THE NATIONAL BUREAU *of* ASIAN RESEARCH

NBR SPECIAL REPORT #89 | DECEMBER 2020

POWERING SOUTHEAST ASIA

Meeting the Region's Electricity Needs

By Han Phoumin, Mikkal E. Herberg, Nikos Tsafos, and Courtney Weatherby

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INTRODUCTION

Southeast Asia has been among the regions with the fastest-growing energy demand, rising 6% annually over the last two decades. The inevitable outcome has been a severe deterioration in air quality and significantly higher carbon emissions across the region. The environmental, social, and health impacts of climate change, including an estimated 450,000 premature deaths caused by air pollution in Southeast Asia in 2018, are increasingly shaping national plans for power generation. While there has been significant progress among regional countries in ramping up renewable energy projects, meeting electricity demand growth and ensuring access in remote areas remain key challenges to sustainability in the power sector.

Even as environmental outcomes are increasingly factoring into energy policy decisions, the past twenty years have shown that countries prioritize affordability and security when choosing fuel for power generation. Current national plans suggest that coal will likely continue to be cheap and abundant, retaining and even expanding its key role in the region's power mix for the next decade. Meanwhile, natural gas faces obstacles as the share of cleaner options like wind and solar grows (albeit from an extremely low base). The challenge of meeting power generation needs while transitioning to a cleaner energy mix reinforces the importance of forceful action to alter the underlying trajectory of rapidly rising demand for electricity.

At the same time, there is heightened geopolitical competition to shape Southeast Asia's future energy needs. China's Belt and Road Initiative continues to expand its energy sector financing, with a majority of projects supporting new coal-fired generation across the region. As Nadège Rolland and others have detailed extensively in their analysis for the National Bureau of Asian Research (NBR), including in last year's report for the Energy Security Program, China's approach often has strings attached and undermines the economic interests of recipient states in favor of Beijing's broader strategic and economic interests.

By contrast, the United States and Japan, with endorsement by the G-20, are leading international efforts to promote cleaner "high-quality infrastructure" as a key component of their free and open Indo-Pacific energy strategies. The establishment of the Blue Dot Network to create universal standards to promote quality infrastructure investment is just one of many initiatives. Whether it will be successful, however, remains to be seen. Another initiative, the Japan-U.S. Strategic Energy Partnership, was launched in 2017 and has recently established a trilateral partnership between the United States, Japan, and Vietnam to "provide competitive alternatives to malign actors in the region" and support the development of liquefied natural gas (LNG).[1]

Other key components that have emerged in the United States over the past several years are the Better Utilization of Investments Leading to Development (BUILD) Act, which would more than double the capacity of the U.S. government to support overseas strategic private investment to $60 billion, and the Asia Enhancing Development and Growth through Energy (EDGE) initiative, which focuses on increasing opportunities for trade and investment by promoting public-private partnerships and assisting partner governments with establishing market-based energy policies. How can the region's energy policies meet the future demand for power and accelerate the

[1] "The United States and Japan Join with Vietnam to Advance Shared Energy Goals," U.S. Department of State, December 3, 2020, https://www.state.gov/the-united-states-and-japan-join-with-vietnam-to-advance-shared-energy-goals.

transition toward a cleaner energy mix, while also navigating the complex and charged geopolitical environment created by the U.S.-China rivalry?

Three additional challenges loom over efforts to develop Southeast Asia's power sector. First, the ability of energy markets to actually absorb available natural gas and LNG into their power mix to replace coal will in many countries depend greatly on reforming and opening up domestic gas markets. Many gas markets are still monopolized by state-owned enterprises. Although some Asian markets have moved toward greater deregulation and liberalization, various rates of reform pose new risks for outside investors. How can stakeholders across the region work together to accelerate the pace of capacity building and market reform?

A second key challenge is bringing infrastructure to scale and effectively mobilizing financing. Southeast Asia is estimated to require more than $2 trillion in energy infrastructure investments, and innovative approaches to financing, as well as better opportunities for public-private partnerships, will be critical to balance regional power mixes. Cheap, abundant coal supplies where infrastructure for coal-fired power is already in place or requires lower upfront costs act as a barrier to investment in new energy sources or technology upgrades. How can U.S.-led initiatives like Asia EDGE, the BUILD Act, and the Blue Dot Network meaningfully support ongoing infrastructure needs in the region? Is the scale of available U.S. and Japanese investment and financing capacity sufficient to compete with China's massive financing capacity and lower-cost, but less transparent and environmentally sustainable, investment?

A third key challenge will be seizing opportunities created by the Covid-19 pandemic to enact market or financial reforms that would be unlikely to pass under business as usual. Massive disruptions have placed immense pressure on governments throughout the region, many of which are reliant on revenues from the oil and gas sectors or are having to divert project financing for social welfare and healthcare priorities. Yet this also presents a somewhat blank slate for governments to rebuild, raising the question of the short- and long-term implications of the Covid-19 pandemic for political and economic cooperation in the power sector.

Given the important questions that remain in Southeast Asia about the actual implementation and potential for success of the energy dimension of the U.S. Indo-Pacific strategy, the theme of NBR's 2020 Energy Security Program is "Powering Southeast Asia: Meeting the Region's Electricity and Sustainability Needs." For sixteen years this program has provided an assessment of major developments in Asian energy markets and geopolitics to assist policymakers in better understanding and responding to the implications for energy and environmental security in the region. The 2020 program focused on a range of critical issues, including how the Covid-19 pandemic and other developments may shape the trajectory of Southeast Asia's power mix, what steps are needed to create environments that encourage investment to bridge the infrastructure gap, and what are the prospects for building out a more sustainable power sector that relies on lower-carbon and renewable energy sources.

NBR commissioned essays by four scholars with expertise on these issues. The preliminary results were discussed at a workshop in Washington, D.C., on July 22, 2020, which NBR was pleased to once again co-host with the Woodrow Wilson International Center for Scholars, albeit this time in a virtual setting. Participation in the meeting included senior representatives from the U.S. government and foreign policymaking communities as well as leading industry and geopolitical experts. The authors have drawn on feedback they received at the workshop to strengthen their research and findings.

In the opening essay, Nikos Tsafos from the Center for Strategic and International Studies (CSIS) situates the role of Southeast Asia's power sector development in the broader context of geopolitical maneuvering and alliance building in the Indo-Pacific. He also emphasizes the requisite to recognize the diversity and scope of the regional states' needs and provides country-specific considerations shaping the trade and development of coal, natural gas, and renewables. Finally, Tsafos cautions against a one-size-fits-all approach and forcing governments to pick sides in the ongoing U.S.-China competition. The regional countries may have broad goals for achieving energy access, but how they get there will vary, and the vast amount of investment needed will require multiple partners moving forward.

The second essay by Courtney Weatherby of the Stimson Center examines the role for renewable energy in Southeast Asia and the obstacles to energy diversification. She notes that although there are encouraging targets set for renewable energy development across Southeast Asia, one of the key obstacles is the need to rapidly provide electricity access to 45 million people. Although many still highlight the cost or intermittency of renewables as a reason to avoid aggressive expansion, Weatherby considers several case studies, such as solar power development in Vietnam, that show that many of these barriers are surmountable or even no longer exist.

In the third essay, Mikkal E. Herberg sets the stage for questions shaping high-quality infrastructure investments in Asia and considers the initiatives put forth by countries like the United States and Japan and the role they can play in bridging the infrastructure gap. As highlighted by Tsafos, geopolitical competition can have an impact on which projects get built. The essay expands on this finding and assesses the potential of initiatives like the Japan-U.S. Strategic Energy Partnership, Asia EDGE, the Japan-U.S. Mekong Power Partnership, and the Blue Dot Network. It concludes by outlining the importance of providing competitive alternatives that emphasize free and open markets and align with existing regional and domestic goals.

In the final essay, Han Phoumin from the Economic Research Institute for ASEAN and East Asia examines the importance of sustainable, quality infrastructure and the specific areas in which investments should be focused. He argues that economic development and infrastructure buildout must not come at the expense of environmental or social damage. Instead, there is a need to reassess international approaches to financing clean-coal technologies, as restrictions limit the ability of countries to diversify their supply sources and partnerships. To balance these challenges, Han identifies priority technologies and areas for investment that can support a low-carbon transition. He concludes by considering the impact of Covid-19 on the ability to ramp up efforts for clean-energy transitions that may have previously been less attractive or prioritized.

Collectively, these four essays paint a much clearer and revealing portrait of the needs and prospects for the development of Southeast Asia's power sector. But the analysis also suggests that much more work must be done if regional countries and their partners across the Indo-Pacific want to move from a broad vision for the region's future to an executable roadmap that can effectively engage the stakeholders needed to foster sustainable economic and energy demand growth. As the authors of this report note, serious challenges loom for efforts to promote more diverse, sustainable, and secure power sectors and build out the necessary infrastructure to support such a transition. Doing so will also require decision-makers to make difficult choices, including about when and how to expend limited resources and political capital, particularly amid an ongoing economic crisis brought about by the pandemic.

The 2020 program would not have been possible without the tremendous support, guidance, and dedication of a number of organizations and individuals whose efforts are particularly worthy

of recognition. First, we are grateful to Chevron and ConocoPhillips for their ongoing sponsorship of this initiative. Their contributions are indispensable for the program's activities and research agenda. Second, over the past several months we have received comments from numerous U.S., Japanese, and Southeast Asian scholars, representatives at international organizations, and government officials on how the region is approaching power sector and infrastructure development. These include Virginia Palmer of the U.S. Department of State, Nao Kawakami of the Japan Bank for International Cooperation, Cecilia Tam of the Organisation for Economic Co-operation and Development (OECD), and Ken Koyama of the Institute of Energy Economics, Japan. We were pleased to host these officials in our formal energy programming throughout the course of 2020.

Behind the scenes, Clara Gillispie, Jeanne Choi, Audrey Mossberger, and Tom Lutken of NBR worked tirelessly to develop the program and refine the policy discussions, as did Michael Kugelman and his team at the Wilson Center in support of the July workshop. This report is the product of their hard work, as well as the efforts of numerous others. We hope that you enjoy it as much as we enjoyed working on it.

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The Outlook for Power Generation in Southeast Asia and the Geopolitics of the Indo-Pacific

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EXECUTIVE SUMMARY

This essay examines the outlook for power generation in Southeast Asia and argues that how the region meets its electricity needs will have profound consequences for the geopolitical balance of the Indo-Pacific and the global fight against climate change.

MAIN ARGUMENT

Southeast Asia's electricity market is caught between two geopolitical crosscurrents. On the one side is the fault line between China and the U.S., which forces countries in the region to navigate relations between the two powers. On the other side, Southeast Asia confronts a dilemma familiar to many emerging economies: energy use remains low relative to the global average but is growing fast. To meet that demand, many countries in the region have turned to coal, worsening local air pollution and contributing to climate change. How to provide the energy and electricity needed for economic growth without the negative side effects that come from coal use is one of the region's greatest challenges.

POLICY IMPLICATIONS

- Southeast Asia is a large and growing electricity market, and its fuel and technology choices will reverberate beyond the region. It is essential, therefore, to help the region meet its electricity needs while reducing CO_2 emissions.
- The U.S. should continue to encourage countries to implement market reforms, invite private capital, award projects fairly, implement high standards, and strengthen local institutions and civil society.
- Southeast Asia needs to develop credible alternatives to coal-fired generation and must be supported in doing so, but such support must go beyond asking the region to reject coal or refuse financing from China. The U.S. needs to develop a more flexible approach to the region that allows China to also play a role.

Southeast Asia's electricity market has become a battleground in the geopolitics of energy, driven by two crosscurrents: the rivalry between China and the United States and the battle between competing resources to meet growing energy demand. The region is a booming market: from 2009 to 2019, energy demand rose by 4.6% a year, faster than the global average of 1.9%.[1] High growth means that there is a race to supply the fuels and build the infrastructure to meet demand. Around 650 million people live in Southeast Asia, and their energy use per capita is far below the global average, meaning that growth is likely to continue.[2] Meanwhile, coal has emerged as the fuel of choice, and in a few years the region is likely to consume more coal than the United States.[3] How Southeast Asia powers its economic growth will have widespread economic, political, and environmental repercussions for the region and beyond.

This essay addresses three questions: How does Southeast Asia currently generate its electricity, and why? What forces could change its choices going forward, and under what conditions? And what strategic issues does the regional electricity market pose for the United States, China, and other major powers? Finally, the essay concludes by outlining key considerations for the United States and other regional actors for effective and successful energy cooperation and engagement in Southeast Asia.

Electricity Generation in Southeast Asia

Southeast Asia's electricity sector is heterogeneous, with significant variation among countries in terms of how much electricity they generate and consume per person and how much carbon dioxide (CO_2) they emit in the process (see **Figure 1**).[4] Four countries—Indonesia, Vietnam, Thailand, and Malaysia—accounted for 82% of total generation in 2017, and thus what happens in these countries drives the regional picture. Consumption per capita ranges from significantly above the global average in Singapore and Brunei, to just above average in Malaysia, to below average everywhere else, including significantly so in Myanmar and Cambodia, which consume 12% and 15% of the global average, respectively. The carbon intensity of electricity generation also varies, with Indonesia emitting twice as much CO_2 per megawatt hour as Vietnam.[5]

Coal is the main generation source in Cambodia, the Philippines, Malaysia, and Indonesia, whereas Brunei, Singapore, and Myanmar generate less than 10% of their electricity from coal (see **Figure 2**).[6] Every country except Cambodia uses gas in power generation, and it is dominant in Brunei, Singapore, and Thailand. Hydro generates more than half the electricity in Myanmar and almost half in Vietnam. Indonesia and the Philippines also rely on geothermal energy, while other countries generate electricity from biofuels, waste, wind, or solar. There are also modest

[1] This calculation includes data for Indonesia, Vietnam, Thailand, Malaysia, and the Philippines. See BP, "Statistical Review of World Energy," https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html.

[2] Population data is for 2017. See World Bank, "Population, Total," DataBank, https://data.worldbank.org/indicator/SP.POP.TOTL. For energy consumption data, see International Energy Agency (IEA), "Data and Statistics," https://www.iea.org/data-and-statistics. This calculation includes Brunei, Cambodia, Indonesia, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam.

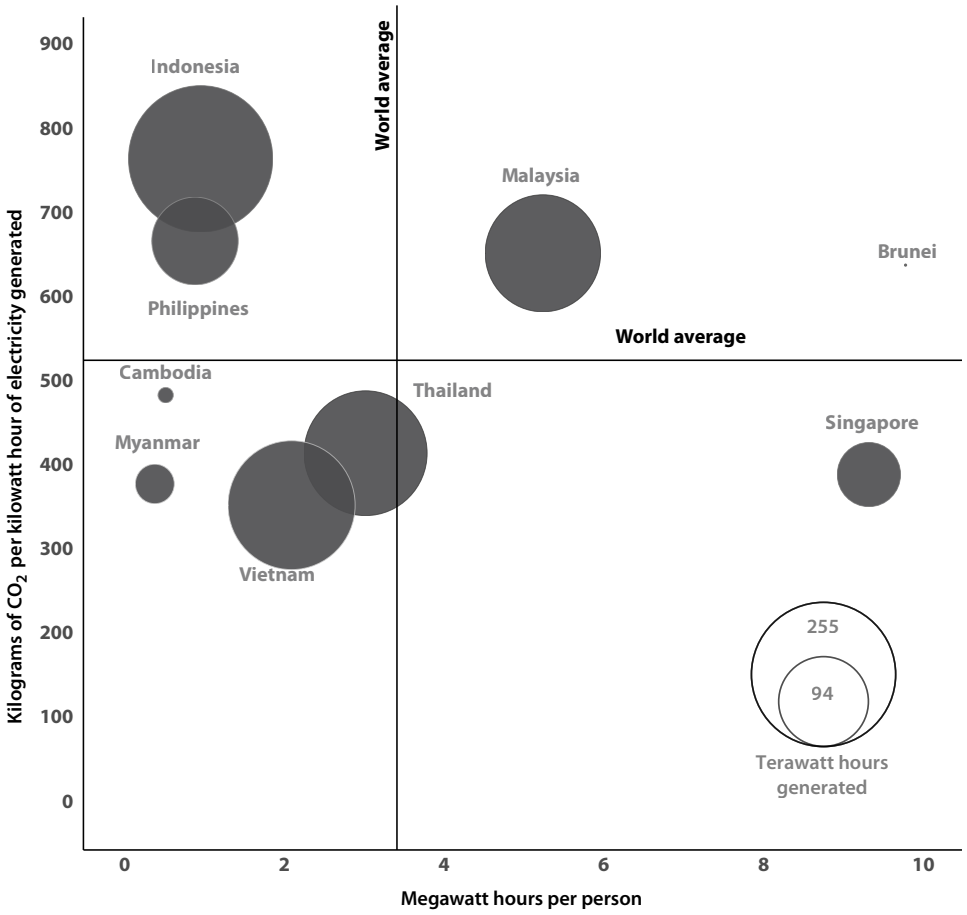
[3] See also Nikos Tsafos, "The Center of Coal Demand Keeps Shifting," Center for Strategic and International Studies (CSIS), October 15, 2018, https://www.csis.org/analysis/center-coal-demand-keeps-shifting.

[4] This section uses "Southeast Asia" to refer to Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. Data on generation comes from the IEA, "Data and Statistics"; data on emissions comes from IEA, "CO_2 Emissions from Fuel Combustion 2019 Highlights," November 15, 2019, https://webstore.iea.org/co2-emissions-from-fuel-combustion-2019-highlights; and data on population comes from the World Bank, "Population, Total."

[5] This was in 2017. In more recent years, Vietnam's electricity has moved more heavily toward coal, meaning that these numbers will look different.

[6] This analysis is based on data from the IEA, "Data and Statistics."

FIGURE 1 Electricity generation in Southeast Asia, 2017



SOURCE: IEA, "Data and Statistics"; and World Bank, "Population, Total."

cross-border flows of electricity, though imports are significant for only Cambodia and Thailand. Both countries rely on Laos, whose power generation depends on a mix of hydro and coal (with the coal-based electricity going primarily to Thailand).[7]

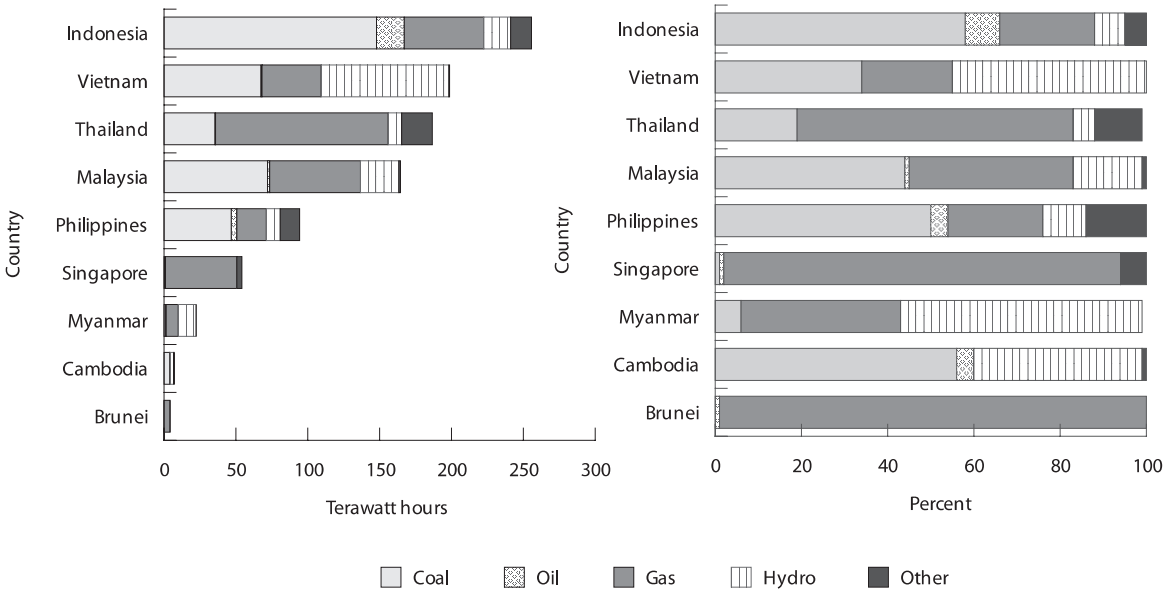
The Role of Coal

Region-wide trends in power generation are largely shaped by five markets: Indonesia, Vietnam, Thailand, Malaysia, and the Philippines. It is helpful to pay closer attention to these countries, looking not just at electricity but at their energy systems as a whole (see **Figure 3**).[8] Unlike in other regions where countries built their economies on coal over decades, Southeast Asia is a more recent convert. Until the mid-1990s, coal was a marginal fuel, accounting for only 13% of primary energy in Thailand and less than 10% in Malaysia, Indonesia, and the Philippines. Only in Vietnam was

[7] Laos is not included in most of the regional numbers due to the limited availability of data. The IEA's online database does not cover Laos, nor does the BP Statistical Review. For more information on the country's electricity system, see "Lao PDR Energy Statistics 2018," Economic Research Institute for ASEAN and East Asia, https://www.eria.org/publications/lao-pdr-energy-statistics-2018.

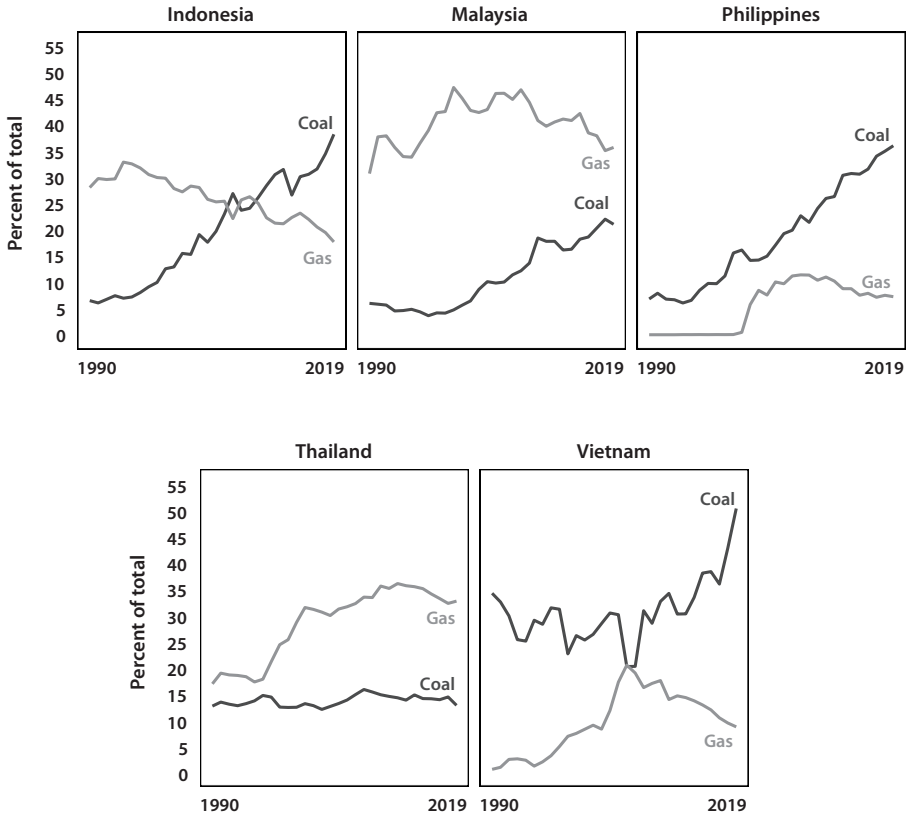
[8] BP, "Statistical Review of World Energy."

FIGURE 2 Electricity generation in Southeast Asia, 2017



SOURCE: IEA, "Data and Statistics."

FIGURE 3 Energy consumption in select Southeast Asian markets, 2017



SOURCE: BP, "Statistical Review of World Energy," June 2020.

coal a significant source of energy. Energy systems across the region were instead dominated by oil and gas. In some countries, the turn to coal started in the mid-1990s, whereas in Vietnam coal did not become the dominant fuel until the 2010s. In Thailand, coal never took off, maintaining a flat market share over time (though Thailand imports 13% of its electricity, which, as noted above, is largely from Laos and largely generated from coal).[9]

The reliance on coal is difficult to explain using the typical models focused on "incumbency" or "path dependency"—the idea that countries continue to use coal because of past choices and that any established fuel has an advantage over newcomers. It is not even obvious that resource endowment is a primary driver, at least not anymore. With the exception of Indonesia, every country in the region was a net importer of coal in 2017, although some countries produced enough coal to cover a major share of their needs: 76% in Vietnam, 45% in Myanmar, 37% in the Philippines, and 25% in Thailand (see **Table 1**).[10] Cost is a major factor, of course, but even cost should be understood in the proper context. For example, in a country like Indonesia, which has ample local resources and a large production base, there is indeed a major disparity between the cost of coal-fired generation and generation from other sources like gas (at least when ignoring the externalities of coal such as its contribution to local air pollution and climate change).[11]

When countries rely on imported coal, however, the cost of generation can be high. Until 2013, for example, it was cheaper for Malaysia to generate electricity from gas even after the country had started to shift its electricity system toward coal. But a perception of scarcity triggered a progressive increase in prices, which made gas less competitive than coal. In nominal terms, the fuel cost of gas to generate electricity rose by a factor of 3.5 from 2005 to 2020, whereas it merely doubled for

TABLE 1 Southeast Asia's coal balance, 2017 (in thousands of tons of oil equivalent)

	Production	Imports	Exports	Stock changes	Supply	Net imports	Self-sufficiency
Brunei	0	0	0	0	0	0	N/A
Cambodia	27	928	0	54	1,009	928	3
Indonesia	262,706	3,053	217,381	N/A	48,378	-214,328	543
Malaysia	1,884	19,181	382	58	20,741	18,799	9
Myanmar	287	347	0	0	634	347	45
Philippines	6,298	13,105	3,258	682	16,827	9,847	37
Singapore	0	899	0	0	899	899	0
Thailand	4,105	14,770	28	-2,459	16,389	14,742	25
Vietnam	21,413	7,827	1,270	230	28,199	6,557	76
Total	**296,720**	**60,110**	**222,319**	**-1,435**	**133,076**	**-162,209**	–

SOURCE: IEA, "Data and Statistics."

[9] See Electricity Generating Authority of Thailand, "Annual Report 2019," 2019, 134, https://www.egat.co.th/en/information/annual-report.

[10] IEA, "Data and Statistics."

[11] See Natalie Bravo and Nikos Tsafos, "Indonesia: The Nexus of Gas and Electricity," National Bureau of Asian Research, NBR Special Report, no. 53, December 1, 2015, https://www.nbr.org/publication/indonesia-the-nexus-of-gas-and-electricity.

coal during the same period. As a result, by 2019 gas was 42% more expensive per kilowatt hour of electricity produced than coal.[12] Furthermore, Malaysia is a major gas exporter, and gas (along with oil) is an essential source of revenue for the government. Thus, maintaining gas exports could become a higher priority than generating cheap electricity.

For other countries—such as Vietnam and the Philippines—gas use in power generation has tracked with the development of indigenous gas resources. Both countries built a gas industry on the back of domestic supplies, and when those supplies peaked, the countries proved unable to manage the process of enabling liquefied natural gas (LNG) imports and instead turned to coal. Thailand, by contrast, managed to supplement domestic production with imports of pipeline gas and later LNG. The country thus has avoided reliance on coal generation, at least directly, even though imported gas has often been expensive. What explains this variation across the region, therefore, is not just cost but institutional capacity and commitment, the relative power and influence of bureaucracies, and the familiarity with different options, among other factors. Coal has won not because it is cheaper—it often was not—but because it is easy to implement, powerful constituencies knew how to deploy and scale up projects, and big coal plants could deliver a lot of electricity and often enable supply chains that bring politically salient rents and jobs.[13]

This trajectory also underscores the difficulty in simply blaming China for the region's turn to coal. For one, the boom far predates China's Belt and Road Initiative, and there has been little discernible acceleration in coal use in recent years that could be attributed to Chinese financing. Understanding China's role in enabling the boom in coal-fired power generation is tricky, however—not least because the data available for a full analysis is often lacking. There is good evidence, for example, that China has favored coal over other electricity-generation technologies.[14] Yet one estimate found that Chinese companies built less than 20% of the coal-fired generation added in emerging Asia from 2013 to 2022.[15] Country-level analysis shows an even more mixed picture.

In Indonesia, the International Energy Agency estimates that 43% of the funds provided for coal-fired plants commissioned between 2016 and 2019 came from China.[16] A World Bank report on financing electricity generation in Vietnam from 2010 to 2017 shows a diverse funding picture, but without providing a precise breakdown of Chinese financing. There is, however, a mix of domestic and foreign sources, both public and private.[17] In the Philippines, much of the financing comes from the domestic banking sector, although domestic banks, of course, can have international linkages that lead to indirect financing of coal plants.[18] In Pakistan, China often responds to what local governments ask of it—it is financing coal in Pakistan in part because

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12 Tenaga Nasional Berhad, "Financial Info," https://www.tnb.com.my/suppliers-investors-media-relations/financial-info.

13 See also Mark C. Thurber, *Coal* (Cambridge: Polity, 2019).

14 See Figure 1 in IEA, "Chinese Companies Energy Activities in Emerging Asia," April 23, 2019, https://webstore.iea.org/chinese-companies-energy-activities-in-emerging-asia.

15 Emerging Asia also includes Pakistan and Bangladesh. In this report, Chinese involvement is focused on Chinese contractors used for construction. IEA, "Chinese Companies Energy Activities in Emerging Asia."

16 IEA, "Attracting Private Investment to Fund Sustainable Recoveries: The Case of Indonesia's Power Sector," July 2020, https://www.iea.org/reports/attracting-private-investment-to-fund-sustainable-recoveries-the-case-of-indonesias-power-sector.

17 World Bank, "Vietnam: Maximizing Finance for Development in the Energy Sector," December 2018, http://documents.worldbank.org/curated/en/290361547820276005/Vietnam-Maximizing-Finance-for-Development-in-the-Energy-Sector.

18 See, for example, Office of the Compliance Advisor/Ombudsman, "Philippines / Rizal Commercial Banking Corporation (RCBC)-01," filed October 11, 2017, http://www.cao-ombudsman.org/cases/case_detail.aspx?id=1266.

coal is what the country wanted.[19] China is of course not alone in funding coal projects. Since 2016 the Japan Bank of International Cooperation (JBIC) has financed four coal-fired projects in Indonesia and three in Vietnam, providing over $6.3 billion in funds for over 8.4 gigawatts (GW) of generation capacity.[20] The Export-Import Bank of Korea is often found alongside JBIC in both Vietnam and Indonesia.[21] The boom in coal, in other words, has been funded by diverse sources that differ by country and whose durability is driven as much by a pull from the region as by a push from the outside.

The Role of Gas

Coal has largely displaced gas in market share. The relative decline in the role of natural gas has often tracked trends in domestic production. In Vietnam and the Philippines, for example, all the gas consumed in the power sector is produced locally. Both countries have failed, despite ongoing efforts, to build the infrastructure to import LNG. In Malaysia, gas-based electricity generation has fluctuated around a narrow band for a decade. In part, this reflects a perception emerging in the late 2000s that Malaysia was exhausting its gas resources and should instead focus on coal. The more recent uptick in gas production reflects a continued preference for gas exports and the revenues they generate. In fact, Malaysia is both an exporter and an importer. There has been a modest intra-Malaysia flow of LNG, but most of the country's LNG intake came from Australia in 2019.[22] In Indonesia, generation from gas has continued to increase, albeit at a much slower pace than coal. This reflects a clear desire to prioritize domestic use at a time when overall production is declining (manifest in the growing intra-Indonesia LNG trade).[23] Thailand is an outlier when it comes to the role of gas as a primary energy source. Even though in the power sector the market share of gas has declined recently, it remains higher than in other countries.[24] Thailand boosted gas prices before other countries, in part because it started pipeline imports from Myanmar in 2000.

How well gas does in the future, therefore, will not merely be a matter of price, although the relative abundance of global LNG supplies that has helped push prices to historic lows should encourage adoption by countries previously afraid of the sticker shock of high prices. That said, more than competitive prices are needed. A government commitment is paramount, either in directing domestic state-owned enterprises to build infrastructure and procure supplies or in creating an environment where gas can compete. For example, governments must ensure market-based prices for electricity and enable generators to recover costs and earn a return on their investment in order to help unlock the private capital needed for the sector to thrive.

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[19] Erica Downs, "China-Pakistan Economic Corridor Power Projects: Insights into Environmental and Debt Sustainability," Columbia University, Center on Global Energy Policy, October 2019, https://energypolicy.columbia.edu/research/report/china-pakistan-economic-corridor-power-projects-insights-environmental-and-debt-sustainability.

[20] Data is from the Japan Bank for International Cooperation, "Annual Report for FY2019," 2019, 31, and various press releases, https://www.jbic.go.jp/en/information/press/index.html.

[21] Examples include the Nghi Son 2 and Mong Duong II coal-fired projects in Vietnam and the Cirebon project in Indonesia.

[22] International Group of Liquefied Natural Gas Importers, "GIIGNL 2020 Annual Report," 2020, https://giignl.org/publications.

[23] The overall gas consumption in Indonesia remains largely flat according to the BP Statistical Review of World Energy. The IEA database on electricity generation by source, which only goes to 2017, shows a general increase in power generation from gas.

[24] Energy Policy and Planning Office (Thailand), "Table 5.5-1: Import of Electricity," http://www.eppo.go.th/index.php/en/en-energystatistics/electricity-statistic.

The Recent Boom in Renewables

The shift to coal-fired generation over the past two decades should not obscure the trend toward renewable energy—in particular, wind and solar (see **Table 2**).[25] The growth in generation capacity is still recent, and its durability remains to be seen. From 2015 to 2019, generation capacity from solar increased almost sixfold, from under 2 GW to over 11 GW. The majority of this increase came from Vietnam and Thailand, although most countries have seen a sharp

TABLE 2 Southeast Asia's installed capacity of solar and wind power (megawatts)

	Solar energy					
	2015	**2016**	**2017**	**2018**	**2019**	**% total**
Brunei	1	1	1	1	1	0.1
Cambodia	12	18	29	28	98	4.3
Indonesia	51	58	60	62	197	0.3
Malaysia	229	278	370	536	882	2.5
Myanmar	21	32	44	48	88	1.4
Philippines	165	776	897	897	922	3.6
Singapore	46	97	118	160	255	1.8
Thailand	1,425	2,451	2,702	2,967	2,987	5.7
Vietnam	6	6	9	106	5,695	10.3
Total	**1,956**	**3,717**	**4,230**	**4,805**	**11,125**	**4.3**
% total	***1.0***	***1.7***	***1.8***	***2.0***	***4.3***	**–**

	Wind energy					
	2015	**2016**	**2017**	**2018**	**2019**	**% total**
Brunei	0	0	0	0	0	0.0
Cambodia	0	0	0	0	0	0.0
Indonesia	1	1	1	76	76	0.1
Malaysia	0	0	0	0	0	0.0
Myanmar	0	0	0	0	0	0.0
Philippines	427	427	427	427	427	1.7
Singapore	0	0	0	0	0	0.0
Thailand	234	507	628	1,103	1,507	2.9
Vietnam	136	160	205	237	374	0.7
Total	**798**	**1,095**	**1,261**	**1,843**	**2,384**	**0.9**
% total	***0.4***	***0.5***	***0.5***	***0.8***	***0.9***	**–**

SOURCE: IRENA, *Renewable Capacity Statistics 2020*.

[25] IRENA, *Renewable Capacity Statistics 2020*.

increase in solar capacity. By 2019, solar accounted for 10% of Vietnam's installed capacity and almost 6% of Thailand's. In wind, the growth has been somewhat smaller and more concentrated: capacity has grown threefold from 800 MW in 2015 to 2,384 MW in 2019, once again driven by Thailand and Vietnam.

Southeast Asia has learned from the experience of other regions.[26] The growth in solar in Vietnam was enabled by generous feed-in tariffs, which enabled over 5 GW of capacity to be added in 2019. Some countries have introduced auctions, while others are encouraging the direct procurement of renewable energy by corporations, following the example of countries in other regions. As elsewhere, countries that have offered strong policy support for renewable energy have been rewarded by greater investment from the private sector.

These efforts are made easier by the continued declining cost of both wind and solar worldwide, which has come from increased deployment of these technologies. This has made renewables cheaper and more politically palpable. This boom, of course, is still in its infancy, and experience shows that countries must keep tinkering with the model to sustain investor interest. As renewables start grabbing market share, accessing the grid and managing intermittency become bigger questions, especially for systems that have been centered on one major state-owned utility. Even so, there is no doubt that Southeast Asia still sees the potential of wind and solar and is embracing it—often quickly.

Conclusion: Competing Geopolitics and the Next Steps for Cooperation

For the United States, any strategy toward Southeast Asia must begin with certain basic truths. First, there remains an urgent need to provide electricity in the region: over 600 million people live in countries where per capita electricity consumption is below the world average. There is no durable strategy for achieving this goal that does not entail a sustained, significant, and speedy increase in electricity generation. Second, U.S. strategy must navigate the complex and overlapping goals that different countries have. There is clearly a cleavage around China's role in Southeast Asia's electricity generation, but many countries have no wish to antagonize China or make a choice between Washington and Beijing.

Similarly, there is no uniformity when it comes to fuel choices. The United States exports both coal and gas to Asia. Japanese companies are building and financing coal plants, but Japanese utilities are also interested in the region as a possible market for surplus LNG. Australia might have a clearer geopolitical alignment with the United States vis-à-vis China, but as a major exporter of both coal and gas, its energy interests are diverse (and its engagement in geoeconomics is more limited anyway). Due to these overlapping interests, language often means different things to different countries. This is evident in disputes about Japan's support for coal-fired generation. In the past, Japanese officials have made a distinction between coal investment in general and investment using cutting-edge technologies that reduce some of the environmental side effects from coal-fired generation (chiefly related to air pollution). This ambiguity can sometimes be constructive; other times it can lead to tension.

[26] See IEA, "Southeast Asia Energy Outlook 2019," October 2019, https://www.iea.org/reports/southeast-asia-energy-outlook-2019; and IRENA, *Renewable Energy Market Analysis: Southeast Asia* (Abu Dhabi: IRENA, 2018), https://irena.org/publications/2018/Jan/Renewable-Energy-Market-Analysis-Southeast-Asia.

In concrete terms, the United States must continue to support long-standing policies: encourage countries to introduce market reforms and reduce subsidies; ensure that private capital has an opportunity to compete; make procurement processes transparent and open to all; strengthen social and environmental standards; improve local institutions to conceive, plan, negotiate, and oversee megaprojects; nurture civil society to investigate abuse and hold parties accountable; and ensure a sensible dispute resolution mechanism that is not overly biased toward one party. Such goals can be achieved both diplomatically as well as economically, chiefly by leveraging new institutions that the United States has created for that purpose.[27]

However, this strategy must also evolve to match the realities on the ground. Often, U.S. policy seems to consist of a standardized checklist—a "gold standard"—that projects must meet in order to secure private investment or U.S. economic support. Such aspirations are healthy, but they often mean, in practice, that countries are turned away and look to China instead. Sometimes, technical assistance and support can nudge a country toward that gold standard. But other times a more flexible approach with greater risk could unlock more capital and come closer to meeting the region's needs. More importantly, it is essential to find a way to allow Chinese investment. A project cannot face a choice of taking money from either China or the United States; it must be possible, under the right conditions, to get both. This would require, above all, a change in mindset in the U.S. government and a willingness to judge investment based on whether it serves U.S. interests more generally, and not simply on whether the funds or contractors are coming from China.[28] These two modest shifts could enhance the more traditional aspects of U.S. policy and enable Southeast Asia to meet its electricity needs in an environmentally and socially sustainable manner.

[27] Nikos Tsafos, "The Role of LNG in the United States' Indo-Pacific Strategy," in "Revolutionizing LNG and Natural Gas in the Indo-Pacific," NBR, NBR Special Report, no. 81, October 17, 2019, https://www.nbr.org/publication/revolutionizing-lng-and-natural-gas-in-the-indo-pacific.

[28] See Sarah Ladislaw and Nikos Tsafos, "Race to the Top: The Case for a New U.S. International Energy Policy," CSIS, July 6, 2020, https://www.csis.org/analysis/race-top-case-new-us-international-energy-policy.

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Renewable Energy in Southeast Asia

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EXECUTIVE SUMMARY

This essay explores the current status and future role of renewable energy in Southeast Asia's power-generation system, reviews obstacles to energy diversification, and analyzes specific policy successes and failures in supporting rapid deployment.

MAIN ARGUMENT

The ten members of the Association of Southeast Asia Nations (ASEAN) are set to double their capacity for power generation through 2040 in order to meet projected increases in demand. Despite a shared renewable energy target of 23% by 2025, most countries in Southeast Asia are transitioning slowly toward modern renewable technologies. Policymakers in many ASEAN countries face the simultaneous challenges of expanding power generation to meet rising demand, improving electricity access and grid reliability, and deploying renewable energy technologies. Widespread perceptions that renewable energy is expensive and too technically complicated to integrate have slowed the transition to clean energy. However, these perceptions are increasingly at odds with price trends and on-the-ground experiences, and policymakers around Southeast Asia are beginning to respond to these market shifts. The rapid deployment of solar power in Vietnam and the experiences with geothermal power in the Philippines and Indonesia offer important lessons for scaling up the renewable energy transition elsewhere in the region.

POLICY IMPLICATIONS

- The cost of solar and wind technologies has dropped rapidly, and new renewable energy projects are increasingly cost competitive with fossil fuel technologies. These trends provide policymakers with the opportunity to lower overall electricity costs while simultaneously improving the social and environmental sustainability of the power system.
- Initially low levels of variable renewable energy penetration are manageable through operational changes to grid dispatch and load planning, even for countries with relatively underdeveloped grid systems. Investment in the transmission and distribution system will support higher levels of penetration in the future.
- Adjusting the policy and regulatory environment to manage investment risk in renewable technologies is key to attracting private-sector investment.

Although the growth of energy demand in Southeast Asia has declined slightly in recent years due to improved energy efficiency and economic shifts, the International Energy Agency still estimates that the region's demand will grow 60% through 2040. Meeting these needs will require major investments in new power generation and transmission infrastructure. Although stated power development plans in the Association of Southeast Asian Nations (ASEAN) reveal that most new demand will be met by traditional power sources, climate change considerations are increasingly focusing policy and investor attention on the need for clean energy alternatives. ASEAN countries have set a target of meeting 23% of the region's primary energy supply with renewable energy by 2025, which will require a rapid expansion of renewable electricity generation.

While the ten ASEAN members agree on the overall target, there are some differences in terms of how each nation defines renewable energy and which types of renewable energy have been prioritized, as well as significant variation in how each will pursue the target and their progress to date. Current plans, by and large, include explicit mention of meeting renewable energy targets through development of hydropower, geothermal, wind, biomass, and solar photovoltaic power generation. Yet these plans do not exclude emerging technologies such as concentrated solar power or large-scale battery storage.

This essay will first explore the current status of renewable energy sources like hydropower, biomass, wind, and solar across ASEAN. The subsequent section will identify and address some of the obstacles to rapid deployment of renewable energy, particularly low rates of electrification in some countries, concerns over cost, and challenges related to grid integration of variable solar and wind technologies. Finally, the essay will consider case studies of solar and geothermal deployment and identify key policy lessons that could be applied elsewhere in ASEAN to support the renewable energy transition.

The Current State of Renewable Energy

The region as a whole remains highly dependent on fossil fuels for electricity generation: Brunei and Singapore are almost entirely dependent on natural gas, and more than 60% of electricity generation in Thailand, Vietnam, Malaysia, the Philippines, and Indonesia comes from a mix of coal and natural gas (see **Table 1**). All ASEAN countries have identified national renewable energy targets, but renewable energy—including hydropower, geothermal, solar, wind, and modern biofuels—only satisfies 15% of Southeast Asia's energy demand as of 2019.[1] Meeting the shared target of 23% will require massive expansion of renewable energy generation in coming years.

Hydropower is by a significant margin the largest non–fossil fuel contributor to power generation in Southeast Asia. It currently provides the majority of electricity generation in Laos (75%), Cambodia (64%), and Myanmar (55%)[2] and contributes to a lesser, but by no means insignificant, degree in Thailand, Vietnam, Indonesia, Malaysia, and the Philippines. Cambodia, Indonesia, Laos, Malaysia, and the Philippines all have plans to expand large-scale hydropower generation in coming decades, and all of the aforementioned eight nations will likely expand

[1] International Energy Agency (IEA), "Southeast Asia Energy Outlook 2019," October 2019, 7, https://www.iea.org/reports/southeast-asia-energy-outlook-2019.

[2] Percentages for Laos's, Cambodia's, and Myanmar's reliance on hydropower are drawn from "Mekong Infrastructure Tracker," Stimson Center, May 25, 2020, https://www.stimson.org/2020/mekong-infrastructure-tracker-tool.

TABLE 1 Existing installed energy capacity in Southeast Asia (percentage of energy mix)

	Coal	Gas	Oil	Hydropower	Small-scale hydropower	Biomass	Geothermal	Renewable energy	Other
Brunei (2017)	–	99.0	0.5	–	–	–	–	0.5	–
Cambodia (2020)*	30.2	–	2.5	62.3	–	–	–	3.5	1.5
Indonesia (2018)	57.0	29.0	1.6	–	–	–	–	12.4	–
Laos (2020)*	19.0	–	–	79.0	1.0	1.0	–	–	–
Malaysia (2017)	44.0	38.0	1.0	16.0	–	0.5	0.0	0.5	–
Myanmar (2016)	3.0	35.6	1.0	60.3	–	–	–	0.1	–
Philippines (2017)	50.0	22.0	4.0	10.0	–	1.0	11.0	1.0	1.0
Singapore (2017)	1.3	94.9	0.7	–	–	0.5	–	0.3	2.3
Thailand (2018)	18.0	57.0	1.0	5.0	–	–	–	19.0	–
Vietnam (2018)*	38.0	15.0	–	35.0	6.0	–	–	6.0	–

SOURCE: IEA country profiles; ERIA 2020 Outlooks for individual countries" and "Mekong Infrastructure Tracker."

NOTE: Asterisk indicates information on installed capacity.

small-scale and micro hydropower. However, hydropower is not without controversy. Due to the significant non-climate environmental and social impacts associated with large-scale dams, many stakeholders note that hydropower may be renewable but is not necessarily sustainable or clean. Impacts on regional food security as well as environmental impacts on biodiversity and the natural flow of water and sediment have been particularly well-documented in the Mekong region, but hydropower's attractiveness for policymakers lies in its familiarity and local availability. Nonetheless, rising costs and growing understanding of how drought and climate change affect hydropower productivity may stall stated plans to expand large-scale hydropower.

Following hydropower, geothermal and biomass have the greatest historical footprint as renewable energy sources in the region. Although geothermal makes up a nominal amount of the global energy mix, Southeast Asia's location along the volcanically active Ring of Fire makes it highly suitable for geothermal power generation. Indonesia and the Philippines currently have the second and third most installed capacity for geothermal energy globally, with 2,133 megawatts (MW) and 1,988 MW, respectively.[3] Though not all ASEAN countries have geothermal potential,

[3] Alexander Richter, "The Top 10 Geothermal Countries 2019—Based on Installed Generation Capacity (MWe)," Think GeoEnergy, January 27, 2020, https://www.thinkgeoenergy.com/the-top-10-geothermal-countries-2019-based-on-installed-generation-capacity-mwe.

both Indonesia and the Philippines have significant remaining geothermal resources that could be tapped to meet future energy demands.

It is impossible to discuss biomass without recognizing that for millions in developing countries around the world solid biomass is a key fuel source used for cooking and heating. As of 2018, traditional biomass still provided for nearly 10% of Southeast Asia's energy demand and was the main energy source for 45 million people without access to electricity.[4] Modern bioenergy is produced in biogas and biomass facilities, and in 2019 it provided approximately 3% of the region's power generation.[5] Thailand, Malaysia, and Indonesia have all introduced modern biogas digestors and other biomass inputs into the electricity supply chain. There is also a policy interest in exploring further use of liquid biofuels as an alternative to fossil fuels in the transportation sector. However, there are supply chain challenges in normalizing the collection of agricultural waste for offsite use and pricing it as a fuel input. Thailand has been a leader in bioenergy, with approximately 3,000 MW of installed biomass and biogas power plants, but there have been recurring challenges to developing and managing supply chains.[6] Some biomass plants in Thailand have faced recurring shortages of material, due in part both to seasonality of individual agricultural byproducts and to challenges of coordinating contracts and supply chains across a large number of small family farmers.

Wind and solar power are the latest major renewable technologies to gain a foothold in Southeast Asian markets. Pilot commercial projects for both wind and solar began in the mid-2000s. While solar radiation levels are sufficiently high throughout most of the region to support solar power on a commercial scale, high-quality wind resources are more concentrated along the coastlines and some inland areas in Indonesia, Myanmar, Thailand, and Vietnam.[7] In particular, Vietnam, Thailand, and the Philippines have all adopted policies and targets to support the buildout of wind power plants such as zoning or permitting processes and feed-in tariffs. The Philippines had more than 427 MW installed as of 2018,[8] and Thailand and Vietnam each have roughly 1,000 MW installed as of 2020.[9] However, the pace of investment has not been as rapid as some analysts expected due to low feed-in tariffs and other risks as well as bankability challenges.

Solar has only become a fixture in ASEAN countries in the last five years, but its use is expanding rapidly and providing constructive disruption to the regional electricity market. Despite having relatively high average solar irradiation, and therefore relatively high solar potential, Southeast Asia at large has lagged behind the rest of the world in adopting supportive policies. Thailand was an early adopter of a feed-in tariff and for years led the region in terms of installed capacity. Yet, starting in 2016 other ASEAN countries began to seriously explore solar projects as the price of solar dropped rapidly. The scale-up has been swift in some places: Vietnam went from having almost no installed solar power in 2017 to more than 4,500 MW in 2019, surpassing Thailand.[10]

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4 IEA, "Southeast Asia Energy Outlook 2019," 7.

5 Ibid., 27.

6 "Biomass Ventures in Thailand," Pugnatorius, February 4, 2020, https://pugnatorius.com/biomass; and Ministry of Energy (Thailand), "Biomass Database Potential in Thailand," http://weben.dede.go.th/webmax/content/biomass-database-potential-thailand.

7 International Renewable Energy Agency (IRENA) and ASEAN Centre for Energy, *Renewable Energy Outlook for ASEAN* (Abu Dhabi: IRENA, 2016), 40.

8 Department of Energy (Philippines), *Empowered: Renewable Energy Decade Report 2008–2018* (Taguig, January 2019), 119, https://www.doe.gov.ph/sites/default/files/pdf/renewable_energy/empowered-re-decade-report-2008-2018.pdf.

9 "Mekong Infrastructure Tracker."

10 Julia Nguyen, "Vietnam's Solar Industry: Bright Prospects for Investors," Vietnam Briefing, August 10 2020, https://www.vietnam-briefing.com/news/vietnams-solar-industry-bright-prospects-investors.html.

Malaysia held its first large-scale solar auction in 2016 and now has approximately 1,500 MW in solar projects under development.[11] Cambodia's first project went online in 2017, and Cambodian policymakers are now pushing for solar to make up 20% of total installed capacity by 2023.[12] Myanmar held a 1,060 MW solar tender in 2020 and awarded tenders to 30 companies that offered prices between 37% and 57% lower than the current average cost.[13]

Challenges to the Renewable Energy Transition

Many policymakers in ASEAN support the clean energy transition in principle but are unable to prioritize it given the political and economic impetus to first meet basic electricity needs for their citizens. Electrification rates vary across ASEAN countries: Singapore, Brunei, Thailand, and Vietnam have had nearly universal electricity access for years, while Cambodia, Myanmar, and Indonesia are home to many of the 45 million people throughout Southeast Asia still lacking electricity access. Progress toward electrification has intensified in recent years: Myanmar's electrification rate rose from only about 35% in 2014 to just over 50% by the end of 2019,[14] and Indonesia announced in late 2019 that 98% of households now have electricity access.[15]

Within this context, the arguments against renewable energy—particularly solar and wind—often come down to two points. First, renewable energy is expensive compared to traditional power sources; and second, variable energy is technically difficult to integrate.

Manufacturing is a key component of the region's economy, and investment in energy-intensive industries like manufacturing is often determined partially by energy costs. The combination of this factor and severely limited spending power from domestic consumers means that cost is the first consideration for many energy planners in ASEAN countries.

While solar and wind technologies may have been economically noncompetitive in the early 2010s, the levelized cost of energy for both has dropped drastically. Globally, since 2010 the prices of solar and wind have dropped 82% and 40%, respectively.[16] This is largely due to economies of scale in production capacity, growing trust in the technologies that translate into improved policy environments and financing terms, and in the case of solar the utilization of an auction system as an alternative to subsidies and feed-in tariffs. As a result, prices are increasingly competitive. The International Renewable Energy Agency's global dataset indicates that 75% of new wind projects and 40% of new utility-scale solar projects were cheaper than the most affordable new fossil fuel power plant.[17] This trend has been seen in Southeast Asia, where new solar projects in both Cambodia and Malaysia undercut traditional alternatives like coal, gas, and hydropower.[18] As the

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11 Wan Syakirah Wan Abdullah et al., "The Potential and Status of Renewable Energy Development in Malaysia," *Energies* 12, no. 12 (2019): 2437.

12 Thou Vireak, "Gov't to Reduce Reliance on Hydro," *Phnom Penh Post*, July 8, 2019, https://www.phnompenhpost.com/business/govt-reduce-reliance-hydro.

13 Kyaw Ye Lynn and Thomas Kean, "Chinese Companies Dominate Myanmar Solar Tender," China Dialogue, September 22, 2020, https://chinadialogue.net/en/energy/chinese-companies-dominate-myanmar-solar-tender.

14 Nay Yaing and Zeyar Tun, "Over 50% of Myanmar to Have Access to Electricity by December," Eleven Media, December 6, 2019, https://elevenmyanmar.com/news/over-50-of-myanmar-to-have-access-to-electricity-by-december.

15 Stefanno Reinard Sulaiman, "Govt Says 98.05 Percent of Households Have Electricity. What Does It Mean?" *Jakarta Post*, January 23, 2019, https://www.thejakartapost.com/news/2019/01/23/govt-says-98-05-percent-of-households-have-electricity-what-does-it-mean.html.

16 IRENA, *Renewable Power Generation Costs in 2019* (Abu Dhabi: IRENA, 2020), https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019.

17 Ibid., 14

18 Koustav Samanta and Roslan Khasawneh, "Cheaper Solar Power Gains Ground in Southeast Asia," Reuters, October 31, 2019, https://www.reuters.com/article/us-singapore-energy-solar/cheaper-solar-power-gains-ground-in-southeast-asia-idUSKBN1XA1KJ.

economics have shifted, many governments in the region have begun to rethink their national energy policies and priorities. Some—particularly Laos, Myanmar, Indonesia, and Brunei—have not yet adopted clear supportive policies that would enable a rapid scaling up of solar power, but most governments are slowly moving in that direction.

The second challenge is tied both to the intermittent nature of solar and wind energy and to the challenges of grid management. The grids in many ASEAN countries are already in need of expansion and modernization. Simply being connected to the grid does not necessarily ensure that a household or business has consistent or reliable access to electricity. For example, a local study in Jakarta found that low voltage and interruptions were common obstacles.[19] Likewise, Phnom Penh faced months-long rolling blackouts during the dry season in 2019 due to severe drought disrupting hydropower production.[20] Given that both communities have nearly universal electricity access in terms of grid connection, their short-term blackouts due to supply-and-demand imbalances or other disruptions emphasize the importance of stabilizing the electricity supply.

The cause of these disruptions is often insufficient power infrastructure. Many Southeast Asian countries face the simultaneous challenges of meeting rising electricity demand while also building out national electricity grids and regional interconnections. In the Greater Mekong Subregion, Thailand and Vietnam are both seeking to expand connectivity between provinces, while Cambodia, Laos, and Myanmar all have incomplete national grids. Myanmar's situation is unique given its history of ethnic conflict and local control, which to this day limits national connectivity. However, Cambodia, Laos, and Myanmar all face the challenge of providing electricity access to areas with relatively low population density, mountainous terrain, and financial constraints on public spending.

Indonesia, the Philippines, and parts of Malaysia face similar difficulties but are additionally challenged by island geography. While a large percentage of maritime Southeast Asia's population clusters on islands large enough to support a traditional electricity grid, the region's archipelagic nature—with thousands of inhabited islands—has necessarily led to fragmentation and uneven distribution of electricity access. Unlike on the mainland, where smaller population areas are often off the grid but will in the near to medium term connect to a national grid, it is technically difficult and expensive to connect smaller islands to existing grids via subsea cables. While this fragmented grid system makes distributed generation and small-scale renewable technology uniquely suitable for remote areas, the relatively underdeveloped power systems in many ASEAN countries pose technical and operational challenges to integrating commercial-scale renewable energy into the grid. Solar and wind both produce variable amounts of electricity depending on when the sun is shining or the wind is blowing. Managing sudden surges or drops in electricity production due to cloud cover or decreased wind poses a challenge to grid operators who must maintain system stability by balancing the load on a moment-to-moment basis.

Particularly in countries with underdeveloped grids where most electricity production comes from highly predictable fossil fuel power plants or hydropower operations, integration of variable energy sources may require transmission system upgrades or operational shifts. This challenge

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[19] Sarah Martin and Hening Marlistya Citraningrum, "Beyond a Connection: Improving Energy Access in Indonesia with Open Data," World Resources Institute, March 9, 2017, https://www.wri.org/blog/2017/03/beyond-connection-improving-energy-access-indonesia-open-data.

[20] Phorn Bopha, "As Power Cuts Cripple Cambodia, Generator Sales Soar," Voice of America, May 24, 2019, https://www.voacambodia.com/a/as-power-cuts-cripple-cambodia-generator-sales-soar/4930097.html; and David Hutt, "Cambodia Struggles to Keep the Lights On," *Asia Times*, December 2, 2019, https://asiatimes.com/2019/12/cambodia-struggles-to-keep-the-lights-on.

is not insurmountable. As renewable energy makes up an increasing percentage of the electricity system, integration of smart-grid technology to intricately track shifts in supply and demand and battery storage will be vital to ensure system stability. When the portion of the overall energy mix coming from renewable energy is relatively low, the system can largely be managed by operational shifts such as improving weather forecasting, planning for advanced loads, giving faster and more regular dispatch updates, or prioritizing dispatch of renewable energy generation over traditional power sources. Studies by the Asian Development Bank (ADB) indicate that even relatively underdeveloped power systems, such as Cambodia's, can integrate up to 10% variable renewable energy without difficulty.[21] This level is easily higher in countries with more developed grids and existing baseloads, particularly as the prices of battery storage and other technical upgrades to the grid continue to drop.

Unexpected Solar Success: Vietnam

Although Thailand was the earliest ASEAN country to begin supporting solar power, Vietnam stands out as the region's model for how solar investment can rapidly move forward in an improved policy environment. After years of debate, Vietnam in 2017 announced a series of policy changes to promote renewable energy, which it defines primarily as solar, wind, and biomass. The first of these was an attractive feed-in tariff for solar power of 9.35 U.S. cents per kilowatt hour (c/kWh), with some variation by type and regular anticipated revision depending on market conditions. At the same time, Vietnam also clarified policies on a series of other issues related to risk and bankability, such as establishing a template for power purchase agreements (PPAs), providing tax exemptions for equipment and land rental fees, and committing the utilities company Electricity Vietnam to offtake the power output from grid-connected projects. PPAs are important for the viability of a project because they ensure that the project has a market for its power after construction and can be used to estimate income. The specific terms of a PPA can help manage risk in the eyes of investors and are often required to secure good financing terms for project developers.

While there is still some criticism of Vietnam's solar PPA—particularly the relatively high-risk terms compared to those for coal and oil power plants—the provision of legal standards and a relatively generous feed-in tariff unlocked significant investment. Vietnam's installed capacity rose from 134 MW in 2018 to more than 5,000 MW by the end of 2019,[22] surpassing that of Thailand in two years.[23] According to Vietnam Electricity, more than 25,000 MW of additional solar projects are currently registered for future development.[24] This is magnitudes higher than the levels of investment that were originally anticipated, and Vietnam has already surpassed its 2025 target of 4,000 MW of installed solar capacity.

Despite this success, Vietnam's experience offers cautionary lessons. The lack of existing transmission lines in areas of heavy development has led to the curtailment of some projects and

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21 Asian Development Bank (ADB), *Cambodia: Energy Sector Assessment, Strategy, and Road Map* (Mandaluyong City: ADB, 2018), 7.

22 "Vietnam Becomes Southeast Asia's Hottest Solar PV Market," Wood Mackenzie, November 1, 2019, https://www.woodmac.com/press-releases/vietnam-becomes-southeast-asias-hottest-solar-pv-market.

23 Nguyen, "Vietnam's Solar Industry."

24 Hung Le, "Vietnam Set to Become a Solar Power Hotspot," *VnExpress International*, October 31, 2019, https://e.vnexpress.net/news/business/industries/vietnam-set-to-become-a-solar-power-hotspot-4004965.html.

difficulties managing surges of power for grid operators.[25] Projects facing curtailment are taking a hit on the return on investment, and local developers that have been deeply involved in the solar boom but do not have deep pockets may end up defaulting on projects. This would surely have an impact on future rollout.

These challenges and other shifting market conditions will result in continued policy adjustment, but Vietnamese policymakers view the success to date as the beginning of a transition. Politburo Resolution 55, passed in late 2019, clearly prioritizes wind and solar in electricity generation, with a target of replacing the maximum feasible amount of fossil fuel generation.[26] Power Development Plan VIII is still under development but will likely raise renewable energy targets to 25%–30% of the total primary energy supply and presumably a greater portion of electricity supply.

Slow Progress on Geothermal: Indonesia and the Philippines

Indonesia's potential geothermal reserves are the largest identified in the world, estimated at approximately 29,000 MW or 40% of the global total.[27] Indonesia's support for geothermal power began with regulatory clarification for power plants in 2003 and an initial target of developing 9,500 MW of geothermal power by 2025. The Philippines is less ambitious than Indonesia, partly due to lower reserves: it began exploring geothermal power in the 1960s, and by 2000 had installed nearly 2,000 MW.[28] Only around 1,000 MW of geothermal plants have been added to Indonesia's grid since 2010, and the Philippines has seen even lower levels of new capacity added during that time frame. A 2015 review of Indonesia's geothermal sector by the ADB and World Bank found that a range of institutional, regulatory, and tariff issues had stymied development targets.[29]

While the policy and regulatory environments in each country differ, one shared challenge is that the private sector is required to shoulder significant amounts of risk. The Philippines has limited foreign ownership of assets in key sectors, and this has affected the geothermal sector. Geothermal exploratory wells have significant upfront costs with no guarantee of return. The government bore much of the initial cost during earlier phases of development in the Philippines, but for new projects the private sector must bear exploratory costs. A similar situation exists for would-be investors in Indonesia, on top of the permitting process and other regulatory challenges that have delayed progress on geothermal projects in recent years.[30]

Both governments have recently indicated interest in pushing for further geothermal development. It is unclear whether the policy or regulatory regimes exist in either country to make geothermal an attractive investment opportunity compared to traditional power supplies or even new renewable alternatives such as solar and wind. There are some indications that Indonesia

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25 "Renewable Energy Has Not Met Potential: Conference," *Việt Nam News*, July 12, 2020, https://vietnamnews.vn/environment/749504/renewable-energy-has-not-met-potential-conference.html; and Dat Nguyen, "Vietnam Yet to Optimize Renewable Energy Utilization as Shortages Loom," *VnExpress International*, July 8, 2020, https://e.vnexpress.net/news/business/economy/vietnam-yet-to-optimize-renewable-energy-utilization-as-shortages-loom-4126932.html.

26 Central Committee of the Communist Party of Vietnam, "Politburo's Resolution 55-NQ/TW on the Orientation of the Viet Nam's National Energy Development Strategy to 2030 and Outlook to 2045," February 11, 2020, http://en.greenidvietnam.org.vn/politburos-resolution-55-nqtw.html.

27 IRENA, *Renewable Energy Prospects: Indonesia, a REmap Analysis* (Abu Dhabi: IRENA, 2017), 46.

28 Subir K. Sanyal et al., "Comparative Analysis of Approaches to Geothermal Resource Risk Mitigation: A Global Survey," Energy Sector Management Assistance Program, March 2016, 23.

29 ADB and World Bank, *Unlocking Indonesia's Geothermal Potential* (Mandaluyong City: ADB, 2015), 1.

30 Stephen Naimoli and Jane Nakano, "2018 Compendium Report: Renewable Energy in Southeast Asia," Center for Strategic and International Studies, October 2018, 17.

is moving to de-risk new projects. In 2019 the World Bank provided financial support to help mitigate risk for companies interested in exploration,[31] and in July 2020 government stakeholders announced that they are considering an incentive scheme to reimburse companies for exploration activities and provide a tax holiday to help offset high upfront capital costs.[32] Indonesia is also likely to announce a new feed-in tariff scheme that will support geothermal development alongside other renewable energy options, but the ongoing challenges have compelled the government to downsize the target and shift it five years later to 2030.[33] The Department of Energy in the Philippines has similarly sought to simplify the permitting process in recent years, with unclear success.[34] However, in October 2020 the Philippines changed national policy so that geothermal projects—which previously had to abide by majority national ownership requirements throughout the project development cycle—could now be wholly foreign-owned.[35]

Conclusion: Lessons Learned for Scaling Up

Vietnam's experience in rapidly scaling up solar investment shows what the private sector can contribute when the policy environment for renewable energy is improved. Conversely, the persistent challenges of deploying proven geothermal technology in Indonesia and the Philippines highlight the difficulties of attracting investment when the regulatory environment does not effectively manage risk. If ASEAN countries are collectively determined to meet their energy needs in line with the shared target for increasing renewable energy and mitigating future impacts of climate change, most will need to reconsider their policies and investment incentives for renewable energy.

The Covid-19 pandemic has severely disrupted the global economy and investment environment. This is particularly true for the energy sector, which has seen clear short-term shifts in energy use. Several infrastructure projects have been put on hold due to uncertainties around future demand or concerns over financing in a new and less welcoming investment environment. Moreover, some of these changes may be long-lasting. Yet, while the pandemic is undoubtedly causing short-term pain, these disruptions may provide an opportunity for ASEAN countries that are just beginning to benefit from a clean energy transition to rethink their longer-term plans. As they prepare for the post-pandemic buildout of energy infrastructure, regional policymakers should consider optimizing national policies and limited public funding to support renewable energy technologies that will be resilient in the face of climate change and future economic shocks.

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31 "Indonesia: Scaling up Geothermal Energy by Reducing Exploration Risks," World Bank, Press Release, September 26, 2019, https://www.worldbank.org/en/news/press-release/2019/09/26/indonesia-scaling-up-geothermal-energy-by-reducing-exploration-risks.

32 Alexander Richter, "Indonesia Still Trying to Find Balance between Geothermal Tariffs and Investor Expectations," Think GeoEnergy, August 5, 2020, https://www.thinkgeoenergy.com/indonesia-still-trying-to-find-balance-between-geothermal-tariffs-and-investor-expectations.

33 Norman Harsono, "Geologic Time: Indonesia's Geothermal Dreams Deferred for 5 Years," *Jakarta Post*, June 16, 2020, https://www.thejakartapost.com/news/2020/06/16/geologic-time-indonesias-geothermal-dreams-deferred-for-5-years.html.

34 "The Philippines: Key Issues for Developing Renewable Energy Projects," Watson Farley & Williams, August 2018, https://www.wfw.com/wp-content/uploads/2018/08/WFWBriefing-Renewable-energy-Philippines.pdf.

35 Melinda T. Quinones, "PH Now Allows 100% Foreign Ownership in Large-Scale Geothermal Projects—DOE," Philippine Information Agency, October 27, 2020, https://pia.gov.ph/index.php/news/articles/1057204.

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High-Quality Infrastructure and the Free and Open Indo-Pacific Vision

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EXECUTIVE SUMMARY

This essay examines the energy initiatives rolled out by Japan and the U.S. as part of their "free and open Indo-Pacific" visions to compete with China's energy financing and investment in Southeast Asia as regional governments decide how to best meet rising electricity demand.

MAIN ARGUMENT

With Southeast Asia expected to see continued rapid economic and energy demand growth over the next two decades, policymakers are faced with the dual challenge of attracting the huge investments required to meet rising power demand while also transitioning toward a cleaner power mix. At the same time, the U.S. and Japan have begun initiatives to promote high-quality infrastructure (HQI) that can potentially help policymakers across the region achieve these goals. With an emphasis on transparency, these projects seek to mobilize private capital, in contrast to China's state-funded Belt and Road Initiative (BRI). However, to unlock the full potential of funding for HQI, policymakers must first understand and identify needed policy and market reforms.

POLICY IMPLICATIONS

- In order for HQI initiatives to succeed, there must be major energy policy reforms to attract the huge amount of investment and financing for power generation. Most importantly, reforming natural gas markets and pricing and opening up to private investment are required to take advantage of a surge in available, competitively priced liquefied natural gas (LNG) in Asia.
- To be successful, proponents of HQI need to finance, support, and accelerate the energy policymaking capacities, training, and skills required to evaluate new projects and investments in natural gas and renewable energy infrastructure. Environmental, transparency, procurement, and other reforms will lengthen and complicate the evaluation and decision-making process, resulting in the possible continuation of the policymaking default to simpler, more standard coal-fired power capacity, often from BRI sources.
- The U.S. and Japan, along with other partners, must prioritize mobilizing international private capital from investment funds, infrastructure funds, pension funds, sovereign wealth funds, and U.S. and Japanese companies to provide the investments and financing needed to make HQI initiatives successful. To effectively leverage the most private capital possible, they must carefully target their public share of funding.

Electricity demand growth in Southeast Asia has been among the world's fastest, rising 6% annually over the last two decades. The International Energy Agency's 2019 forecast predicts another twenty years of 4% annual growth to 2040.[1] Of course, this forecast was made before the coronavirus pandemic ushered in a global recession. But assuming some gradual economic recovery over the next few years, it seems likely that Southeast Asia's electricity demand and investment needs will continue to rapidly grow, albeit starting from a somewhat lower baseline. The Asian Development Bank (ADB) forecasts that the region will need on the order of $1.5 trillion annually over the next two decades to meet rising electricity demand to fuel economic growth, an expanding population, and rapid urbanization.[2] Mobilizing investment and financing on such a scale will require huge inflows from inside and outside the region.

At the same time that electricity investment needs are skyrocketing, the shape of Southeast Asia's electricity generation mix and its future trajectory are increasingly posing a profound challenge due to rising air pollution and carbon emissions. Since 2000, coal has cemented its baseload role in the region's generation mix, doubling its share region-wide from 20% to 40%.[3] Cleaner-burning natural gas for electricity generation has plateaued since 2010, and its share of the mix has declined sharply. During this period, hydropower made up the bulk of growth in renewables, while wind and solar hardly registered at all. Looking forward, given the low cost and abundant indigenous supply of coal, current trends suggest that coal will continue growing in use and retain its long-term role in the region's power mix. Regarding energy policy preferences, gas and liquefied natural gas (LNG) risk losing out to coal on affordability grounds and to wind and solar on environmental grounds. Deployment of modern renewables is expected to expand rapidly, but it remains unclear whether wind and solar can achieve the scale needed to reduce the underlying trend of rising coal use.

The inevitable results of this generation mix have been a severe deterioration in air quality and rapidly rising carbon emissions across the region. The health consequences have been catastrophic. Yet, while environmental outcomes are increasingly factoring into energy policy decisions in Southeast Asia, to what extent can energy sustainability and health concerns compete with the goals of providing cheap energy and meeting rising demand?

In sum, Southeast Asia faces a dual challenge of attracting the enormous investment needed to meet rising power demand while simultaneously trying to transition toward a cleaner power mix. This creates a dilemma for regional governments. Will they undertake energy market reform in order to attract large capital investments from private sources facilitated by Japanese and U.S. government funding, or will they tie their infrastructure needs to China's state-funded Belt and Road Initiative (BRI)?

To address this question, this essay will first survey the current landscape of Southeast Asia's energy infrastructure and the geopolitics involved. The subsequent sections will then describe the high-quality infrastructure (HQI) initiatives laid out by the United States and Japan and examine how they align with U.S. and Japanese interests in the region. The essay will conclude by examining the policies needed on the Southeast Asian side for infrastructure investment.

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[1] International Energy Agency (IEA), "Southeast Asia Energy Outlook 2019," October 2019, https://www.iea.org/reports/southeast-asia-energy-outlook-2019.

[2] Asian Development Bank (ADB), *Meeting Asia's Infrastructure Needs* (Mandaluyong City: ADB, 2017), https://www.adb.org/sites/default/files/publication/227496/special-report-infrastructure.pdf.

[3] IEA, "Southeast Asia Energy Outlook 2019."

Assessing the Geopolitical Landscape

Southeast Asia's scramble to meet its future electricity needs is not occurring in a vacuum but rather taking place amid a broader, intensifying geopolitical rivalry over future economic and political power in the Indo-Pacific. China's rising economic and political power and increasingly assertive posture over its regional interests run directly against the traditional regional dominance of the United States while also presenting a challenge to Japan's long-standing position as the major economic power in Asia and U.S. partner in the region.

The competition is manifest between China's BRI, on the one hand, and the expanding "free and open Indo-Pacific" (FOIP) strategic vision of the United States, Japan, and other regional partners, on the other. BRI has unleashed a tidal wave of infrastructure financing and investment across Eurasia, South Asia, and Southeast Asia. This has triggered concerns in the West about China's influence and economic power as well as the country's alternative views on Asia's geopolitical future and economic development. The FOIP concept has developed as a counter to China's expanding influence by bringing together the United States, Japan, Australia, and other regional partners to offer an alternative vision.

Much of China's BRI footprint has been aimed at investments in energy and power infrastructure. For example, the government of Pakistan notes that over a half of China's projected $39 billion investment in the China-Pakistan Economic Corridor is focused on electricity generation, with three quarters of the capacity from coal-fired power plants.[4] China has also invested more than $27 billion in energy projects in mainland Southeast Asia since 2013.[5] Its infrastructure investment under BRI has been criticized for relying on opaque deals with little public scrutiny. This investment is dominated by subsidized Chinese state-owned companies and financed by Chinese state banks, with little environmental input. It often features high interest rates and high guaranteed returns from host governments, thereby contributing to unsustainable debt burdens.

The concept of "high-quality infrastructure" should be viewed in the context of this geostrategic competition for influence with China. The United States and Japan are lining up with their partners to use energy investment to counter growing Chinese influence in Southeast Asia. For Japan, and increasingly the United States and Australia, HQI is a key differentiator in contrasting Western infrastructure development with China's brand of infrastructure investment. From this perspective, the concept denotes projects that are market-competitive, transparent, open-procurement, environmentally sound, a mix of private and public financing, and rules-based, with lower interest rates and financing that are consistent with sustainable debt burdens.

High-Quality Infrastructure Initiatives

The concept of HQI has evolved since 2015 through a veritable blizzard of new and expanded initiatives, bilateral and plurilateral agreements, and proposals initially developed by Japan but increasingly adopted by the United States and key regional partners such as Australia. Japan first

[4] Erica Downs, "China-Pakistan Economic Corridor Power Projects: Insights into Environmental and Debt Sustainability," Columbia University, Center on Global Energy Policy, Report, October 2019, 9, https://www.energypolicy.columbia.edu/sites/default/files/pictures/China-Pakistan_CGEP_Report_100219-2.pdf.

[5] "China Global Investment Tracker," American Enterprise Institute, https://www.aei.org/china-global-investment-tracker.

offered its vision in the 2015 Partnership for Quality Infrastructure, which aimed to mobilize $110 billion of financing and investment for Asia from 2015 to 2020 with key support from the Japan Bank for International Cooperation, Japan International Cooperation Agency, and ADB.[6] It is no coincidence that the initiative was announced within eighteen months of Xi Jinping's 2013 speech announcing BRI. In 2016, Japan expanded its proposal to take on a global focus in the upgraded Expanded Partnership for Quality Infrastructure, aimed at mobilizing $200 billion in financing and investment from 2016 to 2021. This also included key roles for Nippon Export and Investment Insurance and others in the energy sector.

Interconnected HQI Initiatives

In November 2017, Japan and the United States announced the Japan–United States Strategic Energy Partnership (JUSEP), which prioritizes "open and competitive energy markets" and energy infrastructure development that "adheres to principles of good governance, respect for the interests of all stakeholders, and transparency in bidding and financing; and expands access to the global energy market."[7] The two countries also state that "JUSEP is at the core of our joint efforts to achieve FOIP."[8] The partnership prioritizes advanced nuclear technologies; deployment of highly efficient, low-emissions coal technologies; and development of a global market for natural gas. In November 2018, Japan and the United States issued a joint statement—"Advancing a Free and Open Indo-Pacific through Energy, Infrastructure and Digital Connectivity Cooperation"—whereby Japan announced its intention to facilitate "high-standard investment in projects to supply liquefied natural gas (LNG) or build LNG infrastructure by aligning the Japanese government's target of $10 billion in public and private finance and capacity-building training."[9] In September 2019, Japan announced an increase of another $10 billion in public and private financing toward LNG market development in Asia.

In mid-2018 the United States advanced this vision with the launch of the Asia EDGE (Enhancing Development and Growth through Energy) program to promote new public and private energy investment in the Indo-Pacific. That same year, it enacted the BUILD (Better Utilization of Investments Leading to Development) Act, which created the U.S. International Development Finance Corporation as the successor agency to the Overseas Private Investment Corporation. The agency provides financing, risk insurance, and equity investments in infrastructure, with funding authority up to $60 billion in order to leverage private-sector investment in emerging markets, particularly in developing Asia.[10]

In June 2019, Japan succeeded in getting the G-20 to endorse the "Principles for Quality Infrastructure Investment." Its aim was to consolidate international standards for infrastructure development at the summit, which of course included China. Earlier, Japan had added a focus on the Mekong region when it announced its "Tokyo Strategy 2018 for Mekong-Japan Cooperation" promoting "quality infrastructure" in the region. In August 2019 the Japan–United States Mekong

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6 "Announcement of Partnership for Quality Infrastructure," Ministry of Economy, Trade and Industry (Japan), May 2015, https://www.meti.go.jp/english/press/2015/0521_01.html.

7 Japan-United States Strategic Energy Partnership (JUSEP), https://www.meti.go.jp/english/press/2017/pdf/1107_001a.pdf.

8 "2019 Japan-U.S. Strategic Energy Partnership Statement: Recent Major Developments," U.S. Department of State, November 4, 2019, https://www.state.gov/2019-japan-u-s-strategic-energy-partnership-statement-recent-major-developments.

9 Ibid.

10 "U.S. International Development Finance Corporation Begins Operations," U.S. International Development Finance Corporation, January 2, 2020, https://www.dfc.gov/media/press-releases/us-international-development-finance-corporation-begins-operations.

Power Partnership (JUMPP) was announced to promote enhanced electricity connections between the Mekong countries for "free, open, stable and rules-based regional electricity markets."

The Blue Dot Network

The most recent and specific evolution of HQI initiatives, both strategic and energy-focused, is the Blue Dot Network announced in November 2019 at the Indo-Pacific Business Forum in Bangkok. This trilateral partnership between the United States, Japan, and Australia "is a multi-stakeholder initiative that brings together governments, the private sector, and civil society to promote high quality, trusted standards for global infrastructure development in an open and inclusive framework." The U.S. State Department says that the Blue Dot Network "builds on the success of Japan's G-20 leadership in building consensus on the Principles for Quality Infrastructure Investment."[11] The initiative is open to other countries to join as long as they support the mission of promoting high-quality, private sector–led investment.

The three countries maintain that the Blue Dot Network is not a response to China's BRI, although it clearly is. The network is still being filled out and establishing funding priorities, and its financing specifics are not yet clear. However, it brings the potential for large sources of funding from pension funds, insurance companies, and infrastructure funds looking for bankable investment opportunities. Mobilizing private capital is central to the initiative. More importantly, according to the United States, it is essentially a "confidence-building" measure to reduce environmental, social, health, safety, rule-of-law, foreign exchange, and other inherent infrastructure investment risks. The Blue Dot Network serves as a "seal of approval" for projects demonstrating transparency, sustainability, and developmental impact and is equipped to incur some risk by taking equity in projects. Although this initiative certainly cannot compete on the scale of BRI, it has the potential to mobilize new capital and set high standards for infrastructure development across the Indo-Pacific.

Aligning HQI with Existing Goals

The focus on quality infrastructure as a key aspect of the U.S. and Japanese Indo-Pacific visions clearly overlaps with the energy strategy dimension. Energy investments are seen by both the United States and Japan as central to building influence and economic power in the region, and LNG is a key driver of the FOIP energy strategy. The promotion of LNG use in Southeast Asia served the Trump administration's goal of promoting the U.S. LNG industry and its exports. It also serves Japan's interests by expanding region-wide LNG supply and trade and promoting the growth of Japan's large trading companies—state energy enterprises like JOGMEC and Inpex—as well as its construction and manufacturing businesses. Japan expects the expansion and greater marketization of the LNG market in Asia to increase competition and lower long-term LNG prices. Australia also has vital interests in promoting LNG markets and infrastructure now that it is one of the two largest LNG exporters in the world.

Coal has a complex place in the energy dimension of HQI. Despite intense criticism, Japan has continued to finance what it views as high-standard coal technology such as ultra-supercritical coal-fired power plants and equipment along with integrated gasification combined cycle

[11] "Blue Dot Network," U.S. Department of State, https://www.state.gov/blue-dot-network.

power plants. The reality is that there has been strong demand among Southeast Asian countries for new investment in coal-fired power to meet rapidly rising electricity demand. Coal supplies are abundant in the region and, at least upfront, tend to be lower in cost than LNG or gas, at least historically. Coal generation is also easier to feed into power grids than integrating new, variable renewable supplies such as solar and wind.

This has been a major business for a number of large Japanese companies. Moreover, the perception is that if Japan and others do not provide the highest-standard coal-fired technology to Southeast Asian countries, China will end up being the alternative supplier of potentially lower-quality coal plants in deals that are far more opaque and dubious. Nevertheless, bowing to pressure, Japan announced in July that it will curb its financing and supply of new coal-fired capacity, except under very limited circumstances. This followed an earlier announcement by the Japan Bank for International Cooperation in April 2020 that it would no longer accept loan applications for new coal-fired power plants.[12]

The role of coal-fired power as HQI is also a complex political issue for the United States. While the Obama administration had moved to end support for new coal-fired capacity in developing countries, the Trump administration has been a vocal supporter of coal and included "clean coal technology" and U.S. coal exports in the Asia EDGE initiative. These are included in JUSEP as well.

Renewables have also been part of the energy dimension of HQI, but in a more modest role. The major emphasis of Japan's initiatives has been on LNG. The Trump administration has included U.S. clean energy technology exports as part of Asia EDGE, but not with the same vigor that it has pursued exports of U.S. LNG and clean coal technology and coal exports.

Conclusion

Despite both countries' denials, HQI initiatives are seen as key levers in U.S. and Japanese efforts to help meet Southeast Asia's enormous future energy needs while at the same time countering China's growing economic power and political influence through BRI. The concept of HQI is an important part of the FOIP strategy. The United States' efforts to reshape its approach to economic statecraft to promote private-sector investment and financing in developing Asia as an alternative to the state-directed economic statecraft of BRI are also significant.

Success will depend heavily on the ability to leverage and mobilize private capital from large pension funds, private companies, infrastructure funds, and other private capital. This, in turn, will depend on the pace of the energy market reform in Southeast Asia that is necessary to open space for private investment, which is currently monopolized by state energy enterprises and their domestic partners, and also to create market-driven incentives for private investors. This implies politically tricky and painful reform measures, such as ending the monopolies of state-owned enterprises and their domestic partners in the energy sector, opening up procurement, reducing price subsidies and cross-subsidies that distort investment incentives, and moving toward market pricing and potentially higher energy prices. A key reason BRI is so enticing is that the investment

[12] Aaron Sheldrick and Yuka Obayashi, "Japan Tightens Rules on Support for Overseas Coal-Fired Plants," Reuters, July 8, 2020. The move was foreshadowed by the Japan Bank for International Cooperation's announcement in April. See Tim Ha, "Japan Bank for International Cooperation Takes First Steps Away from Coal-Plant Financing," Institute for Energy Economics and Financial Analysis, April 24, 2020; and "Sumitomo Mitsui and Mizuho to End Lending for New Coal-Fired Plants," *Japan Times*, April 16, 2020.

it offers does not require recipient countries to clear these kinds of hurdles and make politically challenging domestic energy reforms.

Another factor determining the success of the U.S. and Japanese HQI approach will be the extended process required to ensure that proposed energy projects and investments meet the high standards set in the proposal. Verifying that projects are transparent, have open bidding and procurement, demonstrate good governance, are environmentally sound, remain competitively financed, and are within metrics of debt sustainability will be a far lengthier process than many governments may be willing to undertake. Whether Southeast Asian leaders will have the patience for such a complex and intrusive process remains an open question. BRI financing is attractive precisely because it requires little in the way of review, transparency, or extra time.

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The Need for Quality Infrastructure to Meet Rising Energy Demand in the ASEAN Region

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EXECUTIVE SUMMARY

This essay examines the importance of sustainable quality infrastructure to meet growing energy demand in the Association of Southeast Asian Nations (ASEAN) region.

MAIN ARGUMENT

Although the ASEAN region's fast economic growth in the past decades has improved the quality of life for millions of people, it has also increased the pressure on energy security and sustainability. Fossil fuels (oil, coal, and natural gas) remain the dominant energy source to meet rising demand. In particular, the share of coal in power generation is expected to rise tremendously in the mix by 2040. Policy reforms are also taking place at different speeds across Southeast Asia, reflecting the characteristics of each country in the region. ASEAN will need to increase investment in high-quality infrastructure, clean technologies, and clean fuels such as renewables to ensure that development is sustainable.

POLICY IMPLICATIONS

- The fast economic growth in ASEAN may not be sustainable if growth is pursued at the expense of environmental and social damage. High-quality infrastructure and the deployment of clean coal technology will play crucial roles for the future sustainability of the region's development.
- Expanding the use of liquefied natural gas (LNG) will have significant implications for energy security and the environment in the ASEAN and East Asia region. LNG can help meet demand for power generation, lessen coal use in the power mix, and act as a bridge fuel toward a clean energy future. Promoting natural gas use will affect future gas consumption and investment in gas-related infrastructure and will bolster trade with the U.S.
- The Covid-19 pandemic presents an opportunity for leaders to boldly increase renewable and green energy investment as part of economic recovery packages; revise energy policies, such as by removing fossil fuel subsidies; and introduce more clean energy technology to decarbonize emissions. Regional governments and financial institutions may need to promote investment in green projects through green bonds or other instruments like carbon credits.

Fast economic growth has prepared Southeast Asia to join the international production network, allowing more exports of manufactured goods, textiles, and other primary high-quality valued-added products. Investments from around the globe have poured into the region due to a favorable labor force, growth of connectivity and innovation, and regional political stability driven by the Association of Southeast Asian Nations (ASEAN). This connectivity, along with human resource development, has facilitated regional growth and created a better standard of social well-being through income generation and employment. Now that Southeast Asia has embarked on a path of rapid infrastructure development, an emphasis on quality infrastructure, connectivity, and innovation is key for the region to become more prosperous and ensure that future development is sustainable.

This essay first discusses the outlook for power generation mixes across the region. It then examines the need to build quality energy infrastructure to meet this demand and identifies development priorities. Finally, the essay concludes by considering the impacts of the Covid-19 pandemic and drawing policy implications.

ASEAN's Power Generation Outlook

ASEAN's primary energy demand is expected to grow at an average annual rate of 3.6% between 2015 and 2040.[1] The shares of both primary and final energy consumption by fuel source point to oil as the dominant source of energy, followed by coal and natural gas. However, by 2040, coal's share of power generation is projected to be the largest at 53%, which is a significant increase from 33% in 2015 (see **Figure 1**). By contrast, the share of natural gas is projected to drop from 46% in 2015 to 34% in 2040,[2] an indication of the depletion of gas fields in resource-rich countries. It is forecasted that ASEAN countries as a group will continue to be a net natural gas exporter until 2030, but the situation will change due to declining domestic natural gas production and increasing domestic energy demand in the region.

Most natural gas used in ASEAN and East Asia is imported in the form of liquefied natural gas (LNG). The demand for LNG in the region is primarily driven by the increasing demand for power generation in industrial sectors. Because of sustained growth in demand for electricity, public preference for cleaner fuels, and dwindling domestic production, most countries in ASEAN will see a rise in LNG imports in the future. Indonesia, which was the largest LNG supplier in the world until the mid-2000s, in 2012 became the first LNG importer in ASEAN.[3] In Singapore, fossil fuel imports have long been the dominant energy supply source. It first imported natural gas by pipeline from Malaysia in 1992 and from Indonesia in 2001, and in 2006 Singapore decided to import LNG to further diversify its gas supplies.[4] While Malaysia is still the world's third-largest LNG producer after Qatar and Australia, the country has imported LNG since 2013 because of increased demand. In Thailand, LNG imports started in 2011 to fill the gap between growing natural gas demand and declining domestic offshore natural gas production and are mostly used

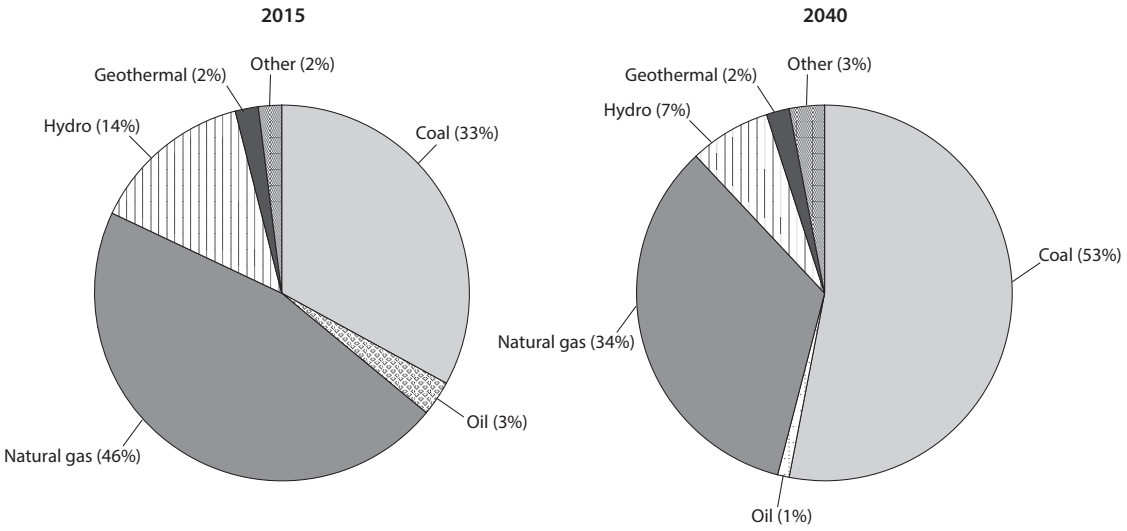
[1] Shigeru Kimura and Han Phoumin, eds., *Energy Outlook and Saving Potential in the East Asia* (Jakarta: Economic Research Institute for ASEAN and East Asia [ERIA], 2019), https://www.eria.org/uploads/media/0.Energy_Outlook_and_Energy_Saving_Potential_2019.pdf.

[2] This report uses the assumptions of the current national energy policies and targets in each ASEAN country and projects the future power mix.

[3] Kobayashi Yoshikazu and Han Phoumin, eds., "Natural Gas Master Plan for Myanmar," ERIA, December 2018, https://www.eria.org/uploads/media/RPR_FY2017_17_fullreport.pdf.

[4] Although the plan was suspended after the 2008 global financial crisis, LNG imports started in 2013.

FIGURE 1 Share of power generation output in a business-as-usual model, 2015 and 2040



SOURCE: Author's calculations based on data from Kimura and Han, eds., *Energy Outlook and Saving Potential in the East Asia*.

for the power generation sector.[5] In the Philippines, depleted natural gas production has forced the country to find alternative natural gas sources, with LNG imports expected as early as 2023. Brunei's economy is largely dependent on oil and gas exports and will benefit from the rest of ASEAN's increased gas use.

Other sources in the power mix include hydropower, geothermal, wind, solar, and biomass. The share of hydropower in power generation is also projected to drop from 14% in 2015 to 7% in 2040. This reflects the real situation that most hydropower resources have already been fully tapped, while other power sources still have room for growth. In absolute terms, however, hydropower output will increase from 30.5 terawatt hours (TWh) in 2015 to 205 TWh in 2040. The share of geothermal will likely be a constant 2% from 2015 to 2040.

Intermittent renewables—wind, solar, and biomass—account for the remaining sources of power generation and are negligent in this business-as-usual scenario. Although they are the most abundant energy resources in ASEAN countries, solar and wind have so far contributed little to the power mix, increasing from 1.5% in 2015 to 2.4% in 2020. Phase two of the ASEAN Plan of Action for Energy Cooperation (APAEC) will set key energy policy targets, including the establishment of a new sub-target for the share of renewables in installed power capacity that will complement the existing target of a 23% share of renewables in the total primary energy supply by 2025.

Hydrogen has not yet entered the policy agenda in many ASEAN countries as an alternative fuel. However, phase two of APAEC will include policy measures to address emerging and alternative technologies such as hydrogen and energy storage.

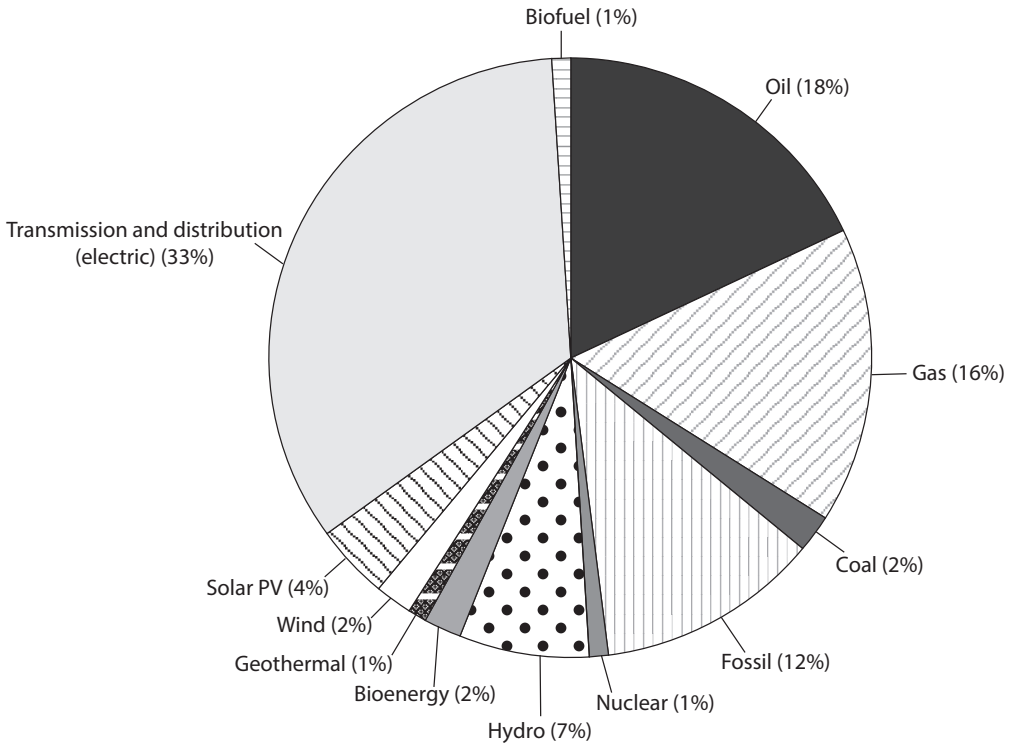
[5] Enerdata, "Global Energy Statistical Yearbook 2020," 2020, available at https://yearbook.enerdata.net/natural-gas/balance-lng-trade-world.html.

Required Investment in Energy Infrastructure to Meet Growing Demand

Given the transition to a lower-carbon economy, ASEAN currently faces paramount challenges in matching demand with a sustainable energy supply. This implicates the region's heightened need for a transition toward development and deployment of greener energy sources and the clean use of fossil fuel. To ensure sustainability, development, and a healthy environment, this rapid increase in demand will need coordinated management and appropriate quality energy infrastructure and investment.

To satisfy growing demand, huge energy-related infrastructure investment is necessary between now and 2040. The Economic Research Institute for ASEAN and East Asia projects that $430–$440 billion would be necessary in the power generation sector, $149–$226 billion for refineries, and $16–$28 billion for LNG terminals.[6] More broadly, the International Energy Agency projects that $2.1 trillion would be required for oil, gas, coal development, and power supply infrastructure.[7] More than 60% of investment would go to the power sector and transmission and distribution accounts, totaling more than half the necessary investment in the power sector (**Figure 2**).

FIGURE 2 Share of cumulative required energy infrastructure investment, 2017–40



SOURCE: International Energy Agency, "Southeast Asia Energy Outlook 2017," October 2017.

[6] Kimura and Han, *Energy Outlook and Saving Potential in the East Asia*.

[7] International Energy Agency, "Southeast Asia Energy Outlook 2017," October 2017, https://www.iea.org/reports/southeast-asia-energy-outlook-2017.

Thus, the huge potential for energy-related investment will need to be guided by the right policy to promote quality infrastructure and resilience for growth and sustainability. ASEAN's transition from a system based on fossil fuels to one based on clean energy use will rely on investment in renewables and cleaner use of fossil fuel in order to reduce global greenhouse gas emissions and avoid the most serious impacts of climate change.

Considering the Cleaner Use of Coal as Part of ASEAN's Energy Transition

The ASEAN region depends heavily on abundant supplies of coal as a reliable energy source to meet the rising demand for electricity needed to power and steer economic growth. Hence, building low-efficiency coal-fired power plants (CFPPs) is an obvious choice for power-hungry emerging Asia, particularly ASEAN, due to lower capital costs. The upfront cost of subcritical technology ranges from $800 million to $1,200 million for 1,000 megawatts (MW) of installed capacity, whereas the upfront cost for ultra-supercritical technology ranges from $1,800 million to $2,000 million for 1,000 MW. However, plants that use subcritical technology cause more environmental harm and health issues due to air pollution, carbon dioxide (CO_2), and other greenhouse gas emissions. Air pollution is a silent killer responsible for approximately seven million global deaths per year, with two million of those occurring in Southeast Asia.[8]

Widespread construction of coal power plants could also point to the low environmental standards for coal-fired power generation in ASEAN.[9] Regional countries have relatively high allowable emissions in terms of sulfur oxide (SO_x), nitrogen oxides (NO_x), and particulate matter (PM) (see **Figure 3**). ASEAN as a bloc also has poor emission standards compared with advanced countries such as Germany, South Korea, and Japan, where clean coal technology is mandatory.

Given the need for high-quality investment to improve environmental standards, the climate narratives at the UN Climate Change Conference known as the Conference of the Parties (COP) 25 and the coming COP 26 have seen setbacks. They will likely enforce bans on public coal financing through financial instruments, influencing multilateral banks and all Organisation for Economic Co-operation and Development (OECD) members. The efforts of developed economies to ban coal financing in order to force clean energy transitions have merit, but there are unintended impacts. Technological requirements for clean-coal technology (CCT) to abate CO_2 and greenhouse gas emissions are easily achieved in developed nations. However, developing nations lack the means to afford the available technologies, and the transfer and diffusion of know-how of CCT to the developing world has been slow.[10]

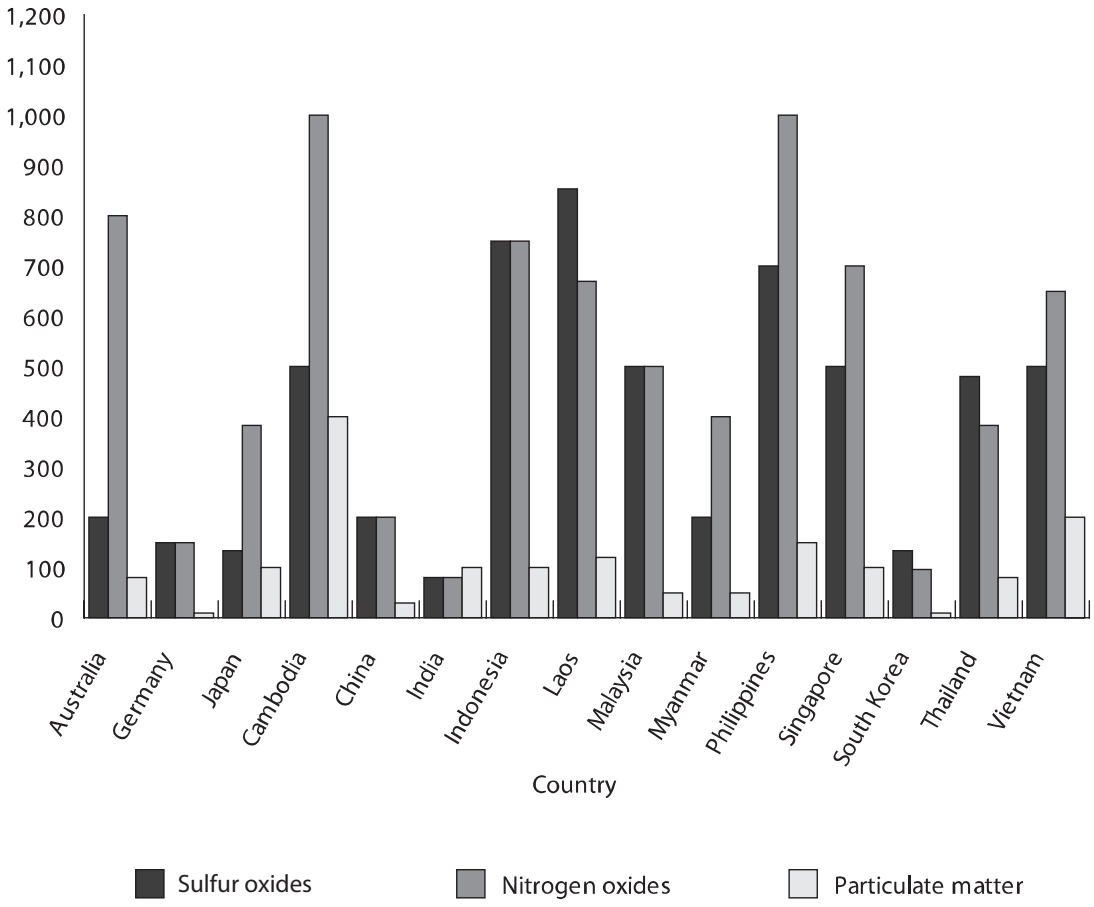
Thus, ASEAN leaders may need to consider the promotion of CCT alongside higher standards or stringent environmental regulation for CFPPs, coupled with effective enforcement, that will push investors to select more advanced technologies, especially the ultra-supercritical technology for CFPPs. These plants are considered "clean" because they use coal more efficiently than traditional subcritical CFPPs. Furthermore, supporting a framework to ensure that developing

[8] Han Phoumin, Farhad Taghizadeh-Hesary, and Fukunari Kimura, eds., *Energy Sustainability and Development in ASEAN and East Asia* (Abingdon: Routledge, 2020).

[9] Mitsuru Motokura, Jongkyun Lee, Ichiro Kutani, and Han Phoumin, eds., "Improving Emission Regulations for Coal-Fired Power Plants in ASEAN," ERIA, August 2017, http://www.eria.org/publications/research_project_reports/FY2016/No.02.html.

[10] The estimated cost of retrofitting inefficient coal plants with abatement technologies could increase the upfront cost by 20%–30%.

FIGURE 3 Emission standards for newly constructed coal-fired power plants in selected countries



SOURCE: Mitsuru Motokura et al., eds.,"Improving Emission Regulations for Coal-Fired Power Plants in ASEAN," ERIA, August 2017, https://www.eria.org/RPR_FY2016_02.pdf.

countries can afford CCT is urgent because the upfront cost of ultra-supercritical CCT is much higher than traditional CFPP technologies.[11]

This need is particularly true with regard to investments from China, which is a leader in public financing of CFPPs unbound by the OECD's rules and obligations to restrict financing of carbon-intensive projects. If not paired with the proliferation of more sustainable energy development, there is a real concern that increasing coal use in emerging Asia without any consideration to emissions levels will have negative effects on the region's environmental security. China will need to embed environmental standards into its funding mechanism to ensure that the CFPPs deployed are at least using ultra-supercritical technologies.

[11] Han Phoumin, "Enabling Clean-Coal Technologies in Emerging Asia," National Bureau of Asian Research, Pacific Energy Summit, Working Paper, 2015, 18, https://www.nbr.org/wp-content/uploads/pdfs/programs/PES_2015_workingpaper_Phoumin.pdf.

Promoting Natural Gas as a Bridge Fuel to a Clean Energy Future

The prospect of using natural gas in the ASEAN region as a transition fuel to a cleaner energy system is optimistic, given that future demand will likely increase by twofold or threefold. Much of this growth, however, depends on the future stability of gas and LNG prices and whether ASEAN and East Asia can remain competitive with suppliers such as Australia and the United States. ASEAN has long discussed the need to accelerate the establishment of a regional gas-trading hub, which will require market liberalization and policies to allow gas-on-gas competition to reveal market equilibrium prices. Singapore aims to be this Asian LNG market hub and has been actively expanding its receiving terminal to allow both ship-to-ship and truck-to-ship LNG bunkering and trading.

Although ASEAN is expected to be a key market for future gas demand, it must close the LNG infrastructure gap by implementing policies that promote investment to support the increasing demand of gas use. This includes LNG receiving terminals, pipelines or virtual pipelines, regasification plants, transportation, and storage. Additionally, the promotion of smaller-scale LNG projects will support archipelagic countries such as Indonesia and the Philippines that have long used oil products, thus replacing old and inefficient oil-fired power generation with more efficient and economically justifiable natural gas systems. It is thus critical to consider extending the small-scale LNG supply network in the ASEAN region as well.

Increasing the Share of Renewables and Adopting a Smart Grid

Energy sustainability in Southeast Asia, as well as around the globe, requires increasing the share of renewables in the energy mix. As a result, phase two of APAEC will include policy measures to pursue smart grids and renewable energy grid integration as well as measures to address emerging and alternative technologies and strategies such as hydrogen, energy storage, bioenergy, nuclear energy, climate change and decarbonization, energy investment, and financing from the private sector.

Many ASEAN grid operators hold misperceptions about renewable energy. Their concerns stem from its variable and intermittent nature, which will add higher costs to grid systems requiring backup capacity from conventional gas power plants. Yet this risk of variable energy output can be minimized if power systems are largely integrated within countries and the region. The aggregation of output from solar and wind from different geographic locations has a balancing effect on variability.[12] However, the power grid is making slow progress, and the integrated power market may remain unrealized due to several reasons such as regulatory and technical harmonization issues between ASEAN power grids and utilities.

Some of the greatest challenges that the energy transition presents are the costs associated with the technology, infrastructure, and adoption of a higher share of renewables into the energy system. For ASEAN members that can afford to invest in renewable energy, an important concern is the need for electricity storage and smart grids to support the higher penetration of renewables into the electricity sector. Smart grid technologies are already making significant contributions to electricity grids in some OECD countries.

However, these technologies are undergoing continual refinement and hence are vulnerable to potential technical and nontechnical risks, such as miscalculation of accurate outputs and

[12] P. Denholm and J. Cochran, "Wind and Solar on the Power Grid: Myths and Misperceptions," National Renewable Energy Laboratory, May 2015, https://www.nrel.gov/docs/fy15osti/63045.pdf.

mismanagement of complex technologies due to unfamiliarity. Renewable energy growth will thus be constrained by infrastructure development as well as by the evolution of technology, including the capacity to assess and predict the availability of sources and the use of the Internet of Things in power grids. Investment in the Internet of Things and telecommunications, which represent the telecommunication services that monitor, protect, and control the grid and include wide area networks, field area networks, home area networks, and local area networks, is also critical. These smart grid capacities offer additional benefits, notably the promise of higher reliability and overall electricity system efficiency.

Developing Renewable Hydrogen to Scale Up Renewable Penetration

The current development of hydrogen holds promise as an enabler to scale up renewable resources. Many countries in ASEAN are endowed with natural resources for wind, solar, hydropower, and geothermal, but these are far from demand centers and cost-intensive. In many cases, development requires investment in costly undersea transmission cables to transport electricity. In contrast, renewables can also be turned into hydrogen and easily shipped to demand centers for use in many sectors. The more electricity that is produced from wind and solar, the higher the penetration of renewables into the grid, creating surplus power during low-demand periods. This surplus can be used for hydrogen production.

To date, hydrogen production in ASEAN countries is mainly used in the refining, fertilizer, and petrochemical industries. However, renewable hydrogen has attracted attention as an option to increase the share of renewables in the electrical grid amid the falling costs of wind and solar. The International Renewable Energy Agency (IRENA) predicts that the cost of electrolysers, which are the devices used to produce hydrogen from water, will halve from $840 today to $420 in 2040.[13] If coupled with the falling cost of renewables in general, renewable hydrogen production could be the cheapest energy option for the foreseeable future.

Good policy will enable economies of scale to focus on cost-competitive hydrogen production so that investors will be more interested in electrolyser manufacturing; improvements in electrolysis efficiency, operations, and maintenance; and the use of low-cost renewable power.[14] If governments around the world implement the right policies, business players and other stakeholders could make hydrogen a bridging fuel to scale up renewable energy over the next ten to twenty years, thus decarbonizing global emissions.

Conclusion

The Impact of the Covid-19 Pandemic on Policymaking Strategies

The magnitude of the economic impact of the Covid-19 pandemic on energy markets and infrastructure investment is hard to predict and will depend largely on the effectiveness of ongoing containment efforts. The International Monetary Fund (IMF) projects that in 2020 the world economy will contract by 4.9%, while the ASEAN-5 (Thailand, Singapore, Malaysia, the Philippines, and Indonesia) is likely to contract by 1.3%, much worse than during the 2008–9

[13] IRENA, *Innovation Landscape Brief: Renewable Power-to-Hydrogen* (Abu Dhabi: IRENA, 2019).

[14] "Hydrogen for Policymakers," Hydrogen Council, February 1, 2019, https://hydrogencouncil.com/en/hydrogen-for-policymakers.

financial crisis.[15] The economic crisis has also brought with it low energy consumption in all sectors. As a result, daily global emission levels declined by 17% in the first quarter of 2020, compared with 2019 levels. However, as governments begin lifting restrictions and business activities return, so too will the demand for energy. Economic recovery could see the levels of CO_2 emissions bounce back very quickly. Indeed, global data from late May showed an all-time high for levels of CO_2 as countries started to reopen their economies.

The post-pandemic economic recovery will drive increased energy demand and thus the need to secure investment to fill gaps in energy infrastructure. Therefore, ASEAN will need to prepare different levels of policy to facilitate investment opportunities. Improved connectivity will transform the region and allow it to benefit from global value chains in the near future by attracting more investment, cutting down logistics costs, and creating agglomeration and location advantages. The region is fortunate to have a variety of stakeholders. In this sense, ASEAN should focus on key partners that promote long-term development sustainability through quality infrastructure, human resources, and knowledge and innovation.

Nevertheless, ASEAN will need to work toward institutional connectivity to facilitate international commercial trade and policies by removing behind-the-border barriers as soon as possible. Innovation through R&D will increase capabilities and human resource development to attract more industrialized investment and high technology. People-to-people connectivity has already improved social and environmental aspects as well. Strengthening institutional frameworks; improving access to support services, credit markets, and finance; upgrading technology; and expanding markets can promote inclusive growth and development in the region. ASEAN thus should be bold in its response to the risks caused by the Covid-19 pandemic. In particular, regional countries and ASEAN as a group may need to work on a green deal to return economic activities to normal as soon as possible through various measures, including financing green projects and promoting quality infrastructure.

Policy Implications

Southeast Asia's connectivity via rail, road, port, aviation, and energy infrastructure has integrated the region by compressing the time and space required for the movement of goods and services. However, ASEAN still faces challenges in building long-term, sustainable quality infrastructure and must choose appropriate investment partners.

Although there is a clear need for resilient energy infrastructure in the region, policy measures and actions undertaken to build high-quality infrastructure have varied from country to country, reflecting socioeconomic, political, and geographic differences. ASEAN faces tremendous challenges in promoting sustainable growth and a low-carbon economy, energy access, and energy affordability. As part of their energy transition, member countries will need to consider deploying CCT and other related high-quality energy infrastructure. Currently, investment in renewable energy and clean technologies in the ASEAN region still carries high costs, which need to be addressed through a political commitment to appropriate energy policy cooperation and supporting frameworks. Without shifting energy policy toward high-quality infrastructure, increased coal use for power generation will likely lead to widespread construction of CFPPs. Without employing the best available CCT, this will result in higher greenhouse gas

[15] See the IMF's World Economic Outlook reports, available at https://www.imf.org/en/Publications/WEO.

and CO_2 emissions. The investment opportunity in energy-related infrastructure is great; the challenge is how to ensure that the infrastructure is of a quality that will promote sustainability in the ASEAN region.

CFPP development. The current policy of banning coal use should be reviewed to assist emerging Asia in acquiring CCT to meet medium-term energy demands. Emerging Asia will rely on whatever technology is most affordable. Thus, it is necessary to lower the upfront cost of ultra-supercritical technology through policies such as attractive financial and loan schemes or political institutions delivering public financing for CCT to emerging Asia.

A policy framework should clearly state the corporate social responsibilities of developed and developing nations by highlighting near- and long-term policy measures aimed at the coal industry and coal-fired power generation to accelerate commercial carbon capture sequestration, utilization, and storage. Finally, public consultation or local participation is needed to disseminate information on the potential impacts of less efficient coal technologies such as CFPPs, something that is currently lacking in emerging Asia's existing institutions.

Natural gas use. Expanding LNG use in the ASEAN and East Asia region will have significant implications for energy security and the environment because LNG can help meet demand for power generation, lessen coal use in the power mix, and act as a bridging fuel toward a clean energy future. The East Asia Summit must strengthen energy security in the Asia-Pacific and bolster trade with the United States. Each policy target of increasing the share of natural gas use will affect future gas consumption and investment in gas-related infrastructure.

Penetration of renewable energy through smart grids and the Internet of Things. Stakeholders must not only increase investment in hard infrastructure, which includes the physical components of the power grid that deal with power generation, transmission, distribution, and energy storage to balance the load fluctuations as a result of higher renewable energy penetration. They must also invest in data management, which ensures proper data mining and utilization to facilitate smart grid applications, as well as in tools and software technologies that use information from the grid to monitor, protect, and control the hard infrastructure layer and reinforce the grid to allow renewable energy integration.

Hydrogen development. Regional governments will need to establish targets for hydrogen penetration and use in all sectors. Energy policies to promote hydrogen use will encourage investment in the supply chain. Further, curtailed electricity generated from renewable energy is suitable for use in hydrogen production, but clear policies and regulations for such production must be in place to encourage investment in the development and deployment of these technologies. Public awareness and a willingness to pay, public and private partnerships, and public financing will also be key.

Bold action to revisit energy policy after the Covid-19 pandemic. The pandemic presents an opportunity for leaders to boldly increase renewable and green energy investment as part of economic recovery packages; revise energy policies, such as by removing fossil fuel subsidies that discourage renewable investment; and introduce more clean energy technologies to decarbonize emissions. The government and financial institutions may need to promote investment in green projects through green bonds or other instruments like carbon credits. These efforts will create jobs and social benefits for long-term sustainability. If, however, leaders become complacent, energy consumption and emissions could bounce back to even greater levels than before the Covid-19 pandemic.

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