自然エネルギー財団
RENEWABLE ENERGY INSTITUTE

Renewable Energy: The Top-Priority for Southeast Asia to Fully Blossom

September 2023

自然エネルギー財団
RENEWABLE ENERGY INSTITUTE

Renewable Energy Institute (REI)

Renewable Energy Institute is a non-profit organization which aims to build a sustainable, rich society based on renewable energy. It was established in August 2011, in the aftermath of the Fukushima Daiichi Nuclear Power Plant accident, by its founder Mr. Masayoshi Son, Chairman & CEO of SoftBank Corp., with his own private resources. The Institute is engaged in activities such as: Research-based analyses on renewable energy, policy recommendations, building a platform for discussions among stakeholders, and facilitating knowledge exchange and joint action with international and domestic partners.

Author

Romain Zissler, Senior Researcher, Renewable Energy Institute.

Acknowledgements

The author would like to thank BloombergNEF, the global authority on economic data on energy investments, who allowed Renewable Energy Institute to make use of BloombergNEF's data in some key illustrations of this report.

The author would also like to thank Apala Group, a consulting and procurement services firm dedicated to accelerating the clean energy transition and supply chain decarbonization in Asia and the Americas. In particular, the kind contribution of Ms. Trang Bui, Decarbonization Lead, APAC, in providing invaluable insights into Vietnam's new power sector policies has been greatly appreciated.

Suggested Citation

Renewable Energy Institute, Renewable Energy: The Top-Priority for Southeast Asia to Fully Blossom (Tokyo: REI, 2023), 35 pp.

www.renewable-ei.org/en/

Table of Contents

MAP OF SOUTHEAST ASIA

List of Charts

List of Tables

Introduction

Southeast Asia includes ten countries: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. It is a very dynamically growing region. Since 2010, Southeast Asia's population increased by 13%[1], and its gross domestic product by 55%[2]. As a result of these demographic and economic developments, the region's energy consumption increased by 26%.[3] Half of this energy consumption growth came from the power sector alone.

In the past decade, coal power played a major role by meeting 70% of Southeast Asia's electricity generation growth.[4] In 2021, its share in the region's electricity mix reached 44%, a significant increase from 27% in 2010.

However, this heavy reliance on the most polluting fossil fuel is environmentally unsustainable. Even more in Southeast Asia where half the region ranks among the world's top-15 most vulnerable countries to climate change (i.e., Cambodia, Myanmar, the Philippines, Thailand, and Vietnam).[5]

Moreover, with the exceptions of Indonesia and Laos, all other Southeast Asian countries consume more coal than they produce.[6] This means they need to rely on coal imports, which is a weakness in terms of energy security.

Coal power is thus causing a double environmental and energy security crisis, jeopardizing a prosperous future for the region. To overcome this crisis, there is a consensus that clean and domestic renewable energy electricity is the most important supply-side solution. Since renewable energy is economically and technologically readily available, there is no need for gas to play the role of a "bridge fuel", as sometimes advocated by fossil fuel lobbyists. Even more so that gas is another source of environmental pollution, which future contribution is limited by proved reserves estimated to less than 20 years in Southeast Asia's three biggest gas producers: Indonesia, Malaysia, and Thailand.[7] In other words, renewable energy electricity will replace both coal and gas.

Focusing on the power sector, this report first explores the great renewable energy opportunity in Southeast Asia. It highlights encouraging progress realized to date, an overall excellent potential for renewable energy, a good cost competitiveness of renewable energy against coal and gas, projections of high shares of renewable energy, and a global leadership in solar photovoltaic manufacturing.

Then, this report addresses four major challenges impeding renewable energy accelerated growth in Southeast Asia: weak medium-term decarbonization policies, coal power lock-in, incomplete electricity system reform, and international electrical grid expansion.

With this publication, Renewable Energy Institute aims at updating outdated mindsets. Particularly those of influential Japanese energy decision makers, who despite robust evidence in favor of renewable energy, wrongfully keep promoting thermal power in Southeast Asia.

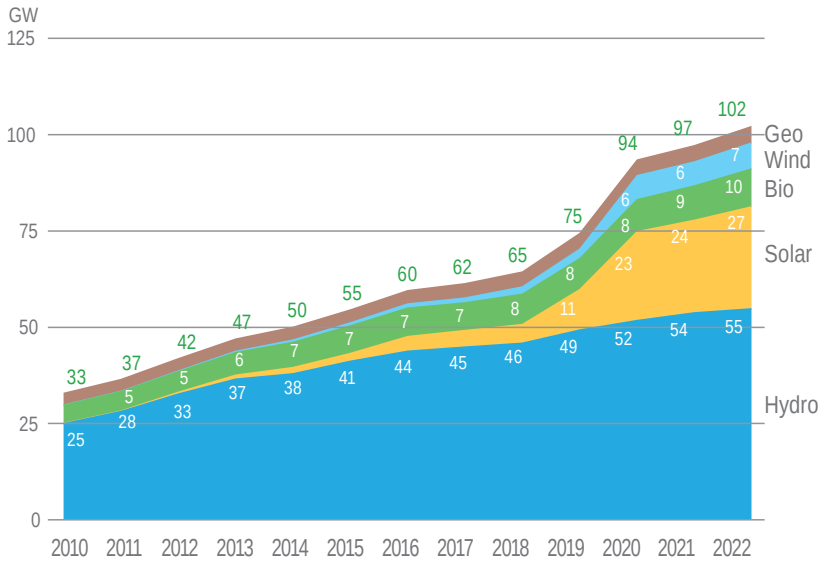
Chapter 1

The Great Renewable Energy Opportunity

1) Overview of renewable energy deployment

Encouraging renewable energy (RE) progress has already started to take place in Southeast Asia. Indeed, between 2010 and 2022, cumulative RE installed capacity more than tripled from 33 gigawatts (GW) to 102 GW (Chart 1). More than 80% of this growth came from two technologies: hydro and solar. As a result of this growth, cumulative RE installed capacity now exceeds cumulative coal power installed capacity in the region: 102 GW against 100 GW.[8]

Chart 1: Southeast Asia Cumulative RE Installed Capacity 2010-2022

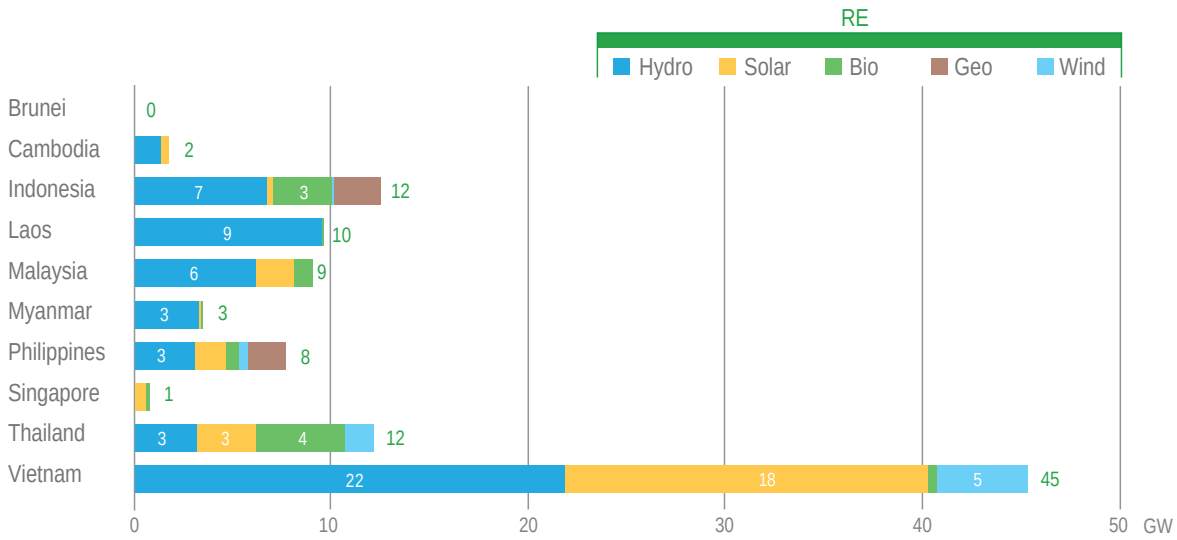


Note: capacity below 5 GW is not displayed for readability purposes.

Source: International Renewable Energy Agency, Renewable Capacity Statistics 2020 (March 2020), 2021 (April 2021), 2022 (April 2022), and 2023 (March 2023).

A closer look at the situation in each country indicates that RE progress has been uneven across Southeast Asia. Indeed, as of 2022, 44% of the region's total cumulative RE installed capacity was concentrated in only one country: Vietnam (Chart 2). Compared to other countries, Vietnam especially stands out for its growth in solar power. The takeoff of solar power in Vietnam was made possible thanks to a stimulating feed-in tariff (FiT) policy introduced in 2017.

Chart 2: Southeast Asia Cumulative RE Installed Capacity by Country 2022

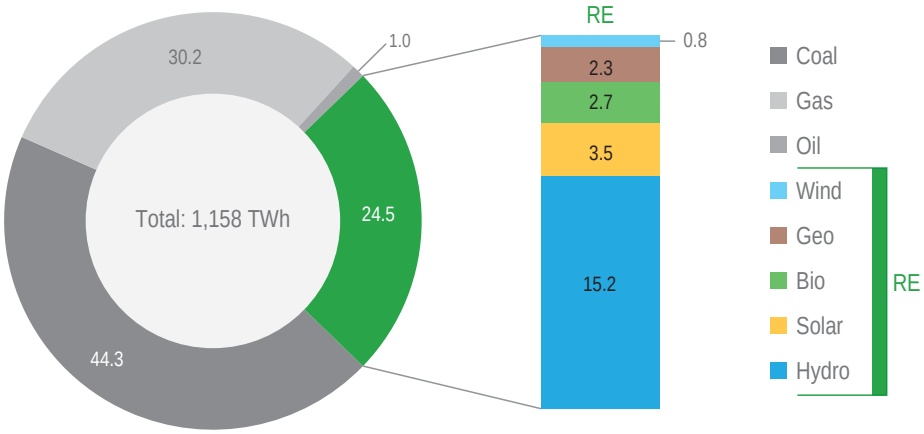


Note: capacity below 3 GW is not displayed for readability purposes.

Source: International Renewable Energy Agency, Renewable Capacity Statistics 2023 (March 2023).

RE technologies generally have lower capacity factors than fossil power plants, as for examples coal power plants. Thus, despite the encouraging progress in terms of installed capacity, RE accounted for just one-quarter of Southeast Asia's electricity generation mix in 2021 (Chart 3). Compared to 2010, this is a 7 percentage points increase.

Chart 3: Southeast Asia Electricity Generation Mix 2021 (%)

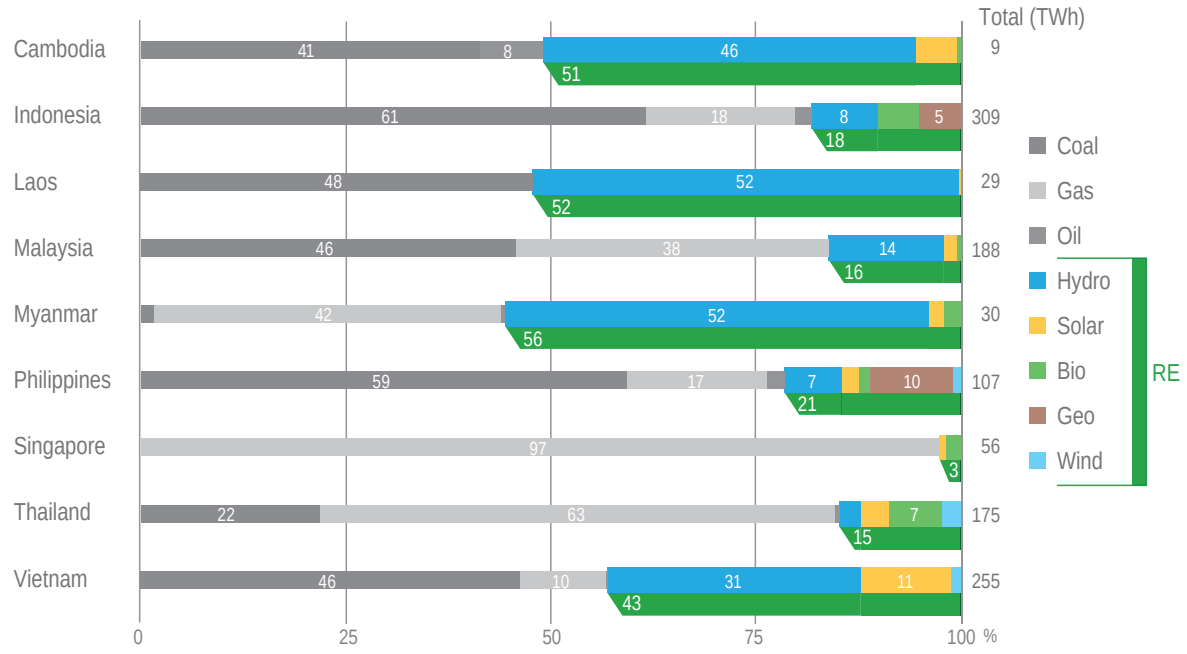


Notes: no data available for electricity generation in Brunei in 2021. Electricity generation in Brunei in 2020 was close to 6 TWh, and it was essentially based on fossil fuels.

Source: BloombergNEF, Southeast Asia Country Profiles (accessed June 2, 2023) [subscription required].

Into more detail, the share of RE in Southeast Asian countries' electricity generation mixes ranged between less than 5% in Singapore to about 50-55% in Cambodia, Laos, and Myanmar – three rather small power systems with high shares of hydropower (Chart 4). With a share of 11% for solar power, Vietnam was among the world's leaders for the penetration rate of this technology. And with a share of 10% for geothermal power, so was the Philippines.

Chart 4: Southeast Asia Electricity Generation Mix by Country 2021



Notes: share below 5% is not displayed for readability purposes. No data available for electricity generation in Brunei in 2021. Electricity generation in Brunei in 2020 was close to 6 TWh, and it was essentially based on fossil fuels.
Source: BloombergNEF, Southeast Asia Country Profiles (accessed June 2, 2023) [subscription required].

2) Abundant, largely untapped renewable energy potential

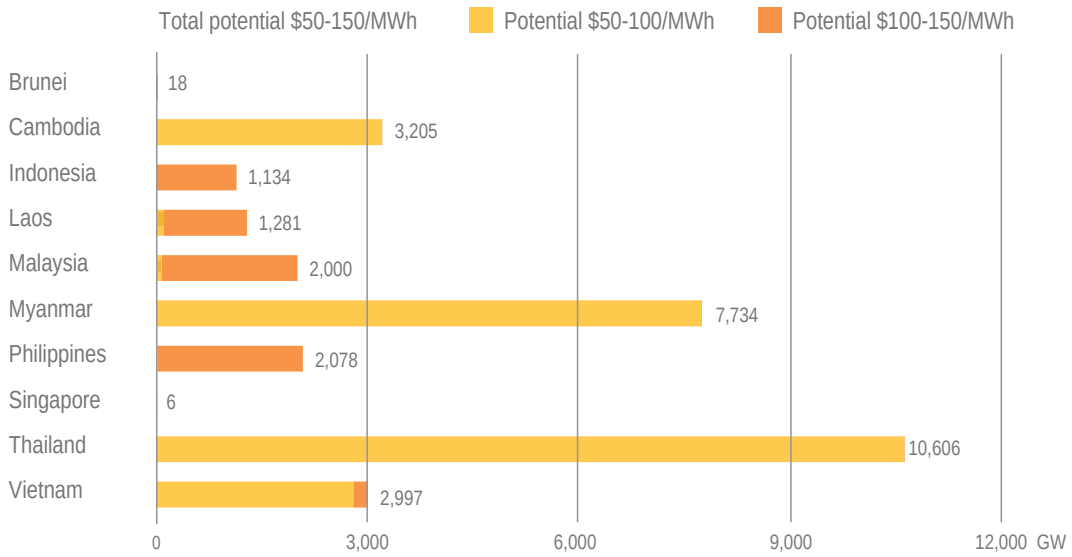
According to various estimates, Southeast Asia's potential for RE power is excellent and exceeds by many folds the region's current total electricity generation of 1,158 terawatt-hours (TWh).

Before entering into detail, it should be noted that this section mainly focuses on solar photovoltaic (PV) and onshore wind potentials. It also provides information about offshore wind, hydro, biomass, and geothermal potentials, which are less precise due to the quantity and quality of the data identified.

Based on rather conservative estimates by the United States' National Renewable Energy Laboratory (NREL) published in 2020 (i.e, more recent estimates – not focusing on potential – show lower cost levels than those presented below – see next section), Southeast Asia's potential for solar PV is enormous: around 31,000 GW that could generate more than 45,000 TWh at a cost between $50 and $150 per megawatt-hour (MWh). This includes almost 25,000 GW that could generate over 36,000 TWh at a cost of $50-100/MWh which is quite economically competitive. Considering that only 41 TWh were generated from solar PV across Southeast Asia in 2021, it is obvious that the region's abundant solar PV potential is largely untapped.

The challenge is that this potential is unevenly distributed across the region. More specifically, Thailand, Myanmar, Cambodia, and Vietnam are the countries with the best solar PV potentials (i.e., ample resources which can be exploited cost competitively) (Charts 5 & 6). In other countries, reductions in installation and operation & maintenance costs of solar PV should be pursued to optimize the economic exploitation of significant potential.

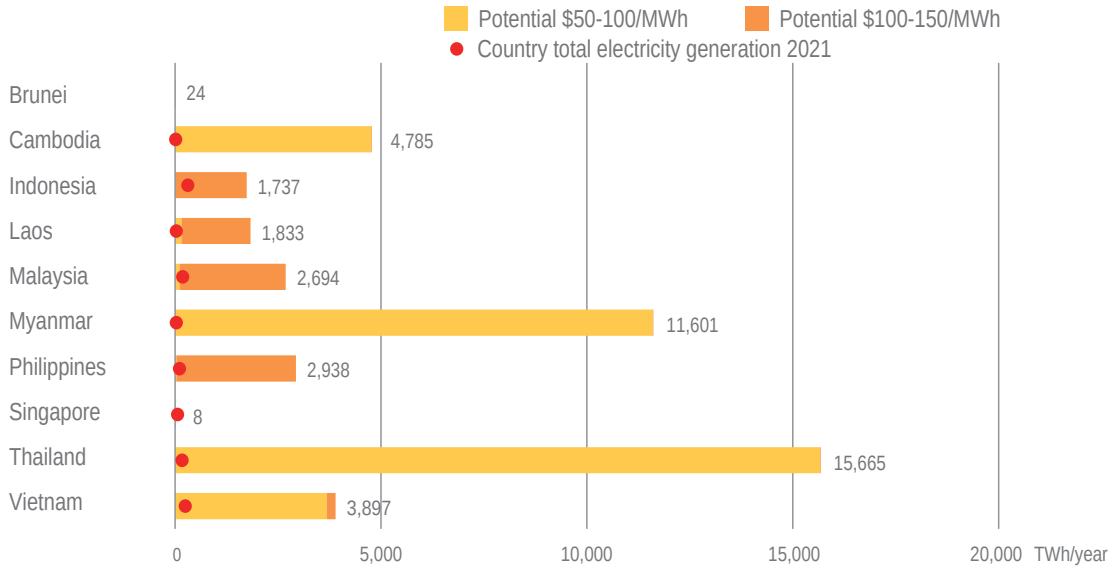
Chart 5: Southeast Asia Solar PV Potential $50-150/MWh by Country – Installed Capacity



Note: "Moderate" and "Urban" scenarios combined.

Source: National Renewable Energy Laboratory, Exploring Renewable Energy Opportunities in Select Southeast Asian Countries: A Geospatial Analysis of the Levelized Cost of Energy of Utility-Scale Wind and Solar Photovoltaics (June 2020).

Chart 6: Southeast Asia Solar PV Potential $50-150/MWh by Country – Electricity Generation



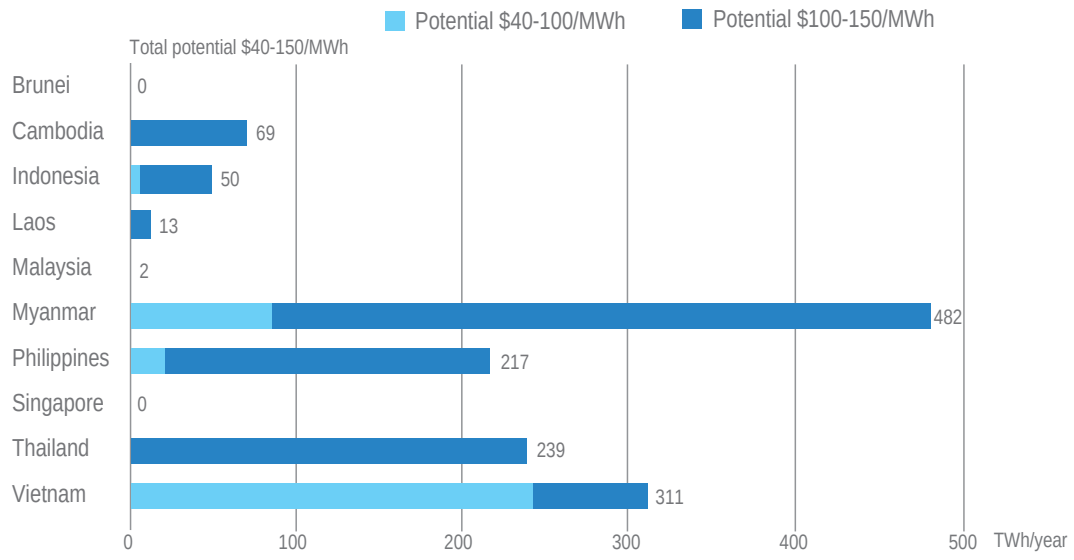
Notes: "Moderate" and "Urban" scenarios combined. No data available for electricity generation in Brunei in 2021. Electricity generation in Brunei in 2020 was close to 6 TWh, and it was essentially based on fossil fuels.

Source: National Renewable Energy Laboratory, Exploring Renewable Energy Opportunities in Select Southeast Asian Countries: A Geospatial Analysis of the Levelized Cost of Energy of Utility-Scale Wind and Solar Photovoltaics (June 2020).

Still based on estimates by NREL, Southeast Asia's potential for onshore wind is also good: approximately 1,400 GW that could generate more than 2,500 TWh at a cost between $40 and $150/MWh. This includes more than 350 GW that could generate nearly 800 TWh at an affordable cost of $40-100/MWh. In 2021, a modest 9 TWh were generated from on- & off-shore wind combined in Southeast Asia. Once more it is clear that this RE potential is far from being fully exploited.

The challenge again is that onshore wind potential is unevenly distributed across the region. Myanmar, Vietnam, the Philippines, and Thailand are the countries with the best onshore wind potential (Charts 7 & 8 / Chart 8).

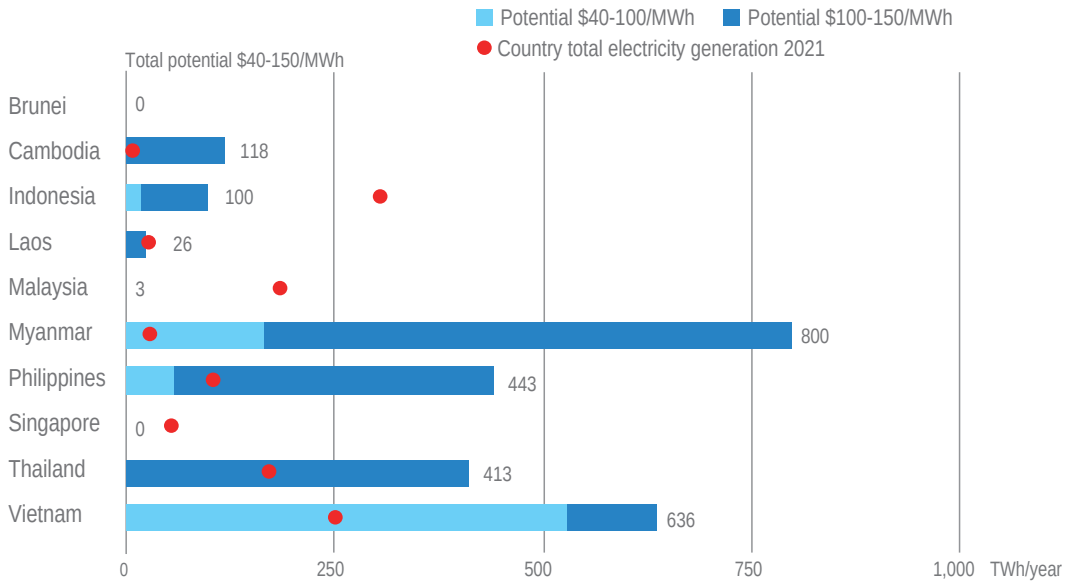
Chart 7: Southeast Asia Onshore Wind Potential $40-150/MWh by Country – Installed Capacity



Note: "Moderate" scenario.

Source: National Renewable Energy Laboratory, Source: National Renewable Energy Laboratory, Exploring Renewable Energy Opportunities in Select Southeast Asian Countries: A Geospatial Analysis of the Levelized Cost of Energy of Utility-Scale Wind and Solar Photovoltaics (June 2020).

Chart 8: Southeast Asia Onshore Wind Potential $40-150/MWh by Country – Electricity Generation

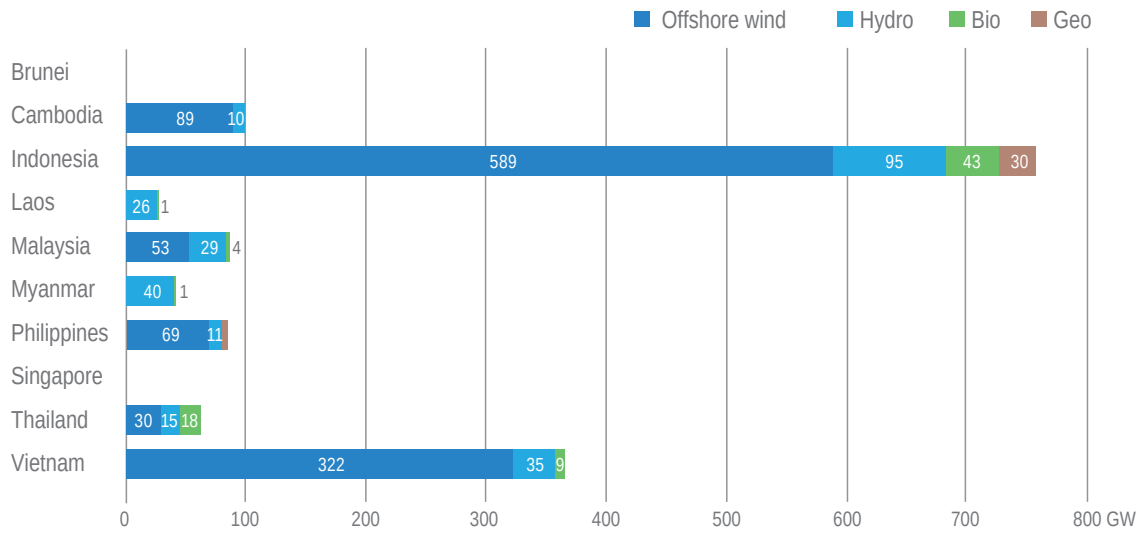


Notes: "Moderate" scenario. No data available for electricity generation in Brunei in 2021. Electricity generation in Brunei in 2020 was close to 6 TWh, and it was essentially based on fossil fuels.

Source: National Renewable Energy Laboratory, Exploring Renewable Energy Opportunities in Select Southeast Asian Countries: A Geospatial Analysis of the Levelized Cost of Energy of Utility-Scale Wind and Solar Photovoltaics (June 2020).

As for the potentials of offshore wind, hydro, biomass, and geothermal power in Southeast Asia, the International Renewable Energy Agency (IRENA) provides some information in terms of installed capacity without mentioning at which costs these four technologies could be developed (Chart 9). Based on this information, it appears that in almost all cases, Southeast Asian countries enjoy a combination of various other RE potentials (mostly offshore wind and hydro, sometimes biomass and geothermal), sufficient to meet their power needs.

Chart 9: Southeast Asia Offshore Wind, Hydro, Biomass, and Geothermal Potentials by Country

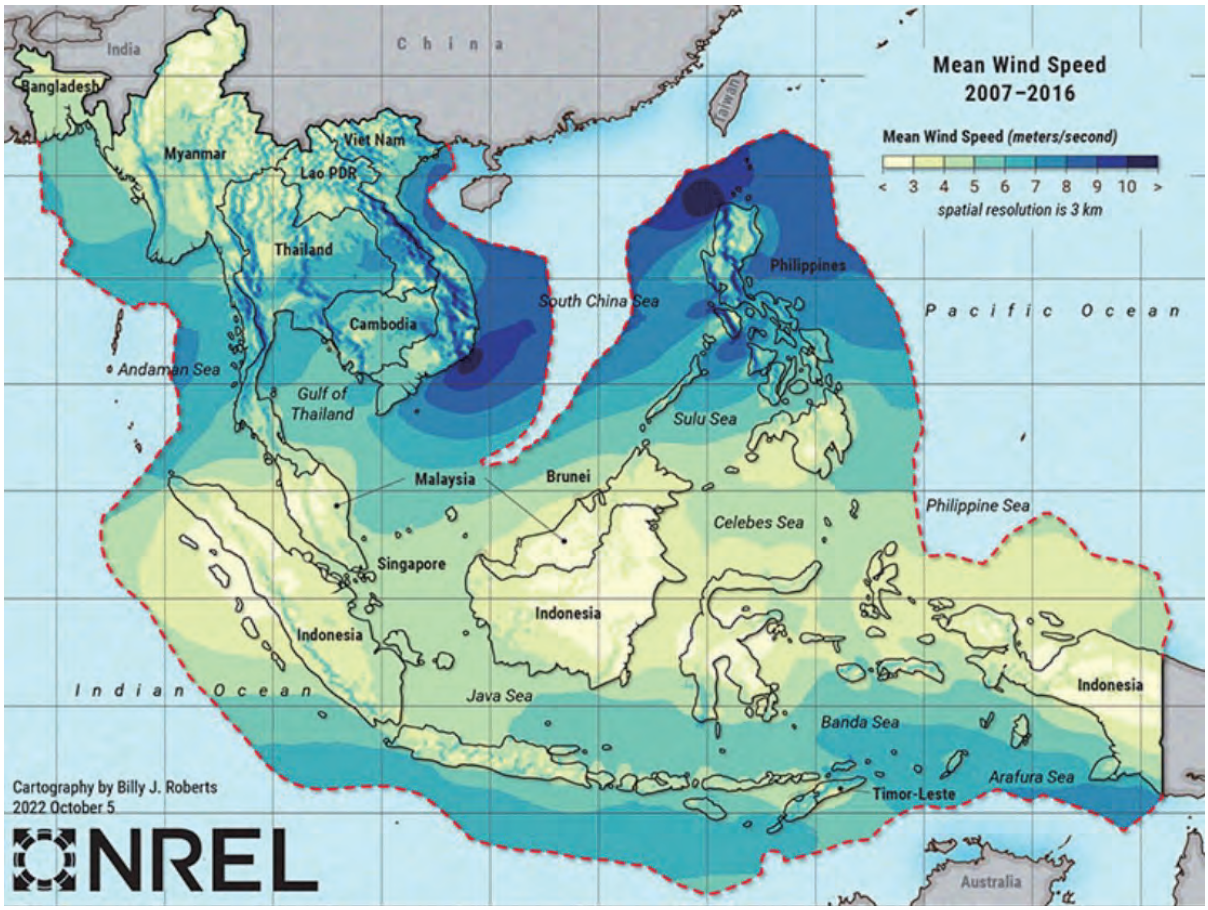


Source: International Renewable Energy Agency, Renewable Energy Outlook for ASEAN: Towards a Regional Energy Transition / 2nd Edition (September 2022).

With a regional total of about 1,150 GW, it is indicated that the potential of offshore wind is somewhat like that estimated by NREL for onshore wind ($40-150/MWh), with Indonesia, Vietnam, Cambodia, the Philippines, and Malaysia having the best potentials.

More specifically, among these countries, owing to the fact that it is the world's largest archipelago, Indonesia has the biggest offshore wind potential by far: almost 600 GW – more than half of Southeast Asia's total offshore wind potential (Chart 10). In comparison, Vietnam or the Philippines have shorter coastlines than Indonesia, but have access to higher wind speeds.

Chart 10: Southeast Asia Mean Wind Speed Map



Source: National Renewable Energy Laboratory, Holly Darrow, Southeast Asia Wind Resource Data Set Released Through the renewable Energy Data Explorer – March 27, 2023 (accessed June 22, 2023).

Considering actual developments, Vietnam is the most advanced country with over 1 GW of offshore wind installed capacity in 2022.[9] It is also the most ambitious with targets of 6 GW by 2030 and at least 70 GW by 2050.[10] Offshore wind power is also attracting a lot of attention in the Philippines. As of April 2023, the country's Department of Energy had awarded 63 offshore wind contracts with a total potential capacity of 50 GW.[11] Challenges to take advantage of the Philippines' offshore wind potential include typhoons, earthquakes, and deep waters. Regarding the latter, according to the World Bank, around 90% of the resource is found in waters deeper than 50 meters, which will require the use of floating offshore wind turbines.[12]

In comparison to solar PV and on- & off-shore wind, the region's potentials for hydro, biomass, and geothermal are lower, but certainly not negligible: about 260 GW, 80 GW, and 30 GW respectively. For hydro, which large-scale exploitation may be constrained by environmental impact and social acceptance issues, the countries with the best potentials are Indonesia, Myanmar, Vietnam, Malaysia, and Laos. For biomass, which is limited for sustainability reasons, Indonesia, Thailand, and Vietnam have the best potentials. Finally, for geothermal, Southeast Asia's potential is essentially concentrated in Indonesia and the Philippines.

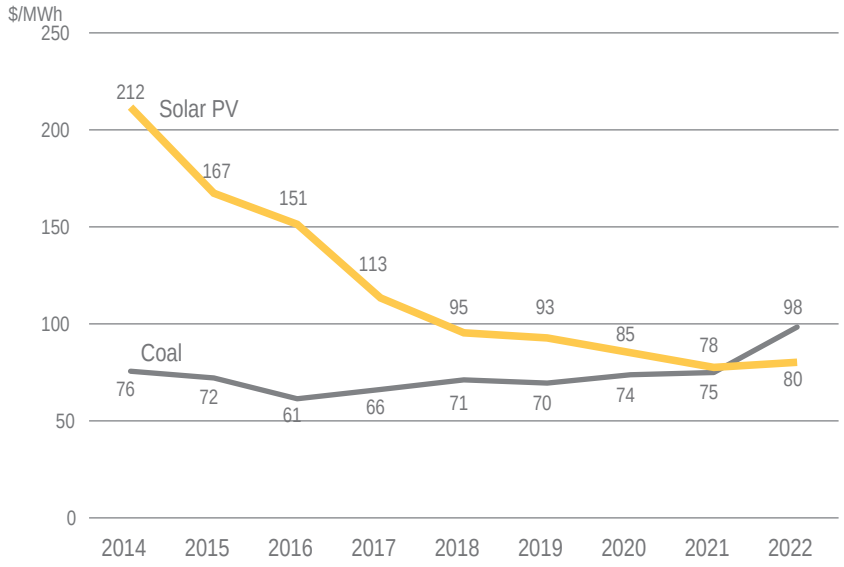
3) Renewable energy cost competitive against coal and gas

In the past decade, RE – especially solar and wind power – benefitted from technological improvements and economies of scale, reducing their costs dramatically across the world. Conversely, fossil fuel prices recently significantly increased with the COVID-19 pandemic recovery in 2021, and because of the invasion of Ukraine by Russia in February 2022 (e.g., the price of Indonesian thermal coal that is the most used for electricity generation approximately tripled from roughly $30 per ton in 2020 to $90 per ton in 2022).[13] As a result of these opposite trends, the costs of generating electricity from new RE has become competitive with those of new coal and gas power in Southeast Asia.

In this regard and supporting this claim, at the end of last year, BloombergNEF published an analysis focusing on the unsubsidized levelized cost of electricity (LCOE) of new power technologies in the second half of 2022. This analysis notably covers Southeast Asia's five largest power systems: Indonesia, Malaysia, the Philippines, Thailand, and Vietnam (a little less than 90% of the region's total electricity generation altogether).

Based on the data provided in this analysis, it is first found that on average the benchmark LCOE of new solar PV became lower than the benchmark LCOE of new coal in Southeast Asia in 2022 (Chart 11). To adequately measure this remarkable achievement, one should keep in mind that back in 2014 – less than 10 years ago – the benchmark LCOE of solar PV was nearly three times higher than that of coal.

Chart 11: Average Benchmark LCOEs of New Solar PV and New Coal in Southeast Asia 2014-2022 2H

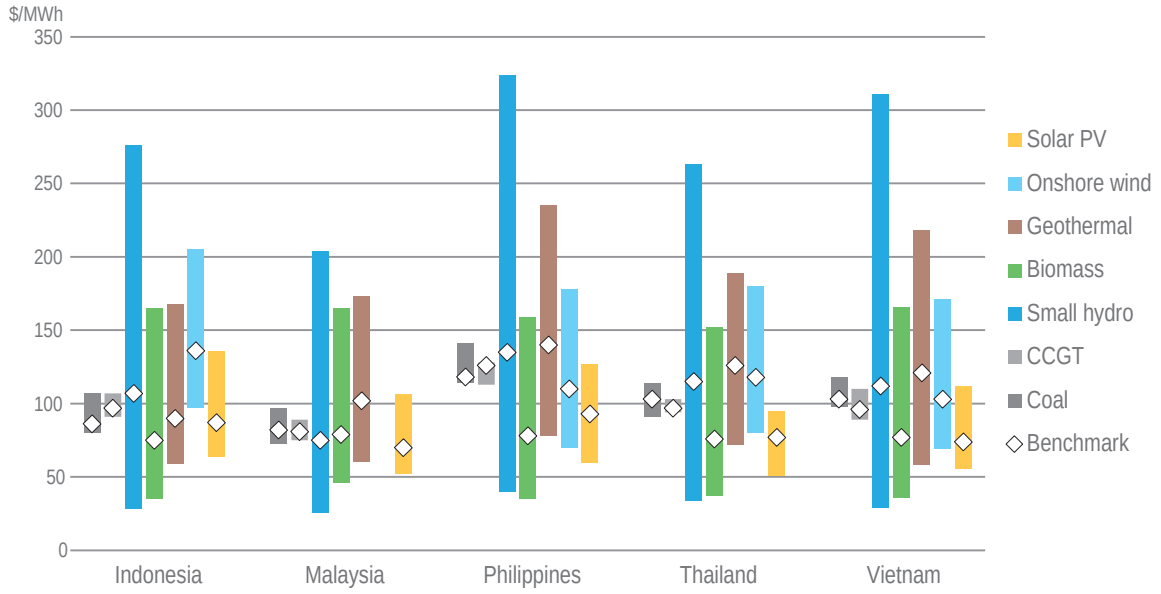


Note: average of estimates for Indonesia, Malaysia, the Philippines, Thailand, and Vietnam.
Source: BloombergNEF, Levelized Cost of Electricity 2022 2H (December 2022) [subscription required].

Into more detail, in this analysis it is also found that the benchmark LCOEs for RE technologies in Southeast Asian countries currently range between $70 and $95/MWh for solar PV, $75-80/MWh for biomass, $75-135/MWh for small hydro, $90-140/MWh for geothermal, and $105-135/MWh for onshore wind (chart 12).

In comparison, the benchmark LCOE ranges for coal and combined-cycle gas turbine (CCGT) are $80-120/MWh and $80-125/MWh, respectively.

Chart 12: LCOE of New Power Technologies in Selected Southeast Asian Countries 2022 2H



Source: BloombergNEF, Levelized Cost of Electricity 2022 2H (December 2022) [subscription required].

The cost competitiveness of RE in Southeast Asia has been empirically observed in the past few years, mainly thanks to the organization of auctions in different countries. For instance: in 2019, the auction price for solar PV in Cambodia was $39/MWh.[14] In 2020, the auction prices for solar PV in Myanmar were $35-51/MWh.[15] And in 2021, the auction prices for solar PV in Malaysia were $43-60/MWh.[16]

Furthermore, it may be noted that energy policy makers in the region are now well-aware of RE's competitiveness. This has been demonstrated by the recent announcements of new, more aggressive FiTs. Indeed, in 2022, Thailand advanced tariffs of $62/MWh for solar PV and $89/MWh for onshore wind.[17] And in early 2023, Vietnam set prices of $51/MWh for solar PV, $68/MWh for onshore wind, and $78/MWh for offshore wind.[18]

These levels of prices indicate a strong economic case for RE to be pursued as the new installed capacity of choice to meet Southeast Asia's growing electricity needs.

4) Towards high shares of renewable energy

In 2022, the world's two major energy intergovernmental organizations, the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA), as well as Asian think tanks through a collaboration, the Economic Research Institute for ASEAN and East Asia (ERIA) – an organization historically influenced by the Japanese government – & the Institute of Energy Economics, Japan (IEEJ) published energy outlooks for Southeast Asia. These outlooks focus on decarbonization pathways for the region. Hereinafter, three decarbonization scenarios from these energy outlooks are selected (Table 1).

Table 1: Selected Decarbonization Scenarios from Recent Energy Outlooks for Southeast Asia

Organization	Type	Year	Outlook	Scenario	Objective
IEA	Intergovernmental	2022	World Energy Outlook 2022	APS ("Announced Pledges Scenario")	Aspirational targets announced by governments are met on time and in full
IRENA	Intergovernmental	2022	Renewable Energy Outlook for ASEAN: Towards a Regional Energy Transition / 2nd Edition	1.5-S RE90	Net-zero emissions globally by 2050 with 90% RE electricity in Southeast Asia
ERIA & IEEJ	Think tanks	2022	Decarbonization of ASEAN Energy Systems: Optimum Technology Selection Model Analysis up to 2060	CN2050/ 2060	Net-zero CO2 emissions in 2050 or 2060, considering carbon sinks

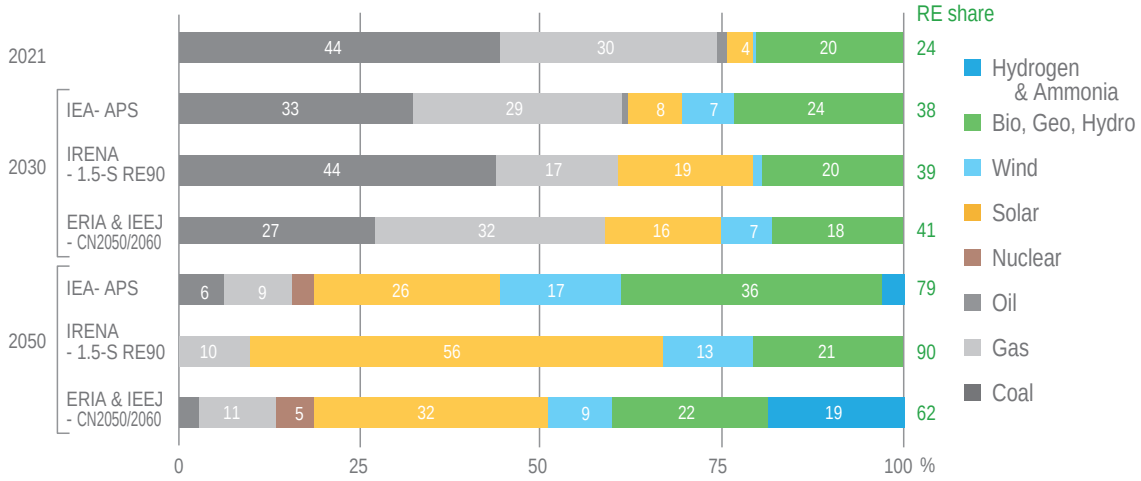
Source: information selected by Renewable Energy Institute.

Considering the power sector only – on the one hand, two consensuses emerge from these three scenarios:

First, RE will be the most important supply-side decarbonization solution for Southeast Asia's power sector (Chart 13). By 2030, all scenarios project the share of RE to reach around 40% of the region's total electricity generation (against 24% in 2021). And by 2050, RE will account for the large majority of Southeast Asia's electricity generation mix: 62-90%. Among RE technologies, the role of solar will be central.

Second, with forecasted shares of 0-5% in 2050, the contribution of nuclear power will be minor. This is unsurprising given the facts that no nuclear reactor has ever been operated in Southeast Asia, and that no nuclear reactor is currently under construction in the region. Lack of experience and concrete developments seem insurmountable for this controversial technology.

Chart 13: Southeast Asia Electricity Generation Mix Projections



Note: share below 3% is not displayed for readability purposes.

Sources: for 2021; BloombergNEF, Southeast Asia Country Profiles (accessed June 2, 2023) [subscription required]. For 2030 and 2050 projections; International Energy Agency, World Energy Outlook 2022 (October 2022), International Renewable Energy Agency, Renewable Energy Outlook for ASEAN: Towards a Regional Energy Transition / 2nd Edition (September 2022), and Economic Research Institute for ASEAN and East Asia & the Institute of Energy Economics, Japan, Decarbonization of ASEAN Energy *Systems: Optimum Technology Selection Model Analysis up to 2060 (July 2022).*

On the other hand, a noteworthy difference opposes ERIA & IEEJ's projection with those of the IEA and IRENA: the share of decarbonized thermal (i.e., hydrogen & ammonia) in 2050. Indeed, whereas the think tanks predict a rather high share of 19%, the intergovernmental organizations calculate shares of only 0-2%. The reason behind this difference comes from modelling assumption choices about international electrical grid expansion and battery storage. These two technologies are proven alternatives to immature decarbonized thermal to provide power system flexibility which is necessary to integrating high shares of RE.

In this regard, ERIA & IEEJ's CN2050/2060 scenario appears conservative when it comes to international electrical grid expansion and battery storage. This leads to a significant reliance on decarbonized thermal. Interestingly, in their energy outlook, ERIA & IEEJ also

conducted a sensitivity analysis case called "PowerInov". This case is more ambitious about international electrical grid expansion and battery storage. As a result, in the "PowerInov" case, projections for 2060 (i.e., no projections for 2050 are available) show that while the share of RE substantially increases to 76% (against 56% in the CN2050/2060 scenario), the share of decarbonized thermal falls to only 11% (against 26% in the CN2050/2060 scenario). More importantly, power system costs are reduced. This means the combination of international electrical grid expansion and battery storage is more cost efficient. Therefore, it should be prioritized over decarbonized thermal.

5) Global leadership in solar photovoltaic manufacturing capacity

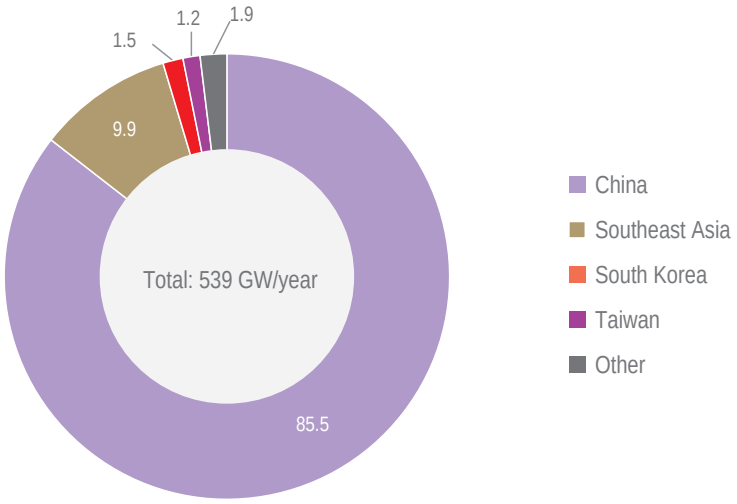
Thanks to its excellent potential and strong economic competitiveness, solar PV is the key technology for the decarbonization of Southeast Asia's power sector. The expansion of solar PV in the region should be facilitated by the fact that Southeast Asia is a global leader in solar PV manufacturing capacity. Indeed, considering crystalline silicon cells and modules manufacturing capacity, two of the most important components of the solar PV supply chain, Southeast Asian ranks second behind China.

In two different ways, the global leadership of Southeast Asia in solar PV manufacturing capacity is critical in terms of energy security. First, from a regional perspective, domestic manufacturing and deployment of solar PV strengthens Southeast Asia own energy security. Then, from a global perspective, Southeast Asia as the main alternative solar PV supplier to China helps counterbalance the otherwise overwhelming domination of China. A domination that is unsustainable for this industry and which calls for a diversification of suppliers.

Into more detail, Southeast Asia accounts for 10% of global crystalline silicon cells manufacturing capacity (Chart 14). On a single country basis, Vietnam stands #2 in the world ranking, Thailand #3, Malaysia #4. Other countries such as Cambodia, the Philippines, and Singapore also owns crystalline silicon cells manufacturing capacity.

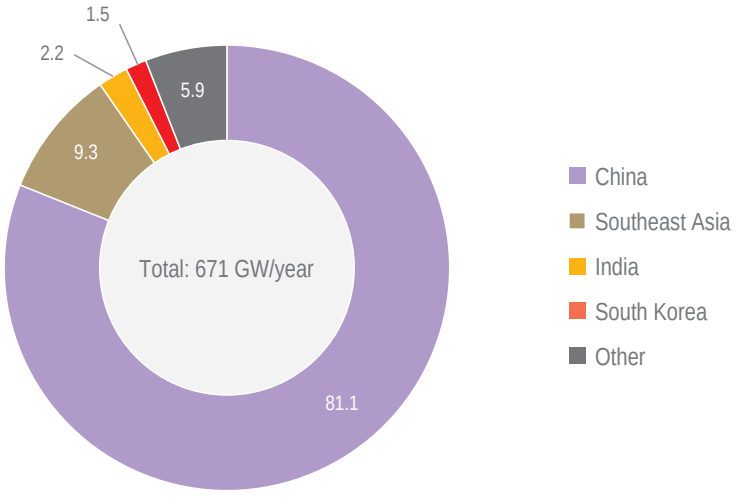
As for modules, Southeast Asia accounts for 9% of global manufacturing capacity (Chart 15). On a single country basis, Vietnam ranks #2 in the world, Malaysia #3, and Thailand #5. Other countries as for examples Cambodia, Indonesia, and Singapore also owns modules manufacturing capacity.

Chart 14: Solar PV Crystalline Silicon Cells Manufacturing Capacity by Country 2023 (%)



Source: BloombergNEF, Equipment Manufacturers: Solar PV – Updated March 29, 2023 (accessed May 26, 2023) [subscription required].

Chart 15: Solar PV Modules Manufacturing Capacity by Country 2023 (%)



Note: including crystalline silicon modules, thin film non silicon modules, and thin film silicon modules.
Source: BloombergNEF, Equipment Manufacturers: Solar PV – Updated March 29, 2023 (accessed May 26, 2023) [subscription required].

Compared to raw materials, commercial exports of manufactured, high value-added solar PV technologies are a healthy source of income for the region.

Chapter 2

The Four Challenges to Accelerate Renewable Energy Growth

1) Weak medium-term decarbonization policies

The first challenge to accelerate RE growth in Southeast Asia is weak medium-term decarbonization policies, especially those to support RE deployment. A few good examples may, however, be referred to.

Considering again the region's five largest power systems, four of them have pragmatically adopted either carbon neutral or net-zero greenhouse gas (GHG) emissions goals by 2050-2065 (Table 2). This is rather positive.

Table 2: Carbon Neutral and Net-Zero Emissions Goals in Selected Southeast Asian Countries

Country	Goal(s)
Indonesia	Net-zero by 2060
Malaysia	Carbon neutral by 2050
Philippines	X
Thailand	Carbon neutral by 2050 and net-zero by 2065
Vietnam	Net-zero by 2050

Source: BloombergNEF, Southeast Asia Power Market Outlook 2022 (December 2022) [subscription required].

The issue, however, is the policies to be implemented to reach these long-term decarbonization objectives.

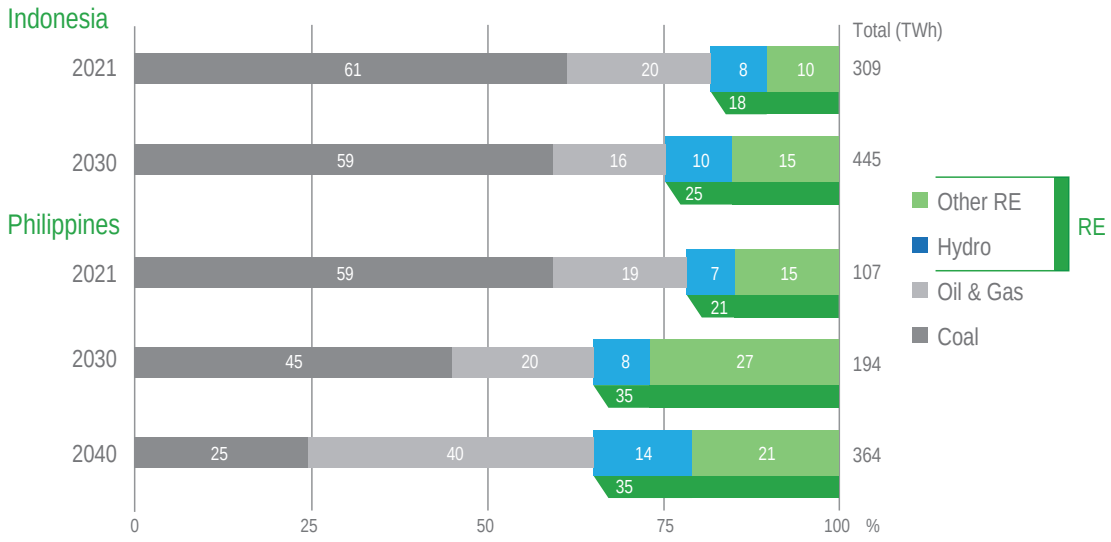
The medium-term targets and support schemes for RE of selected Southeast Asian countries are unaligned with what is required to achieve the deep decarbonization of their power systems.

Starting with medium-term targets for RE (i.e., 2030-2040), the selected Southeast Asian countries have advanced targets for RE shares either in electricity generation (Indonesia and the Philippines) or installed capacity (Malaysia, Thailand, and Vietnam).

Regarding RE shares in electricity generation (Chart 16):

- Indonesia aims to increase the share of RE from 18% in 2021 to 25% in 2030, only a 7 percentage points increase.
- The Philippines plans to increase the share of RE from 21% in 2021 to 35% in 2030, and to maintain this 35% share to 2040. These future low RE shares are incompatible with ambitious decarbonization trajectories.

Chart 16: Indonesia and Philippines Electricity Generation Mixes 2021 and Medium-Term Targets



Note: "Other RE" includes biomass, geothermal, solar, and wind.

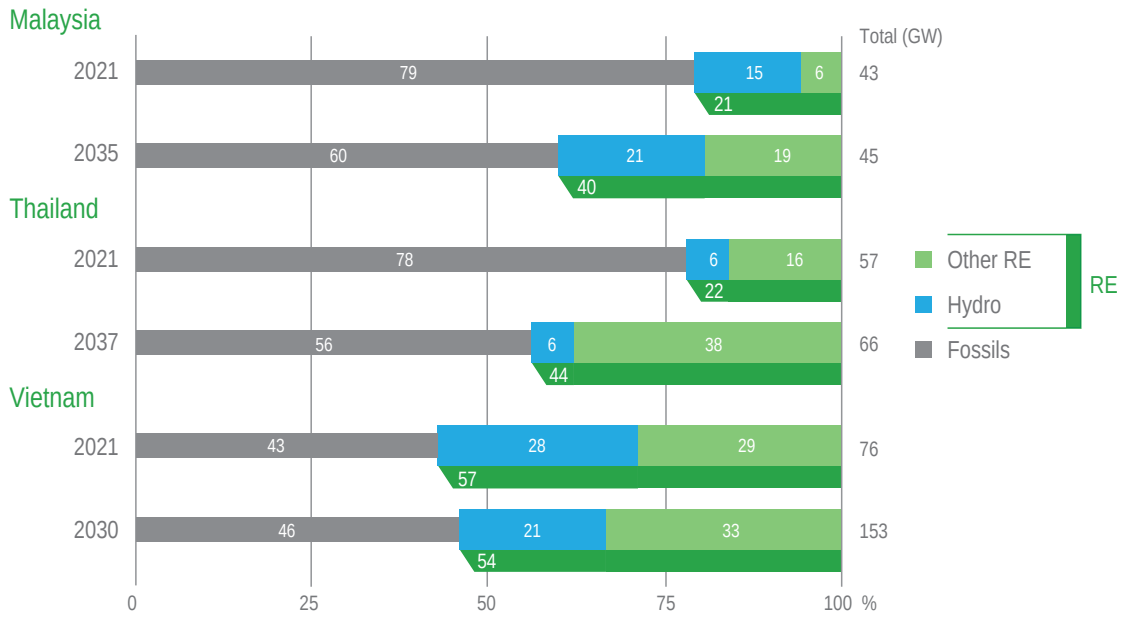
Sources: for 2021; BloombergNEF, Southeast Asia Country Profiles (accessed June 2, 2023) [subscription required]. For targets; Indonesia – Perusahaan Listrik Negara, Electricity Supply Business Plan 2021-2030 (October 2021) (in Indonesian), and the Philippines – Philippines Department of Energy, Philippine Energy Plan 2020-2040: Towards a Sustainable and Clean Energy Future (August 2022).

As for RE shares in installed capacity (Chart 17):

- Malaysia pursues to double the share of RE in its installed capacity mix from 21% in 2021 to 40% in 2035. Building upon this unimpressive medium-term goal, Malaysia announced a new target share of 70% by 2050 in May 2023.[19] The latter is likely to be insufficient for the country to meet its 2050 carbon neutral objective. Malaysia should therefore revise its entire power sector decarbonization pathway, starting with a more ambitious medium-term goal to make it possible to realize the full decarbonization of its electricity by mid-century.
- Thailand's planned medium-term RE progress is like that of Malaysia, with a doubling from 22% in 2021 to 44% in 2037. It should also be revised upward to keep the country's 2050 carbon neutral objective credible.

- At last, Vietnam's medium-term goal for the share of RE in its installed capacity mix is to slightly decrease from 57% in 2021 to 54% in 2030. This can hardly be seen as an improvement. As a result of this unsatisfactory medium-term trajectory, the share of RE in Vietnam's installed capacity mix is only seen to grow slowly beyond 2030. It could ultimately reach about 75-80% by 2050. Therefore, in the Vietnamese government's energy policy it is decided that the country significantly needs to rely on hydrogen & ammonia power and/or carbon capture and storage for decarbonization. Since these technologies do not have solid track records today, neither technologically nor economically, this is certainly a risky bet.

Chart 17: Malaysia, Thailand, and Vietnam Installed Capacity Mixes 2021 and Medium-Term Targets



Notes: "Fossils" include coal, gas, and oil. "Other RE" includes biomass, geothermal, solar, and wind.

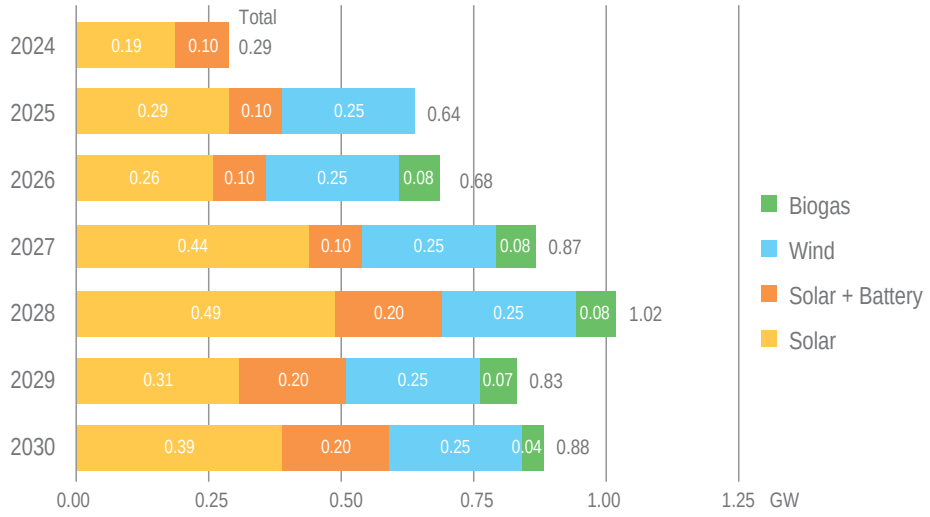
Sources: for 2021; International Energy Agency and Imperial College London, ASEAN Renewables: Opportunities and Challenges (March 2023). For targets; Malaysia – Malaysia Sustainable Energy Development Authority, Malaysia Renewable Energy Roadmap – Updated October 6, 2021 (accessed May 29, 2023), Thailand – Thailand Ministry of Energy, Thailand Power Development Plan 2018-2037 Revision1 (October 2020) (in Thai), and Vietnam – Vietnam Prime Minister, Decision: Approving the National Electricity Development Plan for the Period of 2021-2030, with a vision to 2050 (May 2023) [English translation provided by Apala Group].

Rapidly revamping medium-term RE targets is thus a priority for Southeast Asian countries. New more ambitious targets should be advanced together with consistent supportive RE schemes. As mentioned in Chapter 1, Southeast Asian countries are now experienced in managing FiTs and auctions. Until now, what they have sometimes lacked, however, is continuity to ensure predictability and thereby investors' confidence.

For example, Vietnamese FiTs for solar PV and wind have been characterized by boom-and-bust cycles. Victims of their success, thanks to previous generous tariffs of $71/MWh for solar PV, $85/MWh for onshore wind, and $98/MWh for offshore wind, these schemes have been very effective in supporting the quick uptake of these technologies (i.e., in 2020 alone, around +12 GW for solar PV and +4 GW for wind).[20] This uptake was actually so fast that power grid developments could not catch up, resulting in RE curtailment. This conducted Vietnam to temporarily suspend these support schemes.

A preferable approach may be that adopted by Thailand in 2022. Last year, Thailand announced the procurement under FiTs of more than 5 GW of RE capacity between 2024 and 2030, with quotas for each technology (biogas, solar, solar + battery, and wind) and each commissioning year (Chart 18). This support scheme combining tariffs and planification is useful because it brings visibility by controlling incentives and volumes.

Chart 18: Thailand FiT Capacity Quotas by RE Technology and Commissioning Year



Source: BloombergNEF, Southeast Asia Power Market Outlook 2022 (December 2022) [subscription required].

In this regard, another good example may also be referred to: the repetition of auctions allocating pipelines of projects through competitive pricing. Between 2016 and 2020, Malaysia organized four large-scale solar PV auctions and awarded more than 2 GW of projects through this route. More recently, in 2022, the Philippines launched its Green Energy Auction Program. In the first round of this program almost 2 GW of RE capacity was awarded. In April 2023, the second round of this program was announced with nearly 12 GW of RE capacity on offer.[23]

Finally, though it is only indirectly supporting RE, the importance of carbon pricing may also be stressed here. Carbon pricing is a mechanism to internalize the negative externalities on the environment caused by energy-related activities. In such a framework the polluter pays principle is applied. In the case of the power sector, carbon pricing should penalize fossil power plants for their GHG emissions, deteriorating their biased economic competitiveness. Carbon pricing may be implemented via a carbon tax or an emissions trading system (ETS). Incomes from carbon pricing may be used as funds to support clean technologies.

So far, the introduction of mandatory carbon pricing mechanisms in Southeast Asia's main power systems has been limited to Indonesia. In 2021, Indonesia first advanced a voluntary pilot (ETS).[24] This pilot ETS involved 32 facilities, representing more than 75% of the power sector's emissions, with an average price of $2 per ton of carbon dioxide (CO_2). Then, in February 2023, Indonesia announced the launch of a mandatory ETS for the power sector. This mandatory ETS will be implemented in three phases. The first phase (2023-2024) will cover most of the country's coal power plants (99 facilities). In the second and third phases (2025-2027 and 2028-2030, respectively), it is planned that the coverage of the ETS will be expanded to oil and gas power plants, as well as the remaining coal power plants not included in the first phase. This mandatory ETS is welcome progress, but its efficiency remains to be seen and will depend on whether the price signal delivered will be meaningful to drive emissions down.

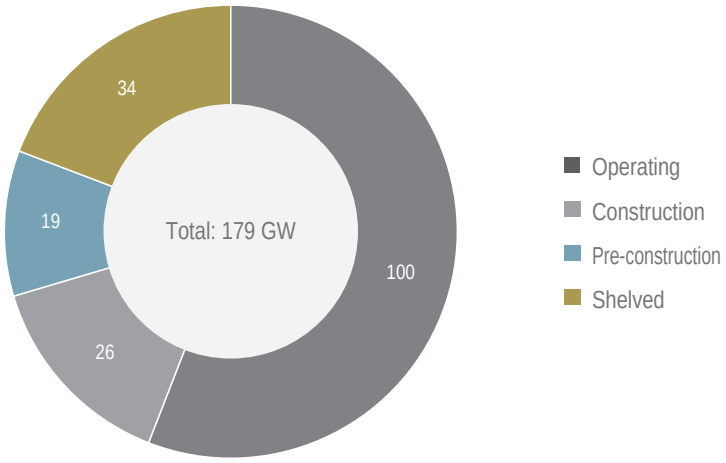
2) Coal power lock-in

Heavy reliance on coal power is the second challenge slowing down the acceleration of RE growth in Southeast Asia. In March 2021, the Secretary-General of the United Nations, António Guterres urged non-OECD (Organization for Economic Co-operation and Development) countries to phase out coal power by 2040.[25] This objective will be difficult to achieve in Southeast Asia because of four major obstacles. On a more positive note, the recent emergence of new international financing initiatives to accelerate the phaseout of coal power in the region is a step in the right direction.

As of 2023, one can hardly imagine that coal power will be phased out in Southeast Asia by 2040. This is because of serious evidence that coal power will keep playing an important role in the region in the next two decades.

In Southeast Asia in 2022, there were 100 GW of operational coal power capacity and 79 GW at various stages of development (i.e., 26 GW under construction, 19 GW in pre-construction, and 34 GW shelved) (Chart 19).

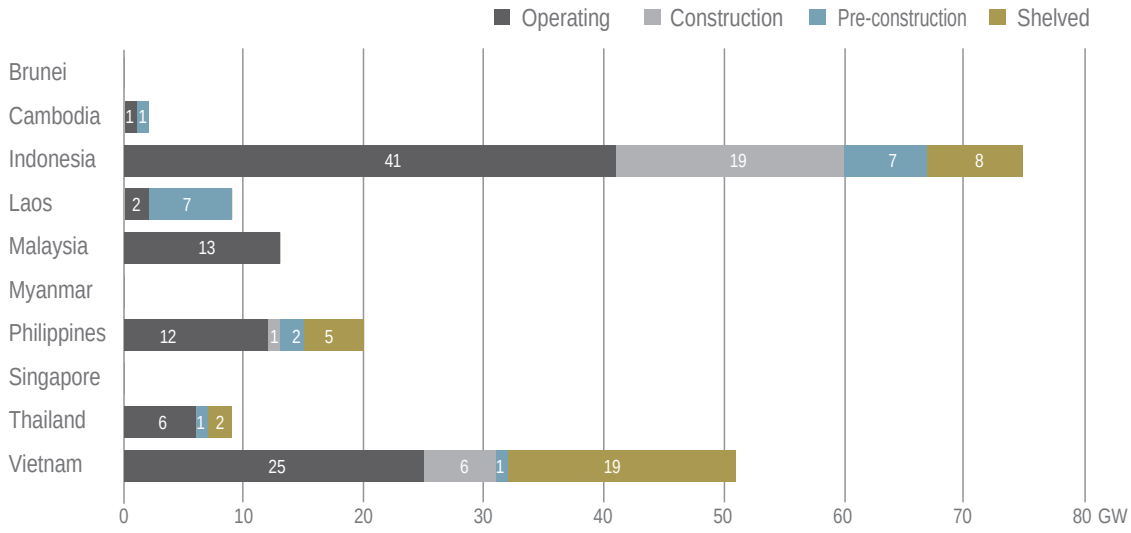
Chart 19: Southeast Asia Coal Power Capacity Status 2022 (GW)



Source: Global Energy Monitor, CREA, E3G, Reclaim Finance, Sierra Club, Solutions for Our Climate, Kiko Network, CAN Europe, Bangladesh Groups, Alliance for Climate Justice & Clean Energy, and Chile Sustentable Boom and Bust Coal 2023: Tracking the Global Coal Plant Pipeline (April 2023).

The very large majority of coal power projects were concentrated in the region's five largest power systems (Charts 20).

Chart 20: Southeast Asia Coal Power Capacity Status by Country 2022



Source: Global Energy Monitor, CREA, E3G, Reclaim Finance, Sierra Club, Solutions for Our Climate, Kiko Network, CAN Europe, Bangladesh Groups, Alliance for Climate Justice & Clean Energy, and Chile Sustentable Boom and Bust Coal 2023: Tracking the Global Coal Plant Pipeline (April 2023).

The first major obstacle to quickly phasing out coal power in Southeast Asia is that operational capacity is massive and young. In the four biggest coal power markets: Indonesia, Malaysia, the Philippines, and Vietnam, the average age of the coal power plant fleet is below 15 years.[26]

The second obstacle is that existing coal power plants are often locked-in investments for decades due to long-term (i.e., 25-30 years) power purchase agreements (PPAs).[27] Early termination of such deals can be costly.

The third obstacle is that the pipeline for new coal power plants is still significant and could materialize to some extent. Any new plant starting operation in the coming years will likely still be operational in the 2040s. In this regard, it is also worrisome that the Sustainable Finance Taxonomy of the Association of Southeast Asian Nations (ASEAN) includes new coal power plant: to be built before 2028 and with a lifespan capped at 35 years. This is unwelcome support to operate coal power plant until the beginning of the 2060s.[28]

Finally, the fourth obstacle is that coal power is still unfairly subsidized. This issue is particularly acute in Indonesia, where the price of the thermal coal that is the most used for electricity generation is capped at approximately $40 per ton when consumed in domestic power plants.[29] This subsidy probably exceeded $5 billion in 2022.

Against this backdrop, the emergence of new international financing initiatives to accelerate the phaseout of coal power in Southeast Asia is a necessary glimpse of hope. Two of these initiatives deserve particular attention: the Just Energy Transition Partnership (JETP) and the Energy Transition Mechanism (ETM).

A JETP is a nascent financing initiative in which developed countries fund a coal-dependent developing country to support its own path to phase-out coal and transition towards clean energy. A JETP also addresses the social consequences of implementing such plans (e.g., ensuring training and alternative job creation for affected workers and new economic opportunities for affected communities). The first JETP, between developed countries and South Africa, was announced in November 2021.[30]

The ETM is another nascent financing initiative. Launched by the Asian Development Bank in 2021, this program aims at helping confront the issue of climate change by reducing GHG emissions in Asia-Pacific.[31] Concessional and commercial capital is to be used to accelerate the retirement or repurposing of fossil fuel power plants and replace them with clean energy alternatives. The ETM began with three pilot countries, Indonesia (which is briefly focused on below because it is the most advanced case), the Philippines, and Vietnam.

These two initiatives are especially relevant for Indonesia and Vietnam, the two countries with the most installed coal power capacity in Southeast Asia. Moreover, it may be noted that Indonesia was the world's largest coal exporter in 2022.[32]

In November 2022, a JETP was announced between developed countries and Indonesia.[33] This JETP has committed to mobilize $20 billion to support the acceleration of emissions reduction in Indonesia's power sector. Into more detail, the plan is to accelerate and reduce peak emission in the power sector by 2030 (290 million tons of CO_2 equivalent) and to reach net-zero emissions in the power sector by 2050. To achieve these goals, actions to be taken include early retirement of coal power plants and increasing the share of RE electricity to 34% by 2030. Still in Indonesia, but under the ETM program this time, the first project exploring the early retirement of a 660 megawatts (MW) power coal power plant owned by Cirebon Electric Power in Western Java is moving forward.[34]

In December 2022, a JETP was announced between developed countries and Vietnam.[35] This JETP has committed to mobilize $15.5 billion to support the acceleration of emissions reduction in Vietnam's power sector. More specifically, the plan aims at accelerating and reducing peak emission in the power sector by 2030 (170 million tons of CO_2 equivalent). Actions to be taken include reducing planned peak coal power capacity from 37 GW to 30.2 GW and increasing the share of RE electricity to 47% by 2030.

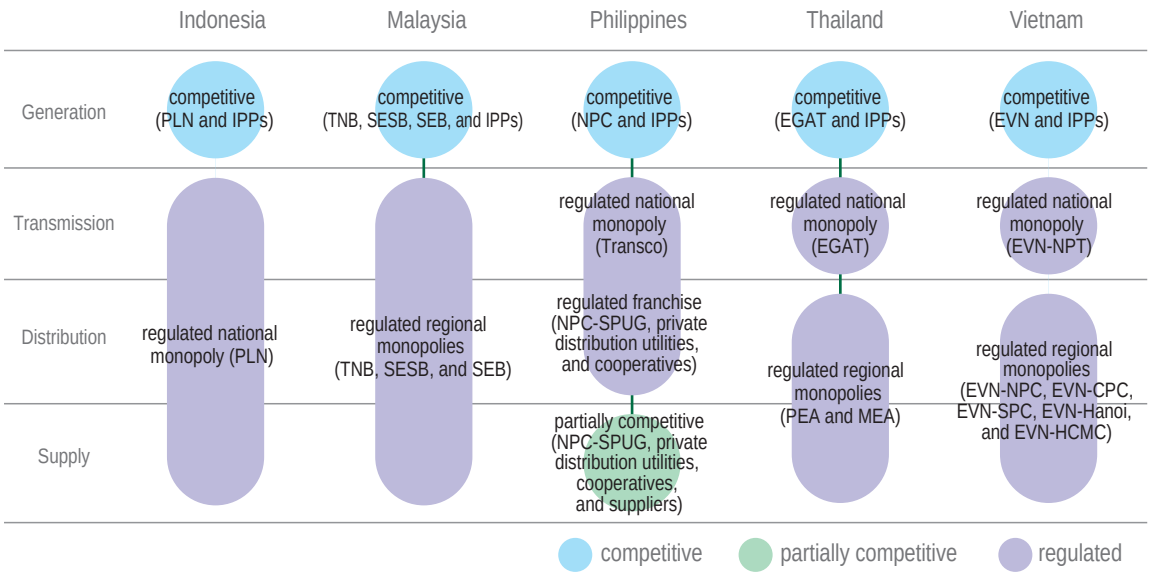
3) Incomplete electricity system reform

The third challenge to accelerate RE growth in Southeast Asia is incomplete electricity system reform. The region's five largest power systems are characterized by a lack of competition and inadequate regulations. This is generally problematic, even more so when energy policies are insufficiently supportive of RE. Unless conservative policy makers and regulated utilities suddenly become forward-thinking, independent power producers (IPPs) and consumers will keep having to play key roles in shifting paradigm.

In Southeast Asia's five largest power systems, competition almost exclusively takes place in the generation segment (the supply segment of the Philippines being a partial exception) (Chart 21). The transmission and distribution (T&D) segments are always regulated – sometimes integrated, and often include the participation of the national or regional monopolies which are also active in the generation and/or supply segments: Perusahaan Listrik Negara (PLN) in Indonesia,

Tenaga Nasional Berhad (TNB), Sabah Electricity Sdn. Bhd. (SESB), and Sarawak Energy Berhad (SEB) in Malaysia, National Power Corporation (NPC) in the Philippines, Electricity Generating Authority of Thailand (EGAT) in Thailand, and Vietnam Electricity (EVN) in Vietnam. The configuration of such power structures typically hinders the emergence of new participants and new business models.

Chart 21: Simplified Power Structure of Selected Southeast Asian Countries



Source: information selected by Renewable Energy Institute.

Nonetheless, these unfavorable conditions have not deterred daring companies to invest in the power sector of these countries, notably in the generation segment. These include both local and foreign companies. Regarding the latter, the participation in RE projects of the Japanese companies ITOCHU and Kyushu Electric Power Company in Indonesia, of the French company ENGIE in Malaysia, and of the Portuguese company Energias de Portugal (EDP) in Vietnam may be highlighted.

Furthermore, even if the supply segment is heavily regulated, an increasing number of businesses are actively requesting RE to meet their electricity consumption. These actions drive change and accelerate RE growth. For example, a minimum of 150 member companies belonging to the RE100 initiative, a global corporate RE initiative bringing together businesses committed to 100% RE electricity, have operations in Southeast Asia.[36]

In this regard, it may be noted that in the region's five largest power systems various corporate clean power procurement options exist, such as: RE certificates, net metering, on- & off-site PPAs (Table 3).

Table 3: Corporate Clean Power Procurement Options in Selected Southeast Asian Countries

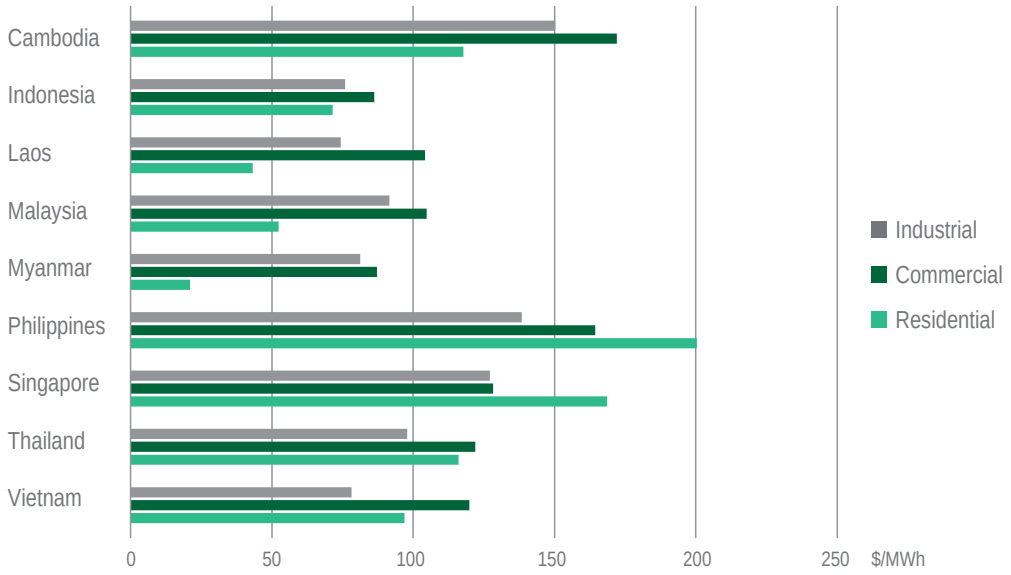
Country	RE certificate	Net metering	Onsite PPA	Offsite PPA
Indonesia	✓	✓	✓	○
Malaysia	✓	✓	✓	○
Philippines	✓	✓	✓	✓
Thailand	✓	○	✓	✕
Vietnam	✓	Regulation expired, under review	✓	Under discussion

Notes: Thailand's net metering scheme is limited to households. Indonesia's power market structure does not allow for offsite PPAs, however, Amazon signed the country's first solar corporate PPA with PLN in November 2022. Malaysia's Corporate Green Power Program allows for 0.6 GW of offsite PPAs.

Source: BloombergNEF, Southeast Asia Power Market Outlook 2022 (December 2022) [subscription required].

Finally, while still considering electricity system reform, it will also be important to revise retail electricity prices, which are frequently too low to stimulate necessary infrastructure investments (e.g., power plants, electrical grid…) in the region (Chart 22). Indeed, most of the average retail electricity prices for industrial, commercial, and residential customers ranged between only $70/MWh and $130/MWh in Southeast Asia in 2021.

Chart 22: Southeast Asia Average Retail Electricity Prices by Consumer Type and Country 2021



Note: no data available for Brunei.

Source: BloombergNEF, Prices, Tariffs & Auctions: Power & Fuel – Updated November 17, 2022 (accessed June 1, 2023) [subscription required].

Stopping fossil fuel subsidies which make prices artificially low should help put an end to this vicious circle.

Revising retail electricity prices should, however, be done in a socially acceptable way to protect vulnerable consumers and bearing in mind that more than 30 million people in Southeast Asia, or 5% of the region's population, still lacked access to electricity in 2020.[37]

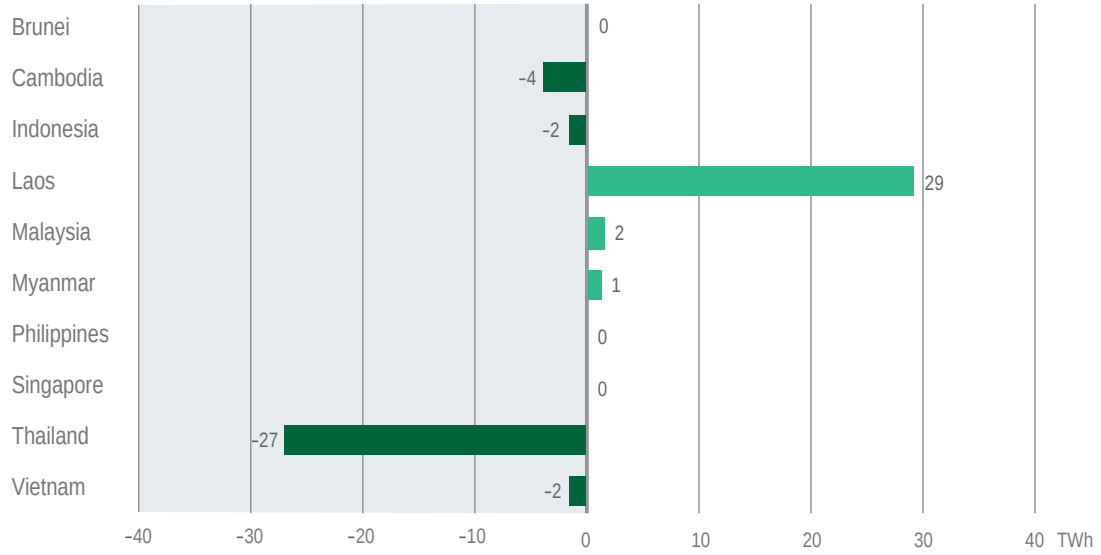
4) International electrical grid expansion

The fourth and last challenge to accelerate RE growth in Southeast Asia is to significantly expand cross-border electricity trade. This would optimize sharing the unevenly distributed RE potential of the region and help reduce RE curtailment. Southeast Asian countries are well-experienced in trading electricity cross-border, and many new projects are in the pipeline. However, to reach high shares of RE in electricity generation (i.e., 60-90%), even more will need to be done.

For more than a quarter of century already, Southeast Asian countries have been developing a regional power grid, the ASEAN Power Grid. Agreed in 1997, the original goals of this grid were to improve economic efficiency and strengthen energy security.[38] More recently, with the increasing awareness of climate change dangers, and robust evidence that RE is the best supply-side solution against climate change, the ASEAN Power Grid also became worth pursuing from an environmental point of view.

As of May 2022, nearly 8 GW of cross-border interconnection capacity existed in Southeast Asia.[39] In 2020, the year for which the latest data for cross-border electricity trade are available, Laos was the region's largest net exporter of electricity and Thailand its largest net importer (Chart 23).

Chart 23: Southeast Asia Net Exports of Electricity by Country 2020



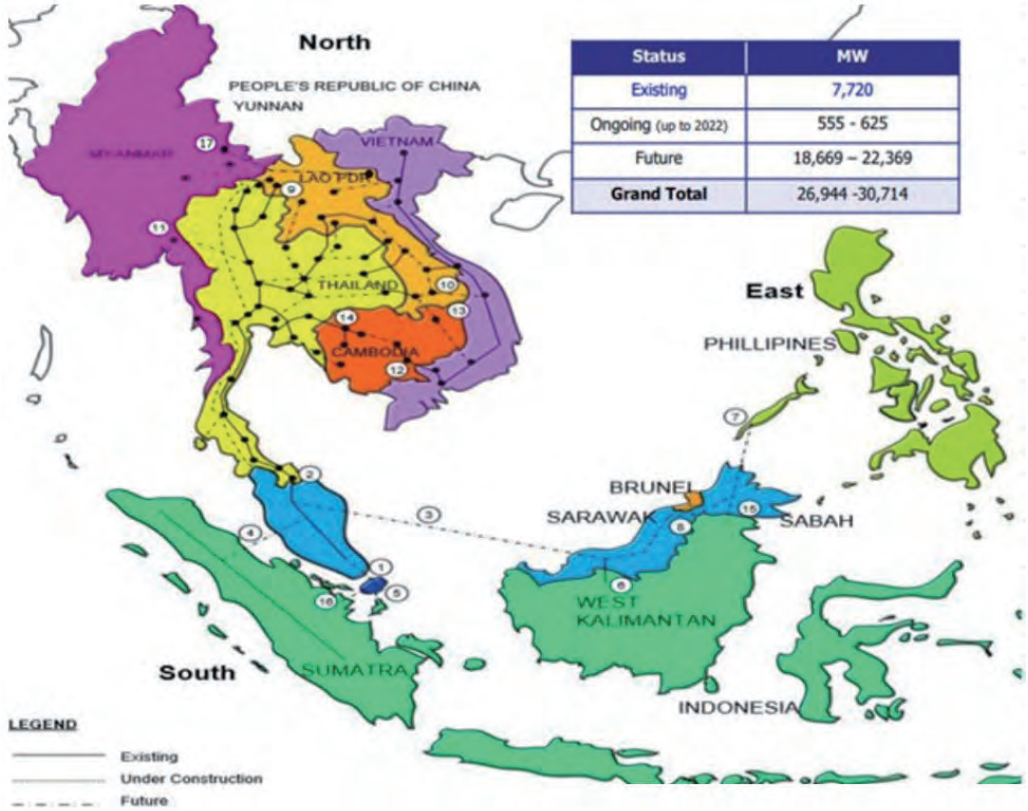
Source: International Energy Agency, Energy Statistics Data Browser: Electricity – Southeast Asia Countries – 2020 (accessed June 5, 2023).

Until now, cross-border electricity trade in Southeast Asia has mostly been conducted on a bilateral basis. Nevertheless, this situation is evolving. In June 2022, Laos and Singapore signed a PPA to trade RE electricity cross-border.[40] Based on this agreement, Laos exports 100 MW of hydropower to Singapore via Thailand and Malaysia. This is a good step towards regional multilateral power trade.

Another recent positive development is the announcement by Malaysia in May 2023 that the country lifted its ban on RE power exports that was in place since October 2021.[41] This decision should benefit Singapore, Malaysia's south neighbor. Indeed, Singapore, which RE potential is limited, targets decarbonized imports to account for 30% of its electricity supply in 2035.

If plans currently envisioned are realized, cross-border interconnection capacity in Southeast Asia could reach 27-31 GW in the foreseeable future (Chart 24).

Chart 24: Southeast Asia International Power Grid Interconnection Projects, as of May 2022



Note: slightly modified by Renewable Energy Institute for readability purposes.
Source: Heads of ASEAN Power Utilities/Authorities, Status Update of APG Interconnection Projects – Updated May 2022 (accessed June 5, 2023).

Reaching around 30 GW of cross-border interconnection capacity would be good yet insufficient, especially considering the integration of high shares of RE. Indeed, according to the energy outlooks presented in Chapter 1, Section 4 ("Towards high shares of renewable energy", pages 13-15): ERIA & IEEJ's CN2050/2060 scenario projects 55 GW of regional cross-border interconnection capacity for a RE share of 62%, and IRENA's 1.5-S RE90 scenario 157 GW for a RE share of 90%.

Successfully expanding the international electrical grid in Southeast Asia is of utmost importance. Failing to do so will result in the adoption of suboptimal options, such as decarbonized thermal power, which should be minimized.

Conclusion

There is a great opportunity for Southeast Asia to embrace renewable energy. This is because the region is blessed with an overall excellent renewable energy potential that can be exploited economically. Among renewable energy technologies, solar photovoltaic will have the brightest future. The potential of solar photovoltaic in Southeast Asia is enormous and its cost competitiveness well-established. Moreover, some countries in the region (especially Malaysia, Thailand, and Vietnam) play a leading role in manufacturing solar photovoltaic components. This leadership should help accelerate local adoption of the technology. It is also strategically crucial considering the global geopolitics of energy.

However, to accelerate renewable energy growth in Southeast Asia four challenges should be overcome: weak medium-term decarbonization policies, coal power lock-in, incomplete electricity system reform, and international electrical grid expansion. For each of these challenges, some recent positive developments have been witnessed which invites a cautious optimism. For examples, a new feed-in tariff scheme in Thailand, the repetition of auctions in Malaysia and the Philippines, the announcements of Just Energy Transition Partnerships in favor of Indonesia and Vietnam, the emergence of audacious independent power producers and consumers challenging conservative incumbent electric utilities, and the signature of a power purchase agreement between Laos and Singapore to trade renewable energy electricity cross-border.

Undoubtedly, renewable energy should thus be Southeast Asia top priority to fully blossom. Therefore, it is now of utmost importance that all stakeholders involved in the region share this common understanding and work in unison to accelerate renewable energy growth. Unreasonably pursuing risky alternatives instead, such as decarbonized thermal power and/or carbon capture and storage, may prove costly mistakes.

List of Abbreviations

ASEAN: Association of Southeast Asian Nations
CCGT: combined-cycle gas turbine
CO_2: carbon dioxide
EGAT: Electricity Generating Authority of Thailand
ERIA: Economic Research Institute for ASEAN and East Asia
ETM: Energy Transition Mechanism
ETS: emissions trading system
EVN: Vietnam Electricity
FiT: feed-in tariff
GHG: greenhouse gas
GW: gigawatt
IEA: International Energy Agency
IEEJ: Institute of Energy Economics, Japan
IPP: independent power producer
IRENA: International Renewable Energy Agency
JETP: Just Energy Transition Partnership
LCOE: levelized cost of electricity
MW: megawatt
MWh: megawatt-hour
NPC: National Power Corporation
NREL: National Renewable Energy Laboratory
OECD: Organization for Economic Co-operation and Development
PLN: Perusahaan Listrik Negara
PPA: power purchase agreement
RE: renewable energy
SEB: Sarawak Energy Berhad
SESB: Sabah Electricity Sdn. Bhd.
Solar PV: solar photovoltaic
T&D: transmission and distribution
TNB: Tenaga Nasional Berhad
TWh: terawatt-hour

Endnotes

[1] World Bank, Population, Total – Updated May 10, 2023 (accessed May 17, 2023).

[2] World Bank, GDP (constant 2015 US$) – Updated May 10, 2023 (accessed May 17, 2023).

[3] International Energy Agency, Energy Statistics Data Browser: Balances – ASEAN – 2010 and 2020 (accessed May 18, 2023).

[4] BloombergNEF, Southeast Asia Country Profiles (accessed June 2, 2023) [subscription required].

[5] Germanwatch, Global Climate Risk Index 2021: Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2019 and 2000 to 2019 (January 2021).

[6] International Energy Agency, Energy Statistics Data Browser: Balances – Southeast Asia Countries – 2020 (accessed May 18, 2023).

[7] Energy Institute, Statistical Review of World Energy 2023 (June 2023).

[8] Global Energy Monitor, CREA, E3G, Reclaim Finance, Sierra Club, Solutions for Our Climate, Kiko Network, CAN Europe, Bangladesh Groups, Alliance for Climate Justice & Clean Energy, and Chile Sustentable Boom and Bust Coal 2023: Tracking the Global Coal Plant Pipeline (April 2023).

[9] International Renewable Energy Agency, Renewable Capacity Statistics 2023 (March 2023).

[10] Vietnam Prime Minister, Decision: Approving the National Electricity Development Plan for the Period of 2021-2030, with a vision to 2050 (May 2023) [English translation provided by Apala Group].

[11] Philippine News Agency, EO 21 to Hasten Offshore Wind Projects, Says DoE – April 23, 2023 (accessed May 30, 2023).

[12] World Bank, Offshore Wind Roadmap for the Philippines (April 2022).

[13] International Energy Agency, Coal 2022: Analysis and Forecast to 2025 (December 2022).

[14] International Energy Agency and Imperial College London, ASEAN Renewables: Opportunities and Challenges (March 2023).

[15] PV Magazine, Emiliano Bellini, Myanmar's 1 GW Solar Tender Concludes with Lowest Bid of $0.0348/kWh – September 24, 2020 (accessed May 23, 2023).

[16] PV Magazine, Emiliano Bellini, Malaysia's 1 GW PV Tender Attracts Lowest Bid of $0.0429/kWh – March 15, 2021 (accessed May 23, 2023).

[17] BloombergNEF, Southeast Asia Power Market Outlook 2022 (December 2022) [subscription required].

[18] Vietnam Electricity, Ministry of Industry and Trade Sets Ceiling Prices for Solar and Wind Projects – January 16, 2023 (accessed May 23, 2023).

[19] Malaysian Investment Development Authority, Renewable Energy Capacity Targeted at 70% by 2050 – May 9, 2023 (accessed May 29, 2023).

[20] International Renewable Energy Agency, op. cit. note 9.

[21] BloombergNEF, Country Profiles: Malaysia – Updated December 5, 2022 (accessed May 30, 2023) [subscription required].

[22] BloombergNEF, op. cit. note 17.

[23] BloombergNEF, Caroline Chua, Philippines Goes Big on Renewables in Second Auction Round – April 5, 2023 (accessed May 30, 2023) [subscription required].

[24] International Carbon Action Partnership, Indonesia Launches Emissions Trading System for Power Generation Sector – February 27, 2023 (accessed May 30, 2023).

[25] United Nations Framework Convention on Climate Change, UN Chief Calls for Immediate Global Action

to Phase Out Coal – March 2, 2021 (accessed July 24, 2023).

[26] International Energy Agency and Imperial College London, op. cit. note 14.

[27] Institute for Energy Economics and Financial Analysis, Coal Lock-In in Southeast Asia: An Analysis of Existing and Planned Coal-Fired Capacity in Southeast Asia (December 2021).

[28] BloombergNEF, Miquel Kishimoto Guardiola, New ASEAN Taxonomy Bolsters Emerging Market Transition – April 10, 2023 (accessed May 31, 2023) [subscription required].

[29] International Institute for Sustainable Development and Global Subsidies Initiative, Indonesia's Coal Price Cap: A Barrier to Renewable Energy Deployment (May 2019).

[30] European Commission, Joint Statement: South Africa Just Energy Transition Investment Plan – November 7, 2022 (accessed May 31, 2023).

[31] Asian Development Bank, Update on ADB's Energy Transition Mechanism – April 2023 – April 27, 2023 (accessed May 31, 2023).

[32] Energy Institute, op. cit. note 7.

[33] Institute for Essential Services Reform, Indonesia Energy Transition Outlook 2023: Tracking Progress of Energy Transition in Indonesia – Pursuing Energy Security in the Time of Transition (December 2022).

[34] Asian Development Bank, ADB and Indonesia Partners Sign Landmark MoU on Early Retirement Plan for First Coal Power Plant Under Energy Transition Mechanism – November 14, 2022 (accessed May 31, 2023).

[35] European Commission, Political Declaration on Establishing the Just Energy Transition Partnership with Vietnam – December 14, 2022 (accessed May 31, 2023).

[36] RE100, Carbon Disclosure Project, Climate Group, RE100 Annual Disclosure Report 2022: Driving Renewables in a Time of Change (January 2023).

[37] International Energy Agency, SDG7 Database: Access to Electricity Data Set (SDG 7.1.1) – Updated March 30, 2022 (accessed June 1, 2023).

[38] International Energy Agency, Establishing Multilateral Power Trade in ASEAN (August 2019).

[39] Heads of ASEAN Power Utilities/Authorities, Status Update of APG Interconnection Projects – Updated May 2022 (accessed June 5, 2023).

[40] Energy Market Authority, Singapore Commences First Renewable Energy Electricity Import via Regional Multilateral Power Trade – June 23, 2022 (accessed June 5, 2023).

[41] Eco-Business, Samantha Ho, Malaysia Lifts Renewable Energy Export Ban, Move Welcomed in Singapore – May 10, 2023 (accessed June 22, 2023).

Renewable Energy:
The Top-Priority for Southeast Asia to Fully Blossom

September 2023

Renewable Energy Institute
11F, KDX Toranomon 1-Chome Bldg., 1-10-5 Toranomon, Minato-ku, Tokyo 105-0001 JAPAN
TEL：+81(0)3-6866-1020
info@renewable-ei.org
www.renewable-ei.org/en