

# Energy Technology Supply Chains in Southeast Asia

An Energy Technology Perspectives  
Special Report

International  
Energy Agency



# INTERNATIONAL ENERGY AGENCY

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# Abstract

Southeast Asia will play a central role in the future of the global energy system. The region's energy demand has increased by nearly 140% over the past quarter-century, and it is set to account for around one-fifth of global energy demand growth over the next decade under stated policy settings. Secure and resilient supply chains for key energy technologies, such as solar PV, wind, electric vehicles (EVs) and batteries, will be central to sustaining this growth, as will identifying opportunities to reap the economic benefits that can accompany these new supply chains.

The region already has a strong foundation to build on, with the second-largest solar PV manufacturing capacity globally and a rapidly growing EV and battery manufacturing sector. Many Southeast Asian countries have the ambition to play a more active role in the supply chains for these technologies, increasing the domestic share of value addition and employment associated with their development. Achieving this goal can also avoid undue dependence on a single source of supply to the region, and at the same time contribute to increased supply chain diversification globally.

This *Energy Technology Perspectives Special Report* examines recent trends in clean energy technology manufacturing, trade and investment in Southeast Asia, building on analysis conducted for [Energy Technology Perspectives 2026](#). The analysis draws on the latest information on energy, climate, trade and industrial policies – as well as manufacturing project announcements – to inform projections for clean energy technology manufacturing and trade in the region and put forward key considerations to guide effective industrial strategy design.

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# Executive summary

## Oil and gas supply shocks expose Southeast Asia's vulnerabilities as the Age of Electricity takes hold

**For Southeast Asia, the energy crisis resulting from the current conflict in the Middle East is an important juncture in the longer-term development of its energy system.** Prior to the outbreak of the conflict, some 60% of Southeast Asia's crude oil imports and around one-fifth of its natural gas imports originated from the Middle East. Governments have introduced measures to curb energy use and cushion consumers from the short-term economic and social impacts of the conflict, but these have added to fiscal pressures. Alongside these short-term measures, electrification and increased renewable deployment are emerging as crucial elements of the response to reduce import dependence and exposure to future supply shocks. Policies fostering the development of clean energy technology supply chains can underpin these efforts while at the same time creating industrial opportunities for the region.

**Despite the challenging context of an energy crisis – and increasingly as a result of it – electrification is gaining ground.** Electrification is becoming central to energy security strategies in the region, in addition to its importance for long-term decarbonisation, economic development and increasing energy access. Southeast Asia's electricity demand growth – which will be explored in a forthcoming IEA report on electrification in the region – is among the fastest in the world, having increased by over 70% since 2015. Investments in efficiency and alternative sources of energy since 2015 have avoided an estimated USD 30 billion in fossil fuel imports to the region in 2025. Surging electric car sales are contributing increasingly to this electricity demand growth and avoided fossil fuel imports. By the end of Q3 2026, more than one in four cars sold in the region was electric. While coal remains a key pillar of region's electricity generation, renewables are on the rise, with combined capacity additions of wind and solar PV set to nearly triple over the next decade in the Stated Policies Scenario (STEPS), reaching around 26 GW per year.

**As electrification in the region accelerates, new markets for clean energy technologies are expanding rapidly.** The market for key clean energy technologies<sup>1</sup> in Southeast Asia reached around USD 25 billion in 2025, having

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<sup>1</sup> Electric cars, electric vehicle batteries and battery energy storage systems, solar PV modules, wind turbines, heat pumps and electrolyzers.

climbed steeply from around USD 5 billion in 2020. This expands to just over USD 80 billion in 2035 in the STEPS, at double the rate of global growth. Electric cars and batteries account for most of this expansion. In the Current Policies Scenario (CPS), the market size grows much more slowly, reaching around USD 55 billion by 2035, largely due to weaker growth in the electric car market.

## Solar PV propelled Southeast Asia to become a clean technology manufacturing hub, but the focus is shifting

**Southeast Asia is a sizeable manufacturing hub for several key clean energy technologies, backed by foreign investment and, increasingly, by national trade and industrial policies.** Overall manufacturing currently accounts for more than one-fifth of GDP in many Southeast Asian countries – more than the global average of 18%. The region overall is a net exporter of solar PV modules and cells, battery anodes and cathodes, heat pumps and wind towers. Investment in clean energy technology manufacturing in the region halved from its 2023 peak of approximately USD 8.5 billion to just under USD 5 billion in 2025, partly reflecting a slowing in global manufacturing capacity expansion. But investment flows to EV and battery manufacturing continued to grow, reaching around USD 3 billion in 2025. China is the largest source of foreign investment in clean technology manufacturing in the region, accounting for an estimated 30% of cumulative inflows during 2015-2025, when assessed using the most granular data available at the project level. To date, most of this investment has been directed towards solar PV.

**Solar PV module manufacturing capacity now stands at more than three times the region's current demand.** The region's position as the world's second-largest solar PV module manufacturer after China has now slipped to third, behind India. Solar PV dominated manufacturing investment growth at the start of this decade, as manufacturers capitalised on the region's competitive production costs and role as an alternative export base to the United States in the face of trade restrictions on China. However, the sector's reliance on exports to the United States meant it was highly exposed to the recent changes in tariff and duty rates on products from Southeast Asia. Combined with a broader global surplus of manufacturing capacity, this has led to a decline in investment. Solar PV module production in the region continues to fall sharply over the next decade in both the STEPS and CPS, with existing capacity levels being more than sufficient to meet projected future demand. Were domestic – or international – demand to outpace the levels seen in the IEA's exploratory scenarios, Southeast Asia would be well-positioned as a source of additional supply.

**Growth in EV and battery manufacturing in the region is backed by rising domestic demand, industrial policy incentives and investment by foreign manufacturers.** Based on announced projects, electric car production capacity is

projected to almost double from around 1 million vehicles in 2025 to 1.8 million by 2030. By 2035 in the STEPS, increased capacity could enable the production of 3.6 million electric cars, making the region a net exporter, with Europe, Australia and New Zealand being the primary export destinations. In 2025, carmakers headquartered in China operated around half of the region's capacity and account for more than 70% of the planned additions by 2030. Domestic manufacturers also play a key role, led by Viet Nam's VinFast, which owns much of the remaining capacity in the region.

**The battery manufacturing industry is also beginning to scale.** Installed battery cell manufacturing capacity in 2025 amounted to around 40 GWh – around 1% of the global total – and this could grow to more than 100 GWh by 2030, based on announced projects. Just over half the battery manufacturing capacity installed in the region today is attributable to firms headquartered in China – if all announced projects came to fruition, this share would rise to nearly three-quarters by 2030. By 2035 in the STEPS, output rises to over 300 GWh of EV battery cells, up from just a few GWh in 2025. The region could also provide supply chain diversification upstream, leveraging domestic critical mineral resources and competitive production costs. By 2035 in the STEPS, the region accounts for 25% of global cathode active material production outside China (up from 4% today), and over 40% for anode materials, providing an opportunity for Southeast Asia to support greater regional diversification of supply chains.

**Some Southeast Asian countries have strengths in manufacturing other clean energy technologies.** The region is home to nearly 20% of installed capacity for wind towers outside of China, for which incremental growth is expected to 2030, predominantly in Viet Nam. Thailand has a unique role within the region as a globally significant manufacturing base for air conditioners and, to a lesser extent, for heat pumps. Electrolyser manufacturing remains limited, and this is not expected to change significantly in the coming years.

## The region's competitive production costs make it an attractive source of supply chain diversification

**Southeast Asia is approaching cost parity with China at certain steps in clean energy technology supply chains.** Continued investment and expansion hinge on realising the region's potential as a competitive manufacturing hub, leveraging its relatively low labour and energy costs, and its ample domestic reserves for certain critical minerals. For solar cells, the region is also close to production cost parity with India, a key competitor in large export markets. It also has potential to become a competitive exporter of batteries, with production costs that are only around 10% higher than China today and 25% lower than in the European Union.

**Gross exports of clean energy technologies from the region to the world have more than doubled since 2015 to USD 16 billion, with exports of clean energy technologies comparable to those of Korea or Mexico.** In line with investment trends, solar PV accounted for more than two-thirds of trade by value in the late 2010s. It remained the region's largest clean energy technology export in 2025, but recent growth is increasingly led by batteries and EVs. The regional export structure is uneven, with only Indonesia and Malaysia recording a clean energy technology surplus in 2025. China has a central role as a supplier of upstream manufacturing inputs, and the United States remained the largest single export destination in 2025, receiving over half of the region's exports, though demand from other countries in Asia is growing.

**Over the next decade in the STEPS, clean technology manufacturing investment in the region remains broadly similar to the average level seen in recent years, bucking the global trend, where investment declines by half.** The level of investment and its composition depend on policy direction: in the CPS, the region finds it more difficult to enter the global market as clean energy deployment is comparatively lower, and so annual investment remains lower than today. In the STEPS, the region's manufacturing investment doubles between 2025 and 2035, driven in large part by battery cell manufacturing for EVs, with global sales of electric cars in 2035 being nearly 15% higher than in the CPS.

**Governments are increasingly articulating ambitions beyond existing policies to reshape their role in clean energy technology supply chains.** These ambitions range from attracting investment and building competitive manufacturing industries to strengthening resilience and diversifying sources of supply. The Announced Industrial Policy Case (AIPC), developed for this report, explores how clean energy technology manufacturing and trade could evolve if countries around the world achieve these ambitions. Cumulative investment in Southeast Asia over the next decade is around USD 14 billion (20%) higher in the AIPC than in the STEPS. Most of the increase is concentrated in the battery and upstream solar PV supply chains, where strong policy support and competitive production costs lead to an additional USD 10 billion of investment across these value chains.

## **To capture the benefits of emerging growth, policy design will need to carefully balance competing goals**

**Addressing new security imperatives can go hand-in-hand with seizing new domestic manufacturing opportunities.** The 2022 and 2026 energy crises, and recent shifts in investment and trade patterns, illustrate that Southeast Asia is highly exposed to the effects of geopolitical and macroeconomic change at the global level. Electrification is emerging as a structural feature of countries' responses to these crises, and with it come both industrial opportunities and

trade-offs. While successful industrial strategies tend to share some features, no strategy can maximise all objectives simultaneously. Southeast Asian countries have pursued different pathways for the rollout of EVs, with some prioritising rapid market growth via affordable imported EVs, and others focusing on building domestic manufacturing capacity.

**There is no single model for success, but a number of low-regret policy options can be identified.** Strategic partnerships with foreign firms, including many headquartered in China, have helped many of the region's manufacturing industries to expand, through investment, technology transfer and skills development. International co-operation in trade and investment can further strengthen and diversify supply chains, allowing countries to specialise at different steps in supply chains. As markets evolve, access to reliable data on manufacturing and trade remains crucial for effective policy design. The IEA stands ready to support countries in the region in pursuing their industrial strategy goals in the realm of energy technology supply chains.

# Introduction

*Energy Technology Supply Chains in Southeast Asia* is the IEA's first Special Report to examine the manufacturing and trade of key energy technologies and components in this highly dynamic region.

Southeast Asia is undergoing a deep economic and energy transition that will make it a key actor in the future global energy system. The region is set to represent around one-fifth of global energy demand growth over the next decade under stated policy settings, as increases in GDP, rising living standards and urbanisation all drive up energy demand. Southeast Asia's energy supply remains dominated by fossil fuels today, but renewables are expanding rapidly, albeit from a low base. Multiple Southeast Asian countries have strengthened their energy transition plans in recent years, promoting the deployment of renewables and electrification to support announced climate pledges and enhance energy resilience. Clean energy technologies such as solar PV, wind, electric vehicles (EVs) and batteries are making inroads in the region's energy sector, offering the potential to diversify energy supplies and to reduce reliance on fossil fuel imports.

The global energy crisis sparked by the conflict in the Middle East that began in February 2026 has only emphasised the significance of diversifying the energy mix in Southeast Asia. Prior to the crisis, around 60% of the region's imports of crude oil and one-third of its imports of gas came from the Middle East, and 45% of its oil product supply was dependent on Middle Eastern crude. The impacts of disruption to these supplies are already being seen in higher energy bills, inflation and increasing economic risk. As energy security concerns rise up the policy agenda – against the backdrop of growing energy demand – attention is increasingly being drawn to the strategies needed to reduce fossil fuel imports and to bring down the region's energy import bill. Globally, the crisis has served as a reminder of the importance of access to diverse, secure and resilient supply chains to reduce exposure to risk and volatility.

The changing global context may also give fresh impetus to Southeast Asia's trade and industrial policies relevant to the development of clean energy technology supply chains. These policies have expanded in recent years, both to meet domestic deployment aims and – for some countries in the region – to reap the economic benefits associated with energy technology manufacturing. The combined global market for clean energy technologies surpassed USD 1.1 trillion in 2025, [and continues to grow in all IEA scenarios](#). In Southeast Asia, the market for these technologies is set to more than triple by 2035 on the basis of the Stated Policies Scenario, reaching just over USD 80 billion.

Southeast Asia already has a strong manufacturing base to build on. The region as a whole is the world's third-largest manufacturer of solar PV, with more than 80 GW of manufacturing capacity. The existing skills base and relatively low labour and energy costs in some countries, combined with a growing domestic market, are continuing to attract investment in manufacturing. While investments earlier this decade focused on solar PV, EVs and batteries have now become the fastest-growing segments, reflecting growth in regional demand and a supportive policy environment. A major driver of this trend has been project-level investments from the People's Republic of China (hereafter, "China") in the region, which have supported rapid growth but also exposed Southeast Asian manufacturing to evolving trade measures that restrict access to products from Chinese-owned entities.

Many governments and industries are now seeking to diversify their global supply chains, and to reduce reliance on China, which remains the leading global supplier for many key energy technologies and components. In this context, some countries are now looking to Southeast Asia as a potential player in their diversification efforts. Export growth for key technologies and components could give the region an increasingly important role in global trade.

Further expansion of clean energy technology supply chains therefore represents an opportunity for economic development in Southeast Asia, as well as a route to supply chain diversification that can enhance energy security. Many countries in the region are looking to play a more active role in these supply chains, and to increase their share of domestic value addition and employment.

The analysis presented in this report builds on multiple editions of the *Southeast Asia Energy Outlook*, and the *Energy Technology Perspectives* series. Recent editions of the latter series have dedicated an increasing amount of analysis to clean energy technology manufacturing and trade in Southeast Asia, reflecting the region's growing global importance in this space.

The IEA has for many years collaborated with the countries of the Association of Southeast Asian Nations (ASEAN), which today comprises Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Singapore, Thailand, Timor-Leste and Viet Nam. This relationship was deepened further still with the opening of the Regional Cooperation Centre in Singapore in October 2024, which is the IEA's first such regional hub anywhere in the world.

The core analytical scope of the report focuses on ASEAN members and the supply chains for solar PV, wind, EVs and batteries. Analysis of supply chains for air conditioners, heat pumps and electrolyzers, as well as for key pieces of equipment for the build-out of the electricity grid, is provided to supplement this core scope.

The first chapter of this report sets the context for the analysis that follows, with an overview of the major energy and economic trends that are shaping the Age of Electricity in Southeast Asia and of the impacts of the energy crisis. This is followed in Chapter 2 by an in-depth look at energy technology supply chains in Southeast Asia, highlighting where investments are being made and the status of manufacturing projects in different countries. This demonstrates the impact of industrial and trade policy measures, including how changes in the international trade policy landscape are affecting manufacturing across the region. Chapter 3 then turns to the outlook for manufacturing and trade, using the IEA's exploratory scenarios generated with the [Manufacturing and Trade model](#) to provide projections for market growth across different technologies. Chapter 4 contains a series of visual dashboards and country profiles that provide a snapshot of major trends across the region. Finally, Chapter 5 distils the report's findings into a set of strategic considerations relevant to decision-making within Southeast Asia. It draws on the key implications of the analysis presented in the report to highlight best practices and lessons learned that can inform the deliberations of decision makers weighing up the industry and trade policy measures that will continue to drive development in the region into the foreseeable future.

The countries in Southeast Asia are as diverse as they are dynamic, with differing resource endowments and a varied range of policy priorities. Each country seeking to enhance its standing in energy technology supply chains will follow its own path, backed by an understanding of its strengths and potential opportunities. At the same time, regional co-operation to leverage complementary strengths will remain important, and essential to some infrastructure projects necessary to energy technology supply chains. This report aims to provide a robust evidence base that can inform development in different countries across the region as they seek to grasp the opportunities offered by key energy technology supply chains in the Age of Electricity.

## Scenarios used in this report

The **Current Policies Scenario (CPS)** sets out a pathway for the future of the energy system in which no change in energy-related policies is assumed beyond what is already in place. The CPS therefore builds on a narrow reading of today's policy settings, considering only those that are adopted in legislation and regulation, and assuming no changes will be made, even where governments have indicated their intention to do so. Where existing policies target a range of outcomes, it is assumed that the lower end of the range is achieved. In the CPS, policies that are time-bound or that target specific years are not strengthened after they expire. Alongside this view of the policy landscape, the CPS also offers a generally cautious perspective on the speed at which new energy technologies are deployed and integrated into the energy system. It tends to project slower

adoption of new technologies in the energy system than has been seen in recent years, or than projected in the Stated Policies Scenario (STEPS). The pipeline of announced manufacturing projects is assumed to be less certain in the CPS, even with respect to those projects that have reached final investment decision (FID) or are already under construction.

The **Stated Policies Scenario (STEPS)** is designed to reflect the direction of travel of the global energy sector based on existing energy-related policies, including those that have already been adopted or announced, or are in the advanced planning stage – even if they are not yet enshrined in law or regulations. Examples of the latter include power sector development plans aimed at achieving a certain mix of generation assets by a specific date, regulatory reforms in the transport sector and energy efficiency targets for appliances. Policy targets are not assumed to be automatically met: in each case, their prospects are assessed taking account of market conditions, infrastructure readiness and financial constraints. The STEPS assumes that time-bound policies continue beyond the currently stated durations and retain a similar pace of change. However, it does not assume that aspirational goals, such as those included in the Paris Agreement, are achieved. Announced projects that have reached FID or are under construction proceed even if existing capacity is sufficient to meet demand.

# Chapter 1. Southeast Asia in the Age of Electricity

## Highlights

- Southeast Asia is entering a more electricity-intensive phase of development at a time of heightened energy security concerns. The region is facing an energy supply shock linked to the conflict in the Middle East, where around 60% of its crude oil imports and one-fifth of its natural gas imports originated from prior to the crisis. This is prompting governments to reassess measures to strengthen energy security and affordability, including through diversification, efficiency and faster deployment of clean energy technologies.
- Electricity demand has increased by over 70% since 2015, growing around 6% per year, faster than overall energy demand. In the Stated Policies Scenario (STEPS), the share of electricity in final energy consumption rises from around 11% in 2000 to 29% by 2035. The global average in 2025 was 21%, compared to 23% in Southeast Asia.
- Demand for cooling has doubled since 2015 and now accounts for around 13% of regional electricity demand, while air conditioner ownership rises from some 30% of households today to nearly 55% by 2035. Industrial electricity demand grows to about 900 TWh by 2035 in the STEPS, from 650 TWh in 2025.
- Transport electrification is becoming a driver of electricity demand. Electric cars reached around 40% and 45% of new car sales in Viet Nam and Singapore in 2025. This share exceeds 80% in Viet Nam and 95% in Singapore by 2035 in the STEPS. Combined with electrification of two/three-wheelers, where the electric share of sales approaches 45% by 2035, this creates an opportunity to reduce oil dependence, strengthen energy security and improve air quality.
- Rising electrification increases the importance of reliable, resilient and affordable electricity systems. Electricity access is near universal in most Southeast Asian countries, but reliability, power quality and system resilience – though improving – remain uneven, requiring continued investment in networks, flexibility, system-stability solutions and supporting infrastructure.
- The extent to which electrification can contribute to strengthening energy security, affordability and industrial competitiveness will be shaped by policy. Targeted support for efficient appliances, electric vehicle (EV) deployment, grid investment, regional co-ordination and clean energy technology manufacturing can reduce reliance on fossil fuel imports and support economic development.

## The role of clean energy technology supply chains in Southeast Asia

Southeast Asia's energy system is facing disruption related to the energy crisis triggered by the Middle East conflict in the midst of rapid economic development and increasing electrification in buildings, industry and transport. This increasingly dynamic situation poses new questions for maintaining and expanding the region's clean energy technology supply chains, as well as ensuring they can compete in a global marketplace and remain resilient to shifts and disruptions.

Key uncertainties include the potential size of growing markets for products such as EVs,<sup>2</sup> both domestically and internationally, as well as deployment pathways for renewable energy technologies such as solar PV and wind. This demands consideration of whether industries can become profitable, where the most attractive supply chain steps are to be found – in terms of potential comparative advantage and future areas of specialisation – and what the implications for employment and infrastructure may be. This also requires an assessment of how clean energy technology supply chains and renewable energy deployment can support the region's long-term economic security by reducing exposure to external shocks, strengthening industrial capabilities and creating new sources of growth.

Identification of these opportunities will also benefit from consideration of how Southeast Asia could contribute to the geographical diversification of global supply chains, responding to broader concerns around supply chain concentration, and supporting the strategic objectives of policy makers in other regions. This will need to be informed by an understanding of where these supply chains are most concentrated and vulnerable across the region, and what steps can be taken to minimise these risks.

Moreover, realisation of these opportunities will require the alignment of industrial development, energy security and energy transition goals. Reducing reliance on highly concentrated supply chains will be important to limit vulnerability to shocks related to supply disruptions, price volatility and geopolitical tension. The opportunities are vast, but achieving sustainable industrial development will depend on targeted investment, adequate infrastructure, and policies that build on national and regional comparative advantages. Regional co-ordination will be important to support resilience, for example by enhancing grid connectivity, co-ordinating infrastructure plans, harmonising technical standards and grid codes, and enabling mutual recognition of testing and certification. The economic pressures generated by the energy crisis will also require close attention to the effects on investment

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<sup>2</sup> In this report, unless otherwise specified, EV refers to both battery electric and plug-in hybrid electric vehicles (PHEVs) but does not include fuel cell electric vehicles (FCEVs).

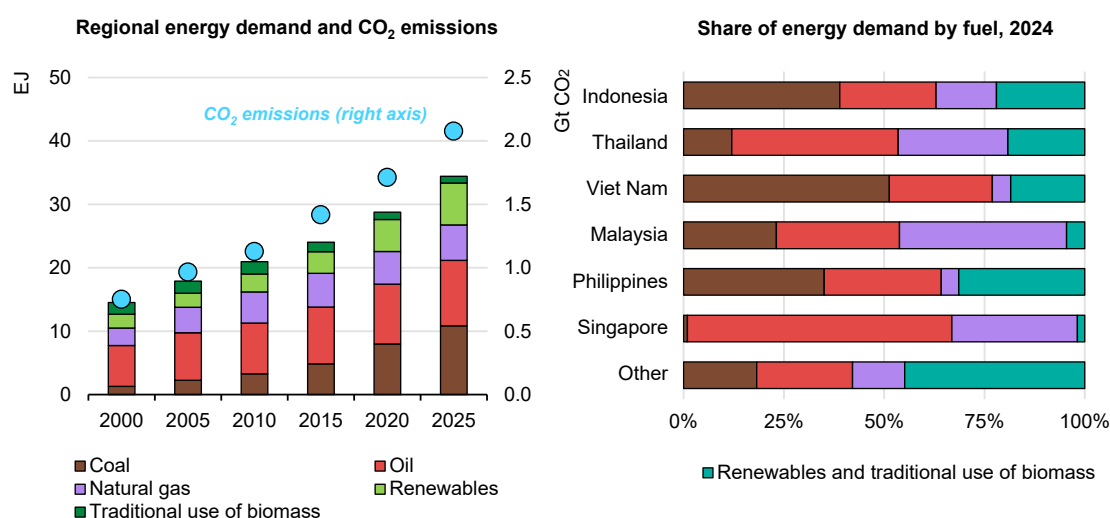
conditions and the cost of capital, both of which will play a role in determining the pace and scale of clean energy technology supply chain development.

This chapter sets out the context for Southeast Asia's energy sector today and its expected evolution under current and stated policy frameworks. It establishes the foundation for the subsequent analysis of clean energy technology supply chains,<sup>3</sup> manufacturing and trade opportunities, country-level dynamics and the strategic choices facing policy makers across the region.

## Southeast Asia's energy system today

Southeast Asia is fast becoming a key actor in the future of the global energy system. Since 2015, the region has accounted for 10% of global energy demand growth, as its industry, transport and power sectors have expanded, backed by rapid economic development, a growing population and rising incomes. Total energy demand has grown by an average of 4% per year over the same period, and is now nearly 45% higher. Most of this increase has been met by fossil fuels, which have supplied more than 70% of additional demand since 2015.

**Figure 1.1 Energy demand and CO<sub>2</sub> emissions and share of energy demand by fuel and by country in Southeast Asia, 2000-2025**



IEA. CC BY 4.0.

Notes: Other countries include Brunei Darussalam, Cambodia and Lao PDR. Data not available for Timor-Leste. Further details for each country can be found on the IEA [website](#).

Source: Adapted from IEA (2026), [Southeast Asia Energy Outlook 2026](#).

**Energy demand and CO<sub>2</sub> emissions have risen steadily in Southeast Asia since 2000; fossil fuels accounted for more than three-quarters of the region's energy demand in 2025.**

<sup>3</sup> Electric cars, EV batteries and battery energy storage systems (BESS), solar PV modules, wind turbines, heat pumps and electrolyzers.

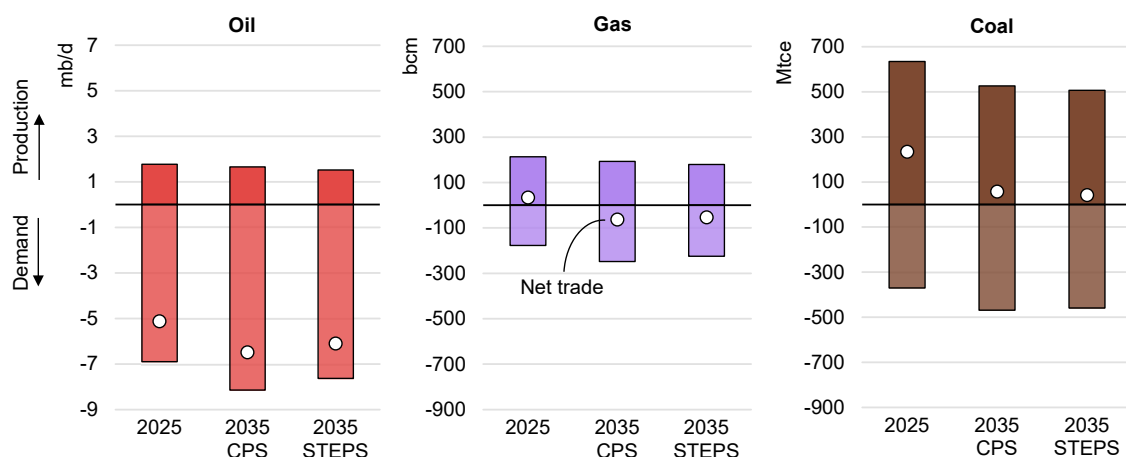
Renewable energy has also expanded rapidly, growing by around 7% per year since 2015. Within this, solar PV and wind have been the fastest-growing energy technologies, expanding at around 35% per year from a low base. Nevertheless, coal has remained the fastest-growing major energy source, with demand rising by 8% per year and its share of the energy mix increasing from 20% in 2015 to 30% in 2025. Oil demand has grown steadily since 2015, increasing by an average of 1.6% per year to reach 5 mb/d (excluding international bunkers) in 2025. Indonesia, Malaysia and Thailand remain the region's largest oil producers, but declining output has heightened reliance on imports. By 2025, total regional output had fallen by around 40% since its peak in the 1990s. Combined with steadily rising oil demand, this has contributed to crude oil imports rising to more than 30% above 2015 levels, increasing vulnerability to price fluctuations and external supply disruptions.

Natural gas continues to play a key role in the region's energy system, accounting for nearly one-fifth of Southeast Asia's energy mix. The region has historically been a significant net gas exporter, with Indonesia and Malaysia among the world's largest liquefied natural gas (LNG) suppliers. However, production has edged down since 2015 while demand has continued to grow by around 1% per year, substantially narrowing the region's export surplus.

## **Southeast Asia's energy system has been disrupted by the energy crisis**

The dominance of fossil fuels in Southeast Asia's energy mix left the region particularly exposed to the impacts of the energy crisis triggered by the Middle East conflict that began in February 2026. Once a major producer of oil and gas, Southeast Asia has become increasingly dependent on imported fuels as rising demand and declining production from mature fields have eroded its energy self-sufficiency. Today the region is a net importer of oil but remains a net exporter of both natural gas and coal. Most natural gas exports are in the form of LNG, primarily from Indonesia and Malaysia, although cross-border pipeline trade also remains an important component of regional gas markets. By 2035, declining domestic oil and gas production, combined with growing demand, means net oil imports grow to more than 6 mb/d in both the Current Policies Scenario (CPS) and STEPS. The region also becomes a net gas importer of around 50-60 bcm per year by 2035 in both scenarios. Coal remains the exception among fossil fuels, largely due to Indonesia's role as a major exporter. However, the region's net coal exports decline sharply by 2035 as production falls and domestic consumption rises, limiting its ability to offset growing oil and gas import requirements.

**Figure 1.2 Production, demand and net trade in fossil fuels in selected countries by scenario, 2025-2035**



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Notes: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario. Net trade is considered for Southeast Asia as a single region. Oil demand includes international bunkers.

**Southeast Asia's dependence on imported oil and gas is set to increase by 2035 in both the Current Policies Scenario and the Stated Policies Scenario.**

Prior to the outbreak of conflict in February 2026, around 60% of Southeast Asia's crude oil imports and one-fifth of its natural gas imports originated from the Middle East. Around 60% of the region's refined oil products are typically supplied domestically, which is providing some buffer against import disruptions. However, 45% of its oil product supply has previously relied on Middle Eastern crude, meaning that supply disruptions affect not only imports but also a large share of domestically refined fuels. The region's overall dependence on Middle Eastern supply is therefore significant.

Supply disruptions resulting from the energy crisis pushed up global benchmark crude oil and regional LNG prices by around 60% relative to pre-conflict levels. In turn, these increases have driven up wholesale energy prices across much of Southeast Asia, with significant repercussions for energy security and affordability.

Both the disruption following the Russian Federation's full-scale invasion of Ukraine and that following the outbreak of conflict in the Middle East demonstrate that Southeast Asia is now increasingly exposed to international energy markets as import dependence rises and domestic oil and gas production declines. The immediate impacts have been felt most acutely in refining, petrochemicals, power generation and cooking fuels. Disruptions have led to shortages of key products, particularly naphtha, a critical petrochemical feedstock, and liquefied petroleum gas (LPG), a cooking fuel used by three-quarters of the region's population. Fuel prices have risen sharply, particularly for transport, adding to broader inflation in essential goods and services. The effects of higher fuel prices are falling most

heavily on lower-income households and informal workers, who are typically more sensitive to energy costs, more reliant on transport fuels and less able to absorb price increases. In some cases, higher energy prices are changing behaviour, with consumers reducing use of transport and shifting to lower-cost but more polluting cooking methods. These changes have implications for livelihoods, welfare and public health.

## Policy responses to the crisis

Governments across Southeast Asia have responded to the crisis by making extensive use of energy efficiency and demand-side measures as rapid, least-cost tools to curb energy use. Investments in efficiency and alternative sources of energy over the past decade have avoided [an estimated USD 30 billion in fossil fuel imports](#) to the region in 2025. To date, most of these measures have focused on managing the short-term energy impacts of the crisis. Measures include limitations on vehicle use and fuel consumption, promotion of remote work, demand reduction for large consumers and restrictions on official travel. The ASEAN Centre for Energy estimates that measures of this kind could reduce fuel consumption associated with [commuting and office buildings by around 20%](#).

These measures have been implemented alongside policies to cushion consumers from higher prices. Almost all of the region's governments have reduced taxes on energy products or introduced direct subsidies to provide immediate relief for consumers. Thailand and Viet Nam introduced measures to limit increases in retail fuel prices, albeit temporarily in the case of Thailand, while other countries have adopted targeted measures, such as [free public buses](#) during peak periods in Cambodia.

While these interventions have helped limit near-term economic and social impacts, they have added to already elevated fiscal pressures following extensive use of subsidies during the 2022 energy crisis, when high international oil and gas prices prompted governments across the region to shield consumers from rising energy costs. In some cases, broad-based price support measures also weakened incentives for demand reduction and energy efficiency improvements. This highlights the importance of pairing temporary measures targeting prices and demand with structural actions that reduce energy consumption and import dependence over the longer term, while ensuring that support reaches vulnerable consumers.

**Table 1.1 Notable policy responses to the 2026 energy crisis**

| Country                       | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Demand-side policies</b>   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Indonesia</b>              | <ul style="list-style-type: none"> <li>• Limits on official travel and energy-saving measures in government buildings.</li> <li>• Civil servants to work from home every Friday.</li> <li>• Measures to promote domestically sourced compressed natural gas (CNG) as an alternative to imported LPG.</li> <li>• Plans to build new fuel storage facilities to expand national energy reserves.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Malaysia</b>               | <ul style="list-style-type: none"> <li>• Restrictions on overseas travel for ministers and administration members under consideration except for scheduled or compulsory engagements.</li> <li>• Work-from-home arrangements for government ministries, agencies and government-linked companies began in April.</li> <li>• Local councils advised to limit AC to 24°C and implement building energy management systems.</li> <li>• Biodiesel with 15% palm oil produced from June to help lower diesel prices.</li> <li>• Civil Aviation Authority permitted more direct flight paths to reduce fuel consumption.</li> </ul>                                                                                                                                                                                                                                                                                                                                                    |
| <b>Philippines</b>            | <ul style="list-style-type: none"> <li>• All government agencies and universities to reduce fuel consumption by at least 10%, with AC set no lower than 24°C.</li> <li>• The President signed an executive order adopting a compressed four-day work week for provincial employees.</li> <li>• State of national energy emergency declared, with action against fuel hoarding and profiteering.</li> <li>• Free bus rides available for students and workers in selected cities.</li> <li>• Bill proposing a strategic fuel reserve of 90-180 days' supply is under consideration.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Singapore</b>              | <ul style="list-style-type: none"> <li>• Energy minister has advised residents and businesses to save energy through efficient appliances and reduced car trips.</li> <li>• Government "Let's Save Energy Together" campaign promoting use of fans rather than AC, a 25°C limit, and energy efficiency grants.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Thailand</b>               | <ul style="list-style-type: none"> <li>• Defence Ministry has advised agencies to reduce AC use, hold video conferences and allow work from home.</li> <li>• Energy-saving measures include suspending overseas trips, setting AC at 26-27°C and adopting casual dress codes and remote work.</li> <li>• Chiang Mai province has announced local energy-saving measures urging all sectors to use power only as necessary.</li> <li>• Cabinet approved negotiations with oil refineries to recover excess margins and profits for public benefit.</li> <li>• Government price support for E20 (20% ethanol blend) to increase the price gap between E20 and gasohol 95 at about THB 3 (Thai baht) per litre (USD 0.09 per litre).</li> <li>• Remote work encouraged for all public and private sector enterprises.</li> <li>• Overnight fuel station closures considered between 10pm and 5am.</li> <li>• Reduced street lighting on low-risk rural roads from 1 May.</li> </ul> |
| <b>Viet Nam</b>               | <ul style="list-style-type: none"> <li>• Ministries and localities are required to organise efficient energy production and use.</li> <li>• Companies asked to encourage remote work to reduce fuel consumption.</li> <li>• Switched fully to E10 gasoline (10% bioethanol) as of June.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Consumer price support</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Indonesia</b>              | <ul style="list-style-type: none"> <li>• Government will increase fuel subsidies to IDR 381.3 trillion (Indonesian rupiah) (USD 22.5 billion) in the state budget.</li> <li>• Increased funding for fuel subsidies, including subsidised 3 kg LPG and potentially CNG cylinders.</li> <li>• Government increased the fuel surcharge on domestic flights while cutting VAT on economy class tickets for two months.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Malaysia</b>               | <ul style="list-style-type: none"> <li>• Government announced an MYR 5 billion (Malaysian ringgit) (USD 1.27 billion) support package for small and medium-sized enterprises (SMEs), including loan guarantees, regulatory relief and possible tax exemptions.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| Country                    | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Philippines</b>         | <ul style="list-style-type: none"> <li>The President has been granted emergency powers to suspend or reduce fuel excise taxes during the oil price surge.</li> <li>Launched a PHP 5 000 (Philippine peso) (USD 83) cash subsidy for public utility vehicle drivers, expanded nationwide.</li> <li>The Department of Transportation reduced air and seaport terminal fees and provided PHP 10 000 (USD 166) fuel subsidies per bus unit.</li> <li>The Land Bank provided fuel subsidies, MRT-3 fare cashback, and concessional loans for transport operators and small businesses.</li> <li>Excise taxes on LPG and kerosene suspended from April to July to reduce household energy costs.</li> <li>A PHP 10 (USD 0.17) per litre fuel discount was available nationwide for eligible public utility vehicle drivers at participating stations from April to July.</li> </ul> |
| <b>Singapore</b>           | <ul style="list-style-type: none"> <li>The government introduced support measures such as SGD 500 (Singapore dollar) (USD 391) Community Development Council vouchers (brought forward from January 2027 to June 2026), SGD 400-600 (USD 313-469) cost-of-living payments (September), and SGD 200 (USD 156) relief for taxi and platform workers.</li> <li>The government will temporarily co-fund cost increases for essential bus services and increase the corporate income tax rebate.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Thailand</b>            | <ul style="list-style-type: none"> <li>Diesel prices capped at approximately THB 30 (USD 0.93) per litre until 17 March 2026 and subsequently began a gradual increase toward a THB 33 (USD 1.02) per litre ceiling. On 24 March, authorities removed diesel price controls, allowing pump prices to float in line with market conditions.</li> <li>Fuel and LNG exports are banned (except to Lao PDR and Myanmar), and oil traders must maintain increased reserves.</li> <li>The government has frozen cooking gas prices until October and is subsidising biodiesel use.</li> <li>Cabinet has approved borrowing THB 400 billion (USD 12.2 billion) for cost-of-living relief and energy transition support.</li> </ul>                                                                                                                                                   |
| <b>Viet Nam</b>            | <ul style="list-style-type: none"> <li>Petroleum product import tariffs revised, and uncommitted oil exports must be sold to domestic refineries.</li> <li>The Petroleum Price Stabilisation Fund is allocating VND 4 000-5 000 (Vietnamese dong) (USD 0.16-0.20) per litre to cushion fuel price increases.</li> <li>The Prime Minister has approved in principle a state budget advance for the Petroleum Price Stabilisation Fund.</li> <li>Fuel import tariffs have been temporarily cut to 0% for gasoline, diesel, kerosene and other fuels until 30 June 2026.</li> </ul>                                                                                                                                                                                                                                                                                              |
| <b>Structural policies</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Indonesia</b>           | <ul style="list-style-type: none"> <li>Government considering new EV incentives to strengthen the manufacturing sector.</li> <li>Presidential order to accelerate conversion of diesel-powered plants to solar power.</li> <li>Government accelerating the conversion of LPG stoves to electric.</li> <li>Plans are underway to convert 120 million gasoline-powered motorcycles to electric motorcycles.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Malaysia</b>            | <ul style="list-style-type: none"> <li>Local councils are recommended to install solar PV systems and LED lighting.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Philippines</b>         | <ul style="list-style-type: none"> <li>The Department of Energy has intensified nationwide energy audits to achieve a 10-20% reduction in fuel and electricity use by 2026.</li> <li>A bill is being prepared to accelerate the development of alternative energy sources with energy efficiency as a key focus.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Singapore</b>           | <ul style="list-style-type: none"> <li>The 2026 budget expands the Energy Efficiency Grant to all sectors, extended until 31 March 2028.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Thailand</b>            | <ul style="list-style-type: none"> <li>The Transport Ministry is drafting a royal decree to extend the 80% annual vehicle tax cut for new EVs.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Viet Nam</b>            | <ul style="list-style-type: none"> <li>The government plans to extend the reduced special consumption tax on EVs (1-3%) until 2030, subject to parliamentary approval.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

Note: Includes both announced policies and those that are being considered.

Source: IEA (2026), [Energy Crisis Policy Response Tracker](#).

Fossil fuel consumption subsidies are widespread across Southeast Asia, reflecting long-standing policy goals to reduce energy poverty, ensure affordability and offset cost-of-living pressures. In practice, these subsidies reduce end-user prices for transport fuels and electricity below international market levels and mean that electricity tariffs do not reflect the full cost of supply. Although this can provide immediate relief from inflation, it can also create long-term structural risks. As a result, these policies weaken incentives for energy conservation, as outlined above, undermine utility cost recovery and deter critical private sector investment.

Fossil fuel consumption subsidies in the region increased to more than USD 110 billion during the 2022 global energy crisis, driven by high international prices and policy efforts to shield consumers. By 2025, this had declined to around USD 36 billion, reflecting lower prices and reform measures. Nevertheless, fossil fuel subsidies remain uneven across the countries. For example, they remain significant in Indonesia, reaching more than USD 100 per capita in 2025, roughly equivalent to the government's healthcare expenditure per capita.

Energy price reform remains politically sensitive in Southeast Asia, and there is continued risk that broad-based support will be reintroduced when international prices rise sharply. Subsidy reform in the coming years may therefore be more uneven than in 2023-2024.

Short-term emergency measures do not address the underlying sources of vulnerability. The energy crisis of 2026 has highlighted Southeast Asia's continued exposure to fossil fuel price volatility and supply risks, driven by rising import dependence, concentrated supply sources and reliance on maritime trade routes linked to the Middle East. Strengthening the region's energy security will therefore require medium- and long-term measures that reduce import dependence and improve system flexibility. At the same time, while fossil fuels play a significant role in the region's energy system, effective emergency response capabilities remain important, including adequate strategic fuel stockholding, robust emergency arrangements and targeted investment in resilient fuel supply infrastructure where needed.

## Reducing reliance on fossil fuel imports

Reducing demand for imported fossil fuels is central to limiting exposure to global market shocks over the medium and long term. Accelerating deployment of low-emissions energy sources, electrifying end-use sectors and scaling up energy efficiency can help reduce reliance on imported fuels, while contributing to energy security, affordability and emissions reductions. However, ensuring energy security will require a balanced approach that also addresses system integration, supply chain and investment challenges.

In some countries, higher gas prices and concerns over import dependence have also supported continued reliance on coal-fired generation as a means of

enhancing energy security. A rapid expansion of renewable power can increase domestic energy production, diversify generation mixes and reduce reliance on imported coal and gas. Today, the region's strong renewables potential remains underexploited due to grid, financing and regulatory constraints. There are opportunities to learn from faster-scaling markets.

The electrification of transport, buildings and certain industrial processes can reinforce these benefits by reducing demand for directly imported fuels. Since 2015, deployment of clean energy technologies has reduced Southeast Asia's fossil fuel import bill by around USD 30 billion. Around half of these savings come from renewables, one-third from efficiency gains and the remainder from electrification. In the STEPS, these savings continue to grow. In road transport, a combination of electrification through EV uptake, fuel economy improvements and biofuels reduces oil demand substantially. Within this, EV adoption alone is projected to displace around 5 500 million barrels of oil cumulatively over the period to 2050, almost six times current annual road transport oil demand.

## The Age of Electricity in Southeast Asia

Responses to the energy crisis are taking place in the context of a new phase of energy development, characterised by rapid growth in electricity demand and the expanding electrification of end uses across the economy. Industrialisation, urbanisation and the expansion of middle-income households are increasing demand for electricity-intensive goods and services, including air conditioning, mobility, appliances and digital services. Unlike in many advanced economies, where electrification is closely linked to decarbonisation and the replacement of fossil fuel demand, Southeast Asia's Age of Electricity is unfolding alongside broader structural economic transformation. The region's GDP has increased nearly 4% per year on average over the past decade, supporting continued growth in overall energy demand. While electrification is an important component of long-term decarbonisation strategies across the region, much of the growth in electrification reflects the region's economic growth, industrialisation and increasing energy access. In addition, although electrification can support energy security and decarbonisation goals, the costs and benefits depend on the technologies and energy sources used to meet growing electricity demand.

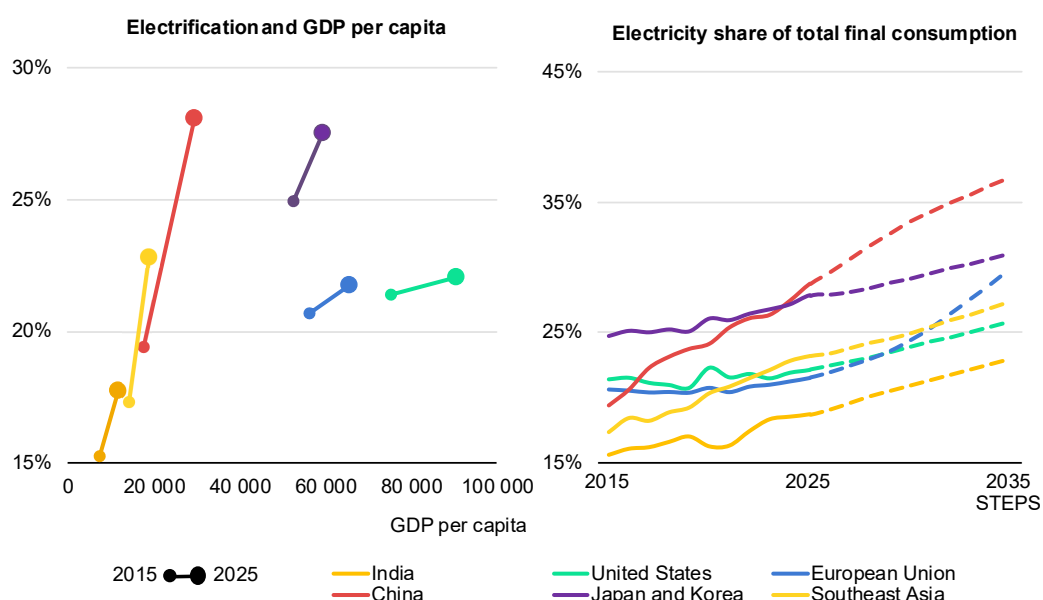
Electricity accounts for a growing share of final energy consumption in Southeast Asia, rising from around 11% in 2000 to 23% in 2025. In the STEPS, electricity reaches 29% of final energy consumption by 2035, compared with 27% in the CPS. The region remains below the global average in electricity intensity (electricity consumption per capita) but is undergoing a structural shift towards more electricity-intensive patterns of energy use.

## Southeast Asia as a high-growth electricity system

Southeast Asia's electricity demand growth – which will be explored in a forthcoming IEA report on electrification in the region – is among the fastest in the world. Total electricity demand is now over 70% higher than in 2015, growing at an average rate of around 6% per year, compared with overall energy demand growth of 4% per year. Electricity consumption per capita remains at 60% of the global average and nearly 30% of levels observed in advanced economies, but it is expected to increase by 48% by 2035 in the STEPS as countries move through successive stages of economic development and electrification.

The relationship between income levels, industrial composition and electricity consumption remains strong in Southeast Asia. Countries with higher levels of industrialisation and urbanisation tend to exhibit significantly higher electricity consumption per capita, reflecting both greater household demand and more electricity-intensive economic activity. Singapore and Malaysia already have relatively high levels of electricity consumption per capita, with Singapore reaching around 10 000 kWh per capita – comparable to the upper range of advanced economies – while Malaysia lies at a more moderate level. By contrast, electricity consumption in Indonesia, the Philippines and Viet Nam ranges from 1 000 to 2 800 kWh per capita.

**Figure 1.3 Electrification and GDP per capita, and electricity as a share of total final energy consumption in selected regions in the Stated Policies Scenario, 2015-2035**



IEA. CC BY 4.0.

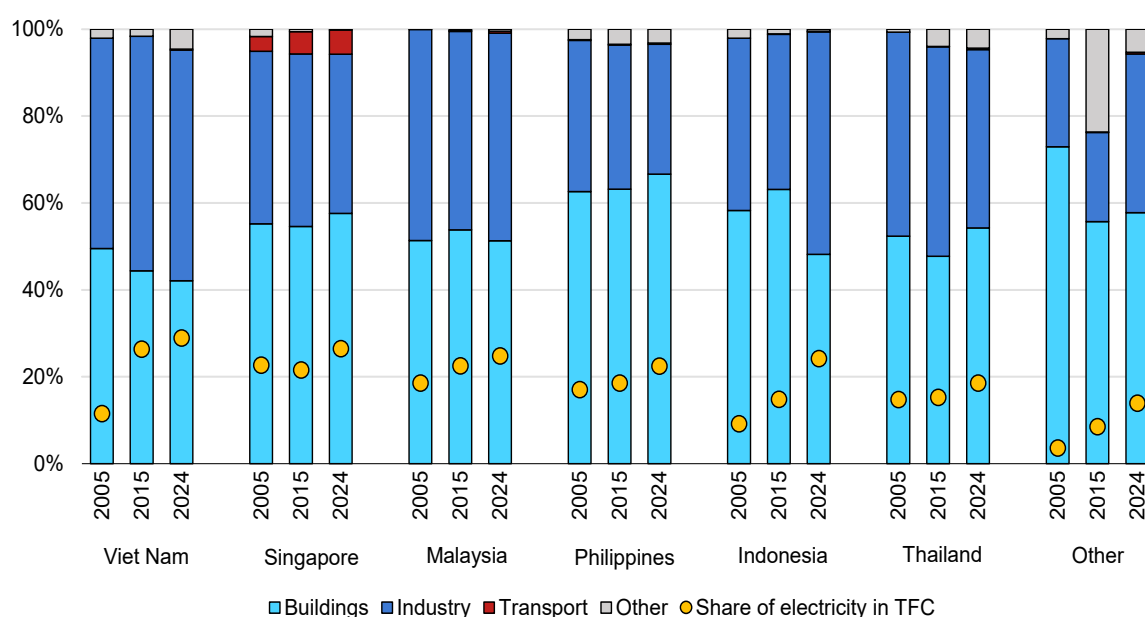
Notes: STEPS = Stated Policies Scenario. Electrification (left chart) is calculated as the share of electricity demand in total final consumption of energy.

**Southeast Asia is rapidly electrifying as its GDP per capita grows, with the share of electricity in total final consumption of energy reaching 29% in 2035 in the STEPS.**

## Structural transformation of demand

The drivers of electricity consumption in Southeast Asia are becoming increasingly diversified. These drivers are closely linked to affordability, since household energy costs influence both electricity consumption and the uptake of technologies such as air conditioning and EVs (Box 1.1). Growth is driven by both rising cooling needs in the buildings sector and expanding industrial activity. Electricity demand for cooling has doubled since 2015 and now accounts for around 13% of regional electricity demand and 16% of the region's electricity demand growth. In several countries with large manufacturing sectors, including Indonesia, Malaysia and Viet Nam, industrial activity is the main source of demand growth. Demand in transport remains modest but is expected to grow to 2035 in the STEPS as rising incomes support higher vehicle ownership and early-stage electrification begins to accelerate in several markets.

**Figure 1.4 Sectoral shares of electricity demand in selected countries, 2005-2024**



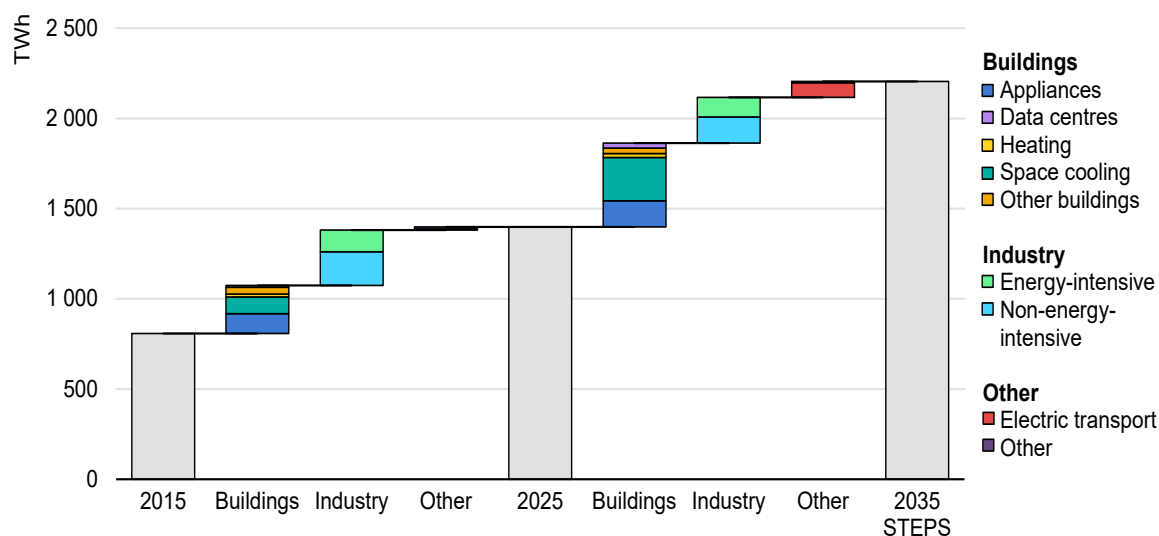
IEA. CC BY 4.0.

Notes: TFC = total final consumption. Other includes Brunei Darussalam, Cambodia and Lao PDR.

### Electricity use is largely concentrated in buildings and industry across Southeast Asia.

Industrial activity continues to shape regional electricity demand patterns. Several Southeast Asian economies are expanding their manufacturing bases and deepening integration into regional and global supply chains. Industrial development increases demand for reliable electricity supply while creating opportunities for greater electrification of industrial processes, particularly in low- and medium-temperature heating applications and across motor-driven systems. New sources of electricity demand, including data centres and digital infrastructure, are also gaining importance in some markets (Box 1.5).

**Figure 1.5 Growth in electricity demand by sector in Southeast Asia and in the Stated Policies Scenario, 2015-2035**



IEA. CC BY 4.0.

Notes: STEPS = Stated Policies Scenario. "Other" includes other services.

**Buildings and industry have driven similar electricity demand growth over the past decade, but space cooling becomes the largest contributor to 2035 in the STEPS.**

### Box 1.1 Affordability and electricity demand growth

The affordability of electricity remains a central energy challenge across Southeast Asia. While access to modern energy has expanded considerably, many households continue to face pressure from rising energy costs. Between 2019 and 2024, residential energy expenditure per capita increased across the region's major economies. The 2022 energy crisis exposed the vulnerability of households to higher fuel and electricity costs. Six weeks after the start of the crisis, diesel prices had increased by 67% in Singapore and Thailand, by slightly more than 100% in Malaysia and Viet Nam, and by around 140% in the Philippines. These increases had particularly pronounced impacts on households that rely on transport fuels for daily mobility.

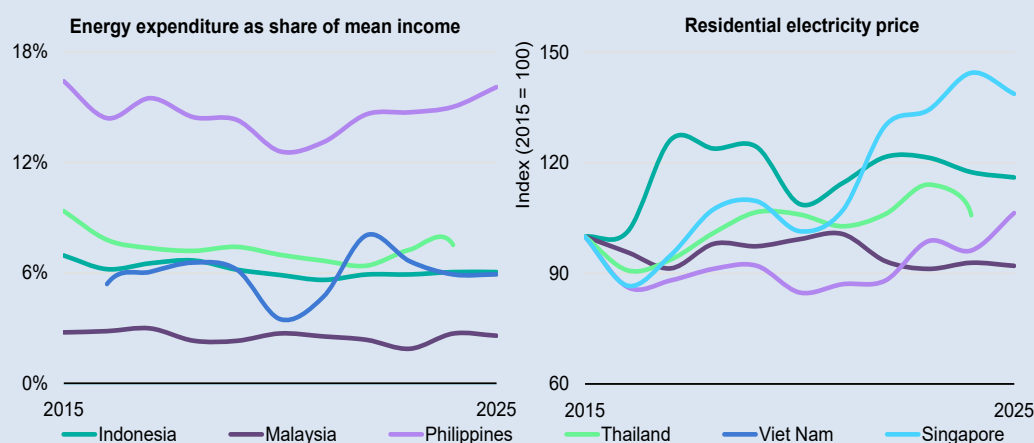
Energy costs affect households unevenly. Low-income households in the region spend around 16% of their income on energy, compared with around 11% for median-income households and 8% for high-income households. Despite this larger expenditure burden, low-income households consume substantially less energy than wealthier households. In practice, rising energy costs often result in reduced consumption of essential energy services or lower spending on other necessities such as food and healthcare. Energy expenditure represents a particularly large

share of household income in Indonesia, the Philippines and Thailand, underlining the continuing importance of affordability considerations in energy policy.

Affordability also helps determine which technologies households adopt. Access to affordable electricity is a prerequisite for technologies such as air conditioners, for which ownership remains strongly linked to income. Across the wider Asia Pacific region, air conditioner ownership among the richest households was around three times higher than among the poorest in 2020. Affordability considerations are becoming increasingly important for other technologies as well, including EVs, where purchase incentives, tax reductions and tariff policies have helped support adoption in markets such as Indonesia and Thailand.

Electricity tariffs and subsidies therefore influence both consumption patterns and technology choices. Energy subsidies remain widespread across Southeast Asia and have historically helped shield households from higher electricity and fuel costs, although they can also weaken incentives for energy efficiency and demand response. At the same time, targeted measures can improve affordability while encouraging more efficient energy use. For example, Malaysia's efficiency programmes have benefited around 9.2 million households, delivering savings of more than USD 500 million and helping stabilise energy bills for 85% of households. As electricity demand continues to rise, aligning affordability objectives with incentives for efficiency and electrification will be increasingly important for maintaining energy security, supporting household welfare and moderating future demand growth.

### Energy expenditure as share of mean income and residential electricity price in selected Southeast Asian countries, 2015-2025



IEA. CC BY 4.0.

Notes: Data are calculated using real 2024 USD (purchasing power parity [PPP] terms). Residential electricity price data are not available for Viet Nam. Energy expenditure data are not available for Singapore.

Source: IEA (2026), [Household Energy Expenditure Database](#).

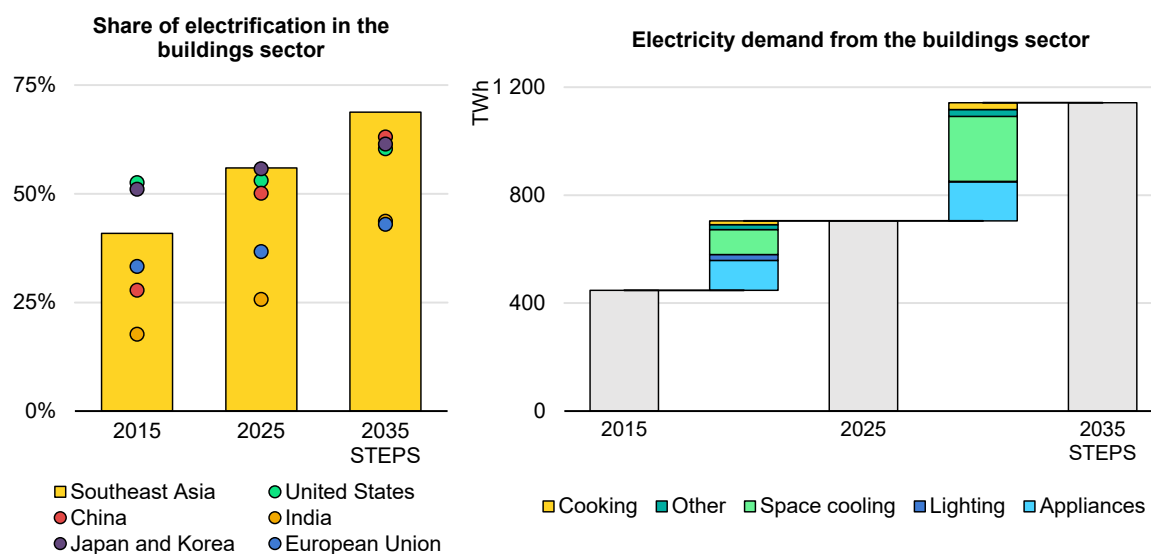
## Electricity demand in buildings

Southeast Asia is set to have one of the highest rates of electrification in the buildings sector, compared to other advanced and developing economies, largely driven by its cooling needs. Demand for cooling is emerging as one of the defining features of electricity consumption growth in the region, due to a combination of climate conditions, rising incomes and urbanisation. Many countries in Southeast Asia have high cooling and dehumidification needs throughout the year, particularly in densely populated urban centres.

Space cooling as a share of total electricity demand increases from around 13% today to 20% in 2035 in the STEPS. By contrast, at the global level, its share increases from 10% today to 13% in 2035 in the STEPS.

As cooling demand becomes increasingly embedded in patterns of electricity consumption across the region, it is playing a larger role in shaping electricity system operations. In several Southeast Asian economies, cooling already shapes daily load curves and peak electricity demand, particularly during hot periods. Expanding cities increase exposure to heat through denser built environments, reduced natural ventilation and urban heat island effects. Urban households typically exhibit higher appliance ownership and greater use of cooling technologies than rural households, while commercial buildings, retail centres and office space also contribute to rising demand for cooling. Ownership and use of other appliances, such as refrigerators, televisions and computers, also add around 130 TWh of electricity demand growth to 2035 in the STEPS.

**Figure 1.6 Share of electrification in the buildings sector in selected regions and electricity demand from the buildings sector in Southeast Asia and in the Stated Policies Scenario, 2015-2035**



IEA. CC BY 4.0.

Note: STEPS = Stated Policies Scenario. Other includes space heating and water heating.

**Electrification in buildings continues to rise, while growing demand for cooling and appliances drives strong increases in electricity use in the buildings sector.**

## Air conditioner ownership today and future growth potential

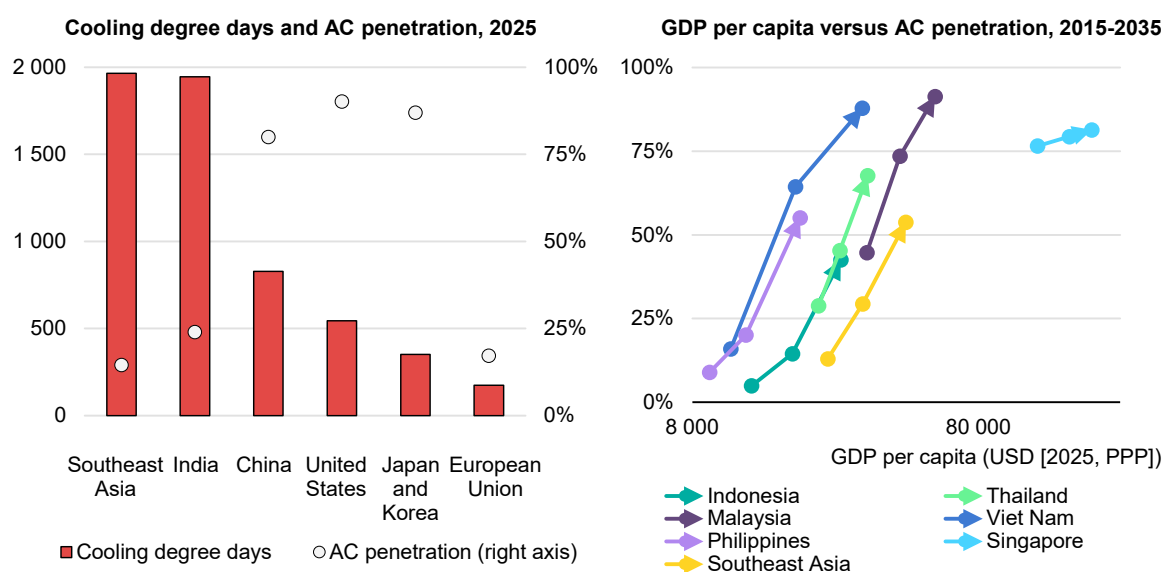
Despite rapid growth in recent years, air conditioner ownership in Southeast Asia remains below levels observed in many advanced economies. Almost 30% of households in the region own an air conditioner (AC), although there are significant differences between countries, reflecting variations in income levels, urbanisation rates and electricity access. Higher-income countries such as Malaysia and Singapore have a penetration rate of over 75%, compared to less than 20% in several lower-middle income economies, including Indonesia and the Philippines.

This indicates significant scope for future growth in demand. AC ownership is expected to increase rapidly over the coming decade in all IEA scenarios, rising to nearly 55% by 2035, particularly among middle-income households. In Indonesia, the share of households with ACs rises from less than 15% today to 40% by 2035. While there are examples of alternatives to air conditioning emerging in the region, such as district cooling networks being deployed in cities in Malaysia, Singapore and Thailand, air conditioning is still expected to be the predominant cooling solution.

The number of households with an AC is projected to double between 2025 and 2035 in the STEPS, over a period during which heat waves are expected to

become more common. Without additional measures to mitigate climate change, the number of cooling degree days averaged across Southeast Asia rises by more than 10% by 2050 in the STEPS. Although smaller than the relative increase seen in some regions, this still leaves Southeast Asia with a number of cooling degree days per year far higher than in most other regions. Demand for cooling is therefore likely to remain strong even under moderate economic growth assumptions.

**Figure 1.7 Air conditioner ownership compared to cooling demand in selected countries and regions, and to GDP per capita in Southeast Asia in the Stated Policies Scenario, 2015-2035**



IEA. CC BY 4.0.

Notes: AC = air conditioner. Cooling demand is expressed in terms of cooling degree days, which describe the overall need for cooling in buildings, and are equivalent to the number of degrees that a day's average temperature is above 21°C. GDP assumptions are the same across all IEA scenarios; see the IEA [Global Energy and Climate Model](#) documentation for more details.

**AC penetration in Southeast Asia increases with income and cooling degree days but is still lower than in advanced economies despite high cooling needs.**

## Electricity demand in transport

### Mobility growth as a structural driver of energy demand

Economic growth and expanding urban economies are increasing demand for passenger and commercial transport across Southeast Asia. Vehicle ownership has increased steadily over the past decade, at an average rate of 3% per year, particularly in rapidly growing economies such as Indonesia, the Philippines and Viet Nam. Further growth is expected as incomes continue to rise.

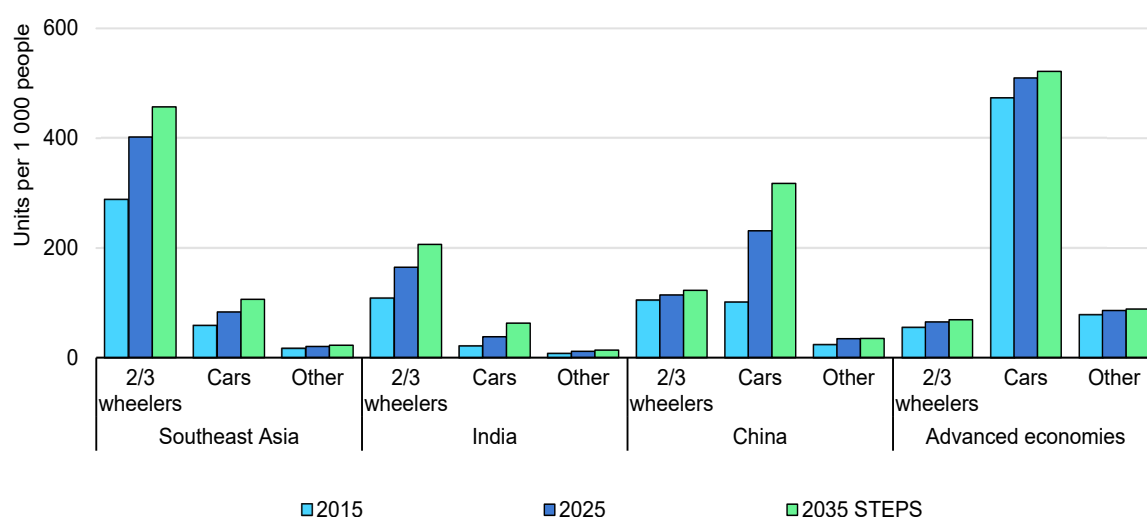
Increasing vehicle ownership contributes to higher oil demand and transport-related energy consumption, while expanding shares of EVs in some countries are also creating growing demand for transport infrastructure, electricity networks and charging systems.

## Vehicle ownership and changing mobility patterns

Vehicle ownership in Southeast Asia, excluding two/three-wheelers (2/3Ws), is rising but remains well below levels observed in advanced economies, suggesting considerable scope for growth over the coming decade. Mobility patterns across the region are currently dominated by smaller vehicles, with around 400 2/3Ws per 1 000 people. As a result, passenger car ownership remains relatively low, at around 80 vehicles per 1 000 people in 2025, compared with more than 500 per 1 000 people in advanced economies. Levels of passenger car ownership are already relatively high in Malaysia and Thailand, whereas ownership in Indonesia, the Philippines and Viet Nam is growing from a base roughly ten times lower.

Southeast Asia's mobility transition differs from that of many advanced economies. The region has the world's largest 2/3W fleet and these vehicles remain central to mobility in many countries and have important implications for electrification pathways (Box 1.2). In the STEPS, the number of 2/3Ws grows by 20% to nearly 340 million, meaning that Southeast Asia remains among the world's largest markets, alongside India.

**Figure 1.8 Vehicle ownership per capita in Southeast Asia in selected regions and in the Stated Policies Scenario, 2015-2035**



IEA. CC BY 4.0.

Notes: 2/3 wheelers = two- and three-wheelers; STEPS = Stated Policies Scenario. Other includes buses, freight trucks and light-duty commercial vehicles.

**Vehicle ownership remains lower in Southeast Asia than in advanced economies and is dominated by 2/3Ws, though car ownership is growing quickly.**

Growing demand for cars and 2/3Ws, as well as growth in commercial transport activity is likely to become an increasingly important driver of energy demand and electricity consumption over the coming decade.

## Electric vehicle uptake

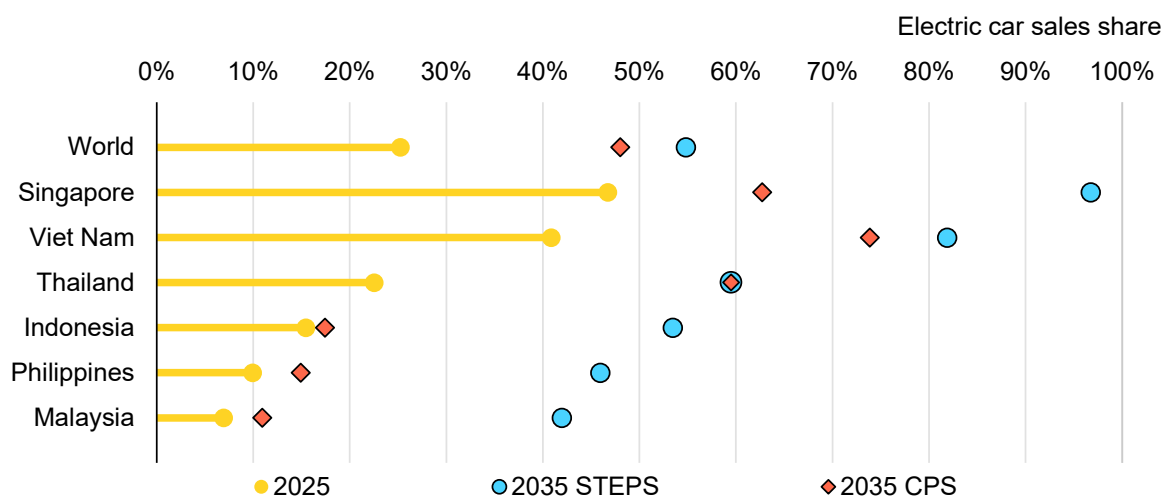
EV adoption remains uneven across Southeast Asia. Uptake has accelerated rapidly in leading markets, particularly for electric cars: in 2025, around 45% and 40% of new car sales in Singapore and Viet Nam were electric, up from nearly 20% and 10% in 2023. These shares remain below the close to 55% recorded in the People's Republic of China (hereafter, "China") but are above the EU average (27%) and the share in the United States (just below 10%). By contrast, adoption remained at an earlier stage in 2025 in other countries in the region, with shares of around 10% in the Philippines and 7% in the region's largest car market, Malaysia. Electric car adoption continued to make strides in 2026: by the end of the third quarter, more than one in four cars sold in Southeast Asia was electric.

Singapore, Thailand and Viet Nam have emerged as the [leading EV markets in the region](#), supported by a combination of incentives, industrial policies, improving affordability and infrastructure deployment. Indonesia is also positioning itself as a major EV and battery manufacturing hub. Affordability constraints, infrastructure gaps and weaker policy support together explain the comparatively limited uptake in Malaysia and the Philippines.

Overall, Southeast Asia's evolving policy, industry and market landscape supports strong growth in electric car sales. In the STEPS, their share of total car sales rises from close to 20% in 2025 to nearly 40% in 2030 and 55% in 2035, with battery electric models commanding over 80% of electric car sales. In the CPS, where policies expire as scheduled and upfront affordability constrains uptake, the share reaches only around 35% in 2035. Across much of the region, however, rising vehicle ownership more than offsets the energy savings from electrification, resulting in continued growth in road transport energy demand in both scenarios.

2/3Ws also play a key role in the region's transport electrification. Electric 2/3Ws can offer important opportunities for reducing fuel consumption and air pollution, although adoption patterns vary considerably across countries. The air-quality benefits of electrification are especially relevant in dense urban areas, where transport, power generation and industrial activity remain major sources of energy-related air pollutant emissions.

**Figure 1.9 Electric car sales shares in selected Southeast Asian countries by scenario, 2025-2035**



IEA. CC BY 4.0.

Note: STEPS = Stated Policies Scenario; CPS = Current Policies Scenario.

**Electric car uptake rises across all markets in the STEPS, led by Singapore and Viet Nam, which reach sales shares of more than 80% by 2035.**

### Box 1.2 Two-wheelers compared to cars: implications for electrification

2Ws dominate mobility across much of Southeast Asia. In several countries, including Indonesia, the Philippines and Viet Nam, 2Ws represent the primary mode of motorised transport for large parts of the population, thanks to their lower costs and practicality in crowded urban environments, especially when public transport is limited.

Sales of electric 2Ws in the region have grown considerably in recent years, reaching almost 900 000 in 2025, up from around 260 000 in 2020. Viet Nam has Southeast Asia's largest electric 2W market, with sales more than doubling to around 735 000 in 2025. By contrast, in Indonesia, Southeast Asia's largest 2W market, sales of electric models have fluctuated in recent years and fell by 20% in 2025 following the end of purchase subsidies.

Shifting to an electric 2/3W can offer an accelerated pathway to electrification when compared to shifting to an electric car, thanks to their lower upfront purchase costs and lower need for charging infrastructure. Use of 2/3Ws for ride-hailing, delivery and other commercial applications – for which owners are typically especially cost sensitive – can also translate into increased uptake of electric models.

Electrification of 2/3Ws can therefore deliver early emissions reductions in Southeast Asian economies and reduce reliance on imported fuels. Their smaller

batteries, widespread use of removable battery packs and compatibility with battery-swapping systems can substantially reduce charging infrastructure requirements relative to electric cars for a given number of users and transport services provided. Of course, a transition towards electric cars can provide the same benefits, but with increased energy demand per capita and a greater need for investment in charging infrastructure.

The pace and direction of electrification across vehicle types in Southeast Asia will be influenced by policy choices. Some countries have already introduced measures such as purchase subsidies, support for domestic manufacturing and plans for low-emissions zones in major cities. In Hanoi, for example, fossil fuel-powered 2Ws are being [gradually banned](#) from certain central areas. Industry-led promotional campaigns and incentives, such as the discounts and trade-in schemes [offered by VinFast in Viet Nam](#), can also spur uptake.

## Manufacturing growth and electrification in industry

### Industry as a major energy demand driver

Industry is the largest end-use sector of energy demand across Southeast Asia and strongly influences regional electricity consumption patterns. Manufacturing expansion and export-oriented economic development have contributed significantly to growth in final energy consumption over recent decades, and industry now accounts for around 45% of total final consumption. Industry is also central to electricity demand growth in several countries. In Indonesia, industrial electricity demand has nearly tripled since 2015, led by growth in light industries such as food processing and textiles. Across the region, electricity use in light industries has nearly doubled since 2015, accounting for more than 30% of electricity demand growth over this period.

Industrial activity has been a major contributor to GDP growth across the region. Light industries, in particular, accounted for more than a quarter of regional GDP growth over the past decade, while value added from iron and steel more than tripled. As Southeast Asian economies industrialise and integrate more deeply into regional and global supply chains, industrial production increasingly supports growth in manufacturing exports, construction activity and domestic consumption. This increases demand for electricity, fuels and industrial infrastructure, while reinforcing the importance of reliable and affordable power supply for economic competitiveness.

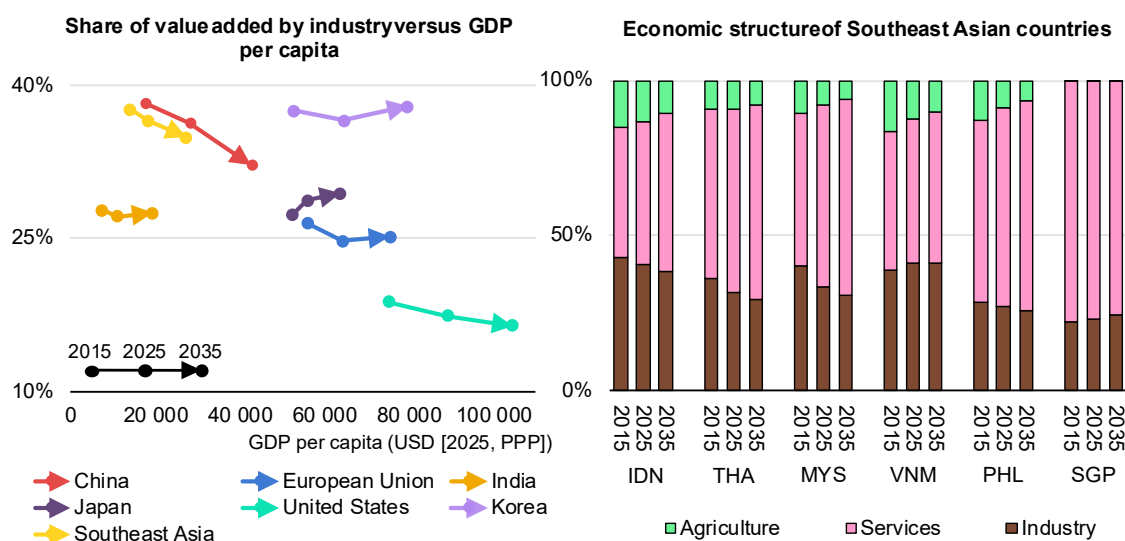
## Diversity of industrial structures

Industrial structures differ considerably across Southeast Asian countries, depending on resource endowments, stages of economic development and industrial policy priorities. Some economies maintain relatively large energy-intensive industries, while others are more strongly oriented toward downstream manufacturing, electronics, assembly and export-driven industrial production. For example, Indonesia maintains a large industrial base linked to resource processing, mining and heavy industry, while Malaysia, Thailand and Viet Nam have developed strong manufacturing sectors integrated into regional supply chains. Singapore's economy is more heavily weighted towards high-value manufacturing and services, and the Philippines has a comparatively larger services sector relative to industry. Lao PDR and Myanmar retain substantial agriculture sectors. These differences influence not only overall electricity demand levels, but also the intensity, structure and timing of electricity consumption across economies.

The structure of industrial activity also shapes the potential for electrification. Manufacturing sectors that intensively use motors, machinery, assembly processes and lower-temperature applications are generally more compatible with increased electricity use than highly energy-intensive sectors dependent on high-temperature heat. As a result, industrial electrification pathways are likely to differ substantially across Southeast Asian economies depending on their industrial composition and energy use patterns.

Differences in industrial structure contribute to varying levels of electricity intensity across the region. Economies with larger industrial sectors and more energy-intensive manufacturing activity typically exhibit higher electricity demand per capita and greater sensitivity to electricity reliability and power quality. Economies with larger services sectors tend to exhibit more electricity demand growth in commercial buildings, cooling and digital services. Indonesia uses around 20% more industrial electricity per unit of output than Singapore, while Viet Nam uses around 70% more than Indonesia, even though its industrial sector is only about one-third as large as Indonesia's. This suggests that differences in industrial electricity demand reflect not only sector size, but also industrial composition and efficiency. As Southeast Asian economies continue to evolve, shifts in the balance between manufacturing and services will influence the composition of electricity consumption across sectors.

**Figure 1.10 Share of value added by industry compared to GDP per capita and economic structure of selected Southeast Asian countries, 2015-2035**



IEA. CC BY 4.0.

Notes: IDN = Indonesia; THA = Thailand; MYS = Malaysia; VNM = Viet Nam; PHL = Philippines; SGP = Singapore. GDP per capita is expressed in purchasing power parity (PPP) terms. GDP assumptions are the same across all IEA scenarios; see the IEA [Global Energy and Climate Model](#) documentation for more details.

**The share of value added by industry as a share of GDP is falling in Southeast Asia as the services sector grows.**

Much like in advanced economies and other major emerging economies, growth in the services sector in Southeast Asia is outpacing that in other parts of the economy. The expanding services sector is now responsible for over half of the region's GDP, and the shift to a more service-oriented economy is set to continue, with the share of services in GDP rising to more than 55% by 2035. At the same time, some economies are expected to deepen industrial development and manufacturing integration, while others may gradually transition toward higher-value services and digital economic activity.

### **Box 1.3 Technology and policy to support near-zero emissions steel production in Southeast Asia**

In Southeast Asia, as in the rest of the world, steel production from iron ore largely uses coal and – to a lesser extent – natural gas. While around one-third of global steel production comes from recycled scrap used mainly in electric arc furnaces, scrap availability globally is not sufficient to meet the sector's metallic input needs. This is particularly acute in developing economies, including those in Southeast Asia, where vehicle fleets and stocks of buildings and infrastructure tend to be young and small relative to future levels of demand.

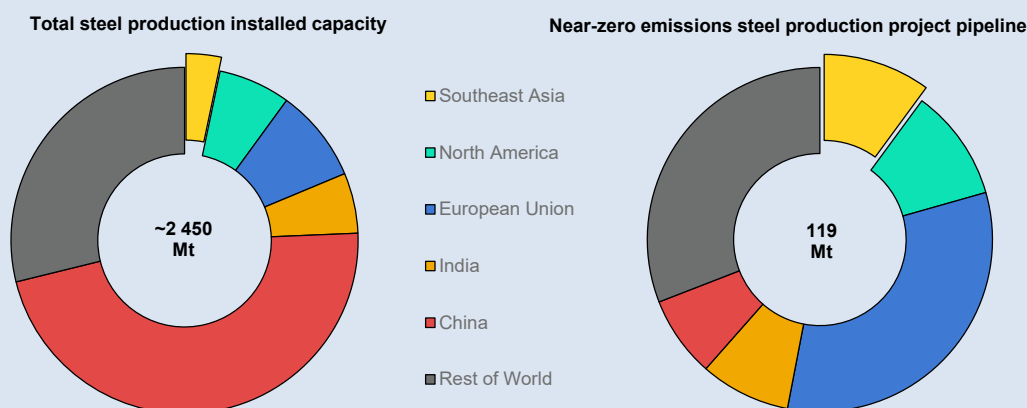
Innovative near-zero emissions technologies will need to be deployed to address the steel industry's emissions from iron production, which accounted for around 60% of the sector's 2.8 Gt of CO<sub>2</sub> emissions in 2025. Many of these technologies use electricity, either directly or indirectly (e.g. for hydrogen production), and are more expensive per unit of steel produced than blast furnaces and other technologies deployed at scale today. Policy settings will therefore play an important role in efforts to substantially reduce emissions in this sector. While still nascent, important progress is being made on both the technology and policy dimensions of these efforts in Southeast Asia.

In the IEA's tracking of near-zero emissions steel plants, together with those that are capable of transitioning to near-zero emissions without major reinvestment in the future, there are three steel plants in Southeast Asia due to begin operation by 2030. When combined, these plants are thought to have a capacity of around 12-13 Mt of near-zero emissions capable iron-based steel. This is equivalent to around 10% of the existing and announced near-zero emissions steel capacity being tracked globally by the IEA, which is higher than Southeast Asia's share of total steel production. While these near-zero emissions capable plants have been planned to produce iron and steel using natural gas during their initial phases of operation, minimal additional investment would be required to achieve full near-zero emissions production, provided that the necessary low-emissions hydrogen, around 55 kg H<sub>2</sub> per tonne of steel produced, were available.

On the policy front, lead markets will be an important factor in determining the pace at which the plants capable of producing near-zero emissions steel can proceed to do so economically. Thailand's Building Emission Assessment Tool, combined with Environmental Product Declarations and its Green Public Procurement guidelines, is an example of a policy framework designed to create these lead markets for both near-zero emissions steel and cement via the buildings sector, which is among the largest end-use segments of demand for these materials. Establishing robust emissions measurement frameworks and a chain of custody for embodied emissions along the supply chain are crucial elements in creating differentiated

markets for near-zero emissions materials and transmitting from end users to producers the price signals required to offset higher production costs.

### Steel production capacity and near-zero emissions project pipeline by region, 2025



IEA. CC BY 4.0.

Notes: Project pipeline for near-zero emissions steel production includes estimated capacity based on publicly available project announcements for iron-based steel and includes both near-zero emissions and near-zero emissions capable capacity. "Near-zero emissions" refers to projects that, once operational, will operate at an emissions intensity consistent with near-zero emissions from the start. "Near-zero emissions capable" refers to capacity that operates using the same core process equipment as near-zero emissions capacity and will achieve a substantial reduction in emissions intensity (compared to current conventional technologies) from the start – but initially fall short of the emissions intensity for near-zero emissions. Production from announced projects shown here excludes near-zero emissions steel from 100% scrap.

Sources: OECD crude steelmaking capacity database; IEA analysis based on publicly available announcements as of October 2026.

## Manufacturing expansion and electricity demand

Continued manufacturing growth is expected to remain an important driver of electricity consumption across Southeast Asia over the coming decade. Industrial expansion increases demand for electricity across production processes, machinery, motors, cooling systems and digital control infrastructure. In several Southeast Asian economies, industrial electricity consumption is expected to continue rising alongside broader economic growth and investment in manufacturing. In the STEPS, regional electricity demand from industry grows to 900 TWh by 2035, up from 650 TWh in 2025.

Across the world, rates of electrification in energy-intensive industrial sub-sectors tend to be lower than those elsewhere in industry. Electricity met around 17% of final energy demand in energy-intensive industry globally, compared with around 40% in other industries. The gap is widest in iron and steel, with electricity's share at around 14%, and non-metallic minerals, at around 16%. With the exception of the non-ferrous metals sector, where primary aluminium production uses electrolysis, the high-temperature heat, reduction agents and feedstock required in sectors like non-metallic minerals, iron and steel, and chemicals are mostly

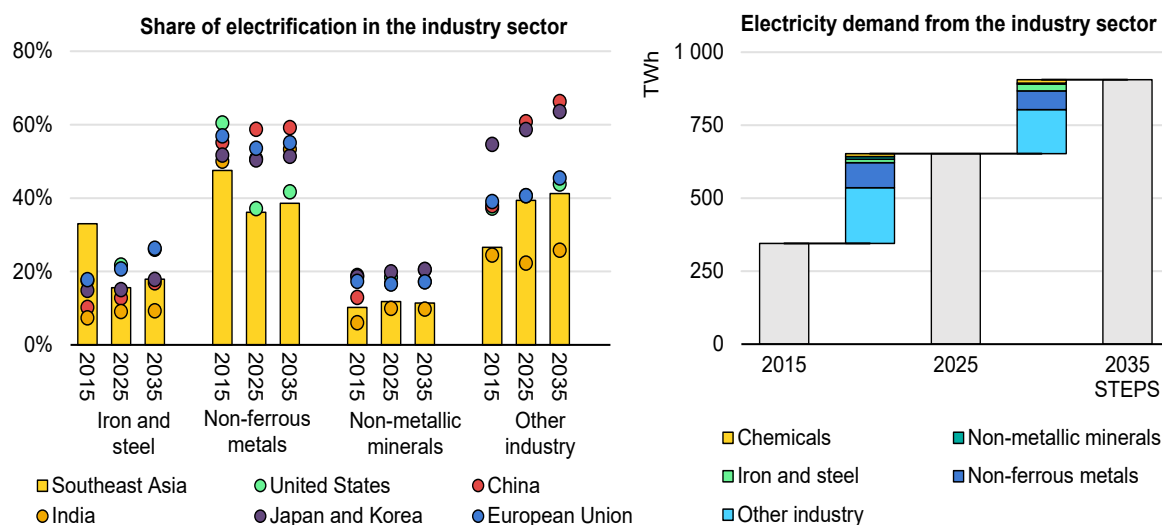
derived from fossil fuels today. As many countries pursue efforts to reduce emissions from these sectors, electricity is likely to play a greater role in these sectors' energy consumption. Southeast Asia's steel industry is in the early stages of such a transition, with some important developments currently underway (Box 1.3).

In the STEPS, most of the increase in Southeast Asia's industrial electricity consumption over the next decade comes from light industry sub-sectors, such as food processing and textile manufacturing. In this context, reliable electricity supply is becoming more important, especially as manufacturing processes become more technologically sophisticated and integrated into regional and global production networks. Advanced manufacturing, electronics production and digitalised industrial systems often require stable, high-quality electricity supply and are more sensitive to outages and voltage fluctuations than traditional industrial processes. Electricity reliability therefore increasingly influences industrial productivity, investment attractiveness and supply chain competitiveness.

Industrial electricity use is also evolving as factories adopt more automated and digitalised production systems. Greater use of automation, data processing and digitally controlled equipment increases the role of electricity in industrial activity, even where total industrial energy demand growth moderates over time. In some sectors, electricity already represents a central input for production processes, machinery operation and environmental control systems.

While there is significant potential to expand electrification across parts of Southeast Asia's industrial sector, electricity prices also strongly influence industrial energy choices. Manufacturers operating in highly competitive export markets are often particularly sensitive to electricity costs, as well as outages and power quality issues.

**Figure 1.11 Share of electrification in industry sectors across selected regions and electricity demand from industry sectors in Southeast Asia and in the Stated Policies Scenario, 2015-2035**



IEA. CC BY 4.0.

Notes: STEPS = Stated Policies Scenario. A decline in electrification shares does not necessarily imply lower electricity consumption. For example, in Southeast Asia's iron and steel sector, electricity use increased between 2015 and 2025, but its share of final energy consumption declined as coal-based primary steel production expanded more rapidly than electricity demand. Other industry includes construction, food and tobacco, machinery, mining and quarrying, non-specified industry, textile and leather, transportation and equipment, and wood and wood products.

**Electrification in parts of Southeast Asia's industry is approaching advanced-economy levels, although gaps remain across several energy-intensive sectors.**

#### Box 1.4 Air pollution as a driver of electrification

Air pollution remains an important energy-related challenge in Southeast Asia, as rapid economic growth, industrialisation and urbanisation continue to increase demand for transport, electricity and industrial output. Over the past decade, more than 70% of the increase in the region's total energy demand has been met by fossil fuels, contributing to a rise in energy-related air pollutant emissions of around 2% per year. This contrasts with developments in many advanced economies, where stronger emissions controls, improving energy efficiency and the wider deployment of clean energy technologies have contributed to declining emissions of major air pollutants.

The outlook to 2035 in the STEPS marks a departure from recent trends. Air pollutant emissions in Southeast Asia increased between 2015 and 2025 but decline gradually towards 2035 as clean energy deployment accelerates and emission-control measures become more widespread. However, despite progress in some areas, exposure to heavy air pollution in Southeast Asia continues to

increase through 2035, in contrast to declining trends in many other regions, leaving a substantial share of the population exposed to harmful levels of pollution.

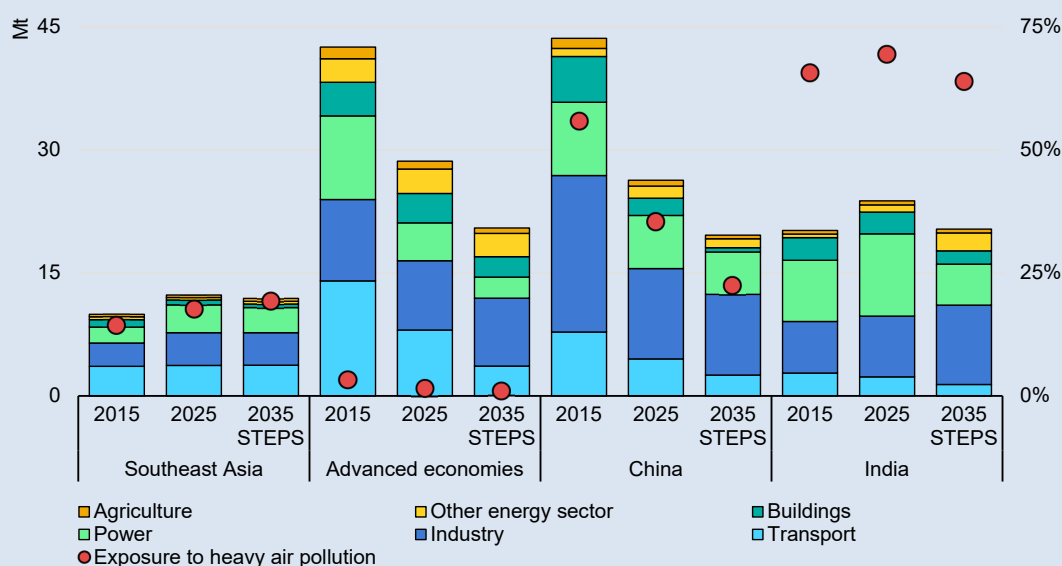
Transport, coal-fired power generation and industrial activity account for the largest share of energy-related air pollutant emissions in the region. As economic activity expands, these sectors will continue to affect air quality, particularly in urban areas where population growth and rising incomes increase demand for mobility and energy services. The health impacts associated with poor air quality are becoming an increasingly important consideration in energy policy, alongside energy security, affordability and economic development objectives.

In 2025, premature deaths associated with household and ambient air pollution were estimated at around 1.8 per million people per day, nearly twice the level in advanced economies. While premature deaths from household air pollution have fallen by more than 40% over the past decade, progress slows towards 2035 in the STEPS. Deaths associated with ambient air pollution increase by around 25% by 2035.

Recent [World Bank](#) analysis estimates that outdoor air pollution causes more than 5.7 million premature deaths globally each year and economic losses equivalent to nearly 5% of global GDP. In Southeast Asia, [assessments](#) found that the health costs of inaction on air pollution could be equivalent to between 1.6% and 2.1% of GDP in Cambodia, Indonesia and Thailand by 2030. These findings highlight the substantial economic benefits that can accompany policies to reduce air pollution alongside improvements in energy security and emissions performance.

Electrification offers a pathway to reduce many of these pressures. Greater adoption of EVs, electric cooking technologies and the electrification of industrial processes reduce the direct combustion of fossil fuels and lower emissions at the point of use. The largest benefits occur when electrification is accompanied by a cleaner power sector, allowing reductions in both local air pollutants and GHG emissions. Concerns over air quality therefore provide an additional rationale for accelerating electrification in Southeast Asia, alongside efforts to strengthen energy security and reduce emissions.

### Air pollution and exposure in selected regions and in the Stated Policies Scenario, 2015-2035



IEA. CC BY 4.0.

Notes: STEPS = Stated Policies Scenario. Total air pollution based on emissions of sulphur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>) and fine particulate matter (PM<sub>2.5</sub>).

## Power system enablers

### Expanding electricity access

Southeast Asia has made substantial progress in expanding access to electricity over the past two decades. This has been closely linked to broader economic development, urbanisation and improvements in living standards. Despite electricity access being near universal today, important differences remain between countries and across regions within countries. In some markets, rural and remote communities continue to face more limited access to reliable electricity services, reflecting geographic challenges, infrastructure constraints and uneven grid development.

Electricity access in Southeast Asia has risen to around 98% today, bringing the region close to achieving the Sustainable Development Goal 7 target of universal access by 2030. This expansion has enabled wider adoption of appliances, digital technologies and productive uses of electricity across households and businesses.

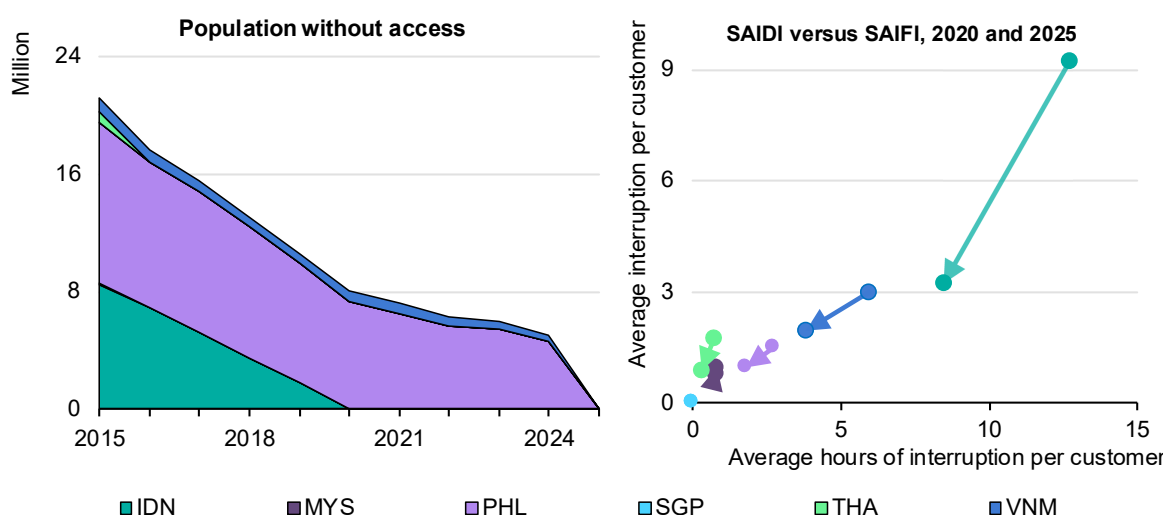
As electricity access improves, demand for modern energy services tends to increase rapidly, contributing to higher electricity consumption per capita and accelerating the broader electrification of end uses across the economy. Electricity access represents not only a social development objective, but also a structural driver of future electricity consumption growth.

## Reliability and quality of electricity supply

As Southeast Asia enters a more electricity-intensive phase of economic development, the reliability and quality of electricity supply are gaining importance. Electrification of cooling, transport, manufacturing and digital infrastructure depends on electricity systems that are capable of delivering stable and reliable power at growing scale.

Reliability challenges differ significantly across Southeast Asian markets. Several countries maintain relatively reliable power systems and continue to invest heavily in generation and network infrastructure. Others have made substantial progress in recent years, notably Indonesia and Viet Nam, which significantly reduced both the frequency and duration of electricity interruptions between 2020 and 2024. In rapidly expanding urban centres, electricity consumption growth is increasing pressure on existing infrastructure and creating new investment requirements across transmission and distribution networks.

**Figure 1.12 Population without electricity access across selected Southeast Asian countries and average duration and number of interruptions, 2015-2025**



IEA. CC BY 4.0.

Notes: Calculated based on SAIDI = System Average Interruption Duration Index (calculated after excluding major event days) and SAIFI = System Average Interruption Frequency Index. Differences in calculation and reporting methods across utilities, including the treatment of extreme events and planned outages, limit cross-country comparability; the figure is intended to illustrate trends over time. The 2025 SAIDI value for Indonesia includes recent major outages and therefore does not fully reflect progress; SAIDI averaged around 5.5 hours in 2023-2024. Values for Thailand are a simple average of those of the Metropolitan Electricity Authority and the Provincial Electricity Authority. Where 2025 values were not reported, the latest available 2024 value is used, as in the case of the Philippines and the Provincial Electricity Authority in Thailand.

Sources: IEA analysis based on data from [World Bank](#); [EVN](#); [Provincial Electricity Authority](#); [Metropolitan Electricity Authority](#); [PLN](#); [Tenaga Nasional Berhad](#); [Energy Commission Malaysia](#); [Meralco](#) and [Energy Market Authority](#).

**Electricity access has expanded significantly across the region in the past decade, notably in Indonesia, while reliability indicators show differentiated progress.**

The expansion of digital infrastructure, data centres and advanced manufacturing also increases the economic value of reliable electricity supply. Interruptions to electricity services can create significant economic costs in electricity-intensive sectors and reduce the attractiveness of markets for industrial and technology investment. Data centres are an emerging example of this challenge.

### **Box 1.5 Artificial intelligence, data centres and electricity demand uncertainty**

The rapidly growing data centre sector is emerging as a new source of electricity demand in Southeast Asia, although its share of total regional consumption remains modest. The region's data centres consume more than 10 TWh of electricity, equivalent to just under 3% of global demand from data centres and around 7% of such demand in the Asia Pacific region. Malaysia and Singapore are major data centre hubs in Southeast Asia, while Indonesia and Thailand are also emerging markets, particularly around Jakarta and Bangkok. By comparison, the sector remains nascent in the Philippines.

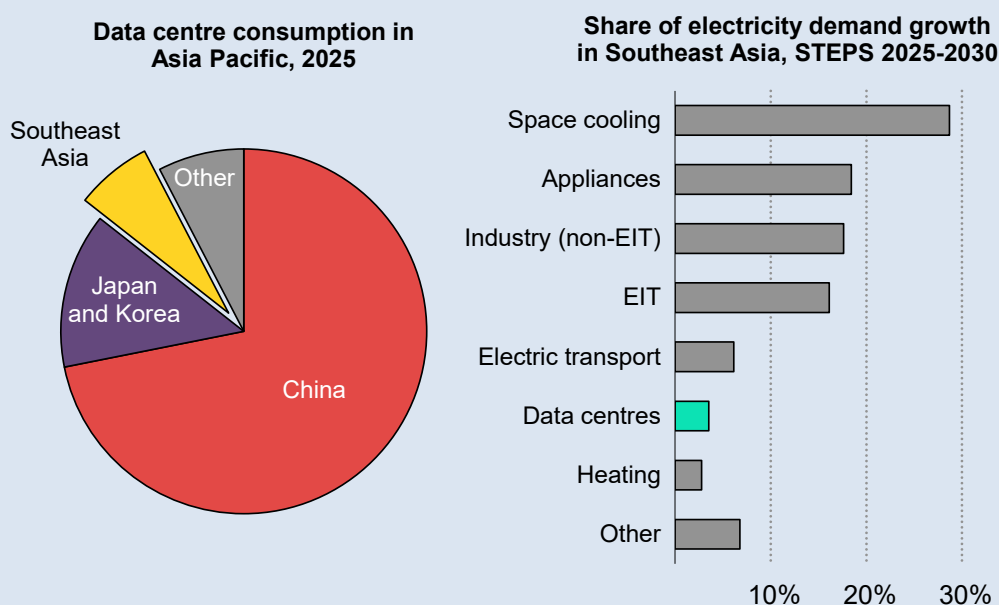
Southeast Asia's proximity to large economies such as Australia, China, India and Japan, comparatively low land, labour and energy costs in some markets, and relatively stable geopolitical environment have strengthened its attractiveness as a regional data centre hub. Demand for digital services is also expanding quickly within the region, driven by e-commerce, financial technologies, government digital infrastructure and cloud services. Policy frameworks are reinforcing this trend, including Malaysia's [Digital Economy Blueprint \(MyDIGITAL\)](#) and [digital tax incentives](#), Singapore's [Digital Economy Partnership Agreement](#), Viet Nam's [Digital Economy Strategy 2030](#) and the Philippines' [Digital Transformation Strategy](#). At the regional level, the [ASEAN Digital Masterplan 2025](#) points to a broader push to strengthen connectivity and scale up information technologies.

As a result, data centre expansion is expected to contribute around 3.7% of electricity demand growth in Southeast Asia to 2030 in the STEPS. However, there is uncertainty surrounding the sector's future electricity needs, notably their scale and timing. The rise of artificial intelligence is speeding up deployment of high-performance accelerated servers, increasing power density. How quickly such [accelerated servers are adopted is therefore a key determinant](#) of future electricity use.

There is also uncertainty over how much of the announced project pipeline will materialise. Data centres represent highly localised and electricity-intensive loads, and nearly all facilities in the region are grid connected, posing a distinct planning challenge for electricity systems. Physical bottlenecks related to land, water and grid capacity have already constrained expansion, as seen in Singapore at the start of the decade. In 2024, Johor in Malaysia rejected up to 30% of data centre

applications because efficiency measures related to power and water use were considered insufficient. Indonesia is also experiencing grid constraints, leading to extended connection queues that are slowing further expansion.

### Data centre electricity consumption in Asia Pacific and electricity demand growth by source in Southeast Asia, 2025-2030



IEA. CC BY 4.0.

Note: EIT = Energy-intensive industry.

Source: IEA (2026), [Southeast Asia Energy Outlook 2026](#).

Around 60% of data centres under construction or announced in the region are being developed in or close to cities with a population of at least 1 million, whose grids already serve large loads. This can intensify grid congestion and connection delays. Supply chains for key components, such as transformers, cables, gas turbines and critical minerals, are already under pressure. Lengthening backlogs in transformer delivery are affecting infrastructure rollout for data centre construction, and an estimated 20% of projected data centre additions worldwide by 2030 are at risk of delay. Power sourcing will also be central to the sector's wider system impact: most data centres are connected to the grid, so the electricity they consume reflects the generation mix of the regions where they operate. In Southeast Asia, coal remains one of the leading sources of electricity for data centres in the STEPS and CPS, while renewables provide the largest share of incremental supply, at around 45% in both scenarios.

## Grid expansion and system readiness

Rapid growth in electricity demand across Southeast Asia is creating substantial requirements for power system expansion and modernisation. Rising electricity

consumption is increasing the need for additional generation capacity, transmission infrastructure and distribution network investment. Power systems will increasingly need to manage larger and more variable demand patterns. Cooling demand contributes strongly to peak electricity loads, while the expansion of electric mobility and digital infrastructure creates new load centres and changing consumption profiles. At the same time, as more diverse, variable and decentralised energy sources, as well as advanced technologies, are integrated into modern power systems, changing supply- and demand-side dynamics are increasing grid complexity. In several Southeast Asian markets, rapid urbanisation is concentrating electricity demand growth, increasing pressure on local grids and distribution systems.

System readiness will increasingly determine how quickly and efficiently electrification can expand across the region. Grid congestion, transmission bottlenecks and delays in infrastructure investment could slow the deployment of electricity-dependent technologies and increase system costs. Regional integration through the [ASEAN Power Grid \(APG\)](#) could complement domestic grid expansion by helping to balance supply and demand across power systems, improve system flexibility and reliability, and support the integration of variable renewable energy resources (see IEA report [Expanding power trade in ASEAN – An Implementation Framework for the ASEAN Power Grid](#) for further context). Moreover, improving appliance efficiency, deploying advanced grid technologies, strengthening automation and digital control, expanding flexibility resources and managing peak demand growth can help reduce pressure on electricity systems and improve overall system efficiency. These considerations are likely to become more important as electricity consumption continues to expand. The transition towards a more electricity-intensive economy will depend not only on the pace of technology adoption, but also on the ability of electricity systems to expand reliably and affordably. Power system infrastructure increasingly underpins economic activity, industrial development and access to modern energy services across Southeast Asia.

The Age of Electricity in Southeast Asia is as much an infrastructure challenge as it is a technology transition. The ability to expand electricity access, strengthen grids and improve system reliability will shape electrification pathways across the region and influence deployment of clean energy technologies in the years ahead.

## Chapter 2. Energy technology supply chains in Southeast Asia today

### Highlights

- Southeast Asia has emerged as a sizeable manufacturing hub for clean energy technologies, with foreign investment playing an important role. China's project-level investments in the region reached USD 10 billion in 2025, down from a 2023 peak of USD 31 billion. An earlier focus on solar PV investment has since shifted to batteries and electric vehicles (EVs). Indonesia is the largest recipient of cumulative investment over the 2015-2025 period.
- Changes in trade and industrial policies in other regions, and overcapacity, are reversing the recent surge in Southeast Asia's solar PV module exports. Despite remaining an important pillar of Southeast Asia's clean energy manufacturing sector, module manufacturing capacity contracted from 106 GW in 2023 to around 82 GW in 2025 and is projected to decline to 72 GW by 2030. The sector's high reliance on exports to the United States has left it exposed to changing trade policy.
- A new growth story is starting to take shape in electric car manufacturing, backed by supportive policies and burgeoning domestic markets. Based on announced projects, manufacturing capacity is projected to nearly double from around 1 million vehicles in 2025 to 1.8 million by 2030. While facilities run by companies headquartered in China account for around half of current capacity – and over 70% of planned capacity – domestic players are emerging.
- The battery manufacturing industry is also beginning to scale. Installed capacity amounted to around 40 GWh in 2025, while announced projects point to an expansion to more than 100 GWh by 2030. Still-nascent policy support and incentives, and reliance on imported technology, could present challenges.
- Wind manufacturing capacity for towers stands slightly below 30 GW, representing nearly 20% of the installed capacity outside of China, with only incremental growth expected to 2030 – predominantly located in Viet Nam.
- Southeast Asia is approaching production cost parity with China across several clean energy technologies, with less than a 1% cost difference for battery materials, 4-6% for EVs and wind towers, and 10-30% for battery cells and solar PV. EVs and battery cells offer the most promising export opportunities, especially for Malaysia and Thailand.

# Investment

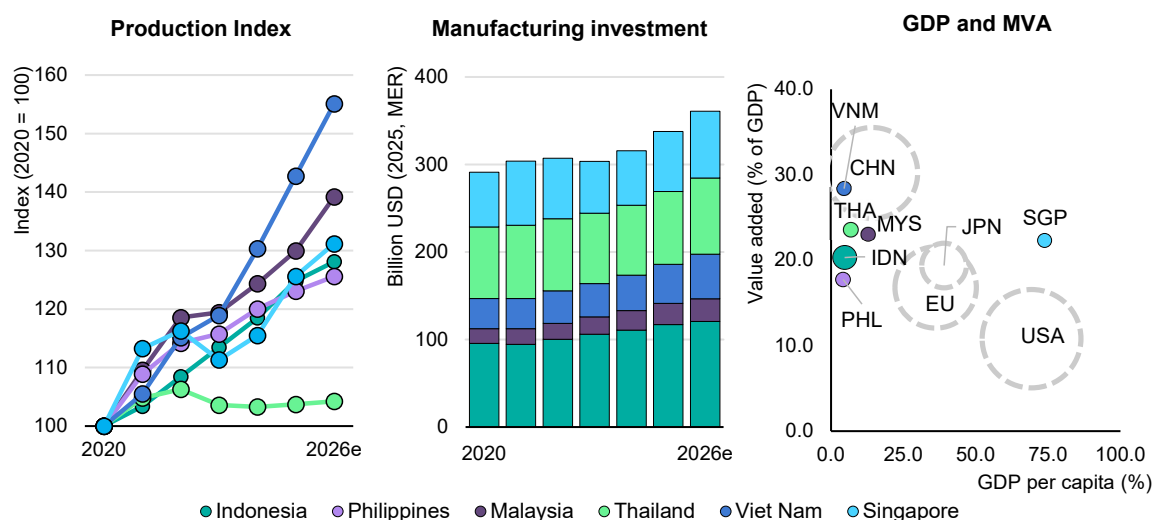
## Macro trends in broader manufacturing

Manufacturing is a defining feature of Southeast Asian economies, accounting for over one-fifth of GDP in most countries in 2026 – well above the global average of around 18%. Since the Industrial Revolution, manufacturing has been one of the principal vehicles through which countries have achieved sustained increases in productivity, incomes and living standards. Its enduring importance is evident even in advanced economies, where the race to scale clean energy technologies, semiconductors and AI-related infrastructure [is fuelling](#) a renewed wave of industrial investment. Southeast Asia is no exception, with industrial expansion playing a central role in the region's economic transformation and integration into global markets.

Developing a country's manufacturing industries demands substantial upfront investment. Total investment in manufacturing in the region has grown at an average rate of 4.6% per annum over the past decade, hitting an estimated USD 360 billion in 2026. Indonesia represented nearly 45% of this total, broadly in line with its share of the region's GDP at 37%. This reflects large-scale investment across a range of capital-intensive manufacturing sectors, including basic metals, chemicals, pulp and paper, and transport equipment. By comparison, manufacturing investment in France and the United Kingdom reached an estimated USD 130 billion combined in 2026. The nature of these investments varies across countries. Viet Nam combines a high manufacturing value-added share, at close to 30% of GDP, with the strongest growth in output, suggesting that industrial expansion is translating into both higher production volumes and greater domestic value creation. By contrast, Indonesia pairs large-scale manufacturing investment with slightly more moderate output growth and a lower value-added share, indicating that a significant proportion of new capacity is either slower to materialise or concentrated in lower value-added activities.

These differences highlight that the economic impacts of industrialisation depend not only on the scale of manufacturing activity, but also on the amount of value it creates domestically. While industrialisation remains a key driver of growth, countries capture these gains to varying degrees. [Cross-country evidence](#) shows that similar levels of manufacturing value added can still be associated with markedly different income outcomes, reflecting differences in technological capabilities, domestic value creation and integration into higher-value segments of global supply chains. In practice, the most successful manufacturing economies are often those that move beyond assembling goods to develop domestic capabilities in design, engineering, advanced production and supporting services.

**Figure 2.1 Manufacturing production index, investment, GDP and manufacturing value added in Southeast Asian countries, 2020-2026e**



IEA. CC BY 4.0.

Notes: 2026e = estimated for 2026; CHN = China; EU = European Union; JP = Japan; USA = United States. MVA = manufacturing value added. Manufacturing investment refers to manufacturing industries within ISIC Rev. 4 Divisions 10-33. USD figures are real 2025 dollars in market exchange rate terms. The manufacturing value added as a percentage of GDP represents the net output of the manufacturing sector after adding up all outputs and subtracting intermediate inputs. The manufacturing production index measures the changes in the volume of industrial output over time, relative to a base period (2020). Bubble size refers to the absolute GDP size in 2026. No manufacturing investment data were available for the Philippines, and no manufacturing data were available for Brunei, Cambodia, Lao PDR, Myanmar and Timor-Leste. Sources: IEA analysis based on Oxford Economics (2026) and [ASEAN Statistics](#).

**Investment in manufacturing in Indonesia has averaged nearly USD 110 billion per year since 2020, but Viet Nam has the highest manufacturing value added as a share of GDP.**

## Clean energy technology manufacturing investment

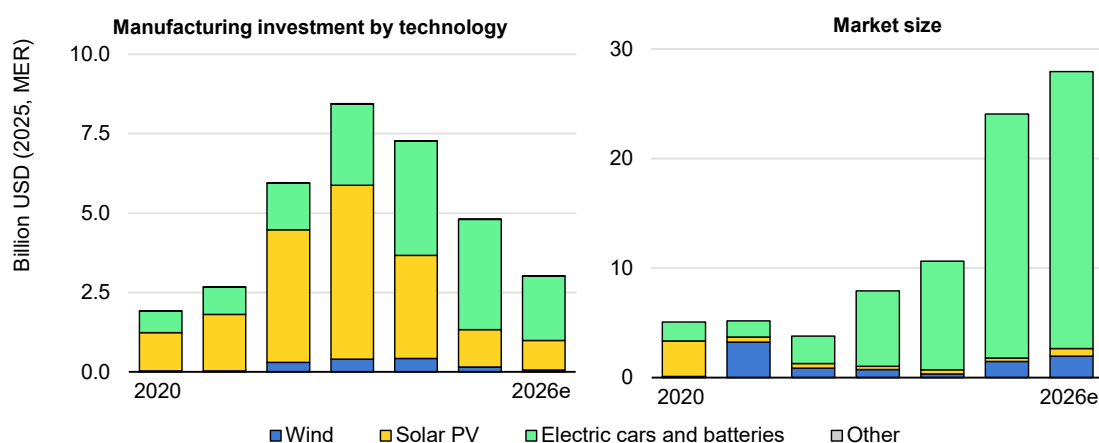
Investment in clean energy technology<sup>4</sup> manufacturing in Southeast Asia almost halved from its 2023 peak of roughly USD 8.5 billion to just under USD 5 billion in 2025, broadly in line with the global slowdown centred on solar PV. Solar drove growth at the start of the decade, as manufacturers paired the region's competitive production conditions with its role as an alternative base for exports to the United States, following trade restrictions on the People's Republic of China (hereafter, "China"). The subsequent decline reflected both global surplus capacity and the region's exposure to shifting US trade conditions. Globally, module production exceeded installations by around 175 GW in 2025, adding to inventories and intensifying price competition. At the same time, the United States, which had accounted for around 81% of Southeast Asian solar PV exports at their 2023 peak, introduced anti-dumping and countervailing duties on regional producers (see the [Trade and industrial policy](#) section). Meanwhile, investment in

<sup>4</sup> Unless stated otherwise, clean energy technologies include electric cars, EV batteries and battery energy storage systems, solar PV modules, wind turbines, heat pumps and electrolyzers.

EVs and battery manufacturing continued to grow, reaching over USD 3 billion in 2025, supported by increasing regional demand, industrial policy incentives and investment by foreign manufacturers.

The reorientation of investment mirrors a deeper shift in regional demand. The combined market size for clean energy technologies in Southeast Asia reached around USD 25 billion in 2025, having climbed steeply from around USD 5 billion in 2020, but this expansion has been led almost entirely by batteries and EVs. The regional solar PV market fell sharply after 2020, when Viet Nam experienced an exceptional installation boom ahead of the expiry of feed-in tariffs, pushing annual installations to around 13 GW for the region. As activity stabilised, solar additions dropped to around 1.8 GW in 2021 before gradually recovering to an estimated 11.3 GW by 2026. Declining module prices amplified the fall in market value, with prices around 60% lower in 2026 than in 2020.

**Figure 2.2 Investment in manufacturing capacity and market size for key clean energy technologies in Southeast Asia, 2020-2026e**



IEA. CC BY 4.0.

Notes: 2026e = estimated for 2026. Other includes electrolyzers and heat pumps. The market size is based on deployment or sales within the region in a given year. For more details on how energy technology manufacturing investments and market sizes are calculated, please see the [Manufacturing and Trade Model](#) documentation.

**Investment is shifting towards EV and battery manufacturing, with combined spending reaching over USD 3 billion in 2025, partially offsetting the drop in solar PV investment.**

## Foreign investment in the region

### Trends in broader manufacturing foreign direct investment

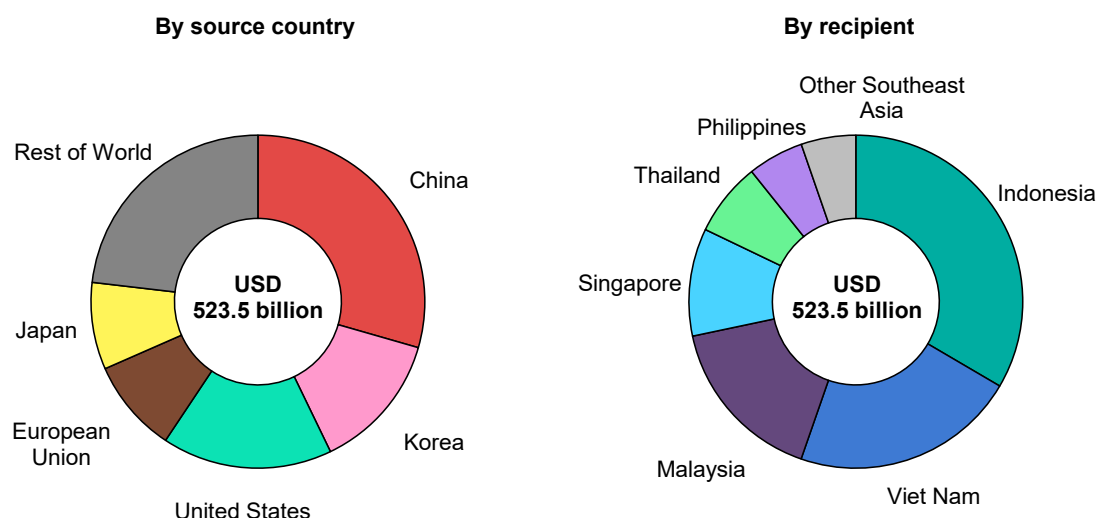
Southeast Asia is cementing its position as a major destination for global foreign direct investment (FDI), drawing a record USD 244 billion in 2025 and bucking the global downward trend in FDI flows. Manufacturing has been a key driver of investment in recent years, with Southeast Asia-bound FDI in the sector more than

doubling between 2020 and its 2023 peak. Although inflows eased thereafter, Southeast Asia accounted for 12% of cumulative global manufacturing FDI over 2015-2025, compared with 18% for the United States and 7% for India.

China was the largest source of cumulative manufacturing FDI in Southeast Asia from 2015-2025, accounting for around 30% of cumulative inflows. Having reached a peak in 2023, China's FDI in the region has shifted away from the metals and materials processing sector and towards electrical and electronic components in recent years. The United States was the second-largest source of manufacturing FDI in the region, contributing 16% of cumulative inflows from 2015-2025, but its role has expanded significantly in recent years. The increasing US share of investment has been driven largely by semiconductor fabrication projects, which accounted for around 88% of US manufacturing FDI in the region. Korea, Japan and the European Union are the next largest sources of Southeast Asia's manufacturing FDI.

Indonesia attracted the largest share of cumulative manufacturing FDI between 2015 and 2025, accounting for around 33% of regional inflows, ahead of Malaysia and Viet Nam. Automotive original equipment manufacturer (OEM) investment was concentrated in Indonesia, followed by Malaysia and Thailand. Thailand and Viet Nam have emerged as the main destinations for automotive component manufacturing, together attracting around three-quarters of related investment. Investment in electronic components was primarily directed toward Viet Nam and Indonesia, which accounted for around 40% and 30% of regional inflows, respectively. Meanwhile, investment in metals and materials processing was overwhelmingly concentrated in Indonesia, much of it directed towards nickel refining. The country captured nearly all major investment waves in the sector, including the surges observed in 2015-2018 and again in 2022-2023, reflecting changes in its export restrictions (see the [Trade and industrial policy](#) section).

**Figure 2.3 Total foreign direct investment in manufacturing by source and receiving country in Southeast Asia, 2015-2025**



IEA. CC BY 4.0.

Notes: Data are based on announced cross-border investment projects. Investment values represent stated or estimated capital expenditure on projects.

Source: IEA analysis based on [FDI Intelligence](#).

**China accounted for 28% of cumulative FDI inflows into manufacturing in Southeast Asia between 2015 and 2025.**

## Project-level investments by Chinese manufacturers

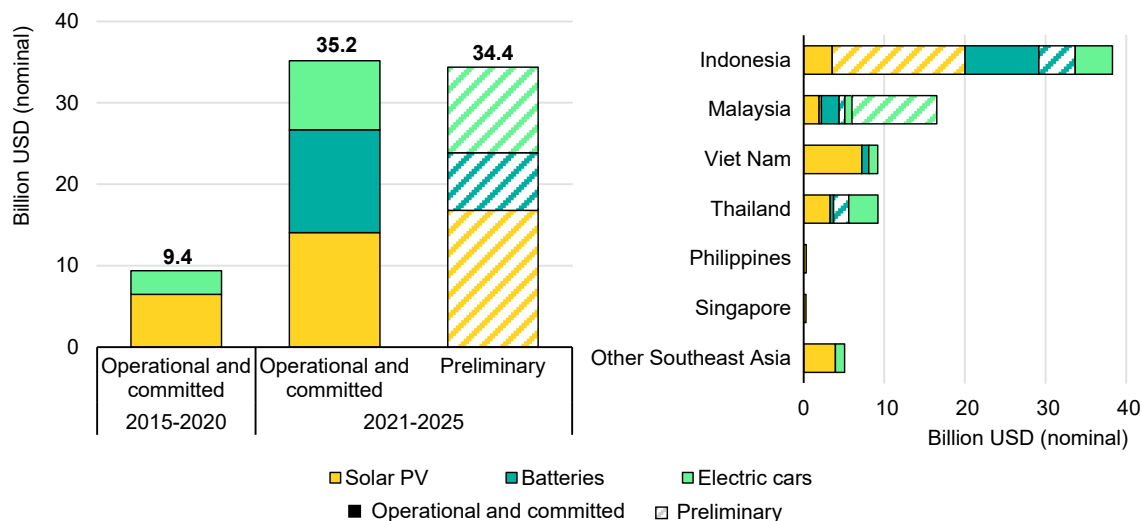
While instructive in observing macro-level trends, manufacturing FDI tells only part of the story. Examining the role of foreign firms and countries in Southeast Asia's industrial base – and its capacity to manufacture clean energy technologies specifically – requires more granular information. FDI datasets primarily track company announcements of cross-border greenfield investment projects and may therefore overlook manufacturing capacity added through subsequent plant expansions, changes in ownership, or facilities identified through specialised industry sources. Building on the work done by the [Net Zero Industrial Policy Lab](#) and [the London School of Economics](#), the IEA has conducted new project-level analysis that tracks factory ownership, new plant construction and capacity expansions to provide a more complete picture. The analysis focuses on China and Chinese firms, which are the largest sources of this project-level investment.

Between 2015 and 2025, Chinese firms invested USD 45 billion in operational and committed manufacturing projects across the region, with a further USD 34 billion announced for preliminary projects. Early investment was heavily concentrated in solar PV manufacturing, which accounted for more than two-thirds of investment value between 2015 and 2020. Since 2021, however, investment has diversified

considerably, with batteries and EVs emerging as major destinations for Chinese firms' capital. As a result, solar PV's share of operational and committed investment has fallen to around 40%, while batteries and EVs together now account for more than half of both realised project value and the current project pipeline. Notably, all preliminary solar PV projects were announced in 2023-2024, and few have since progressed to construction or operation. This suggests that the wave of solar manufacturing announcements has lost momentum in the context of industry-wide overcapacity and a more challenging trade environment (see the [Trade and industrial policy](#) section), raising questions about how much of the current project pipeline will ultimately be realised.

Indonesia has attracted more Chinese clean energy manufacturing investment than any other country in Southeast Asia, accounting for around 22% of operational and committed investment and over 61% of preliminary investment between 2015 and 2025. The country has established a particularly strong position in battery manufacturing, supported by large nickel reserves and policies aimed at capturing more value downstream, including [fiscal incentives for investment](#) and [restrictions on exports of unprocessed nickel ore](#).

**Figure 2.4 Cumulative Chinese project-level investments in selected clean energy technologies by receiving country, project status and technology, 2015-2025**



IEA. CC BY 4.0.

Notes: Committed projects are those that are under construction or have reached final investment decision (FID). Preliminary projects comprise those that have not yet reached FID or whose status is unspecified. For projects with unspecified status, classification is based on the time elapsed since announcement, with a 2-year threshold used to distinguish committed from preliminary projects.

Sources: IEA analysis based on EV Atlas Hub; S&P Global; Rho Motion; Battery Mineral Intelligence; InfoLink; Climate Energy Finance; American Enterprise Institute and Larsen and Xue (2025), [China's Green Leap Outward: the rapid scale-up of overseas Chinese clean-tech manufacturing investments](#).

**Indonesia captured 22% of cumulative Chinese investment in operational and committed projects and 61% in preliminary projects.**

These investments have exposed Southeast Asian operations to certain trade measures and constraints on investment and subsidy access. For instance, [US “prohibited foreign entity” rules](#) governing tax credits for advanced manufacturing make eligibility conditional on a “material assistance cost ratio”. This extends scrutiny beyond country of production to ownership structure and supply chain sourcing from entities controlled by certain foreign governments, including China. This raises compliance costs for facilities embedded in Chinese supply chains and weakens the rationale for using Southeast Asia as an intermediary production base. The investments also create new dependencies, tying much of the region’s capacity to Chinese technology, equipment and expertise. As such, the same ownership and sourcing structures that enabled rapid capacity build-up in the region are becoming a constraint on sustaining it.

## Trade

### Gross trade in clean energy technologies

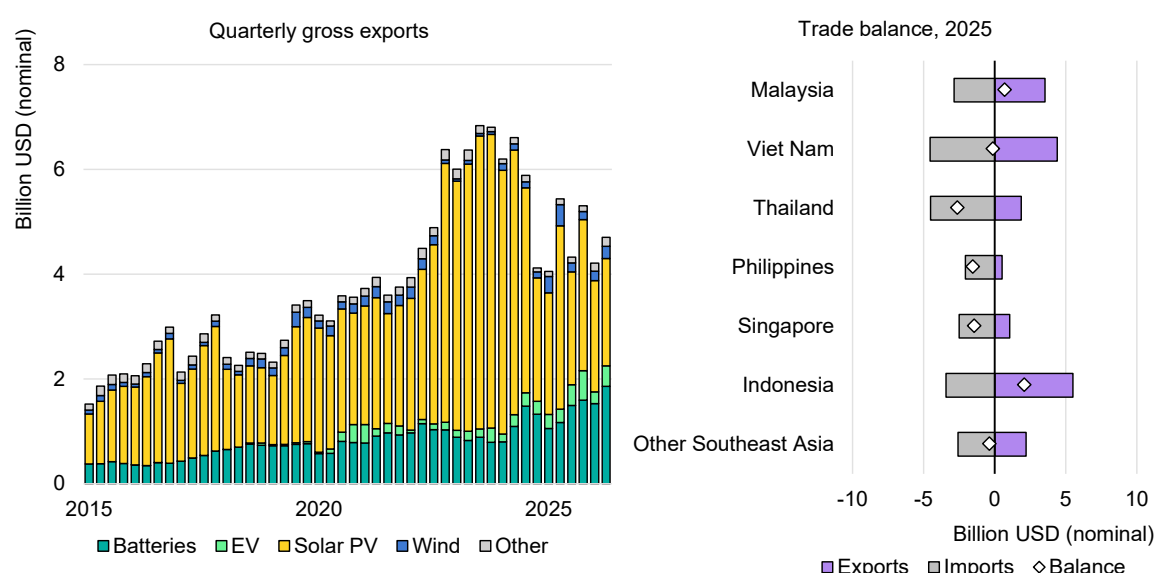
Trade in clean energy technologies has expanded rapidly in Southeast Asia over the past decade. Exports have more than doubled from around USD 7.5 billion in 2015 to approximately USD 19 billion in 2025 – or nearly USD 16 billion when excluding trade within Southeast Asia – with the strongest growth occurring after 2020. The composition of trade has evolved considerably. Consistent with investment trends, solar PV accounted for more than two-thirds of the value up to the late 2010s, whereas recent trade growth is increasingly led by batteries and EVs. Batteries underpin both imports and exports, reflecting the development of regional manufacturing capacity and integration into global value chains.

Southeast Asia’s battery manufacturing capacity stood at around 40 GWh in 2025, accounting for around 1% of the global total. While the region is beginning to develop EV battery manufacturing, a significant share of existing capacity is dedicated to portable electronics batteries, which have been produced in the region for over a decade and account for an additional 16 GWh of installed capacity. However, the recent increase in exports also reflects rising EV battery output, which remains nascent in the region but is expanding. EV exports are still modest, as most vehicle production serves domestic demand, with limited export capacity. Electric car sales in Southeast Asia grew by around 50% in 2024, reaching about 10% of total car sales, and more than doubled in 2025, reaching close to 20% of total car sales (see Chapter 1).

At the aggregate level, trade balances in clean energy technologies point to a concentrated and uneven regional export structure. Export activity and trade surpluses are concentrated in a handful of countries and technologies, while most Southeast Asian economies remain net importers.

In 2025, Indonesia and Malaysia were the only Southeast Asian economies to record a clean energy technology surplus, at around USD 2 billion and USD 0.7 billion, respectively, compared to deficits of approximately USD 2.6 billion in Thailand and USD 1.5 billion in the Philippines. Comparing clean energy technology trade balances with broader merchandise trade balances highlights that success in clean energy value chains does not necessarily mirror a country's overall export performance. Indonesia's clean energy technology surplus is consistent with its broader merchandise trade surplus, which reached [USD 41 billion](#) in 2025. Malaysia and Viet Nam also ran overall goods trade surpluses of [USD 35 billion](#) and [USD 20 billion](#), respectively, in 2025. Thailand and the Philippines both posted an overall goods trade deficit, at around [USD 5.3 billion](#) in the former and [USD 50 billion](#) in the latter, consistent with their positions as net importers of clean energy technologies.

**Figure 2.5 Gross exports of clean energy technologies from Southeast Asia and trade balances by selected country, 2015-H1 2026**



IEA. CC BY 4.0.

Notes: EV = electric vehicle. For 2026, data are available for the first half of the year. Values are compiled from customs data using Harmonized System product categories that best correspond to the clean energy technologies. However, these do not fully align with technology boundaries (e.g. wind towers mapped to “towers and lattice masts” categories or battery-related codes covering multiple applications such as portable consumer electronics). Hence, cross-country comparisons are more robust than absolute levels, as classification constraints are similar across countries. No data are available for electrolyser trade; batteries include only battery cells, and solar PV only modules and cells (for more information please see the [Manufacturing and Trade Model](#) documentation). Values are in gross nominal terms and include intra-Southeast Asia trade. Other includes electrolysers and heat pumps.

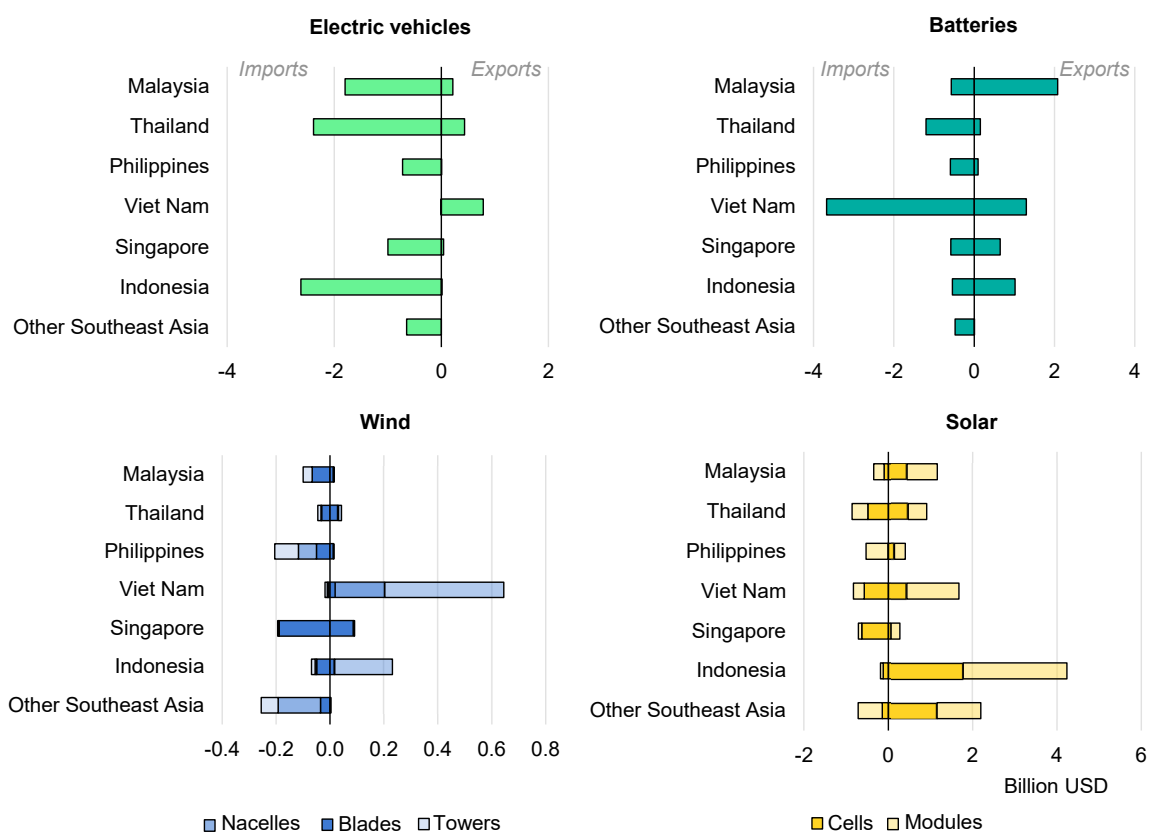
Source: IEA analysis based on data from Global Trade Tracker (2026).

**Solar PV remained Southeast Asia’s largest clean energy technology export in 2025, accounting for nearly USD 11 billion of the region’s USD 19 billion export total.**

Trade balances vary across markets and technology. The region posts a sizeable surplus for solar PV, largely driven by Indonesia, which accounted for nearly

USD 4 billion in net solar PV exports in 2025. Smaller markets such as Singapore, by contrast, run a solar PV trade deficit, at nearly USD 0.4 billion in 2025. For wind, export volumes are smaller and more narrowly distributed: only Viet Nam and Indonesia hold small surpluses in wind energy technology, reaching approximately USD 0.6 billion and USD 0.2 billion, respectively, while the rest of the region remains a net importer of wind technologies. Trade balances in batteries and EVs indicate continued import dependence across most Southeast Asian economies. Viet Nam is the only country in the region with a meaningful EV trade surplus, while Malaysia and, to a smaller extent, Indonesia stand out as net battery exporters. Nevertheless, Viet Nam records the largest battery import deficit, highlighting the continued reliance of its growing EV manufacturing industry on imported batteries and battery components. Indonesia and Thailand also post sizeable EV trade deficits, reflecting strong deployment that continues to outpace domestic vehicle production.

**Figure 2.6 Clean energy technology trade balances by country, 2025**



IEA. CC BY 4.0.

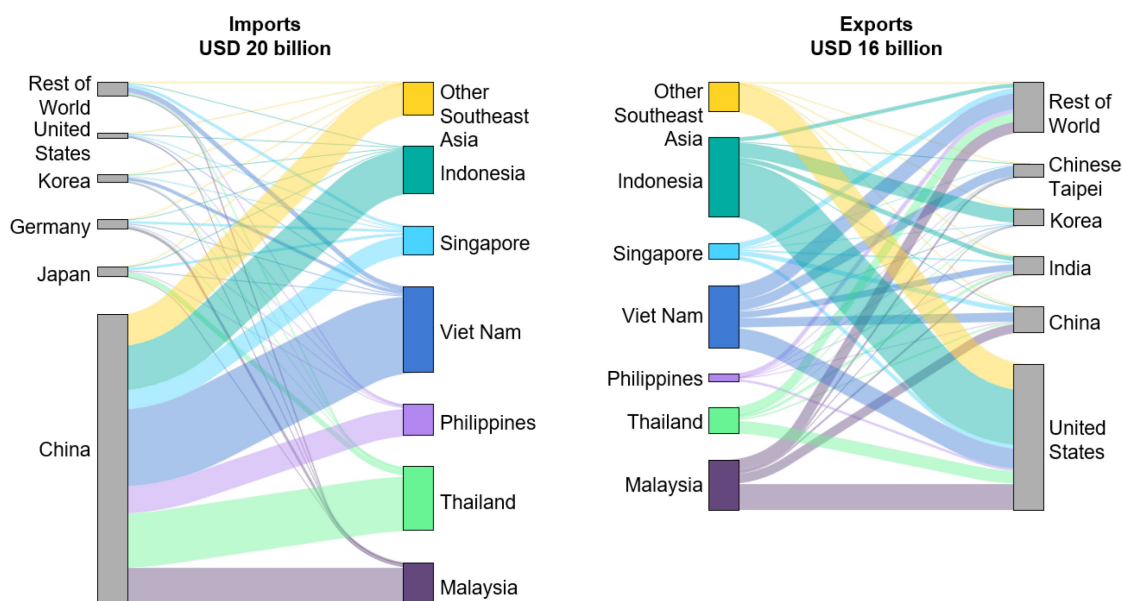
Notes: Values are in nominal terms and include intra-Southeast Asia trade. Wind trade estimates may include non-wind products due to broad HS-6 codes. Wind manufacturing in 2025 was concentrated in tower production in Viet Nam and Indonesia.

Source: IEA analysis based on Global Trade Tracker (2026).

**The region is a net exporter of solar PV modules and cells, with export-to-import ratios of 3:1 for solar and 1:1 for wind, but remains import-dependent for EVs and batteries.**

Southeast Asia operates both as an export hub to the rest of the world and as an integral node for goods trade in key energy technologies within the Asia Pacific region. This position is underpinned by a high degree of concentration in both suppliers and destination markets, leaving trade flows particularly sensitive to changes in industrial, trade and investment policies in a small number of economies. In 2025, excluding intra-Southeast Asia flows, China supplied nearly 90% of the region's imports of key clean energy technologies, highlighting its central role as an upstream supplier of manufacturing inputs. Integration is particularly strong with Thailand and Viet Nam, which together accounted for 40% of regional imports and are tightly connected to Chinese supply chains. On the export side, the United States remained the largest single destination, receiving over half of Southeast Asia's clean energy technology exports. The reliance is most pronounced in solar PV, with around 85% of the region's module exports and two-thirds of its cell exports destined for the US market. The United States is also a significant outlet for other technologies, receiving roughly one-quarter of battery cell exports and one-sixth of battery electric vehicle exports. Demand from wider Asia is nonetheless becoming increasingly important, with China, India and Korea together absorbing over 20% of exports in 2025.

**Figure 2.7 Clean energy technology gross imports and exports by trading partner, excluding intra-Southeast Asia trade, 2025**



IEA. CC BY 4.0.

Notes: Values are compiled based on statistical data on the value of trade collected by customs authorities for product categories that best correspond to the four key clean energy technologies examined (solar PV, electric vehicles, batteries and wind technologies). Both final technologies and their components are included. Values are stated in gross terms and exclude intra-Southeast Asia trade.

Source: IEA analysis based on data from Global Trade Tracker (2026).

**In 2025, the United States absorbed more than half of Southeast Asia's clean energy technology exports, while China supplied nearly 90% of imports.**

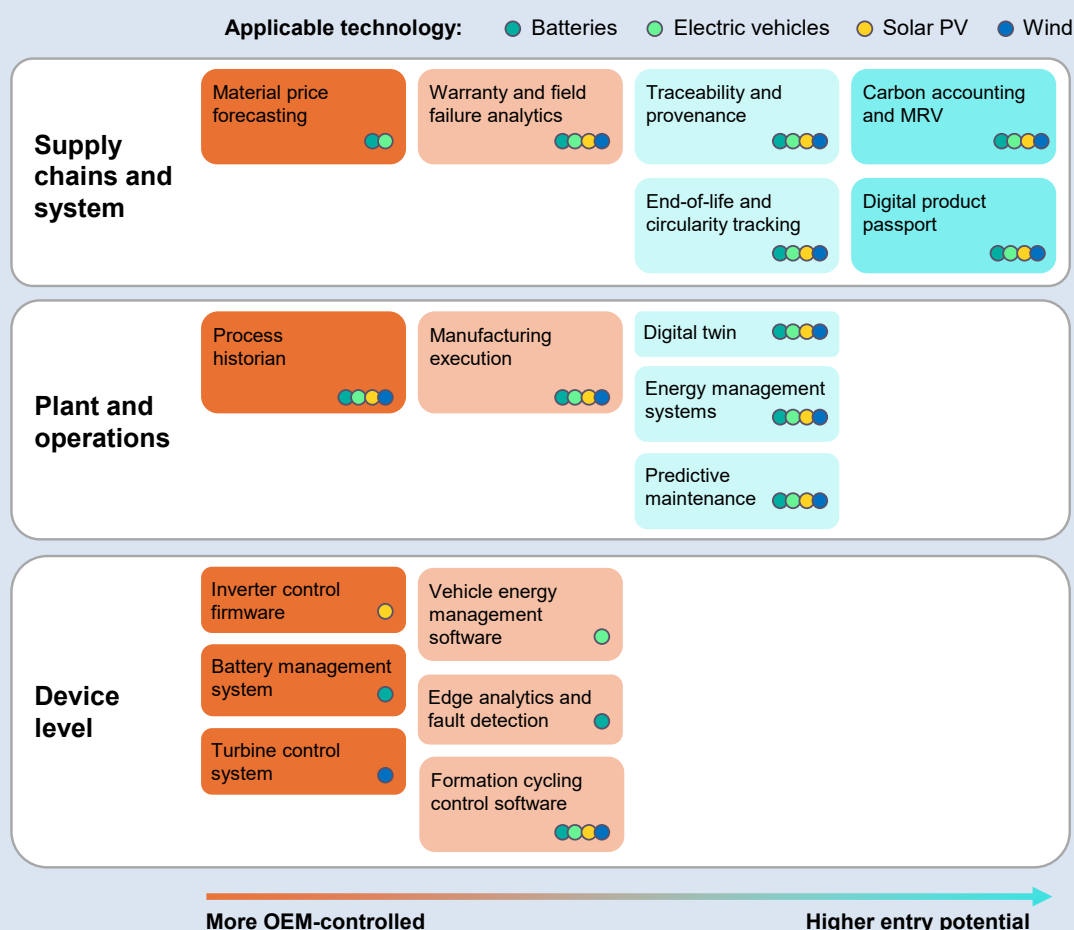
### Box 2.1 Software can open new pathways into clean energy technology supply chains

Participation in technology supply chains is often framed in terms of physical capital, industrial capacity and access to manufacturing equipment. Yet clean energy technologies are increasingly delivered as a combination of hardware, software and services, with a growing share of value embedded in areas such as power electronics control, data management, system optimisation and grid integration. Their deployment also creates opportunities across installation, operation, repair and maintenance, including through digitally enabled services. Together, this provides entry points to energy technology supply chains that are less dependent on capital-intensive manufacturing.

Clean energy software spans several layers. At the device level, embedded software governs how equipment operates, from the performance of solar inverters to the

control of compressors in air conditioners. Beyond the device, software supports manufacturing, monitoring and analytics, enabling real-time performance tracking, fault detection and predictive maintenance. At the system level, software links individual assets to the wider power system, for example through smart charging and vehicle-to-grid applications that optimise electricity flows across networks.

### Role of software across clean technology supply chains



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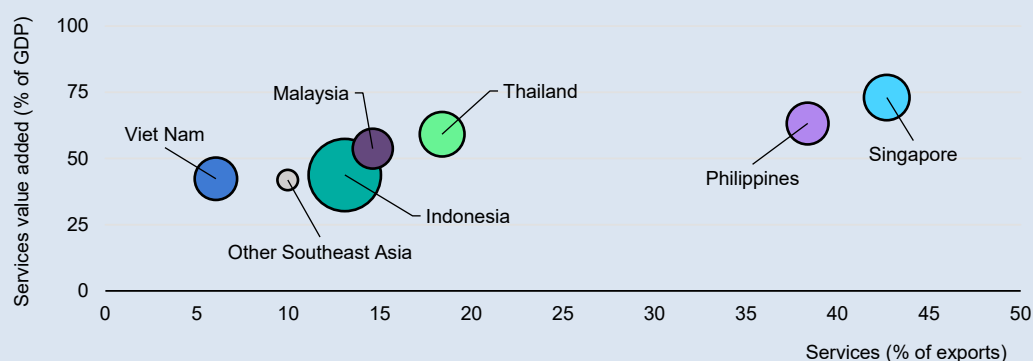
Notes: OEM = original equipment manufacturer; MRV = monitoring, reporting and verifying (in the context of GHG emissions associated with products). The list of software is non-exhaustive. Formation cycling control software manages the charging and discharging of new batteries during manufacturing and ensures they work correctly before leaving the factory. "Digital twin" refers to a virtual representation of a physical asset or process that mirrors its behaviour in real time. A digital product passport contains key information on a product's composition, origin and lifecycle, used to comply with regulatory requirements.

Control over many of these software layers is often maintained by manufacturers, who typically develop and retain software as part of vertically integrated product offerings. Firmware embedded in inverters, battery management systems and turbine controls remains proprietary to leading firms, including Huawei, Sungrow, SMA, CATL, BYD, LG, Vestas, Siemens Gamesa and GE. As a result, importing clean energy equipment often entails dependence on associated embedded software and limits opportunities for independent participation at this level of the value chain.

By contrast, competition is more open in upstream and downstream layers that sit outside the core product. These include manufacturing optimisation, system orchestration and market-facing applications, where capabilities are less tied to hardware production. Firms operating in these segments can integrate across equipment from multiple suppliers and capture value through data, analytics and platform-based services.

The path to generating value from software necessary for clean energy technologies depends on a broad set of capabilities, including skills, innovation, R&D and intellectual property. The potential for countries to do so can be explored by examining the scale of their domestic services activity and their participation in international services markets.

### Services share of exports and services value added as a share of GDP, 2025



IEA. CC BY 4.0.

Notes: Bubble size represents the size of the economy (GDP in current USD). Services include all service industries (ISIC Rev. 4, Divisions 45-99).

Source: IEA analysis based on data from [World Bank Open Data](https://data.worldbank.org/).

Within Southeast Asia, countries differ sharply in their participation in international services markets. Services account for around 40% of exports in Singapore and the Philippines, but only 6-20% in Indonesia, Malaysia, Thailand and Viet Nam, where goods still dominate. By comparison, services make up around 35% of exports in the United States and nearly 50% in India, while China, like most of Southeast Asia, remains heavily goods-oriented, with services representing 12%. Singapore and the Philippines both combine strong service sectors with established export channels, albeit on different foundations: Singapore's exports are concentrated in high value-added businesses, such as financial and other professional services, while the Philippines has built a strong export base in business process outsourcing, information technology and other business services. In goods-exporting economies, services are largely confined to a domestic role. For these countries, the software pathway implies either building export-oriented services capabilities or capturing more value through software within existing manufacturing activities.

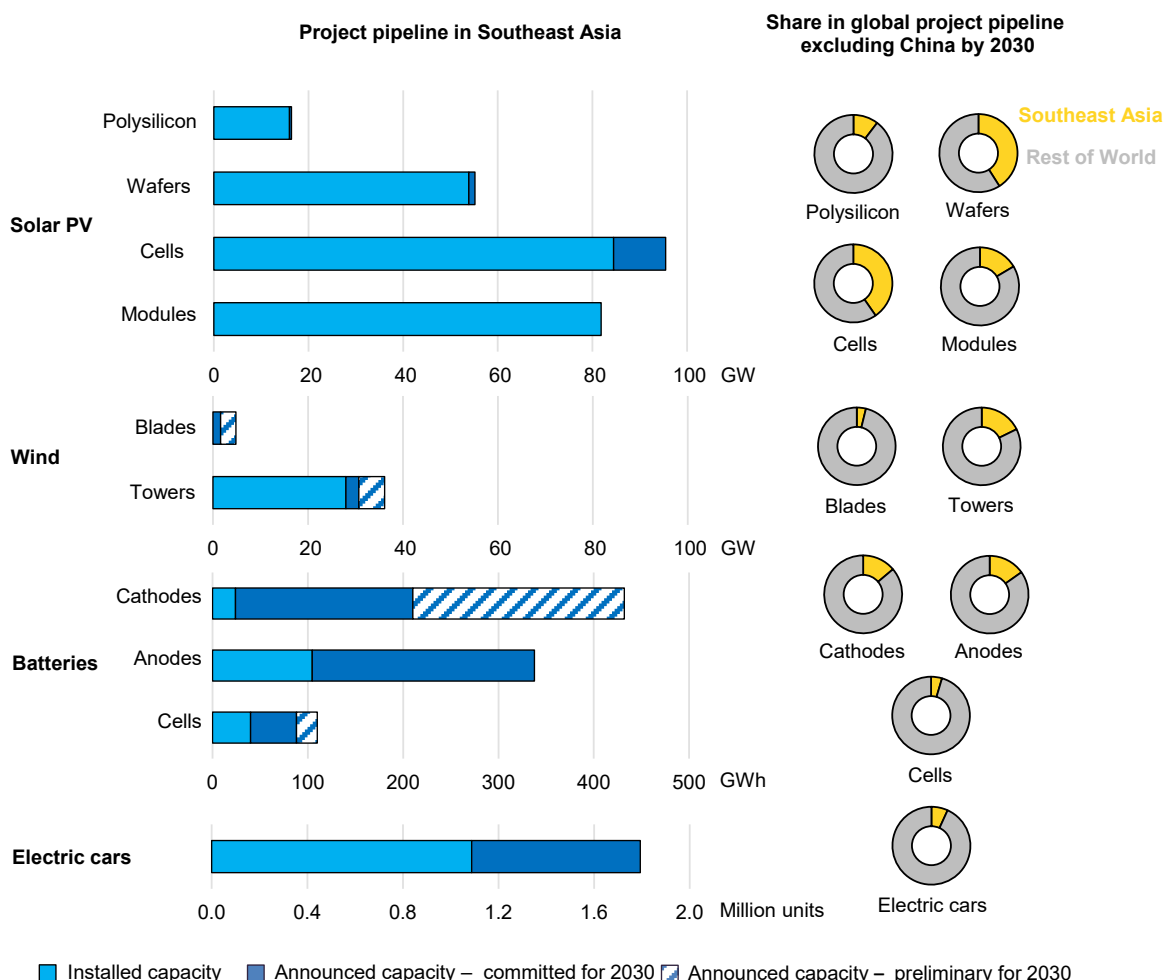
Singapore provides an example of how economies can position themselves in the more contestable software market segments. It has developed niche capabilities in factory digitalisation, with firms such as Vallis Technology Holding specialising in smart manufacturing solutions for electronics production. At the same time, it has emerged as a regional hub for compliance and certification software, including platforms such as REDEX for renewable energy certificates and a broader ecosystem of carbon-accounting providers serving export-oriented manufacturers.

## The existing clean energy technology manufacturing base

### Manufacturing project pipelines

Southeast Asia's solar PV module manufacturing capacity declined from approximately 106 GW in 2023 to over 80 GW in 2025, with nearly one-third of that being located in Indonesia. Installed capacity is projected to fall further to just over 70 GW by 2030 due to a limited project pipeline and ongoing closures among existing plants. The region was among the world's leading manufacturers in 2023, representing roughly 10% of global manufacturing capacity, after China (82%) and ahead of India (2%). Today, it represents less than 6% of global installed manufacturing capacity for modules and cells outside of China. The factors underpinning this decline are discussed in the section on Trade policy measures. Southeast Asia's solar PV manufacturing base is largely operated by companies headquartered outside the region, mostly in China. While cost advantages played a role in the expansion of manufacturing facilities in Southeast Asia, it also coincided with trade measures affecting solar PV modules and components produced in China.

**Figure 2.8 Existing and announced manufacturing capacity for selected clean energy technologies in Southeast Asia, 2025-2030**



IEA. CC BY 4.0.

Notes: The Southeast Asian share of manufacturing capacity outside of China for electric cars refers only to the installed manufacturing capacity. Wind blades refer only to announced manufacturing capacity. The total project pipeline includes currently installed plants and all announced projects. Battery refers to lithium-ion battery cells, accounting for EV batteries and battery energy storage systems. Other applications, such as portable electronic batteries, are excluded from the analysis.

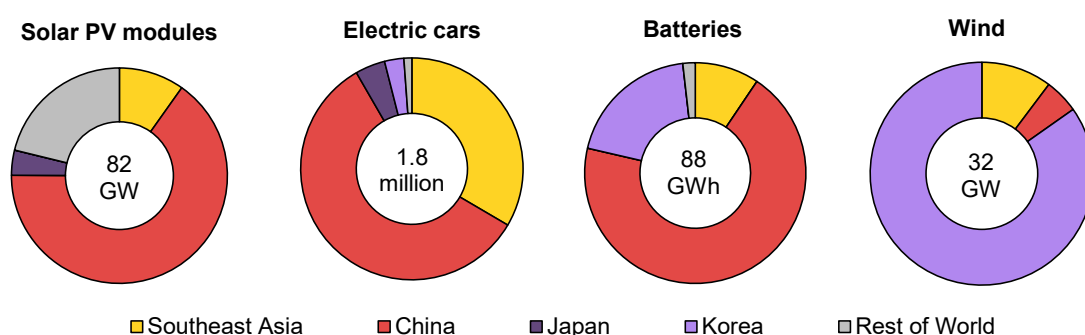
Sources: IEA analysis based on data from Benchmark Mineral Intelligence (2025); BNEF (2025); EV Volumes (2025); InfoLink (2025) and S&P Global (2025).

**Southeast Asia is already a sizeable producer of solar PV modules and towers for wind turbines, and its electric car and battery industries are set to grow substantially to 2030.**

Southeast Asia is home to a sizeable manufacturing base for electric cars, with capacity reaching about 1 million vehicles in 2025. This represents roughly one-eighth of the region's estimated total vehicle manufacturing capacity, including internal combustion engine (ICE) vehicles. Around half of the electric car manufacturing capacity is owned by firms headquartered in China, making the region the largest overseas manufacturing hub for Chinese carmakers. Much of the remaining capacity is concentrated in Viet Nam and owned by VinFast. Although their electric car manufacturing footprint remains comparatively limited,

Japanese and Korean carmakers continue to operate the region's largest ICE vehicle assembly plants and are gradually retooling them for electric car production. Based on the current project pipeline, total electric car manufacturing capacity in the region is set to reach 1.8 million by 2030, with new Chinese-owned facilities accounting for more than 70% of the planned expansion. As a result, Southeast Asia is set to emerge as a regional electric car manufacturing hub, accounting for more than 15% of global production capacity outside of China, Europe and the United States by 2030.

**Figure 2.9 Current and committed manufacturing capacity for selected clean energy technologies in Southeast Asia by location of manufacturer headquarters, 2030**



IEA. CC BY 4.0.

Notes: Wind includes blade and tower facilities. The number inside the doughnut chart represents the total Southeast Asian manufacturing capacity in 2030, including both currently installed capacity and committed project announcements. Committed projects are those that have reached a final investment decision or are under construction. For companies headquartered in a country but owned by a company headquartered in a second country, the second country is considered the ownership location for this analysis. The manufacturing capacity of joint ventures is allocated in proportion to the ownership shares.

Sources: IEA analysis based on data from Benchmark Mineral Intelligence; InfoLink and S&P Global.

**Chinese, Korean and domestic firms are driving investments in solar PV module, wind tower and blade, electric car and battery manufacturing capacity in Southeast Asia.**

The **battery** manufacturing project pipeline is significant, with 48 GWh of announced capacity being committed – either under construction or with a final investment decision (FID) – and a further 22 GWh of planned additions, largely oriented towards the growing regional EV market (see Box 2.2 for a discussion of battery inventories). However, part of the battery ecosystem in Southeast Asia, notably the production of cathode active materials, also serves the battery energy storage system (BESS) market. Indonesia hosts the largest operating lithium iron phosphate (LFP) cathode active material [plant](#) outside China, with LFP chemistry accounting for over 90% of the global BESS market. Chinese and Korean firms are the main drivers of investment in the region, accounting for around 90% of the battery and battery components manufacturing capacity pipeline. Investments come from a diverse set of producers, reflecting broad interest in developing a full battery supply chain in the region, spanning mineral extraction and processing,

battery components and cell manufacturing. These investments, combined with the region's relative cost-competitiveness and duties being imposed on Chinese EV imports in different countries worldwide, are expected to strengthen regional EV and battery supply chains, increase domestic production and create new export opportunities.

**Wind** manufacturing capacity in Southeast Asia remains sizeable but stable at roughly 28 GW for towers in 2025, with no blade or nacelle production. Expansion is expected to be incremental and confined to Viet Nam, with little sign of a forthcoming step change in capacity. Outside of China, Southeast Asia represents about 20% of wind tower manufacturing capacity. Viet Nam hosts the world's largest wind turbine tower factory, operated by Korea's CS WIND. Indonesia also has tower manufacturing capabilities, but at a smaller scale. CS WIND has announced several capacity expansions in Viet Nam, and CRRC, a Chinese blade manufacturer, has [announced](#) plans to open a blade manufacturing facility.

**Table 2.1 Notable examples of manufacturing project announcements and cancellations in Southeast Asia, 2024-2026**

| Company                                             | Headquarters  | Location    | Description                   | Production capacity (GW, GWh or units/year) | Year of completion                                                      |
|-----------------------------------------------------|---------------|-------------|-------------------------------|---------------------------------------------|-------------------------------------------------------------------------|
| <b>Solar PV</b>                                     |               |             |                               |                                             |                                                                         |
| <a href="#">LONGi</a>                               | China         | Indonesia   | Modules                       | 1.6                                         | 2026                                                                    |
| <a href="#">SEG Solar</a>                           | United States | Indonesia   | Cells                         | 3                                           | 2026                                                                    |
| <a href="#">Deye New Energy – Gstar</a>             | Singapore     | Philippines | Modules and cells             | 1                                           | 2026                                                                    |
| <a href="#">Moxeon Solar Technologies</a>           | Singapore     | Malaysia    | Cells                         | 1.8                                         | Cancelled                                                               |
| <a href="#">JinkoSolar</a>                          | China         | Viet Nam    | Modules and cells             | 3 and 4                                     | Cancelled                                                               |
| <b>Batteries</b>                                    |               |             |                               |                                             |                                                                         |
| <a href="#">CATL</a>                                | China         | Indonesia   | Cells and modules             | 6.9 to 15                                   | 2026-2027                                                               |
| <a href="#">REPT BATTERO</a>                        | China         | Indonesia   | Cells                         | 4 to 8                                      | 2027-2029                                                               |
| <a href="#">Zhejiang Huayou Cobalt / EVE Energy</a> | China         | Indonesia   | Cells                         | 20                                          | 2026                                                                    |
| <a href="#">Jiangsu Lopal</a>                       | China         | Indonesia   | Cathode active material (LFP) | Approx. 60 (plant expansion)                | 2026-2027                                                               |
| <a href="#">LG Energy Solution</a>                  | Korea         | Indonesia   | Cells                         | 20                                          | Cancelled ( <a href="#">taken over</a> by Zhejiang Huayou / EVE Energy) |
| <a href="#">Zhejiang YouShan</a>                    | China         | Indonesia   | Cathode active material (LFP) | 25                                          | 2026                                                                    |

| Company                                              | Headquarters        | Location    | Description                   | Production capacity (GW, GWh or units/year) | Year of completion              |
|------------------------------------------------------|---------------------|-------------|-------------------------------|---------------------------------------------|---------------------------------|
| <a href="#">Hunan Yuneng</a>                         | China               | Malaysia    | Cathode active material (LFP) | Approx. 45                                  | 2026-2027                       |
| <a href="#">EVE Energy Co</a>                        | China               | Malaysia    | BESS                          | 5                                           | 2028                            |
| <a href="#">HIGHSTAR</a>                             | China               | Malaysia    | Battery cells                 | 2.5                                         | 2026                            |
| <a href="#">Sunwoda</a>                              | China               | Thailand    | Battery cells                 | NA                                          | NA                              |
| <a href="#">T&amp;T Group</a>                        | Viet Nam            | Viet Nam    | BESS                          | 2 / 10                                      | 2026 (Phase 1) / 2030 (Phase 2) |
| <a href="#">DCH consortium</a>                       | China / Viet Nam    | Viet Nam    | BESS                          | 5                                           | 2028                            |
| <b>Wind energy</b>                                   |                     |             |                               |                                             |                                 |
| <a href="#">CRRC</a>                                 | China               | Viet Nam    | Onshore blades                | 480 units (3 MW)                            | 2026                            |
| <a href="#">CS WIND</a>                              | Korea               | Viet Nam    | Onshore and offshore towers   | 150 000 to 200 000 tonnes                   | NA                              |
| <b>Electric cars</b>                                 |                     |             |                               |                                             |                                 |
| <a href="#">XPeng Inc. / EP Manufacturing Berhad</a> | China / Malaysia    | Malaysia    | EV                            | NA                                          | 2026                            |
| <a href="#">Leapmotor / Stellantis</a>               | China / Netherlands | Malaysia    | EV                            | 60 000                                      | 2026                            |
| <a href="#">BYD</a>                                  | China               | Malaysia    | EV                            | NA                                          | Paused                          |
| <a href="#">Mitsubishi Motors</a>                    | Japan               | Philippines | EV (PHEV only)                | NA                                          | 2028                            |
| <a href="#">Hyundai</a>                              | Korea               | Thailand    | EV                            | 5 000                                       | 2026                            |
| <a href="#">Mazda Motor Corporation</a>              | Japan               | Thailand    | EV (PHEV only)                | 100 000                                     | 2027                            |
| <a href="#">BYD</a>                                  | China               | Indonesia   | EV                            | 150 000                                     | 2026                            |
| <a href="#">VinFast</a>                              | Viet Nam            | Indonesia   | EV                            | 50 000 (Phase 1) / 350 000 (Phase 2)        | 2026 (Phase 1) / NA (Phase 2)   |
| <a href="#">Chery (Omoda &amp; Jaecoo)</a>           | China               | Viet Nam    | EV                            | 120 000                                     | 2026                            |
| <a href="#">Geely</a>                                | China               | Viet Nam    | EV                            | 75 000                                      | 2026                            |
| <b>Electrolysers</b>                                 |                     |             |                               |                                             |                                 |
| <a href="#">HET Hydrogen</a>                         | Singapore           | Singapore   | Stacks                        | 1 MW                                        | 2024                            |
| <b>Air conditioners</b>                              |                     |             |                               |                                             |                                 |
| <a href="#">Midea</a>                                | China               | Indonesia   | AC                            | 1 million                                   | 2024-2026                       |
| <a href="#">Daikin</a>                               | Japan               | Indonesia   | AC                            | 1.5 million                                 | 2025                            |
| <a href="#">Midea</a>                                | China               | Thailand    | AC                            | 4 million                                   | NA                              |
| <a href="#">Haier</a>                                | China               | Thailand    | AC                            | 4 million                                   | 2025 (Phase 1) / 2027 (Phase 2) |

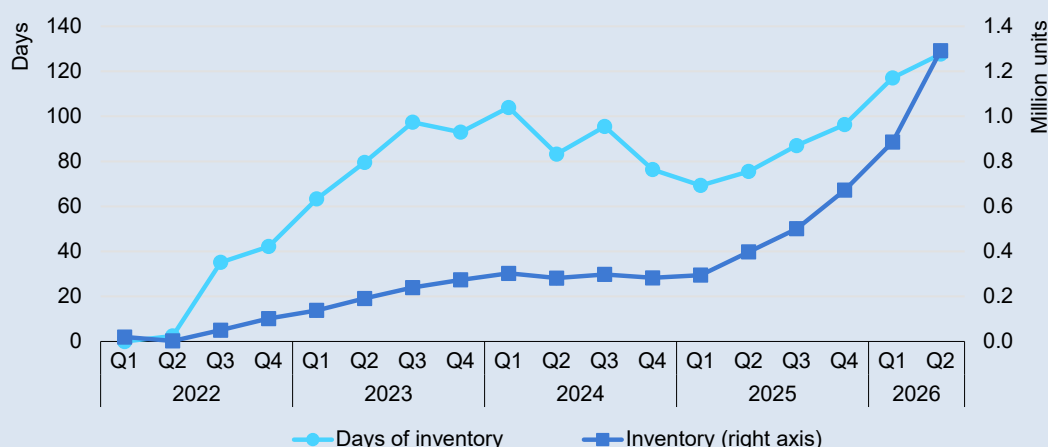
Notes: BESS = energy storage system. LFP = lithium iron phosphate; PHEV = plug-in hybrid electric vehicle; AC = air conditioner. Manufacturing projects include announced projects, projects under construction and planned expansion (only the additional capacity in GW is reported). Cancelled projects are also reported. Production capacity for EV manufacturing projects refers to overall vehicle production capacity including conventional vehicles.

Sources: IEA analysis based on data from Benchmark Mineral Intelligence (2025); BNEF (2025); EV Volumes (2025); InfoLink (2025) and S&P Global (2025).

## Box 2.2 Growing inventories in the EV and battery markets

Inventories of electric cars, EV batteries and BESS have increased in recent years, driven mainly by abundant manufacturing capacity in China, expectations of strong demand growth and response to changes in trade policy settings. Inventories can serve multiple purposes, including strengthening security and resilience by providing a buffer against supply disruptions, anticipating tariff and duty changes, and sustaining the utilisation of excess capacity. Maintaining inventories at a certain level reflects normal operational practice, as shipping a car or a battery from China to Europe or the Americas can take 30 to 60 days, depending on the route.

### Overseas inventories of electric cars manufactured in China, 2022-Q2 2026



IEA. CC BY 4.0.

Notes: Initial inventory in Q2 2022 is assumed to be zero. Inventory levels are derived by considering the difference between data on Chinese vehicle exports and independent figures on their overseas sales. Days of inventory is calculated as the ratio of the inventory level to daily sales and represents the number of days needed to fully draw down inventories in the absence of additional supply.

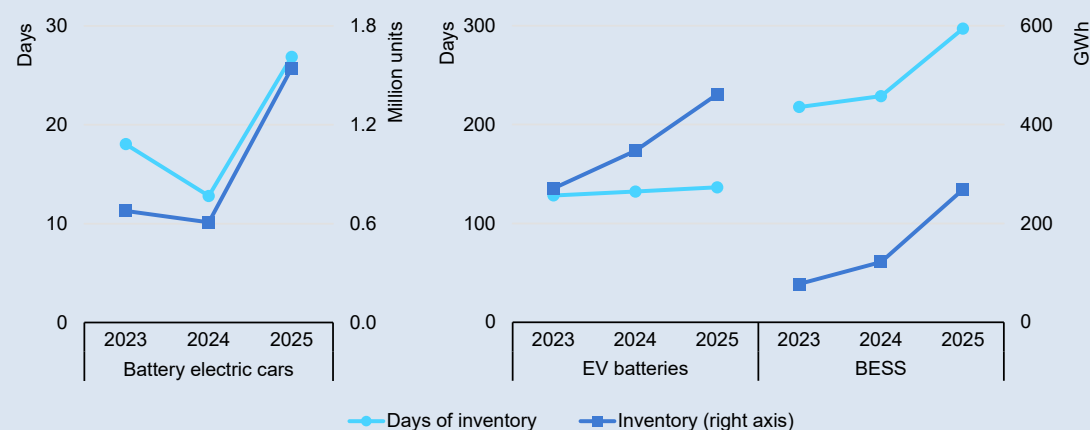
Sources: IEA analysis based on data from [EV Volumes](#), [CAAM](#) and [CPCA](#) (used for electric car exports).

Overseas inventories of Chinese electric cars increased sharply in early 2026, exceeding 1.2 million by the second quarter (Q2) of 2026. This is equivalent to more than three-quarters of total global electric car inventories at the end of 2025. While factors such as unreported registrations in some destination markets and the inclusion of completely knocked-down kits in Chinese trade data may explain small portions of this increase, the sharp build-up suggests that overseas registrations are not keeping pace with shipments. As these factors are not fully captured in the data, the estimated gap should be regarded as an upper bound.

This trend has coincided with a slump in China's domestic EV market, which has increased pressure on the country's carmakers to seek alternative sales channels overseas. Export volumes were also boosted by shipments brought forward ahead of tariff changes at the end of 2025 in key destination markets, including Brazil, Mexico and Southeast Asia. Because many of these exports failed to translate into actual registrations, overseas inventory levels for Chinese electric cars reached

around 130 days of sales in Q2 2026, nearly 70% higher than the level estimated for a year earlier. This build-up was the main driver behind the sharp increase in global EV inventories; global days of inventory had already doubled year-on-year by the end of 2025.

### Estimated global inventories of battery electric cars, electric car batteries and battery energy storage systems, 2023-2025



IEA. CC BY 4.0.

Notes: EV = electric vehicle; BESS = battery energy storage systems. Inventory is derived using the difference between global production and global registrations (or deployment in the case of batteries). Days of inventory is the ratio of global inventory to global daily registrations (or deployment in the case of batteries).  
Sources: IEA analysis based on data from EV Volumes, Rho Motion, BNEF and CRU.

For batteries, inventories are estimated to have reached over 450 GWh for EV batteries and over 250 GWh for BESS by the end of 2025. Although EV battery stocks were larger in absolute terms, they represented around 4-5 months of the 2025 annual deployment, part of which reflects the time lag between battery shipment and vehicle production. By contrast, estimated BESS stocks have grown sharply over the past 2 years, reaching nearly 10 months of inventory at the end of 2025, double the level of EV batteries. This indicates a growing supply-demand imbalance in the BESS market, despite the record growth rate of BESS installations – in 2025, BESS installations were two-and-a-half times those in 2023. This imbalance is likely to have contributed to the sharp decline in BESS prices, with global average prices in 2025 falling by 30% compared with 2024.

## Cost competitiveness

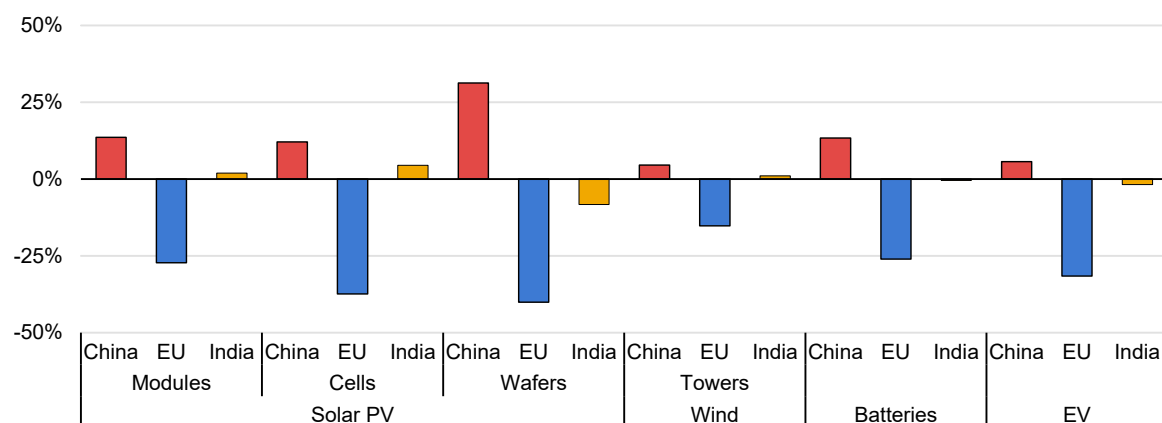
For some clean energy technologies, Southeast Asia is approaching the same level of manufacturing cost as China, which is currently the most cost-competitive producer of all the clean energy technologies examined in this report. Across the solar PV and battery supply chains, estimated production costs in Southeast Asia are typically 15% higher on average than in China, positioning the region lower on the cost curve than the European Union in parts of these supply chains. These relatively small gaps can sustain export competitiveness under open trade

conditions, but they remain highly exposed to policy shocks: new tariffs and trade measures can quickly erase the underlying cost differentials observed today.

Estimated levelised costs of production (LCOP) suggest that Southeast Asia is quite close to cost parity with Indian producers for some solar PV components though not yet with Chinese producers.<sup>5</sup> The difference with China ranges from below 15% for cells and modules to 30% for wafers. However, compared to India – which Southeast Asia competes with in large export markets – the region is virtually at production cost parity.

Southeast Asia has potential to become a competitive production base outside of China for batteries, with estimated production costs typically only around 10% higher than China’s and about 25% lower than in the European Union. The gap with China could narrow further as battery production scales up in the region. The region’s relative cost-competitiveness is driven mainly by lower battery component and material costs, as well as lower labour and energy costs. Indonesia and Malaysia are emerging as important battery manufacturing hubs, and investment is also expanding in Viet Nam. Beyond batteries, Southeast Asia also appears relatively competitive in EV and wind tower manufacturing, with estimated production cost premiums of around 5% relative to China.

**Figure 2.10 Manufacturing cost differential for clean energy technologies in Southeast Asia relative to selected regions, 2025**



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Notes: EU = European Union. The analysis is based on the levelised cost of production (LCOP), which corresponds to the price that would have to be charged per unit of production to achieve a net present value of zero for a given investment. A positive value indicates that Southeast Asia has higher production costs than the comparator, while a negative value indicates that it has lower costs.

**Differences in manufacturing costs between Southeast Asia and other regions vary widely across technologies, ranging from near cost parity to gaps of around 15-30%.**

<sup>5</sup> See the [Manufacturing and Trade Model](#) documentation for more details.

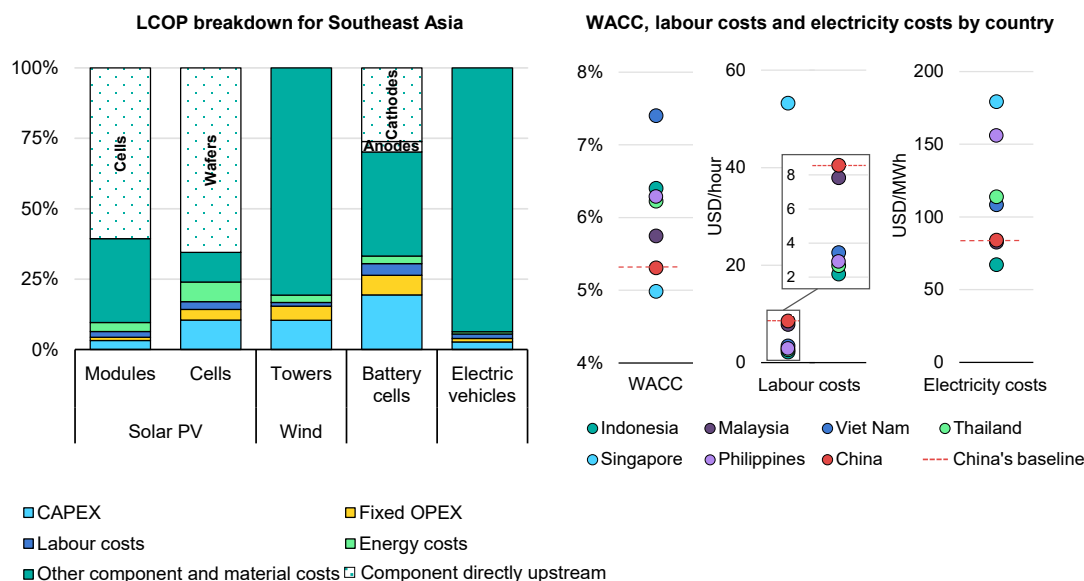
Materials and components account for 60-95% of the LCOP across all major clean energy technologies. Scale, purchasing power in procurement and supply chain integration are therefore key levers for driving cost advantages. By comparison, labour, energy and financing account for a smaller share of total costs. However, while material costs remain relatively stable across the region, labour, energy and financing conditions vary significantly and create meaningful differences in relative cost positions.

Energy prices for industry display clear differences between countries. The contribution of energy costs varies significantly across supply chain steps. Energy accounts for around 50% of total costs in polysilicon production, compared with around 5% in solar PV module manufacturing. In batteries, energy represents around 30% of anode material costs and around 5% of cell manufacturing costs. For instance, Indonesia records some of the lowest industrial electricity prices, at around USD 67/MWh, lower than those in China, while Singapore sits at the upper end of the range. Low industrial electricity prices in Indonesia reflect regulations and state intervention in the power sector, including cross-subsidisation and domestic resource policies.

Labour costs also differ across countries. Indonesia has the lowest, at around USD 2 per hour, while Singapore reaches USD 53 per hour, at the top of the range. This gap reflects differences in cost structures, with Singapore incorporating higher non-wage components, including social contributions and compliance costs. Labour costs across most of Southeast Asia remain well below China's, but at only around 5% of total costs, labour alone is not sufficient to close the cost gap with China.

Financing conditions also differ markedly. The weighted average cost of capital (WACC) – a standard indicator capturing the cost of debt and equity financing and their respective shares – stands at around 7.5% in Viet Nam, compared with 5% in Singapore. By contrast, WACC in advanced economies typically falls within the 3-4% range. This has important implications as even relatively small changes in WACC can significantly affect annualised financing costs. A USD 1 billion investment with a WACC of 5% and a 15-year depreciation period translates into annualised capital costs of around USD 95 million. Increasing the WACC to 10% raises this figure to approximately USD 130 million – making the WACC one of the largest drivers of overall capital expenditure.

**Figure 2.11 Breakdown of the levelised cost of production and its key components for selected clean energy technologies in Southeast Asia, 2025**



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Notes: OPEX = operating expenditure; CAPEX = capital expenditure, including the cost of financing; WACC = weighted average cost of capital; LCOP = levelised cost of production. Batteries refer to lithium-ion batteries; costs are based on the global sales-weighted average battery chemistry sales. Indirect manufacturing costs are excluded from this analysis. Electricity cost represents the total electricity price for industry. Labour costs are an average for the four key clean energy technologies (i.e. solar PV, electric vehicles, batteries and wind) for 2024. WACC is shown in real terms. Electricity prices are for 2024.

Sources: IEA (2026), [End-use Energy Prices](#); Damodaran, A (2013), [Cost of Capital by Sector](#).

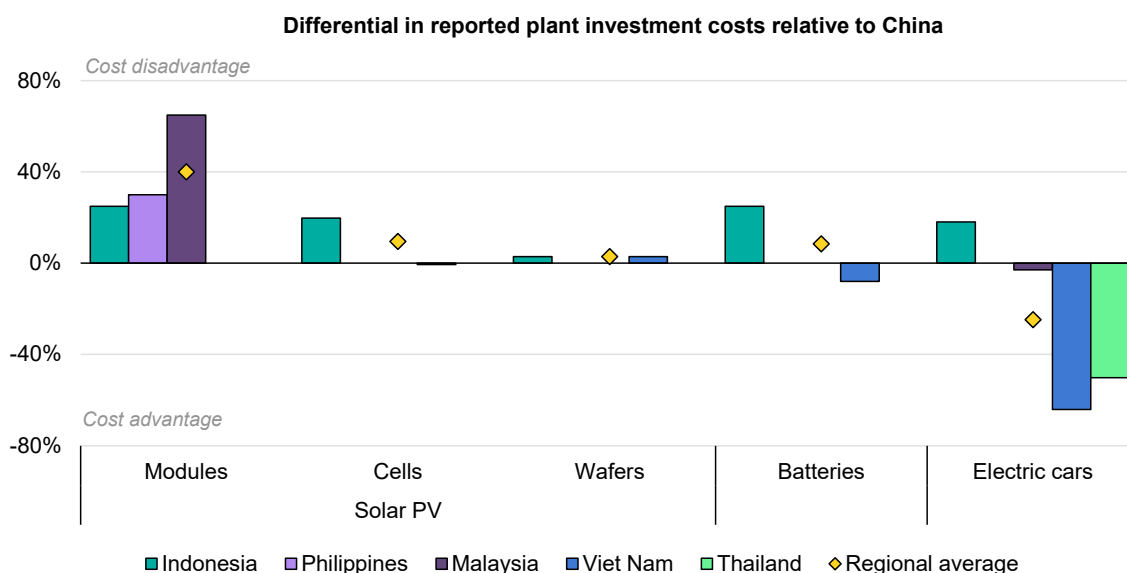
**Southeast Asia's labour costs are typically lower than China's, whereas energy and financing costs differ markedly by country and are typically higher.**

In addition to financing costs, there are differences in the capital required to build manufacturing facilities.<sup>6</sup> Relative to China, capital cost intensity varies considerably across technologies and countries. In battery cell and EV manufacturing, project-level investment requirements in several Southeast Asian countries are estimated to be close to, or below, those observed in China. Viet Nam records the lowest estimated capital costs for both battery cells (-8% compared to China) and electric cars (-64%), while Thailand also shows substantially lower estimated investment intensity for electric cars. However, these comparisons should be interpreted with caution, as part of the difference may reflect the nature of the announced projects rather than underlying construction costs alone. Many of these projects are vehicle assembly facilities, not fully integrated manufacturing plants, and exhibit a sizeable cost advantage (-50%).

<sup>6</sup> To assess these differences, project-level investment announcements were compiled and normalised by nameplate production capacity. The resulting estimates provide an imperfect proxy for overnight capital expenditure, as announced project costs may include expenditures beyond facility construction and are not reported consistently across projects. They should therefore be interpreted as indicative measures of capital investment intensity rather than precise estimates of construction costs.

Solar PV presents a more mixed picture, with Viet Nam close to parity with China for wafer and cell manufacturing, but with estimated investment intensity for modules higher than in China (+65% for Malaysia and +25% for Indonesia).

**Figure 2.12 Estimated capital costs per unit of manufacturing capacity for selected clean energy manufacturing projects in Southeast Asia compared to China, 2025**



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Notes: Capital costs per unit of manufacturing capacity are estimated using the year of announcement, the announced capacity and reported investment value. Investment costs are converted into constant 2025 USD using market exchange rates and country-specific GDP deflators. They are compared to the capital cost available to manufacturing investors in China ("absolute capital expenditure"). Regional average represents the simple average across the countries for which data are available.

Source: IEA analysis based on project announcements.

**EV manufacturing exhibits the strongest competitiveness on capital costs relative to China, with estimated investment costs below Chinese levels in most countries.**

## Industrial proximity and comparative advantage

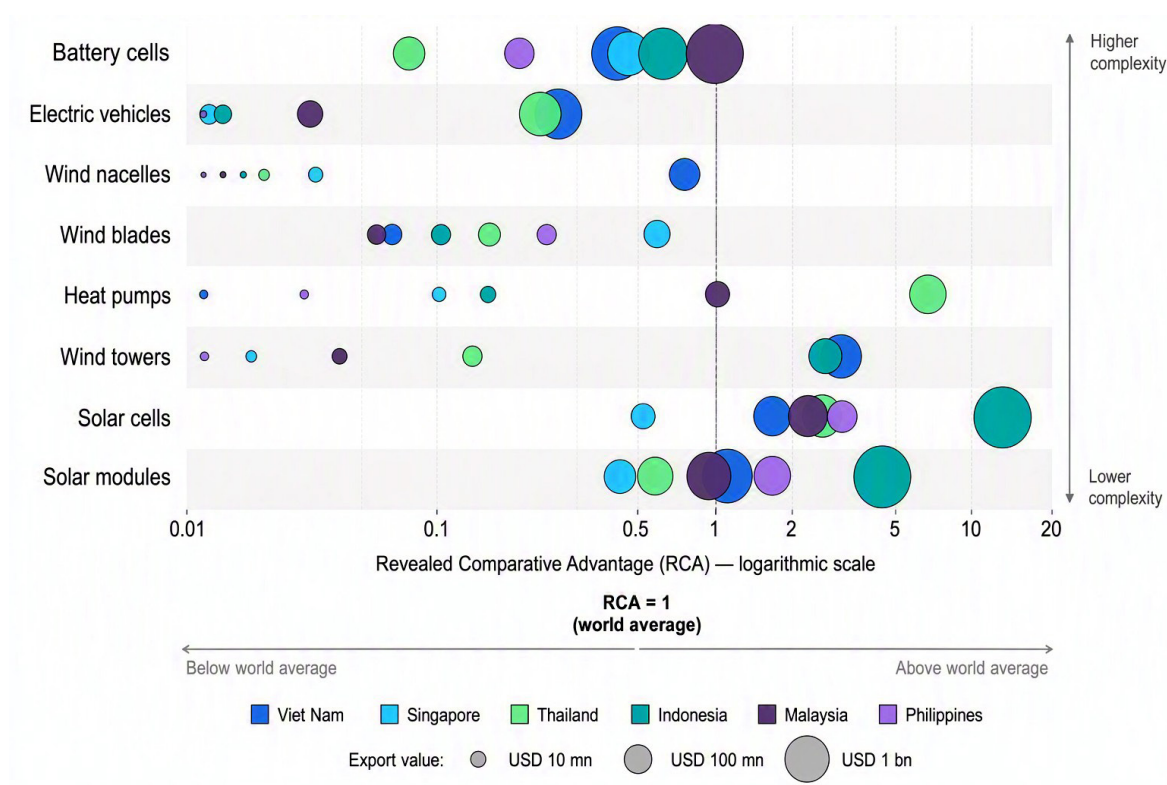
The economic case for clean energy manufacturing extends beyond production costs. These industries generate wider benefits through several channels. Clean energy technology manufacturing already represents an important source of energy-sector employment in Southeast Asia, with further growth expected as investment tilts towards more labour-intensive battery and EV production.

Policy makers must consider both whether a manufacturing activity can generate broader economic benefits and whether existing industrial capabilities provide a realistic foundation for developing the technology in question. These two dimensions do not always align. Technologies associated with more sophisticated manufacturing capabilities may offer greater opportunities to move into higher-value manufacturing activities yet may be further removed from a country's

existing industrial base. Conversely, technologies that are closer to existing capabilities may be easier to develop but offer more limited opportunities for economic transformation.

Two indicators can help assess these dimensions. Revealed comparative advantage (RCA) measures a country's export position compared with the global average, indicating relative competitiveness. The Product Complexity Index (PCI), meanwhile, measures the sophistication of the capabilities associated with producing and exporting a given product. A comparison of these indicators suggests that Southeast Asia's strongest competitive positions are not always concentrated in the most complex clean energy technologies.

**Figure 2.13 Revealed comparative advantage and Product Complexity Index, 2025**



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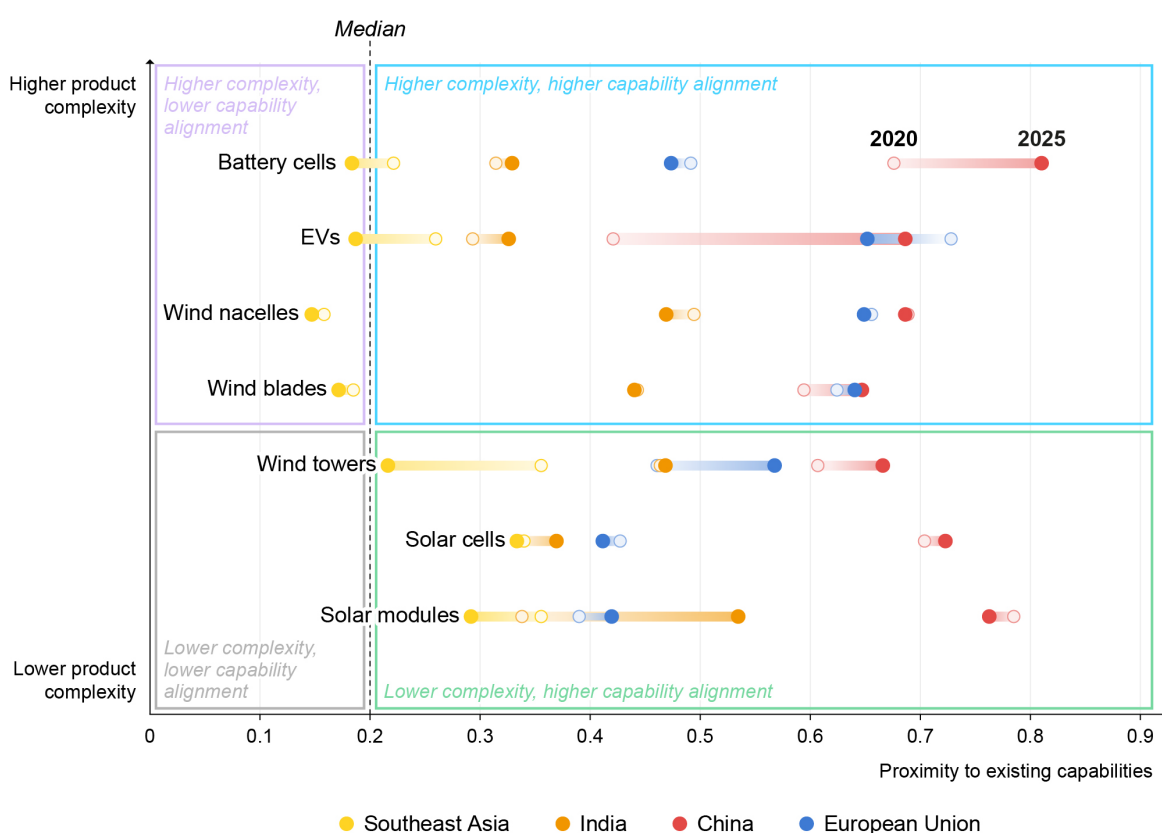
Notes: The revealed comparative advantage (RCA) index is calculated as the ratio of a product's share in a country's exports to that product's share in global trade, indicating relative specialisation compared with the world average. An RCA above 1 indicates a comparative advantage. The Product Complexity Index (PCI) provides a ranking of products derived from patterns of specialisation in global trade data and is a helpful proxy for product sophistication. It is built from two dimensions of the binary RCA export matrix: a product's ubiquity (the number of countries that export it with RCA > 1) and the diversity of the countries exporting it (the number of products each of those countries exports with RCA > 1). Bubble size reflects each country's total exports of that product in USD. Bubble sizes are comparable across all products. For the list of HS codes used by technology, see the [Manufacturing and Trade Model](#) documentation. The analysis is based on individual HS6 product categories.

Source: IEA analysis based on data from Sinoimex (2026).

**Southeast Asia displays clear export competitiveness in solar PV manufacturing and could cross the threshold in battery cell manufacturing.**

In the solar PV supply chain, most countries in the region feature RCA values above 1, indicating that solar PV products account for a larger share of their exports than they do in global trade on average. This suggests a degree of export specialisation in this industry. Yet some solar PV components also sit in lower-complexity segments, generally associated with limited economic benefits. Battery cell manufacturing, by contrast, lies at the higher end of the complexity spectrum, with Indonesia and Malaysia – where most regional investment has been directed – exhibiting stronger competitiveness. This suggests a potential entry point for further capability upgrading as domestic capacity expands.

**Figure 2.14 Product Complexity Index and proximity to countries' existing industrial bases, 2020 and 2025**



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Notes: Proximity to existing industries measures how close a given product is to a country's existing comparative-advantage product mix and is calculated following the methodology of [Hidalgo et al. \(2007\)](#). Horizontal separation of the quadrants represents the median product complexity index (PCI) for the clean energy products and components examined. Vertical dashed line represents the median proximity score for Southeast Asia across all products and components examined. Changes in PCI between 2020 and 2025 were generally modest across technologies, with polysilicon, batteries, nacelles and blades showing only limited movement. The notable exceptions were solar cells and solar modules, whose PCI fell sharply, and, to a lesser extent, wind towers. For Southeast Asia, the dot represents the country with the highest proximity score rather than the regional average. The European Union is pooled as a reporting region with intra-EU trade removed. Source: IEA analysis based on data from Sinoimex (2026).

**Batteries and EVs are emerging as the most viable entry point into higher-complexity clean energy technology manufacturing for countries in Southeast Asia.**

The picture is more mixed across other clean energy technologies. EVs combine relatively high complexity with limited comparative advantage, which is reflected in the region's position as a net importer. Wind components show a more dispersed pattern of capabilities, with no clear export specialisation emerging across countries.

The relationship between product complexity and proximity to existing capabilities indicates where a country may be best positioned to expand its clean energy technology manufacturing base. Proximity to existing industries estimates how close a given product is to a country's existing comparative-advantage product mix. A higher score suggests that the capabilities required to produce it are more closely aligned with the capabilities already reflected in the country's export structure, and is generally associated with a higher likelihood of developing competitiveness in that product.

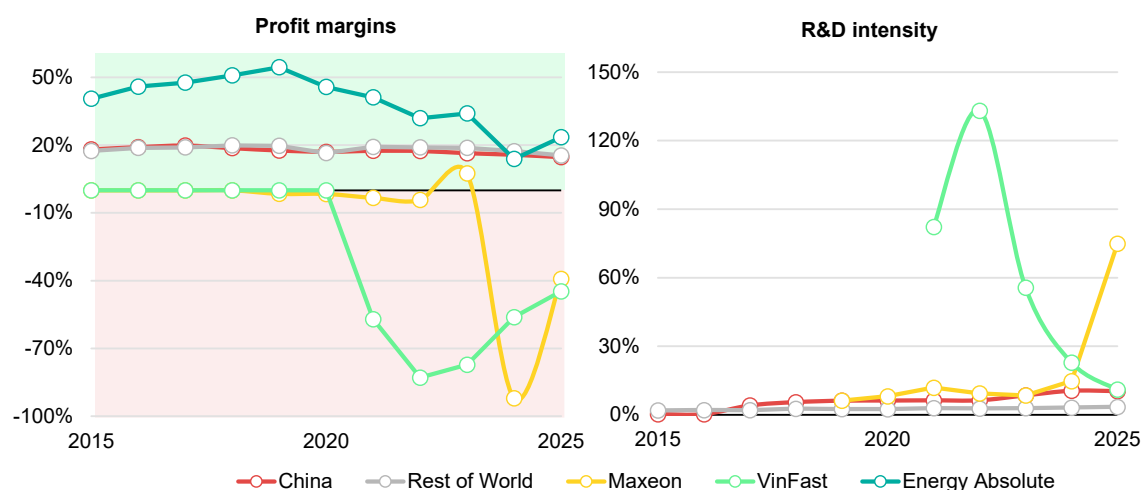
While several clean energy technologies exhibit high levels of complexity, only a limited number are closely aligned with Southeast Asia's current industrial structure. Among the technologies assessed, battery cell and EV manufacturing offer Southeast Asia the clearest opportunities for industrial upgrading. They combine relatively high product complexity with a strong foundation of existing capabilities. In addition, growing domestic demand from the rapidly expanding EV market provides a favourable environment for further industrial development. Malaysia and Thailand show the strongest alignment between proximity to existing capabilities and higher-complexity technologies.

## Profitability of domestic manufacturers

Southeast Asia's clean energy technology manufacturing base is largely dominated by companies headquartered outside the region, particularly in China. Domestic participation remains limited across most clean energy supply chains, with the notable exception of Viet Nam's VinFast, which accounts for more than 40% of the region's electric car manufacturing capacity. Companies headquartered in Southeast Asia represent only around 10% of solar PV and wind manufacturing capacity, and 20% for batteries. Only a handful of firms produce at scale, including Thailand's Energy Absolute, which operates the region's first battery gigafactory. However, both Energy Absolute and VinFast remain [loss-making](#) and are affected by ongoing [governance concerns](#). Similarly, Singapore-based solar manufacturer Maxeon entered [insolvency proceedings](#) in 2024 following the imposition of US trade restrictions. Beyond these larger companies, many manufacturers in the region, such as IDN Solar Tech in Indonesia and Vina Solar in Viet Nam (acquired by LONGi in 2021), are privately held and ultimately controlled by parent companies headquartered overseas.

Aggregate profit margins for the Southeast Asian peer group are far more volatile than those of Chinese and other international manufacturers, swinging from profitability in 2020 to deep losses by 2021. The combination of weak profitability and unusually high R&D intensity suggests that the region's domestic champions are still in a capital-intensive catch-up phase, with innovation spending concentrated in a very small number of firms and not yet matched by stable earnings power. This position is made more challenging as some foreign markets, notably the United States for solar PV, become less accessible. Southeast Asia has produced a few ambitious clean energy technology firms but does not yet have a financially resilient layer of domestic manufacturers able to scale profitably across technologies.

**Figure 2.15 Profit margins and R&D intensity for selected clean energy technology manufacturing companies headquartered in China and Southeast Asia, 2015-2025**



IEA. CC BY 4.0.

Notes: The basket includes companies operating in the solar, wind, battery and EV industries. Maxison (Singapore), VinFast (Viet Nam) and Energy Absolute (Thailand) were singled out as companies headquartered in Southeast Asia. Sources: IEA analysis based on data from Bloomberg; Capital IQ (2026) and companies' financial reports.

**The combination of unstable margins and high R&D intensity points to a home-grown industrial base that is still nascent.**

# Trade and industrial policy

## Trade policy measures

### Tariffs and duties on clean energy technologies

Recent trade tensions have been characterised by the targeted use of tariffs, anti-dumping (AD) measures and countervailing duties (CVDs) along certain supply chains. While such measures are not new, they have become increasingly concentrated in a relatively small number of sectors considered critical for economic security, technological leadership or supply chain resilience. In this context, trade policy is being used not only to protect domestic producers from import competition, but also to influence where manufacturing activity takes place and how supply chains are structured. Southeast Asia's clean energy technology industries illustrate this trend.

For Southeast Asian exporters, the **United States** is by far the most restrictive destination market. Trade-weighted tariffs and duties on solar PV imports have risen sharply in recent years, peaking at around 300% in 2025 before declining to roughly 61% on average in 2026. These levels far exceed underlying production cost differences between China and Southeast Asia, fundamentally altering sourcing and investment decisions rather than merely compressing profit margins. The effects are evident in the solar PV sector: manufacturing in Cambodia, Malaysia, Thailand and Viet Nam initially expanded as companies sought to avoid restrictions on Chinese exports, but these countries later became subject to AD and CVD measures (see next section). Although exposure is lower in other clean energy technology industries, tariffs remain significant, averaging around 50% for wind equipment, 25% for EVs, 26% for batteries and around or below 10% for heat pumps and electrolyzers.

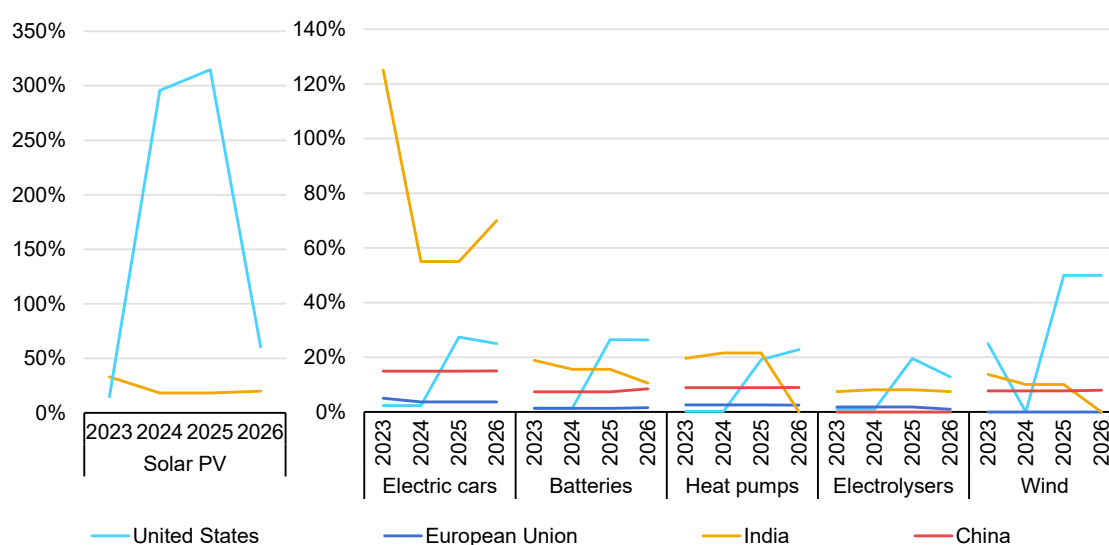
**India's** tariff structure varies considerably across technologies and is closely aligned with its industrial policy objectives. Higher duties on products such as EVs and certain solar components are intended to promote domestic manufacturing by reducing reliance on imports. Instead of being a potential export market, India is evolving into a competitor in export markets – especially for solar PV.

By contrast, **China** maintains relatively low tariffs on imports of most clean energy technologies, typically below 15%. Yet the market holds little promise for Southeast Asian exporters given its immense and fiercely competitive manufacturing base.

The **European Union** presents a less stringent tariff environment. Tariffs and duties generally range between 0% and around 4% across most clean energy technologies, including for EVs, where CVDs remain significantly lower than those

imposed by the United States. As a result, the European Union remains a relatively stable export market for technologies such as solar PV, batteries, heat pumps and electrolyzers. However, lower tariffs do not necessarily translate into unrestricted market access. Increasingly, access depends on compliance with non-tariff requirements, including sustainability standards, carbon footprint criteria and supply chain due diligence obligations, as exemplified by the proposed [Industrial Accelerator Act](#). These requirements may prove particularly challenging for manufacturers with strong links to China-centred value chains.

**Figure 2.16 Announced trade-weighted average tariff and duty rates on imports of clean energy technology manufactured in Southeast Asia by importing region, 2023-2026**



IEA. CC BY 4.0.

Notes: Announced trade-weighted tariff rates are calculated using announced tariffs, anti-dumping duties and countervailing duties in force for each technology, weighted by import values. Changes in trade-weighted tariff rates may therefore reflect shifts in import composition and trade volumes, in addition to changes in tariff schedules. For example, the decline in the trade-weighted tariff rate for solar PV imports into the United States reflects lower imports from highly tariffed sources rather than a reduction in import barriers.

Source: IEA analysis based on country announcements as of August 2026.

**Southeast Asia's solar PV industry has been particularly exposed to shifts in US trade policy, whereas other regions' tariffs have remained comparatively stable.**

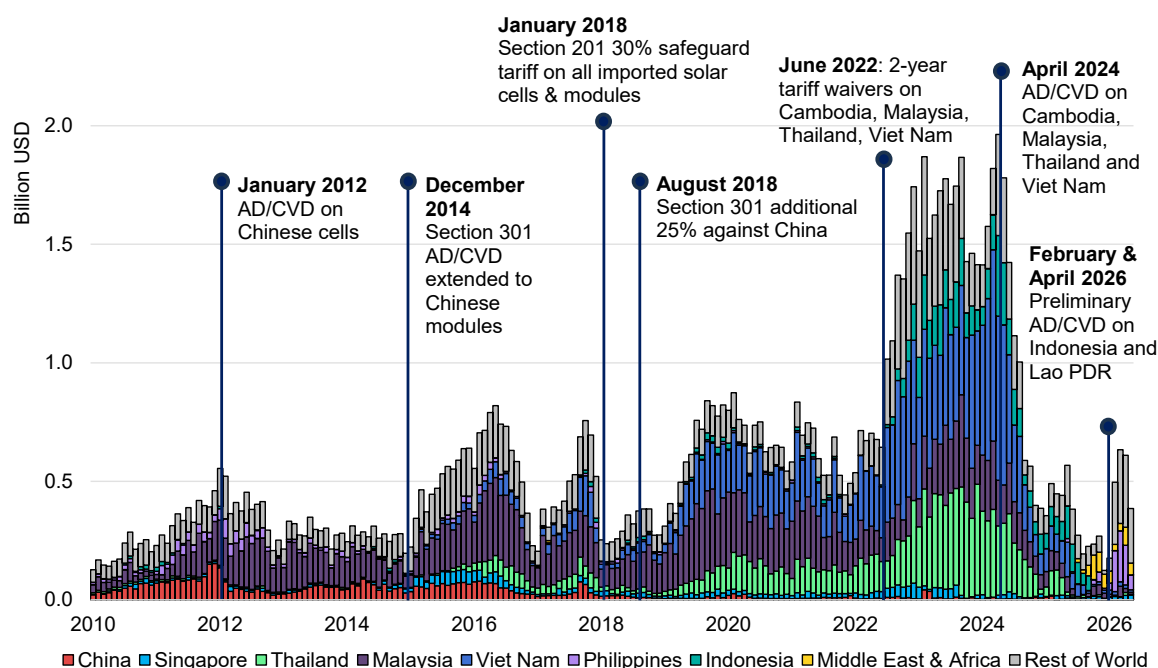
## Effects of US trade and industrial policies on solar PV manufacturing

The development of solar PV manufacturing in Southeast Asia has been driven by foreign investment aimed at serving export markets, the United States in particular. At its peak in 2023, the United States absorbed nearly 50 GW of imports from the region, representing approximately 90% of Southeast Asia's output in GW terms that year. However, following the Southeast Asia [AD/CVD ruling](#) in April 2025, sourcing began to reconfigure.

Reflecting these changing trade conditions, several China-headquartered manufacturers – including JinkoSolar, Risen Energy, LONGi and JA Solar – have [announced](#) plant closures, cut production or halted expansion plans in Cambodia, Malaysia, Thailand and Viet Nam. At the same time, manufacturing capacity and exports increasingly shifted towards other countries in the region. By the third quarter of 2025, Indonesia and Lao PDR had become the leading suppliers of solar PV modules to the US market, accounting for nearly half of total imports.

The rerouting of solar PV exports prompted a further round of trade enforcement by the United States. In February 2026, the US Department of Commerce issued preliminary CVD determinations for Indonesia (86-143%) and Lao PDR (81%). This was followed by preliminary AD margins released on 23 April 2026 for Indonesia (35%), Lao PDR (22%) and India (123%). These determinations prompted further supply-side adjustment, with additional project cancellations and capacity retrenchment.

**Figure 2.17 Monthly US imports of solar PV modules and international trade policy announcements, 2010-H1 2026**



IEA. CC BY 4.0.

Note: AD = anti-dumping; CVD = countervailing duties.

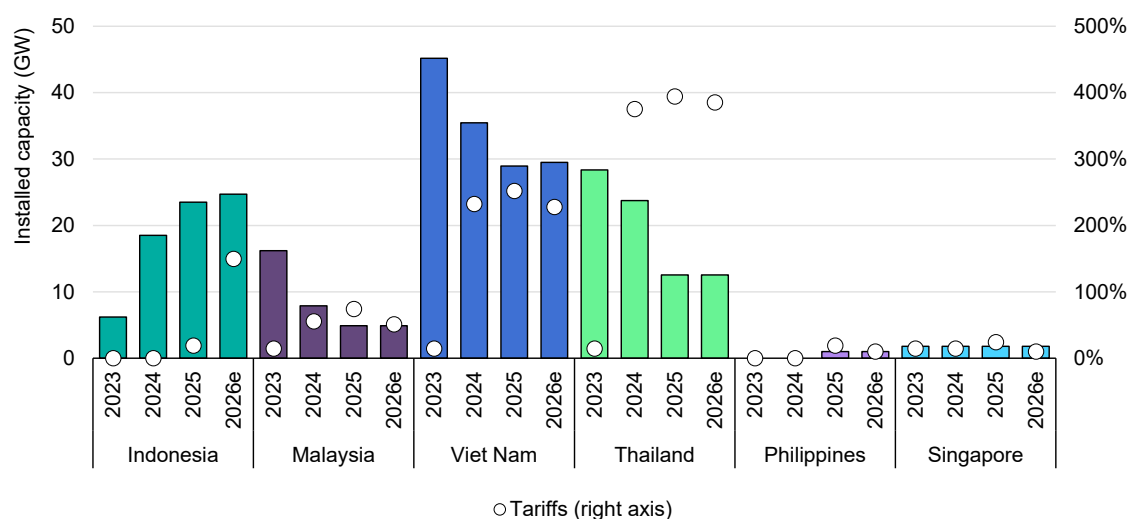
Sources: IEA analysis based on data from Sinoimex and Global Trade Tracker (2026).

**Trade policy announcements are redrawing the map of US solar PV imports, but imports from new suppliers only partly offset lower imports from traditional suppliers.**

These trade measures are taking their toll on manufacturing. Between 2023 and 2026, particularly following the 2025 AD/CVD measures, installed capacity

declined by around 35% in Viet Nam, 56% in Thailand and 70% in Malaysia, while capacity in Indonesia – initially outside the scope of the measures – continued to expand. As trade restrictions extended to alternative production locations, options to relocate capacity within the region vanished. The result has been a shift from reallocation towards outright contraction.

**Figure 2.18 Solar PV module manufacturing capacity and announced trade-weighted average tariff and duty rates on US imports of solar PV modules, 2023-2026e**



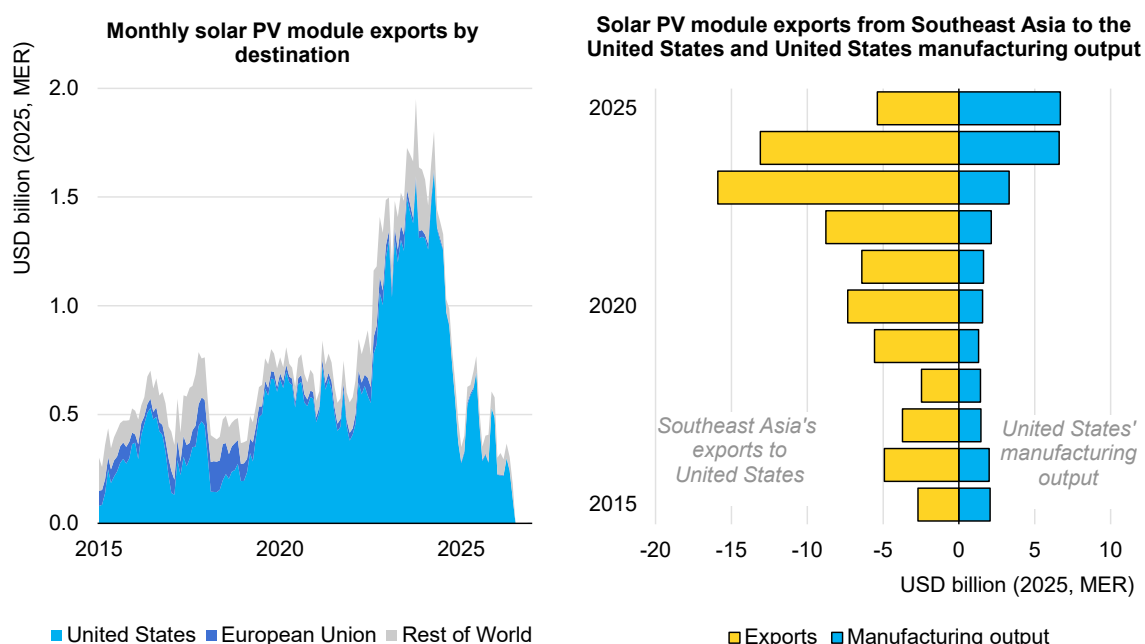
IEA. CC BY 4.0.

Sources: IEA analysis based on data from InfoLink (2026) and [White House](#) tariff announcements.

**In Thailand and Viet Nam, which face some of the highest tariffs, installed manufacturing capacity decreased by approximately 56% and 35%, respectively, between 2023 and 2026.**

The decline in Southeast Asian solar PV exports to the United States has not been offset by a rerouting of shipments to other markets. The value of modules exports to the United States declined by USD 11.5 billion from 2023 to 2025 and there was no meaningful change in exports to the European Union or other countries. At the same time, the United States rapidly expanded its domestic module manufacturing, with output reaching almost 34 GW in 2025, equivalent to around USD 7 billion. Together, these trends suggest that imports from Southeast Asia are increasingly being replaced by US production rather than by imports from alternative suppliers.

**Figure 2.19 Monthly solar PV module exports from Southeast Asia by destination and US module manufacturing output, 2015-2026e**



IEA. CC BY 4.0.

Notes: MER = market exchange rate. Export data for 2026 are available up to June 2026.

Source: IEA analysis based on data from Global Trade Tracker (2026).

**Southeast Asia's solar PV module exports fell from close to USD 16 billion at peak to a trickle in the first half of 2026, coinciding with a ramp-up in US module manufacturing.**

## Regional trade agreements

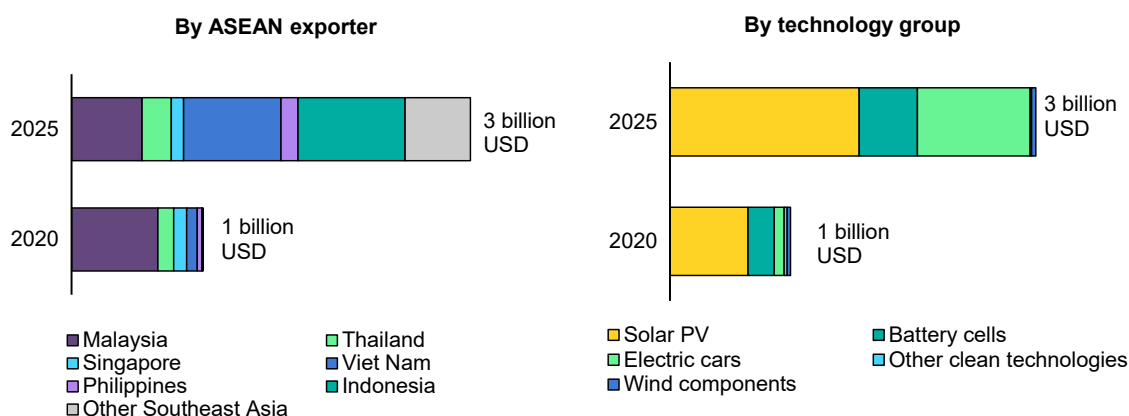
The Association of Southeast Asian Nations (ASEAN)'s trade integration has deepened steadily since the launch of the [ASEAN Free Trade Area](#) in 1992. Tariff liberalisation began with the initial six ASEAN members (Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore and Thailand), which reduced more than 99% of tariff lines to the [0-5%](#) range by 2003. Cambodia, Lao PDR, Myanmar and Viet Nam followed under longer transition periods, with all commitments subsequently consolidated under the 2009 [ASEAN Trade in Goods Agreement](#). By 2025, tariffs had been eliminated on [99%](#) of intra-ASEAN tariff lines, leaving only a small number of sensitive agricultural and industrial products outside the agreement. This deepening engagement is evident in clean energy technologies, where intra-ASEAN trade increased from USD 1 billion of total exports in 2020 to nearly USD 3 billion in 2025, reflecting increasingly integrated regional supply chains.

ASEAN's trade relationship with China is shaped by two overlapping frameworks. The [ASEAN-China Free Trade Area](#), established through a series of agreements between 2002 and 2025, progressively reduced trade restrictions, supporting

preferential market access for most goods. These arrangements have been complemented by the [Regional Comprehensive Economic Partnership](#) (RCEP), a broader 15-country agreement signed in 2020 and in force since 2022, which covers the ASEAN members plus Australia, China, Japan, Korea and New Zealand. It aims to eliminate tariffs on over 90% of traded goods. Although tariff reductions under RCEP are significant, its main contribution lies in harmonising rules of origin across participating economies, allowing manufacturers to source inputs from multiple RCEP members while retaining preferential market access. Exports of clean energy technologies from ASEAN countries to the other RCEP members increased by roughly 35% between 2020 and 2025, reaching around USD 3 billion in 2025.

Beyond ASEAN-centred integration initiatives, Southeast Asian economies have increasingly deepened their participation in regional and plurilateral trade frameworks. The [Comprehensive and Progressive Agreement for Trans-Pacific Partnership](#) provides Southeast Asian economies with preferential access to major markets outside the region, including Australia, Canada, Japan and Mexico. The agreement also includes provisions on investment, services and regulatory co-operation that extend beyond traditional tariff liberalisation. Brunei Darussalam, Malaysia, Singapore and Viet Nam are already members, and preparatory discussions for the accession of Indonesia and the Philippines began in 2026.

**Figure 2.20 Intra-regional gross exports in Southeast Asia by selected technology category and exporter, 2020 and 2025**



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Source: IEA analysis based on data from Global Trade Tracker (2026).

**Compared to 2020, when Malaysia accounted for nearly 70% of intra-ASEAN exports, mainly through solar PV exports, more ASEAN countries are now technology exporters.**

Across all clean energy technologies, solar PV faces the lightest tariff burden within the region, consistent with the deep integration of ASEAN solar manufacturers into Chinese supply chains. Tariff rates on electric cars differ the

most. Battery electric passenger vehicles imported into Thailand from China benefit from a 0% preferential tariff rate, compared with preferential rates of 20% for Japan and 40% for Korea, against Thailand's 80% most-favoured-nation tariff. On the other hand, Indonesia has maintained most-favoured-nation tariffs of 50% on fully assembled vehicles and 10% on partially assembled kits, making it one of the few economies in the region where Chinese exporters face a meaningful tariff barrier on EVs. Indonesia previously offered a temporary tax exemption to manufacturers committing to establish local production and meet applicable local-content requirements, valid through end-2025. However, from 2026, beneficiaries are required to produce domestically in volumes equivalent to their imports. In Viet Nam, following an investigation into below-cost pricing by Chinese exporters, the government imposed a [97% anti-dumping duty](#) on wind towers from China in December 2024, effective for 5 years.

**Table 2.2 Trade-weighted tariff rate imposed by Southeast Asian countries on clean energy technology imports by exporting region, 2026**

| Product       | Indonesia |     | Malaysia |     | Philippines |     | Singapore |     | Thailand |     | Viet Nam |     |
|---------------|-----------|-----|----------|-----|-------------|-----|-----------|-----|----------|-----|----------|-----|
|               | CHN       | RoW | CHN      | RoW | CHN         | RoW | CHN       | RoW | CHN      | RoW | CHN      | RoW |
| Solar PV      | 0%        | 0%  | 0%       | 0%  | 0%          | 0%  | 0%        | 0%  | 0%       | 0%  | 0%       | 0%  |
| Wind          | 0%        | 12% | 15%      | 2%  | 0%          | 0%  | 0%        | 0%  | 10%      | 6%  | 97%      | 4%  |
| Electric cars | 33%       | 33% | 0%       | 0%  | 0%          | 0%  | 0%        | 0%  | 0%       | 29% | 19%      | 13% |
| Batteries     | 0%        | 8%  | 10%      | 7%  | 0%          | 4%  | 0%        | 0%  | 10%      | 7%  | 0%       | 4%  |
| Heat pumps    | 0%        | 9%  | 18%      | 6%  | 0%          | 13% | 0%        | 0%  | 2%       | 3%  | 0%       | 14% |
| Electrolysers | 0%        | 5%  | 0%       | 0%  | 0%          | 0%  | 0%        | 0%  | 0%       | 0%  | 0%       | 0%  |

Notes: CHN = China; RoW = Rest of World, excluding Southeast Asia and RCEP countries (Australia, China, Japan, Korea and New Zealand).

## Non-tariff measures and soft trade constraints

### Non-tariff measures and market access

Non-tariff measures (NTMs) also shape trade by setting product requirements and market entry conditions. Measures include technical regulations and standards, as well as procedural requirements such as inspections or licensing, which can raise compliance costs and constrain market access. While NTMs are often introduced for safety, environmental or consumer protection purposes, they can also reflect broader policy objectives. For example, Indonesia has [stated](#) that its import standards for solar PV modules are intended to support the competitiveness of its industries. While such requirements can encourage domestic industrial development, they can also increase compliance costs for foreign suppliers seeking access to the market.

Comparing NTMs across countries requires looking beyond the simple, absolute number of measures in place. Some NTMs apply across a broad range of products, while others target specific technologies or individual product categories. To account for these differences, a specificity-weighted NTM index is used in this analysis. This gives greater importance to measures affecting a narrow, specific set of products and less importance to measures that apply widely across an economy. The index captures the regulatory requirements imposed by each major market, irrespective of trading partners, and therefore provides a comparison of regulatory burden faced by all exporters seeking to access that market.

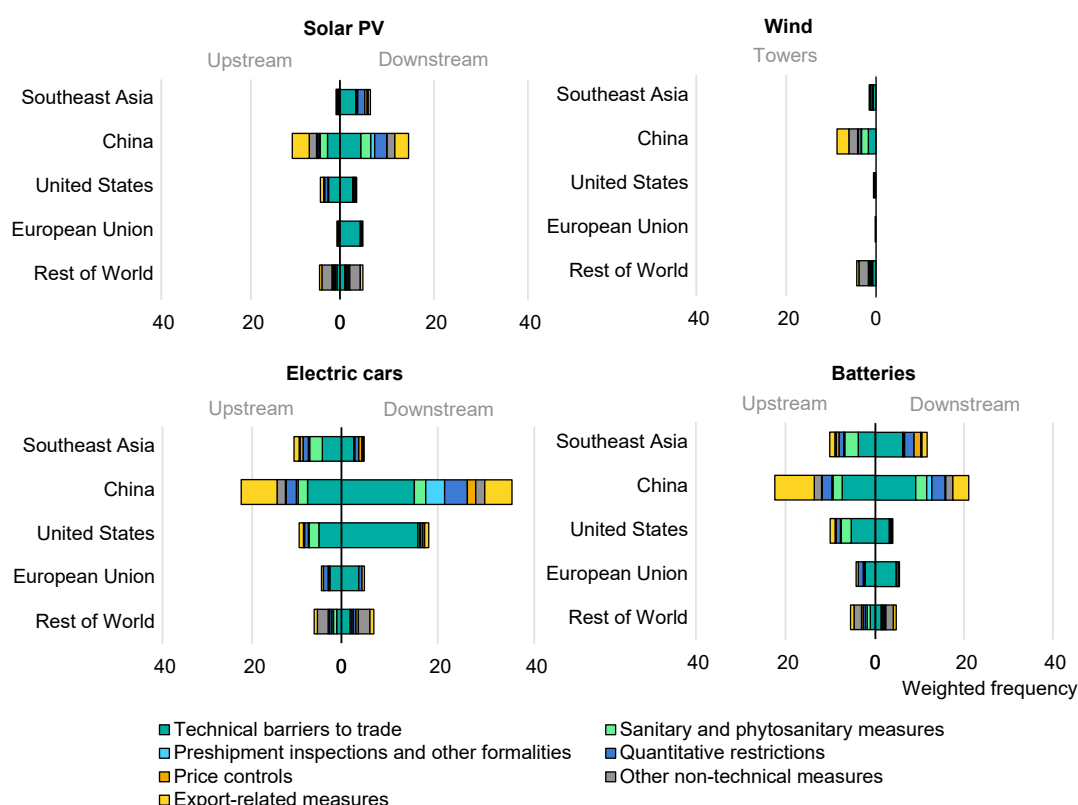
The index reveals important differences in the use of NTMs across major markets. China applies by far the largest number of measures, although these are generally broad in scope and spread across many product categories rather than tailored to specific clean energy technologies. Nevertheless, China remains at or near the top of the specificity-weighted index for most technologies, indicating that the overall regulatory burden is comparatively high. The European Union generally exhibits lower NTM burden, although its measures are concentrated on specific products. Similarly, Southeast Asian economies generally impose fewer measures in absolute terms, but these are often concentrated on specific products and technologies. This pattern suggests a targeted use of NTMs as part of broader industrial and downstream development strategies, rather than economy-wide trade protection. Within Southeast Asia, Thailand stands out, with NTM exposure levels comparable to or exceeding those of China for batteries, wind, heat pumps and electrolyzers. Indonesia presents a similar pattern of targeted intervention, relying on product-specific technical standards linked to its downstream industrial strategy. Approaches of this kind can also be observed elsewhere in Asia. India has expanded the use of technical regulations through [Quality Control Orders](#), requiring certification for a growing range of products, including imported solar components. Such measures are intended to ensure product quality, safety and conformity with national standards.

The composition of NTMs also differs across products and within the supply chain. Technical barriers to trade, which set standards, certification and labelling requirements, together with quantitative restrictions, mainly affect downstream segments. On the other hand, upstream segments are more exposed to sanitary and phytosanitary measures related to health risks, as well as export controls on raw materials. Although less frequent, [rules of origin](#) and government procurement restrictions can have a significant impact by shaping sourcing decisions and eligibility for market access. EVs stand out from other clean energy technologies because they are subject not only to extensive technical requirements but also to a higher incidence of price-control measures, such as import licence fees and excise taxes. China makes particularly extensive use of these measures in EV-related

products, which highlights how NTMs can be used to both regulate market access and influence the competitive conditions facing domestic and foreign producers.

Overall, the concentration of NTMs in clean energy technologies points to a growing use of targeted regulatory measures as part of industrial and trade policy strategies. As a result, firms' competitiveness increasingly depends not only on their production costs, but also on their ability to meet the technical, certification and administrative requirements needed to access key markets.

**Figure 2.21 Frequency and intensity of non-tariff measures across clean energy technology supply chains, 2026**



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Notes: Non-tariff measures are assessed on the basis of the specificity-weighted non-tariff measure index, which captures the intensity of NTMs affecting HS6 products mapped in the [Manufacturing and Trade Model](#). Rather than simply being counted, measures are weighted inversely to the number of HS6 products covered, giving greater weight to targeted measures. The indicator sums these weights for measures implemented before 2026. Upstream and downstream segments refer respectively to key inputs and final manufacturing stages. For solar PV, downstream refers to module and cell production and upstream refers to wafers and polysilicon production. For batteries, downstream refers to battery cell production and upstream to anode and cathode production. For electric cars, downstream refers to battery electric car and plug-in hybrid electric car production; upstream refers to battery supply chain production. Southeast Asia refers to the average of the six largest ASEAN economies.

Source: IEA analysis based on UNCTAD TRAINS (2026).

**Non-tariff measures affecting clean energy technologies vary across supply chains and regions but are largely dominated by technical barriers to trade.**

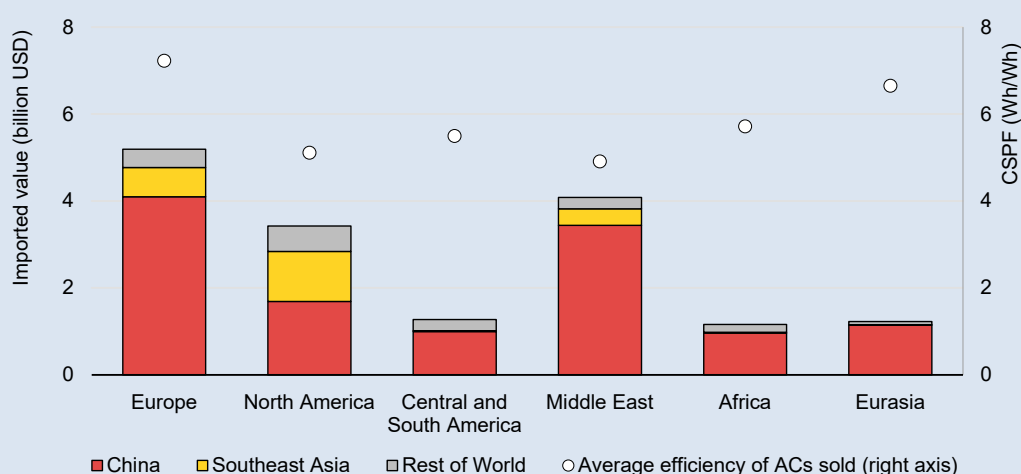
### Box 2.3 China's energy efficiency grades for residential air conditioner exports

[On 1 January 2026](#), China introduced a voluntary national grading standard combining energy- and carbon-efficiency metrics for room air conditioners destined for export. The standard covers most residential room air conditioners commonly traded in international markets, i.e. free-blow units with rated cooling capacity of up to 14 kW using air-cooled condensers and hermetic motor compressors.

Although the standard neither imposes licensing, inspection or certification requirements nor prohibits exports of low-efficiency units, exports may still be constrained in practice, as exports remain subject to broader control and can be subject to commodity inspection by the Ministry of Commerce. As a result, the standard's voluntary provisions could support incremental upgrading of export quality and gradually reduce the relative competitiveness of low-cost, low-efficiency segments. Its implementation also precedes China's domestic carbon footprint standard for air conditioners and reflects a broader trend towards more stringent appliance standards in major export markets, including the European Union's Ecodesign and Energy Labelling frameworks.

In Southeast Asia, the new export standard could influence domestic cooling markets as its efficiency requirements exceed existing minimum energy performance standards in Indonesia, Malaysia, the Philippines and Viet Nam, all of which currently import around one-third of their air conditioners from China.

#### Air conditioner imports by region and average efficiency of air conditioners sold, 2025



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Notes: AC = air conditioner; CSPF = cooling seasonal performance factor. The figure does not include intra-regional trade; e.g. European imports do not include trade between two EU member states.  
Source: IEA analysis based on data from Sinoimex (2026).

In addition, the standard is likely to have an impact on the air conditioner (AC) export market. Over the past 5 years China represents on average about two-thirds of

residential AC exports<sup>7</sup> globally and dominates supply across many markets, including both low- and high-efficiency regimes. Outside China, only a few ASEAN countries have a notable presence, most prominently Thailand. Should the new export standard lead Chinese manufacturers to withdraw from the low-price, low-efficiency segment, Southeast Asian manufacturers could step in to fill this gap. This dynamic may be especially relevant for the Middle East and North America, where exports from Southeast Asia already have a foothold in the market and where the efficiency of ACs sold is generally lower than in other regions.

However, several factors suggest that this shift may not materialise. While stricter efficiency requirements may increase the cost of Chinese exports, these products are unlikely to become significantly more expensive than low-efficiency ACs from Southeast Asian manufacturers. China has a cost advantage in manufacturing, and high-efficiency units are often already competitive on a total cost of ownership basis. Moreover, Southeast Asia is closely integrated into Chinese-led supply chains, with much of the region's manufacturing capacity operated by Chinese and Japanese firms. Finally, the low-efficiency segment is expected to shrink over time, as more than 100 countries have introduced minimum energy performance standards that are progressively tightened, effectively phasing out less efficient units. With these considerations in mind, it appears more likely that the new export standard will increase competition in the high-efficiency segment, particularly over the long term.

## Export restrictions

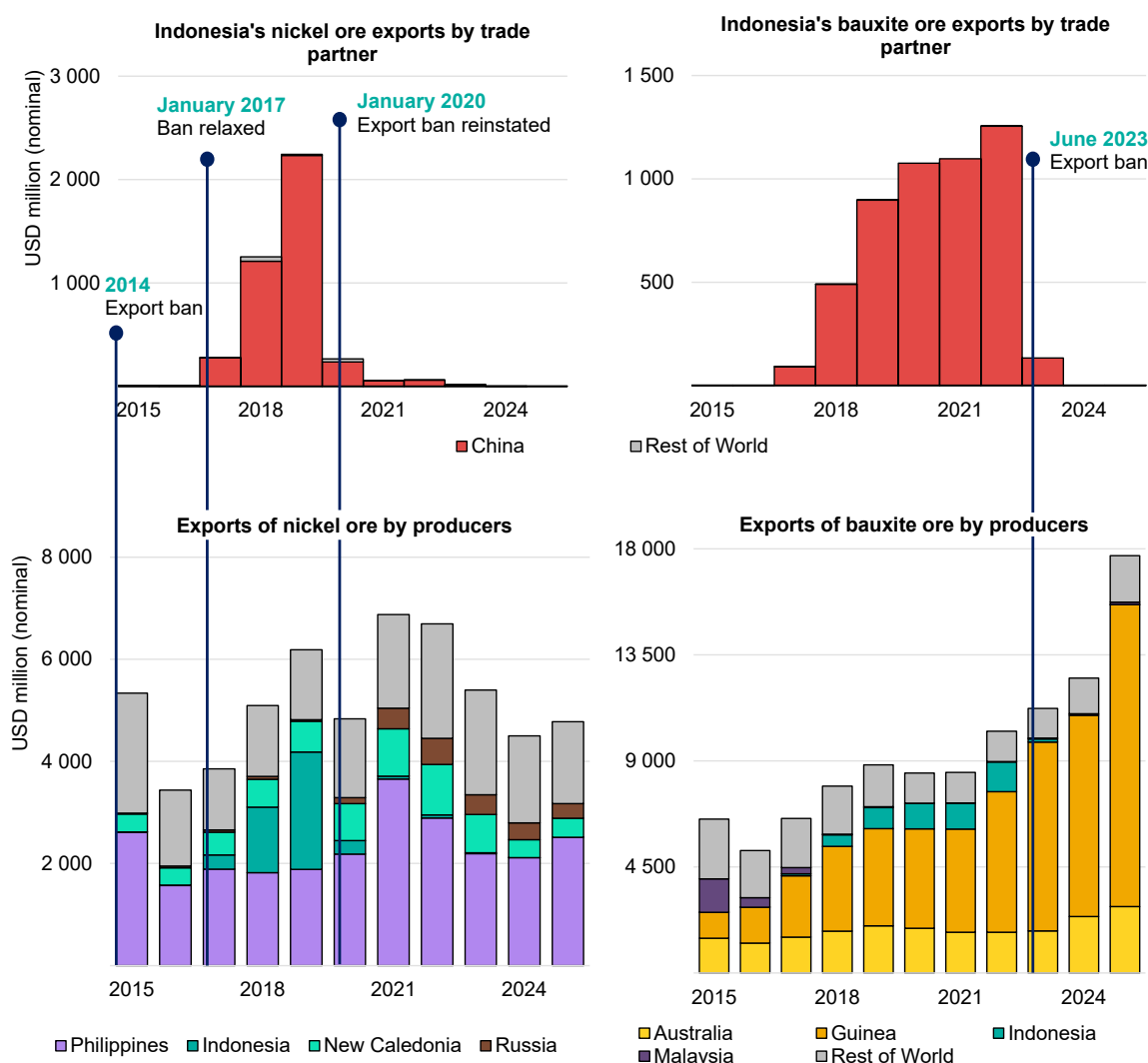
Within the broader set of NTMs, quantitative restrictions have become an increasingly important policy tool. Export bans, quotas and licensing requirements can restrict access to raw materials and encourage their processing within the country of origin. Globally, the prevalence of these measures increased sharply in the previous decade: [OECD](#) data show that the incidence of such measures was around five times higher in 2021 than in 2011. In Southeast Asia, export controls on critical minerals and raw materials have also become a prominent means of supporting downstream industry development (see Box 2.4 on biofuels export restrictions). Their growing use has also heightened concerns about supply security and supply chain resilience, particularly in markets where production and processing are highly concentrated, as changes to export control regimes can increase uncertainty for downstream industries and strengthen the case for more diversified sources of supply.

Indonesia provides two contrasting examples of the use of export restrictions to build downstream processing industries. In nickel, where Indonesia accounted for 67% of global mine production and 47% of refined supply in 2025, the progressive

<sup>7</sup> As per HS code 841510.

ban on nickel ore exports culminated in a full export prohibition in January 2020. The measure was accompanied by a rapid expansion of domestic processing capacity and a shift in exports from ore to higher-value products, including ferronickel, nickel pig iron and battery intermediates. By contrast, the June 2023 ban on bauxite exports has so far produced more limited downstream development. Indonesia produced 32 Mt of bauxite in 2024, but operational alumina refining capacity in 2023-2024 could absorb only around 16-17 Mt of bauxite, leaving domestic supply well in excess of processing capacity. In addition, Indonesia's share of global bauxite exports is far smaller than its share of the nickel market, accounting for slightly more than 10% of global bauxite exports at its peak in 2022, compared with nearly 40% of global nickel ore exports in 2019. This more limited market leverage reduces the scope for export restrictions to reshape global trade flows and to create strong incentives for downstream investment, as was observed in the nickel sector. Refinery bottlenecks have therefore prompted discussions on easing the ban.

**Figure 2.22 Gross annual bauxite and nickel exports from Indonesia by export market and exports from all main producers, 2015-2025**



IEA. CC BY 4.0.

Source: IEA analysis based on data from Sinoimex (2026).

**While nickel markets continue to adjust to Indonesia's export restrictions, the 2023 bauxite export ban was offset by rising exports from Guinea, limiting its impact on global trade.**

At the same time, Southeast Asian countries' efforts to build clean energy technology manufacturing capacity can be undermined by export control regimes imposed by major technology holders such as China. Although many such measures are designed to address security, strategic or technology-governance concerns, they can also complicate efforts by emerging manufacturing hubs to access the technologies, equipment and know-how required to capture value further along the supply chain.

**Table 2.3 Recent announcements and updates to export restrictions relevant to clean energy technology manufacturing in Southeast Asia**

| Material / Technology                                                              | Country   | Description                                                                                                                                                                                      | Impact                                                                                                                                                                                                                                                                         |
|------------------------------------------------------------------------------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Export restrictions imposed by countries in Southeast Asia</b>                  |           |                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                |
| Nickel                                                                             | Indonesia | Phased ban on unprocessed nickel ore exports introduced in <a href="#">2009</a> , tightened <a href="#">in 2014</a> and <a href="#">reinstated from January 2020</a> .                           | Catalysed large-scale investment in nickel refining and downstream battery manufacturing (e.g. LG Energy Solution's <a href="#">USD 9.8 billion</a> Memorandum of Understanding in 2020), resulting in a shift of Indonesia's export mix towards higher-value nickel products. |
| Bauxite                                                                            | Indonesia | Export ban on bauxite ore in place since <a href="#">June 2023</a> .                                                                                                                             | Lower-than-expected downstream investment, leaving domestic bauxite supply well above existing processing capacity ( <a href="#">9 Mt</a> of additional capacity unrealised), with continued reliance on alumina imports ( <a href="#">512 000</a> DMT in 2025).               |
| Rare earths                                                                        | Viet Nam  | <a href="#">Restrictions</a> on exports of unprocessed ore and on exploring, mining and processing activities by unapproved entities entered into force in January 2026.                         | Downstream ambition (increase processed output to <a href="#">20 000-60 000 tpa</a> by 2030) constrained by commercial and financial barriers. Some investments have still been announced (e.g. <a href="#">Trident Global Holdings</a> , <a href="#">Lynas Rare Earths</a> ). |
| Rare earths                                                                        | Malaysia  | <a href="#">Moratorium</a> on unprocessed rare earth exports in place since January 2024. Re-affirmed in 2025 through a <a href="#">planned</a> moratorium for 2025-2027.                        | Supported the development of midstream processing capacity. Export controls maintained uniformly across trading partners <a href="#">despite international co-operation agreements</a> .                                                                                       |
| Silica sand                                                                        | Viet Nam  | White silica sand exports banned in <a href="#">November 2017</a> due to <a href="#">impacts</a> of mining (partially lifted in 2020).                                                           | Exposed persistent enforcement challenges linked to illegal mining and exports.                                                                                                                                                                                                |
| <b>Export restrictions affecting countries in Southeast Asia</b>                   |           |                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                |
| Rare earths and permanent magnets                                                  | China     | <a href="#">Export licensing requirements</a> introduced in April 2025 and expanded in October 2025 to cover additional materials, technologies and equipment.                                   | Constrained access to critical rare-earth-based inputs and permanent magnets, which could increase supply chain uncertainty for manufacturers in Southeast Asia.                                                                                                               |
| Advanced LFP technologies and lithium processing                                   | China     | Advanced-generation LFP active material and lithium processing technologies added to the list of technologies prohibited or restricted from export <a href="#">in 2025</a> .                     | Expected to delay the development of LFP production capacity and expertise outside China, as these technologies are critical to reducing EV battery costs while improving driving range and fast-charging performance.                                                         |
| Battery (cathode precursors, LFP materials, nickel-based cathode active materials) | China     | Export controls introduced in <a href="#">October 2025</a> , then paused for one year. Emerging technologies such as high-performance batteries and lithium-rich manganese chemistries included. | Very broad coverage (including manufacturing equipment and associated production technologies), which could have a significant impact on supply chains if fully enforced.                                                                                                      |

|                               |       |                                                                                                                                                                                                                                                                     |                                                                                                                                                      |
|-------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Solar manufacturing equipment | China | Announced <a href="#">intention</a> to introduce export controls on advanced solar PV manufacturing equipment, including heterojunction technologies. <a href="#">Discussions</a> have focused on the United States but the controls could be applied more broadly. | Could create uncertainty around access to next-generation manufacturing technologies, slowing production upgrades and risking technological lock-in. |
|-------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|

Notes: LFP = lithium iron phosphate batteries, DMT = dry metric tonne, tpa = tonnes per annum.

Market access restrictions aimed at supporting domestic industry also appear in downstream markets. In July 2026, Malaysia introduced new import requirements for EVs, restricting market access through minimum value and performance thresholds. Imported EVs must meet a minimum declared value of MYR 200 000 (Malaysian ringgit) (USD 50 880) and a minimum motor power of 180 kW. As the vast majority ([89%](#)) of EVs sold in Malaysia are below this price point, the measure significantly curtails imports of lower-cost vehicles, particularly from Chinese manufacturers that previously accounted for [49%](#) of the market. The measure could slow overall EV uptake while shifting market opportunities towards domestically assembled vehicles.

#### Box 2.4 Biofuel mandates and export restrictions

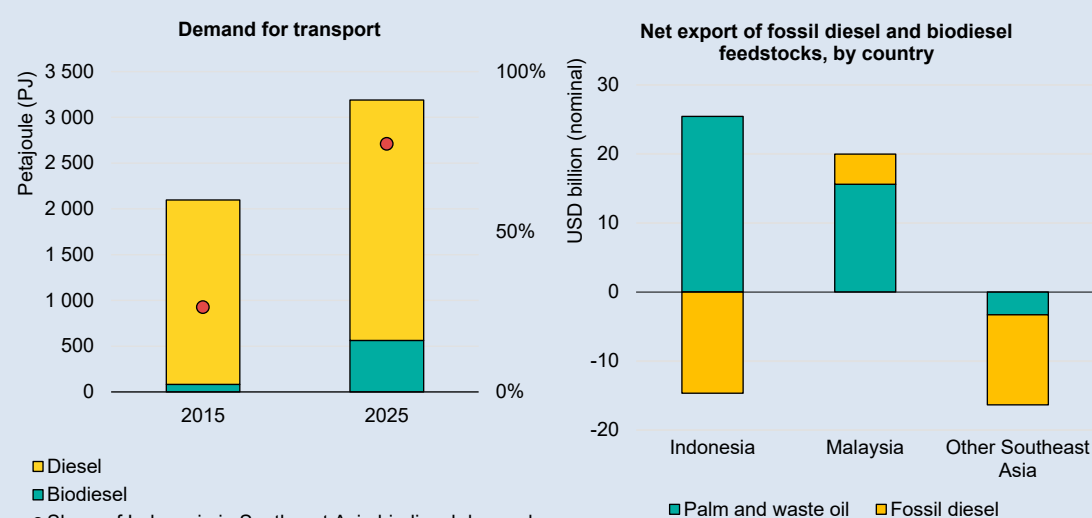
Liquid biofuels play an increasingly important role in Southeast Asia's transport sector. Biofuel blending already meets nearly 10% of road transport fuel demand in the region, the second-highest share among major world regions after Central and South America. Biodiesel is the dominant biofuel, supported by blending mandates across several countries, including Indonesia, Malaysia, the Philippines and Thailand. The primary objectives are to reduce dependence on imported oil products, support domestic agricultural sectors and enhance energy security.

Southeast Asia benefits from a strong domestic resource base and accounts for around one-quarter of global biodiesel production, with Indonesia producing nearly 70% of Southeast Asia's liquid biofuels.

In recent years, several countries have strengthened biofuel policies alongside broader efforts to promote low-emissions transport. The expansion of biofuel mandates has increased domestic demand for feedstocks and encouraged governments to adopt measures aimed at retaining greater value within national supply chains. Some Southeast Asian countries have introduced or strengthened export restrictions on biofuels or feedstocks to ensure domestic availability, support local processing industries and reduce fuel import dependence. These policies also reflect a broader industrial strategy of favouring exports of higher-value fuels rather than raw feedstocks.

Indonesia provides the clearest example of this trend. As part of its drive for energy self-sufficiency and for reducing its reliance on diesel imports, the government began implementing a [B50 mandate programme](#) in July 2026, increasing the minimum palm oil-based biodiesel share in diesel fuel from 40% to 50%. To secure the feedstock and financing needed to support this policy, Indonesia has deployed a suite of measures across the palm oil value chain. These include restrictions on exports of used cooking oil and palm oil mill effluent, an export levy on palm oil products that helps fund biodiesel subsidies, and tighter state oversight of palm oil exports. Together, these measures aim to ensure feedstock availability for domestic biodiesel production while increasing the share of value added retained within the Indonesian economy.

### Biodiesel production and feedstock imports and exports in Southeast Asia, 2015-2025



Source: IEA analysis based on data from Sinoimex (2026).

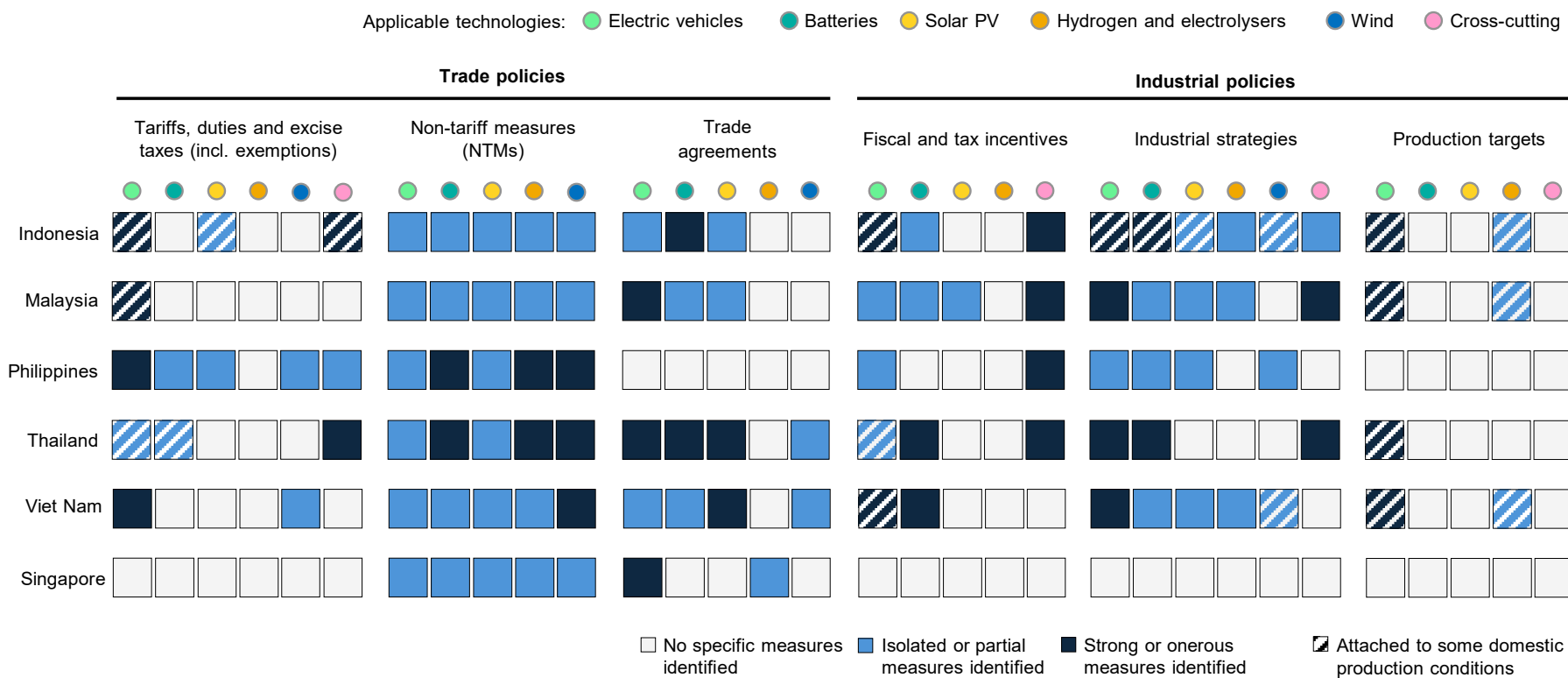
## Industrial policies

Trade and industrial policies across Southeast Asia are now being used more frequently to steer the development of domestic manufacturing in clean technology sectors. This marks a shift from earlier frameworks, which focused on market opening and relied on import liberalisation, tax exemptions and demand-side incentives to enable rapid deployment through access to low-cost imported equipment. For example, in 2017 and 2018 Viet Nam provided import duty exemptions for [solar](#) and [wind](#) equipment not available locally. Similarly, Malaysia's [2011 Renewable Energy Act](#) promoted investment through tax incentives without local content requirements. The Philippines and Thailand also implemented renewable procurement programmes that relied on imported equipment.

Progressively, countries across the region also sought to attract manufacturing capacity through FDI, using tax holidays and special economic zones. Viet Nam, for example, expanded industrial parks in locations such as Hai Phong and Bac Giang, offering [preferential incentives](#) to investors.

From 2020 onwards, the pandemic and rising trade tensions prompted a rapid increase in industrial policy activity across Southeast Asia. Countries began placing greater emphasis on domestic value creation, particularly in EVs and batteries. For example, Indonesia advanced an integrated strategy centred on its nickel resources, which, together with stronger local content rules, fostered large-scale investment and supported the development of downstream processing capacity. This attracted investments from companies such as [LG Energy Solution](#) and [Vale](#). Thailand likewise strengthened its EV strategy with a long-term ambition to become a regional EV manufacturing hub, supported by the Board of Investment incentives and its “[30@30](#)” vision aiming to raise zero-emissions vehicles to at least 30% of total domestic vehicle production by 2030. Thailand also introduced an [EV 3.0](#) policy package offering consumer purchase subsidies and temporary reductions on import duties for completely built-up units under the condition that manufacturers commit to future local production.

However, not all countries have prioritised domestic manufacturing. Some have focused on accelerating deployment through open market policies and demand-side incentives, maintaining access to imported technologies. The Philippines largely maintained open market policies, although the 2015 Comprehensive Automotive Resurgence Strategy ([CARS](#)) programme sought to stimulate local car assembly via [USD 600 million](#) in fiscal incentives for lead firms. The country’s 2022 [Electric Vehicle Industry Development Act](#), alongside the subsequent removal of import duties on EVs and components, continues to emphasise demand-side incentives and rapid adoption. Singapore similarly remains focused on deployment, prioritising innovation and overseas investment in solar PV manufacturing rather than developing large-scale domestic production, although this also reflects its land and labour constraints.

**Figure 2.23 Notable industrial and trade policy developments in Southeast Asia, 2015-2026**

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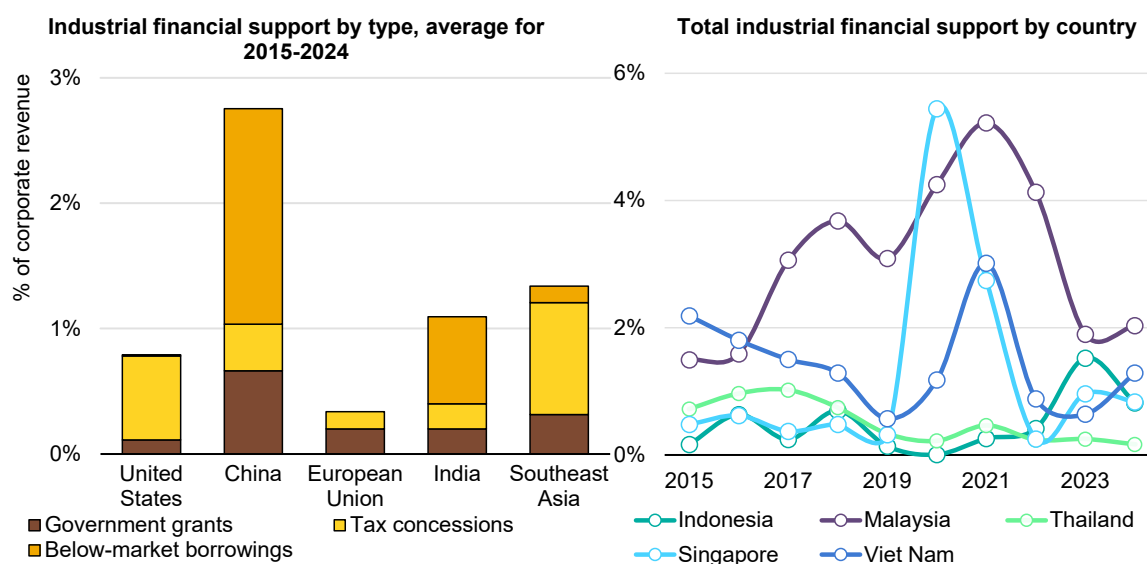
Note: For detailed information on each policy, please refer to Chapter 4.

**Market access and incentives are increasingly being tied to domestic production requirements.**

## Government financial incentives

Government financial support can play an important role in reducing production costs and improving profitability, although measuring its impact is inherently challenging. Government support in Southeast Asia is heavily skewed towards corporate tax concessions, with limited use of concessional finance and only episodic deployment of grants, contrasting with more finance-based and system-wide support models observed elsewhere. This reflects the widespread use of tax holidays, investment allowances and duty exemptions, which are central to national strategies aimed at attracting FDI.<sup>8</sup>

**Figure 2.24 Average rate of financial support as a share of corporate revenue for industries by country or region, 2015-2024**



IEA. CC BY 4.0.

Notes: The values above are averaged by geographical grouping using firms' revenue as weights. Geographical groupings are based on the location of firms' headquarters or main place of production.

Source: IEA analysis based on OECD (2025), [MAGIC database](#).

**Measurable government financial support for manufacturing in Southeast Asia is provided mostly in the form of tax concessions.**

<sup>8</sup> While grants can often be directly observed, estimating the value of tax incentives and below-market financing requires counterfactual analysis. The estimates presented here are based on the [OECD's MAGIC database](#).

## Chapter 3. The outlook for manufacturing and trade

### Highlights

- Southeast Asia's clean energy technology market grows faster than the global average in the Stated Policies Scenario (STEPS), more than tripling to reach over USD 80 billion in 2035. Batteries and electric cars account for over 90% of the value. In the Current Policies Scenario (CPS), the market reaches some USD 55 billion by 2035, mainly due to weaker growth in the electric car market.
- By 2035, electric car production exceeds 3.6 million units in the STEPS, nearly twelve times more than in 2025, with exports accounting for nearly 35% of output and establishing the region as a net exporter. Exports are primarily destined for Europe, Australia and New Zealand. The region's cost competitiveness is underpinned by strong manufacturing project pipelines for batteries and electric cars and by supportive industrial policy frameworks.
- The battery manufacturing industry develops alongside the electric vehicle (EV) industry, with output increasing from just a few GWh today to over 300 GWh in 2035 in the STEPS. Upstream, anode and cathode active material industries look set to be largely export-oriented in the STEPS, providing an important source of supply chain diversification.
- In both the STEPS and CPS, solar PV module production falls sharply by 2035 as declining exports to the United States – Southeast Asia's largest export market in recent years – are not offset elsewhere. Exports fall from the peak of USD 20 billion reached in 2023 to around USD 3.6 billion in 2035 in the STEPS.
- Announced electrolysis projects in Southeast Asia are equal to 12% of current regional hydrogen demand, but only 6% of announced capacity has reached final investment decision (FID). The main opportunities to use low-emissions hydrogen to produce low-emissions fuels lie in targeting existing applications based on hydrogen produced from unabated fossil fuels.
- In the Announced Industrial Policy Case (AIPC) – in which countries achieve their industrial policy and diversification ambitions – global production diversifies across all clean energy technologies. Cumulative investment in Southeast Asia increases by around USD 14 billion to 2035 relative to the STEPS, largely in the battery supply chain.

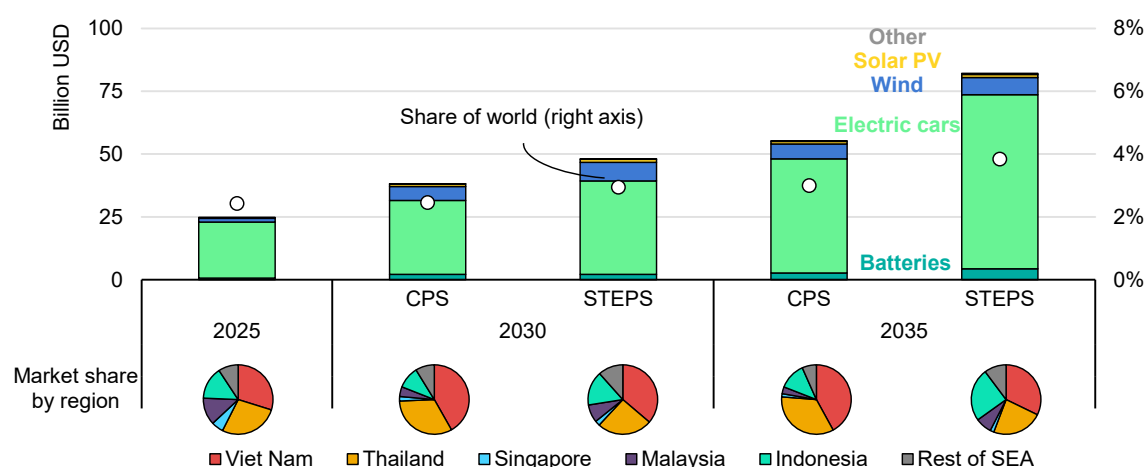
## Overview

This chapter sets out projections of manufacturing activity and inter-regional trade for key clean energy technologies<sup>9</sup> to 2035 under two exploratory scenarios: the CPS and the STEPS,<sup>10</sup> as well as the AIPC developed for this report. The projections are derived from the IEA's [Manufacturing and Trade Model](#). The CPS and the STEPS are broadly consistent with those to be published in the forthcoming edition of the *World Energy Outlook* and other analyses derived from the latest [Global Energy and Climate](#) modelling cycle.

## Market size

The market for clean energy technologies in Southeast Asia is projected to increase under all IEA scenarios, although policy direction has a strong impact on growth. In the STEPS, the market is projected to rise from USD 25 billion in 2025 to almost double that level by 2030 and just over USD 80 billion by 2035. Growth is considerably more muted in the CPS, as the region continues to rely heavily on fossil fuels, with the market reaching around USD 55 billion by 2035.

**Figure 3.1 Market size of clean energy technologies in Southeast Asia by scenario, 2025-2035**



IEA. CC BY 4.0.

Notes: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario; SEA = Southeast Asia. Batteries include battery cells for non-car electric vehicles and battery energy storage systems (BESS). Other includes heat pumps and electrolyzers.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**The market for key clean energy technologies is dominated by batteries and electric cars, reaching USD 55 billion in the CPS and more than USD 80 billion in the STEPS by 2035.**

<sup>9</sup> Electric cars, electric vehicle batteries and battery energy storage systems (BESS), solar PV modules, wind turbines, heat pumps and electrolyzers.

<sup>10</sup> See the introduction for further details on the scenarios.

Electric cars account for the largest share of the market in the STEPS by 2035, representing 85% of the total value. This reflects rapid growth in several countries, including Thailand and Viet Nam, where expanding electric car markets are supported by increasing affordability and favourable trade policies. The market for batteries – including those used in EVs and in battery energy storage systems (BESS) – increases more than fivefold by 2035, driven largely by the expansion of domestic electric car manufacturing. By contrast, in the CPS, the market for electric cars is around one-third lower than in the STEPS in 2035, as policies expire as scheduled and high upfront costs for electric cars and slow charging infrastructure rollout weigh on uptake.

Deployment of wind turbines and solar PV modules is underpinned by [supportive policies](#) for renewables, such as national climate and energy commitments, feed-in tariffs and renewable energy auctions, which have been implemented across multiple countries. For example, Viet Nam's revised [Power Development Plan 8](#) sets more ambitious deployment targets, while Indonesia's 2025 [National Electricity Plan](#) (RUKN) provides a long-term pathway for increasing low-emissions generation. The market for wind turbines expands more than threefold in the STEPS by 2035, while the market for solar PV grows slightly more slowly but from a higher starting point.

Southeast Asia's share of the global market for clean energy technologies is projected to increase steadily as its growth outpaces that of the rest of the world. This increase reflects accelerated electrification, rather than just economic expansion – while GDP in the region is expected to grow by nearly 50% to 2035, the market size for clean energy technologies in the STEPS more than triples.

## Manufacturing investment and capacity

Average annual investment in clean energy technology manufacturing in Southeast Asia over the next decade is expected to remain broadly similar to the average between 2023 and 2025 in the STEPS, at around USD 6.5 billion. This contrasts with clean energy technology manufacturing investment at the global level, which is expected to decline by over 60% over the next decade. The CPS follows a different trend, reflecting lower demand for clean energy technologies, a higher share of which is met by ample manufacturing capacity in the People's Republic of China (hereafter, "China"). In this scenario, the lack of strong policy support for domestic manufacturing capability in Southeast Asia means the region struggles to enter the global market and its average annual investment between 2026 and 2035 is around USD 3 billion.

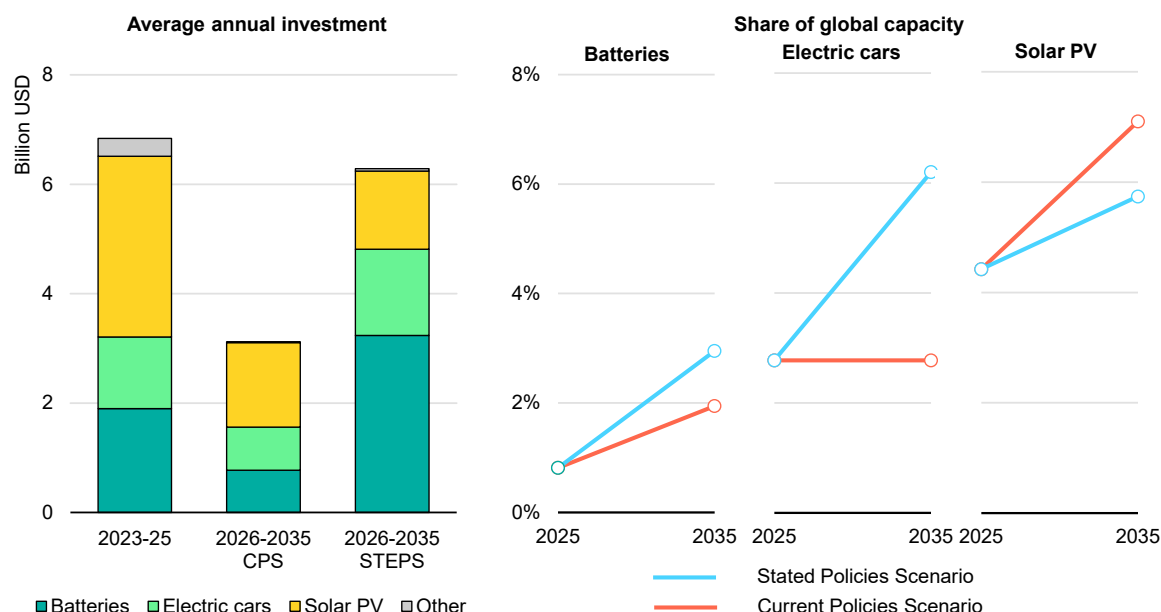
The composition of investment changes markedly compared to today. In the STEPS, the battery sector accounts for half of manufacturing investment, as investment in batteries doubles between 2025 and 2035. Batteries comprise cells

both for electric cars and for use in a battery energy storage system (BESS), with the former contributing more than 95% of investment. This is the result of significant growth in domestic electric car manufacturing capacity, and further expansion upstream, particularly in the manufacturing of cathode active materials, with investment in these materials growing by 70% to 2035. Southeast Asia is a prime location for manufacturing these battery components, given its growing strength in nickel refining and the potential for integration within the electric car supply chain. Investment in electric car manufacturing also doubles to 2035 as increasing electric car demand in the region is met by domestic supply.

Southeast Asia today has the third-largest solar PV module manufacturing capacity globally, in part thanks to a surge in investment between 2021 and 2023, primarily from Chinese companies. However, recent trade restrictions on exports to the United States (see Chapter 2) are assumed to continue to 2035 in the STEPS, severely reducing demand for module exports to the country, the primary destination for Southeast Asia's production in recent years. In both the STEPS and CPS, annual average investment to 2035 is lower than it was between 2023 and 2025. This reflects reinvestment to maintain existing capacity, rather than greenfield investment, and is concentrated in upstream components.

Capacity expansion alone does not necessarily translate into a stronger manufacturing position globally. Instead, global manufacturing position is determined by growth relative to the rest of the world. The outlook for both electric car and battery manufacturing in Southeast Asia is positive, with their shares of global capacity increasing in the STEPS. Electric car manufacturing rises from less than 3% of total global capacity in 2025 to more than 6% in 2035, while battery manufacturing expands from less than 1% to around 5% over the same period. Both industries remain highly cost-competitive with China, supporting continued scaling of production. The region's share of global solar PV manufacturing capacity also increases in both the CPS and the STEPS, not because of capacity growth in the region, but because global manufacturing capacity declines more rapidly.

**Figure 3.2 Average annual manufacturing investment and share of global capacity in Southeast Asia and by scenario, 2023-2035**



IEA. CC BY 4.0.

Notes: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario. Batteries include anode and cathode active material, and battery cells. Solar PV includes polysilicon, wafers, cells and modules. Global capacity is measured across steps in supply chains.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Future solar PV manufacturing investment sustains existing capacity, while investment in electric car and battery manufacturing is highly dependent on domestic demand.**

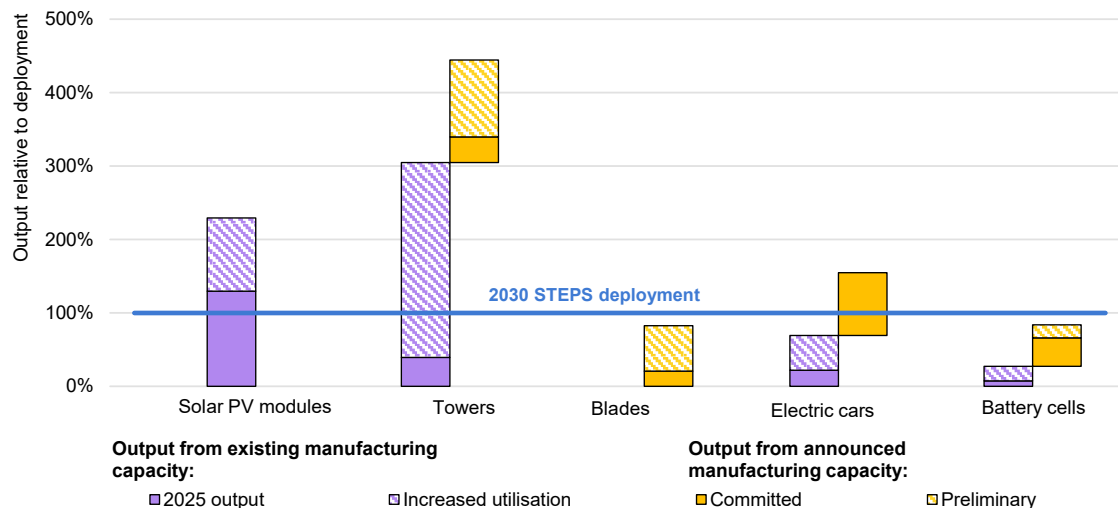
In the STEPS, Southeast Asia is expected to have ample manufacturing capacity across solar PV modules, wind towers and electric cars relative to demand in 2030, supported by its position as an export-oriented producer. Wind tower production has the largest potential output relative to regional deployment in 2030, with output from existing capacity at increased utilisation alone exceeding 300% of deployment. In the EV, battery and solar PV supply chains, capacity is concentrated in downstream manufacturing, and the region relies on imports for upstream components, which limits value capture and supply chain resilience. For example, solar PV module production is sufficient to meet future needs, with potential output equivalent to 147% of demand, but for upstream components such as wafers, domestic capacity falls short. Similarly, while the region is a large producer and exporter of wind towers, it does not have any domestic production of wind nacelles and blades today.

As exports account for a large share of production, utilisation rates are heavily influenced by external demand. This increases exposure to shocks such as changes in trade policy or local content requirements in other regions that may slow demand in key markets. In this context, even modest disruptions can translate into sharp declines in capacity utilisation, given the limited role of

domestic demand as a buffer. This dynamic is particularly relevant in sectors such as solar PV and batteries that already face significant global surplus capacity, where increased competition can compress margins and intensify aggressive pricing strategies. Over time, this may weaken the financial viability of producers and discourage further investment in the region. Conversely, if global demand were to outpace the levels projected in the CPS and the STEPS, Southeast Asia would be well-positioned to capture a larger share of the global market for key clean energy technologies.

The prospects for some sectors are more dependent on Southeast Asia's domestic markets and how they evolve. The further development of the region's wind manufacturing industry is more reliant on credible regional project pipelines as a source of demand. Recent disruptions to traditional energy supply chains resulting from the energy crisis triggered by the conflict in the Middle East have also reinforced the strategic value of domestic clean energy deployment as a means of improving energy security. Over time, stronger policy support for clean energy infrastructure could increase regional demand and provide a more stable source of utilisation for local manufacturers.

**Figure 3.3 Projected output from existing and announced manufacturing capacity relative to deployment in Southeast Asia in the Stated Policies Scenario, 2030**



IEA. CC BY 4.0.

Notes: STEPS = Stated Policies Scenario. Announced projects are as at end Q1 2026. Committed capacity refers to projects that have reached a final investment decision or are under construction. Increased utilisation refers to the gap between 2025 production levels and existing capacity being utilised at 85%. This rate is assumed for both existing and announced manufacturing capacity in 2030.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Southeast Asia has ample export-oriented manufacturing capacity, but limited domestic demand leaves utilisation exposed to reductions in export demand.**

### **Box 3.1    What if global demand for clean energy technologies outpaces the levels seen in the IEA's exploratory scenarios?**

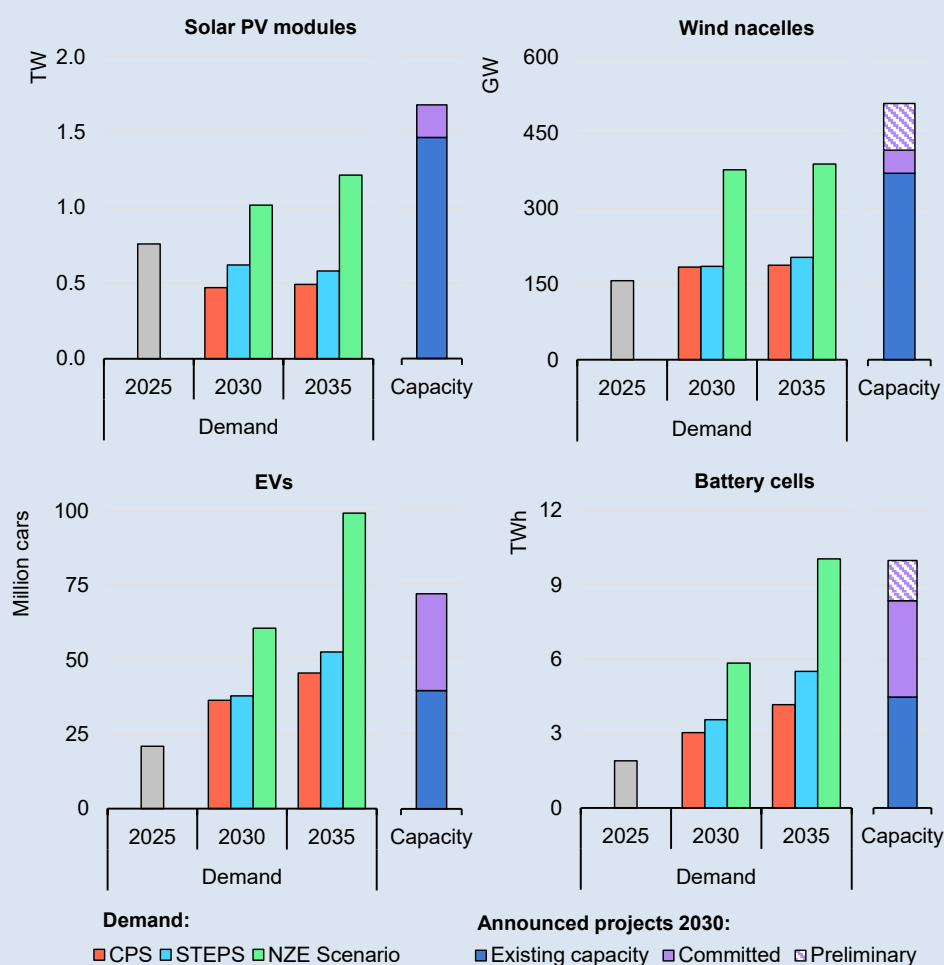
Although demand for clean energy technologies grows in all IEA scenarios, just how much it will grow is a key source of uncertainty affecting the outlook for manufacturing and trade. Each of the IEA scenarios therefore models differing levels of demand for key clean energy technologies.

The CPS, which sets out a pathway for the future of the energy system in which no change in energy-related policies is assumed beyond what is already in place, constitutes the lower bound of deployment in all cases for these technologies. By contrast, deployment levels in the STEPS, which also takes account of policies that have been formally tabled but not yet adopted, are 18% higher than in the CPS by 2035 for solar PV, 10% higher for wind, 14% higher for EVs and 33% higher for batteries. In the IEA's Net Zero Emissions by 2050 Scenario (NZE Scenario), which encompasses a more rapid transformation of the energy sector, deployment levels are substantially higher for these four technologies: 140% higher than in the CPS and 85% higher than in the STEPS by 2035.

To put this in context, for solar PV modules, there is enough existing and committed manufacturing capacity (i.e. those facilities that have reached an FID or are under construction) to meet demand across all IEA scenarios, even when considering a maximum practical utilisation rate of 85% of nameplate capacity and 2035 deployment levels in the NZE Scenario. For wind nacelles, existing and committed manufacturing capacity could already meet demand across all scenarios, and if capacity that is today preliminary (i.e. has been announced but does not yet have an FID and has not begun construction) is also included, total capacity could significantly exceed this level of demand. For battery cells, there is ample existing and committed capacity to meet the deployment levels in both the CPS and the STEPS to 2035, but meeting more ambitious demand levels in the NZE Scenario would also require all the capacity that today remains preliminary to come online.

If global demand does outpace the levels modelled in the CPS and the STEPS, Southeast Asia could become an important source of supply for several key clean energy technologies. The region's existing strengths in solar PV manufacturing and expanding capacity in EV and battery manufacturing, as well as key battery components, mean that it could play an important role in diversifying the global supply chain in the context of rapidly increasing demand.

## Global demand by scenario and capacity of existing and announced projects for key clean energy technologies, 2025-2035



IEA. CC BY 4.0.

Notes: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario; NZE Scenario = Net Zero Emissions by 2050 Scenario. Existing EV manufacturing capacity is based on reported plant-level data. Announced capacity additions to 2030 are derived from available project announcements and do not cover all markets. Estimates of EV manufacturing capacity in 2030 are therefore subject to greater uncertainty than those for the other technologies shown.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation for details.

## Production and trade

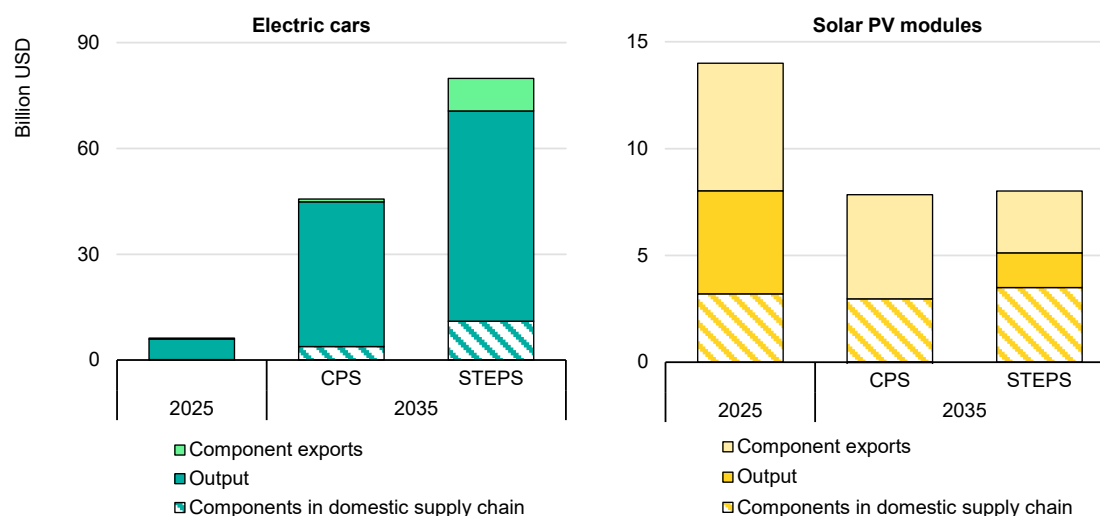
As with investments, production of clean energy technologies in Southeast Asia evolves along different pathways depending on the policy settings in place.<sup>11</sup> Governments worldwide are also setting additional ambitions to redefine their places in manufacturing supply chains for these technologies which could further reshape the outlook (see 0). The electric car and solar PV supply chains illustrate the diverging trends. Electric cars account for the vast majority of output value in both scenarios. In the STEPS, the output value of electric cars increases almost twelve-fold, rising from around USD 6 billion in 2025 to more than USD 60 billion in 2035. Regional demand is set to more than triple, with the majority met by domestic manufacturing capacity. In contrast, the output value of the solar PV supply chain declines steeply as module production falls in line with collapsing exports that are not offset by an increase in domestic demand. Component exports are composed entirely of cells, which also see a significant drop in production value.

Across the supply chain, producing a higher share of upstream components domestically increases the value retained within the region. Even when the final value of a product is unchanged, the total value created domestically depends on the extent to which upstream stages are localised. In the electric car supply chain, the value of battery production (including anode and cathode active material) expands significantly to support domestic vehicle manufacturing in both the CPS and the STEPS and makes up around 15% of electric car output value in both scenarios. However, batteries, including their main components, can account for up to [one-quarter of a vehicle's total value](#). In contrast, the value of solar PV module production falls significantly, but a much larger share of upstream components is produced domestically, supported by cell and wafer manufacturing capacity, reducing the need for imports of these components.

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<sup>11</sup> For further details of policies used to inform scenario analysis in the STEPS, see the [Manufacturing and Trade Model](#) documentation.

**Figure 3.4 Total value of output for selected technologies in Southeast Asia by scenario, 2025-2035**



IEA. CC BY 4.0.

Notes: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario. The value of output is calculated by multiplying physical output by the levelised cost of production, rather than the final sale price. For electric cars, components include anode and cathode active materials and battery cells. For solar PV, components include polysilicon, wafers and cells.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Electric car production has the largest output value across clean energy technologies, surpassing USD 70 billion in 2035 in the Stated Policies Scenario.**

International trade continues to play a central role in meeting demand for downstream products as well as sourcing upstream components. Southeast Asia's aggregate trade (the sum of imports and exports) increases from around USD 37 billion in 2025 to almost USD 70 billion by 2035 in the CPS, and to almost USD 90 billion in the STEPS. Over this period, the region becomes a net exporter of clean energy technologies in aggregate value terms, with exports approximately 50% higher than imports in the STEPS – a shift driven primarily by the surging electric car exports.

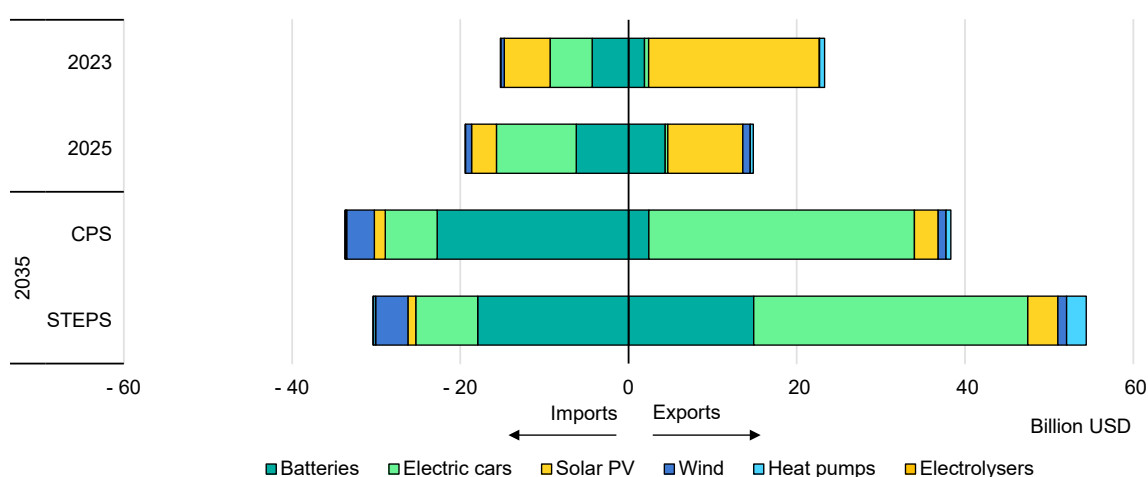
The composition of trade evolves significantly to 2035 in the STEPS, with marked differences in import dependence and export orientation across clean energy technologies. Both electric cars and batteries record substantial increases in traded value. Electric car trade more than quadruples to 2035, driven mostly by exports, at USD 32.5 billion – 4.5 times higher than the value of imports. The demand for imports is limited, as domestic manufacturing satisfies around 90% of regional demand. At the same time, production remains reliant on imports of upstream components, with battery cell imports for electric cars exceeding USD 13 billion.

By contrast, exports along the solar PV supply chain fall by nearly 85% through to 2035 compared to their peak in 2023 in the STEPS, driven by the collapse of the

module export market, primarily as a result of trade policy by the United States. The structure of trade also changes significantly, with component trade accounting for over 30% of trade in 2025 compared to around 75% in 2023 in the STEPS and nearly 80% in the CPS.

In the wind sector, the traded value more than quadruples in the STEPS by 2035, driven almost entirely by increased imports of nacelles. This reflects both the absence of regional nacelle manufacturing capacity and continued deployment of wind turbines through 2035. While Southeast Asia continues to export towers, these account for only a relatively small share of overall trade.

**Figure 3.5 Inter-regional trade in clean energy technologies in Southeast Asia by scenario, 2023-2035**



IEA. CC BY 4.0.

Notes: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario. Trade flows are modelled and reported in net terms between regions. "Batteries" includes anode and cathode active material and battery cells. Solar PV includes polysilicon, wafers, cells and modules. Excludes trade between countries in Southeast Asia.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Southeast Asia becomes a net exporter of clean energy technologies by 2035 in the CPS and STEPS, but imports remain necessary to meet manufacturing and deployment needs.**

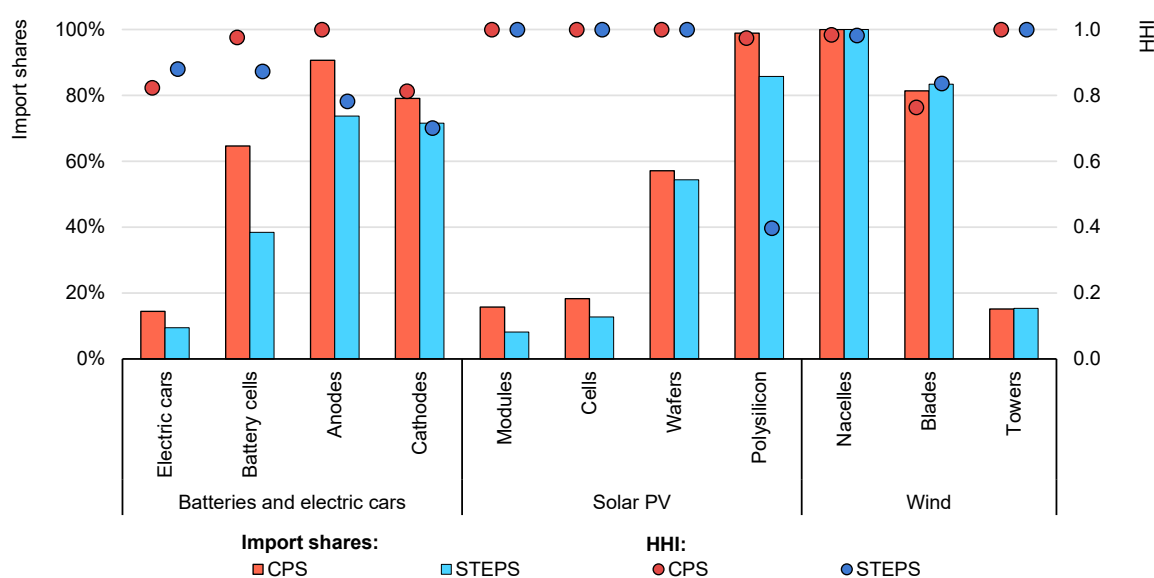
Although Southeast Asia becomes a net exporter of clean energy technologies in aggregate by 2035, it continues to import certain components and technologies. The concentration of imports by source varies significantly across individual supply chains and is most acute where domestic production capacity is limited.<sup>12</sup> Differences in levels of concentration between scenarios reflect the evolving geography of production. In the CPS, import concentration remains higher than in the STEPS, largely due to China retaining its dominance as the leading producer

<sup>12</sup> Import concentration is assessed on the basis of the Herfindahl–Hirschman Index (HHI), in which 1 is the maximum concentration.

and exporter across multiple supply chain segments and capacity in other countries developing more slowly than in the STEPS. For some components and technologies – notably modules, cells, and wafers – China represents the sole source of imports to Southeast Asia in both the CPS and the STEPS. The exception is polysilicon – in the STEPS, Southeast Asia imports from regions with cheap energy that already have planned investment, such as the Middle East.

In the STEPS, the share of demand met by domestic production increases relative to the CPS. For example, the share of demand met by domestic production in cathode, polysilicon and blade manufacturing increases by over 10 percentage points for each component.

**Figure 3.6 Import concentration in Southeast Asia by scenario, 2035**



IEA. CC BY 4.0.

Notes: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario. Import concentration is assessed using Herfindahl–Hirschman Index (HHI), a measure of concentration where 1 is the maximum concentration. Excludes trade between countries in Southeast Asia.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

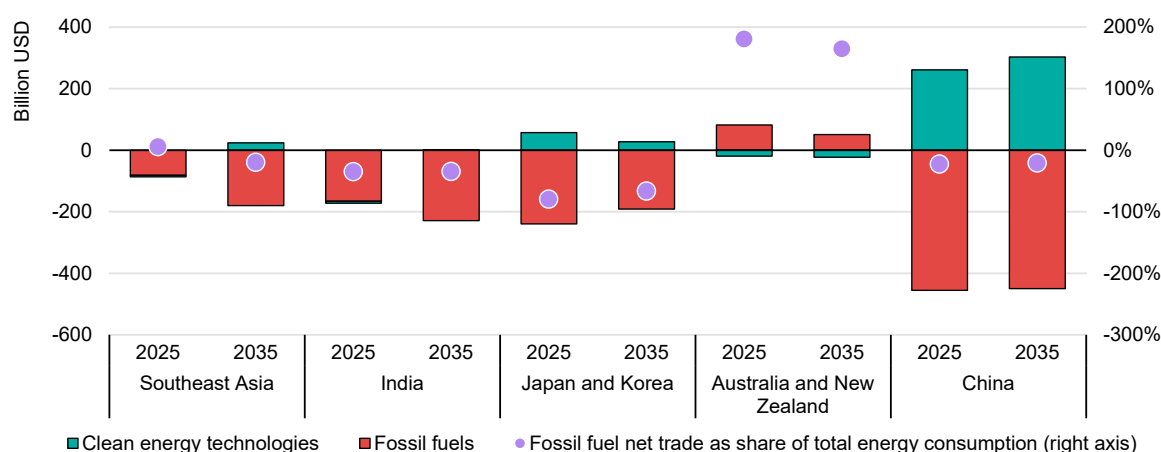
**Import concentration remains high in the STEPS and the CPS, with some components relying on a single region for imports in both scenarios.**

Southeast Asia's energy demand is projected to grow by 25% to 2035 in the STEPS compared to today, well above the global average of around 10%, while electricity accounts for an increasing share of demand (see Chapter 1). In this context, trade plays a critical role in meeting energy needs, as the region lacks sufficient domestic resources. Southeast Asia's net imports of fossil fuels increase from around USD 80 billion in 2025 to USD 180 billion by 2035 in the STEPS.

Deployment of solar PV modules and wind turbines grows faster than the global average, supported by falling technology costs, policy support and rising electricity demand. However, this expansion starts from a relatively low base and is not sufficient to keep pace with overall energy demand growth. As a result, fossil fuel consumption continues to rise in absolute terms, and net imports of fossil fuels increase further as a share of total energy consumption. Despite Southeast Asia becoming a manufacturing hub and net exporter of clean energy technologies, the value of these exports remains significantly smaller than the region's fossil fuel import bill. This limits the region's ability to offset the trade imbalance associated with energy imports.

Elsewhere in the Asia Pacific region, India, and Japan and Korea combined have similar trade balances by 2035. Net imports of fossil fuels reach USD 230 billion in India and over USD 190 billion in Japan and Korea combined. China remains the largest net importer of fossil fuels, with a net import bill approaching USD 450 billion by 2035. However, substantial net exports of clean energy technologies offset nearly 70% of this cost. Australia and New Zealand are net importers of oil, but their large net exports of coal and natural gas mean they remain net exporters of fossil fuels.

**Figure 3.7 Net trade in clean energy technologies and fossil fuels in selected Asia Pacific regions in the Stated Policies Scenario, 2025-2035**



IEA. CC BY 4.0.

Notes: Positive values are net exports; negative values are net imports.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Increased renewable deployment does not reduce Southeast Asia's reliance on fossil fuel imports in the STEPS; but clean technology export revenues partly offset import costs.**

### **Box 3.2 Southeast Asia's manufacturing outlook in the Announced Industrial Policy Case**

Governments are increasingly articulating ambitions to reshape their role in clean energy technology supply chains. These ambitions range from attracting investment and building competitive manufacturing industries to strengthening resilience and diversifying sources of supply. The Announced Industrial Policy Case (AIPC), developed for this Special Report, explores how clean energy technology manufacturing and trade could evolve if countries successfully realise these ambitions.

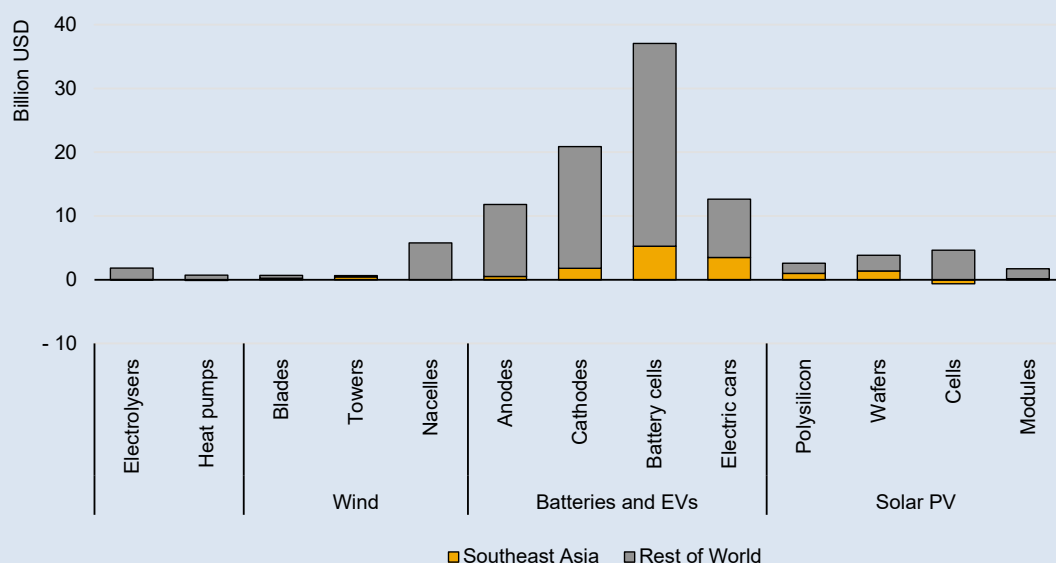
In contrast to the STEPS, the AIPC considers the aims, targets and priorities across a suite of policy documents, even if presently there are insufficient enabling mechanisms – in the form of regulation, domestic production incentives, trade measures and other legislation – in place to achieve them. Limitations on the realisation of these policy ambitions are imposed via quantitative and qualitative assessments of feasibility. As in the STEPS, assessments of domestic markets, project pipelines, estimated production costs and adjacent policy priorities are also brought to bear when examining the feasibility of achieving ambitions. This analysis will be explored further in the forthcoming *Energy Technology Perspectives 2027* report.

Southeast Asia presents a mixed picture across supply chains in the AIPC, but cumulative investment increases by around USD 14 billion to 2035, relative to the STEPS. Most of the increase is concentrated in the battery supply chain, where strong policy support and competitive production costs lead to an additional USD 7.6 billion of investment. For example, cathode manufacturing capacity installed in 2035 is 40% higher in the AIPC than in the STEPS.

Upstream solar PV investment also expands. Cumulative investment in polysilicon and wafer production capacity is almost USD 2.5 billion higher than in the STEPS, although combined investment in cells and modules falls by around USD 0.5 billion as competition among exporters intensifies. Other technologies make smaller gains: investment in wind tower and blade manufacturing is around USD 700 million higher, and blade production triples, supported by policies favouring domestic enterprises when projects are awarded. No new nacelle capacity is added.

Electrolyser stack manufacturing also emerges in the region, supported by interest from OEMs in local supply chains and partnerships between domestic assemblers and international manufacturers. Capacity reaches 0.5 GW per year by 2035, compared with none in the STEPS. Output serves domestic and export markets, and competitive production costs support activity, particularly in Indonesia. Heat pump manufacturing is broadly unchanged because the region has no significant additional policy ambition beyond that incorporated in the STEPS.

### Change in cumulative investment in the Announced Industrial Policy Case compared to the Stated Policies Scenario, 2035



IEA. CC BY 4.0.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

Globally, the more diversified pattern of investment lowers production concentration across all modelled technologies and major components in 2035. As regions meet more demand through domestic production, the value of global clean energy technology trade falls by 6% relative to the STEPS.

Southeast Asia's solar PV production expands in the AIPC as diversification efforts in importing markets create opportunities for the region's cost-competitive manufacturers. By 2035, module output is around 10% higher than in the STEPS, while wafer production is almost 60% higher. The region more than doubles wafer exports to 27 GW and reduces its reliance on wafer imports. Higher wafer output also lifts polysilicon production to more than triple the STEPS level, although Southeast Asia continues to import around half of its requirements because it is less cost-competitive in this energy-intensive segment. The Middle East supplies the largest share of these imports. This expansion occurs even though Southeast Asia has no specific additional solar PV industrial policy ambition beyond that reflected in the STEPS. Instead, it benefits from continued demand from countries seeking to diversify their sources of supply, supported by the region's favourable cost fundamentals across several parts of the supply chain. A larger domestic share of the value chain also lowers delivered module costs, as low labour costs and reduced exposure to trade-related costs allow regional production to compete with, and in some cases undercut, imports from China.

Battery and electric car production also grows, supported by low production costs, expanding regional demand and opportunities to serve export markets. Announced measures reinforce this direction: Indonesia's Perpres No. 79/2023 would raise

local content requirements for EVs to 80% by 2030; Thailand has introduced export-linked EV incentives and long-term tax support for EV and battery investments; and Malaysia's proposed manufacturing conditions would require new EV plants to export most of their output while retaining key production activities domestically.

In the AIPC, Southeast Asia supplies almost 20% of electric car demand outside China by 2035, 2 percentage points more than in the STEPS. Southeast Asian countries also supply 20% of battery demand outside of China in 2035, a similar share to that in the STEPS. By 2035, cathode production is almost 40% higher in the AIPC than in the STEPS, outpacing the 20% increase in demand. Indonesia also remains one of the few countries outside China with sizeable anode active material production capacity. This expands the region's role beyond downstream assembly, although cathode precursors and graphite anodes remain highly concentrated in China. Average delivered electric car costs in Southeast Asia are almost 1.5% lower than in the STEPS, as greater domestic manufacturing avoids import tariffs and reduces logistics costs, while battery costs are broadly unchanged.

## Solar PV

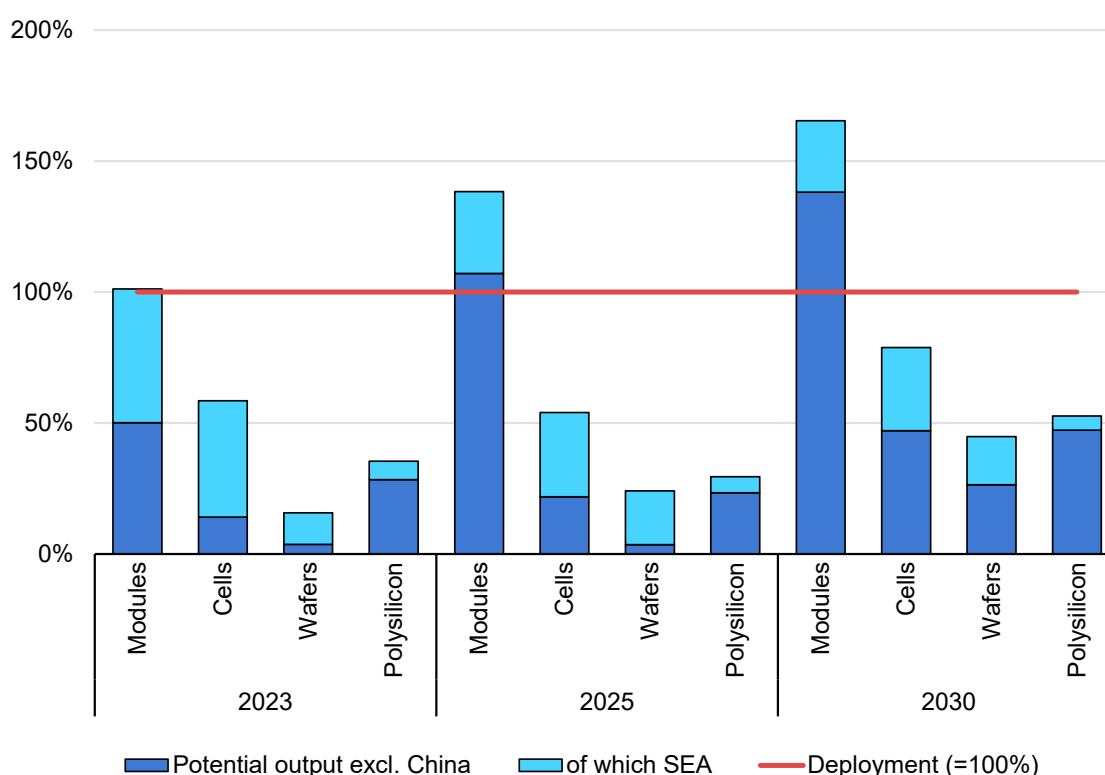
### Solar PV manufacturing

Since the beginning of the decade, Southeast Asia has rapidly expanded its solar PV manufacturing capacity, reaching a peak in 2023. This was partly driven by efforts to address trade restrictions on products from China, while taking advantage of Southeast Asia's cost-competitiveness as a manufacturing hub. As a result, the region has become a highly export-oriented manufacturing base, with the United States serving as its primary export destination.

However, Southeast Asia's role as an alternative manufacturing hub is now shrinking. As the United States has strengthened countervailing duties on solar PV exports from Southeast Asia, investment has declined and some manufacturing facilities have been shut down (see Chapter 2). At the same time, investment in manufacturing capacity in other countries has increased rapidly, supported by industrial policies such as the US Inflation Reduction Act and India's Production Linked Incentive scheme. The results are already visible: while Southeast Asia accounted for around 50% of potential solar PV module output (assuming an 85% utilisation rate) outside China in 2023, and around 75% of solar cell output, these shares have now fallen to around 25% for modules and 60% for cells. This trend is expected to continue through 2030, with these shares declining further to around 15% for modules and 40% for cells in the STEPS, as other countries seek to establish or further expand their domestic manufacturing industries.

Despite these developments, manufacturing capacity outside China is expected to remain insufficient to supply solar deployment outside China across all upstream segments of the solar PV supply chain. Southeast Asia's export-oriented manufacturing base is therefore expected to continue to play an important role, particularly in supplying countries that cannot produce competitively themselves but seek sources of supply other than China as a diversification strategy.

**Figure 3.8 Solar PV potential output and deployment outside of China in the Stated Policies Scenario, 2023-2030**



IEA. CC BY 4.0.

Notes: SEA = Southeast Asia. Potential output is calculated by assuming installed capacity is utilised at 85%. This rate is assumed for both existing and announced capacity in 2030.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Southeast Asia's role as an alternative PV module supplier declines as other regions expand domestic capacity, but it remains critical for upstream segments.**

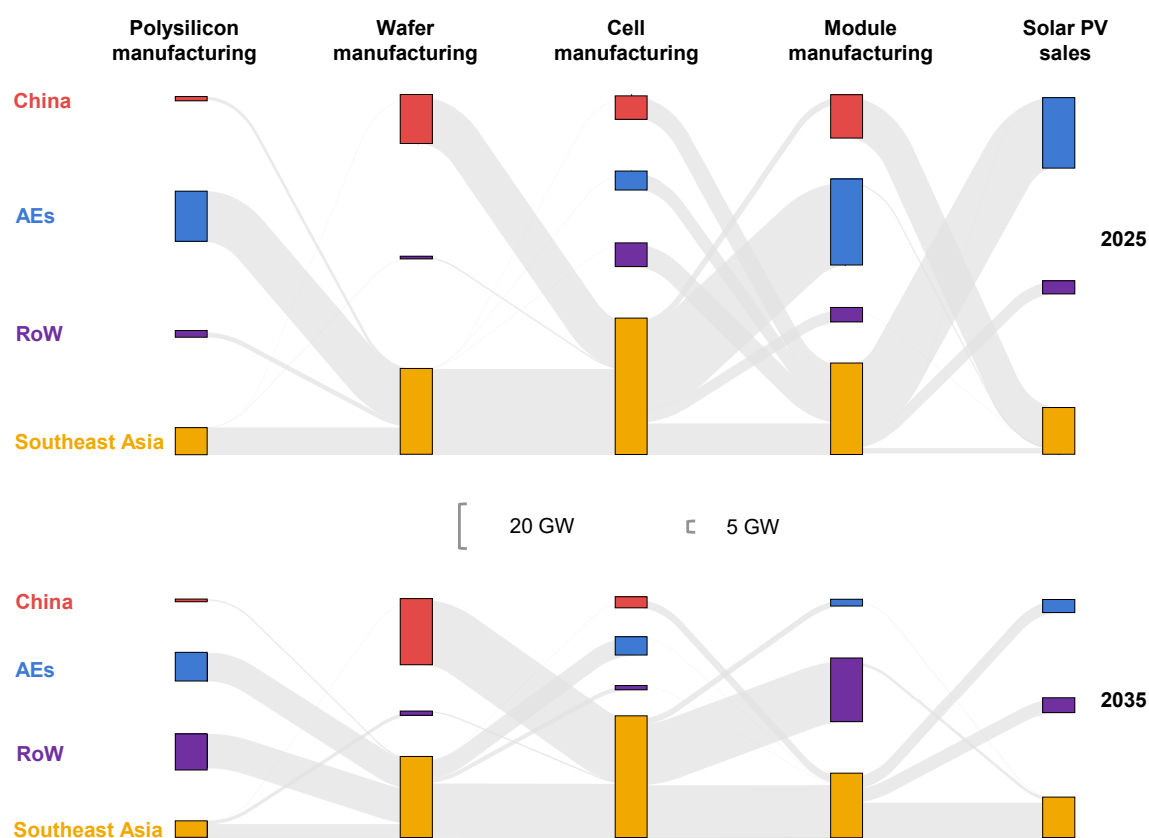
**As access to the US market decreases, it is not possible to fully offset the decline in exports**

These manufacturing capacity dynamics are reflected in projected output and trade flows in the STEPS, as solar module production in the region declines by 20% by 2035 compared with 2025 levels, amid high levels of inventories globally. Most of the production previously destined for export is redirected to the domestic market, displacing imports, although Southeast Asia continues to export part of its output to

other markets and maintains a positive net trade position. Nevertheless, the value of module exports falls by more than 85%, reflecting smaller volumes as well as lower prices in new destination markets. In 2025, for example, a solar module sold in the United States was priced at more than twice the average price of modules sold elsewhere.

Solar cell and wafer production declines by only around 5%. By 2035, Southeast Asia improves its net trade position in solar cells compared with 2025, supplying primarily the Indian market, where investment in cell manufacturing is expected to lag behind investment in module manufacturing. The region remains a net importer of both wafers and polysilicon in 2035. While overseas polysilicon supply remains relatively diversified, wafer imports continue to originate predominantly from China.

**Figure 3.9 Manufacturing and trade flows in the solar PV supply chain in Southeast Asia in the Stated Policies Scenario, 2025 and 2035**



IEA. CC BY 4.0.

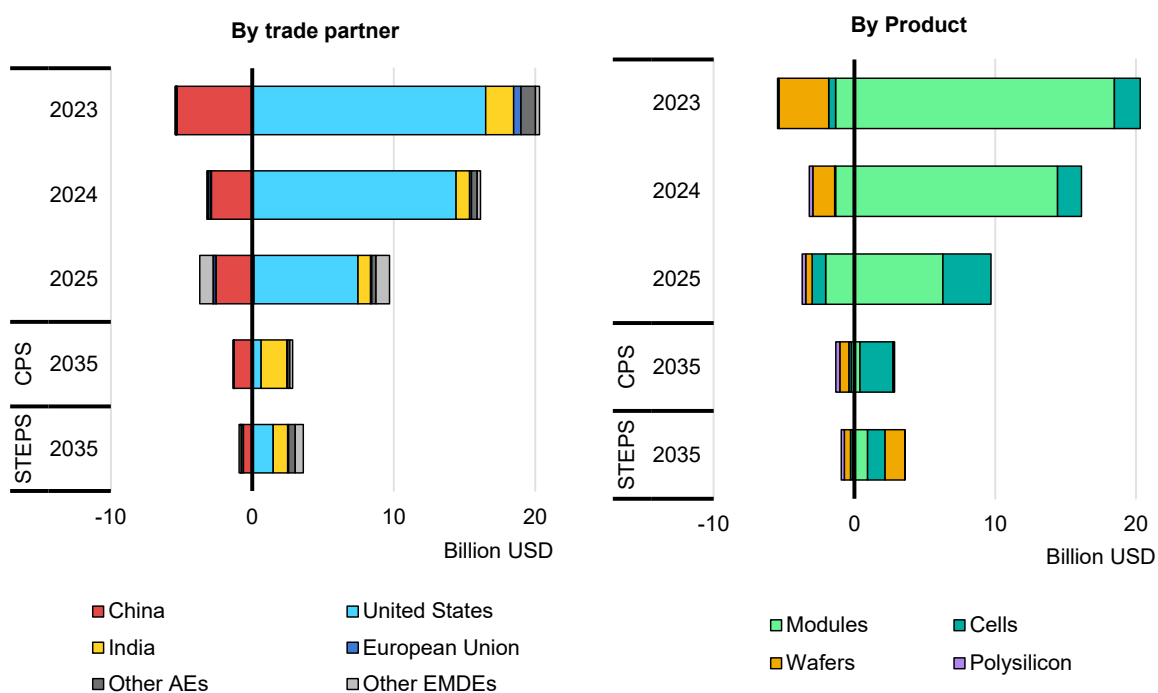
Notes: AEs = advanced economies; RoW = Rest of World. Module sales include inventory changes.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Solar PV output falls in Southeast Asia to 2035 across the supply chain as the region struggles to offset declining exports to the United States, its primary export market.**

Exports peaked in 2023 at USD 20 billion and had already halved by 2025. They decline further to USD 3.6 billion by 2035 in the STEPS, primarily driven by an additional reduction in exports to the United States, which meets most of its module demand with domestic manufacturing by 2035. In the CPS, however, some planned investment in new manufacturing capacity in major markets such as India and the United States does not materialise, reflecting lower demand and huge surplus capacity globally, alongside weaker implementation of industrial policy in several regions. Southeast Asia's cost competitiveness therefore enables the region to expand its cell exports, which increase their total value to USD 2.1 billion by 2035. Higher cell exports, in turn, increase demand for wafers within Southeast Asia, with this additional demand being met through higher domestic wafer production.

**Figure 3.10 Solar PV supply chain trade in Southeast Asia by trade partner, product and scenario, 2023-2035**



IEA. CC BY 4.0.

Notes: CPS = Current Policies Scenario. STEPS = Stated Policies Scenario. EMDEs = emerging markets and developing economies; AEs = advanced economies.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

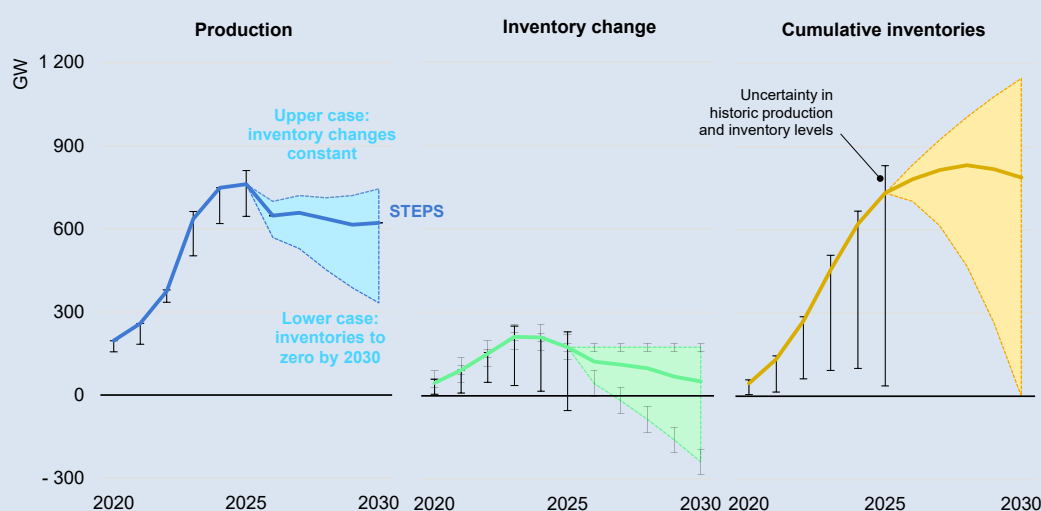
**Exports along the solar PV supply chain fall from their peak of USD 20 billion in 2023 to around USD 3.6 billion in 2035 in the STEPS.**

### Box 3.3 Global solar PV inventories

In recent years, global solar PV module production has consistently exceeded deployment, leading to the accumulation of inventories well beyond the levels normally required for logistics and operational purposes. No single factor can fully explain this inventory build-up. In China – by far the largest producer and exporter of solar PV modules – there have been incentives to maintain production levels above those needed to meet immediate demand. Trade data, however, suggest that much of this excess output has been exported rather than retained domestically. At the same time, there has been little co-ordinated policy effort to secure large volumes of solar modules in importing countries. Private actors in the supply chain – importers, wholesalers, retailers – appear to have accumulated stocks in anticipation of stronger future demand or to benefit from very low module prices, hedging against potential price increases resulting from new tariffs or market consolidation.

Quantifying these inventories precisely remains challenging. Estimates of annual historical solar PV module production can vary by more than 150 GW across different sources, creating substantial uncertainty around global surpluses and annual inventory changes. The growing role of off-grid applications of solar PV and behind-the-meter systems, including plug-and-play solutions, also adds uncertainty to deployment estimates, further widening the range of possible inventory outcomes.

#### Implications of global inventory developments for the solar PV module production outlook, 2020-2030



IEA. CC BY 4.0.

Notes: A 10% annual scrappage rate is assumed, reflecting module deterioration and obsolescence.  
Sources: IEA analysis based on PVPS, InfoLink, S&P Global, ITRPV.

The IEA estimates global module production to have reached 760 GW in 2025, while installations were around 585 GW, resulting in a net inventory change of +175 GW. Our estimates suggest that cumulative inventories now exceed annual solar PV installations. Only around 10% of these inventories are estimated to be located in China, while the European Union and the United States account for roughly 30% and 12%, respectively. The remainder is distributed across other regions, each holding comparatively smaller volumes.

The future evolution of these solar PV module inventories will have significant implications for the solar PV module market, including in Southeast Asia. In the STEPS, inventories are assumed to remain broadly stable at current levels, resulting in global production falling by around 20% by 2030 relative to 2025. If current inventories were instead fully drawn down by 2030 – after taking account of scrappage of solar PV modules that become too old to sell – global production would nearly halve over the same period. Conversely, if annual inventory increases were to continue at recent levels, production would follow deployment growth and remain only slightly below 2025 levels by 2030. This latter case would result in global inventories rising to more than double the level of annual installations by the end of the decade.

## Wind

### Wind manufacturing

Wind power is playing an increasingly important role in Southeast Asia's renewable energy mix and is a key component of broader electrification strategies. Total installed offshore and onshore wind energy capacity grew nearly fourfold between 2020 and 2025 to 10 GW, representing just under 10% of renewable electricity capacity. Governments across the region are supporting deployment through a range of demand-side measures, including renewable energy targets, competitive auctions, feed-in tariffs and power purchase agreements. Examples include Viet Nam's revised Power Development Plan 8 ([PDP8](#)); the Philippines' Green Energy Auction ([GEA](#)) programmes 5, 6 and 9, which cover onshore and offshore wind; and Indonesia's Electricity Supply Business Plan ([RUPTL](#)), which outlines approximately 7.5 GW of additional wind capacity by 2035. As reflected in the STEPS, these policies are expected to increase installed wind energy capacity sevenfold, raising annual demand for turbines from 1.5 GW in 2025 to nearly 8 GW by 2035.

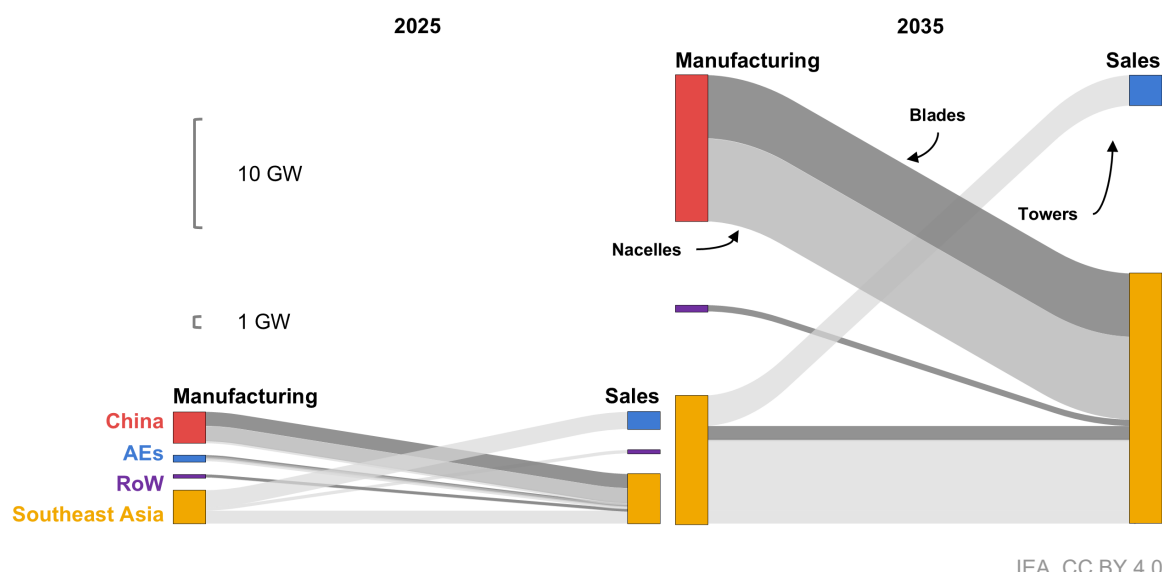
In recent years, the importance of Chinese original equipment manufacturers (OEMs) for Southeast Asia has grown significantly. Between 2021 and 2025, around 40% of wind additions were manufactured by Chinese OEMs, whereas 5

years earlier European and North American OEMs supplied about 95% of additions. Today, Southeast Asia is totally reliant on imports to meet its deployment needs for nacelles and blades and has no local manufacturing capacity. In contrast, the region has maintained tower manufacturing capacity since the early 2000s, developing into a major production hub thanks to its relatively low labour costs and proximity to steel manufacturers. Today, it is estimated that roughly half of this output is used domestically, and the remainder is exported to the United States, Europe, Korea and India.

In the STEPS in 2035, the region continues to import nacelles, mostly from China. By contrast, nearly one-fifth of blade deployment needs are met with domestic production. The remaining blades are imported from China, Korea and India. Tower production more than triples by 2035 to exceed 10 GW, with a larger share of production being directed to regional demand, although exports still increase to 3 GW. The destination of exports does change, however. Exports to Europe and North America disappear as these regions increasingly focus on local production, driven by policies such as the Net-Zero Industry Act (NZIA). By 2035, Southeast Asian tower exports instead increasingly supply the wider Asia Pacific region, where demand is growing.

In the CPS, global wind additions outside China are roughly 10% lower by 2035 than in the STEPS. Decelerating demand for wind turbine components, combined with policies such as the NZIA not being fully implemented, reduces manufacturing capacity outside China for nacelles by 40 GW and for blades by 10 GW. As a result, imports from China meet nearly all of Southeast Asia's demand for blades and nacelles. Towers remain an exception as existing manufacturing capacity in the region is sufficient to meet the lower levels of demand in the CPS, eliminating the need for imports.

**Figure 3.11 Manufacturing and inter-regional trade flows of wind turbines in Southeast Asia in the Stated Policies Scenario, 2025 and 2035**



IEA. CC BY 4.0.

Notes: AEs = advanced economies; RoW = Rest of World. Each 1 GW of installed wind capacity requires 1 GW of nacelles, 1 GW of blades, and 1 GW of towers. For visualisation purposes, these component requirements are aggregated and represented as a single 1 GW flow to wind sales.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Manufacturing of wind towers and blades ramps up by 2035 in the STEPS, meeting a larger share of domestic demand.**

## Viet Nam has the most developed wind manufacturing base in Southeast Asia

Viet Nam is well-positioned to make headway on offshore wind deployment over the next decade. Its technical offshore wind potential is estimated at over [1 TW](#), owing to its long coastline and high wind speeds. Furthermore, the country has the highest offshore wind deployment targets in Southeast Asia and is aiming for [6-17 GW](#) of power supply from offshore wind between 2030 and 2035. In the STEPS, offshore wind accounts for roughly 40% of wind capacity additions across Southeast Asia between 2030 and 2035, up from 20% between 2022 and 2025, when nearly all offshore wind deployment was concentrated in Viet Nam.

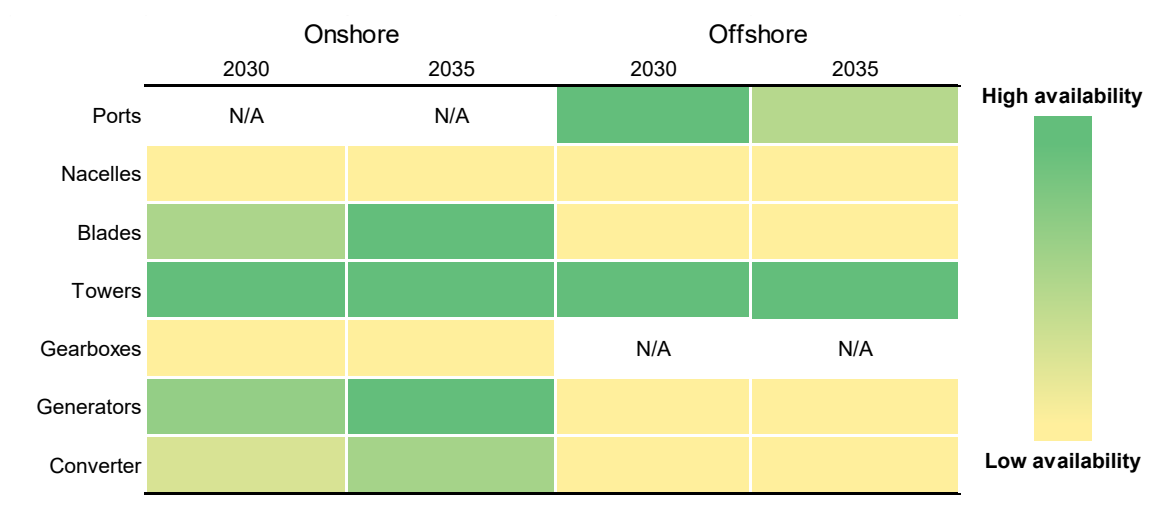
Viet Nam's wind manufacturing base is an export hub supplying Asia Pacific, Europe and North America, with companies such as CS WIND playing a leading role. Manufacturing is primarily concentrated in tower production, reflecting the country's existing industrial strengths. Current offshore tower manufacturing capacity is estimated at around 6.5 GW, enough to supply roughly half of Southeast Asia's offshore wind buildout by 2035.

Under both scenarios, Viet Nam is not expected to develop manufacturing capacity for nacelles by 2035. However, nacelles and large subcomponents, such

as generators and gearboxes, are some of the most complex and therefore valuable parts of the wind supply chain. Viet Nam is well placed to expand its wind manufacturing footprint further by starting to produce gearboxes, and it already produces sizeable volumes of onshore generators, which are mostly exported to North America and Europe.

Besides component manufacturing, offshore wind installations require port capacity, which could become a bottleneck. Current port capacity in Viet Nam appears sufficient for the next 5 years of expansion plans. However, the rapid offshore additions by 2035 projected in the STEPS mean that, even with planned port expansions, a gap of over 50% appears between demand for offshore installations and available port capacity.

**Figure 3.12 Availability of domestic ports and manufacturing for wind turbine components in Viet Nam based on the current project pipeline and demand in the Stated Policies Scenario, 2030 and 2035**



IEA. CC BY 4.0.

Notes: Low availability means there is no capacity. High availability means all demand can be met with domestic capacity.  
Sources: IEA analysis based on the [Manufacturing and Trade Model](#) documentation.

**Offshore wind relies more on imports of components by 2035 than onshore wind, and port capacity could become a potential bottleneck in future offshore wind deployments.**

## Electric cars and batteries

### Electric car and battery manufacturing

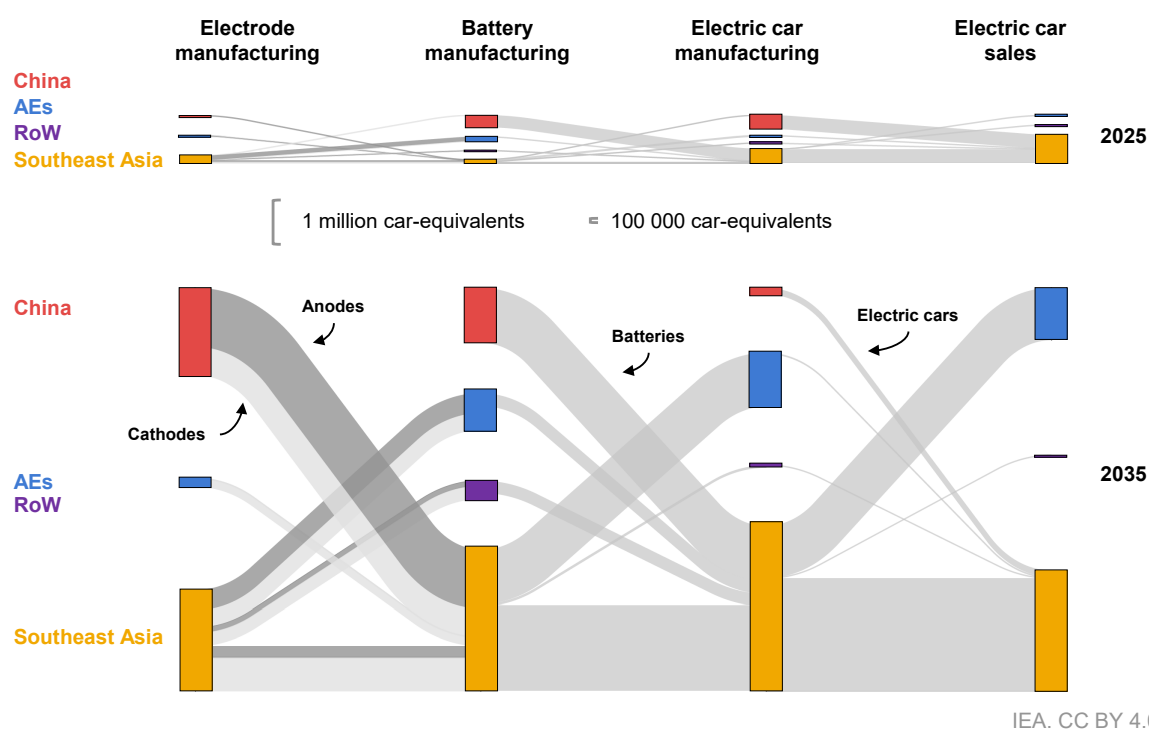
In 2025, electric car sales shares in some countries in Southeast Asia were among the highest seen globally, reaching about 40% in Viet Nam, 47% in Singapore and 23% in Thailand. While these markets are still relatively small in absolute terms, sales are expected to increase further in the coming years, supported by the

growing availability of more affordable EV models, the continued rollout of charging infrastructure, and policy support such as [registration fee exemptions](#) in Viet Nam, the [EV3.5 scheme](#) in Thailand, and [VAT](#), excise and [import duties](#) exemptions in Indonesia.

With the exception of Viet Nam, where Southeast Asia's leading domestic manufacturer VinFast accounted for most electric car sales, countries in the region relied [primarily](#) on imports from China in 2025. However, policy support to promote domestic manufacturing in countries such as [Thailand](#), [Indonesia](#) and [Malaysia](#) is expected to drive substantial growth in regional electric car production over the next decade. Over time, manufacturing is also expected to shift from the assembly of knockdown kits towards fuller-scale vehicle production. Yet despite the various policies supporting local production in the region and the sizeable manufacturing capacity, domestic output still needs to materialise and compete against Chinese shipments. In the first half of 2026, Chinese-made models accounted for nearly 60% of electric car registrations in Southeast Asia, up 7 percentage points compared to the same period in 2025.

Under the STEPS, electric car sales in Southeast Asia are projected to reach 2.7 million in 2035, more than 4 times their 2025 level, while production is projected to exceed 3.6 million vehicles, around 12 times more than in 2025. Southeast Asia is projected to become a net exporter of electric cars before 2030, especially to the European Union and Australia, where trade policies are expected to significantly affect the affordability of competing Chinese-made models. Rising demand for EV batteries, together with export opportunities in markets seeking to reduce reliance on China as a source of supply, also underpins the development of a regional battery and battery component ecosystem. By 2035, EV battery cell production is projected to equal regional demand, up from less than 30% of demand in 2025. While about two-thirds of its 2035 output serves domestic demand, the region continues to import batteries from China while exporting part of its production to markets where they can command higher prices in order to capture higher profits.

**Figure 3.13 Manufacturing and trade flows of electric cars, lithium-ion batteries and anode and cathode active material in Southeast Asia in the Stated Policies Scenario, 2025 and 2035**



Notes: AEs = advanced economies; RoW = Rest of World. Batteries and battery components include only those used in electric cars. “Cars-equivalent” is a combined unit of measure for electric cars, batteries and battery components, with the latter two expressed as the number of cars that could be produced with a given quantity thereof. Electric car sales include inventory changes.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Electric car sales and production in Southeast Asia expand four- and twelve-fold, respectively, over the next decade in the STEPS, making the region a net exporter.**

## Domestic deployment and cost competitiveness underpin growth

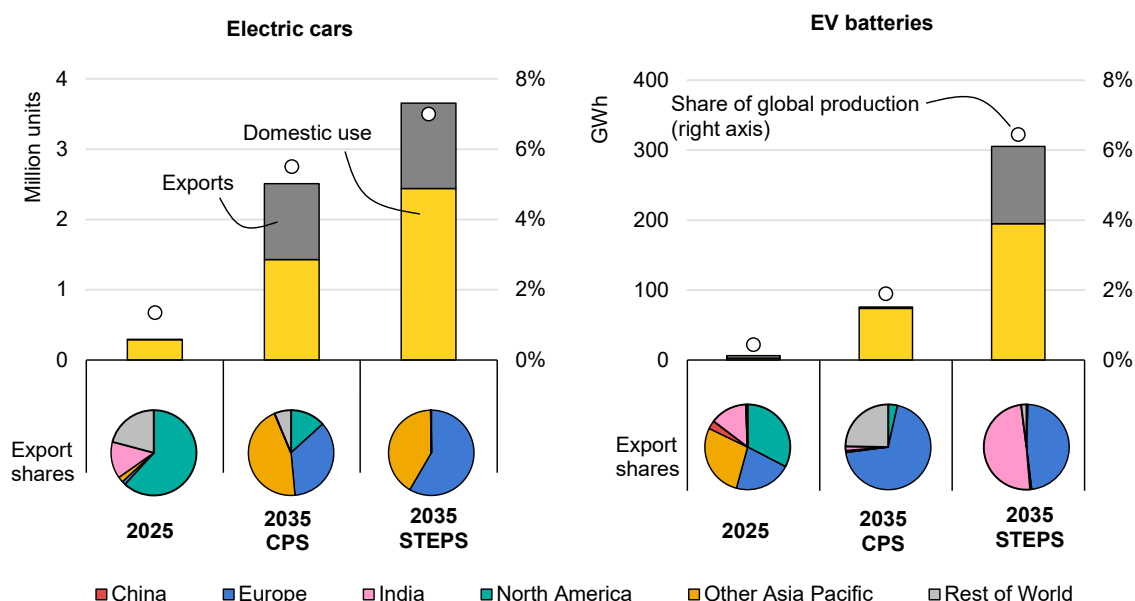
Imports from China met about half of Southeast Asia’s demand for electric cars in 2025, but the share met by domestic production is set to increase markedly in the coming years. By 2030, growing domestic demand and sizeable EV manufacturing capacity (see Chapter 2) could support a fivefold increase in production from today’s level, with output later reaching 2.5 million electric cars in the CPS and 3.6 million electric cars in the STEPS by 2035. Competitive manufacturing costs, expanding project pipelines and supportive industrial policies in Thailand, Indonesia, Malaysia, and Viet Nam could also position the region as a growing export hub. Much of the region’s new EV capacity is being developed by Chinese, Korean and Japanese carmakers with established models and sales networks in major markets such as Europe and North America. Producing these models in Southeast Asia, where exports are not currently subject to the same trade restrictions as Chinese-made battery electric vehicles, could strengthen their

competitiveness in these destination markets. By 2035, under the STEPS, over one-third of the region's output is earmarked for export, primarily to Europe (60% of total exports), Australia and New Zealand. In the CPS, while destination markets remain broadly unchanged, exports account for a larger share of output due to lower domestic demand.

The region's prospects for growth in electric car and battery manufacturing are now much stronger than those for solar PV. In the case of solar PV, production was largely aimed at exports to the United States, and the introduction of US tariffs removed much of the rationale for those investments. For EVs and batteries, by contrast, growth is expected to be driven primarily by domestic demand, despite significant export potential. This makes the sector's expansion more resilient and less dependent on policy decisions abroad. Southeast Asia's potential also rests on its cost competitiveness. For example, battery cell production costs in countries such as Indonesia and Malaysia are estimated to be roughly 10% higher than in China, a much smaller premium than the 50% cost gap observed between Europe and China today (see the Cost competitiveness section in Chapter 2). The region's premium could narrow further over the next decade as economies of scale increase and manufacturing efficiency improves, bringing production costs close to parity with those in China by 2035 in the STEPS.

EV battery production is projected to increase from just a few gigawatt-hours (GWh) in 2025 to over 320 GWh in 2035 in the STEPS, meeting a growing share of domestic demand and serving export markets. Growth is also sustained in the CPS, with production reaching around 80 GWh by 2035, but remains significantly more limited than in the STEPS. This is driven by weaker regional demand, which limits economies of scale, and by fewer export opportunities, as global demand is lower and supply chain diversification receives less support in the CPS than in the STEPS.

**Figure 3.14 Electric car and electric vehicle battery production in Southeast Asia by scenario, 2025 and 2035**



IEA. CC BY 4.0.

Note: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Southeast Asia's share of global electric car and battery production grows fourfold in the Current Policies Scenario, and even more in the Stated Policies Scenario.**

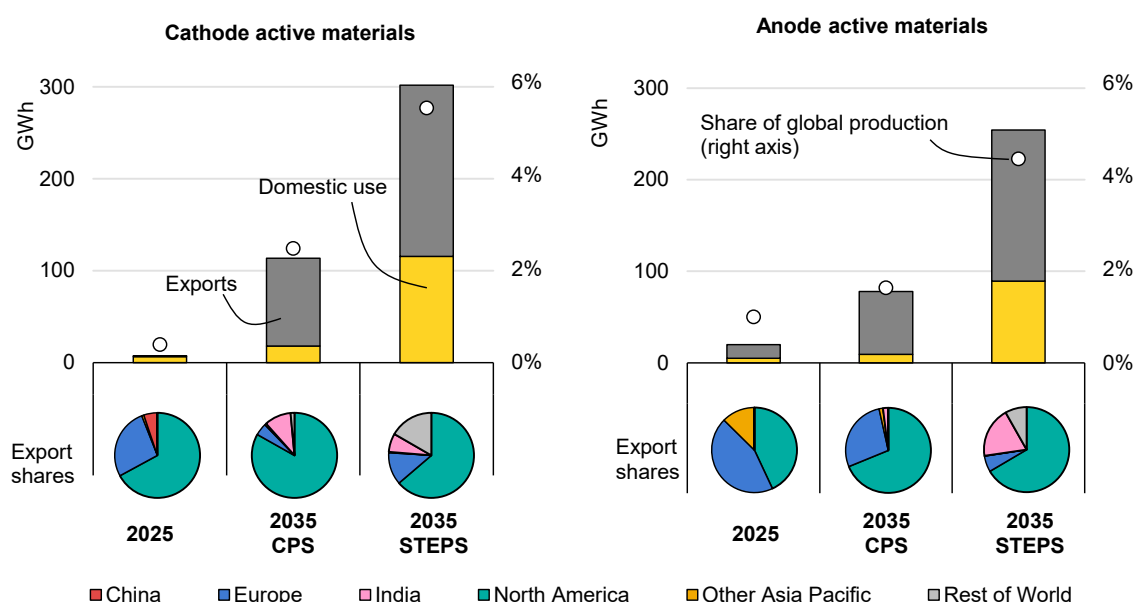
Southeast Asia is starting to become a larger contributor to the diversification of global battery supply chains, which today remain [heavily concentrated](#) in China. This is the case for graphite anode material, thanks to competitive production costs and Chinese investments in the region, such as the [BTR New Material](#) graphite plant in Indonesia, the largest facility of its kind outside China. The region's role in cathode active material production is also projected to expand, supported by access to critical minerals such as nickel, competitive production costs, and investments from leading companies such as [Jiangsu Lopal](#) and [EcoPro](#) (Indonesia), and [Hunan Yuneng](#) (Malaysia).

Southeast Asia's share of global anode active material production is projected to rise from around 1% today (representing nearly 30% of global production outside of China) to around 4% by 2035 in the STEPS, corresponding to over 40% of global production outside China. In the CPS, Southeast Asia would account for an even greater share – almost half – of anode production outside China, but the overall anode market does not diversify significantly, with China retaining a near-monopoly position. For cathode active materials, the Southeast Asian share of global production is projected to grow from less than 0.5% (4% of production outside of China) in 2025 to 2% (25%) in 2035 in the CPS, and to over 5% (25%)

in the STEPS. Importantly, this includes both lithium nickel manganese cobalt oxide and lithium iron phosphate (LFP) materials, with Indonesia currently hosting the largest operating LFP cathode active material [plant](#) outside China.

These industries are expected to be largely export-oriented, with the United States projected to be the largest destination, as battery manufacturers operating in the country seek to diversify supply chains away from China to maintain access to [production tax credits](#). In the STEPS, imports from Southeast Asia are expected to account for over one-quarter of cathode active material and anode active material demand in the United States in 2035, with Indonesia as the largest supplier.

**Figure 3.15 Cathode and anode active material production and trade in Southeast Asia by scenario, 2025 and 2035**



IEA. CC BY 4.0.

Note: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

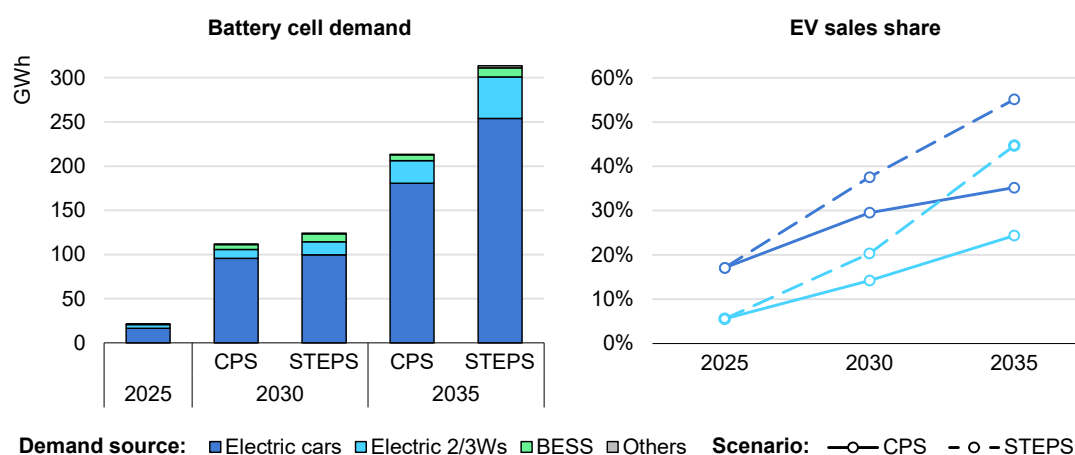
**Southeast Asia could become an important source of supply chain diversification for cathode and anode active materials.**

EVs should not be equated with electric cars. Although cars account for most EV sales and the associated battery demand, two- and three-wheelers (2/3Ws) remain central to mobility in Southeast Asia, due to their comparatively affordable upfront cost and suitability for congested urban areas. In 2025, these vehicles accounted for more than half of passenger-kilometres travelled in the region, compared with 35% for cars and less than 10% for buses. This contrasts

with the global average, where cars account for more than 60% of passenger-kilometres travelled and 2/3Ws for 20%.

The region may be well-positioned to produce batteries for 2/3Ws, which often use cylindrical battery cells, the same physical configuration ([form factor](#)) traditionally used in many portable electronic devices, for which Southeast Asia already has manufacturing experience. In 2025, 2/3Ws accounted for 20% of total battery demand in the region. Their share is projected to fall to around 10-15% across all scenarios by 2030 and 2035, as electric car sales are increasingly underpinned by domestic production.

**Figure 3.16 Battery demand by segment and scenario, and electric vehicle sales share in Southeast Asia, 2025, 2030 and 2035**



IEA. CC BY 4.0.

Notes: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario; BESS = battery energy storage systems; 2/3Ws = two- and three-wheelers.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Battery demand in Southeast Asia is set to grow rapidly across all scenarios, led by electric cars, although 2/3Ws remain important.**

### Box 3.4 Battery energy storage systems in Southeast Asia

BESS are moving from policy targets to practical grid planning tools in Southeast Asia, particularly to support the integration of higher shares of variable renewable electricity generation. Under its 2025 Electricity Supply Business Plan, Indonesia aims to add [more than 4 GW](#) of BESS capacity between 2025 and 2034. In Malaysia, BESS will become [mandatory](#) for solar PV projects under the sixth round of its [Large Scale Solar](#) programme, with a target of [over 1 GW](#) BESS capacity. Viet Nam has set the most ambitious target in the region, aiming for [between 10 GW and more than 16 GW](#) of installed BESS capacity by 2030, and

has recently [introduced](#) a standardised framework for determining electricity service and power purchase prices for standalone grid BESS. The Philippines has also begun procuring renewables paired with storage at scale, supported by the need for greater system flexibility across its island geography. Its [fourth](#) Green Energy Auction awarded [1.2 GW](#) of integrated renewable energy and energy storage system projects, scheduled for delivery by 2029.

While these targets are significant, they remain small relative to the projected growth in EV battery demand. Under stated policies, Southeast Asia is expected to install less than 10 GWh of BESS in 2030, compared with EV battery demand of more than 100 GWh in the same year.

Given the relatively small size of the Southeast Asian BESS market in the coming years, attracting sufficient investment to build a domestic BESS industry is likely to depend not only on local demand, but also on export opportunities. Ongoing Chinese investment could help lay the foundations for such an industry. In particular, planned LFP material plants such as [Hunan Yuneng](#) in Malaysia and [Jiangsu Lopal](#) in Indonesia could support the later development of LFP cell and BESS manufacturing, given that the LFP chemistry accounted for more than 90% of global BESS deployment in 2025.

## Heat pumps and air conditioners

### Heat pump manufacturing

Southeast Asia's climate is characterised by persistently high temperatures and humidity. At the same time, the region is undergoing rapid population growth and urbanisation, driving demand for heating and cooling solutions in the growing building stock (see Chapter 1). Domestic demand for and manufacturing of heating, ventilation and air conditioning (HVAC) equipment are largely focused on air conditioners (AC) used for space cooling, whereas heat pumps (used for space and/or water heating) have a more peripheral role. However, the two technologies share much of their supply chains and components, leading to manufacturing synergies which are already evident in Southeast Asia. Heat pump deployment in the residential sector remains limited, although adoption is increasing in the service sector, particularly in hotels.

Thailand is the region's leading manufacturer, home to about 8% of the world's AC manufacturing capacity, and is the world's second-largest exporter of residential ACs.<sup>13</sup> Indonesia and Malaysia also have expanding HVAC industries.

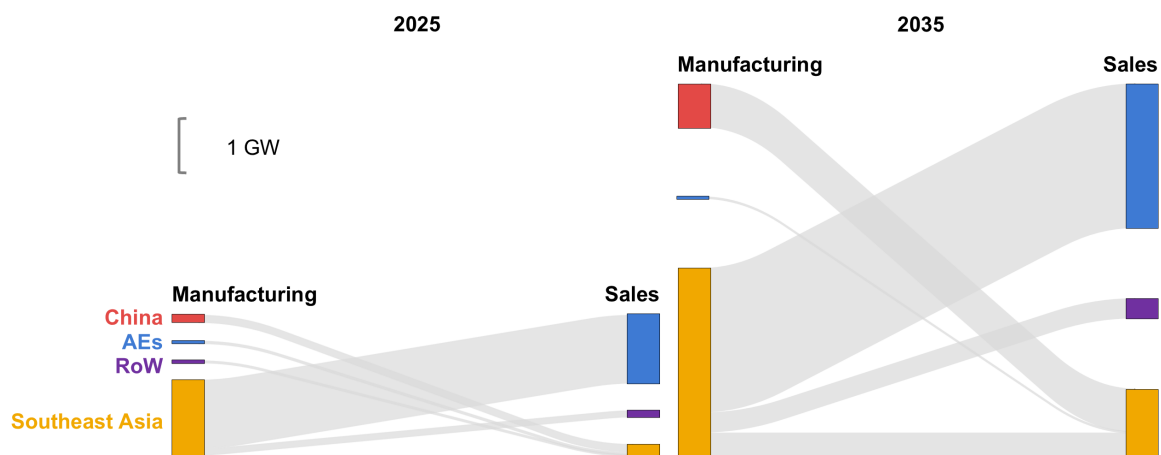
<sup>13</sup> As per Harmonized System (HS) code: HS841510

Heat pump manufacturing in Southeast Asia covers both hydronic distribution heat pumps and reversible air distribution heat pumps (also known as reversible ACs). As such, some of the heat pump manufacturing arises as a “by-product” of AC manufacturing – reversible ACs made up less than 15% of all AC exports in 2025. Manufacturing dedicated to “heating-only” hydronic distribution heat pumps, such as those used for heating domestic tap water, also takes place and is sizeable. Here several manufacturers specialise in the service sector segment, producing heat pumps that are used in hospitals, hotels and other commercial buildings. While the HVAC manufacturing scene is dominated by larger multinational manufacturers such as Daikin, Panasonic and Mitsubishi, domestic companies such as Saijo Denki, Uni-Aire and Taitronics Industries remain present, albeit with revenues that are orders of magnitude lower.

### The heat pump industry is export-oriented

Heat pump manufacturing in Southeast Asia amounted to more than 1 GW in 2025, with the majority being exported to advanced economies, where demand for heat pumps is highest and Southeast Asian manufacturers can compete based on cost. Southeast Asia is a minor manufacturing hub on the global scale, making up less than 3% of total heat pump manufacturing capacity in 2025. However, with over 90% of production going towards exports in 2025, it stands out as one of few regions with an export-oriented heat pump industry – globally, only 15% of manufactured heat pumps were exported. In the STEPS, manufacturing reaches 4 GW in 2035 and remains primarily export-oriented, but less so than today due to increased deployment of heat pump water heaters and increased competition from China, where there is stronger targeted policy support for heat pump manufacturing and production costs that are around 20% lower in 2025 and in the coming years. In this scenario, Southeast Asia captures around 12% of global heat pump exports in 2030, a share that then decreases to 10% by 2035 due to Chinese competition. In the CPS, manufacturing stagnates to 2035, remaining at just above 1 GW. Due to less policy support for heat pump uptake globally, consumers face higher costs, which decreases overall demand for heat pumps but also causes China’s cost advantage to weigh more heavily on buying decisions. This in turn means that Southeast Asia’s market share of global heat pump exports declines faster, to 6% by 2030 and 3% by 2035.

**Figure 3.17 Manufacturing and inter-regional trade flows of heat pumps in Southeast Asia in the Stated Policies Scenario, 2025 and 2035**



IEA. CC BY 4.0.

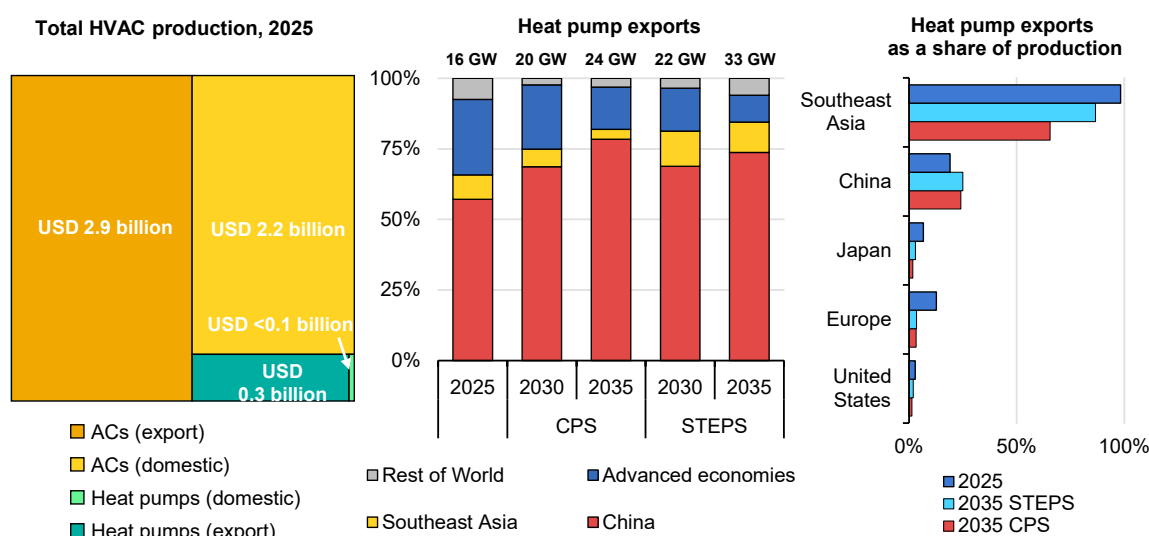
Note: AEs = advanced economies; RoW = Rest of World.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Southeast Asia's heat pump production increases to 2035 in the STEPS, with a greater share supplying its growing domestic demand.**

Globally, heat pump manufacturing remains a primarily domestic affair, with imports of heat pumps worldwide reaching 24 GW and 33 GW by 2035 in the CPS and the STEPS respectively; however, these imports still make up only around 15% of total demand in both scenarios. Southeast Asia could also play a role in the upstream supply chain as manufacturers in Europe, Japan and the United States are still largely reliant on imports of compressors from China, in particular for rotary compressors, which are typically used for smaller air distribution heat pumps. As the home to 50% of the world's rotary compressor manufacturing capacity outside of China, and with notable capacity for other types of compressors too, the region could position itself as a strategic partner for overseas heat pump manufacturers looking to diversify their supply chains.

**Figure 3.18 Heating, ventilation and air conditioning production in Southeast Asia, global exports of heat pumps, exports as a share of production and by scenario, 2025-2035**



IEA. CC BY 4.0.

Notes: HVAC = heating, ventilation and air conditioning; CPS = Current Policies Scenario; STEPS = Stated Policies Scenario; HVAC production includes finished air conditioners and heat pumps. For Southeast Asia and Europe, exports used in calculating exports as a share of production include exports to other regions within the same aggregated region.

Sources: IEA analysis based on a range of data sources; see the [Manufacturing and Trade Model](#) documentation.

**Southeast Asia exports a larger share of the heat pumps it produces than any other region.**

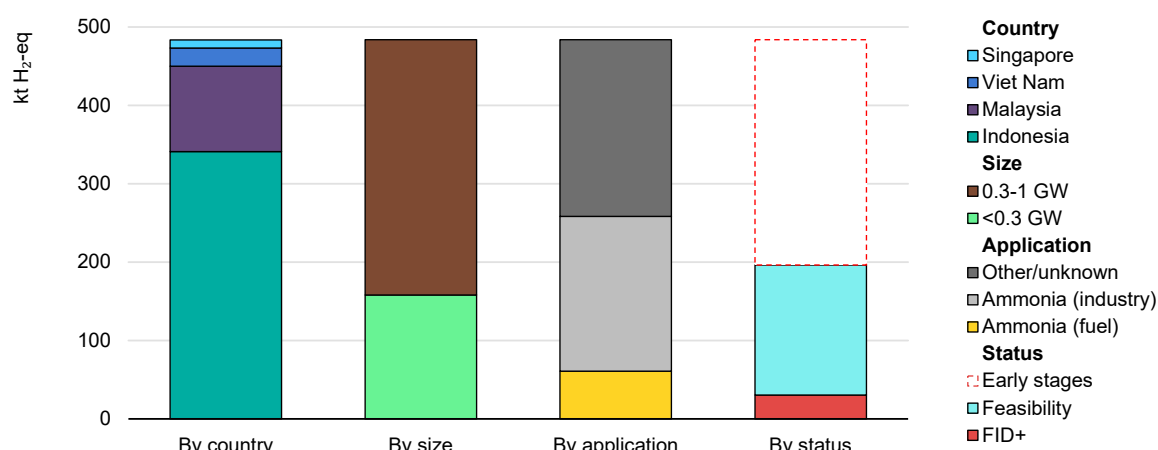
## Electrolysers, hydrogen and sustainable fuels

Electrolyser manufacturing activity in Southeast Asia remains limited. While some module assembly takes place through partnerships between [domestic assemblers and international manufacturers](#), the only commercial-scale stack manufacturer is Singapore-based HET Hydrogen, which is taking the first steps to establish [large-scale manufacturing capacity](#) outside of the region. In both the CPS and the STEPS, the region continues to rely on imports from China, which dominates global electrolyser manufacturing due to its cost competitiveness and large pipeline of committed projects. While manufacturing capacity is available in other regions, such as the European Union and the United States, manufacturers in these regions are unlikely to serve the Southeast Asian market because their manufacturing costs are between 40% and 75% higher.

The development of markets for low-emissions hydrogen and sustainable fuels will depend on establishing the enabling conditions needed to stimulate demand and reduce costs, with progress in Southeast Asia closely linked to the maturation of global markets. In the region, the main opportunities to use low-emissions hydrogen for the production of low-emissions fuels come from existing

applications that are currently based on hydrogen produced from unabated fossil fuels. Domestic production of low-emissions ammonia, in particular, offers the possibility to reduce emissions and displace imports, strengthening energy security. Indonesia and Malaysia, which are both ammonia exporters, have the region's largest markets for ammonia, followed by Viet Nam, which imported 11% of its demand in 2024. Thailand currently relies entirely on imports but has a strong opportunity to develop domestic production, as its market is large enough to provide economies of scale. In general, the main enabling factors for low-emissions ammonia production are high capacity factors for renewables and the low cost of capital, as ammonia's low transport cost means that imports from regions that benefit from these enabling factors are cheaper than domestic production. In Southeast Asia, the main barrier is the high cost of capital.

**Figure 3.19 Breakdown of announced electrolysis projects in Southeast Asia, 2030**



IEA. CC BY 4.0.

Notes: FID+ = projects with a final investment decision, including those in operation and under construction. Only projects with a disclosed start year are included.

Source: IEA (2026), [Hydrogen Production Projects Database](#).

**Announced electrolysis projects in Southeast Asia are equal to 12% of current regional hydrogen demand, but only 6% of announced capacity has reached FID.**

Hard-to-electrify sectors such as shipping and aviation also offer opportunities for the use of sustainable fuels to curb emissions and reduce oil demand. The Port of Singapore has the largest demand for bunkering fuels in the world, and is pursuing a [multi-fuel strategy](#), including methanol, ammonia and hydrogen. As part of its National Hydrogen Strategy, in October 2025 Singapore [selected a consortium led by Keppel Ltd](#) to undertake a front-end engineering design study for the supply of low- or zero-carbon ammonia for power generation and bunkering. In aviation, demand in Southeast Asia is concentrated in a limited number of major airports, creating opportunities for targeted deployment of sustainable aviation fuels (SAF). Various Southeast Asian countries, including [Indonesia](#), [Malaysia](#), [Singapore](#) and [Thailand](#), have already adopted aviation decarbonisation strategies and SAF

blending mandates, although only Thailand's mandate is currently in force. These strategies largely focus on biofuels, with initiatives such as [Neste's bio-based SAF supply chain in Singapore](#) already supporting deployment.

The pipeline of low-emissions hydrogen production projects, which consists entirely of electrolysis projects, is highly concentrated in Indonesia and Malaysia, which together account for more than 90% of announced capacity.

The industry is still at an early stage, with only around 6% of announced capacity (30 ktpa) having reached FID. Of this, more than 20 ktpa came from a single project, the [Tra Vinh project](#) in Viet Nam, which will use a 240 MW electrolyser to produce ammonia, and started construction in 2023, targeting operation in 2027. A highly concentrated pipeline limits opportunities to test different configurations, users and stakeholders. Dependence on a few large projects also increases execution risk and the likelihood of delays from unexpected events. In addition, the pipeline lacks mature 50-250 MW projects that could act as stepping-stones to giga-scale projects, as existing projects at this scale are unlikely to come online in the next few years.

While Southeast Asia could produce low-emissions hydrogen and hydrogen derivatives at globally [competitive costs](#), regional supply will need to compete with other major economies targeting exports, such as China, India and Australia, which benefit from more advanced project pipelines and favourable production costs. For example, projects in [China](#) and [India](#) have already secured long-term agreements to supply renewable ammonia to Japanese buyers.

### Box 3.5 Unlocking future demand for sustainable fuels

Demand for sustainable fuels remains limited and uncertain, as significant cost gaps with incumbent fossil fuel pathways continue to constrain uptake. However, the market has the potential to expand significantly under the right enabling conditions. Globally, hydrogen and hydrogen-based fuel markets could grow from around USD 2 billion today to over USD 50 billion by 2035 in the STEPS. Realising this potential will depend on the successful deployment of a range of policy and market mechanisms to stimulate demand and reduce costs. At the global level, governments have started implementing measures to stimulate demand for sustainable fuels, but results have been mixed. Positive outcomes have been [observed for tenders for low-emissions hydrogen](#) in the refining sector and in ammonia production, while tenders in the steel sector have faced difficulties in progressing to the contracting phase.

Existing applications relying on unabated fossil-based hydrogen represent a key opportunity for early demand creation. Numerous projects targeting these

applications are ready to take FID, if support is provided to reduce the cost gap with fossil-based pathways. Their implementation could support the scale-up of low-emissions fuels production and enable cost reductions. To mitigate risks on the supply side, a range of policies have been deployed. These include grants and fixed premiums, commonly used in the European Union through [Important Projects of Common European Interest](#) and the [European Hydrogen Bank](#); contracts for difference, such as those applied in [Japan](#) to support low-carbon ammonia supply for use in power generation and industry; and double-sided auction schemes, as introduced by [H2Global](#). The timely and co-ordinated development of transport and storage infrastructure will also be essential to connect production with demand and avoid bottlenecks along emerging supply chains. Recent milestones include the start of construction of the world's longest dedicated [hydrogen pipeline](#) in China, the development of underground storage facilities in the [United States](#), [Germany](#) and [China](#), and the first commercial-scale [international shipments](#) of electrolytic ammonia.

Beyond existing applications, creating lead markets for end-use products or services that use low-emissions fuels as intermediates can unlock demand in the near term, as cost premiums tend to decrease along the value chain and translate into only marginal impacts on final consumer prices. Mandates for hydrogen-based synthetic kerosene (e-SAF) in Europe are an example of this approach. These are set to create demand for [more than 630 ktpa of e-SAF](#) by 2030, with current global production below 10 ktpa. Their impact on ticket prices is set to be limited – less than USD 5 per passenger on short-haul flights and less than USD 30 on long-haul flights – despite the high price premiums for early e-SAF production.

International transport regulations can play a critical role, as co-ordinated global standards represent an opportunity to accelerate the adoption of sustainable fuels by setting a level playing field. The International Maritime Organization [Net-Zero Framework](#) could be a decisive first step in this direction, combining limits on the GHG intensity of marine fuels with an emissions-pricing mechanism to incentivise the uptake of low-emissions alternatives. However, its implementation has been delayed due to a lack of consensus on its adoption.

Finally, certification and traceability systems are essential for creating demand for sustainable fuels, as they allow producers and buyers to verify lifecycle GHG emissions and differentiate low-emissions fuels from conventional alternatives. While [several regions](#) already have a certification scheme in place, significant differences exist between these schemes, which could adversely affect trade in sustainable fuels.

## Other key technologies for the Age of Electricity

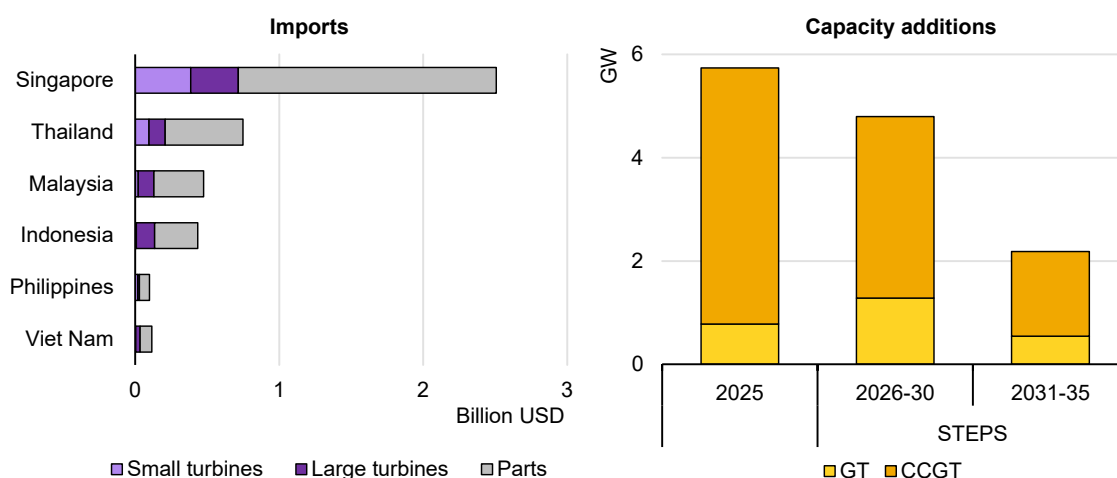
### Gas turbine manufacturing

Ensuring reliable electricity supply as demand grows and becomes more variable will require not only expanded grid infrastructure, but also sufficient dispatchable generation capacity that can respond quickly to changes in system conditions. Gas turbines are one such technology which can play a key role in this context, providing flexible and controllable generation that can ramp up rapidly to meet peak demand and support system stability. As electricity demand increases and load profiles evolve across Southeast Asia, the deployment of gas turbine capacity is expected to expand in parallel with wider power system development.

Like other capital-intensive power system equipment, gas turbines are typically sourced through international supply chains, reflecting the concentration of manufacturing among a limited number of global suppliers. As a result, the region's ability to ensure reliable electricity supply will be increasingly linked to access to imported generation technologies alongside continued investment in domestic power infrastructure. However, after two decades of broadly stable global demand, the gas turbine market has entered a period of rapid growth, driven by rising electricity demand, notably from data centres.

Demand for gas turbines in Southeast Asia is set to increase by 20% by the end of the decade in the STEPS, equivalent to around 140 GW of total installed capacity by 2030. Electricity generated by the region's gas turbines in the next 5 years will be 25% higher than in the previous 5 years, even though the share of electricity generated from gas turbines compared to other sources will remain at roughly the same level as today. Examples of recent projects are the expansion of Nhon Trach combined cycle power plant in Viet Nam, made operational in 2025, with two H-class turbines for 1.5 GW of new capacity to the grid. Two to three similarly large projects are typically finished each year in the region on average.

**Figure 3.20 Gas turbine trade and annual capacity additions in Southeast Asia in the Stated Policies Scenario, 2025-2035**



IEA. CC BY 4.0.

Note: STEPS = Stated Policies Scenario; GT = gas turbine; CCGT = combined cycle gas turbine.

**Southeast Asia is currently reliant on imports of gas turbines and has no large turbine manufacturing capacity to meet future capacity additions.**

Some of the future demand results from data centre buildout, especially in Malaysia. In contrast to some other regions, such as North America, data centre operators in the country plan to use electricity from the public power grid, and there is no evidence of private gas plant projects. However, the Malaysian government actively manages expansion of its gas-fired power plant fleet through the [NewGen26](#) bidding programme.

Manufacturing of gas turbines is highly concentrated in the United States, Europe and Japan. As there is no manufacturing capacity for large turbines in Southeast Asia, gas turbines are imported from global manufacturing hubs, mainly from the United States (which is responsible for nearly 40% of imported value). Singapore, Thailand, Malaysia and Indonesia have the highest imports to meet domestic demand, while Singapore also imports large quantities of turbine parts, in part to feed the servicing and maintenance centres located in the country. For example, GE Vernova's repair facility in Singapore serves as a global hub for repairs, and the company recently invested USD 20 million to introduce repair capabilities for advanced H-class turbines, in addition to existing F-class repair capabilities.

Manufacturers are running at full capacity, and orders for gas turbines reached a record high in 2025, with 2026 orders expected to be even higher. As manufacturer backlogs grow, customers will need to account for longer lead times and rising prices. Data centre customers tend to be less price sensitive and can often pay a premium of up to 50% for faster delivery. As such, any additional

demand for gas turbines by operators in the region may face supply constraints, at least in the next 5 years. As the region is dependent on imports, it is important for governments to ensure visible and credible regional demand to attract supply. Growing demand for gas turbines from Southeast Asia that cannot be satisfied by incumbent manufacturers could in future be met by Chinese suppliers that have mostly only served the domestic market to date.

### **Box 3.6 The gas turbine supply chain**

Gas turbines are thermal engines that generate electricity and heat by burning gaseous fuels. Gas turbines can be used either in isolation, often as “peaking plants”, or within a combined cycle, where the gas turbine is combined with a heat exchanger and a steam turbine to optimise the energy conversion efficiency. Apart from utility power generation, gas turbines are often used in the oil and gas industry to power heavy machinery or to provide off-grid, reliable electricity. Recently, the surge in data centre buildout has ignited new demand for gas turbines, which are often placed behind the meter to power the digital infrastructure.

Manufacturing of a gas turbine requires advanced materials and metallurgy capabilities. The peak combustion temperatures in large modern turbines require the use of advanced alloys and thermal barrier coatings, as well as precision drilling of cooling channels. To withstand the high temperature and pressure, the blades are cast from nickel-based superalloys as single metallic crystals to avoid any potential weak points. The manufacturing process for these types of parts is a very advanced technology, and is categorised as “dual use” in many jurisdictions due to the similarity with advanced jet engine manufacturing. Only a handful of companies worldwide are capable of producing the components required for gas turbines.

Due to the high entry and operational costs, the supply chain for gas turbines and their key components is very concentrated. About two-thirds of the market is captured by three companies – Siemens Energy, GE Vernova and Mitsubishi Power – which dominate the manufacturing of the largest and most advanced units. China has been home to joint-ventures manufacturing gas turbines since 2004, but today, Chinese manufacturers are still not present in the market for the most advanced and largest turbines.

## **Transformer manufacturing**

The performance and availability of core grid components will play a central role in shaping system readiness. Among core grid components, transformers are critical enablers of grid expansion, allowing electricity to be transported efficiently across long distances and delivered safely to end users. By adjusting voltage levels at key points throughout transmission and distribution networks,

transformers underpin the ability of power systems to integrate new generation capacity, connect emerging load centres and manage more variable demand patterns. As such, their availability, deployment and performance will be central to ensuring that grid infrastructure keeps pace with the region's growing electrification needs. While this section focuses on transformers, other strategically important grid technologies, including high-voltage direct current cables, advanced power semiconductors, switchgear and power electronics, will also be important to supporting power system expansion and reliability.

Today, there are around 400 transformer manufacturing plants worldwide.<sup>14</sup> Southeast Asia hosts only around 20 of these plants, primarily located in Viet Nam, Thailand and Indonesia. The production of large power transformers is particularly complex, requiring highly skilled labour, specialised machinery – such as core cutting and stacking equipment and advanced testing facilities – and critical inputs, including grain-oriented electrical steel (GOES) and continuously transposed conductors. A limited transformer manufacturing base, combined with strong reliance on specialised materials, means the region is heavily dependent on imports for both transformers and upstream inputs.

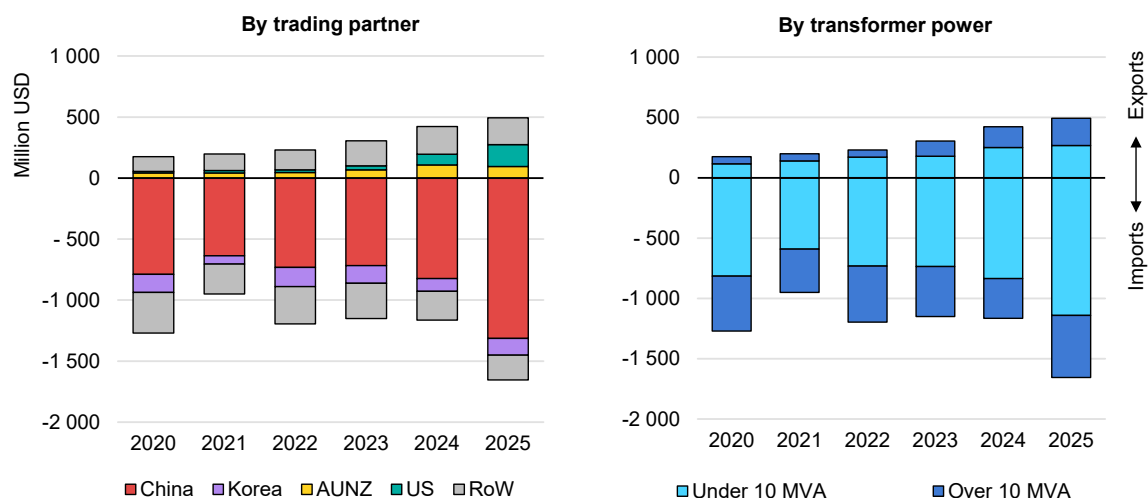
From 2020 to 2025, the value of transformer imports to the region grew from USD 1.3 billion to USD 1.7 billion. China is the main supplier of transformer materials and components<sup>15</sup> to Southeast Asia. Around 95% of GOES, close to 90% of winding wire and more than 80% of transformer parts were imported from China in 2025. At the same time, exports of transformers from the region increased almost threefold, with particularly notable growth in exports to the United States. This is happening as local manufacturers, such as [TRT](#) in Thailand and [Sintra](#) in Indonesia, increase production targeting the North American market.

Indonesia, Thailand and Viet Nam together accounted for 85% of Southeast Asia's transformer export value in 2025, with transformers with a capacity of over 10 MVA representing about half of export value in these countries. The Philippines, Malaysia and Singapore have a more significant share of export value in lower-capacity transformers. Since the unit price of these transformer types is lower than that of larger power transformers, this export value nevertheless indicates that a substantial number of units are being exported.

<sup>14</sup> Refers to plants capable of manufacturing transformers of capacity above or equal to 10 MVA.

<sup>15</sup> "Transformer parts and components" refers to HS Code 850490.

**Figure 3.21 Trade balances for transformers in Southeast Asia by country or region and by transformer power, 2020-2025**



IEA. CC BY 4.0.

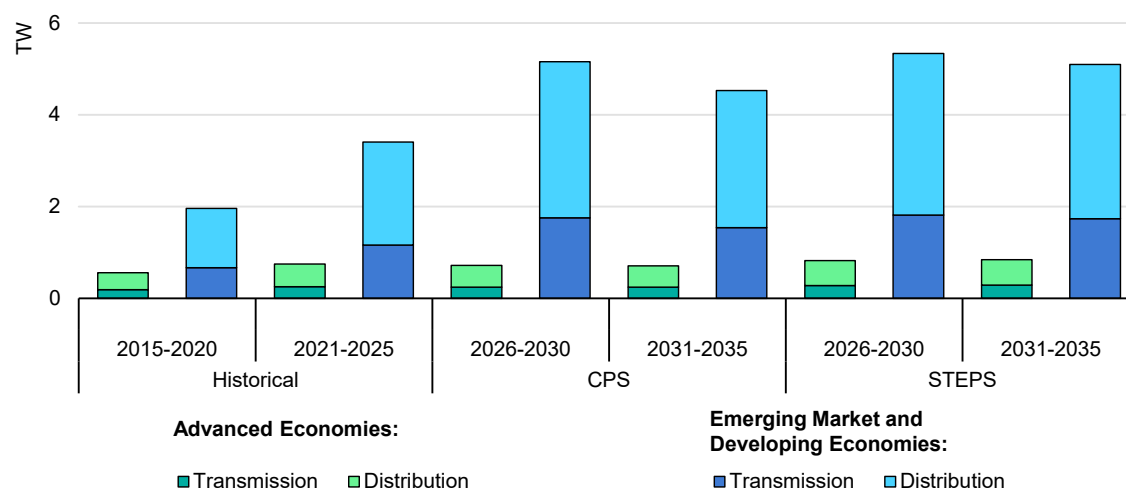
Note: AUNZ = Australia and New Zealand; US = United States; RoW = Rest of World.  
Source: IEA analysis based on data from Sinoimex (2026).

### Transformer exports from Southeast Asia have increased almost threefold since 2020.

Substantial investments have been announced to expand power transformer manufacturing capacity in Southeast Asia in response to an increase in both local and export demand. However, these remain lower than those in European and US manufacturing bases. Between 2025 and Q1 2026, announced investments in Southeast Asian transformer manufacturing capacity amounted to around USD 200 million, compared with over USD 1.3 billion in Europe and USD 1.8 billion in the United States. Investments in Southeast Asia are concentrated in plants owned by foreign companies. While differences in capital and construction costs across regions mean that investment values are not directly comparable in terms of the manufacturing capacity they may deliver, they indicate the relative scale of investment activity.

Southeast Asia's electricity networks currently comprise around 6 million km of overhead lines and underground or subsea cables and are projected to expand to nearly 8 million km by 2035 in the STEPS. This expansion in infrastructure will be needed to underpin rising electricity demand, which is expected to increase from around 1 400 TWh in 2025 to over 2 000 TWh by 2035. Globally, average yearly transformer demand almost doubled in the period 2021-2025 compared to the previous 5 years and is set to increase by a further 50% to 2030, before stabilising near 6 TW per year by 2035 in the STEPS, with more than 85% of this concentrated in emerging markets and developing economies. As the network extends and new demand centres are connected, there will be more need for transformers to manage voltage across transmission and distribution systems.

**Figure 3.22 Average yearly transformer deployment by economic grouping and power level by scenario, 2015-2035**



IEA. CC BY 4.0.

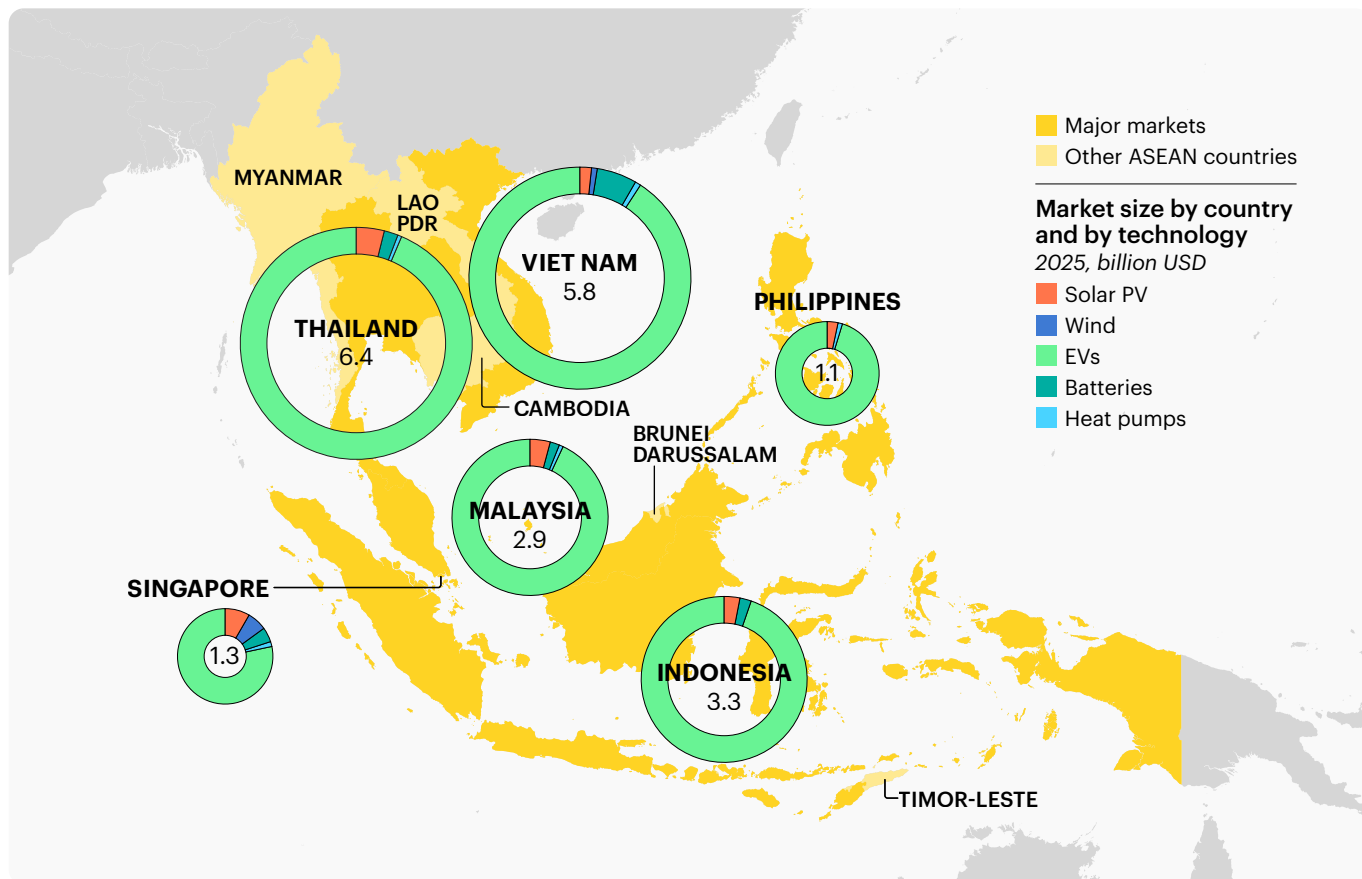
Notes: CPS = Current Policies Scenario; STEPS = Stated Policies Scenario. Values refer to annual average transformer capacity additions and replacements.

**Emerging market and developing economies will see the largest growth in transformer deployment.**

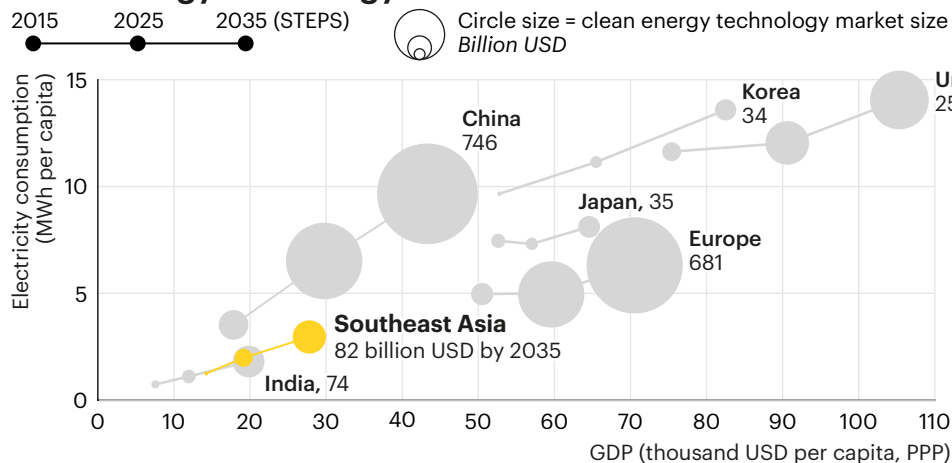
## Chapter 4. Country profiles

This chapter contains a series of visual dashboards and brief country profiles that provide a snapshot of major trends for Southeast Asia as a whole and for several focus countries. The profiles highlight clean energy technology deployment, investments in manufacturing capacity and trade, with an overview of major policy initiatives in the countries concerned, as well as trade measures such as tariffs that can affect the development of supply chains.

# Southeast Asia



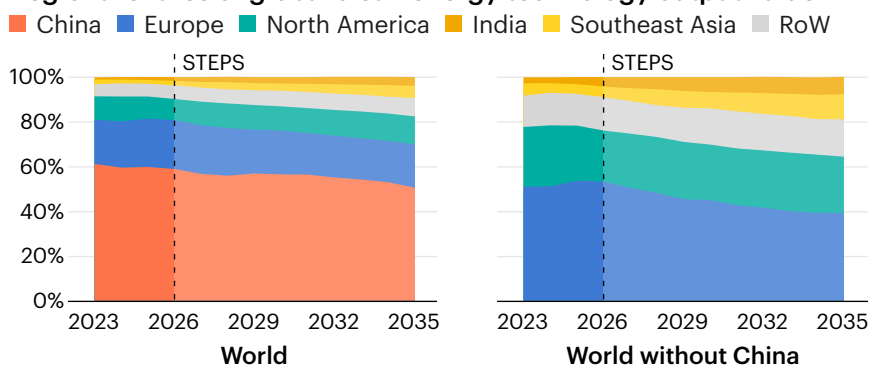
## Clean energy technology market size relative to income and electricity use



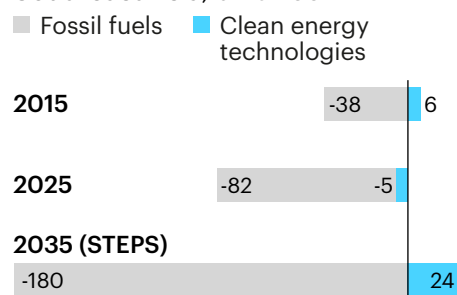
The market for clean energy technologies in Southeast Asia is set to **more than triple** between 2025 and 2035 while GDP and electricity consumption per capita increase by around 45% and 50%, respectively.

## Southeast Asia emerges as a key production centre and exporter

### Regional shares of global clean energy technology output value



### Net trade in fossil fuels and clean energy technologies in Southeast Asia, billion USD



## Regional overview

### Clean energy technology deployment

Southeast Asia's electricity demand has increased by around 6% per year since 2015, making the region one of the fastest-growing electricity markets in the world. Electricity demand is now around 70% higher than in 2015, growing faster than overall energy demand, which increased by around 5% per year over the same period. Despite this rapid growth, electricity consumption per capita remains at 60% of the global average, leaving room for further expansion as incomes rise and industrialisation continues. The share of electricity in final energy consumption has increased from around 11% in 2000 to 23% in 2025 and rises further to 26% by 2030 in the Stated Policies Scenario (STEPS) – above the projected global average.

Several end-use sectors are driving this growth. Demand for cooling has doubled since 2015 and now accounts for around 13% of regional electricity demand, while air conditioner ownership is projected to rise from around 30% of households today to more than 40% by 2030. Industrial electricity demand also continues to grow strongly, increasing from around 650 TWh in 2025 to 790 TWh by 2030 in the STEPS.

The region's wind and solar electricity generation accounted for around 5% of total generation in 2025, up from around 2% in 2020. While this share remains below levels seen in the People's Republic of China (hereafter, "China") and Europe, it is growing rapidly as governments seek to diversify energy supplies and reduce dependence on imported fossil fuels. In 2025, around 9.5 GW of solar PV and less than 0.2 GW of wind capacity were installed. By 2035 in the STEPS, annual additions increase to around 26 GW, with wind and solar together accounting for nearly 20% of electricity generation.

Electric car sales in the region have increased dramatically since 2020, reaching 17% of all car sales, a share that is higher than in many advanced economies. The surge in electric car adoption has been promoted by the availability of affordable models developed by Chinese and domestic carmakers. The electric car market share continues to grow in the STEPS, reaching over 50% by 2035, thanks to a supportive policy environment targeting energy security and vehicle affordability.

The market size for clean energy technologies in Southeast Asia reached around USD 25 billion in 2025, compared with around USD 5 billion in 2020. By 2035, the market expands to over USD 80 billion in the STEPS, growing faster than the global average. Batteries and electric vehicles (EVs) account for the majority of

this growth, reflecting the region's increasing electrification and its emergence as an important manufacturing base for multiple clean energy technologies.

## Clean energy technology manufacturing capacity and investment

Southeast Asia has established itself as one of the world's largest clean energy manufacturing hubs outside China, supported by foreign investment, competitive production costs and growing domestic markets.

Solar PV remains the largest manufacturing sector. At the start of 2026, Southeast Asia hosted around 81 GW of module manufacturing capacity, alongside 84 GW of solar cell manufacturing capacity, 54 GW of wafer manufacturing capacity and 16 GW of polysilicon production capacity. Despite recent contraction linked to changing trade policies in major export markets, Southeast Asia continues to account for a significant share of global solar PV manufacturing capacity outside China.

The region also has a well-established position in wind manufacturing. Southeast Asia hosts around 30 GW of tower manufacturing capacity, representing nearly one-fifth of installed tower manufacturing capacity outside China. The region currently has no meaningful blade or nacelle manufacturing capacity and remains dependent on imports for key upstream wind components.

Battery and EV manufacturing have emerged as the fastest-growing segments of the region's clean energy technology industry. Southeast Asia currently hosts around 40 GWh of battery cell manufacturing capacity, alongside 24 GWh of cathode manufacturing capacity and over 100 GWh of anode manufacturing capacity. The growth of these industries has been supported by expanding EV markets, strong project pipelines and increasing investment in battery supply chains. Electric car manufacturing capacity reached around 1 million vehicles per year in 2025, making Southeast Asia the largest overseas manufacturing hub for Chinese EV producers.

Annual average investment in clean energy technology manufacturing over the next decade is expected to remain broadly similar to the average observed between 2023 and 2025, at around USD 6.5 billion in the STEPS. This contrasts with a projected decline in clean energy manufacturing investment globally, and reflects Southeast Asia's growing attractiveness as both a production base and an expanding market for clean energy technologies.

The composition of investment is changing markedly. Solar PV manufacturing is entering a period of consolidation, with cell manufacturing capacity declining to 65 GW in 2035 in the STEPS. Instead, investment is increasingly shifting towards batteries, battery materials and EVs. Based on announced projects, electric car

manufacturing capacity is projected to increase to 1.8 million vehicles by 2030, while battery cell manufacturing capacity expands to more than 100 GWh. Investments in cathode and anode materials are also growing, strengthening regional integration across battery supply chains.

## Trade balance

Southeast Asia's trade in clean energy technologies is broadly balanced at the regional level. Including trade within Southeast Asia, exports reached around USD 19 billion in 2025 compared with imports of around USD 22 billion. Excluding intra-regional trade, the corresponding figures were approximately USD 16 billion and USD 20 billion, respectively. However, there are significant differences between countries (see Chapter 2).

Trade remains central to Southeast Asia's role in global clean energy technology supply chains. The region serves both as a manufacturing hub supplying overseas markets and as an important node within wider Asian supply chains. China remains the dominant source of imports, supplying nearly 90% of the region's imported clean energy technologies and components in 2025. On the export side, the United States was the largest destination market in 2025, receiving over half of regional exports, although China, India and Korea are becoming increasingly important markets.

The composition of trade is also changing. Solar PV remains the region's largest clean energy technology export, accounting for more than USD 11 billion of exports in 2025 when including intra-regional trade, but growth is increasingly shifting towards batteries and EVs. This mirrors broader changes in manufacturing investment.

In the STEPS, Southeast Asia becomes a net exporter of clean energy technologies to the rest of the world by 2035, driven primarily by rapid growth in EV and battery manufacturing. Electric car production exceeds 3.6 million units by 2035, with exports accounting for around one-third of output, establishing the region as an important global supplier. As a result, the total value of clean energy technology trade continues to expand.

Despite this increase, clean energy technology exports remain smaller than Southeast Asia's fossil fuel import bill by 2035. As energy demand continues to grow, oil, gas and coal imports remain substantial even as electrification accelerates. Compared with China, where clean energy technology exports offset a large share of fossil fuel import costs, Southeast Asia faces a sizeable net energy trade deficit through 2035.

# Indonesia

👤 280 million people

🌃 56% live in urban areas

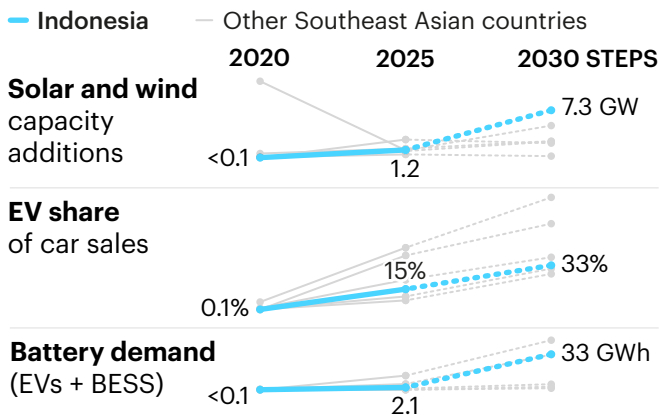
⚡ 500 TWh electricity consumed annually

📈 +4% GDP growth (10-yr CAGR)

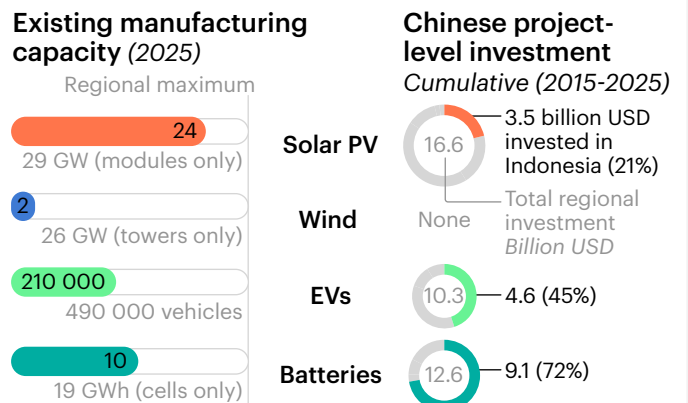
💰 3.3 billion USD clean energy technology market



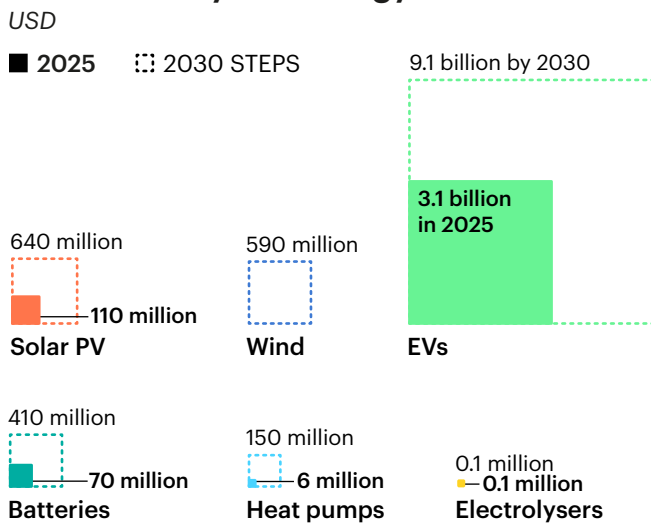
## Clean energy technology deployment



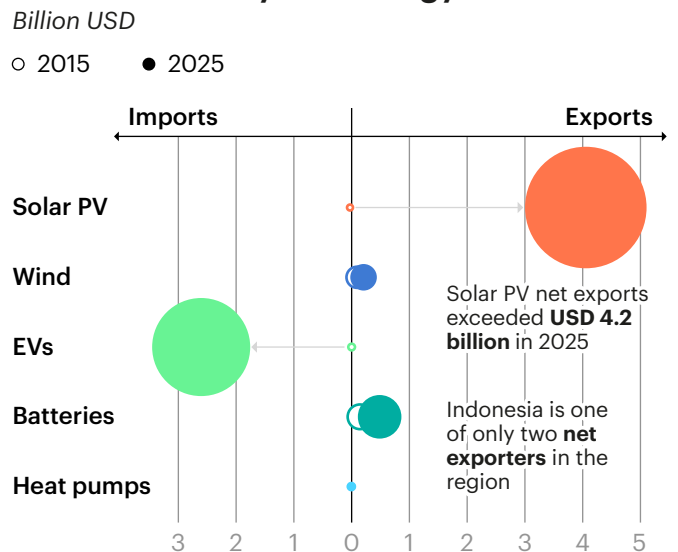
## Manufacturing capacity and investment



## Market size by technology

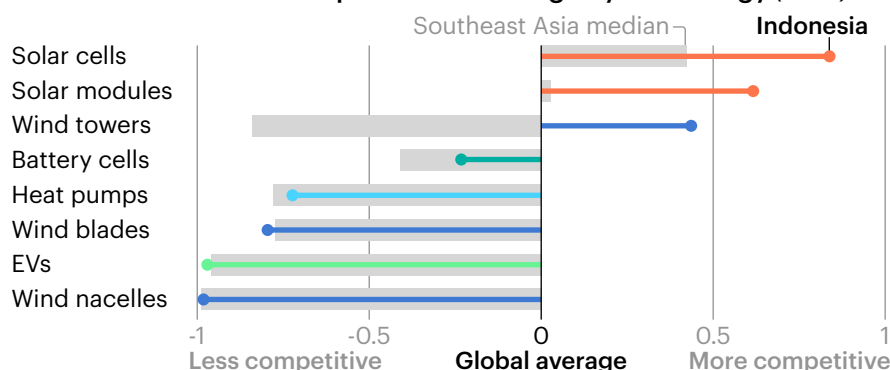


## Trade balance by technology



## Competitive position and strategic outlook

### Normalised revealed comparative advantage by technology (2025)



Strong investment in **battery cell manufacturing** targeting 40 GWh of capacity

Recent **requirements for EV importers** to produce equivalent volumes domestically aim to support local production

Foreign direct investment in the region in **metals and materials processing** has been heavily concentrated in Indonesia

## Indonesia

Indonesia has emerged as Southeast Asia's primary destination for foreign direct investment in clean energy technology manufacturing, underpinned by industrial policy efforts to anchor value chains domestically. Policy measures, including export restrictions on raw materials, local content requirements and targeted fiscal incentives, are attracting investment.

### Clean energy technology deployment

Electricity demand in Indonesia has been increasing rapidly, growing by an average of 8% per year in the past 10 years. Growth is projected to slow down but remain at 5% per year over the next decade in the STEPS. The share of electricity in final energy consumption has increased from 14% in 2014 to 24% in 2024 and is projected to reach nearly 27% in 2030 in the STEPS.

Indonesia's wind and solar electricity generation still accounts for less than 1% of the total, but this is projected to grow to 5% in the STEPS by 2030. In 2025, 1 GW of solar was installed – significantly more than just 5 years earlier. By 2030, yearly installations exceed 7 GW for solar PV and 0.5 GW for wind in this scenario. Electric car sales have increased rapidly in the past 5 years, from almost none in 2021 to a 15% market share in 2025. By 2030, sales reach a market share of around 35% in the STEPS.

The market for clean energy technologies in Indonesia reached USD 3.3 billion in 2025, nearly all of which is related to electric cars and the battery supply chain. Indonesia accounts for 13% of the total market for key clean energy technologies in Southeast Asia. In the STEPS, the market is set to more than double by 2030, reaching over USD 8 billion.

### Clean energy technology manufacturing capacity and investment

Indonesia is home to a significant solar manufacturing industry, primarily developed between 2022 and 2025 as an export hub to the United States. In 2025, the country hosted enough manufacturing capacity for 24 GW of solar PV modules, 14 GW of cells and 3 GW of wafers. The capacity is owned by a diverse set of companies, including joint ventures, such as the one between China-based Trina Solar and Sinar Mas (an Indonesian industrial conglomerate).

Solar manufacturing capacity is significantly higher than local demand. There is no polysilicon production capacity, meaning the country is dependent on imports, but Indonesia has expressed strong interest in developing domestic polysilicon production, supported by its large quartz sand resources. In 2022, authorities

announced plans for up to USD 4 billion of investment in two integrated polysilicon plants, with a combined annual capacity of around [200 000](#) tonnes. However, these projects remain at the planning stage with no operational facilities to date.

Indonesia has a small wind turbine industry, with manufacturing capacity for wind turbine towers only.

The country is already home to substantial automotive manufacturing capacity. Its electric car manufacturing footprint reached around 0.2 million vehicles in 2025, [representing](#) one-fifth of Southeast Asia's total capacity. Most of the electric car manufacturing capacity is owned by Chinese firms.

Battery and battery material producers are also investing in Indonesia, attracted by relatively low production costs, policy support for the development of a domestic battery industry, and abundant mineral resources, particularly nickel. Most investment targets the EV battery value chain and is led by Chinese firms, including CATL, REPT BATTERO, Huayou and EVE Energy in battery manufacturing, as well as LBM Energi and Jiangsu Lopal in cathode active materials and BTR New Material Group in graphite anode materials. In 2025, Indonesia had 10 GWh of battery cell manufacturing capacity, 15 GWh of cathode manufacturing capacity and 100 GWh of anode manufacturing capacity – making it one of the largest battery component manufacturers outside China.

Based on announced investments, manufacturing capacity for electric cars is set to increase to 0.5 million per year by 2030 on the basis of announced projects, mostly on the back of investments by local and Chinese carmakers. Announced investments in battery cells could bring the total domestic manufacturing capacity to 40 GWh, while for cathodes and anodes, committed projects would bring the manufacturing capacity to 150 GWh and 200 GWh, respectively – putting Indonesia in a strong position as a supplier for international markets. In the solar supply chain, there are committed projects to expand cell manufacturing capacity to 25 GW, which would match the country's module manufacturing capacity.

Indonesia has a growing heating, ventilation and air-conditioning (HVAC) manufacturing base, including new investments by a major international manufacturer, although dedicated heat pump manufacturing cannot be identified.

There are currently no manufacturing facilities for electrolyzers, and none are in the pipeline.

## Trade balance

Indonesia is one of only two countries in Southeast Asia that are net exporters of clean energy technologies. In 2025, these exports totalled USD 5.8 billion, compared to USD 4 billion in imports. Solar modules and cells represented the

majority of these exports, while electric cars represented the largest share of the country's imports in value terms.

The main export destination was the United States, followed by Korea. Around 80% of clean energy technologies and their components came from China.

## Industrial and trade policies

| Category                           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Trade policies                     | <ul style="list-style-type: none"> <li>• <b>EV – tariffs:</b> Completely built-up (CBU) EV tariff exemption expired end-2025; incentives now <a href="#">tied to local production</a>.</li> <li>• <b>Equipment – tariffs:</b> <a href="#">Import duty exemption</a> on machinery, goods and materials for 2 years, extendable to 4 years for projects meeting a 30% share of locally produced machines.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Industrial strategies and policies | <ul style="list-style-type: none"> <li>• <b>EV – tax incentives:</b> <a href="#">15% luxury tax rebate</a> for battery electric vehicles (BEVs) meeting local content requirements; incentives tied to rising <a href="#">local production commitments</a> to 2027.</li> <li>• <b>Renewables – local content requirements:</b> <a href="#">Local content requirement</a> for goods and services reduced to 20% for solar power plants and 15% for wind electricity infrastructure in 2024.</li> <li>• <b>Materials – tax incentives:</b> <a href="#">0% income tax rate</a> for exporters placing 100% of their natural resource (other than oil and gas) export earnings in the domestic financial system, i.e. through state-owned banks, for at least a year.</li> <li>• <b>Indonesia's Hydrogen and Ammonia Roadmap:</b> <a href="#">Targets 6.4-17.5 Mtpa</a> by 2060, with up to 15.5 Mtpa coming from electrolytic hydrogen.</li> <li>• <b>Special Economic Zones (SEZs):</b> <a href="#">Corporate Income Tax holiday</a> of 5-20 years for pioneer industries (at least IDR 500 billion [Indonesian rupiah]), followed by a 50% reduction for 2 years. Smaller projects receive a 50% reduction for 5 years, then a 25% reduction for 2 years.</li> <li>• <b>EV – local content requirements (TKDN):</b> For two/three-wheeler BEVs, 40% (2019-2026), 60% (2027-2029), 80% (2030 onwards). For BEVs with 4 or more wheels, 35% (2019-2021), 40% (2022-2026), 60% (2027-2029), 80% (2030 onwards). Import duty exemptions, VAT reductions and other fiscal incentives for completely knocked down (CKD) and CBU EVs meeting these thresholds.</li> </ul> |

# Thailand

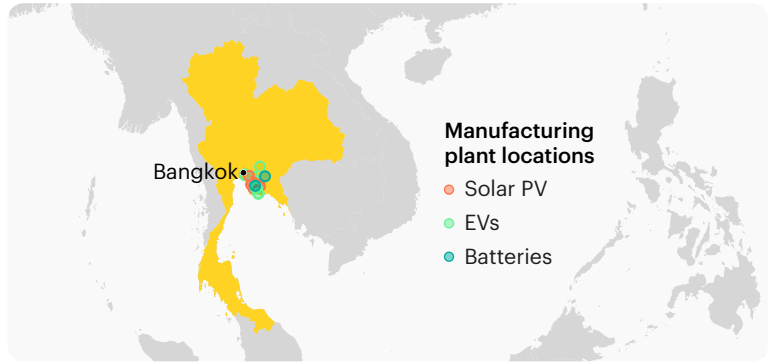
👤 72 million people

🌃 63% live in urban areas

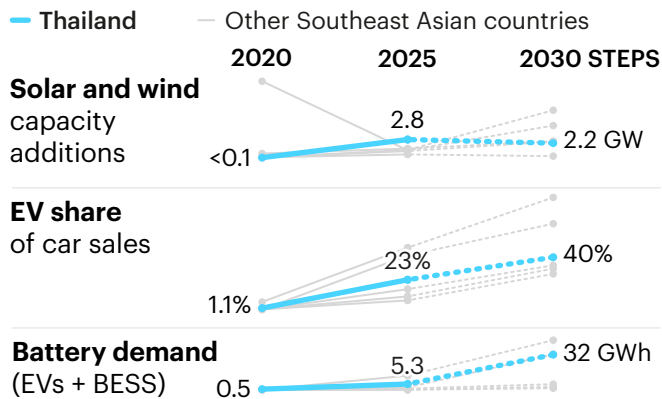
⚡ 200 TWh electricity consumed annually

📈 +2% GDP growth (10-yr CAGR)

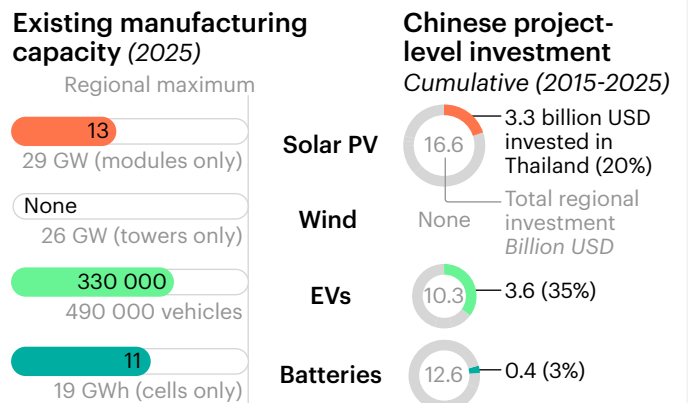
💰 6.4 billion USD clean energy technology market



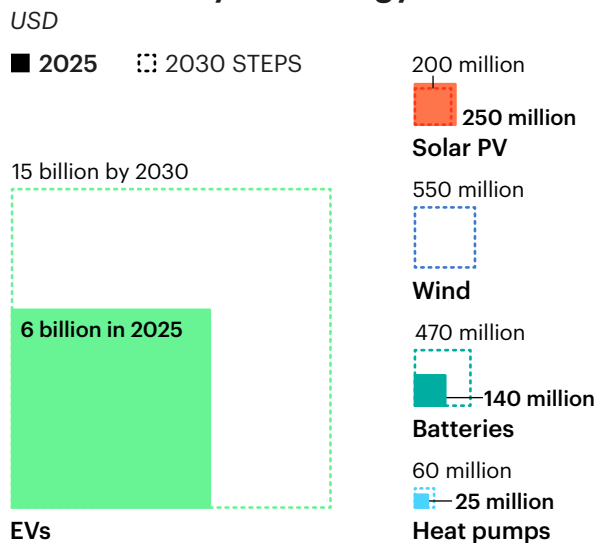
## Clean energy technology deployment



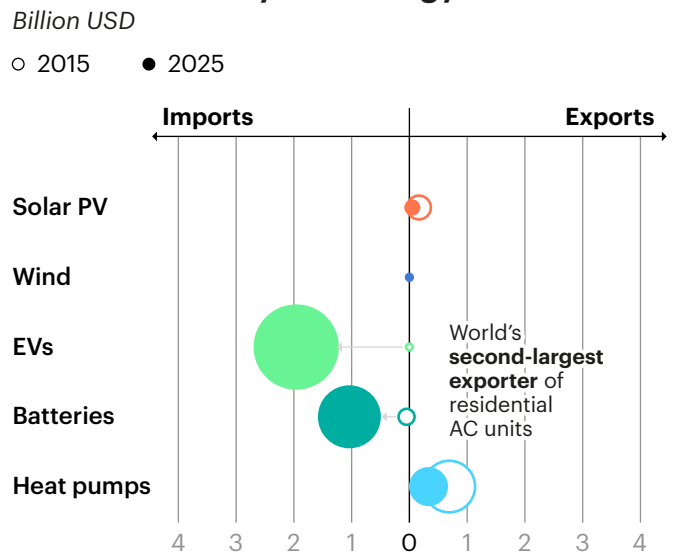
## Manufacturing capacity and investment



## Market size by technology

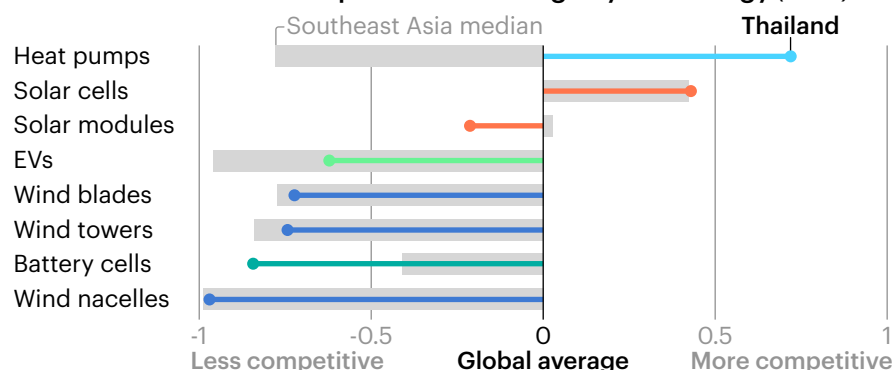


## Trade balance by technology



## Competitive position and strategic outlook

### Normalised revealed comparative advantage by technology (2025)



Thailand is the **region's leading manufacturer of heat pumps**, home to about 8% of the world's AC manufacturing capacity

Thailand's **trade in solar PV is balanced**, with the country mostly exporting modules and importing upstream components

Thailand's 30@30 policy targets **30% ZEVs** among cars manufactured domestically by 2030

## Thailand

Thailand's existing manufacturing base could provide a springboard for further expansion, with a large solar PV manufacturing industry, significant car assembly capacity and unique strengths in HVAC trade.

### Clean energy technology deployment

Electricity demand in Thailand has increased by an average of 2% per year in the past 10 years. The share of electricity in final energy consumption is growing comparatively slowly, rising from 15% in 2014 to 18% in 2024.

Wind and solar electricity generation accounts for around 5% of the total, up from around 1% 10 years before, with solar representing around 60% of this. Thailand's electric car sales have climbed rapidly in the past 5 years, from a share of around 1% of sales in 2021 to 23% in 2025.

The market for clean energy technologies in Thailand has reached USD 6.4 billion in 2025, nearly exclusively related to electric cars and the battery supply chain. Thailand accounts for 26% of the regional market for key clean energy technologies.

### Clean energy technology manufacturing capacity and investment

Thailand has a large solar PV manufacturing industry, focused on the downstream steps of the supply chain. It is home to nearly 13 GW of module capacity and nearly 20 GW of cell manufacturing capacity, but has no wafer or polysilicon manufacturing capacity. Module production capacity peaked in 2023 and has since declined by 56% as a result of the introduction of tariffs on exports to the United States in 2025. Thailand is home to several producers, many of which are headquartered overseas: two of the largest are Canadian Solar and China-based Runergy.

Thailand has a major export-oriented automotive industry composed of international carmakers and component suppliers. This includes manufacturing capacity for around 0.33 million electric cars. The battery supply chain is not well developed, with a small amount of existing capacity largely focused on battery energy storage systems (BESS). There is no production capacity for anode or cathode material. There is no manufacturing capacity for wind turbines or electrolyzers.

Thailand is one of the few economies outside China and the European Union to play a meaningful role in global HVAC trade, supported by a rapidly expanding manufacturing base focused primarily on air conditioners and, to a lesser extent,

heat pumps. The country hosts around 50% of global rotary compressor manufacturing capacity outside China and is among the leading exporters of compressors for HVAC and refrigeration equipment. Production is dominated by firms headquartered overseas, including Mitsubishi, Daikin, Toshiba, Samsung, LG, Haier and Midea.

The manufacturing project pipeline suggests that the Thai solar industry is set to retain a roughly constant level of manufacturing capacity in the next 5 years. Electric car production capacity is set to increase to over 0.5 million cars per year, backed by investments by Chinese carmakers, while the project pipeline for batteries suggests no significant expansion.

## Trade balance

Thailand is a net importer of clean energy technologies. In 2025, its exports totalled USD 1.9 billion, compared to USD 4.5 billion in imports.

Around 60% of exports were directed towards India and the United States. Three-quarters of imports of clean energy technologies and their components came from China.

Thailand's trade in solar PV is balanced, with the country mostly exporting modules and importing upstream components. It is the region's second-largest exporter of electric cars, but imports six times more than it exports.

Thailand is the world's second-largest exporter of residential air-conditioners (AC), with exports exceeding USD 3 billion in 2025 and accounting for around 15% of global trade. Exports have grown<sup>16</sup> by an average of 4% annually over 2015-2025. While the industry remains centred on ACs, Thailand has also developed a smaller heat pump segment, with exports – consisting mostly of air-to-air units and largely directed to Europe – peaking at over USD 600 million in 2022 amid surging demand, before almost halving thereafter. AC export markets are diversified, though recent dynamics highlight a sharp reorientation towards the US market, where exports rose from around USD 20-65 million annually prior to 2020 to over USD 1 billion in 2025.

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<sup>16</sup> As per HS code: HS841510. These are not counted within the scope of clean energy technologies and are therefore not considered among total clean energy technology exports.

## Industrial and trade policies

| Category                           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Trade policies                     | <ul style="list-style-type: none"> <li>• <b>EV – tariffs:</b> <a href="#">Reduced import duties</a> for CBU EVs priced below THB 2 million (Thai baht) (USD 62 000) over 2024-2025 under the EV 3.5 scheme.</li> <li>• <b>Free Trade Zones (FTZs):</b> Enable duty-free inputs for export-oriented manufacturing.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Industrial strategies and policies | <ul style="list-style-type: none"> <li>• <b>EV – excise duty:</b> EV 3.5 (2024-2027) <a href="#">cuts rates</a> from 8% to 2% for EVs priced below THB 7 million (USD 216 000), conditional on 40% local content. Imported battery cells temporarily count towards the threshold.</li> <li>• <b>Batteries – corporate tax:</b> 3-year <a href="#">Corporate Income Tax (CIT) exemption</a> for key battery components; duty exemptions on machinery and materials.</li> <li>• <b>Special Economic Zones (SEZs):</b> 8-year CIT exemption plus a 50% reduction (5 years); duty exemptions and permission for 100% foreign ownership.</li> <li>• <b>Eastern Economic Corridor (EEC):</b> All advantages included under FTZs and SEZs; CIT exemption extended to up to 13 years (compared with 8 years under standard Board of Investment rules), plus a further 50% CIT reduction for 5 years after that.</li> <li>• <b>30@30 Vision:</b> <a href="#">30% zero-emissions vehicle (ZEV) production</a> by 2030, equivalent to approximately 725 000 cars and 675 000 motorcycles annually.</li> </ul> |

# Malaysia

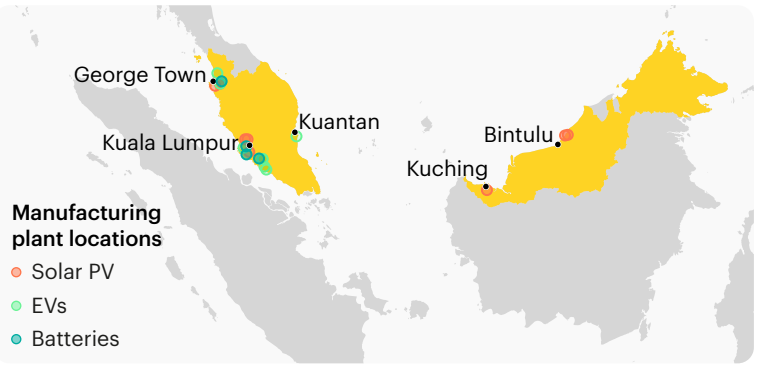
35 million people

77% live in urban areas

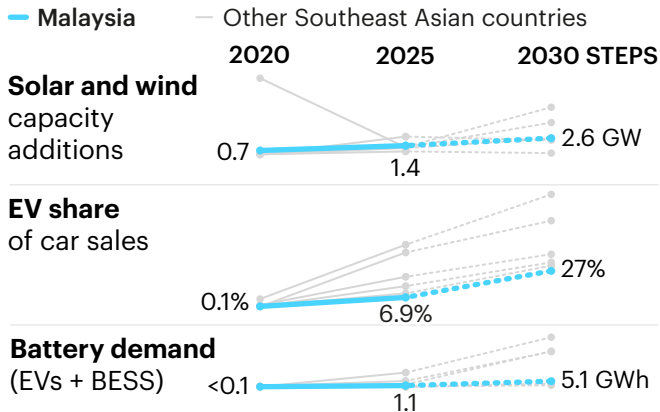
180 TWh electricity consumed annually

+4% GDP growth (10-yr CAGR)

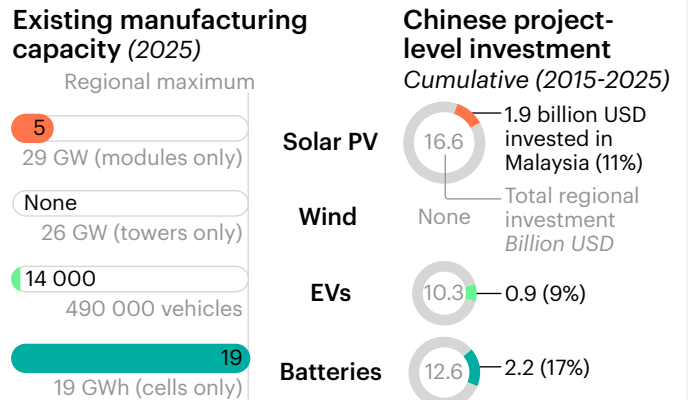
2.9 billion USD clean energy technology market



## Clean energy technology deployment



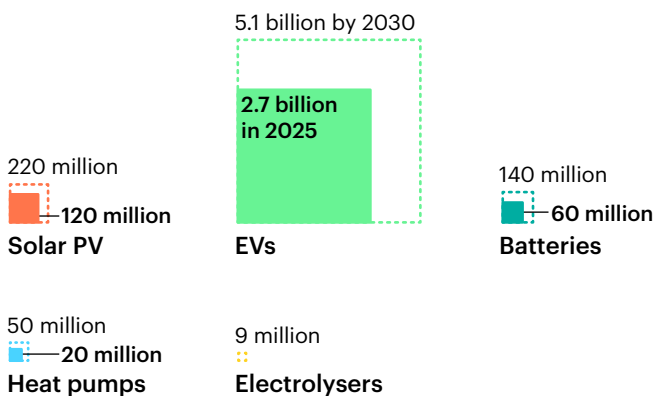
## Manufacturing capacity and investment



## Market size by technology

USD

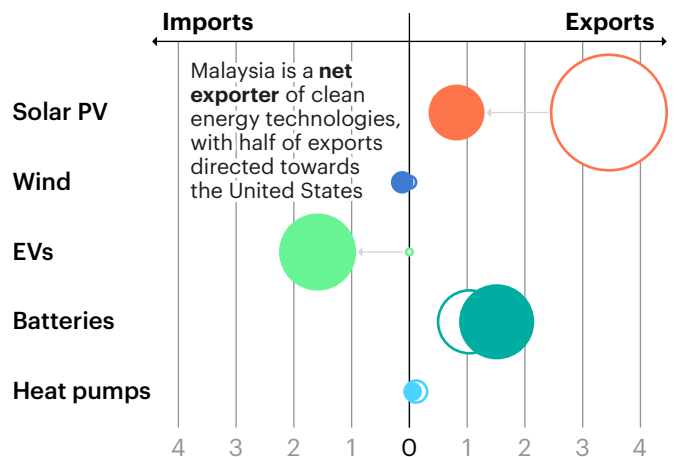
2025 2030 STEPS



## Trade balance by technology

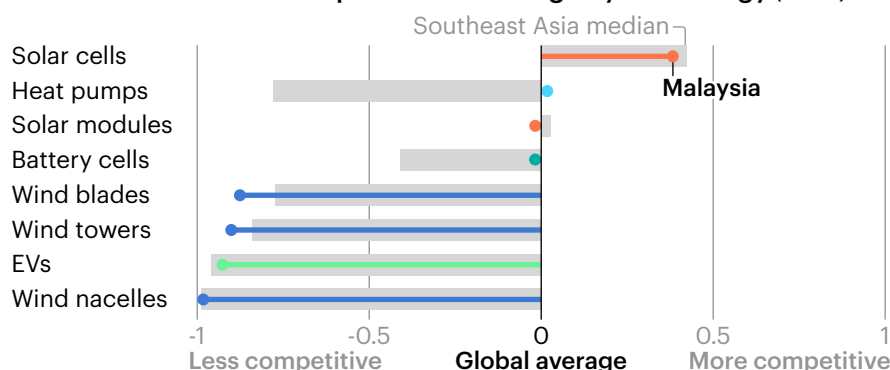
Billion USD

2015 2025



## Competitive position and strategic outlook

Normalised revealed comparative advantage by technology (2025)



Malaysia is home to a **significant solar industry** and is the only country in the region with large-scale **solar polysilicon production**, which is set to expand

The latest **import requirements for EVs** could encourage local assembly

**Battery cell manufacturing** aligns with existing industrial capabilities

## Malaysia

Malaysia's clean energy technology manufacturing story has been shaped primarily by its established position in solar PV manufacturing and its broader strength in export-oriented electronics and components. Policy support and incentives have helped attract investment in EV assembly, but activity remains incremental rather than transformational.

### Clean energy technology deployment

Electricity demand in Malaysia has increased by an average of 2% per year over the past 10 years. The share of electricity in final energy consumption is relatively high, but is growing comparatively slowly, rising from 21% in 2014 to 25% in 2024.

Solar electricity generation accounts for 3% of the total, up from less than 1% 5 years earlier. There is no significant electricity generation from wind. Malaysia's electric car sales have climbed in recent years, from a share of less than 1% of sales in 2022 to 7% in 2025.

The market for clean energy technologies in Malaysia has reached USD 2.9 billion in 2025, nearly exclusively related to electric cars and the battery supply chain. The country accounts for 12% of the regional market for key clean energy technologies.

### Clean energy technology manufacturing capacity and investment

Malaysia is home to a significant solar industry, with around 5 GW of manufacturing capacity for both modules and cells, and 7 GW for wafers. Manufacturers include major producers headquartered in China, but also in the United States – the longest-standing solar module manufacturer is US-based First Solar, which began operations in Malaysia in 2008. Malaysia is currently the only country in Southeast Asia with large-scale solar polysilicon production. This is concentrated in the Samalaju Industrial Park in Sarawak, where OCI Malaysia (a subsidiary of Korea's OCI Holdings) operates a major polysilicon facility. Malaysia does not have any wind turbine, heat pump or electrolyser manufacturing.

Malaysia was Southeast Asia's largest car market in 2025, although electric cars have the lowest share in new car sales among the region's major economies. There was manufacturing capacity for less than 15 000 EVs annually in 2025. Most of this is geared towards CKD car assembly, as a result of the national EV trade policy framework that has encouraged EV makers to rely on this manufacturing model, although some fully domestic models have started to be

produced in 2026. Malaysia is one of only two countries in the region with established domestic carmakers.

The country has attracted investments across battery manufacturing and battery materials, including from Korean and Chinese firms such as [Samsung](#) and [EVE Energy](#). It is now home to 19 GWh of battery production capacity, building on the existing battery manufacturing base for portable electronics. Further upstream, Malaysia has 4 GWh of anode production capacity.

The manufacturing project pipeline suggests that Malaysia's solar module assembly capacity is set to decline by 2030, while cell and wafer component manufacturing capacity remains unchanged. OCI has announced a [USD 618 million](#) investment to expand polysilicon capacity by 2027. In addition, a polysilicon factory led by the joint venture between [OCI TerraSus](#) and Japan-headquartered Tokuyama is now under construction and aims to produce semiconductor polysilicon by 2029, with applications for silicon wafers.

Electric car assembly is expected to increase as new factories owned by local producers come online. Battery production capacity is also set to grow to nearly 50 GWh by 2030 thanks to investments by Chinese and Korean firms. Malaysia has also attracted upstream investment, notably for a lithium iron phosphate (LFP) cathode active material plant from [Hunan Yuneng](#), the world's [largest](#) LFP material producer, and a synthetic graphite anode project from domestic manufacturer [Graphjet Technology](#). By 2030, cathode production capacity will reach over 45 GWh, while anode production capacity will reach over 65 GWh.

## Trade balance

Malaysia is a net exporter of clean energy technologies. In 2025, its exports totalled USD 3.5 billion, compared to USD 2.8 billion in imports.

Almost half of its exports were directed towards the United States. Around 80% of all imports of clean energy technologies and their components came from China.

Malaysia is a net exporter of solar PV components, as well as of batteries (including non-EV-related batteries). For other clean energy technologies, it is a net importer, with electric cars from China representing the largest share of imports.

## Industrial and trade policies

| Category                           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Trade policies                     | <p><b>EV – tariffs:</b> <a href="#">0% import duty</a> on CKD EV kits until 31 December 2027. Import and excise duty exemptions for imported CBU EVs expired at the end of 2025. From July 2026, newly imported CBU EVs must have a <a href="#">minimum cost, insurance and freight</a> value of MYR 200 000 (Malaysian ringgit) (USD 49 900), up from the previous MYR 100 000 (USD 25 000) floor price.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Industrial strategies and policies | <ul style="list-style-type: none"> <li>• <b>EV – excise duty:</b> <a href="#">0% excise duty</a> on CKD EV kits for local assembly until 31 December 2027.</li> <li>• <b>Green Investment Tax Allowance (GITA):</b> 100% allowance on qualifying capital expenditure incurred over up to 10 years, offset against up to 70% of statutory income annually.</li> <li>• <b>Green Income Tax Exemption (GITE):</b> 100% income tax exemption for qualifying green technology services companies.</li> <li>• <b>Pioneer Status:</b> <a href="#">Grants a 70% exemption</a> on statutory income for 5 years.</li> <li>• <b>Reinvestment Allowance:</b> <a href="#">60% allowance</a> on qualifying capital expenditure for up to 15 consecutive years, available to existing manufacturers expanding or modernising their production capacity.</li> <li>• <b>Malaysia's National Energy Transition Roadmap (NETR)</b> and <b>New Industrial Master Plan 2030 (NIMP):</b> Set a target of 90% local EV manufacturing.</li> <li>• <b>Green Investment Strategy (GIS):</b> Carries an overarching investment goal of MYR 300 billion (USD 74.9 billion) by 2030 across seven pillars, covering EVs, solar PV, renewable energy, hydrogen, bioenergy, carbon capture, utilisation and storage (CCUS) and circular economy.</li> <li>• <b>Malaysia's Hydrogen Roadmap:</b> <a href="#">Targets 7-15 Mtpa hydrogen</a> production by 2050, nearly half of which should be electrolytic hydrogen.</li> </ul> |

# Viet Nam

100 million people

39% live in urban areas

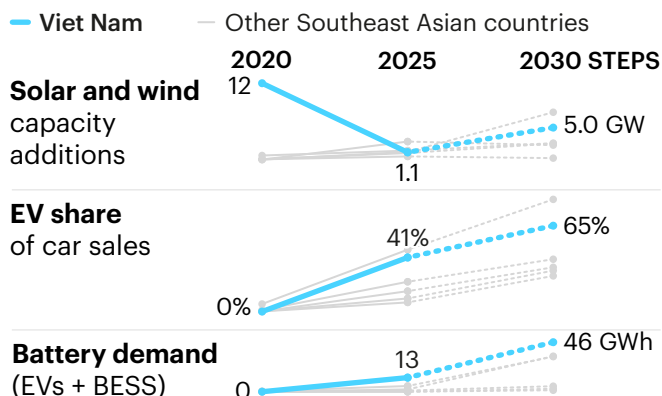
250 TWh electricity consumed annually

+6% GDP growth (10-yr CAGR)

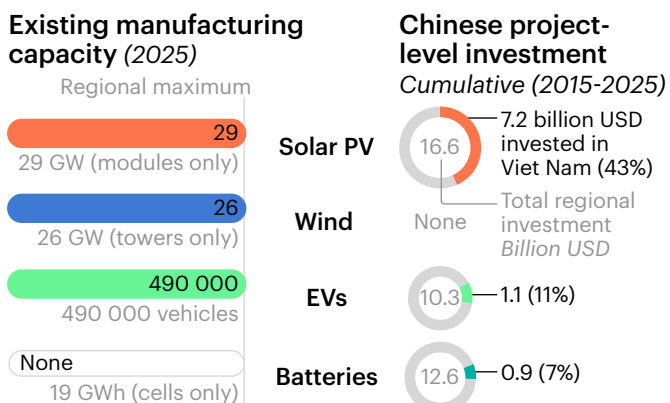
5.8 billion USD clean energy technology market



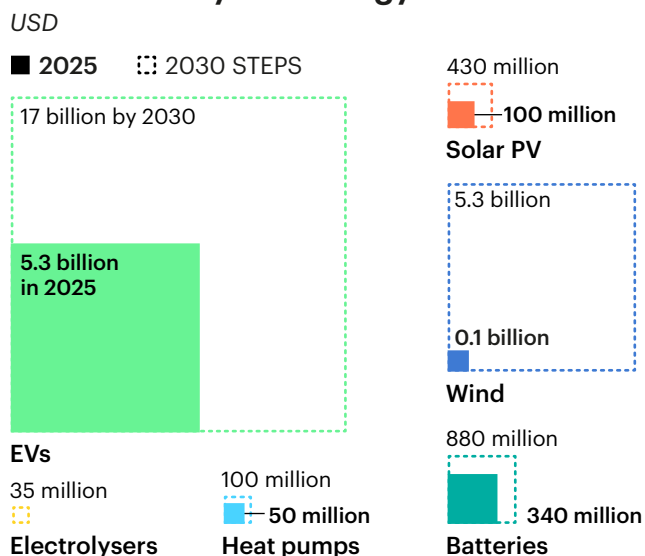
## Clean energy technology deployment



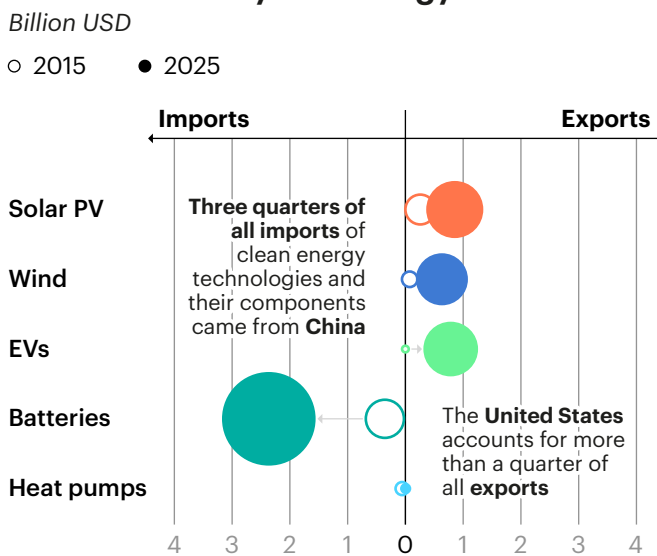
## Manufacturing capacity and investment



## Market size by technology

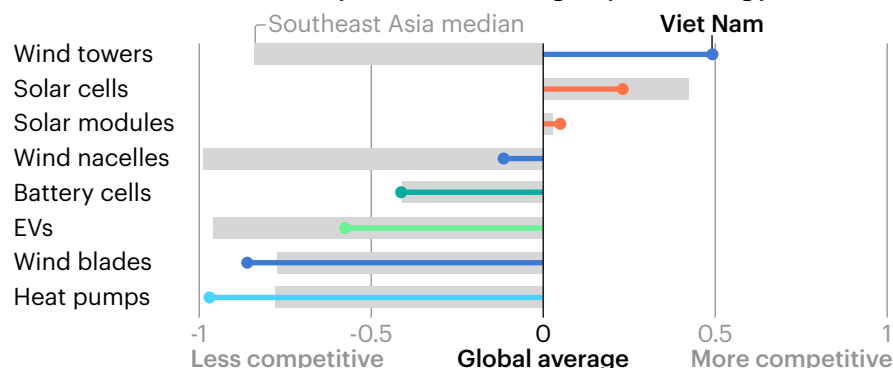


## Trade balance by technology



## Competitive position and strategic outlook

### Normalised revealed comparative advantage by technology (2025)



Viet Nam hosts one of the world's largest wind tower factories and further expansion is planned

Viet Nam is focusing on scaling its domestic EV and battery manufacturing capacity, in part to supply its burgeoning domestic electric car market, the region's largest in 2025

Downstream solar industry manufacturing capacity is set to continue downsizing through 2030

## Viet Nam

Viet Nam's clean energy technology manufacturing trajectory has been shaped by its role as an alternative export platform amid US-China trade tensions. Proximity to China, competitive labour costs and an extensive network of free trade agreements have supported rapid capacity build-out and the expansion of manufacturing pipelines. However, these factors have also increased exposure to external trade dynamics. Policy support has sought to foster the development of a domestic EV industry.

### Clean energy technology deployment

Electricity demand in Viet Nam has increased rapidly at an average of 7.5% per year in the past 10 years. The share of electricity in final energy consumption is high, having risen from 20% in 2014 to 30% in 2024.

Wind and solar electricity generation accounts for 13% of the total, up from only around 2% just 5 years before. Two times more electricity is generated by solar than by wind. Viet Nam reached an electric car sales share of about 40% in 2025 – one of the highest shares in the world, having surged from less than 1% in 2020. Growth has been buoyed by the presence of a domestic carmaker building cost-competitive cars.

The market for clean energy technologies in Viet Nam is one of the region's largest, at USD 5.8 billion. Electric cars and wind turbines account for the majority of this. Viet Nam represents 24% of the regional market for key clean energy technologies.

### Clean energy technology manufacturing capacity and investment

Viet Nam's large solar industry has 29 GW of manufacturing capacity for modules, and 18 GW for cells, while factories belonging to several manufacturers can produce 36 GW of solar wafers. There is no capacity for polysilicon. Most of the manufacturing capacity is owned by China-headquartered companies, but some domestic companies are active. The US tariff regime has sharply eroded the economics of Vietnamese solar exports to the United States recently, resulting in the reduction of manufacturing capacity, especially for module assembly.

Viet Nam is one of the few countries in Southeast Asia to produce wind turbine components. It has the capacity to build wind towers equivalent to nearly 26 GW of wind turbines and is home to one of the world's largest wind tower factories, operated by Korea-based CS WIND. The company has been active in Viet Nam for more than 20 years and supplies wind turbine manufacturers around the world.

Viet Nam is focusing on scaling its domestic EV and battery manufacturing capacity, in part to supply its burgeoning electric car market, the region's largest in 2025. Its homegrown EV champion, VinFast, has rapidly expanded its manufacturing footprint across the region, reaching a total electric car production capacity of nearly 0.5 million cars per year. Assembly plants in Hai Phong and Ha Tinh account for most of this capacity, making Vietnamese EV production capacity Southeast Asia's largest in 2025. VinFast has also recently begun looking overseas for new manufacturing investments. The sizeable EV production capacity of VinFast, coupled with the improving affordability of its EVs, helped the company capture more than 99% of domestic electric car sales in 2025. Viet Nam has also recently attracted foreign EV investments, primarily from China, with Geely and Chery announcing plans for new assembly plants.

VinFast is also the main driver of EV battery and BESS investments in the country, notably through the 5 GWh [Gotion-VinFast plant](#) planned to start operations in 2026. The country is home to cathode production capacity of 9 GWh, but no anode production capacity.

According to the project pipeline, the downstream solar industry manufacturing capacity is set to continue being downsized through 2030, but there is potential activity in polysilicon production, with Japan-headquartered Tokuyama announcing a [USD 30 million](#) project to produce polysilicon for semiconductors and solar cells. Wind tower production will also expand as the CS WIND facility increases its capacity to build wind turbine towers for offshore applications. Electric car production capacity is expected to reach 0.6 million cars per year according to the project pipeline, mostly due to the expansion of domestic manufacturers. Battery production capacity will expand to 7 GWh, albeit remaining insufficient to match electric car production capacity.

## Trade balance

Viet Nam's clean energy technology trade is broadly balanced. In 2025, its exports totalled USD 4.4 billion, compared to USD 4.6 billion in imports.

Over a quarter of exports were directed towards the United States. Three-quarters of all imports of clean energy technologies and their components came from China.

Viet Nam is a net exporter of solar PV components, electric cars and wind turbine components, but it imported around USD 3.7 billion worth of batteries, mostly from China.

## Industrial and trade policies

| Category                           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Trade policies                     | <ul style="list-style-type: none"> <li>• <b>Zero-duty component imports for domestic vehicle assembly:</b> <a href="#">0% import tariff</a> for qualifying carmakers on eligible automobile components that are not produced domestically.</li> <li>• <b>Viet Nam Automotive Supporting Industry Tariff Incentive Programme:</b> <a href="#">Provides a 0%</a> tariff for raw materials, supplies and components that are not produced domestically and are imported to be used in manufacturing priority automotive industry products.</li> </ul>                                                                                                                                                         |
| Industrial strategies and policies | <ul style="list-style-type: none"> <li>• <b>Viet Nam's Investment Law:</b> EV batteries <a href="#">classed as high-tech priority</a>; 4-year CIT holiday plus 9-year 50% reduction; 10% CIT (compared to 20% standard). <a href="#">Import tax relief</a> on EV parts and manufacturing equipment.</li> <li>• <b>Viet Nam's Hydrogen Strategy:</b> <a href="#">Targets 0.1-0.5 Mtpa hydrogen</a> production by 2030 and 10-20 Mtpa by 2050, considering both electrolysis and fossil fuels with CCUS.</li> <li>• <b>EV – special consumption tax incentives:</b> 1-3% <a href="#">preferential excise tax rates</a> on BEVs depending on the number of seats, rising to 4-11% from March 2031.</li> </ul> |

# Philippines

👤 120 million people

🌃 56% live in urban areas

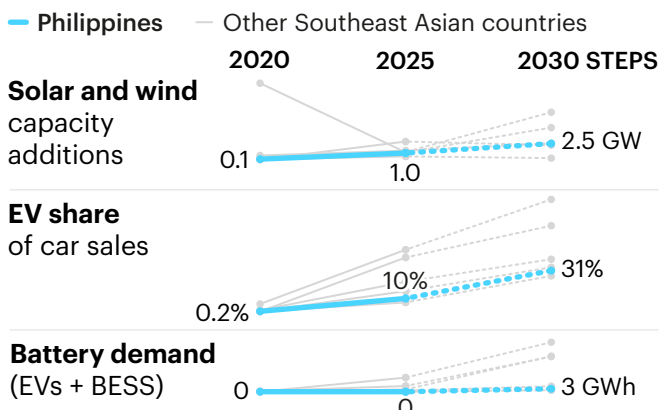
⚡ 96 TWh electricity consumed annually

📈 +5% GDP growth (10-yr CAGR)

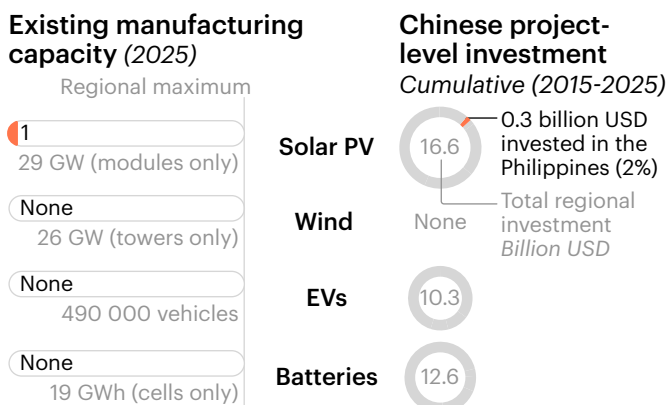
💰 \$ 1.1 billion USD clean energy technology market



## Clean energy technology deployment



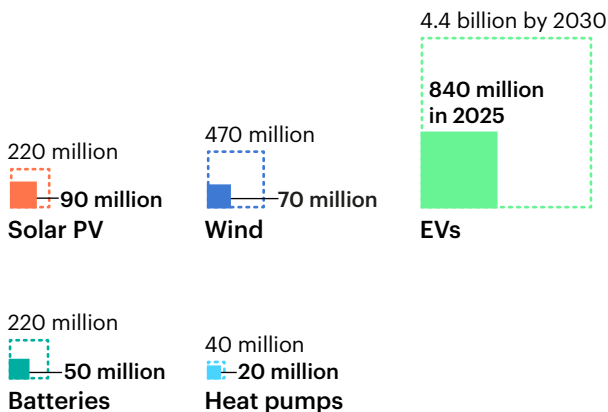
## Manufacturing capacity and investment



## Market size by technology

USD

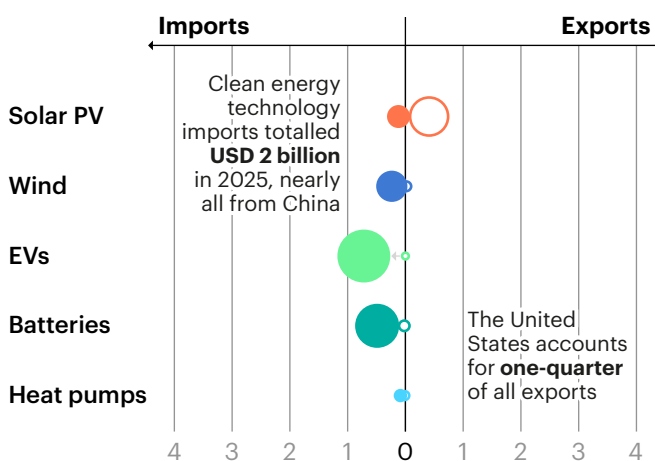
■ 2025 ■ 2030 STEPS



## Trade balance by technology

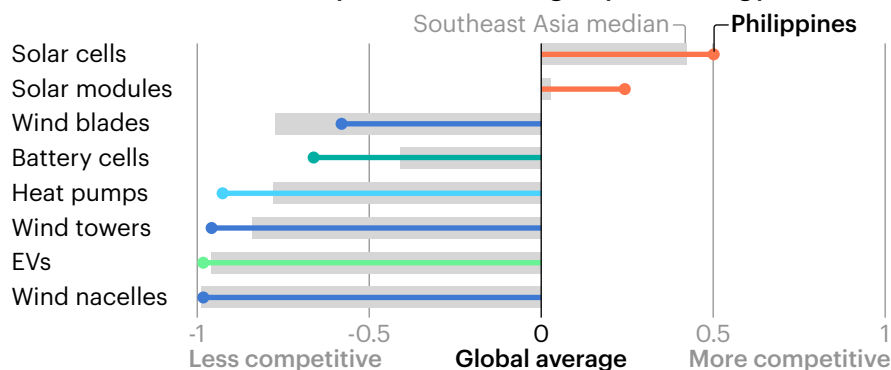
Billion USD

○ 2015 ● 2025



## Competitive position and strategic outlook

Normalised revealed comparative advantage by technology (2025)



The Philippines is one of the few countries in the region with **growing solar manufacturing capacity** since 2023

Policy incentives focus on accelerating **EV uptake** and **renewable energy deployment** rather than building domestic production capacity

## Philippines

The Philippines' clean energy technology industrial pathway is shaped by a policy framework that prioritises deployment over manufacturing, with incentives focused on accelerating EV uptake and renewable energy deployment rather than building domestic production capacity. Import duty exemptions and tax relief have supported rapid growth in EV adoption, but this has translated into an import-led market.

### Clean energy technology deployment

Electricity demand has grown by almost 5% per year over the past decade, but the rate of growth is expected to slow down in the STEPS. The share of electricity in final energy consumption grew from 19% in 2014 to 22% in 2024.

Wind and solar electricity generation accounts for around 4% of total electricity generation. Rooftop solar deployment has accelerated in recent years, partly due to high retail electricity prices, which increased by around [17%](#) between May 2025 and May 2026. Electricity prices for residential consumers are the highest in Southeast Asia. Electric car sales grew rapidly to represent 10% of new car sales in 2025, up from just 1% the previous year. Chinese imports, particularly from BYD, made up most of these sales.

The market for clean energy technologies in the Philippines reached USD 1.1 billion in 2025, accounting for 4% of the regional market, and is driven by electric cars and wind turbines.

### Clean energy technology manufacturing capacity and investment

The Philippines has a solar PV industry, with a few factories providing 1 GW of manufacturing capacity for modules and 2.5 GW for cells. There is no production capacity for upstream components. The manufacturing capacity in the Philippines has been increasing since 2023.

The Philippines has virtually no EV manufacturing capacity, and limited EV makers have announced plans to invest in the country. Nor does it host any EV battery or BESS manufacturing projects.

### Trade balance

The Philippines is a net importer of clean energy technologies, with solar PV being the only technology exported. In 2025, exports totalled USD 0.5 billion, compared to USD 2 billion in imports.

Exports from the Philippines serve diverse markets. The main trade partner is the United States, which accounted for one-quarter of exports in 2025. Nearly all imports of clean energy technologies and their components came from China.

## Industrial and trade policies

| Category                           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Trade policies                     | <ul style="list-style-type: none"> <li>• <b>EV – tax incentives:</b> Excise tax relief and import duty exemptions will remain in place until 2028.</li> <li>• <b>EV – excise duty:</b> 0% <a href="#">excise duty</a> for BEVs and 50% of standard duty for plug-in hybrid electric vehicles.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                       |
| Industrial strategies and policies | <ul style="list-style-type: none"> <li>• <b>CREATE MORE Act (RA 12066):</b> Tax incentive period <a href="#">extended by</a> 10 years to 27-years, 100% power expense deductions and 20% CIT rates for registered business enterprises.</li> <li>• <b>Renewable Energy Act of 2008 (RA 9513):</b> <a href="#">Fiscal incentives</a> including a 7-year CIT holiday followed by a reduced 10% CIT rate, duty exemptions for RE (renewable energy) machinery and materials for 10 years and zero-VAT rating on sales.</li> <li>• <b>DOE Department Circular DC2022-11-0034:</b> <a href="#">Allows</a> 100% foreign ownership of solar, wind and hydropower projects.</li> </ul> |

# Singapore

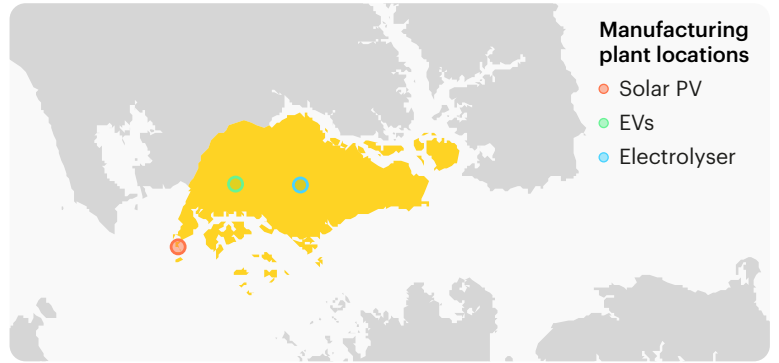
6 million people

100% live in urban areas

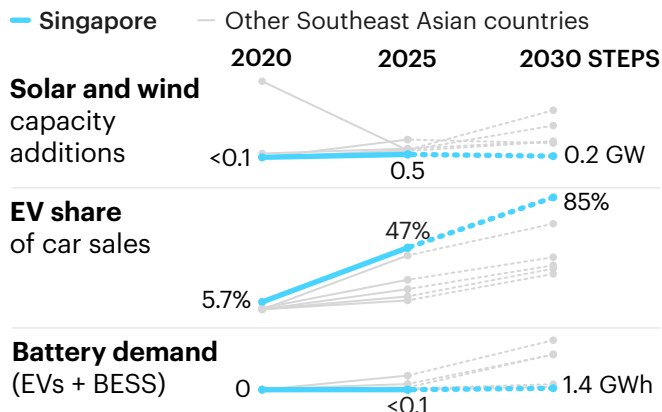
55 TWh electricity consumed annually

+3% GDP growth (10-yr CAGR)

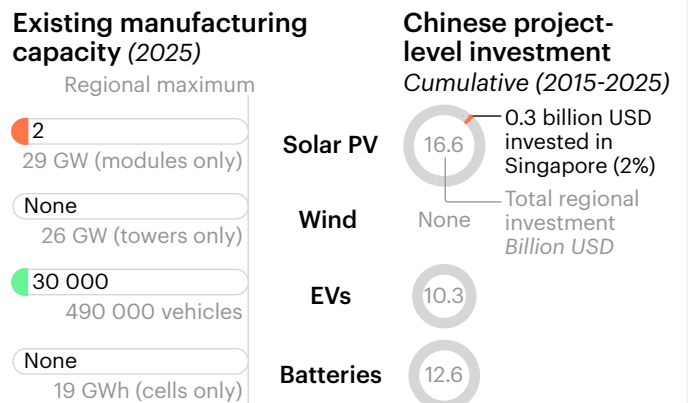
\$ 1.3 billion USD clean energy technology market



## Clean energy technology deployment



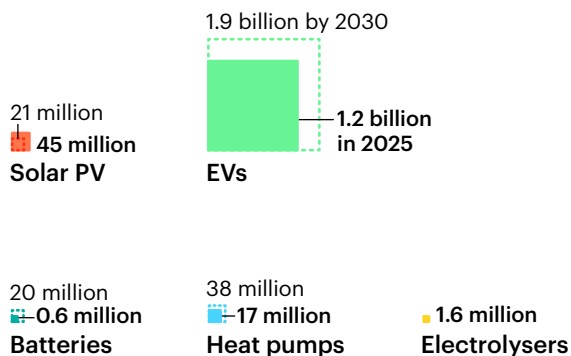
## Manufacturing capacity and investment



## Market size by technology

USD

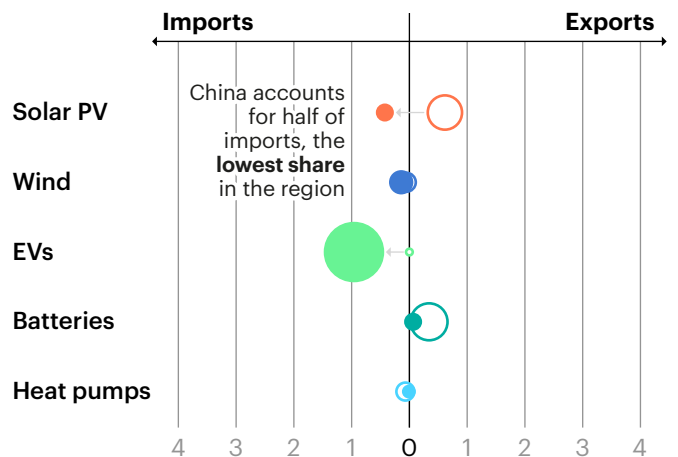
2025 2030 STEPS



## Trade balance by technology

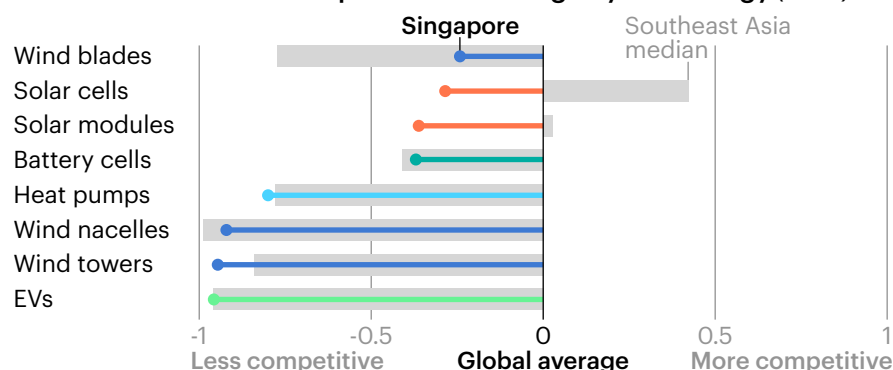
Billion USD

2015 2025



## Competitive position and strategic outlook

Normalised revealed comparative advantage by technology (2025)



Singapore functions as the **co-ordination hub** for Southeast Asia's clean energy technology manufacturing ecosystem

**Battery trade is balanced** due to a local battery producer supplying portable electronics applications and a small-scale electric car assembly factory

Singapore is the only country in the region to host an **electrolyser** manufacturing facility

## Singapore

Singapore functions as the co-ordination hub for Southeast Asia's clean energy technology manufacturing ecosystem. It attracts the largest share of foreign direct investment (FDI) in the region, predominantly in financial, legal and corporate services, and plays a central role in anchoring supply chain management, capital allocation and corporate decision making. High labour and operating costs, and land constraints, however, effectively limit manufacturing activities to high-value, low-volume production facilities. Instead, Singapore specialises in enabling roles, including logistics, trade intermediation, research and development, and regional headquarters functions, facilitating the flow of goods, capital and intellectual property across Southeast Asia.

### Clean energy technology deployment

Electricity demand in Singapore has increased by an average of 2% per year in the past 10 years. This is in line with growth in mature economies, as is the share of electricity in final energy consumption, which is stable at around 25%.

Solar electricity generation accounts for around 3% of the total, up from less than 0.5% 10 years before. There is no significant electricity generation from wind. Singapore's electric car sales have climbed rapidly in the past few years, from a share of around 6% of sales in 2020 to 47% in 2025.

The market for clean energy technologies in Singapore has reached USD 1.3 billion in 2025, nearly exclusively related to electric cars, and accounts for 5% of the regional market.

### Clean energy technology manufacturing capacity and investment

Singapore is home to [one factory](#) producing solar modules and cells with a production capacity of 1.8 GW; this was one of the earliest factories built in the region. Singapore also hosts [one of the first](#) overseas factories of the Japanese firm Murata, which continues to produce high-performance cylindrical cells, mostly for the consumer electronics market. While the Murata factory is not comparable in scale to EV battery gigafactories, this legacy provides a base of manufacturing know-how in high-precision battery assembly. This expertise is more directly applicable to smaller battery formats, which are useful for electronics and robotics. Singapore is also home to an [advanced small-scale electric car factory](#) owned by Hyundai.

Singapore acts as an investment, R&D and financing hub for the region's industries. Singapore is also developing niche strengths in software and digital services supporting clean energy technology manufacturing and trade.

## Trade balance

Singapore is a net importer of all clean energy technologies except batteries. In 2025, its exports were over USD 1 billion, compared to nearly USD 2.5 billion in imports.

Over 40% of exports were directed towards China and the United States. China accounted for half of imports, the lowest share of all countries in the region, which indicates more diversified trading relationships.

Singapore's battery trade is balanced thanks to a local battery producer and a small-scale electric car assembly factory which is importing batteries.

# Technical notes on the dashboards

## General notes

### Common abbreviations

|       |                               |
|-------|-------------------------------|
| AC    | Air conditioner               |
| BESS  | Battery energy storage system |
| CAGR  | Compound Annual Growth Rate   |
| EV    | Electric vehicle              |
| RoW   | Rest of World                 |
| STEPS | Stated Policies Scenario      |
| ZEV   | Zero-emissions vehicle        |

### Trade

Net trade in fossil fuels and clean energy technologies in Southeast Asia shown on the regional dashboard excludes intra-regional trade to reflect Southeast Asia's net trade position to the rest of the world.

### Electric vehicles and batteries

Unless otherwise specified, the term EV is used to refer to both battery electric and plug-in hybrid electric vehicles (PHEVs) but does not include fuel cell electric vehicles (FCEVs).

Battery manufacturing capacity and market size refer specifically to lithium-ion batteries used in EVs and battery energy storage system applications, while imports and exports include all lithium-ion battery applications.

### Revealed comparative advantage

Revealed comparative advantage (RCA) compares a technology's share in an economy's exports with its share in global exports. An RCA above 1 indicates relative export specialisation. Normalised RCA rescales RCA around zero, so that positive values indicate comparative advantage and negative values comparative disadvantage.

# Chapter 5. Strategic considerations for industrial strategy in Southeast Asia

## Highlights

- Successful industrial strategies tend to share several common principles: clear objectives, stable and predictable policy frameworks, support for innovation, openness to investment and competition, investment in infrastructure and skills, and mechanisms for monitoring and adjusting policies over time. Yet no industrial strategy can maximise all objectives simultaneously. Trade-offs are an inherent feature of policy making in this area, requiring governments to balance competing goals such as affordability, speed of deployment, domestic value creation, fiscal costs and long-term industrial competitiveness.
- Experience with electric vehicle (EV) policies illustrates these trade-offs. Southeast Asian countries have pursued different pathways: some prioritised rapid market growth through access to affordable imported cars, while others focused on building domestic manufacturing capabilities. In many cases, measures supporting local production reduced the short-term availability of affordable electric cars and slowed progress towards energy security, affordability and emission reduction objectives, while more open approaches accelerated deployment but generated fewer domestic industrial benefits.
- There is no single model for success, but a number of low-regret policy options emerge across countries. Co-operation with best-in-class companies can help countries capture greater benefits from the clean energy transition. Many of Southeast Asia's manufacturing industries – including solar PV, batteries and EVs – have expanded through partnerships with foreign firms, supporting investment, technology transfer and skills development. International co-operation in trade and investment can further strengthen supply chains, improve market opportunities and allow countries to specialise in different stages of clean energy technology production.
- Better data and greater transparency can improve policy outcomes. Reliable information on technology costs, trade flows, manufacturing activity and deployment trends helps governments design more effective industrial strategies, evaluate trade-offs and adjust policies as markets evolve.

## Key principles for industrial strategies

Governments and firms in Southeast Asia already play important roles in global energy technology supply chains, with an established manufacturing ecosystem that results from industrial and trade policy instruments developed over the past decade. Governments in Southeast Asia – as in any other region – are faced with the challenge of satisfying competing policy objectives in clean energy manufacturing and trade, such as the affordability and pace of deployment and supply chain resilience, as well as broader national and economic security considerations.

In [prior work](#) on energy technology supply chains, the IEA has identified principles to guide the development of governments' industrial strategies. These include:

- **Strengthening the domestic market.** Strong and predictable demand signals – including procurement commitments, infrastructure plans and regulatory targets – help de-risk investment in both deployment and manufacturing. Regional integration and trade frameworks further expand market size and support efficient supply chains.
- **Prioritising and playing to strengths.** Industrial strategies should focus on areas of comparative advantage, recognising that countries cannot compete across all technologies or value chain segments. Clear objectives and measurable success criteria are essential, alongside the flexibility to adjust or discontinue support where outcomes fall short.
- **Attracting and supporting innovators.** Innovation and manufacturing are closely linked. Supporting R&D, technology development and industrial clustering can enable firms to compete on quality and performance rather than cost alone. Policies should foster ecosystems that attract talent, support early-stage firms and enable knowledge spillovers.
- **Plugging cost gaps strategically and for the long term.** Public support can help bridge competitiveness gaps, but should be used selectively and with clear long-term objectives. Structural cost reductions – such as faster permitting, improved productivity, harmonised technical requirements and targeted workforce development – can be more effective than ongoing subsidies.
- **Collecting data and tracking progress.** Robust and harmonised data are essential for effective policy making. Governments should improve data collection on production, trade, investment, costs, employment and emissions, and co-ordinate internationally to enable consistent tracking of clean energy supply chains.
- **Co-ordinating efforts across supply chains.** Supply chains are only as strong as their weakest link. Governments should align policies across different stages of production, identify bottlenecks and avoid duplication. Collaboration – including sharing best practices and co-ordinating investment – can strengthen overall resilience.

- **Identifying and building strategic partnerships.** Strategic partnerships can enhance resilience and enable participation in segments where domestic competitiveness is limited. A structured approach to evaluating partnerships can help balance export opportunities with domestic development objectives and manage associated risks.

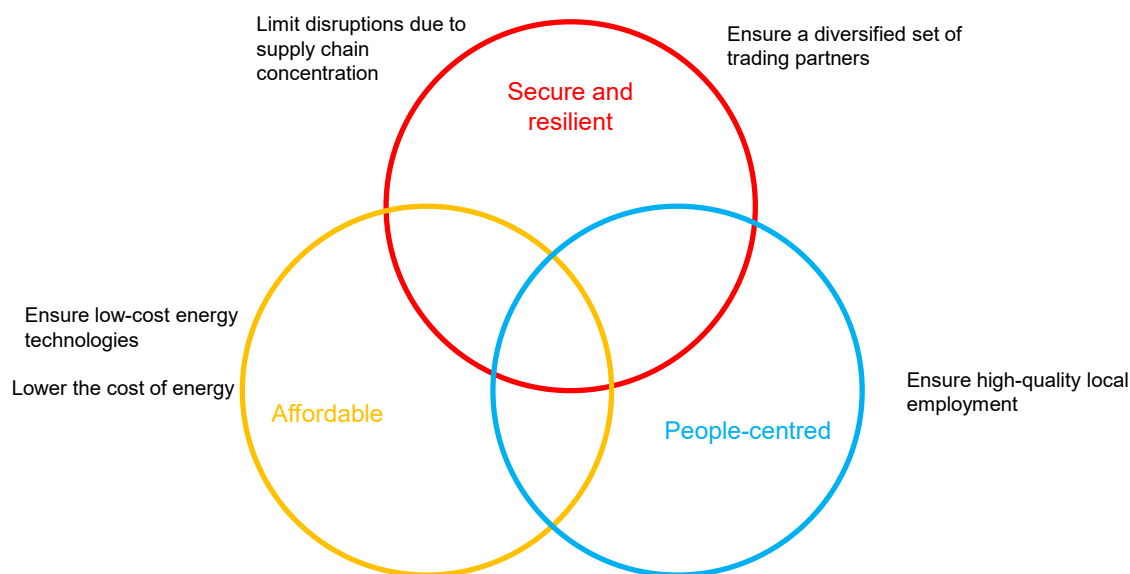
Even when adhering to these principles, governments and firms will be faced with trade-offs across different policy priorities, especially as the markets for these technologies become more mature and the geopolitical environment evolves. Identifying and acknowledging trade-offs can help governments to design policy frameworks that best address their priorities.

This chapter builds on the principles established above by using five country case studies to illustrate the trade-offs that are being navigated in the Southeast Asian context. The case studies focus on the major markets in the region – Thailand, Indonesia, the Philippines, Malaysia and Viet Nam – and on supply chains for electric cars, in order to enable comparison. The chapter concludes with some low-regret policy options that all governments in the region may wish to consider.

## Navigating industrial policy trade-offs

Governments must manage a set of different, and at times diverging, policy objectives. The IEA's [Energy Technology Perspectives 2024](#) identifies three objectives that are particularly relevant for the clean energy technology industry: secure and resilient supply chains that limit exposure to hazards that may compromise supplies; availability of affordable technologies to minimise the costs borne by households and firms; and people-centred industries that ensure that the benefits of this industry are fairly distributed and that local employment is preserved. Well-designed policies can promote competitiveness by reinforcing these three policy aspects; however, these three priorities are often in tension.

**Figure 5.1 Policy priorities for clean energy technology manufacturing and trade**

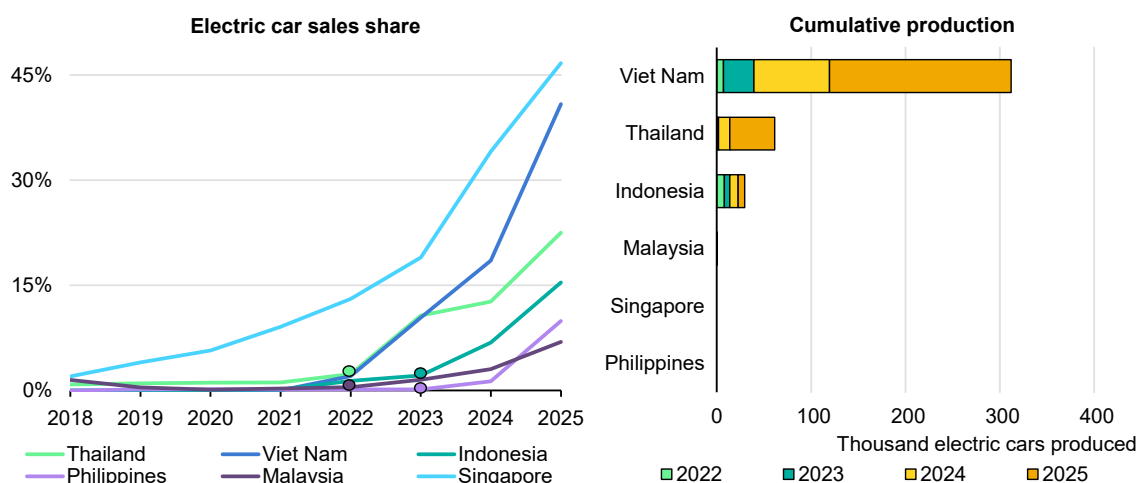


IEA. CC BY 4.0.

Source: Adapted from IEA (2024), [Energy Technology Perspectives 2024](#).

Southeast Asia is facing an energy shock triggered by the conflict in the Middle East (see Chapter 1). Crude oil prices – and particularly those for certain oil products – have skyrocketed compared to 2025 averages, and some countries are experiencing shortages. Since more than 80% of gasoline and diesel in the region is used for road transport, the deployment of electric cars is a key approach that countries can use to shield themselves from price shocks in international markets. At the same time, the supply chain for electric cars is concentrated in China. Several countries in Southeast Asia have been at the forefront of electric car sales growth worldwide in the past few years. Rapid uptake has been triggered by a series of industrial, trade and energy policies implemented by governments in the region.

**Figure 5.2 Electric car sales share and production by country, and year in which import restrictions were lifted or reduced, 2018-2025**



IEA. CC BY 4.0.

Note: Dots in the left-hand graph represent the year in which import restrictions were lifted or reduced. Prior to 2022, production was marginal in these countries.

## Country case studies

### Thailand: shifting existing industries to new technologies

Thailand's strategy builds on its strong automotive industry, aiming to transition towards electric cars while maintaining its role as a major manufacturing and export hub. Early policies focused on protecting domestic electric car production and supporting manufacturers, resulting in limited electric car uptake. From 2022, the government introduced incentives and reduced import barriers to stimulate demand, while requiring importers to make local production commitments. This enabled rapid market growth and price parity, alongside the development of local assembly capacity. More recent policies focus on exports and scaling production. Key trade-offs include balancing deployment speed with domestic industry protection, and export competitiveness with limited local value capture, particularly due to reliance on imported batteries and foreign firms.

#### Stated policy objectives and implemented measures

Thailand has a long history of industrial policy targeting the automotive industry. For decades, Thailand's government has nurtured an export-oriented automotive sector by attracting foreign investment, incentivising local manufacturing and supporting supplier clusters. Past policies targeted specific vehicle segments, notably pickups, to capture a competitive niche in global markets. These policies turned Thailand into the region's largest car exporter, with [around 1 million cars](#)

[exported in 2025](#), and production capacity for more than 3 million cars operated by manufacturers from the People's Republic of China (hereafter, "China"), Europe, Japan and Korea.

Thailand has aimed to pivot its successful automotive industry based on internal combustion engine (ICE) vehicles towards new technologies without losing its status as a major manufacturing and export hub. The stated objectives of Thailand's electric car strategy have therefore emphasised industrial continuity and competitiveness – as evidenced by the "30@30" initiative – targeting car production rather than sales.

## What happened

### Phase 1: Electric car transition as industrial continuity

Thailand's electric car strategy began with explicit ambitions for electrification and exports, formalised through the 30@30 initiative and the establishment of a National EV Policy Committee in 2020. From the outset, policy makers signalled a clear intent to position Thailand as a regional electric car manufacturing and export hub, rather than a passive importer of new technologies. As a result, early measures focused on subsidies for local electric car manufacturing in preference to consumer incentives, while strong protection of domestic assembly remained in place, through an 80% import duty for all cars. Demand incentives were implemented but were relatively limited. This, added to the high cost premium for electric cars and the scarcity of available models, meant that electric car uptake remained marginal up until the end of 2021.

### Phase 2: Market activation and manufacturing scale-up

A decisive shift occurred in 2022 with the introduction of the EV 3.0 programme, which marked Thailand's move from industrial signalling to active market creation. Policy makers explicitly accepted a temporary opening to imports and fiscal support as necessary to accelerate electric car adoption and achieve scale. Direct purchase incentives were introduced and, crucially, import duty cuts enabled low-cost Chinese models to enter the market. The industrial policy focus was not set aside, as the exemptions came with strict conditions on future local production commitments. A key example of this is the agreement signed in 2022 with BYD, which completed its electric car factory in Thailand in mid-2024. During this period, the focus for localisation was car assembly, with the battery supply chain almost exclusively relying on imports. The combination of lower import duties and a growing local industry led Thailand to reach purchase price parity for electric and ICE cars by 2024, which propelled the electric car sales share from 2% in 2022 to nearly 15% in 2024.

### Phase 3: Consolidation and export orientation

As electric car adoption gained momentum and price gaps narrowed, Thailand again adjusted its policy approach under the EV 3.5 framework. Purchase subsidies were gradually reduced to manage government spending, while local production and export requirements were tightened. Policy emphasis shifted towards scaling up automotive exports, building on Thailand's existing strengths.

By 2025, Thailand had begun to export electric cars and the country's electric car sales share is now higher than that is not far from that of the European Union. This phase has reinforced Thailand's affordability and employment objectives but also highlighted dependencies: the domestic battery supply chain remains limited, and foreign firms, particularly Chinese manufacturers, play a dominant role in electric car supply.

### Trade-offs

**Deployment speed versus domestic industry protection:** Thailand's initial emphasis on local production incentives for electric cars meant that uptake remained low, as high domestic costs and limited model choice constrained purchases. The market took off only when import restrictions were relaxed and subsidies introduced, enabling an influx of more affordable electric cars. This underscores the trade-off between rapid deployment and domestic industry protection. Thailand's approach suggests a sequenced solution to this tension: temporary market-opening measures combined with clear localisation timelines to preserve long-term industrial goals. This strategy has both delivered improved affordability and laid the foundation for increased local production.

**Export competitiveness versus domestic value capture:** Thailand's electric car industrial strategy prioritised leveraging its large production capacity for ICE cars to assemble electric cars locally for export markets. Focusing on the last step of the supply chain enabled Thailand to develop a globally competitive local industry quickly, since it could leverage local expertise, suppliers and logistics gained through decades of car and car parts production. However, electric car manufacturing in Thailand today uses only limited local content in electric-car-specific, high-value components such as batteries and power electronics. This reflects the decision to prioritise objectives around affordability and industrial competitiveness over the establishment of a secure and resilient supply chain. Import reliance for key components does not address supply chain risk and misses out on part of the value creation from car manufacturing, as around 30% of the economic value flows abroad. Nevertheless, current incentives target these supply chain steps, and some manufacturing projects have already been announced, meaning that Thailand may also become a battery cell producer in due course.

## Indonesia: leveraging natural resources for downstream industries

Indonesia's strategy centres on leveraging its large nickel reserves to build a domestic electric car and battery industry through downstream industrialisation. Policies such as export bans and local processing requirements have aimed to capture more value, attract foreign investment and strengthen supply chain resilience. An initial focus on domestic manufacturing constrained early electric car uptake, due to high costs and limited availability. From 2022 onwards, policies expanded to include demand incentives, while later adjustments temporarily opened imports to improve affordability and accelerate deployment. This resulted in rapid electric car market growth but increased reliance on imports. Key trade-offs include domestic value creation versus affordability, exposure to global market shifts such as battery chemistry changes, and tensions with international trade rules.

### Stated policy objectives and implemented measures

Indonesia has long pursued a broad [“downstreaming” strategy](#) – leveraging its rich natural resource base to spur domestic industrial development rather than exporting raw materials. The landmark Mineral and Coal Mining Law (Law No. 4/2009) enshrined this approach, mandating that mineral ores be processed locally before export. In line with this, export bans on unprocessed ores created strong incentives for mining companies to build domestic smelters and refineries. The intent was to add value to Indonesia's vast mineral base and capture more economic benefits at home – including higher manufacturing output, job creation and fiscal revenues – by moving up the value chain. Indonesia's downstream strategy encompasses many key commodities. Export restrictions introduced under the 2009 Mining Law have been broadened over time – nickel ore exports were prohibited from 2014 (with the ban reinforced from 2020), and similar measures have since been extended to bauxite (from mid-2023) and other minerals. In parallel, downstream processing of agricultural and other natural resources – for example, increasing domestic refining of palm oil – has been encouraged through incentives and regulations, all aimed at maximising domestic value addition across sectors.

This downstream focus reflects multiple policy objectives. By processing minerals and manufacturing intermediate products domestically, Indonesia aims to boost the manufacturing sector's contribution to GDP and reduce over-reliance on raw commodity exports. Policy makers also view downstream development as a path to economic resilience and macroeconomic stability. Strengthening value-added exports while curbing shipments of unprocessed resources can improve the trade balance and current account position, insulating the economy from volatile global commodity prices. Downstream industrialisation is also expected to generate new employment and skills, extending the benefits of resource wealth in a people-centred way.

At the same time, the Indonesian government aims to enhance its energy security by reducing dependence on oil imports [through increasing sales of electric cars](#), which instead can rely on domestic sources of energy.

## What happened

### Phase 1: Resource-based industrialisation and supply chain security

In the first phase, the Indonesian government focused primarily on the objective of creating a domestic downstream industry. This objective was embodied in measures such as nickel ore export bans (enforced in 2020) to mandate in-country processing. These moves attracted substantial foreign direct investment (FDI) from major mining and processing companies, especially from China, resulting in the value of Indonesian nickel-related product exports jumping from USD 0.8 billion in 2020 to USD 6 billion in 2022 and reaching USD 10 billion by 2025. Further downstream investments also started to pour in, with a USD 1.1 billion investment by Korean firms in a battery cell factory that broke ground in 2021. In this early period, some incentives were in place for the adoption of electric cars, but market shares remained below 1%. In 2022, the World Trade Organization (WTO) ruled the export ban to be non-compliant with WTO rules, which hindered relationships with some trading partners.

### Phase 2: Broadening to domestic manufacturing and demand creation

Around 2022, Indonesia's policy objectives were further developed to support both supply and demand. Policy makers sought to not only continue building up domestic electric car and battery manufacturing capacity but also to stimulate an internal market for electric cars. Targets for electric car production and use were articulated through [national roadmaps](#) that set out local content requirements, fiscal incentives for manufacturers and consumers, and plans for charging infrastructure. At the same time, the government introduced tax and VAT incentives for electric car purchases to help bridge the price gap with ICE cars and kick-start early adoption. Despite these efforts, electric car deployment remained nascent, mainly due to high costs and limited model availability.

### Phase 3: Adjustment and balancing objectives

Since 2024, Indonesia's strategy has been recalibrated to better balance industrial policy with market expansion and broader transition goals. Recognising that domestic electric car adoption was lagging, the government temporarily eased import restrictions and duties on fully built electric cars from late 2023 into 2025. This measure, which essentially used affordable imported electric cars (largely from China) to boost local market growth, was presented as a time-bound compromise. It improved consumer choice and affordability while requiring foreign carmakers to commit to future local production – resulting, for example, in [BYD's](#)

[USD 1 billion investment](#) in a battery and electric car factory in Indonesia. In this period, investment in the battery supply chain continued to flow in, for example in [CATL's battery factory](#) and associated component factories.

This adjustment, effectively allowing short-term imports with the aim of expanding model choice and reducing purchase prices, triggered an acceleration in electric car sales.

## Trade-offs

### **Domestic industry development versus short-term electric car deployment**

Indonesia's reliance on protective measures and local content rules, while building domestic electric car and battery capacity, initially constrained consumer choice and kept electric car prices high. The result was very slow early electric car adoption. To address this, Indonesia temporarily liberalised electric car imports and boosted purchase incentives, dramatically improving affordability and model availability. Electric car sales surged thereafter: by the first half of 2025, battery electric cars had reached around 10% of new car sales, up from almost zero just a few years earlier. Indonesia therefore became one of the fastest-growing electric car markets in Southeast Asia. Most of this growth was driven by an influx of competitively priced Chinese electric car models, which now dominate Indonesia's electric car market. This underscores a trade-off: an initial focus on developing a local downstream industry rather than on delivering affordable cars over the near term meant electric car sales shares remained low for several years, thus slowing down progress towards the country's energy security objectives. Subsequent policy changes focusing more on imports have supported a rebalancing of energy security and industrial objectives.

### **Technology-prescriptive policy versus a dynamic market environment**

Another strategic trade-off that emerges is between committing early to a specific technology path and adapting to uncertain market shifts. Indonesia's emphasis on nickel-centric battery supply chains is now encountering a moving target: the rapid rise of lithium iron phosphate (LFP) battery chemistries globally, which require no nickel. As of 2025, LFP batteries accounted for more than half of electric car battery capacity deployed globally, up from a negligible share a decade earlier; in emerging markets, they powered roughly two-thirds of electric cars sold, double their 2023 share. This trend implies that future demand for high-nickel battery materials could be lower than was projected before LFP became so prevalent. Indonesia's burgeoning nickel-processing infrastructure, optimised for nickel-rich chemistries, thus faces a risk of underutilisation or diminished returns if market preferences continue shifting towards nickel-free alternatives. This illustrates an inherent tension in industrial policy making: balancing an early, targeted push for a specific value chain with the need for flexibility in the face of evolving technologies.

## Strategic policy versus international co-operation

Indonesia's unilateral measures to nurture domestic supply chains have led to friction in global trade. The nickel ore export ban – central to Indonesia's resource-based industrialisation – was challenged by the European Union and ruled inconsistent with WTO rules in late 2022. This outcome signals another trade-off: industrial policy can conflict with international trade commitments, risking retaliatory measures, loss of market access and soured international relationships. Balancing legitimate development goals with adherence to rules-based trade is an ongoing challenge.

## Philippines: maximising technology affordability

The Philippines prioritises affordability and rapid electric car adoption over domestic manufacturing, reflecting its small and import-dependent automotive sector. Policies focus on reducing costs through tariff removal and tax incentives, driven by energy security concerns and high reliance on imported oil. Electric car adoption remained minimal until 2023, when import duty exemptions enabled a surge in low-cost imported cars, particularly from China. This led to rapid market growth but limited domestic industrial development. The country remains dependent on foreign supply chains, with relatively little local manufacturing capacity. Key trade-offs include faster deployment and lower consumer costs versus missed opportunities for local value creation and increased reliance on external supply chains.

### Stated policy objectives and implemented measures

The Philippines entered the electric car transition from an industrial baseline markedly different from that of some of its regional peers. Its automotive sector has historically been small, fragmented and heavily dependent on imports, with domestic activity largely limited to assembly using imported components rather than integrated manufacturing. Earlier industrial programmes sought to build a local automotive base, although the sector remained small. Car demand has long been met primarily through imports, reflecting structural competitiveness challenges. As a result, industrial policy in the transport sector has been focused less on export-led manufacturing and more on meeting domestic demand at least cost.

The policy shift towards EVs accelerated in the context of rising and volatile fuel prices, which increased pressure on households and transport operators and highlighted the macroeconomic risks of oil dependence. Government measures adopted from 2022-2023, including the removal of import tariffs on electric cars, were explicitly designed to reduce vehicle costs, expand consumer access and support a transition away from fossil fuels. These choices reflect a clear

prioritisation of affordability, rapid deployment and energy security over domestic industrialisation. While the government's plans also outline ambitions to develop an electric car industry, including attracting investment and generating employment, policy design has so far favoured open-market access to competitively priced imports as the fastest route to achieving these priorities.

## What happened

### Phase 1: Preparatory phase

Electric car adoption remained limited through 2021, given the lack of concrete incentives and the high cost of the few electric car models available. The 2022 Electric Vehicle Industry Development Act (EVIDA) provided a framework – including the creation of a Comprehensive Roadmap for the EV Industry – but its measures needed follow-up regulation to take effect. During this period, the focus was on creating plans for infrastructure and potential incentives, without yet committing major fiscal support. Meanwhile, surging oil prices in 2021 and 2022 put pressure on the macroeconomy and household budgets, reinforcing the government's resolve to accelerate electric car adoption to cut fuel imports and cushion consumers.

### Phase 2: Affordability-driven market activation

The turning point was Executive Order No. 12 in January 2023, which slashed import tariffs on electric cars and parts to 0% for an initial 5-year period. Together with excise tax exemptions under EVIDA, this measure cut electric car prices substantially, opening the gates to an influx of affordable electric cars. As a result, electric car sales in the Philippines soared in 2025 to nearly 10% of new car sales (from close to zero in 2022). Chinese brands dominated these sales, as they offered competitively priced models and could quickly ramp up supply via imports. The expanded tariff exemption (which was extended in 2024 to run until 2028 and broadened to more vehicle categories) further cemented the Philippines' strategy of an import-led electric car transition. By 2025, essentially all electric cars on Philippine roads were imported, reflecting the deliberate policy choice to prioritise immediate uptake over local production.

With the 0% import duty policy now extended through 2028, the Philippines has signalled that it will continue prioritising technology affordability and market growth. This means the country is likely to remain almost entirely dependent on imports to supply its electric car market. Just as most ICE car sales have historically been met by imports, so too are electric car sales.

## Trade-offs

### Industrialisation versus consumer uptake

The Philippines' case exemplifies the trade-off between rapid deployment of clean technologies and domestic industry development. By opening its market to imports to maximise near-term affordability, the Philippines achieved faster electric car uptake than would have been possible under an approach aimed at developing local capabilities. Consumers benefited from lower prices and greater model choice. At the same time, the policy included no significant measures to promote local electric car manufacturing. Therefore, there has been no significant FDI, nor local investment in electric car assembly or battery factories.

### Energy security gains versus supply chain dependence

On one hand, the Philippines' import-oriented strategy is already delivering energy security dividends: rising electric car adoption helps displace oil consumption in transport, a significant benefit for a nation that imports nearly all of its oil. On the other, the electric car supply chain is highly concentrated and relies mostly on imports from a single country. This highlights another trade-off: reducing vulnerability to oil markets by increasing reliance on manufacturing supply chains overseas.

## Malaysia: building on local strengths and protecting industry

Malaysia's electric car strategy has sought to reconcile electric car deployment with the preservation and technological upgrading of its large domestically oriented automotive industry. The main objective has been to increase economic complexity, with rapid electric car adoption being a secondary priority, which also reflects the country's low reliance on oil imports. Malaysia opened only the high end of its car market to imports, reducing tariffs only for cars sold at prices above a certain threshold; this enabled it to begin introducing electric cars while giving its domestic carmakers enough time to develop their own electric cars. Electric car adoption consequently remained slower than in several neighbouring markets until affordable national-brand models became available from late 2024 and especially in 2025. The principal trade-off has been between rapid deployment and technology affordability on the one hand, and the preservation of domestic manufacturers and suppliers, as well as technical know-how, on the other.

### Stated policy objectives and implemented measures

Malaysia is home to a deeply integrated automotive industry, including homegrown carmakers which focus on the domestic market. The two domestic manufacturers

(Perodua and Proton) together account for just under two-thirds of the country's car sales and support extensive supplier, distribution and servicing networks.

Malaysia is also a major oil producer with only a small oil import bill. While electric car deployment is mentioned in Malaysian energy security documents (National Energy Policy 2022-2040), it is primarily portrayed as a means to improve the environmental sustainability and efficiency of the transport sector. Energy security has played a relatively limited role in shaping the country's approach to electric vehicle deployment.

Malaysia's electric car strategy has therefore been shaped first and foremost by an industrial policy and upgrading objective. The country has published multiple industrial master plans over time, and the aim to become an electric car producer was mentioned as early as 2014. Under the National Automotive Policy 2020, electrification forms part of the broader Next Generation Vehicle agenda, encompassing connected vehicles, autonomous systems, advanced manufacturing and domestic engineering capabilities. The objective is not merely to increase the number of electric cars sold or assembled, but to use the technological transition to enhance the sophistication of Malaysia's automotive industry. This includes expanding participation in vehicle design, testing, digital systems, embedded software, electronics and systems integration, while enabling existing manufacturers and suppliers to move away from activities tied exclusively to the ICE.

This industrial-upgrading objective was reinforced by the New Industrial Master Plan 2030. It contains two closely connected mission-based projects: one to launch a locally manufactured electric car, and another to establish Malaysia as a hub for advanced integrated-circuit (IC) design by developing globally competitive Malaysian IC-design companies serving electric car, renewable-energy and artificial-intelligence applications. The plan therefore treats the electric car transition not as an isolated automotive programme, but as an opportunity to connect two of Malaysia's most important manufacturing ecosystems: automotive production and electrical and electronics manufacturing.

Malaysia's policy objectives place particular weight on the people-centred and industrial-resilience dimensions of the electric car transition: maintaining domestic manufacturers, preserving employment, helping established suppliers take up new technologies and linking automotive demand to the country's semiconductor capabilities – leveraging its existing strengths.

## What happened

### **Phase 1: Local-assembly-led industrial preparation**

Under the National Automotive Policy 2014, the government sought to position Malaysia as an Association of Southeast Asian Nations (ASEAN) hub for energy-efficient vehicles, a broad category that included efficient ICE vehicles, hybrids and battery electric cars. Import- and excise-duty exemptions for electric cars assembled in Malaysia were extended until the end of 2017. The emphasis was therefore on attracting local production rather than opening the domestic market to fully built imported electric cars.

In February 2020, the government launched the National Automotive Policy 2020. This broadened the industrial strategy through the concept of the Next Generation Vehicle, encompassing electrification and digital vehicle technologies, with the objective of making Malaysia a regional leader in automotive manufacturing, engineering and technology while leveraging domestic strengths in electronics.

In this period, there were no significant incentives for electric car adoption; therefore, electric car model availability was limited and reliant on highly priced imports. As a result, the market share for electric cars remained below 1%.

### **Phase 2: Selective market opening while domestic capabilities were built**

In 2022, the government introduced a set of measures to incentivise electric car adoption. These included time-limited import tariff exemptions for imported electric cars and components, as well as purchase tax exemptions for electric cars manufactured locally. In 2023 this framework was further extended in time and scope.

The import tariff exemption had an important caveat: it was only applicable to cars priced above a threshold that was far higher than the price for mass market cars that were instead predominantly produced by the domestic carmakers. In this period, electric car model availability increased significantly, and adoption started to gain some momentum, but it was limited to the premium market.

In 2023, the New Industrial Master Plan 2030 introduced the aim of building end-to-end domestic capabilities and connecting the automotive transition with Malaysia's semiconductor and electronics industries.

In this period, Malaysia's domestic manufacturers began investing heavily in the development of electric cars, and by 2024 both companies had started to introduce locally produced prototypes.

### **Phase 3: Domestic carmaker entry and return to localisation**

Electric car adoption started to pick up more rapidly from 2025, as electric cars were no longer limited to imported vehicles for the upper and premium segments of the market, but also included mass-market models, benefiting from the dealer networks and after-sales services of the largest Malaysian carmakers. Electric car sales more than doubled in 2025, and the first half of 2026 saw another near doubling of sales year-on-year. Local brands accounted for nearly 20% of electric car sales in 2025, and in the first half of 2026 they accounted for nearly half. However, most of those cars were still produced in China.

Malaysia's electric car strategy shifted even more towards domestic production when import tariff exemptions for electric cars ended in December 2025, though exemptions for car components remained in place.

## **Trade-offs**

### **Deployment speed versus domestic industry protection**

Malaysia's experience illustrates the trade-off between maximising the speed of clean technology deployment and preserving an established domestic industry. Removing import and excise duties helped electric car sales to grow, but the price threshold prevented foreign manufacturers from fully exploiting their cost advantage in small and inexpensive electric cars.

This protected domestic carmakers and their suppliers from immediate competition in their core market. It also meant that most Malaysian car buyers, who typically purchased national-brand vehicles at prices well below the price threshold, had no similarly priced electric alternative for most of the 2022-2025 incentive period. Electric car adoption consequently remained slower than in other parts of Southeast Asia, even though Malaysia nominally exempted imported electric cars from import duties, as did other countries.

The policy effectively prioritised the objective of maintaining domestic producers and employment over the immediate affordability objective.

### **National industrial participation versus dependence on foreign technology**

There are different ways to support domestic industries – one is to focus on domestic production, irrespective of where the company involved is headquartered; another is to focus on homegrown companies. In the former case, employment and the supply chain are retained, while in the latter case, design and engineering knowledge also stays within the country.

In Malaysia, the objective to not only manufacture but also develop electric cars domestically meant that competition with international players was more

constrained than in other countries in the region. The existing carmakers in Malaysia already had a strong market position and technical knowledge in ICE cars, but transitioning to electric cars took some time. The two national champions took different approaches.

Proton achieved a more rapid market entry through its strategic relationship with a Chinese manufacturer. This provided access to a competitive vehicle platform, batteries, electronic systems and manufacturing knowledge, allowing Proton to introduce attractively priced electric cars a year earlier than its local competitor. However, this approach relied more strongly on foreign technology and foreign manufacturing capacity. Perodua's approach placed greater emphasis on domestic development, local suppliers and co-operation with Malaysian institutions, but required more time to reach market.

Malaysia has to date succeeded in preserving the market share of national manufacturers while meeting its goals of economic diversification and increased complexity by pushing the domestic carmakers to develop electric drive technologies.

## **Viet Nam: establishing a domestic champion**

Viet Nam's electric car strategy has combined the creation of a domestic automotive industry with the gradual electrification of the car market. As the country lacked an established car-making base, the government initially prioritised building domestic production capacity, increasing local value added and reducing reliance on imported vehicles and components. Electrification was pursued as one strand of this broader industrial agenda rather than as an energy security measure. This objective became closely aligned with the rise of VinFast, a new national champion that pivoted from ICE cars to become an electric car pioneer from 2022. VinFast ceased production of ICE passenger cars and invested simultaneously in vehicle manufacturing and charging infrastructure, and built fleet demand through its affiliated companies. Combined with purchase tax incentives and long-term transport targets introduced in the same year, this integrated, producer-led approach helped overcome the co-ordination barriers that often slow electric car deployment. By 2025, Viet Nam had become the region's largest electric car producer and reached an electric car sales share of around 40% – ranking second in Southeast Asia after Singapore – while retaining substantial domestic participation in vehicle manufacturing. The principal trade-offs concern the benefits of an integrated domestic ecosystem versus the risks of high market concentration and the rapid expansion of downstream vehicle assembly compared to continued reliance on imported components, particularly battery cells from China.

## Stated policy objectives and implemented measures

Viet Nam did not have a significant national automotive industry. Vehicle production was limited and dominated by the local assembly of cars made by foreign brands using a high share of imported components. The government's initial objective was broader than electrification: it sought industrial development and the benefits it could bring for economic development and supply chain resilience.

Electric cars were incorporated into this industrial development agenda as one category of environmentally friendly and technologically advanced vehicles. Policy documents, such as the government's automotive strategy to 2025 (Decision 1168/QD-TTg), presented electrification as an opportunity to modernise domestic manufacturing, develop engineering capabilities and enable Vietnamese firms to participate in higher-value segments of the automotive supply chain. Even though Viet Nam is reliant on imports for over half of its oil supply, electric cars were not initially framed as an energy security lever.

A new carmaker with limited experience in ICE technology – and therefore with fewer legacy investments in incumbent technologies – was more likely to embrace electric vehicles. As the company chose to pivot towards electric car manufacturing, its objectives became closely aligned with Viet Nam's broader industrial development goals.

## What happened

### Phase 1: Supporting the domestic automotive industry

During the first phase, the government concentrated on establishing domestic vehicle and component production capabilities. The 2014 automotive strategy to 2025 and subsequent implementing measures offered investment incentives, preferential treatment for “environmentally friendly” vehicles and support for local component production. Import rules introduced in 2017 increased the regulatory requirements faced by car importers, while tariff relief for eligible components supported domestic assembly.

VinFast was established in 2017 and developed a large vehicle manufacturing complex. The company initially produced ICE cars, drawing on international vehicle platforms, engineering expertise and components.

The policy framework in this period did not include substantial electric car purchase incentives or a comprehensive national charging programme. Model availability remained limited and electric car sales were negligible. The priority was the creation of a domestic automotive producer and manufacturing base, rather than immediate electrification of the car market.

## **Phase 2: Producer-led ecosystem expansion and market scale-up**

A decisive change occurred in 2022, when VinFast's corporate strategy and government policy shifted towards electrification almost simultaneously. In January, the national champion announced that it would cease producing ICE passenger cars by the end of the year, and instead concentrate its R&D on electric powertrains, with the aim of introducing electric models covering most car segments.

From 2023, VinFast's founder also established the Green and Smart Mobility electric taxi and leasing company, which created a large anchor customer for VinFast vehicles, and V-Green, which assumed responsibility for expanding VinFast's charging network. This integrated approach helped address the co-ordination problem between vehicle availability, fleet demand and charging infrastructure, as a large share of early deliveries was made to affiliated businesses rather than independent retail customers. In the same year, another company began locally assembling electric cars from a Chinese carmaker.

By 2025, Viet Nam had produced more electric cars than any other country in Southeast Asia, and had reached an electric car sales share of 40% – close to the levels seen in Singapore, historically the country with the highest electric car sales share in the region. By that year, VinFast was also selling electric cars elsewhere in Southeast Asia and even globally, although overall car export volumes remain relatively low compared to those of other countries in the region. While some plans have been drawn up, battery cells for cars produced in Viet Nam are currently mostly imported from China.

## **Trade-offs**

### **Opening up the market versus betting on a domestic champion**

Viet Nam's reliance on an integrated domestic champion helped overcome several barriers that normally delay EV deployment. The company developed vehicles, charging infrastructure and sales networks in parallel, supporting co-ordinated roll-out. The timing of government incentives was aligned with the progress being made by the domestic industry, meaning that the country could achieve high levels of electrification while keeping its automotive industry shielded from international markets.

In Viet Nam, this approach has to date been largely successful: the country has achieved wide availability of affordable electric cars, rapid deployment and the buildout of a strong domestic industry and technical know-how. However, this was a high-risk approach. Other companies had previously tried to develop a domestic automotive industry and failed. Moreover, electric car sales only really started to pick up once the domestic company was ready to produce the cars, meaning that

consumers potentially lost out on several years of access to low-cost electric cars that could have been sourced from international markets. In addition, Viet Nam has a very high market concentration, with a single company accounting for 99% of all electric car sales in the country. This means significant market power rests with a single company, which may prevent consumers from accessing a broader variety of affordable models that are available in international markets.

### **Focus on downstream versus integrated supply chains**

The speed and scale of Viet Nam's growth in electric car manufacturing were achieved by focusing on car design and assembly, while deprioritising the development of the full supply chain. This means that even though Viet Nam is now home to a global electric carmaker, its electric car production is still reliant on imported battery cells, mostly from China. The trade-off, therefore, is one where rapid downstream production expansion is favoured over a buildout of the supply chain. Relying on a single country for the supply of batteries means that the security-of-supply objective was deprioritised, as was the capture of the full value added from the manufacturing of electric cars.

## **Low-regret policy options**

An open, collaborative approach to clean energy supply chains can help Southeast Asian countries pursue all three strategic policy priorities identified above – security, affordability and people-centred development – concurrently. While trade-offs are inevitable in all policy making, here we explore some measures that aim to minimise those trade-offs and can therefore be considered “low-regret” options to pursue.

Firstly, international trade and partnerships can broaden the range of suppliers, reducing over-reliance on any single source and enhancing resilience against disruptions. A wide network of trading partners without major barriers expands options during crises, ensuring that critical materials, components and technologies can be sourced from alternative routes if one channel falters. A diverse supplier base also encourages competition and economies of scale, putting downward pressure on technology costs and boosting affordability.

Secondly, co-operation with “best-in-class” international partners (whether advanced economies or leading global companies) helps firms absorb state-of-the-art technologies and practices, strengthening local capabilities and the workforce. Strategic alliances and joint ventures can accelerate technology transfer and skill development across borders, boosting the region's innovation potential and fostering FDI into local clean energy technology industries.

Finally, collaborative initiatives on standards and data can cut non-tariff barriers, preserve quality and improve transparency, further reducing trade frictions and

supporting efficient investments. Examples include aligning technical specifications, adopting international standards, enabling mutual recognition of testing and certification, supporting interoperable digital protocols and sharing supply chain information.

## Co-operate and trade internationally

Trade and co-operation agreements have played an important enabling role in Southeast Asia's clean technology development. By reducing tariff and non-tariff barriers, improving regulatory predictability and facilitating cross-border investment, these agreements can enlarge markets for clean energy technologies. This allows firms to specialise, access lower-cost inputs, integrate production across borders and reach economies of scale. More open markets can also increase competitive pressure, support technology diffusion and give consumers and firms access to cost-competitive clean technologies. An open economy architecture has allowed the region to benefit from shifts in global technology markets, FDI and changes in trade policy in major economies.

Developing the conditions for transparent, responsible and lower-impact supply chains can further strengthen trade relationships and unlock demand for clean energy technologies. As importing markets increasingly scrutinise carbon intensity, environmental impacts, labour practices, ownership structures and supply chain traceability, Southeast Asian economies that can demonstrate compliance with high standards may be better placed to access stable export markets and attract long-term investment. Regulations that improve transparency, minimise environmental harm and protect labour rights can therefore support both people-centred development and industrial competitiveness, while making firms more resilient to evolving trade and due-diligence requirements.

Unlike most industrial policy measures, government action to foster international trade and co-operation comes with fewer direct trade-offs. The region has already engaged heavily in international agreements; some key examples include:

- **ASEAN Trade in Goods Agreement (ATIGA):** ATIGA consolidated intra-ASEAN tariff liberalisation and has reduced tariffs on most intra-regional trade to zero, subject to rules of origin. Its relevance for clean energy technologies is that ASEAN-originating components, equipment and intermediate goods can move across the region with lower tariff friction. However, rules-of-origin compliance, customs procedures, standards and non-tariff measures remain a constraint.
- **ASEAN-China Free Trade Area (ACFTA) and Regional Comprehensive Economic Partnership (RCEP):** ACFTA was initiated in 2002 and developed and upgraded through agreements on trade in goods, services and investment between 200 and 2025. It helped anchor China-ASEAN

production networks before the most recent wave of clean technology investment into Southeast Asia. For clean technologies, ACFTA is best understood as an enabling framework: it reduced trade frictions and helped create an investment and production environment in which firms could combine inputs, machinery and know-how from China with ASEAN's industrial facilities. From 2022, this architecture was broadened through RCEP, which links ASEAN and China with Australia, Japan, Korea and New Zealand in a wider regional trade agreement.

- **Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP):** CPTPP provides an additional layer of trade integration for participating countries in the region (Brunei Darussalam, Malaysia, Singapore and Viet Nam). It links these economies with partners such as Australia, Canada, Japan and New Zealand – countries with significant know-how in clean energy technologies as well as energy and mineral resources.
- **ASEAN-Australia-New Zealand Free Trade Area (AANZFTA):** AANZFTA provides an ASEAN-wide framework with Australia and New Zealand. Australia is an important supplier of critical minerals and is developing ambitions in low-emissions hydrogen, ammonia and low-emissions metals.
- **ASEAN-Japan Comprehensive Economic Partnership and Japan's bilateral economic partnership agreements:** Japan-facing agreements are particularly important because Japanese firms are deeply embedded in Southeast Asia's automotive, machinery, electronics and power-equipment supply chains. These linkages provide a basis for collaboration on incumbent and emerging energy technologies.
- **US-ASEAN Trade and Investment Framework Arrangement (TIFA):** The US-ASEAN TIFA is a non-binding framework for dialogue on trade and investment. It provides a channel for discussion on trade facilitation, standards, regulatory co-operation, investment conditions and business links with the United States.
- **EU trade and investment agreements:** The European Union has concluded free trade agreements with Singapore and Viet Nam and is advancing further agreements in the region, including with Indonesia. These agreements matter for clean technologies because they combine market access with regulatory co-operation, sustainability requirements and alignment with EU product and supply chain requirements. The EU-Viet Nam Free Trade Agreement is relevant for export-oriented manufacturing and clean energy investment, while the EU-Indonesia Comprehensive Economic Partnership Agreement is particularly important for critical raw materials, batteries and clean technology supply chain diversification.

### **Box 5.1 Inheriting a solar industry born out of trade disputes**

Southeast Asia has been at the centre of a trade and industrial policy dynamic between China and the United States, whereby Chinese producers shifted production to Southeast Asian countries to avoid US import tariffs (see Chapter 2). While some view this as a negative example of production hopping between countries to dodge tariffs, it can equally be seen as the dynamic that made the region the world's second-largest solar PV producer after China.

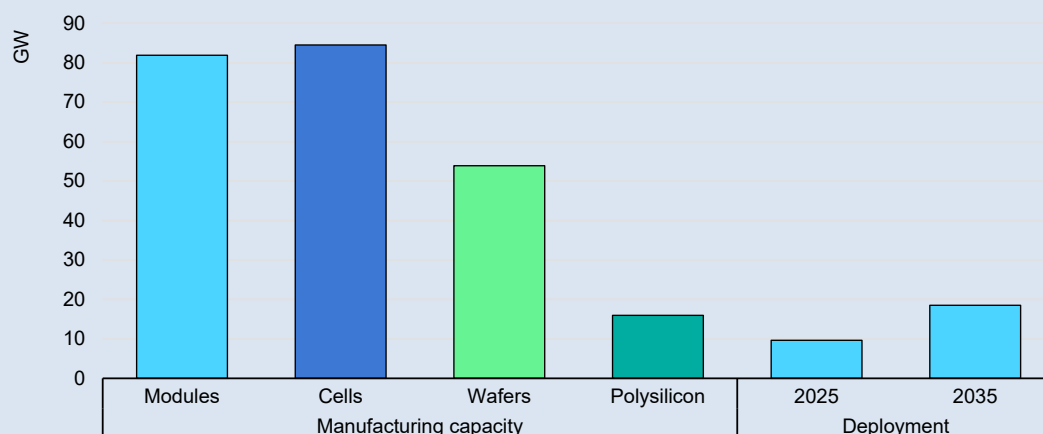
This supply chain triangle between China, ASEAN and the United States rested on a supportive co-operation architecture: ACFTA facilitated investment by China's most efficient producers, ATIGA integrated regional supply chains and built economies of scale, and good trade relations gave the region (non-preferential) access to the US market.

Solar PV is therefore not a model of homegrown industrial strategy: both the industry's rise and its retrenchment were largely determined by forces outside the region's control – the trade and industrial policy decisions of China and the United States. Even so, these frameworks helped Southeast Asian countries emerge as the main alternative to Chinese production.

The region now hosts the third largest solar module manufacturing capacity outside China – some 8 times local deployment and more than enough to cover 2035 demand under the Stated Policies Scenario. This capacity was built with minimal government spending or intervention in the economy and supported by local suppliers and a workforce skilled in panel production. As such, although exports to the United States have now all but disappeared, the region retains a large manufacturing base that is struggling to continue operating. However, this production capacity could be redirected to serve domestic demand or new export markets if there is a demand surge which could be linked to increased climate ambitions, or if more countries look to diversify their supply chains away from China.

The future of the industry will be determined by multiple factors that are beyond the control of the region's governments or individual companies. The region's manufacturing footprint is skewed towards downstream modules and cells – the minimum needed to avoid US barriers – leaving the region dependent on China for around 40% of wafers and around 70% of polysilicon.

### Solar manufacturing capacity and demand in Southeast Asia in the Stated Policies Scenario, 2025 and 2035



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Note: Manufacturing capacity refers to 2025.

## Co-operate with technology leaders

Some of the highest value addition in the global manufacturing industry is captured by technology leaders that can increase market share and command higher profit margins by providing new and better products to the market. Profitable technology companies can produce large volumes of products, thus continuously gaining manufacturing experience, and they can reinvest their profits to further advance the innovation frontier. Southeast Asia is a powerful manufacturing hub, but the region hosts relatively few companies operating at – or advancing – the technological frontier through R&D.

Governments have a direct role in supporting the development of such companies, including through public funding of R&D. However, allocating broader government financial support to cultivate domestic champions can be difficult when public finances are stretched, such as by the current energy crisis (see Chapter 1). Collaboration with global technology leaders in a specific sector can be a lower-risk strategy to gain local expertise and enable technology transfer, and one that does not entail large amounts of government financial support. Certain safeguards can help maximise the benefits of co-operation while minimising the risks of over-reliance on a single source of external investment. These include diversifying sources of investment, ensuring effective technology transfer, and retaining domestic control over critical physical and cyber infrastructure.

Countries in Southeast Asia have already gained much experience from initiating and participating in successful energy technology collaboration programmes. Some notable examples from which positive lessons may be drawn include:

- **Malaysia – solar PV: First Solar’s thin-film PV manufacturing cluster.** First Solar, a US-headquartered firm, established large-scale thin-film solar module plants in Malaysia in 2008, leveraging the country’s electronics industry base. By 2020, its Kulim site had grown to six advanced factories from a set of global manufacturers and local R&D centres, transferring modern PV manufacturing know-how to a Malaysian workforce of over 2 000 and making Malaysia one of the world’s largest PV exporters outside China.
- **Indonesia – batteries: Hyundai-LG-IBC electric car battery joint venture.** Hyundai Motor and LG Energy Solution, both Korea-headquartered firms, teamed up with the Indonesia Battery Corporation (IBC) to establish a joint venture that resulted in a battery cell factory in Karawang. Production of lithium-ion cells began in 2024 with an initial 10 GWh annual capacity. This joint venture brought advanced battery technology and manufacturing processes to Indonesia, creating local high-tech jobs and positioning the country as a major producer in Southeast Asia for electric car battery cells. Demand from this factory is now also attracting local anode and cathode production, making Indonesia one of the few countries in the world with an integrated battery supply chain.
- **Thailand – batteries: PTT-Gotion battery factory.** PTT, Thailand’s publicly owned energy company, and Gotion, a China-headquartered battery company, launched a joint venture that opened Thailand’s largest battery factory in late 2023. Located in Rayong, the plant started with relatively small-scale production of 2 GWh per year and is limited to battery pack assembly. It introduced advanced battery manufacturing to Thailand, helping the country move upstream in the electric car supply chain, while building up manufacturing experience within the local workforce in battery production.
- **Viet Nam – solar PV: Trina Solar’s integrated PV manufacturing.** Trina Solar, a China-headquartered firm, has built a fully integrated solar manufacturing complex in Thai Nguyen, covering advanced wafer, cell and module production. Commissioned in 2023 with a USD 203 million investment, the facility quickly doubled its workforce to 1 500 local employees and reached 6.5 GW wafer, 4 GW cell and 5 GW module capacity. This partnership of foreign capital and local resources has transferred valuable PV technology and skills to Viet Nam, as the facility is one of the few integrated solar PV manufacturing sites outside China.
- **Viet Nam – wind: CS WIND Viet Nam wind turbine towers.** CS WIND, a Korea-headquartered firm, established a manufacturing plant for wind turbine towers in Bà Rịa-Vũng Tàu, Viet Nam, in 2003. Over two decades, this facility has become a leading global supplier of heavy offshore turbine towers and in recent years has exported large 10 MW-class towers to projects abroad. The investment has fostered local engineering expertise and skilled jobs in wind component manufacturing, integrating Viet Nam into the international wind supply chain.

## Foster data availability and market transparency

Improving [data availability and market transparency](#) is critical to support more effective and timely decision making across clean energy supply chains. Over time, internationally harmonised energy statistics have enabled a shared understanding of energy markets, helping identify emerging imbalances and guide policy responses. A similar level of transparency is now needed for manufacturing and trade of clean energy technologies, which are increasingly central to energy security and industrial strategies. Efforts are underway in this area in a UK-led initiative that governments in Southeast Asia and elsewhere are welcome to engage with.

In Southeast Asia, gaps in data are particularly acute. Limited visibility on supply chain structures, firm capabilities, employment and investment trends constrains governments' ability to identify comparative advantages and attract investment. For companies and governments alike, these information gaps increase uncertainty and raise perceived risks, slowing decision making and weakening the efficiency of markets that are already highly exposed to external demand and global trade dynamics.

Key areas where improved transparency could deliver high value relative to the costs of collecting, processing and analysing data include:

- **Trade and industrial activity data:** Current classifications often do not distinguish clean energy technologies from other industrial products, making it difficult to track trade, investment and value added in sectors such as solar PV, batteries and wind. This limits the ability to assess policy impacts or monitor regional integration into global value chains.
- **Employment and skills data:** Limited information on workforce availability and capabilities makes it harder to align training with industry needs and to assess where local value creation can be strengthened.
- **Supply chain mapping and firm-level visibility:** In many countries, there is no comprehensive view of domestic industrial ecosystems, including suppliers, capabilities and relevant intellectual property, reducing the effectiveness of industrial policy and investment promotion efforts.
- **Cost, price and financial data:** Limited transparency on production costs, financing conditions and contract structures hinders benchmarking and makes it difficult to calibrate policy support or assess competitiveness.
- **Environmental and performance data:** Inconsistent data on lifecycle emissions and technology performance complicate certification, standard-setting and participation in international markets.

Strengthening data collection, standardisation and sharing – including through regional co-operation – would help Southeast Asian economies move from a reactive role in global supply chains towards more strategic positioning, improving

resilience, enabling more efficient investment and supporting broader economic benefits from the clean energy transition.

### **Box 5.2 Strengthening supply chains through data and co-ordination**

The United Kingdom has led efforts to tackle a persistent challenge across clean energy supply chains: the lack of timely, granular and comparable data. In 2025, it launched the [Supply Chains Mission under the Global Clean Power Alliance](#) to strengthen clean power supply chains through international collaboration and targeted policy action.

A central data pillar aims to improve the availability, quality and accessibility of supply chain data. Working with international partners, the United Kingdom has identified key gaps – production capacity, trade flows, investment trends and costs – and developed a structured approach to close them.

Potential actions under consideration include strengthening domestic co-ordination mechanisms, improving the mapping of data responsibilities across institutions and enhancing the use of administrative data from permitting, subsidy and industrial programmes. Internationally, partners are exploring opportunities to convene governments, organisations and experts through workshops and ministerial dialogues to align priorities, share best practices and improve data availability.

A key area under consideration is the promotion of [harmonisation and interoperability](#). As national datasets are often fragmented and not comparable, partners are exploring the use of common definitions, classifications and methodologies, including engagement with systems such as the Harmonized System, to enable consistent cross-country comparisons and better monitoring of supply chain risks and opportunities.

The initiative stresses the need to balance transparency with commercial sensitivity. Since firms have strong incentives to protect sensitive information, the initiative explores mechanisms such as aggregated reporting and confidentiality frameworks so that governments can access critical data without undermining competitiveness.

## Abbreviations and acronyms

|                 |                                                                       |
|-----------------|-----------------------------------------------------------------------|
| 2/3W            | two- and three-wheeler                                                |
| AANZFTA         | ASEAN-Australia-New Zealand Free Trade Area                           |
| AC              | air conditioner                                                       |
| ACFTA           | ASEAN-China Free Trade Area                                           |
| AD              | anti-dumping                                                          |
| AEs             | advanced economies                                                    |
| AI              | artificial intelligence                                               |
| AIPC            | Announced Industrial Policy Case                                      |
| APG             | ASEAN Power Grid                                                      |
| ASEAN           | Association of Southeast Asian Nations                                |
| ATIGA           | ASEAN Trade in Goods Agreement                                        |
| B50             | diesel blend containing 50% biodiesel                                 |
| BESS            | battery energy storage system                                         |
| BEV             | battery electric vehicle                                              |
| CAGR            | compound annual growth rate                                           |
| CAPEX           | capital expenditure                                                   |
| CARS            | Comprehensive Automotive Resurgence Strategy                          |
| CBU             | completely built-up                                                   |
| CCGT            | combined-cycle gas turbine                                            |
| CCUS            | carbon capture, utilisation and storage                               |
| CIT             | corporate income tax                                                  |
| CKD             | completely knocked down                                               |
| CNG             | compressed natural gas                                                |
| CO <sub>2</sub> | carbon dioxide                                                        |
| CPCA            | China Passenger Car Association                                       |
| CPS             | Current Policies Scenario                                             |
| CPTPP           | Comprehensive and Progressive Agreement for Trans-Pacific Partnership |
| CRU             | Commodities Research Unit                                             |
| CSPF            | cooling seasonal performance factor                                   |
| CVD             | countervailing duty                                                   |
| DOE             | Department of Energy                                                  |
| EEC             | Eastern Economic Corridor                                             |
| EIT             | energy-intensive industry                                             |
| EMDEs           | emerging market and developing economies                              |
| e-SAF           | electro-sustainable aviation fuel                                     |
| EU              | European Union                                                        |
| EV              | electric vehicle                                                      |
| FCEV            | fuel cell electric vehicle                                            |
| FDI             | foreign direct investment                                             |
| FID             | final investment decision                                             |
| FTZ             | free trade zone                                                       |
| GDP             | gross domestic product                                                |

|                 |                                                                             |
|-----------------|-----------------------------------------------------------------------------|
| GHG             | greenhouse gas                                                              |
| GOES            | grain-oriented electrical steel                                             |
| GT              | gas turbine                                                                 |
| HHI             | Herfindahl-Hirschman Index                                                  |
| HS              | Harmonized System                                                           |
| HVAC            | heating, ventilation and air conditioning                                   |
| IC              | integrated circuit                                                          |
| ICE             | internal combustion engine                                                  |
| IDR             | Indonesian rupiah                                                           |
| ISIC            | International Standard Industrial Classification of All Economic Activities |
| ITRPV           | International Technology Roadmap for Photovoltaics                          |
| LCOP            | levelised cost of production                                                |
| LED             | light-emitting diode                                                        |
| LFP             | lithium iron phosphate                                                      |
| LNG             | liquefied natural gas                                                       |
| LPG             | liquefied petroleum gas                                                     |
| MER             | market exchange rate                                                        |
| MRV             | monitoring, reporting and verification                                      |
| MVA             | manufacturing value added                                                   |
| MYR             | Malaysian ringgit                                                           |
| NO <sub>x</sub> | nitrogen oxides                                                             |
| NTM             | non-tariff measure                                                          |
| NZE Scenario    | Net Zero Emissions by 2050 Scenario                                         |
| NZIA            | Net-Zero Industry Act                                                       |
| OEM             | original equipment manufacturer                                             |
| OPEX            | operating expenditure                                                       |
| PCI             | Product Complexity Index                                                    |
| PHEV            | plug-in hybrid electric vehicle                                             |
| PHP             | Philippine peso                                                             |
| PPP             | purchasing power parity                                                     |
| PV              | photovoltaic                                                                |
| PVPS            | IEA Photovoltaic Power Systems Programme                                    |
| R&D             | research and development                                                    |
| RCA             | revealed comparative advantage                                              |
| RCEP            | Regional Comprehensive Economic Partnership                                 |
| RE              | renewable energy                                                            |
| RoW             | Rest of World                                                               |
| SAF             | sustainable aviation fuel                                                   |
| SAIDI           | System Average Interruption Duration Index                                  |
| SAIFI           | System Average Interruption Frequency Index                                 |
| SEZ             | special economic zone                                                       |
| SGD             | Singapore dollar                                                            |
| SME             | small and medium-sized enterprise                                           |
| SO <sub>2</sub> | sulphur dioxide                                                             |
| STEPS           | Stated Policies Scenario                                                    |

|        |                                                     |
|--------|-----------------------------------------------------|
| TFC    | total final consumption                             |
| THB    | Thai baht                                           |
| TIFA   | US-ASEAN Trade and Investment Framework Arrangement |
| UK     | United Kingdom                                      |
| UNCTAD | United Nations Conference on Trade and Development  |
| US     | United States                                       |
| USD    | United States dollar                                |
| VAT    | value-added tax                                     |
| VND    | Vietnamese dong                                     |
| WACC   | weighted average cost of capital                    |
| WTO    | World Trade Organization                            |
| ZEV    | zero-emissions vehicle                              |

## Units

|                       |                                   |
|-----------------------|-----------------------------------|
| °C                    | degrees Celsius                   |
| bcm                   | billion cubic metres              |
| DMT                   | dry metric tonne                  |
| EJ                    | exajoule                          |
| Gt CO <sub>2</sub>    | gigatonnes of carbon dioxide      |
| GW                    | gigawatt                          |
| GWh                   | gigawatt hour                     |
| kg                    | kilogramme                        |
| km                    | kilometre                         |
| kt H <sub>2</sub> -eq | kilotonne of hydrogen equivalent  |
| ktpa                  | kilotonnes per annum              |
| kW                    | kilowatt                          |
| kWh                   | kilowatt hour                     |
| mb/d                  | million barrels per day           |
| Mt                    | million tonnes                    |
| Mtce                  | million tonnes of coal equivalent |
| Mtpa                  | million tonnes per annum          |
| MVA                   | megavolt-amperes                  |
| MW                    | megawatt                          |
| MWh                   | megawatt hour                     |
| PJ                    | petajoule                         |
| tpa                   | tonnes per annum                  |
| TW                    | terawatt                          |
| TWh                   | terawatt hour                     |

See the [IEA glossary](#) for a further explanation of many of the terms used in this report.

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