



# ASEAN's clean power pathways: 2024 insights

Growing electricity demand and reliance on fossil fuels in ASEAN continue to hinder climate goals and economic opportunities. Solar, wind and batteries, supported by international cooperation and grid interconnection, offer the best solutions.

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## About

This report provides a brief overview of ASEAN's power sector landscape in 2023, tracks energy transition development in the past five years, presents several scenarios on decarbonisation for ASEAN, documents policy changes in the past year and emerging discourses in ASEAN energy transition. This report presents strategies to fine-tuning policies to reduce dependence on fossil fuels and start the systemic shift necessary for a clean power sector transition, providing strategic guidance for policymakers, researchers and energy practitioners in the region.

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## Highlights

# +3.6%

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Rise in electricity demand in 2023, that was entirely met by fossil fuels

# +62%

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Percentage point of average bioenergy cost compared with wind and solar

# 21 TWh

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Decline in hydro generation between 2022 and 2023 despite 0.5 GW capacity addition

# 3-5x

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ASEAN's renewable capacity increase by 2035 according to several published pathways

## Executive Summary

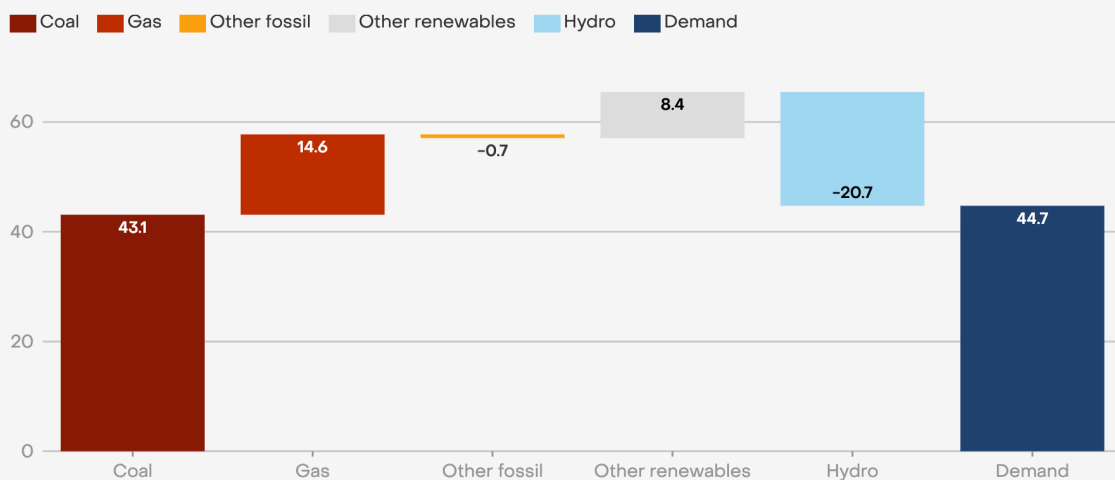
# ASEAN is the next growth powerhouse - will renewable energy lead the charge?

ASEAN has ambitious economic growth targets, whilst transitioning away from coal and seeking suitable renewables solutions.

ASEAN economic growth remains [strong and resilient](#), driven by domestic and global demand. Ongoing industrialisation, electrification and digitalisation are expected to drive [greater electricity demand](#), putting more pressure on a region traditionally dependent on fossil fuels. Demand is set to increase even further, up to 41% by 2030 from 2023 level.

### Growth in ASEAN's fossil generation far outweighed the demand rise in 2023

Change in generation 2022 vs 2023 (TWh)



Source: Annual electricity data, Ember  
'Other renewables' include solar, wind, bioenergy and geothermal

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If ASEAN continues its energy transition at the [current pace](#), it risks missing out on the opportunities provided by the declining costs of wind and solar, now [cheaper than fossil fuels](#).

Between 2018 and 2022, 38 GW of renewable energy capacity was added, with about 44% coming from solar capacity growth in Viet Nam. However, replicating this success is challenging due to curtailment risks and grid constraints, leading to governments taking a more [cautious approach](#) and slowing down the shift away from fossil fuels.

Current plans indicate that much of the rising electricity demand will be met by fossil fuels, potentially increasing import dependence for some countries, as seen with [Singapore](#) and [Malaysia](#)'s reliance on gas. In other countries like Indonesia, [maintaining coal dependency](#) risks undermining their potential contribution to climate targets.

In light of the droughts and changing climatic conditions in 2023, [hydro is becoming less reliable](#) for the energy transition. Bioenergy, often seen by the government as the most promising solution for energy security and economic development, particularly for farmers, faces challenges such as seasonality, unpredictability, limited maximum quantity and food versus fuel allocations, making it an expensive [energy source](#) in ASEAN.

Wind, solar and batteries offer a promising way forward, as [seen](#) in other countries. Moreover, a levelized cost of electricity (LCOE) and auction prices confirm that solar is amongst the cheapest energy sources for electricity generation.

Across the region, solar and wind have interesting [complementarities](#), showing that ASEAN can ease its collective energy transition journey through cooperation and interconnection.

Other policy options for governments are available to boost clean energy use in the power sector, the end-use sector (industrial) and the wider landscape, including direct renewable power purchases, fast-tracking rooftop solar and creating green jobs.

Direct power purchase agreements are essential for [unlocking wider cross-border electricity trading in ASEAN](#) and creating new opportunities to spur the growth of green industries in Indonesia.

Governments in Viet Nam, the Philippines, Thailand and Indonesia have implemented strategic policies to boost rooftop solar deployment. These include Viet Nam's pilot scheme

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for selling excess solar power, Thailand's relaxed permit requirements and tax incentives, the Philippines' push of peer-to-peer trading and large renewable energy projects, and Indonesia's regulation setting annual quotas for rooftop solar installations.

Green job policies create employment opportunities in renewable energy sectors, stimulating economic growth while helping to offset job losses in fossil fuel industries.

## 01 ASEAN electricity demand grew by 3.6% in 2023, entirely met by fossil fuels

Between 2022 and 2023, ASEAN electricity demand grew by 45 TWh that was entirely met by fossil fuels. Without rapid scaling of energy efficiency solutions and low-carbon electricity sources in the coming years, emissions could rise significantly, especially as electricity demand is projected to grow by about 7.3% annually through 2030.

## 02 Solar and hydro are the main drivers of transition; however, annual hydro generation declined in 2023

Hydropower generation in 2023 decreased by 21 TWh from 2022 levels, despite an additional installed capacity of 0.5 GW. The impacts of climate change, including droughts, may further undermine hydro reliability for clean energy generation. At the same time, solar generation only increased by 2.7 TWh, demonstrating the need to boost renewables.

## 03 Solar, hydro and geothermal are the cheapest options for new generation

Bioenergy remains the most expensive option compared to other renewable sources in ASEAN. In Indonesia, Malaysia and Thailand, its LCOE ranged between \$59-98 USD per MWh, while coal was nearly \$60 USD per MWh across countries. Gas costs \$42-43 USD per MWh in Malaysia, Singapore and Thailand. In comparison, hydro was around \$25 USD per MWh in Lao PDR, and solar between \$44-50 USD per MWh in Viet Nam and Thailand. Wind costs \$43-73 USD per MWh in the Philippines, Thailand and Viet Nam.

## 04 Solar and wind's compatibility in ASEAN may be the driver for renewables growth

Across Southeast Asia, spatial and temporal analyses demonstrate that wind and solar power generation complement each other during different months. This presents opportunities for securing power through interconnections, enhancing mutually beneficial relationships among countries with renewables potential and market opportunities. Scaling up solar use is important, as its reliability often surpasses that of wind (such as onshore wind) in some parts of the region.

ASEAN renewable energy shift promises new jobs, stronger energy security and economic growth opportunities. Collective efforts through interconnection programmes and international cooperation in financing and sharing of resources offer solutions to push and pull dynamics for renewables.

**Dr Dinita Setyawati**

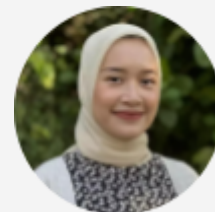
Senior Electricity Policy Analyst - Southeast Asia, Ember



Effective carbon market regulations can scale the market and drive the transition to a low-carbon power sector. Carbon pricing can channel revenue more effectively into climate projects, including renewables, surpassing the impact of voluntary markets. A well-designed carbon price, particularly in the power sector, ensures liquidity and accountability and supports energy affordability.

**Shabrina Nadhila**

Electricity Policy Analyst - Southeast Asia, Ember





Power interconnectivity is key to ASEAN's economic cooperation. Lao PDR's success in electricity exports highlights the region's potential. By fostering a shared identity around renewable resources, interconnection can drive economic growth, create jobs and improve livelihoods across the region. This cross-border trade in clean energy will enhance regional integration and contribute to the ASEAN Economic Community, opening new revenue streams for Lao PDR and neighbouring countries.

**Souliya Sengdalavong**

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Department, Ministry of Energy and Mines, Lao PDR



## Introduction

# Systemic shift necessary for ASEAN's clean power transition

What are the trends in ASEAN electricity sector transition, and why fine-tuning policies is necessary?

ASEAN aims to increase the share of renewable energy to 23% of its total energy mix by 2025, with a goal of achieving a 35% share of renewable energy in installed power capacity, up from 32% in 2022.

Electricity generation from renewable sources reached 28% in 2022, with hydro contributing the largest share. While there is no collective target for net-zero carbon emissions, some individual countries have set net zero targets between 2050 and 2060. Current regional goals also include achieving 100% electricity access by 2040.

The region currently accounts for [3.5%](#) of global greenhouse-gas emissions. However, this share is expected to increase substantially due to population growth, [expansion of manufacturing](#) and increasing electricity demand from the region's [data centres](#).

In a business-as-usual scenario, ASEAN's path to decarbonisation will be [gradual](#), with [coal](#) and [gas](#) continuing to play a primary role in securing the region's energy supply.

The region's energy transition, led by countries like Viet Nam and Singapore, will progress at its [own pace](#), more likely to align with national energy policies than the IEA's global net-zero emissions scenario by 2050. However, the opportunities presented by cleaner, more efficient and sustainable renewable energy offer an alternative and could [speed up](#) the region's pace of transition.

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## However, data limitation may potentially hinder energy transition planning

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Electricity data in ASEAN faces limitations in terms of update frequency and data types. The availability of electricity sector data varies by country. Singapore, Viet Nam, Philippines and Thailand have the most up-to-date and aggregated data at the monthly level. The rest of ASEAN countries provide electricity data on an annual basis. The latest generation data available for Brunei Darussalam, Cambodia, Lao PDR, the Philippines, Myanmar and Malaysia, at the time of the writing of this report, only extends to 2022.

Data on ASEAN countries' power capacity from [Global Energy Monitor](#) (GEM) reflects differences in the inclusion of captive power plants. For example, all coal plants in Brunei Darussalam are captive, and Indonesia's coal capacity data includes captive power. Understanding these distinctions is important for a clearer view of capacity data across the region.

While Ember has curated and interpreted data on Asia in the [Asia Electricity Data Finder](#), the limited publicly available data in Southeast Asia poses a significant risk to the energy transition. Effective integration of renewable energy sources into the grid requires accurate, real-time data on energy production and consumption. Without such information, policy-making and investment decisions are at risk of delays, potentially slowing down progress. Addressing these limitations through better data collection, analysis and sharing is crucial to accelerate the transition to a sustainable energy system.

With rising electricity demand, energy transition decision-making must consider strategies for better data transparency, availability and accuracy, as well as fine-tuning policies to incentivise data reporting and support data analytics for stakeholders. This will enable a more holistic planning to reduce dependence on fossil fuels and start the systemic shift necessary for a clean power sector transition. This includes attracting more sustainable corporations through clean energy procurement options, aligning national targets with regional goals and implementing supportive policies to foster renewable energy market growth. These recommendations are explored in more detail in this report, providing strategic guidance for policymakers, researchers and energy practitioners in the region.

Power sector 2023

# Electricity landscape in ASEAN

ASEAN demand grew by 3.6% in 2023, entirely met by fossils as clean energy growth struggled to keep pace, pushing emissions up by 6.6% in 2023. Peak demand in some countries occurs during daytime, highlighting the potential for solar.

ASEAN energy demand has more than doubled in the past two decades, rising from 458 TWh in 2003 to 1,258 TWh in 2023. Post-pandemic economic recovery, [rising use of electric vehicles](#) and the [development of data centres](#), will drive electric utilities to increase their forecasts for additional power needed by 2030.

Using a six-year compound annual demand growth rate of 3.3% between 2018 and 2023, demand could reach 1,626 TWh by 2030, up 30% from 1,258 TWh in 2023. Meanwhile, the [ASEAN Energy Outlook \(AEO\) 8](#) projects total power generation requirements in 2030 to range between 1,545-1,567 TWh, demonstrating the urgency for a faster clean energy transition.

## Rising electricity demand is expected across ASEAN

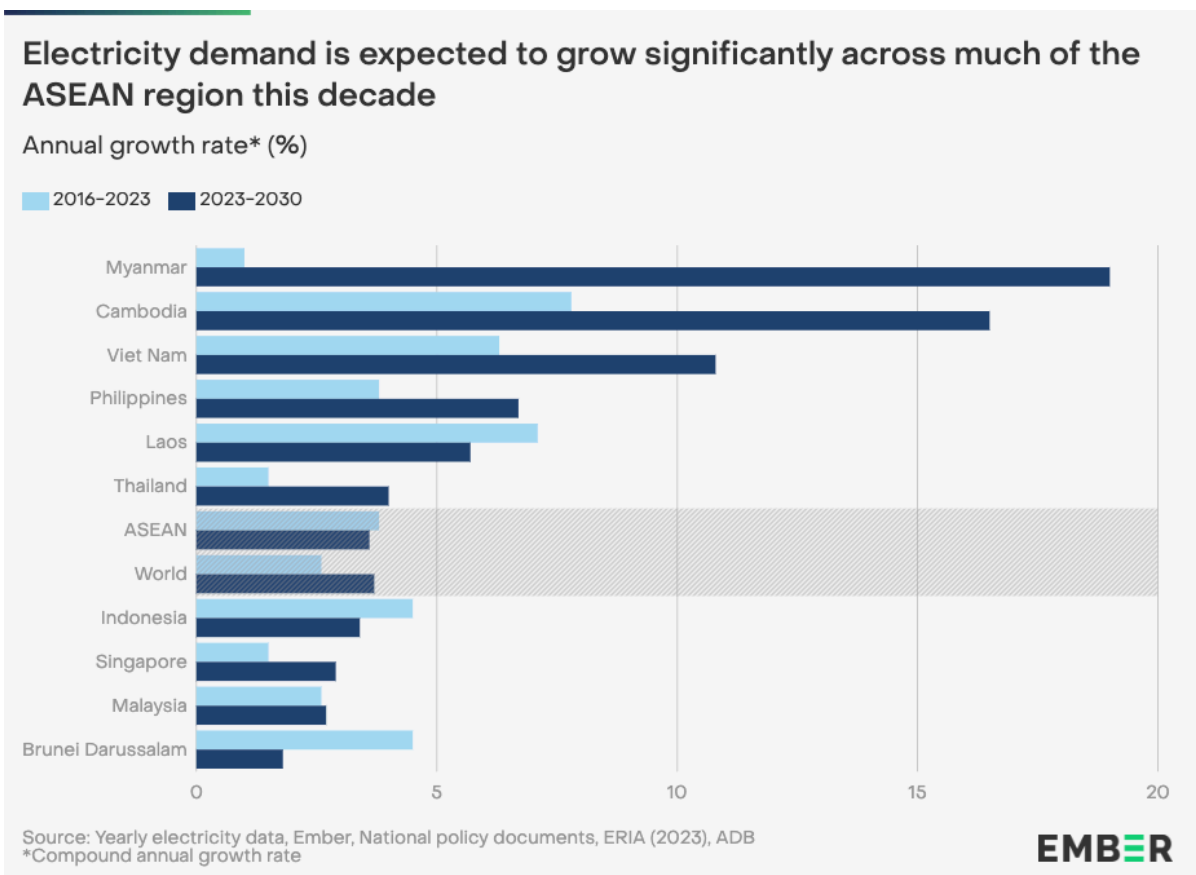
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Electricity demand growth slowed to 3.6% in 2023, down from 4.9% in the previous year. Nevertheless, demand for electricity is expected to keep [rising](#).

This year, extreme [heat waves](#) hit ASEAN cities, prompting governments to close schools. Electricity demand for cooling homes, shopping centres and offices is likely to surge as climate change pushes global temperatures higher.

Country-level variations in Southeast Asia’s power sector are pronounced, with diverse energy resources, population density, geographical topography, development goals and the availability of clean energy investments. Myanmar and Viet Nam, for instance, have large [wind potential](#), while Lao PDR and Cambodia hold significant hydro potential.

In contrast, Singapore is emerging as a significant economic hub despite its limited natural resources, relying on [regional grid connectivity](#) for clean energy imports to meet increasing electricity demand. Currently Singapore aims to import up to [6 GW of low carbon electricity by 2035](#), positioning the country to nearly meet the IEA’s target of [8.1 GW low carbon electricity import by 2035](#).



All ASEAN countries are forecasting electricity demand growth through 2030, with annual growth projections ranging from 1.8% to 19%.

Myanmar is expected to see the largest increase, with electricity demand projected to reach [57 TWh by 2030](#), up from 17 TWh in 2023. Viet Nam and Cambodia anticipate growth rates of [11%](#) and [17%](#), respectively, during the same period. Brunei projects a more modest growth

of [1.8% by 2030](#). Overall, the average demand growth across the region is expected to be around 7.3% annually by 2030.

## All new electricity demand in 2023 was met by fossil fuels

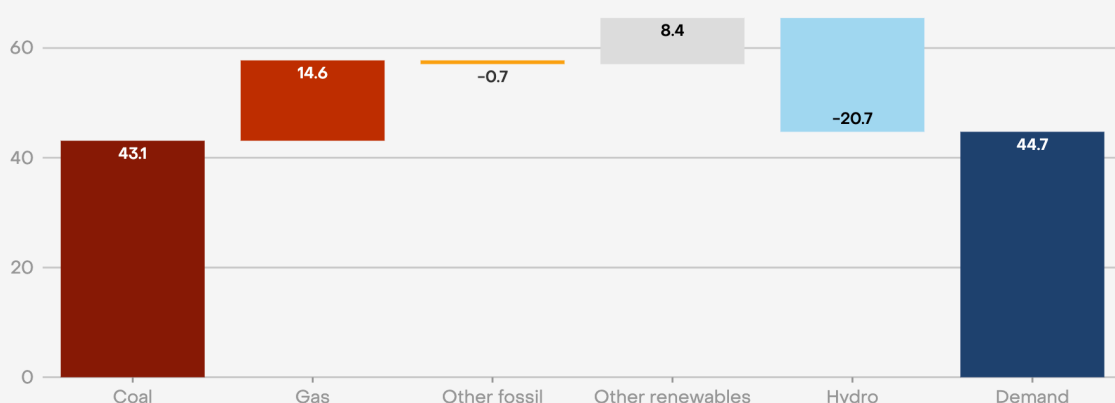
In 2023, fossil fuels made up 74% of electricity generation, with coal providing the majority at 44%. Renewables accounted for 26% of power, down from 28% in 2022, primarily driven by a 2.3% decline (-21 TWh) in hydro's share of power generation between 2022 and 2023.

Between 2022 and 2023, new demand growth was 3.6% (45 TWh), which was entirely met by coal and gas power generation. Indonesia alone contributed 11 TWh to the coal increase, [highlighting its position](#) as the largest coal user with young coal power plants. In contrast, ASEAN's non-hydro renewables grew by only 8.5 TWh during the same period.

### Growth in ASEAN's fossil generation far outweighed the demand rise in 2023

Change in generation 2022 vs 2023 (TWh)

Coal Gas Other fossil Other renewables Hydro Demand



Source: Annual electricity data, Ember  
'Other renewables' include solar, wind, bioenergy and geothermal

Continuing at this pace of transition risks ASEAN becoming more dependent on fossil fuels, missing opportunities presented by emerging clean energy technologies and economics, and failing to meet climate targets. Meanwhile, electricity demand continues to grow rapidly, making it more important than ever to meet this demand with clean energy.

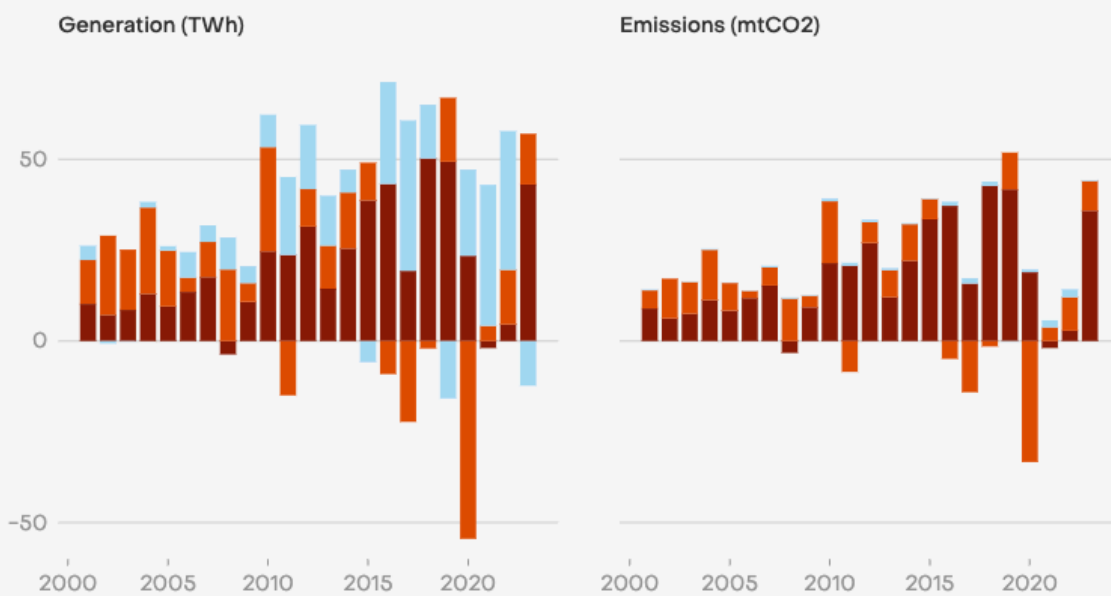
## Soaring demands coupled with intense fossil fuel use are pushing up emissions

Increased use of coal and gas was the main driver behind the rise of over 44 million tonnes in ASEAN power sector emissions in 2023, marking the largest annual rise in absolute terms in the past decades after 2019.

### Growth in the ASEAN's electricity generation and power sector emissions has been driven by fossil fuels

Annual change

Coal Gas and other fossil Other

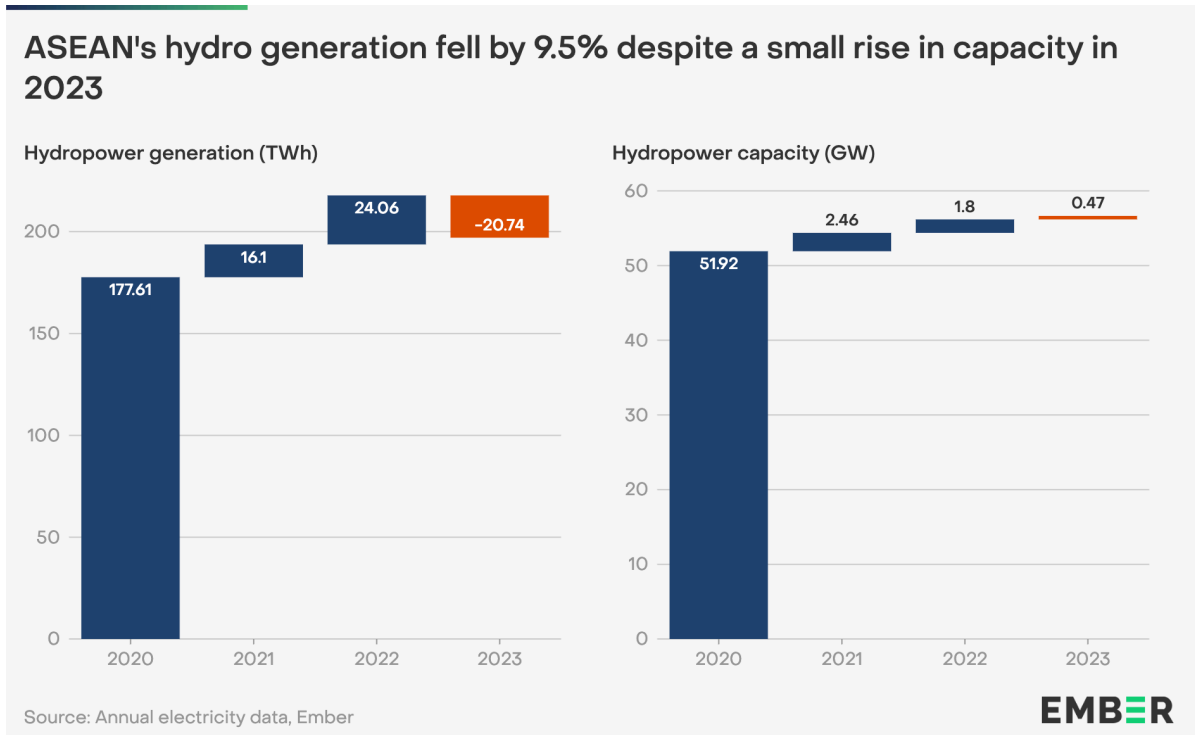


Source: Yearly electricity data, Ember

ASEAN power sector emissions rose by 6.6% in 2023 to 718 million tonnes per CO<sub>2</sub>, with 66% coming from coal and 32% from gas and other fossil. About 78% of this power sector emissions increase came from Indonesia Viet Nam, where emissions rose by 14 million tonnes and 20 million tonnes respectively.

In Indonesia, Viet Nam, Malaysia and the Philippines, coal was the biggest contributor to carbon emissions, while in Thailand and Singapore, emissions stemmed mostly from gas.

## Decline in hydro generation in 2023 indicates seasonal risks exist



ASEAN's reliance on hydro poses [risks](#) from [less predictable and potentially more variable](#) hydro generation due to climate change and the scarcity of viable hydro sites.



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In the summer of 2023, persistent [droughts](#) across the region resulted in declining electricity generation from hydro, despite capacity additions of 0.5 GW.

Hydropower-rich member states may need to ramp up other renewable energy sources, such as solar and wind, to diversify energy supply in times of changing climate. For example, Northern Viet Nam's heavy reliance on hydro [hit the region](#) particularly hard in 2023 when severe droughts halted operations, leading to a regional power shortage.

## Surging peak demand during solar hours presents opportunities for some ASEAN countries

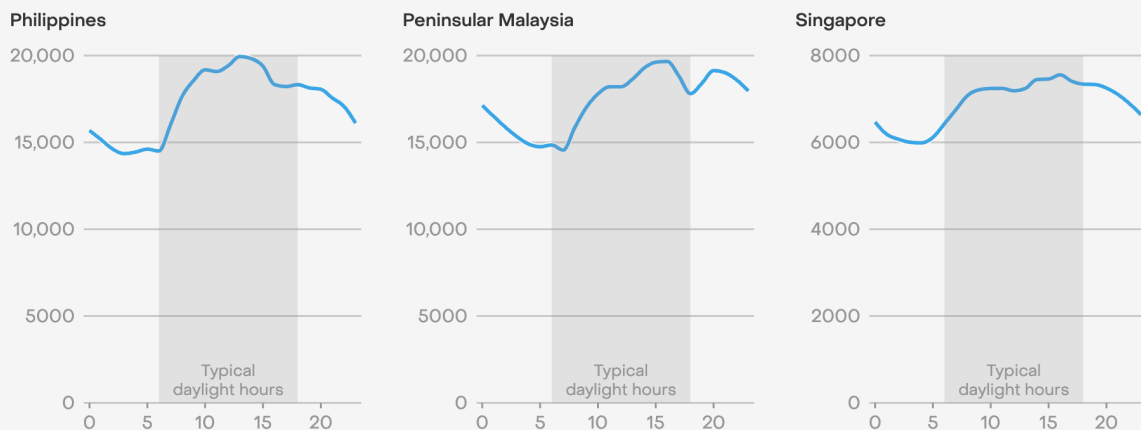
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As ASEAN is finding solutions to decarbonise their power systems through renewable energy integration, understanding the electricity demand patterns is crucial for maintaining [grid stability and frequency](#). To enable grids to absorb intermittent energy sources, [several measures](#) are needed, such as improvement of forecasting practices, system flexibility, operational flexibility and grid reliability.

Understanding consumption patterns and daily load profiles is a crucial first step in analysing the different demand characteristics and drivers in ASEAN. Due to limited aggregate hourly data for some countries, this report presents the load profiles of Singapore, the Philippines and Peninsular Malaysia in 2018 and 2023 to observe changes in electricity consumption patterns.

### Surges in peak demand during daylight hours present solar opportunities for some ASEAN countries

Average daily load profile in 2023 (MW)



Source: Grid System Operator (GSO) Malaysia, Det Norske Veritas (DNV), Energy Market Company (EMC) Singapore NEMS Market Data, National Grid Corporation of the Philippines (NGCP)



The data suggests that peak demand follows similar trends in Malaysia, the Philippines and Singapore where peak electricity consumption was seen during daylight hours. In Malaysia, peak demand reached 20 GW at 4 pm in 2023. In the Philippines, peak demand also recorded at 20 GW at 2 pm. In Singapore, peak demand reached 7.6 GW at 4 pm in 2023, which changed from 11 am in 2018. These daytime peak demand hours highlight the opportunities to ramp up solar power use as one of the solutions to meet electricity consumption during these periods.

## State of transition

# ASEAN needs to scale up renewables to help meet rising demand

In ASEAN, the cost of electricity from hydro, solar and geothermal is now cheaper than bioenergy and coal. Falling costs make solar and wind more viable than before, especially as climate change impacts on hydro production intensify.

ASEAN's focus on clean energy is set to shift towards solar and wind in the coming years. [Regional targets](#) set by the countries in 2023 aim for 15% of power generation coming from solar and wind by 2040, up from 4.5% in 2023.

ASEAN countries are aligning their [national energy targets](#) and policies with this shift, prioritising solar and wind. Viet Nam has set an explicit target of [47%](#) renewables in electricity generation by 2030, with [62%](#) of this coming from solar and wind. The Philippines targets 35% of renewables by 2040, with [16%](#) of this target met by solar and wind, according to their Power Sector Development Plan 2020-2040.

To achieve a net zero future, these targets need to be backed by delivery. Despite progress in the past five years, fossil fuels continue to dominate the region's electricity use. Concerns remain that the grid systems in ASEAN may not be ready to accommodate more intermittent energy sources, as seen in Viet Nam where [curtailment](#) has been an issue, [avoiding risk](#) for system grid operators due to the uncertain timing and [quantity of electricity](#) supply.

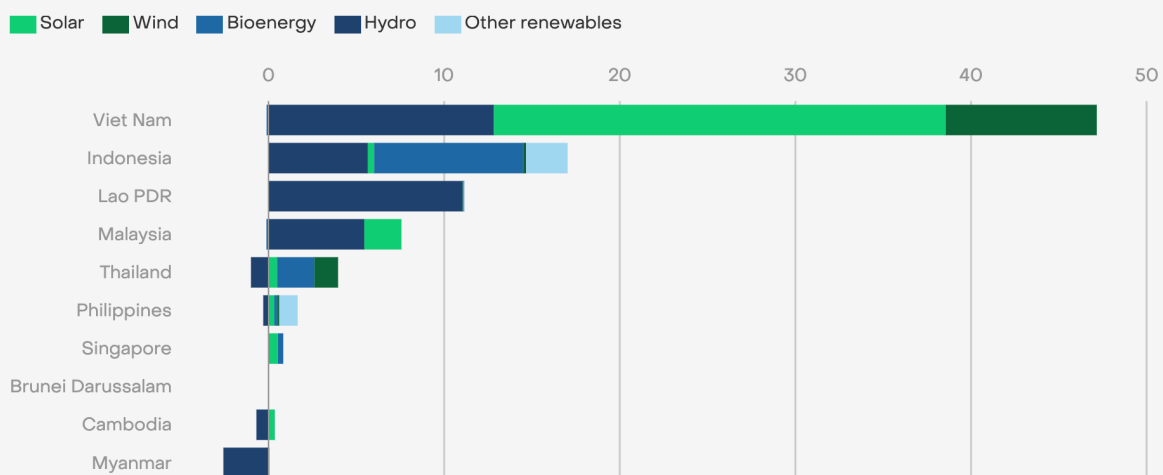
## Solar and hydro have been the main drivers of RE growth in ASEAN since 2017

A quick review of electricity demand and renewables buildup in ASEAN in the past five years shows some progress and a [pivot away from coal](#). Financial institutions are imposing [restrictions](#) on coal investment, likely encouraging ASEAN to move away from coal.

Historically, hydro and solar have been the main drivers of renewables growth in ASEAN. Hydro expansion is most notable in Lao PDR, followed by Malaysia and Viet Nam. Solar power capacity surged from 11 GW in 2019 to 26 GW in 2023, largely due to Viet Nam's feed-in tariff introduced in 2017. Peninsular Malaysia has also made strides with its solar net metering scheme, consistently meeting its quotas.

### Viet Nam has been a significant driver of renewables growth in the ASEAN region

Change in generation in the 5 years to 2022 (TWh)



Source: Ember electricity data explorer

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Between 2018 and 2023, solar capacity addition in the region was 21 GW, mainly due to the solar capacity growth in Viet Nam. Bioenergy capacity increased by 2.3 GW, reaching a total of 9.9 GW in 2023. Similarly, hydro capacity grew by 11 GW. However, wind power, historically less common in the region, faces challenges due to its relatively new technology status, [lack of scale and underdeveloped supply chains](#).

The historic reliance on fossil fuels has resulted in significant path dependencies on these industries that should be shifted. Factors influencing this shift also include the availability of low-interest financing or grants for new renewable energy technologies that will accelerate the adoption of renewables.

Renewables can help [curb the rise in emissions](#) while also [driving economic growth](#) by attracting investment and promoting local manufacturing. This supports ASEAN's goal of [avoiding the middle-income trap](#) caused by GDP losses due to climate change.

## The volatility in hydro generation means ASEAN needs to boost other clean energy

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Over the past five years, hydro generation has been volatile, demonstrating that over-reliance on hydro poses a risk to the stability of clean electricity supply mix in countries where fossil fuel use and electricity demand is high. Despite adding 12 GW hydro capacity between 2017 and 2023, its share in the electricity mix has declined by 2.2 percentage-points. In 2023, the installed capacity of hydro reached 57 GW, or 18% of the region's total installed power capacity.

Geographically, the largest hydro capacity is in Viet Nam (23 GW), followed by Lao PDR (9.8 GW), Indonesia (6.8 GW) and Malaysia (6.2 GW). Lao PDR exports hydroelectricity to neighbouring countries, including Cambodia, Viet Nam, China, Thailand and Singapore, making it a [profitable market](#).

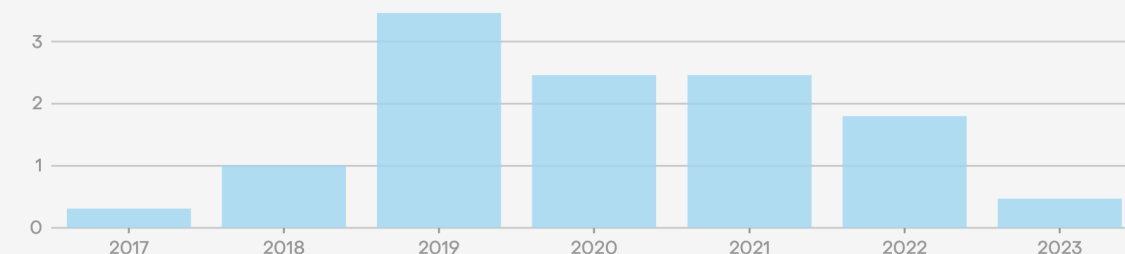
As the most mature technology in the region, hydro has consistently attracted the largest share of investments, accounting for around [38% public private partnerships](#) of total

investments in ASEAN. However, collectively, the capacity factor of hydropower plants has also decreased from 46% to 40%, highlighting the risks of ASEAN’s over-reliance on hydro to meet rising energy consumption and manage emission growth.

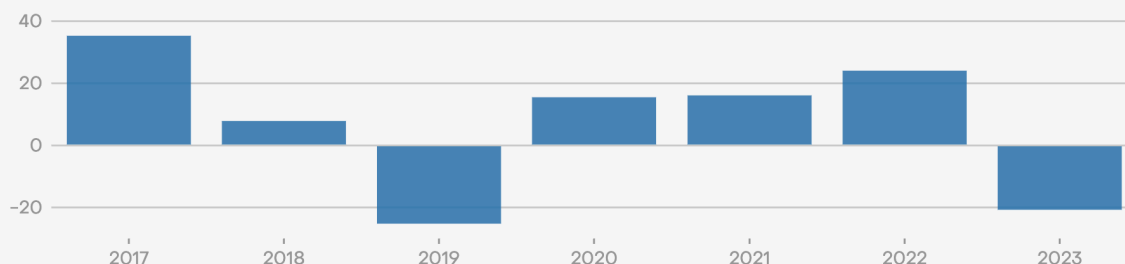
### Despite continuous growth in the ASEAN region's hydro capacity, hydro power generation has been volatile

Annual change

Capacity additions (GW)



Generation change (TWh)



Source: Yearly electricity data, Ember

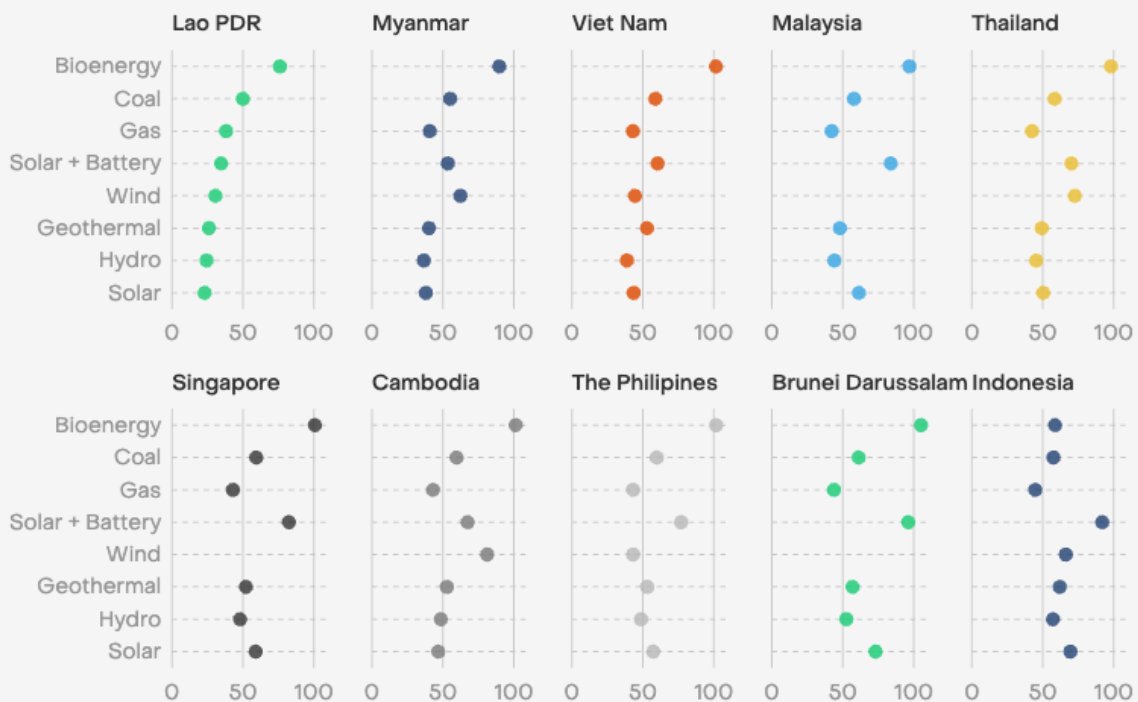
## Solar, hydro and geothermal are currently cheaper than bioenergy

In ASEAN, bioenergy is traditionally seen as a renewable energy source with [significant potential](#) for economic development linked to agricultural products, new business opportunities and poverty alleviation. For example, the Indonesian government [has introduced](#) a mandatory 35% blended biofuel regulation for the transportation sector, with a further plan to raise it to 50% .

However, bioenergy’s levelized cost of electricity (LCOE) remains the most expensive option compared to other renewable sources. Renewables, including solar, solar with battery storage, hydro, geothermal and wind, are cheaper than bioenergy, on an LCOE basis.

### Solar, hydro and geothermal are cheaper than bioenergy in most ASEAN countries

Levelised cost of electricity in 2023 (USD per MWh)



Source: Ember's analysis using NREL's Annual Technology Baseline (ATB) workbook, World Development Indicators for GDP, PWC (2024) and CPI (2023)



### Levelized cost of electricity (LCOE)

The levelized cost of electricity (LCOE) is the average cost to produce electricity from a system over its entire lifetime, including the cost to build and run it.

The LCOE of bioenergy is [almost four times more](#) than the costs of hydro in some countries. For example, bioenergy costs from biomass power plants in Indonesia, Malaysia and Thailand range from \$59 to \$98 USD per MWh, compared to hydro, which is much cheaper at around \$25 USD per MWh in Lao PDR. Similarly, solar power costs between \$38 to \$46 USD per MWh in Viet Nam and Thailand, while coal costs nearly \$60 USD per MWh.

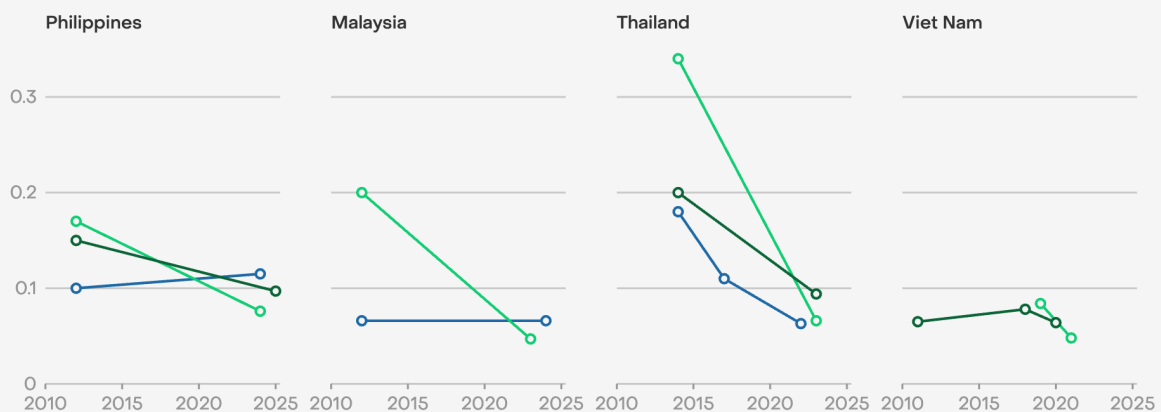
In Indonesia, the cost of bioenergy can be even higher due to incineration and biomass technologies that primarily use agricultural waste, such as palm oil residues. With average overnight costs for these technologies reaching [\\$4,400 USD per MWe](#), the resulting LCOE can rise to \$87 USD per MWh, further highlighting the financial challenges of bioenergy compared to other renewable options.

## Auction prices show falling solar and wind tariffs

### Solar power costs fell in the last decade, now cheaper than bioenergy in many ASEAN countries

Feed-in tariff and auction rates (USD per kWh)

■ Bioenergy ■ Solar ■ Wind



Source: Department of Energy Philippines, Sustainable Energy Development Authority Malaysia, Energy Policy and Planning Office Thailand · Bioenergy includes: biomass power plants in the Philippines, biomass and biogas power plants in Malaysia, and biomass, biogas and waste-to-energy plants in Thailand



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When looking at actual [auction](#) and Feed-in Tariff (FiT) rates, bioenergy is not experiencing the same cost reductions as solar and wind, except in Thailand. It is important to note that while biomass power generation is low cost in Thailand, [most types of biomass](#) have low energy density and require large amounts to be collected for processing, which may result in high transportation costs, which is not reflected in the auction prices.

Although these rates may not fully reflect true generation costs or include expenses like transmission costs and grid upgrades, they are useful for identifying trends in the implementation costs of these technologies over time.

In the Philippines, bioenergy FiT rates were [\\$0.1 USD per kWh in 2012](#), slightly increasing to [\\$0.115 USD per kWh](#) in 2024. Malaysia's FiT rates for bioenergy, including biogas and biomass, have remained relatively stable from 2012 to 2024 at [\\$0.066 USD per kWh](#).

In contrast, the Philippines' solar, initially priced much higher at [\\$0.17 USD per kWh](#) in 2012, has significantly dropped to [\\$0.076 USD per kWh](#) based on Green Energy Auction prices for 2024 installations. Solar rates in Malaysia also plummeted from [\\$0.2 USD per kWh](#) based on FiT rates in 2012 to only [\\$0.047 USD per kWh](#) by 2023 installations from the auction program. Thailand's solar FiT rates decreased from [\\$0.34 USD per kWh](#) in 2014 to [\\$0.066 USD per kWh](#) in 2023.

Similar to solar, onshore wind power plants also experienced a price drop from [\\$0.15 USD per kWh](#) based on 2012 FiT rates to [\\$0.097 USD per kWh](#) auction rates for 2025 installations.

Battery policy development in ASEAN has been shaped by the region's push for [leveraging critical mineral resources](#), solar energy adoption, electric vehicle (EV) growth, and securing energy storage solutions. Indonesia recently launched its first [electric vehicle battery plant](#) in West Java, while [Thailand](#) and Malaysia have developed Battery Energy Storage System (BESS) projects alongside solar and wind operations.

[The largest BESS](#) in the region is set to start development in Malaysia's Sabah, with completion expected by June 2030. The project will have a storage capacity of 400 MWh, marking a milestone for Malaysia in addressing solar intermittency following the [announcement](#) of its first utility-scale BESS pilot project earlier this year.

Similar BESS deployment initiatives are underway in the Philippines, where a [feasibility study](#) explored integrating BESS with a hydropower plant. Additionally, [the world's largest paired](#)

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[solar and BESS](#) project is poised to commence with a 20-year power supply agreement (PSA) with Meralco, the country's largest distribution utility. This project combines 3.5 GWp of solar power capacity with 4.5 GWh of battery storage. Indonesia and Singapore have also secured [a deal](#) on 2 GW solar plus 8GWh of utility-scale BESS ventures.

## Different pathways show ASEAN's renewable capacity needs to increase 3-5x by 2035

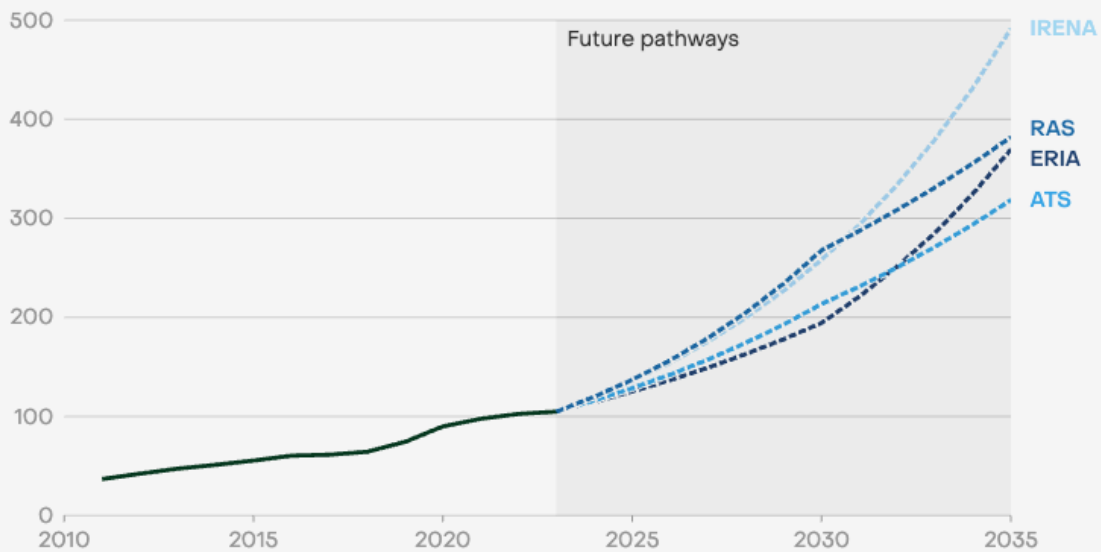
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ASEAN's power sector has several pathways to decarbonise in the next few decades. The [International Renewable Energy Agency](#) (IRENA) pathway indicates that ASEAN should reach 3.4 TW of renewable capacity by 2050 to meet the 1.5C global warming threshold with 100% renewable energy. Meanwhile, the International Energy Agency's [Renewables 2024](#) forecasts 91 GW renewable capacity addition from 2024 to 2030, bringing ASEAN's total capacity to 196 GW by 2030.

The recently published [ASEAN Energy Outlook 8](#) introduces two new scenarios. The first, the ASEAN Member States' Targets (ATS) scenario, envisions the region achieving a 69% renewable energy share, equivalent to 773 GW of installed capacity, by 2050. The second, the Regional Aspiration Scenario (RAS), sets a target of a 72% renewable energy share, or 1 TW, by 2050. This scenario explores accelerated national targets across ASEAN, using a bottom-up approach while adhering to the common-but-differentiated-responsibilities and respective-capabilities principle.

## Renewables capacity needs to more than triple by 2035 in the ASEAN region to meet key decarbonisation pathways

Targeted installed capacity of renewable energy (GW)



Source: Regional Aspiration Scenario (RAS) and ASEAN member states Target Scenario (ATS) based on ASEAN Energy Outlook 8 (AEO8), Economic Research Institute for ASEAN and East Asia (ERIA), International Renewable Energy Agency (IRENA)



A study by the [Economic Research Institute for ASEAN and East Asia \(ERIA\)](#) projects that ASEAN will reach a total installed renewable capacity of 1.6 TW by 2050 and 1.9 TW by 2060, leading to a 62% and 56% of renewable share in total generation, respectively.

Based on these pathways, by 2035, ASEAN needs to increase its renewable energy capacity by three to five times the 2023 levels. This highlights the urgent need for a steep acceleration of renewables uptake in ASEAN to align with the goals set in the pathways.

## Policy insights

# Policies in the power sector and the wider landscape

ASEAN confidence in market reforms is slowly growing, sustainability is now featuring in investment decisions, rooftop solar policies are gaining prominence and the energy transition promises to create jobs.

Sustainability is now a key factor in ASEAN investment decisions, indicated by growing confidence in market reforms. The governments have introduced policies and measures between 2023 and 2024 to boost the growth of green industries, energy security and inclusive development.

Key developments include direct power purchase introduction in Viet Nam, Thailand and Malaysia, relaxation of local content requirements, introduction of an ASEAN taxonomy, fast-tracking rooftop PV and [green jobs](#) policies to create employment opportunities.

## Growing confidence in direct renewable purchase

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Each ASEAN country operates a unique market structure, following its own path towards emissions reduction and renewables ambitions. Most ASEAN power markets function under a single-buyer model, where independent power producers can take part in generating electricity but state-owned companies are the sole off-takers. In contrast, the Philippines and Singapore have an open power market with multiple players, which is meant to promote [transparency, fair grid access and efficiency](#).

This year, Viet Nam, Thailand and Malaysia have taken steps towards [introducing direct renewable purchase by corporate customers](#) to meet the growing demand for clean power from the industrial sector.

### Viet Nam, Thailand and Malaysia are actively developing power wheeling schemes with different stages of implementation

Country	Scheme	Key features	Target sector	Status
Viet Nam	Direct Power Purchase Agreement (DPPA)	<ul style="list-style-type: none"> <li>Allows large electricity consumers (22 kV+ connection or 200,000 kWh/month) to directly procure renewable energy</li> <li>Includes solar, wind, small hydropower, biomass, geothermal and ocean energy</li> <li>Offers physical DPPA (no capacity/output cap) and virtual DPPA (fixed-price contracts).</li> </ul>	Large electricity consumers (industrial, commercial)	Ongoing implementation
Thailand	Third Party Access (TPA) Framework Guideline	<ul style="list-style-type: none"> <li>Develops TPA code for distribution system</li> <li>Attracts private retail entities</li> <li>Pilot phase focuses on 2 GW renewable energy for data centres.</li> </ul>	Data centres	In development
Peninsular Malaysia	Third Party Access (TPA) under CRESS (Corporate Renewable Energy Supply Scheme)	<ul style="list-style-type: none"> <li>Renewable energy producers can use the national grid to deliver clean power to regional buyers</li> <li>Part of PETRA's GREENS MADANI initiative.</li> </ul>	Regional buyers	Starting in September 2024

Source: The countries' power wheeling mechanism guidelines

Viet Nam recently approved a [Direct Power Purchase Agreement \(DPPA\)](#) scheme, enabling major electricity consumers with a connection voltage level of 22 kV or higher, or an average monthly consumption of 200,000 kWh, to directly procure renewable energy from producers via the national grid or private transmission line. Eligible producers include power plants using solar, wind, small hydropower, biomass, geothermal and ocean energy. The scheme [offers](#) a physical DPPA with no cap on capacity, output and connection voltage level, or a virtual DPPA based on fixed-price contracts, passing sustainable attributes to the buyer.

In Thailand, the Energy Regulatory Committee (ERC) announced [the development of the Third Party Access \(TPA\) Framework Guideline](#), aiming to create a TPA code for the distribution system. This move is designed to attract private retail entities to the distribution and outlining wheeling charges. The pilot phase of the DPPA will initially focus on [2 GW](#) of renewable energy to meet electricity demands of data centres.

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In Peninsular Malaysia, the government plans to introduce a [TPA](#) scheme starting [September 2024](#), allowing renewable energy producers to use the national electricity grid to deliver clean electricity to regional buyers. This scheme is part of the Corporate Renewable Energy Supply Scheme (CRESS) programme under PETRA's Government Renewable Energy Enhancement for Niche Sector (GREENS MADANI) initiative.

Indonesia is [reconsidering power wheeling](#) under the upcoming Renewable Energy Bill. This bill would allow renewable energy producers to sell electricity directly to consumers through transmission networks owned by the state electricity company, PLN, with negotiable rates. However, detailed guidance on the implementation of this policy has not yet been provided.

These developments signal a growing interest in further exploring the TPA scheme, which is essential to [unlocking wider cross-border electricity trading in ASEAN](#), and open new opportunities to spur the growth of green industries in Indonesia.

## Incorporating sustainability tools into financial decisions

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A key enabler of ASEAN's progress in climate and energy transition is [targeted investment](#) for energy security, affordability and sustainability. Due to the differences in investment landscapes, population sizes and development levels, there is varying investor confidence and clarity in assessing the sustainability performance of investment opportunities across ASEAN.

Central to addressing this is the introduction of the [ASEAN Taxonomy for Sustainable Finance](#), designed to catalyse growth while curbing emissions. The Taxonomy sets criteria to financing energy transition projects, including [renewable energy](#) and [coal phase-out](#) initiatives. It also provides guidance for ASEAN to classify eligible green and transition projects in line with the Paris Agreement's goals.

Except for Brunei Darussalam, Cambodia, Lao PDR and Myanmar, the rest of ASEAN have established their own national taxonomy and green bond mechanism. These mechanisms enable private or public institutions to issue debt specifically dedicated to financing

climate-related projects, including renewable energy. While green bonds in most ASEAN countries are led by the public sector, in Viet Nam, they are issued by [a private commercial bank](#), with the government concurrently [developing](#) a national green taxonomy.

### ASEAN countries adopt diverse economic strategies to create an enabling environment for renewable energy development

Country	National Taxonomy	Green bonds	Tax incentives	Mandatory local content requirements	Foreign participation guidelines
Brunei Darussalam	-	-	Yes	-	Yes
Cambodia	-	-	Yes	-	Yes
Indonesia	Yes	Yes	Yes	Yes	Yes
Lao PDR	-	-	Yes	-	Yes
Malaysia	Yes	Yes	Yes	-	Yes
Myanmar	-	-	Yes	-	Yes
Philippines	Yes	Yes	Yes	-	Yes
Singapore	Yes	Yes	Yes	-	Yes
Thailand	Yes	Yes	Yes	Yes	Yes
Viet Nam	Yes	Yes	Yes	-	Yes

Source: National policy documents, 2023 Investment Climate Statements by US Department of State, ASEAN-Germany Energy Programme, Myanmar Energy Monitor, International Renewable Energy Agency, Power Philippines, Ernst & Young, UMBRA, Lexology, Open Development Mekong, Ali Budiardjo, Nugroho, Reksodiputro Law, Solar Quarter, Japan Times, Rahmat Lim, Norton Rose Fulbright, Tilleke & Gibbins, Allens, UN Trade and Development, PriceWaterhouseCoopers and Chandrawat & Partners



Some ASEAN countries are applying developmental economics perspectives to enhance clean energy use and leverage their commitment to sustainability.

Indonesia has [relaxed](#) local content requirements for some [solar energy projects](#), aiming to create a more favourable investment environment and accelerate the deployment of sustainable technologies. Projects signed before 31 December 2024 and operational by 30 June 2026 can benefit from this change.

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Thailand has [no specific regulation](#) on local content requirements, except for a [40% threshold](#) for battery-powered electric vehicles produced in the free zones.

The absence of local content requirements may have contributed to growth of the renewable energy industry in Malaysia and Viet Nam, positioning them as [key solar supply chain hubs](#) in the region.

[From investors' point of view](#), relaxing local content requirements allows project developers to source materials, components and technologies from the most efficient and cost-effective global suppliers, potentially leading to the adoption of advanced technologies not available locally.

This support includes tax incentives, such as Malaysia's Green Investment Tax Allowance and Green Income Tax Exemption, as well as favourable loans for the renewable energy industry. In Viet Nam, the Green Credit Fund and preferential loans are examples of financial support designed to bolster the industry.

All [ASEAN countries](#) have offered tax incentives for renewable energy projects and other green technologies in various forms. Income tax deductions or exemptions, import duty waives and sales tax deductions are available to attract businesses in deploying renewable energy plants, fostering a welcoming business environment for the private sector.

Provisions to encourage foreign participation in the renewable energy sector can also stimulate investments and facilitate the transfer of technology and knowledge, especially for new technologies. Most ASEAN countries do not have restrictions on foreign ownership of renewable energy companies or assets.

However, Malaysia has implemented the Large Scale Solar reverse auction programme, mandating that participating companies and consortia must hold [at least 51% Malaysian equity](#). Similarly, Thailand also applies [this approach](#).

Meanwhile, the Philippines just [lifted](#) foreign ownership restrictions on renewable energy businesses, being one of the contributing factors in breaking a new record high of investment this year.

While solar technologies may have reached maturity, the need for storage facilities to accommodate solar and wind growth may require such provisions to welcome more foreign



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entities. The provisions can help enhance competitiveness and accelerate the deployment of these technologies.

## Advancing rooftop solar with new policies and incentives

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Governments in Viet Nam, the Philippines and Thailand have initiated strategic policies and regulations to boost rooftop solar power deployment, though some [limitations](#) exist. Viet Nam initially proposed to [ban](#) the export of solar energy to the grid but later [introduced](#) a pilot scheme allowing the sale of unused excess solar power, with an offtake volume of up to 10%. Currently, there are approximately [103,000 rooftop solar installations](#) nationwide, with a total capacity of about 9.5 GW. Based on the PDP 8, an additional 2.6 GW of rooftop solar capacity is expected by 2030.

In Thailand, a proposal is set to [relax permit requirements for rooftop solar installations](#) exceeding 1 MW under the Factory Act. Additionally, a [tax reduction scheme](#) is in place for solar panels adopters with a power generation capacity of less than 10 kW and a cost of less than \$5,800 USD (200,000 baht). This scheme targets 90,000 households between 2024 and 2027.

The Department of Energy of the Philippines [aims to install](#) 4.2 GW of renewable energy projects in 2024. The project will include 1.98 GW of solar, including 590 MW of battery storage. The market mechanism allows for peer-to-peer trading via a trading platform, enabling [excess electricity generated to be sold](#) to the grid or to host distribution utilities with compensation.

The Indonesian government's recent Regulation No. 2 of 2024 sets an annual quota of 1 GW for rooftop solar power systems (PLTS) connected to the PLN network and an additional 0.5 GW from non-PLN sources. This regulation aims to harness Indonesia's abundant silica sand resources to strengthen the domestic solar cell and module industries. However, it also marks the end of the net metering system, which previously allowed customers to export excess electricity back to the grid.

In Malaysia, rooftop solar deployment has primarily been driven by the [Net Energy Metering \(NEM\) scheme](#), introduced in 2016. This scheme offers various procurement methods,

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including outright purchase of panels, power purchase agreements (PPAs) and solar leasing options. While the NEM programme started slowly, it has grown significantly through three phases, resulting in [around 1 GW](#) of solar installations across households, agricultural sites, commercial and industrial facilities, and government buildings. In addition to NEM, the Self-Consumption (SELCO) programme, launched in 2017, focuses on on-site consumption only and does not allow consumers to export surplus electricity to the grid.

Singapore is accelerating rooftop solar development through the [SolarNova](#) programme, which currently generates about 420 GWh of solar energy annually. The programme is being renewed as [SolarNova 8](#) to provide clean electricity for companies.

## Energy transition expected to spur more jobs, and policy is key

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Governments in ASEAN are developing policies to support green jobs and industries. For example, the Philippines passed the [Green Job Act](#), offering incentives like tax deduction for skills training, tax-free imports of capital equipment tied to green jobs promotion and R&D.

Indonesia has yet to integrate green jobs into policy, but the government is preparing a [Roadmap for Green Jobs](#) as part of the upcoming 2025-2029 National Medium Term Development Plan to track progress towards green job goals.

The net employment gain from the energy transition could benefit coal producing countries and build trust in policies supporting renewable industry development. In Indonesia, [96,000 new jobs](#) could be created in coal regions through renewables, and with labour reallocation and retraining, more than [1 million new jobs](#) could offset [the 31,000 job losses](#) from the transition. Similar trends could apply to other fossil fuel-dependent countries in the region, such as [Viet Nam and the Philippines](#).

Green job policies create employment opportunities in renewable energy sectors, stimulate economic growth, support the transition to cleaner energy sources, reduce carbon emissions, and promote environmental protection. Additionally, these policies enhance social equity by providing opportunities to disadvantaged communities and contribute to resilience and adaptation through sustainable practices and infrastructure improvements.

What's hot in 2024

# ASEAN is feeling the heat to transition

Regional interconnections, carbon financing and just transition are some of the key themes shaping discussion in ASEAN's energy landscape.

As a [major engine of global economic growth](#), ASEAN has significant leverage and opportunities to drive the clean energy transition through regional collaboration and policy reforms.

As rising demand from data centres and ambitious economic growth targets drive further industrial expansion, decarbonisation is more urgent than ever. ASEAN currently operates [1.5 GW of data centres](#), with more in the pipeline, indicating significant demand growth.

Malaysia's data centre market is expanding rapidly, forecasted to grow by [13.9% between 2024 and 2029](#). Indonesia is also emerging as a hotspot, especially with plans to [relocate](#) data centres from the costlier Singapore. Thailand is another potential market, with investments reaching up to [\\$2.9 million USD](#).

This growing sector will not only require a large and stable electricity supply, but also challenge governments to align this demand with their clean energy agendas, creating an opportunity for the region to tap into its vast renewable energy resources.

# ASEAN is set to be more interconnected in the coming decade

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## Interconnections in Southeast Asia

Despite being proposed nearly 30 years ago, interconnections in the ASEAN region remain limited. The first roadmap for the ASEAN Power Grid was set out in the ASEAN Plan of Action for Energy Cooperation (APAEC) 2004-2009, aiming to boost regional energy security through cross-border projects. A year later, the ASEAN Interconnection Master Plan Study (AIMS) assessed the technical and economic feasibility of these projects.

Out of 18 key interconnection plans, eight interconnections have been completed, resulting in [7.7 GW](#) of cross-border transmission capacity, which includes [4.7 GW](#) of dedicated Independent Power Producer (IPP) generation exports (generation to grid), and [266 GWh](#) of electricity traded as of July 2023.

Most of these interconnections are bilateral, with energy trade conducted through long term power purchase agreement. In bilateral power trading, Lao PDR has become the main exporter of hydropower in Southeast Asia. Lao PDR is increasing its electricity exports to neighbouring countries while promoting renewable energy development. Its main export markets [include](#) Thailand (\$2.03 billion USD), Cambodia (\$188 million USD), Vietnam (\$134 million USD), Singapore (\$24 million USD) and China (\$3.69 million USD).

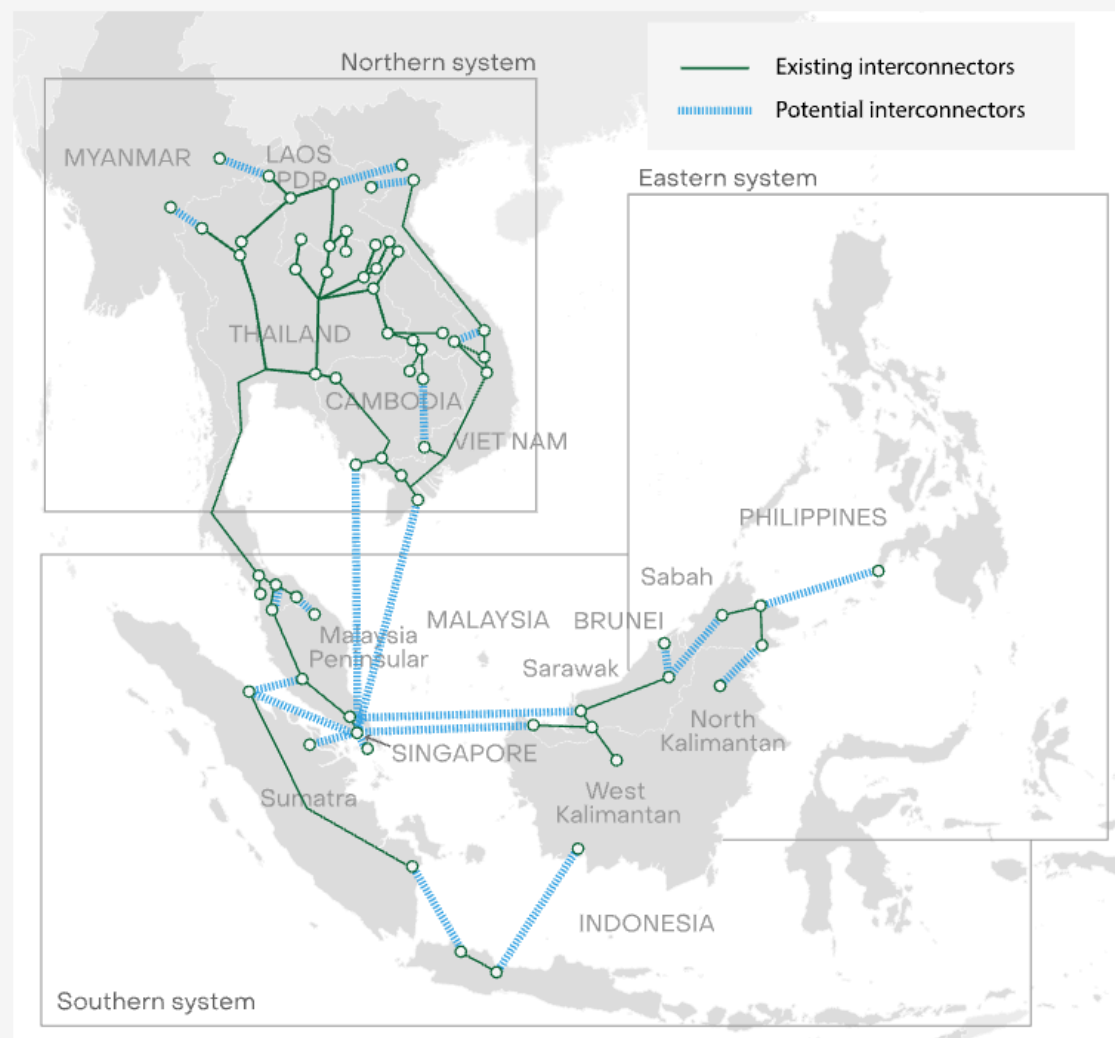
To date, only one multilateral power trading currently operates through the ASEAN power grid. The power interconnection between Lao PDR, Thailand, Malaysia and Singapore (LTMS- PIP/[Lao PDR- Thailand - Malaysia - Singapore](#) power integration project) marks a significant milestone in ASEAN's regional energy cooperation and integration, with the potential to drive economic growth, enhance energy security and support sustainable development across the region.

Future developments of both bilateral and multilateral power trading are expected to follow. The Brunei Darussalam, Indonesia, Malaysia and the Philippines Power Integration Project ([BIMP-PIP](#)) is the next agenda of the ASEAN Power Grid. Singapore's [6 GW](#)

[low-carbon electricity import](#) target by 2035 lays the foundation for its ambition to become [a renewable energy hub](#). Plans to import from [Australia](#), [Indonesia](#), [Cambodia](#) and [Viet Nam](#) demonstrate progress toward this goal.

## Enhancing regional power connectivity could promote energy security and spur renewables growth

Existing and potential cross-border electricity interconnectors



Source: ASEAN Centre for Energy (2023, 2021); Huda, Seah and Qiu (2023)  
 Note: the map particularly highlights cross-border interconnections and does not reflect the overall grid infrastructure in ASEAN countries; points on the map are suggestive, not exact

## Wind and solar exhibit good complementarity in ASEAN

The complementary nature of wind and solar power could be understood by examining [capacity factors and weather data](#) from 2019 to 2024 across several ASEAN countries, under the current grouping:

- Indonesia (Kalimantan Island) - Malaysia (Sabah and Sarawak) - Brunei Darussalam
- Viet Nam - Cambodia - Thailand - Indonesia
- Lao PDR - Thailand - Peninsular Malaysia - Singapore
- Peninsular Malaysia - Indonesia - Singapore
- Brunei Darussalam - Indonesia - Malaysia - the Philippines

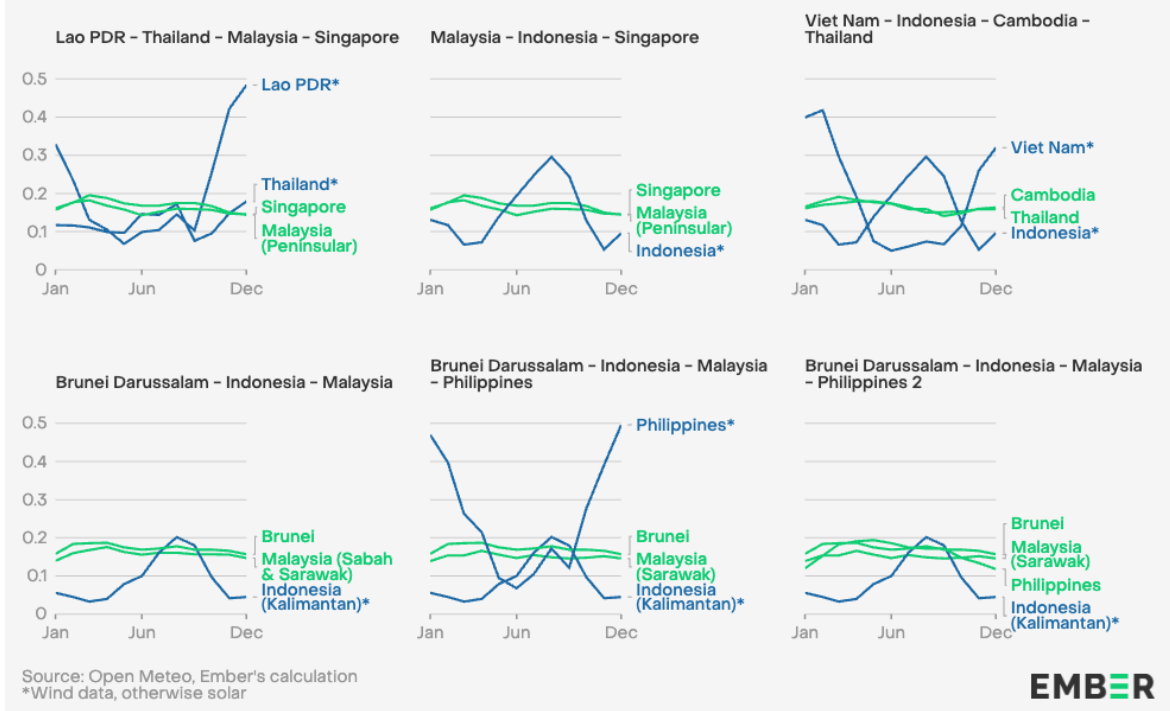
The solar capacity factors in Peninsular Malaysia and Singapore, peaking at around 20% from January to April, align well with Indonesia's wind capacity factor of up to 30% from May to October. This temporal complementarity can help balance supply and demand across the countries, highlighting the potential of interconnection projects.

Wind and solar power complement each other based on diurnal patterns (active patterns during the day). With solar power peaking during midday and tapering off as the sun sets, wind patterns can complement solar with [wind speeds expected to be higher at night](#) in some locations.

This indicates that cross-border interconnection and grid-flexibility improvement can boost solar and wind use, fostering mutually beneficial relationships among countries with market opportunities and varying renewables potential, especially in solar and wind. Countries equipped with the necessary technologies can build a robust renewable energy ecosystem.

### Wind and solar exhibit good complementarity in ASEAN making regional interconnections a key lever

Capacity factors for wind and solar, for each month of the year



## Opportunities to prioritise and strengthen regulations to boost renewables in carbon financing

As some ASEAN countries establish domestic carbon markets, the idea of a [regional carbon market](#) is gaining traction. Such a market could accelerate decarbonisation in the power sector and beyond by mobilising finance from carbon-intensive sectors to renewable energy and advanced technologies like storage facilities.

Two types of carbon markets can be implemented regionally: voluntary and compliance markets. Compliance markets are regulated by law, mandating businesses to reduce

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emissions typically through carbon pricing instruments, such as carbon taxes and emissions cap-and-trade mechanism. In contrast, voluntary carbon markets rely on the willingness of businesses to reduce emissions through carbon offsets to meet climate pledges.

While voluntary carbon markets are emerging globally and in Southeast Asia, regulated carbon markets are still in development. Singapore is currently the only ASEAN country implementing a carbon tax mechanism. However, some ASEAN countries are taking steps toward regulated carbon markets, putting a price on greenhouse gas emissions.

### **The rise of carbon markets and pricing mechanisms in ASEAN**

Indonesia has introduced a carbon pricing mechanism following [the 2021 presidential decree](#) on the economic value of carbon. This led to the [launch](#) of an emission trading mechanism for the power sector, covering 99 grid-connected coal power plants, although captive coal plants are not yet included. The carbon tax mechanism, originally scheduled for 2022, has been [postponed](#) indefinitely, with no clear timeline for its official rollout.

Thailand is [on its way](#) to become the second country in ASEAN to [introduce a carbon tax](#), targeting implementation next year. Announced in June, the tax will levy 200 baht (\$5.60 USD) per tonne of carbon dioxide equivalent on oil products like diesel and gasoline.

Malaysia's National Carbon Market Policy is underway and expected to be finalised by [next year](#). The policy aims to support the mandatory and voluntary carbon market mechanisms and accommodate potential investments in carbon projects.

The Philippines is also [eyeing carbon pricing instruments](#), conducting a study to explore suitable options.

Viet Nam, having earned [\\$200 million USD per year](#) from carbon credits, [plans](#) to enter a pilot phase of its emission trading system from 2025 to 2027, aiming for official operation by 2028. Recognising the large potential for carbon revenues, Lao PDR is also preparing a [decree on carbon credits](#) to centralise its carbon trading system.

As the leading ASEAN country in the domestic carbon market, Singapore's market size was valued at [\\$14.5 million USD in 2023](#) and is expected to grow exponentially to around \$55 million USD by 2030.



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Additionally, the [Article 6 mechanism](#) under the Paris Agreement is gaining momentum in ASEAN, enabling country-to-country emissions trading to meet Nationally Determined Contributions (NDCs) and providing developing nations with additional financing through emission reduction sales.

Singapore is positioning itself as a regional carbon trading hub, actively [sourcing Article 6 carbon credits](#) to meet the growing domestic corporate demand for offsetting their carbon tax liabilities and achieving climate goals. To date, Singapore has signed [agreements](#) with Cambodia, Lao PDR, Viet Nam and the Philippines on Article 6 cooperation, along with broader climate change and sustainability cooperation [with Indonesia](#).

The Article 6 cooperation between Thailand and Switzerland marks a global first, having [completed the inaugural transfer](#) of Internationally Transferable Mitigation Outcomes (ITMOs) earlier this year from an electric bus initiative toward fulfilling NDC commitments.

Another carbon finance initiative is the transition credit mechanism, which focuses on emissions reductions from early coal power plant decommissioning. Such a mechanism has been established through Singapore's [Transition Credits Coalition](#) and the [Coal to Clean Credit Initiative](#), which explore a pilot project in the Philippines.

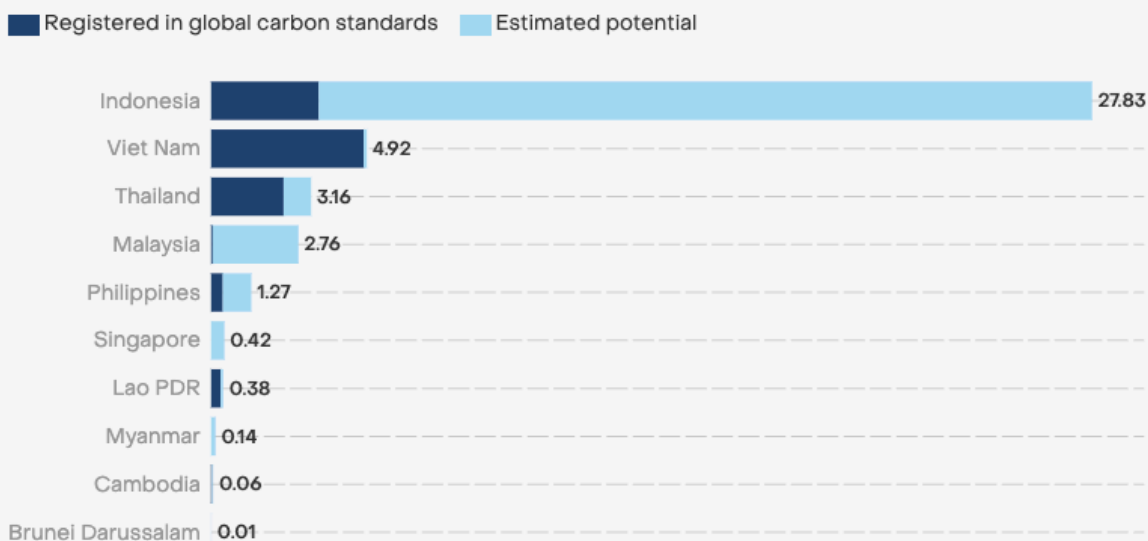
### **Optimising carbon finance distribution with robust regulations**

In the voluntary carbon market, some renewable energy plants in ASEAN are certified under prominent carbon credit standards, [Verra](#) and [Gold Standard](#), resulting in more than 11 million tonnes of carbon dioxide equivalent (tCO<sub>2</sub>e) in registered annual emission reductions as of this report.

Our analysis shows ASEAN could achieve 41 million tCO<sub>2</sub>e in potential emission reductions from renewable energy generation in 2023, leaving 30 million tCO<sub>2</sub>e of emission reductions untapped for carbon revenues (see [Methodology](#)).

## ASEAN could have 30 million tCO<sub>2</sub>e of untapped potential emission reductions from non-hydro renewables in 2023

Annual volume of emission reductions (million tCO<sub>2</sub>e per year)



Source: Ember's analysis, Gold Standard, Verra, Grid emission factor from the Institute for Global Environmental Strategies (IGES) ·  
 Note: Annual volume of registered renewables under Verra and Gold Standard. Potential emission reduction from renewable energy generation in 2023 excl. hydro and other technologies with more than 5% share of total installed capacity, following carbon standard criteria.



Stringent certification requirements for maintaining additionality, high certification costs—particularly for small-scale projects—and regulatory developments are likely contributing factors.

For example, Indonesia’s ongoing carbon policies have led to [a halt](#) in the international carbon certification, pending clarity since 2021. As a result, no new carbon projects have been registered or issued during this period.

[Additionality](#) concept ensures an intervention from carbon finance has a substantial effect when compared to the baseline. Stringent requirements currently limit renewables’ access to carbon finance, making new grid-connected renewable plants no longer [eligible for carbon credit application](#) unless the technology penetration rate is less than 5% of the total grid installed capacity in the national grid, among other conditions.

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## Carbon credit

Carbon credit is a tradable certificate representing the reduction of one tonne of carbon dioxide equivalent (tCO<sub>2</sub>e). Depending on the design of the carbon markets, carbon credits can be used as emission offsets to avoid carbon taxes in regulated markets or to help entities meet their climate goals in voluntary markets.

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The untapped potential of emission reductions through renewable energy offers ASEAN a valuable opportunity to establish a regional carbon market with a [semi-compliance](#), or a compliance system. These potential emission reductions can serve as emission trading supply, enabling more renewable energy facilities with high additionality to generate additional revenue alongside electricity sales.

High additionality could mean the implementation of such technologies in the host country is uncommon and may likely not be feasible without carbon finance. In carbon markets, renewable energy is typically viewed as economically viable even [without carbon finance](#). However, economically challenging technologies in the renewable sector, such as storage facilities and offshore wind, can benefit from this mechanism.

Depending on the design of the regional carbon market, compliance markets can go hand-in-hand with carbon offsets. However, additionality assessments for offset credits will need to be [remodelled](#) and strengthened to ensure the integrity of the carbon market and that offsetting does not distract from the growth of the renewable sector.

For ASEAN to establish a regional carbon market, regulatory implementation can enable market growth at scale and facilitate a faster shift to a lower-carbon power sector. By pricing carbon emissions, generated revenue can be effectively channelled into climate mitigation and adaptation projects, including renewable energy, surpassing the impact of voluntary markets.

[Well-designed carbon pricing mechanisms](#), with a strong and appropriate price signal—particularly in the power sector—are essential for ensuring liquidity and accountability, and improving energy affordability.

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The success of a carbon market hinges on a robust monitoring, reporting and verification (MRV) system. Ensuring data transparency and accuracy, as well as standardised approach across the region, is vital for the effective MRV operations, which uphold the credibility and reliability of the carbon market. Moreover, stringent criteria for renewable energy projects remain necessary to ensure the delivery of high-quality emission offsets in the compliance markets.

Some requisites are essential to initiate and ensure a robust regional carbon market in ASEAN. A unified emission reduction target can serve as the basis for creating a framework that equitably distributes emission reduction responsibilities among ASEAN countries. Once a regional target is established, emission allowances can be capped at the national level, allowing each country to maintain autonomy over its climate objectives while ensuring a coordinated approach to climate mitigation that aligns with regional goals.

## Just transition to secure social acceptance

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The concept of a just transition has gained traction in regional energy discourse in recent years and remains a focal point in 2024, particularly with the launch of the just and inclusive energy transition report by the ASEAN Centre for Energy. During the [2023 ASEAN Ministers of Energy Meeting Plus Three](#), leaders emphasised the importance of a just and inclusive energy transition to achieve carbon emissions reduction in the energy sector while ensuring energy security.

Just Energy Transition Partnerships (JETP), [initiated at COP 26](#), aims to fund energy transitions and have included Indonesia and Viet Nam among Southeast Asian participants. The JETP structure is designed for Global North countries to support the Global South by mainstreaming more equitable, inclusive and democratic approaches to clean energy deployment and transitioning from fossil fuels. This includes enhancing nationally determined contributions and setting more ambitious national energy plans while also improving gender equality and empowerment, protecting biodiversity, diversifying local economies and providing social protection for affected communities.

While a regionally recognised transition framework has yet to be introduced, some ASEAN countries, like Indonesia, have begun incorporating just transition concepts into their

long-term and medium-term development plans. Integrating these concepts into project planning and proposals can increase investor confidence in financing energy projects in ASEAN. Most importantly, a just transition can help secure social acceptance from communities, policymakers and wider market actors, fostering a [positive perception of renewables](#) that may encourage further adoption.

Besides JETP, other regions have established mechanisms to support just transitions. The European Union has a Just Transition Mechanism that allocates €55 billion to mitigate the socio-economic impacts of the transition. In South Africa, the [Just Energy Transition Funding Platform](#) serves as a matchmaking tool between funders and project implementers. If similar mechanisms were available in ASEAN, a faster integration of renewable energy into the energy system could be expected.

## Key recommendations

# Recommendations to ASEAN

Balancing energy security, economic growth and the acceleration of renewables necessitates holistic planning, cooperation, grids and flexibility.

### 1. Global cooperation is key for ASEAN's clean transition

ASEAN can significantly reduce the overall cost of renewables through global cooperation. This approach will enhance mutually beneficial relationships among countries with renewables potential, countries that own the technologies, those with market opportunities, and those equipped to build the renewable energy ecosystem. In this context, cooperation with both developed and developing countries through platforms like G20, Asia Pacific, ASEAN Plus 3 (China, Japan, South Korea), [BRIC](#), and other existing mechanisms is essential.

### 2. Captive renewables instead of coal

By promoting green industries and manufacturing, for example through guidelines on captive renewables rather than captive coal, the region can restructure its energy infrastructure around renewables and develop a robust renewable energy ecosystem. Building such an ecosystem would require holistic planning in close coordination with the industry to ameliorate their challenges in switching to captive renewables. This would also help enable ASEAN to build the supply chain necessary for strengthening the renewable energy sector.

### 3. Better targeted renewable investment

Increased private sector investment is crucial for turning Southeast Asia's aspirations for a cleaner electricity future into concrete results. Mobilising sufficient private investment for renewable energy projects is often hindered by a range of project-specific challenges, including complexity in participating in auction schemes and securing fiscal incentives such as tax exemptions, relaxation of local content requirements and subsidies. The [ASEAN Taxonomy for Sustainable Finance](#) can catalyse growth in renewable energy project

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financing while breaking down barriers such as high local content requirement and limited quotas for renewable energy projects.

#### 4. Tapping carbon market potentials

Establishing a regional compliance carbon market with a standardised approach can scale up market size and amplify the impacts of carbon finance. To ensure high-quality emission offsets and maintain market liquidity and accountability, more stringent additionality assessments on renewable energy and well-designed carbon policies for the power sector are essential. Data transparency and accuracy, benchmarked against a unified emission reduction target across the region are vital for maintaining market credibility and reliability. This would enable the establishment of national emission allowances, allowing each country to retain autonomy over its climate objectives while fostering a coordinated approach to climate mitigation that aligns with regional goals.

#### 5. Stronger interconnections a key lever to ASEAN energy transition

Interconnection will unlock the potential to improve energy security by diversifying energy sources across ASEAN, ensuring a stable supply during challenges like droughts, while also contributing to economic growth. Moreover, it strengthens regional cooperation and aligns with the ASEAN Power Grid Initiative, deepening ties and fostering partnerships that promote stability and prosperity across the region.

#### 6. Interconnections can stimulate financing

Enhancing regional power connectivity could [incentivise](#) much-needed private investment for large-scale power projects that may not be feasible at the national level, particularly for smaller, resource-rich countries with relatively low electricity demand. Additionally, increased connectivity is expected to deliver benefits for energy security, decarbonisation costs and emission reduction by optimising the energy system, thereby [reducing the need](#) for 1.2 TWh of electrical storage, 16 TWh of hydrogen storage and 600 GW of solar generation capacity by 2050. Interconnection will also [improve](#) access to electricity and deliver economic benefits, including creating new revenue streams, driving economic development and enhancing livelihoods across the region.

To promote regional power connectivity, it's crucial to foster a shared [regional identity](#) among ASEAN countries, despite their diverse histories, cultures and socio-economic backgrounds. This requires [a broader perspective](#) that considers the geopolitical, socio-economic and cultural factors shaping regional power connectivity efforts. Moreover, positioning power connectivity within a region-wide economic cooperation framework will allow ASEAN to remain adaptable to emerging opportunities.

## Conclusion

# The pendulum swings

For ASEAN to raise the bar on energy transition, global cooperation and strategic investment are key.

A shift in ASEAN's energy strategy is expected, although progress is likely to be gradual. Current measures need to be accelerated to ensure a successful transition, which calls for timely preparation, supportive regulations, fostering knowledge sharing through regional networks and building capacity across sectors. Policies promoting renewable energy and energy efficiency are crucial for balancing energy security, affordability and environmental sustainability.

Southeast Asia's growth in renewable energy capacity is often hindered by grid infrastructure that struggles to manage the intermittency of renewable generation and the remote locations of new projects, which are often far from major load centres. Viet Nam exemplifies this challenge. Despite its solar boom between 2017 and 2020, the addition of over 16 GW of solar capacity overwhelmed the grid, forcing the national utility, EVN, to curtail solar generation to maintain system reliability.

However, this presents an opportunity for ASEAN nations to invest in modernising their grid infrastructure and introduce flexibility measures. By adopting innovative technologies to enhance flexibility and interconnections, countries like Indonesia, Malaysia, Singapore and the Philippines can overcome these challenges. The widespread distribution of renewable energy resources across islands and remote areas in these archipelagic countries can be effectively managed with strategic investments and collaborative efforts, ultimately leading to a more integrated and efficient energy system that supports the region's renewable energy goals.



## Supporting Materials

# Methodology

### **Generation and capacity**

Ember sourced Indonesia's generation and capacity data from the Handbook of Energy and Economics Statistics of Indonesia (HEESI), the latest version available from 2023. The Handbook includes on-grid generation and capacity data for all energy sources, and off-grid generation and capacity data for hydro, solar, wind and bio energy.

Explicit demand projections are only found in Cambodia, Indonesia and Singapore power development documents, while other countries are sourced from external studies.

For ASEAN, the latest generation data is projected by applying absolute changes by fuel from available annualised monthly data to historical annual values. In a few cases where a specific fuel is not available in monthly data, it is treated as showing no change in the annualised projection. As such, note that simply summing up monthly values will not produce the same results as our annual values for any given year.

### **Complementary energy sources**

Capacity factors for wind and solar are calculated using hourly weather data from the ERA5 dataset collected from Open-Meteo. Weather data was sampled for representative locations for each of the examined regions. Wind capacity factors assume standard power curves for wind turbines using wind speeds at 100 m. Estimates for solar capacity factors are based on global tilted irradiance and temperature data in the representative locations, converted using [this approach](#). Data for individual months comprises average monthly values for 2019-2024

The analysis locations are relatively representative of where wind and solar would be built across the countries. While actual deployment patterns could vary, this analysis serves as an approximation due to insufficient data on specific capacity build locations. Most locations used in this data are based on projects that are in operation, under construction or have been announced.

### Levelized cost of energy (LCOE)

Ember calculates LCOE using NREL's Annual Technology Baseline (ATB) 2023 Methodology. Some financial cases were taken from the ATB, and some were obtained from [World Development Indicators](#), [Climate Policy Initiatives \(2023\)](#) for the cost of capital, [PWC \(2023\)](#) for Cambodia and [NREL \(2020\)](#) to reflect tailored countries' situations and recent interest rate increases. Capacity factors for various energy technologies were adjusted using yearly historical data to better account for system degradation over its lifetime.

### Emission reductions from renewable energy in ASEAN

The total registered emission reductions/carbon credits in global standards are derived from estimated annual carbon credits from projects with a status of at least "Registered" or "Certified" on [Verra](#) and [Gold Standard](#) registries, respectively.

The potential emission reductions from renewable energy power plants follow the Clean Development Mechanism (CDM) Methodology "[ACM0002: Grid-connected electricity generation from renewable sources version 22.0](#)", where emission reductions equal baseline emissions minus project emissions. The total electricity generation per fuel per country serves the basis for this calculation due to limited generation data per plant.

Due to limited data, all hydro is assumed to be large hydropower plants in this analysis. Therefore, hydro and other technologies with more than 5% share of total installed grid capacity in each country are excluded from the calculation to maintain additionality assessment according to carbon standards criteria.

Baseline emissions are derived from electricity generation from renewables multiplied by the respective country's grid emission factor value, as used by CDM projects based on a study by the [Institute for Global Environmental Strategies](#) (IGES).

According to the ACM0002 methodology, project emissions from most renewable energy plants are considered zero. However, acknowledging significant direct emissions from bioenergy, especially biomass power plants, an emission factor for biomass generation is assumed to be 230 g/kWh, the median value of lifecycle emissions according to [IPCC](#). Given limitations in power plant data, a more detailed study at the plant level is needed to calculate more accurate baseline emissions and project emissions according to the project context.

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## Contributors

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## Cover image

The Nam Theun 2 power station at the foot of the Nakai Plateau escarpment in the Nam Kathang Valley, Lao PDR, uses water from a 3,500 million m<sup>3</sup> reservoir

Credit: [Rob Arnold](#) / Alamy Stock Photo

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