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LNG Pricing and Market Opportunities in the Philippines

July 2021

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LNG PRICING AND MARKET OPPORTUNITIES IN THE PHILIPPINES

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Authors:	Uday Turaga, Founder & CEO, ADI Analytics Andreas D. Thanos, Policy Specialist, Gas Division, Massachusetts Department of Public Utilities Diane X. Burman, Commissioner, New York State Public Service Commission

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List of Abbreviations

ASEAN	Association of Southeast Asian Nations
bcm	Billion cubic meters
BMR	The Bangkok Metropolitan Region
Btu	British thermal units
Capex	Capital expenditure
CO	Carbon monoxide
CO_2	Carbon dioxide
CREA	Centre for Research on Energy and Clean Air
DES	Delivered ex-ship
EIA	United States Energy Information Administration
EPA	United States Environmental Protection Agency
FOB	Free on-board
FSRU	Floating storage and regasification unit
GHG	Greenhouse gas
GIIGNL	International Group of Liquefied Natural Gas Importers
GWh	Gigawatt-hour
g/KWh	Grams per kilowatt-hour
HC	Hydrocarbons
IEA	International Energy Agency
IGU	International Gas Union
KWh	Kilowatt-hour
LCOE	Levelized cost of electricity
LNG	Liquefied natural gas
mg/Nm^3	milligrams per cubic meter
MMBtu	Million British thermal units
MW	Megawatt
MWh	Megawatt-hour
NOx	Nitrous oxides
NYMEX	New York Mercantile Exchange
Opex	Operating expenditure
PEP	The Philippines energy plan
PHP	Philippine peso
PM	Particulate matter
SOx	Sulfur oxides
TWh	Terawatt-hour
U.S.	United States
USD	U.S. Dollars
µg/m^3	Micrograms per cubic meter

ACKNOWLEDGEMENT, DISCLAIMER, TERMS OF USE, AND INTENDED PURPOSE OF THE REPORT

This report systematically reviews the state of liquefied natural gas (LNG) pricing and energy market opportunities in the Philippines consistent with the cooperative goals of the U.S.-Asia Gas Partnership (AGP). The report is not intended to prescribe a specific approach on developing LNG infrastructure or contracting for LNG. Rather, this report should be viewed as a reference that describes relevant global, regional, and Philippines-specific data and considerations as the Philippines explores LNG as an option to meet the country's energy needs and environmental goals.

The authors of this report – Diane X. Burman, Andreas Thanos, and Uday Turaga, through a partnership with the U.S. Energy Association (USEA) and the National Association of Regulatory Utility Commissioners (NARUC) – hope that this report will serve as an important regulatory, market, and technical reference tool to assist stakeholders from the Philippines as they seek to make sound economic and environmental investment and policy decisions around LNG opportunities. Critical to this is understanding how the technical operations, pricing, market, and regulatory drivers can play a role in the effort to optimize the development of secure, reliable, and economic sources of energy.

Accordingly, the overview provided as it concerns LNG in the Philippines is neither laying out all the current country-specific standards nor detailing all specifications. This report should be viewed more accurately as a summary of observations within the LNG market and its impact in the Philippines. While this report may contain much useful information, it is not specifically intended to be a comprehensive assessment of LNG in the Philippines. For instance, although it presents the various pricing mechanisms for LNG, it does not recommend a specific price index.

As illustrated in the body of this report, decisions about generation resources can only be made once the particular needs of the geographic region (or market) have been reviewed and evaluated. Depending on the market, a pricing index that has a history of few fluctuations can provide the price stability that the market is looking for. Under different circumstances, a pricing index based on the spot market may be more desirable as it will provide real-time pricing.

Similarly, the report neither lists nor prescribes the wide variety of sales and purchase contracts. The terms of such agreements are mostly confidential and based on negotiations between sellers and buyers. However, the availability of a diverse number of suppliers provides buyers with negotiating options.

As the Philippine government and investors move forward with the development of LNG-based infrastructure, we strongly recommend that readers ensure they are in possession of the latest information, standards, and specifications for any opportunities or decision-making actions they intend to engage in. The authors, relying on a variety of public and proprietary data, have exercised their best efforts in preparing this report, but do not represent or warrant that it is free from errors or omissions.

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Disclaimer: Please note that Sections 1 and 3 of this document were prepared on behalf of NARUC by Andreas Thanos; Sections 2 and 4 were prepared by ADI Analytics LLC on behalf of the USEA. Citations for figures, exhibits, and statistics are attributed to the respective authors unless otherwise noted.

ABOUT THE AUTHORS

The **United States Energy Association (USEA)** is an association of public and private energy-related organizations, corporations, and government agencies. The USEA represents the broad interests of the U.S. energy sector by increasing the understanding of energy issues, both domestically and internationally. Major USEA initiatives are energy partnerships, energy events, and energy briefings. Over 80 energy partnerships established by the USEA provide a vehicle to convey U.S. experiences and best business and regulatory practices to the partner nations on petroleum exploration, production and transportation; natural gas exploration, production, and transportation; and electric power production, transmission, distribution, and utilization. The USEA hosts several major informational events that address important issues impacting various sectors of the U.S. energy industry. The USEA organizes informational briefings that are designed to inform their members and constituents on developments in energy technologies, policies, and market trends while providing networking opportunities for energy industry professionals to meet and collaborate on projects of mutual interest. For more information, please visit the Association's web site at www.usea.org.

The **National Association of Regulatory Utility Commissioners (NARUC)** is a non-profit organization founded in 1889 dedicated to representing the state public service commissions who regulate the utilities that provide essential services such as energy, telecommunications, power, water, and transportation. NARUC's members include all 50 U.S. states, the District of Columbia, Puerto Rico, and the Virgin Islands. Its mission is to serve in the public interest by improving the quality and effectiveness of public utility regulation. Under state law, NARUC's members have an obligation to ensure the establishment and maintenance of utility services as may be required by law and to ensure that such services are provided at rates and conditions that are fair, reasonable, and nondiscriminatory for all consumers. For more information, please visit the organization's web site at www.naruc.org.

ADI Analytics is a boutique consulting firm serving the oil and gas, energy, and chemical industries. In oil and gas, ADI Analytics brings deep expertise in global large- and small-scale LNG markets along with upstream and oilfield services, midstream and natural gas, and fuels and refining. Founded in 2009, ADI Analytics has completed 450+ projects for 150+ clients including Fortune 500 and mid-sized companies, start-ups, investors, and government agencies. The company's offerings include consulting services, subscription research, data analytics, and executive forums. ADI Analytics' consulting services include market research, competitive intelligence, economic analysis, strategic planning, and technology assessments. ADI Analytics conducts its work through the disciplined use of content, data, and analytics, reliance on field-based energy industry expertise, and a relentless focus on creating value for clients. For more information, please visit the company's web site at www.adi-analytics.com.

Author Biographies

Diane X Burman
Diane X. Burman serves as a Commissioner of the New York State Public Service Commission (Commission). Her term runs through February 2024. Ms. Burman is a member of NARUC, and serves on numerous committees. Ms. Burman is Chair of the NARUC Department of Energy Natural Gas Partnership Initiative. She was recently appointed by the NARUC President as Co-Vice Chair of the Select Committee on Regulatory and Industry Diversity and to the Taskforce on Emergency Preparedness, Recovery, and Resiliency as well as the Task Force's Special Subcommittee on Lessons Learned from COVID 19. Ms. Burman was awarded with NARUC's *Terry Barnich Award for Promoting International Cooperation among Utility Regulators and Development of Professional Regulation*, the highest honor bestowed by the NARUC Committee on International Relations. Ms. Burman also serves as the Vice Chair of the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) Gas Pipeline Advisory Committee. She obtained her B.A. from Molloy College, her J.D. from Fordham University School of Law, and was admitted to the bar in 1992.

Andreas D. Thanos
Andreas Thanos has been, in various capacities, with the Gas Division of the Massachusetts Department of Public Utilities since 1993. In addition to his regular gas division-related duties, he works on local and regional cybersecurity matters, and cooperates with utilities, counterparts, and commissioners at the state and regional level. At the national level, he is the Chair of the NARUC Staff Subcommittee on Gas. He was the key staff person on NARUC's LNG Working Group – a NARUC-U.S. DOE partnership established to educate commissions about LNG. He is a member of the Advisory Council to the North American Energy Standards Board. Mr. Thanos has participated in several international USAID-funded NARUC projects on topics varying from communications and cybersecurity to natural gas interstate and local transportation and planning. He was awarded with NARUC's *Terry Barnich Award for Promoting International Cooperation among Utility Regulators and Development of Professional Regulation*, the highest honor bestowed by the NARUC Committee on International Relations. Finally, in his spare time, he produces a monthly summary of LNG news. Mr. Thanos has previously served on the Board of the Boston Fuel Consortium (currently Green Energy Consumers Alliance) and was an adjunct professor at the University of MA/Boston. He holds an MBA from the University of Massachusetts in Boston, and a Master's in Energy Economics from Boston University.

Uday Turaga
Uday Turaga is Founder & CEO of ADI Analytics. Through 20 years of industry experience gained at ExxonMobil, ConocoPhillips, Booz, and ADI, Turaga brings deep commercial and technical expertise in oil and gas, coal, renewables, and chemicals. He specializes in corporate strategy, market research, economic analysis, competitive intelligence, and technology assessments with rich domain expertise spanning oil and gas exploration, production, and refining, coal and power, and chemicals. Turaga holds a PhD in fuel science from Penn State and an MBA from the University of Texas at Austin. In addition to authoring over 100 papers and patents, he has been recognized by the U.S. National Academy of Engineering, the American Chemical Society, and the Penn State Alumni Association. Finally, Turaga has been featured in various news and media outlets including Wall Street Journal, National Public Radio, and Bloomberg, and is a frequent speaker on energy issues at conferences and events globally.

ABOUT THE U.S. – ASIA GAS PARTNERSHIP (AGP)

This paper was funded by the U.S. Agency for International Development (USAID) as part of the AGP. The AGP began in 2019 as a coordinated public-private partnership effort between USAID, the USEA, and NARUC to optimize the development of secure, reliable, and economic natural gas sectors across the Indo-Pacific. AGP focus countries include Bangladesh, Indonesia, the Philippines, Sri Lanka, Thailand, and Vietnam, as well as Papua New Guinea.

One of the fastest growing economic regions in the world, the Indo-Pacific accounts for more than half of global energy consumption, which consists of 84% fossil fuels.[1] At the same time, increasingly competitive renewables are reshaping the global gas industry as countries in the Indo-Pacific look to LNG imports and highly efficient, natural gas-fired generation as a means of balancing grid variability.

The AGP convenes a diverse set of stakeholders to optimize gas network infrastructure planning through USAID, in collaboration with the USEA and NARUC, to develop domestic gas markets in Asia. The AGP supports strategic planning to promote the development of resilient and least-cost power systems that will continue to meet demand over time.

The objective of the AGP is to share best practices in the development of secure, reliable, and economic sources of natural gas, enhance downstream natural gas markets, and help create stable and predictable regulatory and business environments that attract increased international investment and other economic engagement in the sector to help meet respective national energy policy goals.

[1] "Fossil Fuels Still Supply 84 Percent of World Energy." Forbes. https://www.forbes.com/sites/rrapier/2020/06/20/bp-review-new-highs-in-global-energy-consumption-and-carbon-emissions-in-2019/?sh=22738981166a1

FOREWORD BY COMMISSIONER DIANE X. BURMAN

This report is a product of AGP, sponsored by USAID and implemented by the USEA and NARUC. AGP reflects initiatives that span several decades. In 2009, NARUC published *Global Liquefied Natural Gas Supply: An Introduction for Public Utility Commissioners*, which explored the supply dimensions of LNG: where it comes from, what it costs, and the factors that make it an important resource for state commissions to consider. During that period, LNG discussions focused on imports to the U.S.

However, by February 2016, the U.S. became an exporter of LNG. In addition, new gas production and liquefaction technologies provided new opportunities for LNG use. Thus, in 2018 NARUC published a new LNG handbook for regulators in response to the changing U.S. role regarding liquefied natural gas. *LNG: A Local Market – A Global Market, An Introductory Handbook for State Public Utility Commissioners* is a tool for regulators and others to understand the basics behind today's LNG market and facilitate a thoughtful discourse among producers, regulators, and consumers.

With the support of USAID, in 2017 the USEA published *Understanding Natural Gas & LNG Options* as a guide for policymakers and companies to help develop sub-Saharan natural gas resources, expand critical infrastructure necessary to increase access to electricity, and drive industrial activity and economic growth.

USAID, the USEA, and NARUC have consistently been engaged in examining the evolving LNG market and seeking to convey information to interested stakeholders for their critical evaluation on the LNG options both within the U.S. and globally. In fact, NARUC and the USEA are participatory members of the U.S.-India Gas Task Force (GTF), convened under the U.S.-India Strategic Energy Partnership. The goal of the Task Force is to facilitate the continued energy collaboration between our countries to promote the development of India's natural gas sector.

LNG is an important element for driving regulatory change in the energy markets. A diverse group of experts authored this report in the hope that we can facilitate a shared understanding about the technical, environmental, and economic benefits that may spur development in the Philippines and Asia Pacific LNG sectors.

This report is intended to inform decision-makers of the options available for the Philippines. It does not promote a specific business or regulatory model, but it is intended to assist stakeholders in gaining a better understanding of why LNG is a superior option to the "business as usual" model.

LNG continues to play a significant and important role not only in the U.S. market, but also globally. LNG is viewed by many market participants as a viable asset to help expand the use of natural gas and support environmental policies striving to reduce the volume of CO_2 and other pollutants that are emitted in the atmosphere by human activity.

In an over 50-year-history of being traded, LNG has fostered alliances and become a vital source of revenue to producing regions. LNG has helped consumers in many regions reduce their carbon footprint and enjoy an energy source not bound by agreements entered into by a handful of producers.

Technological advances have propelled LNG from a fuel used under extreme conditions, such as a cold spell, to a fuel that can be produced, transported, stored, and delivered safely to consumers for a broad range of applications, from vehicular fuel to power generation. The LNG market is a global market. We are starting to see LNG used more routinely around the world. Therefore, we must critically assess issues around the economics, the environment,

energy security, power generation and cleaner fuels. This market is developing as countries are moving from coal and oil to a cleaner fuel mix for heating and power generation.

LNG markets, regulations, and the implementation of new technology will continue to evolve, and with that evolution comes new opportunities, challenges, more food for thought, and likely more engagement with the U.S., the Philippines, and the Asia Pacific Region on what this future may look like. It is my hope that interested stakeholders will find this report both educational and useful.

A special thanks to USAID, the USEA, and NARUC for their collaborative efforts to undertake this report.

Sincerely yours in dedicated public service,

Diane X. Burman

1. POLICY, GEOPOLITICAL, AND ENERGY SECURITY DRIVERS FOR LNG

Throughout the past 50 years, the world has seen an evolution among prevalent fuel sources used for power generation. Given the recent widespread use of natural gas drilling technologies, many countries in the world are producing a surplus of natural gas, which is now globally imported and exported in the form of LNG used for power generation and industrial activities. In terms of energy consumption, the role of LNG in meeting energy demand was initially limited to a few regions, both in terms of exporting as well as importing. LNG exports began in 1964, with the first LNG export from Algeria. Since then, LNG trade has flourished.

Currently, according to the International Gas Union's 2021 World LNG (IGU Report),[2] the four top LNG exporters in terms of volume are Qatar, Australia, the U.S., and Russia. The IGU Report also names the Asia-Pacific region as the largest importing region[3] and lists the Philippines as one of the new LNG importers that is expected to significantly contribute to the new regasification capacity growth.[4]

One of the key positive attributes of using natural gas for power generation is its ability to significantly reduce emissions by replacing other available generation fuels, such as coal and oil. This alone has had a major impact on global interest in LNG, as policy shifts prioritizing emissions reductions have become more widespread. Data from the United States Energy Information Administration (EIA) demonstrates that natural gas provides significant benefits in terms of CO_2 emissions.[5] CO_2 emissions from natural gas exhibit levels at 44% less than those emitted by coal, and 33% lower than those emitted by heavy fuel oil.

Additionally, according to the EIA, only 60% of the methane emitted in the atmosphere results from human activity. Further, the EIA notes that the largest source of anthropogenic methane emissions is agriculture, which is responsible for one-quarter of the total, followed closely by the energy sector, which includes emissions from coal, oil, natural gas, and biofuel combustion. According to the United States Environmental Protection Agency (EPA), methane emissions in the United States exhibited an overall decrease of 18.1% between 1990 and 2018.[6]

During the same period, methane emissions from the energy sector decreased by 29.7%, while consumption of natural gas increased by 58%. Technological advancements in production, storage, and transportation of natural gas, combined with the economic benefits associated with preventing leaks and capturing methane, have served as the primary drivers behind the dramatic reduction of methane emissions. Finally, in addition to the significantly lower CO_2 emissions associated with natural gas combustion, other emissions (e.g. nitrous oxides) from natural gas combustion are 1/6th of those emitted for oil and 1/15th of those emitted from coal.

Figure 1: Emissions factors for stationary combustion in kilograms of CO_2 per MMbtu[7]

Fuel	CO_2
Coal (Generation)	95.52
Natural Gas	53.06
Heavy Fuel (#5,6, bunker)	78.80

[2] "World LNG Report 2021." International Gas Union. https://www.igu.org/resources/world-lng-report-2021/
[3] Ibid.
[4] Ibid.
[5] "Carbon Dioxide Emissions Coefficients." The U.S. Energy Information Administration. https://www.eia.gov/environment/emissions/co2_vol_mass.php
[6] "Overview of Greenhouse Gases." United States Environmental Protection Agency. https://www.epa.gov/ghgemissions/overview-greenhouse-gases#methane
[7] Data provided by Andreas Thanos, 2021.

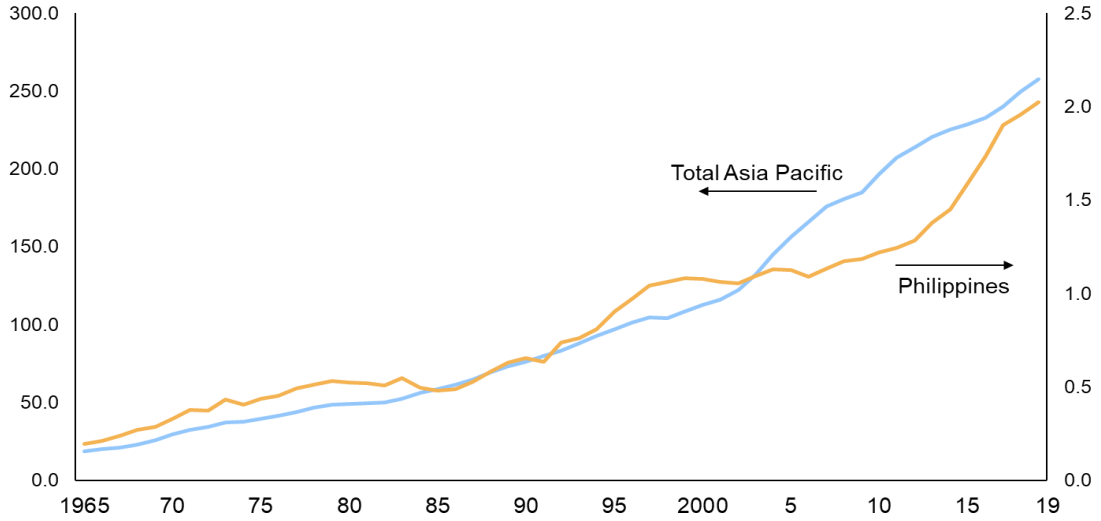
Natural gas is a readily available generation fuel through which countries in the Asia Pacific Region such as the Philippines can viably address both regional and global climate concerns as well as successfully meet national and regional decarbonization goals. In addition to being a low-carbon fuel source, natural gas can provide base load generation as well as ramping capabilities that enable increased penetration of variable renewable resources to enter the grid.

Regional and Philippine Demand

Philippine Energy Mix

Energy demand in the Philippines, and the Asia Pacific region in general, has been consistently increasing. Starting in 2006, the Philippines experienced a high increase in energy consumption. Between 2006 and 2019, energy consumption in the Philippines increased by 85% – exceeding the region's average rate of 55%. In 2019, the Philippines' energy consumption comprised less than 1% of total energy consumption for the region.[8]

Figure 2: Energy consumption in Asia Pacific and the Philippines in exajoules[9]



There are certain notable differences with regard to the Philippines' energy mix when compared with other countries throughout the rest of the Asia Pacific. For example, the Philippines had a higher percentage of renewables and a lower percentage of coal represented in its energy mix. Between 1994 and 2005, natural gas consumption in the Philippines was less than 0.05 billion Cubic Meters (bcm). With the Malampaya field, which became online and operational in 2001, natural gas consumption increased. By 2003, natural gas consumption in the Philippines reached 2.6 bcm. Data for 2018 and 2019 indicate that natural gas consumption plateaued at 4.1 bcm.[10]

Coal's share in the Philippines' energy mix has been increasing rapidly since 1995, and so have CO_2 emissions. According to 2020 generation data from the Philippines Department of Energy,

[8] "Region" and "Asia Pacific" are used interchangeably in this report. They comprise the following countries: Australia, Bangladesh, China, China Hong Kong SAR, India, Indonesia, Japan, Malaysia, New Zealand, Pakistan, Philippines, Singapore, South Korea, Sri Lanka, Taiwan, and Thailand.
[9] BP Statistical Review, 2020
[10] Ibid.

57.2% of total generation was comprised of coal-fired generation, while oil comprised 2.4%, natural gas 19.2%, and renewable resources 21.2%.[11]

Figure 3: Primary energy consumption by fuel as percentage of total energy consumption in the Philippines and Asia Pacific[12]

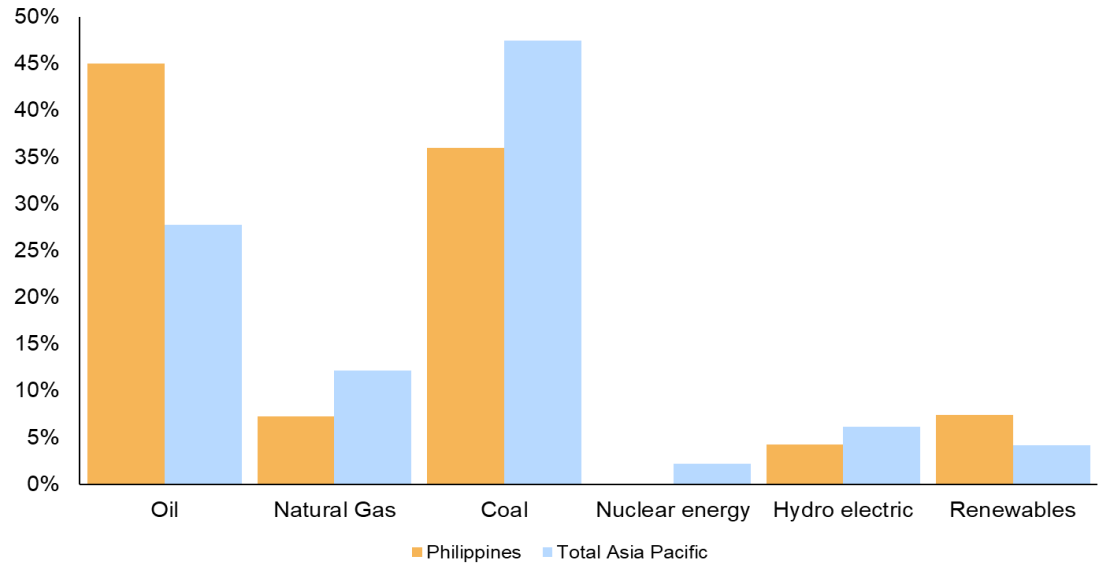
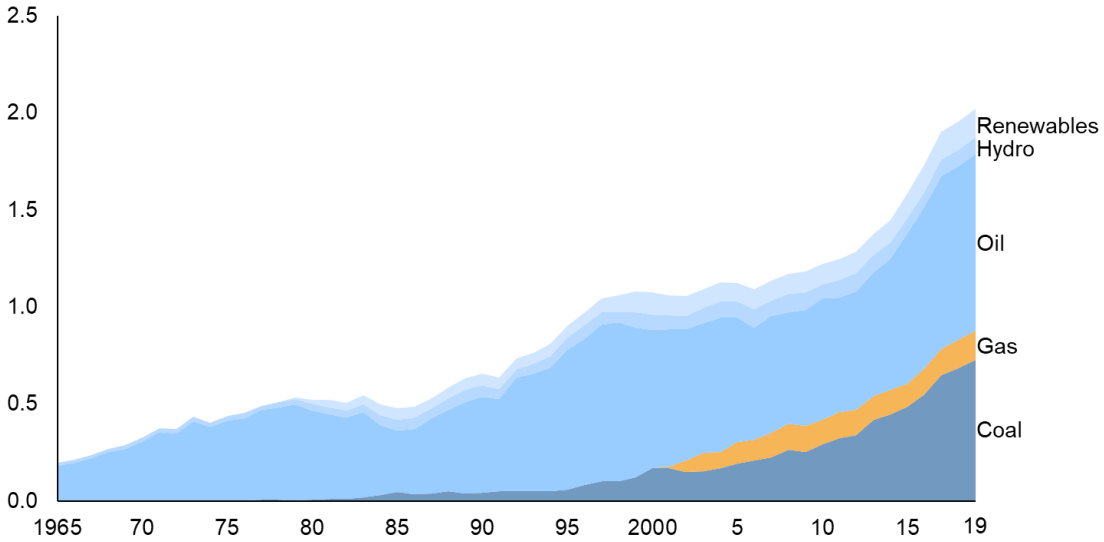


Figure 4: Energy in the Philippines in Exajoules[13]



Philippine Generation Mix: Challenges and Opportunities

According to data from the Philippines' Department of Energy, the share of coal in baseload power generation has been increasing steadily since 2009. Seventy percent of coal-fired generation is associated with the Luzon grid, while the Visayas and Mindanao grids share the remaining 30% of coal generation. In 2020, the power generation fuel mix was comprised of

[11] "Philippine Power Statistics." Philippines Department of Energy. https://www.doe.gov.ph/energy-statistics/philippine-power-statistics
[12] "World LNG Report 2021." International Gas Union.
[13] Ibid.

57% coal, 2% oil, 19% gas, and 21% renewable energy.[14] The change over the past decade that saw the share of coal-based generation increase significantly is depicted in Figure 5 below.

Figure 5: Power generation in the Philippines by plant type in gigawatt hours[15]

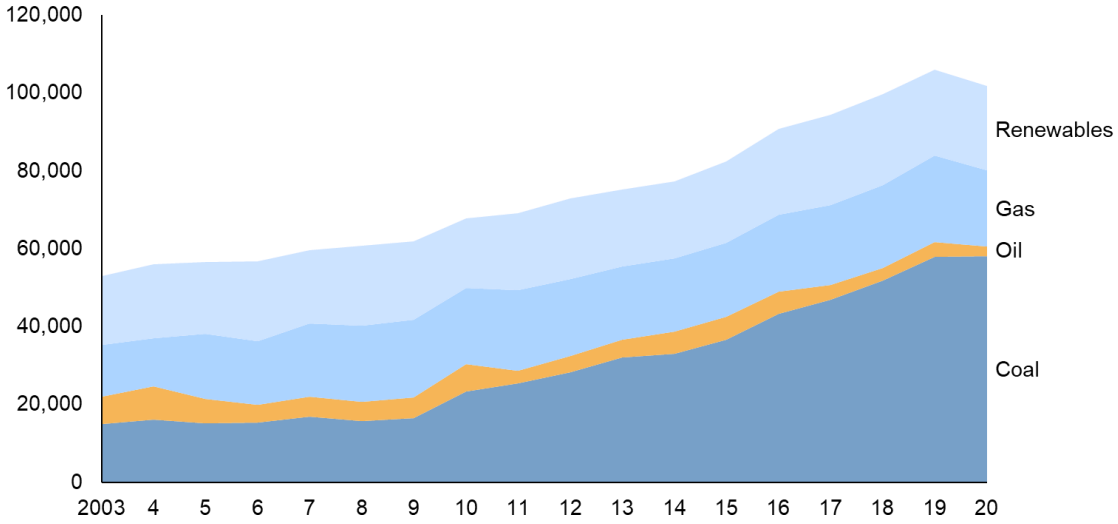
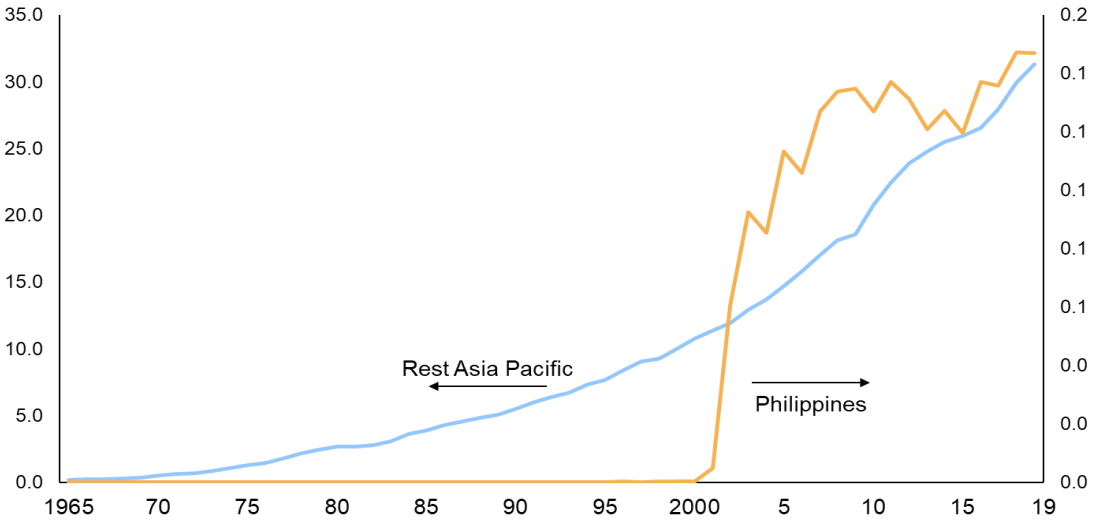


Figure 6: Natural gas consumption in the Philippines and the rest of the Asia Pacific in exajoules[16]

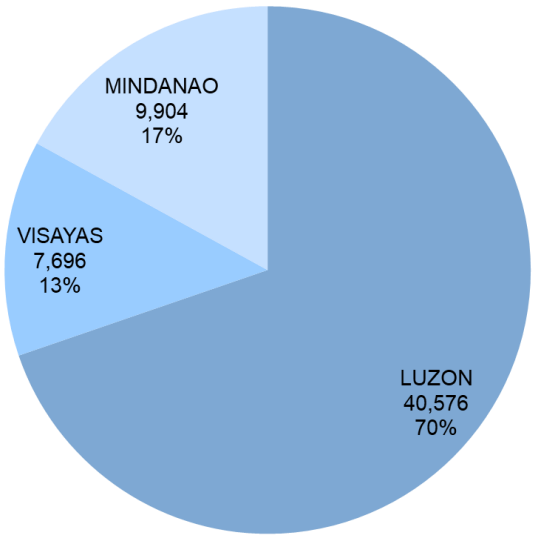


The CO_2 emissions that are associated with continued or increased coal consumption will hinder the Philippines' efforts to combat high levels of harmful air pollution and address local, regional, and global climate change concerns. Given economic, climate change, technological, and health-related objectives set forth by the Government of the Philippines, transitioning away from coal as a fuel source for power generation is more important than ever.

As previously noted, 70% percent of the coal-fired generation is associated with the Luzon grid, while the Visayas and Mindanao grids share the remaining 30% of coal generation.

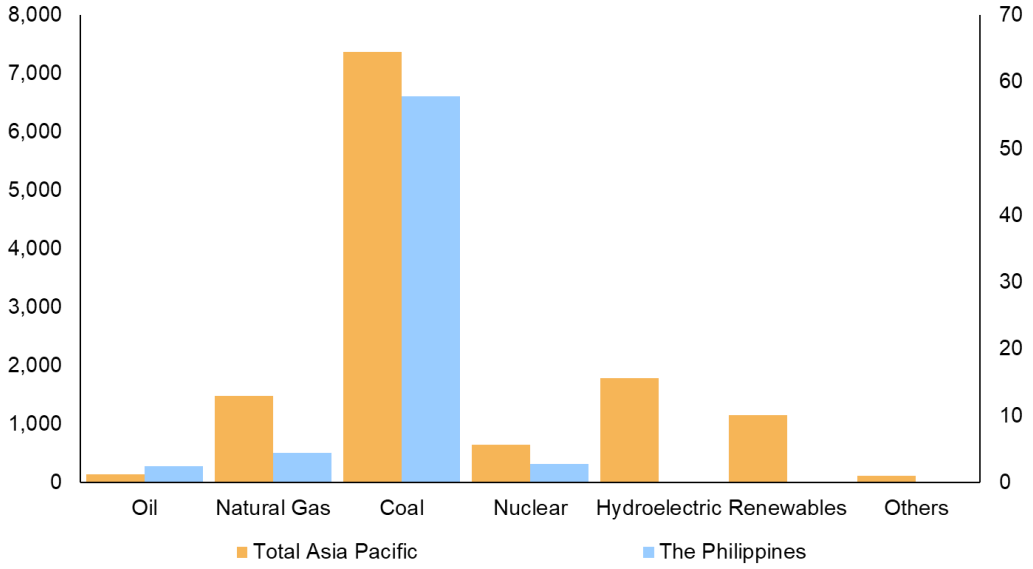
[14] Philippines Department of Energy. https://www.doe.gov.ph
[15] Data provided by Andreas Thanos, 2021.
[16] "World LNG Report 2021." International Gas Union.

Figure 7: Coal-fired power generation by grid-type in the Philippines in 2020 in gigawatt hours[17]



Despite the significant role of coal in the country's power generation mix, the Philippines has a relatively high national usage rate of renewables and natural gas.

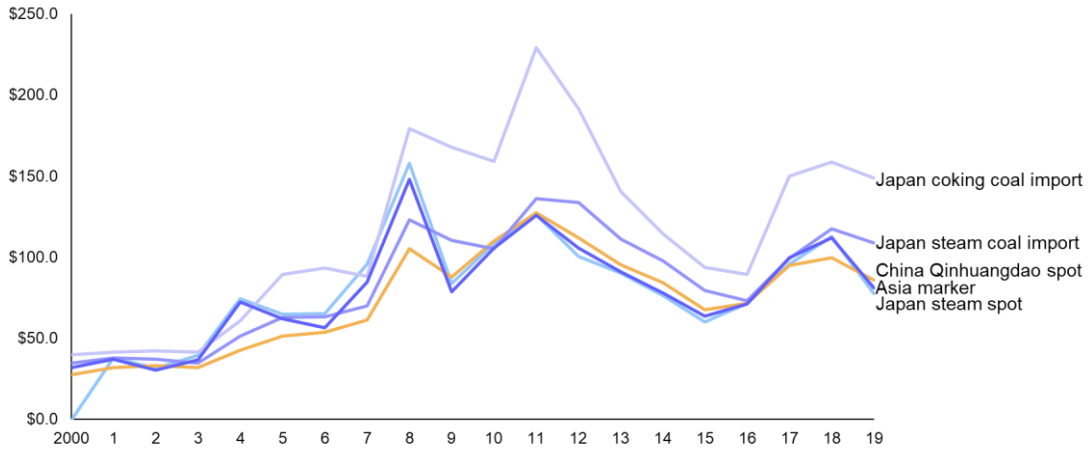
Figure 8: Power generation mix in Asia Pacific (left axis) and the Philippines (right axis) in 2019 in terawatt hours[18][19]



Historically, coal has been used as a reliable fuel for power generation across the world. Coal advocates and producers have asserted that the price of coal has been fairly stable as it is rarely subjected to market manipulations by coal producers. However, regional data shows that coal prices have been on a roller coaster in the past 20 years, as illustrated in Figure 9 below.

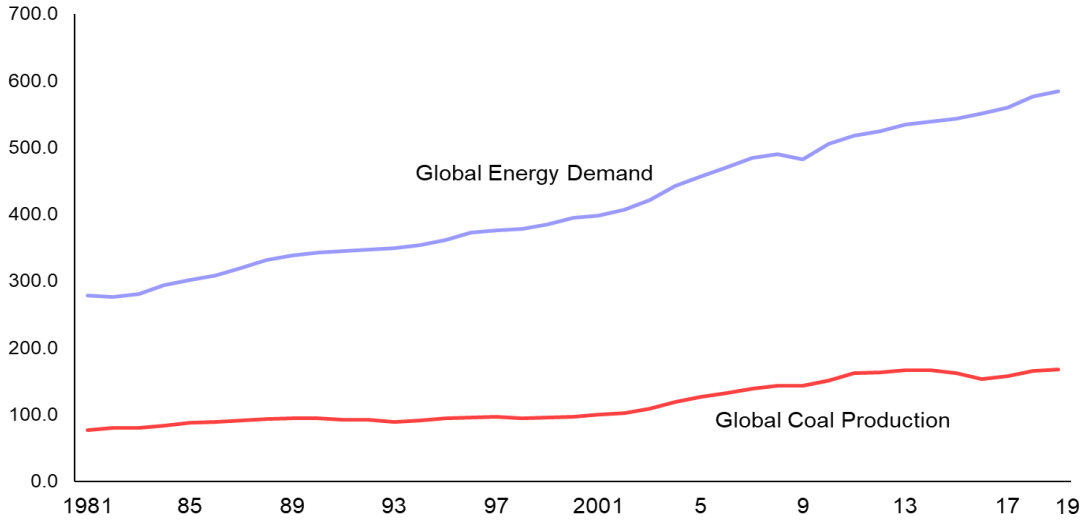
[17] "Overview of Greenhouse Gases."
[18] "World LNG Report 2021." International Gas Union.
[19] "Overview of Greenhouse Gases."

Figure 9: Regional coal prices in U.S. dollars per ton[20]



Globally, coal production peaked in 2013, although production in 2019 hit levels close to the production record set in 2013. However, considering the increase in global energy demand, coal production appears to have plateaued throughout the past decade.

Figure 10: Global energy demand and coal production in exajoules per year[21]



Several factors are currently affecting the amount of coal that is produced globally. Operational efficiency is a key factor, as newer technologies now require less fuel. Governments worldwide also are making strategic decisions to decarbonize their power sectors and transition away from coal generation in the short- and long-term.

Additionally, it is expected that local, regional, and global opposition to coal consumption will present a significant obstacle in the continuing growth of coal consumption in the context of efforts to mitigate climate change.

As aging generating facilities reach the end of their useful lives, governments and investors are seeking to make sound investment decisions (many in advanced technologies for power generation) that will provide positive impacts on energy consumption and the environment for several decades. As noted in the beginning of this section, natural gas offers several

[20] Data provided by Andreas Thanos, 2021.
[21] "World LNG Report 2021." International Gas Union.

environmentally-related advantages when compared to other conventional fuels – namely oil and coal. The Philippines Environmental Management Bureau produced an important report on both the efficiencies of the three types of power plants as well as the CO_2 emissions factors of coal, diesel, and natural gas.[22]

Item	Values	Reference
Best heat efficiency of natural gas power plant	60% (combined cycle)	Department of Energy
Best heat efficiency of coal power plant	39% (Circulating Fluidized Bed)	Department of Energy
Best heat efficiency of diesel power plant	49%	JCM Approved Methodologies: PW_AM001, MN_AM003, etc.
CO2 emission factor of other bituminous coal	89,500 kgCO2/TJ	IPCC guideline for National Greenhouse Gas Inventories 2006, Chapter 2, stationary combustion
CO2 emission factor of natural gas	54,300 kgCO2/TJ	
CO2 emission factor of diesel	72,600 kgCO2/TJ	

According to the table above, the efficiency of gas-fired generation, combined with the lower CO_2 emissions of gas generation, render natural gas the fuel of choice for generation, accompanying the many renewable energy opportunities that the Philippines plans to integrate as referenced in the Philippine Energy Plan 2018-2040.

Global LNG Import Market: General Overview

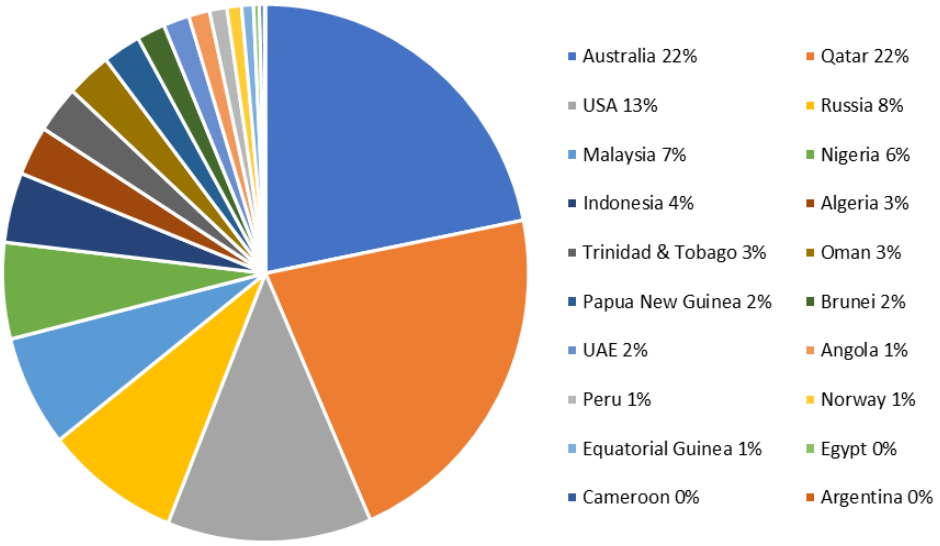
LNG trade has increased by almost 350% over the past 20 years. According to the IGU, in 2020 Qatar and Australia were the top two global LNG producers with approximately 44% of the market, followed by the U.S. (13%)[23] and Russia (8%),[24] as referenced in the chart below.

[22] "Additional information on calculating the emission factors of the Philippines for the JCM." Department of Environment and Natural Resources, the Philippines. https://emb.gov.ph/wp-content/uploads/2019/11/3.-Add-information-for-solar-PV-systems_Philippines_final.pdf

[23] According to GIIGNL, 38% of U.S. volumes in 2019 were delivered to Europe, 37% to Asia, and 21% to the Americas

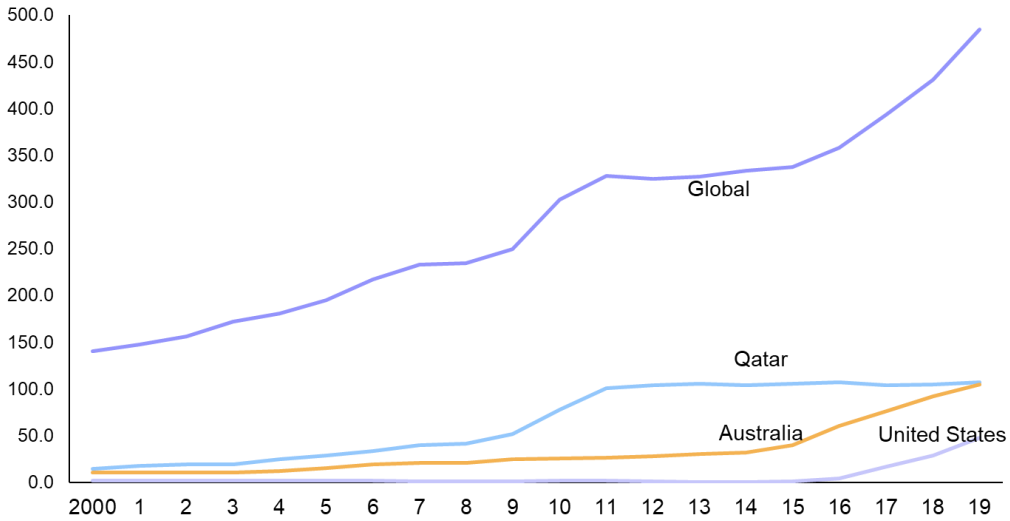
[24] According to GIIGNL, 51% of Russian volumes in 2019 were delivered to Europe, 46% to Asia, and 2% to the Middle East

Figure 11: Global LNG production in 2020 by country in percentage[25]



Some LNG producers, such as Algeria, Egypt, Indonesia, and more recently Trinidad and Tobago, have experienced a significant decrease in production. However, these limited decreases have been more than offset by increases in production exhibited by Australia, Qatar, Russia, and the U.S.

Figure 12: Global LNG exports and exports from Qatar, Australia, and U.S. in million tons per year[26]



More natural gas reserves are being discovered globally and countries like the U.S. and Qatar are slated to increase LNG production. With more approved facilities in the U.S. coming online in the near future as well as Qatar's expansion of the North Field, the long-term availability of LNG remains certain.

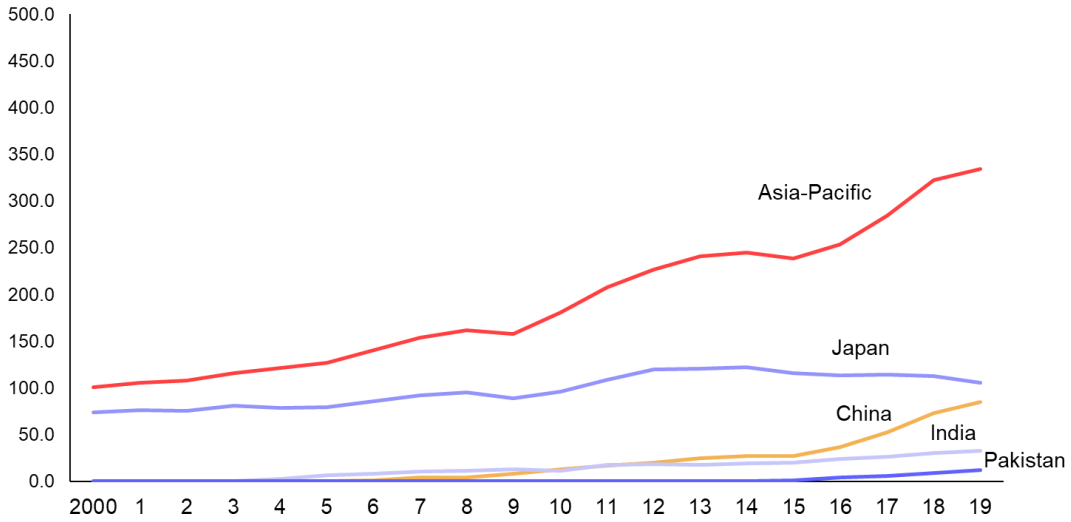
Recognizing the value of LNG in their energy mix, countries in the Asia Pacific have prudently increased their LNG imports from 140.5 billion cubic meters in 2000 to 485 billion cubic

[25] "World LNG Report 2021." International Gas Union.
[26] Ibid.

meters in 2019. For example, between 2010 and 2012, Japan increased LNG imports by 24%,[27] in part fueled by the Fukushima Daiichi nuclear accident in 2011. Following this increase, for the period from 2012 through 2019, LNG imports to Japan decreased by 12%.

Beginning in 2016, the increase in LNG imports to Asia was led by China, India, and Pakistan. Other Asian countries also increased LNG imports, and Bangladesh began importing LNG in early 2018. (See Annex 1: LNG Imports in the Asia Pacific, 2000-2019).

Figure 13: LNG imports in Asia Pacific and select countries in Asia Pacific in billion cubic meters[28]



[27] Dr. Umbach, Frank. "Japan's LNG Dilemma and Energy Supply Challenges." Geopolitical Intelligence Services. https://www.gisreportsonline.com/japans-lng-dilemma-and-energy-supply-challenges,energy,538.html
[28] "World LNG Report 2021." International Gas Union.

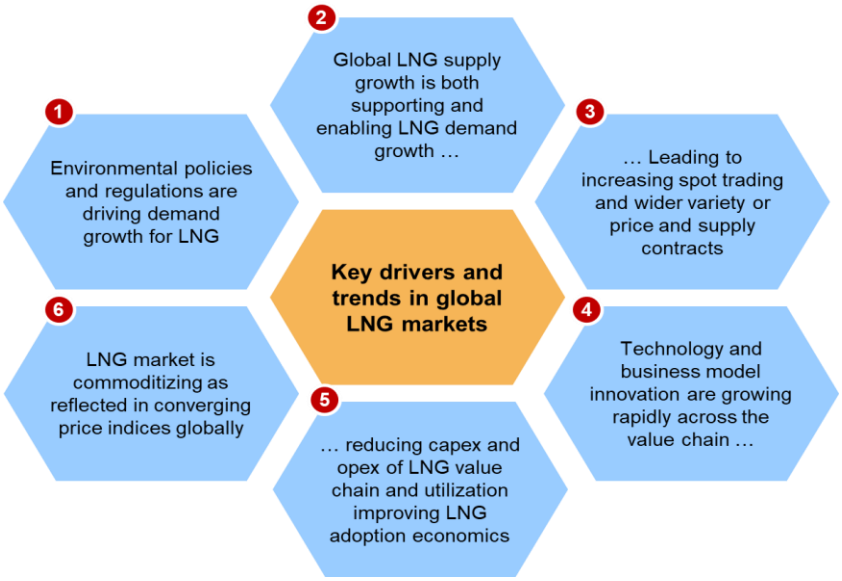
2. GLOBAL LNG MARKET DRIVERS AND TRENDS

LNG has emerged as an exciting fuel with surging demand exhibited over the past two decades. It is being used as a fuel for power generation, road and marine transportation, and industrial applications. Further, LNG is the safest and most efficient way to transport natural gas over long distances where building pipelines is impractical.

The global LNG market is expanding, supported by a number of key driving factors summarized in Figure 14. These global market drivers include demand growth, capacity additions, regulatory support, increased spot trading, a wider variety of price and supply contracts, and cost and business model innovation.

These factors contribute to the growing commoditization and expansion of LNG markets, reflected in converging price indices globally. Collectively, these drivers and trends will help new adopters of LNG enjoy access to cost-competitive and flexible supply as well as achieve highly beneficial environmental and economic outcomes.

Figure 14: Key drivers and trends in global LNG markets



A key growth driver behind LNG demand has been environmental policy and regulatory pressure driven by decarbonization and air quality improvement goals, as illustrated in Figure 15. The Paris Agreement, signed in 2016, aims to restrict global greenhouse gas (GHG) emissions and slow the global temperature rise to 2°C above pre-industrial levels.[29]

Many countries, including the Philippines, have committed to the agreement, subsequently pushing the use of cleaner sources of energy such as natural gas in these countries. Several other countries have announced pledges and commitments to become carbon neutral over the next 30 years – providing a new impetus to displace coal with natural gas.

Another key driver impelling LNG demand growth is air quality. Air quality goals have been announced, limiting pollutants such as carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NOx) and sulfur (SOx), and particulate matter (PM) in major cities around the world, including Asia. As described in Figure 15, the Philippines has announced limits to these pollutants, as have Singapore and key cities in Thailand.

[29] "The Paris Agreement." The United Nations. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

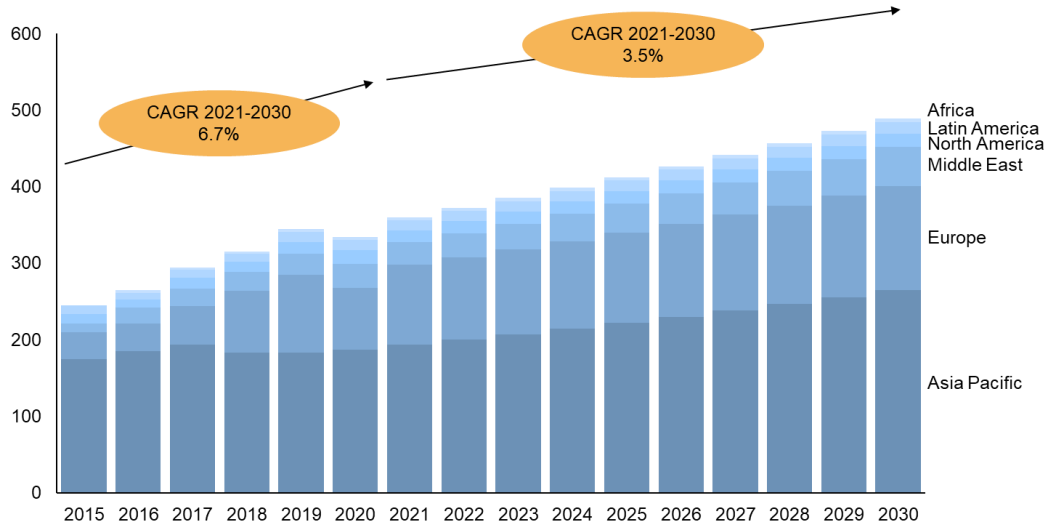
Figure 15: Examples of decarbonization and air quality drivers for LNG demand growth

1 Decarbonization goals	2 Air quality goals
▪ The Paris Agreement aims to restrict global GHG emissions and slow global temperature rise 2°C above pre-industrial levels ▪ The Philippines has signed the Paris agreement and pledged to reduce its emissions to 70% below business-as-usual case by 2030 ▪ China has pledged to become carbon neutral by 2060 ▪ Denmark and South Korea have pledged to reach carbon neutrality by 2050	▪ The Philippines limits CO, HC, NOx, and PM emissions from heavy-duty vehicles to 2.45, 0.73, 6.90, and 0.14 g/kWh respectively ▪ Singapore plans to switch power stations and industries to cleaner fuel such as gas to reduce SOx and particulate matter (PM) emissions ▪ Bangkok Metropolitan Region (BMR) targets to reduce $PM_{2.5}$ pollutants in the air from 50 to 35 $\mu g/m^3$ in the next 3 – 5 years and to 25 $\mu g/m^3$ in next 10 – 20 years

Given these drivers, LNG demand has grown at a robust pace as illustrated in Figure 16. Global LNG demand has increased at 6.4% annually in the past five years, growing from 245 million tons per year in 2015 to 334 million tons per year in 2020.

We expect the demand to further grow annually by 3.5% per year to 489 million tons per year in 2030. The growth is expected to be dominated by Asia Pacific followed by Europe and the Middle East. In comparison, North America, Latin America, and Africa are small contributors to LNG growth either due to abundant local natural gas supply or slower economic growth expectations over the next decade.

Figure 16: Global LNG demand growth in million tons per year[30]

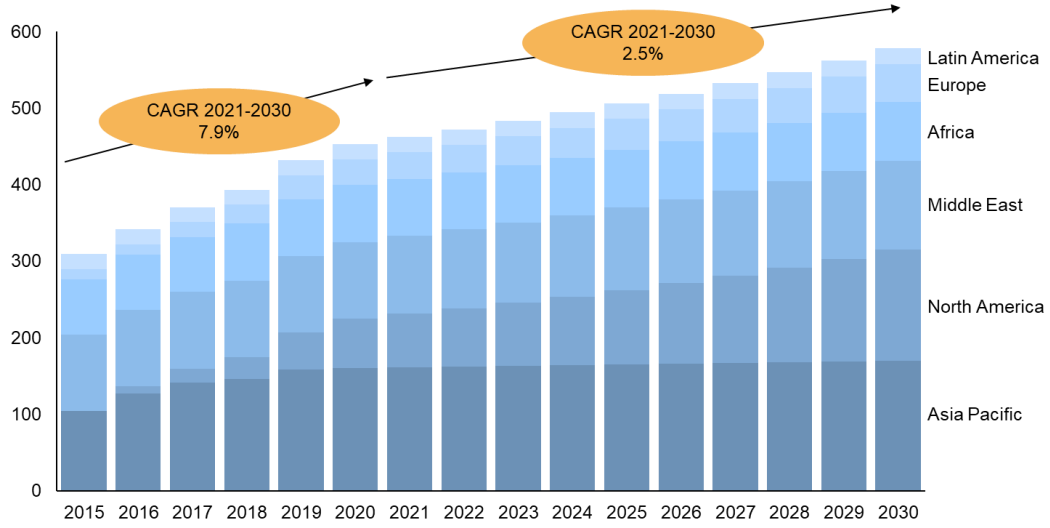


LNG demand growth is expected to accelerate driven by broader market drivers around decarbonization policy and air quality regulations, as well as major natural gas discoveries such as shale gas reserves in North America that have led to a significant expansion of LNG capacity.

Figure 17 shows global LNG liquefaction capacity grew annually by 7.9% over the past five years from 309 million tons per year in 2015 to 453 million tons per year in 2020. It is anticipated to grow annually by 2.5% through 2030 to reach 578 million tons per year in 2030. Expanding LNG capacity coupled with advancing technology and business model innovation has enabled attractive LNG pricing and additional demand growth in recent years.

[30] "World LNG Report 2021." International Gas Union.

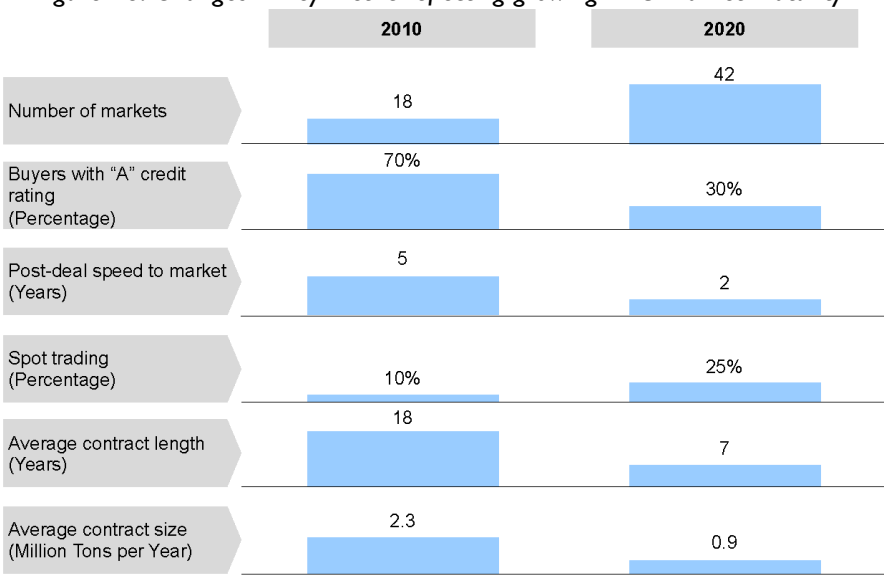
Figure 17: Global LNG liquefaction capacity growth in million tons per year[31]



The LNG market is maturing rapidly. Figure 18 shows that LNG markets in the past ten years have matured across a number of metrics. For example, the number of countries using LNG has increased significantly and capacity expansions have enabled suppliers to engage in contracts with a wider range of buyers instead of limiting themselves to the counterparties with the best creditworthiness.

The post-deal speed to market, that is, time between signing an LNG supply contract and the first LNG being delivered, has lowered from five to two years in the past ten years. Volumes traded on the spot market have grown from 10% of the total volumes traded in 2010 to 25% in 2020. Moreover, the average contract length and size have dropped from 18 years and 2.3 million tons per year, respectively, in 2010 to 7 years and 0.9 million tons per year, respectively, in 2020.

Figure 18: Changes in key metric reflecting growing LNG market maturity



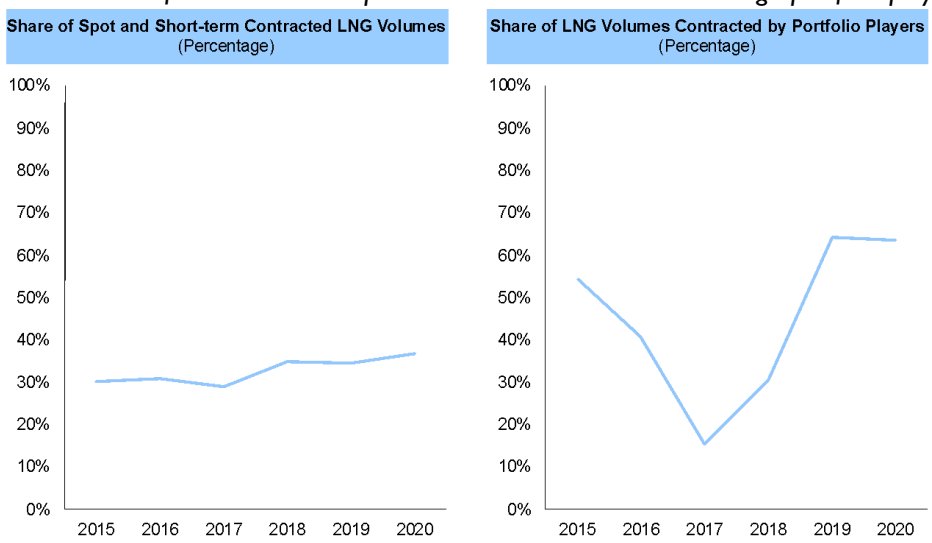
Further, a greater volume of LNG is now traded in spot markets, and typical contractual terms such as length and volume are now smaller than they once were in the past. As illustrated in

[31] Ibid.

Figure 19, the share of LNG volumes contracted on spot contracts and short-term contracts (left) has grown as has the share of LNG volumes contracted by portfolio players (right). The increasing share of portfolio players in the recent past has enabled LNG penetration in smaller applications and lowered the risk for importers.

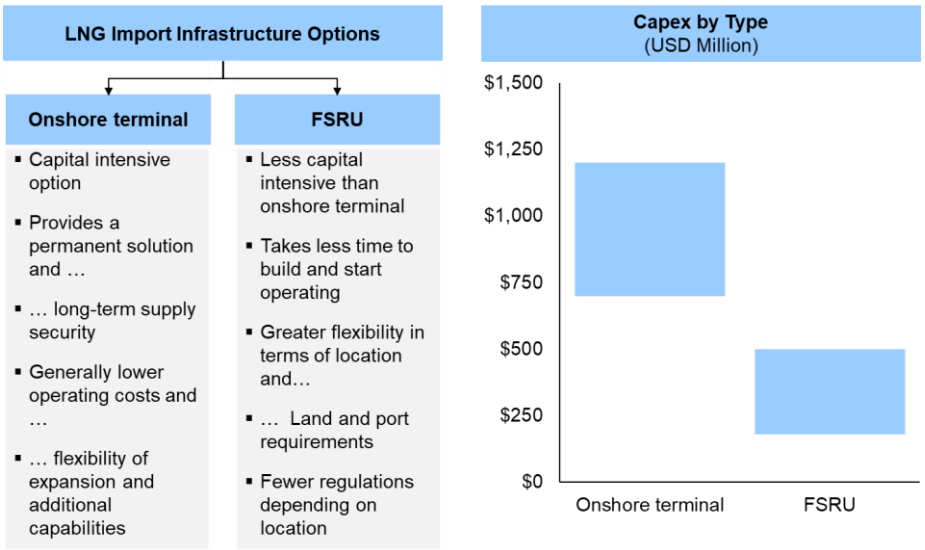
The progress seen across each of these metrics in the LNG market reflects its growing maturity and similarity to the paths charted globally by other commodities including oil and natural gas. As the LNG market deepens and attracts a broader range of players, contracting patterns and models, a wider range of consumers and end-users will find it easy to adopt and use LNG. In addition, the risks associated with making investments to switch away from competing fuels in favor of LNG will fall and accelerate further demand growth.

Figure 19: Share of LNG traded on spot and short-term bases and through portfolio players



Besides market maturity, LNG has also benefited from innovation across the value chain. Figure 20 describes LNG import infrastructure options that were historically limited to onshore regasification terminals. Innovation in recent years has allowed new importers to regasify using more flexible floating storage and regasification units (FSRU).

Figure 20: LNG import infrastructure options and their capital expenditure in million U.S. dollars



Although onshore terminals offer permanent and expandable solutions, they are capital-intensive. An FSRU is less time- and capital-intensive and provides greater operational flexibility as shown in Figure 20.

The operational flexibility of a FSRU is described in Figure 21. Near-shore and offshore mooring options can be implemented depending on shoreline availability and water depth.

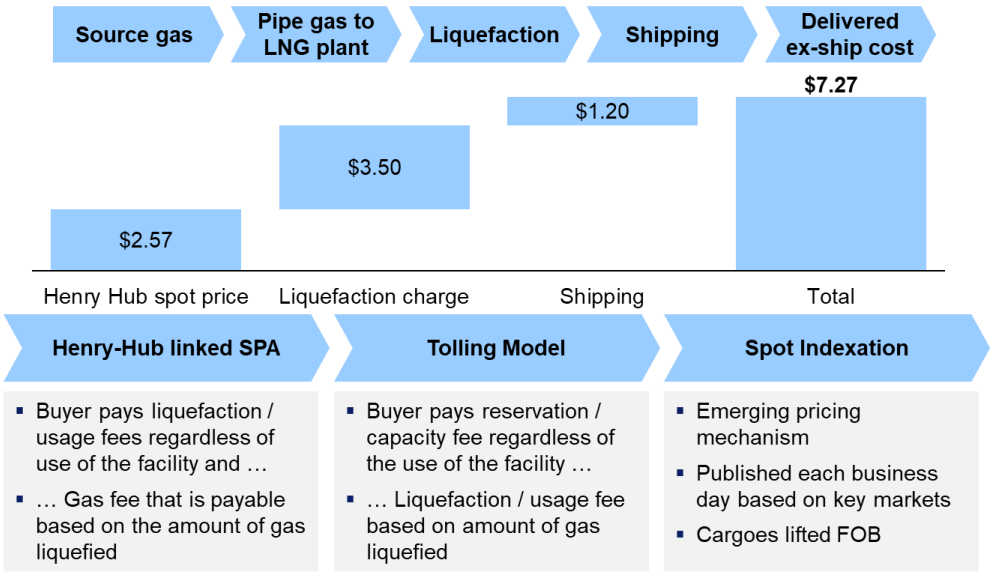
Figure 21: Operational flexibility of using FSRUs reflecting innovation in LNG value chain

Project type	FSRU
Near-shore mooring and LNG transfer options	▪ Single Berth and ship-to-ship LNG transfer ▪ Double berth and across-the-berth LNG transfer
Offshore mooring and LNG transfer options	▪ Single submerged mooring buoy with ship-to-ship transfer ▪ Above water single point mooring (fixed or floating) with ship-to-ship LNG transfer

In addition to technological innovation, there have been significant changes to LNG business models around the world. Rapid discovery and exploitation of shale gas in the U.S. spawned dramatic growth in LNG export capacity within a short period of time. Further, shale gas-based LNG capacity introduced a new business model, supplementing the traditional model of integrating the LNG value chain from exploration and production through liquefaction and export.

Specifically, U.S. LNG exporters allowed LNG buyers to pay tolling fees and reserve liquefaction capacity regardless of liquefaction or usage fees, introducing both flexibility and cost competitiveness. Figure 22 shows that such a tolling model could facilitate long-term U.S. LNG supply to the Philippines at an illustrative delivered ex-ship cost (DES) of as low as $7.27 per million Btu. The DES costs have been estimated using a model based on a large-scale LNG carrier transporting via Panama Canal from a liquefaction plant located on the U.S. Gulf Coast.

Figure 22: Illustrative DES cost of U.S. LNG to the Philippines in USD per MMBtu

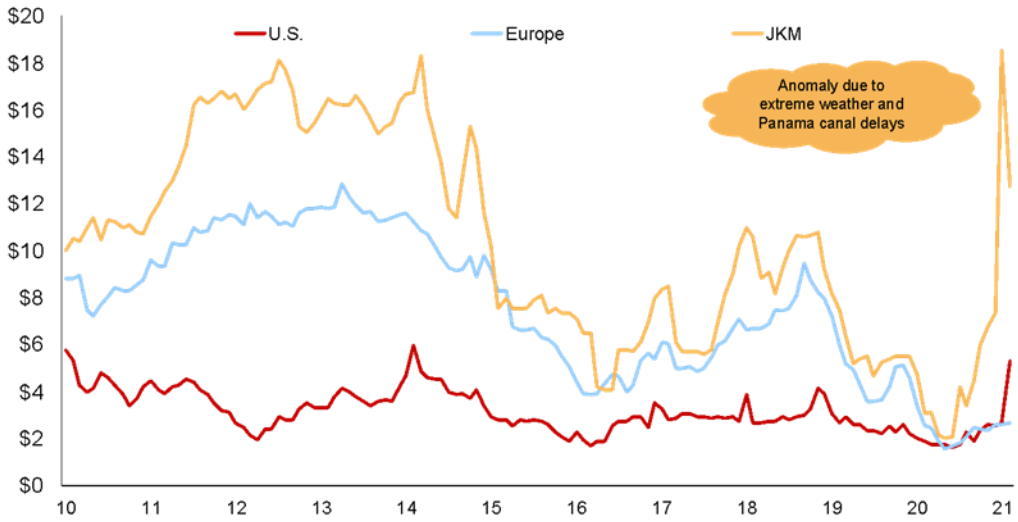


In Figure 22, the DES of LNG indicates that the seller is responsible for arranging the vessel and bears the risk of lost or damaged goods during the voyage. Delivery destination is generally predetermined unless otherwise mentioned in the contract, and the buyer does not retain any rights to resell the LNG.

On the contrary, free on-board (FOB) indicates a contract where the buyer is responsible for arranging the vessel, and the title and risk of lost or damaged goods will shift to the buyer. In addition, the buyer may have complete freedom to resell or send the LNG to whatever destination it chooses.

Collectively, the global LNG market is commoditizing and creating new opportunities for broader adoption and use of LNG across the world. The LNG market's commoditization is reflected in converging natural gas prices across the U.S., Europe, and Asia, as shown in Figure 23. While some of the price convergence can be attributed to oversupplied LNG markets, some stagnation in demand growth, and challenges related to COVID-19, the broader trend over the past five years indicates converging prices.

Figure 23: Natural gas and LNG prices in the U.S., Europe, and Asia in USD per MMBtu[32]



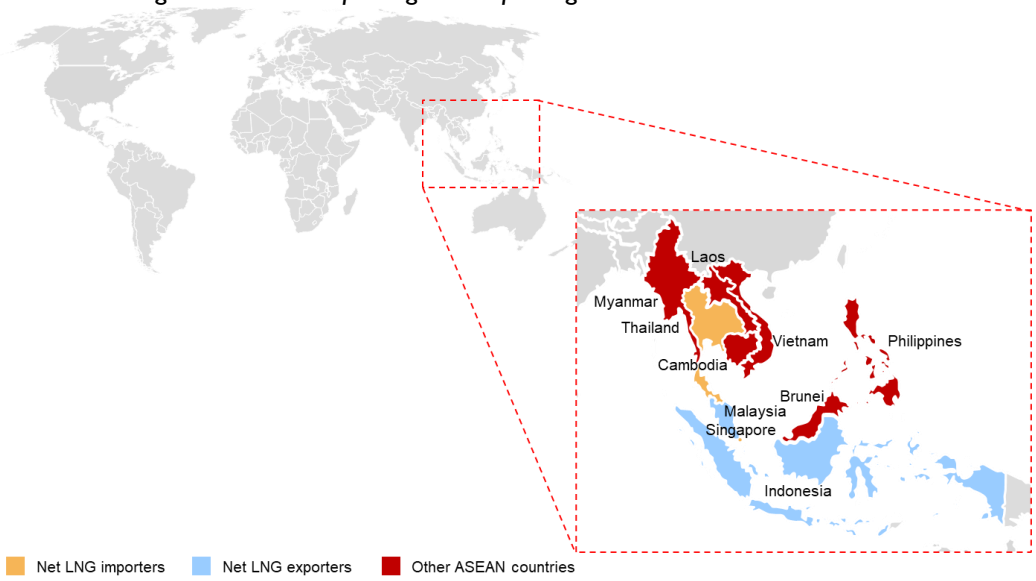
Given these trends, there is a wide diversity of LNG supply options for the Southeast Asian countries, including the Philippines, as shown in Figure 24. The region currently imports from Australia, Qatar, Russia, and the U.S., and imported a total of 176 million tons in 2019.

Malaysia and Indonesia are net exporters (shown in blue) while Thailand, Singapore, and more recently Myanmar are net importers (shown in orange). Other countries including Laos, Cambodia, Vietnam, Brunei, and the Philippines (shown in red) do not currently import LNG, but could benefit by carefully considering options to switch to and import LNG.

Increasing maturity and commoditization of the LNG market are expected to increase favorability of LNG imports in these countries in terms of supply and import options, contractual terms, volumes, and pricing.

[32] U.S. Energy Information Administration. World Bank, Japan Ministry of Economy. ADI Analytics.

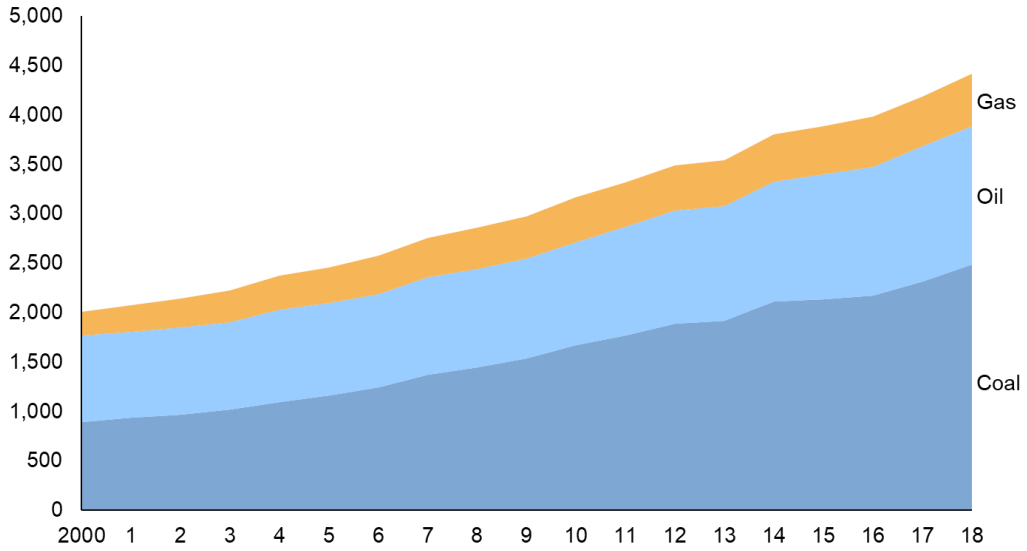
Figure 24: LNG importing and exporting countries in Southeast Asia



3. ENVIRONMENTAL BENEFITS OF LNG

The International Energy Agency (IEA) reports that CO_2 emissions in Asia, excluding China, increased from 2,010 million tons in 2000 to 4,415 million tons in 2018. In 2018, the majority (or 56%) of the CO_2 emissions were a byproduct of coal combustion, while 31% and 12% resulted from oil and gas combustion, respectively.

Figure 25: CO_2 emissions in Asia excluding China in million tons per year[33]



According to the IEA, in Asia regionally, excluding China, CO_2 emissions from coal combustion increased from 19.9 million tons in 2000 to 69.9 million tons in 2018, representing a 300% increase. Emissions from natural gas increased from 0.3 million tons in 2001 to 8.5 million tons in 2018, while emissions from oil increased from 48.2 million tons in 2000 to 53.7 in 2018.

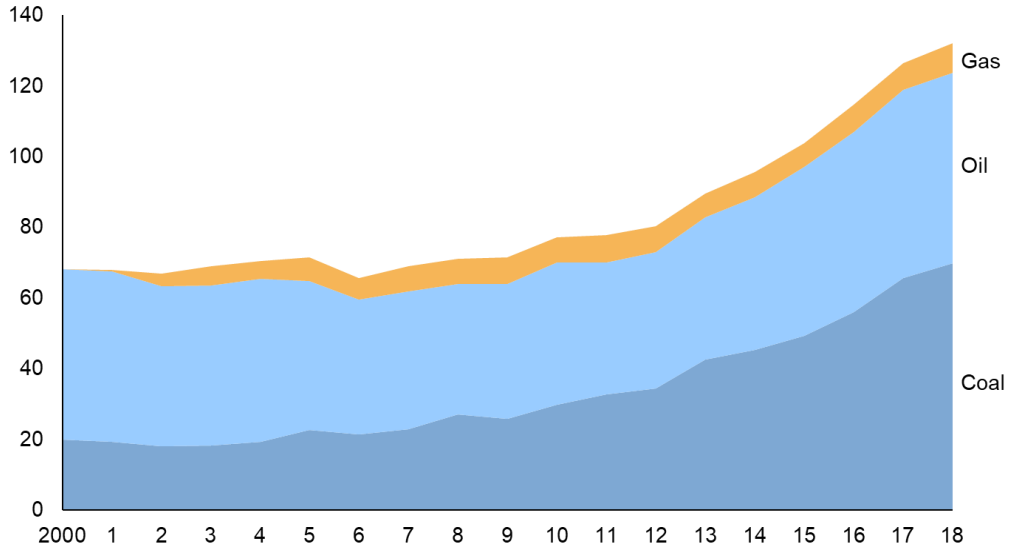
Although natural gas-related CO_2 emissions represent the highest increase, they still comprise 6.4% of total CO_2 emissions. Overall, in 2018, coal-related CO_2 emissions comprised 52.9% of the Philippines' emissions, with oil and gas at 40.7% and 6.4% respectively.

According to Helsinki-based Centre for Research on Energy and Clean Air (CREA),[34] the current coal-fired fleet in the Philippines was responsible for an estimated 630 air pollution-related deaths in 2019, as well as 1,300 new cases of child asthma, 149,000 days of work absence (sick leave) and 240 pre-term births. The same study estimated the total annual cost borne by the public at $165 million (PHP 8.5 billion).

Additionally, reductions in carbon and particulate emissions (including mercury, lead, and cadmium, among other toxic chemical emissions) from coal-fired power generation can translate to public health benefits, as these pollutants have been historically linked to problems such as bronchitis, asthma and coughing, lung cancer and complications, and heart disease for local inhabitants.[35]

[33] "World LNG Report 2021." International Gas Union.
[34] Centre for Research on Energy and Clean Air. *Air Quality & Health Impacts of Coal-fired Power in the Philippines*. December 2020
[35] "Coal and Air Pollution." Union of Concerned Scientists. 2017. https://www.ucsusa.org/resources/coal-and-air-pollution

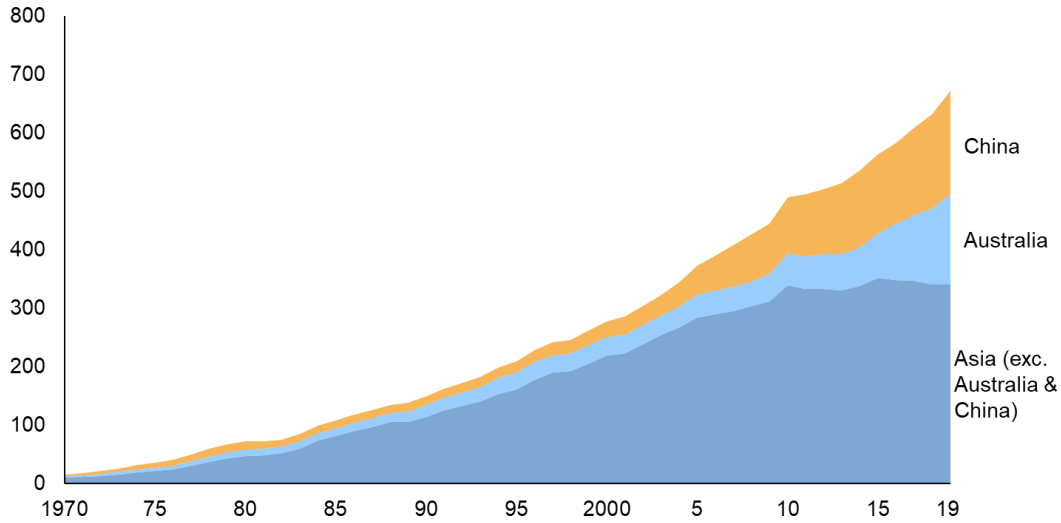
Figure 26: CO_2 emissions in the Philippines in million tons per year[36]



Excluding Australia and China, overall Asia-Pacific regional domestic natural gas production has significantly decreased because of general resource depletion. Recently, Australia increased its natural gas production and LNG exports.

In addition to Australia, the only country in the region where natural gas production has increased is China. However, as it diversifies its portfolio and endeavors to reduce the country's reliance on coal, China is also a significant importer of natural gas – both as LNG from the U.S. and Australia and as piped gas from Russia.

Figure 27: Natural gas production in Asia Pacific in billion cubic meters[37]



As mentioned in Section 2 above, if chosen appropriately, LNG pricing can provide a certain level of flexibility and security that is not necessarily available with petroleum products. For instance, pricing of U.S.-produced LNG that is based on the Henry Hub index can provide the stability buyers may seek. In addition, once regasified, LNG provides a superior fuel for power generation and other uses in terms of atmospheric pollutants.

[36] "World LNG Report 2021." International Gas Union.
[37] Ibid.

For instance, the EIA states that in 2019, natural gas fired generation in the United States produced the least amount of CO_2 emissions per kWh.[38]

Figure 28: CO_2 emissions by production activity in the U.S. in 2019 in million metric tons[39]

2019	Million kWh	CO_2 Million Metric Tons	Lb./kWh
Coal	947,891	952	2.21
Natural gas	1,358,047	560	0.91
Petroleum	15,471	15	2.13

The challenge of stranded investment with regards to power generation frequently comes up in policy discussions. It is imperative that this discussion be conducted from the point of view of an investor, be it a nation or a financial institution that, prior to making an investment decision, should consider and evaluate the four primary factors: availability of resources, reliability of supply, health and environmental benefits, and price.

LNG is readily available globally at present and for the foreseeable future. As more sound investment decisions bring more production online, the reliability of supply will continue to be guaranteed. There are currently 15 major LNG producing countries in the Americas, Europe, Middle East, Africa, and Asia Pacific. A number of other countries will soon come online, ensuring that LNG will be available through the life of any planned gas-fired generation facilities.

Regarding the environmental benefits of LNG-fired generation, the comparison exhibited in Figure 28 above shows significantly lower CO2 emissions per kilowatt hour produced than coal or petroleum. Hence, LNG-fired generation provides a reliable and cleaner bridge fuel to complement and supplement variable renewable energy as it increases in prevalence. Finally, with regards to price, stability can be built into the agreement that has been entered. Most agreements that are indexed to oil are subject to the peaks and valleys of oil pricing.

As international exchanges become more established, LNG will eventually be decoupled from oil. In the meantime, however, pricing tied to the Henry Hub index can provide the stability buyers are looking for, as illustrated in Figure 29. The Henry Hub is a natural gas pipeline located in the Southern U.S. that connects to four intrastate and nine interstate pipelines and serves as the official delivery location for futures contracts on the New York Mercantile Exchange (NYMEX).[40]

As the Henry Hub natural gas pipeline is the pricing point for natural gas futures on the NYMEX, daily settlement prices are referred to as pricing benchmarks for the North American natural gas market, as well as parts of the global LNG market. Henry Hub pricing is globally important because it is based solely on the actual supply and demand of natural gas as an independent commodity. Henry Hub also is used for LNG delivery contracts globally.[41]

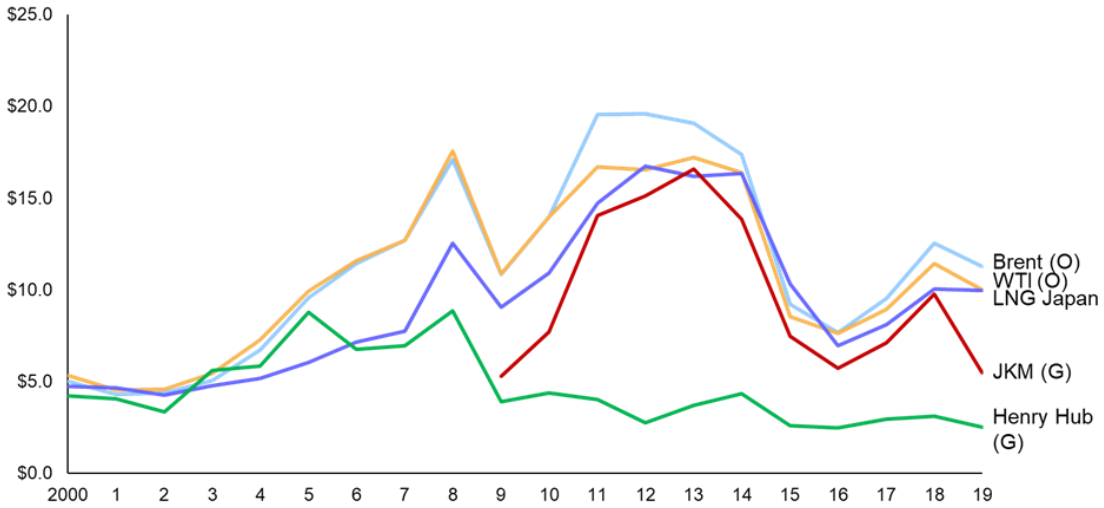
[38] "FREQUENTLY ASKED QUESTIONS (FAQS)." The U.S. Energy Information Administration. https://www.eia.gov/tools/faqs/faq.php?id=74&t=11#:~:text=In%202019%2C%20power%20plants%20that,U.S.%20electricity%2Drelated%20CO2%20emissions

[39] "World LNG Report 2021." International Gas Union.

[40] "Futures & Commodities Trading: Henry Hub." Investopedia. https://www.investopedia.com/terms/h/henry_hub.asp

[41] Ibid.

Figure 29: Annual average oil and gas prices in U.S. dollars per MMbtu[42]



[42] "World LNG Report 2021." International Gas Union.

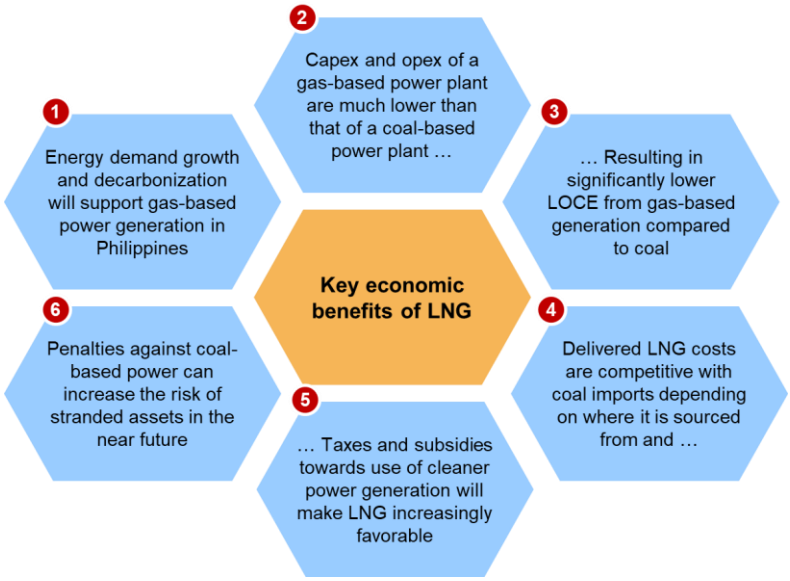
4. ECONOMIC BENEFITS OF LNG

In comparison to coal, LNG not only offers significantly lower detrimental environmental impacts for large-scale power generation, but also can provide a number of economic advantages, particularly when environmental costs are factored in. Figure 30 summarizes the key economic benefits of LNG, beginning with the critical role it can play in contributing towards meeting energy demand, which is critical for economic growth without compromising decarbonization and air quality improvement goals.

Further, capital and operating costs of natural gas-based power generation are much lower than those of coal-fired power plants. As a result, levelized costs of electricity for a gas-based power plant are significantly lower than that of a new coal-based power plant.

Delivered LNG costs are becoming more competitive as new LNG suppliers emerge and various taxes and subsidies towards clean fuels are expected to make gas-based power generation increasingly favorable. Additionally, penalties against coal-based power increase the risk of stranded assets for investors in the near to medium term.

Figure 30: Key economic benefits of LNG-based power generation

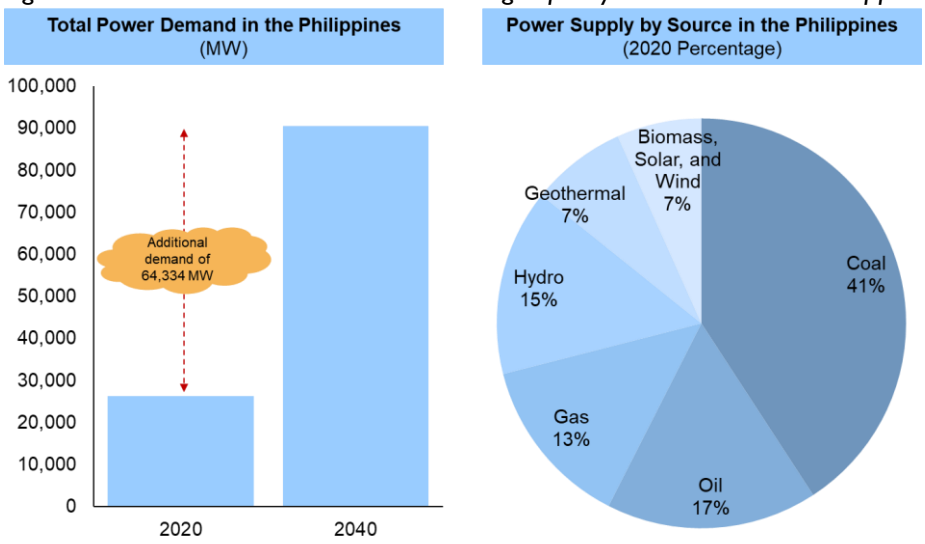


LNG offers emerging economies the opportunity to meet growing energy demand with a smaller environmental footprint. The Philippines Department of Energy's Energy Plan 2018-2040 projects the country's energy demand to rise at a rate of 5% per year during this period, representing 64,334 MW of additional power generation capacity by 2040.[43]

The Philippines signed the Paris Agreement in 2017, and more recently set a moratorium on new coal-based power plants to meet its pledge under the agreement. Figure 31 shows projected incremental demand in the Philippines by 2040 and current power-generation breakdown by source. This above scenario positions natural gas to have a growing contribution to the energy mix of the Philippines by 2040. China and South Korea have also pledged to become carbon neutral by 2050, and similar pledges by other countries will drive greater adoption of LNG in the region.

[43] "Philippine Energy Plan: 2018-2040." Department of Energy, the Philippines. https://www.doe.gov.ph/sites/default/files/pdf/pep/pep-2018-2040_20210323.pdf

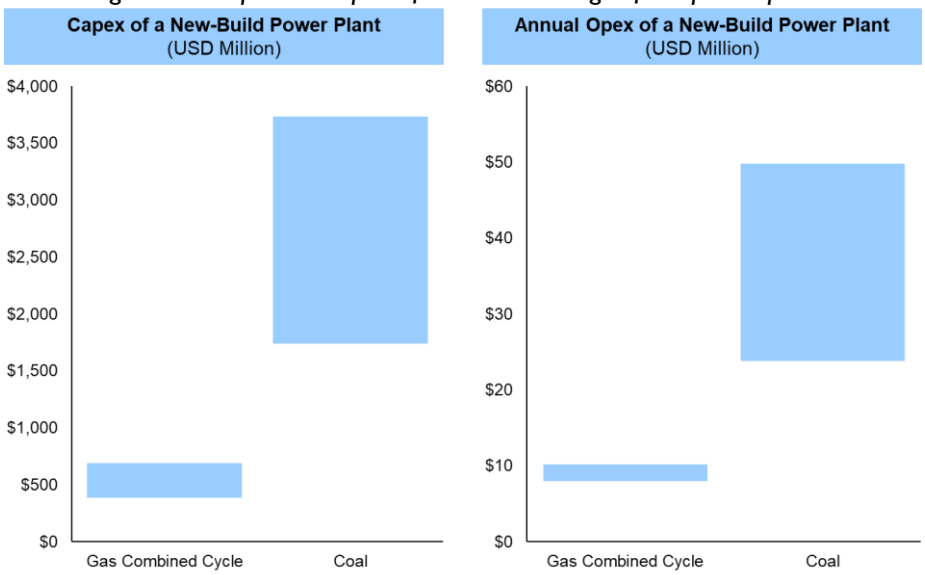
Figure 31: Power demand outlook and existing capacity breakdown in the Philippines[44]



Another element of LNG's economic competitiveness stems from the capital and operating costs of gas-based power plants, which are lower than those of a coal-based power plant as shown in Figure 32. A gas-based power plant's capital expenditure (capex) is 78 – 82% lower than that of a coal-based power plant. Further, it takes five to six years to build a coal-based power plant while a gas-based combined-cycle power plant can be up and running and start generating cash flow in two to three years.

Figure 32 shows that the operating expenditure (opex) of a new-build gas-based combined cycle power plant is 67 – 80% lower than that of a coal-based power plant. Although a coal-based power plant has a longer life of about 40 years compared to about 20 years for a gas-based power plant, it comes with increasing operating costs over its life.

Figure 32: Capex and opex of new coal- and gas-fired power plants



As Figure 32 shows, the levelized cost of gas-based electricity is significantly lower than that based on coal. Assuming a gas feedstock price of $6.40 per MMBtu and coal prices at $2.80 per MMBtu, the levelized cost of electricity from a gas-based power plant ranges from $54 to

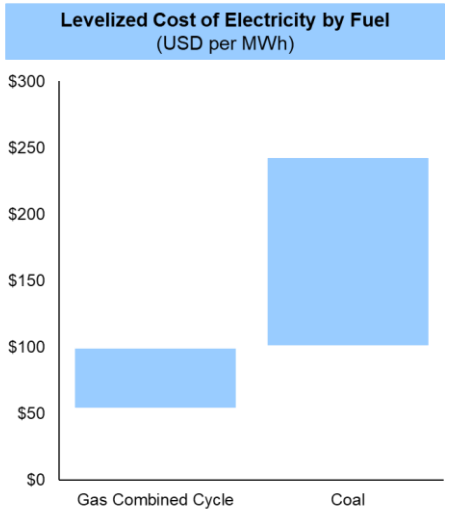
[44] "World LNG Report 2021." International Gas Union.

$99 per MWh. In comparison, that of a coal-based power plant is estimated at $101 to $242 per MWh, including carbon capture and storage costs.

Figure 33: Levelized cost of electricity by fuel in U.S. dollars per MWh

Assumptions

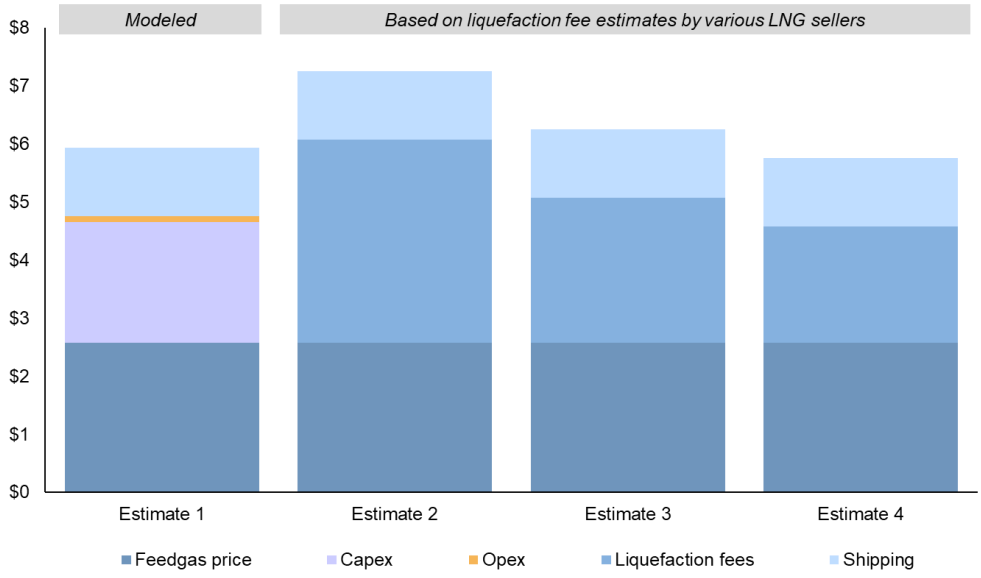
Parameter	Unit	Gas-Based Power Generation	Coal-Based Power Generation
Plant capacity	MW	200	200
Plant life	years	20	40
Time to build	years	2 – 3	5 – 6
Feedstock costs	$/mmbtu	$6.4	$2.8



LNG's growing supply and falling prices contribute to its increasing economic attractiveness. The delivered LNG price from the U.S. to the Philippines could range as low as $5.75 to $7.25 per MMBtu based on suppliers and contractual terms. As seen in Figure 34, the DES U.S. LNG cost to the Philippines, based on a modelled large-scale LNG export terminal is estimated at $5.93 per MMBtu.

Based on the announcements by some key U.S. LNG exporters, the liquefaction costs can range from $2.00 to $3.50 per MMBtu and these fees constitute a large portion of the delivered price for U.S.-sourced LNG to the Philippines. We expect these costs to be more favorable in the future, making LNG imports into Asia more competitive. Shipping costs from the U.S. to the Philippines are estimated at $1.20 per MMBtu based on modelled economics of an LNG vessel, which may also fall as LNG shipping capacity grows in the future.

Figure 34: Estimates of DES U.S. LNG cost to the Philippines in USD per MMBtu



Subsidies and regulations that support gas-based power generation in Asia – see Figure 35 for an illustrative list – could also contribute to LNG's economic competitiveness. Over the last few years, LNG has been widely recognized as a bridge fuel to quickly move away from coal while renewable power capacity such as wind and solar have ramped up and are becoming more integrated into power grids and electricity markets.

Indonesia has capped gas prices for power plants and industries to shield their consumers from high prices and Malaysia also regulates its natural gas prices. Similar measures to support adoption of gas-based power generation and additional subsidies or tax credits to power companies will help higher adoption of gas-based power plants in the Philippines and the broader region.

Figure 35: Subsidies or regulations supporting gas-based power generation in Asia

Country	Subsidy / Regulations Supporting Gas-Based Power Generation
Indonesia	The government passed a regulation in April 2020 to cap natural gas prices for power plants and seven other industries in the country at $6 per mmbtu
Malaysia	The government regulates natural gas prices for power generation helping Petronas avoid forgone revenues by selling gas at prices lower than market cost
India	There is an ongoing discussion to introduce tax credit on gas-based industries including power and fertilizer industries to support adoption and utilization of gas

Finally, carbon taxes and other regulations will increase the costs of coal-fired power plants and highlight LNG's economic benefits. Singapore is the first country in Asia to introduce a carbon tax. Industrial facilities will have to pay $0.74 USD per ton of GHG emissions until 2023. Beyond 2023, the tax may rise to $10 USD to $15 per ton by 2030. The Philippines has set a moratorium on new coal power plants and is planning to introduce carbon pricing or taxation based on emissions from industry.[45]

India has announced stringent limits on PM, SOx, and NOx emissions to be met by 2022 for power plants that were installed after 2017. In addition, plants installed before 2004 must meet PM and NOx norms of 100 mg/Nm^3 and 600 mg/Nm^3 respectively. Those installed between 2004 and 2016 have to meet norms of 50 mg/Nm^3 for PM and 450 mg/Nm^3 for NOx. Almost ~65% of Indian power plants will not be able to meet the regulations by 2022.[46] All such regulations will add to the operating costs of coal-based power plants, rendering them less competitive in the future in addition to potentially rendering them as stranded assets in the future. Figure 36 summarizes these regulations penalizing coal-based power generation in Asia.

Figure 36: Taxes or regulations against coal-based power generation in Asia

Country	Taxes / Regulations Against Coal-Based Power Generation
Singapore	Singapore announced carbon tax of S$1 (US$ 0.74) per ton of GHG emissions from 2019 to 2023. This tax may rise to S$10 to S$15 per ton by 2030
Philippines	Philippines has set a moratorium on new coal-based power plants for now, and is also planning to introduce carbon pricing or taxation based on emissions from power generation plants and other industrial sectors
India	India announced in 2015 that power plants installed after 2017 will have to meet PM norm of 30 mg/Nm^3 and SO_2 and NOx norms of 100 mg/Nm^3 by 2022, which may render ~65% coal-based power plants non-compliant

[45] "PH looks into carbon tax to fight climate change." Philippine Daily Inquirer. https://business.inquirer.net/318668/ph-looks-into-carbon-tax-to-fight-climate-change

[46] "65 per cent of coal-fired power plants in India may not meet environmental norms by the deadline year of 2022: CSE." Centre for Science and Environment. https://www.cseindia.org/65-per-cent-of-coal-fired-power-plants-in-india-may-not-meet-environmental-norms-10366

5. FINDINGS, RECOMMENDATIONS, AND CONCLUSIONS

As seen above, this report systematically reviews the state of LNG pricing and energy market opportunities in the Philippines consistent with the cooperative goals of the AGP. The report lays out a policy, economic, and technical market framework for discussion on why the Philippines may wish to pursue LNG to meet the country's energy needs and environmental goals by reviewing relevant global, regional,[47] and Philippines-specific data.

This report, which assesses the energy sector and the potential for LNG in the Philippines and the Asia Pacific, has resulted in several findings and recommendations, with key insights outlined below. The main drivers of LNG market opportunities in the Philippines can arise from:

1. Sound environmental policies and regulations that help to drive demand growth for LNG;
2. Global LNG supply growth supporting and enabling such continued LNG growth;
3. Spot trading, flexibility, contract optionality, transparent price signals; and
4. Technological innovation, market opportunities, and supportive economic signals across the value chain.

These drivers should be positive for supporting access to new LNG market opportunities. As Philippines stakeholders seek to make sound economic and environmental investment and policy decisions around LNG opportunities, an understanding of the main drivers is critical if there is to be an optimization of the development of secure, reliable, and economic sources of energy.

In conclusion, as previously noted in this report, there are currently 15 major producing countries in the Americas, Europe, Middle East, Africa, and Asia Pacific. A number of other countries will soon come online, ensuring that LNG will be available through the life of any planned gas-fired generation facilities.

Energy demand in the Philippines and the Asia Pacific region in general has been increasing consistently. In fact, energy demand growth and complementary decarbonization policies can support gas-based power generation. Such focus on decarbonization efforts, growing uncertainty regarding the availability of coal, technological advances in LNG, and incentives and regulatory support for LNG infrastructure development will help to accelerate LNG growth. It is clear that LNG is readily available now and for the foreseeable future.

As more sound investment decisions bring more production online, the reliability of supply will continue to be guaranteed. In summary, the Philippines and the Asia Pacific Region can realize strong economic and environmental benefits from the use of LNG as a part of its energy demand solutions. The LNG market is still evolving and growing, and it continues to provide safe, clean, and reliable fuel. We hope this report will assist in supporting strategic decision-making and future policy initiatives towards the LNG market.

[47] "Fossil Fuels Still Supply 84 Percent of World Energy." Forbes.

Annex 1: LNG Imports in the Asia Pacific Region, 2000-2019

LNG imports																				
Billion cubic meters	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**
China	-	-	-	-	-	-	1.0	4.1	4.6	8.0	13.0	16.9	20.1	25.1	27.3	27.0	36.8	52.9	73.5	**84.8**
India	-	-	-	-	2.8	6.3	8.4	10.4	11.3	13.0	11.5	17.4	18.4	18.0	19.1	20.0	24.3	26.1	30.6	**32.9**
Japan	74.0	76.0	75.4	81.4	78.5	79.6	85.6	92.0	95.4	88.9	96.4	108.6	119.8	120.4	121.8	115.9	113.6	113.9	113.0	**105.5**
Malaysia	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0	2.2	2.2	1.5	2.0	1.8	**3.3**
Pakistan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	4.0	6.1	9.4	**11.8**
Singapore	-	-	-	-	-	-	-	-	-	-	-	-	-	1.3	2.6	3.0	3.2	4.1	4.5	**5.0**
South Korea	20.6	22.8	25.0	26.3	30.7	31.1	34.5	36.0	38.3	35.3	45.0	47.7	49.7	55.3	51.8	45.8	46.3	51.4	60.2	**55.6**
Taiwan	6.2	6.6	7.3	7.8	9.6	9.8	10.8	11.4	12.6	12.4	15.0	16.3	17.1	17.2	18.6	19.6	20.4	22.7	22.9	**22.8**
Thailand	-	-	-	-	-	-	-	-	-	-	-	1.1	1.4	2.0	1.9	3.6	3.9	5.2	6.0	**6.7**
Other Asia Pacific	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	0.8	**5.7**
Total Asia Pacific	100.7	105.4	107.7	115.6	121.5	126.8	140.3	153.9	162.2	157.5	180.9	207.9	226.6	241.2	245.2	238.5	253.9	284.6	322.7	**334.1**

For questions regarding this publication, please contact
Arielle Swett (aswett@naruc.org)
Erin Hammel (ehammel@naruc.org)

National Association of Regulatory Utility Commissioners (NARUC)
1101 Vermont Ave, NW, Suite 200
Washington, DC 20005 USA
Tel: +1-202-898-2210
www.naruc.org