# Southeast Asia Energy Outlook 2026

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# Abstract

The Southeast Asia Energy Outlook 2026 is the seventh edition of this World Energy Outlook Special Report, making Southeast Asia by far the most regularly updated regional outlook compiled by the International Energy Agency (IEA). This reflects the dynamism of the region, as well as the importance of the IEA's partnership with the eleven countries that make up the Association of Southeast Asian Nations (ASEAN) – Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Singapore, Thailand, Timor-Leste (joined ASEAN in 2025) and Viet Nam.

As energy security concerns move ever higher on the policy agenda, this year's report explores the trajectory that the region was on prior to the conflict in the Middle East, and discusses the potential implications of the energy crisis triggered by this conflict for policy priorities and investment strategies in the region.

# Foreword

The world has been facing the largest energy security threat in history as a result of the Middle East conflict. Many governments are reshaping their energy policies in response. Southeast Asia is among the regions most exposed to the energy impacts of the crisis, while also being one of the key economic centres that will drive future global growth.

Over the past two decades, Southeast Asia's economic expansion and rising energy demand have been underpinned by abundant and affordable domestic resources, mainly hydropower, coal and natural gas. However, the region's dependence on Middle Eastern oil imports has continued to rise: in 2024, the Middle East accounted for 60% of imported crude oil, or more than 35% of total crude oil supply when domestic resources are included, and around 45% of refined oil products in the region were derived from Middle Eastern crude. Governments acted quickly to cushion the immediate shock, but delivering a sustainable, affordable and secure energy system will require structural transformations of the region's energy supply.

Looking ahead, Southeast Asia alone accounts for 20% of the increase in global energy demand to 2035. By 2050, its energy demand is set to be more than three times Japan's current level. To meet this strong growth, policy makers face important choices about how to recalibrate energy policies in light of the vulnerabilities that have been revealed by the crisis. ASEAN countries differ widely in their stages of development, industrial structures, political systems, geography and energy needs, but diversification and stronger regional cooperation will be central to the response.

In 2025, the International Energy Agency (IEA) opened its Singapore Office, the first office outside its Paris headquarters in the Agency's history. This Southeast Asia Energy Outlook, started in 2013 and now in its seventh edition, reflects the IEA's deepening dialogue with ASEAN member states and industry stakeholders, as well as the Agency's objective data and analysis. Against the backdrop of the crisis, it aims to provide regional stakeholders with comprehensive data, insights and guidance.

This report is also the result of a strong collective effort across the IEA. Under the leadership of Tim Gould, Chief Energy Economist, an outstanding team worked with great expertise and dedication. I would like to express my sincere appreciation to all colleagues and partners, both inside and outside the IEA, whose expertise and support made this report possible.

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# Executive summary

# Executive summary

**Southeast Asia is a very dynamic region that is set to be a major driver of global energy demand growth, but the Middle East conflict has provided a stark wake-up call for the region's energy system.** Southeast Asia accounts for 9% of the world's population and 4% of its GDP, but nearly 20% of global energy demand growth to 2035 under today's policy settings. The disruption in global fuel markets has exposed deep structural vulnerabilities linked to import dependence, limited diversification and concentrated supply routes. Before the crisis, around 60% of Southeast Asia's imports of crude oil and a third of its imports of gas were coming from the Middle East, while 45% of its oil product supply were dependent on Middle Eastern crude. The resulting price shock is already feeding through to higher energy bills, inflation and mounting economic risk. The crisis is prompting a reassessment of policy and investment strategies amid a strong prioritisation of energy security. The exploratory scenarios included in this new *Outlook*, which reflect pre-crisis policy settings, show that the direction of travel for the region's energy sector does not adequately address the risks it now faces. A robust, collective response is required.

**For the moment, governments are focused on managing the short-term energy impacts of the crisis.** Measures include demand-restraint (such as promoting public transport and remote working), emergency interventions including price controls and subsidies, and efforts to secure alternative fuel supplies. Price controls and subsidies provide some protection for consumers but come at significant fiscal cost – especially when untargeted – and complicate market adjustments to the disruption. Fossil fuel subsidies in the region were around USD 40 billion prior to the crisis and are set to rise sharply in 2026. Looking further ahead, without structural change, the region's energy import bill could rise sharply from over USD 80 billion in 2024 to around USD 245 billion by 2035, further increasing exposure to global price volatility. By contrast, if the region were to reach its announced climate pledges, the fossil fuel import bill in 2035 would be around half this level. The challenge is therefore not only to manage the near-term impacts of the crisis, but also to accelerate the structural changes needed to reduce exposure to future shocks.

**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. Many Southeast Asian refineries are configured to process medium and heavy Gulf crudes, and the loss of these supplies has reduced operational flexibility, lowering utilisation rates and, in some cases, output. This dual reliance – on imported refined products and relatively inflexible refining configurations – is a structural weakness in the region's energy system and is already affecting downstream manufacturing, transmitting shocks through global supply chains. The loss of supplies from key Middle Eastern exporters has also tightened global liquefied natural gas (LNG) markets, increasing the cost of gas-fired generation and prompting fuel switching, including towards coal. These pressures are exposing the risks associated with import dependence and concentrated supply chains, including the growing reliance on LNG: gas use in the power sector is projected to rise by over 60% under today's policy settings even as domestic supply declines by one-third to 2050. The crisis may therefore spur efforts to diversify energy sources and buttress domestic supply in producing countries such as Indonesia, Malaysia and Thailand.

**A stronger and more co-ordinated regional response will be essential to address these challenges.** Enhanced cooperation across Southeast Asia can improve resilience, reduce costs and deliver shared benefits. In fuel markets, this includes opportunities to strengthen collective security through co-ordinated stockholding and emergency response arrangements. In power systems, expanding cross-border connections through the ASEAN Power Grid can help balance supply and demand, integrate renewable resources and improve system flexibility, lowering costs for all participating countries. Recent developments have also highlighted the importance of regional initiatives such as POWERR Asia, which can enhance collective preparedness and mitigate cascading disruptions across interconnected energy and industry systems.

**Diversification is now a central priority for Southeast Asia, with clean energy, electrification and efficiency as key levers to reduce import exposure and strengthen resilience.** Since 2015, investment in renewables, electrification and efficiency has already tempered growth in fossil fuel import requirements, saving the region around USD 30 billion in import costs in 2025. The crisis is reinforcing the attraction of renewables that can be developed cost-effectively at home, while aligning with longer-term transition pathways. Renewable capacity stood at 120 GW in 2024 and is projected to nearly triple by 2035 under today's policy settings or grow five-fold if announced targets are achieved. Early signs of additional momentum are visible in solar deployment: the Philippines became the second-largest destination for Chinese solar exports in the first quarter of 2026, with imports around three times higher than the same period in 2025. While large-scale projects take time to materialise, these developments signal a broader reorientation of energy strategies underway. Alongside renewables, greater use of domestic resources – including hydropower, geothermal and existing fossil fuel production – can also support diversification.

**Nuclear power remains a longer-term diversification option in Southeast Asia, but its role will depend on accelerating deployment and overcoming long lead times.** Non-fossil fuel baseload sources already play an important role in the region's power systems but remain unevenly distributed. Hydropower already supplies a significant share of electricity generation – reaching as high as 75% in Lao PDR, which also exports power to neighbouring systems – and remains central to system stability. Geothermal capacity, concentrated in Indonesia and the Philippines, is also set to expand, more than doubling over the next decade under today's policy settings. The most advanced nuclear plans are in Indonesia, Viet Nam and the Philippines, where governments are actively exploring deployment pathways and international partnerships, although timelines remain long and uncertain. Nuclear deployment could meet almost 10% of electricity demand growth to 2050 if announced targets are achieved.

**Coal is widely available in Southeast Asia and continues to play an important role in the energy system; it could see some upside from the renewed focus on energy security.** Coal accounts for around half of electricity generation, reflecting its availability and established role in supporting system adequacy. Indonesia is the dominant player in the regional coal market, accounting for nearly 90% of production and close to half of demand, while Viet Nam, Thailand and the Philippines also produce smaller amounts for domestic use. Across scenarios, the region's relatively young coal fleet continues to provide flexibility and backup capacity, including during supply disruptions such as the recent crisis, but it increasingly operates at lower utilisation rates as other sources expand. At the same time, coal use entails broader risks, including high levels of air pollution – which contributed to an estimated 330 000 premature deaths in 2024 – and emissions that are incompatible with achieving long-term climate targets.

**Alongside supply-side measures, energy efficiency is a cost-effective way to strengthen resilience in response to the crisis and in the longer term.** Governments have already turned to demand-side measures to rapidly reduce fuel use in response to the crisis, but these are increasingly being accompanied by structural measures – like building codes and the electrification of transport – to moderate future energy demand growth. There are huge opportunities for effective action: tighter performance standards for air conditioners – with stocks set to triple by 2035 – have already improved the efficiency of the average residential AC unit by around 40% since 2015. Implementing fuel economy standards for trucks could also play a major role in curbing road freight demand as the fleet expands by around 50% by 2050. There remains substantial untapped potential to further increase efficiency actions across the region in support of both short- and long-term policy goals.

**Electricity is becoming ever more important to Southeast Asia's energy future – electricity demand is already growing twice as fast as overall energy use.** Electricity makes up almost a quarter of total final consumption today and rises rapidly to 2050 across all scenarios: over the next decade alone, demand increases by an amount equivalent to Japan's total electricity generation today. Among established uses, cooling demand in buildings is the fastest growing, with the stock of residential air conditioners set to triple by 2035. Rapid growth in data centres is also creating new sources of electricity demand in several countries, reinforcing the need for timely investment in generation, grids and system flexibility. In industry, the electrification rate is already at a level comparable to that of the European Union.

**New uses of electricity are expanding and the shift to electric mobility, as well as bioenergy and low-emission transport fuels, could accelerate further in response to the crisis.** Electric vehicle (EV) sales more than doubled in 2025 to around half a million units, representing nearly 20% of sales. Fuel price spikes have prompted countries such as Viet Nam to expand EV incentives, highlighting the role of electrification in improving resilience. Southeast Asia also has the world's largest two- and three-wheeler fleet, with the electric share of sales projected to reach nearly 60% by 2035 under today's policy settings. Despite this momentum, oil demand in transport is still set to increase by 20% to 2035. Beyond electricity, bioenergy also plays a growing role in transport: biofuel blending already meets around 10% of road transport fuel demand – second only to Central and South America – and rises to around 15% by 2050. Singapore's position as the world's largest bunkering hub supports early adoption of alternative maritime fuels such as ammonia and methanol.

**The outlook for electricity supply and emissions is increasingly shaped by the pace at which renewables and other sources of low-emissions power can be scaled up.** Eight countries have economy-wide net zero targets including the region's largest power systems – Viet Nam and Indonesia. Both have mapped out long-term pathways in their national power plans to expand low-emissions generation, positioning them as key drivers of regional change. Wind and solar PV are at the forefront of this expansion, with several countries moving towards competitive procurement mechanisms: in 2025, almost 19 GW of renewable energy capacity were awarded through auctions. If announced targets are achieved, low-emissions sources provide around 50% of generation in 2035 and 90% in 2050. Coal and gas-fired power plants continue to play a role in all scenarios – supplying bulk electricity under scenarios based on current and stated policies, while pivoting more quickly to flexible operation under announced pledges.

**Delivering this transition depends on an efficient build-out and use of enabling infrastructure, particularly grids and storage.** Transmission and distribution networks need to more than double in length by 2050 to keep pace with rising demand and to cope with rising variability of supply and demand. Battery storage, demand response and other sources of flexibility, including existing thermal capacity, are essential for maintaining system reliability. Investment in grids and storage needs to ramp up, from USD 13 billion today to USD 50 billion in 2050 to meet announced pledges. To 2040, this includes an estimated USD 27 billion required to realise planned cross-border interconnections under the ASEAN Power Grid.

**Investment will be a key determinant of Southeast Asia's future energy security.** Clean energy investment has risen 60% since 2015, driving growth in total energy investment, which reached over USD 100 billion in 2025. However, at around 3% of global energy investment, this remains well below the region's 9% share in global population. Energy investment rises 35% over the next decade under today's policy settings and nearly doubles if announced pledges are met. Oil and gas spending is largely to stem declining output from existing fields. Investment in low-emissions power, electricity networks, storage and electrification of end uses rises across all scenarios.

**Financing conditions will be critical in determining whether required investment levels can be achieved.** The inflationary impacts of the energy crisis could result in higher interest rates which would push up financing costs, posing challenges for capital-intensive clean energy technologies. In much of Southeast Asia, where the cost of capital can be around twice as high as in advanced economies and China, this further weakens risk-adjusted returns and slows the pace of deployment of renewables, grids and energy efficiency measures, with implications for import dependence and system resilience. Mobilising sufficient investment, particularly to meet announced pledges, will depend on regulatory reforms and strong international public support to reduce costs of capital and to crowd in private finance.

**Southeast Asia's energy transition is closely linked to its role in global industrial and supply chains, particularly for critical minerals and clean energy technologies.** The region is among the world's fastest-growing hubs for energy-intensive aluminium, iron and steel production, with output rising by 70% by 2035. Aligning industrial development with energy transition and security goals will be crucial, both to capture the economic opportunities in clean energy manufacturing and to reduce exposure to concentrated supply chains. Countries such as Thailand and Indonesia are increasingly linking EV deployment with domestic manufacturing strategies. Indonesia is a leading global supplier of nickel, while Malaysia, Myanmar and the Philippines also hold significant mineral resources and processing capacity. Battery manufacturing capacity is set to more than triple by 2030, while EV production capacity could rise more than tenfold, driven by strong industrial policy and increasing foreign investment, including from China. This expansion is a major opportunity for further economic development and job creation, but also requires policies to ensure responsible resource development, well-sequenced infrastructure investments, and approaches that play to national and regional strengths in a co-ordinated way.

**Ensuring that the development of Southeast Asia's energy systems is fair and inclusive remains a central challenge.** While electricity access is close to universal in most countries, clean cooking access still lags, affecting 120 million people, or almost a fifth of the region's population. Energy affordability pressures are acute, particularly for lower-income households, and the costs of energy policies must be managed carefully. Changes in energy and industrial systems offer opportunities to create jobs, expand access and support economic development, building on successful examples such as the emergence of EV manufacturing hubs in Thailand and Viet Nam. Achieving these outcomes requires policies that balance emissions reduction, affordability and social inclusion, while ensuring that all people can participate in and benefit from the transition.

**The Middle East conflict is both a stress test of Southeast Asia's current energy system and a catalyst to accelerate structural change.** It has exposed persistent vulnerabilities, but current trends do not yet point to a commensurate shift in energy strategies, leaving the region exposed to future shocks. The central challenge is to bridge near-term crisis management with faster implementation of longer-term solutions, including through stronger regional cooperation. How Southeast Asia responds will be pivotal for its resilience and for the global energy system.

# Introduction

# Introduction

The *Southeast Asia Energy Outlook 2026* is the seventh edition of this regional study. The regular publication of this outlook by the IEA reflects both the region's rapidly evolving energy landscape and the deepening partnership between the IEA and the eleven member states of the Association of Southeast Asian Nations (ASEAN), which from 2025 has included Timor-Leste. The region today comprises Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Singapore, Timor-Leste, Thailand and Viet Nam.

Cooperation strengthened further with the opening of the IEA Regional Cooperation Centre in Singapore in late 2024, the Agency's first office outside Paris. The centre provides a platform for policy engagement, data and modelling collaboration, capacity building, and joint analytical work across the region. At the 2026 Ministerial Meeting in Paris, Viet Nam also became an Association country of the IEA, alongside Indonesia, Singapore and Thailand, marking another important step in expanding regional engagement.

The publication of this 2026 edition comes at a time of heightened volatility in global energy markets. After adjusting to the structural shifts caused by the coronavirus (Covid-19) pandemic and the Russian Federation's (hereafter "Russia") full-scale invasion of Ukraine in 2022, Southeast Asia has faced huge uncertainty from the conflict in the Middle East, which has disrupted supply flows and put pressure on fuel prices and trade, underscoring the region's continued focus on energy security and affordability.

At the same time, climate change is an increasingly pressing concern across Southeast Asia. Eight out of the eleven ASEAN countries have announced net zero emissions targets, generally conditional on international support, and all have collectively committed to scale up renewable energy, improve efficiency and enhance resilience. The question facing policy makers is whether today's shocks and uncertainty will accelerate or delay progress towards these goals.

This *Outlook* examines three scenarios, none of which is a forecast. These scenarios do not reflect policy changes that may result from the energy crisis, which will become clearer only with time, but they provide a valuable frame of reference for the region's possible energy trajectories prior to the conflict. They provide a consistent basis to explore the implications of different policy pathways, and the changes that may now be necessary to tackle the risks and vulnerabilities that the crisis has revealed:

- The Current Policies Scenario (CPS) reflects only those measures already embedded in existing laws and regulations. It is not a "business as usual" pathway, but this scenario assumes that constraints, such as limited infrastructure, financing, or policy support, slow the deployment of new and emerging technologies.

- The Stated Policies Scenario (STEPS) assesses how Southeast Asia's energy sector could develop based on existing and announced policy measures, including energy, climate, industrial and financial policies. It incorporates these policies only to the extent that they are backed by concrete implementation plans, providing a grounded view of the region's prevailing direction.
- The Announced Pledges Scenario (APS) assumes that all national targets, including updated Nationally Determined Contributions (NDCs) and net zero emissions pledges, are achieved in full and on time. It outlines a pathway consistent with governments' stated ambitions, while recognising the gap between these commitments and current measures.

The *Southeast Asia Energy Outlook 2026* opens with a review of current energy trends and policies, followed by chapters presenting the two core analytical pillars: projections based on today's policies (CPS and STEPS) and pathways aligned with national targets (APS). The final chapter brings these strands together by examining key challenges facing ASEAN energy systems – from improving reliable energy access and air quality to strengthening supply chains and creating jobs. It also considers the implications of the Middle East crisis, including strategies to reduce reliance on imported fuels, the potential role of nuclear power, and the investment and financing needed to build a secure and sustainable energy future.

# Energy in Southeast Asia

# Special note

## Having long relied on Middle Eastern crude oil, the energy crisis has tested Southeast Asia's energy system, triggering short-term responses and exposing the need for structural measures

Southeast Asia's energy system remains closely linked to the Middle East. Prior to the crisis, around 60% of crude oil imports and a third of natural gas imports originated from the region.

With refining capacity of around 5.4 million barrels of oil equivalent per day (mboe/d), Southeast Asian refiners supply almost 60% of the region's refined products, providing some buffer against disruptions in refined product markets. However, this resilience is constrained by continued dependence on Middle Eastern crude, which accounts for a substantial share of refinery feedstock. When both direct imports and indirect exposure through refined product trade are considered, the region's overall dependence on Middle Eastern supply is clearly significant.

The crisis has already had pronounced impacts on energy security and affordability in Southeast Asia. Fuel prices have surged across the region, particularly for transport fuels, contributing to broader inflationary pressures on essential goods. Lower-income households and informal workers have been disproportionately affected, reflecting their higher vulnerability to energy costs and limited capacity to absorb price increases.

Several Southeast Asian governments were among the earliest globally to act. They implemented a wide range of demand-side and short-term measures to curb consumption and ease affordability pressures, including restrictions on vehicle use, promotion of remote working and flexible schedules, and mandated reductions in energy use for large industrial and commercial consumers. Public sector measures, such as limiting official travel and reducing non-essential energy consumption in government buildings, have also been deployed.

These efforts have been made in conjunction with price-support measures. Many governments have reduced taxes on energy products or introduced temporary subsidies along with targeted interventions such as cash transfers, public transport fare reductions and tax exemptions. In some cases, price caps and subsidised public transport have been introduced to cushion impacts on households. While these interventions have helped mitigate the immediate economic and social impacts, they have also added to fiscal pressures, highlighting not only the limits of short-term responses but also the need for more durable structural measures.

The crisis will also have lasting implications for future energy demand and supply trends in Southeast Asia. While these effects are not incorporated into the Global Energy and Climate Model scenario projections presented in Chapters 2 and 3, the crisis and its broader implications are examined in detail in Chapter 4.

# Today's energy trends

# Southeast Asia's energy system remains dominated by fossil fuels – particularly coal – even as renewables grow rapidly alongside rising overall demand

Southeast Asia remains one of the world's fastest-growing economic regions, generating around 4% of global GDP in 2024. Since 2015, it has accounted for 10% of global energy demand growth, driven by expanding industrial, transport and power sectors, underpinned in part by rising incomes and population growth. Despite global economic headwinds and energy market disruptions, the region's economy expanded by around 4% per year over the past decade.

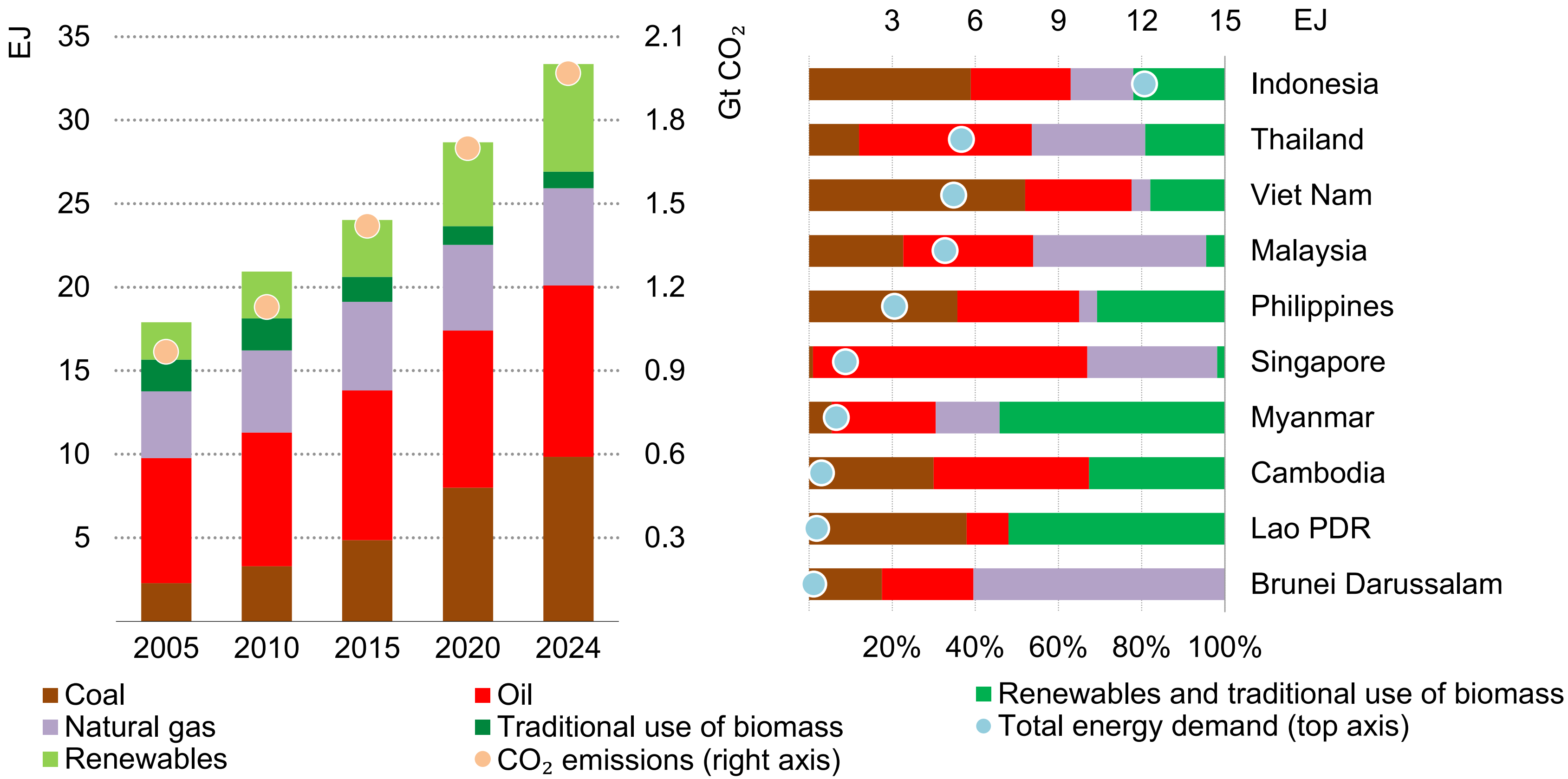
Total energy demand is now 40% higher than in 2015, growing by 4% per year on average. This increase has been met largely by fossil fuels, supplying over 70% of additional demand since 2015. As a result, energy-related $CO_2$ emissions also rose by 4% per year. The use of all major energy sources expanded, except for the traditional use of biomass. Coal was the fastest-growing major energy source, with demand rising by 8% per year, increasing its share in the energy mix from 20% in 2015 to 30% today. Renewables followed as the second-fastest, growing at 7% per year, with solar PV and wind expanding particularly rapidly at around 35% per year, albeit from a low base. Modern bioenergy, hydropower and geothermal remain dominant, accounting for over 95% of total renewable energy supply in 2024. However, new projects and policy momentum are supporting further diversification into solar PV and wind, especially in Viet Nam, the Philippines and Thailand.

Indonesia remains the region's largest coal producer, accounting for nearly 90% of output, followed by Viet Nam. Both countries have increased coal consumption alongside power sector expansion. Oil demand has risen on average by 1.5% per year since 2015 to 5 mb/d. Indonesia, Malaysia and Thailand remain major oil producers in the region. However, as total regional output has declined by around 40% since its peak in the 1990s, crude oil imports have therefore risen to over 30% above 2015 levels, increasing exposure to price volatility and external supply risks. Natural gas continues to play a central role, comprising around one-fifth of Southeast Asia's energy mix. In 2024, gas consumption saw one of the largest annual increases in a decade. The region was once a major net exporter, with Indonesia and Malaysia among the world's largest LNG suppliers. However, since 2015, production has declined slightly while demand has grown by around 1% per year, tightening the regional trade balance.

Energy trends across Southeast Asian countries vary widely, reflecting different resource endowments, economic structures and policy priorities. For example, while Cambodia and Lao PDR are both lower-income countries experiencing rapid energy demand growth, Cambodia's energy demand has been met mainly through fossil fuels, while Lao PDR has relied heavily on hydropower.

# Energy demand and $CO_2$ emissions have risen steadily in Southeast Asia over the past 20 years

Total energy demand by fuel (left) 2005-2024 in Southeast Asia and by country (right), 2024






Note: EJ = Exajoules. Gt $CO_2$ = gigatonnes of carbon dioxide. Data not available for Timor-Leste. Further details for each country can be found on the IEA website.

## Industrial expansion is powered by coal and electricity, while growth in the transport sector is fuelled by oil, and the buildings sector is turning to electric appliances for cooking and heating

Energy consumption in Southeast Asian end-use sectors increased by nearly 4.5 EJ from 2015, led by industry and transport. Total final consumption increased by around 2.5% per year, equivalent to the pace of growth seen in Brazil a decade prior, making Southeast Asia one of the fastest-growing energy consumers globally.

**Industry** is the largest end-use sector in the region, accounting for around 45% of total final consumption. It has also been the main driver of energy demand growth since 2015, rising by 35% to reach 9 EJ in 2024. The growth has been led by non-energy-intensive industries and non-ferrous metals, such as aluminium, whose production doubled from 2015 to 4 Mt. Energy demand for non-ferrous metals – especially nickel – increased six-fold over the same period, with Indonesia accounting for 90% of this growth and nearly 20% of regional aluminium production today. Viet Nam led growth in energy demand for cement and iron and steel, while its non-energy-intensive industries (textile, leather, food and tobacco) were also large consumers. Expanding manufacturing activity has driven sharp increases in industrial coal and electricity demand – up almost 90% and 75%, respectively, over the past decade – while natural gas demand rose by 45%. Although oil demand increased mainly in the chemicals sector in Singapore, declines elsewhere, mostly in non-energy-intensive industries, resulted in a net 10% fall in industrial oil consumption. Industry has also been a major contributor to regional GDP growth, as Southeast Asia builds on its existing manufacturing base, integrating itself into global value chains. Non-energy-intensive industries accounted for more than a quarter of regional GDP growth over the past decade, while value added from iron and steel more than doubled. However, rising global trade barriers and increasing fragmentation pose risks to sustaining this pace of growth.

**Transport** is the main driver of rising oil demand in Southeast Asia. Oil use in total final consumption increased by 10% from 2015 and now accounts for around 45% of energy demand in the region's end-use sectors. Transport energy demand rose by 30% over the past decade to nearly 6.5 EJ in 2024, with road transport alone accounting for over half of the region's 5 mb/d of oil demand. This growth has been driven mainly by rising road freight activity, underpinned by rapid economic growth, manufacturing expansion and limited alternatives such as rail. As a result, heavy-duty truck tonne-kilometre activity has risen 55% from 2015 and now represents the bulk of the nearly 2.5 trillion road freight tonne-kilometres in 2024. Rising incomes and limited public transport have further boosted transport energy demand, with car ownership increasing from 60 cars per 1 000 people in 2015 to 80 in 2024. The region's rapidly expanding two- and three-wheeler fleet – the largest globally – is integral to meeting mobility needs, accounting for half of all passenger-kilometres in 2024, a higher share than in any other major economy. Oil has fuelled 75% of transport energy demand growth since 2015, with most of the remainder met by bioenergy, reflecting Indonesia's biodiesel supply boom; the country accounts for 70% of Southeast Asia's transport bioenergy demand and is the world's second-largest biodiesel consumer after the United States. Electricity demand in transport, while still modest, has doubled since 2015 due to rapid growth in electric car sales, with nearly one in five cars sold in the region being electric in 2025. This expansion has been supported by policy incentives, shifting consumer preferences and the availability of affordable models from Chinese and domestic automakers. In Viet Nam, electric car sales more than doubled between 2024 and 2025 to reach nearly 180 000. By contrast, electric truck sales remain negligible. Electric two- and three-wheelers account for around 6% of sales, offering major potential for further electrification given their cost competitiveness and prominence in the region.

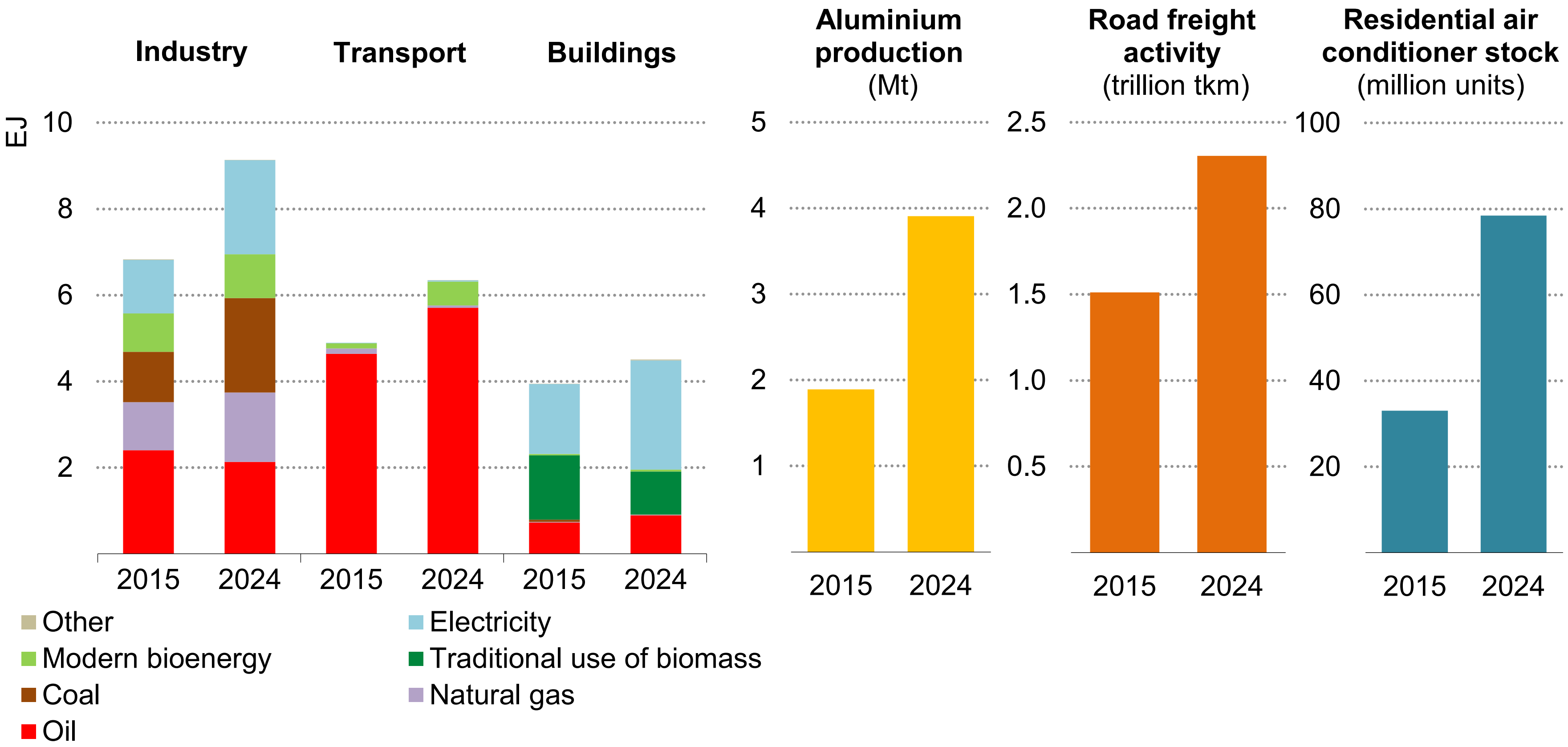
**Buildings** energy demand has been shaped by rising incomes, rapid urbanisation, and expanding access to electricity and clean cooking, reaching a total demand of 4.5 EJ in 2024. The region has made substantial progress in electricity access, rising from 86% in 2015 to 97% today, with more than 40% of the population in Cambodia and Myanmar gaining access over this period. Access to clean cooking also improved, rising from 63% to 83%, reducing demand for the traditional use of solid biomass in buildings by one-third. More than 40% of the population in Cambodia and 35% in Myanmar gained access to clean cooking over the past decade, while Viet Nam achieved universal access in 2023. Progress slowed during the 2022 energy crisis, however, and clean cooking access in Malaysia declined by 10 percentage points compared with 2015.

Despite these gains, the traditional use of biomass still accounts for one-fifth of buildings energy demand, with oil products making up another fifth. Oil use has expanded since 2015, driven mainly by rising liquefied petroleum gas (LPG) use for cooking and, to a lesser extent, water heating. LPG demand in buildings has grown around 30% over the past decade to reach 0.5 mb/d, with more than half concentrated in Indonesia, where over 90% of the population relies on LPG as the primary cooking fuel. Across Southeast Asia, buildings LPG consumption per capita has risen 20% since 2015, with roughly 75% of the population using LPG for cooking. Malaysia, Indonesia and Thailand have the highest per capita consumption levels. The region is increasingly dependent on LPG imports, with the Middle East remaining one of its main suppliers.

Rising ownership of appliances – especially to satisfy increasing cooling needs driven by more frequent heatwaves – has made electricity the main energy source in buildings. Electricity demand increased by around 250 TWh over the past decade, a rise comparable to that seen in industry. Since 2015, the share of households owning an air conditioner has doubled, while overall ownership of washing machines increased by one-third and refrigeration ownership by 20%.

# Energy demand growth across end-use sectors was fuelled by electricity, coal and oil, driven by growth in the non-ferrous metals industry, freight activity and cooling needs

Total final consumption in Southeast Asia by sector and fuel (left), 2015 and 2024, and main energy demand growth drivers (right), 2015 and 2024

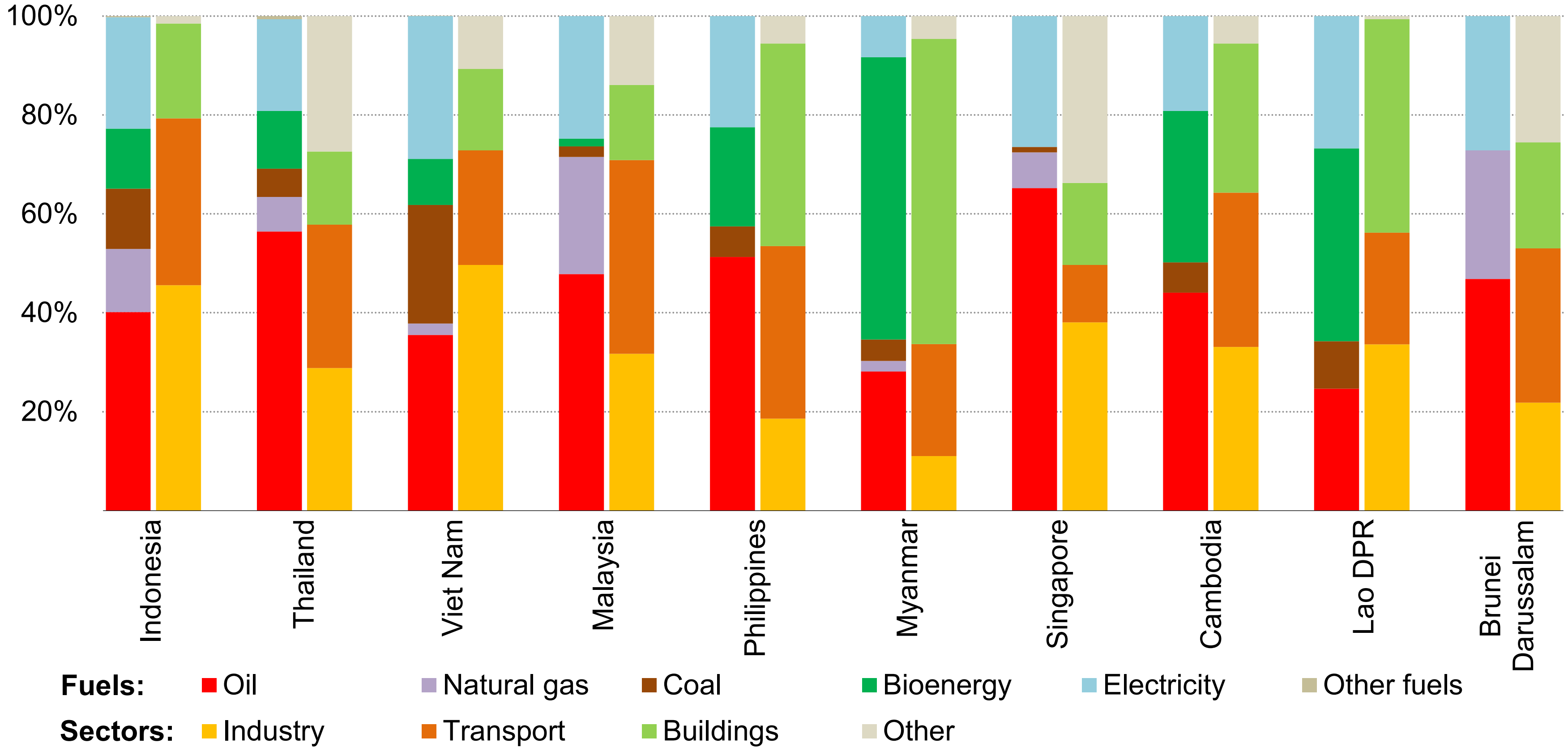





Notes: International aviation and shipping are excluded. 'Other' includes geothermal, solar thermal, district heating and non-renewable waste. EJ = exajoule. Mt = million tonnes; tkm = tonne-kilometres.

## In most Southeast Asian countries, oil is the dominant fuel in total final energy consumption while energy use across end-use sectors varies widely

Total final consumption mix by fuel and in end-use sector in Southeast Asia, 2024






Notes: International aviation and shipping are excluded. Data not available for Timor-Leste. 'Other fuels' include solar thermal and geothermal used directly in end-use sectors. 'Other' includes agriculture and other non-energy use. Countries are in order of largest to smallest total energy consumption.

## The region's electricity demand has surged since 2015, driven by appliances, space cooling and non-energy-intensive industries, and now makes up more than a fifth of final energy use

Electricity demand in Southeast Asia has grown rapidly at an average annual rate of 6% since 2015 – nearly twice the global average, and well above overall regional energy demand growth of 4% per year. Total electricity demand now exceeds 1 300 TWh, accounting for more than 20% of total final consumption. Electrification is rising across the region, with electricity making up around 30% of total final consumption in Viet Nam and Brunei Darussalam, the countries with the highest shares in Southeast Asia.

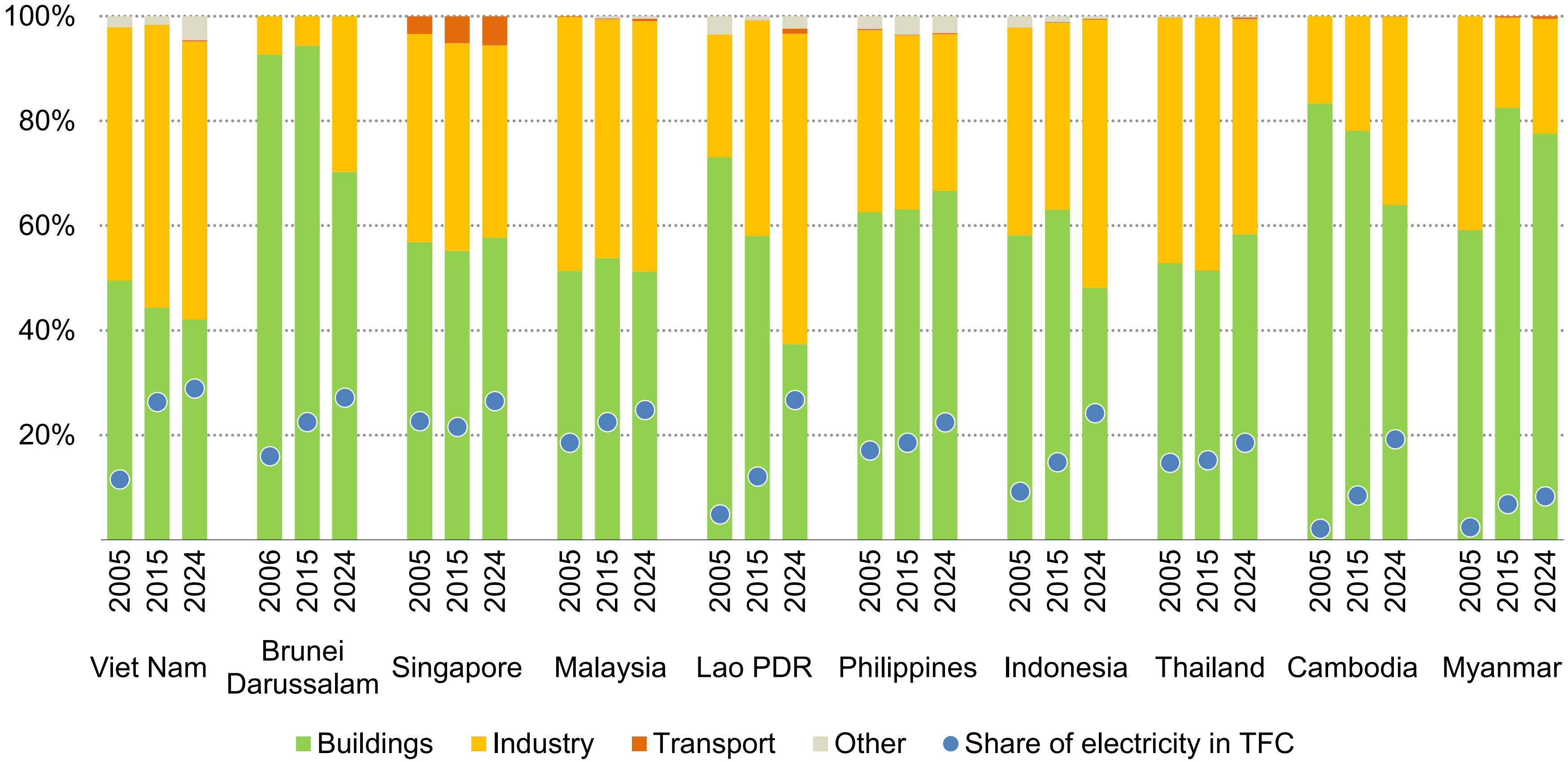
While industry and transport dominate total energy demand, electricity demand is concentrated in **buildings**. In households, rising incomes and population growth are driving appliance uptake. Since 2015, refrigerator and freezer ownership has risen by 40% to nearly 120 million, while washing machine ownership has grown by 50% to 90 million. As a result, residential appliances now consume around 200 TWh per year, almost 60% more than in 2015. Space cooling demand has been an important driver of growth, with electricity use doubling since 2015 and now accounting for over 10% of regional electricity demand. Almost 30% of households in the region own an air conditioner (AC), although the ownership rate ranges from around 80% in Singapore and Brunei Darussalam to around 5% in Myanmar. High cooling needs reflect the region's hot, humid climate, with average cooling degree days exceeding 2 000 per year and temperatures rarely dropping below 20 °C.

**Industry** is a major and growing source of electricity demand in Southeast Asia as output expands and processes electrify. In Indonesia, for example, industrial electricity demand has nearly tripled since 2015. Growth has been particularly strong in light industries, such as food processing and textiles, reinforcing Southeast Asia's position as a regional manufacturing hub. Across the region, electricity consumption in non-energy-intensive industries has nearly doubled since 2015, while their direct use of coal and oil has declined, indicating a shift to electrified processes. These industries account for more than 40% of the electricity demand growth over this period.

Electricity use in **transport** remains modest, at around 7 TWh today, but is growing quickly. Singapore leads the region in the electrification of transport, where electricity accounts for more than 15% of its transport energy demand, mainly due to its fully electrified rail network. Despite transport's small overall electricity share, electric vehicles (EVs) are gaining momentum. It is estimated that in 2025, EVs accounted for around 40% of new vehicle sales in Singapore and Viet Nam, up from around 20% and 10% in 2023, respectively.

# Electricity use is rising across the region, driven mainly by industry and buildings, while Singapore is leading the emerging electrification of transport

Electricity consumption shares by end-use sector and by country in Southeast Asia, 2005-2024






Note: Lao PDR = Lao People's Democratic Republic. TFC = Total final consumption. Brunei Darussalam shows 2006 instead of 2005 due to data availability. No data available for Timor-Leste. 'Other' includes agriculture and other non-energy use.

## Electricity generation in Southeast Asia has increased 60% since 2015, with coal driving most of the growth, but hydro and, more recently, wind and solar PV have gained larger shares

Electricity generation in Southeast Asia nearly doubled between 2005 and 2015 and increased by a further 60% between 2015 and 2024, reaching 1 457 TWh in 2024. Indonesia remains by far the region's largest electricity producer, while Cambodia, Lao PDR and Viet Nam have recorded some of the fastest growth in output over the past decade. Over the same period, the length of the region's transmission and distribution grids increased by 60%.

Coal has underpinned most of this expansion. Coal-fired electricity generation increased from 338 TWh in 2015 to 691 TWh in 2024, growing by more than 8% per year on average and lifting coal's share of regional generation from around 37% to 47%. In 2024, coal accounted for around 70% of generation in Indonesia and almost two-thirds in the Philippines, while its share was about 45% in Malaysia and nearly 50% in Viet Nam.

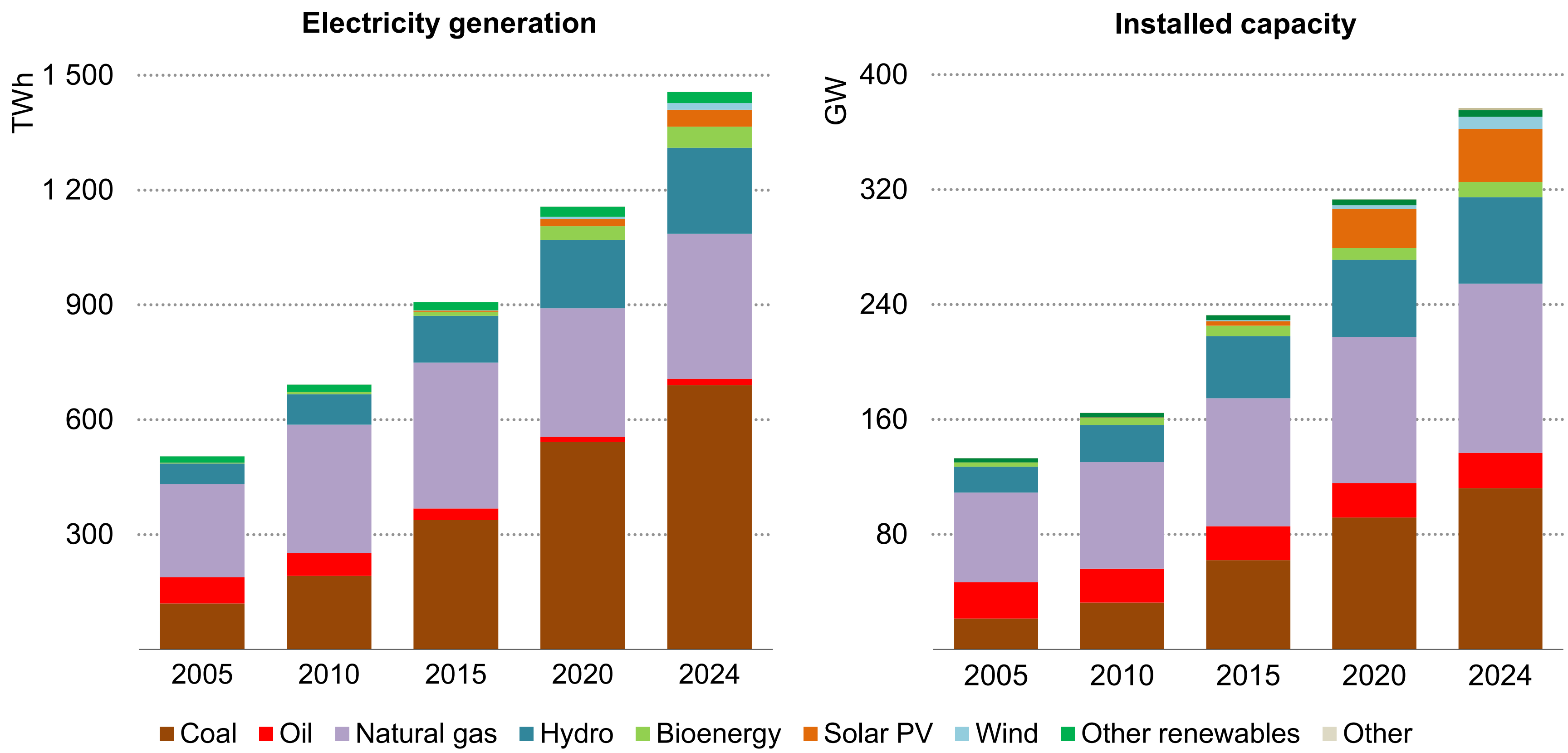
Natural gas-fired generation remained broadly stable in absolute terms, at about 380 TWh in both 2015 and 2024, while gas-fired capacity increased by around one-third to 118 GW, indicating that gas plants are increasingly used to provide flexibility. The share of gas in the power mix fell from about 42% in 2015 to 26% in 2024. Gas nevertheless remains central to several power systems in the region, providing almost all generation in Singapore and about two-thirds in Thailand, while continuing to play an important balancing role elsewhere. Oil, by contrast, has steadily lost ground, with generation falling from about 30 TWh in 2015 to 17 TWh in 2024 and its share of supply dropping from around 3% to about 1%.

Hydropower generation increased from 122 TWh in 2015 to 225 TWh in 2024 as installed capacity rose from about 43 GW to 60 GW. Its contribution to the regional mix edged up from 13% to 15%, and hydro remains a critical component of the electricity supply of Viet Nam, the Lao PDR and Myanmar. In the Lao PDR in particular, it underpins its export-oriented electricity sector. Hydro also plays an important role in Malaysia, Indonesia, Cambodia and the Philippines.

While coal, gas and hydro continue to dominate most power systems across the region, there has been an increase in the share of variable renewables – wind and solar PV – in the region's electricity mix. Their combined installed capacity exceeded 45 GW in 2024, up from 4 GW in 2015. Solar PV generation rose from 3 TWh in 2015 to 44 TWh in 2024, while wind increased from 1 TWh to 18 TWh, bringing their combined share to just over 4% of regional generation. Viet Nam remains the largest producer, with solar and wind contributing nearly 40 TWh in 2024, but deployment is broadening across the region. Solar and wind accounted for around 13% of generation in Viet Nam, close to 6% in Cambodia, about 4% in Thailand and the Philippines, and about 3% in Malaysia and Singapore.

# Though renewables capacity has grown significantly over the past 10 years, electricity demand growth has been met mostly by coal, which now accounts for nearly 50% of the electricity mix

Electricity generation (left) and installed electricity generating capacity (right) in Southeast Asia by source, 2005-2024

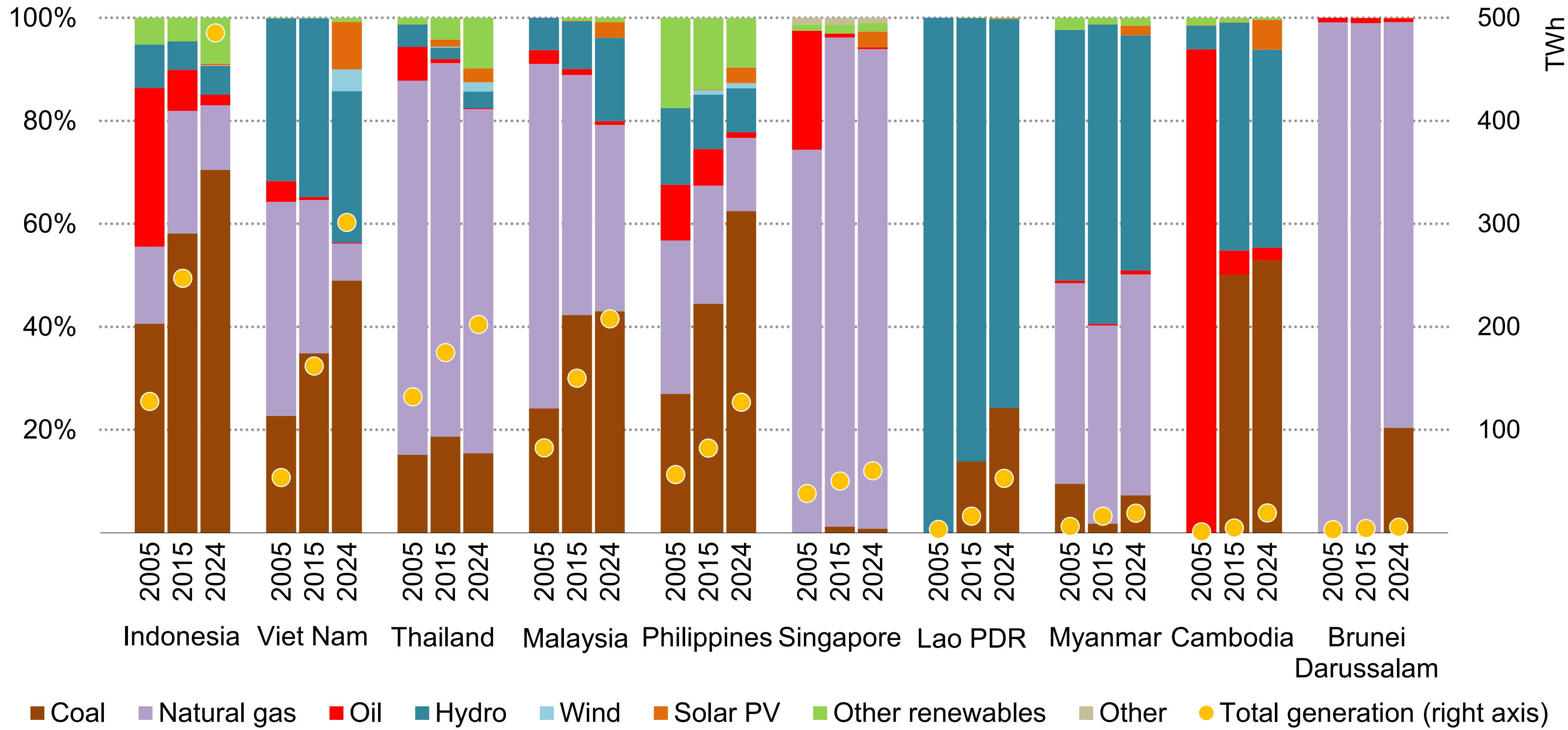





Notes: TWh = terawatt-hours. GW = gigawatts. 'Other renewables' includes geothermal, concentrating solar power and marine power. 'Other' includes non-renewable waste and other sources.

# Rapid electricity demand growth has seen Indonesia and Viet Nam become Southeast Asia's largest electricity markets, with coal playing a major role in both economies

Electricity supply mix and total electricity generation in Southeast Asia by country, 2005, 2015 and 2024






Notes: TWh = terawatt-hours. 'Other renewables' includes bioenergy, geothermal, concentrating solar power and marine power. 'Other' includes non-renewable waste and other sources. No data available for Timor-Leste.

## Energy investment in Southeast Asia is rising as the region adopts a more diversified set of technologies and fuels to meet growing energy demand

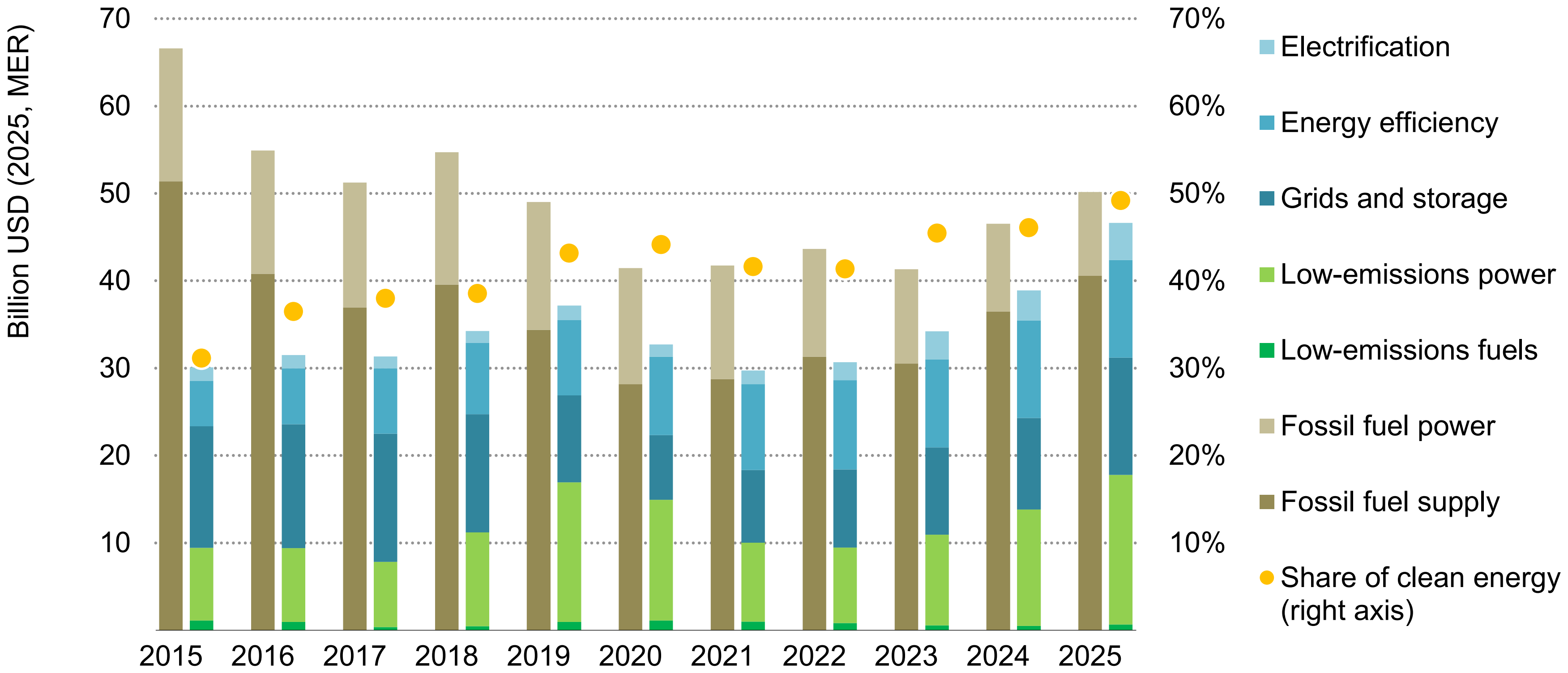
Since the 2024 Outlook, annual energy investment has risen by 30% to over USD 100 billion in 2025. While this is one of the fastest growth rates globally, Southeast Asia still accounts for only around 3% of global energy investment, well below its shares of global energy demand (5%) and population (9%). Around 50% of this growth is driven by renewables, grids and storage, end-use efficiency and electrification. Renewable energy investment is estimated to have reached USD 17 billion in 2025, surpassing the previous peak in 2019, which was primarily driven by rapid solar deployment in Viet Nam. Today, the investment mix is more diversified, with growth across solar, hydropower, wind and geothermal technologies. In the Philippines, recent auctions awarded 10.2 GW of solar, wind and storage capacity, with a further 3.3 GW of offshore wind auction underway. Corporate power purchase schemes have provided new avenues for contracting renewables in Malaysia and Viet Nam, while Thailand is expected to launch a 2 GW direct purchase power agreement (PPA) pilot for data centres in 2026.

Grid investment reached USD 12.4 billion in 2025 and is increasingly prioritised in national power development plans. However, long development timelines and complex permitting processes mean grid spending has not kept pace with investment in power generation and remains below 2015 levels. Supply chain pressures continue to constrain delivery, with lead times for cables and large power transformers doubling since 2021. Investment in battery energy storage systems (BESS) has risen markedly since 2015, including a threefold increase over the last two years, reaching over USD 550 million in 2025. Malaysia's first large-scale BESS project has entered operation, while Indonesia's first utility-scale co-located solar and BESS project has reached financial close. Electrification is also shaping investment trends. Driven by rapid uptake of EVs – notably in Viet Nam and Thailand – spending on EVs and charging infrastructure has increased more than twenty-fold over the past five years alone. Meanwhile, investment in energy efficiency, such as for improvements to building envelopes, has grown more gradually, reaching USD 11 billion in 2025.

Fossil fuels still account for just over half of energy investment, similar to other developing regions. A quarter of total spending is related to natural gas. While gas supply investment remains 10% below its level in 2015, it has rebounded in recent years, rising by 25% from 2024 to 2025. This includes a 50% increase in LNG investment to around USD 6 billion, mainly for regasification terminals, alongside higher spending to offset declining production from existing fields. Investment in oil supply is down 45% from 2015, but has recovered somewhat since 2019, while coal supply investment has remained broadly stable. By contrast, investment in fossil fuel power generation has been in steady decline since 2018.

# Investments in renewable power, grids and end uses reached new highs in 2025 while fossil fuel investments recovered towards pre-pandemic levels

Energy investment in Southeast Asia by sector, 2015-2025






Note: Low-emissions fuels = modern bioenergy, low-emissions hydrogen-based fuels, and fossil fuels with carbon capture, utilisation and storage. MER = Market Exchange Rate.

# Factors affecting energy development

## Rising energy demand is underpinned by continued urbanisation and strong GDP growth, driven by an expanding services sector

Southeast Asia is home to a dynamic group of countries, with diverse demographic and economic trends that underpin the region's energy demand trajectory. Over the past decade, the region has seen an average annual increase in gross domestic product (GDP) of nearly 4%, a strong pace broadly in line with that of emerging market and developing economies (EMDE) worldwide. Viet Nam experienced the fastest GDP growth among the Southeast Asian countries over this period, averaging 6% per year, followed by Cambodia, where growth exceeded 5% annually. GDP per capita varies widely across the region. In Singapore, it is more than six times the global average, and in Brunei nearly four times. By contrast, GDP per capita in Timor-Leste and Myanmar is less than one-quarter of the global average.

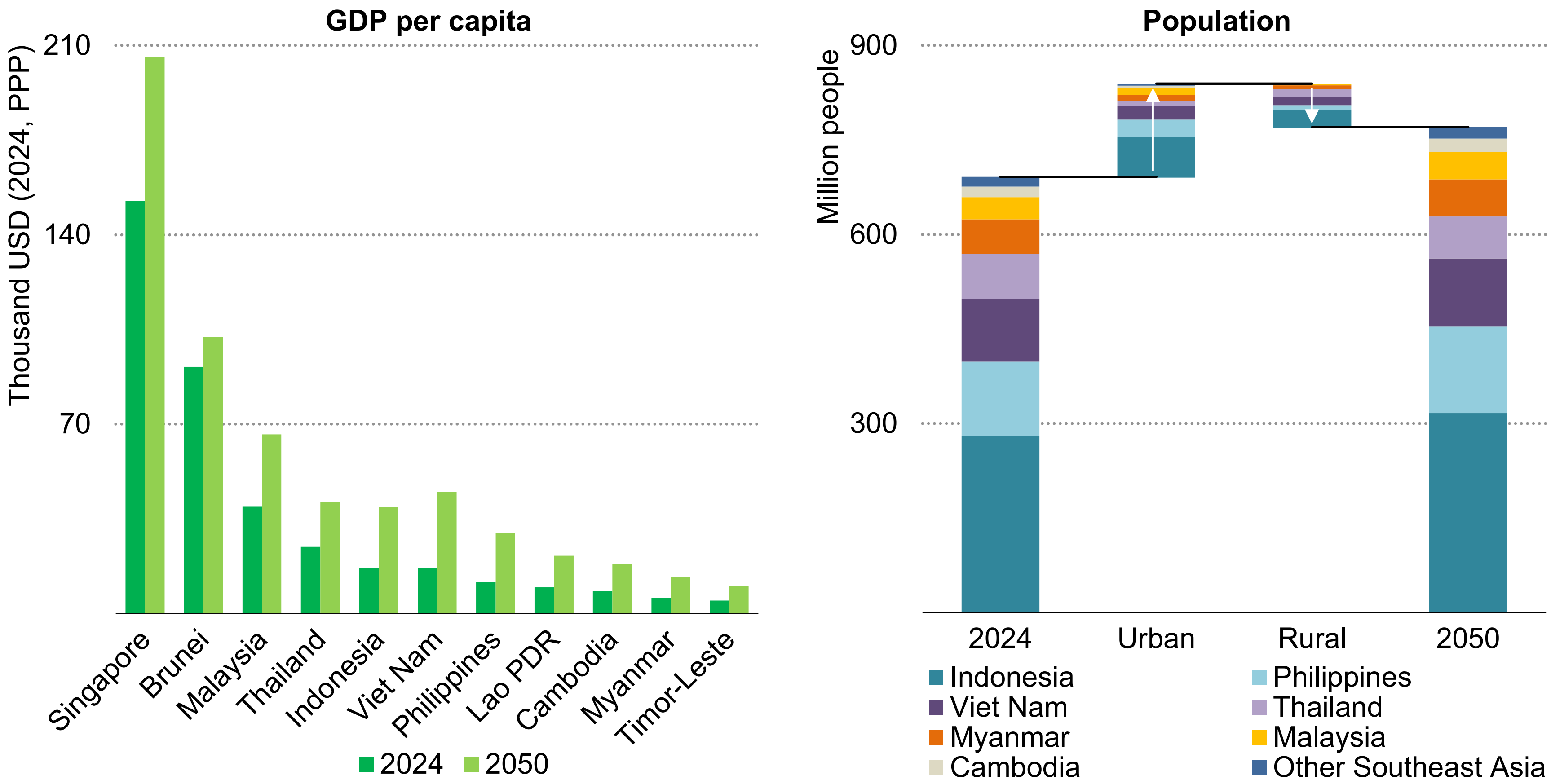
Services account for over half of the region's GDP – and as much as three-quarters of economic output in Singapore – making them the dominant driver of economic activity across Southeast Asia. The region continues to shift towards a more service-oriented economy, with the share of services in GDP rising to nearly 60% by 2050. At present, most of the remaining GDP comes from industry, although some countries retain substantial agricultural sectors, notably Lao PDR and Myanmar, where agriculture represents over 20% of economic activity. While the Middle East crisis may constrain near-term prospects, Southeast Asia's economy is projected to more than double by 2050, maintaining an average annual growth rate of 3.5%, compared with a projected global average of 2.6%.

Southeast Asia's population has grown at an average annual rate of 0.9% since 2015. Indonesia, with a population of around 280 million people, accounts for 40% of the region's population and has grown by 20 million since 2015. The Philippines is the second most populous country in the region, with its population increasing by over 15 million over the same period to reach nearly 120 million people.

Looking ahead, the region's population growth is set to slow to an average of 0.4% per year to 2050, with nearly all growth concentrated in urban centres, underscoring the importance of cities in shaping energy demand. Today, just over half of Southeast Asia's population lives in urban areas and this is expected to rise to two-thirds by 2050. The net increase in the urban population over this period is equivalent to the combined populations of the Philippines and Malaysia today. Timor-Leste is the only country in Southeast Asia where the rural population is projected to increase by 2050, while the region's overall rural population declines by around 70 million people. After remaining relatively stable over the past decade, Thailand's population is projected to decrease by around 5 million by 2050. GDP and population assumptions are held constant across scenarios.

## Economic growth expands across the region but remains uneven, while population growth is increasingly concentrated in urban areas

GDP per capita and change in total population in Southeast Asia, 2024 and 2050






Note: GDP = gross domestic product. PPP = purchasing power parity. 'Other Southeast Asia' includes Lao PDR, Singapore, Brunei and Timor-Leste.
Source: IEA analysis based on International Monetary Fund (IMF).

## While recent reforms have shifted support away from broad price suppression, the Middle East crisis highlights the continuing fiscal and political pull of emergency subsidies and tax relief

Fossil fuel consumption subsidies remain widespread across Southeast Asia, reflecting long-standing objectives to reduce energy poverty, ensure affordability and mitigate cost-of-living pressures. In practice, these measures lower end-user prices for transport fuels below international market levels and keep electricity tariffs below the full cost of supply. While this can dampen short-term inflation, it also undermines demand response, cost recovery and investment incentives.

During the 2022 global energy crisis, fossil fuel subsidies in Southeast Asia rose to over USD 100 billion, driven by high international prices and policy efforts to shield consumers. By 2024, the total had declined to around USD 40 billion, reflecting lower prices and reform measures. Even so, subsidies remain macroeconomically and fiscally significant: in Indonesia, fossil fuel subsidies amounted to around 2% of GDP in 2024, equivalent to government healthcare expenditure.

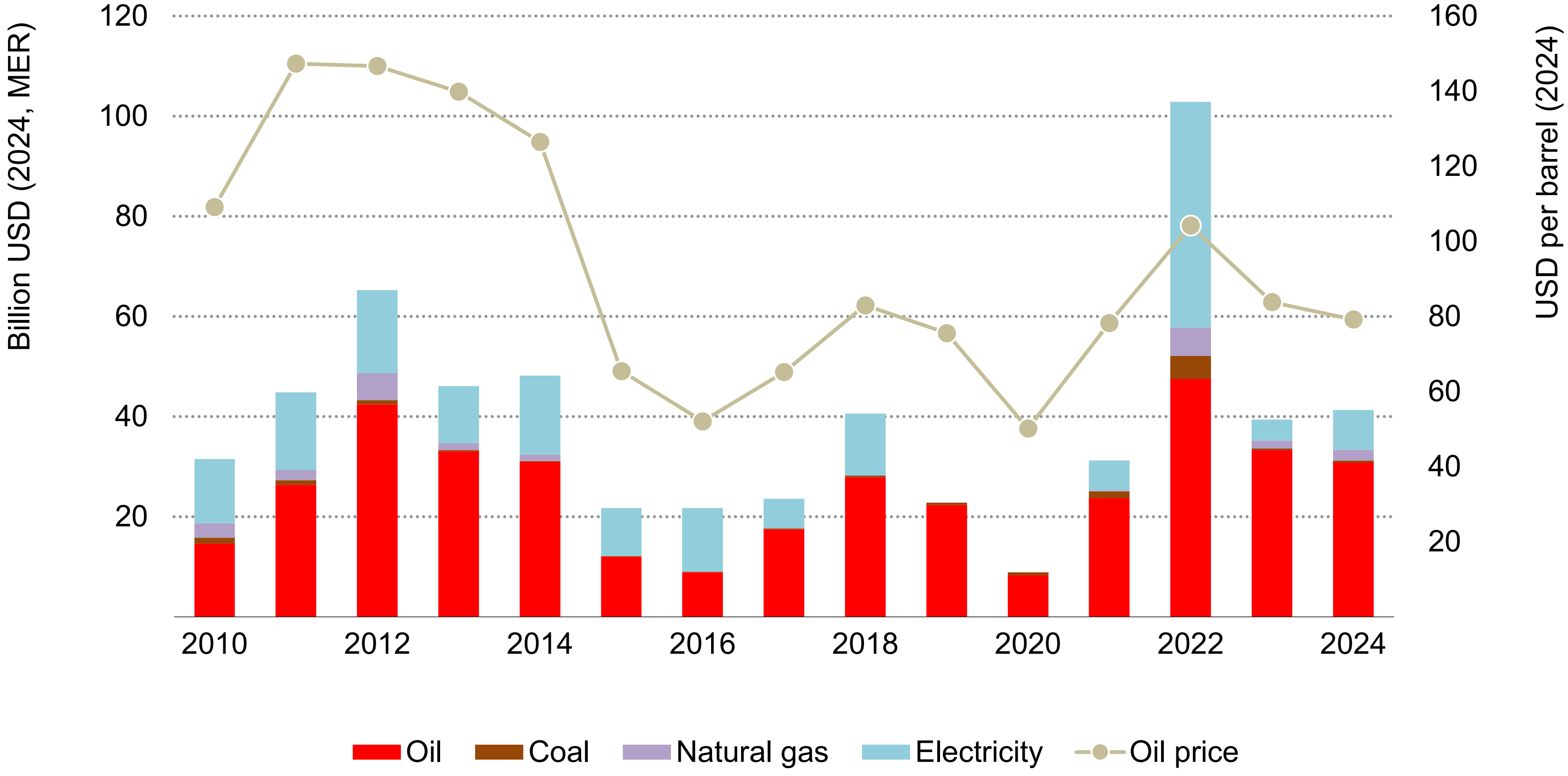
As energy demand rises and import dependence increases, such subsidies often entail large and volatile fiscal costs. When poorly targeted, they disproportionately benefit higher-income households, weaken incentives for efficiency and low-carbon investment, and constrain resources for infrastructure and social spending.

Recent reforms indicate a shift towards more targeted approaches These include tighter eligibility criteria for subsidised fuels and greater reliance on cash transfers for vulnerable groups, such as public transport operators, alongside lifeline tariffs for low-income households. In several cases, governments have also moved towards more market-reflective pricing while retaining protection for vulnerable consumers.

However, the Middle East crisis has prompted several countries in the region to introduce temporary price-stabilisation measures, including emergency subsidies, fuel security funding and tax relief, to contain retail price increases and shield vulnerable consumers. This highlights both the political sensitivity of energy price reform and the continued risk that broad-based support re-emerges when international prices rise sharply, pointing to a more uneven path for subsidy reform in Southeast Asia than observed in 2023-2024. Outcomes will depend critically on the credibility of targeting mechanisms and on the transparency of pricing arrangements that limit discretionary intervention. Given the large fiscal costs involved, any temporary support is best directed towards households and sectors with genuine need and accompanied by clear sunset provisions, helping preserve reform momentum while supporting energy security and longer-term clean energy transitions.

## Fossil fuel consumption subsidies in Southeast Asia declined after the 2022 energy crisis, reflecting lower international fuel prices and recent policy reform efforts

Evolution of fossil fuel consumption subsidies and oil prices, 2010-2024



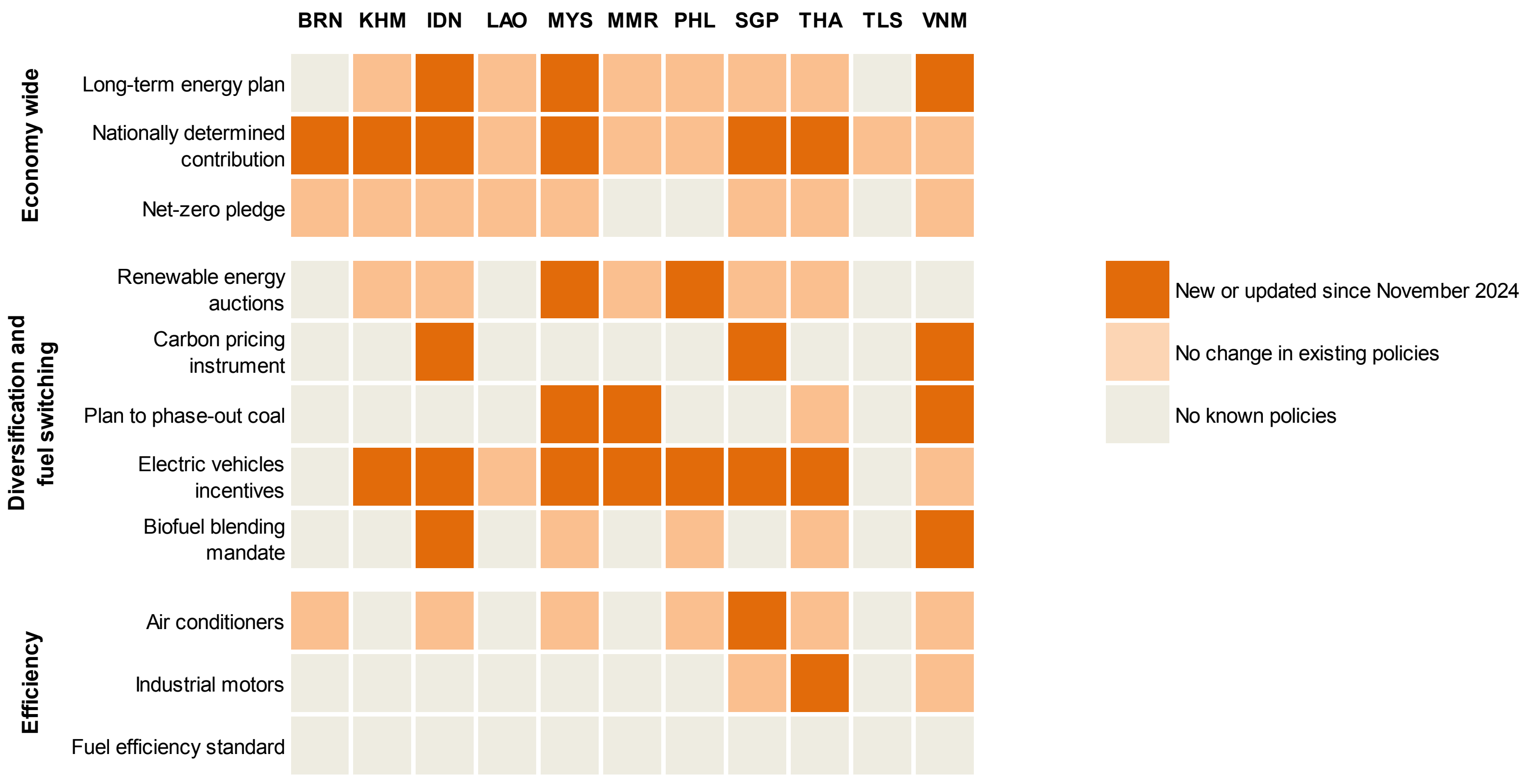



Note: Electricity means electricity generated from fossil fuels. MER = market exchange rate.

# Energy and climate policies

# The most recent policy shifts in Southeast Asia have focused on diversification and fuel switching

State of energy policy in Southeast Asia by type and category, May 2026






Notes: BRN= Brunei Darussalam; KHM= Cambodia; IDN= Indonesia; LAO= Lao People's Democratic Republic; MYS= Malaysia; MMR= Myanmar; PHL= Philippines; SGP= Singapore; THA= Thailand; TLS= Timor-Leste; VNM= Viet Nam.

Source: IEA (2026), IEA Global Energy Policies Hub.

# Southeast Asian countries introduced policies to strengthen energy diversification and electrification in response to new climate pledges submitted in 2025

Under the Paris Agreement, countries were scheduled to submit enhanced emissions mitigation ambitions in 2025. As of April 2026, six of the eleven Southeast Asian countries had submitted new Nationally Determined Contributions (NDCs). These updated pledges indicate a faster pace of mitigation than previous commitments did. If met in full and on time, the new NDCs would limit average annual growth in energy-related greenhouse gas emissions to 0.6% through 2035, down from around 2.5% growth under earlier targets. These mitigation efforts are similar to those in neighbouring EMDE in the Asia Pacific. However, the energy sector emissions implied by Southeast Asia's NDCs are misaligned with their net zero goals, which would require a decline of 5.9% per year.

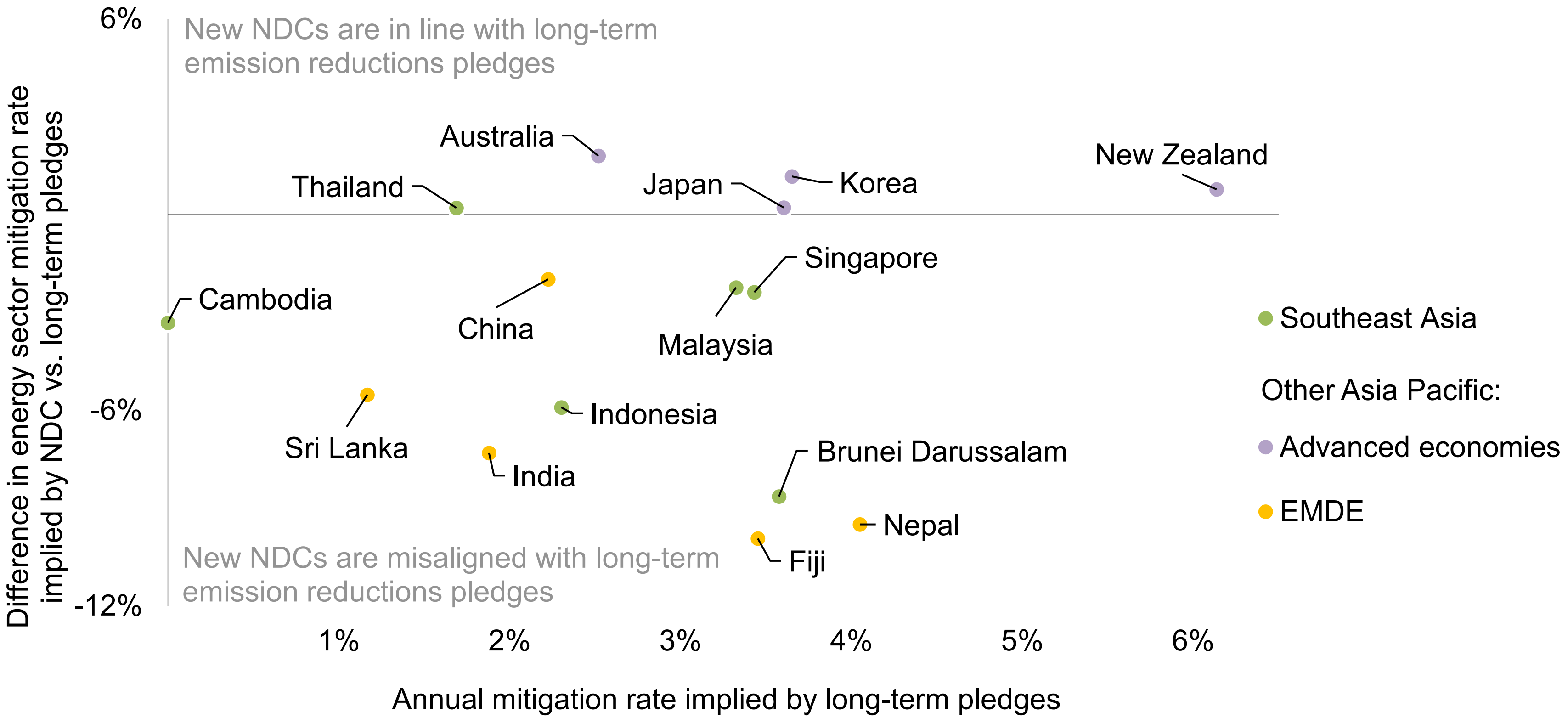
Countries have strengthened their policy frameworks to support announced pledges and strengthen energy sector resilience, with a shared focus on diversification, energy efficiency and fuel switching to renewable energy and electrification. Competitive auctions gained momentum across the region: almost 19 GW of renewable capacity have been awarded in 2025, led primarily by the Philippines' Green Energy Auctions and by Malaysia's Large Scale Solar Photovoltaic (LSSPV) programme. Auctions are expected to account for over half of the region's capacity growth through 2030. To strengthen long-term signals for low-emissions investments, Singapore is progressively raising its carbon tax on industrial facilities, from USD 34/t$CO_2$-eq in early 2026 to USD 37-60/t$CO_2$-eq by 2030. Viet Nam's domestic carbon trading system has entered the pilot phase up to 2028, and Indonesia included gas-fired power plants in the second phase of its emissions trading system in 2025.

Efforts to promote electrification and fuel switching to reduce dependence on fuel imports and mitigate emissions continued to gain momentum, particularly in road transport. Seven countries introduced or updated incentives for electric vehicles and two strengthened their biofuel blending mandates in 2025. Notable developments included Indonesia extending preferential value-added tax measures for electric cars and buses with a minimum domestic component requirement of at least 20%, alongside bringing forward its biodiesel mandate to B50 to July 2026, and Thailand's producer subsidy framework, which has allocated more than USD 4 billion since 2022 to EV local supply chain investments.

There were relatively few new energy efficiency regulations introduced in 2025, with most attention focused on incentive programmes. Singapore notably extended its Energy Efficiency Grant to 2027/2028, offering up to 70% support for the adoption of pre-approved energy-efficient equipment.

# Targets for energy sector emissions implied in the new Nationally Determined Contributions of the Southeast Asian countries are misaligned with their long-term net zero goals

Energy sector mitigation rate implied by new Nationally Determined Contributions and long-term net zero pledges, Asia Pacific






Notes: EMDE = Emerging market and developing economies. NDC= Nationally Determined Contribution. This visualisation shows only countries that submitted a new NDC between 1 January 2024 and April 2026 and have pledged to reach net zero emissions by any given date. The annual energy sector mitigation rates are based on compliance in full and within the timespan of the NDCs and long-term pledges, including any conditional components.

Source: IEA (2026), Climate Pledges Explorer.

# Energy outlook to 2050 based on today's policy settings

# Total energy demand

# Policy implementation, power system readiness and geopolitical risks will shape how Southeast Asia's energy mix evolves, determining future energy security and emissions

The centre of gravity of global energy demand growth is shifting towards Asia. In the Stated Policies Scenario (STEPS), Southeast Asia alone contributes around 20% of the increase in global energy demand to 2035. This reflects sustained economic expansion, with average GDP growth of 4% per year through to 2035, rapid electrification and its growing role as a global manufacturing hub. As energy demand growth in the world's advanced economies is set to plateau, Southeast Asia is set to surpass the European Union's total energy demand before 2040.

This growth is unfolding against an increasingly complex international backdrop. Recent geopolitical tensions, shipping disruptions and competition for fuels have highlighted the risks associated with heavy reliance on internationally traded energy. For Southeast Asia, where rising demand intersects with increasing dependence on oil and LNG imports, these dynamics highlight the importance of the region's policy choices in determining how demand growth is met.

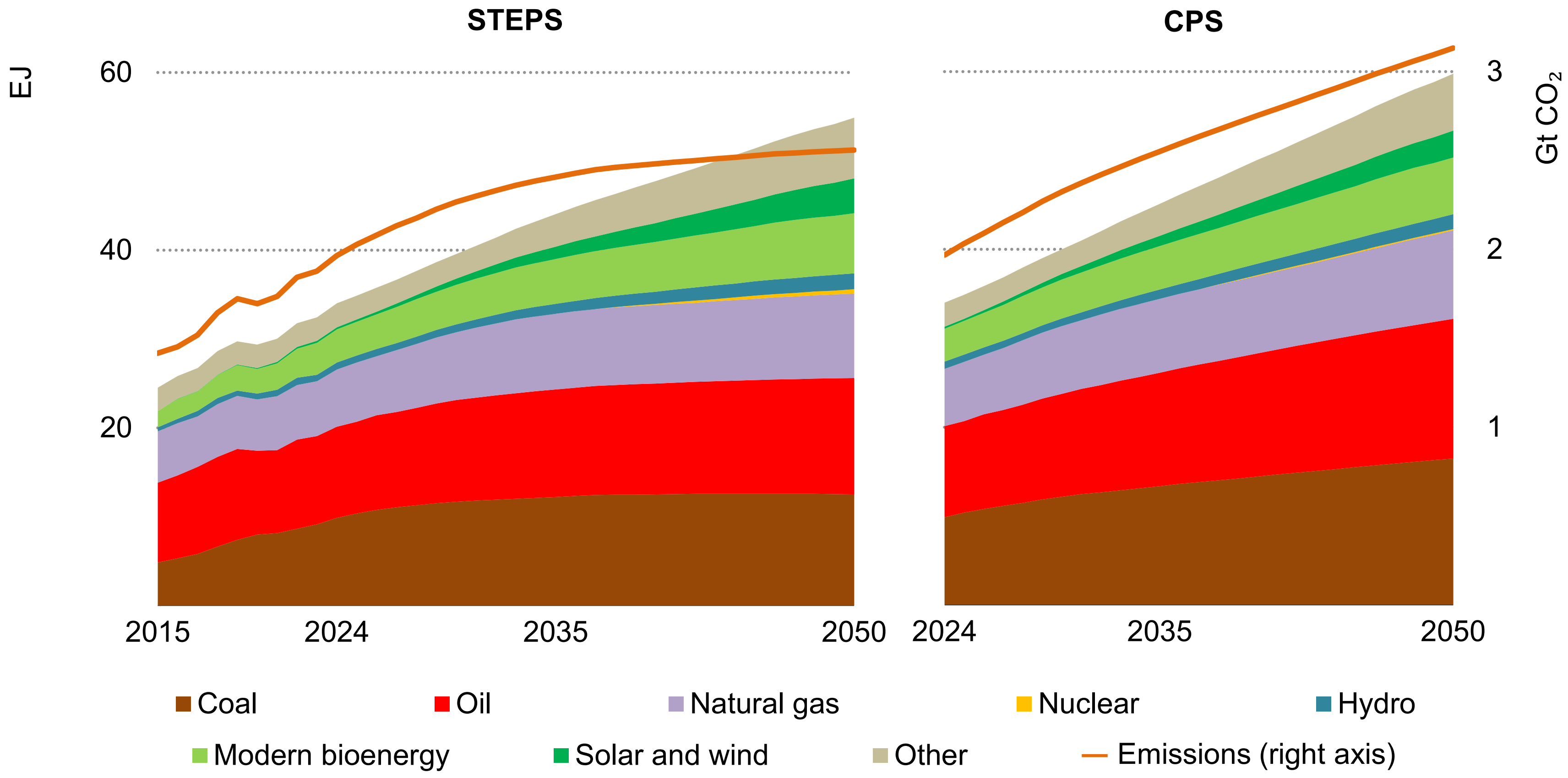
In the STEPS, total energy demand increases by nearly a third to 2035, equivalent to an average annual growth of around 2%. Policy momentum supports a rapid expansion of clean energy, with renewables, efficiency improvements and electrification playing a growing role across the energy system. As a result, clean energy meets over 40% of incremental demand growth, raising its share in the overall energy mix to around 25% by 2035 from less than 20% in 2024. These trends contribute to a sustained decline in the emissions intensity of GDP, falling by more than 2% per year on average.

However, the scale of underlying demand growth means that all the fossil fuels also continue to grow to 2035 in the STEPS. Oil demand continues to rise at an annual pace of 1.5%, reflecting transport, logistics and petrochemical needs. Coal and natural gas consumption also increase, growing by about 2.5% and 2.0% per year, respectively, driven by power generation and industrial demand. Fossil fuels still meet 60% of incremental energy demand growth to 2035, which drives increases in absolute fossil fuel use and energy-related emissions, even as the fossil fuel share of the energy mix declines from around 80% in 2024 to 75% by 2035.

In the Current Policies Scenario (CPS), limited policy development and financing prolong dependence on conventional fuels. Coal demand grows most rapidly, rising at an average rate of around 3% per year, compared with about 2% for gas and oil to 2035. Clean energy deployment is slower than in the STEPS, with solar PV and wind expanding 15% less by 2035 due to less supportive policies. As a result, energy-related $CO_2$ emissions continue to rise throughout the period, increasing at about 2.5% per year to 2035, commensurate with energy demand growth.

# Strong economic growth drives rising energy demand for all fuels; clean energy expands, but fossil fuel volumes also increase under today's policy trajectories

Energy demand by source and total energy-related $CO_2$ emissions in Southeast Asia by scenario, 2015-2050

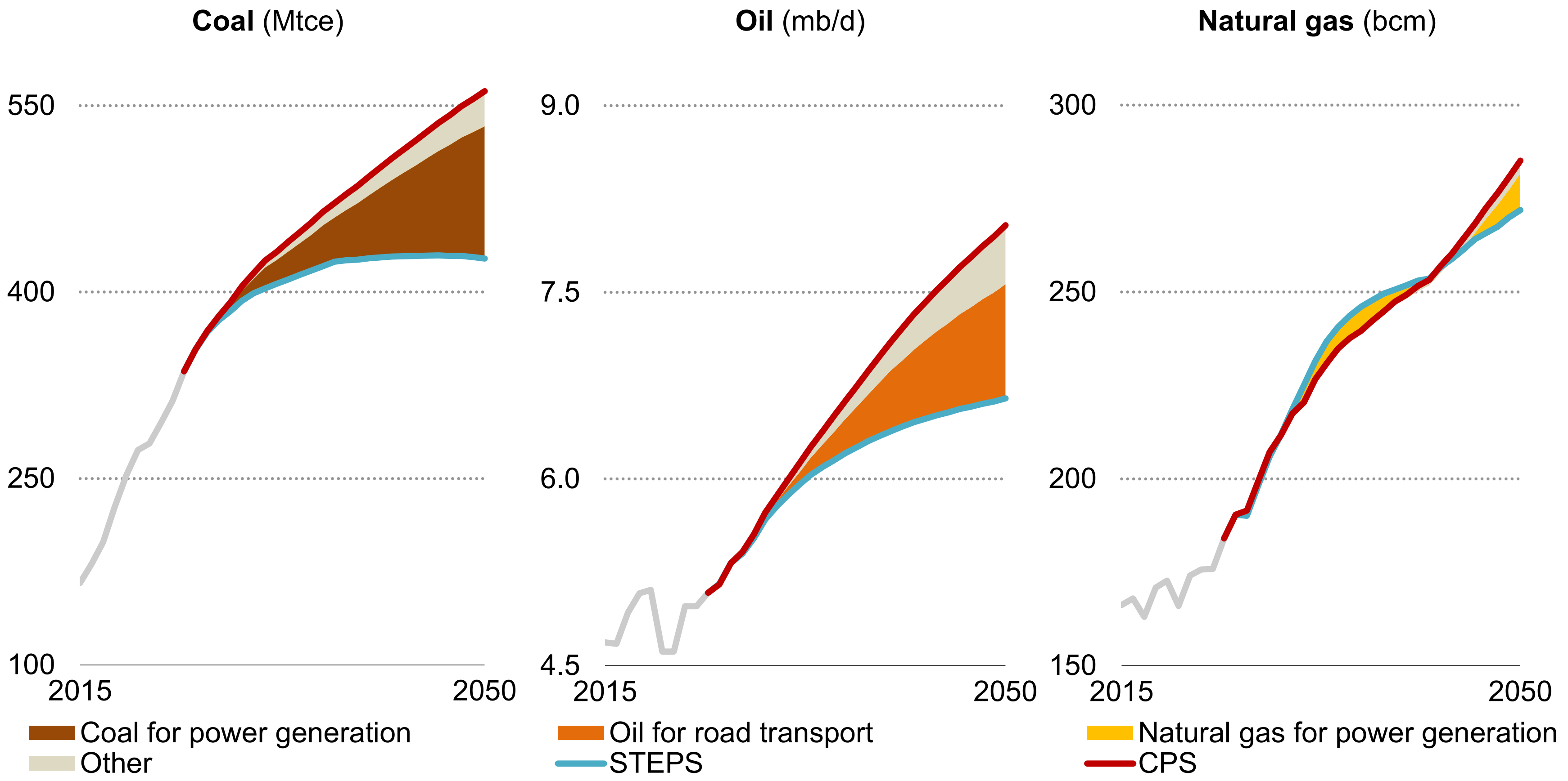





Note: STEPS = Stated Policies Scenario. CPS = Current Policies Scenario. 'Other' includes traditional use of biomass, geothermal, marine and solar thermal.

# Power generation and road transport account for the bulk of incremental coal, oil and gas use, highlighting the central role of electrification and mobility in shaping the energy trajectory

Demand for coal, oil and gas in Southeast Asia by major driver and scenario, 2015-2050






Note: STEPS = Stated Policies Scenario. CPS = Current Policies Scenario. Mtce = million tonnes of coal equivalent; mb/d = million barrels per day; bcm = billion cubic metres.

# Total final consumption

## Electrification and efficiency help moderate significant demand growth in end-use sectors

Total final consumption (TFC) in Southeast Asia is 21 EJ today, with oil accounting for nearly half of this. The other half is split between electricity (23%), bioenergy (13%) and coal and natural gas (10% each). Industry dominates TFC (43%), followed by transport (30%) and buildings (21%). End-use electrification is slightly higher than the global average and about 25% less energy-intensive.

Income, urbanisation and population continue to rise to 2050, driving further increases in car and air conditioner (AC) ownership. Economic trends also boost freight activity, alongside demand for chemicals and non-energy-intensive industries. Together, they lead to a 60% increase in TFC per capita by 2050 in the CPS, and a smaller increase of 45% in the STEPS, as efficiency improvements and electrification help moderate demand growth.

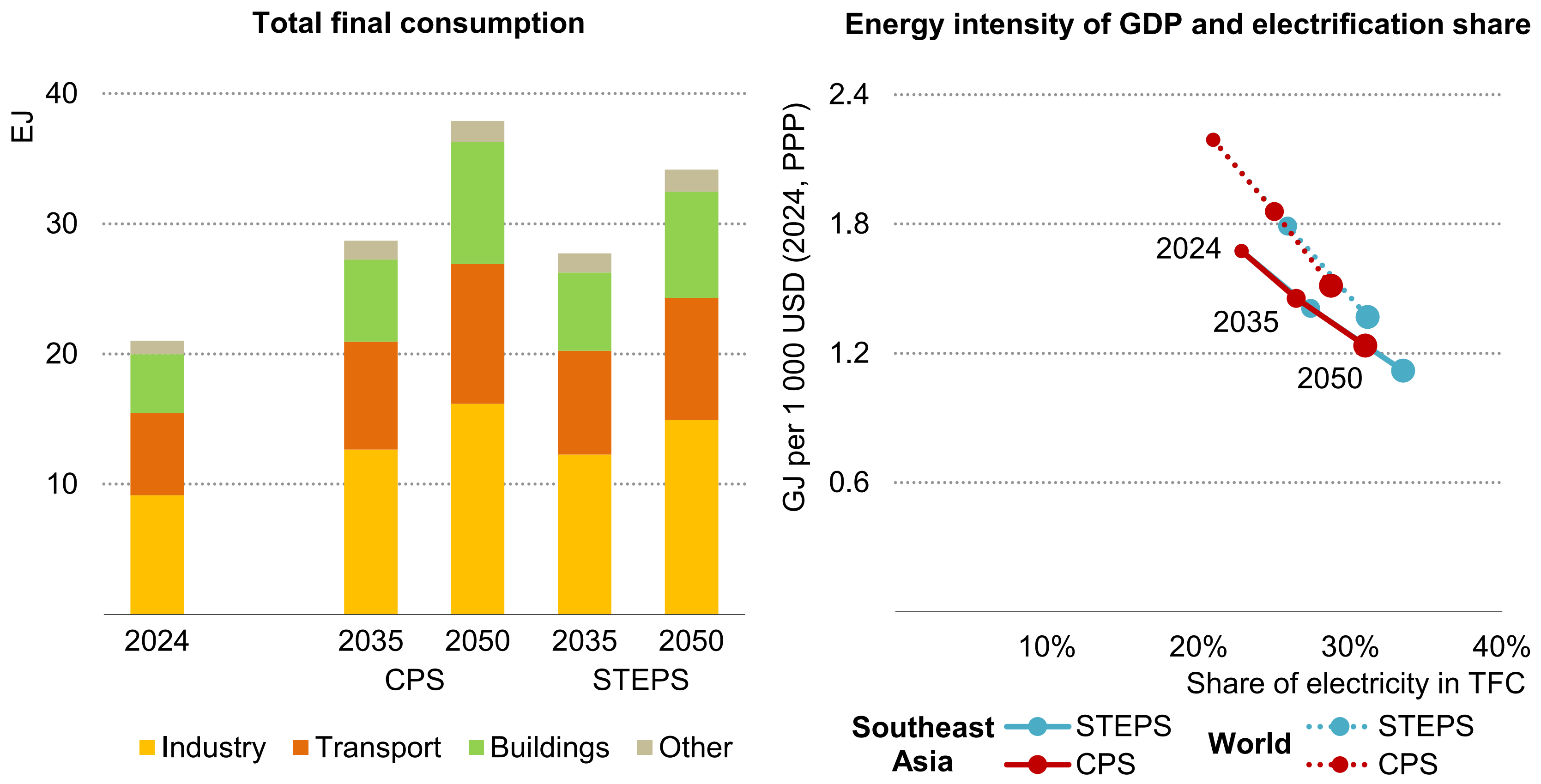
TFC rises by an annual average of 2.5% to 2035 in the STEPS, broadly in line with the previous decade and among the fastest globally. Electricity use increases steadily across sectors, particularly in industry and buildings where demand grows faster than in transport. After 2035, TFC growth begins to moderate, slowing to around 1.5% per year as population growth slows and electrification and energy efficiency continue to improve, supported by policy action and the rising uptake of new technologies. Electrification in final consumption rises from 23% today to 27% by 2035 and 33% by 2050, requiring the region's electricity distribution grid to expand by 50% and 120%, respectively, to maintain secure and reliable supply. Energy intensity improves by 15% to 2035 and a further 20% to 2050. End-use electrification remains higher in Southeast Asia than the global average and energy intensity stays lower than in advanced economies. Improved energy intensity, driven by faster electrification, curbs energy demand growth by more than 15% in 2035, despite rapid economic growth (see *Energy efficiency* in Chapter 3).

TFC grows at nearly 3% per year to 2035 and 2% to 2050 in the CPS, reflecting slower progress in electrification and efficiency. It reaches 38 EJ in 2050, 10% higher than in the STEPS. Oil demand grows from below 5 mb/d to over 6 mb/d by 2035 and around 8 mb/d by 2050, significantly increasing reliance on imports. Demand for coal grows 80% by 2050, as the fuel maintains its 10% share in final consumption.

Stronger policies in the STEPS lead to faster electrification across sectors. Nonetheless, demand for oil expands to 2035, growing 20% to reach almost 6 mb/d, before slowing thereafter to reach just under 6.5 mb/d by 2050. Coal and natural gas remain important, especially in industry, and by 2050 their combined share in TFC remains similar to today's. Bioenergy demand grows by a third, yet its share also falls, accounting for 10% of final consumption by 2050.

# Strong efficiency improvements and increasing electrification help limit growth in total final consumption

Total final consumption in Southeast Asia by sector and scenario (left) and energy intensity of GDP and electrification by scenario (right), 2024-2050






Notes: International aviation and shipping are excluded. CPS = Current Policies Scenario. STEPS = Stated Policies Scenario. 'Other' includes agriculture and other non-energy use. EJ = exajoule. TFC = total final consumption; GJ = gigajoule; USD = United States dollar; PPP = purchasing power parity.

# End-use sectors

## While industrial growth drives energy demand growth, the fuel mix remains broadly unchanged

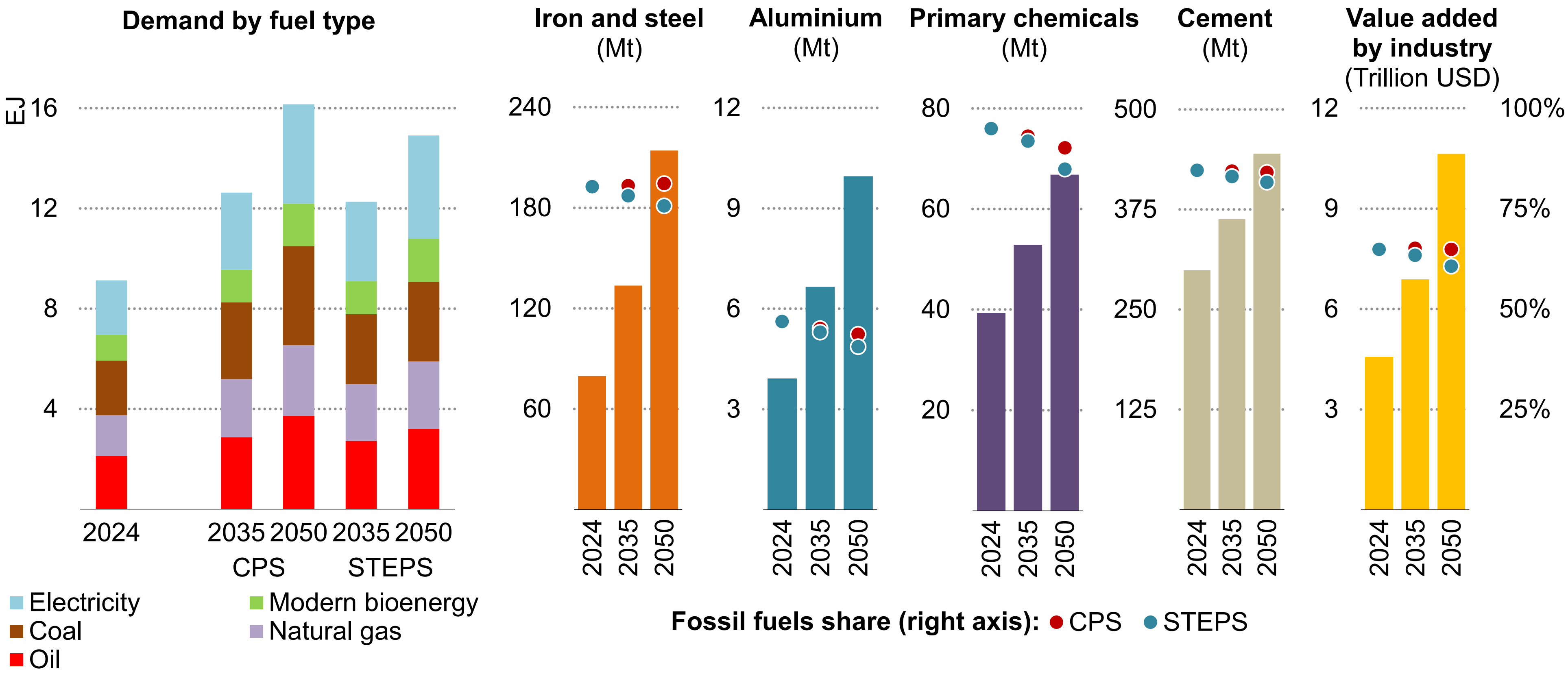
Industry energy demand rises by a third to over 12 EJ by 2035 in both the CPS and STEPS, supported by economic expansion as Southeast Asia consolidates its position as a global manufacturing hub, supported by trade integration and competitive labour costs. Growth is largely led by energy-intensive industries, with the region gaining global importance in these sectors, with around 15% of globally announced new steel plant capacity currently located in the region. To 2035, Southeast Asia is one of the world's fastest-growing regions in terms of aluminium and iron and steel production, with output rising by 70%, supported by Indonesia's and Viet Nam's expertise in these industries. Chemicals and cement production growth is also among the fastest in the world to 2035, growing by 35% and 20%, respectively, while pulp and paper production grows 30%. Indonesia, Thailand and Singapore anchor petrochemical production, while Viet Nam and Thailand lead the region in non-metallic minerals industries.

Southeast Asia's industrial sector continues its heavy reliance on coal in both the CPS and STEPS due to its low cost and abundant domestic supply, especially in Indonesia. Coal accounts for a quarter of industrial energy demand in the region today, a share that remains unchanged in the CPS and declines only slightly, to 20%, in the STEPS by 2050. Established infrastructure in iron and steel, cement and non-ferrous metals industries already depends on coal, driving coal demand up by 30% in the STEPS and 40% in the CPS by 2035 as these industries expand. By then, the average age of this industrial infrastructure will still be just 12 years, due to the speed of the recent and prospective build-out, limiting opportunities for fuel switching. Demand for natural gas increases by over 40% in the next decade, but its share remains below 20% in both the CPS and STEPS. Natural gas growth is concentrated in chemicals and non-energy-intensive sectors, but high prices remain a key barrier. Underdeveloped infrastructure and rising import dependence further constrain its expansion. Demand for oil grows at a similar pace in both the CPS and STEPS, around 30% by 2035, alongside rising global demand for primary chemicals and plastics.

Today, Southeast Asia's industrial electrification rate is comparable to that of the European Union, and electricity contributes more to industry demand growth than any other energy source in this *Outlook*, with Viet Nam, Thailand and Malaysia positioning themselves as export-oriented manufacturing hubs. Electricity demand grows 45% by 2035 in the STEPS, increasing its share in total industrial energy demand slightly to 26%. Non-energy-intensive industries account for three-quarters of this growth. In the CPS, the electrification share remains broadly unchanged.

# Industrial demand grows strongly with expanding energy-intensive production, maintaining the sector's reliance on fossil fuels even as electricity grows rapidly

Energy demand in industry in Southeast Asia by fuel type and scenario (left); output of key industrial products and value added by industry, and the fossil fuel share of their total energy consumption by scenario (other charts), 2024-2050






Notes: Feedstocks are excluded from the fossil fuels share of primary chemicals production. Value added by industry uses the United States dollar (2024, purchasing power parity). EJ = exajoules. CPS = Current Policies Scenario; STEPS = Stated Policies Scenario; Mt = million tonnes.

## Electric vehicles and biofuels temper dependence on oil as transport demand rises

Transport demand in Southeast Asia rises by around 30% to 8 EJ by 2035 in both the CPS and STEPS, driven by economic growth and rising incomes. Road freight remains the main driver of growth, with activity increasing by 40% to over 3 trillion tonne-kilometres. Car ownership rises by more than 25% to about 100 cars per 1 000 people as the fleet expands from 55 million to 75 million. Two- and three-wheelers grow by 20% to around 325 million, placing Southeast Asia among the world's largest markets, alongside India. Aviation demand nearly doubles, while rail demand rises by a quarter, supported by high-speed rail projects in Viet Nam and Thailand.

Oil continues to dominate transport energy use, but its share declines more quickly in the STEPS as electrification and biofuels expand. The share of oil in transport energy use falls to around 85% by 2035 in the STEPS, compared with 88% in the CPS, and continues to diverge thereafter. EVs and biofuels together avoid around 1 mb/d of oil demand by 2035, reducing exposure to import price volatility and saving roughly USD 25 billion in oil imports.

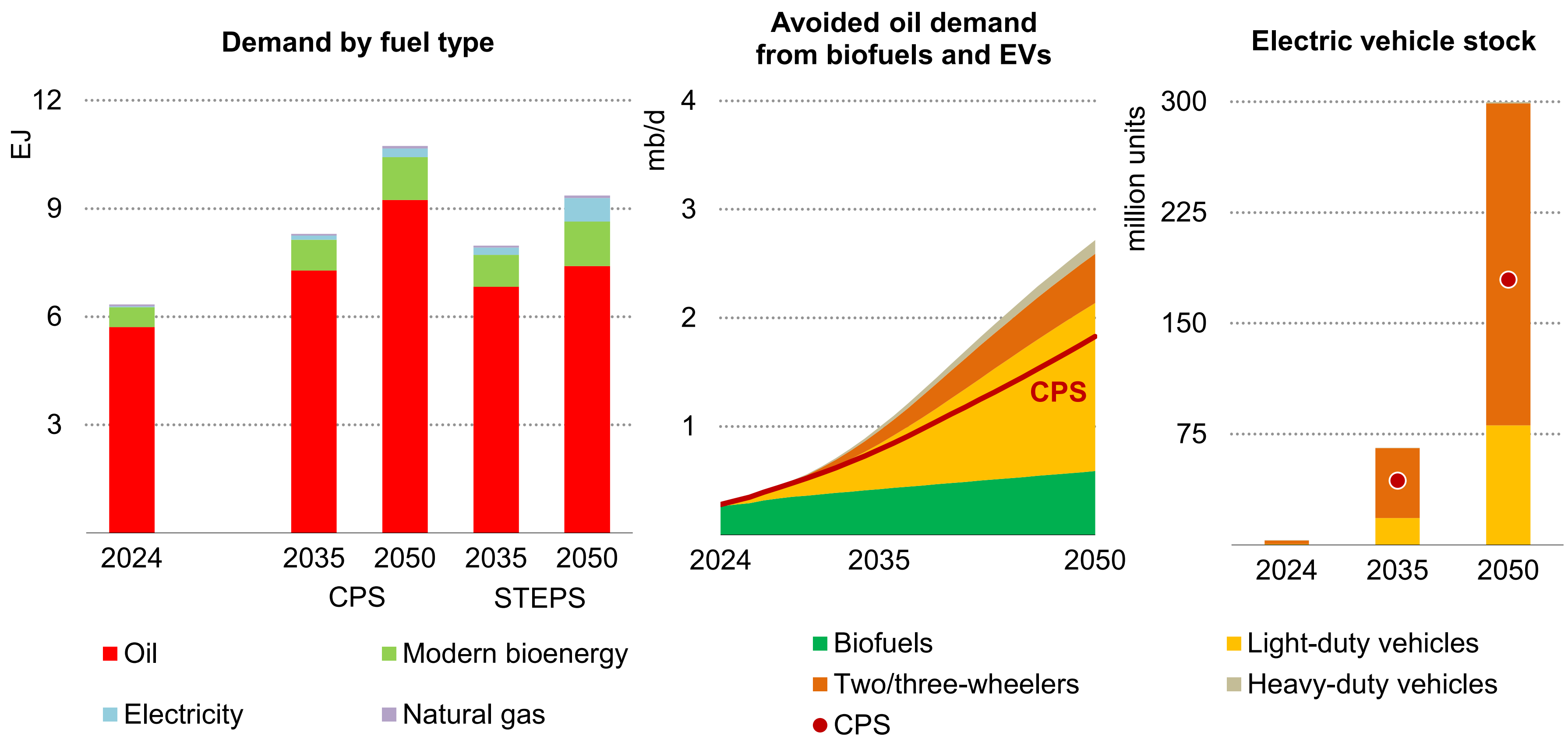
EV adoption accelerated markedly in 2025, with electric car sales shares reaching around 40% in Viet Nam and Singapore, over 20% in Thailand and 15% in Indonesia. Policy support is increasingly aligned with domestic manufacturing objectives: Malaysia, Indonesia and Thailand are phasing out import-duty exemptions while retaining local-content incentives; the Philippines maintains import tax relief; Viet Nam offers registration rebates; and Singapore relies primarily on fiscal incentives. Chinese and domestic automakers are expanding EV production, with VinFast leading in Viet Nam, while several markets depend on Chinese imports. In the STEPS, supportive policy, trade conditions and falling battery costs lift EVs to around 60% of new car sales and 20% of the regional fleet by 2035.

Electric two- and three-wheelers have already reached cost parity with internal combustion engine (ICE) vehicles and benefit from supportive policies in Thailand, Malaysia and Viet Nam. By 2035, they account for 15% of the fleet, contributing to EV-related oil displacement of 0.6 mb/d, rising to 2 mb/d by 2050. Displacement is lower in the CPS, reaching below 1.5 mb/d by 2050. Growing EV markets also offer opportunities to strengthen Southeast Asia's role in clean technology supply chains, reflecting the region's resource base and manufacturing capabilities. At the same time, competition from low-cost EV imports, shifting battery chemistries and constraints related to infrastructure, affordability and financing pose important challenges (see Chapter 4).

Bioenergy remains a key transport fuel, led by Indonesia's biodiesel mandates to reduce diesel imports and support its palm oil sector. In both scenarios regional biofuel demand, led by Indonesia's road sector, grows over 50% by 2035, displacing 0.4 mb/d of oil and reaching 0.6 mb/d by 2050.

# The increasing uptake of electric vehicles and use of biofuels in transport play a major role in curbing oil demand growth in the region

Transport energy demand (left), avoided oil demand (centre) and electric vehicle stock (right) in Southeast Asia by scenario, 2024-2050






Note: International aviation and shipping are excluded. CPS = Current Policies Scenario. STEPS = Stated Policies Scenario. EV = electric vehicle; EJ = exajoule; mb/d = million barrels per day.

# Air conditioning drives rapid electricity demand growth in buildings, while the fuel mix for cooking and water heating continues to evolve

The building sector's energy demand grows rapidly in both the STEPS and CPS to 2035, rising by one-third and 40% respectively. This growth is underpinned by rising incomes and population, which drive an increase in floorspace and the number of households. Electricity is the largest and most significant source of energy demand growth in buildings, increasing by an annual average of 4.5% to 2035 in the STEPS, outpacing the overall rise in buildings demand.

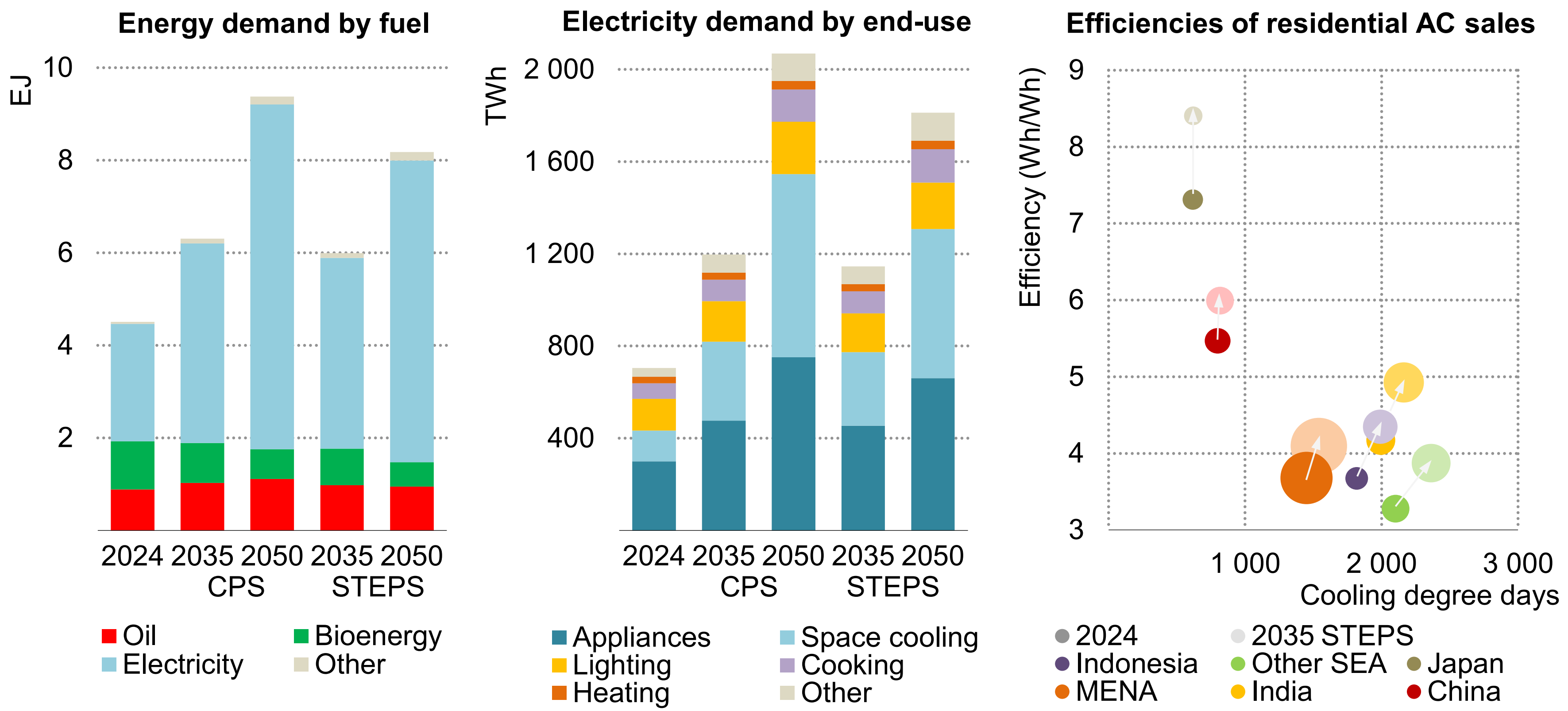
Space cooling is a key driver of this growth. The region's tropical climate, rising temperatures, urban heat island effects and higher incomes accelerate AC ownership rates, which rise from around 30% of households to over 50% by 2035. Electricity demand growth for cooling depends heavily on efficiency policies. While most countries have minimum energy performance standards (MEPS) for ACs, stringency varies widely across the region. The STEPS assumes some tightening of existing MEPS. If standards across Southeast Asia were raised to match those of Japan, residential electricity use for cooling in 2035 would be almost halved compared to the consumption projected in the STEPS. Cooling needs are also shaped by building standards. Aligning energy policy with climate-resilience measures is critical: new construction and major renovation standards need to reflect risks of heatwaves, storms and floods, while also limiting the cooling needs of buildings.

Beyond space cooling, other appliances such as refrigerators, cleaning appliances, televisions and computers, add 150 TWh of electricity demand growth to 2035 in the STEPS. Many countries in the region already apply MEPS to lighting, fans, refrigerators and rice cookers. Regional initiatives such as the ASEAN Plan of Action for Energy Cooperation (APAEC) 2026-2030 promote harmonisation and strengthening of MEPS, especially for cooling, while government incentives further encourage uptake of efficient appliances, for example through Malaysia's SAVE rebate programme and tax deductions for certified highly efficient appliances in Thailand.

At the same time, the fuel mix for cooking and water heating continues to evolve. The use of traditional biomass has been declining as households switch to modern cooking solutions (see Chapter 4). LPG remains widespread, used as the primary cooking fuel by three-quarters of the region's population. Residential oil demand per capita remains broadly stable to 2050 in the CPS but falls by 20% in the STEPS due to electrification and higher efficiencies. Several countries, including Indonesia, Lao PDR and Cambodia, have programmes and subsidies to promote the uptake of electric stoves. The fuel transition in cooking reduces import requirements, improves indoor air quality and can improve household affordability.

# Electricity dominates the building sector's energy demand and growth, driven up by rising cooling needs

Energy demand in the buildings sector by fuel (left), electricity demand by end use (centre) and regional air conditioner efficiencies against cooling degree days (right) in Southeast Asia, 2024, 2035 and 2050






Note: EJ = exajoule; TWh = terawatt-hour; Wh = watt-hour. 'Other' fuels include natural gas, coal and solar thermal; 'Other' end use includes data centre demand. AC = air conditioning, Other SEA = Other Southeast Asian countries; MENA = Middle East and North Africa. The bubble size reflects the average cooling consumption per square metre in the region. Air conditioner efficiencies reflect operation under local climate conditions.

# Electricity

## Electricity demand for space cooling ramps up, while electrification and efficiency affect the composition of electricity demand growth

Annual electricity demand in Southeast Asia increases by nearly 2 000 TWh by 2050 in both the STEPS and CPS, rising from around 1 300 TWh today. This increase is equivalent to four times Indonesia's current electricity demand. In both scenarios, electricity demand grows at an average annual rate of 4.4% to 2035, before easing to 2.8% in the STEPS and 3.0% in the CPS through to 2050. In the STEPS, faster efficiency improvements mean regional electricity demand is nearly 300 TWh lower than the CPS in 2050, even though stronger electrification of end uses partly offsets those savings.

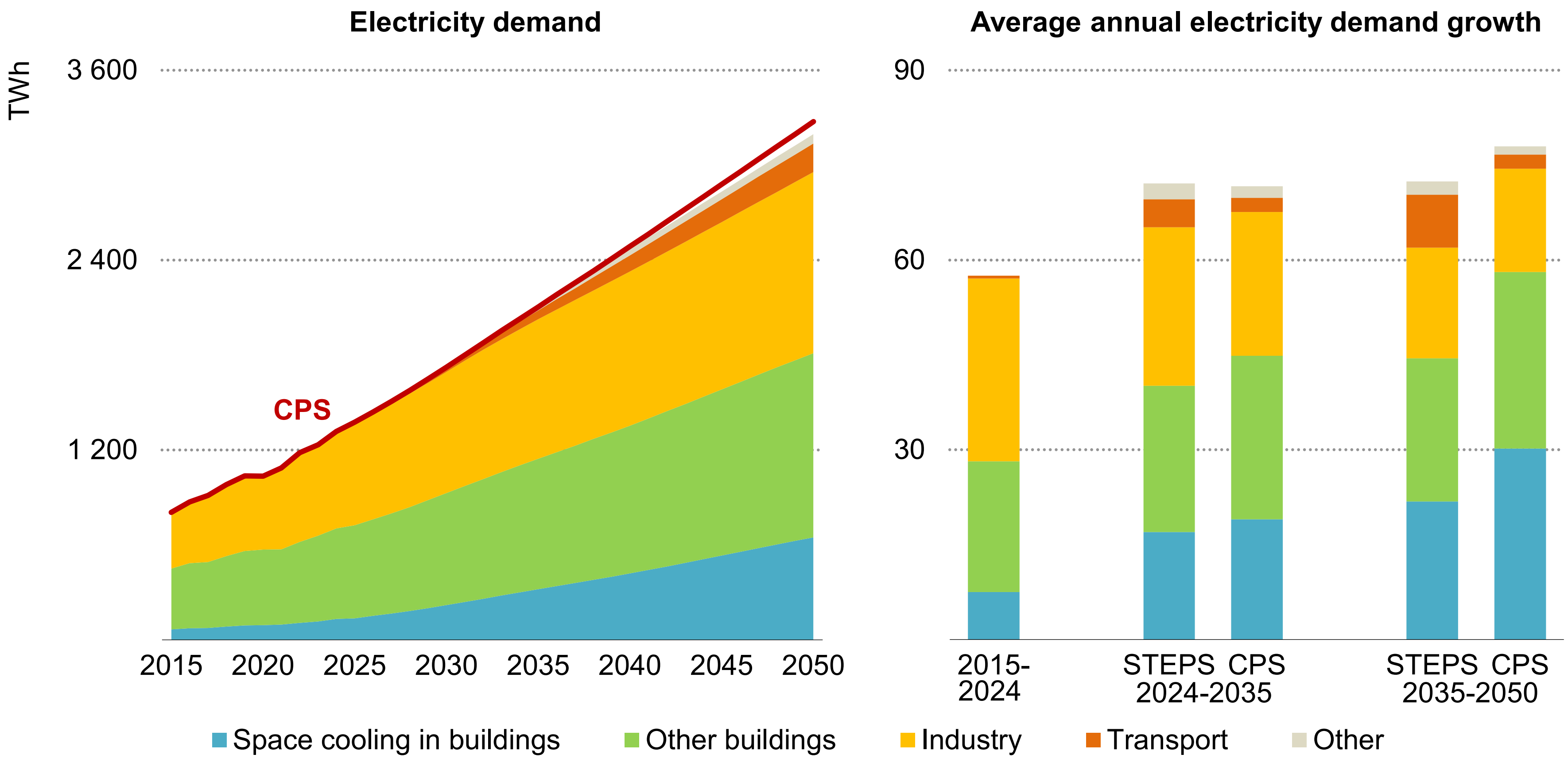
Electricity demand in Southeast Asia rises faster than the emerging market and developing economies (EMDE) average, where demand grows at 3.6% per year to 2035 and slows to 2.3% per year to 2050 in the CPS. Electricity demand per capita in Southeast Asia is currently about three-quarters of EMDE average; by 2050, it converges to the EMDE average, reaching around 4.3 MWh per person per year in the CPS.

The buildings sector accounts for over half of electricity demand today and dominates electricity demand growth to 2050, accounting for as much as 70% in the CPS. Space cooling alone makes up one-third of the total increase in electricity demand. Cooling demand grows nearly five-fold by 2050 in the STEPS and six-fold in the CPS, where it reaches a quarter of total electricity demand. Increasing floorspace, rising incomes, higher AC ownership and warmer temperatures drive this trend. Cooling degree days – a key indicator of cooling needs – increase by over 20% by 2050 in the STEPS and 25% in the CPS, due to rising temperatures in the region. The growing share of space cooling in electricity demand also increases system vulnerability to extreme weather events. Heat waves can place strain on power systems by triggering sharp spikes in electricity demand, and often accelerate air conditioner adoption, leading to a lasting, structural increase in electricity demand.

Electricity demand in buildings is also driven by growing appliance ownership. Some appliance types, such as residential dishwashers and dryers, start from a relatively low base and see rapid growth in stock by 2050, while widely owned appliances such as refrigerators see more modest increases. In the transport sector, rising ownership of electric cars and two- and three-wheelers drives the increase in electricity consumption. In industry, electricity consumption exceeds 1 100 TWh per year by 2050 in both the STEPS and CPS, driven largely by non-energy-intensive industries.

## Electricity demand more than doubles in both scenarios, strongly driven by cooling demand, which grows five-fold by 2050

Electricity demand by end-use sector in Southeast Asia in the Stated Policies Scenario and the Current Policies Scenario, 2015-2050



# As the data centre sector is expanding rapidly, regulatory frameworks are evolving in response to concerns over local impacts and resource allocation

Southeast Asia represents a sizeable segment of the global data centre market, consuming more than 10 TWh of electricity, which is equivalent to just under 3% of global data centre demand and around 10% of data centre demand in the Asia Pacific region. Historically concentrated in Singapore, the sector is becoming more geographically dispersed following Singapore's 2019 moratorium on new developments, which triggered a spillover effect into neighbouring Johor in southern Malaysia. This trend has continued, with Indonesia emerging as a key market centred on Jakarta, and, to a lesser extent, Thailand in Bangkok, while the Philippines remains comparatively nascent. Despite this diversification, Malaysia and Singapore still account for most of Southeast Asia's installed data centre capacity.

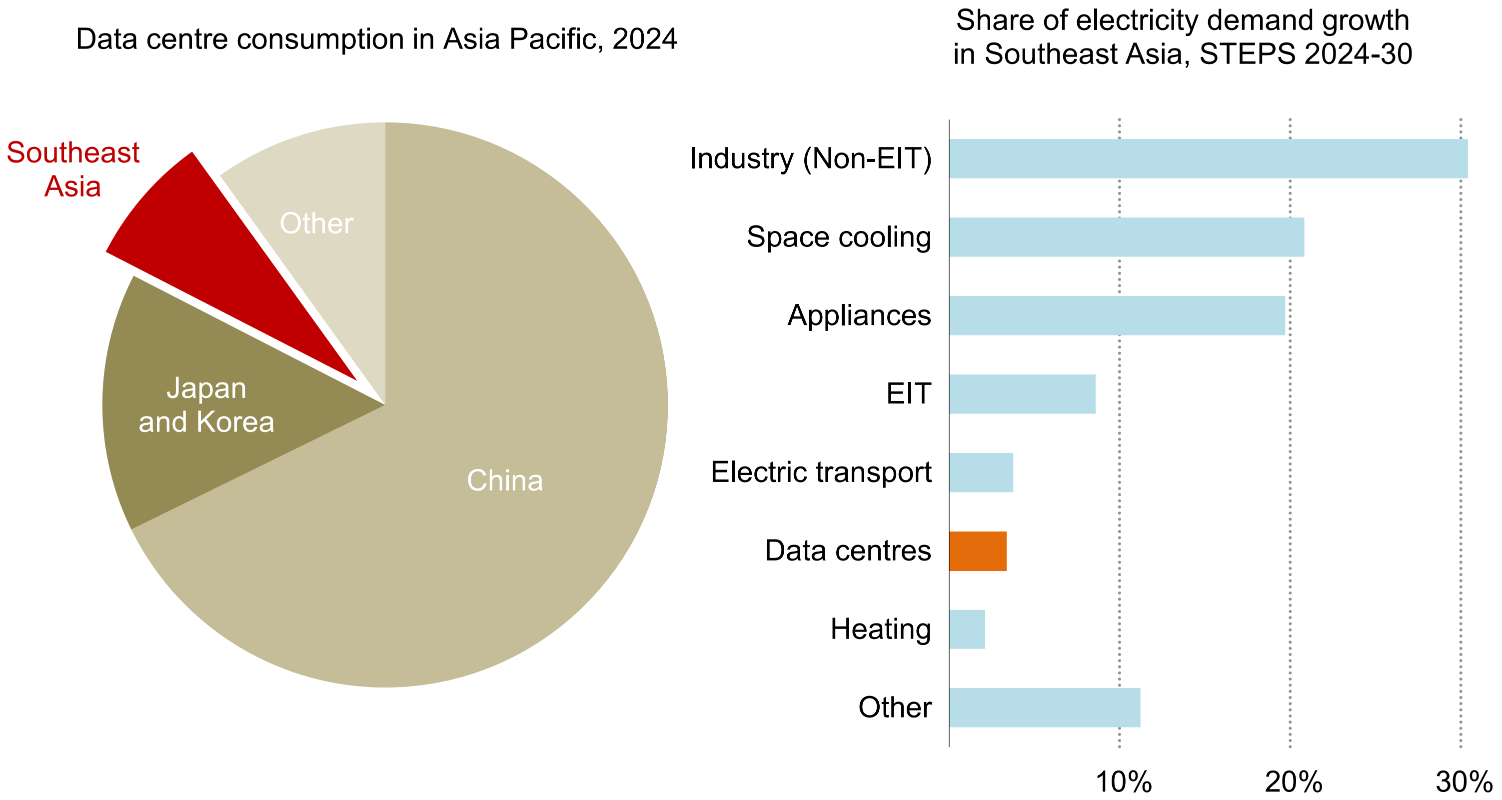
Current industry dynamics in the region remain robust, with the project pipeline exceeding last year's record levels. Google and Meta have demonstrated renewed interest, including billion-dollar investments by Google in Thailand and a major project commissioned by Meta in Singapore in 2024. While Microsoft paused or delayed some developments in Indonesia in early 2025, it announced large-scale investments in Thailand, underscoring the country's emerging role as a data centre hub in the region.

From a policy perspective, the countries are actively strengthening their attractiveness to data centre investors. Malaysia is at the forefront of this effort, offering targeted incentives, like favourable tax regimes, to sustain a competitive investment environment. Singapore has cautiously re-entered the market with a controlled expansion strategy, launching a call for 200 MW of additional capacity. As outlined in the Singapore Green Data Centre Roadmap, the country aims to restore its attractiveness while maintaining strict sustainability criteria. The introduction of national efficiency standards could unlock up to 30% energy savings through measures such as virtualisation and higher operating temperatures. Indonesia is also emerging as a key player, supported by a rapidly expanding project pipeline.

Looking ahead, as Southeast Asia is a growing economy, data centres are among the many sources of electricity demand growth. However, their highly localised and energy-intensive nature poses significant infrastructure challenges as nearly all data centres are grid connected in the region. Physical bottlenecks constrain growth, as observed in Singapore at the start of the decade. For example, in 2024, Johor rejected up to 30% of data centre applications due to insufficient efficiency measures related to power and water usage, reflecting concerns over local resource strain. Similarly, Indonesia is already experiencing grid constraints, translating into extended connection queues, that are slowing further expansion.

# Robust growth is set to double data centre electricity demand by 2030, and while remaining a modest share of total electricity demand, data centres present distinct challenges

Data centre consumption in the Asia Pacific by region in 2024 and sectoral shares of electricity demand growth in Southeast Asia in the Stated Policies Scenario to 2030






Note: EIT = Energy-intensive industry; Heating refers to water and space heating in buildings. STEPS = Stated Policies Scenario.

## Coal-fired generation continues to rise to 2050 in the CPS, but stronger growth in wind and solar PV causes it to level off after 2035 in the STEPS

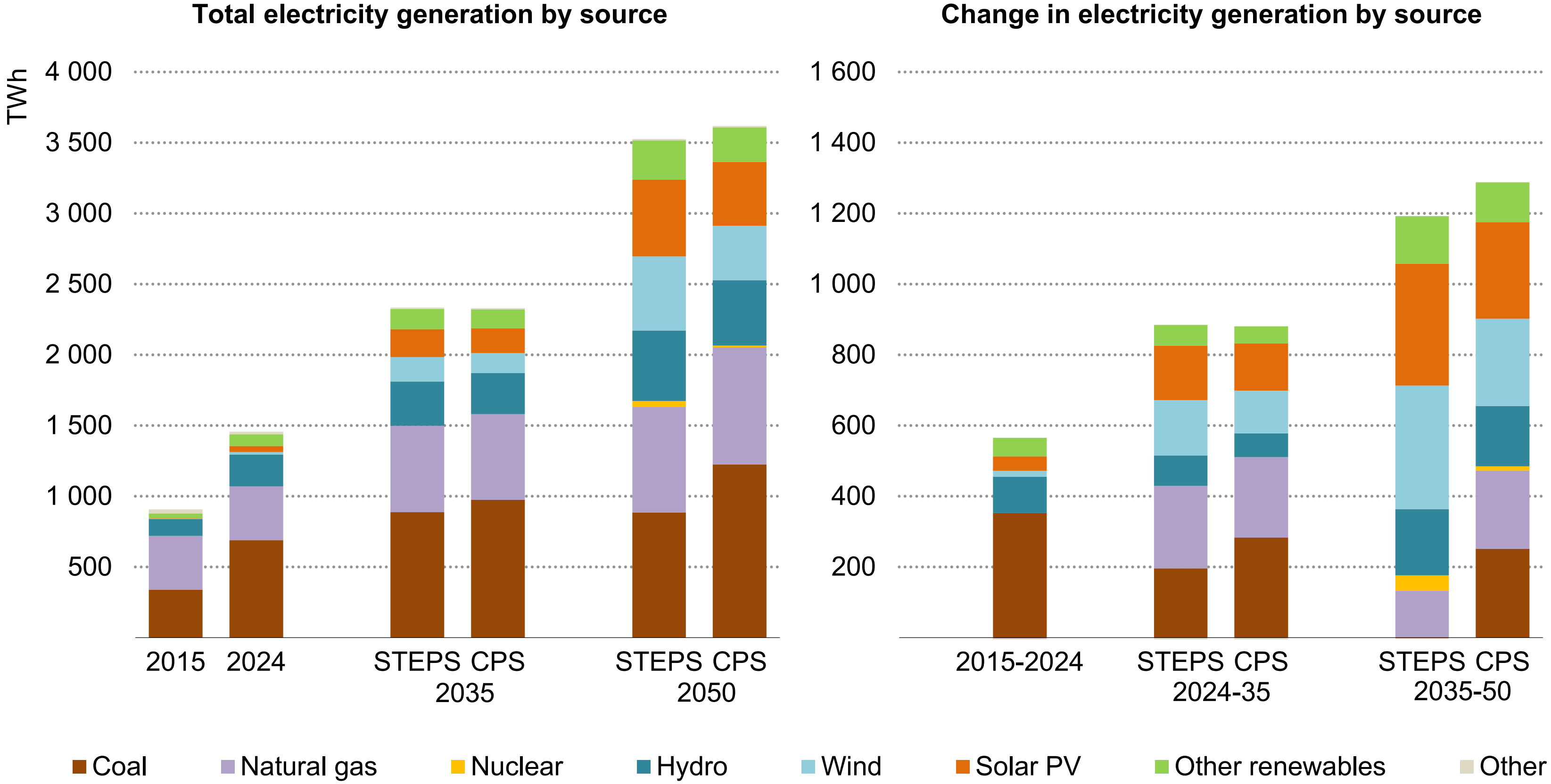
Electricity generation in Southeast Asia continues to grow in both scenarios, but a more supportive policy environment drives a faster shift towards low-emissions sources in the STEPS. Total generation rises from around 1 460 TWh in 2024 to about 2 330 TWh in 2035 in both scenarios, before reaching 3 525 TWh in 2050 in the STEPS and over 3 600 TWh in the CPS. This marks a slowdown from the 2015-2024 period, when generation grew by around 5.4% per year, to around 4.4% per year from 2024 to 2035 in both scenarios, and to around 2.8% per year in the STEPS and 3.0% in the CPS from 2035 to 2050.

Coal remains the largest single source of generation to 2050, but its longer-term trajectory diverges between the scenarios. Coal-fired generation doubled between 2015 and 2024, growing by more than 8% per year. However, this growth slows to around 2.3% per year to 2035 in the STEPS before plateauing through to 2050, causing its share in the overall generation mix to fall as electricity demand continues to grow. Compared to the 2024 Outlook, this represents an upward revision of around 10%, reflecting higher than expected growth in captive coal generation in Indonesia and a more persistent pipeline of coal projects. In the CPS, coal generation continues to grow after 2035, reaching over 1 200 TWh in 2050. Natural gas-fired generation was broadly flat between 2015 and 2024 but is set to return to growth, with annual output increasing by more than 1.5-fold in both scenarios to around 600 TWh by 2035. Further increases to 2050 bring gas-fired generation to around 750 TWh in the STEPS and over 800 TWh in the CPS.

Low-emissions sources gain ground in both scenarios, expanding more rapidly in the STEPS, where renewables and nuclear together provide just over half of total generation by 2050, compared with 43% in the CPS. Wind and solar PV account for much of this growth. In the STEPS, solar PV generation rises from 44 TWh in 2024 to almost 200 TWh in 2035 and more than 540 TWh in 2050, while wind increases from 18 TWh to around 175 TWh in 2035 and more than 520 TWh in 2050. By 2050, wind and solar PV together generate more than 1 060 TWh, equivalent to around 30% of total generation. In the CPS, expansion is slower due to integration challenges, with wind and solar PV together providing 23% of generation in 2050. Hydropower continues to grow in both scenarios, with output increasing from around 225 TWh in 2024 to over 460 TWh by 2050 in the CPS and nearly 500 TWh in the STEPS. Other renewables also increase, led by geothermal (mainly in Indonesia and the Philippines), followed by bioenergy. Nuclear enters the electricity mix after 2035 as reactors are commissioned in Viet Nam and Indonesia, further diversifying the region's generation portfolio.

# Low-emissions sources, led by hydro, wind and solar PV, provide over half of generation by 2050 in the STEPS, resulting in a more diverse mix compared to today

Total electricity generation (left) and change in electricity generation (right) in Southeast Asia by source and scenario, 2015-2050






Notes: TWh = terawatt-hours. 'Other renewables' include bioenergy and renewable waste, geothermal, concentrating solar power and marine power. 'Other' includes non-renewable waste and other sources.

## Technical pathways for power system integration and grid expansion in Southeast Asia

Southeast Asia's power systems are entering a phase where grid capability will increasingly shape electricity security, affordability and system resilience. As electricity demand continues to rise and variable renewable energy plays a larger role in the generation mix, the region's electricity grids will need to expand rapidly. In the STEPS and CPS, total grid length more than doubles by 2050, underlining the scale of the investment and delivery challenge.

The region does not start from a uniform technical base. Some countries operate large land-based systems with established cross-border interconnections, while others rely on fragmented island grids where marine crossings, long radial feeders and weak receiving-end conditions make reinforcement slower and more costly. These structural differences matter as electricity demand rises rapidly, stressing systems that were often designed for centralised generation, lower peak loads and less dynamic operating conditions.

At an operational level, the core challenge is that balancing remains largely national while system conditions are becoming more variable and more demanding. Rising shares of solar PV and wind increase forecast uncertainty and net-load ramps, raising requirements for modern dispatch practices, fast-acting reserves and stronger voltage management. Through 2030, most power systems in the region should be able to accommodate higher shares of variable renewables using proven and relatively cost-effective measures, including improved forecasting, closer-to-real-time dispatch, updated grid codes and stronger monitoring and control. By 2035, however, some countries may reach levels of variable generation at which flexibility, system strength and network visibility become materially more important to maintaining reliable operation.

### Infrastructure requirements

Southeast Asia's geography and climate make grid development technically demanding. Networks must connect dense coastal cities, remote islands, mountainous hydropower locations and rapidly growing industrial and urban demand centres, often across long distances and difficult terrain. At the same time, infrastructure must be designed for harsh operating conditions. Typhoons and tropical storms can damage overhead lines, substations and generation assets. Heavy rainfall and flooding threaten low-lying coastal infrastructure. High humidity, salt air and heat accelerate corrosion, weaken insulation and reduce equipment performance, increasing maintenance requirements and outage risks.

In several key corridors, the most suitable engineering solution will not be conventional AC reinforcement alone. Instead, grid development may depend on submarine cables, long-distance transmission and, in some cases, asynchronous connections better suited to high-voltage direct current (HVDC) technology. Reflecting this, ASEAN's energy ministers called in 2023 for further feasibility work on both inland transmission and subsea cable development. A recent ASEAN Power Grid pipeline study identified a proposed 500 kV, 2.6 GW HVDC Sumatra-Java link by 2031, illustrating the scale and technical complexity of the projects now under consideration. Such links can reduce long-distance losses, connect remote renewable resources to demand centres and strengthen resilience between weakly interconnected subsystems.

## Enabling the Grid

Technical integration is not only a hardware issue. The ASEAN Centre for Energy's 2025 work on LTMS-PIP interoperability highlights that transmission operator co-ordination, congestion management, communications protocols and emergency procedures are becoming central requirements rather than secondary considerations. As cross-border power flows become more dynamic, real-time visibility depends not only on compatible equipment, but also on shared operating procedures, faster data exchange and clearer rules for managing contingencies.

Advanced grid technologies are likely to play a more prominent role in utility planning. Flexible AC Transmission System devices such as STATCOMs, digital monitoring systems and batteries can help improve voltage stability, congestion management, make better use of existing network assets, and can defer some network expansion. In Malaysia, Tenaga Nasional Berhad reported a successful Dynamic Line Rating pilot in 2024 on 132 kV and 275 kV lines, demonstrating how real-time thermal ratings can unlock additional transfer capability. In the Philippines, NGCP's Zamboanga Peninsula Voltage Improvement Project includes a 200 MVAR STATCOM to maintain voltage within prescribed limits in an area characterised by weak system conditions and rising demand.

Distribution networks also require greater attention. Rapid growth in cooling, electric cooking, distributed solar PV and EV charging can create significant low- and medium-voltage challenges, requiring feeder reinforcement, transformer replacement, voltage management, feeder automation, protection upgrades and digital distribution management systems. This is particularly important in archipelagic and island systems, where limited redundancy, last-mile reliability issues and difficult logistics can make distribution reinforcement a binding constraint on electrification.

This build-out depends on supply chains that cannot be mobilised at short notice. Large power transformers, HVDC converters, high-voltage switchgear, cables, protection and control systems all not only require multi-year lead times, but also highly qualified workforces.

## Climate change is projected to exacerbate river flooding risks to Southeast Asia’s energy infrastructure, though resilience measures can mitigate impacts

Southeast Asia’s energy infrastructure is highly exposed to weather-related hazards. Across the region, coastal and river flooding after heavy rainfall often brought by tropical storms and cyclones, regularly causes power outages by damaging power generation assets and electricity networks. For instance, tropical cyclone Yagi in 2024 was responsible for power cuts affecting more than 6.4 million customers in Viet Nam, damaging electricity grids, hydropower and thermal plants assets, with estimated costs of nearly USD 33 million.

IEA analysis shows that nearly 22% of Southeast Asia’s non-hydropower generation capacity, either operational or under construction, is located within a 1-in-500-year river floodplain. More than 52 GW of thermal power capacity, along with nearly 4 GW of solar PV, is exposed to flood risks reaching at least one metre in depth. In addition to power plants, five refineries, accounting for about 10% of Southeast Asia’s capacity, are exposed to river flood risk.

Climate change is expected to exacerbate flood risks to Southeast Asia’s infrastructure, as the region is projected to experience more intense heavy rainfall. As a result, areas currently classified as floodplains are likely to expand and experience higher water levels for a given return period. All the power plants currently located within floodplains in the region are projected to face increases in heavy rainfall in the coming decades. In a scenario consistent with global warming exceeding 3 °C by the end of the century, around 2050, nearly 37% of coal-fired power plants and more than 18% of solar PV installations situated in floodplains are projected to experience increases in heavy rainfall of 10-20% relative to pre-industrial levels.

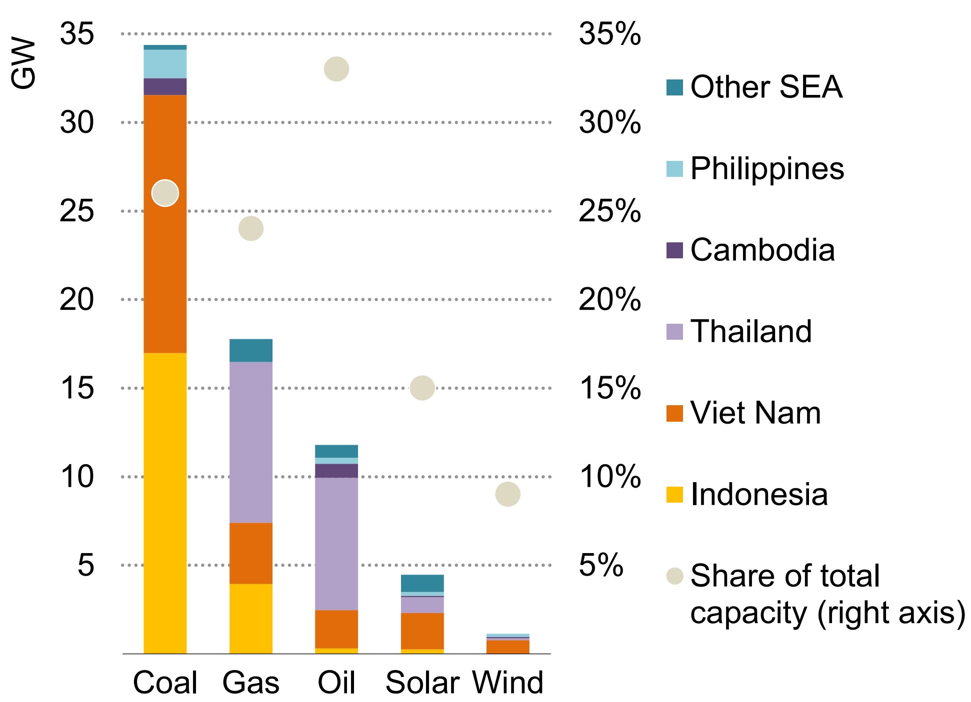
Although adverse impacts of climate change are increasing across the region, they can be avoided or minimised by implementing climate resilience measures. A climate-resilient energy system can prepare for climate change (“readiness”), adapt to and withstand gradual shifts in climate patterns (“robustness”), continue operating during acute shocks from extreme weather events using alternative sources (“resourcefulness”), and restore system functionality following climate-driven disruptions (“recovery”). Despite notable progress in recent decades, the inadequate quality of observation data and climate projections remain a major bottleneck to strengthening the resilience of energy infrastructure against weather-related hazards by mid-century.

## Southeast Asia's power plants face a high exposure to climate hazards, notably flooding

Level of climate hazard and exposure by country in Southeast Asia, 2025

| Country | River flood | Coastal flood | Drought | Tropical cyclone |
|---|---|---|---|---|
| Brunei | 4.8 | 3.3 | 2.1 | 0.0 |
| Cambodia | 8.6 | 3.7 | 4.2 | 1.8 |
| Indonesia | 8.4 | 8.1 | 3.3 | 1.6 |
| Lao PDR | 8.2 | 0.0 | 1.1 | 1.4 |
| Malaysia | 6.8 | 6.4 | 3.1 | 0.0 |
| Myanmar | 8.8 | 8.0 | 0.9 | 5.8 |
| Philippines | 6.7 | 8.9 | 3.5 | 9.2 |
| Singapore | 0.0 | 2.0 | 0.0 | 0.0 |
| Thailand | 9.8 | 5.6 | 5.4 | 1.6 |
| Timor-Leste | 0.0 | 3.3 | 1.9 | 0.5 |
| Viet Nam | 9.9 | 9.6 | 4.5 | 5.9 |
| Global average | 4.5 | 3.5 | 3.4 | 1.6 |

Generation capacity located in a river floodplain by country in Southeast Asia, 2025






Note: Each cell colour in the table indicates the level of climate hazard and exposure. The levels of climate hazard and exposure for river flood, coastal flood, drought and tropical cyclone, are assessed based on the indicators of the INFORM Risk Index 2026 and are defined as Low (0-2.99), Medium (3-6.99) and High (7-10). In the figure, exposure was calculated for floodplains with a 1-in-500-year return period. It includes operational power plants and power plants under construction. Other SEA = Other Southeast Asia.

Sources: IEA analysis based on JRC (2026), INFORM Risk Index; JRC (2024), Global river flood hazard maps; Global Energy Monitor (2025).

# Fossil fuels

# Widening supply gaps in a volatile global oil market heighten energy security risks, reinforcing the importance of demand-side policies as a buffer against potential external shocks

Southeast Asia's oil demand increases significantly to 2050 in both the STEPS and the CPS, with much stronger growth in the latter. Demand stands at 5 mb/d in 2024 (just over 5% of the global total) and rises in the STEPS to around 6.2 mb/d by 2035 and 6.7 mb/d by 2050. In the CPS, demand grows more rapidly, reaching about 8 mb/d by 2050 – around twice the combined oil demand of Japan and Korea – reflecting slower progress on efficiency improvements and a slower pace of electric vehicle adoption.

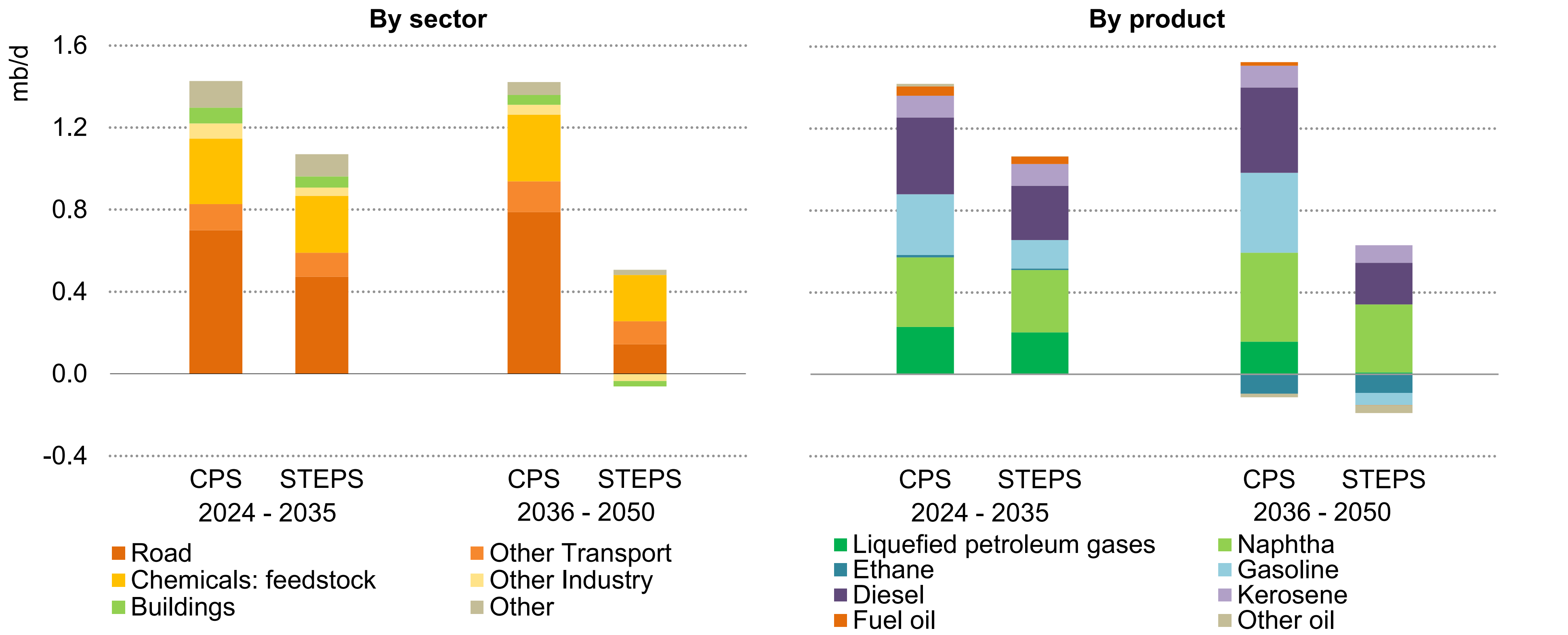
Road-transport fuels dominate growth in all cases: diesel and gasoline use continue rising through mid-century in the CPS, while growth is slower in the STEPS, where the demand is around 10% lower by 2050 compared with the CPS, reflecting faster EV adoption. Building and industrial fuel use grows only modestly in the CPS and flattens in the STEPS. In contrast, oil used for petrochemical feedstock (naphtha) expands steadily in both pathways, at an annual average growth of 2-3% to 2050, keeping overall oil use elevated despite slower transport demand growth. Recent policy actions are already shifting these trends. Thailand's revised EV incentive scheme (2025-27) is boosting EV production and exports, helping to slow petrol demand growth.

On the supply side, Malaysia's state oil firm (Petronas) aims to hold output near 2.0 mb/d through 2026-28, modestly increasing regional oil supply. Exploration activity has also intensified since late 2024. Indonesia reported new discoveries in mature basins such as Rokan and offshore Mahakam, alongside additional licensing rounds covering Sumatra and eastern Indonesia. Viet Nam confirmed a sizeable offshore oil discovery at Hai Su Vang, while Malaysia, Brunei Darussalam and the Philippines launched new bid rounds or awarded service contracts to attract upstream investment. However, most of these finds remain at appraisal or early development stages, and structural decline in ageing fields continues to offset new additions.

As a result, Southeast Asia's import volumes climb sharply. In the STEPS, net oil imports jump by about one-third to 6.7 mb/d by 2035 and continue growing thereafter. Under the CPS, higher demand makes the increase even steeper. The widening import gap, via chokepoints like the Straits of Hormuz and Malacca, underscores the region's growing energy-security challenge.

# Slowing but continuing growth in oil demand reflects diverging transport pathways, with electrification tempering fuel use while petrochemical demand rises

Changes in oil demand by sector and product in Southeast Asia, 2024-2050

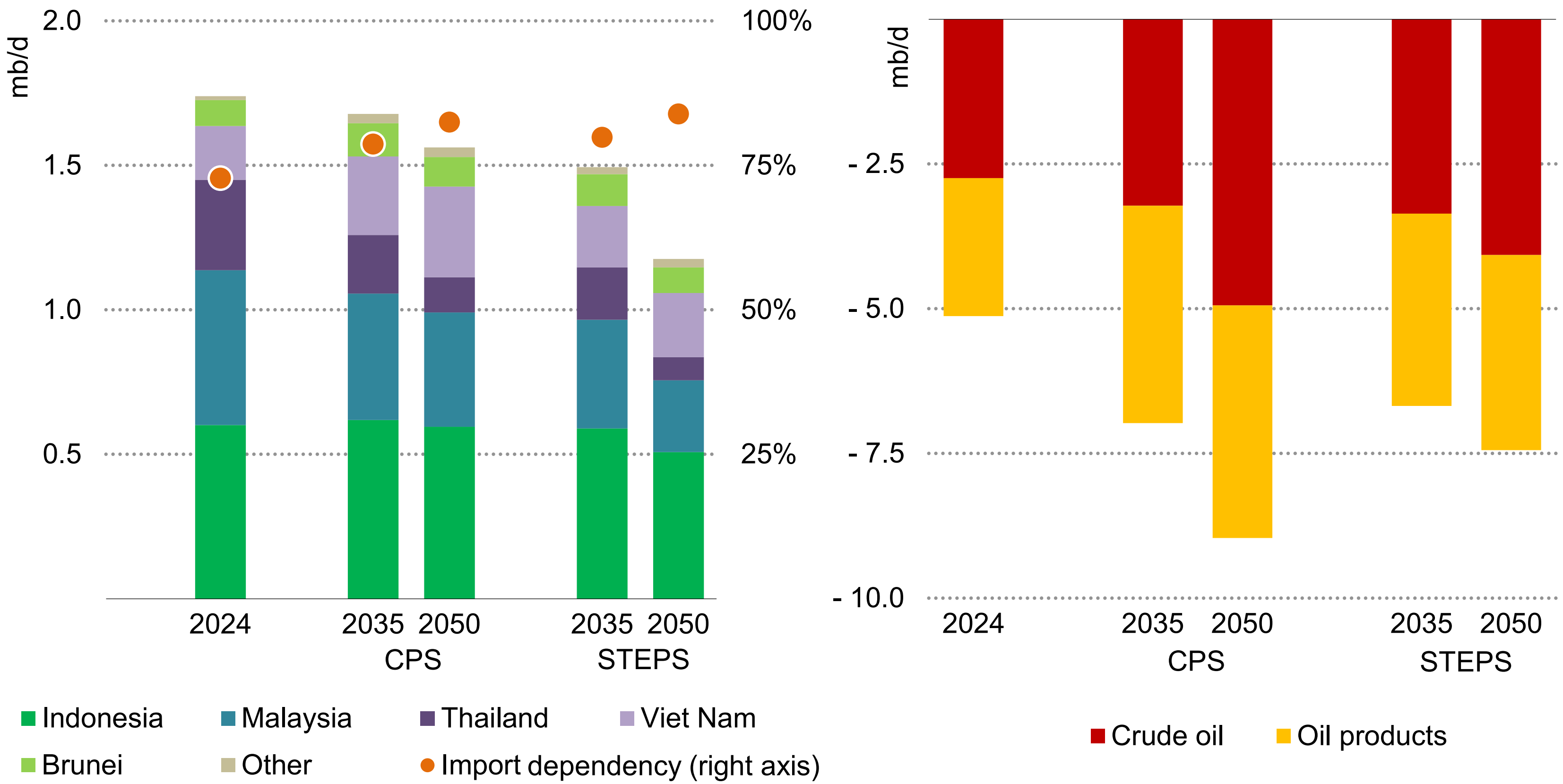





Note: mb/d = million barrels per day. 'Other' includes agriculture, energy sector own use and non-energy uses excluding petrochemical feedstock.

# Continued declines in regional oil production mean imports rise across pathways, as mature fields and limited upstream investment constrain domestic supply

Oil production in Southeast Asia by country and scenario (left) and net trade by type and scenario (right), 2024-2050






Notes: 'Other' includes the Philippines, Myanmar, Cambodia, Lao PDR and Timor-Leste. 'Import dependency' = net oil imports divided by demand including international bunkers. Crude oil includes condensates and natural gas liquids.

## With mature fields declining and new projects insufficient to stabilise output, the region's widening supply gap increases structural reliance on LNG imports in all scenarios

Natural gas remains a central pillar of Southeast Asia's energy system, and one distinctive feature of the regional outlook is the relatively small divergence in demand between the STEPS and the CPS. In many other regions, gas demand in STEPS is more than 10% lower than in the CPS by 2050. In Southeast Asia, by contrast, the gap is limited, reflecting structural factors in the region's power mix and industrial base.

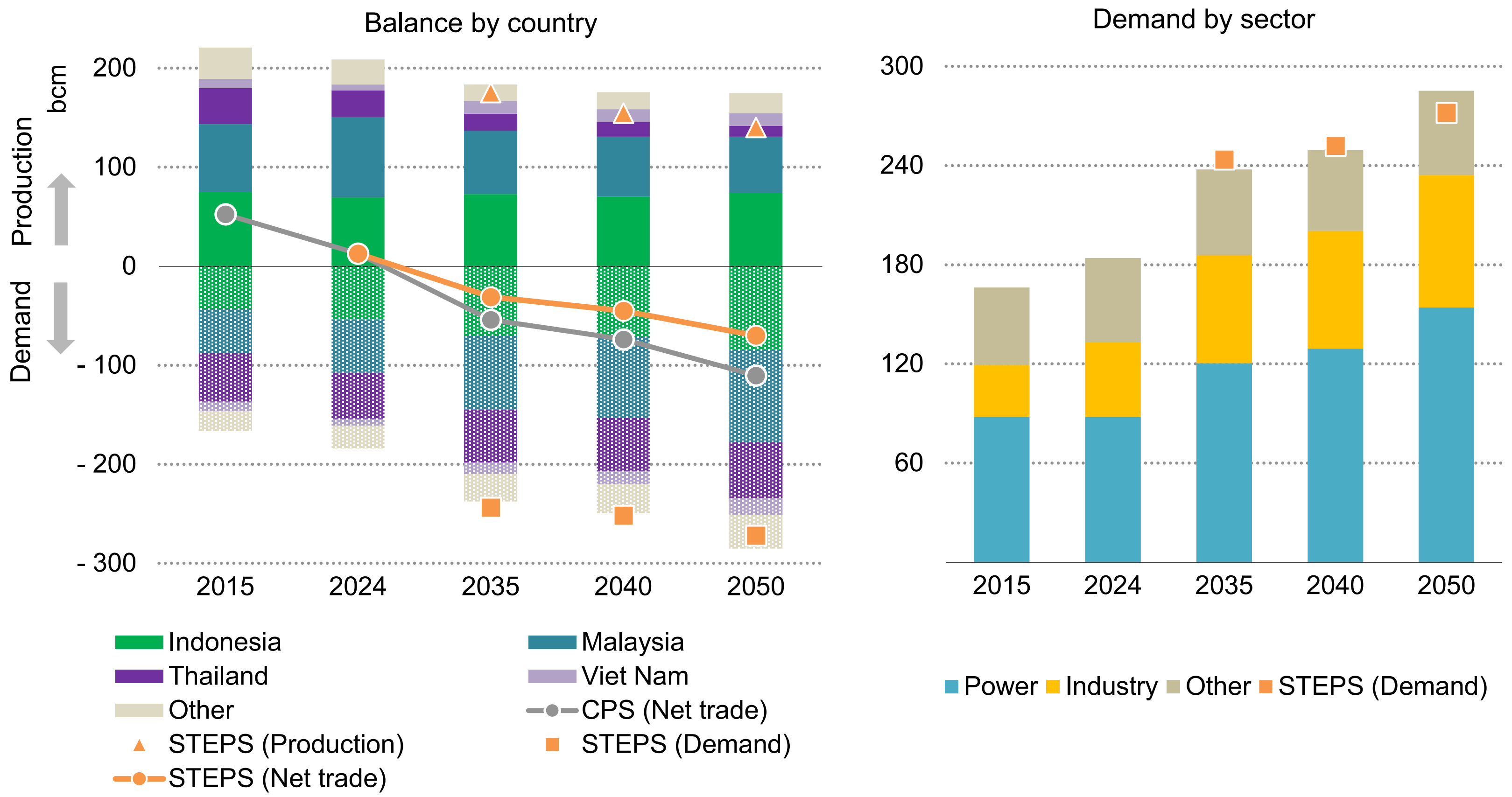
In the STEPS, the price of natural gas imported to Southeast Asia falls by around 30% in the period to 2035 to around USD 7/MBtu. Gas demand increases by more than 30% to 2035, supported by rising electricity consumption, industrial activity and non-energy use such as petrochemicals. Beyond 2035, demand continues to expand, reaching around 1.5 times its 2024 level by 2050. A key driver is coal-to-gas switching in the power sector. As governments implement air-quality and efficiency policies and seek to moderate emissions growth, gas-fired generation expands as a lower-carbon and flexible alternative to coal. Rather than being displaced by renewables at scale, gas in the STEPS plays a complementary role, balancing variable generation while gradually substituting for coal capacity.

In the CPS, gas demand grows at a slightly faster pace and remains marginally higher than in the STEPS by 2050, based on the assumption that gas prices remain 20% above 2024 levels. With weaker policy momentum, coal remains more prevalent, but fast-rising electricity demand and the need for additional firm capacity still support continued build-out and utilisation of gas-fired generation. The region's demand outlook is shaped less by rapid decarbonisation and more by practical fuel substitution within a growing power system.

Regional gas production faces structural decline as mature fields in Indonesia, Thailand, Malaysia and Myanmar deplete. Governments and companies are accelerating upstream investment, including Eni and Petronas projects in Indonesia's Makassar Strait, Malaysia's 2026 exploration bid round, Medco's regional expansion, Brunei's new offshore Block C development and recent discoveries around the Philippines' Malampaya basin. Nonetheless, production falls from about 210 bcm in 2024 to around 175 bcm by 2035 in the STEPS, declining further to 2050. In the CPS, however, stronger upstream momentum enables output to recover gradually, reaching around 200 bcm by 2050. Even so, this increase is insufficient to meet rising demand. As consumption grows faster than supply, Southeast Asia becomes a larger net gas importer, with expanding LNG trade and greater exposure to global market risks. Future gas production also depends on announced projects reaching final investment decisions amid persistent uncertainties due to the Middle East crisis.

# Natural gas demand continues to expand across Southeast Asia in both scenarios, driven by power and industry, reinforcing its role in electricity security and industrial growth

Natural gas balance by scenario (left) and demand by sector (right) in Southeast Asia, 2015-2050

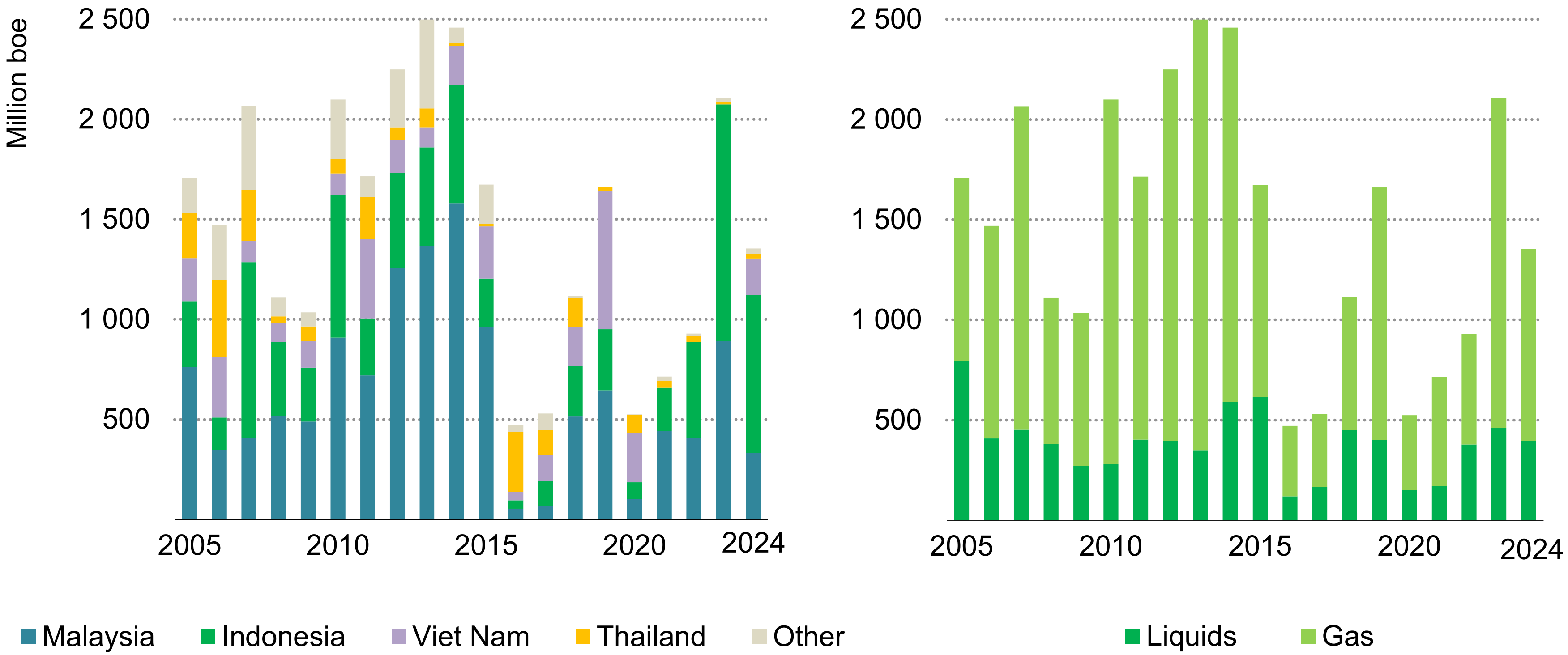





Note: 'Other' (right figure) = the use of energy by transformation industries; bcm = billion cubic metres.

# After a period of slowdown in exploration for new reserves, Southeast Asia has been finding more hydrocarbons following the 2022 crisis

Oil and gas discoveries by country (left) and type (right) in Southeast Asia






Source: IEA's analysis based on Rystad data.
Note: boe = barrels of oil equivalent.

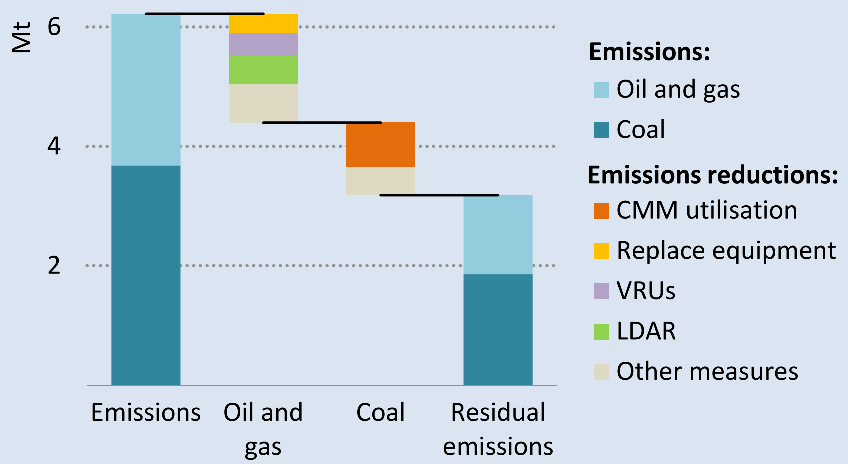
## Reducing methane emissions in the fossil fuel sector and boosting security of supply

The fossil fuel sector in Southeast Asia emitted more than 6 Mt of methane in 2025, with 60% from coal mining and the remainder from oil and gas operations. Indonesia is the largest emitter, accounting for almost 60% of regional emissions, mainly from coal. Methane intensity varies across the region. Viet Nam's coal emissions intensity is more than triple the global average, reflecting limited methane capture. In Indonesia, lower intensities are offset by the dominance of surface mining, where abatement options are limited. Oil and gas methane intensities are generally close to the global average, indicating some progress in mitigation efforts.

Policy momentum is building. Most countries have joined the COP26 Global Methane Pledge and several national oil companies are signatories to the COP28 Oil and Gas Decarbonization Charter. Viet Nam, the Philippines and Cambodia have announced plans to tackle methane emissions, including measures to capture and utilise associated gas. Regional cooperation is also strengthening, through initiatives such as the ASEAN Energy Sector Methane Leadership Programme.

The opportunity for action is substantial. Deploying existing methane abatement technologies could reduce fossil fuel emissions in Southeast Asia by 50%. In oil and gas operations, more than 80% of emissions reductions could be achieved at no net cost to producers. In addition to cutting emissions, applying these measures in gas operations alone could enhance energy security, by bringing close to 2 bcm of gas supply to market, equivalent to 15% of Singapore's total gas demand in 2024.

### Methane emissions abatement potential, Southeast Asia, 2025






Note: CMM = Coal mine methane; LDAR = Leak detection and repair; VRUs = Vapour recovery units; Other measures include improved flaring, blowdown capture, associated gas utilisation, and monitoring and plugging abandoned wells.

# Coal remains a mainstay of power generation, but new capacity increasingly uses higher-efficiency technologies which reduce the amount of coal needed per unit of power produced

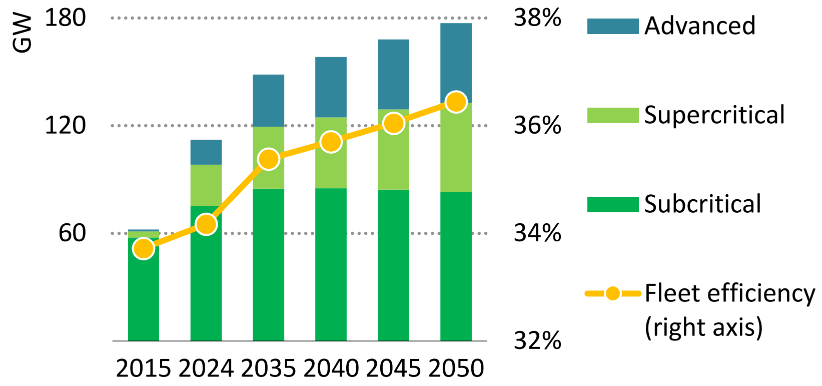
Coal remains an essential component of Southeast Asia's energy system in both the CPS and the STEPS, reflecting strong growth in electricity demand and the continued role of coal-fired generation in several power systems. Regional coal demand rises steadily in the CPS, increasing from around 340 Mtce in 2024 to roughly 460 Mtce in 2035, and continuing to expand thereafter. In the STEPS, demand growth slows after the mid-2030s as alternative generation technologies gain market share.

Coal demand growth in Southeast Asia is fundamentally a power generation story. Rapid economic expansion and electrification drive electricity consumption higher across the region, particularly in Indonesia, Viet Nam and the Philippines. Coal remains an important source of baseload power in several countries because of its cost competitiveness and the presence of a large existing coal fleet, which averages under 15 years old across the region.

On the supply side, Southeast Asia remains heavily dependent on Indonesian production. Indonesia accounts for the bulk of regional coal output, producing around 610 Mtce in 2024 at relatively low production costs. However, rising domestic demand gradually absorbs a larger share of this production. As a result, the region's net export position narrows over time, reflecting a structural shift from export-oriented supply towards greater regional consumption.

The technology profile of new coal-fired capacity evolves in the CPS. While some subcritical plants continue to be deployed, most new additions rely on supercritical and advanced technologies. By 2050, these higher-efficiency technologies account for the majority of the coal fleet, raising average plant efficiency from 34% in 2024 to over 36% by 2050 (35% in the STEPS where fewer new capacity additions limit efficiency gains). This improvement reduces coal consumption per unit of electricity generated, although efficiency gains are not sufficient to offset the impact of rising electricity demands.

### Installed coal-fired capacity by technology and average fleet efficiency in Southeast Asia in the Current Policies Scenario

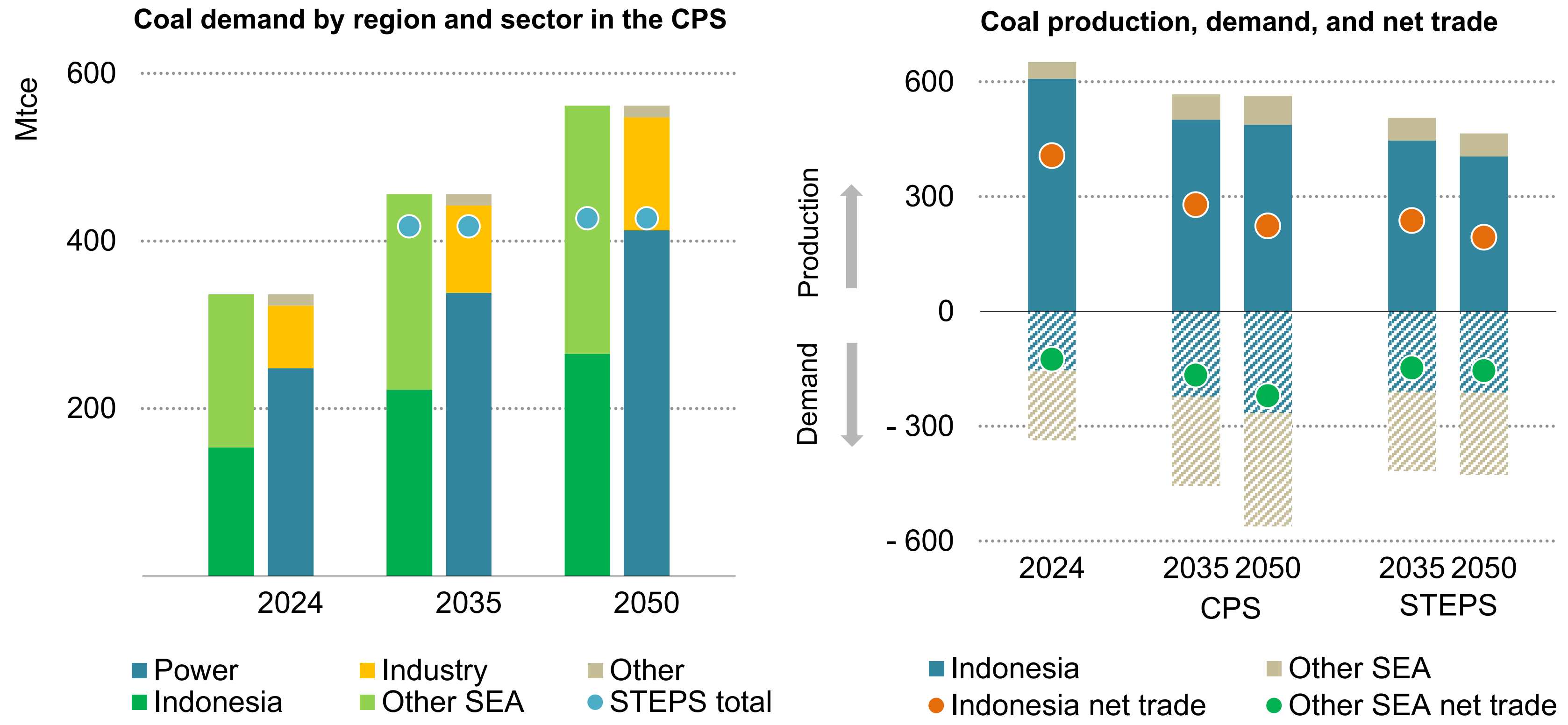





Note: 'Advanced' includes integrated gasification combined cycle and ultra-supercritical plants.

# Coal demand growth in Southeast Asia steadily absorbs Indonesia's export surplus, narrowing the region's net export position despite only moderate declines in Indonesian production

Coal demand (left) and coal production, demand and net trade (right) by scenario in Southeast Asia, 2024-2050






Note: Other SEA = Other Southeast Asia. CPS = Current Policies Scenario. STEPS = Stated Policies Scenario. Mtce = million tonnes of coal equivalent.

# As Indonesia's exportable surplus tightens, Southeast Asia's coal markets become more sensitive to supply disruptions and price volatility

Indonesia's pivotal role in global coal markets means that developments in its domestic demand and export policies have implications well beyond Southeast Asia. Indonesian coal production declines gradually over the projection period, falling from around 610 Mtce in 2024 to roughly 490 Mtce in 2050 in the CPS. Combined with rising regional demand, this trend tightens Indonesia's exportable surplus and reinforces the country's pivotal role in regional coal markets.

This shift has important implications for regional energy security. Several Southeast Asian economies are expected to see continued growth in coal use in the power sector while their domestic coal production remains limited. Countries such as Viet Nam and the Philippines therefore rely increasingly on imported coal to meet power sector needs.

Recent market developments have illustrated the strategic importance of Indonesian supply in the global coal market. Temporary export restrictions introduced to prioritise domestic deliveries have at times tightened seaborne markets and contributed to price volatility. Such disruptions highlight the limited ability of other exporters to rapidly compensate for interruptions in Indonesian shipments, reinforcing Indonesia's role as a key balancing supplier in the international coal trade.

Over the projection period, both CPS and STEPS point to a gradual tightening of Southeast Asia's coal trade balance. While the region remains a net exporter in the near term, rising domestic demand steadily reduces export availability. By mid-century, the gap between regional production and consumption narrows significantly in the CPS, underscoring the increasing importance of Indonesian supply dynamics for both regional and global coal markets.

In this context, the resilience of coal supply chains becomes an important consideration for energy security. Import-dependent countries face growing exposure to market volatility, particularly in periods when supply disruptions or policy changes affect major exporters. At the same time, improvements in coal plant efficiency and diversification of power generation sources can help mitigate some of these risks by moderating the growth of coal demand in the power sector.

# Energy outlook to 2050 based on targets and pledges

# Overview

## Achieving announced pledges requires stronger policies that accelerate structural changes in the energy system, bringing forward peaking and then sustained decline of emissions

In the Announced Pledges Scenario (APS) – where countries meet their energy and climate targets in full and on time – total energy demand growth averages 2% per year to 2035 and slows to around 1% per year to 2050, reflecting stronger efficiency gains and electrification across end-use sectors. Clean energy meets most of the incremental demand growth, raising its share in the energy mix to around 30% by 2035 and around 70% by 2050. These trends are consistent with the region's announced climate targets, including new Nationally Determined Contributions (NDCs) from six of the eleven Southeast Asian countries, as well as regional goals such as the ASEAN Plan of Action for Energy Cooperation (APAEC) 2026-2030, which targets a 30% renewable share in total primary energy supply and 45% share in installed power capacity, and a 40% reduction in energy intensity by 2030 relative to 2005.

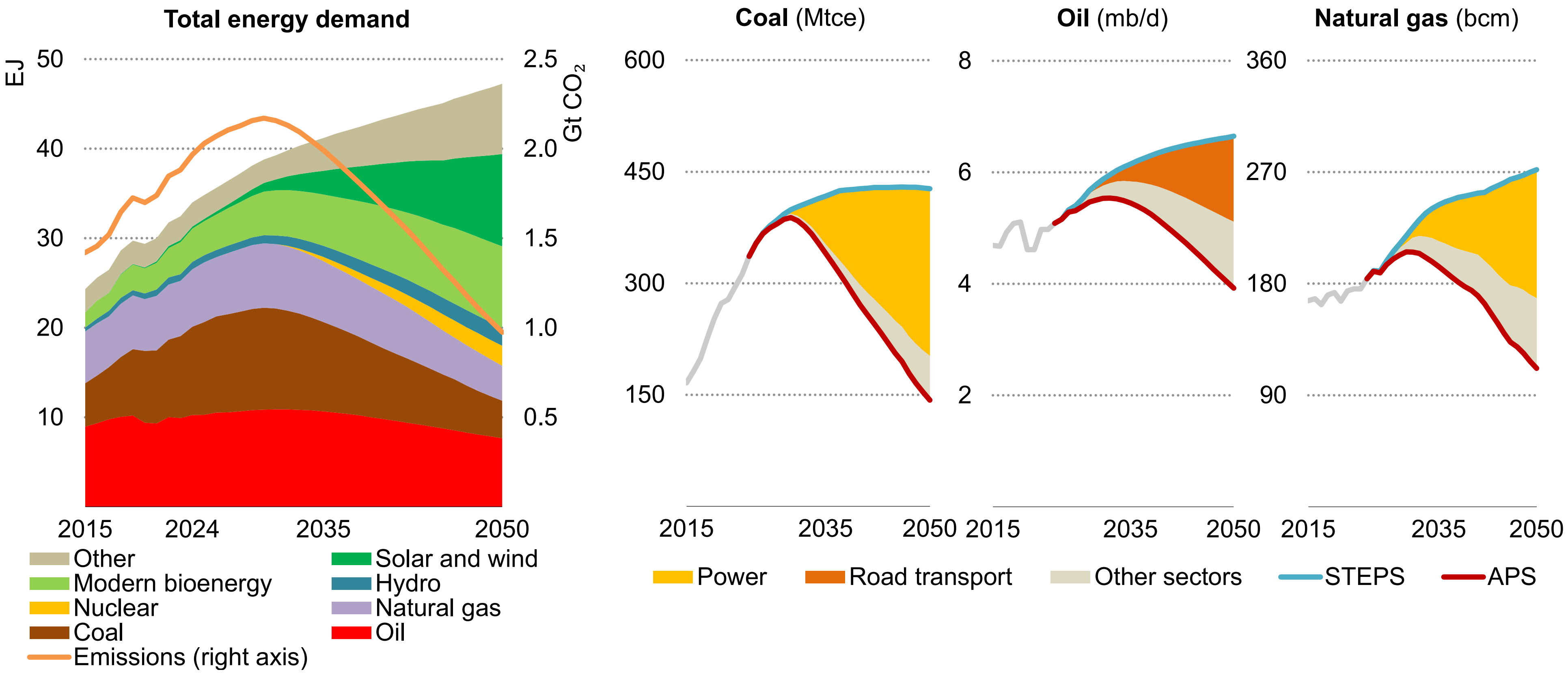
In this scenario, coal demand peaks around 390 Mtce by 2030 and declines sharply thereafter, falling to 140 Mtce by 2050, reflecting a very rapid build-out of low-emissions sources of power, led by renewables. Oil demand peaks in the early 2030s and declines to approximately 3.9 mb/d by 2050, driven by electrification in transport and continued efficiency improvements. Natural gas demand increases more gradually in the near term, reaching a peak of 205 bcm around 2030, before declining to approximately 110 bcm by 2050 as low-emissions alternatives expand and system flexibility requirements evolve.

These shifts result in an earlier peak and sustained decline in emissions. Energy-related $CO_2$ emissions peak around 2030 and fall to 1 Gt $CO_2$ by 2050, while emissions continue to rise in the Current Policies Scenario (CPS) and the Stated Policies Scenario (STEPS) to over 3 Gt $CO_2$ and 2.5 Gt $CO_2$, respectively, by 2050. The decline in emissions is driven by both structural changes in the energy mix and improvements in energy intensity, as electrification and efficiency gains reduce the link between economic growth and energy consumption.

Across sectors, the power system accounts for the largest transformation, with renewables becoming the dominant source of generation growth and coal-fired output declining in absolute terms. In transport, oil demand is increasingly displaced by electricity, particularly in road transport, while in industry and buildings, rising electrification alongside efficiency improvements and fuel switching contribute to lower emissions. Delivering these outcomes requires sustained investment in grids, storage and system flexibility, alongside continued policy support to ensure that announced targets translate into realised deployment.

# Clean energy sources meet the largest share of demand growth, shifting Southeast Asia's energy mix towards electricity and low-emissions fuels

Energy demand and $CO_2$ emissions in Southeast Asia in the Announced Pledges Scenario (left), and fossil fuel demand drivers in the STEPS and APS, 2015-2050 (other charts)

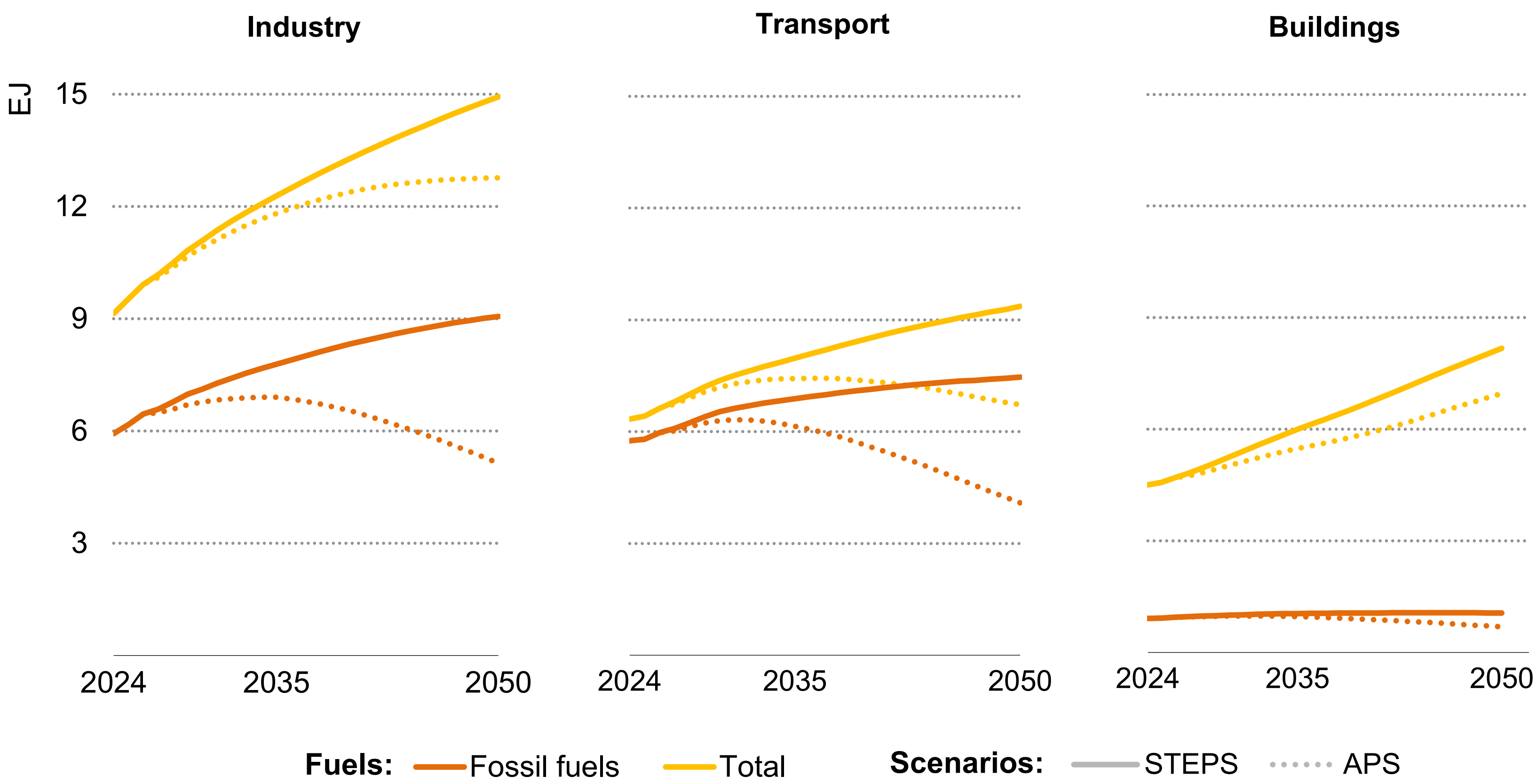





Note: EJ = exajoule; Gt $CO_2$ = gigatonnes of carbon dioxide. 'Other' includes traditional use of biomass, geothermal, marine and solar thermal. Mtce = million tonnes of coal equivalent; mb/d = million barrels per day; bcm = billion cubic metres.

## Under stated policies, fossil fuel use continues to grow through 2050, whereas achieving announced pledges would see peak fossil fuel demand before 2035 across all end-use sectors

Total final consumption in end-use sectors by fuel and scenario in Southeast Asia, 2024-2050






Notes: International aviation and shipping are excluded. EJ = exajoule; STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario.

## Rapid electrification shifts end-use consumption patterns and reduces fossil fuel dependence, helping Southeast Asia avoid oil import volumes equivalent to today's levels by 2050

Strong growth in Southeast Asia's services demand raises total final energy consumption from 21 EJ today to 28 EJ by 2035 in the STEPS. Of this, the fossil fuel share declines only slightly from 65% to 62%. In the APS, energy use grows more slowly due to faster electrification and efficiency gains aligned with climate targets, reaching 26 EJ by 2035, with fossil fuel demand peaking within the next decade and falling to a 58% share. By 2050, fossil fuel demand in end-use sectors rises to over 19 EJ in the STEPS but falls to around 10 EJ in the APS, or less than 40% of total final consumption. This structural shift cuts imported fossil fuel needs, with Southeast Asia importing 4 EJ less by 2050 in the APS compared to the STEPS, resulting in USD 160 billion smaller fossil fuel import bill in that year.

**Industry** energy demand in Southeast Asia grows more than in any other end-use sector in the APS, rising by 40% to 13 EJ by 2050, with electricity demand more than doubling from today's levels, driven by higher activity and electrification of non-energy-intensive sectors. As eight countries in the region advance towards their net zero targets, higher $CO_2$ prices and the gradual phase-out of fossil fuel subsidies raise fossil energy costs, while stricter efficiency standards, fiscal incentives, investment support and declining renewable electricity costs accelerate industrial electrification and efficiency gains. Electrification in energy-intensive industries, which remains limited in the STEPS – rising from 10% today to 13% by 2050 (see Chapter 2) – exceeds 20% in the APS, reducing industry coal demand by around 30% by mid-century. In cement, aluminium and nickel processing, coal use declines significantly due to electrification of process heat and greater use of natural gas, including coal-to-gas switching for processes at high temperatures. In iron and steel production, where coal use increases by around 85% in the STEPS, electrification and the use of natural gas in the APS keep coal demand close to today's levels by 2050, despite output more than doubling. Decarbonisation efforts also moderate natural gas demand, with industry consumption declining by 5% to 2050 instead of rising by 70% in the STEPS, reducing LNG import needs. Overall, lower energy and emissions intensity enhance industrial competitiveness and attract investment in clean energy technology manufacturing and low-carbon value chains (see Chapter 4), while a more diversified energy mix improves Southeast Asia's resilience to price volatility and supply disruptions.

**Transport** energy demand in Southeast Asia is around 5% higher in 2050 than today in the APS, reaching less than 7 EJ, despite the car fleet doubling and the truck fleet expanding by over 50%. This contained growth is driven primarily by rapid electrification, with electric vehicles (EVs) rising from 1% of the car fleet today to 75% by 2050, compared with 65% in the STEPS. Ambitious policy targets across the region support this shift, with Indonesia aiming for 2 million electric cars and 13 million electric motorcycles by 2030, Viet Nam targeting net zero transport by 2050, Thailand planning 100% zero-emissions vehicle car sales by 2035, Singapore preparing to phase out internal combustion engine (ICE) car sales by 2040, Malaysia targeting an 80% EV sales share by 2050, and Cambodia also advancing EV uptake. Falling battery costs and rising oil prices further strengthen EV competitiveness.

In the APS, electric two- and three-wheelers reach 80% of the fleet by 2050, and electric trucks reach 10%, compared with 60% and 5%, respectively, in the STEPS. Strong EV deployment supports Southeast Asia's goal to become a major hub for battery and EV manufacturing, underpinned by growing domestic markets, supportive policies and committed battery manufacturing capacities. Electrification is reinforced by expanding high-speed rail in Thailand, Viet Nam, Malaysia, Indonesia and Cambodia with network lengths in the APS around 3.5 times that of the STEPS by 2050. Biofuels continue to grow, largely driven by Indonesia's blending mandates, reaching about 15% of transport energy demand by 2050 and supporting emissions reductions and domestic value chains. These shifts deliver major energy security benefits, with EVs and biofuels displacing around 3 mboe/d of oil demand by 2050 – an amount equivalent to Southeast Asia's current crude oil imports. The transport sector's oil share falls from 90% today to around 80% in the APS, with demand peaking before 2035, whereas in the STEPS it only declines to 85% as oil demand continues to rise.

**Buildings** energy demand in Southeast Asia rises 55% to reach 7 EJ by 2050 in the APS. Electricity demand grows more than in any other end-use sector, with its share in buildings increasing from 55% today to 85% by 2050, compared with 80% in the STEPS. Rapid growth in appliance ownership – particularly air conditioners (AC) – drives a sharp increase in electricity use for cooling, which becomes one of the fastest-growing components of energy demand across all end uses. This growth is reinforced by the expanding electrification of cooking and heating, which reduces reliance on LPG imports, as LPG demand in buildings falls 35% by 2050 in the APS instead of increasing by around 5% in the STEPS. The share of oil use in the sector is cut in half, accounting for less than 10% by 2050, while natural gas consumption declines and coal is phased out.

Progressively tighter minimum energy performance standards (MEPS) and expanded labelling programmes are set to accelerate the uptake of energy-efficient electrical equipment in buildings including air conditioners and lighting. At the same time, financial factors such as clean cooking programmes and rising fossil fuel costs encourage the electrification of cooking and water heating in buildings. In the APS, the use of traditional biomass declines nearly three times faster than in the STEPS, as a 5-percentage-point higher share of the population gain access to clean cooking and near-universal access is achieved by 2050. Electrification and efficiency improvements fundamentally reshape the use of energy in buildings, reducing fossil fuel import dependence and improving air quality across the region.

# Clean electrification

# Achieving announced pledges leads to rapid electrification, supported by digitalisation and smart infrastructure which help curb rising electricity demand

Electricity demand in Southeast Asia is set to rise sharply over the coming decades. By 2035, demand increases by around 60% in the STEPS and 70% in the APS. By 2050, electricity demand more than doubles in the STEPS relative to today and triples in the APS, reaching around 4 000 TWh per year. Faster growth in the APS reflects a much higher rate of electrification: electricity's share in final consumption rises from one-quarter today to nearly half by 2050, compared to one-third in the STEPS.

Patterns of demand also differ across sectors. In the STEPS, buildings account for 60% of electricity demand growth to 2050, whereas in the APS this share is lower at 35% due to rapid electrification in other sectors. By 2050 in the APS, electricity demand increases by nearly 900 TWh in industry and 400 TWh in transport. While rail accounts for more than half of transport electricity use today, road transport grows rapidly, becoming the main user by 2050.

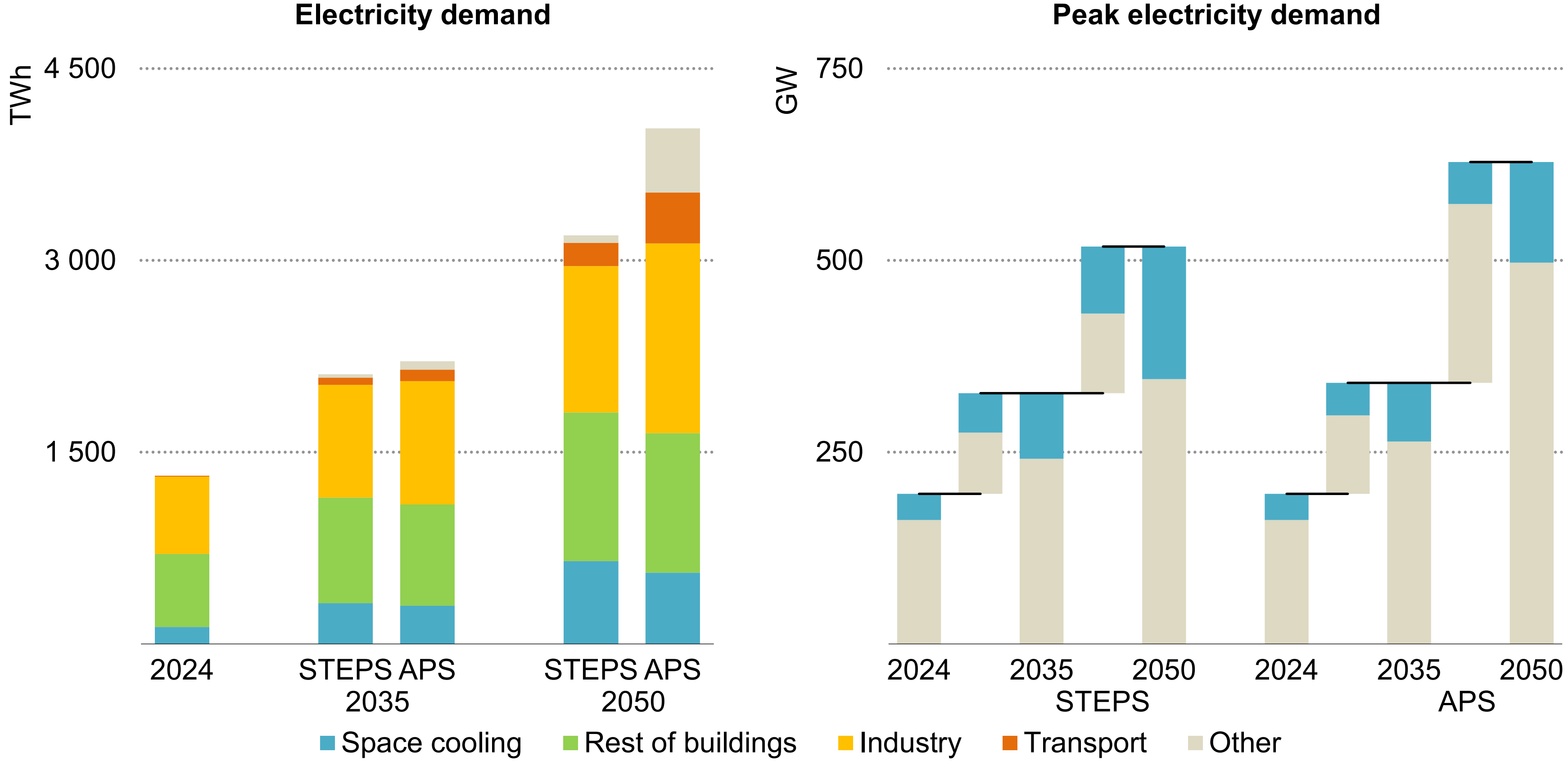
National targets and plans across the region emphasise electrification as a core pillar of long-term energy and climate strategies. Viet Nam's Energy Efficiency Programme and Thailand's Energy Efficiency Plan promote the adoption of energy management systems in buildings and industry alongside electrification, while Malaysia's National Energy Transition Roadmap outlines transport electrification. These trends have major implications for peak electricity demand, which grows faster than overall electricity demand, reflecting time-concentrated end uses such as cooling.

Digitalisation and demand-side flexibility can mitigate growth in peak demand. Flexible end uses, including space cooling and EV charging, can provide demand response by shifting consumption to off-peak hours. In the STEPS, space cooling adds almost 150 GW to peak electricity demand growth and makes up one-third of peak demand by 2050; in the APS, its share is lower at one-fifth due to more efficient AC and better insulated buildings. Promoting energy efficiency can lower both the peak and overall electricity demand. ASEAN has set an ambitious harmonised target to raise the cooling seasonal performance factor of new ACs to 6.09 watt-hours per watt-hour (Wh/Wh) by 2030. Mandating energy management systems in industries and buildings enables real-time monitoring and facilitates participation in demand response programmes.

Urbanisation further shapes future electricity demand, with the share of the urban population rising from half today to two-thirds by 2050. This creates opportunities for integrated urban planning, including the deployment of digital technologies, smart grids, demand-side flexibility and storage, and energy-efficient solutions such as smart lighting. Regional initiatives such as the ASEAN Smart Cities Network can accelerate deployment and share best practices across cities.

# Implementing announced pledges drives a tripling of electricity demand by 2050, while space cooling makes up one-third of peak electricity demand under stated policies

Electricity demand and peak demand growth in Southeast Asia for the Stated Policies Scenario and Announced Pledges Scenario, 2024, 2035 and 2050






Note: 'Other' includes hydrogen production.

## In the APS, low-emissions sources provide around 90% of Southeast Asia's electricity by 2050

Electricity generation rises rapidly in the APS, from around 1 460 TWh in 2024 to about 2 450 TWh in 2035 and nearly 4 600 TWh by 2050. Growth is stronger than in the STEPS and the faster transition reflects climate and energy pledges: eight countries in Southeast Asia have economy-wide net zero targets, including the region's largest electricity systems – Viet Nam (2050) and Indonesia (2060 or earlier). Viet Nam's revised Power Development Plan 8 raises ambitions for wind, solar, storage and nuclear power, while Indonesia's 2025 National Electricity Plan (RUKN) provides a long-term pathway for increasing low-emissions generation. As a result, the electricity mix shifts much more rapidly in the APS: low-emissions sources rise from around one-quarter of generation in 2024 to just over half in 2035 and around 90% in 2050.

Renewables account for most of the increase, led by solar PV and wind. Solar PV generation rises from 44 TWh in 2024 to more than 450 TWh in 2035 and nearly 1 750 TWh in 2050, while wind increases from 18 TWh to over 270 TWh in 2035 and more than 1 080 TWh in 2050. Together, they provide almost 30% of generation by 2035 and more than 60% by 2050, far above their share in the STEPS.

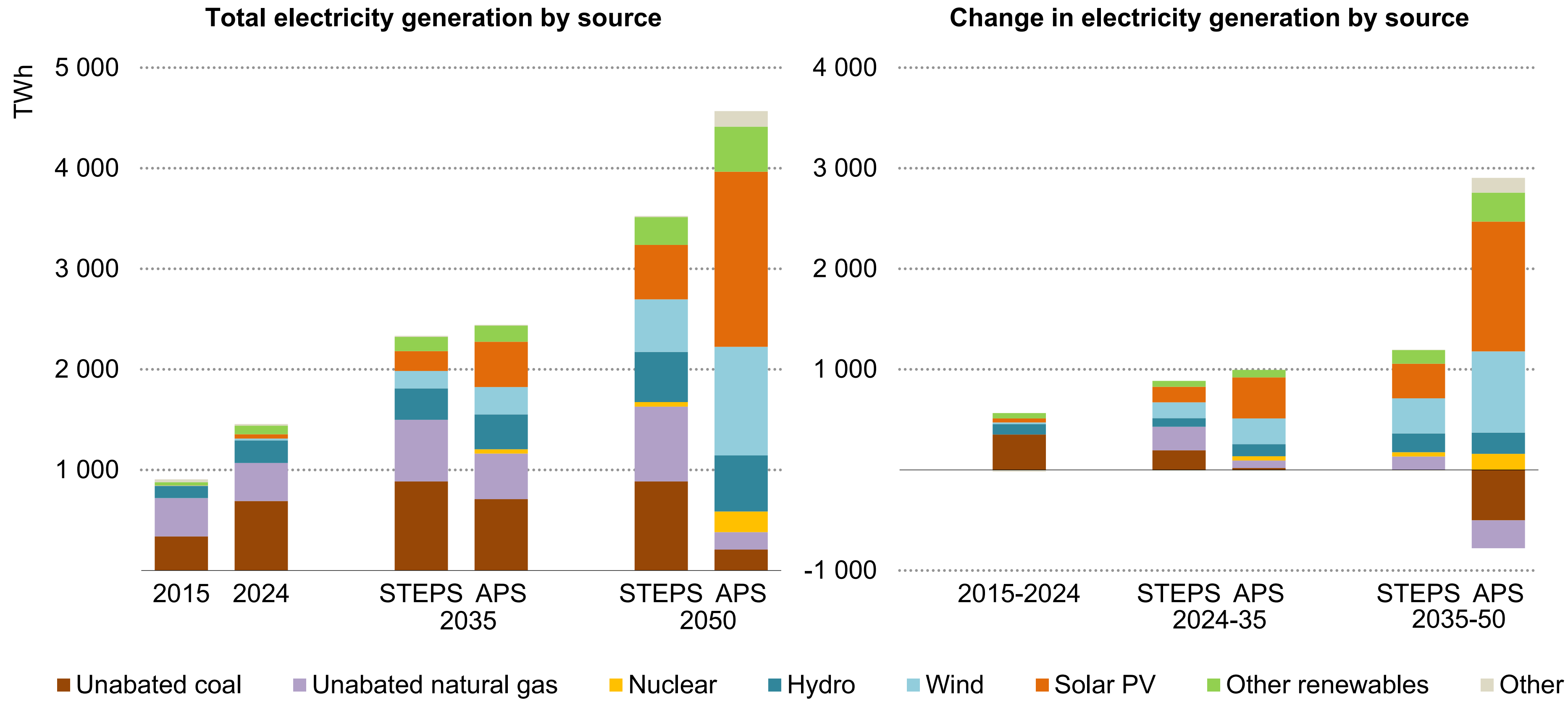
Meeting demand growth and integrating this surge in variable renewables requires significant grid reinforcements: regional transmission and distribution capacity expands more than two-and-a-half-fold up to 2050. It also requires more flexible operation of existing plants, as well as storage and demand response. Battery storage in particular helps integrate solar PV, with installed capacity rising from just over 1 GW in 2024 to more than 60 GW in 2035 and over 300 GW in 2050. Hydropower remains a major pillar of low-emissions supply in the APS, with output rising from 225 TWh in 2024 to nearly 560 TWh in 2050. Other renewables also expand steadily, from 84 TWh in 2024 to almost 450 TWh in 2050, led by bioenergy, with additional geothermal in Indonesia and the Philippines. Several countries – notably Viet Nam, Indonesia and the Philippines – plan to commission nuclear reactors, with the first units scheduled to come online after 2030. Installed nuclear capacity rises to nearly 30 GW by 2050 in the APS, generating just over 200 TWh.

As low-emissions generation expands, unabated coal and natural gas-fired power plants pivot from providing bulk electricity to adequacy and flexibility. Coal generation rises only marginally to 2035 before declining steeply as no new unabated plants are added and some units are retired or converted to co-fire ammonia and biomass. Compared with the APS in 2024 Outlook, coal generation peaks later and at a higher level, reflecting recent growth and an extended project pipeline for captive coal in Indonesia. Output falls to around 240 TWh in 2050, leaving coal at just over 5% of total generation, compared with around one-quarter in the STEPS. Gas follows a similar trajectory, increasing modestly to 2035 before declining to around 190 TWh by 2050 as renewables and nuclear displace thermal generation. By 2050, gas accounts for around 4% of the mix in the APS, compared with more than 20% in the STEPS. Some coal and gas plants are retrofitted with carbon capture, utilisation and storage (CCUS) and contribute around 1% to the regional electricity mix in 2050.

As countries in the region scale up wind and solar power generation, several are moving from feed-in tariffs (FiTs) towards competitive procurement for utility-scale projects. Cambodia, Malaysia, Thailand and the Philippines have used competitive tenders for multiple types of renewables, while Viet Nam is developing auction-based procurement for solar PV and wind. Almost 19 GW of renewable capacity have been awarded in 2025, led primarily by the Philippines' Green Energy Auctions and by Malaysia's Large Scale Solar Photovoltaic (LSSPV) programme. These tenders typically require developers to compete on price, with selected projects awarded long-term power purchase agreements (PPAs). Competitive procurement has improved price discovery and helped expand utility-scale solar PV and onshore wind at lower cost. While underlying conditions, challenges and the governance landscapes differ across regions, India offers a case study on how it scaled up renewable power generation capacity, and how its grid balancing needs have evolved.

# Most of the growth in electricity generation in Southeast Asia in the APS comes from wind and solar PV, while coal and gas decline after 2035

Total electricity generation (left) and change in electricity generation (right) in Southeast Asia by source and scenario






Notes: TWh = terawatt-hours. 'Other renewables' include bioenergy and renewable waste, geothermal, concentrating solar power and marine power. 'Other' includes fossil fuels with carbon capture, hydrogen and ammonia, non-renewable waste and other sources.

## How large-scale renewable energy auctions reshaped India's electricity system

In 2025, India achieved its target of installing 50% non-fossil power generation capacity five years ahead of schedule. This was met to a significant extent by surging solar PV and wind, which together accounted for three-quarters of total capacity additions over the past five years.

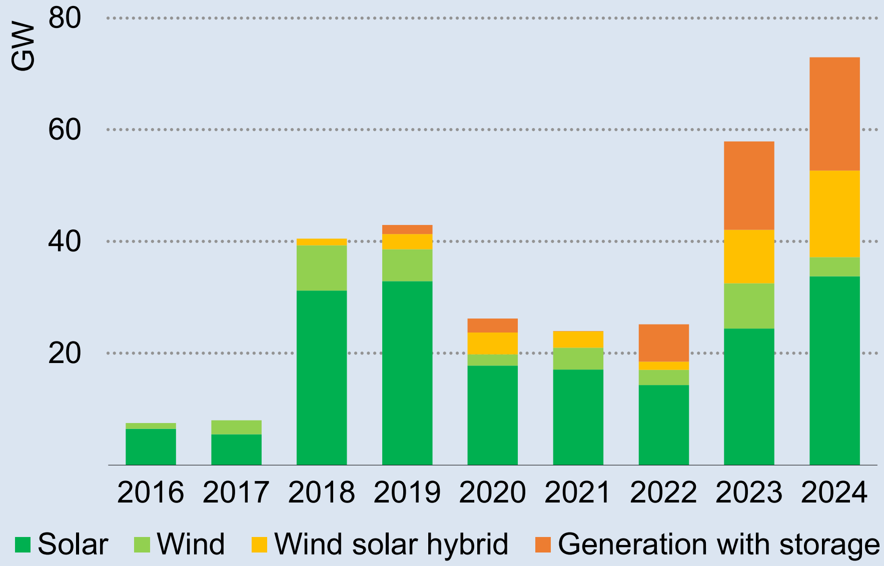
India's successful rollout of renewable energy expansion has rested on three pillars: clearly defined targets, a range of complementary policies and institutional capacity to facilitate the rollout.

First, the government set long-term capacity targets for non-fossil capacity: the updated target currently stands at 500 GW by 2030. This signal created a predictable pipeline for investors, developers and manufacturers.

Second, policies such as Renewables Purchase Obligations with forward trajectories compelled distribution companies to increase renewable procurement, while Green Open Access Rules enabled commercial and industrial consumers to buy renewable power directly from developers, broadening demand beyond utilities. On the manufacturing side, the Production-Linked Incentives scheme incentivised domestic manufacturing of solar PV modules and wind turbines.

Third, public institutions such as SECI and NTPC have issued renewable energy tenders, while IREDA has supported deployment through concessional financing, credit enhancement and refinancing options. The involvement of these institutions has helped reduce risk and unlocked new investment in this sector.

**Renewable energy tender issuance in India, 2016-2024**






Note: Generation with storage includes hybrid projects with generation from solar – or wind and solar – with storage.
Source: IEA analysis based on JMK Research & Analytics, and IEEFA.

India's auction strategy, which has been critical to its success, has evolved over the years to respond to the changing nature of India's needs and the market realities. Its auction framework has moved from being technology-specific and volume-driven to system-oriented procurement. It progressively introduced hybrids, storage, round-the-clock power, and finally auctions that deliver firm, dispatchable clean power rather than just megawatts of capacity.

India's modern competitive tendering system for generation from solar began in 2010. In the initial years, utility-scale auctions largely focused on expanding capacity to cater to the needs of individual states. Auctions later in this period turned their attention to projects that fed directly into inter-state transmission lines, thereby allowing resource-rich states to cater to demand nationally.

Since 2018, India's renewables auctions moved to leverage on various generation technologies and storage together to help smooth out electricity output and help manage an increasingly complex grid. At first, wind-solar hybrid auctions, and then round-the-clock renewable tenders that deployed wind, solar and storage together were introduced.

More recently, since 2023, India launched Firm and Dispatchable Renewable Energy (FDRE) auctions, which required pre-defined demand profiles served by renewable power and supported by storage. In other words, under this auction framework, developers are required to supply clean electricity at specific hours aligned with the distribution companies' demand patterns, helping them manage variability and meet peak hour demand.

As a result of its tendering programme, other supportive policies, domestically available capital and falling technology costs, India has seen expanding renewable energy capacity. The discovered tariffs through this tendering programme have fallen for key technologies, including solar, wind and storage. For example, utility-scale stand-alone energy storage system tariffs declined by 80% over a two-year period.

However, despite this broad success that has helped India meet its interim target of 50 GW of tendered capacity in 2024, there have been challenges which contributed to India missing its annual target in 2025. A share of capacity awarded in this period did not have signed agreements with distribution companies to purchase this power. Additionally, due to the complexity of the tenders, there was undersubscription and cancellations of some of the capacity tendered out under the FDRE route.

Nonetheless, as India further works to address these challenges, the innovations of the tendering system illustrate the policy responsiveness to India's evolving grid and demand conditions, and the far-reaching success of its renewable energy programme.

# Energy efficiency

## After a decade of slow progress, stated policies should now bring a faster pace of efficiency improvement, but much more is needed to meet national pledges

Southeast Asia's energy intensity improved by only 0.1% per year between 2015 and 2024, far below the global average of 1.4% and well short of the COP28 target of more than 4% annual gains by 2030. In the STEPS, efficiency gains accelerate markedly, driven by increasing electrification in transport, buildings and non-energy-intensive industries. Energy intensity falls by 1.7% per year to 2035, limiting demand growth to 10 EJ over the next decade and 21 EJ by 2050. By contrast, without technical efficiency improvements, electrification, fuel switching or structural changes, the region's strong economic growth would drive up regional energy demand by around 12 EJ (35%) by 2035 and 27 EJ (80%) by 2050.

In the APS, the achievement of national commitments delivers even greater savings than in the STEPS. Ten of the 11 Southeast Asian countries have energy efficiency or savings targets extending to between 2030 and 2060, and APAEC Phase III (2026-2030) aims to cut regional energy intensity by 40% from 2005 levels. In the APS, annual efficiency gains reach around 2% by 2030 – 35% faster than in the STEPS – helping to contain overall energy demand growth to 7 EJ by 2035 and 13 EJ by 2050.

**Industry** has been a major driver of rising energy demand, with energy use increasing by 3.5% per year over the past decade and energy intensity improving by only 0.1% annually. Most countries in Southeast Asia have implemented mandatory energy management requirements, energy audits and energy saving measures. Targeted measures include tax incentives for efficient machinery in Thailand and dedicated financing frameworks in Viet Nam.

Key efficiency improvements for low-temperature heat include enhanced waste-heat recovery, better insulation and stronger process control. Electrifying heat supply through industrial heat pumps and electric boilers further strengthens efficiency gains. More efficient motor systems also play a central role in industrial efficiency improvements. MEPS for industrial motors are in place in Singapore, Thailand and Viet Nam, though they remain below the global best-practice IE4 level. In the APS, heat electrification and equipment upgrades – especially in non-energy-intensive industries – reduce industrial value-added energy intensity in Southeast Asia from 2 PJ per billion USD today to 1.7 in 2035 and 1.2 by 2050. Over the same period, electricity's share in industrial heat production rises sharply, from 5% today to 30% by 2035 and 50% by mid-century, helping to curb one of the sector's strongest historical sources of energy demand growth.

**Transport** has driven much of Southeast Asia's oil demand growth, with energy use per vehicle-kilometre rising by 0.5% per year since

2015 due to rising freight demand. Regional frameworks, including APAEC Phase III and the ASEAN Fuel Economy Roadmap, guide policy, but mandatory fuel-economy standards for light-duty vehicles are absent. Viet Nam is set to become the first mover, having issued a transport emissions plan in 2024 that includes 2030 fuel-economy targets for cars and motorcycles, followed by a draft standard which sets consumption limits for cars.

Efficiency improvements in trucks remain a major opportunity, especially as demand for freight expands. Fuel-economy standards for heavy-duty vehicles remain absent, and truck efficiency has improved only around 3% since 2015 to reach 34 litres of gasoline equivalent per 100 km (lge/100 km). At the same time, governments are accelerating electric mobility. Indonesia, Viet Nam, Thailand, Singapore, Malaysia and Cambodia have set ambitious EV objectives, ranging from large-scale stock and manufacturing targets to ICE phase-outs and broader net zero strategies. In the APS, electrification becomes the main driver of improved truck efficiency, despite electric truck sales remaining well below those of electric cars. As total cost-of-ownership advantages continue to strengthen, electric truck sales rise from near zero today to about 2% by 2035 and exceed 20% by 2050. This reduces average new truck fuel consumption to around 31 lge/100 km by 2035 and 26 lge/100 km by 2050, cutting road freight energy demand by 15% relative to the STEPS.

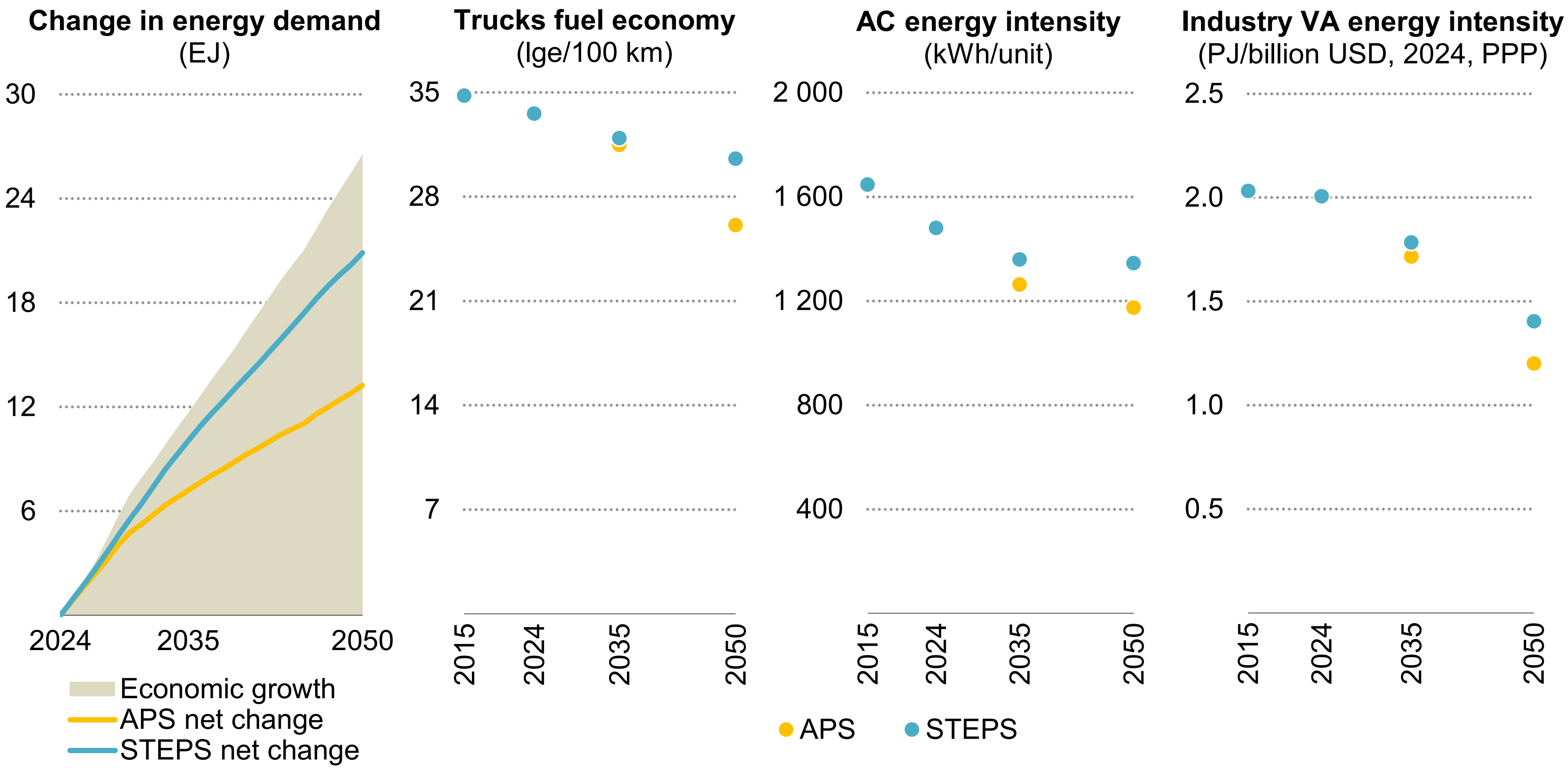
In **buildings**, rising ownership of electric appliances has been a major driver of growing electricity consumption in Southeast Asia over the past decade, even as energy use per square metre improved by an average of 1% per year. Building energy codes that deliver sector-wide savings are already in place in Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam, but there remains significant scope to strengthen implementation and enforcement to unlock deeper efficiency gains.

Residential AC ownership is set to triple by 2035, while the ownership of other appliances expand by around 50%, underscoring the importance of efficiency improvements in moderating electricity demand. Minimum energy performance standards for ACs now exist in all Southeast Asia countries except Cambodia, Lao PDR, Myanmar and Timor-Leste, helping to lower annual residential AC consumption from over 1 600 kWh/unit in 2015 to 1 500 today. Singapore has the most ambitious standards, tightened again in 2025, while Malaysia plans to raise its MEPS to similar levels by 2030. In the APS, average AC consumption falls below 1 300 kWh/unit by 2035 and approaches 1 200 by 2050, slowing electricity consumption growth.

The region is also gradually expanding smart meter deployment, enhancing system flexibility – an increasingly critical need in a rapidly growing electricity market. Brunei Darussalam and Singapore are advancing nationwide smart-meter rollouts; Indonesia, Malaysia and the Philippines have deployment programmes underway; and Viet Nam mandates smart meters in all new buildings.

# Meeting Southeast Asia's announced targets halves the energy demand growth, as electrification and technical efficiency gains grow across key end-use technologies

Change in total energy demand in Southeast Asia (left) and energy efficiency indicators (right) by scenario, 2015-2050






Notes: lge = litres of gasoline equivalent; km = kilometre; AC = air conditioner; kWh = kilowatt-hour; VA = value added; PJ = petajoule; USD = United States dollar; PPP = purchasing power parity. AC energy intensity reflects technical efficiencies, usage patterns and local climates of the residential AC stock average.

# Low-emissions fuels and technologies

# Successful projects for low-emissions hydrogen need faster policy implementation, effective financial de-risking tools and scaled up deployment of renewables

Southeast Asia produced 4 Mt of hydrogen in 2024, nearly all of which was supplied by fossil fuels, with around 80% derived from natural gas and the remainder as an industrial by-product. Demand for hydrogen and hydrogen-based fuels is concentrated in Indonesia, Malaysia, Viet Nam and Singapore, primarily for ammonia and methanol production and refining.

Looking ahead, demand is set to expand into new sectors, most notably shipping, which accounts for nearly 40% of total demand by 2035. A significant share of this demand reflects international bunkering activity linked to Singapore's role as the world's largest hub and the assumed implementation of the IMO's Net Zero Framework. Demand in the power sector also rises in the long term, exceeding 6.5 Mt by 2050 on the back of plans to co-fire ammonia in coal-fired plants. Aviation fuels and industry emerge as key growth areas, particularly in Indonesia and Viet Nam, including through the use of low-emissions hydrogen in direct reduced iron production.

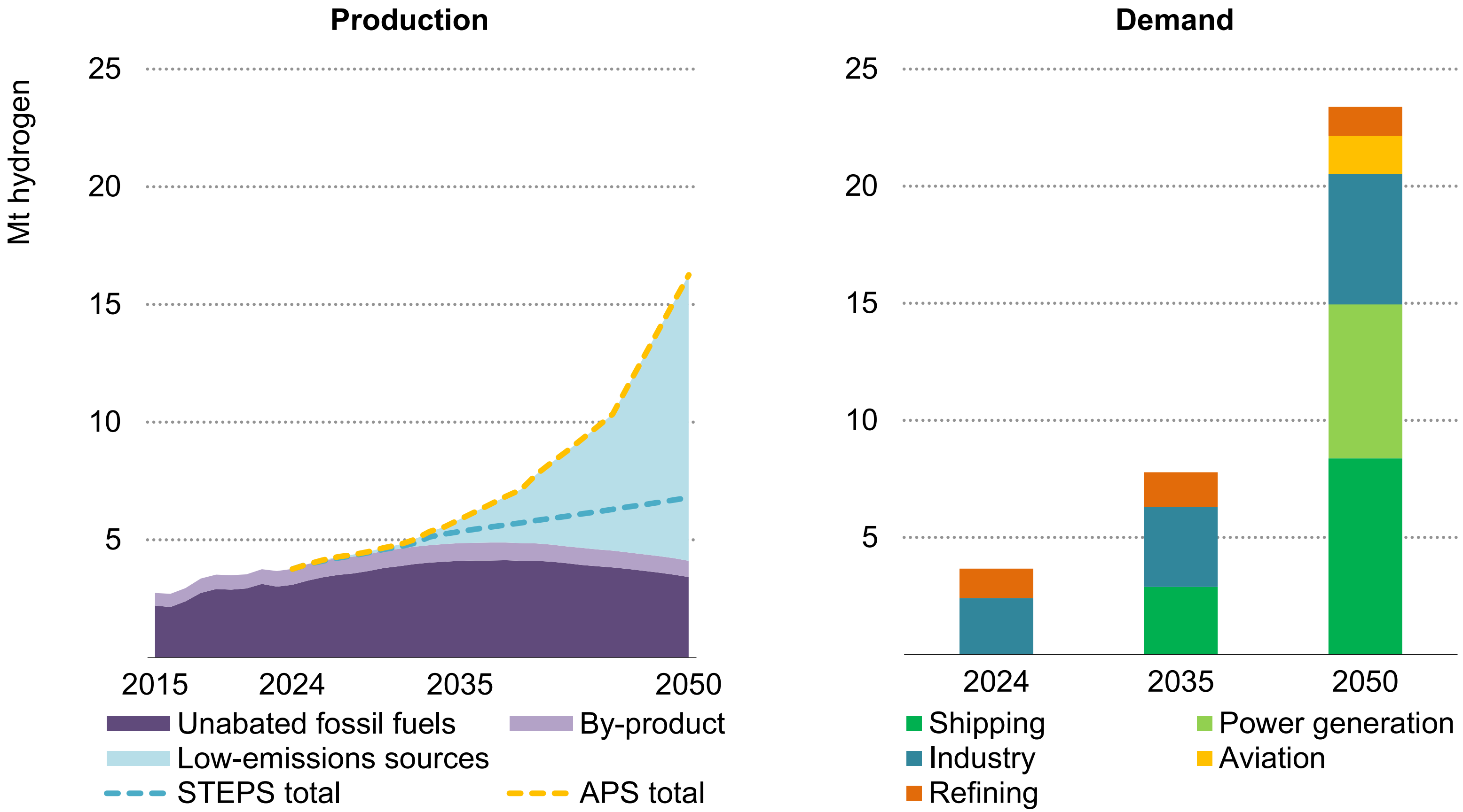
Policy momentum is growing, with state-owned enterprises active across the project pipeline and five countries – Singapore, Indonesia, Malaysia, Viet Nam and Lao PDR – having adopted hydrogen strategies. Existing demand provides a ready market for low-emissions hydrogen to displace gas-based domestic production, while the clustering of new demand in industrial and infrastructure hubs creates leverage points for governments to accelerate uptake of hydrogen-based fuels. Residual demand beyond regional production is met through imports of hydrogen-based fuels.

Southeast Asia has vast renewable potential to power electrolysers for low-emissions production. As a result, around 11 Mt of low-emissions hydrogen production is technically feasible by 2030 at costs below USD 6/kg. In the STEPS, total hydrogen production reaches over 5 Mt by 2035 and 7 Mt by 2050, of which just 4% is low emissions, while in the APS, production rises to 16 Mt by 2050 (6% of global output), three-quarters of which is low-emissions. This gap highlights that despite existing strategies, certification schemes, binding targets and demand-side incentives to drive implementation remain largely absent.

One of the main barriers to the development of low-emissions hydrogen is the high cost of capital, which adds a premium relative to advanced economies and has limited projects reaching final investment decision to just 6% of announced low-emissions capacity. Faster policy implementation, stronger demand signals and financial de-risking tools can reduce these barriers. More broadly, scaling up renewable deployment will generate positive spillover effects for hydrogen development.

# Southeast Asia's concentrated sectoral demand and abundant renewable resources provide a strong foundation for the region's emerging low-emissions hydrogen sector

Southeast Asia's hydrogen production in the Stated Policies Scenario and Announced Pledges Scenario, 2015-2050 (left) and hydrogen and hydrogen-based fuels demand by sector in the Announced Pledges Scenario, 2024-2050 (right)






Note: Hydrogen-based fuels include ammonia and synthetic kerosene. Shipping and aviation include international bunkers.

## Considerable bioenergy resource potential calls for a managed scale-up strategy that supports sustainable practices and mitigates cross-sectoral pressures

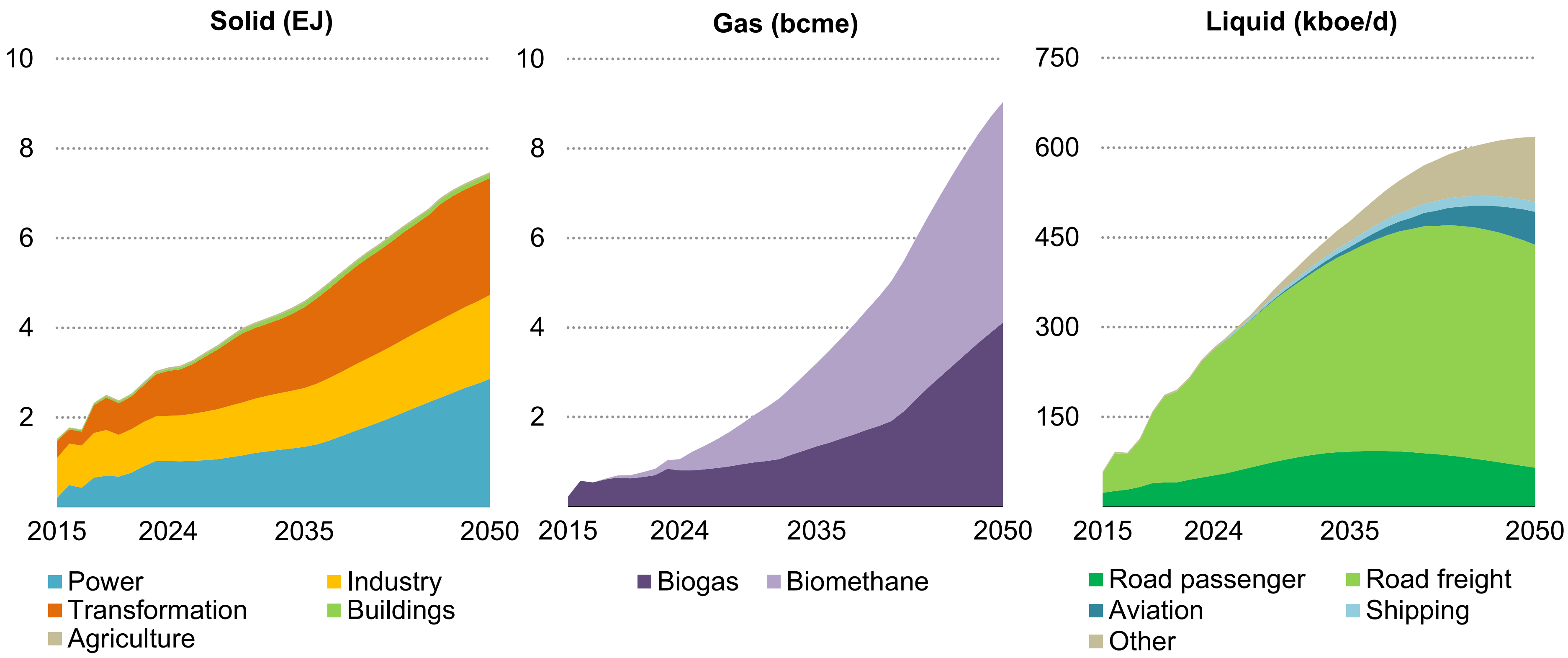
In 2024, modern bioenergy met more than 10% of total energy demand in Southeast Asia, including over 3 100 PJ of solid bioenergy, 560 PJ of liquid biofuels and around 40 PJ of biogas. The region has a strong domestic resource base, accounting for a quarter of global biodiesel production. **Solid bioenergy**, such as wood pellets and agricultural residues, is already used in the power sectors of Indonesia, Thailand and Malaysia, and in the APS, regional demand approaches 3 EJ by 2050, representing around 10% of power inputs. More limited deployment of co-firing in the STEPS keeps bioenergy use in power at around half this level.

**Liquid biofuels** are blended into transport fuels primarily to reduce dependence on imported oil products, a priority reinforced by recent supply disruptions. Indonesia produces more than 70% of the region's liquid biofuels and has set a 50% biodiesel blend target for July 2026. In the APS, regional demand for liquid biofuels rises by 80% to 480 kboe/d by 2035, largely driven by road freight. Current production relies largely on conventional food-crop feedstocks, creating significant sustainability challenges: around 15% and 40% of deforestation in Indonesia and Malaysia, respectively, is linked to palm oil expansion. Scaling production without exacerbating land-use change or food security pressures therefore requires a shift towards advanced biofuels, defined here as non-food-crop feedstocks such as agricultural residues, waste oils and other by-products. In the APS, the ratio of advanced to conventional liquid biofuels improves from 1:14 today to 1:4 by 2035, reaching parity by 2050, implying a strong policy shift towards waste- and residue-based pathways.

**Biogas** production is led by Thailand, accounting for more than 60% of the region's total production, and significant, untapped potential remains in the region, with sustainable feedstock equivalent to around half of natural gas demand today (95 bcme). Biomethane production costs average USD 13/GJ, around 15% above the average JKM price in 2025, with this gap narrowing under recent market conditions. With only 20% of this potential within 20 km of existing gas transmission pipelines, alternative off-take strategies are increasingly important, such as captive industrial use and clean cooking, as demonstrated by Indonesia's household digester programme. Overall, bioenergy can improve energy security, but poorly managed expansion – particularly based on fertiliser-intensive or land-expanding feedstocks – risks displacing dependencies on imported fuels with vulnerabilities related to agricultural inputs, land competition and environmental degradation. Prioritising waste- and residue-based feedstocks and strong land-use governance is therefore central to ensure that bioenergy delivers both short-term resilience and long-term sustainability.

# Modern sustainable bioenergy delivers wide-ranging benefits for Southeast Asia, from improved energy access and stronger energy security to reductions in emissions

Modern bioenergy demand in Southeast Asia by type and sector in the Announced Pledges Scenario to 2050






Note: 'Biogas' is a mixture of methane, $CO_2$ and small quantities of other gases produced by anaerobic digestion of organic matter. 'Biomethane' is a near-pure source of methane produced either by 'upgrading' biogas or through the gasification of solid biomass. 'Other' includes agriculture, industry, rail transport and other sectors. EJ = exajoule; bcme = billion cubic metres of natural gas equivalent; kboe/d = thousand barrels of oil equivalent per day.

# Both carbon capture and geothermal need strong regulatory frameworks to improve bankability

## Carbon capture, utilisation and storage (CCUS)

Even with the scale-up of renewables and energy efficiency efforts under announced climate pledges, significant residual emissions remain from hard-to-abate sectors such as heavy industry. CCUS is one of several critical technologies to address these emissions gaps in the Announced Pledges Scenario.

Deployment of CCUS at commercial scale remains effectively zero today. However, projects currently under construction – at Indonesia's Tangguh LNG (CCUS) and Malaysia's Kasawari gas field (CCS) – could deliver close to 7 Mt $CO_2$ of capture capacity by 2030, and total announced capacity exceeds 18 Mt $CO_2$ by 2035. This pipeline remains well below the APS trajectory, which sees around 30 Mt $CO_2$ being captured by 2035 and more than 150 Mt by 2050. By mid-century, CCUS deployment would need to extend far beyond oil and gas to combustion and industrial process emissions, including power generation and cement production, reaching capture levels equivalent to around 30% of today's industrial $CO_2$ emissions.

The region has several structural advantages for CCUS. These include substantial geological storage potential in sedimentary basins and offshore formations, opportunities to repurpose existing oil and gas infrastructure and technical expertise, and industrial clustering in key countries that could enable economies of scale through shared transport and storage infrastructure.

However, major barriers persist. High upfront capital costs, the absence of a regional carbon price and weak or incomplete regulatory frameworks – covering issues such as storage certification, long-term liability and cross-border $CO_2$ transport – continue to undermine investment confidence. Limited operational track records further deter private capital.

Addressing these challenges will require a suite of targeted solutions, supported by regional cooperation across the Asia Pacific. Priority measures include concessional finance and risk-sharing mechanisms to reduce project risk, regional regulatory harmonisation to improve legal certainty, and government-backed anchor demand through industrial policy measures and low-carbon procurement. Similar regulatory clarity and risk-mitigation frameworks will also be essential to unlock investment in geothermal energy, which faces comparable challenges despite strong resource potential.

## Geothermal

Today, geothermal energy meets around 5% of Southeast Asia's energy demand, well above the global average of about 1%. Deployment to date has been concentrated in power generation in

Indonesia and the Philippines, which together host the largest shares of the region's installed capacity. Development has focused on conventional hydrothermal resources, tapping naturally occurring hot water and steam reservoirs.

In the APS, the ability of geothermal to deliver firm, dispatchable low-emissions power gives it a unique and increasingly valuable system role. Geothermal deployment accelerates substantially, with regional installed electrical capacity more than doubling from around 5 GW today to 11 GW by 2035, while generation increases from roughly 30 TWh to around 75 TWh. This growth is concentrated in Indonesia, where geothermal output reaches 15% of coal-fired generation by 2035. By 2050, Southeast Asia's geothermal output exceeds 200 TWh, providing nearly 5% of the region's electricity.

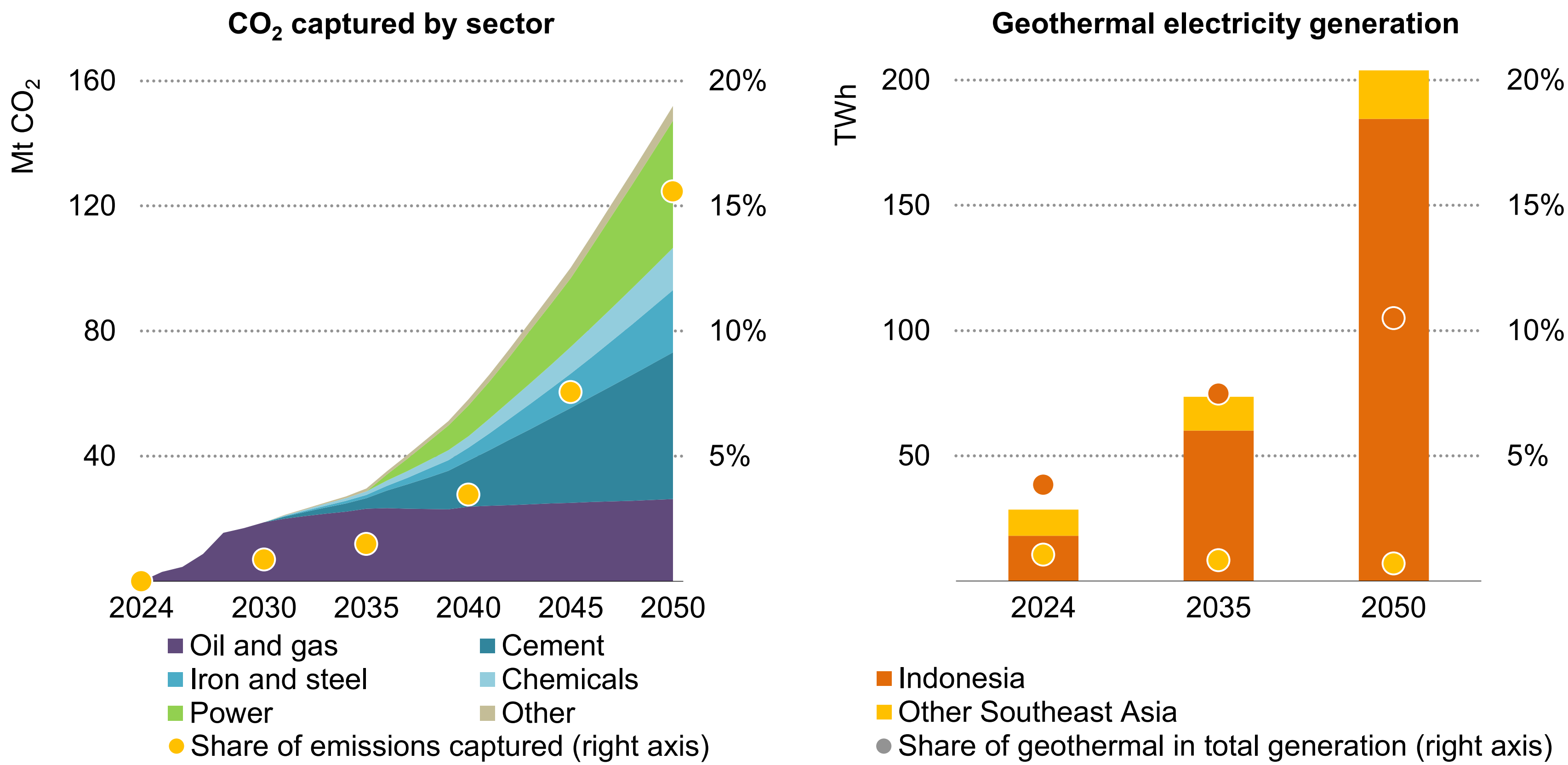
Southeast Asia is already a global leader in geothermal development, underpinned by its experience in exploration, project development and operations, particularly in Indonesia and the Philippines. Both countries have set ambitious strategies for geothermal expansion, with Indonesia embedding multi-GW geothermal targets explicitly in its power plan. The region's location along the Pacific "Ring of Fire" further strengthens this advantage, offering vast untapped resources, as highlighted by Project InnerSpace.

Despite this potential and ambition, significant structural barriers remain. Geothermal projects carry high exploration risk, requiring large upfront investments before resource viability is confirmed. Development timelines are long, often exceeding a decade, and many of the geothermal resources are located in remote areas, raising grid connection costs. Prevailing tariff and market structures also present challenges. In Indonesia and the Philippines, power markets are typically centred on single-buyer utilities, with long-term PPAs based on regulated ceiling prices or negotiated cost-recovery frameworks rather than competitive wholesale markets. While such arrangements are essential for bankability to provide revenue certainty, they often fail to adequately value the dispatchability and system reliability that geothermal provides, undermining its competitiveness in power procurement.

Addressing these challenges will require further targeted policy and financial support. Public and development finance institutions can play a critical role in de-risking early-stage exploration – an approach already adopted in Indonesia and the Philippines through World Bank and Asian Development Bank-backed facilities that help shift early-stage exploration risk from private developers to the public sector. Further reforms to PPA frameworks that explicitly value firm capacity, along with improved resource data transparency and expanded risk-sharing instruments, would strengthen project economics. At the same time, Indonesia is emerging as a regional leader in next-generation geothermal development, including closed-loop systems under its Geothermal Master Plan with Japanese partners, and research into lithium extraction from geothermal brines. Enhanced regional cooperation and knowledge-sharing would further support capacity building and accelerate geothermal deployment across Southeast Asia.

# Clean firm power from geothermal and carbon capture for emitting industrial processes provide emissions reduction solutions across industry and power sectors

Industrial carbon capture and geothermal electricity generation in Southeast Asia in the Announced Pledges Scenario, 2024-2050






Note: $CO_2$ = carbon dioxide; Mt = million tonnes; TWh = terawatt-hour.

# Southeast Asia’s energy challenges and emerging opportunities

# Mitigating the effects of the Middle East crisis on Southeast Asia

## Governments have been quick to act, as households and workers have faced substantial impacts from price spikes triggered by the Middle East crisis

Southeast Asia's reliance on fossil fuel imports has increased its exposure to the Middle East and global energy markets. The resulting supply concerns have driven global benchmark crude oil and regional liquefied natural gas prices up by around 60% compared with pre-conflict levels. These increases have fed through to higher wholesale energy prices, raising gasoline and diesel prices across most countries in the region. In some cases, impacts on end users have been partially buffered by price controls and subsidies, notably in Indonesia and Malaysia.

Higher fuel and power generation costs are driving broader cost-of-living pressures. With oil and gas central to transport, cooking and electricity supply, elevated wholesale prices are pushing up retail energy prices and, in turn, general inflation, raising the cost of essential goods and services. The impacts are unevenly felt, falling most heavily on lower-income households and informal workers, who are typically more reliant on transport fuels and less able to absorb price shocks. In some cases, higher energy prices are already prompting behavioural responses, including reduced transport activity and shifts towards lower-cost but more polluting cooking methods, with implications for livelihoods, welfare and public health.

In response to the crisis, governments across Southeast Asia have been relying heavily on energy efficiency and demand-side measures as fast, least-cost tools to reduce energy use. These include limiting vehicle use and fuel consumption, promoting remote work, demand reductions for large consumers and restricting official travel. The ASEAN Centre for Energy estimates that such measures could reduce fuel consumption related to commuting and office buildings by around 20%.

These efforts have been undertaken alongside consumer price-support policies. Almost all of the region's governments have reduced taxes on energy products or deployed direct consumer subsidies to provide immediate relief. Thailand and Viet Nam have imposed universal fuel price caps, while other countries have adopted targeted interventions, including cash transfers for transport workers, public transport fare reductions in the Philippines, VAT exemptions on domestic economy flights in Indonesia, and free public buses during peak travel periods in Cambodia.

While these interventions have mitigated short-term economic and social impacts, they have also intensified already elevated fiscal pressures following extensive subsidy deployment during the 2022 energy crisis. This underlines the importance of enacting temporary price and demand measures with structural actions that reduce energy consumption and import dependence, while targeting support towards vulnerable consumers.

# Ongoing supply disruptions have led Southeast Asian governments to implement emergency measures at unprecedented speed

## Selected measures put into effect by Southeast Asian governments since the start of the Middle East conflict

**MYANMAR**

- Teleworking
- Even-odd license plate system
- Fuel rationing

**THAILAND**

- Biofuel blending
- Export ban of fuels
- Supply diversification
- Gas-to-coal switching
- Air-conditioning limits
- Fuel subsidies
- Price cap
- Teleworking
- Carpooling
- Reduce travel

**CAMBODIA**

- Teleworking
- Reduce travel
- Reduce energy taxes
- Air-conditioning limits
- Ask public to conserve energy

**MALAYSIA**

- Teleworking
- Reduce travel
- Ask public to conserve energy
- Reduce energy taxes
- Biofuel blending
- Supply diversification

**SINGAPORE**

- Promote public transport and carpooling
- Ask public to conserve energy
- Delayed jet fuel levy
- Cash relief and targeted support
- Adjusted FX policy
- Adjusted CB rate policy

**BRUNEI DARUSSALAM**

- Fuel purchase control


Selected measures by governments since the start of the Middle East conflict:

- Oil demand restraint measures
- Energy conserving measures
- Supply-side measures
- Consumer support measures
- Other measures

**LAO PDR**

- Teleworking
- Rotating shifts
- 3-day school week
- Promote public transport
- Ask public to conserve energy
- Fuel subsidies
- Reduce energy taxes
- Supply diversification

**VIET NAM**

- Teleworking
- Carpooling
- Reduce travel
- Decrease in domestic flights
- Promote public transport
- Fuel rationing
- Fuel subsidies
- Reduce energy taxes
- Biofuel blending
- Supply diversification

**PHILIPPINES**

- Teleworking
- Reduce travel
- 4-day work week
- Reduce consumption
- Air-conditioning limits
- Fuel subsidies
- Reduce energy taxes
- Supply diversification
- Gas-to-coal switching
- Adjusted FX policy

**TIMOR-LESTE**

- Ask public to conserve energy
- Price cap

**INDONESIA**

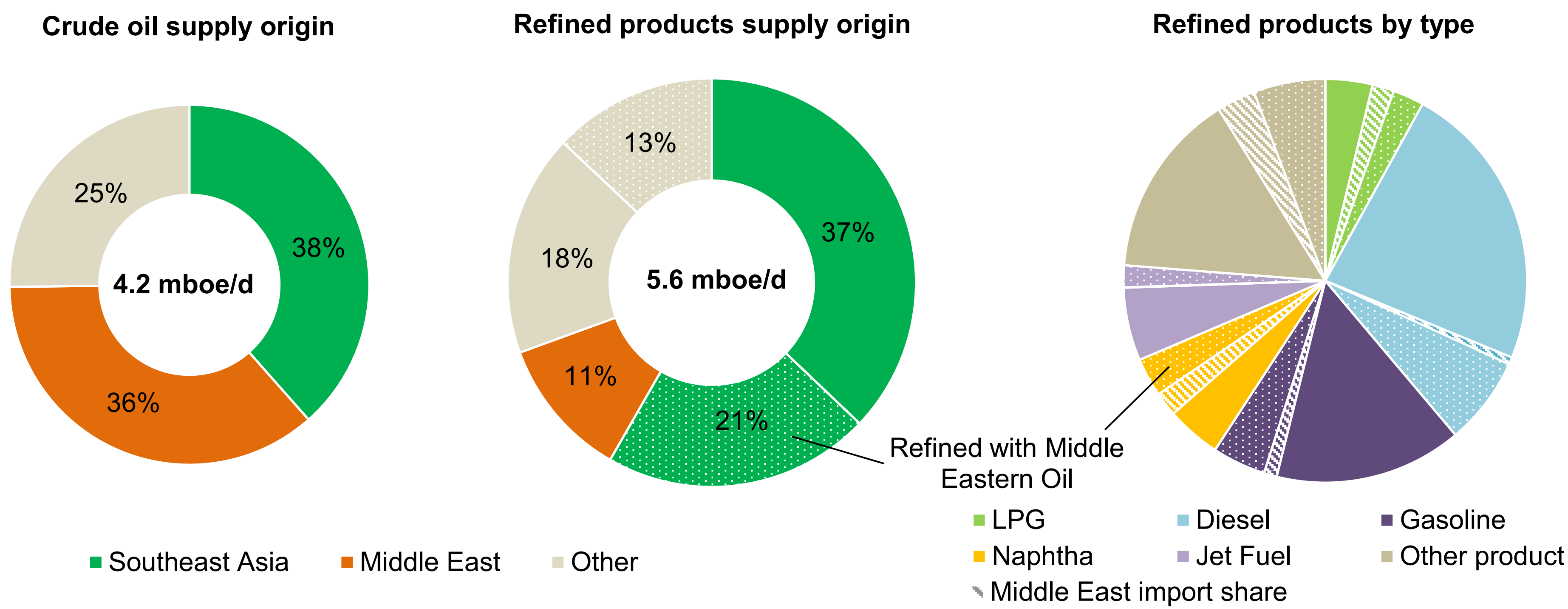
- Teleworking
- Reduce travel
- Fuel subsidies
- Biofuel blending
- Supply diversification
- Adjusted FX policy



Notes: Measures implemented as of 7 May 2026. FX = foreign exchange. CB = central bank.

# Southeast Asia's oil supply chain runs through the Middle East, from crude imports to refinery feedstocks

Supply origin of crude oil and refined products in Southeast Asia, 2024






Source: IEA analysis based on IEA, Kpler and Rystad data.

Notes: Crude oil supply includes crude oil, crude condensates and natural gas liquids (NGLs). Refined products include refined and fractionated products. 'Middle East import share' refers only to direct imports of refined products from the Middle East, while 'Refined with Middle Eastern Oil' represents refined product outputs from non-Middle East suppliers, weighted by the share of their crude oil inputs sourced from the Middle East. Total supply includes international bunkers. LPG = liquefied petroleum gas.

# Southeast Asia's regional refining capacity provides some buffer against supply disruptions, but reliance on Middle Eastern crude constrains overall resilience

The energy impacts of the Middle East conflict are still unfolding, but disruptions have already affected energy security and affordability in Southeast Asia. Before the crisis, 60% of crude oil imports (including condensates and NGLs) came from the Middle East. This share was lower for natural gas, at 33% of imports. Exposure is highest in countries relying on highly concentrated supplier portfolios, while more diversified sourcing provides greater resilience.

Southeast Asia meets just under 40% of its **crude oil** demand from domestic production, while the Middle East supplies a third. Oil self-sufficiency varies widely, ranging from 0% in Singapore, a major refining hub, to 73% in Malaysia and 100% in Myanmar. The region's large refining capacity (5.4 mb/d) provides some buffer against disruptions in refined product markets: almost 60% of **oil products** supply comes from refineries in Southeast Asia, while 11% of the products are imported directly from the Middle East. However, this apparent resilience masks continued upstream dependence. Once Middle Eastern crude oil processed in regional refineries is considered – along with refined product imports from other countries – the region's total exposure to Middle East supply rises to 45%. **Natural gas** self-sufficiency is higher, with around 90% supplied within the region, mainly by Indonesia, Malaysia and Thailand. However, growing demand is increasing the region's reliance on imported LNG. Southeast Asia has 57 million tons per annum (Mtpa) of LNG import capacity, with an additional 7 Mtpa under development. As seen during the 2022 global energy crisis, the rising reliance on imported gas leaves the region more vulnerable to global price shocks.

Recognising near-term supply risks, several countries have developed oil stockholding policies, though these are often aspirational, with few countries maintaining emergency reserves and most relying on commercial inventories. Some governments have set longer-term self-sufficiency targets, including Indonesia's goal of energy independence by 2030 and Viet Nam's aim to meet 70% of petroleum demand domestically by 2030. Cambodia plans its first refinery, enabling crude oil stockpiling, while several countries are also advancing strategic petroleum reserve development.

Southeast Asia's net fuel imports and import bill are set to rise, driven mainly by oil demand and growing reliance on imported gas. The import bill, around USD 82 billion in 2024, is projected to reach USD 245 billion by 2035 in the CPS. While imports rise in all scenarios, costs are much lower in the STEPS and APS – 40% and 80% below the CPS by 2050. Beyond import costs, governments also face fiscal pressure from fossil fuel consumption subsidies, which have been reformed in recent years (see Chapter 1), though several countries have recently reverted to emergency support measures.

# Vulnerability to the recent fuel shock varied across Southeast Asia, influenced by each country's supply diversity, infrastructure and crisis preparedness

## Key fuel security indicators for Southeast Asian countries

| Country | Self-sufficiency | | | Diversity of supply (share of imports from Middle East) | | | Infrastructure capacity | | Oil stockpiling policies (current and/or planned) |
|---|---|---|---|---|---|---|---|---|---|
| | *Crude oil* | *Oil products* | *Natural gas* | *Crude oil* | *Oil products* | *Natural gas* | *Refining (kb/d)* | *LNG import (mtpa)* | |
| **Brunei Darussalam** | 60% | Net exporter | | n/a | Domestic | | 175 | Exporter | Oil companies required to maintain 31-day stock |
| **Cambodia** | n/a | 0% | 0% | n/a | 0% | n/a | 0 | 0.0 | Strategic stocks of 5 days by 2030 |
| **Indonesia** | 64% | 67% | Net exporter | 21% | 13% | Domestic | 1177 | 11.4 | Strategic stocks of 30 days by 2035 |
| **Lao PDR** | n/a | 0% | n/a | n/a | n/a | n/a | 19 | 0.0 | Strategic stocks of 25 days |
| **Malaysia** | 73% | 99% | Net exporter | 64% | 11% | Domestic | 938 | 7.3 | None |
| **Myanmar** | Net exporter | 3% | Net exporter | Domestic | 0% | Domestic | 31 | 0.5 | Strategic stocks of 45 by 2045 and 90 days by 2050 |
| **Philippines** | 4% | 30% | 54% | 96% | 7% | 0% | 180 | 8.1 | Planned |
| **Singapore** | 0% | Net exporter | 0% | 48% | Domestic | 19% | 1277 | 7.3 | None |
| **Thailand** | 22% | Net exporter | 60% | 59% | Domestic | 20% | 1265 | 18.9 | Mandatory stocks of 25 days of oil (refiners and industry) |
| **Viet Nam** | 45% | 62% | 94% | 86% | 8% | 0% | 365 | 4.0 | Strategic stocks of 75-80 days by 2030 and 90 days (of net imports) by 2050 |

Source: IEA analysis based on IEA, Kpler and Rystad data, and ERIA and ACE policy information.

Notes: kb/d = thousand barrels per day; mtpa = million tonnes per annum; n/a = not available. Data for Timor-Leste was not available. 'Self-sufficiency' is domestic production divided by total demand in 2024. 'Diversity of supply' is imports from the Middle East divided by total imports in 2024. Crude oil includes condensates and natural gas liquids. Infrastructure capacity is for 2025. Days of stocks means days of consumption, unless specified otherwise.

# Medium- and long-term measures focused on diversification of energy sources, electrification and efficiency can durably reduce vulnerability to global market disruptions

While short-term emergency measures have cushioned immediate economic and social impacts, they do not address the underlying sources of vulnerability. The energy crisis triggered by conflict in the Middle East has underscored Southeast Asia's 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. Addressing these risks requires complementing crisis responses with medium- and long-term measures that reduce import dependence, improve system flexibility and strengthen energy resilience.

## Reducing reliance on fossil fuel imports through low-emissions energy sources, electrification and efficiency

Over the medium and long term, lowering overall demand for imported fossil fuels is central to reducing exposure to global market shocks. Accelerating deployment of low-emissions energy sources, electrifying end-use sectors and scaling up energy efficiency together deliver substantial energy security, affordability and emissions benefits.

Rapid expansion of renewable power – including solar, wind, hydro and geothermal – can increase domestic energy production, diversify generation mixes and reduce reliance on imported coal and gas. Southeast Asia's strong renewables potential remains underutilised due to grid, financing and regulatory constraints. This situation highlights opportunities to learn from faster-scaling markets such as India (see Chapter 3). Diesel-based microgrids remain widespread in many countries, leaving rural communities exposed to volatility in fossil fuel prices. Here, Southeast Asia can also draw lessons from African countries that have successfully deployed renewable hybrid microgrids (see *Africa's microgrid innovations* box).

Electrification of transport, buildings and certain industrial processes reinforces these benefits by shifting demand away from directly imported fuels. When paired with electricity from renewables, nuclear and domestically sourced low-emissions sources, and underpinned by expanded and reinforced electricity grids, electrification reduces oil and gas consumption. Deployment of clean energy technologies since 2015 has reduced Southeast Asia's fossil fuel import bill by around USD 30 billion, with around half of the savings coming from renewables, one-third from efficiency gains, and the remainder from electrification. Such savings continue to accrue in the STEPS, where uptake of EVs cumulatively displaces around 5 500 million barrels of oil in road transport over the period to 2050, almost six times current annual road transport oil demand.

Energy efficiency is the most immediate and cost-effective way to curb energy demand. Stronger efficiency regulations, supported by information programmes and targeted incentives across industry, transport, buildings and appliances, can reduce pressure on imports and public budgets. Digitalisation and smart technologies further enhance these benefits by improving supply-demand management, with smart grids, demand response and digital monitoring cutting peak loads, deferring network investment and lowering fossil fuel use in systems still reliant on thermal generation.

## Enhancing the resilience of oil supply through diversification and refinery system flexibility

Reducing exposure to oil supply disruptions in Southeast Asia requires addressing not only the volume of crude imports, but also the concentration of supply sources and the flexibility of the downstream system. Many refineries in the region are configured to process medium and heavy Middle Eastern crudes, meaning disruptions to these flows can quickly lower utilisation rates and constrain output due to lack of operational flexibility. Strengthening resilience therefore requires improving the ability of refineries to process a wider range of crude types over time, reducing reliance on a narrow set of supply routes and configurations.

In addition to pursuing absolute increases in non-Middle Eastern crude processing volumes, governments can prioritise enhancing optionality and system flexibility within existing constraints. Key measures include strengthening the capacity to switch crude sources during disruptions, improving operational readiness and feedstock flexibility across the refining system, and reinforcing the role of regional hubs in safeguarding the availability of critical petroleum products – particularly middle distillates – during supply shocks.

This approach recognises the technical, configuration and cost constraints faced by the refining sector, while still delivering meaningful risk mitigation. By prioritising flexibility over volume targets, Southeast Asian oil systems can better absorb external shocks, limit the economic impacts of supply disruptions and reduce vulnerabilities arising from high import dependence.

## Balancing LNG exports and domestic supply through strengthened domestic capacity

Structural developments in recent years have highlighted pressures in parts of Southeast Asia where LNG export commitments coexist with tightening domestic gas availability. These pressures reflect underlying constraints in deliverability, decline management and system flexibility, rather than an explicit policy choice between exports and domestic supply. Recent developments illustrate how countries in the region are responding in different ways. Indonesia has announced measures to prioritise domestic gas use, reflecting tightening availability and rising consumption. Malaysia continues to signal its intention to remain an LNG exporter while simultaneously preparing for LNG imports to meet growing domestic needs.

IEA analysis of decline rates illustrates the scale of this challenge. In Southeast Asia, conventional natural gas fields exhibit average observed post-peak decline rates of around 6.7%, similar to the global average. In the absence of continued investment, decline rates are materially steeper, implying rapid supply erosion and making sustained upstream and midstream investment essential to maintain, let alone expand gas availability.

Strengthening domestic gas supply capacity therefore offers a pathway to easing tensions between LNG exports and domestic availability by increasing effective gas production rather than relying on export curtailments. Southeast Asia is simultaneously a significant LNG exporter and importer, with some countries structurally reliant on imports and others anchoring regional exports, highlighting the importance of greater supply-side flexibility to meet domestic needs while continuing to honour international commitments, particularly during periods of market tightness.

However, enhancing supply-side flexibility in gas systems faces real constraints. Gas production in much of Southeast Asia is predominantly offshore and increasingly reliant on smaller or more mature fields, limiting scope for short-term output adjustments. Measures to manage decline rates or optimise existing assets can help slow the erosion of supply but do not necessarily translate into rapid or easily scalable increases in production, particularly where domestic pricing frameworks weaken investment incentives.

A pragmatic policy response could therefore focus on a portfolio of measures to bolster domestic gas output over time, where this is geologically and economically feasible. These include brownfield optimisation and infill drilling in mature fields, incremental upstream investment to sustain deliverability, and targeted upgrades to gas processing, transport and domestic transmission infrastructure to ease bottlenecks. A similar portfolio of measures could apply in the oil sector, again within the constraints of geological and economic feasibility, to mitigate increased reliance on imports.

Integrating methane-abatement and low-emissions practices into upstream operations can further strengthen this strategy. Around 80% of methane reductions in oil and gas can be achieved at no net cost, while also increasing the volume of gas delivered to market (see Chapter 2). These measures complement efforts to expand domestic supply rather than constrain LNG exports. By supporting higher effective output from existing assets, they enhance system resilience and reduce costly exposure to volatile international LNG markets during periods of compounded price and shipping risk.

### Gas-to-coal switching: short-term risk mitigation with long-term trade-offs

The crisis has prompted greater reliance on coal-fired power in parts of Southeast Asia as a short-term response. During periods of high gas prices, switching from imported gas to domestically or regionally available coal can provide rapid relief where infrastructure already exists. In the medium term, such disruptions may strengthen preferences for domestic energy resources, accelerating renewables deployment but also sustaining coal's role in some countries due to its abundance and established supply chains. However, the scope for gas-to-coal switching is constrained by limited spare coal-fired capacity in some countries, as coal has been generally cheaper than gas, and was already operating at high-capacity factors prior to the crisis.

Even where coal use has the capacity to expand, this expansion entails significant trade-offs. Coal-fired generation produces higher air pollutant and $CO_2$ emissions than alternative sources, with major public health consequences. Ambient air pollution contributed to an estimated 330 000 premature deaths in 2024. Increased reliance on coal also runs counter to ambitious phase-out commitments, including targets of 2044 in Malaysia and around mid-century in Thailand, Indonesia and Viet Nam, with possible acceleration under Just Energy Transition Partnership arrangements. Furthermore, a reliance on coal does not fully shield countries from fossil fuel price volatility, as shown by coal price spikes during the 2022 energy crisis.

Against this backdrop, there is limited structural coal expansion in IEA scenarios (except for the CPS), though existing coal-fired capacity retains an important role to help provide electricity system services, such as capacity adequacy, operating reserves and inertia. This means operating plants more flexibly at lower average utilisation rates and reserving coal mainly for periods of system stress rather than baseload generation. Such an approach is particularly relevant for older, less efficient subcritical units, where reduced operating hours deliver disproportionate emissions reductions. Fuel switching and blending can further moderate emissions. Many countries are advancing biomass co-firing, while ammonia co-firing is being explored as a longer-term option.

Overall, gas-to-coal switching can enhance short-term system resilience during periods of gas market stress, but its contribution remains inherently limited where coal fleets are already heavily utilised. Its role evolves in IEA scenarios as countries balance energy security, affordability and environmental considerations. Effective policy design is needed to manage any temporary reliance on coal in a way that takes air quality and longer-term decarbonisation objectives into account, while maintaining power system flexibility to respond to future disruptions.

## Building ASEAN and Asia-wide resilience through cross-cutting measures

Enhancing resilience to fuel supply disruptions in Southeast Asia requires a system-wide perspective that goes beyond volumes alone. Import risks are correlated with issues relating to supplier concentration, exposure to maritime chokepoints and the flexibility of domestic infrastructure, with concentrated sourcing and rigid systems amplifying the economic and social impacts of external shocks.

Against this backdrop, supply-side measures should complement other mitigation tools such as strategic stocks, emergency co-ordination mechanisms and demand-side measures. Recent crises have demonstrated that countries with more diversified supply sources, greater operational flexibility and stronger interconnections are better positioned to absorb shocks without resorting to costly and disruptive emergency measures.

Regional cooperation is central to strengthening resilience, particularly in the power sector through the ASEAN Power Grid. In fuel markets, recent experience has also highlighted both the value and the current limits of regional co-ordination. During the recent disruptions, ad hoc co-operation has helped preserve supply continuity including temporary exemptions on exports of refined petroleum products to neighbouring countries. At the same time, existing regional frameworks, notably the ASEAN Petroleum Security Agreement (APSA), remain underutilised, reflecting challenges related to ratification, scope and operational readiness.

Looking beyond ASEAN, wider Asia-wide co-operation can further strengthen resilience by adding financial, institutional and infrastructure support that individual countries may not be able to mobilise alone. Japan's USD 10 billion POWERR Asia framework is one example, combining emergency responses such as financing for fuel procurement with longer-term measures to improve resilience, including support for crude oil stockholding systems, infrastructure development and co-ordination with international institutions.

## Africa's microgrid innovations can serve as a model for Southeast Asia's shift beyond diesel

Across much of Southeast Asia, diesel-based microgrids are widely used on islands and in remote areas, yet they are highly exposed to volatile fuel prices, logistical constraints and supply disruptions. The crisis strengthens the argument for transitioning these systems to locally supplied renewable microgrids. Experience from African countries, where mini-grids have been successfully rolled out in remote and difficult-to-access regions, provides valuable insights for managing this shift.

### Hybrid systems and digital control reduce diesel dependence

African experience shows that the transition away from diesel is usually achieved through hybridisation rather than immediate full replacement. Integrating solar PV, battery storage and digital controls can reduce fuel use while preserving reliability through limited backup generation. Mini-grids across Africa have moved towards digital operating models, with remote monitoring, smart metering and demand management central to performance. Husk Power Systems in Nigeria integrated smart metering, app-based billing and AI-based demand forecasting, providing electricity at costs 25% lower than those of diesel alternatives. This matters because operating expenditure maintenance logistics and downtime are often more serious constraints on islands in Southeast Asia than equipment costs alone.

### Regulatory certainty matters before capital arrives

A second lesson from Africa is that investment depends heavily on regulatory clarity. Kenya's mini-grid regulation provides detailed provisions for licensing thresholds, cost-reflective tariffs, and the transition from isolated to interconnected operation, including compensation and asset transfer when the main grid arrives. Rwanda complements this with a simplified licensing framework, clear capacity categories and defined technical and reporting requirements, reducing administrative barriers and improving regulatory certainty for rural electrification and mini-grid deployment.

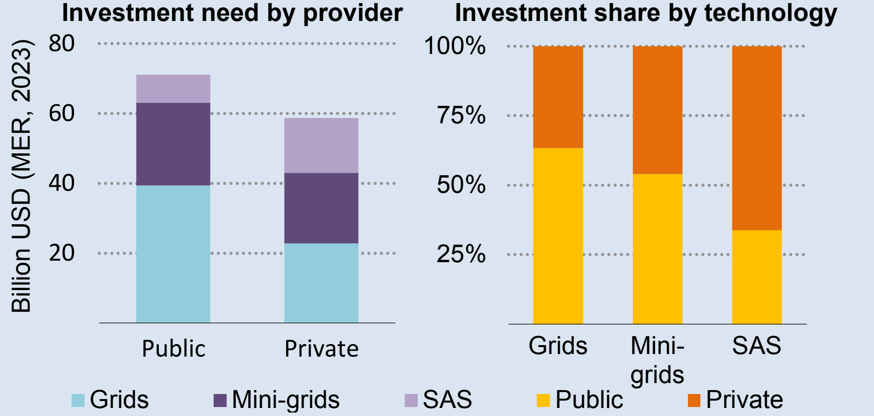
These are not secondary design details but are crucial in reducing the cost of capital. For investors, the risk of stranded assets can be decisive. For Southeast Asia, where some diesel microgrids may eventually be interconnected, a credible transition framework requires clear rules on tariff setting, technical standards, service obligations and grid encroachment. Without these, conversion to renewables remains a pilot activity rather than an investable programme.

## Blended finance and local-currency instruments can support scale-up

Africa has further shown that viable renewable microgrid programmes are rarely developed from commercial tariffs alone in underserved areas. Public support remains necessary, but more effective operating models shift away from recurring fuel dependence towards capital support, risk sharing and performance-based service delivery. In practice, mini-grid deployment is typically financed through a mix of public and concessional funding alongside private capital. Results-based financing has become widespread, but schemes often need to be redesigned because post-delivery payments can strain developer cash flow. This points to a more suitable approach for Southeast Asia: concessional grants, milestone-based payments and blended finance structures that ease upfront capital pressure while still rewarding performance.

Darway Coast in Nigeria provides a relevant example. The project combined concessional first-loss capital from the UK-funded Climate Finance Blending Facility with local-currency debt, helping unlock guaranteed green bonds and crowd in domestic institutional investors. The broader lesson for Southeast Asia is that renewable microgrid conversion can be financed not only through donor support or utility balance sheets, but also through credit-enhanced local capital-market instruments – reducing both diesel subsidy exposure and foreign-exchange risk.

### Investment under ACCESS, sub-Saharan Africa, 2025-2035






Note: SAS = stand-alone system. ACCESS = Accelerating Clean Cooking and Electricity Services Scenario.
Source: IEA (2025), Financing Electricity Access in Africa.

## Microgrids as local economic infrastructure

Renewable microgrids are more bankable when treated as local service platforms rather than as household electrification assets. Their viability improves when anchored by productive and commercial demand. In Zambia, for example, a hospital, telecom towers and a commercial farm formed the anchor load, consuming around 45% of electricity and supporting project viability. These users consume more electricity per connection than households and improve project economics. This is highly relevant for Southeast Asia's islands, where fisheries, tourism and agro-processing can provide a stable demand base.

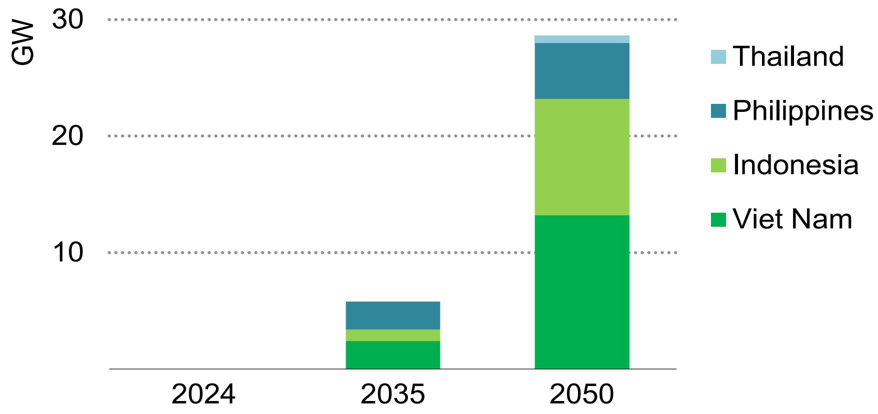
# Exploring the potential of nuclear energy

# Momentum for nuclear power is building across Southeast Asia, with several countries setting out clear development plans

Interest in nuclear power is growing across Southeast Asia as countries seek to meet rising electricity demand and diversify their power mixes, although the region has yet to produce commercial electricity from nuclear reactors. As of 2026, three countries (Indonesia, the Philippines and Viet Nam) have set clear nuclear development targets, while Malaysia, Myanmar, Singapore and Thailand are considering nuclear as an option.

The most advanced countries have made notable progress on feasibility studies, regulatory preparation, international partnerships (such as cooperation with the People's Republic of China [hereafter "China"], Japan, Korea, Russia and the United States) and official planning. Having identified nuclear as a strategic option, Indonesia aims for 0.5 GW by 2032, with a strong focus on small modular reactors (SMRs) and a scale-up to 7 GW by 2040. The Philippines plans around 1.2 GW of nuclear capacity by 2032, increasing to 2.4 GW by 2035 and 4.8 GW by 2050, and is also exploring SMRs, particularly for off-grid applications. The Philippines is also looking into the rehabilitation of the Bataan nuclear power plant, completed in 1984 but never loaded with fuel or operated. Viet Nam's revised Power Development Plan (PDP8) envisages having 4-6.4 GW of nuclear capacity between 2030 and 2035, rising to 10.5-14 GW by 2050, and has signed an agreement with Russia in March 2026 to construct its first two reactors.

Nuclear capacity in Southeast Asia in the APS, 2024-2050





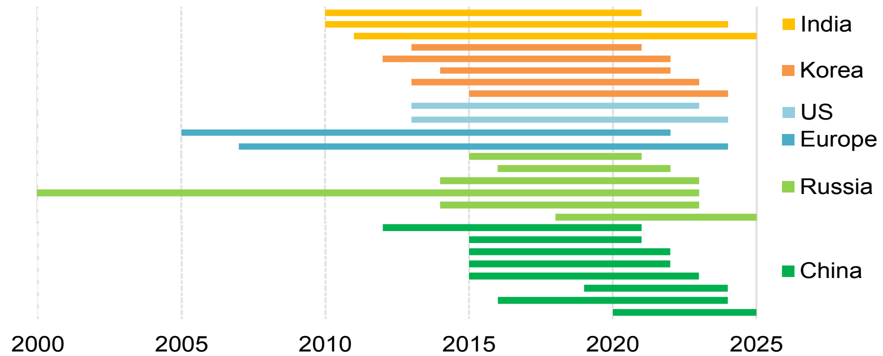

Nuclear power is also attracting interest elsewhere in Southeast Asia. Malaysia has not committed to deployment but has formally reintroduced nuclear energy as a potential option in its long-term energy strategy. Myanmar is engaging with the International Atomic Energy Agency (IAEA) on nuclear safety and security, including technical assistance, and has also signed an agreement with Russia to develop SMRs. Singapore plans to undertake an Integrated Nuclear Infrastructure Review (INIR) by the IAEA starting from 2027 to assess country's ability to make an informed decision on nuclear energy deployment. Thailand has not yet set specific capacity targets but is developing regulatory frameworks and considering the deployment of two SMRs after 2035.

# For countries considering nuclear power for the first time, development timelines and the choice of international partners are among the most consequential strategic decisions

Nuclear energy is not a one-off investment, but a multigenerational commitment. Projects typically involve upfront investments of several billion dollars, construction periods approaching a decade, and operating lifetimes extending to 60-80 years. Over the past decade, most new reactor construction starts in the world have relied on Russian or Chinese designs, reflecting these countries' sustained engagement through vertically integrated supply chains. Many projects are structured as partnerships in which vendors provide reactor technology, as well as construction, project management, fuel supply and, in some cases, financing support. While such models can reduce delivery risks for host countries, they also create long-term strategic dependencies that warrant careful consideration, as they may expose host countries to energy security risks.

Recent experience shows that Chinese-designed reactors often achieve first grid connection within around five to seven years from construction start, while Russian-designed projects are typically completed in seven to nine years, though performance varies across projects and host countries. In Europe and the United States, recent large-reactor projects have faced delays and cost overruns, largely reflecting first-of-a-kind designs, evolving post-Fukushima safety requirements and the need to rebuild supply chains after long periods without new construction. These experiences have generated valuable learning effects, and as designs are replicated and industrial capabilities recover, construction timelines and delivery performance for subsequent projects are expected to improve.

## Recent nuclear reactor construction timelines by origin of design

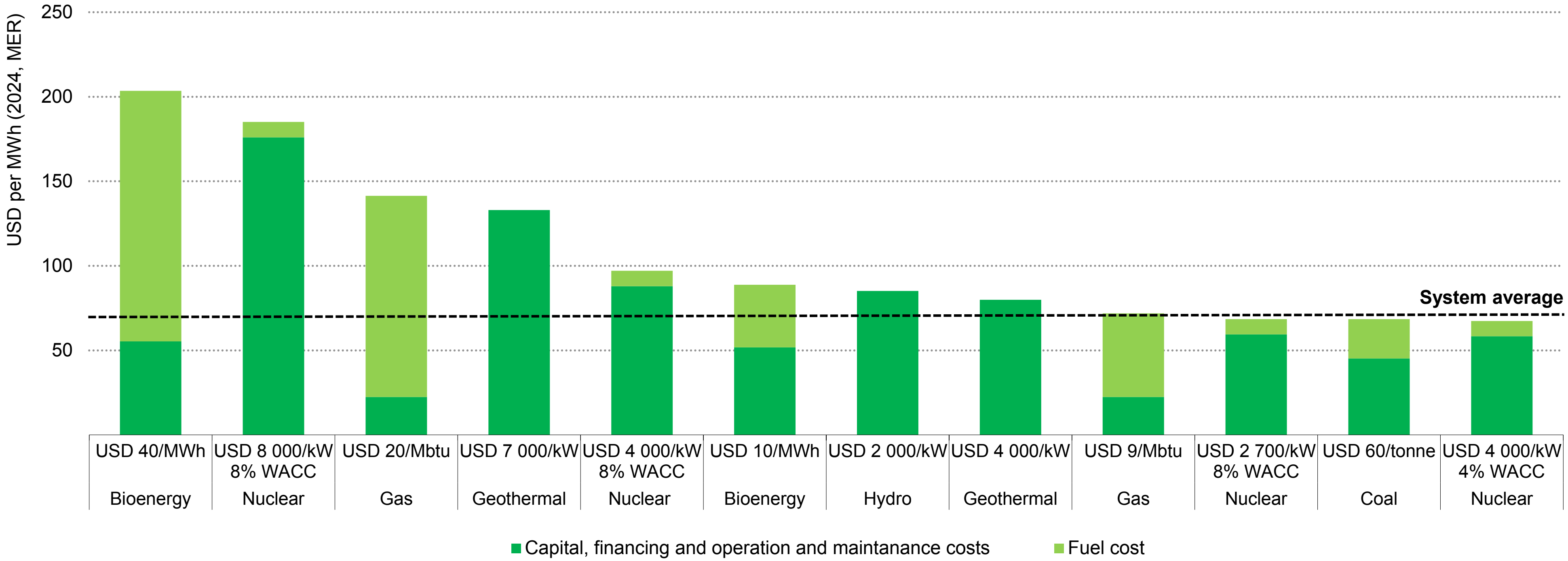





The global nuclear landscape is evolving, with SMR designs under development in many countries – including the United States, the United Kingdom, Korea and France – which could reshape delivery models over the coming decade. Although SMRs have not yet been deployed at scale and face licensing and cost challenges, they aim to shorten construction timelines, lower upfront capital requirements and enable greater modularity and localisation. If successfully commercialised, SMRs could diversify the pool of nuclear partners and expand options for countries considering nuclear power.

# Investment costs and financing conditions are key to the competitiveness of nuclear energy

Levelised cost of electricity in Southeast Asia by selected technology at potential capital and financing costs and fuel price levels, 2035






Notes: USD = United States Dollar; MER = market exchange rate; MWh = megawatt-hour; kW = kilowatt; Mbtu = Million British thermal units; WACC = weighted average cost of capital. Gas refers to efficient natural gas-fired power plants. Beyond those specified, the assumed capital costs are: USD 2 100/kW for bioenergy; USD 1 600/kW for coal-fired power plants; and USD 700/kW for gas-fired power plants. The WACC is assumed at 8% for coal, gas, bioenergy, hydro and geothermal; The economic lifetime is assumed to be 40 years for hydro, 35 years for nuclear, 30 years for bioenergy and coal and 25 years for gas and geothermal. Assumed capacity factors are: 80% for nuclear power; 60% for coal; and 50% for natural gas; The efficiency of coal plants is assumed at 40% and 58% for gas-fired power plants; System average represents the system average electricity generation costs across Southeast Asian countries. The levelised cost of electricity (LCOE) comparison focuses on dispatchable technologies to ensure an assessment of options that can provide firm electricity supply; variable renewables are excluded as their system value depends on the alignment of their availability with evolving system needs, determining their contributions to energy, capacity and flexibility services.

# Nuclear can be cost-competitive and support affordable electricity in Southeast Asia, but only if projects are built on time and budget, and if financing costs are kept low

Assessing the costs of different generation technologies is critical for electricity affordability, particularly in fast-growing power systems where today's investment decisions shape end-consumer prices for decades. The levelised cost of electricity (LCOE) is widely used to compare the cost competitiveness of technologies with similar operating characteristics, notably dispatchable plants operating at high-capacity factors. Across Southeast Asia, average electricity generation costs (excluding grids) are around USD 70/MWh. Nuclear projects delivered close to this range would therefore strengthen long-term electricity affordability while providing firm, low-emissions power that strengthens system adequacy and supports grid stability.

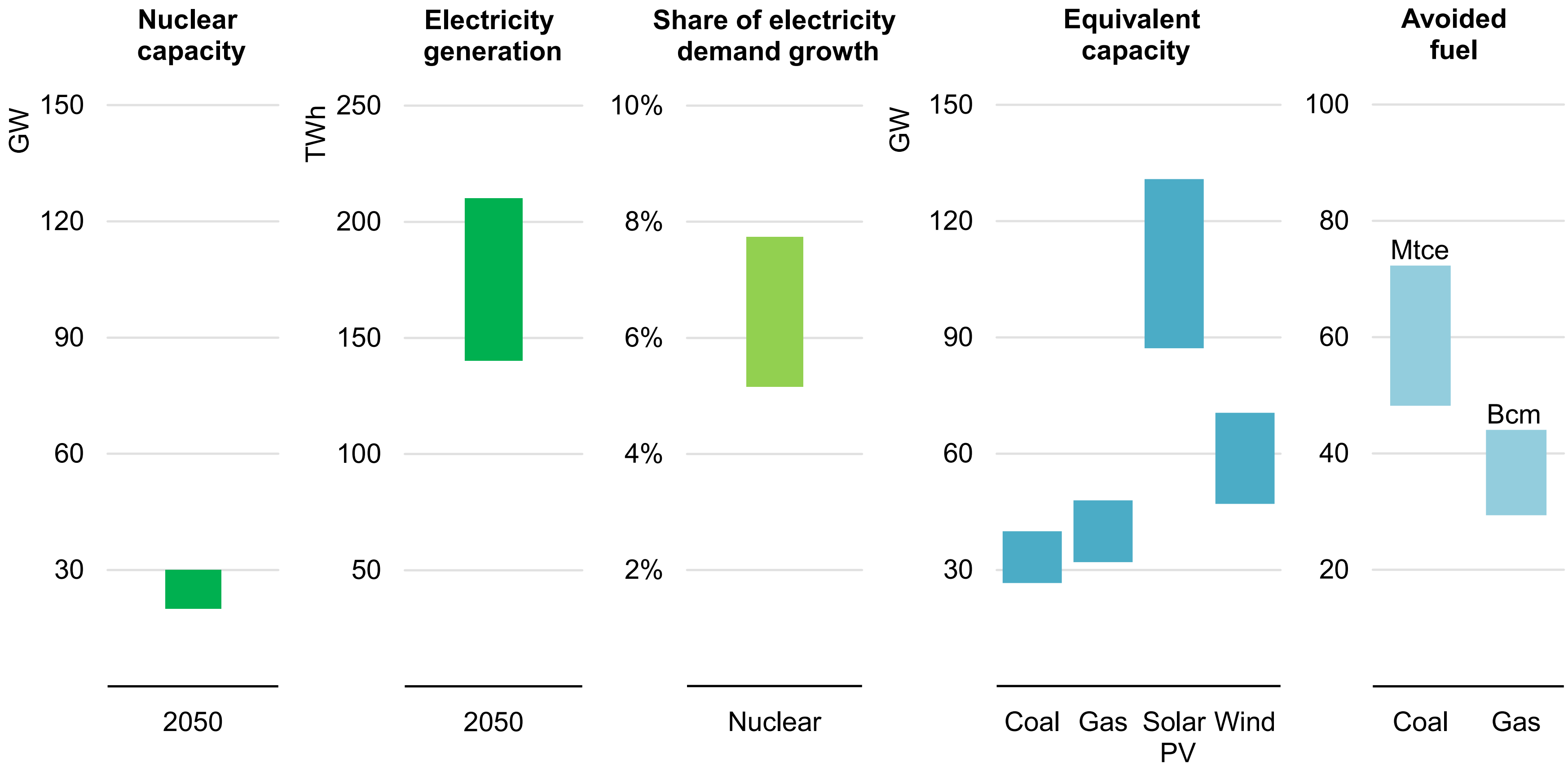
For nuclear power, LCOE outcomes depend primarily on upfront investment costs and financing conditions, reflecting the technology's capital-intensive nature. With investment costs of USD 4 000/kW and financing costs of 8% (real, pre-tax weighted average cost of capital [WACC]), nuclear LCOE is just below USD 100/MWh. Reaching around USD 70/MWh would require either reducing construction costs to USD 2 700/kW or halving the WACC, highlighting the importance of stable policy frameworks, appropriate risk allocation and access to affordable finance. By contrast, high investment costs of USD 8 000/kW under average financing conditions raise the LCOE to around USD 180/MWh. Looking ahead, SMRs could improve competitiveness by lowering upfront capital requirements, shortening construction timelines and reducing investment risk.

Nuclear energy's competitiveness also depends on the costs of alternative technologies and their fuel inputs. Hydropower can offer relatively low costs where high-quality resources remain available. Bioenergy power plants can be cost-competitive only where biomass input costs are very low, usually relying on local sources such as agricultural residues. Comparisons with coal and gas power plants hinge critically on fuel costs, which have become more volatile following recent market disruptions. For natural gas, LNG prices of USD 20/MBtu or higher push the average cost of electricity from a high-efficiency gas-fired plant above USD 140/MWh. At lower gas prices of around USD 9/MBtu – such as those from domestic production or long-term low-cost supply contracts – the LCOE falls to around USD 70/MWh. A similar dynamic applies to coal: at prices of around USD 60 per tonne, representative of domestic supply in some countries, coal-fired power has an LCOE close to USD 70/MWh.

However, while the LCOE is a useful benchmark for comparing technologies, it does not capture system-level impacts such as flexibility needs, integration costs or reliability, and therefore is not appropriate for comparing all technologies and does not necessarily indicate the least-cost option from the system perspective.

## Nuclear power can displace fossil fuel imports while meeting rising electricity demand in Southeast Asia

Nuclear capacity, generation and avoided fuel consumption in Southeast Asia in the Announced Pledges Scenario, 2050






Note: Assumed capacity factors are: 80% for nuclear power, 60% for coal, 50% for natural gas, 34% for wind and 18% for solar PV. The efficiency of coal-fired power plants is assumed at 36% and 48% for gas-fired power plants. Electricity generation refers to the output from the range of nuclear capacity. Equivalent capacity refers to the amount of coal, gas, solar PV or wind capacity required to produce the same amount of electricity as the range of nuclear power capacity specified.

# Nuclear power can deliver firm, low-emissions electricity at scale while strengthening energy security and system stability

The development of nuclear energy in Southeast Asia could bring a range of benefits for electricity systems undergoing rapid growth and transformation. Deployment in line with announced national targets could add significant new capacity by 2050, meeting up to around 8% of total electricity demand growth. In generation terms, this nuclear output could be equivalent to up to around 130 GW of solar PV or 70 GW of wind capacity, highlighting its ability to deliver large volumes of firm power relative to variable alternatives. By diversifying the generation mix, nuclear energy can complement renewables while reducing reliance on a narrower set of technologies.

Expanded nuclear generation could also displace a substantial amount of fossil fuel used in the power sector. By 2050, based on the projected electricity generation mix and the relative shares of coal and natural gas within fossil-fuel generation (coal accounting for 55% and gas for 45% of the combined coal-and-gas output), this generation could displace the need for over 35 Mtce of coal and nearly 20 bcm of natural gas. If nuclear output were to fully replace natural gas generation, it would avoid around 45 bcm of gas per year, corresponding to 50% of current natural gas consumption in the power sector. Alternatively, if it were to fully replace coal-fired generation, it would avoid up to 70 Mtce of coal, equivalent to roughly 30% of total coal use for power generation today in the region. In all cases, the displacement of coal or natural gas would enhance energy security by reducing reliance on imported fossil fuels, lowering exposure to price volatility, and mitigating long-term supply risks.

## Key foundational steps to develop nuclear energy

More advanced nuclear programmes are distinguished by sustained government commitment, clear institutional arrangements, and early investment in human capital and regulatory readiness. Experience shows that a country can move from initial consideration of nuclear power to operating its first nuclear reactors in about 10 to 15 years. Key priorities include establishing a robust nuclear regulatory framework, aligned with the IAEA Milestones Approach, with host countries taking primary ownership and advancing preparations proactively. This framework includes also the creation of an independent regulator with a clear separation between promotion and oversight, supported by emerging regional and international cooperation on safety and emergency preparedness. Additional priorities include jointly developing nuclear skills, strengthening institutional and industry capabilities, sharing and diversifying financial risks, and building durable public trust and social acceptance. These steps are critical to translating stated ambitions for nuclear energy into reality across the region, provided that the countries are able to avoid undue delays and make clear and timely decisions at each stage of the process.

# Maintaining the momentum of the ASEAN Power Grid's expansion

## The ASEAN Power Grid is an opportunity to move towards a more secure, resilient, sustainable and connected power system

The ASEAN Power Grid (APG) is the key vision for regional power cooperation and connectivity in Southeast Asia as set out in the APG memorandum of understanding (MoU) signed in 2007 and the Enhanced APG MoU agreed in 2025. It is a key programme area under the ASEAN Plan of Action for Energy Cooperation 2026-2030.

With rising electricity demand and plans to rapidly deploy variable renewable energy across the region, the APG is seen by countries as a tool to enhance energy security, affordability and sustainability. While Southeast Asia's untapped renewable energy resources are abundant, they are unevenly distributed and often located far from major demand centres. Interconnectors – electricity transmission lines that link power systems, often across borders – can enable the exchange of low-cost renewable electricity from resource-rich areas to urban centres and industrial hubs. Interconnections also support more resilient and reliable power systems through smoothing fluctuations in electricity output from variable renewables, mitigating operational challenges and ensuring supply-demand balance.

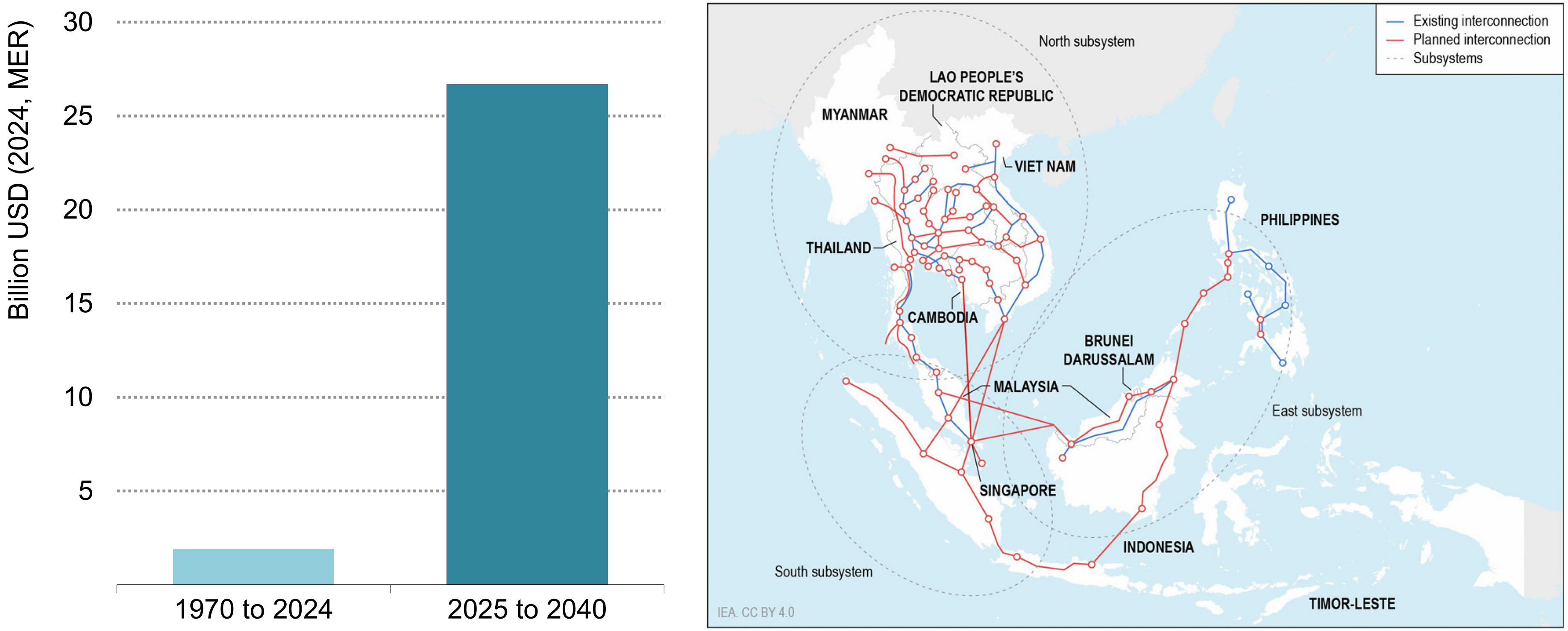
Regional power trade in Southeast Asia remains nascent and is characterised by multiple partially connected subsystems. Since the first project connecting Lao PDR with Thailand in the 1970s, around USD 2 billion has been invested in interconnectors, of which 85% has supported generation-to-grid projects for the one-way export of power. Except for one project, a 2-km subsea interconnector between Singapore and Malaysia, all investment to date has been in overhead lines. Only 15% of investment has targeted the bi-directional, grid-to-grid projects envisioned under regional integration plans.

Yet momentum for the APG has never been stronger. Sustained high-level political backing has been accompanied by several key milestones since 2024, including the agreement of the Enhanced MoU for the APG among ASEAN member states; endorsement of the terms of reference for a Submarine Power Cable Development Framework; the launch of the APG Financing Initiative, with an initial USD 12.5 billion committed by the World Bank and the Asian Development Bank, and the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project entering Phase 2.

The APG has faced institutional, technical, regulatory and financing challenges. Realising its ambitions will require an estimated USD 27 billion of investment between 2025 and 2040 to deliver the pipeline of projects proposed in the ASEAN Interconnection Masterplan Study III and other announced projects – a 14-fold increase compared with total investment in interconnectors in Southeast Asia from the 1970s to 2024. These investments take place in the context of over USD 320 billion of investment needs in transmission and distribution under the STEPS between 2026 and 2040.

# Delivering the ASEAN Power Grid interconnector project requires USD 27 billion of investment

Historical interconnector investment and projected needs, 1970-2040 (left) and map of existing and planned interconnector projects in Southeast Asia (right)



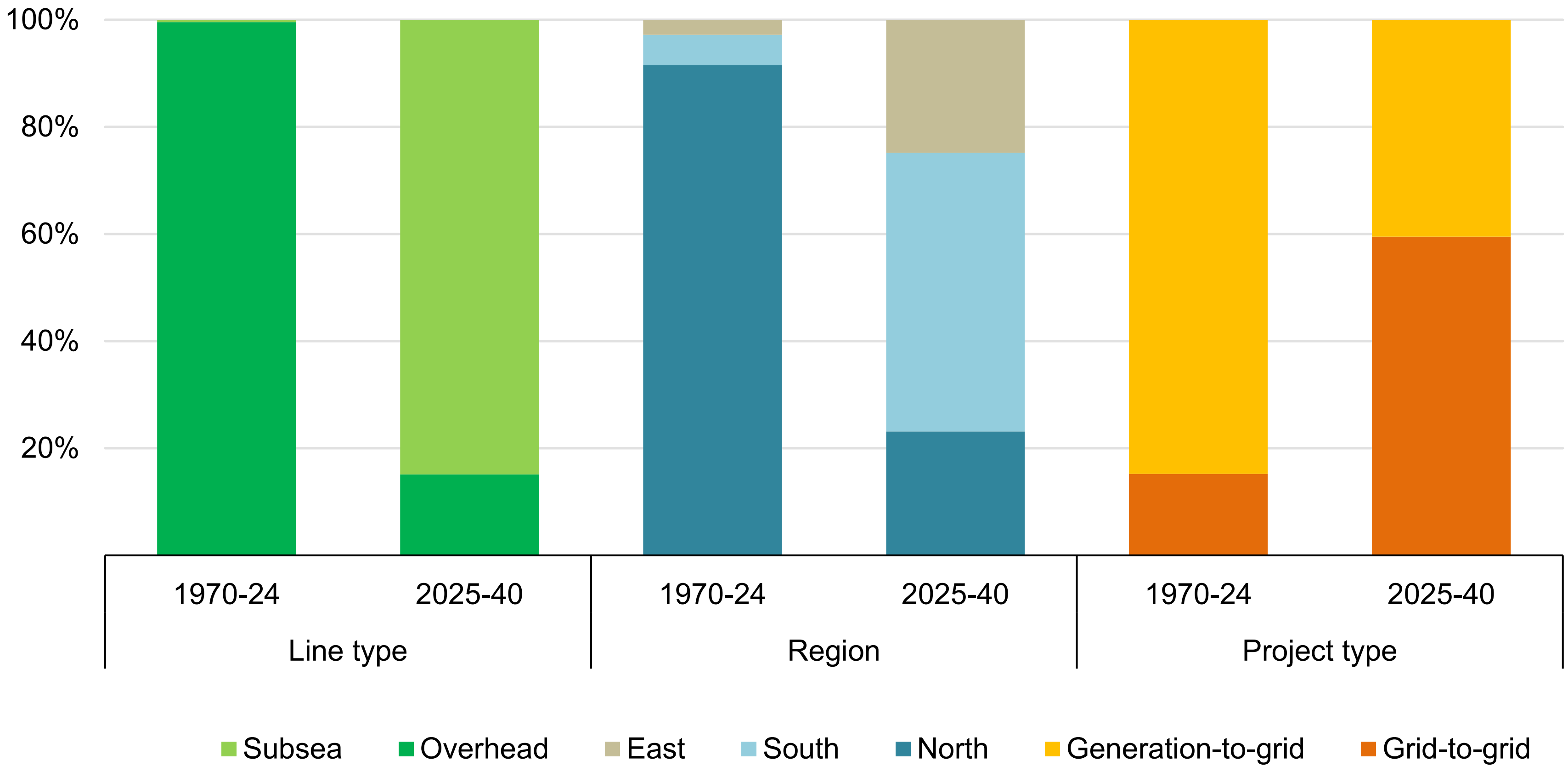



Note: This map is not intended to be an exhaustive list of all operational or planned interconnections in the region. Some existing and planned generation-to-grid and domestic island connections are excluded from this figure.

Source: IEA (2026), Financing the ASEAN Power Grid.

## The scale and complexity of interconnector projects are set to increase as the pipeline moves towards subsea cables and grid-to-grid projects

Cumulative investment in Southeast Asia of interconnector projects by feature, 1970-2040






Source: IEA (2026), Financing the ASEAN Power Grid.

## Subsea cables come with a distinct risk profile and supply chain constraints, requiring strong end-to-end risk management

Interconnector projects in ASEAN face elevated and interrelated risks, including both actual and those perceived by investors. These contribute to high financing costs, or a high cost of capital, which is often a key barrier to scaling investments in transmission and power generation in emerging market and developing economies. Political and regulatory risks are central: interconnectors' long project timelines expose investors to changes in tariff frameworks and shifting government priorities. Technical and physical risks are also significant. In particular, long-distance subsea high-voltage direct current (HVDC) projects are exposed to cable-laying complexity, extreme weather, and the risk of anchor damage. Other factors, including permitting and access risks, off-taker risk and currency risks, remain important considerations for investors.

To realise the project pipeline, robust end-to-end risk management is essential. Governments, developers and other stakeholders involved in project development should adopt an integrated approach to managing risks across the project lifecycle. Early engagement with technical experts, insurers and risk advisers during the project design stage is critical. Contractual arrangements should allocate risks to the parties best placed to manage them. Governments, in particular, can play a key role in addressing regulatory, permitting and access risks. Credit enhancement instruments, such as guarantees, can help mitigate political and off-taker risks, while insurance is necessary given the high potential repair and business interruption costs in the event of cable damage.

To bridge residual bankability gaps, public or concessional financing from development financial institutions can play a catalytic role. Existing examples in Southeast Asia include the APG Financing Initiative and the Regional Connectivity Fund for Energy in Southeast Asia. Such support requires deliberate strategies to catalyse, rather than crowd out, private capital – ensuring that public finance mobilises, instead of substitutes for, commercial capital.

Acute supply chain constraints and rising costs also introduce price uncertainty and the risk of delays to the project pipeline, particularly for subsea HVDC projects. In 2024, prices for transformers and cables were nearly double 2019 levels, while lead times for large power transformers have almost doubled since 2021. Manufacturers of subsea cables and cable-laying vessels are operating at or near full capacity. In this context, strengthened supply chain co-ordination can support a more enabling investment environment. Forward planning, early engagement with manufacturers, and regionally co-ordinated procurement can help secure production volumes while managing rising costs and construction risks.

## Financing models and commercial arrangements must evolve to scale power trade and mobilise new sources of finance

Almost all grid-to-grid interconnectors to date have been financed on the balance sheets of state-owned utilities, primarily supported by government borrowing. This financing model can be challenging to scale where utilities face financial constraints, particularly for large projects with multi-billion investment needs. The split project model, which divides the project at national borders, can also present challenges, as costs are allocated by geography rather than by the distribution of benefits or risks. This is particularly complex in cases where the line traverses multiple jurisdictions or third-party waters.

Alternative financing models can improve cross-border collaboration and attract new sources of capital. Shared ownership and cross-border financing structures can improve end-to-end project management and enable the sharing of costs and benefits for large, long-distance subsea projects. Regional funding mechanisms, such as the Connecting Europe Facility for Energy, illustrate how projects delivering regional benefits beyond the host countries can be supported. Independent transmission project models, which ring-fence project financing and allocate risks off-balance sheet, can also be considered where there are financing constraints and a need to mobilise private sector capital at scale.

Commercial arrangements for cross-border power trade currently rely on bespoke contracts negotiated on a case-by-case basis, with no harmonised approach to cost, risk and benefit allocation, nor a common framework for transmission charges. This limits transparency and scalability. As the number of market participants increases (including exporters, importers, interconnectors and participating countries) this can lead to greater complexity, unequal treatment of parties and higher transaction costs.

To scale power trade, commercial arrangements should be guided by regulation rather than bespoke contracting. Establishing a regional approach to transmission charges for cross-border trading, as seen in the West African Power Pool, can create better visibility for investors and reduce transaction costs. This can be established while accommodating diverse national market structures and priorities. At the project level, revenue mechanisms should be designed with predictability in mind. Availability payments, as seen in Brazil, can improve revenue certainty for investors and improve project bankability.

Achieving the APG vision of a fully integrated operation by 2045 will require co-ordinated action among policy makers, regulators, utilities, financial institutions, commercial investors and industry. Under the right enabling conditions, interconnectors can attract diverse sources of capital at scale and accelerate ASEAN's progress towards a more secure, affordable and sustainable regional power system.

# Ensuring fair and inclusive energy transitions

# Ensuring Southeast Asia's energy development is fair and inclusive remains a key challenge, as governments balance rising energy demand with emissions reductions and energy access

## Emissions reduction

Governments are exploring options to reduce carbon emissions while supporting continued economic development as climate-related risks – including more frequent and severe weather events such as storms, flooding and heatwaves – are increasing in many parts of the region. In 2024, energy-related $CO_2$ emissions from Southeast Asia totalled just under 2 000 Mt, with around 45% from the power sector and a further 45% combined from industry and transport. Total emissions increase by 30% to 2035 in the CPS and by 20% in the STEPS, and continue to rise in both scenarios to 2050. By contrast, in the APS, achieving Indonesia's 2030 peaking target and longer-term net zero emissions targets in eight countries (ranging from 2050 to 2065) means that regional energy-related $CO_2$ emissions remain near today's levels through 2035 and then fall to around 1 000 Mt by 2050.

Renewables currently account for a quarter of power generation in Southeast Asia and are a key lever for moderating emissions growth in the STEPS and shifting the emissions trajectory onto a declining path in the APS. Accelerated deployment raises the share of renewables in the electricity mix to 35% by 2035 in the STEPS, avoiding nearly 80 Mt $CO_2$ more emissions than in the CPS – over half of the reductions needed to close the gap between the scenarios.

In the APS, renewables reach 50% of power generation by 2035, driven by coal phase-out plans and renewables targets in Malaysia, Indonesia, Thailand and Viet Nam. By 2050, low-emissions sources account for 90% of the region's power sector inputs, completely transforming the sector and cutting sector emissions by 70% from today's level of around 900 Mt $CO_2$.

Rapid growth in industrial activity and mobility needs drives higher emissions from end-use sectors, rising by 30% in the CPS, by over 20% in the STEPS, and by under 10% in the APS to 2035. Electrification – led primarily by the uptake of EVs – emerges as a major lever to curb end-use emissions, supported by demand- and supply-side policy incentives in several countries. By 2035, electrification avoids an additional 35 Mt $CO_2$ in the STEPS compared with the CPS, accounting for a quarter of the total emissions gap. At the same time, ongoing and strengthened efficiency improvements across industry, buildings and transport moderate emissions growth further, contributing 20% of the emissions gap between the CPS and STEPS in 2035.

In the APS, faster electrification of rail, Indonesia's EV fleet targets, Viet Nam's transport decarbonisation goal, and Singapore's planned phase-out of $CO_2$-emitting vehicles drive further emissions reductions, as electricity's share of total final consumption rises from

23% today to over 45% by 2050. Combined with efficiency gains, fuel switching and structural change, these trends deliver a 45% reduction in the energy intensity of regional GDP, from 1.7 GJ per thousand USD today. By mid-century, emissions-intensive sectors – including energy-intensive industries, heavy freight transport, shipping and aviation – account for half of remaining energy-related $CO_2$ emissions.

## Energy access and affordability

Since 2000, Southeast Asia has made rapid progress in expanding access to both electricity and clean cooking, broadly in line with economic development, rising incomes and urbanisation. Government policy has also played a central role in accelerating uptake and making access gains widespread across the region.

**Electricity access** has made major progress. Indonesia and Thailand have fully closed their access gaps over the last decade, leaving the remaining shortfall concentrated in Myanmar and the Philippines, where 16 million and 5 million people, respectively, still lack access. In the STEPS, Myanmar and the Philippines continue their progress and reach universal electricity access by 2035. As countries develop and access expands, electricity consumption per connection tends to rise along two distinct paths. Households that already have access typically increase their consumption over time, while newly connected households, often in rural areas, generally begin at a relatively low levels of use. Once access gaps are closed, countries such as Indonesia and Thailand have shown a rapid increase in consumption per household towards the higher consumption levels seen in other regions.

**Clean cooking access** has also expanded strongly, but a sizeable gap remains. In 2024, 120 million people still lacked access to clean cooking, equivalent to 17% of the regional population. The largest remaining clean cooking gaps are in Lao PDR, Myanmar and the Philippines, where access rates stand at only 10%, 46% and 64%, respectively. Liquefied petroleum gas (LPG) is now the dominant clean cooking fuel in the region, used by 74% of people, with the highest shares in Indonesia (89%) and Malaysia (98%).

Indonesia is a key example of how targeted policy can drive rapid transitions at scale. In 2000, only 7% of the population had access to clean cooking. At the time, around 40% of those without access relied on kerosene, while the remainder mainly used traditional biomass. Since 2007, Indonesia's Kerosene-to-LPG Conversion Program has driven a sharp increase in access, bringing the clean cooking rate to over 90% today. The programme distributed free LPG starter kits and exceeded its original rollout target.

With the emergence of the energy crisis in 2026, Indonesia is now looking to further the switch to clean energy and reduce dependence on fossil fuel imports by accelerating the implementation of an LPG-to-electric stove conversion programme. A separate programme has shown initially promising results: nearly 500 000 free rice cookers have been distributed to poor households since 2023. Average household LPG consumption fell by 1.2 kg per household receiving a rice cooker; this has helped to reduce the fiscal cost of LPG subsidies even after accounting for higher use of subsidised electricity, while also delivering nutritional, environmental and time-saving benefits.

While access to energy has progressed over time, **energy affordability** remains a challenge for many households across the region. Between 2019 and 2024, residential energy expenditure per capita increased by nearly 12% on average in Singapore, Thailand, the Philippines, Viet Nam and Indonesia. In the crisis, households have faced rising energy bills, especially those who are reliant on transport fuels for their daily commutes. Six weeks after the start of the conflict, diesel prices had increased by 67% in Thailand and Singapore, by over 100% in Malaysia and Viet Nam, and by around 140% in the Philippines.

Rising energy prices affect income groups unevenly. Median-income households in the region spend around 11% of their income on energy, compared with 8% for high-income households and 16% for low-income households. Despite this, low-income households consume only about half as much energy as high-income households and one-third less than median-income households. When energy costs rise, low-income households often cut back on energy consumption, limiting their ability to meet basic energy needs such as cooling and cooking. Households may also forgo other essential expenditures, such as healthcare or food, to cover energy bills.

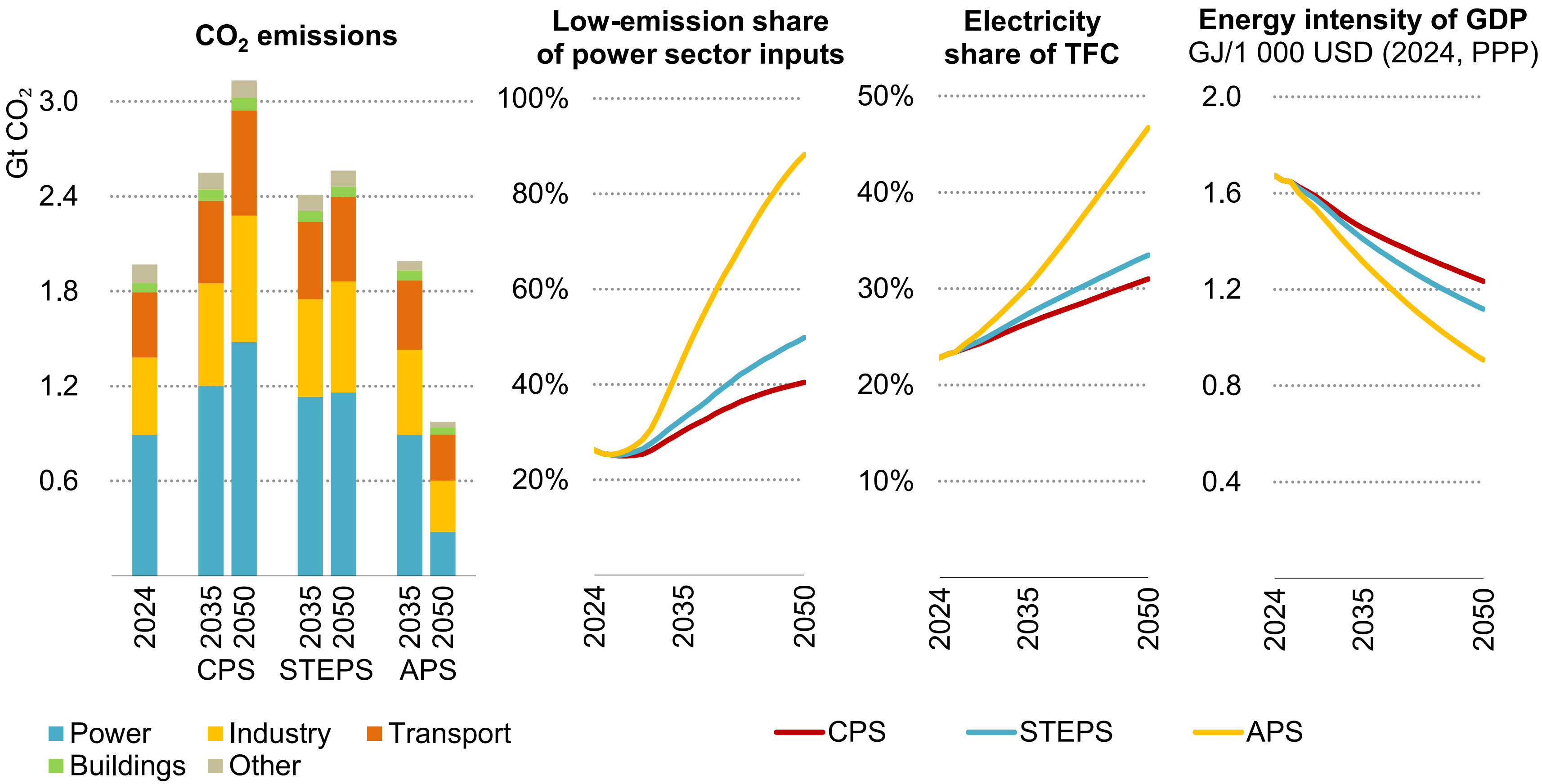
Access to affordable energy determines households' ability to use essential energy technologies such as cooling, which helps prevent millions of heat-related fatalities across Southeast Asia each year. In 2020, AC ownership in the wider Asia Pacific region was around three times higher in the richest than the poorest households.

Preserving energy affordability while meeting growing energy demand is a key objective outlined in the APAEC 2026-2030. Deploying renewable energy and improving energy efficiency are at the core of this strategy, alongside the electrification of transport and the development of public transport infrastructure that responds to consumer needs. The ASEAN Centre for Energy (ACE) estimates that if national energy efficiency plans across the region were fully implemented, consumption could be one-third lower than otherwise projected, generating significant savings on consumer energy bills.

As countries address the immediate impacts of the energy crisis, greater focus on energy efficiency is aligning short-term interventions and long-term objectives to strengthen resilience to future shocks. These are already delivering benefits for households. For example, in Malaysia, 9.2 million households have benefitted from incentives to improve energy efficiency, delivering savings of more than USD 500 million and helping to stabilise the energy bills of 85% of households.

# Emissions pathways diverge markedly across scenarios, with reductions driven primarily by the expansion of renewables in the power sector and the electrification of end uses

$CO_2$ emissions by sector and scenario (left), and emissions reduction drivers in Southeast Asia by scenario (other graphs), 2024-2050

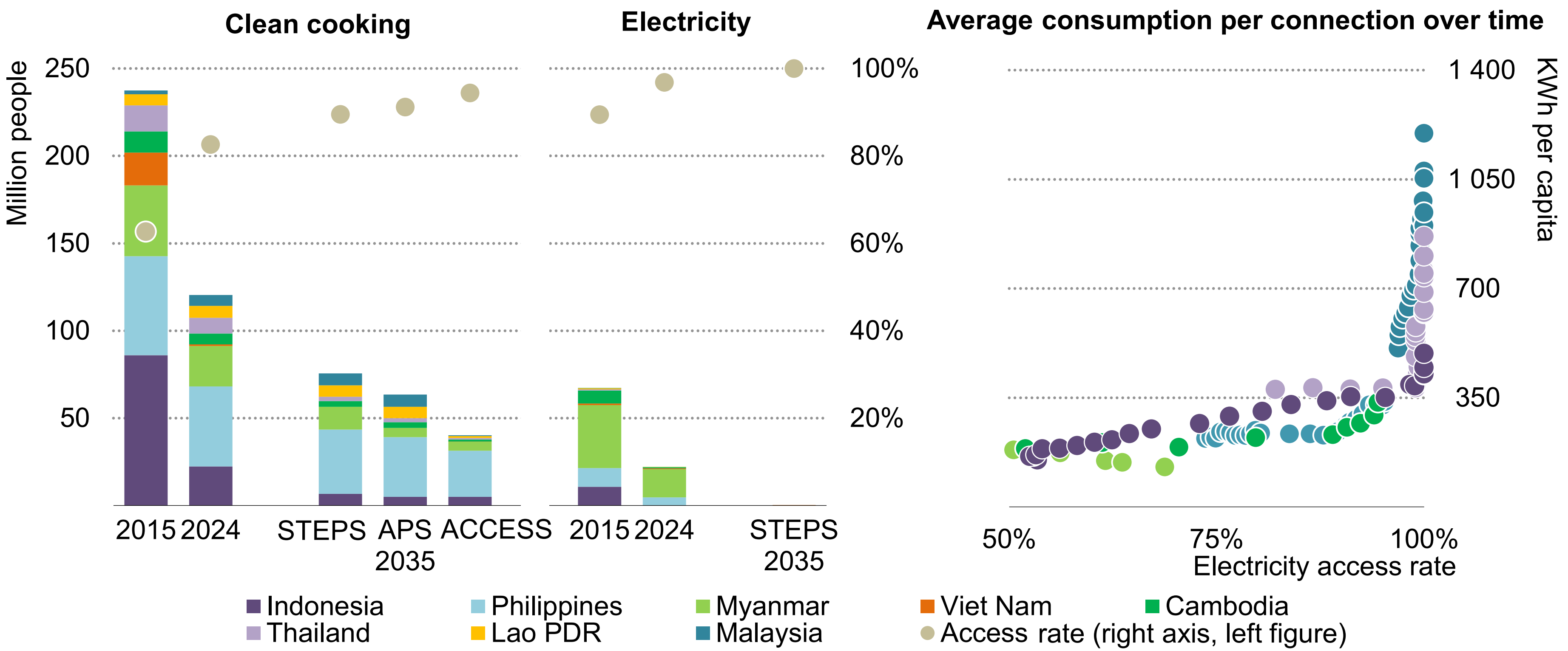





Notes: Gt $CO_2$ = gigatonne of carbon dioxide; TFC = total final consumption; USD = United States dollar; PPP = purchasing power parity. ‘Other’ includes agriculture and other energy transformation sectors.

## Universal electricity access is achieved by 2035 in the STEPS, while gaps in clean cooking persist longer and become concentrated in a small number of countries

Population without energy access by scenario, 2015-2035 (left) and average residential electricity consumption per connection by country, 2000-2023 (right)






Source: Clean cooking 2015-2024: IEA analysis based on WHO (2025).

Note: Lao PDR = Lao People's Democratic Republic. STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; ACCESS = Accelerating Clean Cooking and Electricity Services Scenario. Universal electricity access is reached by 2035 in all three scenarios. Right figure: timeseries for Myanmar 2019-2023 and Cambodia 2015-2023 due to data availability. KWh = kilowatt-hour.

## Job creation

Since 2015, the energy sector has created 800 000 new jobs in Southeast Asia, reaching close to 5 million workers in 2024 – around 1.4% of economy-wide employment in the region. Coal supply accounted for around a third of these net additions as jobs grew by more than a half, owing almost entirely to expanded production in Indonesia, which accounts for the vast majority of the region's coal workforce. By contrast, oil and gas jobs have declined over the past decade, in line with falling crude output in several countries. Meanwhile, low-emissions energy supply is growing in importance for the energy workforce: jobs have doubled since 2015 and now account for around one in six energy supply roles.

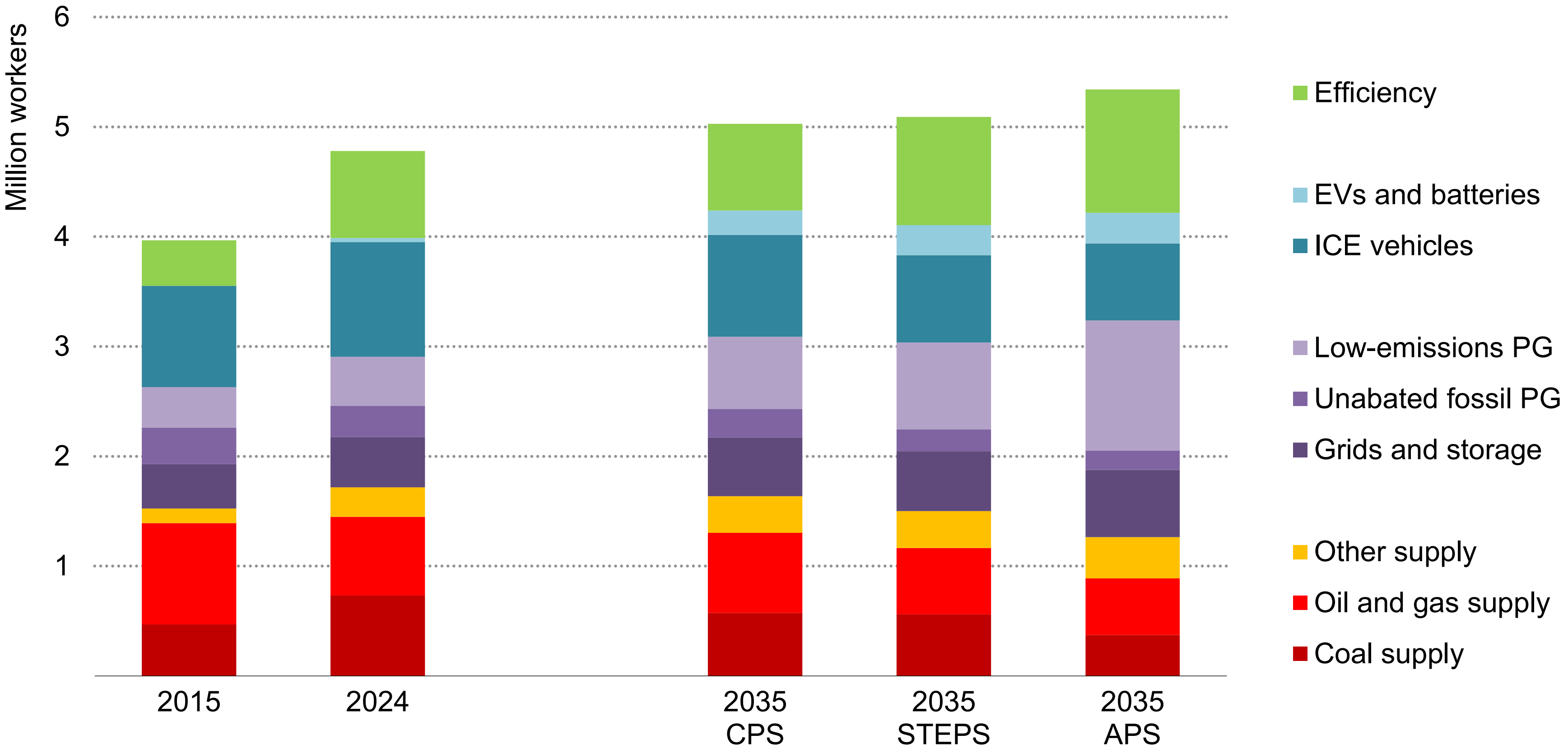
In the power sector, employment growth has been more modest, but with a gradual shift towards low-emissions technologies. In power generation, the share of jobs in these technologies has risen from around 50% in 2015 to approximately 60% today. This increase has occurred despite a recent retrenchment in jobs for solar installers, as the pace of solar PV rollout slowed in the 2020s following a surge in capacity additions between 2019 and 2021; however, installations are likely to pick up again given the recent surge in regional solar PV imports in early 2026. Energy efficiency has also been a significant driver of job creation, as policies and investments supporting deployment of efficient lighting and improvement of industrial energy performance have generated jobs across installation, manufacturing and related services.

Southeast Asia is also strengthening its position in clean technology manufacturing and related sectors. The region has reinforced its role as a global automotive production hub, with electric vehicles set to take a growing share of these jobs, supported by a restrengthening of trade protections, alongside the emergence of domestic manufacturers such as Viet Nam's VinFast. These developments in the EV sector are set to create spillovers across related supply chains, with Southeast Asia also emerging as a hub for battery manufacturing, as well as production of critical minerals such as nickel and cobalt. The region has also become a major centre for solar PV manufacturing, accounting for around 40% of jobs outside China. However, its role is set to decline over the remainder of the decade, owing mainly to the impact of tariffs imposed by the United States, the main customer for its solar panel exports, alongside expanding production elsewhere.

Looking ahead, energy employment is projected to grow by a similar amount in both the CPS and STEPS and would see a further boost in the APS. Employment in low-emissions power is set to rise further, with an especially dramatic take-off presented in the APS, linked to large-scale construction of new power capacity. EV employment is expected to replace jobs linked to internal combustion engine (ICE) vehicles in all scenarios. Major policy uncertainties affecting the energy employment outlook surround the fossil fuel supply sectors, in which jobs decline by as much as 40% by 2035 in the APS (or 560 000 jobs), but only 10% in CPS.

## The energy sector has created 800 000 jobs over the last decade, with future growth set to be driven by solar PV and electric vehicles

Energy employment by technology and scenario in Southeast Asia, 2015-2035






Notes: PG = power generation; ICE = internal combustion engine; EVs = electric vehicles. CPS = Current Policies Scenario; STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario. 'Other supply' includes supply of low-emissions fuels and critical minerals. 'Grids and storage' includes transmission, distribution and storage. Efficiency includes building retrofits, heat pumps and other efficient and renewable heating, ventilation and air conditioning, and efficient appliances and lighting.

## Tracking the social and economic dimensions of energy policies

Robust tracking using indicators helps ensure that energy plans deliver reliable, sustainable energy supply while providing wider socio-economic benefits. Monitoring outcomes such as reductions in energy poverty, economic diversification and the creation of decent jobs supports more effective policy design. In Southeast Asia, indicators are increasingly embedded in national energy planning efforts. For example, Indonesia's Just Energy Transition Partnership includes metrics on job creation, adherence to just transition standards and grievance mechanisms, while at the regional level, the Clean, Affordable and Secure Energy for Southeast Asia project uses indicators to assess renewable energy deployment and stakeholder feedback to inform evidence-based policymaking.

Indicators also capture labour market outcomes, including job quality, informal work and skills development. Monitoring these dimensions helps assess whether policies deliver inclusive economic growth which can strengthen the social acceptance of energy projects. In the Philippines, indicators track curriculum alignment, vacancies and skills-matching to ensure workforce readiness. In Indonesia, inter-ministerial data integration and mandatory reporting are used to identify and address informal work in critical minerals. In Cambodia, attendance records, surveys and interviews assess training quality and sustainable job creation.

Including indicators on access and affordability during programme design helps ensure households can both access and pay for energy, particularly those most vulnerable to cost increases. In Cambodia, household surveys, logbook monitoring and energy audits track progress on clean cooking access, while in Singapore real-time monitoring of utilisation and expenditure helps target energy rebates effectively.

Broad stakeholder engagement in policy design is critical to improving social acceptance, reducing inequities and maximising benefits. Indicators can measure both the reach and effectiveness of this engagement. In Indonesia, surveys and real-time dashboards track participation, while in Malaysia, site visits, surveys and interviews help ensure respect for Indigenous rights. Youth-led proposals highlight the need to track participation and impacts on young people, given concerns about skills gaps in the transition. Qualitative indicators are important to assess not only how often stakeholders are engaged, but also the quality of these exchanges.

Access to transparent, reliable and disaggregated data remains foundational for effective indicator frameworks, yet gaps persist across key areas. Strengthening technical capacity can improve data collection and analysis. Integrating qualitative insights with quantitative metrics further helps capture real-world impacts. To support this, the IEA's Southeast Asia Indicators Handbook for Just and Inclusive Transitions provides practical guidance on selecting indicators, tracking progress and designing inclusive policies.

# Securing critical minerals

## Southeast Asia has the potential to strengthen its position as both a major producer of critical minerals and a key region supporting efforts to diversify global supply chains

Southeast Asia holds a substantial share of global mineral reserves, accounting for around 51% of global nickel reserves as of 2024, as well as shares of bauxite at about 20% and tin at around 17%. The region also hosts reserves of cobalt, rare earth elements and copper, which are critical for energy, transport, advanced manufacturing, electronics and other strategic industries. While most of the processing and manufacturing today lies outside Southeast Asia, these resource endowments underscore the role it can play in contributing to more diversified critical mineral supply chains. From 2024, mined output across cobalt, copper, nickel and rare earths in Southeast Asia is projected to grow by a weighted average of 30% by 2035 in the base case (based on current policies, announced projects and expected market developments), though mined copper production is expected to decline by a quarter over the same period. By 2035, Southeast Asia's refined output is projected to grow by a weighted average of 130% – driven primarily by nickel refining in Indonesia as well as threefold growth in rare earths and cobalt.

As global demand for critical minerals is projected to grow substantially by 2040, with nickel almost doubling, cobalt and rare earth elements rising 50-60%, and copper growing by 30%, Southeast Asia's expanding supply positions the region as a crucial source to meet this rising demand.

Indonesia anchors supply in the region, accounting for 63% of the global mine production for nickel and 12% of global cobalt output in 2024 (both widely used in batteries for electric vehicles and consumer electronics). Indonesia's ban on unprocessed nickel exports in 2020 accelerated domestic refining, attracting almost USD 14 billion in smelter investment and expanding domestic capacity from 2 to more than 30 facilities. A key co-benefit is increased recovery of cobalt, which is produced as a by-product of nickel laterite processing, allowing cobalt output to scale rapidly. Indonesia imports nickel ore from the Philippines, the region's second-largest global nickel producer, accounting for 10% of global mined output in 2024. Moreover, while Indonesia hosts over 40% of global refined nickel production, Indonesian companies own only around 10% of that capacity, with most ownership held by Chinese companies.

Rare earth elements – both light rare earth elements (neodymium, praseodymium) and heavy rare earth elements (dysprosium, terbium) – are essential for permanent magnets used in EV motors and a wide range of energy and high-tech applications where high temperature resistance is crucial. In the region, upstream mining of these magnet rare earth elements is concentrated in Myanmar, which accounted for just under 20% of global mined supply and over 40% of heavy rare earth elements, while Thailand contributed about 2% as of 2024.

Malaysia plays a notable role in refining through the Lynas plant in Pahang, which provides 11% of global rare earth metal output, making it the largest refined supplier outside China in 2025. Although China remains the dominant supplier, the region's contribution supports incremental diversification of global supply chains.

Although Viet Nam holds a substantial share of rare earth element reserves, mined production currently remains limited, highlighting the need for significant investment to unlock the potential. Some investment however is being made for rare earth refining in the country. Beyond rare earths, the country plays a key role in the supply of tungsten as it is the second-largest mined tungsten producer globally, accounting for 4% of global output behind China (82%).

Tin, used in solder for electronics, semiconductors and electrical equipment, presents a strategic opportunity for the region, with Indonesia being the second-largest (19%) ore producer after China. Combined with the production in Myanmar, Viet Nam, Malaysia and Lao PDR, the region accounts for 13% of global mined output of tin. Indonesia hosts a mature tin smelting, industry supported by domestic refineries such as PT Timah, the world's fourth-largest refiner, which accounted for 5% of global refined tin supply in 2024.

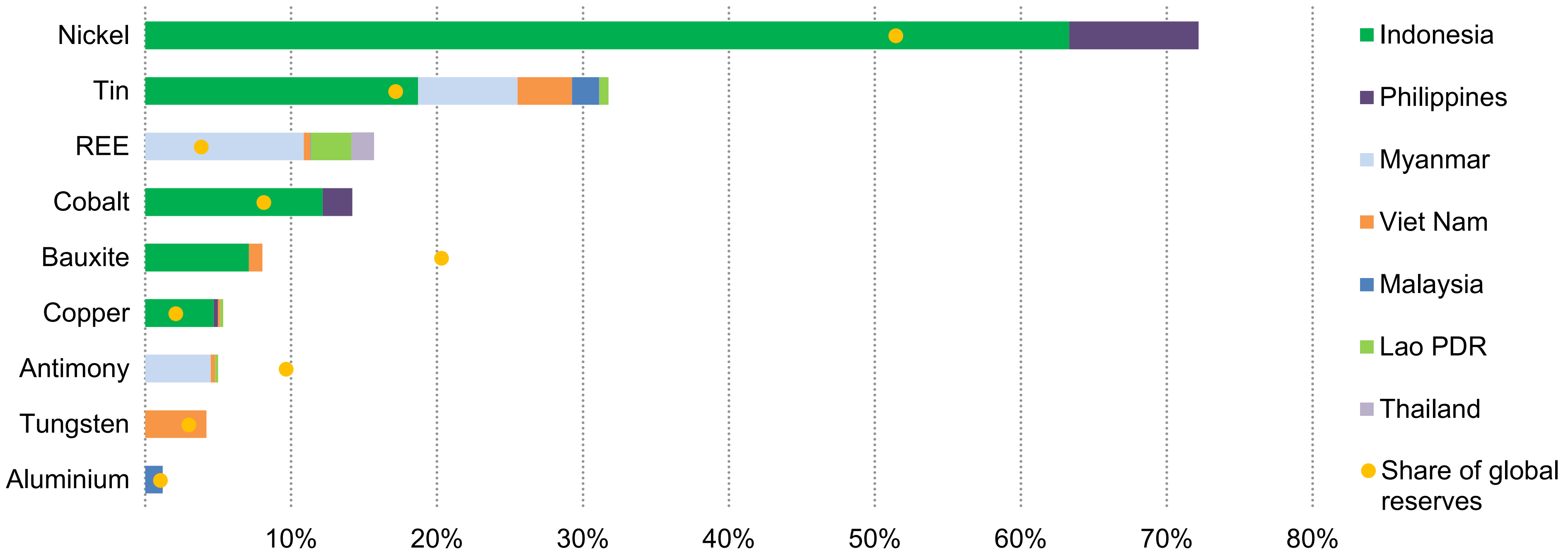
## A global mineral supplier, but also an importer of key critical minerals

Domestic resource endowment does not automatically translate into supply security. Resource-rich regions can still be strategically dependent on other countries for processing, capital investment or technology. Raw or semi-processed materials produced in Southeast Asia have increasingly flowed to other Asian countries for midstream processing and downstream manufacturing. Since Indonesia's export ban in 2020, the Philippines became the world's largest exporter of nickel ores, supplying around 90% of China's nickel ore imports in 2024. The region also leads in the exports of tin and rare earths, with Myanmar accounting for roughly half of China's tin imports and about 57% of its heavy rare-earth imports in 2024. Viet Nam plays a more differentiated role, exporting processed light rare earths. In 2024, nearly a third of Japan's rare earth metal imports came from Viet Nam, supported by investments including from Japan's Shin Etsu and Korea's Star Group in processing and magnet manufacturing.

At the same time, the region's growing role as a manufacturing base has increased reliance on imports of minerals such as lithium, highlighting the need to manage import-dependence risks while strengthening supply resilience. Southeast Asia's trade structure is characterised by the coexistence of resource exports and manufacturing-driven import dependence.

# Southeast Asia has a strategic and expanding role in global critical minerals markets

Southeast Asia's share of global mined production and reserves for selected minerals, 2024






Note: REE = rare earth elements. Reserves data for rare earth elements in Myanmar are not accounted for in the chart due to lack of reliable data, but the country is one of the largest mined producers of medium and heavy rare earths in the world.
Source: Production data from IEA (2025), Global Critical Minerals Outlook 2025. Reserves from the US Geological Survey.

# The Middle East crisis compounds challenges already faced by critical minerals operations in Southeast Asia, adding further uncertainty to global supply

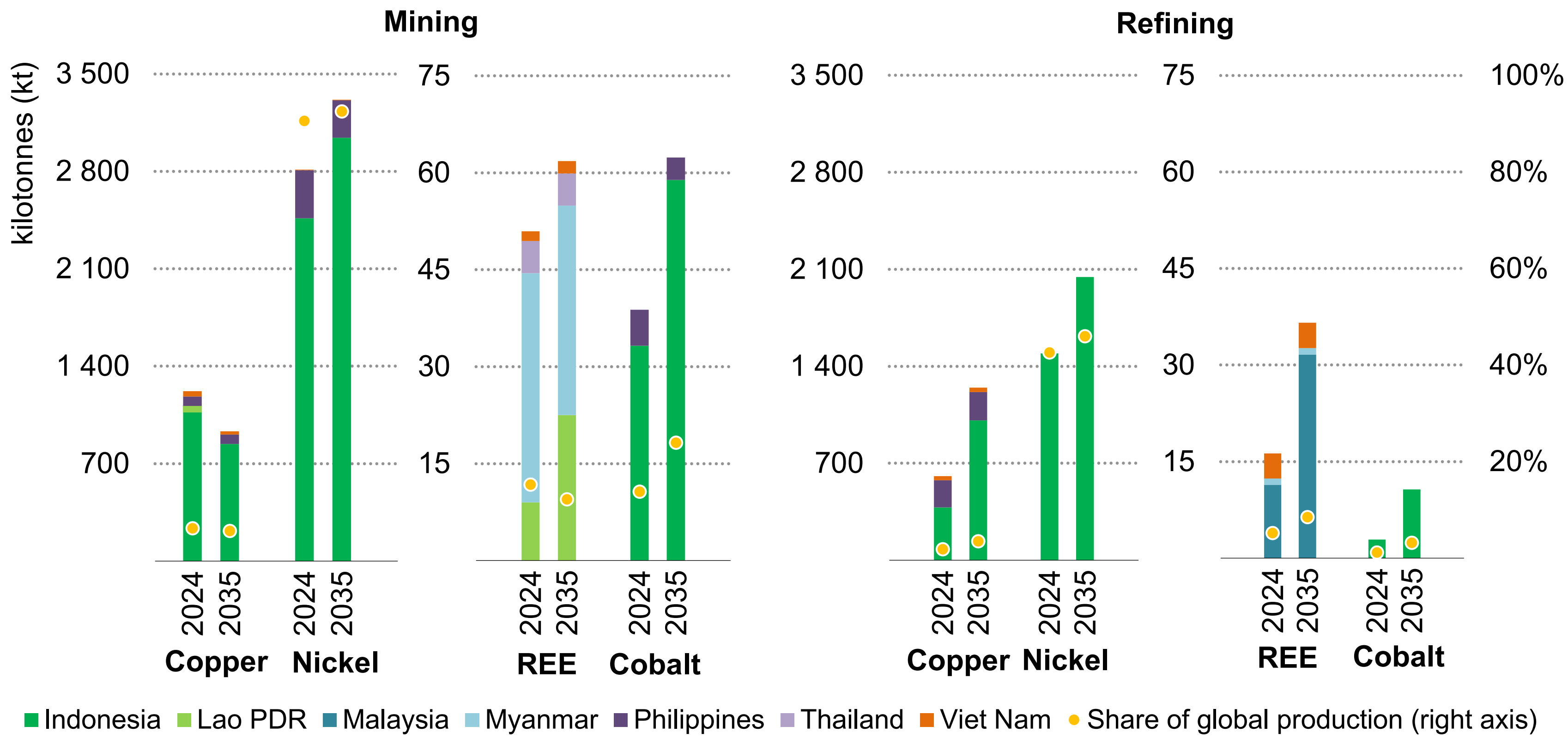
The crisis in the Middle East has impacted global critical minerals markets, inflating the energy and logistics costs for mining and processing operations. This compounds the vulnerability that the sector already faces from other disruptions: high risks associated with market concentration, price volatility and technological uncertainty, with global capital expenditure in critical mineral investment falling 9% year-on-year in 2025. Oil-driven cost inflation driven by impacts of the crisis can further dampen the investment signals for new mines and refineries. This poses potential challenges for emerging markets like Southeast Asia, where nascent processing capacity is already vulnerable to shifts in investor confidence.

Southeast Asia – Indonesia in particular – faces more direct exposure to the crisis. In Indonesia, high-pressure acid leaching (HPAL), a process used to refine nickel ore into the nickel intermediate mixed hydroxide precipitate (MHP), relies heavily on sulphuric acid for leaching. Although Indonesia produces most of its sulphuric acid domestically, it depends heavily on imported sulphur and roughly 75% of supply is sourced from Middle East. In 2025, Indonesian sulphur imports increased sharply to 5.35 million tonnes (Mt) – up by around 48% from 3.6 Mt in 2024. Sulphur also accounts for roughly half of HPAL operating costs, meaning that MHP production costs remain highly sensitive to increases in sulphur prices stemming from the conflict.

Against heightened geopolitical tensions, a sustained rise in sulphur prices could weaken the economics of hydrometallurgical nickel production. Some Indonesian MHP producers have already suspended long-term sales to reassess exposure to sulphur supply disruptions. Furthermore, in April 2026, China announced a ban on sulphuric acid exports from May until the end of the year to prioritise domestic demand. While Indonesia is less exposed due to domestic production, the loss of Chinese sulphuric acid could remove the flexible supply that HPAL producers relied on to cover shortfalls. Reduced availability and higher prices of sulphuric acid could further increase cost pressures on Indonesian nickel production. Further disruption to sulphur from the Middle East and sulphuric acid from China could undermine Indonesia's ability to maintain sustainable nickel smelting capacity.

## The output of mined and refined copper, nickel, rare earths and cobalt in Southeast Asia is poised to grow, except for mined copper, which faces a decline

Mined and refined production by country in Southeast Asia for copper, nickel, rare earths and cobalt, 2024-2035






Note: REE = rare earth elements.
Source: IEA (2025), Global Critical Minerals Outlook 2025.

## Strong policy support boosts exploration and investment in resilient and secure critical mineral supply chains

Multilateral institutions in Southeast Asia have in recent years placed greater emphasis on the minerals sector, reflecting the region's growing role in critical mineral supply chains. ASEAN has articulated a collective vision for critical minerals, anchored in the Minerals Development Vision 2045 and the Fourth ASEAN Minerals Cooperation Action Plan 2026-2030, covering integrated value chain and workforce development, investment attraction and responsible supply. In parallel, the Asian Development Bank launched the Critical Minerals-to-Manufacturing Financing Partnership Facility in March 2026 to de-risk early-stage investments in midstream processing, manufacturing, and recycling through co-financing, risk-sharing and knowledge-sharing. The region is capitalising on fast-growing regional demand while facilitating financing and expanding partnerships across the value chain. Indonesia, Singapore, Malaysia, the Philippines, Viet Nam and Thailand are key countries, having signed strategic partnerships with major consuming countries.

### Indonesia

Indonesia's critical minerals policy is centred on maximising value from its nickel resources while balancing financial returns with environmentally responsible management. A key instrument is the nickel ore mining quota system (RKAB), through which the country actively manages national production levels to support price stability. The 2026 nickel production quota was set at around 260-270 million tonnes, down from 379 million tonnes in 2025, with the aim of reducing the global nickel surplus. Mid-year quota adjustments may be made based on production and smelter demand, giving the government a flexible lever to calibrate supply without committing to a fixed ceiling. The April 2026 revision to the nickel ore pricing framework reinforces this by embedding the value of battery-relevant by-products like cobalt, with implications for downstream cost structures including production of mixed hydroxide precipitate.

Indonesia has also signed strategic partnerships on minerals. To secure additional feedstock for its expanding downstream industry, Indonesia established the IndoPhil Nickel Corridor, an import partnership with the Philippines. Also, of note is its memorandum of co-operation with Japan to support the reliability of global supply chains. Underpinning these measures is a stated ambition to align with responsible sourcing frameworks, seeking to position Indonesian nickel as a credible supplier to global energy supply chains.

### Singapore

Singapore is actively seeking innovative ways to secure and diversify its mineral supply. Aligned with the Closing the Waste Loop CTWL

Initiative, R&D efforts are conducted in collaboration with France and focus on recovering value and resources from key waste streams in Singapore. These efforts include the recycling of lithium-ion batteries and silicon-based solar panels, as well as the recovery of valuable metals from printed circuit boards. Singapore can also play a strategic role as a regional R&D hub for the design and development of advanced magnetic materials, technologies and applications.

## Philippines

The Philippines is in the process of shaping its critical minerals policy framework through a dedicated critical minerals strategy. A significant step is the passage of the Enhanced Fiscal Regime for Large-Scale Metallic Mining in 2025, which introduced a new fiscal framework for large-scale metallic mining and signals a shift towards a more investor-friendly environment. On the international front, an MoU with the United States provides a framework for cooperation on supply chain diversification, responsible resource management and domestic value addition – reflecting an ambition to move beyond raw ore exports. The Philippines has a strong civil society with well-established environmental and social standards, and policy developments in the sector will need to navigate these alongside investment objectives.

## Viet Nam

Viet Nam is poised for further growth in high-tech industries, supported by the Law on the Digital Technology Industry. This provides a comprehensive framework for emerging technologies such as semiconductors, where domestic production of rare earth elements are critical inputs. Following amendments adopted in December 2025 to its Law on Geology and Mineral Resources, the government reinforced oversight on exploration, mining and processing of rare earths and introduced an export ban on unprocessed rare earth ores effective from January 2026. One of Viet Nam's key international partnerships is its Comprehensive Strategic Partnership with the European Union, in which the countries agree to explore and deepen trade and investment opportunities in the resilience and diversification of supply chains, as well as develop co-operation in sustainable mining and processing.

## Thailand

Thailand's critical minerals policy has been defined by a strategic push to position the country as a downstream processing and beneficiation hub, leveraging its location in the Southeast Asian tin-tungsten belt and its rare earth production. The government has used the Board of Investment framework to promote investment in targeted strategic minerals including rare earths, precious metals and potash, conditioning incentives on Green Mining or Corporate Social Responsibility certification. Most recently, in October 2025, Thailand signed a non-binding MoU with the United States to co-operate on diversifying global critical mineral supply chains, signalling an intent to attract technology transfer and develop value-added processing industries.

## Malaysia's expanding ambition to develop an integrated rare earths value chain

Malaysia holds significant rare earth element reserves and hosts major refining infrastructure, positioning it as one of Southeast Asia's most advanced rare earth producers. The country is pursuing a more ambitious industrial strategy – an integrated "Mine to Magnet" model that spans extraction, separation, processing and downstream manufacturing of permanent magnets.

Malaysia sees significant potential for rare earth development and has set a clear upstream production target of 30 000 tonnes of total rare earth oxides per year by 2030. To support this, the government has allocated a USD 2.5 million budget for resource mapping in 2026, alongside clearer licensing processes and government-led resource delineation by the Department of Minerals and Geoscience. Upstream development is centred on mandatory linkage to domestic midstream capacity, with environmental safeguards and regulatory oversight positioned as integral to scaling production.

Malaysia is also pursuing active industrial policies and international partnerships to build on its strengths in refining and processing. The country hosts the world's largest rare earths refinery outside China – operated by Lynas and refining feedstock sourced from the company's Mt Weld mine in Australia – which recently secured a ten-year licence extension. Malaysia also signed a co-operation agreement with the United States on critical minerals supply chain development, while engaging with China on rare earths processing technology exchange.

The government introduced a ban on raw ore exports in 2025, aiming to develop midstream and downstream industries. After this, investor interest in Malaysia's rare earths sector grew rapidly. Lynas plans to invest RM 500 million (approximately USD 120 million) to expand its processing facility. Korea's POSCO announced plans for a USD 30 million joint venture in separation and refining with a Malaysian firm. Downstream activity is also on an uptick, with JS Link and Lynas' plans for a 3 000-tonne permanent magnet facility.

Despite the momentum, structural gaps remain. Mining faces constraints in extraction technology and skilled labour. With only one commercial-scale separation facility in Malaysia, processing output available for local manufacturing is tied to Lynas' long-term offtakes. Geographic fragmentation of research, refining and manufacturing facilities further limits integration, which demands co-ordinated industrial cluster development. Looking ahead, Malaysia's ability to realise a full rare earths value chain depends on how it leverages existing strengths, closes gaps in value chain integration and manages strategic partnerships effectively. In doing so, the nation can position Southeast Asia as a global hub for the magnet supply chain.

# Strengthening clean technology supply chains

# Prospects for solar PV and battery supply chains diverge

While global demand for key clean energy technologies – solar PV, wind, batteries, electric vehicles, heat pumps and electrolysers – continued to grow strongly in 2024 and 2025, investment in manufacturing capacity slowed. This reflected the rapid build-out of factories in supply chains such as solar PV and batteries in recent years, which has left an overhang of capacity, particularly in China. Globally, investment decreased from a peak of nearly USD 220 billion in 2023, to just under USD 200 billion in 2024, and is estimated to have remained broadly flat in 2025. Southeast Asia accounted for roughly 3% of global investment between 2023 and 2025, with diverging trajectories among technologies.

Investments in the downstream segments of the solar PV supply chain (modules and cells) contracted in 2024, reflecting not only global excess capacity, but also two additional factors: (i) increased domestic manufacturing in the United States and India – especially in the United States, the main destination for Southeast Asia's exports of solar PV modules and cells; and (ii) the imposition by the United States of countervailing duties (CVDs) and anti-dumping duties (ADDs) on manufacturing companies operating in the region. As manufacturing capacity of solar modules continues to expand in other regions, on the basis of announced projects, Southeast Asia's share of global capacity excluding China drops from 40% in 2024 to 30% in 2030.

Investment in battery and EV manufacturing in Southeast Asia is expected to grow in the coming years. On the basis of announced projects, battery cell, anode and cathode manufacturing capacity is projected to quadruple, double and grow sevenfold, respectively, by 2030. The projected expansion of domestic EV manufacturing capacity – reaching more than 1 million units of production capacity by 2030 – is the main driver for growth in the battery supply chain. This rapid projected build-out of capacity reflects the ambitions of countries in the region to position themselves in higher value-added segments of this strategically important manufacturing industry, as well as inward investment from Chinese firms looking to establish a foothold in these markets.

Supply chains for other clean energy technologies like heat pumps and wind turbines remain nascent – but plausible – opportunities for the region, conditional on demand growth and spillovers from adjacent industries, such as air conditioner manufacturing.

## Upheaval in solar PV

A significant share of solar PV manufacturing capacity in Southeast Asia is owned by companies head-quartered in China (estimated at around 60% for solar PV modules). These firms have expanded in the region – mostly in downstream segments – to avoid high tariffs and duties imposed on solar PV modules and components produced in China, while upstream components continue to be imported as part of vertically integrated supply chains.

### Announced rates of duties on US solar PV imports from selected countries in Southeast Asia

| Country | Announced ADD rates | Announced CVD rates |
|---|---|---|
| Cambodia | 125% | 535-3 404% |
| Malaysia | 0-81% | 15-171% |
| Thailand | 111-203% | 255-775% |
| Viet Nam | 62-271% | 68-543% |

Note: Figures as of June 2025; rounded to the nearest percentage point.
ADD = Anti-dumping Duty; CVD = Countervailing Duty.
Source: IEA (2026), Energy Technology Perspectives 2026.

Against this backdrop, the US International Trade Commission initiated a probe in 2024 into solar PV manufacturers operating in Southeast Asia to examine whether production in the region was being used to circumvent tariffs on Chinese products. In 2025, it was determined that additional ADDs and CVDs should be imposed on modules and cells from Cambodia, Malaysia, Thailand and Viet Nam. Similar measures were later applied to Indonesia, Lao PDR and India. These duties make it prohibitively expensive to import solar PV equipment from these countries to the United States.

In response, capacity has been progressively shuffled around the region through the decommissioning of some existing plants – Viet Nam's module manufacturing capacity, for example, is expected to shrink by 2030 to less than 40% of its 2024 level – and through investment shifts to countries not subject to the duties. After the duties were imposed on Cambodia, Malaysia, Thailand and Viet Nam in June 2025, Indonesia had the largest projected module capacity in the region by 2030 on the basis of announced projects.

As a result, PV module manufacturing capacity in Southeast Asia – the largest segment of the PV supply chain build-out in the region – stood at around 100 GW at end-2024, down from 107 GW in 2023, with manufacturing capacity in 2030 expected to be 73 GW by 2030. The installed manufacturing capacity of wafers, which are not covered by targeted duties, doubled in 2024 to reach 53 GW, supported by growing demand from cell manufacturing growth in the United States and India.

The gross value of exports for product categories closely linked to the six clean energy technologies we examine in detail fell from USD 27 billion in 2023 to USD 23 billion in 2024 and an estimated USD 19 billion in 2025. Solar PV contributed significantly to this decline as a result of the shifts in investment and trade policy described above: the share of solar PV modules in these exports declined from 70% to one-third over this period.

## Batteries and EVs go from strength to strength

In contrast to solar PV, manufacturing of other clean technologies – most notably batteries and EVs – continues to expand, with new investment flowing into the region. In 2024, a major facility for anode active material (AAM) of BTR, a Chinese company, came online in

Indonesia. With 100 GWh (cell-equivalent) of capacity, it is the largest facility of its kind outside China. Based on current announcements, total AAM capacity in the region will exceed 200 GWh in 2030. This supports Indonesia's ambition to become a major hub in the battery supply chain, underpinned by strong critical mineral endowments – especially nickel – and policies such as minimum EV local-content required to access tax rebates (at least 40%, although this threshold has been relaxed until 2026).

Battery cell manufacturing capacity across all applications increased from 16 GWh in 2023 to 26 GWh in 2024. Committed projects would lift capacity to over 80 GWh by 2030, led by Korea- and China-headquartered battery producers. Similarly, cathode active material (CAM) manufacturing rose from less than 10 GWh (cell-equivalent) in 2023 to almost 25 GWh in 2024, with committed projects lifting it to 70 GWh by 2030.

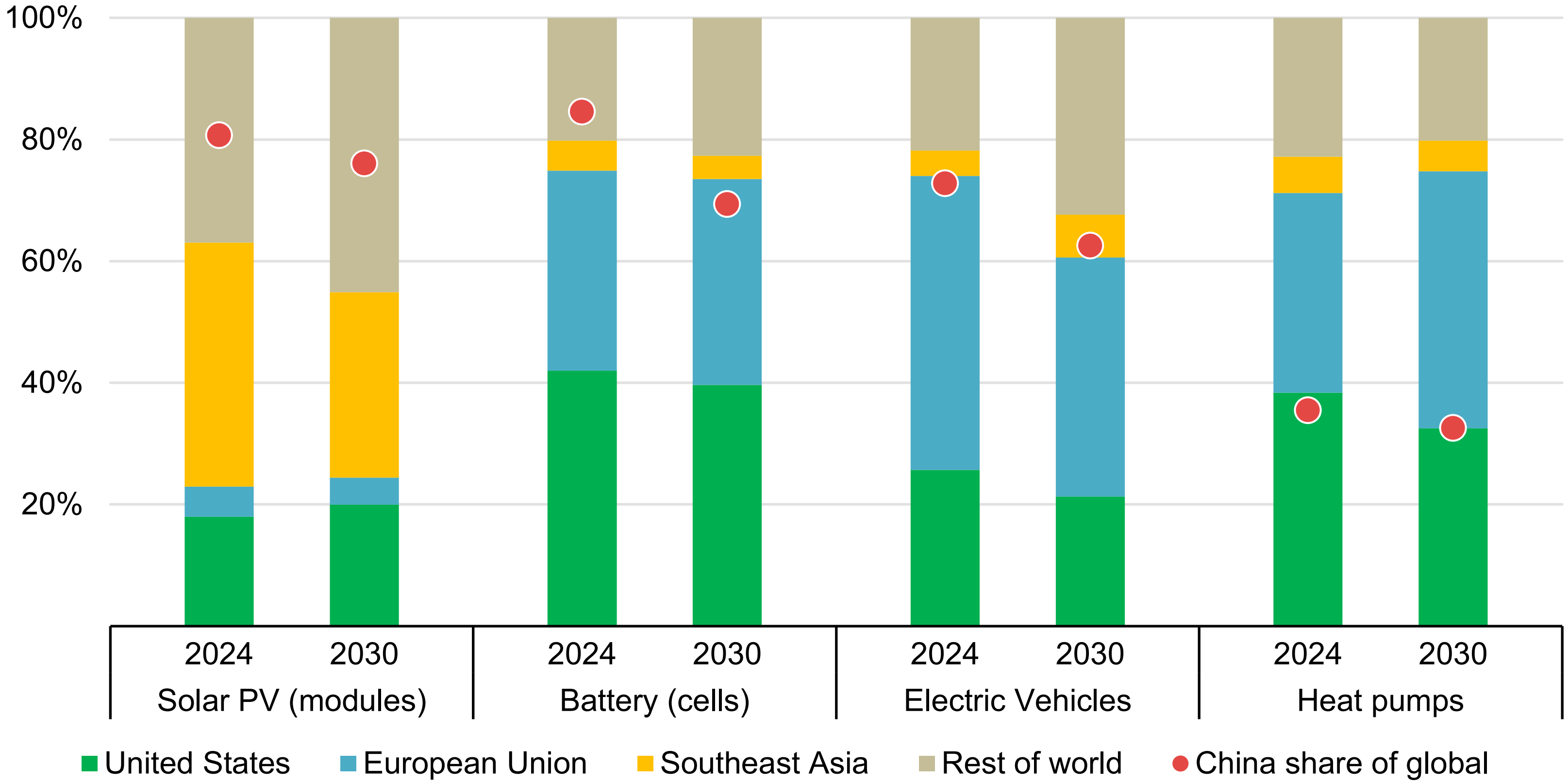
Regional demand for battery cells has grown strongly alongside a rapid expansion in EV manufacturing capacity. Over the past five years, Southeast Asia has been a preferred destination for Chinese overseas investment in EV manufacturing capacity. In 2025, the region accounted for more than half of China's overseas dual ICE-EV manufacturing footprint, with Thailand and Indonesia representing more than 30% and 20% of the total respectively. Viet Nam's VinFast, China's BYD, and several other Chinese carmakers have been key drivers of rising EV output in Southeast Asia, with Thailand emerging as a major EV manufacturing hub supplying the region. In addition, Viet Nam and Indonesia host sizeable electric two-wheeler manufacturing capacity, owned either by locally-headquartered companies (such as VinFast and Dibao) or by Chinese manufacturers (such as Yadea). In 2024, around 90 000 electric cars were produced in the region – more than double the amount in the previous year – with production capacity expected to exceed 1 million units by 2030. While affordable Chinese imports meet most electric car demand today, higher utilisation of local manufacturing capacity is expected to raise the share of demand met by domestic output over time.

## Heat pumps and wind: nascent opportunities

Southeast Asia has a fast-growing air-conditioning market and a competitive, export-oriented manufacturing base. This can have positive spillovers for heat pump manufacturing, given similarities in supply chains and related manufacturing synergies between the two technologies. For wind, rising local deployment can become an important pull factor for manufacturing investment, especially for towers, which are less widely traded and therefore often produced close to demand centres. Tower manufacturing can serve as an entry point into the broader wind supply chain, building on existing facilities in Viet Nam and Indonesia, and supported by the region's established steel and shipbuilding sectors.

# Outside China, Southeast Asia plays a significant role in clean technology supply chains

Capacity shares of existing and committed manufacturing capacity for selected technologies excluding those of China, 2024-2030



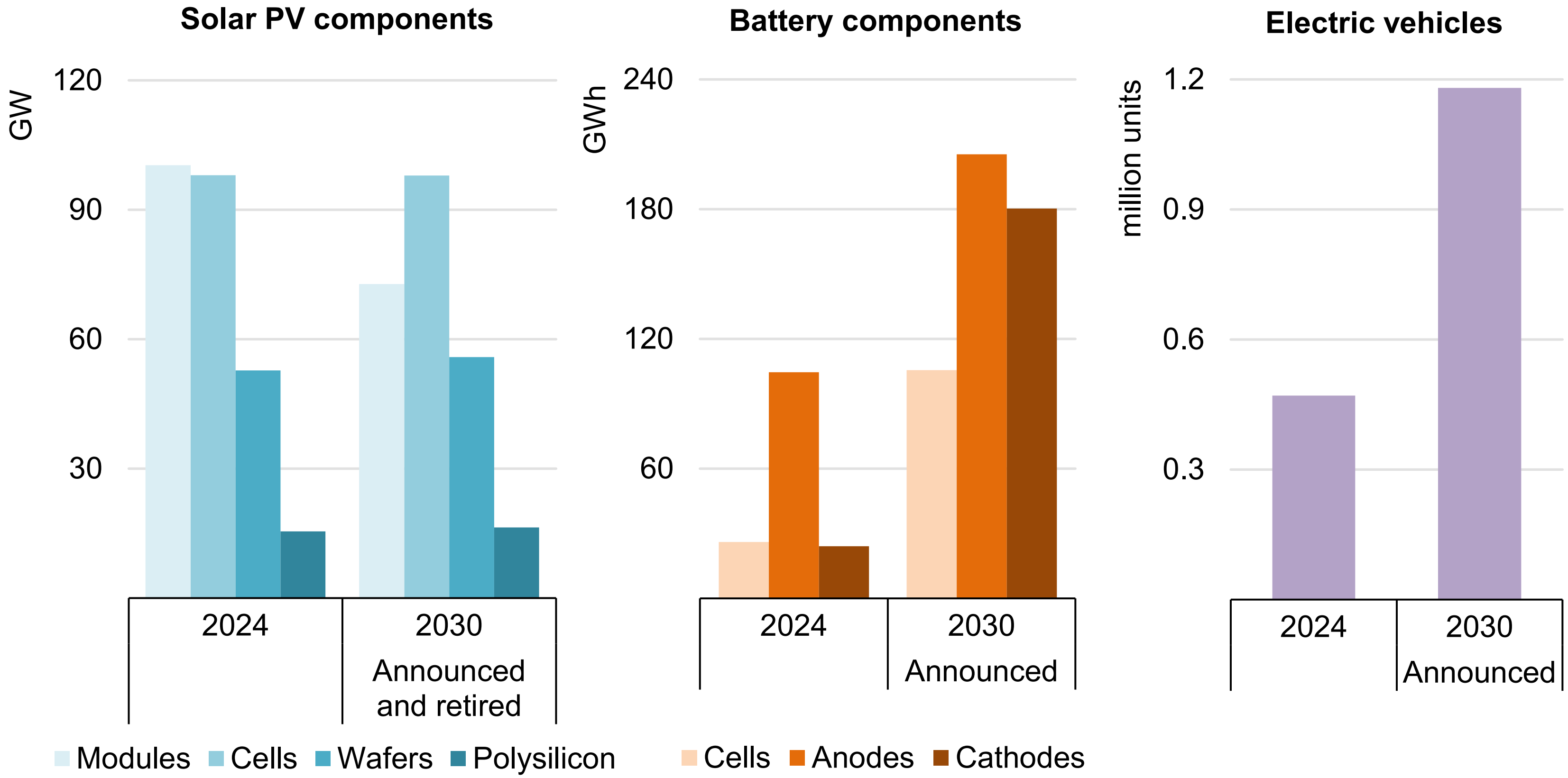



Note: The 2030 capacities are calculated as the sum of existing capacity at the end of 2024 and committed (i.e. under construction or having reached final investment decision) manufacturing capacity additions, less retirements. Capacity shares exclude those of China.

Source: IEA (2026), Energy Technology Perspectives 2026.

## On the basis of announced projects, the solar PV supply chain in Southeast Asia faces the prospect of stagnation, whereas investment in battery and EV manufacturing is surging

Existing and announced manufacturing capacity in Southeast Asia for the solar PV, battery and electric vehicle supply chains, 2024-2030






Note: The 2030 capacities are calculated as the sum of existing capacity at the end of 2024 and announced manufacturing capacity additions less projected retirements. Manufacturing capacity of EVs refers to plants producing EVs, either exclusively or alongside internal combustion engine cars without specifying the EV share.
Source: IEA (2026), Energy Technology Perspectives 2026.

# Mobilising investment and finance

## The investment outlook in Southeast Asia hinges heavily on strategies to diversify energy supply and electrify end-use sectors

The outlook for energy investment in Southeast Asia is shaped by the need to meet rapid demand growth while diversifying the supply mix and meeting long-term targets. Across all scenarios, total energy investment rises, from over USD 100 billion in 2025 to around USD 130 billion by 2035 in the CPS and STEPS, and close to USD 190 billion in the APS. By 2050, energy investment more than doubles from today's level to around USD 250 billion in the APS.

The main divergence across scenarios increasingly lies in the composition of spending. In the CPS, investment remains relatively close to today's pattern, with a sizeable share still directed towards fossil fuel production and power generation. Even so, spending on low-emissions power, grids and storage, and other end-use technologies continues to rise, reflecting growing electricity demand. In the STEPS, the balance shifts further towards low-emissions electricity, networks and electrified end uses, and in the APS this reallocation becomes more pronounced, with a much larger share of capital directed towards low-emissions power, grids and storage, energy efficiency and end-use electrification.

Total spending on oil and natural gas remains stable to 2035 in the CPS but declines by 20% and over 40% in the STEPS and APS, respectively. Investment in oil and gas production remains an important part of the outlook in the CPS where spending rises slightly to around USD 25 billion by 2035, mainly to offset declining output from existing fields. In the STEPS, upstream investment moderates over time, while in the APS, it declines more sharply to USD 7 billion by 2050. Across scenarios, domestic oil and gas production is increasingly insufficient to meet demand, leading to wider net import requirements over time. Investment in import-related infrastructure therefore continues to play a role, though it moderates in the CPS and declines in the STEPS and APS over the next decade from a high level following a recent surge (for example into LNG terminals).

Coal investment follows a distinct pattern. Spending on coal supply totals USD 8 billion today, increasing slightly over the next decade in the CPS but falling by 10% in the STEPS. In both of these scenarios, continued electricity demand growth and the relatively young age of the existing fleet support ongoing spending to sustain coal production and maintain coal-fired generation assets. In the APS, by contrast, coal supply investment falls sharply – to around USD 450 million by 2050 – driven by falling production as coal demand peaks and declines in line with announced targets. Investment in coal-fired power also falls across all scenarios over time, but most markedly in the APS, where coal's role progressively shifts away from meeting bulk demand towards a narrower contribution to system adequacy and flexibility as the power mix diversifies.

The largest source of divergence across scenarios is investment in low-emissions power, which is around USD 17 billion today. In all cases, spending on renewable electricity generation rises from today's levels, reflecting strong growth in solar PV, wind and hydropower. Even in the CPS, low-emissions power investment increases by 80% to 2035, stabilising around USD 30 billion per year to 2050, while in the STEPS this rises further to around USD 45 billion by 2050. In the APS, low-emissions power becomes the single largest category of energy investment, reaching close to USD 70 billion per year by 2035 and around USD 90 billion by 2050, as renewables meet most incremental electricity demand and increasingly displace coal- and gas-fired generation.

Grid and storage investment also grows across all pathways and becomes a major category of energy spending, reflecting rising electricity demand and the need to integrate larger shares of variable renewables while maintaining reliability. In the STEPS and CPS, spending on grids and storage rises to around USD 23 billion by 2035 from USD 13 billion today. In the APS, it grows more rapidly, reaching around USD 30 billion by 2035 and around USD 50 billion by 2050, reflecting the central importance of networks, storage and system flexibility in enabling a more electrified and lower-emissions energy system.

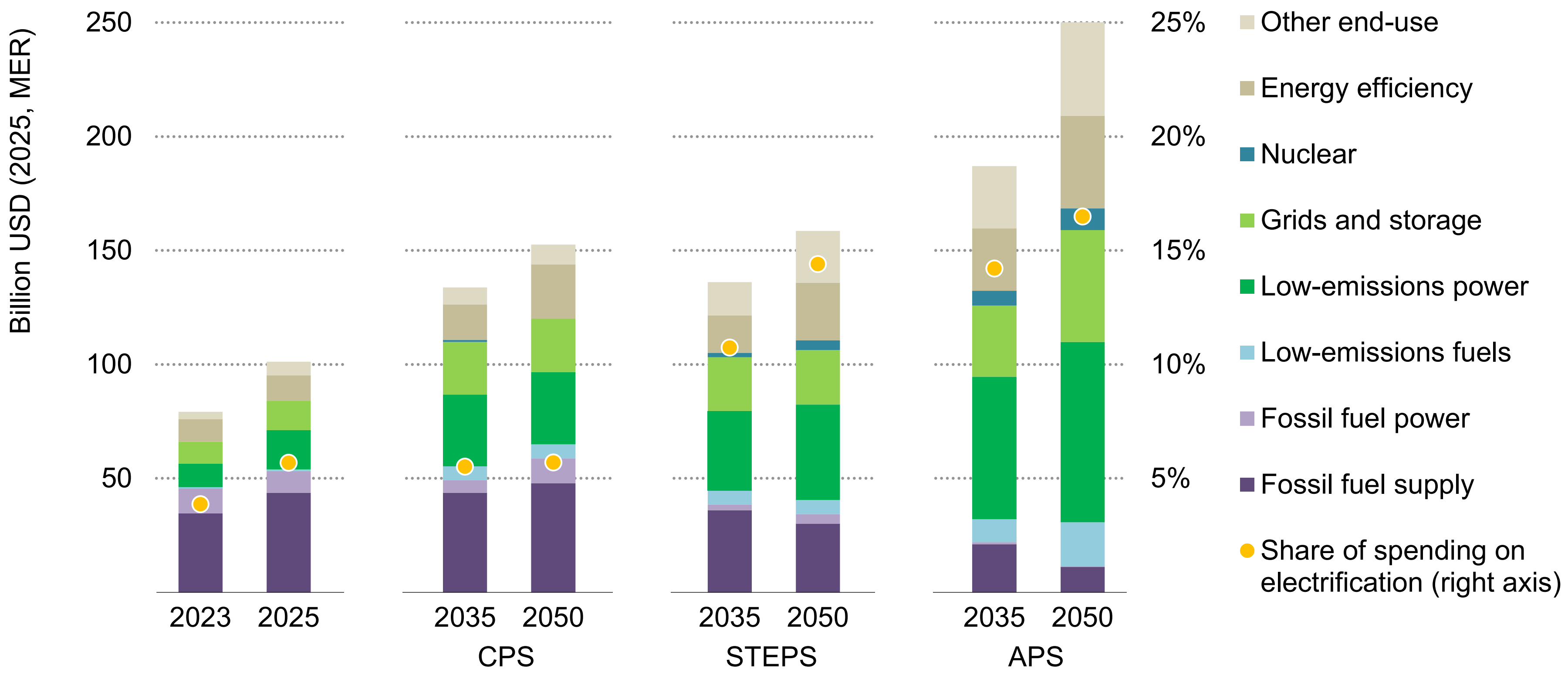
Electrification of end-use sectors also becomes a more important driver of investment over time, but the speed of change differs markedly by scenario. In the CPS, the share of total energy spending directed towards electrification remains flat, while in the STEPS and APS this share increases more substantially, reaching around 15% by 2050. This reflects faster uptake of electric vehicles as well as growing investment in electrified technologies in buildings and, to a lesser extent, industry.

Energy efficiency and other end-use spending also account for a larger share of investment under stronger policy ambition. In the CPS and STEPS, spending on efficiency rises gradually, reflecting incremental improvements in buildings, appliances and industrial equipment. In the APS, this growth is much stronger, with efficiency investment reaching almost USD 30 billion by 2035 and around USD 40 billion by 2050. Spending on other end-use technologies also rises significantly in the APS, underlining that achieving announced pledges is not only a power-sector story, but also requires broader shifts in how energy is used across the economy.

By contrast, low-emissions fuels remain a smaller component of total energy investment in all scenarios. Investment in bioenergy, hydrogen-based fuels and other low-emissions fuels grows over time, particularly in the APS, but remains modest relative to the scale of spending required in electricity supply and networks. Nuclear investment also begins to appear across scenarios, reflecting the role of firm, dispatchable low-emissions electricity in a more diversified power mix, but it remains a comparatively small share of total energy investment through to 2050.

# Meeting long-term energy and climate targets requires energy investment in Southeast Asia to almost double over the next decade

Total energy investment and share of spending on electrification in total spending in Southeast Asia by scenario, 2023-2050






Note: Low-emissions power includes generation from solar PV, wind, hydropower, geothermal, non-fossil fuels, and sources paired with carbon capture. Low-emissions fuels include biogas, biofuels, hydrogen and hydrogen-based fuels. CPS = Current Policies Scenario; STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario.

## Transition finance is evolving, and its implementation is eagerly anticipated

Transition finance in Southeast Asia is shifting to a new phase from rulemaking to implementation in the real economy. The ASEAN Taxonomy Version 4 established grandfathering rules for Amber (Transition) Tier activities to provide greater certainty that investments in transition projects will not be disadvantaged by subsequent criteria changes. Thailand introduced Phase 2 of its taxonomy expanding its scope of transition finance to the manufacturing sector, and the Monetary Authority of Singapore implemented its Guidelines on Transition Planning for financial institutions. By mitigating concerns over greenwashing and definitional ambiguities that have previously hindered private capital inflows to the region, these developments form a critical institutional foundation for attracting capital from international markets.

The direction of regional progress is closely aligned with broader trends in global transition finance discussions. The IEA report Scaling Up Transition Finance estimated that USD 400 to 500 billion of annual investment can be supported by transition finance globally, with approximately half of this directed towards emerging and developing economies, notably Southeast Asia. It also cautioned that overly rapid divestment from hard-to-abate sectors, due to very strict regulations and narrow definitions of Paris Agreement alignment, risked triggering “financial carbon leakage”. Furthermore, an IEA survey of financial institutions highlights that private financiers are actively engaging with transition finance, with many having already integrated related elements into their operational frameworks. However, the survey also reveals a significant challenge for these institutions. A mismatch in transition finance frameworks and taxonomies between the regions of the finance providers and the regions of the finance demanders complicates cross-border financing and the matching of capital supply with demand.

The International Capital Market Association’s (ICMA) Climate Transition Bond Guidelines and Loan Market Association’s (LMA) Guide to Transition Loans have established independent financing labels for high-emitting industries. The messages concerning the importance of addressing high-emitting industries are particularly relevant to the Southeast Asia region, given the region's structural role as a manufacturing hub within global supply chains and its concentration of hard-to-abate sectors, which collectively underpin regional economic development and livelihoods. Furthermore, the Asian Development Bank (ADB) published a report on decarbonisation in Southeast Asia that includes transition finance.

While financiers’ initiatives are being elaborated, collaborative platforms such as the Asia Zero Emission Community (AZEC) are playing an increasingly important role in supporting project development and implementation. AZEC supports various pathways for member countries’ energy transitions and focuses on the harmonisation of regional collaboration with effective use of transition finance based on Japan's leading capability and experience in this field as a participant in the framework.

Looking ahead to strategic developments in 2026, ASEAN – under the Philippines' chairship – is advancing systemic regional connectivity and inclusive growth through its "Prosperity Corridors" priority. Going beyond physical infrastructure planning, the region is actively establishing an "investment-ready environment" for the ASEAN Power Grid (APG) to attract private capital for cross-border multilateral power trade and renewable energy integration. The primary focus moving forward will be on maximising the use of established transition finance and collaborative platforms like AZEC to channel large-scale private capital into the region's economy. Moving forward, maximising the use of established transition finance frameworks and regional co-operative frameworks will be critical to channelling large-scale private capital into the real economy.

Recent developments relating to transition finance in Southeast Asia and the world

| Date | Framework/Initiative |
| --- | --- |
| May 2025 | Thailand Taxonomy Phase 2 |
| October 2025 | Guide to Transition Loans |
| October 2025 | IEA Scaling Up Transition Finance |
| November 2025 | ICMA Climate Transition Bond Guidelines |
| November 2025 | ASEAN Taxonomy Version 4 |
| March 2026 | Singapore MAS Guidelines on Transition Planning |

## While NOC-dominated fossil fuel investment relies on government sponsorship, maturing clean energy markets attract higher levels of private sector spending

In 2025, debt financing accounted for 44% of energy investments across all sectors, remaining broadly consistent with historical levels. Investments in fossil fuel supply are driven by national oil companies (NOCs) such as Malaysia's Petronas and Indonesia's Pertamina. Equity (including retained earnings) is the primary instrument used to finance fossil fuel supply, accounting for two-thirds of spending in 2025. Debt, meanwhile, is dominant in financing wind, solar PV and battery storage projects, which are faster to build than their fossil power counterparts and generally enjoy stable revenues. Biofuels, which in 2025 accounted for 86% of investment in low-emissions fuels, are also financed by larger shares of debt.

State-owned enterprises (SOEs) are the primary sponsors of total energy spending, accounting for 52% of investment in 2025. This is especially prevalent in spending on fossil fuel supply through the provision of state support to NOCs as well as subsidies on fuel prices for end consumers. At the same time, a broad range of power market structures contributes to divergent financing trends for the power sector. Grid expansion and interconnection projects, whose complexity often requires co-ordination among multiple governments and utilities, are primarily directed by SOEs. These firms hold near exclusive rights for development in most countries. In many cases, the same state-owned utilities have played a major role in financing generation projects, especially for fossil power. Meanwhile, Southeast Asia has seen a growing level of private sector investment for low-emissions power, which also accounts for a rising share of total generation investment in the region. The share of solar PV and wind investment directed by private corporations is over 80% as fast-growing markets such as the Philippines and Viet Nam continue with broadly successful competitive auctions for new projects. Indonesia's most recent Electricity Supply Business Plan (RUPTL) also signals a greater role for independent power producers to meet its renewable energy deployment targets. Cost declines for these technologies, in addition to growing government ambitions for the deployment of low-emissions technologies, are rapidly strengthening project bankability for both domestic and international developers.

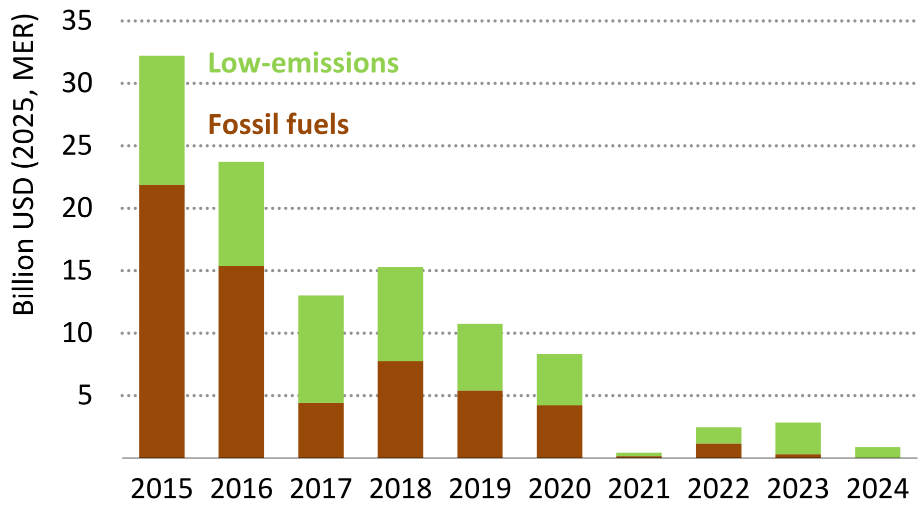
Finally, households play an important role as sponsors of energy efficiency in buildings, electrification of transport and residential solar PV deployment. In 2025, households accounted for 60% of spending across end-use sectors. As electricity demand for space cooling continues to rise in the region, government programmes facilitating households' purchases of energy-efficient appliances, such as Singapore's Climate Friendly Households Programme, are crucial to maintaining this level of investment. Constrained by high fuel prices resulting from the crisis in the Middle East, households are expected to scale up purchases of electric passenger vehicles and two- and three-wheelers.

Energy investment in Southeast Asia was primarily financed by commercial institutions, which accounted for nearly two-thirds of total spending in 2025. Public financing, which often comes with comparatively low interest rates, plays a crucial role in reducing financing costs for energy efficiency and electrification projects in buildings and industry.

Development finance institutions (DFIs) accounted for only 1% of total financing in Southeast Asia in 2025. However, they play a central role in encouraging private sector participation in the region's energy spending by de-risking projects – especially those using nascent technologies. The provision of concessional financing, in addition to other risk mitigation instruments like guarantees and first-loss protections, is most effective when used to demonstrate the bankability of precise projects which can then be replicated at larger scales without the support of DFIs.

Historically, China has been a major provider of development finance in Southeast Asia, channelled through the activities of state-owned enterprises, state-owned commercial banks and state-owned policy banks. However, Chinese financing to the region declined sharply since the early 2020s, from around 30% of total energy spending in 2015 to just 1% in 2024. While official Chinese finance was largely directed towards coal-fired power in 2015, it is now almost entirely focused on renewable power generation, following China's commitment to end overseas financing of coal plants.

### Official finance flows from China to Southeast Asia, 2015-2024



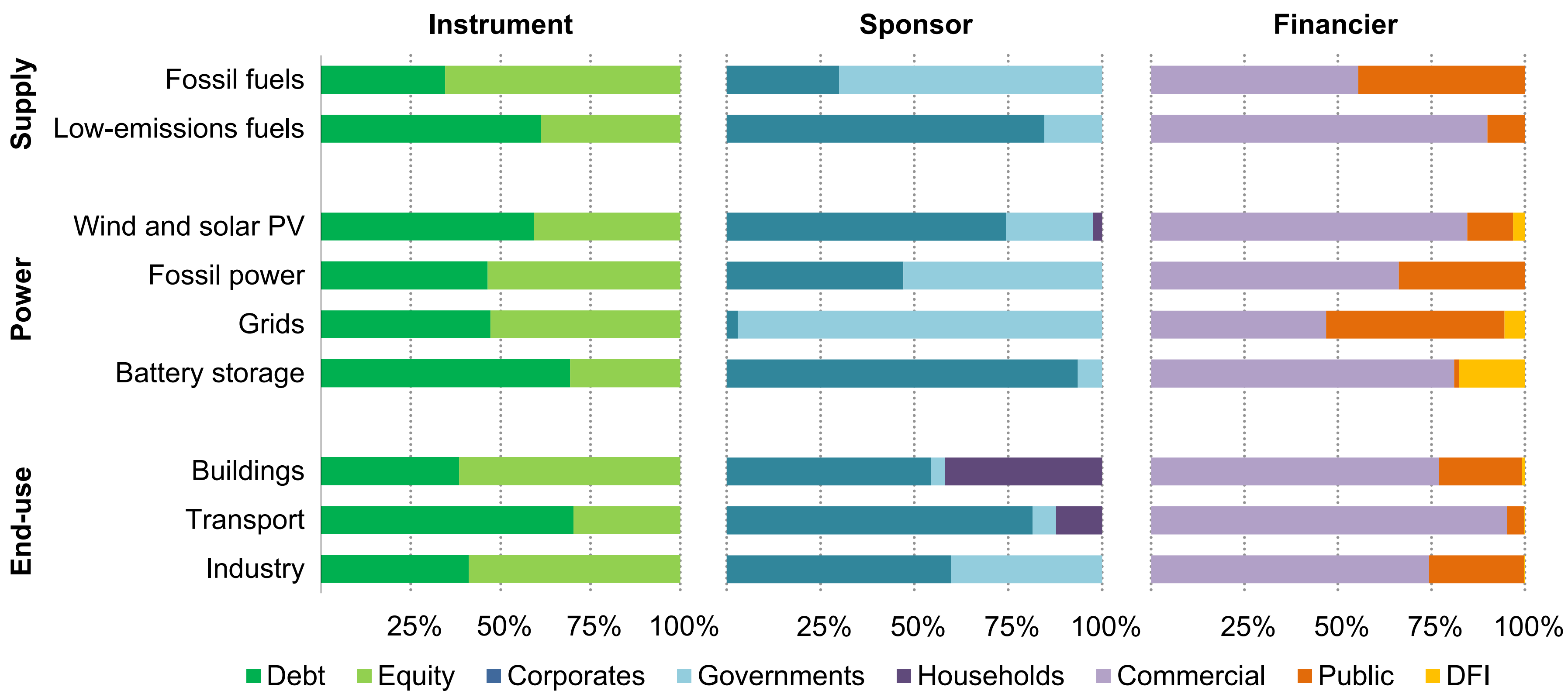



Note: Sources of official finance include government agencies and state-owned enterprises, commercial banks, funds and policy banks. Official finance is provided through loans, equity, guarantees and credit insurance.

Source: IEA analysis based on China's Official Energy Finance in Emerging Economies.

## Most energy spending today is driven by governments and financed commercially, though differences emerge between fossil fuels and low-emissions technologies

Shares of total energy investment in Southeast Asia by instrument, sponsor and financier, 2025






Note: DFI = development financial institution.

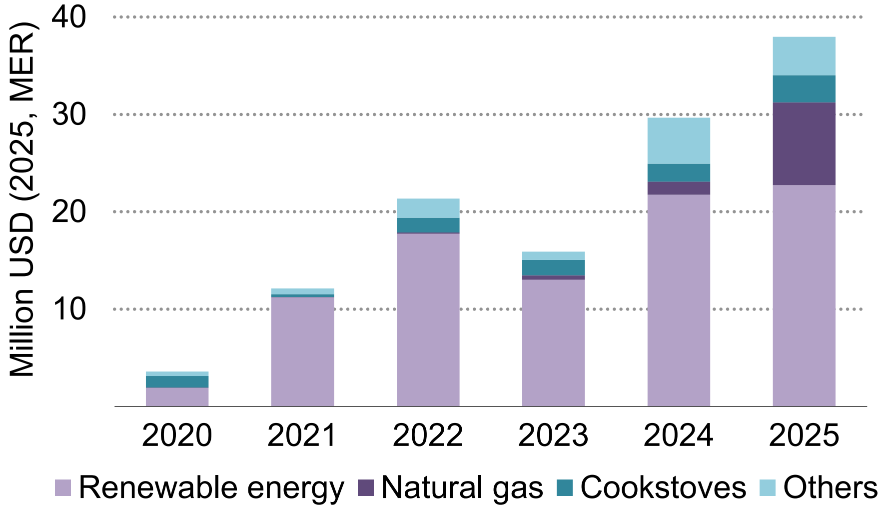
Sources: IEA analysis based on datasets from S&P Capital IQ (2026), IJGLOBAL (2026), Rystad (2026), World Bank (2026) PPI, OECD (2026) CRS, AidData (2024) Global Chinese Development Finance Dataset version 3.0.

# Carbon credits in the energy sector reached USD 38 million in transaction value in 2025, with nearly 85% of this value coming from renewable energy and fuel switching projects

Carbon credits come from different sources: (a) carbon credit standards under UN-government frameworks, such as the Paris Agreement Crediting Mechanism (PACM) under Article 6, (b) independent crediting mechanisms managed by private, non-governmental certification bodies such as Verra and Gold Standard, and (c) domestic government carbon credit mechanisms, such as Indonesia's Sertifikat Pengurangan Emisi Gas Rumah Kaca (SPE-GRK). Different stakeholders can use carbon credits to claim emissions reductions or removals. For example, countries can use Article 6 credits towards their NDCs; corporates can use them to meet decarbonisation targets or to comply with domestic carbon pricing obligations, and airlines can use them to fulfil their obligations under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

The transaction value of energy sector carbon credits grew in Southeast Asia from USD 4 million in 2020 to USD 38 million in 2025. Low-emissions power generation (solar PV, wind, hydro, geothermal and modern bioenergy) dominates, with nearly USD 23 million in value in 2025. Retirements from the SPE-GRK in 2025 accounted for 45% of the 2025 total, mostly coming from geothermal and coal-to-gas switching projects. Due to the SPE-GRK and strong activity in independent crediting mechanisms, Indonesia is the largest regional actor in energy carbon credit markets. Beyond power generation, credit revenues are also significant for the clean cooking sector. In 2025, transactions in clean cooking carbon markets approached USD 3 million, where carbon credit revenue is vital to the business models of clean cooking project developers.

Value of energy sector carbon credit transactions at retirement in Southeast Asia, 2020-2025






Note: Others = End-use sectors, methane, fugitive emissions and utilisation. MER = market exchange rate.
Source: IEA analysis based on AlliedOffsets dataset (2026).

## Southeast Asian countries are exploring the expansion of carbon credit markets and compliance carbon pricing instruments to support power sector decarbonisation

Southeast Asia has been piloting innovative crediting instruments that could support substantial growth in carbon markets in the coming years. Transition credits, for instance, are issued for emissions reductions by accelerating the retirement or repurposing of fossil fuel power assets and replacing them with cleaner alternatives. A notable example is the methodology registered under Verra, which credits the early retirement of grid-connected coal-fired power plants. Transition credits for early coal retirement are being piloted at the South Luzon Thermal Energy Corporation plant in the Philippines, which is expected to generate USD 800 million in additional revenue between 2031 and 2040 from its accelerated phase-out.

Most credits since 2020 have been issued under independent crediting mechanisms. However, cooperation under Article 6 of the Paris Agreement is gaining traction. Article 6.2 enables countries to co-operate by counting internationally transferred mitigation outcomes (ITMOs) towards the achievement of their NDCs. Such co-operation is increasingly viewed as an opportunity for Southeast Asian countries to mobilise additional capital for decarbonisation. As of April 2026, governments in the region have signed five bilateral co-operation agreements under Article 6.2. Such agreements, involving Singapore as a buyer country and Philippines, Viet Nam and Thailand as host countries, establish the legal basis for countries to transfer ITMOs in return for performance-based finance, generating revenue, but also creating carbon accounting liability, for the host countries. These bilateral agreements must be implemented through domestic regulations. Cambodia has taken an early lead by publishing a national framework in alignment with the 2015 Paris Agreement to govern participation in carbon markets. While transaction volume is limited to date, these agreements signal growing political momentum.

Beyond carbon credit markets, compliance carbon pricing instruments, including emissions trading systems (ETS) and carbon taxes, are being advanced by Southeast Asian governments for the purposes of emissions reductions and revenue raising. Singapore's carbon tax, for instance, covers 70% of the country's emissions at a carbon price of SGD 45/t$CO_2$-eq (USD 34). In 2024, the carbon tax raised around SGD 660 million in revenue (around USD 515 million). Since 2023, Indonesia has operated a hybrid carbon pricing system covering 563 coal-fired power plants, where SPE-GRK are integrated as offset credits for covered entities alongside cap-and-trade emissions allowances. Other compliance systems are under development: Viet Nam, for instance, is establishing the infrastructure for an ETS to be piloted in 2027 while Thailand, Malaysia and the Philippines are also exploring domestic ETS.

# Annex A

# Data tables

# Total energy supply

| Unit: PJ | Historical | | | | Current Policies (CPS) | | | Stated Policies (STEPS) | | | Announced Pledges (APS) | | | CPS | STEPS | APS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2023 | 2024 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 | 2050 Shares (%) | | |
| **Total energy supply** | **21 260** | **24 527** | **32 454** | **34 012** | **45 126** | **50 061** | **59 770** | **44 055** | **47 752** | **54 895** | **41 206** | **43 287** | **47 257** | **100** | **100** | **100** |
| Renewables | 2 805 | 3 402 | 6 166 | 6 441 | 9 869 | 12 199 | 16 865 | 10 477 | 13 160 | 18 822 | 12 835 | 18 069 | 29 126 | 28 | 34 | 62 |
| Solar | - | 11 | 162 | 176 | 671 | 980 | 1 663 | 755 | 1 141 | 2 033 | 1 680 | 3 151 | 6 417 | 3 | 4 | 14 |
| Wind | - | 4 | 61 | 64 | 501 | 788 | 1 388 | 628 | 996 | 1 883 | 980 | 1 620 | 3 890 | 2 | 3 | 8 |
| Hydro | 286 | 439 | 746 | 810 | 1 050 | 1 279 | 1 663 | 1 119 | 1 377 | 1 794 | 1 248 | 1 572 | 2 010 | 3 | 3 | 4 |
| Modern bioenergy | 1 486 | 1 827 | 3 591 | 3 711 | 4 879 | 5 370 | 6 366 | 5 055 | 5 583 | 6 767 | 5 717 | 7 016 | 9 091 | 11 | 12 | 19 |
| Traditional use of biomass | 1 922 | 1 491 | 1 024 | 994 | 790 | 724 | 570 | 705 | 616 | 443 | 426 | 220 | 101 | 1 | 1 | 0 |
| Nuclear | - | - | - | - | - | 89 | 134 | - | 132 | 475 | 473 | 1 109 | 2 222 | 0 | 1 | 5 |
| Natural gas | 5 217 | 5 785 | 6 152 | 6 437 | 8 310 | 8 716 | 9 976 | 8 530 | 8 815 | 9 522 | 6 793 | 6 123 | 3 929 | 17 | 17 | 8 |
| Oil | 8 006 | 8 963 | 9 933 | 10 262 | 12 771 | 13 851 | 15 725 | 12 086 | 12 478 | 13 080 | 10 676 | 9 807 | 7 664 | 26 | 24 | 16 |
| Non-energy use | 1 386 | 1 483 | 1 421 | 1 499 | 2 293 | 2 532 | 3 021 | 2 200 | 2 386 | 2 706 | 1 872 | 1 894 | 1 811 | 5 | 5 | 4 |
| Coal | 3 296 | 4 863 | 9 155 | 9 855 | 13 357 | 14 451 | 16 460 | 12 228 | 12 520 | 12 514 | 9 975 | 7 929 | 4 184 | 28 | 23 | 9 |
| **Electricity and heat sectors** | **6 948** | **8 761** | **13 480** | **14 346** | **20 369** | **23 417** | **29 565** | **20 261** | **22 962** | **28 193** | **19 616** | **22 468** | **29 846** | **100** | **100** | **100** |
| Renewables | 1 435 | 1 790 | 3 620 | 3 766 | 6 149 | 8 044 | 11 831 | 6 656 | 8 910 | 13 579 | 8 454 | 12 823 | 22 899 | 40 | 48 | 77 |
| Nuclear | - | - | - | - | - | 89 | 134 | - | 132 | 475 | 473 | 1 109 | 2 222 | 0 | 2 | 7 |
| Natural gas | 2 805 | 3 040 | 2 889 | 3 058 | 4 185 | 4 492 | 5 365 | 4 417 | 4 627 | 5 035 | 3 403 | 2 999 | 1 428 | 18 | 18 | 5 |
| Oil | 611 | 309 | 263 | 233 | 112 | 116 | 116 | 110 | 104 | 101 | 99 | 97 | 93 | 0 | 0 | 0 |
| Coal | 2 084 | 3 608 | 6 695 | 7 276 | 9 908 | 10 661 | 12 100 | 9 063 | 9 173 | 8 984 | 7 174 | 5 370 | 2 396 | 41 | 32 | 8 |
| **Other energy sector** | **2 466** | **2 384** | **3 644** | **3 944** | **4 539** | **4 691** | **5 428** | **4 561** | **4 661** | **5 337** | **4 719** | **5 439** | **7 783** | **100** | **100** | **100** |

# Total final consumption

| Unit: PJ | Historical | | | | Current Policies (CPS) | | | Stated Policies (STEPS) | | | Announced Pledges (APS) | | | CPS | STEPS | APS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2023 | 2024 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 | 2050 Shares (%) | | |
| **Total final consumption** | **14 362** | **16 684** | **20 295** | **21 024** | **28 697** | **31 949** | **37 913** | **27 727** | **30 053** | **34 172** | **25 829** | **26 733** | **27 514** | **100** | **100** | **100** |
| Electricity | 2 208 | 2 905 | 4 493 | 4 800 | 7 583 | 8 930 | 11 749 | 7 589 | 8 860 | 11 444 | 7 818 | 9 471 | 12 855 | 31 | 33 | 47 |
| Liquid fuels | 6 940 | 8 588 | 9 597 | 9 871 | 12 913 | 14 176 | 16 299 | 12 269 | 12 863 | 13 758 | 11 067 | 10 501 | 8 549 | 43 | 40 | 31 |
| Oil | 6 894 | 8 465 | 9 082 | 9 313 | 12 045 | 13 182 | 15 058 | 11 364 | 11 821 | 12 429 | 10 053 | 9 298 | 7 191 | 40 | 36 | 26 |
| Hydrogen-based | - | - | - | - | - | - | - | - | - | 1 | 13 | 33 | 63 | - | 0 | 0 |
| Gaseous fuels | 1 229 | 1 544 | 1 972 | 2 054 | 2 925 | 3 186 | 3 624 | 2 955 | 3 211 | 3 678 | 2 543 | 2 536 | 2 301 | 10 | 11 | 8 |
| Natural gas | 1 229 | 1 543 | 1 963 | 2 043 | 2 887 | 3 130 | 3 516 | 2 895 | 3 116 | 3 477 | 2 476 | 2 412 | 2 025 | 9 | 10 | 7 |
| Hydrogen-based | - | - | - | - | - | 1 | 2 | 2 | 3 | 8 | 9 | 34 | 126 | 0 | 0 | 0 |
| Solid fuels | 3 985 | 3 648 | 4 220 | 4 281 | 5 242 | 5 620 | 6 203 | 4 871 | 5 062 | 5 212 | 4 336 | 4 126 | 3 628 | 16 | 15 | 13 |
| Coal | 1 227 | 1 213 | 2 113 | 2 192 | 3 063 | 3 415 | 3 959 | 2 800 | 3 000 | 3 178 | 2 438 | 2 236 | 1 520 | 10 | 9 | 6 |
| Heat | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Industry** | **5 779** | **6 827** | **8 715** | **9 140** | **12 650** | **13 897** | **16 174** | **12 280** | **13 289** | **14 930** | **11 808** | **12 392** | **12 768** | **100** | **100** | **100** |
| Electricity | 937 | 1 242 | 2 043 | 2 179 | 3 079 | 3 384 | 3 960 | 3 171 | 3 504 | 4 117 | 3 475 | 4 128 | 5 348 | 24 | 28 | 42 |
| Liquid fuels | 1 881 | 2 408 | 2 007 | 2 140 | 2 885 | 3 162 | 3 766 | 2 745 | 2 938 | 3 286 | 2 542 | 2 494 | 2 252 | 23 | 22 | 18 |
| Gaseous fuels | 1 001 | 1 115 | 1 552 | 1 618 | 2 354 | 2 569 | 2 931 | 2 318 | 2 521 | 2 871 | 2 016 | 1 990 | 1 717 | 18 | 19 | 13 |
| Unabated natural gas | 830 | 928 | 1 292 | 1 351 | 1 962 | 2 132 | 2 396 | 1 909 | 2 052 | 2 264 | 1 603 | 1 485 | 941 | 15 | 15 | 7 |
| Solid fuels | 1 959 | 2 061 | 3 113 | 3 202 | 4 333 | 4 782 | 5 517 | 4 046 | 4 327 | 4 656 | 3 763 | 3 758 | 3 399 | 34 | 31 | 27 |
| Unabated coal | 1 155 | 1 153 | 2 094 | 2 173 | 3 040 | 3 390 | 3 934 | 2 778 | 2 978 | 3 156 | 2 394 | 2 125 | 1 230 | 24 | 21 | 10 |
| **Transport** | **3 683** | **4 894** | **6 208** | **6 340** | **8 299** | **9 243** | **10 739** | **7 969** | **8 512** | **9 368** | **7 424** | **7 353** | **6 721** | **100** | **100** | **100** |
| Electricity | 9 | 11 | 19 | 26 | 114 | 167 | 236 | 202 | 369 | 654 | 321 | 656 | 1 433 | 2 | 7 | 21 |
| Liquid fuels | 3 594 | 4 759 | 6 138 | 6 262 | 8 133 | 9 021 | 10 427 | 7 711 | 8 083 | 8 632 | 7 068 | 6 665 | 5 220 | 97 | 92 | 78 |
| Oil | 3 552 | 4 640 | 5 627 | 5 708 | 7 283 | 8 055 | 9 238 | 6 829 | 7 085 | 7 403 | 6 121 | 5 583 | 4 083 | 86 | 79 | 61 |
| Gaseous fuels | 80 | 124 | 51 | 52 | 52 | 55 | 76 | 56 | 60 | 83 | 35 | 32 | 69 | 1 | 1 | 1 |
| Natural gas | 80 | 124 | 51 | 52 | 50 | 52 | 72 | 52 | 52 | 64 | 25 | 14 | 10 | 1 | 1 | 0 |
| **Buildings** | **3 932** | **3 942** | **4 348** | **4 506** | **6 308** | **7 285** | **9 374** | **5 997** | **6 686** | **8 176** | **5 480** | **5 877** | **6 955** | **100** | **100** | **100** |
| Electricity | 1 242 | 1 622 | 2 374 | 2 535 | 4 312 | 5 292 | 7 450 | 4 124 | 4 877 | 6 524 | 3 929 | 4 578 | 5 935 | 79 | 80 | 85 |
| Liquid fuels | 653 | 728 | 871 | 891 | 1 029 | 1 073 | 1 117 | 981 | 976 | 947 | 906 | 822 | 615 | 12 | 12 | 9 |
| Gaseous fuels | 15 | 17 | 18 | 18 | 65 | 87 | 127 | 66 | 87 | 122 | 64 | 82 | 99 | 1 | 1 | 1 |
| Natural gas | 15 | 17 | 16 | 16 | 62 | 83 | 121 | 61 | 80 | 111 | 56 | 70 | 77 | 1 | 1 | 1 |
| Solid fuels | 2 022 | 1 574 | 1 073 | 1 044 | 869 | 796 | 642 | 788 | 698 | 520 | 538 | 335 | 202 | 7 | 6 | 3 |
| Coal | 67 | 48 | 7 | 7 | 8 | 8 | 7 | 7 | 7 | 6 | 5 | 3 | 1 | 0 | 0 | 0 |

# Electricity

| Generation (TWh) | Historical | | | | Current Policies (CPS) | | | Stated Policies (STEPS) | | | Announced Pledges (APS) | | | CPS | STEPS | APS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2023 | 2024 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 | 2050 Shares (%) | | |
| **Total generation** | **692** | **908** | **1 365** | **1 457** | **2 329** | **2 749** | **3 618** | **2 334** | **2 729** | **3 525** | **2 445** | **3 050** | **4 569** | **100** | **100** | **100** |
| Renewables | 105 | 158 | 349 | 370 | 740 | 1 005 | 1 542 | 825 | 1 148 | 1 841 | 1 231 | 1 988 | 3 829 | 43 | 52 | 84 |
| Solar PV | 0 | 3 | 42 | 44 | 177 | 262 | 451 | 198 | 301 | 542 | 452 | 853 | 1 742 | 12 | 15 | 38 |
| Wind | 0 | 1 | 17 | 18 | 139 | 219 | 385 | 174 | 277 | 523 | 272 | 450 | 1 081 | 11 | 15 | 24 |
| Hydro | 80 | 122 | 207 | 225 | 292 | 355 | 462 | 311 | 383 | 498 | 347 | 437 | 558 | 13 | 14 | 12 |
| Bioenergy | 6 | 11 | 55 | 55 | 70 | 78 | 92 | 77 | 89 | 111 | 87 | 131 | 244 | 3 | 3 | 5 |
| Nuclear | - | - | - | - | - | 8 | 12 | - | 12 | 44 | 43 | 102 | 204 | 0 | 1 | 4 |
| Hydrogen and ammonia | - | - | - | - | - | - | - | - | - | - | - | 8 | 101 | - | - | 2 |
| Fossil fuels with CCUS | - | - | - | - | - | - | - | - | - | - | - | 10 | 44 | - | - | 1 |
| Unabated coal | 192 | 338 | 635 | 691 | 974 | 1 057 | 1 225 | 887 | 900 | 886 | 709 | 526 | 208 | 34 | 25 | 5 |
| Unabated natural gas | 335 | 381 | 361 | 379 | 607 | 669 | 828 | 612 | 660 | 745 | 453 | 409 | 174 | 23 | 21 | 4 |
| Oil | 60 | 30 | 19 | 17 | 8 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 7 | 0 | 0 | 0 |
| $CO_2$ intensity of electricity generation (g $CO_2$ per kWh) | | | | 613 | 516 | 470 | 409 | 485 | 423 | 329 | 365 | 225 | 61 | | | |

| Capacity (GW) | Historical | | | | Current Policies (CPS) | | | Stated Policies (STEPS) | | | Announced Pledges (APS) | | | CPS | STEPS | APS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2023 | 2024 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 | 2050 Shares (%) | | |
| **Total capacity** | **165** | **233** | **366** | **377** | **647** | **779** | **1 102** | **683** | **828** | **1 170** | **949** | **1 372** | **2 276** | **100** | **100** | **100** |
| Renewables | 34 | 58 | 114 | 121 | 297 | 402 | 611 | 335 | 465 | 738 | 569 | 914 | 1 705 | 55 | 63 | 75 |
| Solar PV | 0 | 3 | 33 | 37 | 127 | 178 | 287 | 143 | 207 | 344 | 316 | 556 | 1 085 | 26 | 29 | 48 |
| Wind | 0 | 1 | 8 | 8 | 57 | 83 | 138 | 70 | 104 | 189 | 113 | 174 | 363 | 12 | 16 | 16 |
| Hydro | 26 | 43 | 58 | 60 | 91 | 113 | 149 | 97 | 122 | 161 | 111 | 141 | 182 | 14 | 14 | 8 |
| Bioenergy | 5 | 7 | 10 | 10 | 13 | 15 | 17 | 15 | 17 | 20 | 17 | 25 | 46 | 2 | 2 | 2 |
| Nuclear | - | - | - | - | - | 1 | 2 | - | 2 | 6 | 6 | 14 | 29 | 0 | 1 | 1 |
| Hydrogen and ammonia | - | - | - | - | - | - | - | - | - | - | - | 2 | 42 | - | - | 2 |
| Fossil fuels with CCUS | - | - | - | - | - | - | - | - | - | - | - | 2 | 8 | - | - | 0 |
| Unabated coal | 33 | 62 | 112 | 112 | 148 | 158 | 177 | 143 | 146 | 143 | 130 | 112 | 63 | 16 | 12 | 3 |
| Unabated natural gas | 74 | 89 | 114 | 118 | 174 | 189 | 280 | 171 | 178 | 230 | 163 | 159 | 117 | 25 | 20 | 5 |
| Oil | 24 | 24 | 25 | 25 | 20 | 16 | 10 | 20 | 16 | 10 | 19 | 16 | 9 | 1 | 1 | 0 |
| Battery storage | 0 | 0 | 1 | 1 | 8 | 12 | 23 | 14 | 22 | 42 | 61 | 153 | 303 | 2 | 4 | 13 |

# $CO_2$ emissions

| $CO_2$ emissions (Mt $CO_2$) | Historical | | | | Current Policies (CPS) | | | Stated Policies (STEPS) | | | Announced Pledges (APS) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2023 | 2024 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 |
| **Total $CO_2$*** | **1 129** | **1 420** | **1 881** | **1 969** | **2 551** | **2 754** | **3 132** | **2 411** | **2 486** | **2 563** | **1 991** | **1 681** | **975** |
| **Combustion activities** | **1 034** | **1 294** | **1 731** | **1 818** | **2 362** | **2 548** | **2 895** | **2 225** | **2 286** | **2 335** | **1 828** | **1 520** | **841** |
| Coal | 318 | 463 | 845 | 909 | 1 240 | 1 342 | 1 522 | 1 136 | 1 164 | 1 158 | 915 | 704 | 312 |
| Oil | 455 | 537 | 578 | 587 | 718 | 783 | 882 | 676 | 696 | 717 | 601 | 544 | 398 |
| Natural gas | 260 | 291 | 305 | 319 | 400 | 420 | 487 | 409 | 422 | 457 | 309 | 271 | 139 |
| Bioenergy and waste | 2 | 3 | 3 | 3 | 3 | 4 | 5 | 3 | 4 | 5 | 3 | 2 | - 9 |
| **Electricity and heat sectors** | **405** | **543** | **830** | **893** | **1 201** | **1 291** | **1 480** | **1 132** | **1 154** | **1 159** | **892** | **685** | **279** |
| Coal | 201 | 348 | 646 | 702 | 956 | 1 028 | 1 167 | 874 | 885 | 867 | 692 | 508 | 202 |
| Oil | 46 | 23 | 20 | 17 | 8 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 7 |
| Natural gas | 157 | 171 | 163 | 172 | 235 | 253 | 302 | 249 | 260 | 283 | 191 | 169 | 75 |
| Bioenergy and waste | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | - 4 |
| **Other energy sector**** | **68** | **79** | **83** | **86** | **68** | **61** | **61** | **67** | **60** | **58** | **38** | **27** | **19** |
| **Final consumption**** | **647** | **783** | **960** | **982** | **1 273** | **1 394** | **1 585** | **1 205** | **1 266** | **1 342** | **1 061** | **968** | **677** |
| Coal | 118 | 116 | 199 | 206 | 283 | 312 | 353 | 262 | 279 | 290 | 223 | 195 | 109 |
| Oil | 393 | 496 | 542 | 553 | 691 | 755 | 853 | 649 | 669 | 689 | 579 | 524 | 379 |
| Natural gas | 52 | 60 | 76 | 79 | 116 | 127 | 145 | 113 | 123 | 137 | 94 | 88 | 57 |
| Industry** | 314 | 362 | 474 | 488 | 648 | 706 | 798 | 617 | 656 | 704 | 538 | 491 | 323 |
| Transport | 258 | 338 | 405 | 411 | 524 | 579 | 664 | 491 | 509 | 533 | 439 | 400 | 292 |
| Buildings | 50 | 53 | 58 | 59 | 71 | 75 | 80 | 68 | 69 | 69 | 62 | 57 | 44 |
| **Total $CO_2$ removals**** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **0** | **-** | **1** | **2** | **13** |
| **Total $CO_2$ captured**** | **-** | **-** | **-** | **-** | **10** | **9** | **15** | **10** | **9** | **14** | **30** | **58** | **152** |

*Includes industrial process and flaring emissions.

**Includes industrial process emissions.

# Indicators and activity

| Indicators and activity | Historical | | | | Current Policies (CPS) | | | Stated Policies (STEPS) | | | Announced Pledges (APS) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2023 | 2024 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 | 2035 | 2040 | 2050 |
| **Indicators** | | | | | | | | | | | | | |
| Population (million) | 599 | 635 | 685 | 690 | 736 | 752 | 769 | 736 | 752 | 769 | 736 | 752 | 769 |
| GDP (USD 2024 billion, PPP) | 6 850 | 8 788 | 11 747 | 12 312 | 19 236 | 22 628 | 29 803 | 19 236 | 22 628 | 29 803 | 19 236 | 22 628 | 29 803 |
| GDP per capita (USD 2024, PPP) | 11 443 | 13 833 | 17 140 | 17 834 | 26 132 | 30 106 | 38 768 | 26 132 | 30 106 | 38 768 | 26 132 | 30 106 | 38 768 |
| TES/GDP (GJ per USD 1 000, PPP) | 3.1 | 2.8 | 2.8 | 2.8 | 2.4 | 2.2 | 2.0 | 2.3 | 2.1 | 1.8 | 2.1 | 1.9 | 1.6 |
| TFC/GDP (GJ per USD 1 000, PPP) | 2.1 | 1.9 | 1.7 | 1.7 | 1.5 | 1.4 | 1.2 | 1.4 | 1.3 | 1.1 | 1.3 | 1.2 | 0.9 |
| **Industrial production (Mt)** | | | | | | | | | | | | | |
| Primary chemicals | 28 | 34 | 39 | 39 | 54 | 59 | 69 | 53 | 58 | 67 | 52 | 55 | 61 |
| Steel | 20 | 21 | 51 | 56 | 94 | 112 | 147 | 94 | 112 | 147 | 88 | 102 | 125 |
| Cement | 163 | 218 | 298 | 299 | 363 | 392 | 445 | 363 | 392 | 445 | 352 | 374 | 412 |
| Aluminium | 1 | 2 | 4 | 4 | 7 | 8 | 10 | 7 | 8 | 10 | 7 | 8 | 9 |
| **Transport** | | | | | | | | | | | | | |
| Passenger cars (billion pkm) | 649 | 850 | 1 135 | 1 171 | 1 797 | 2 210 | 2 910 | 1 796 | 2 202 | 2 936 | 1 806 | 2 215 | 2 905 |
| Heavy-duty trucks (billion tkm) | 1 070 | 1 399 | 2 100 | 2 164 | 3 032 | 3 395 | 4 029 | 3 030 | 3 395 | 4 037 | 3 019 | 3 372 | 4 017 |
| **Buildings** | | | | | | | | | | | | | |
| Households (million) | 141 | 157 | 178 | 180 | 209 | 220 | 235 | 209 | 220 | 235 | 209 | 220 | 235 |
| Residential floor area (million $m^2$) | 11 403 | 12 999 | 15 434 | 15 766 | 20 259 | 22 266 | 25 766 | 20 259 | 22 266 | 25 766 | 20 259 | 22 266 | 25 766 |
| Services floor area (million $m^2$) | 2 470 | 3 021 | 4 075 | 4 170 | 5 399 | 5 866 | 6 627 | 5 399 | 5 866 | 6 627 | 5 399 | 5 866 | 6 627 |

# Annex B

# Policy tables

# Selected cross-cutting and energy supply policies as modelled by scenario and country

| Region/country | Scenario | Policies and targets |
|---|---|---|
| **Brunei** | APS | • The new NDC (2025) aims to reduce its GHG emissions by 20% by 2035 relative to a business-as-usual trajectory.<br>• Aims for net zero in 2050. |
| **Cambodia** | APS | • The new NDC (2025) aims to reduce its GHG emissions by 16% by 2035 relative to a business-as-usual trajectory, and up to 55% conditional on the provision of international support.<br>• Aims for net zero in 2050. |
| **Indonesia** | CPS | •17-19% share of renewable energy in primary energy supply by 2025. |
| | APS | • The new NDC (2025) aims ot reduce its GHG emissions by 17% to 30% compared to a business-as-usual trajectory by 2035.<br>• Aims for net zero in 2060. |
| **Lao People's Democratic Republic** | APS | • The NDC (2021) aims to reduce its GHG emissions by 60% relative to a business-as-usual trajectory by 2030.<br>• Aims for net zero in 2050. |
| **Malaysia** | APS | • The new NDC (2025) aims to reduce the GHG emission of 15-30 million tonnes of $CO_2$ equivalent by 2035 from the peak level anticipated to be between 2029 and 2034.<br>• Aims for net zero in 2050. |
| **Myanmar** | APS | • The NDC (2021) aims to reduce its emissions by 244.52 Mt $CO_2$-eq relatively to a business-as-usual trajectory by 2030, and up to 414.75 Mt $CO_2$-eq by the same date conditional on the provision of international support. |
| **Philippines** | APS | • The NDC (2021) aims to reduce its GHG emissions by 2.71% relative to a business-as-usual trajectory by 2030, and up to 75% conditional on the provision of international support. |
| **Singapore** | STEPS | • Future Energy Fund (2024); Green Plan 2030 (2021). |
| | APS | • The new NDC (2025) aims to cap emissions at around 45 to 50 $MtCO_2e$ by 2035.<br>• Aims for net zero 2050. |
| **Thailand** | APS | • The new NDC (2025) aims to reduce its GHG emissions by 47% below 2019 level in 2035, conditional on the provision of international support.<br>• Aims for net zero 2065. |
| **Viet Nam** | APS | • The NDC (2022) aims to reduce its GHG emissions by 15.8% relative to a business-as-usual trajectory by 2030, and by up to 43.5% by the same date, conditional on the provision of international support.<br>• Aim for net zero in 2050. |

Notes: NDC = national determined contributions; GHG = greenhouse gas; Mt $CO_2$-eq = million tonnes of carbon dioxide equivalent.

## Selected electricity sector policies and measures as modelled by scenario and country

| Region/country | Scenario | Policies and targets |
|---|---|---|
| ASEAN | APS | ● Renewables capacity is projected to reach 45% in the region by 2030. |
| Brunei | STEPS | ● National Climate Change Policy seeks 30% share of installed renewable capacity by 2030. |
| Cambodia | STEPS | ● Power Development Plan 2022-2040 aims to reach 3.2 GW of solar capacity and 3 GW of hydropower by 2040. |
| Indonesia | STEPS | ● Electricity Supply Business Plan 2025-2034 aims to add 42 GW of renewables, alongside IDR 400 trillion (USD 25 billion) investment for transmission networks. |
| | APS | ● Progress towards achieving net zero emissions by 2060, with the scale-up of low emissions generation broadly following the direction of the 2025–2060 National Electricity General Plan (RUKN), delivering its long term objectives. |
| Malaysia | STEPS | ● National Energy Transition Roadmap aims to increase the share of renewables to 40% in 2040 and 70% in 2050. Coal phase out by 2044. |
| Philippines | STEPS | ● Philippine Energy Plan (2023-2050) aims to increase the share of renewables to 35% by 2030, 50% by 2040 and more than 50% by 2050. |
| Singapore | STEPS | ● Singapore Green Plan 2030 aims to install 2 GW of solar PV by 2030. Coal phase out by 2050. |
| Viet Nam | APS | ● Progress towards reaching targets under Adjusted Power Development Plan 8 to install more than 45 GW of solar PV and 20-38 GW of onshore wind by 2030. Coal-fired generation phase out by 2050. |

# Selected transport sector policies and measures as modelled by scenario and country

| Region/country | Scenario | Policies and targets |
|---|---|---|
| Indonesia | CPS | • Reduce annual vehicle tax in selected regions. 15% luxury tax rebate for BEVs meeting local content requirements.<br>• Biodiesel blending mandate (40%) and partial implementation of ethanol blending mandate (20%). |
| | STEPS | • Biodiesel blending mandate (50%). |
| | APS | • Government aims to have 2 million EVs in passenger light-duty vehicle stock and 13 million electric motorcycles in the fleet by 2030.<br>• Target to extend the national railway network to over 10 000 km by 2030. |
| Malaysia | CPS | • Favourable annual road tax framework for electric cars.<br>• Government procurement of 1 000 electric buses by 2030.<br>• Policies designed to encourage local CKD assembly through import duty reliefs on vehicle parts and components. |
| Philippines | CPS | • Excise tax exemption for EVs.<br>• Import tariff exemption running until 2028.<br>• Electric Vehicle Incentive Strategy (EVIS) will provide incentives that stimulate local production of EVs, batteries, components and charging stations. |
| Singapore | CPS | • Provide relief for car registration fees or surcharges through Vehicle Emissions Schemes (VES) and EV Early Adoption Incentive schemes.<br>• Scrappage schemes for light commercial vehicles and heavy-duty vehicles, including buses and trucks. |
| | APS | • Phase out passenger ICE vehicles by 2040 in Singapore.<br>• Sustainable aviation fuel target of 3-5% by 2030. |
| Thailand | CPS | • EV3.5 scheme: indirect purchase subsidies and purchase tax breaks for electric cars and two/three-wheelers.<br>$CO_2$-emission-based excise tax system introduced in 2026. |
| Viet Nam | CPS | • Offer exemption from registration fees and reduce special consumption tax for BEVs.<br>• Ban gasoline two/three-wheelers in Hanoi from 2026 and Ho Chi Minh City from 2027.<br>• Introduce tariff exemptions for ASEAN-origin EVs under regional free trade agreement.<br>•Offer corporate income tax breaks for EV-makers and import duty exemptions on EV parts and manufacturing equipment. |
| | STEPS | • Extend EV registration fee rebates. |
| | APS | • Net zero GHG emissions in the transport sector by 2050, with a goal of road transport running 100% on electricity and green energy. |

Notes: BEV = battery electric vehicle; EV = electric vehicle; ICE = internal combustion engine; CKD = completely knockdown; GHG = greenhouse gas.

## Selected industry sector policies and measures as modelled by scenario and country

| Region/country | Scenario | Policies and targets |
|---|---|---|
| Malaysia | CPS | ● Energy Efficiency and Conservation Act (EECA): Applies to large industrial consumers (about 4% of firms accounting for roughly 66% of industrial energy consumption) through mandatory energy management systems, audits and efficiency improvements. |
| Singapore | CPS | ● Implement a carbon tax affecting large emitters (>25kt$CO_2$ per year). |
| Viet Nam | STEPS | ● Pilot emissions trading scheme (2025-2028) covering carbon-intensive industrial sectors such as steel and cement. |

## Selected buildings sector policies and measures as modelled by scenario and country

| Region/country | Scenario | Policies and targets |
|---|---|---|
| ASEAN | STEPS | ● Extend and strengthen existing efficiency regulations for appliances and buildings, beyond current expiration dates. |
| | APS | ● Harmonise regional MEPS for air conditioners at a Cooling Season Performance Factor of 6.09 by 2030. |
| Indonesia | CPS | ● Update MEPS for air conditioners (2021). |
| Malaysia | CPS | ● Energy Efficiency and Conservation Act (EECA) 2024 – building energy management requirements. |
| Philippines | CPS | ● Accelerate implementation of the Government Energy Management Programmme for public buildings (2024). |
| Singapore | CPS | ● Revise mandatory building energy codes applied to new large construction (2025). |
| | STEPS | ● Extend subsidies for retrofits provided as part of the Green Market Incentive Scheme Programme (2022). |
| Viet Nam | CPS | ● Apply mandatory building energy codes to new large construction (2022). |

# Abbreviations and acronyms

| | |
|---|---|
| AAM | anode active material |
| AC | air conditioning |
| ACE | ASEAN Centre for Energy |
| ACCESS | Accelerating Clean Cooking and Electricity Services Scenario |
| ADB | Asian Development Bank |
| ADD | anti-dumping duties |
| AERN | ASEAN Energy Regulators' Network |
| AI | artificial intelligence |
| APAEC | ASEAN Plan of Action for Energy Cooperation |
| APG | ASEAN Power Grid |
| APS | Announced Pledges Scenario |
| APSA | ASEAN Petroleum Security Agreement |
| ASEAN | Association of Southeast Asian Nations |
| AZEC | Asia Zero Emission Community |
| B50 | Fuel blend with 50% biodiesel by volume |
| BESS | battery energy storage system |
| CAM | cathode active material |
| CB | central bank |
| CCS | carbon capture and storage |
| CCUS | carbon capture, utilisation and storage |
| CIPP | Comprehensive Investment and Policy Plan |
| COP | Conference of the Parties of the UNFCCC |
| CORSIA | Carbon Offsetting and Reduction Scheme for International Aviation |
| $CO_2$ | carbon dioxide |
| CPS | Current Policies Scenario |
| CVD | countervailing duties |
| DFI | development finance institution |
| EGIB | efficient grid-interactive buildings |
| EIT | energy-intensive industry |
| EMDE | emerging market and developing economies |
| ERIA | Economic Research Institute for ASEAN and East Asia |
| ETS | emissions trading system |
| EV | electric vehicle |
| FDRE | Firm and Dispatchable Renewable Energy |
| FID | final investment decision |
| FiTs | feed-in tariffs |
| FX | foreign exchange |
| GDP | gross domestic product |
| GHG | greenhouse gas |
| HPAL | high-pressure acid leaching |
| HVDC | high-voltage direct current |
| IAEA | International Atomic Energy Agency |
| ICE | internal combustion engine |
| ICMA | International Capital Market Association |
| IEEFA | Institute for Energy Economics and Financial Analysis |
| IEA | International Energy Agency |
| IMO | International Maritime Organization |
| INIR | Integrated Nuclear Infrastructure Review |
| IREDA | Indian Renewable Energy Development Agency |
| ITMO | internationally transferred mitigation outcomes |
| JETP | Just Energy Transition Partnership |
| Lao PDR | Lao People's Democratic Republic |
| LCOE | levelised cost of electricity |
| LMA | Loan Market Association |
| LNG | liquefied natural gas |
| LPG | liquefied petroleum gas |

| | |
|---|---|
| MAS | Monetary Authority of Singapore |
| MEPS | minimum energy performance standards |
| MER | market exchange rate |
| MHP | mixed hydroxide precipitate |
| MoU | memorandum of understanding |
| NDC | Nationally Determined Contributions |
| NGL | natural gas liquids |
| NOC | national oil company |
| NTPC | National Thermal Power Corporation (India) |
| PACM | Paris Agreement Crediting Mechanism |
| PDP | power development plan |
| PLDV | passenger light duty vehicle |
| POWERR Asia | Partnership on Wide Energy and Resources Resilience Asia |
| PPA | Power Purchase Agreement |
| PPP | purchasing power parity |
| PV | photovoltaic |
| R&D | research and development |
| REE | rare earth elements |
| RUPTL | PLN’s Electricity Supply Business Plan |
| SAS | stand-alone system |
| SECI | Solar Energy Corporation of India |
| SMR | small modular reactor |
| SOE | state-owned enterprise |
| SPE-GRK | Sertifikat Pengurangan Emisi Gas Rumah Kaca (Carbon Credit) |
| STEPS | Stated Policies Scenario |
| TFC | total final consumption |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VRE | variable renewable electricity |
| WACC | weighted average cost of capital |

# Units of measure

| | |
|---|---|
| °C | degrees Celsius |
| bcm | billion cubic metres |
| bcme | billion cubic metres (natural gas equivalent) |
| boe | barrels of oil equivalent |
| EJ | exajoule |
| GJ | gigajoule |
| Gt $CO_2$ | gigatonnes of carbon dioxide |
| GW | gigawatt |
| GWh | gigawatt-hour |
| kboe/d | thousand barrels of oil per day |
| kd/d | thousand barrels per day |
| kg | kilogram |
| km | kilometre |
| kV | kilovolt |
| kW | kilowatt |
| kWh | kilowatt-hour |
| kWh/unit | kilowatt-hour per unit |
| lge/100 km | litres of gasoline equivalent per 100 kilometres |
| mb/d | million barrels per day |
| mboe/d | million barrels of oil equivalent per day |
| Mbtu | Million British thermal units |
| Mt | million tonnes |
| Mt $CO_2$ | million tonnes of carbon dioxide |
| Mtce | million tonnes of coal equivalent |
| Mtpa | million tonnes per annum |
| MVAR | megavolt-ampere reactive |
| MW | megawatt |
| MWh | megawatt-hour |
| PJ | petajoule |
| pkm | passenger kilometre |
| t $CO_2$-eq | tonnes of carbon dioxide equivalent |
| tkm | tonne-kilometre |
| TWh | terrawatt-hour |
| USD | US dollars |
| Wh | watt-hour |
| Wh/Wh | watt-hour per watt-hour (efficiency ratio) |

See the IEA glossary for a further explanation of many of the terms used in this report.

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