Imperial College Business School | Centre for Climate Finance & Investment

IEA

ASEAN Renewables: Opportunities and Challenges

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A Joint Report by the International Energy Agency and Imperial College London

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Executive Summary

This report aims to improve financial transparency and provide more data pertaining to clean energy investments in Association of Southeast Asian (ASEAN) Member States[1]. Our research has conceptualized renewable energy risk and return qualitatively and quantitatively. The report further clarifies the opportunities and barriers for private sector investors, as well as priorities and potential solutions for scaling up renewables investment. Individual ASEAN countries have been analysed separately, and as constituent parts of the regional dynamic.

ASEAN countries such as Vietnam, Thailand, Malaysia, Indonesia and Singapore have all committed to either net-zero emissions or carbon neutrality by 2050. Governments have simultaneously increased the role of renewable power in national energy development plans. These dynamics all make ASEAN markets potentially attractive to clean energy investors. Nevertheless, the region's economic development model remains based on fossil fuels, with a high dependence on coal-fired power plants, which account for more than 40% of power generation.

To date, renewable power investment in Southeast Asia has grown inconsistently and deployment remains far from harnessing the region's strong resource potential. Average annual capital expenditures of USD 10 billion in solar PV and wind power over the past five years are amongst the lowest globally and only exceed that of Sub-Saharan Africa. Most of these investments were mobilised in only one country – Vietnam. Private capital has accounted for only 60% of renewable power investment in Southeast Asia, compared to about 90% in advanced economies.

Renewable power development in the region is lagging from inadequate policy and investment frameworks. Regulatory barriers, incumbent interests and inflexible commercial arrangements have enabled the continued prioritisation of fossil generation over renewables. Despite falling costs around the world for renewable technologies, solar and wind project costs remain elevated in Southeast Asia due to lack of deployment scale and underdevelopment of supply chains.

Attracting low-cost financing remains a major hurdle for development. With persistent development, operational and economic risks, financing costs for solar PV and wind remain relatively high in many ASEAN Member States and the financial value proposition for private sector investment often remains less clear than in advanced economies.

On a deployment-weighted basis, we estimate that investment in onshore wind projects across the ASEAN region is characterised by a nominal cost of capital of around 9–12%, in local currency terms. This range is around 8-11% for utility-scale solar PV, while that for commercial and industrial-scale solar PV is assessed at around 10-13%. These values strongly depend on underlying interest rate conditions and market-specific dynamics, including project-level commercial and financing arrangements, which can push metrics above or below these ranges.

To meet sustainability ambitions, countries in Southeast Asia will require much higher levels of energy sector investment, reaching at least USD 200 billion by 2030, of which over three-quarters in clean energy. These clean energy investments include the widespread rollout of renewables, improvements in energy efficiency, electrification of end uses and the deployment of low-emission fuels, including modern bioenergy, hydrogen-based fuels and carbon capture technology.

To attract this level of capital, many energy transition plans and ambitions across the region require better policy design and regulatory improvements to support their implementation. For example, supportive policy incentives in Vietnam have spurred a significant solar and wind buildout over the past five years. However, the process has been characterised by boom-and-bust deployment cycles and significant grid congestion.

This report identifies priorities for decision makers to help unlock investment in renewable power, with a focus on attracting lower cost capital from international investors. While country-specific priorities are highlighted in dashboards found in Annex A (covering key markets of Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam), some cross-cutting priorities have emerged.

Notably, the investment climate for renewable power in the ASEAN region would greatly benefit from:

- Better data and transparency around project-level financial performance
- Stronger regulatory frameworks concerning remuneration for renewables projects
- More robust financial market frameworks for renewables and transition investments
- An enhanced role for development finance institutions (DFIs) and blended finance
- Greater access to risk hedging tools to address credit and currency risks for private investors
- Improved power system connectivity across the region

Progress is occurring in many of these areas, but stronger efforts are required for the ASEAN region to shift towards a more sustainable energy pathway. The potential benefits of such a shift are considerable, including reduced vulnerabilities to climate change and fossil fuel price volatility, as well as enhanced economic opportunities from clean energy development.

This is a fourth report in a series of joint publications by Imperial College London and the International Energy Agency, designed to improve transparency that would enable investors and policymakers to play a bigger role in the energy transition.

1 ASEAN Member States include Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. To refer to this grouping, we use the terms ASEAN and Southeast Asia interchangeably throughout the report

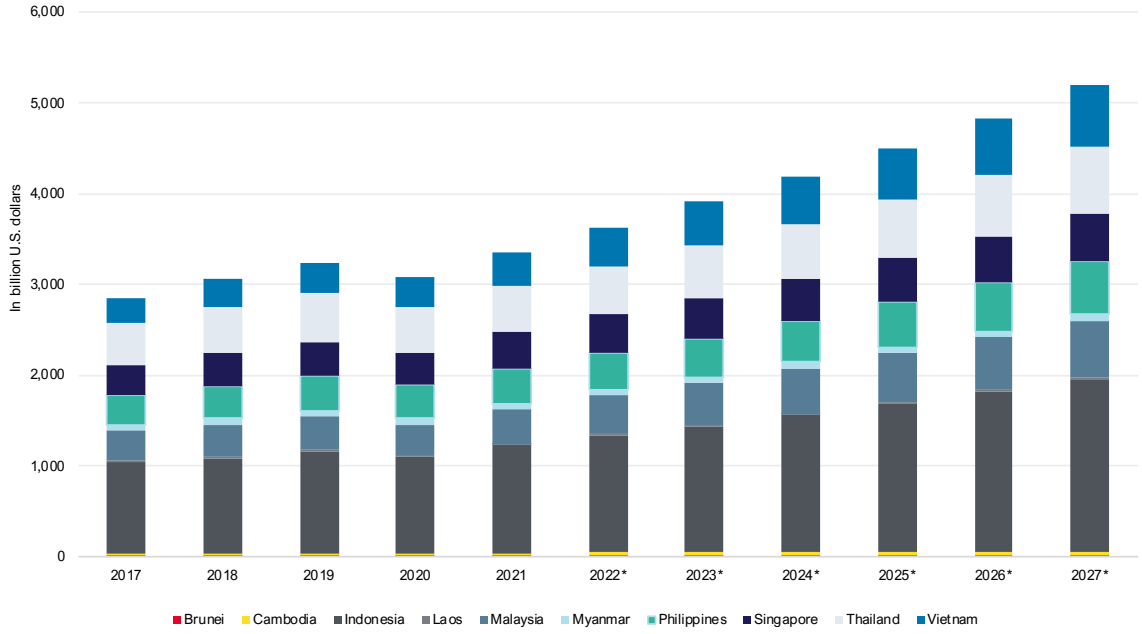
Introduction

As the world contends with a slowdown in global economic activity, inflation and heightened geopolitical tensions, it is increasingly important to address energy security issues. Against this backdrop of macro uncertainties, we shift our focus to a region facing new risks from an energy security and climate change perspective. Countries in the ASEAN region are amongst the most affected globally by climate change, with substantial socio-economic impacts experienced over the last two decades[2]. The ASEAN region's economies have experienced high economic and demographic growth, with rapid urbanisation, industrialisation and a continuing rise in energy demand.

Securely meeting this increasing demand affordably, calls for a rapid scale-up of energy investment. The acceleration of renewables, in combination with energy efficiency and electrification measures, would better address the region's increasing import bill for gas and oil, which otherwise could reach over 5% of GDP by 2030[3].

The gross domestic product (GDP) of ASEAN member states is forecast to grow at a rate exceeding a majority of advanced and developing economies. According to the International Monetary Fund (IMF), regional GDP is expected to grow at an average rate of 6.2% to 2027, led by Vietnam (10.9%), Malaysia (8.7%), Cambodia (8.3%) and Indonesia (8.2%). Such rapid expansion creates an opportunity for an acceleration of renewables investments.

Figure 1. Gross Domestic Product of ASEAN member states from 2017–2027*



Notes: * = forecast

Source: IMF, October 2022

To date, fossil fuels (notably power) have largely underpinned the economic growth model of ASEAN countries. Natural gas and coal account for 34% and 30%, respectively, of installed power capacity and 75% of the region's total generation. The installed capacity of coal-fired power plants has grown at an annual rate of 7% since 2017, and utilisation rates remain elevated. Without a dramatic shift in domestic policies and planning, complemented by financial support from international investors, ASEAN's rising electricity demand is likely to be met mainly by fossil fuels.

Renewable power in the region represents approximately a quarter of installed capacity and power generation (258TWh annual average 2017–2021). To date, much of this has stemmed from hydropower, which accounts for about half of the installed renewables capacity and more than two-thirds of the renewable electricity output. At the country level, the greatest renewable power deployment has occurred in Vietnam, where solar PV and wind surged from near zero in 2017 to over 22 GW in 2021, spurred by the implementation of feed-in tariffs. Thailand has added over 3 GW of renewables capacity since 2017, followed by Indonesia (2.2 GW), the Philippines (1.3 GW) and Malaysia (0.9 GW). However, renewables have yet to fulfil their large potential in capacity and generation.

2 ASEAN Taxonomy for Sustainable Finance (2021), ASEAN Taxonomy Board

3 Southeast Asia Energy Outlook (2022), IEA

The structure and design of power markets in ASEAN provide an important backdrop to understanding opportunities for scaling up and successfully integrating renewables. Countries are still in various stages of market liberalisation. Competitive wholesale power markets are in Singapore and the Philippines, where power generation is primarily privatised, and generators compete for dispatch in near real-time bidding. In these countries, the transmission and distribution sectors are functionally unbundled from the generation sector.

Market liberalisation has partially progressed in Vietnam and Peninsular Malaysia. Some elements of the generation sector are open to competition for dispatch. Nonetheless, a significant portion of generation is still contracted under long-term PPAs with the state-owned incumbent utilities. Vietnam and Malaysia are structured around single buyers, in which a dedicated market operator entity has been set up, but exists and is ring-fenced within the incumbent utility.

Most other power markets in ASEAN are not considered liberalised. Various state-owned entities serve as the incumbent utility (or utilities), with almost no real-time market bidding for dispatch. However, independent power producer (IPP) participation is largely possible and encouraged.[4] In Annex A, country-level dashboards for six key markets (Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam) in the ASEAN region provide a more detailed look at such dynamics.

4 Authors, based on industry surveys and consultations

Investment Opportunities and Challenges

Renewable power investment in the ASEAN region presents a significant opportunity for investors to contribute to sustainable economic growth. Rapidly growing demand for electricity, gradually improving policies and increasingly favourable economics all stand as strong drivers.

An important driver for clean energy investments in the ASEAN region is the evolution of a supportive regulatory framework and government plans.[5] Faced with the challenge to shift the energy mix, several ASEAN countries have put forth ambitious plans and initiated government-backed investment schemes to accelerate the transition toward clean energy. Countries in the region have collectively put forth net zero emissions, or carbon-neutrality targets covering more than 80% of energy supply.

Power sector planning in several markets increasingly sees renewables as the preferred source for new additions. For instance, Cambodia's Power Development Plan, released in 2022, foresees that by 2030 approximately two thirds will come from renewable energy. Malaysia aims to have renewables account for 40% of power by 2035. Singapore plans to increase solar power by up to 1.5 GW by 2025 and recently adopted a net-zero emissions (NZE) target by 2050. Such efforts support growing interest in the region by international investors and boost activity by local players who have underpinned renewables investment to date.

Strong renewable resource potential across the region also creates opportunities for more ambitious development. However, this development is often lagging due to uncertainty over policy and investment frameworks. For example, Vietnam has one of the best wind resources[6] in Southeast Asia with an estimated potential of 311 GW.[7] While reporting indicates that Vietnam is likely to increase the role of renewables in its Power Development Plan 8, the release of this plan has been delayed. Moreover, there are indications that fossil fuels may remain the backbone of its economic development in the medium term.

Other persistent challenges related to structural and regulatory barriers which have enabled the continued prioritisation of fossil generation over renewables remain. The lock-in of fossil fuel-based electricity sources through inflexible power purchase agreements has generally inhibited renewables investment to date. Incumbent interests in coal, concerns about energy security and uncertainties related to operating under a very different power model have all contributed to overall slow progress in policy and regulatory reform.

Higher costs represent another barrier. Despite dramatically falling technology costs for renewables around the world in recent years, capital expenditure requirements for utility-scale solar PV and wind projects remain significantly higher in Indonesia than in China or India. Lack of scale in deployment and underdevelopment of supply chains, amid high domestic content requirements, have all contributed to elevated project costs.

Persistent development, operational and economic risks in many Southeast Asian countries also contribute to a relatively high cost of financing. These risks typically fall around priority areas: power sector sustainability, project bankability, financing, the cost of capital, and the degree to which countries have taken an integrated policy approach to scaling up renewables (Figure 2). In many countries, renewables projects are only marginally bankable. This stems in part from lack of certainty over cash flows, but also from foreign exchange risks in some markets, with power purchase agreements priced in local currencies while a portion of project equipment costs (e.g. solar panels, wind turbines) is priced in international currencies.[8]

5 Seizing green business growth for Asia's energy players (2022), McKinsey
6 Sissingh and Arends, Wind Energy Potential Vietnam (2018)
7 Exploring Renewable Energy Opportunities in Select Southeast Asian Countries (2019), USAID-NREL partnership
8 Authors, based on industry surveys and consultations

Figure 2. Main climate policy ambitions and key investment priorities and risks in selected countries in Southeast Asia

Market	Recent Policy Changes	Investment Priorities			
		Power sector sustainability	Project bankability	Financing	Integrated approaches
Indonesia	Planning for NZE by 2060. More renewable power in long-term plan, though coal still represents almost 65% of generation by 2030.	🔴	🟡	🟡	🔴
Malaysia	Government announced goal to become carbon neutral by 2050 and stop building new coal-fired plants.	🟢	🟡	🟢	🟢
Philippines	Updated nationally determined contribution in 2021	🔴	🟡	🟢🟡	🟡
Singapore	Government announced Net-Zero Emissions by 2050 target in October 2022	🟢	🟢	🟢	🟢
Thailand	Announced intention to develop plan for NZE by 2065. Updated power expansion plan has reduced dependency on coal in favour of natural gas.	🟡	🟡	🟢	🟡
Vietnam	NZE by 2050 target announced at COP26. Substantial capital is mobilised to renewable power, especially solar, while coal capacity is still planned to expand by 2030.	🔴	🟡	🟢🟡	🔴
Cambodia	Cambodia's Basic Energy plan recommends renewable power make up 65% of total generation by 2030.	🟡	🔴	🔴	🔴

🟢 Low risk/supportive factor for investment
🟡 Potential risk factor/barrier for investment
🔴 High potential risk factor/barrier for investment

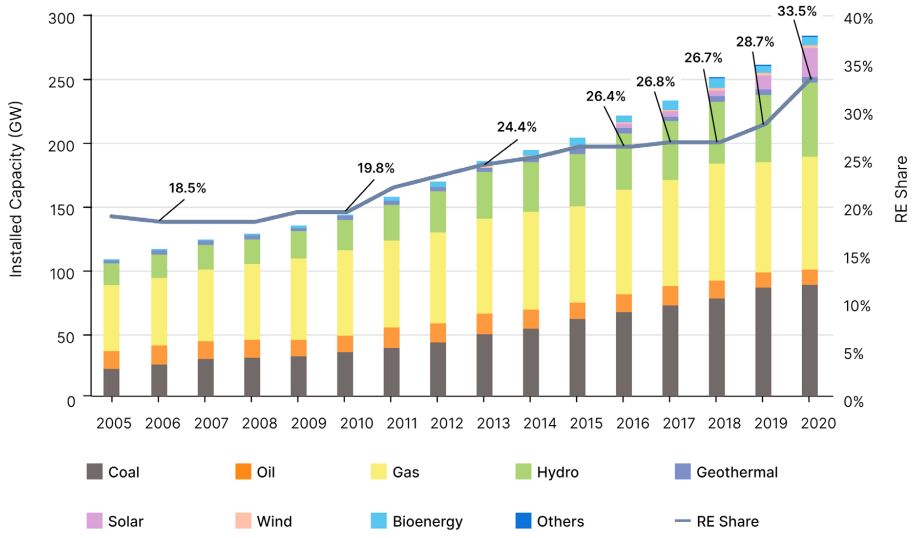
Source: Southeast Asia Energy Outlook (2022), IEA

In this section, we have outlined some key investment opportunities and challenges. More country specific dynamics (e.g. Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam) are outlined in Annex A. Despite good progress in raising ambition levels, further evolving climate policies and implementation across individual countries will be critical. Better country-level policies could encourage more renewable investments. For example, many countries around the world have brought down the cost of renewable power with well-designed renewables auctions, which effectively allocate and manage risks, improve price discovery, and enhance competition for project development. There is considerable potential for such initiatives to support progress and create greater investment impact in the ASEAN region.

ASEAN Renewable Power Investments

Traditionally, emerging and developing economies (EMDEs) have been reliant on public sources of finance, recently accounting for nearly 60% of clean energy investments[9]. To achieve climate targets, this trend would need to shift dramatically. Private capital would need to account for 60% of clean energy investment, albeit at a level below that for advanced economies at almost 90%. This is partly due to the elevated role of EMDE state-owned utilities as investors in electricity grids. To facilitate this shift, regulatory and financing frameworks must improve to reduce the costs, risks and barriers around developing clean energy projects in EMDEs and the ASEAN region, in particular.[10]

Figure 3. Southeast Asia power generation capacity and renewables share



Source: ASEAN Centre for Energy

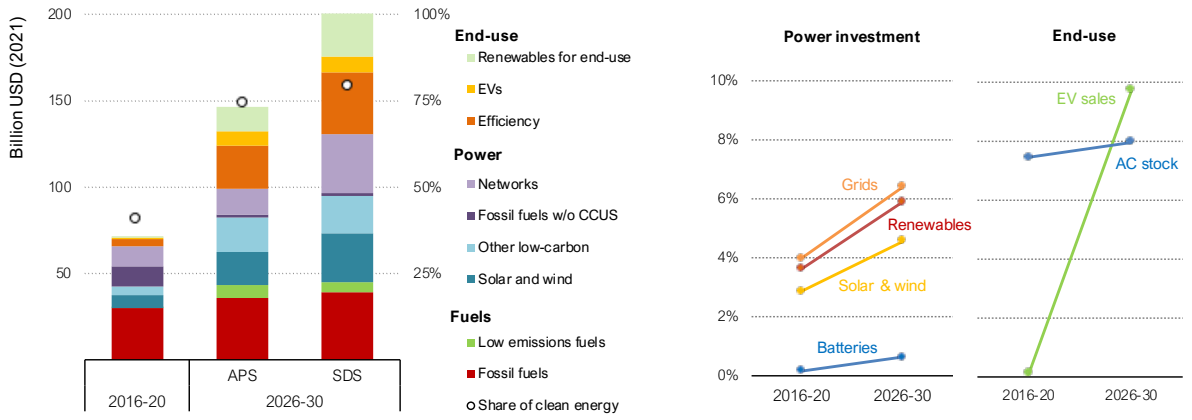
Clean energy investments in Southeast Asia have risen in cases where governments have established a supportive regulatory framework and clear plans for transforming their energy systems, including reaching net-zero emissions. According to the ASEAN Centre for Energy, during the Covid-19 pandemic, fossil fuels as a share of the primary energy supply decreased in ASEAN member states, whereas the share of total renewable energy increased as renewables investments were included as part of government stimulus packages[11].

To further align with sustainability milestones and accelerate the transition towards a clean energy economy, countries in Southeast Asia will require much higher levels of energy sector investment, reaching at least USD 200 billion by 2030, of which over three-quarters would need to be devoted to clean energy[12]. However, investment momentum for renewables has been inconsistent, with insufficient policy signals to support the development of robust project pipelines. With only three years left to reach regional interim renewables targets, which envision renewables to account for 35% of power capacity by 2025, accelerating investments in renewable power and enabling infrastructure, such as electricity networks and battery storage, is critical[13].

Based on IEA scenarios, investment in the energy system would need to rise significantly to meet growing demand in Southeast Asia. By 2030, investments would need to increase substantially in all cleantech sectors (Figure 4).

9 World Energy Outlook (2022), IEA
10 World Energy Outlook (2022), IEA
11 ASEAN Energy in 2022: Outlook Report, ASEAN Centre for Energy
12 Southeast Asia Energy Outlook (2022), IEA
13 ASEAN Energy in 2022: Outlook Report, ASEAN Centre for Energy

Figure 4. Southeast Asia energy investment under Announced Policies Scenario (APS) and the SDS (left) and share of global investment by select technologies (right)



Source: Southeast Asia Energy Outlook (2022), IEA

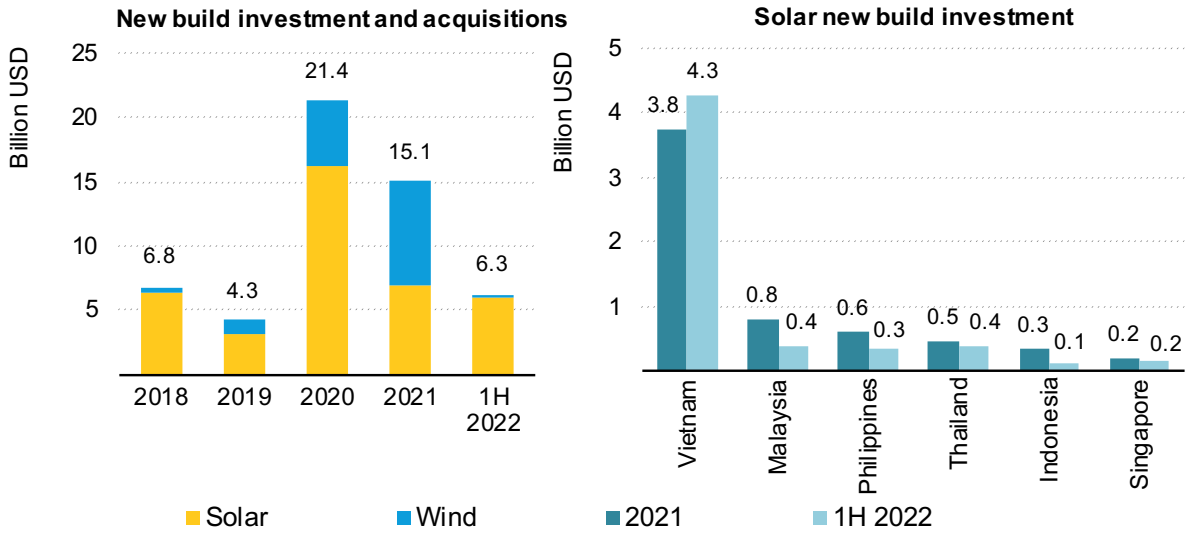
We have outlined the investment level needed, but what is actually being invested in renewables in the region? Between 2016 and 2020, annual average energy investments in Southeast Asia were around USD 70 billion, with those for clean energy below USD 30 billion annually[14]. Of that, average annual capital expenditures of USD 10 billion in solar PV and wind energy over the past five years are amongst the lowest globally and only exceed that of Sub-Saharan Africa. Moreover, the majority of these investments were mobilised in only one country – Vietnam.

Private capital accounted for almost 60% of renewable power investments during this period. Additionally, almost half of private capital for power in Southeast Asia was invested in fossil fuel generation. Overall, investments in clean energy follow a worrying trend: for every dollar invested in renewable power capacity in Southeast Asia, another dollar was invested in unabated fossil fuels. This is compared to USD 0.5 in Sub-Saharan Africa, USD 0.3 in China and USD 0.2 in Latin America.[15]

Bloomberg New Energy Finance estimates that financing for solar and wind assets largely represents new projects to be built in the years ahead, reaching USD 15 billion in 2021. This was 29% lower than in 2020, primarily due to the decrease in Vietnam's solar market since the expiry of its feed-in tariff (FiT) scheme at the end of 2020, amid much lower activity in the rest of the region. Part of the shortfall was made up by wind financings, again, largely in Vietnam, which increased 60% to approximately USD 8 billion. Vietnam's wind capacity reached a record high in 2021, led by local developer Trung Nam Construction and Philippines AC Energy.[16]

14 Global Energy and Climate Model (2022), IEA
15 Southeast Asia Energy Outlook (2022), IEA
16 1H 2022 Southeast Asia Renewable Energy Investment Trends (2022), BNEF

Figure 5. ASEAN solar and wind annual financing (2018 – 2022) (Left) and solar new build investment by country (Right)



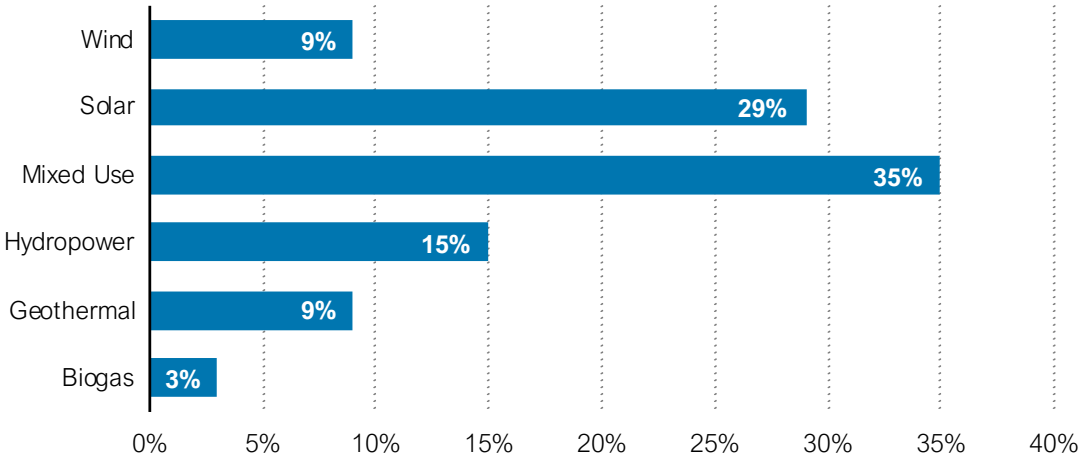
Source: Bloomberg New Energy Finance

The market for acquisitions of existing renewables projects remains small in Southeast Asian countries but saw increased interest from European firms in 2021. Bloomberg estimates further growth in secondary transactions (operating assets and projects under development) as they are easier for international developers relative to greenfield projects.[17]

The role of blended finance

Blended finance transactions, the use of catalytic capital from public sources to increase private sector investment in sustainable development, play a significant role in ASEAN countries. Convergence's Historical Deals Database (HDD) of blended finance transactions has captured 99 such transactions targeting the ASEAN region, representing an aggregate value of USD 19.75 billion (this includes transactions focused solely and partially on ASEAN countries). Roughly a third (34%) of these transactions have targeted renewable energy projects in the ASEAN region, representing USD 10.3 billion in total financing. These represent 13% of global climate blended finance and 6% of the overall blended finance market.

Figure 6. Breakdown of ASEAN renewable energy blended finance transactions by energy technology



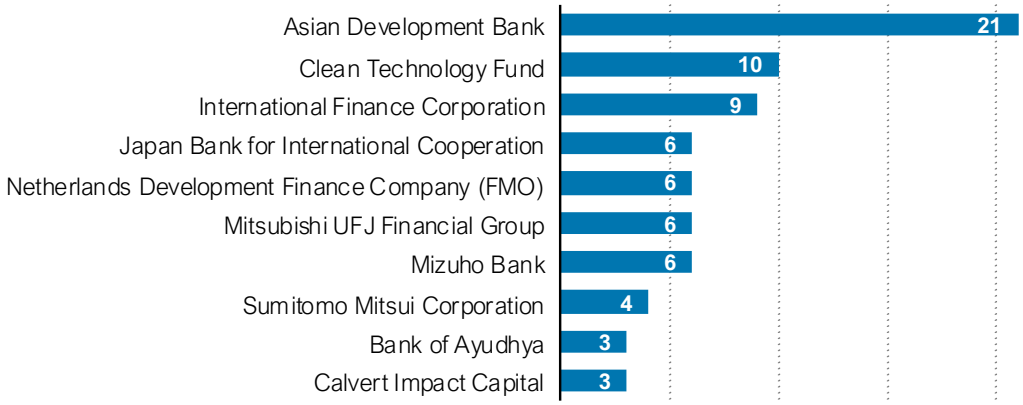
Source: Convergence

17 Southeast Asia Renewable Energy Investment Trends (2H 2022), BNEF

Over one-third of blended finance investments fund mixed-use transactions (transactions targeting more than one renewable energy technology) within the renewable energy sector, given the high proportion of transactions using a portfolio approach (i.e., funds). Beyond this trend, blended finance deals in ASEAN countries have most frequently targeted solar (29%) and hydropower (15%) projects. These figures diverge somewhat from what Convergence observes in the global market, demonstrating a heavy concentration in solar transactions (75% of renewable energy deals between 2019–2021) and wind (25% of transactions between 2019–2021).

The most common investors in renewable energy blended finance deals in the ASEAN region are commercial private investors (40%), followed by development finance institutions (DFIs) (27%), including multilateral development banks (MDBs) and development agencies (19%).

Figure 7. Investor league table for ASEAN renewable energy blended finance transactions, by number of commitments



Source: Convergence

Almost a third of ASEAN renewable energy blended finance transactions are between USD 100–250 million in size, including projects, funds and companies. In fact, about 60% of transactions in the renewable energy sector in the ASEAN region are larger than USD 100 million, outpacing the global market in terms of investment ticket sizes. Larger deals are critical to securing the investment interest of large-scale investors like insurance companies, pension funds and international financial institutions.

In terms of countries, Indonesia and Thailand are the most active blended finance markets in the ASEAN renewable energy sector, accounting for 11 transactions each, closely followed by Vietnam (10) and the Philippines (7). The breakdown of aggregate financing received by individual ASEAN countries largely corresponds with country breakdown by deal count. However, there are some exceptions; for example, Laos PDR is one example of a country that has witnessed larger aggregate financing volumes despite fewer deals due to several large-scale projects and multi-country funds.

Cost of capital metrics for ASEAN infrastructure and renewables

To assess the perceived risks and expected returns for unlisted renewable power assets in ASEAN, this section details cost of capital metrics sourced directly from conversations with private and public investors, as well as industry sources and indices. Differentials in the cost of capital for infrastructure and renewables projects are driven by several dynamics, including:

- Country-level factors, such as base interest rates and currency volatility
- Technology factors, including technical readiness and operational performance
- Policies and regulations, including system planning, market structure and administrative requirements
- Project-level cash flows, including commercial arrangements for pricing and purchase and the degree of industry competition
- Integration issues, including network infrastructure and system operations
- Availability of finance by type of investor, stage of investment and type of funds (e.g., commercial or concessional)

For six key markets in the ASEAN region (Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam), many of these dynamics are assessed in more detail in the country dashboards found in Annex A.

As in our previous report, this report considers metrics from EDHECinfra to provide a broad benchmark for infrastructure financial metrics[18]. A more detailed description of the EDHECinfra South-East Asia index, which consists of assets in the Philippines, Malaysia and Singapore (all ASEAN countries), is provided in Annex C. We refer to it to provide a starting point for assessing the cost of capital for unlisted infrastructure in the ASEAN region. We show in Table 1 that the expected equity return for unlisted infrastructure within the index, in local currency terms over the past decade, is 10.5%, with the distribution of returns ranging from under 8% to over 13%. This average expected return is based on a cost of debt of 4.6%, suggesting an overall weighted-average cost of capital (WACC) of 8.1% (in nominal terms). Nevertheless, as described further in Annex C, the composition of this index is limited in terms of geographical and sectoral coverage and so does not provide a robust proxy for assessing the cost of capital for renewable power in the region.

Table 1. Southeast Asia unlisted infrastructure financing and profitability metrics, mid-2012 to mid-2022

	Mean	Min	Max	25th Percentile	75th Percentile
WACC	8.1%	4.7%	11.5%	6.6%	9.6%
Expected Return (IRR)	10.5%	7.4%	13.6%	8.6%	12.1%
Cost of Debt	4.6%	3.0%	6.3%	3.6%	5.3%
EV / EBITDA	13.6	2.7	54.4	5.1	17.9

Notes: data are in local currency terms; IRR = internal rate of return; EV = enterprise value; EBITDA = earnings before interest, taxes, depreciation and amortisation

Source: The authors, based on EDHECinfra database

18 Climate Infrastructure Investing: Risks and Opportunities for Unlisted Renewables (2022), IEA and CCFI

By comparison, in Tables 2–5, the performance metrics for wind and solar PV projects gathered directly from industry sources and the Cost of Capital Observatory[19] point to generally higher levels of expected equity returns and cost of capital (expressed in nominal terms). These metrics vary strongly by market and technology, with wide ranges to reflect these variations. Summary averages are presented on an unweighted basis – the simple mean across the countries evaluated for each technology – as well as on a capacity-weighted basis, reflecting deployment expectations over the next five years.

Table 2. ASEAN cost of capital metrics for onshore wind and solar PV

	Onshore wind (unweighted mean)	Onshore wind (weighted mean)	Utility-scale solar PV (unweighted mean)	Utility-scale solar PV (weighted mean)	C&I solar PV (unweighted mean)	C&I solar PV (weighted mean)
WACC (LCY)	8.7% – 11.4%	9.0% – 12.3%	7.9% – 10.3%	8.2% – 10.5%	8.6% – 11.0%	9.8% – 12.8%
Expected Return (LCY)	11.1% – 14.4%	11.5% – 14.7%	10.3% – 13.0%	10.4% – 12.8%	10.7% – 13.3%	12.1% – 15.0%
Cost of Debt (LCY)	7.8% – 10.0%	8.0% – 11.0%	7.0% – 9.0%	7.3% – 9.4%	7.7% – 9.5%	8.7% – 11.3%
WACC (USD)	6.4% – 9.1%	6.7% – 9.6%	6.0% – 8.5%	6.1% – 8.5%	7.0% – 9.6%	7.8% – 10.6%
Expected Return (USD)	10.1% – 13.3%	10.9% – 13.9%	9.3% – 11.8%	9.5% – 11.8%	9.7% – 12.2%	11.2% – 14.1%
Cost of Debt (USD)	5.0% – 7.1%	5.0% – 7.3%	4.7% – 6.8%	4.7% – 6.8%	5.7% – 7.8%	6.0% – 8.3%
Leverage ratio	68.0% – 73.0%	66.2% – 71.2%	67.0% – 73.0%	65.6% – 72.3%	59.2% – 68.3%	59.8% – 67.0%

Notes: WACC is expressed in nominal terms. LCY = local currency, C&I = commercial and industrial scale; weighted means are calculated based on the country share of 5-year capacity additions forecast in IEA (2022), Renewables 2022. Debt and equity ranges for each technology reflect inflationary environments, interest rate regimes and local currency fluctuations versus USD in recent years, pricing variations by investor and the country-level assumptions detailed in Tables 3–5

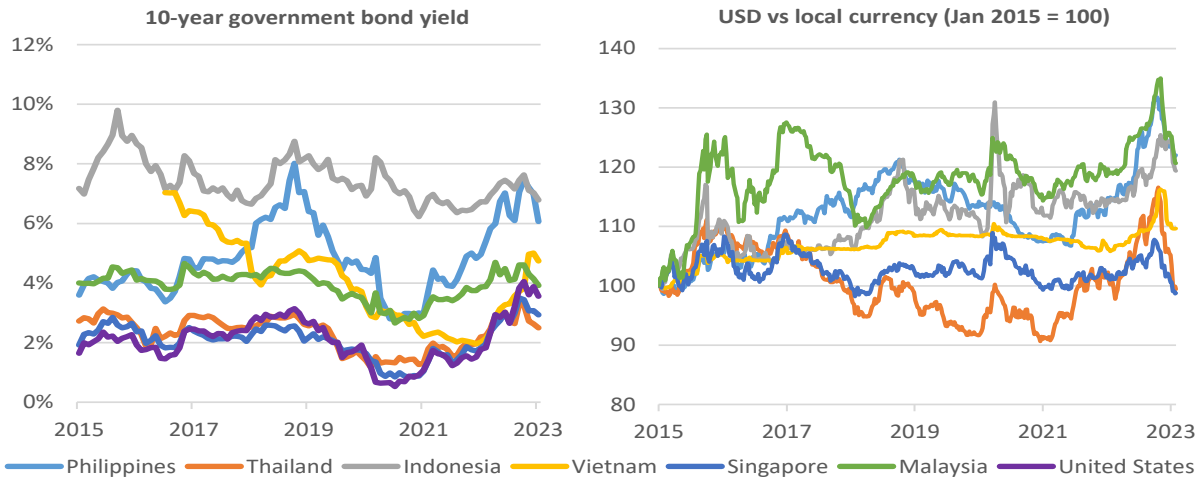
Source: The authors, based on investor and industry stakeholder discussions

The following paragraphs give a broad overview of the drivers behind these variations, while the country dashboards in this report provide greater detail on market-level dynamics. The metrics reflect expectations for equity returns and debt pricing by market participants for investment in new renewable power generation projects over 2022 and early 2023.

Such expectations can differ from actual returns and are highly dependent on underlying policy and market conditions, which continue to fluctuate in ASEAN. They also integrate points across a year (2022) during which interest rates and currency values fluctuated significantly. As shown in figure 9, 10-year government bond yields rose across key markets in ASEAN and the United States in 2022. In some cases, rates reached near pre-Covid 19 levels. In other instances, interest rates increased above pre-pandemic levels. Throughout this period local currencies have experienced high volatility relative to USD.

19 Cost of Capital Observatory (2022), IEA, the World Economic Forum, Imperial College London and ETH Zurich

Figure 8. Government bond yields (left) and indexed currency movements (right), select countries



Source: Bloomberg

As such, the lower bounds in the tables below reflects a lower interest rate environment in each country and other risk factors. Given interest rate uncertainity and the long-term perspective investors take into their decisions, including for refinancing projects, our values represent data across different rate regimes.

Onshore wind

For onshore wind projects, expected local currency-based equity returns average, on a deployment-weighted basis, from over 11% to nearly 15%, higher than that for broader infrastructure. This is strongly driven by the region's largest market (in terms of capacity additions), Vietnam, where IRRs range from 12-15%. These levels in Vietnam reflect the financial attractiveness of the previous feed-in tariff scheme, but also the high level of returns required to compensate for integration and contractual risks there, as well as uncertainty over the next incentive scheme. By comparison, in the Philippines and Thailand (the second and third largest markets, respectively), where tariffs are less generous, but policy and integration risks are lower, IRRs range from over 10% to near 14%. While the availability of long-term PPAs provides some regulatory stability, in Indonesia, the range of 12% to 15% reflects a more limited track record of deployment to date compared with other markets. Across all markets, stakeholders point to a constraint in equity available for early-stage project development, a bottleneck that pertains to other renewables projects as well.

Table 3. Onshore wind cost of capital metrics for select countries

	Vietnam		Thailand		Indonesia		Philippines		Mean (unweighted)		Mean (weighted)	
Currency	VND	VND	THB	THB	IDR	IDR	PHP	PHP	N/A	N/A	N/A	N/A
Technology	Wind	Wind	Wind	Wind	Wind	Wind	Wind	Wind	Wind	Wind	Wind	Wind
WACC (LCY)	9.6%	13.1%	7.5%	9.7%	10.6%	13.1%	7.0%	9.8%	8.7%	11.4%	9.0%	12.3%
Expected Return (LCY)	12.0%	15.0%	10.5%	13.5%	12.0%	15.0%	10.0%	14.0%	11.1%	14.4%	11.5%	14.7%
Cost of Debt (LCY)	8.5%	12.0%	6.5%	8.0%	10.0%	12.0%	6.0%	8.0%	7.8%	10.0%	8.0%	11.0%
WACC (USD)	7.0%	10.0%	6.0%	8.5%	6.8%	9.6%	6.0%	8.5%	6.4%	9.1%	6.7%	9.6%
Expected Return (USD)	11.5%	14.5%	9.0%	12.0%	11.0%	14.5%	9.0%	12.0%	10.1%	13.3%	10.9%	13.9%
Cost of Debt (USD)	5.0%	7.5%	5.0%	7.0%	5.0%	7.0%	5.0%	7.0%	5.0%	7.1%	5.0%	7.3%
Tariff currency indexation	USD	USD	THB	THB	USD	USD	PHP	PHP	N/A	N/A	N/A	N/A
Leverage ratio	65.0%	70.0%	70.0%	75.0%	65.0%	70.0%	70.0%	75.0%	68.0%	73.0%	66.2%	71.2%

Notes: WACC is expressed in nominal terms. LCY = local currency; weighted means are calculated based on the country share of 5-year capacity additions forecast in IEA (2022), Renewables 2022. Debt and equity ranges for each country reflect inflationary environments, interest rate regimes and local currency fluctuations versus USD in recent years, pricing variations by investor and the following market assumptions:

- Vietnam – includes projects under previous feed-in tariff (FIT) regime and during post-FIT period
- Thailand – includes tariffs under FIT scheme announced in October 2022
- Indonesia – includes projects under new tariff scheme announced in September 2022
- The Philippines – includes projects under the Renewable Portfolio Standard (2020) and Green Auction Program (2022)

Source: The authors, based on investor and industry stakeholder discussions

In local currency terms, the cost of debt for onshore wind, at 8–11% on average, is also higher when compared to the broader infrastructure index. The higher cost of debt compared with the infrastructure index (whose data goes only through June 2022) likely reflects recent interest rate increases, depending on geography. It also reflects perceived bankability issues for wind projects and underdeveloped commercial banking systems in some markets (e.g., Vietnam, Indonesia). Lower credit ratings associated with the main utility power purchaser, as in Vietnam and Indonesia, also contribute to a higher cost of debt in these markets.

Projects can generally achieve 70–75% leverage ratios in most markets, similar to international benchmarks, such as India. Ratios are lower in Vietnam, at 65–70%, where non-recourse project financing structures are also less prevalent. These values depend a lot on the source of funding. Stakeholders indicate that access to commercial debt from advanced economies or credit enhancement through concessional funds (e.g., guarantees, subordinated debt) can decrease debt costs and enhance leverage ratios.

Overall, these metrics for onshore wind point to a WACC range of 9% to over 12% in local currency terms, higher than the SE Asia (ASEAN) unlisted infrastructure index at just over 8%. Still, the broader infrastructure index is heavily concentrated in the Philippines and Malaysia. So, it is possible that the cost of capital for the infrastructure index is underestimated compared to a portfolio that includes additional markets, such as Indonesia and Vietnam. In that case, on average, unlisted renewable power projects in the region may benefit from similar or better financing terms than other unlisted infrastructure assets.

The metrics above only concern onshore wind, offshore wind development in Southeast Asia remains nascent. Our discussions indicated growing investment opportunities, with higher equity and debt pricing, and lower leverage levels, for offshore wind projects in markets with good resource potential (i.e., Vietnam and the Philippines).

Utility-scale solar PV

For utility-scale solar PV projects, expected local-currency-based equity returns average over 10 to near 13% on a deployment-weighted basis. These values vary significantly by country, with expected returns in more established markets (e.g., Malaysia, the Philippines and Thailand) generally lower. In Vietnam, return expectations are much higher. While deployment there surged over 2019–20, projects face significant revenue risks. Development has stalled with the expiration of feed-in tariffs for new projects, which have recently been renewed. Indonesia is expected to be the largest deployment market over the medium term, but starting from a low base, with investors expecting relatively high returns to compensate for elevated project costs (partly due to local content requirements) and a more uncertain policy environment.

Though still higher than that for the broader infrastructure index, expected equity returns for utility-scale solar PV projects are below those for onshore wind across most markets, reflecting lower perceived integration risks associated with utility-scale solar PV. However, in Vietnam, system integration challenges and curtailment risks are more acute for solar PV projects than wind, pushing up return requirements.

In general, stakeholders point to the potential across the region for competitive auctions for power purchase agreements to push down project costs and erode returns over time. Still, such pricing mechanisms have not been rolled out on a widespread scale in ASEAN, and there are uncertainties over the transition towards more competitive pricing schemes.

Table 4. Utility-scale solar PV cost of capital metrics for select countries

	Vietnam		Thailand		Malaysia		Indonesia		Philippines		Mean (unweighted)		Mean (weighted)	
Currency	VND	VND	THB	THB	MYR	MYR	IDR	IDR	PHP	PHP	N/A	N/A	N/A	N/A
Technology	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV
WACC (LCY)	10.1% – 13.6%		7.0% – 9.2%		6.5% – 8.1%		9.4% – 11.3%		6.5% – 9.3%		7.9% – 10.3%		8.2% – 10.5%	
Expected Return (LCY)	12.5% – 15.5%		10.0% – 13.0%		8.0% – 10.5%		11.5% – 12.5%		9.5% – 13.5%		10.3% – 13.0%		10.4% – 12.8%	
Cost of Debt (LCY)	9.0% – 12.5%		6.0% – 7.5%		6.0% – 7.0%		8.5% – 10.5%		5.5% – 7.5%		7.0% – 9.0%		7.3% – 9.4%	
WACC (USD)	7.5% – 10.5%		5.5% – 8.0%		5.1% – 7.3%		6.3% – 8.7%		5.5% – 8.0%		6.0% – 8.5%		6.1% – 8.5%	
Expected Return (USD)	12.0% – 15.0%		8.5% – 11.5%		7.0% – 9.0%		10.5% – 12.0%		8.5% – 11.5%		9.3% – 11.8%		9.5% – 11.8%	
Cost of Debt (USD)	5.5% – 8.0%		4.5% – 6.5%		4.5% – 6.5%		4.5% – 6.5%		4.5% – 6.5%		4.7% – 6.8%		4.7% – 6.8%	
Tariff currency indexation	USD	USD	THB	THB	MYR	MYR	USD	USD	PHP	PHP	N/A	N/A	N/A	N/A
Leverage ratio	65.0% – 70.0%		70.0% – 75.0%		70.0% – 75.0%		60.0% – 70.0%		70.0% – 75.0%		67.0% – 73.0%		65.6% – 72.3%	

Notes: WACC is expressed in nominal terms. LCY = local currency; weighted means are calculated based on the country share of 5-year capacity additions forecast in IEA (2022), Renewables 2022. Debt and equity ranges for each country reflect inflationary environments, interest rate regimes and local currency fluctuations versus USD in recent years, pricing variations by investor and the following market assumptions:

- Vietnam – includes projects under previous feed-in tariff (FIT) regime and during post-FIT period
- Thailand – includes tariffs under FIT scheme announced in October 2022
- Malaysia – includes projects under the current auction scheme
- Indonesia – includes projects under previous scheme as well as new tariff scheme announced in September 2022
- The Philippines – includes projects under the Renewable Portfolio Standard (2020) and Green Auction Program (2022)

Source: The authors, based on investor and industry stakeholder discussions. Debt data for Indonesia are additionally based on the Cost of Capital Observatory (2022)

Stakeholders indicate that local banks are generally comfortable financing utility-scale solar PV projects. While the cost of debt for utility-scale solar PV, at over 7% to more than 9%, in local currency terms, is higher when compared to the broader infrastructure index, it remains lower than that for onshore wind. The highest cost of debt is again present in Vietnam and Indonesia due to higher base interest rates and greater perceived bankability risks for projects.

The cost of debt estimate for utility-scale solar PV in Indonesia reflects both stakeholder insights and the results of a survey by the Cost of Capital Observatory. The survey gathered data points for a representative 100 MW solar PV project taking investment decision in 2021. By comparison, the same data was gathered for a 250 MW gas-fired power project. The results pointed to a cost of debt 0.5% lower for utility-scale solar PV than for gas power in Indonesia, an indication of potentially more attractive financing terms emerging for renewables than fossil-fuel-based power, which has so far dominated the generation mix.

Overall, these metrics for utility-scale solar PV point to a WACC range of around 8.0% to nearly 11% in local currency terms, somewhat higher than the ASEAN unlisted infrastructure index at just over 8%. Again, the same caveats apply as in onshore wind – the lack of projects for the infrastructure index in riskier markets, such as Vietnam, suggests that utility-scale solar PV projects may enjoy a cost of financing that is comparable to or better than that for broader infrastructure when taking a fuller regional view.

The solar PV projects in this discussion do not include battery storage. While solar PV plus battery projects have the potential to address production curtailment issues and facilitate integration, such configurations remain costly in terms of upfront investment and have yet to be deployed in Southeast Asia.

Commercial and industrial-scale solar PV

Given their smaller size and revenue models dependent on the distribution grid, where developers often face greater barriers to investment, commercial- and industrial-scale (C&I) solar PV typically faces a higher cost of capital compared with utility-scale projects but may also represent a more attractive equity investment in terms of returns. Their cost of capital is also subject to the creditworthiness of the off-taker and developer, which may also lack scale compared with utility-scale solar PV developments.

In Southeast Asia, expected local-currency-based equity returns, on a deployment-weighted basis, are estimated at around 12% to 15% for C&I solar PV projects. Lower values are observed in the relatively established markets of Thailand, Singapore and Malaysia. In Thailand, projects can benefit from feed-in tariffs for remuneration, while deployment in Singapore and Malaysia relies on net metering schemes. Capacity additions have been greatest in Vietnam, due to attractive feed-in tariffs. Persistent integration risks and lack of visibility over future projects keep required returns high.

Generally, securing bank debt on a non-recourse basis for C&I solar PV can be a significant challenge, translating into lower leverage ratios than utility-scale solar PV. In local currency terms, the cost of debt for C&I solar PV (nearly 9% to over 11%) is higher than that for utility-scale solar PV, while leverage ratios are somewhat lower. The presence of corporate PPA agreements for C&I projects also influences debt pricing in markets such as Malaysia, Singapore and Thailand, but this depends on the quality of the off-taker and structure of the financing. In the case of a high-quality off-taker, the differential with utility-scale solar PV may narrow to only around 0.50%-0.75%, which reflects the smaller project scale. There is considerable potential for the aggregation of existing projects into larger investment vehicles that can be refinanced through the debt capital markets at a lower cost. However, such transactions have yet to be carried out in Southeast Asia.

Overall, these metrics for C&I solar PV point to a WACC range of around 10%–13% in local currency terms.

Table 5. C&I solar PV cost of capital metrics for select countries

	Vietnam		Thailand		Malaysia		Indonesia		Philippines		Singapore		Mean (unweighted)		Mean (weighted)	
Currency	VND	VND	THB	THB	MYR	MYR	IDR	IDR	PHP	PHP	SGD	SGD	N/A	N/A	N/A	N/A
Technology	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV	Solar PV
WACC (LCY)	11.2% – 14.7%		8.2% – 10.7%		7.6% – 9.4%		10.6% – 12.4%		7.7% – 10.9%		6.5% – 8.0%		8.6% – 11.0%		9.8% – 12.8%	
Expected Return (LCY)	13.5% – 16.5%		11.0% – 14.0%		9.0% – 11.5%		12.5% – 13.5%		10.5% – 14.5%		7.5% – 9.5%		10.7% – 13.3%		12.1% – 15.0%	
Cost of Debt (LCY)	10.0% – 13.5%		7.0% – 8.5%		7.0% – 8.0%		9.5% – 11.5%		6.5% – 8.5%		6.0% – 7.0%		7.7% – 9.5%		8.7% – 11.3%	
WACC (USD)	8.8% – 11.8%		6.7% – 9.5%		6.2% – 8.4%		7.6% – 10.0%		6.7% – 9.4%		6.1% – 8.3%		7.0% – 9.6%		7.8% – 10.6%	
Expected Return (USD)	13.0% – 16.0%		9.4% – 12.4%		7.9% – 9.9%		11.4% – 13.0%		9.4% – 12.4%		7.5% – 9.5%		9.7% – 12.2%		11.2% – 14.1%	
Cost of Debt (USD)	6.5% – 9.0%		5.5% – 7.5%		5.5% – 7.5%		5.5% – 7.5%		5.5% – 7.5%		5.5% – 7.5%		5.7% – 7.8%		6.0% – 8.3%	
Tariff currency indexation	USD	USD	THB	THB	MYR	MYR	USD	USD	PHP	PHP	SGD	SGD	N/A	N/A	N/A	N/A
Leverage ratio	60.0% – 65.0%		60.0% – 70.0%		60.0% – 70.0%		55.0% – 65.0%		60.0% – 70.0%		60.0% – 70.0%		59.2% – 68.3%		59.8% – 67.0%	

Notes: WACC is expressed in nominal terms. LCY = local currency; weighted means are calculated based on the country share of 5-year capacity additions forecast in IEA (2022), Renewables 2022. Debt and equity ranges for each country reflect inflationary environments, interest rate regimes and local currency fluctuations versus USD in recent years, pricing variations by investor and the following market assumptions:

- Vietnam – includes projects under previous feed-in tariff (FIT) regime and during post-FIT period
- Thailand – includes tariffs under FIT scheme announced in October 2022
- Malaysia – includes projects under net metering scheme
- Indonesia – includes projects under new tariff scheme announced in September 2022
- The Philippines – includes projects under the Renewable Portfolio Standard (2020) and Green Auction Program (2022)
- Singapore – includes projects under net metering scheme

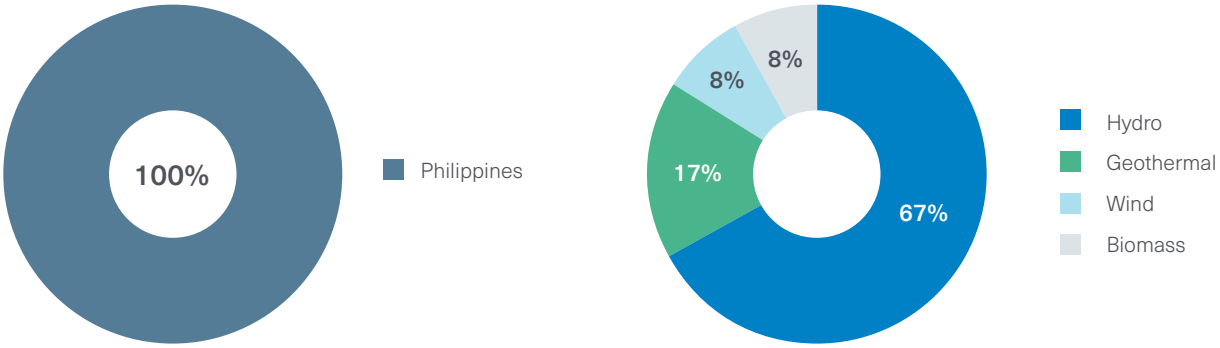
Source: The authors, based on investor and industry stakeholder discussions

Financial performance of ASEAN infrastructure and renewables

This section aims to assess the financial performance of unlisted renewable power and broader unlisted infrastructure assets in the ASEAN region. The analysis is conducted by using indices from EDHECinfra as in our previous report[20]. Please see Annex C for index country and sector breakdowns.

The South-East Asia (ASEAN) unlisted infrastructure equity, equally-weighted (local, frozen), renewable power index from EDHECinfra consists of hydropower, geothermal, wind and biomass power generation. As previously mentioned, all renewable power assets are located within the Philippines, which is a limitation of this analysis.

Figure 9. Composition of SE Asia unlisted renewable power index, by country and sub-sector



Source: The authors, based on EDHECinfra (2022)

Hydropower accounts for two-thirds of the index, and many plants are over a decade old. Geothermal power (17%), onshore wind (8%) and bioenergy (8%) comprise the remainder of the portfolio. The Philippines was an early adopter of policies to promote renewable power, and returns reflect the evolution of incentives, such as feed-in tariffs, which the government implemented over the years. However, the market for renewables there has grown inconsistently over time (see the Philippines country sheet in Annex A). The exclusion of solar PV and the low share of wind assets within the index represent additional limitations of the analysis as these resources represent most of the future deployment potential in ASEAN.

Given the critical role of country-level regulatory frameworks and policy mechanisms in shaping risks and returns for these assets, and the varied approaches taken by governments to date, return data from a single country, such as the Philippines, cannot be used as a proxy for returns in the broader ASEAN region. In the previous section, we presented data collected from industry partners who currently invest in wind and solar PV projects in other countries, including Thailand, Vietnam, Malaysia and Indonesia. This helps extend our analysis across a more diversified set of geographies and assets.

Historical risk and return

The South-East Asia (ASEAN) unlisted renewable power index (100% Philippines RE) posted higher returns than the broader South-East Asia (100% ASEAN assets) unlisted infrastructure index, over a 10-year horizon ending on June 30th, 2022, with a total return of 23% compared to 11% for the broader infrastructure index. The renewable power index has also demonstrated lower return volatility. Though returns were lower for renewables over the last five years analysed, they were still higher on a risk-adjusted basis due to the much higher level of volatility associated with broader infrastructure investments.

20 Climate Infrastructure Investing: Risks and Opportunities for Unlisted Renewables (2022), IEA and CCFI

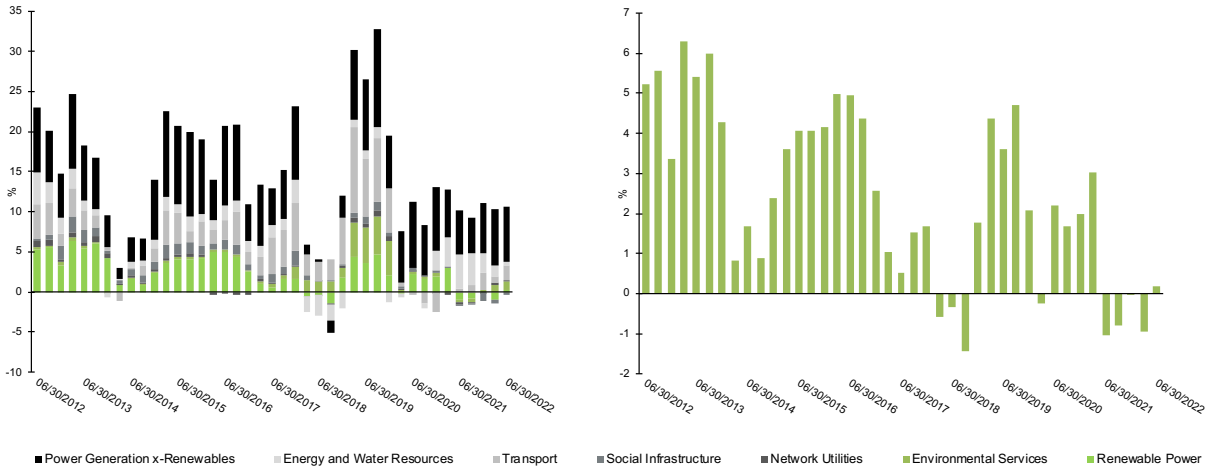
Table 6. ASEAN unlisted infrastructure index: total return and volatility

South-East Asia Unlisted Infrastructure Equity		
	Unlisted Infrastructure	Unlisted Renewables
	1-year	
Total Return	10.27%	0.18%
Volatility	–	–
	3-year	
Total Return	6.39%	1.31%
Volatility	8.07%	3.63%
	5-year	
Total Return	6.40%	4.58%
Volatility	10.24%	3.71%
	10-year	
Total Return	10.96%	23.09%
Volatility	8.96%	4.36%

Source: The authors, based on EDHECinfra (2022)

Given the strong role of fossil-fuel-based power in the broader infrastructure index, the higher level of volatility associated with that benchmark may stem in part from thermal power assets operating under variable pricing in wholesale power markets, such as in Singapore and the Philippines. The lack of diversification in the unlisted renewable power index means that historical performance has been heavily dependent on deployment and output associated with new and existing hydropower plants in the Philippines.

Figure 10. Total return of the unlisted infrastructure (left) and renewables (right) indices



Source: The authors, based on EDHECinfra (2022)

Most hydropower assets in the Philippines are run-of-river plants and do not have reservoirs or pumping capabilities to act as storage. This means they have limited dispatchability, and their output depends on prevailing water table levels and precipitation volumes, which have varied considerably – over the last decade, there has been significant annual variability in precipitation from around 2400mm to around 3200mm.

Recent year underperformance of the renewable power index could be attributed to the inability of plants to fulfil generation requirements in years of lower water levels. Hydropower capacity within the Philippines has grown by only about 200MW in the last decade, and around 35 projects representing a potential maximum capacity of 3.2GW are at various early stages of development. However, utilisation rates associated with the existing capacity have fallen over time, from 33% in 2012 to below 25% in 2019 and 2020. Capacity factors are also considerably lower than global averages, which sit in the 50%+ range.

At the same time, geothermal power in the Philippines has exhibited relatively steady utilisation rates over the past decade (between 60% and 70%)[21] compared to hydro which fell from 33% utilisation in 2012 to ~20% in 2020. Although geothermal accounts for a much smaller share of the index, the dispatchable nature of geothermal power and its improving operational performance may have partly buffered the reduced utilisation of hydropower, helping to keep volatility low in the overall renewables index.

The renewables index with a focus on the Philippines is narrow and cannot be extrapolated to other countries in the region. However, the data collected in the Philippines represents a starting point for assessing the region's risk and returns for renewables. Given a high degree of regional heterogeneity, this analysis needs to be complimented with additional data points from other ASEAN countries.

21 Renewable Energy Statistics (2022), IRENA

Priorities and Potential Solutions

This section details potential solutions: real-world initiatives and case studies that are helping to address priorities for scaling up investment in renewables. While several initiatives are underway, many require further development and scale to create a lasting impact on renewables investment across the region.

Box 1: Better data and transparency – The Cost of Capital Observatory

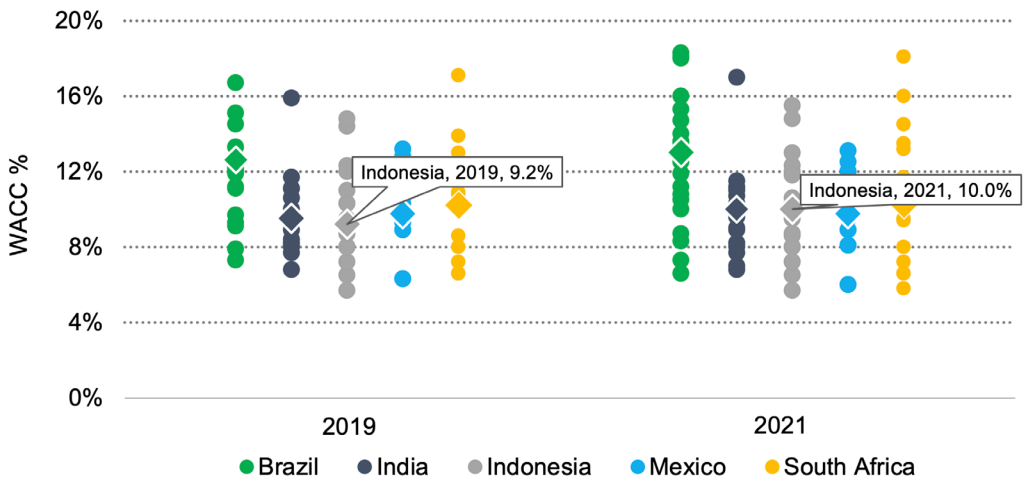
To support the development of an enabling environment for investments in renewable energy projects in emerging economies, the International Energy Agency (IEA), in collaboration with the World Economic Forum, Imperial College London and ETH Zurich, launched the Cost of Capital (CoC) Observatory in September 2022. The CoC Observatory aims to address the obstacles to investing in renewable energy by providing reliable data and improving transparency around clean energy investments in emerging economies.

The CoC Observatory tracks and aggregates financing cost data for solar PV and gas-fired power generation across five emerging economies, including Indonesia. It provides a new way to assess project-level performance indicators and better understand the factors behind the USD 800 billion clean energy financing gap between advanced and emerging and developing economies. In addition, it highlights the main drivers leading to higher cost of capital in emerging and developing economies and showcases de-risking efforts, including remuneration mechanisms which have effectively reduced financing costs for clean energy investments.

Given the well-documented link between information efficiency and the cost of capital [22], by improving access to quality data, the Observatory aims to help expand the pool of capital allocated towards emerging economies and help them achieve their climate ambitions. By deepening understanding of the major risk profiles across countries, technologies and projects, the Observatory can help facilitate appropriate policy responses.

The data in the CoC Observatory is based on survey responses from investors, financiers and developers. The CoC Observatory provides tools and analysis and a dedicated section to highlight case studies.

Figure 11. Cost of capital in different countries for a 100 MW Solar PV project



Source: Cost of of Capital Observatory (2022), IEA

22 Easley, D. & O'Hara, M., Information and the Cost of Capital (2005) , The Journal of Finance

Box 2: Stronger remuneration frameworks – the case of auctions in Cambodia

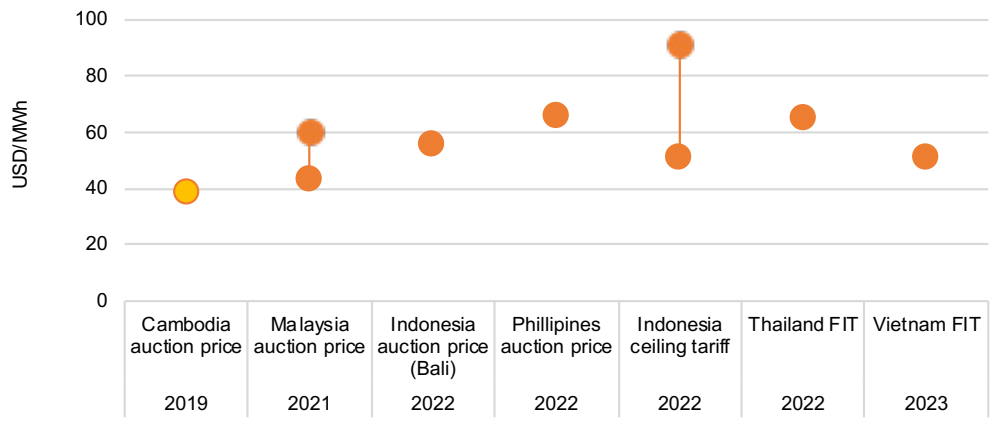
Over the past decade, prices for solar PV and wind power generation have fallen dramatically around the world. A major driver of this trend has been appropriate risk allocation within contracts, which has enhanced project bankability, and competition, which has supported cost efficiency through well-designed auctions.

Over 130 countries have adopted competitive auctions as a transparent way of determining prices for renewable power purchase agreements[23]. While auction prices for solar PV and wind rose in 2022 by 10-25% (compared to pre-Covid levels) due to higher equipment costs and supply chain constraints, such remuneration mechanisms remain major drivers of private investment, especially in markets with more challenging macro risk environments[24].

To date, relatively few auctions have been held in Southeast Asia (with auctions occurring in Malaysia, the Philippines, Singapore and Indonesia). For the most part, auctions have taken a backseat to feed-in tariffs and direct selection processes. This has resulted in inconsistent development of a pipeline of bankable projects. As highlighted above, costs for solar PV and wind generally remain higher in ASEAN countries compared with the rest of the world.

The experience of Cambodia provides an example of how well-designed auction frameworks combined with blended finance mechanisms can attract investment in a market with a limited track record for renewables deployment. In 2019, the auctioning of 60 MW of utility-scale solar PV capacity attracted 26 developers and resulted in a regional low for the pricing of a solar project at USD 39/MWh. As part of the auction, the Cambodian single-buyer utility (Electricité de Cambodge [EDC]) provided a 20-year power purchase contract, which also included land and grid connection to help address risks faced by developers. In terms of blended finance, the Asian Development Bank (ADB) provided a sovereign loan to fund grid infrastructure, as well as technical assistance advisory and project preparation services.

Figure 12. Comparison of recent auction price awards and tariff schemes for utility-scale solar PV in Southeast Asia



Source: The authors, based on government and public reporting

Cambodia's solar PV auction is highlighted as a "model" for other ASEAN countries[25]. That said, the replicability and scalability of auctions in Cambodia and Southeast Asia more widely face challenges. In Cambodia, the majority of the highly leveraged financing packages were provided by international development actors.[26] Both in Cambodia and across the region, investors face constraints in terms of permitting and licensing, lack of clear policy vision and governance, and questions about the bankability of power purchase agreements and the commercial viability of projects for developers and financiers at lower power price levels.

There is considerable potential for competitive procurement and blended finance packages to boost market development, reduce revenue risks and lower financing costs for renewable power in ASEAN.

A recently announced joint venture between EDC and the ADB aims to harness such potential in the development of 2 GW of solar PV in Cambodia over the next decade. Nevertheless, questions over how remuneration frameworks will evolve, as well as related measures around existing thermal generation and system integration, continue to keep renewables investment risks elevated in several ASEAN markets.

23 Renewables 2022 Global Status Report, REN21
24 Renewables (2022), IEA
25 Vakulchuk et al. , Cambodia: Five Actions to Improve the Business Climate for Renewable Energy Investment. (2020) , ASEAN Centre for Energy
26 Cambodia solar nears COD – financing revealed. (2022), IJ Global

Box 3: More robust market for sustainable finance – ASEAN Taxonomy

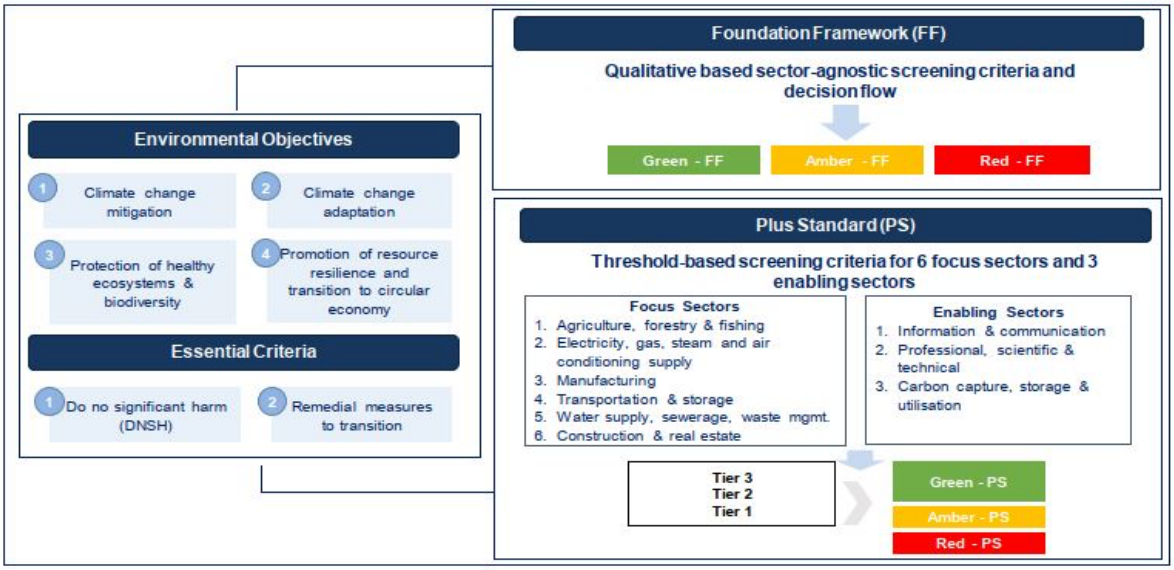
Cultivating a robust market for sustainable finance, including through a clear investment taxonomy that can improve access to lower-cost financing for capital-intensive clean energy projects, is an important step towards attracting higher levels of renewable power investment.

With the publishing of the ASEAN Taxonomy for Sustainable Finance in 2021, regulators have put forth a framework that could help guide capital flows. Governments in the region increasingly recognise that a taxonomy is important, along with credible transition pathways and measurement of progress through disclosures.

The Taxonomy focuses on environmental objectives and is seen as a method to harmonise language and act as a guide for borrowers and investors in their capital allocation processes, climate risk assessments, and evaluations of the sustainability of a project or economic activity in ASEAN member states[27]. The Taxonomy is non-binding and is principles-based, rather than prescriptive, to reflect the diverse nature of ASEAN member states. These principles aim to:

- Provide a common language and complement national sustainability initiatives
- Take into consideration other taxonomies and facilitate an orderly transition towards a sustainable ASEAN
- Foster inclusivity and benefit for all ASEAN member states
- Provide a credible framework, including definitions, and where appropriate, be science-based
- Align, or not conflict, with the sustainability initiatives taken by the capital market, banking and insurance sectors

Figure 13. Overview of Taxonomy Classifications



Source: ASEAN Taxonomy for Sustainable Finance (2021), ASEAN Taxonomy Board

In practice, the Taxonomy puts forth a framework to classify economic activities into green, amber, or red, based on their contribution to decarbonisation, carbon lock-in and climate change mitigation.

The Taxonomy includes the electricity sector as a priority sector and is likely to have an important impact in supporting capital allocation decisions for renewable power, which could potentially help reduce the cost of capital. The application of its decision tree framework, particularly around questions of carbon lock-in, may be open to significant interpretation. This may leave the door open for transition-related investments, such as gas-fired power.[28]

27 ASEAN Taxonomy for Sustainable Finance (2021), ASEAN Taxonomy Board
28 Joint Report on Multilateral Development Banks' Climate Finance (2022), Group of Multilateral Banks

Box 4: Enhanced role for DFIs and blended finance

In Southeast Asia, renewable investments face several financing constraints and bankability issues, including the availability of capital for early-stage project development, contractual and the scale of projects, which can act as barriers for mobilising capital from commercial and financial providers.

The increased provision of blended finance from DFIs is likely to be an important catalyst, alongside policy reforms, in addressing such issues. Notably, MDBs are a primary source of climate finance, having a particular role in funding mitigation activities such as renewable energy. In 2021, MDBs globally provided around USD 51 billion (62% of total MDB climate financing) in climate finance to low and middle-income countries. Over USD 33 billion (65%) was spent on mitigation.[29]

The upcoming energy demand and climate challenges in ASEAN will require multilateral development banks (MDBs) to step up their financing for both mitigation and adaptation in the region over the next decade. While MDBs already have a strong commitment to do so, the speed and scale of their support will be critical. There are several intervention strategies that MDBs can use to increase investment. One such strategy is for MDBs to increase their direct grants and loans to countries by expanding their balance sheet, raising more funds from capital markets and slightly increasing their leverage ratio. Today MDBs are geared around 0.8 (they raise 80 cents of debt for every equity dollar on their balance sheet). Although MDBs have traditionally been cautious and under-leveraged to maintain their triple ratings and access low-cost capital, this approach could help them increase their investments.

However, MDB financing alone will not be sufficient to meet the renewable energy investment needs of the ASEAN region. As outlined in this report, private finance will play an important role. MDBs must work to attract and, to the extent possible, secure private capital flows to the regions that need it most. Several risks discourage cross-border private investment. Some of these risks can be effectively addressed by the tools and resources that MDBs can provide to secure private investment. These can include guarantees, which provide investors with first-loss risk-absorbing capital, or blended finance mechanisms, where MDBs co-invest or provide technical assistance alongside private capital providers, especially in the early stages of a project.

The main objectives of these interventions are to lower the risk, and hence, the cost of financing while increasing the bankability and attractivity for projects and, in future, bringing capital to clean energy technologies in the ASEAN market. Despite efforts to mainstream and prioritise private investment whenever possible, guarantees and blended finance deals still account for a small fraction of MDBs' portfolio.

Closer to the MDBs' core mandate, the technical assistance they provide to countries will remain important. For example, the World Bank has been working with governments in the ASEAN region to develop carbon pricing mechanisms, a key component of putting renewable energy on a level playing field with other fossil fuel-based generation technologies.[30] Carbon pricing schemes are in place or under consideration in most ASEAN countries. Initiatives have been taken to go further, such as the Climate Action Data Trust, recently launched to provide technical assistance in building a regional voluntary carbon market.[31]

29 Partnership for Market Implementation Website (2022), World Bank
30 Climate Action Data Trust website (2022), World Bank
31 Southeast Asia Energy Outlook (2022), IEA

Box 5: Risk Management – Exchange Rate Coverage Facility

Currency exchange rate risk is a major hurdle to clean energy investment in developing economies. Columbia University's Center on Global Energy Policy, the World Bank and the World Economic Forum created a proposal for an Exchange Rate Coverage Facility to unlock investments in EMDE renewables at scale.

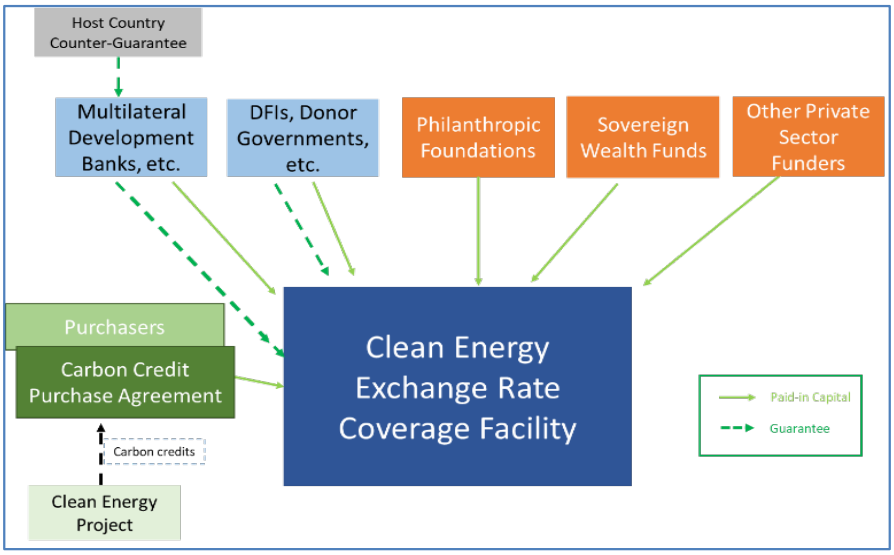
An Exchange Rate Coverage Facility would be established as an offshore guarantor protecting international lenders against depreciation of local currency payments, while also largely protecting domestic sponsors from related increases for debt service payments arising from currency mismatches between revenues and financing obligations.

This facility would absorb this currency depreciation risk, drawing on blended finance resources to pay the shortfall between the value of contracted local currency (LC) payments and foreign currency (FC) debt repayments if the local currency depreciates relative to the pre-defined exchange rate.

Critical proposed features of the Facility include:

- Full coverage for currency shortfalls – covering any gap between FC and LC-denominated payment, even from extreme depreciation of the LC
- Effective protection for both foreign lenders and local stakeholders – through the establishment of the Facility as a creditworthy guarantor assuming the depreciation risk on its books
- Use of carbon credits generated by the project – to fund "first loss" under this currency protection
- Blended finance/burden-sharing – by mobilising concessional funding with burden-sharing among international development agencies, host country stakeholders (including the project's carbon credits) and international capital
- Leveraging – funding catalyses larger clean energy capital investments
- Scalability – easy to grow over time to help address the need for increased clean energy investment
- Complementarity – with existing commercial hedging products to create coverage

Figure 14. World Bank Exchange Rate Coverage Facility



Source: Benoit et al., Scaling Clean Energy Through Climate Finance Innovation: Structure of an Exchange Rate Converage Facility for Developing Countries (2022), Columbia | SIPA Center on Global Energy Policy

Box 6: Improved power system connectivity – the ASEAN Grid

Accelerating the deployment of variable renewable electricity (VRE), solar PV and wind, amid growing demand requires measures to enhance and maintain ASEAN power systems' reliability, flexibility and security. Such flexibility can come from a variety of means, including technical resources (e.g., grids, power plants, storage, demand response), contractual/institutional flexibility (e.g., around PPAs, fuel supply, curtailment) and better operational practices (e.g., scheduling, dispatching)[32]. With most of ASEAN's power demand met today by thermal baseload generation, often under inflexible commercial terms, successful integration of renewables going forward will hinge upon a range of measures.

Improved regional connectivity and multilateral trade arrangements through the development of the ASEAN Power Grid (APG) are set to act as critical enablers of all this. The APG is a regional initiative conceived in 2007 to coordinate the buildout of a large-scale, intra-regional transmission network. As laid out in the ASEAN Interconnection Master Plan Study (AIMS) III, the APG seeks to more than triple interconnection capacity from under 8 GW in 2020 to 27–30 GW over the next two decades[33]. This expansion would help to:

- Enhance opportunities for electricity trading within ASEAN and diversify the power supply
- Decrease energy costs by connecting demand centres with resource-rich areas
- Reduce ASEAN's overall reliance on fossil-fuel-based thermal power

The start of imports under the Lao PDR - Thailand - Malaysia - Singapore (LTMS) Interconnection Project in 2022, in which up to 100 MW of Lao hydropower is wheeled from north to south using existing power lines, marked an important milestone for this vision. Given the dispersion of ASEAN's renewable resources, such projects have the potential to enhance commercial options for flexibility providers (e.g., Lao PDR), improve balancing in places with rapid VRE growth (e.g., Vietnam), better connect remote areas (e.g., in Indonesia) and help resource-constrained economies (e.g., Singapore) meet decarbonisation goals.

Concerning longer-term development, Singapore has initiated a request for proposal (RFP) to import up to 4 GW of low-carbon electricity, around 30% of its supply, into its wholesale market via new interconnectors by 2035. This process grants participants authorisation and an import license but stops short of providing commercial arrangements or financing. While the RFP is attracting interest from 30+ companies, outcomes remain too early to assess.

Potential projects face uncertainties, which also pertain to wider APG development. All proposed APG interconnections under AIMS are assessed as technically viable[34]. However, implementation will hinge on efforts to strengthen internal national grids, overcome public funding constraints and tackle regulatory and commercial challenges, including through:

- Integration of power systems with different market structures, from a single buyer to competitive wholesale, ownership rules and grid codes
- Boosting availability of remuneration, with appropriate risk allocation, that supports private investment in capital-intensive grid infrastructure and renewables projects
- Development of models for mobilising private finance for transmission[35]
- Enhancing contractual flexibility for existing thermal generators with offtake guarantees

Such challenges may keep progress incremental and temper overly ambitious projects for now. Still, the potential benefits are compelling. The APG, when coupled with a high level of renewables deployment well beyond the 2025 target, represents a least-cost pathway to regional power system development[36]. It also offers better opportunities for creating new jobs, reducing dependence on fossil fuels and avoiding harmful pollution.

32 Presentation on Regional Power Grid Connectivity: The ASEAN Power Grid (APG) & Presentation on The ASEAN Interconnection Masterplan Study (AIMS) (2021), ASEAN Centre For Energy
33 Presentation on The ASEAN Interconnection Masterplan Study AIMS (2021), ASEAN Centre For Energy
34 Attracting private finance to transmission in the Asia-Pacific Region (2022), United Nations Economic and Social Commission for Asia and the Pacific
35 Presentation on The ASEAN Interconnection Masterplan Study AIMS (2021), ASEAN Centre For Energy
36 Southeast Asia Energy Outlook (2022), IEA

Conclusion and Implications

For a successful transition to a lower carbon economy, the deployment of renewables must be significantly accelerated in the ASEAN region. However, the penetration of renewable energy in the region has been slower than in other parts of the world and hampered by risks and barriers to private cross-border investments, some country-specific while others span the region.

Our main findings are:

- When comparing historical risk and return for unlisted infrastructure in ASEAN countries, an index of unlisted renewable power assets outperformed the broader infrastructure index on a ten-year basis, with lower volatility. In recent years, returns of the renewables index have been lower. However, the narrow composition of the renewables index makes its performance dependent on existing hydropower in the Philippines. Our sample is not representative of all assets that today's investors are likely to target in Southeast Asia.
- Investment in onshore wind projects across the region is characterised by a weighted-average cost of capital of around 9–12% in nominal, local currency terms. This range is around 8–11% for utility-scale solar PV, while that for commercial and industrial-scale solar PV is assessed at around 10–13%. These values strongly depend on underlying interest rate conditions and market-specific dynamics.
- Expected equity returns and the cost of debt are higher for onshore wind and solar PV projects compared with corresponding metrics for an index of unlisted infrastructure assets in Southeast Asia over the past ten years. The unlisted infrastructure index, however, is much more limited regarding geographical coverage.
- The cost of capital for wind and solar PV investments remains relatively high in many ASEAN member states and the financial value proposition for private sector investment in renewables often remains less clear than in advanced economies.
- To date, private capital has accounted for only 60% of renewable power investment in Southeast Asia, compared to about 90% in advanced economies. This is despite the falling cost of solar PV and wind generation globally and efforts by some Southeast Asia countries and international development actors to kick-start deployment.

While these findings are useful for starting to assess renewables investment opportunities in the ASEAN region, the mixed performance results are indicative of the persistent uncertainties that investors face, as well as data shortfalls that could support more robust comparisons, as in our previous reports. Moreover, as mentioned, the narrow composition of the renewables index, dominated by hydropower in the Philippines, is a significant limitation.

How does the region move forward?

To accelerate the transition to a lower carbon economy, international and domestic policy support to the ASEAN region is critical, along with better regulatory frameworks. Additionally, to transition to a more secure and sustainable growth model, the economies of the ASEAN region must dramatically increase investments in the energy sector as well as the share of capital going to clean energy technologies.

The investment levels required to meet sustainable development goals would support a shift in the energy mix while building upon four factors necessary for transition to net-zero emissions by 2050. These include the widespread rollout of renewables, improvements in energy efficiency, electrification of end uses and the deployment of low-emission fuels, including modern bioenergy, hydrogen-based fuels and CCUS[37]. This shift in the energy mix is necessary to ensure a sustainable future while reducing the vulnerabilities to climate change.

37 Southeast Asia Energy Outlook (2022), IEA

To attract the required investment levels, we highlighted a few key priorities and potential solutions that could help mobilise these investments. Addressing cross-cutting issues such as financial markets frameworks for renewables and transition investments, as well as currency risk management will be important for attracting cross-border private investments. In the form of development institutions and blended finance, financial catalysts are likely to play an important supporting role in bringing down the cost of capital. Improved power system connectivity across the region is also critical. There are initiatives already underway, now it is time to scale them.

The objective of this report is to enable investors and policymakers to help accelerate the energy transition in the ASEAN region. This is our fourth and final report in this series. Our joint aim was to provide more transparency through financial analysis of renewables assets and to make recommendations regarding how climate finance frameworks need to evolve, how to address barriers on foreign investments and suggest bolder government policies to change the energy system across developed and emerging economies. We hope our work will help accelerate progress.

Annex A: Country Sheets

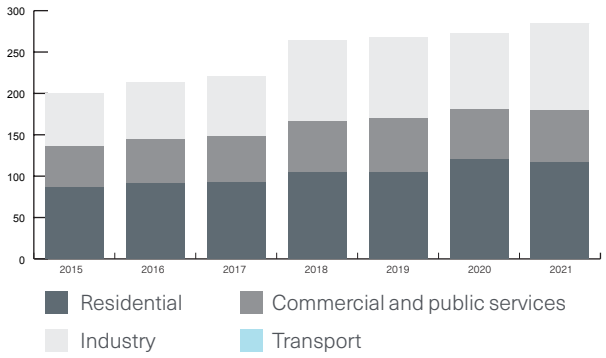
Country Name: Indonesia

Cross-Cutting Macro Indicators

Population (mm): 275
GDP Per Capita (USD, 3-yr CAGR): 14638 (5.46%)
Trailing 12M Currency Movement (IDR/USD): -4.98%
Sovereign Debt Rating (S&P): BBB
10Y Gov. Bond Yield: 4.62%
Sustainable Debt Issuance (USD, 3-yr CAGR): 2.85bn, (13.3%)
FDI net (USD, 3-yr CAGR): 21.2 bn (3.8%)
FDI % of GFCF: 5.8%
Energy Subsidies (Yes/No, Type, USD): Yes, Oil ($22bn), Electricity ($2bn)
Fuel net imports (USD): -16.3 bn
CO2 Emissions (per capita, 3-yr CAGR): 2.32t, (2.73%)
2030 GHG Reduction Target: 32% (unconditional), 43% (conditional)
Net-Zero Target: Yes, 2060
Carbon Pricing: Yes for coal power, $2/t

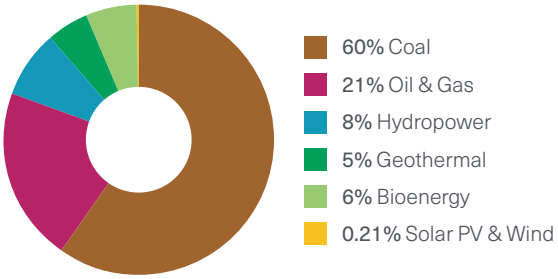
Power Market Fundamentals

Power Demand By End-Use Sector (TWh)

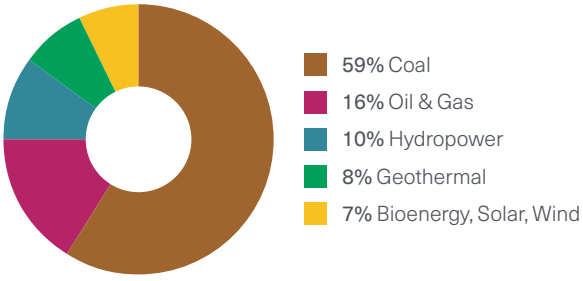


Electricity Generation

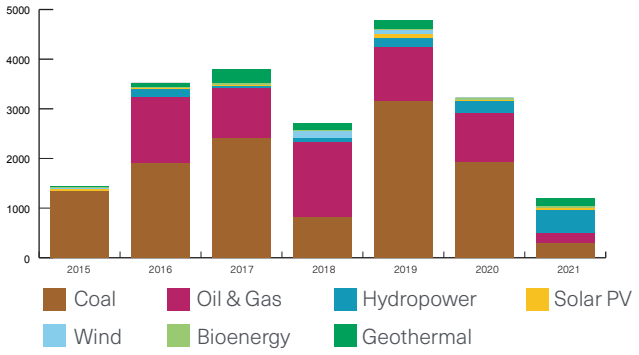
2021 Generation by Technology (299 TWh)



Planned 2030 Generation by Technology (445 TWh) based on RUPTL 2021–30



Annual Capacity Additions By Technology (MW)



Coal Fleet Age Avg.: 13 **Peak Demand GW:** 40
Reserve Margin: 40% **Annual T&D Loss:** 8.66%

Power Market Investment Framework

Total Power Capacity GW: 75.5 **Renewables Capacity GW and % share:** 8.8 / 12% **Renewables Capacity Target:** 23% by 2025

Power Generation Investment Sources of Finance

Rank	Renewable Power	$ Million	Fossil Fuel Power	$ Million	Oil & Gas	$ Million
1	PLN Batam	2000	Perusahaan Listrik Negara PLN	6,789	BP Global	4,571
2	Sarawak Energy	875	Nalco	4,000	Pertamina	2,396
3	Orka Energy	850	Marubeni	1,659	JX Nippon Oil and Energy	1,715
4	Star Energy	420	Kansai Electric Power	1,398	CNOOC	1,710
5	PT International Nickel Indonesia	300	Guangdong Guangxin Holdings	1,040	Tuban Petro	1,369

Market Structure: Single-buyer utility with IPPs
Grid Ownership: Fully public
Pricing: Mostly set through long-term contracts
Generation Ownership: Mix of public and private

Remuneration Mechanisms – Renewable Power and Key Enabling Technologies

Technology	Mechanism	Ceiling Price Level (USD), lifetime avg.	Duration	Currency of Payment	Inflation Adjustment	Grid onnection and Land	Other features
Solar PV (utility-scale)	Competitive auction with ceiling price	USD 51-90/MWh, varies by size and location	30 years	IDR with indexation to USD	No	Developer responsibility	Tax incentives, accelerated depreciation, local content
Solar PV (distributed)	Net metering	Exported power receives 100% of retail tariff	N/A	IDR	No	Developer responsibility	Tax incentives, accelerated depreciation, local content
Onshore Wind	Competitive auction with ceiling price	USD 70-101/MWh, varies by size and location	0	IDR with indexation to USD	No	Developer responsibility	Tax incentives, accelerated depreciation, local content
Hydropower (>1 MW)	Negotiated tariff with PLN	USD 40-100/MWh, varies by size and location	30 years	IDR with indexation to USD	No	Developer responsibility	Tax incentives, accelerated depreciation, local content
Geothermal	Negotiated tariff with PLN	USD 69-104/MWh, varies by size and location	30 years	IDR with indexation to USD	No	Developer responsibility	Tax incentives, accelerated depreciation, local content; concessional funds for exploration
Biomass (>1 MW)	Competitive auction with ceiling price	USD 81-111/MWh, varies by size and location	30 years	IDR with indexation to USD	No	Developer responsibility	Tax incentives, accelerated depreciation, local content

Main Drivers, Challenges and Priorities for Investment

Investment & Return Drivers

- Net-zero emissions goal by 2060 (2050 for power); Electricity Supply Business Plan (RUPTL) sees doubling of renewable power to 20 GW by 2030, amid strong electricity demand growth
- Falling technology costs have improved competitiveness of renewables, with two utility-scale solar PV projects in 2022 contracted at under $60/MWh – down from over $100/MWh in 2017
- The September 2022 announcement of a tariff scheme based on competitive auctions and new location-based, ceiling prices has the potential to enhance the attractiveness and bankability of projects as well as better support system integration
- GOI has signalled restrictions on new coal-fired power as well as the accelerated closure of existing plants, creating more space for renewables. These efforts have been bolstered by announcements of the first early retirement of a coal plant under the Energy Transition Mechanism and international support under the Just Energy Transition Partnership

Challenges

- Although global technology costs have come down, the cost of financing remains relatively high and renewables project costs remain elevated due to local content provisions at 60%
- PLN remains reluctant to procure more renewables due to cost of solar PV and wind compared with existing generation costs - which are subsidised through coal and gas price caps - as well as perceived integration challenges, raising questions over the implementation of the new tariff scheme and auctions in practice
- Economic and integration challenges stem in part from the favourable position of thermal power plants, which benefit from fuel price subsidies and inflexible contractual structures. PLN's inability to recover its operating costs through electricity prices, which are also subsidised, contribute to a weakened financial position, inhibiting system transformation
- Investors lack predictability over the size and schedule of future renewables auctions, which have, to date, also suffered from lack of transparency and complex negotiation processes

Policy and Market Priorities

- Put the power sector on more firm financial footing through energy subsidies reform
- Renegotiate inflexible thermal power plant contracts and accelerate phase out of coal
- Improve predictability and design of renewables auctions, including development support for land acquisition and feasibility studies, to create a more robust pipeline of projects
- Diversify commercial arrangements for buying and selling power for independent players
- Phase-in approaches to local content to better align with domestic manufacturing capacity
- Boost financing options through enhanced provision of international blended finance mechanisms and continued cultivation of a domestic market for sustainable finance

Sources

IEA: Energy Subsidies, CO2 Emissions, Power Demand by end-use sector, Renewable power annual capacity additions by technology, Electricity generation by technology (2021), Total Installed Capacity (Fossil fuel power based on calculations from S&P Platts), Renewable Power Capacity, Coal Fleet Age (Based on calculations from S&P Platts), Reserve Margin (Java-Bali System), Annual T&D Losses

S&P (Platts): Fossil fuel power annual capacity additions by technology

IMF: Population, GDP Per Capita

Bloomberg: Trailing 12M currency movement, 10Y Gov. yield, Sustainable Debt Issuance

IJ Global: Power market sources of finance

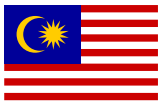
World Bank, UN: FDI, GFCF, Fuel net imports

Government of Indonesia: 2030 GHG reduction target, Net-Zero target, Carbon pricing, Planned 2030 electricity generation, Peak demand, Renumeration Mechanisms

Notes

1. FDI, GFCF, Energy Subsidies, Fuel net imports, Total Power Capacity, and Renewables Capacity current as of 2021 year end, all other values current as of 2022 year end unless otherwise specified; 2. All $ values in USD; 3. Bond yields in local currency; 4. CO2 emissions taken from 2020 real IEA data and extrapolated based on GDP growth rate from IMF data to 2022; 5. Power market sources of finance calculated based on IJ global asset database project capex & ownership. The asset database capex is incomplete for projects in ASEAN, the numbers represented serve as best estimates based on available data.

Country Name: Malaysia

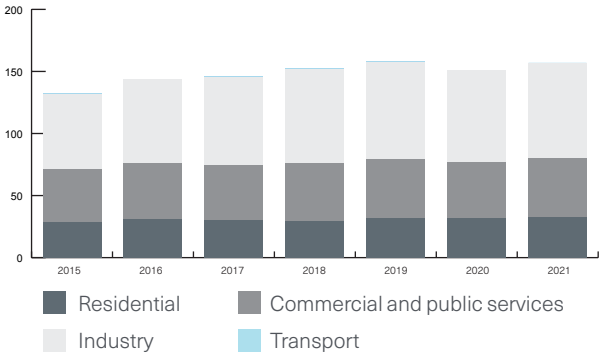


Cross-Cutting Macro Indicators

Population (mm): 33
GDP Per Capita (USD, 3-yr CAGR): 33113 (4.41%)
Trailing 12M Currency Movement (IDR/USD): -2.82%
Sovereign Debt Rating (S&P): A-
10Y Gov. Bond Yield: 4.05%
Sustainable Debt Issuance (USD, 3-yr CAGR): 2.24bn, (44.42%)
FDI net (USD, 3-yr CAGR): 18.6 bn (30.8%)
FDI % of GFCF: 25.8%
Energy Subsidies (Yes/No, Type, USD): Yes, Oil ($3bn)
Fuel net imports (USD): -7.4 bn
CO2 Emissions (per capita, 3-yr CAGR): 8.25t, (5.11%)
2030 GHG Reduction Target: 45% (unconditional)
Net-Zero Target: Carbon Neutrality, 2050
Carbon Pricing: No

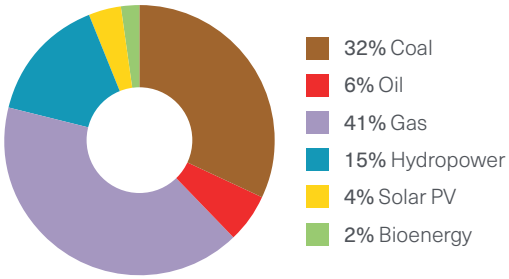
Power Market Fundamentals

Power Demand By End-Use Sector (TWh)

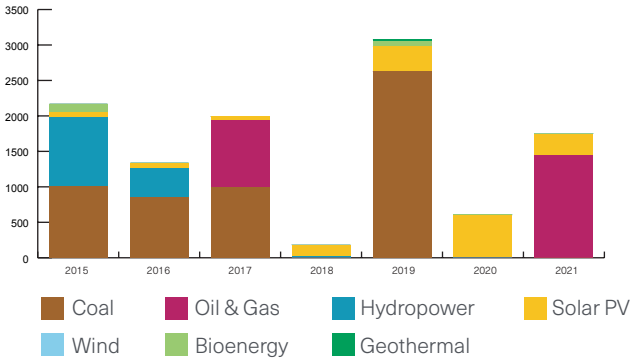


Electricity Capacity

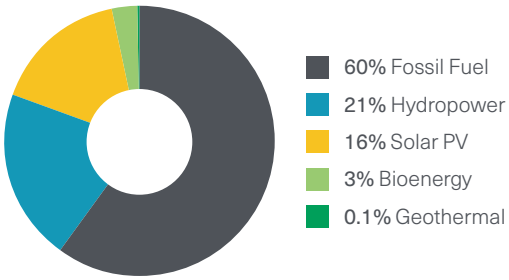
2021 Capacity by Technology (42.9 GW)



Annual Capacity Additions By Technology (MW)



Planned 2035 Capacity by Technology (45 GW) based on Malaysia Renewable Energy Roadmap



Coal Fleet Age Avg.: 13
Peak Demand GW: 23.3
Reserve Margin: 40%
Annual T&D Loss: 6.9%

Power Market Investment Framework

Total Power Capacity GW: 42.9
Renewables Capacity GW and % share: 9.3 / 22%
Renewables Capacity Target: 40% by 2035

Power Generation Investment Sources of Finance

Rank	Renewable Power	$ Million	Fossil Fuel Power	$ Million	Oil & Gas	$ Million
1	Coara Solar	227	Tanjong Energy	2,132	PETRONAS	16,515
2	Tenaga Nasional	147	Teknologi Tenaga Perlis Consortium Sdn Bhd	456	Royal Vopak	800
3	SunEdison	42	Tenaga Nasional	380	Royal Vopak	250
4	Sarawak Energy	40	PETRONAS	201	Petrofac	197
5	Fumase Malaysia	8	Sabah Government	134	SapuraKencana Petroleum Berhad	189

Market Structure: Single-buyer utility with IPPs
Pricing: Tariffs based on Market Reference Price with cost pass-through mechanism
Grid Ownership: Fully public
Generation Ownership: Mix of public and private

Remuneration Mechanisms – Renewable Power and Key Enabling Technologies

Technology	Mechanism	Ceiling Price Level (USD), lifetime avg.	Duration	Currency of Payment	Inflation Adjustment	Grid onnection and Land	Other features
Solar PV (utility-scale)	Competitive auction	USD 43-60/MWh (March 2021)	21 years	MYR	No	Developer responsibility	Tax & financing incentives; foreign ownership capped at 49%
Solar PV (distributed)	Net metering	Average system marginal price (C&I projects)	10 years	MYR	No	Developer responsibility	Tax & financing incentives; quota of 800 MW over 2021-23
Hydropower (up to 30 MW)	Feed-in tariff	USD 51-66/ MWh, by size and technology	21 years	MYR	No	Developer responsibility	Tax & financing incentives; capacity quota
Geothermal (up to 30 MW)	Feed-in tariff	USD 102/MWh	16 years	MYR	No	Developer responsibility	Tax & financing incentives; capacity quota
Bioenergy (up to 30 MW)	Feed-in tariff	USD 50-72/ MWh, by size and technology	21 years	MYR	No	Developer responsibility	Tax & financing incentives; capacity quota
Biomass (>1 MW)	Competitive auction with ceiling price	USD 81-111/MWh, varies by size and location	30 years	IDR with indexation to USD	No	Developer responsibility	Tax incentives, accelerated depreciation, local content

Main Drivers, Challenges and Priorities for Investment

Investment & Return Drivers

- Carbon neutrality goal by 2050. In planning, it aims to have renewables account for 40% of power capacity by 2035
- Current investment driven by capacity awards under solar PV auction in 2021 – whose lowest bid registered under $45/ MWh - as well as increased quotas under net metering for distributed solar PV
- In 2022, the government announced intentions to permit direct power purchase of renewables, or corporate PPAs, by private players, which is likely to provide more project development opportunities
- Malaysia has seen a tripling of sustainable debt issuance over the past three years, indicative of its strong financial ecosystem and growing attractiveness for international capital markets. Its power system and utilities are also on sound financial footing
- Discussions around a potential national roadmap for renewables-based hydrogen could lead to increased partnerships and pre-development activity for associated renewable power projects

Challenges

- Much of Malaysia's renewable growth in recent years came from the distributed solar PV segment, where smaller project sizes limit the scale that international investors may be seeking
- Foreign ownership limits, at 49%, continue to act as a barrier to attracting more foreign direct investment
- Fewer opportunities for wind project investment compared with other Southeast Asia countries, due to more limited resource availability

Policy and Market Priorities

- Manage net metering scheme to ensure remuneration balances investment incentive with system financial sustainability
- Review limits around foreign ownership of renewables projects
- Put forth a robust framework around direct renewable power purchase to stimulate a market for corporate PPAs
- Explore efforts to aggregate and securitize distributed renewables projects

Sources

IEA: Energy Subsidies, CO2 Emissions, Power Demand by end-use sector, Renewable power annual capacity additions by technology, Electricity capacity by technology (2021), Total Installed Capacity (Fossil fuel power based on calculations from S&P Platts), Renewable Power Capacity, Coal Fleet Age (Based on calculations from S&P Platts), Annual T&D Losses

S&P (Platts): Fossil fuel power annual capacity additions by technology

IMF: Population, GDP Per Capita

Bloomberg: Trailing 12M currency movement, 10Y Gov. yield, Sustainable Debt Issuance

IJ Global: Power market sources of finance

World Bank, UN: FDI, GFCF, Fuel net imports

Government of Malaysia: 2030 GHG reduction target, Net-Zero target, Carbon pricing, Planned 2035 generation capacity, Peak demand, Renumeration Mechanisms

The Star: Reserve Margin

Notes

1. FDI, GFCF, Energy Subsidies, Fuel net imports, Total Power Capacity, and Renewables Capacity current as of 2021 year end, all other values current as of 2022 year end unless otherwise specified; 2. All $ values in USD; 3. Bond yields in local currency; 4. CO2 emissions taken from 2020 real IEA data and extrapolated based on GDP growth rate from IMF data to 2022; 5. Power market sources of finance calculated based on IJ global asset database project capex & ownership. The asset database capex is incomplete for projects in ASEAN, the numbers represented serve as best estimates based on available data.

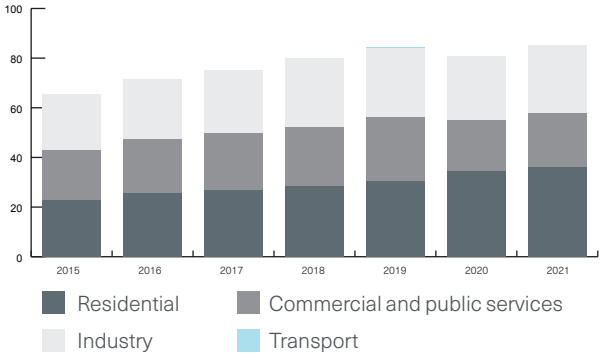
Country Name: Philippines

Cross-Cutting Macro Indicators

Population (mm): 112
GDP Per Capita (USD, 3-yr CAGR): 10344 (3.38%)
Trailing 12M Currency Movement (IDR/USD): -5.71%
Sovereign Debt Rating (S&P): BBB+
10Y Gov. Bond Yield: 4.30%
Sustainable Debt Issuance (USD, 3-yr CAGR): 5.86bn, (28.84%)
FDI net (USD, 3-yr CAGR): 10.5 bn (1.9%)
FDI % of GFCF: 12.0%
Energy Subsidies (Yes/No, Type, USD): No
Fuel net imports (USD): 14.5 bn
CO2 Emissions (per capita, 3-yr CAGR): 1.36t, (2.7%)
2030 GHG Reduction Target: 2.71% (unconditional), 72.29% (conditional)
Net-Zero Target: No
Carbon Pricing: No

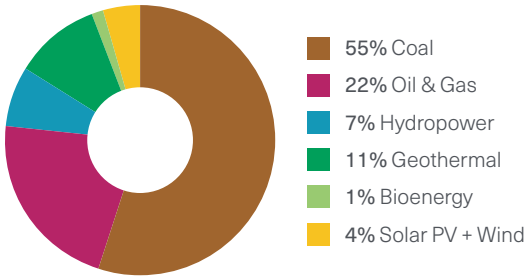
Power Market Fundamentals

Power Demand By End-Use Sector (TWh)

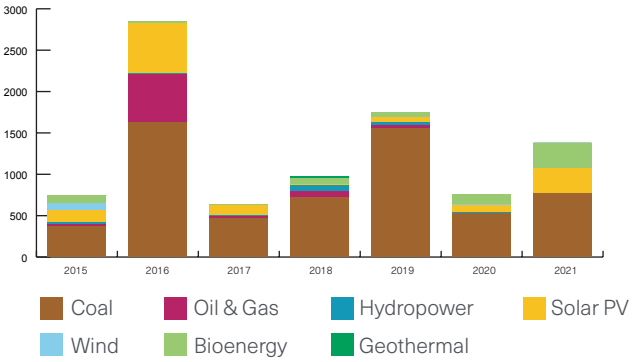


Electricity Capacity

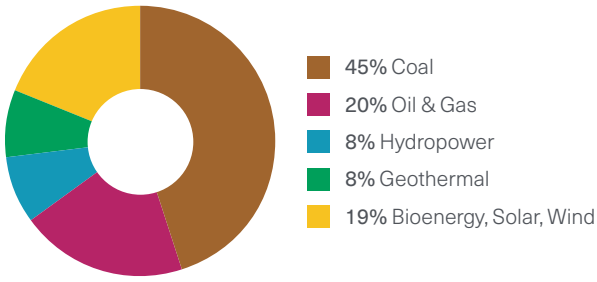
2021 Generation by Technology (104 TWh)



Annual Capacity Additions By Technology (MW)



Planned 2030 Generation by Technology (195 TWh) based on PEP2022-2040



Coal Fleet Age Avg.: 13
Peak Demand GW: 16
Reserve Margin: 25%
Annual T&D Loss: 9.57%

Power Market Investment Framework

Total Power Capacity GW: 26.3
Renewables Capacity GW and % share: 6.3/24%
Renewables Capacity Target: 35% by 2030

Power Generation Investment Sources of Finance

Rank	Renewable Power	$ Million	Fossil Fuel Power	$ Million	Oil & Gas	$ Million
1	ACEN	604	First Gen Corporation	1,299	Udenna	2,025
2	Government of The Philippines	570	Government of The Philippines	1,129	First Gen Corporation	1,000
3	Energy Development Corporation	543	San Miguel Corporation	1,000	Philippine National Oil Company	450
4	SN Power	425	Ayala Corporation	900	Energy World Corporation	130
5	Aboitiz Power Corp	216	Electricity Generating Public Co	854	Otto Energy	95

Market Structure: Wholesale Market
Pricing: Mostly set through long-term contracts
Grid Ownership: Fully public (Concesssions for operation and maintenance)
Generation Ownership: Mix of public and private

Remuneration Mechanisms – Renewable Power and Key Enabling Technologies

Technology	Mechanism	Ceiling Price Level (USD), lifetime avg.	Duration	Currency of Payment	Inflation Adjustment	Grid onnection and Land	Other features
Solar PV (utility-scale)	FIT gradually replaced by competitive auction with ceiling price	USD 68-163/MWh	20 years	PHP/kWh	No	Developer responsibility	FIT rates revised upwards periodically / No revision for the auction mechanism
Solar PV (distributed)	Net metering	Exported power receives 100% of retail tariff (with capacity limited to 100kw)	N/A	PHP/kWh	No	Developer responsibility	Tax incentives, accelerated depreciation, local content
Onshore Wind	FIT gradually replaced by competitive auction with ceiling price	USD 111-149/MWh	20 years	PHP/kWh	No	Developer responsibility	FIT rates revised upwards periodically / No revision for the auction mechanism
Hydropower (>1 MW)	FIT gradually replaced by competitive auction with ceiling price	USD 101-108/MWh	20 years	PHP/kWh	No	Developer responsibility	FIT rates revised upwards periodically / No revision for the auction mechanism
Biomass (>1 MW)	FIT gradually replaced by competitive auction with ceiling price	USD 93-118/MWh	20 years	PHP/kWh	No	Developer responsibility	FIT rates revised upwards periodically / No revision for the auction mechanism
Biomass (>1 MW)	Competitive auction with ceiling price	USD 81-111/MWh, varies by size and location	30 years	IDR with indexation to USD	No	Developer responsibility	Tax incentives, accelerated depreciation, local content

Main Drivers, Challenges and Priorities for Investment

Investment & Return Drivers

- 75% CO2 emission reductions by 2030; Philippines Energy Plan (PEP) adds 22 GW of renewables by 2030, three times the currenly installed capacity
- Falling technology costs have improved competitiveness of renewables, especially solar projects which were able to bid at record low prices during the GEAP first auction round
- The first implementation, in 2022, of a tariff scheme based on competitive auctions with ceiling prices has the potential to enhance the attractiveness and bankability of projects for international developpers
- Foreign ownership restrictions on solar, wind and hydro assets were lifted in late 2022 and should be conducive to increased capital flows in the country
- A moratorium on building new coal power plants entered into force in 2020 and has been renewed in 2022, paving the way for more renewables integration

Challenges

- The cost of electricity is high in the country due to historical lack of competition, high T&D losses and grid integration challenges
- Although global technology costs have come down, the cost of financing remains relatively high and renewables project costs remain elevated due to local content provisions still recently in force (60%)
- Existing high FIT levels compared to auction ceilings might deter investors to channel funds to new renewables capacity, especially in solar
- The incentives mechanisms seem unfair for hydropower generation which sees FIT and auction ceilings below its estimated LCOE
- Despite a sizable generation potential, geothermal power is not covered by the FIT, not eligible to participate in auctions and is given low priority access to the grid

Policy and Market Priorities

- Renegotiate inflexible thermal power plant contracts and accelerate early retirements of coal
- Decrease the FIT levels as fast as possible to benefit from cost reductions
- Accelerate the pace of renewables auctions, and include development support for land acquisition and feasibility studies, to create a more robust pipeline of projects
- Simplify the land acquisition and permitting process and include geothermal in renewables auctions
- Boost financing options through enhanced provision of international blended finance mechanisms and continued cultivation of a domestic market for sustainable finance
- Consider implementing a carbon price on fossil fuel power generation, with appropriated re-distribution mechanisms

Sources

IEA: Energy Subsidies, CO2 Emissions, Power Demand by end-use sector, Renewable power annual capacity additions by technology, Electricity generation by technology (2021), Total Installed Capacity (Fossil fuel power based on calculations from S&P Platts), Renewable Power Capacity, Coal Fleet Age (Based on calculations from S&P Platts), Annual T&D Losses

S&P (Platts): Fossil fuel power annual capacity additions by technology

IMF: Population, GDP Per Capita

Bloomberg: Trailing 12M currency movement, 10Y Gov. yield, Sustainable Debt Issuance

IJ Global: Power market sources of finance

World Bank, UN: FDI, GFCF, Fuel net imports

Government of the Philippines: 2030 GHG reduction target, Net-Zero target, Carbon pricing, Planned 2030 electricity generation, Peak demand, Reserve Margin, Renumeration Mechanisms

Notes

1. FDI, GFCF, Energy Subsidies, Fuel net imports, Total Power Capacity, and Renewables Capacity current as of 2021 year end, all other values current as of 2022 year end unless otherwise specified; 2. All $ values in USD; 3. Bond yields in local currency; 4. CO2 emissions taken from 2020 real IEA data and extrapolated based on GDP growth rate from IMF data to 2022; 5. Power market sources of finance calculated based on IJ global asset database project capex & ownership. The asset database capex is incomplete for projects in ASEAN, the numbers represented serve as best estimates based on available data.

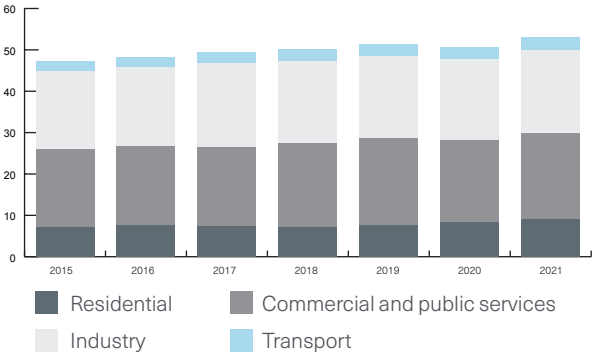
Country Name: Singapore

Cross-Cutting Macro Indicators

Population (mm): 5
GDP Per Capita (USD, 3-yr CAGR): 131426 (8.66%)
Trailing 12M Currency Movement (IDR/USD): 2.23%
Sovereign Debt Rating (S&P): AAAu
10Y Gov. Bond Yield: 2.98%
Sustainable Debt Issuance (USD, 3-yr CAGR): 24.13bn, (13.37%)
FDI net (USD, 3-yr CAGR): 105.5 bn (9.1%)
FDI % of GFCF: 114.7%
Energy Subsidies (Yes/No, Type, USD): No
Fuel net imports (USD): 29.4 bn
CO2 Emissions (per capita, 3-yr CAGR): 10.8t, (10.91%)
2030 GHG Reduction Target: 2005 intensity by 36%, peaking at 60Mt total emissions by 2030
Net-Zero Target: Net-zero, 2050
Carbon Pricing: Yes $3.75/t on facilities that emit 25 ktCO2e or more

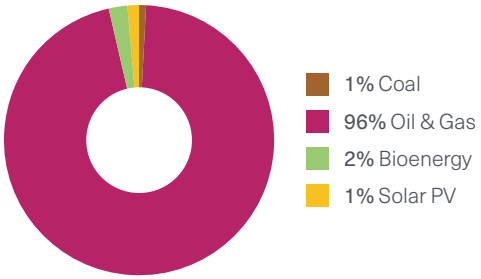
Power Market Fundamentals

Power Demand By End-Use Sector (TWh)

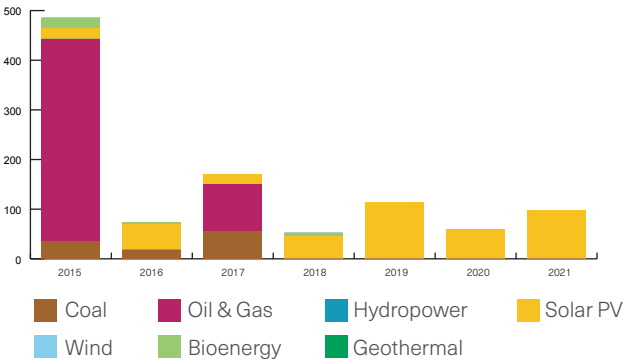


Electricity Capacity

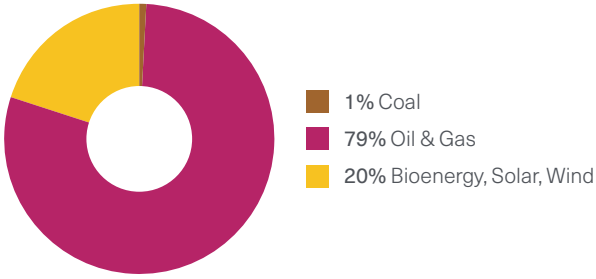
2021 Generation by Technology (56 TWh)



Annual Capacity Additions By Technology (MW)



Estimated 2030 Generation by Technology (74TWh)
based on Singapore Electricity Market Outlook 2021



Coal Fleet Age Avg.: 9
Peak Demand GW: 8
Reserve Margin: 50%
Annual T&D Loss: 0.94%

Power Market Investment Framework

Total Power Capacity GW: 14.3
Renewables Capacity GW and % share: 0.7 / 5%
Renewables Capacity Target: 35% by 2035

Power Generation Investment Sources of Finance

Rank	Renewable Power	$ Million	Fossil Fuel Power	$ Million	Oil & Gas	$ Million
1	Singapore Power	1,294	Keppel	1,000	ExxonMobil	6,000
2	Hyflux	110	GMR Group	840	Government of Singapore	2,000
3	Keppel	65	PETRONAS	360	Golar LNG	1,360
4	SembCorp Industries	29	Engie	1	SK Group	750
5	Sunseap Group	0	Kansai Electric Power	0	Jiangsu Sanfangxiang Group	625

Market Structure: Wholesale Market + IPPs + Retail Competition
Grid Ownership: Fully public (Concesssions for operation and maintenance)
Pricing: Set through market competition + retail tariff
Generation Ownership: Mix of public and private

Remuneration Mechanisms – Renewable Power and Key Enabling Technologies

Technology	Mechanism	Ceiling Price Level (USD), lifetime avg.	Duration	Currency of Payment	Inflation Adjustment	Grid onnection and Land	Other features
Solar PV (utility-scale)	Market	USD 133-226/MWh	N/A	SGD	No	Developer responsibility	Electricity wholesale price bid every half hour
Solar PV (distributed)	Net metering or market	USD 133-226/MWh	N/A	SGD	No	Developer responsibility	Tax incentives, accelerated depreciation, local content
Biomass (>1 MW)	Market	USD 133-226/MWh	N/A	SGD	No	Developer responsibility	Electricity wholesale price bid every half hour

Main Drivers, Challenges and Priorities for Investment

Investment & Return Drivers

- Peaking emissions at 65MtCO2e by 2030 requires Singapore to address emissions from the power sector which account for 40% total emissions. The very limited availability of land requires heavy investment in securing energy imports
- Singapore's electricity market has been liberalised over the years and combined with appropriate market regulations, it offers one of the most reliable networks in the world
- Singapore's financial sector is fully developped and the government is very proactive on clean energy and climate action

Challenges

- Land availability for development is extremely limited and Singapore is completely dependant on imports for most of its electricity generation (Natural Gas). Affordability and security depend on the global commodity price context
- Electricity wholesale prices highly correlated to fluctuations of international natural gas prices
- Achieiving renewable electricity targets will depend on the ability to secure access to regional power grids and trade clean power with neighboring countries

Policy and Market Priorities

- Improve system resilience by diversifying energy sources and integrating regional grids. Leverage Singapore's financial market maturity to provide access to sustainable finance to other countries in the region
- Foster innovation in low carbon technologies (Hydrogen) and energy storage, develop geothermal
- Promote energy efficiency and demand reductions strategies
- Continue to develop carbon pricing schemes to price emissions from fossil fuel generation, and invest proceeds in price stabilization and renewables development

Sources

IEA: Energy Subsidies, CO2 Emissions, Power Demand by end-use sector, Renewable power annual capacity additions by technology, Electricity generation by technology (2021), Total Installed Capacity (Fossil fuel power based on calculations from S&P Platts), Renewable Power Capacity, Coal Fleet Age (Based on calculations from S&P Platts), Annual T&D Losses

S&P (Platts): Fossil fuel power annual capacity additions by technology

IMF: Population, GDP Per Capita

Bloomberg: Trailing 12M currency movement, 10Y Gov. yield, Sustainable Debt Issuance

IJ Global: Power market sources of finance

World Bank, UN: FDI, GFCF, Fuel net imports

Government of Singapore: 2030 GHG reduction target, Net-Zero target, Carbon pricing, Planned 2030 electricity generation, Peak demand, Reserve Margin, Renumeration Mechanisms

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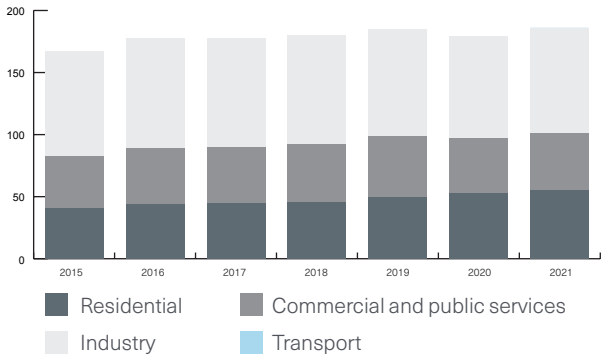
Country Name: Thailand

Cross-Cutting Macro Indicators

Population (mm):	70
GDP Per Capita (USD, 3-yr CAGR):	21114 (3.19%)
Trailing 12M Currency Movement (IDR/USD):	0.88%
Sovereign Debt Rating (S&P):	BBB+
10Y Gov. Bond Yield:	2.66%
Sustainable Debt Issuance (USD, 3-yr CAGR):	4.51bn, (76.74%)
FDI net (USD, 3-yr CAGR):	12.2 bn (-2.7%)
FDI % of GFCF:	10.2%
Energy Subsidies (Yes/No, Type, USD):	Yes, Coal (13.7 bn), Oil & Gas (18.6 bn)
Fuel net imports (USD):	31.5 bn
CO2 Emissions (per capita, 3-yr CAGR):	4.02t, (3.64%)
2030 GHG Reduction Target:	20% from BAU
Net-Zero Target:	Carbon Neutrality, 2050 Net-Zero, 2065
Carbon Pricing:	Voluntary ETS

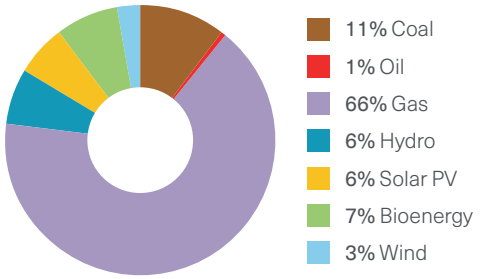
Power Market Fundamentals

Power Demand By End-Use Sector (TWh)

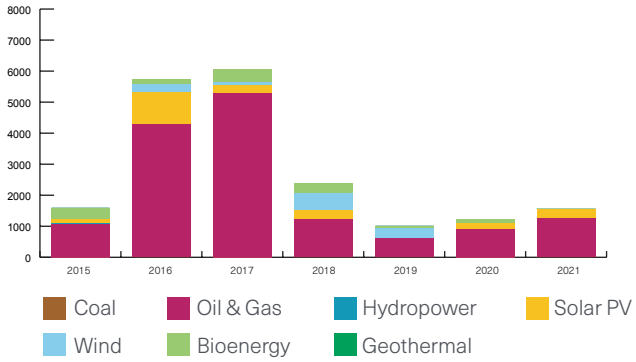


Electricity Capacity

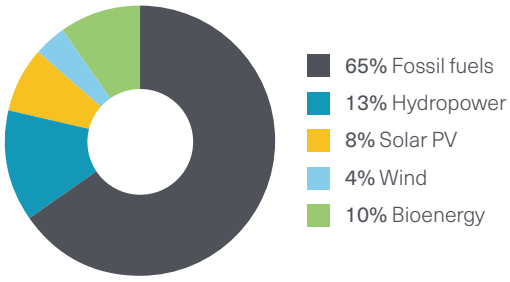
2021 Capacity by Technology (56.7 GW)



Annual Capacity Additions By Technology (MW)



Planned 2035 Capacity by Technology (77.2 GW) based on PDP 2018



Coal Fleet Age Avg.: 19 **Peak Demand GW:** 32.3

Reserve Margin: 40% **Annual T&D Loss:** 7.23%

Power Market Investment Framework

Total Power Capacity GW: 56.7 **Renewables Capacity GW and % share:** 12.9 / 23% **Renewables Capacity Target:** 30% by 2036

Power Generation Investment Sources of Finance

Rank	Renewable Power	$ Million	Fossil Fuel Power	$ Million	Oil & Gas	$ Million
1	Electricity Generating Public Co	411	Electric Power Development	3,027	PTT Exploration and Production	1,075
2	Gunkul Engineering	165	Electricity Generating Public Co	1,117	Mubadala Investment Company	167
3	Solar Power Company	131	Gulf Energy	1,113	Dow Chemical Group	150
4	Aeolus Associated	119	Mitsui & Co	477	Biggas Technology	132
5	Tang Kim Heng Group	113	Electricity Generating Public Co	430	Tap Oil Limited	111

Market Structure: Single-buyer utility with IPPs

Grid Ownership: State Owned

Pricing: Government Regulated; tariffs set for residential and commercial use

Generation Ownership: Mix of public and private

Remuneration Mechanisms – Renewable Power and Key Enabling Technologies

Technology	Mechanism	Ceiling Price Level (USD), lifetime avg.	Duration	Currency of Payment	Inflation Adjustment	Grid onnection and Land	Other features
Solar PV (utility-scale)	Feed-in tariff	USD 65/MWh	25 Years	THB	No	Developer responsibility	+15/MWh if located in southern border province, min. 51% Thai ownership
Solar PV (utility-scale) + Storage	Feed-in tariff	USD 86/MWh	25 Years	THB	No	Developer responsibility	10-90MW capacities, 100% output from 9am - 4pm & 60% output from 6pm-6am, +15/MWh if located in southern border province, min. 51% Thai ownership
Wind Power	Feed-in tariff	USD 94/MWh	25 Years	THB	No	Developer responsibility	+15/MWh if located in southern border province, min. 51% Thai ownership
Biogas (wastewater / waste)	Feed-in tariff	USD 63/MWh	20 Years	THB	No	Developer responsibility	+15/MWh if located in southern border province, min. 51% Thai ownership

Main Drivers, Challenges and Priorities for Investment

Investment & Return Drivers

- Carbon neutrality goal by 2050. In planning, it aims to have renewables account for 35% of power capacity by 2036
- Significant FiTs now avaliable for solar, wind, and biogas which will drive investment and create pricing certainity for investors
- The country is still heavily reliant on fossil fuel imports, these markets have been extremely volatile over the past few years, and as such the government sees renewable energy as a primary strategy for energy security within Thailand. This indicates the government will continue to be supportive of renewable development and buildout over the next decade
- Since 2018 the government has been working with the SEC to encourage the issuance of green bonds within the country, reducing registration fees associated with issuance to offset costs associated with monitoring targets

Challenges

- The majority of Thailand's current generation comes from centralized fossil fuel thermal plants, as a result transmission buildout will need to be massive to accomodate high levels of intermittent generation
- The country's economic growth has stagnated over the last decade, access to electricity is a key driver of economic growth, and as a result renewable buildout will need to ensure that grid stability and energy security are maintained and improved
- Lack of a competitive and wholesale electricity market create pricing uncertainity for technologies and projects that are not supported by the current FiT program
- Control of Thailand's energy system is segmented between several state-owned utilities, causing fragmentation and a lack of unified approach. Additionally, the public and private sector have not been unified in their efforts in the space

Policy and Market Priorities

- Focus on transmission buildout to allow for decentralized generation & distribution of intermittent generation
- Creation of a competitive and transperant wholesale electricity market
- Introduction of mandatory carbon pricing or emissions trading scheme to force industry towards decarbonization, as the majority of economic activity in the country is associated with fossil fuel use
- Creation of synergies between state-owned utilites for a targetted and unified approach to renewable and transmission buildouts

Sources

IEA: Energy Subsidies, CO2 Emissions, Power Demand by end-use sector, Renewable power annual capacity additions by technology, Electricity capacity by technology (2021), Total Installed Capacity (Fossil fuel power based on calculations from S&P Platts), Renewable Power Capacity, Coal Fleet Age (Based on calculations from S&P Platts), Reserve Margin, Annual T&D Losses

S&P (Platts): Fossil fuel power annual capacity additions by technology

IMF: Population, GDP Per Capita

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IJ Global: Power market sources of finance

World Bank, UN: FDI, GFCF, Fuel net imports

Government of Thailand: 2030 GHG reduction target, Net-Zero target, Carbon pricing, Planned 2035 generation capacity, Peak demand, Renumeration Mechanisms

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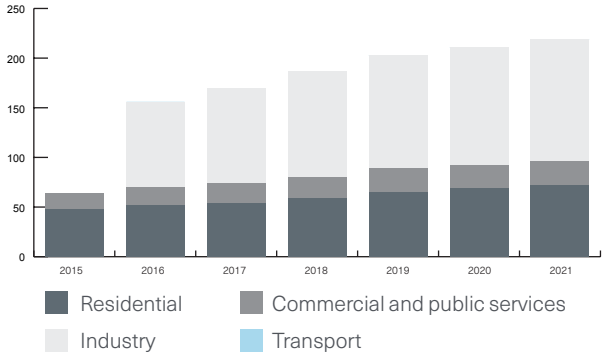
Country Name: Vietnam

Cross-Cutting Macro Indicators

Population (mm):	99
GDP Per Capita (USD, 3-yr CAGR):	13075 (7.38%)
Trailing 12M Currency Movement (IDR/USD):	-2.92%
Sovereign Debt Rating (S&P):	BB+
10Y Gov. Bond Yield:	4.92%
Sustainable Debt Issuance (USD, 3-yr CAGR):	0.84bn, (68.36%)
FDI net (USD, 3-yr CAGR):	15.7 bn (0.3%)
FDI % of GFCF:	13.5%
Energy Subsidies (Yes/No, Type, USD):	Yes, Coal (18.1 bn), Oil & Gas (13.4 bn)
Fuel net imports (USD):	13.1 bn
CO2 Emissions (per capita, 3-yr CAGR):	3.55t, (6.51%)
2030 GHG Reduction Target:	15.8% (unconditional), 43.5% (conditional)
Net-Zero Target:	Net-Zero, 2050
Carbon Pricing:	No, environmental tax on gas (0.0428 USD/L) and diesel (0.0214 USD/L)

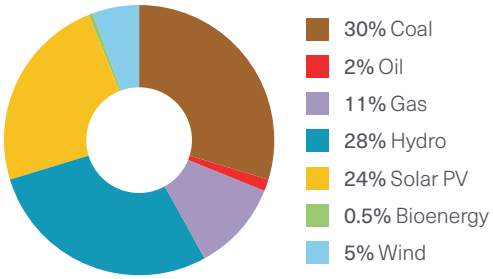
Power Market Fundamentals

Power Demand By End-Use Sector (TWh)

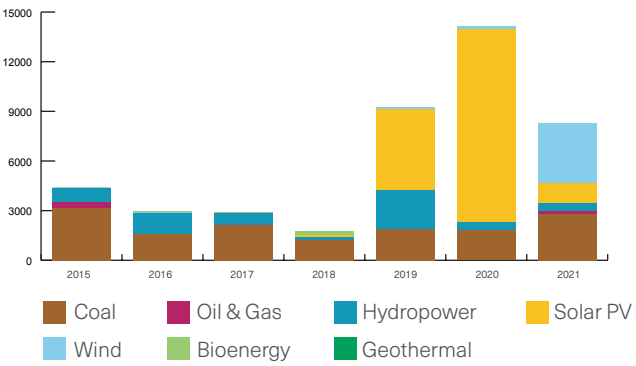


Electricity Capacity

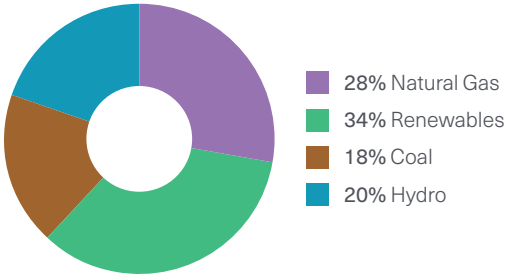
2021 Capacity by Technology (75.5 GW)



Annual Capacity Additions By Technology (MW)



2035 Capacity by Technology (158 GW)
Based on Vietnam PDP8



Coal Fleet Age Avg.: 8 **Peak Demand GW:** 42.5

Reserve Margin: 34% **Annual T&D Loss:** 6.53%

Power Market Investment Framework

Total Power Capacity GW: 75.5 **Renewables Capacity GW and % share:** 43.7 / 58% **Renewables Capacity Target:** 32% by 2030

Power Generation Investment Sources of Finance

Rank	Renewable Power	$ Million	Fossil Fuel Power	$ Million	Oil & Gas	$ Million
1	Bamboo Capital Group	1,031	Electricity of Vietnam Group EVN	5,716	PetroVietnam	4,959
2	Xuan Thien Group	867	PetroVietnam	3,491	PetroVietnam	4,445
3	PetroVietnam	740	EVN Group	3,251	Vung Ro Petroleum Company Limited	4,000
4	Electricity of Vietnam Group EVN	734	Teknik Janakuasa	1,760	Idemitsu Kosan	3,159
5	Trungnam Group	673	AES Corporation	994	SCG Chemicals	2,700

Market Structure: Single-buyer utility with IPPs **Pricing:** Government Regulated

Grid Ownership: State Owned **Generation Ownership:** Mix of public and private

Remuneration Mechanisms – Renewable Power and Key Enabling Technologies

Technology	Mechanism	Ceiling Price Level (USD), lifetime avg.	Duration	Currency of Payment	Inflation Adjustment	Grid onnection and Land	Other features
Solar PV (Utility Scale)	Feed-in tariff	USD 51/MWh	20 Years	VND	No	Developer responsibility	Ceiling price, renewed FiT scheme replacing expired rates
Floating Solar PV (Utility Scale)	Feed-in tariff	USD 65/MWh	20 Years	VND	No	Developer responsibility	Ceiling price, renewed FiT scheme replacing expired rates
Onshore Wind	Feed-in tariff	USD 68/MWh	20 Years	VND	No	Developer responsibility	Ceiling price, renewed FiT scheme replacing expired rates
Offshore Wind	Feed-in tariff	USD 78/MWh	20 Years	VND	No	Developer responsibility	Ceiling price, renewed FiT scheme replacing expired rates

Main Drivers, Challenges and Priorities for Investment

Investment & Return Drivers

- Vietnam has signed the Paris agreement targeting net-zero by 2050. In planning, it aims to have renewables account for 47% of electricity generation by 2030. To reach these goals Vietnam estimates USD 11bn+ in annual financing will be necessecary
- The country has recently seen a massive spike in electricity demand as it has become a manufacturing hub in recent years, putting significant strain on the grid, making energy security a primary concern for the country. To alleviate this strain the government is now allowing private & foreign investors to build, manage, and operate transmission lines
- Recent buildout in solar (+16GW 2017-2022) has been fuelled by Solar FiT program which recently expired and was renewed to include FiTs for wind at the beginning of 2023
- In 2022, the government launched a direct PPA (DPPA) program, allowing projects to sign PPAs directly with corporate offtakers, which will increase the number of bankable projects for investors
- Discussions around creation of a transparent and competitive wholesale market could make renewable investment in the country much more attractive in the coming years

Challenges

- Massive buildout of solar has caused the grid to become extremely strained due to the increased penetration of intermittent renewables, indicating high levels of curtailment are likely in the short term
- Growth in electricity demand is further putting strain on the grid and is increasing the need for dispatchable generation as intermittent buildout in recent years has been significant
- The lack of a competitive wholesale market makes the country less attractive for renewable investors who tend to benefit from merchant upside in competitive markets
- Clarity on FiT pricing, timeline, and structure has been poor in the last 5 years; new FiT scheme alleviates these concerns for the time being, however, renewable subsidies are likely to take the form of an auction in the coming years, creating pricing uncertainity outside of the current FiT regime

Policy and Market Priorities

- Targetted transmission buildout to support increasing intermittent generation and demand; incentives for private investment in transmission lines
- Creation of a robust and transparent wholesale electricity market
- Clarity and standardization of renewable PPA structure and pricing
- Expansion of DPPA program beyond two year pilot, encouraging direct private investment in the country by increasing the number of bankable projects with high-quality offtake

Sources

IEA: Energy Subsidies, CO2 Emissions, Power Demand by end-use sector, Renewable power annual capacity additions by technology, Electricity capacity by technology (2021), Total Installed Capacity (Fossil fuel power based on calculations from S&P Platts), Renewable Power Capacity, Coal Fleet Age (Based on calculations from S&P Platts), Annual T&D Losses

S&P (Platts): Fossil fuel power annual capacity additions by technology

IMF: Population, GDP Per Capita

Bloomberg: Trailing 12M currency movement, 10Y Gov. yield, Sustainable Debt Issuance

IJ Global: Power market sources of finance

World Bank, UN: FDI, GFCF, Fuel net imports

Government of Vietnam: 2030 GHG reduction target, Net-Zero target, Carbon pricing, Planned 2035 generation capacity, Peak demand, Reserve Margin, Renumeration Mechanisms

Notes

1. FDI, GFCF, Energy Subsidies, Fuel net imports, Total Power Capacity, and Renewables Capacity current as of 2021 year end, all other values current as of 2022 year end unless otherwise specified; 2. All $ values in USD; 3. Bond yields in local currency; 4. CO2 emissions taken from 2020 real IEA data and extrapolated based on GDP growth rate from IMF data to 2022; 5. Power market sources of finance calculated based on IJ global asset database project capex & ownership. The asset database capex is incomplete for projects in ASEAN, the numbers represented serve as best estimates based on available data.

ANNEX B: IEA Scenarios

The Stated Policies Scenario (STEPS) is designed to give decision-makers feedback about the course they are on today, based on stated policy ambitions. This scenario incorporates our assessment of stated policy ambitions, including the energy components of announced stimulus or recovery packages (as of mid-2020) and the Nationally Determined Contributions under the Paris Agreement. Broad energy and environmental objectives (including country net-zero targets) are not automatically assumed to be met. They are implemented in this scenario to the extent that they are backed up by specific policies, funding and measures. The STEPS also reflects progress with the implementation of corporate sustainability commitments. It assumes that the pandemic will be brought under control over the course of 2021.

The Sustainable Development Scenario (SDS) is designed to meet the energy-related United Nations Sustainable Development Goals to achieve universal access to affordable, reliable and modern energy services by 2030, a substantial reduction in air pollution and effective action to combat climate change. The SDS is fully aligned with the Paris Agreement to hold the rise in global average temperature to "well below 2°C ... and pursuing efforts to limit [it] to 1.5 °C". The SDS assesses the combination of actions required to achieve these objectives. In this Outlook, investments in the 2021–23 period are fully aligned with those in Sustainable Recovery: World Energy Outlook Special Report (IEA, 2020). In the SDS, many of the world's advanced economies will reach net-zero emissions by 2050 – or earlier in some cases – and global carbon dioxide (CO2) emissions are on course to fall to net zero by 2070.

The Net Zero Emissions by 2050 Scenario (NZE) is a normative IEA scenario that shows a narrow but achievable pathway for the global energy sector to achieve net-zero CO2 emissions by 2050, with advanced economies reaching net-zero emissions in advance of others. This scenario also reaches key energy-related United Nations Sustainable Development Goals (SDGs), including universal energy access by 2030 and major improvements in air quality. The NZE does not rely on emissions reductions from outside the energy sector to achieve its goals, but with corresponding reductions in emissions from outside the energy sector, it is consistent with limiting the global temperature rise to 1.5 °C without a temperature overshoot (with a 50% probability).

ANNEX C: SE Asia Unlisted Infrastructure Index Breakdown (EDHEC)

The South-East Asia unlisted infrastructure index from EDHECinfra represents three markets within the region (Singapore, the Philippines and Malaysia). The Philippines accounts for about 50% of the index composition and 100% of the renewable power portion of the index. As such, the performance of the index is heavily concentrated among just a few geographies, which is a significant limitation. The majority of returns within the index come from contracted cash flows (67%).

Figure 16. EDHEC SE Asia unlisted infrastructure index breakdown by country

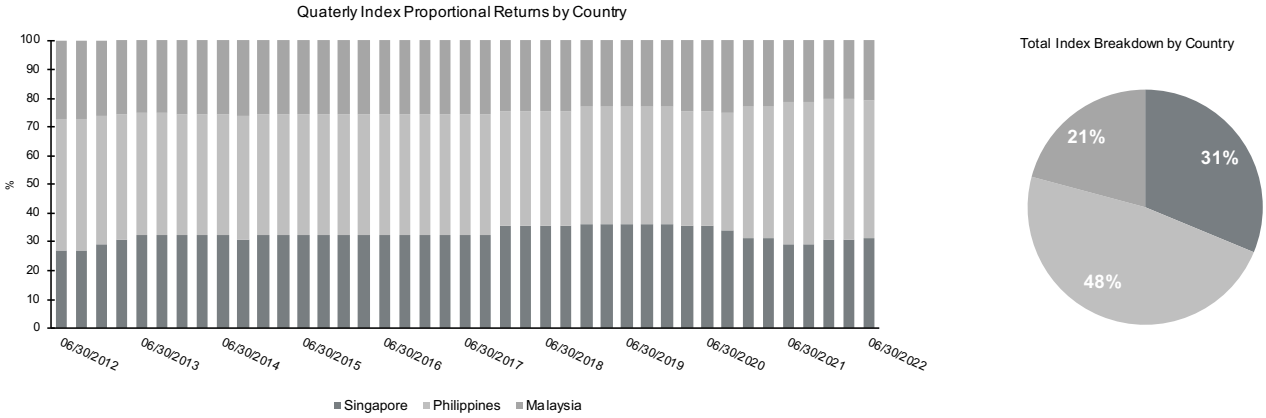
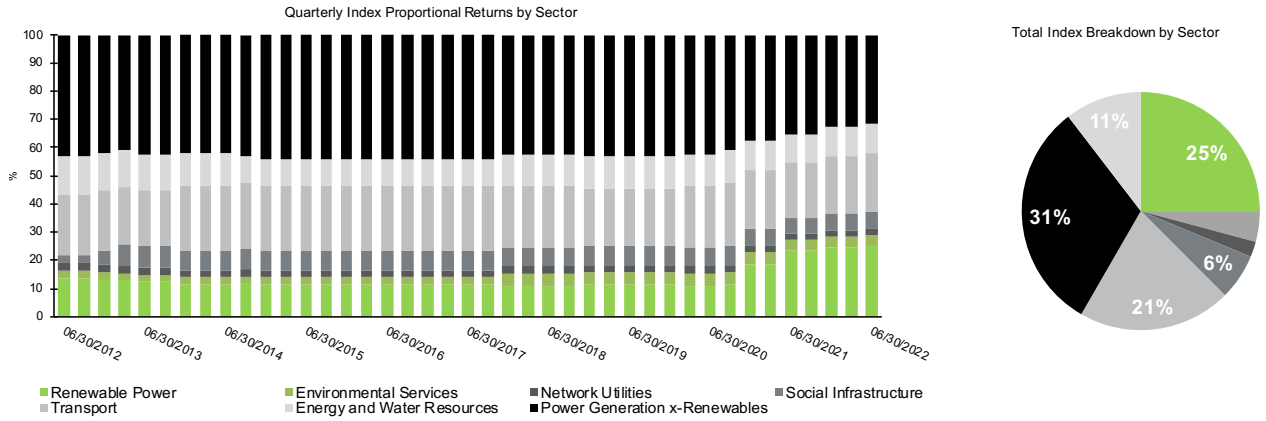


Figure 17. EDHEC SE Asia unlisted infrastructure index breakdown by sector



ANNEX D: Index Return and Volatility Calculation Methodology

Total Return (Geometric Return)
Total return is equivalent to rebalancing the portfolio, reinvesting gains and realising losses with the effects of compounding on an annual basis.

Annualised Volatility
Volatility is a range of prices for a security or portfolio of securities. We have adopted here a definition of volatility as the standard deviation over the stated period. An appropriate adjustment has been made to arrive at annualised figures, given quarterly data observations.

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The International Energy Agency

The IEA examines the full spectrum of energy issues, including oil, gas, and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand-side management, and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability, and sustainability of energy in its 31 member countries, 11 association countries, and beyond.

The Centre for Climate Finance & Investment

The Centre for Climate Finance & Investment (CCFI)'s purpose is to unlock solutions within mainstream capital markets to address the challenges posed by global climate change. It aims to make a material impact on increasing the flow of capital to climate change mitigating investments.

Combining interdisciplinary research with real-world experience, the CCFI is creating a point of interface between academics and practitioners. Researchers working with the CCFI bridge the academic and business worlds and undertake research and industry collaborations geared towards answering the questions that the investment community is asking.

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