (in yellow) for an LNG value chain involving a large and strategic sales contract



Source: authors' illustration.

Figure 23: Key differentiators (in yellow) for an LNG value chain involving a nimble and flexible sales contract



Source: authors' illustration.

In the conceptual example above, we have focused on the potential differences in two types of LNG contracts: 'large and strategic LNG supply' and 'nimble and flexible LNG supply'. 'Large and strategic LNG supply' may be representative for customers that use LNG as the main source for electrical power. LNG is generally contracted from few suppliers with large volumes and with long duration contract terms. Price and reliability of supply are the most important criteria for sourcing LNG. Customers want to be guaranteed that suppliers have financial robustness, also when technical or economic upsets may occur. The energy value chain is likely extended with significant downstream investment into power generation, power distribution, and gas distribution networks. As these downstream investments are most often project financed, predictability of returns driven by gas throughput and gas price over a long time period is paramount. Financial stability is generally valued higher than potential short-term opportunity value. Fuel switching is a potential threat to the value chain of these LNG customers and therefore, LNG prices are likely to be indexed against alternative sources of electrical power. Open markets threaten the stability of supply and gas-to-gas competition can be a threat to long-term stable prices. However, the economies of scale that are achievable with high volume/long-term LNG supply are likely to be more competitive in the long run. To further secure these long-term stable offtake arrangements, it is common for these strategic LNG buyers ('anchor customers') to acquire share interest in the upstream elements of the LNG value chain (gas production, LNG liquefaction, and LNG transportation). This ensures a broader alignment between LNG producers and customers, improves transparency, and provides a hedge against potential shift in value transfer across the LNG value chain. Also, in case of future (lower cost) capacity expansion in LNG supply, it positions existing LNG buyers as potential preferred off-takers.

'Nimble and flexible LNG supply' may be representative for customers that use LNG as a backup source of energy against declining domestic supplies of natural gas or as a flexible source to even out imbalances in energy supply and demand. Market examples that target flexible LNG supply include seasonal energy fluctuations in demand (cooling in summer and/or heating in winter), seasonal energy fluctuations in supply (e.g. to bridge dry seasons of limited hydropower generation), and intermittency in renewable energy generation (solar, wind). The characteristics of such LNG buyers are more opportunistic, seeking flexibility in contract terms (source, volume, duration, price). The LNG demand profile is often starting with small volumes that are growing organically over time, as demand increases and local energy (natural gas) supplies deplete. LNG and gas infrastructure are most likely serving local demand with limited downstream access, until sufficient scale in volume demand is established that can support further downstream investment. Opportunities are often identified to diversify the use of LNG once the initial infrastructure has been established. For example, LNG as fuel and LNG bunkering opportunities can create additional market growth when LNG storage and jetty are available as part of the LNG regassification infrastructure. To promote such LNG market growth opportunities and link these to LNG supplies, it can be mutually beneficial for LNG suppliers to take minor interests in such downstream ventures. Sources of nimble and flexible LNG demand are not the most ideal in supporting final investment decision (FID) of a large LNG liquefaction opportunity, as these are typically not the type of anchor customers that can commit to purchasing large volumes of long duration LNG supply. However, flexible LNG demand customers can be instrumental in absorbing wedge volumes and/or LNG supply that is the result of spare capacity.

10 Conclusions

The most significant challenge facing our planet and that is key to driving the energy transition is climate change. Latest reports suggest we are heading for at least a 2ºC increase in global mean temperatures. This is well beyond the 1.5ºC now regarded by the Intergovernmental Panel on Climate Change as the threshold at which serious impact on climate conditions is likely. Energy demand is growing at its fastest rate since 2010. Carbon emissions from energy are growing by 2 per cent, the fastest expansion in many years.

After renewables, natural gas is forecast to be the fastest growing source of energy. Within this, LNG growth much exceeds growth rates for pipeline exported gas or locally consumed gas. Asia has long history with LNG both as a market and as a supply region. Although the LNG market has become globalized, each country has its own specific issues and opportunities, local context and perspectives. The underlying drivers for the energy transition are demographics, rising living standards, technology advancements, and climate change.

These drivers set the energy transition priorities. Some reflect **human development**: bringing energy to all people of the world through affordability for low income populations and access for the more than 1 billion people who currently have no access to electricity. Others address **international** commitments made by countries under the Paris Climate Agreement as well as **local citizen** anxieties of air pollution and that 2.8 billion people do not have access to clean cooking fuel. Lastly, priorities concern **national** energy security of supply; efficiency of operational processes through continuity of supply; and grid balancing.

A comparison has been made how each of the main fuel types (coal, oil, natural gas/LNG, and renewables) contribute differently to these eight energy transition priorities. The ranking of the energy priorities is strongly dependent on local context. China, India, and South East Asia (SEA) have been compared based on recorded evidence to what degree each of the energy transition priorities drives energy decision making. An analytical model has been developed that links a ranking of energy transition priorities to an alignment with the four fuel types. The model determines which fuel types are most aligned with a certain set of energy transition priorities. The predicted alignment with fuel types appear to match the energy investment decisions well for each of the three regions.

The relative ranking of China's energy transition priorities and how this ranking aligns with each of the four fuel types show a stronger alignment with gas (air quality) and energy diversity (away from coal). Yet it is also positive for coal (energy security). Turning to India, among the three regions, India energy priorities show a stronger alignment with coal (affordability) and renewables (affordability and energy access). Lastly for SEA, the strongest alignment is with coal and for oil, reflecting the energy transition priorities of affordability, continuity of supply, and energy security.

Understanding of regions and countries' fuel type priorities and the underlying energy priorities provides marketing insights to LNG suppliers. LNG marketing strategy should address LNG buyers' and sellers' key concerns that can be clustered into the following categories: price, flexibility, risk, and performance. Value-chain design optimization is critical for greenfield LNG ventures to demonstrate their ability to drive performance once operational. It is value chain transparency and best practice that helps to build trust from buyers, even in the absence of operational track record. Each of the elements in the value chain has 'value drivers'. These value drivers can become key differentiators in securing an LNG contract, if their importance in optimizing the value chain is understood and shared among parties.

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Abbreviations and units

ASEAN	Association of Southeast Asian Nations
Bcfd	Billion cubic feet per day (1 Bcfd NG = 7.6 mtpa of LNG)
bcm	Billion (= one thousand million) cubic meter
BRIC	refers to the countries of Brazil, Russia, India and China
cagr	Compound annual growth rate
capex	Capital Expenditure
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage (Sequestration)
CCUS	Carbon Capture, Use and Storage (Sequestration)
CNG	Compressed Natural Gas
DMO	Domestic Market Obligation
EAX	East Asia LNG price marker
ECA	Emission Control Area
EMA	Energy Market Authority (Singapore)
FAANG	FAANG is an acronym for the market's five most popular and largest tech stocks
FLNG	Floating LNG (liquefaction facility)
LNG	Liquefied Natural Gas
FID	Final Investment Decision
GT	Giga tonnes (1 GT = 10^{12} kg)
GW	Giga (one thousand million) Watt
H1	First half of the year
HFO	Heavy Fuel Oil
HH	Henry Hub - USA natural gas price marker
J	Joule - measure of the energy (1J = 1N × 1m)
JCC	Japan Crude Cocktail
Kg	Kilogram – SI unit of mass
LHS	Left Hand Side (of a graph)
m	Meter – SI unit of distance
MGO	Marine Gasoil
MJ	Mega (one million) Joule
MMBtu	Million British Thermal Unit - measure of the energy content in fuel (1 BTU = 1.06 J)
MT	Megatonne (Mt), a unit of mass equal to one billion kilograms (10^9 kg)
mtpa	Million tonne per annum
MW	Mega (one million) Watt
MWh	Megawatt hour - unit of measure of electric energy
N	Newton – SI unit of force (1N = 1Kg m/s^2)
NBP	National Balancing Point - UK natural gas price marker
NE	North East
NG	Natural Gas
NGO	Non-Governmental Organisation
OECD	Organization for Economic Cooperation and Development

opex	Operational Expenditure
Regas	Regassification (of LNG)
RHS	Right Hand Side (of a graph)
s	Second – SI unit of time
s-curve	Indexation based pricing formula with a smaller slope at bottom and top of the range
SDG	Sustainable Development Goal (as defined by United Nations)
SEA	South East Asia
SECA	Sulphur Emission Control Area
SIAC	Singapore International Arbitration Centre
SLing	SGX LNG Index Group – Singapore LNG price marker
SPA	Sales and Purchase Agreement
SW	South West
S$	Singapore dollar
TJ	Terra Joule (10^{12} J)
TTF	Title Transfer Facility - a virtual trading/price point for natural gas in the Netherlands
US$	United States Dollar
W	Watt – SI unit of power (1W = 1J/1s)
WHO	World Health Organisation
°C	Degree Celsius - unit of temperature
°F	Degree Fahrenheit – unit of temperature