Clean Energy Trade and Emerging Markets

Bloomberg Philanthropies

BloombergNEF

Executive summary

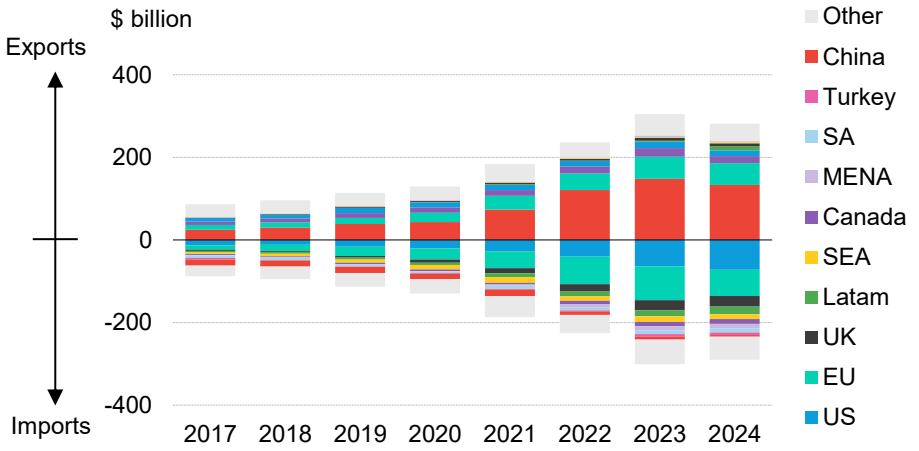
- **Industrial strategy is enjoying a revival.** China is at the center of clean-tech manufacturing, hosting at least 80% of capacity across every major part of the solar and battery supply chains. That could change: G-20 members have announced at least 18 industrial strategies which include a clean-tech component, evenly split across emerging and developed economies.
- **Clean-tech trade flows are growing fast.** In 2024, global solar module and cell imports rose by 36% and 70% in gigawatt-terms, respectively. The picture is similar across other clean technologies.
- **Emerging markets levy low tariffs on clean tech.** The share of Chinese clean-tech exports destined for emerging markets has risen from 23% to 31% over 2022-25 (through August 2025). That trend is enabled by relatively low tariffs in emerging economies. Rising shipments have enabled a series of unforeseen import surges, from a boom in solar modules in Pakistan to an influx of EVs in Brazil.
- **Prominent developing countries are considering increasing trade barriers.** Citing various motivating factors, several large emerging economies – this report highlights eight – are either considering or in the process of imposing higher duties on clean tech.
- **Import duties are used to pursue a variety of objectives.** Trade barriers are employed for everything from local value creation and attracting foreign direct investment, to diversification and security concerns. Equally, tariffs come at a cost and involve distinct trade-offs.
- **Tariffs raise the cost of achieving clean power deployment goals.** BloombergNEF assessed the impact of higher duties on the solar and battery storage spend required to meet 2030 “tripling renewables” targets agreed at COP28 across eight selected geographies. Under an “extreme” scenario where solar modules are subject to a 100% tariff and batteries to 50%, the total cost of achieving the renewables goal would rise by at least $137 billion, or 16%. With higher financing costs and lower project margins, emerging markets are more sensitive to such cost increases.

$137 billion More investment needed to hit the UN goal of tripling renewables by 2030 under the BNEF “extreme” tariff scenario

31% Share of China’s clean-tech exports to emerging economies in 2025 (through August)

8 Large emerging economies considering raising tariffs on clean-tech imports

Global clean-tech trade by geography

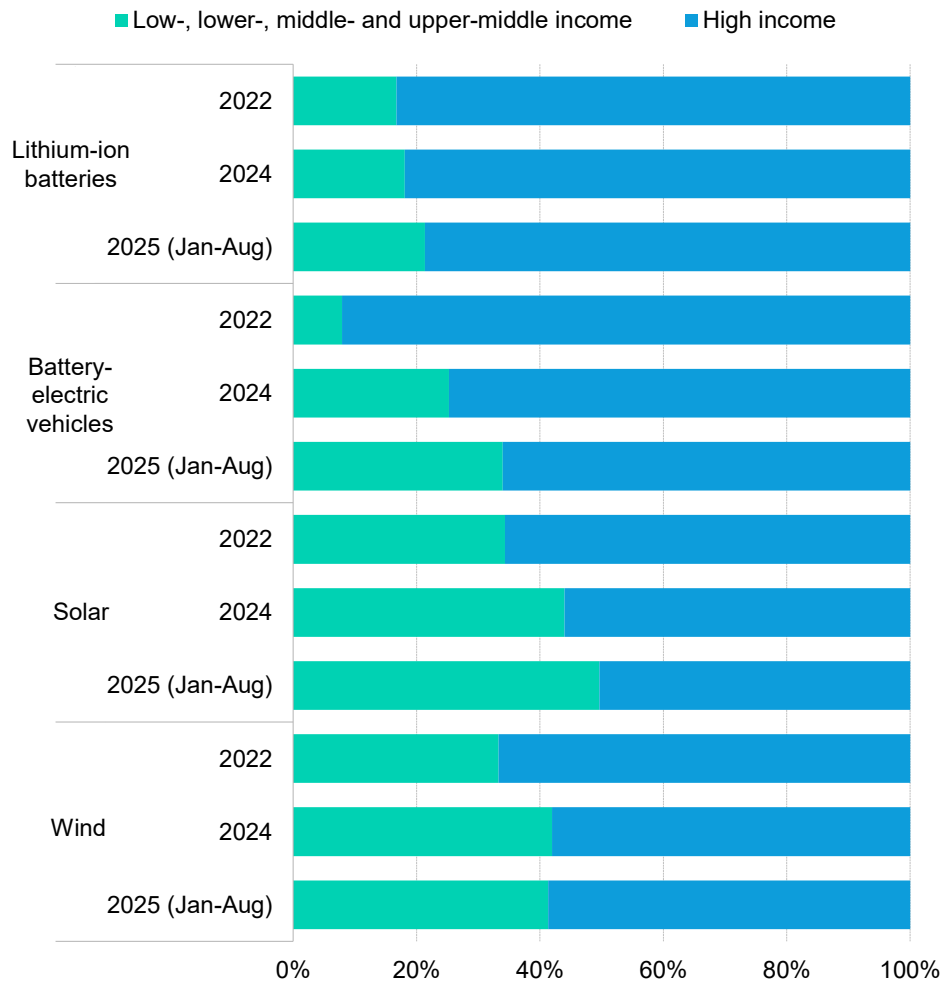


Source: Trade Map, BloombergNEF. Note: Clean energy products includes solar cells, solar modules, wind turbines and components, lithium-ion batteries, battery electric vehicles and plug-in hybrids. ‘Latam’ refers to Latin America; SEA refers to Southeast Asia; SA refers to South Asia; MENA refers to Middle East and North Africa. See slides 49-50 for country lists. Other includes the rest of the world. Trade data represent globally reported imports.

Background

- **Industrial policy is taking on a renewed importance in the energy transition.** China's entrenched lead in clean-tech manufacturing defines today's landscape, and it is against this backdrop that governments around the world are seeking to enhance their domestic industrial capacity to compete. Both developed and large emerging economies are seeking to build more electric vehicles (EVs) and batteries at home and bolster local production of solar and wind technology.
- **Trade barriers to clean tech are rising.** Recent tariff revisions in developed countries – notably the US – have grabbed the world's attention, but emerging economies have comparatively low barriers to trade in clean tech. That could change: emerging markets have been raising trade barriers in recent years and are considering higher tariffs.
- **Higher tariffs are being weighed just as clean-tech prices hit new lows.** Exports from China are booming across most emerging markets, with the country's low costs accelerating the energy transition across energy storage, clean power generation and electrified transport. That is bringing clean energy within reach for more emerging markets.
- **Governments face a series of trade-offs.** Policy choices range from pursuing the lowest-cost transition to fostering domestic manufacturing. Striking a balance between accelerating decarbonization, maximizing local value, and advancing strategic goals is no easy task. This report seeks to support a balanced debate on how best to reconcile those objectives.
- The **Clean Energy Trade and Emerging Markets** report, produced by BloombergNEF and commissioned by Bloomberg Philanthropies, aims to support policy, business and investment professionals by making available key data about the state of supply chains and trade across electric vehicles, batteries, solar products and wind turbines.

Share of China clean-tech exports by technology and country income group



Source: BloombergNEF, Sinoimex. Note: Income country group classification by the World Bank according to gross national income per capita for 2024. For 2025, data runs through August.

Contents

This report seeks to unpack the impact of import tariffs on the energy transition in emerging markets and evaluates how higher duties on clean-tech equipment could affect the investment required to meet global climate goals. Its contents are broken down as follows:

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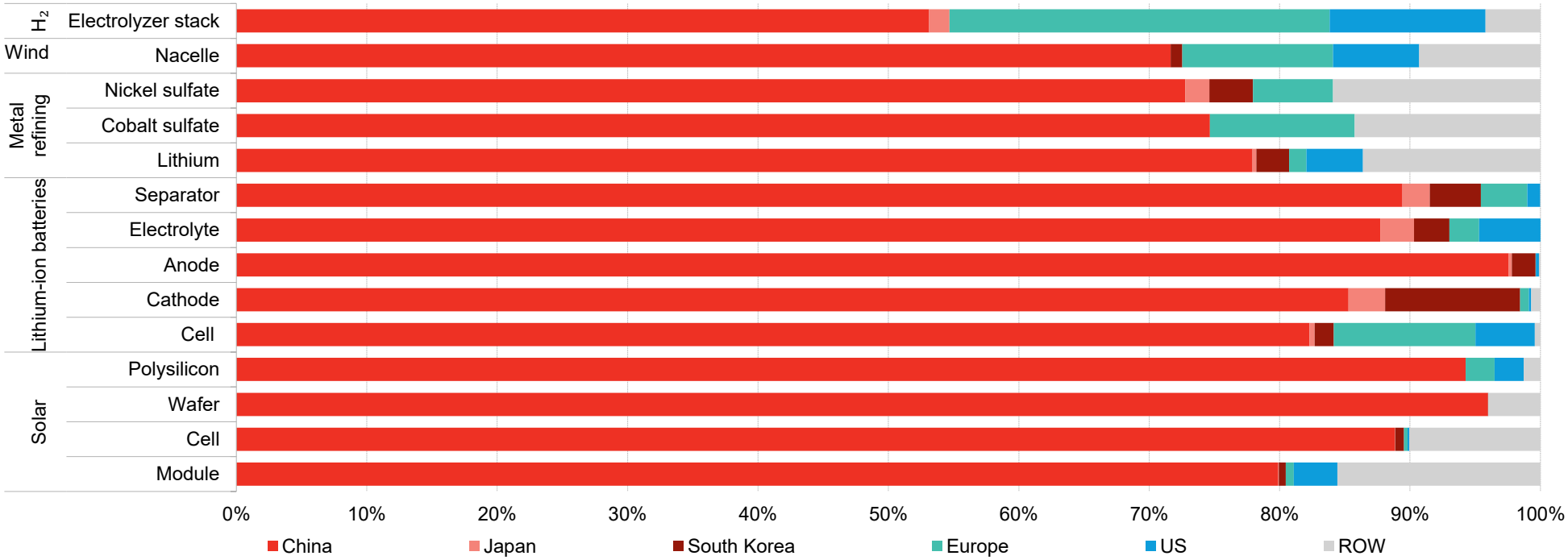
Clean industrial strategies

Governments push to onshore clean-tech manufacturing

China: the epicenter of global clean-tech manufacturing

- China today is the axle on which global clean-tech manufacturing spins. The country is home to more than 70% of production capacity in all but one significant segment of equipment manufacturing. Even in industries where European manufacturers once led, such as wind nacelle production, China has taken the lead. Its role is even more pronounced in solar and batteries, where over 80% of global factory capacity sits within its borders.
- Japan, South Korea, the EU and the US together make up most of the remaining share of manufacturing capacity. Importantly, China's position is only growing stronger: over 2022-24, its share of global capacity increased by at least 5 percentage points across six clean-energy value chain segments. China's entrenched lead defines today's landscape, and it is against this backdrop that governments around the world are seeking to develop local clean-tech manufacturing.

Clean energy manufacturing capacity by location in 2024



Source: BloombergNEF. Note: Chart reflects the share of capacity by market and is based on the locations of production facilities (not location of corporate parents). Solar photovoltaic, hydrogen and battery components expressed in megawatts, megawatt-hours, square meters or metric tons. Nickel is the Class 1 variety. H_2 is hydrogen. ROW refers to rest of the world. Throughout this report, China refers to mainland China.

Developed countries are eager to localize clean-tech value chains

Importance of clean-tech manufacturing within industrial strategy

- Central
- Significant
- Minor

Since the start of the decade, developed nations have rolled out a series of economic development strategies that have, to varying degrees, focused explicitly on building out clean-tech supply chains.

December 14, 2020
NextGenerationEU

- Aims to improve EU economic resilience across priority sectors, taking the form of a Covid-era stimulus package.
- Raises nearly €725 billion in joint debt which EU member states have sometimes accessed to subsidize clean-tech manufacturing.

July 14, 2021
(Green) New Deal 2.0

- Outlines expansive post-Covid recovery plan for climate and digital-led growth. Update to the plan had a greater focus on carbon neutrality.
- Value of South Korean spending is hard to track, but the plan seemingly makes available a large volume of clean-tech manufacturing subsidies.

October 12, 2021
France 2030

- Plans for €54 billion in decarbonization and infant-industry investment, the aim being to reduce dependency in strategic sectors.
- One of 10 objectives includes the annual local manufacture of two million hybrid and electric vehicles by 2030.

August 16, 2022
Inflation Reduction Act

- Authorizes billions for climate and energy as part of a climate and reindustrialization package.
- Introduces lucrative federal tax credits, grants and subsidized loans for clean-tech manufacturing.

February 23, 2023
Realization of Green Transformation (GX)

- Sets out a $140 billion decarbonization and energy security investment plan aligned with 2050 net-zero ambitions.
- Sector-specific strategies emphasize Japanese battery and electric-vehicle manufacturing.

June 13, 2024
Net-Zero Industry Act

- Establishes 2030 targets to meet at least 40% of EU demand, across a range of clean technologies, with local production.
- Legislates clean-tech non-price criteria that are to apply from end-2025 in member state procurement schemes.

December 10, 2024
Future Made in Australia

- Allocates some $15 billion to invest in manufacturing, critical mineral and energy sectors through 2034.
- Introduces multiple subsidy schemes for clean-technology manufacturing, but total support expected to reach just $1.2 billion.

March 5, 2025
Industrial Action Plan for the European automotive sector

- Mentions a host of future measures to bolster local automotive and battery manufacturing.
- Proposes as yet undefined EU content requirements to be applied to locally-sold battery cells and EV components.

June 23, 2025
Modern Industrial Strategy

- Launches a 10-year plan to reduce investment barriers in eight sectors to have high growth potential.
- Adds £700 million in UK clean-tech manufacturing subsidies.

Source: BloombergNEF. Note: List is not exhaustive and highlights only the most recent implemented or planned strategies relevant to clean-technology manufacturing.

Emerging markets are also committed to onshoring clean tech

Importance of clean-tech manufacturing within industrial strategy

- Central
- Significant
- Minor

For over a decade, emerging-market economies have been crafting domestic industrial policies intended to develop local clean-tech manufacturing.

September 25, 2014
Make in India

- Plans to boost foreign direct investment in 25 manufacturing sectors.
- Sets initial target to raise manufacturing's share of GDP to 25% by 2022.
- Clean-tech manufacturing supported alongside other sectors.

May 31, 2015
Made in China 2025

- Initiates extensive support for 10 prioritized high-tech sectors, including new energy vehicles, to transform China's industrial capabilities.
- Aims to increase Chinese competitiveness, global market share and self-sufficiency.

May 12, 2020
Atmanirbhar Bharat – Production Linked Incentives

- Launches 14 sector-specific, production-linked incentive programs worth $22 billion to reduce India's dependence on imports.
- Includes solar, battery and advanced automotives initiatives.

April 5, 2022
Argentina Productiva 2030

- Outlines policies to strengthen the country's manufacturing sector through 11 initiatives.
- Little mention made of clean-tech manufacturing, even in initiatives relating to enabling the "green transition" and sustainable mobility.

December 23, 2023
Plan Sonora

- Plans to nationalize critical material production while developing the Mexican state of Sonora into a hub for clean-energy generation and automotive manufacturing.
- Rolls out tax incentives for clean-tech manufacturing.

January 8, 2024
Ministry of Industry and Technology 2024-2028 Strategic Plan

- Sets out Turkish priority sectors for subsidies, including industrial incentives and high-technology investment programs.
- Clean-tech manufacturing supported alongside other sectors.

January 22, 2024
Nova Indústria Brasil

- Seeks to attract $60 billion of public-private investment in cross-sector projects through 2026.
- Only $300 million been earmarked for clean-tech factories. More ad-hoc support is expected from Brazil's national development bank.

June 27, 2024
Green Mobility and Innovation Program (MOVER)

- Includes tax reforms for plug-in hybrids and BEVs and mandatory emissions targets.
- Establishes $3.6 billion in automotive and auto part manufacturing tax credits through 2028.

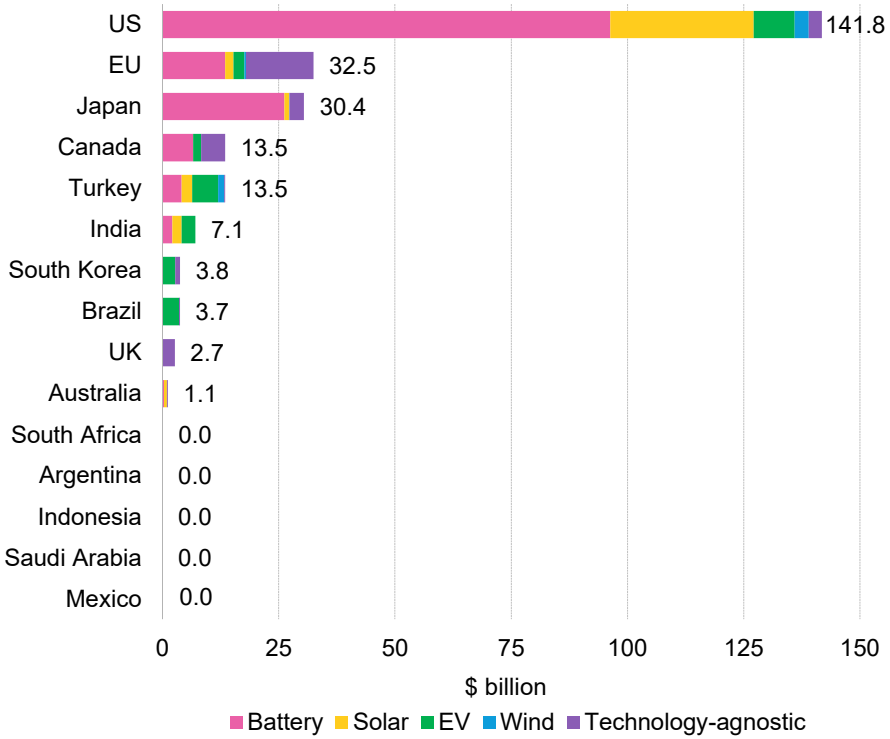
January 13, 2025
Plan México

- Aims to attract foreign companies looking to nearshore industrial production. Includes government subsidies, tax reforms and localization goals.
- Sets a 15% local content target for all vehicles produced in Mexico in 2030.

Source: BloombergNEF. Note: List is not exhaustive and highlights only the most recent implemented or planned strategies relevant to clean-technology manufacturing.

G-20 members set out $250 billion in subsidies for clean-tech manufacturing

Estimated subsidies available for solar, battery, wind and electric vehicle manufacturers in selected markets over 2022-32



Source: BloombergNEF. Note: US assessment correct as of August 19, 2025. For non-US markets, assessment as of December 31, 2024. Shows national subsidy schemes across grants, loans, loan guarantees and tax credits. "Technology-agnostic" support targets several technologies. Sector-specific funding breakdown assumed in some cases based on prior disbursements. Shows the value of currently accessible subsidies. "EV" refers to passenger battery-electric vehicles.

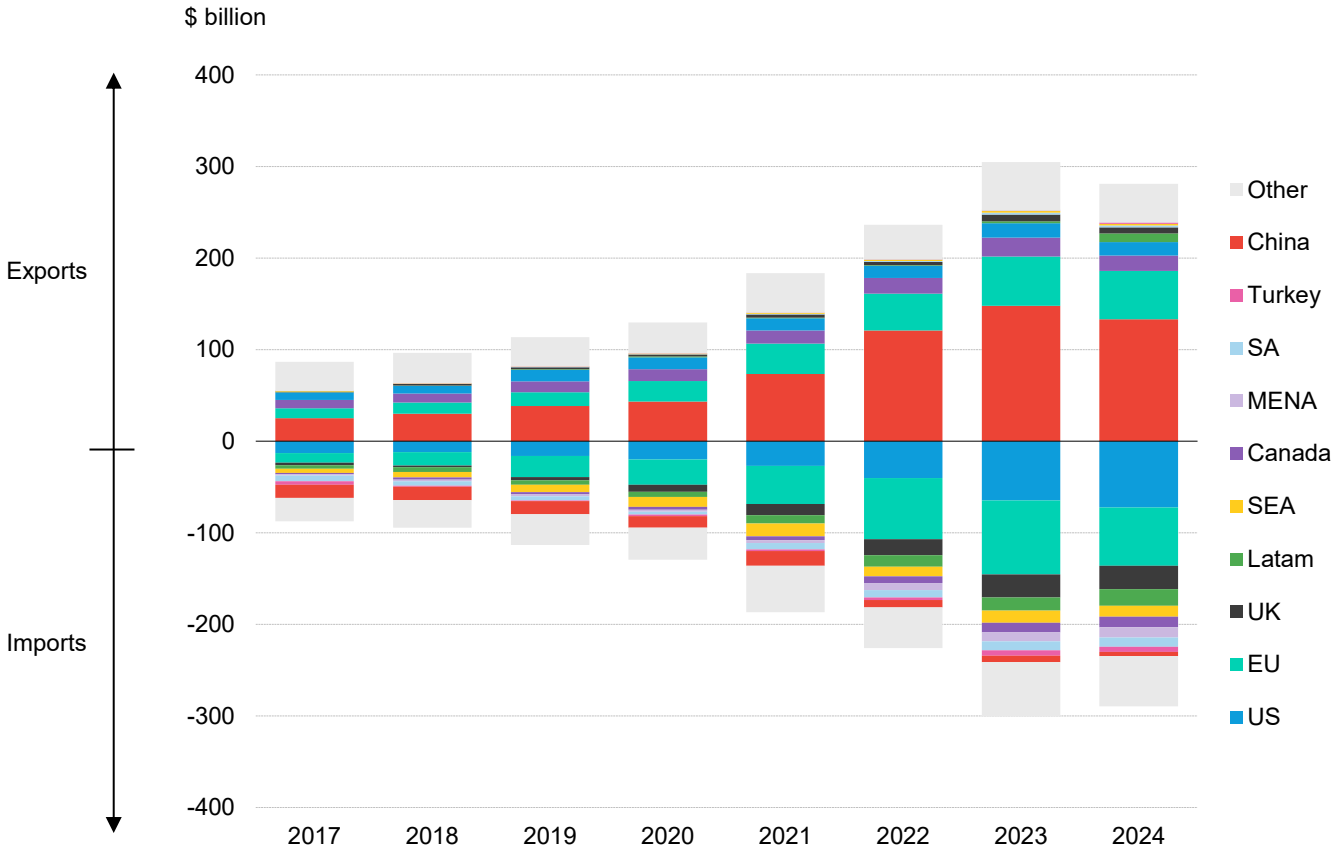
- BNEF has tracked subsidies for solar, battery, wind and electric vehicle manufacturers, limiting our scope to national grants, low-interest loans, loan guarantees and tax credits. That excludes harder to track forms of support like cheap electricity or land.
- By this measure, no market matches the US in terms of commitment, even with revised totals following President Donald Trump's curtailment of previously earmarked support. Those subsidies triggered an impressive $108 billion factory pipeline, but policy changes and uncertainty have frozen many projects.
- Despite ambitious manufacturing targets, the EU has pledged just $32.5 billion in support. With limited budget options, much of it comes from repurposed programs. Member states must draw on national funds to expand local capacity, but cheap imports, low prices and weak manufacturers limit the impact.
- Japan's approach is to concentrate 86% of its $30.4 billion in expected support on the battery sector. That is in line with its domestic manufacturing target of 150GWh by 2030. Reaching that goal may be a stretch. Battery factories are particularly costly to set up compared to other clean technologies, meaning even generous government support may not yield significant growth in manufacturing capacity. Low local demand also adds to the challenge.
- Elsewhere, clean-tech manufacturing support is limited. Reasons vary: clean-tech manufacturing often ranks low among policy priorities, market conditions are tough, capital requirements significant, and locally produced technology tends to be pricier than low-cost, high-quality imports. Equally, fewer subsidies may be needed in emerging markets with competitive manufacturing environments.
- Clean-tech supply chain subsidies can be large in relative terms. Turkey's $13.5 billion subsidy budget accounts for 1% of its 2024 GDP, for instance. But emerging markets contribute little to global clean-tech manufacturing subsidies. That hasn't stopped Chinese manufacturers from expanding into these regions, often without substantial local incentives. Their investments highlight the growing importance of market access and supply-chain diversification over direct state support.

Clean tech global trade flows

Rising exports to emerging markets

China accounts for nearly half of global clean-tech exports

Global clean-tech trade by geography

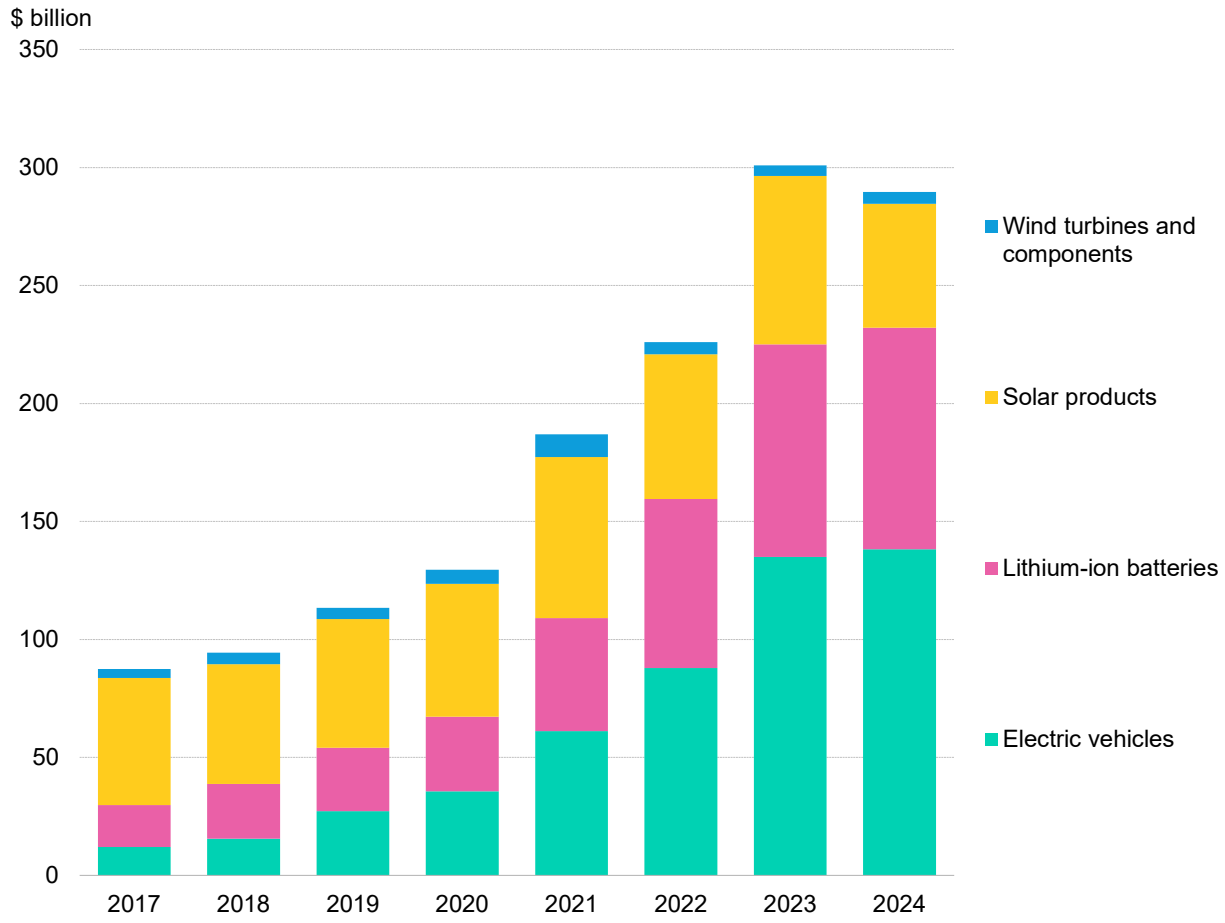


Source: Trade Map, BloombergNEF. Note: Clean-energy products includes solar cells, solar modules, wind turbines and components, lithium-ion batteries, battery electric vehicles and plug-in hybrids. Latam refers to Latin America; SEA refers to Southeast Asia; SA refers to South Asia; MENA refers to Middle East and North Africa. See slides 49-50 for country lists. Other includes the rest of the world. Trade data represent globally reported imports.

- China is the single largest exporter of clean energy components, accounting for 47% of global solar, wind, battery, and EV exports in 2024, on a dollar basis. Its importance owes much to integrated supply chains, significant economies of scale, and intense domestic competition.
- China's share of exports is particularly high for solar and batteries, where it accounts for about two-thirds of the global total. Despite rapid growth in EV exports, China's shipments only represent 30% of the world's total exports.
- The US and EU are major exporters but remain net importers, accounting for 47% of global imports in 2024 – about equal to China's exports. Their trade gaps help explain the turn toward protectionist policies.
- Latin America and Southeast Asia are emerging as key exporters, variously driven by Chinese firms relocating solar manufacturing and expanding into EV and battery production.
- Over the past three years, more regions have emerged as net importers of clean tech. The Middle East and North Africa, along with South Asia, have sharply increased their imports, with solar products and batteries the main sectors driving this growth.

Electric vehicles and batteries are 80% of global clean-tech trade

Global clean energy trade by technology

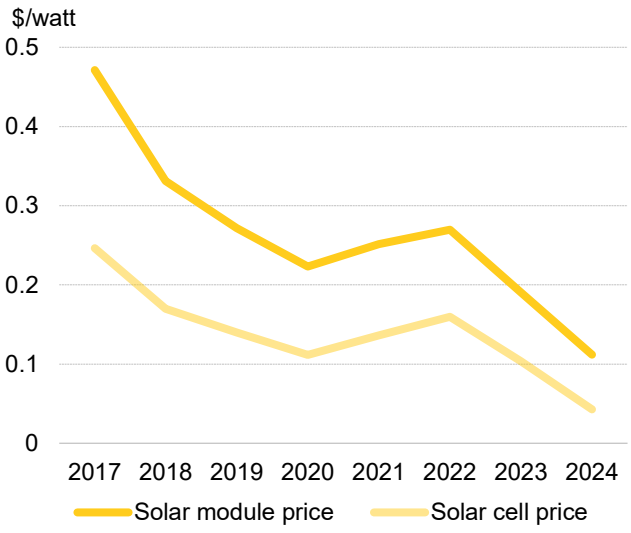


Source: Trade Map, BloombergNEF. Note: Solar products include solar cells and modules. Electric transport includes battery electric vehicles and plug-in hybrid vehicles. Trade data represent globally reported imports.

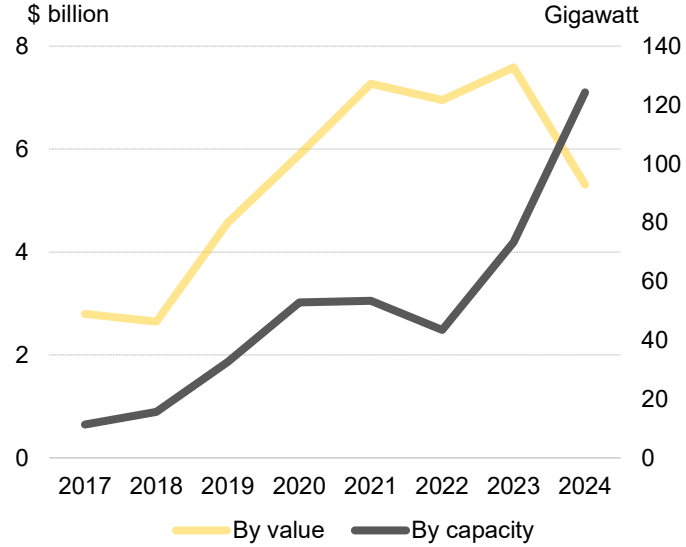
- The global trade in clean energy goods – a category spanning solar cells and modules, wind turbines and components, lithium-ion batteries, battery electric vehicles and plug-in hybrids – has expanded steadily during the last six years. Growth has been fueled by surging electric transport and lithium-ion battery shipments.
- Few sectors have expanded as quickly as electric vehicles. Annual global EV imports rose 126% between 2021 and 2024, while global lithium-ion battery imports grew by 96% over the same period.
- After peaking in 2023, the trade in clean energy products declined by 4% to $290 billion in 2024. The slippage reflects lower equipment and EV prices rather than weaker volumes: in most cases, imports measured in unit terms actually rose.
- Despite this, the trade clean energy products has continued to expand robustly – a trend that contrasts with rising talk of deglobalization and protectionism.
- Batteries and EVs have grown at pace and now make up 80% of the total. Steep module price drops mean that the value solar products – a category that includes PV cells and modules – is relatively small at just 18%.
- Wind equipment shipments are more limited. Bulky turbine components are typically costly to transport, and much of the manufacturing value-add occurs proximate to demand.

The global trade in solar products is surging as prices crater

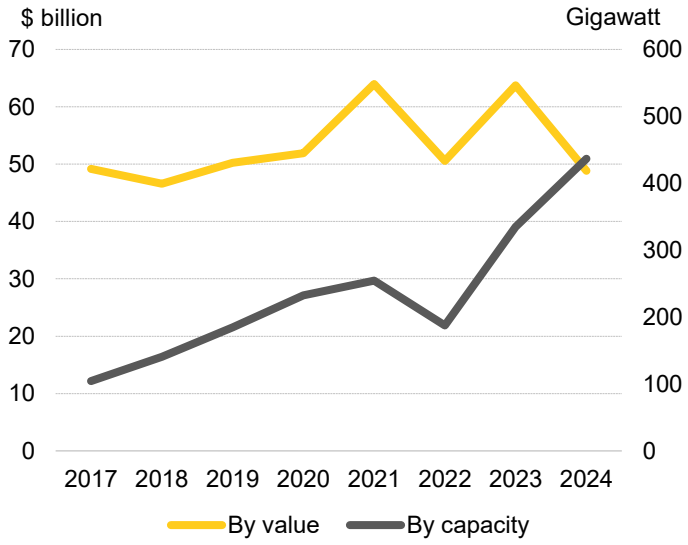
Solar module and cell price



Global solar cell imports by value and capacity



Global solar module imports by value and capacity

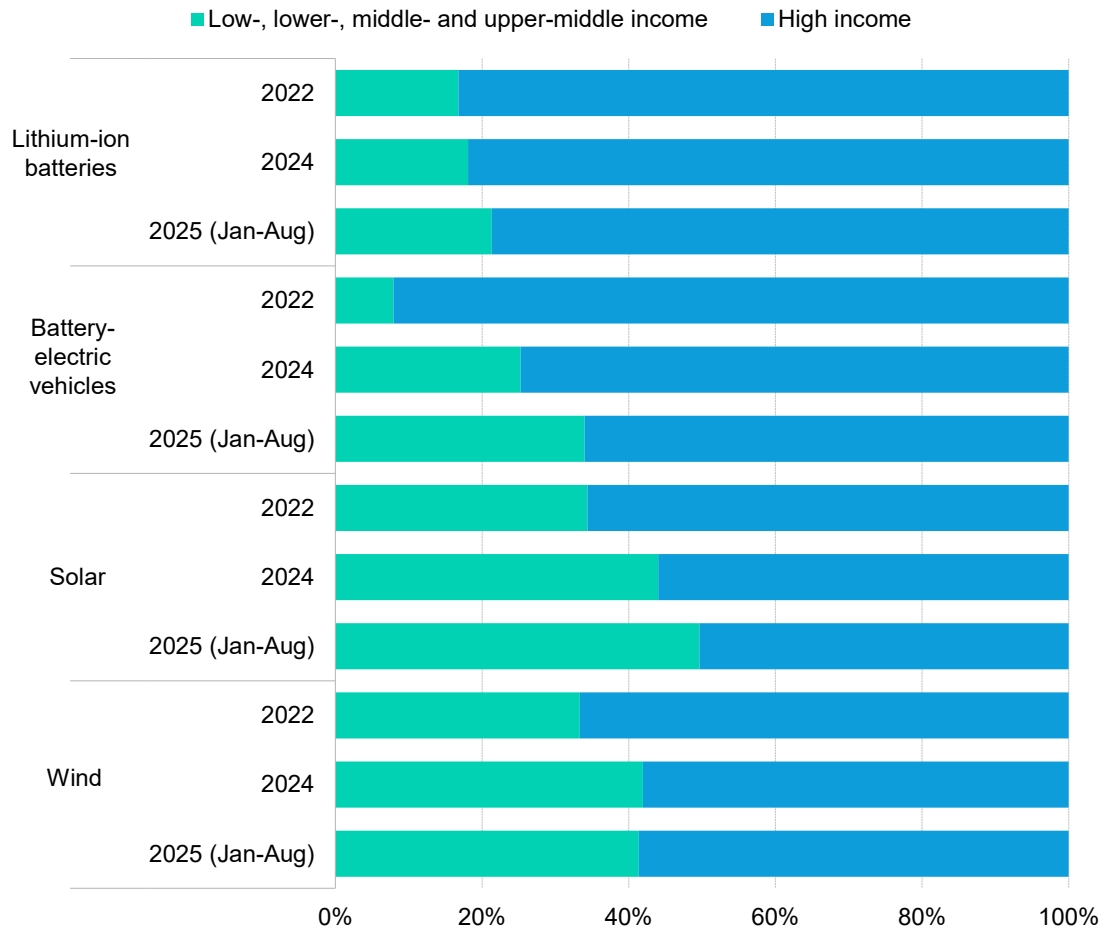


Source: Trade Map, BloombergNEF. Note: Solar cell and module prices extracted from the solar spot price index from the BNEF website. Pricing is based on the global annual averages for solar cells and modules plus a blended average shipping cost. Since import data for cells and modules was not split out before 2022, a 9:1 module to cell split is assumed for 2020-21 with a lower cell share for previous years.

- Overcapacity is depressing solar cell and module prices with the drop especially sharp over the past two years. Last year, cell prices dropped by almost 60% while modules fell by 44% as extreme competition – fueled by overcapacity in China – squeezed manufacturer margins.
- Last year's fall in the value of global solar shipments owed much to this steep price decline. But trade actually surged as measured in unit (gigawatt) terms. On a capacity basis, solar module imports increased 36% in 2024 while cell imports jumped by 70%.
- Cells are used to produce modules, and account for just 11% of the dollar total across solar products.
- Rising cell shipments point to the spread of PV manufacturing. Governments have been wielding a mix of subsidies, local content rules and trade barriers to promote solar manufacturing. Nevertheless, because cell manufacturing is more capital-intensive than module assembly, scaling up takes longer.
- PV cell and module prices weren't the only technologies which saw significant price declines. Last year, electric vehicle battery prices fell by 20%, while the price of Chinese wind turbines dropped by 15%. Fierce competition, economies of scale and, in some cases, supply-demand imbalances are acute across the clean-tech sectors.

Half of China's solar exports went to emerging markets in 2025

Share of China clean-tech exports by technology and country income group



Source: BloombergNEF, Sinoimex. Income country group classification by the World Bank according to gross national income per capita for 2024. Data for 2025 runs through August.

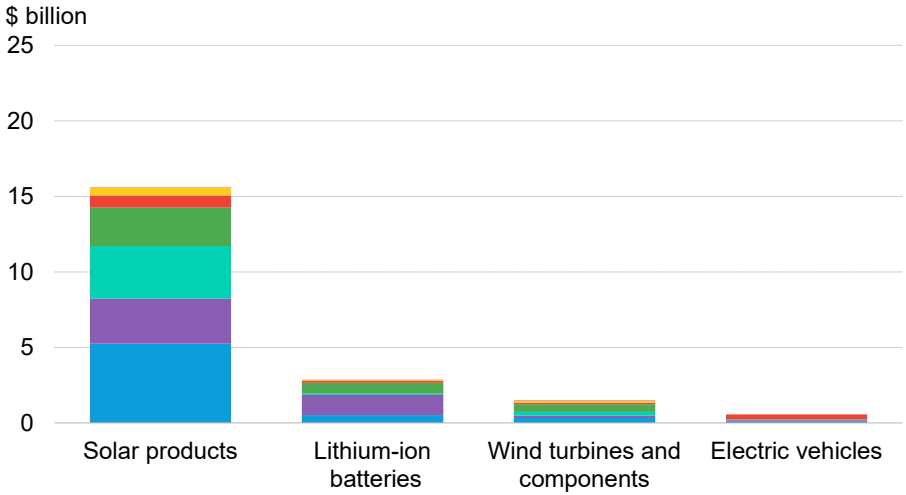
- China's leading role in clean-tech manufacturing is reshaping global trade patterns, with emerging economies taking an increasing share of its exports.
- The share of lithium-ion batteries, battery-electric vehicles (BEVs), solar modules, and wind turbines shipped to markets classified by the World Bank as "low" to "upper-middle income" climbed from 23% in 2022 to 27% in 2024, before reaching 31% in 2025 (for the year through August).
- Chinese manufacturers have expanded production capacity rapidly in recent years and are increasingly targeting overseas markets to absorb surplus output.
- In solar manufacturing, for instance, production growth surged in 2023, resulting in global supply exceeding demand across much of the value chain – a pattern equally present in other clean-tech segments.
- Defensive trade policies of the kind being implemented in the US could amplify these shifts. A combination of import tariffs, local content requirements, and software-related restrictions in advanced economies has already begun redirecting trade flows toward markets more open to Chinese products.

Emerging market trends

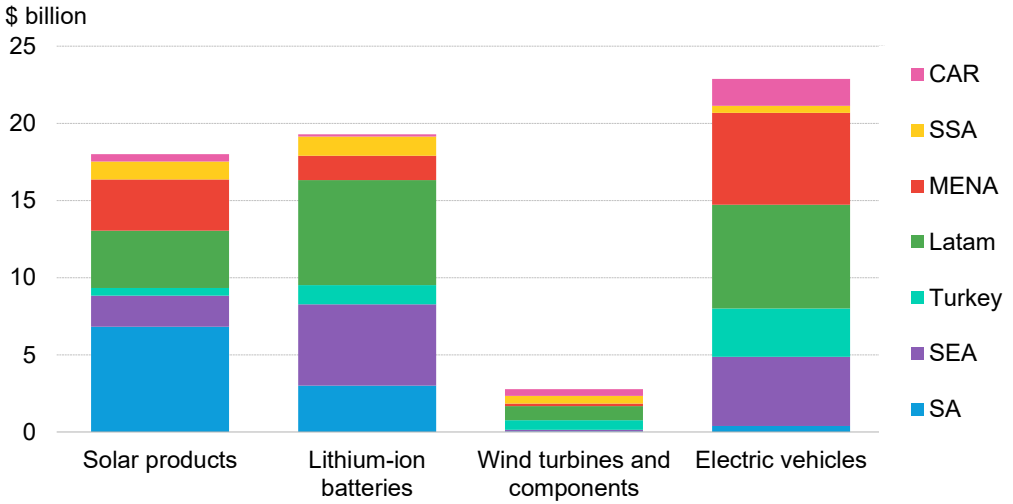
Low-cost equipment, high growth rates

Batteries and EVs now top imports across emerging markets

Clean energy imports in selected emerging market regions, 2017



Clean energy imports in selected emerging market regions, 2024

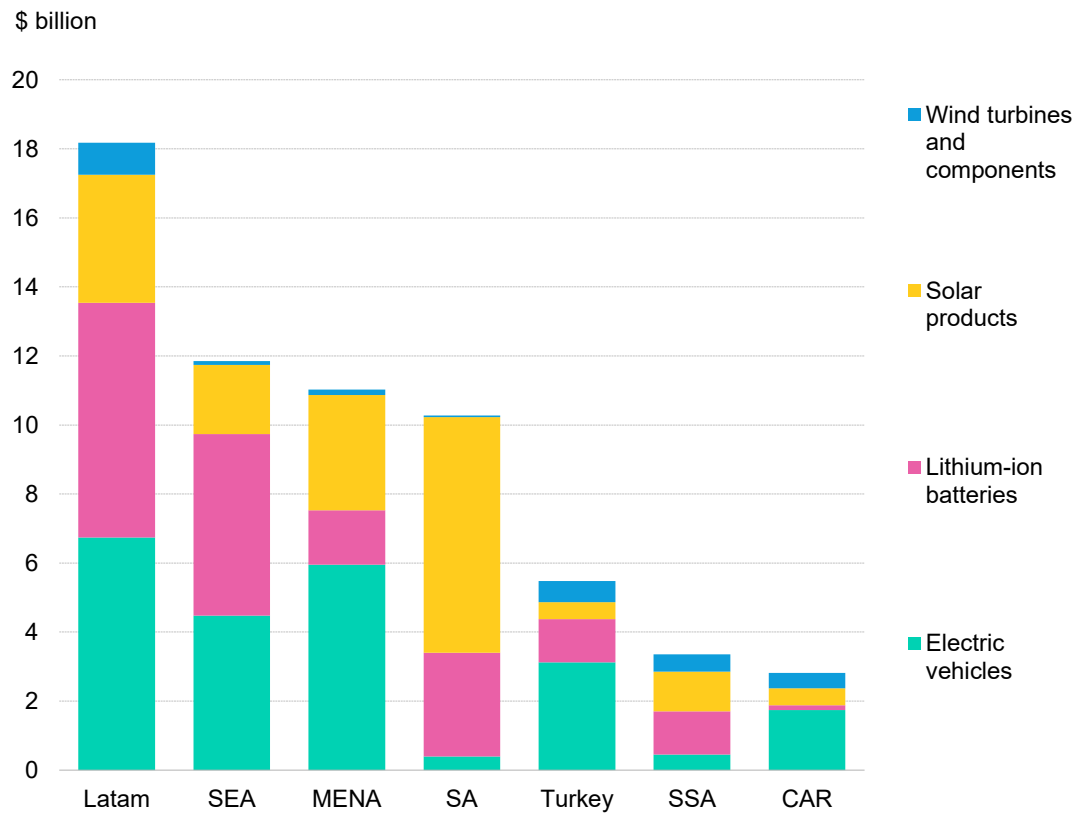


Source: Sinoimex, Trade Map, BloombergNEF. Note: CAR refers to Central Asian Republics; SSA refers to sub-Saharan Africa; Latam refers to Latin America; SEA refers to Southeast Asia; SA refers to South Asia. See slides 49-50 for regional breakdowns. Solar products include solar cells and modules. Electric vehicles includes battery-electric vehicles and plug-in hybrids.

- The structure of emerging market clean-tech imports has evolved substantially in recent years. In 2017, solar products accounted for 76% of clean-energy imports into developing economies with price declines keeping solar imports stable as volumes grew. Seven years later, lithium-ion batteries and electric vehicles have taken the lead. Together, they account for two-thirds of clean-tech imports into these markets.
- Since 2017, lithium-ion battery imports have increased nearly sevenfold, while EV imports have surged by a factor of almost 40. In contrast, wind turbine and component imports have stayed low, with the Central Asian Republics and Latin America standing out for higher volumes.
- Despite recent growth in clean-tech imports across emerging markets, their total value remains modest compared with advanced economies such as the EU, US, and UK. Some of the growth in emerging market imports is linked to tariff circumvention. Countries such as the US are seeking to curb so-called transshipments – the routing of goods through third countries to evade higher tariffs on Chinese products.

Latam accounts for 30% of emerging market clean-tech imports

Clean energy imports by technology and geography, 2024

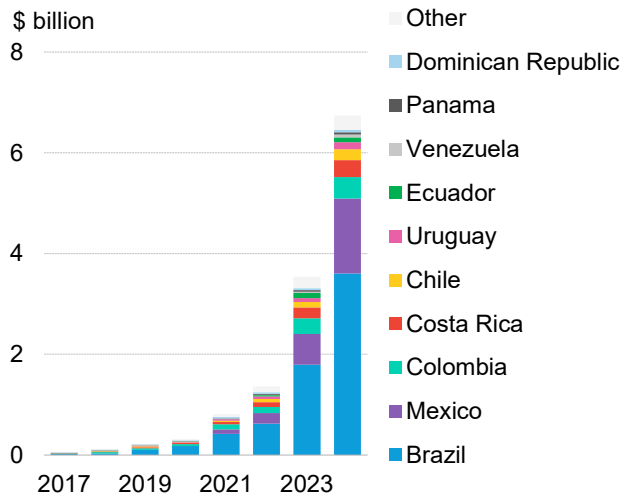


Source: Sinoimex, Trade Map, BloombergNEF. Note: Solar products include solar cells and modules. Electric transport includes battery electric vehicles and plug-in hybrid vehicles. CAR refers to Central Asian republics; MENA refers to Middle East and North Africa. SSA refers to sub-Saharan Africa; Latam refers to Latin America; SEA refers to Southeast Asia; SA refers to South Asia. See slides 49-50 for regional breakdowns.

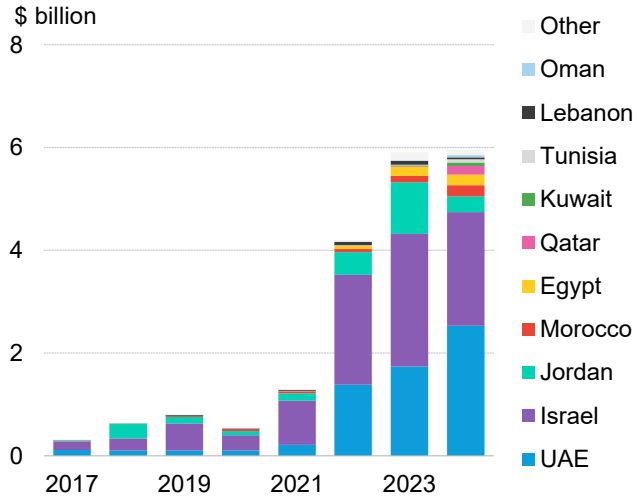
- Latin America (Latam) stood out among emerging markets for the scale of its clean-energy imports in 2024, accounting for nearly 30% of total clean-tech imports in our sample. Southeast Asia (SEA), the Middle East and North Africa (MENA), and South Asia (SA) together imported a comparable value, highlighting the growing diversification of global demand.
- The composition of clean-tech imports varies widely by region, reflecting different needs and industrial structures. Latin America and Southeast Asia have shown similar growth in lithium-ion battery and EV imports, driven by established automotive sectors, limited local battery production, and expanding domestic EV markets.
- In MENA, growth in battery imports has been more modest relative to EVs. Unlike SEA and Latam, several countries in the region are prioritizing electrification of transport through imports rather than building a domestic automotive industry.
- South Asia has increased imports of solar products, especially solar cells, as local-content rules and tariffs on modules encourage domestic manufacturing. Both South Asia and sub-Saharan Africa show more concentrated import patterns than other regions, with a few countries accounting for most of the trade in batteries or solar equipment.
- Turkey has emerged as a heavyweight when it comes to clean-tech imports. The value of the country's imports surpasses those of the entirety of sub-Saharan Africa.

EV imports to Latin America are surging

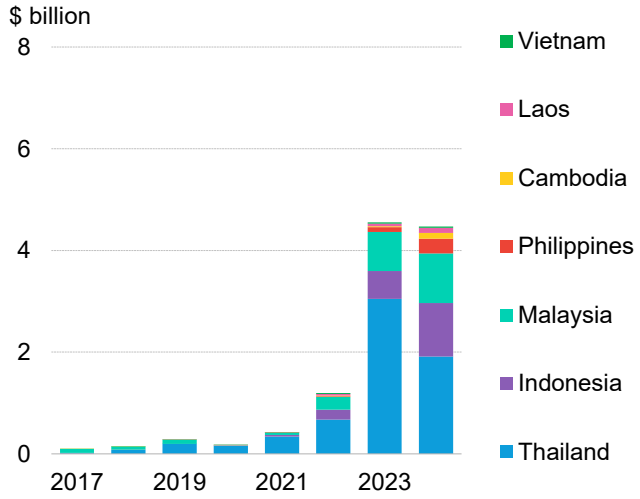
Latin America electric vehicle imports



Middle East and North Africa electric vehicle imports



Southeast Asia electric vehicle imports

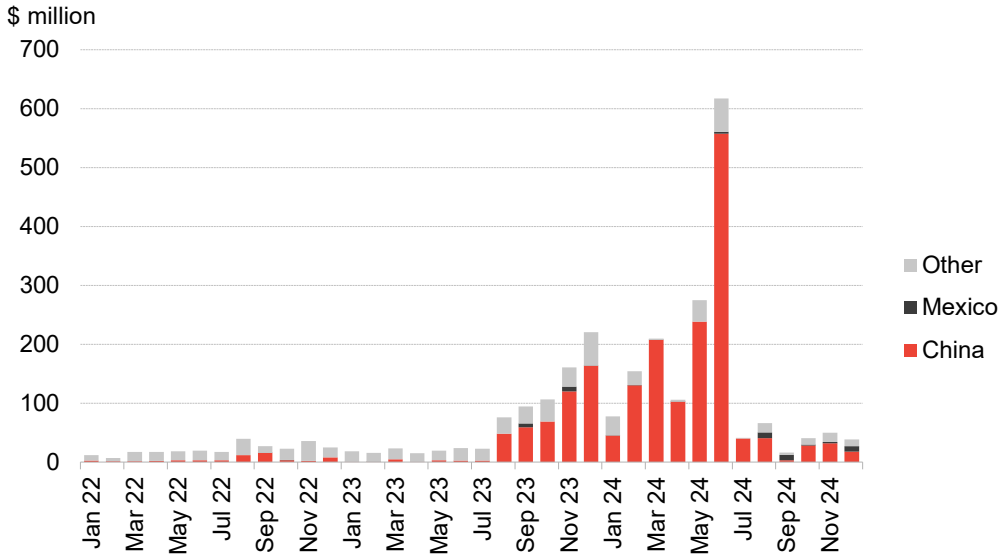


Source: Sinoimex, Trade Map, BloombergNEF. Note: Other refers to markets other than a region's top 10 importers by value.

- Electric vehicle imports have been among the fastest-growing areas of clean-tech trade over the past three years. Emerging markets – particularly Latam, MENA and SEA – are driving this expansion, though most activity is concentrated in just a few countries.
- In 2024, Brazil accounted for just over half of Latam's EV imports, followed by Mexico at around 22%. Brazil's imports have nearly doubled each year since 2018, supported by minimal import tariffs and falling prices.
- In MENA, imports are heavily concentrated in the UAE, Israel and Jordan, which together represent 91% of regional EV imports since 2019. In contrast, subsidized fuel prices have slowed EV adoption in other countries across the region.
- The UAE has rapidly increased EV imports in recent years, accounting for 43% of the region's total in 2024.
- Growth has been driven by low electricity prices and high purchasing power, which have supported rising EV sales. Major automakers such as Tesla and BYD have opened multiple showrooms, while the UAE previously served mainly as a re-export hub for regional markets, particularly during 2022–2023.
- In Southeast Asia, trends mirror those in Latin America. Chinese manufacturers are expanding assembly operations in Thailand, leveraging its established auto industry, and lower labor and power costs. This strategy is expected to further boost exports of semi-finished vehicles for final assembly. Chinese automakers' share of EV sales in the country rose to 81% in 2024, up from 77% in 2023.
- EV imports were fairly low across most other emerging market regions, though Central Asia and Turkey are both receiving significant imports.

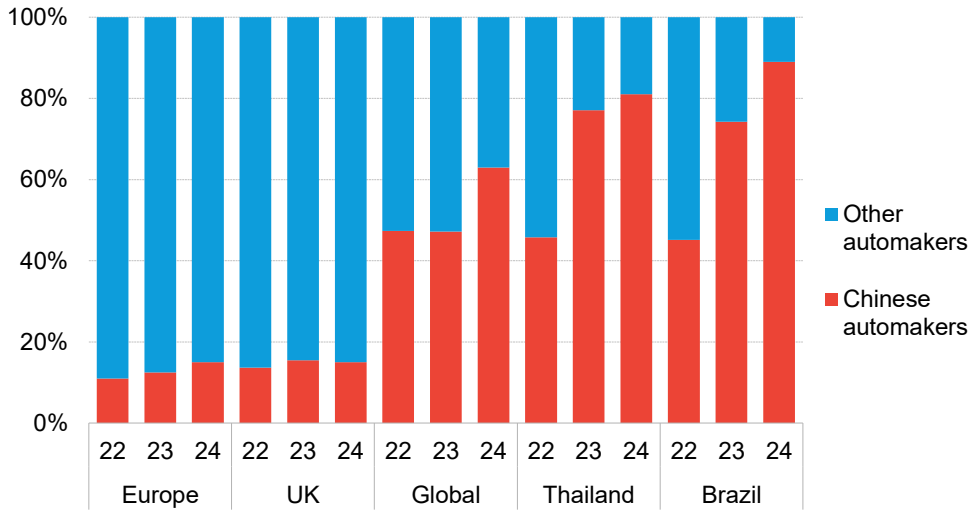
Chinese automakers supply nine out of 10 EVs sold in Brazil

Brazil battery electric vehicle imports



Source: Sinoimex, Trade Map, BloombergNEF.

Automakers share of total passenger EV sales



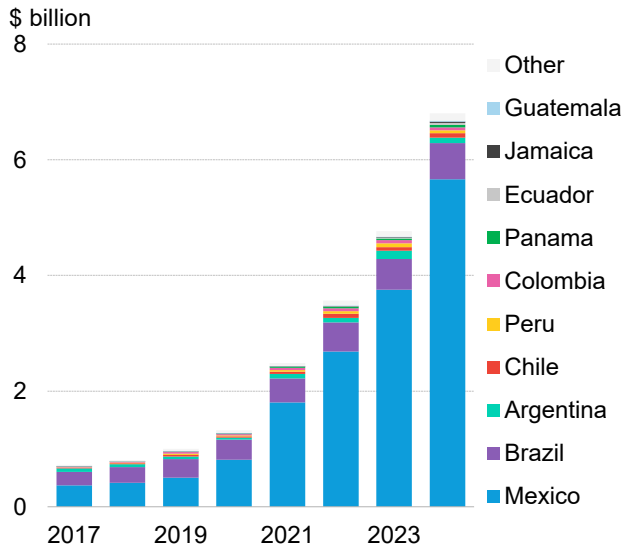
Source: BloombergNEF, MarkLines, Jato Dynamics.

- Brazil's EV imports surged from late 2023 through early 2024, totaling $2.2 billion over that period. Imports then slumped after the government raised tariffs. The country tripled imports in 2023 and doubled them again in 2024.
- Nine out of 10 EVs sold in Brazil in 2024 were made in China. After the government began phasing in import tariffs early in the year — and announced higher rates midyear — importers rushed to bring in vehicles before the increases took effect. That contributed to a surge in imports in the first half of 2024.
- While many EVs continue to arrive from China, BYD and other Chinese automakers have committed to building domestic EV factories. If production scales, these could displace imports.

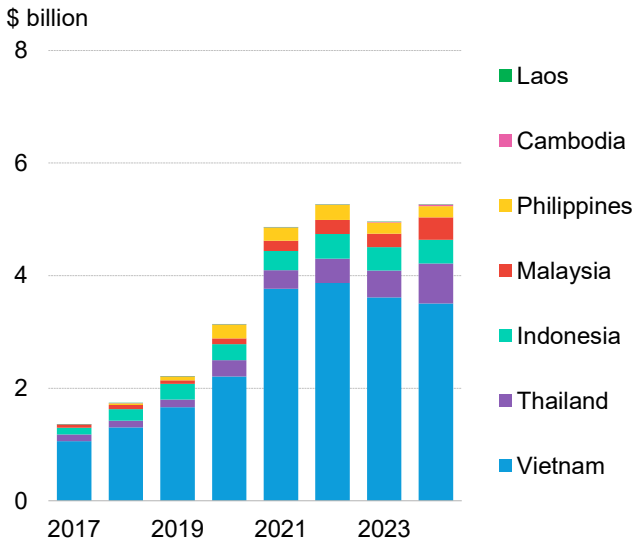
- BYD opened its first EV plant in Brazil in 2025, with an estimated annual capacity of 150,000 cars. Great Wall Motor also launched EV assembly operations in August 2025 with capacity make around 50,000 cars per year.
- Passenger EV sales in Brazil are expected to grow 70% in 2025, albeit from a relatively low base. EVs are projected to make up nearly 9% of total car sales in 2025, adding about 213,000 units to the country's roads.

Lithium-ion battery imports are concentrated in a select few markets

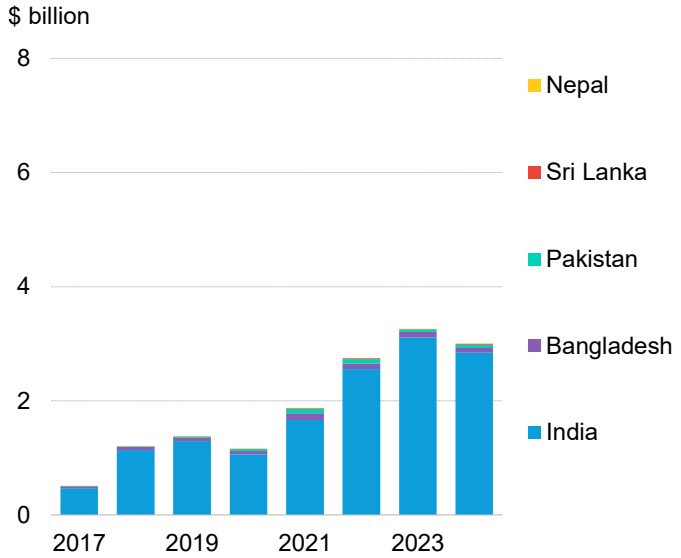
Latin America lithium-ion battery imports



Southeast Asia lithium-ion battery imports



South Asia lithium-ion battery imports

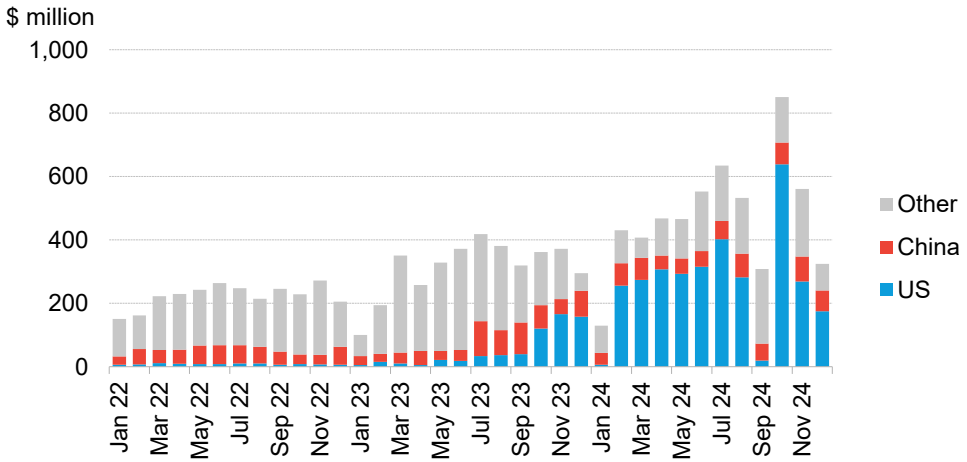


Source: Sinoimex, Trade Map, BloombergNEF. Note: Other refers to markets other than a region's top 10 importers by value.

- Lithium-ion battery imports in emerging markets are highly concentrated, with Mexico, Vietnam and India dominating their respective regions. This surge reflects limited local production capacity, which has made foreign supply essential to meet growing demand.
- Mexico alone accounted for 45% of total imports among these markets in 2024. In Latin America, growth has closely tracked the expansion of EV adoption, supported by Mexico's proximity to the US and its strong manufacturing base.
- Southeast Asia is emerging as a key clean-tech hub. Though the region includes only seven countries, it has seen strong import growth from China and is rapidly developing into an alternative battery manufacturing base, primarily to support the EV segment.
- Unlike other major importing regions, imports are more evenly distributed here: Vietnam accounts for 67% of the total, but other countries are gradually expanding their share.
- When it comes to other emerging market regions, imports are largely concentrated across Saudi Arabia, Uzbekistan and South Africa.

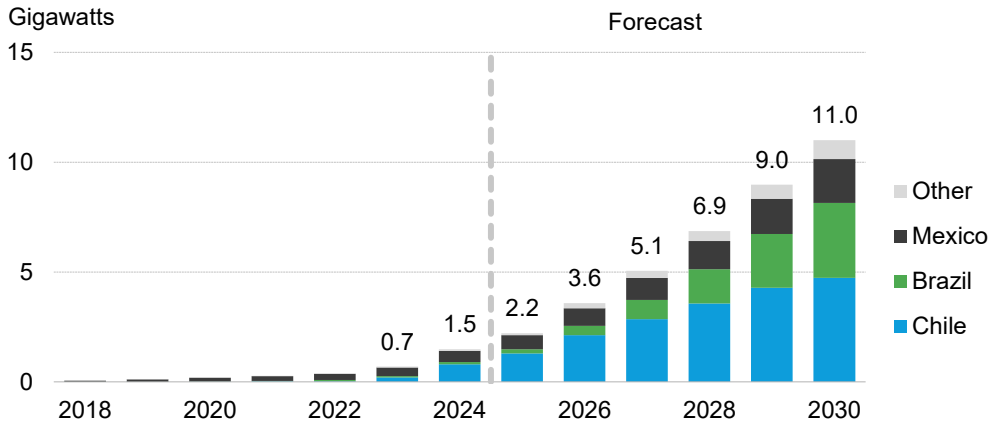
Mexico takes batteries in, sends EVs back out

Mexico lithium-ion battery imports



Source: Sinoimex, Trade Map, BloombergNEF.

Cumulative energy storage forecast for Latin America, by country

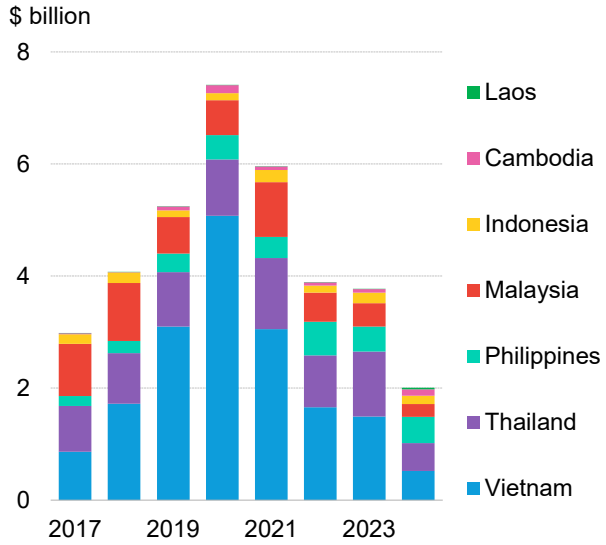


Source: BloombergNEF. Note: Other include Argentina, Belize, Bolivia, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Peru and Uruguay.

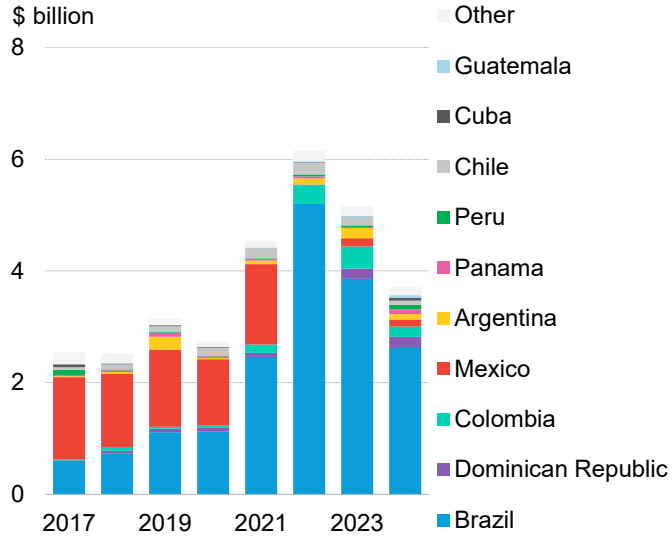
- Mexico's lithium-ion battery imports have jumped in recent years, rising 51% from 2023 to 2024. The surge reflects growth both in the domestic EV market and in exports of cars assembled by the country's strong automotive sector.
- Mexico still lacks domestic battery manufacturing, despite government efforts to attract investment which largely lost momentum after 2024. This may be linked to policy changes on the US side of the border.
- In 2024, about 57% of Mexico's lithium-ion battery imports came from the US, supplying firms such as Ford and General Motors for local production of EVs such as the Ford Mustang Mach-E and Chevrolet Equinox EV. Mexico's established auto industry remains closely integrated with the US.
- China supplied nearly 30% of Mexico's lithium-ion battery imports over the same period. While this is roughly half the share coming from the US, China remains an important trade partner for Mexico and negotiations between the two countries are being reevaluated ahead of US-Mexico-Canada Agreement renegotiations scheduled for 2026.
- Mexico ended tax breaks for EV imports from China in late 2024 and under US pressure announced it will increase tariffs on all cars from China to 50% in September 2025.

Solar imports into South Asia are booming

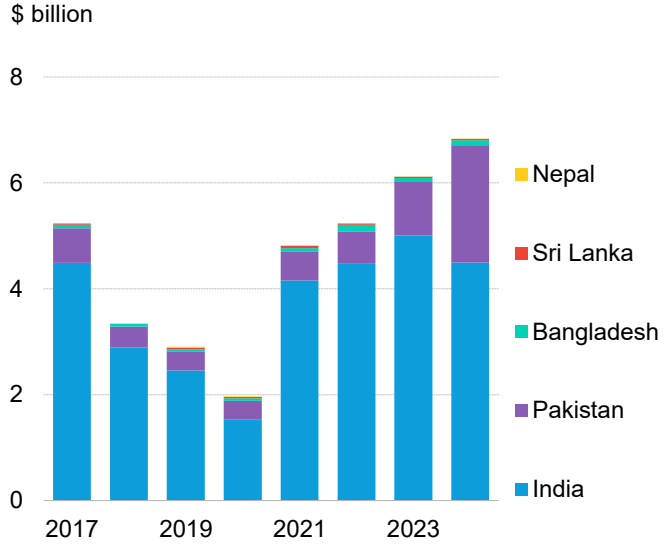
Southeast Asia solar cell and module imports



Latin America solar cell and module imports



South Asia solar cell and module imports

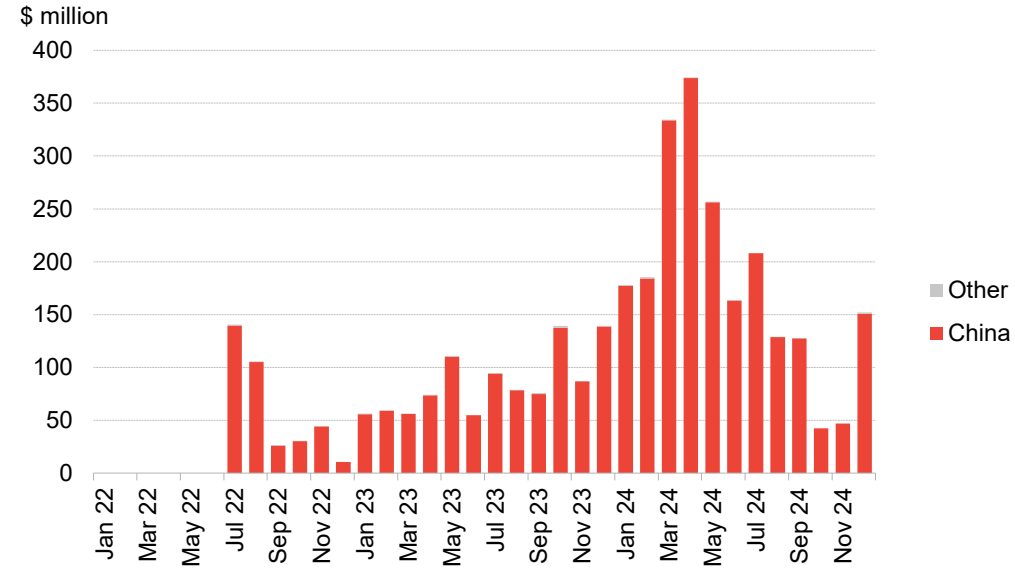


Source: Sinoimex, Trade Map, BloombergNEF. Note: Other refers to markets other than a region's top 10 importers by value.

- In Southeast Asia, solar imports have declined as feed-in tariff policies expired across the region. Meanwhile, manufacturers have set up in the region to cut exposure to trade barriers and take advantage of lower labor and logistics costs. As a result, countries such as Malaysia, Vietnam and Thailand have emerged as important manufacturing bases supplying both regional and Western demand. But most of these firms' production is destined for exports, with local solar projects relying on Chinese imports due to affordability.
- In South Asia, by contrast, imports have continued to rise. Led by India, the region has experienced a solar boom since 2021, driven by limited domestic cell manufacturing capacity and lower prices for imported products. Chinese exports made up 77% of the region's total solar product imports in 2024.
- Pakistan has seen remarkable growth in clean energy in recent years, driven by a surge in rooftop solar installations. Solar module imports more than doubled in 2024, with virtually all equipment sourced from China.
- Latin America, by contrast, tells a different story – one shaped largely by developments in Brazil. The country's solar market is struggling with electricity oversupply and a sharp rise in curtailment of production from existing projects, leading to delays in new investment amid uncertainty over project returns. As a result, solar imports fell 30% from 2023 to 2024.

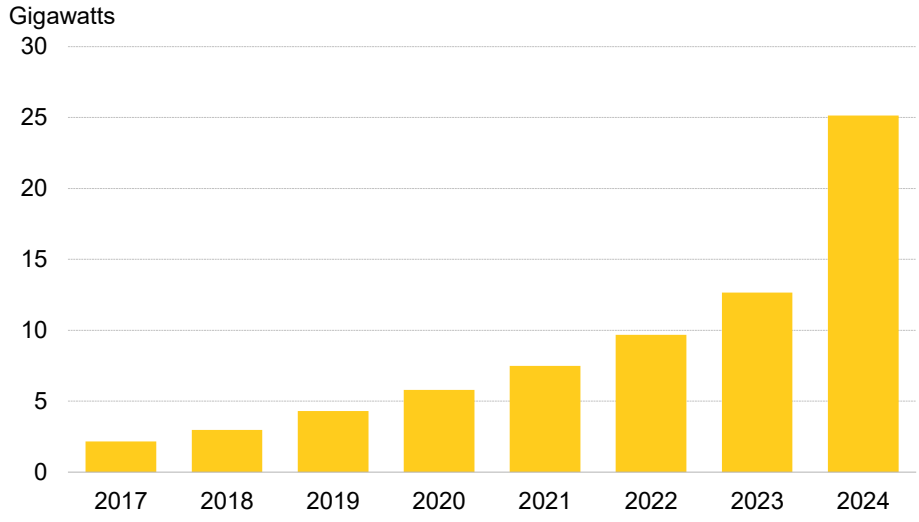
Pakistan solar imports boom off the back of low prices

Pakistan solar cell and module imports



Source: Sinoimex, Trade Map, BloombergNEF.

Pakistan cumulative installed solar capacity

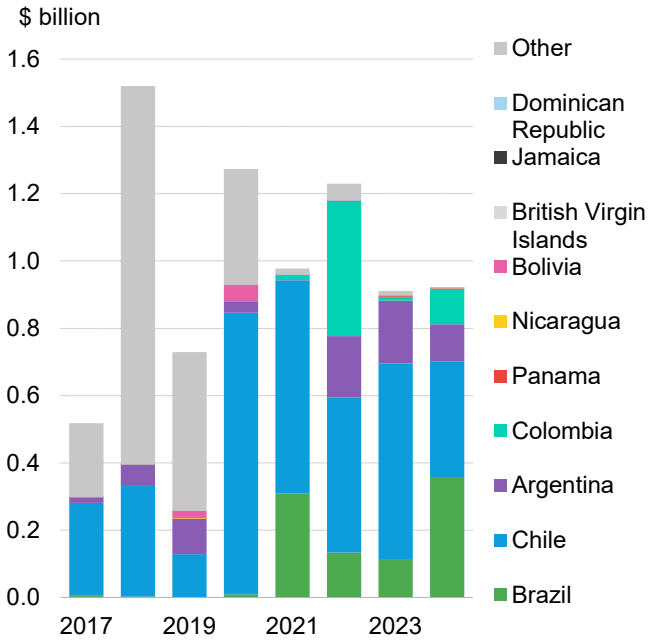


Source: BloombergNEF

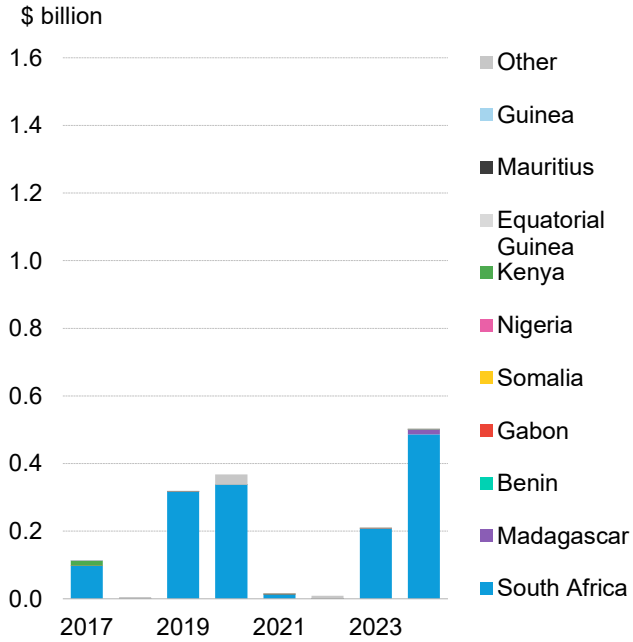
- Pakistan drew attention with a sudden surge in solar module imports from China, totaling around 13GW in the first half of 2024. Imports peaked in March 2024, when $374 million of modules entered the country in a single month. The jump was driven by falling solar module prices, along with frequent power outages, rising retail tariffs and the expansion of net metering, all of which accelerated solar adoption.
- To assess whether the sudden increase in reported imports was linked to real projects, BNEF combined satellite imagery analysis to detect PV installations. The findings revealed widespread deployment on industrial rooftops in cities such as Lahore, Islamabad and Karachi – supporting the view that much of this capacity is for self-consumption and goes unreported.
- The rapid spread of rooftop solar has helped households and businesses manage blackouts and high electricity costs, but it is also adding pressure to Pakistan's power system.
- Pakistan's solar boom has reduced grid demand, but the resulting variability is increasing the risk of instability and outages. Utilities are struggling with unpredictable consumption patterns, which complicate power tariffs and supply planning.
- The government also relies on electricity revenues to service energy-sector debt – much of it owed to Chinese lenders – creating additional fiscal pressure. In response, lawmakers introduced a tax on solar panel imports, initially set at 18% before being reduced after public backlash. Pakistan's PV boom now sits at a delicate crossroads.

Latin America wind imports loom large as other regions reach new heights

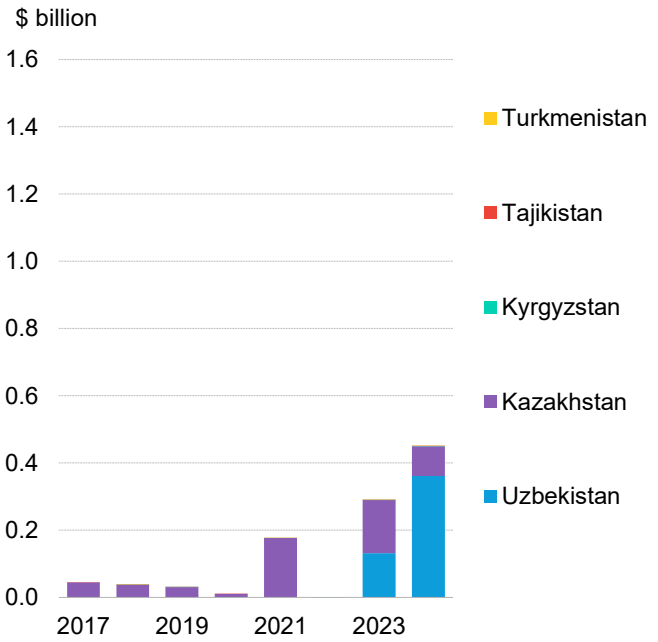
Latin America wind imports



Sub-Saharan Africa wind imports



Central Asia wind imports

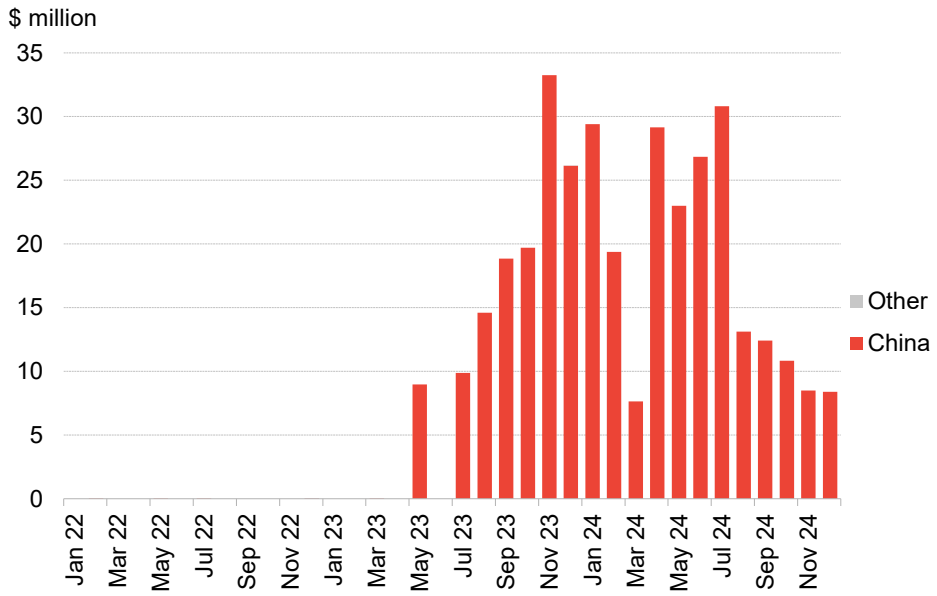


Source: Sinoimex, Trade Map, BloombergNEF. Note: Other refers to markets other than a region's top 10 importers by value.

- Wind turbine trade is more challenging than that of other clean-tech components, as turbine parts are large, difficult to transport and require specialized logistics. In addition, the high upfront costs of wind projects make it harder for many emerging markets to keep pace.
- Even so, Latin America has maintained the most stable import levels over the past seven years, led by Brazil and Chile thanks to their strong wind resources, long coastlines with accessible ports and steady project pipelines.
- In regions such as sub-Saharan Africa (SSA) and Central Asia, imports are increasing from a relatively low base, though growth remains intermittent. The data indicate that imports typically surge when large projects are launched, then drop off once those projects are completed, only to rise again as new initiatives gain momentum through policy support, external financing or government backing.

China’s wind manufacturers gain ground in Central Asia

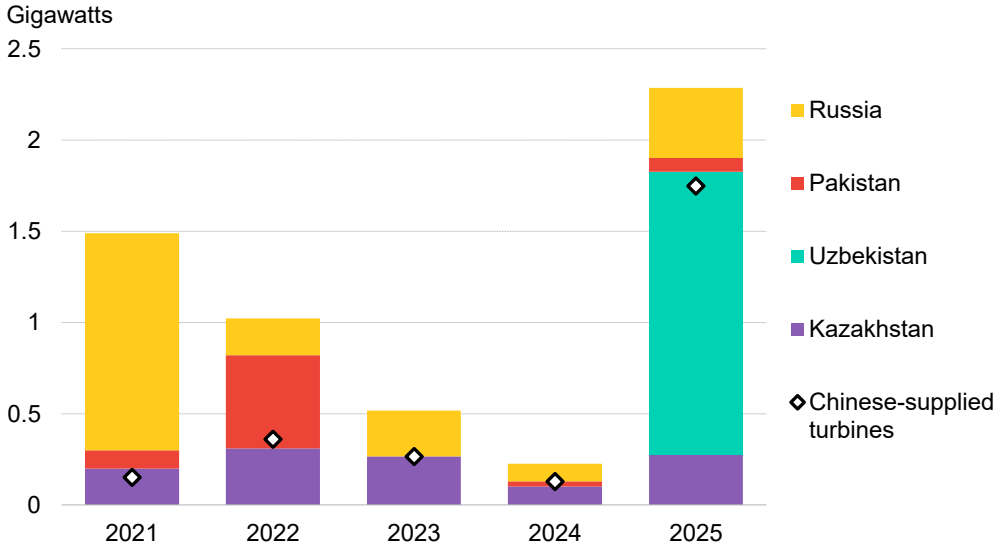
Uzbekistan wind turbine imports



Source: Sinoimex, Trade Map, BloombergNEF.

- Uzbekistan increased its wind turbine imports by 175% last year, accounting for nearly 80% of the region’s total. Chinese turbine manufacturers are the main exporters, expanding rapidly across Central Asia and increasingly challenging Western suppliers’ market share.
- The boom coincides with the commissioning of Uzbekistan’s first wind farms – two 514MW projects co-developed by Saudi Arabia’s ACWA Power and China Southern Power Grid. The ventures partnered with China Energy Engineering Group as the EPC contractor, while Envision Energy supplied all 158 turbines.

Wind installations across selected geographies and share of turbines supplied by Chinese manufacturers



Source: BloombergNEF. Note: Chinese-supplied turbines refers to the capacity provided by Chinese wind turbine manufacturers.

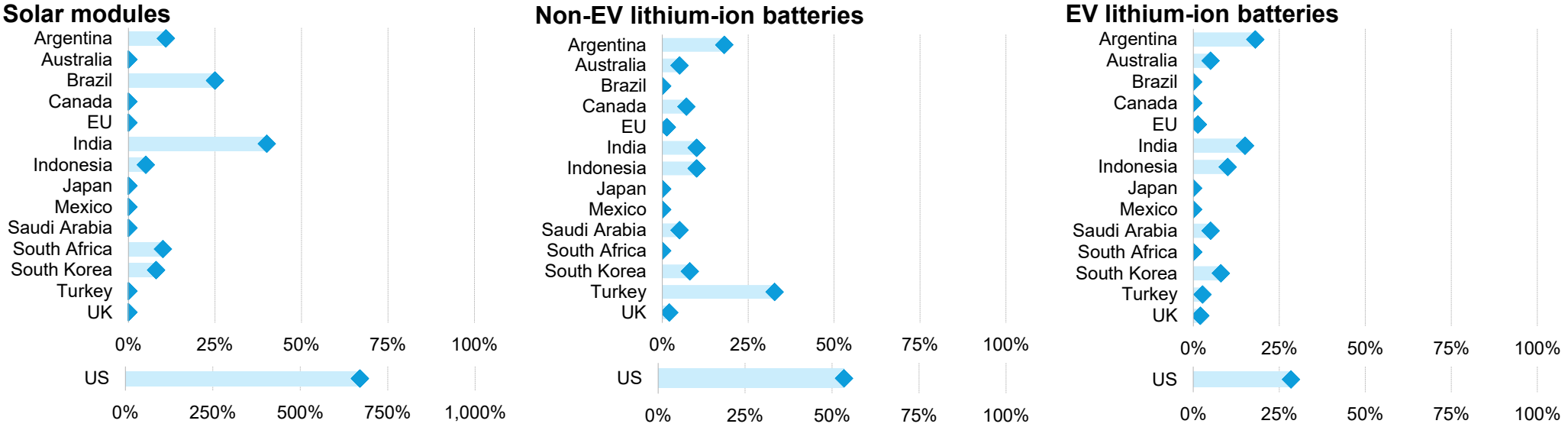
- Kazakhstan is emerging as a gigawatt-scale wind market, driven by international tenders and investment from Chinese and Middle Eastern developers. Companies such as State Power Investment Corp., China Southern Power Grid, and ACWA Power are expanding their presence.
- BNEF expects Uzbekistan and Kazakhstan to add 1.8GW of new wind capacity this year, all supplied by Chinese turbine makers such as Goldwind and Envision. This will lift China’s share of turbine installations across the Shanghai Cooperation Organization (SCO) – a regional bloc that includes Central Asian nations, China and Russia – from 10% in 2021 to 76.5% by 2025.

Trade barriers and clean technology

Emerging markets ponder new levies

Emerging markets trade has so far been unencumbered by major tariffs

Import tariffs on selected clean technologies in select markets as of September 2025



Source: BloombergNEF. Note: Non-US import tariffs updated as of September 17, 2025. Import tariffs apply to all markets unless exempted by a free or preferential trade agreement, or subject to additional tariffs. They reflect the most-favored-nation rate under WTO rules. US import tariffs updated September 19, reflects maximum tariff applied on non-China markets. BEV refers to battery-electric vehicle

- Low import barriers on clean energy, storage and transport products have supported expansion of clean-tech trade. Across the 14 markets analyzed – the G-20 excluding the US, China, Russia and the African Union – the simple average import tariff on six key products is just 9.4%.

Solar modules

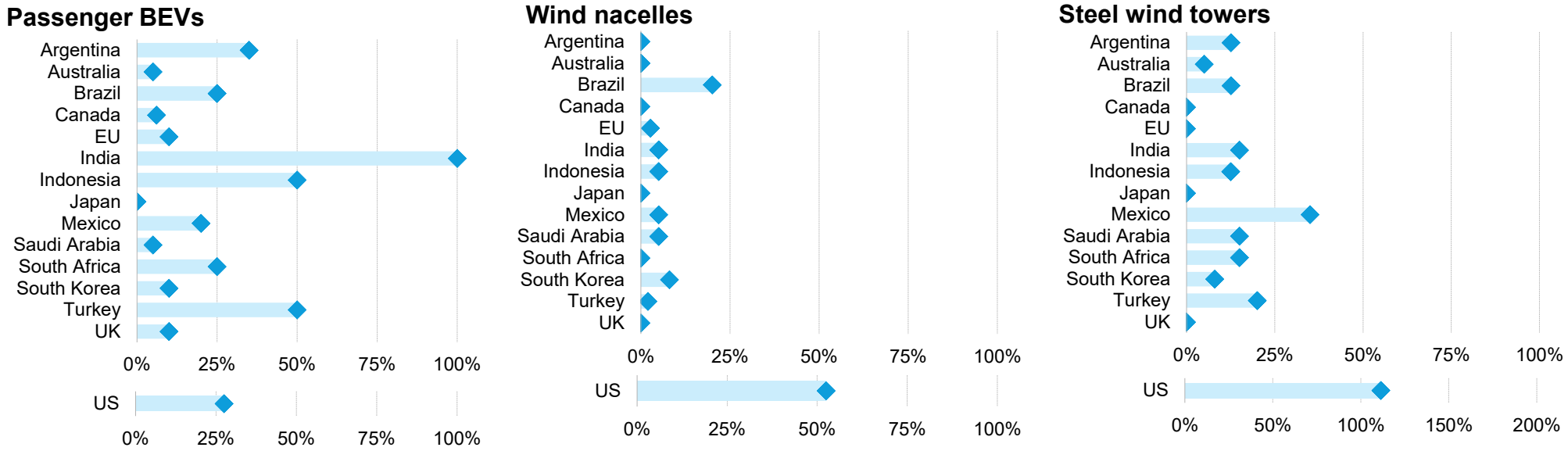
- Among clean-tech products, solar modules are the most likely to benefit from tariff exemptions, with most markets allowing duty-free imports. Even where tariffs apply, their effect is limited. In Indonesia, Chinese modules qualify for exemptions and made up 93% of imports in 2024.
- In South Africa, importers can claim refunds on the 10% solar module duty when local manufacturing within the five members of the Southern African Customs Union falls short of demand across the bloc. South Africa has just 0.7GW of solar module manufacturing capacity, compared with 2.2GW of new solar generation capacity added last year.

Lithium-ion batteries

- Import tariffs on batteries typically range from 0–10%, with three exceptions: Argentina, India and Turkey. Turkey's 33% tariff on non-EV batteries is the highest, though its impact is limited since most energy-storage projects in the country are exempt from duties on imported components.

EVs are subject to the highest tariffs across clean tech

Import tariffs on selected clean technologies in select markets as of September 2025



Source: BloombergNEF. Note: Non-US import tariffs updated as of September 17, 2025. Import tariffs apply to all markets unless exempted by a free or preferential trade agreement, or subject to additional tariffs. They reflect the most-favored-nation rate under WTO rules. US import tariffs updated September 19, reflects maximum tariff applied on non-China markets. BEV refers to battery-electric vehicle.

Passenger BEVs

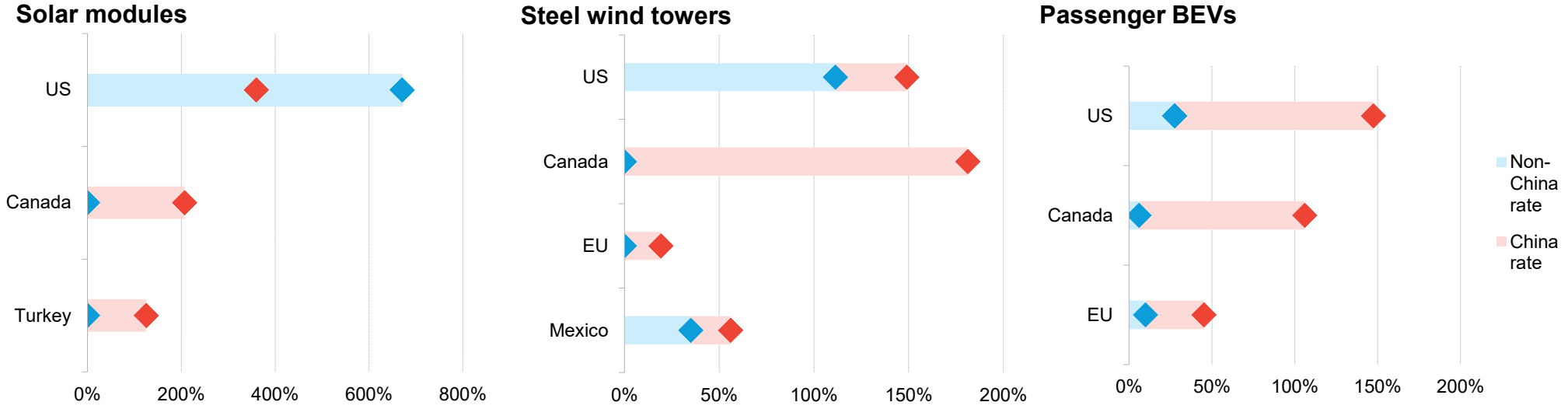
- Passenger BEVs are generally subject to higher tariffs than other clean-tech products. Nearly half of all trade policy changes that raised barriers in 2024 and 2025 affected passenger BEVs, largely because they are grouped with conventional automotive imports, which face steeper duties than clean energy or storage technologies. While reasons vary by country, domestic auto manufacturing tends to carry greater political weight than other sectors.
- Several markets have lowered BEV tariffs conditionally to attract foreign investment in local manufacturing. In 2024, India and Turkey reduced duties on finished BEVs under specific terms, while Indonesia offered lower rates on vehicles imported in parts for local assembly

Wind nacelles and steel wind towers

- Tariffs on steel wind towers are generally higher than those on wind generating sets, as they are often influenced by policies protecting domestic steel production.
- Brazil is an exception, applying higher rates on generating sets than on towers. At the start of 2024, Brazil removed tariff exemptions on all but the largest generating sets, raising rates to 11.2%. In May 2025, the rate increased again to 20%, with another hike to 25% scheduled for January 2026. Brazil's wind supply chain is strong enough to meet annual capacity addition demand for the next five years from local production.

Chinese clean-energy products are occasionally targeted by higher tariffs

Current import tariffs on Chinese clean tech in selected markets with additional China-specific rates

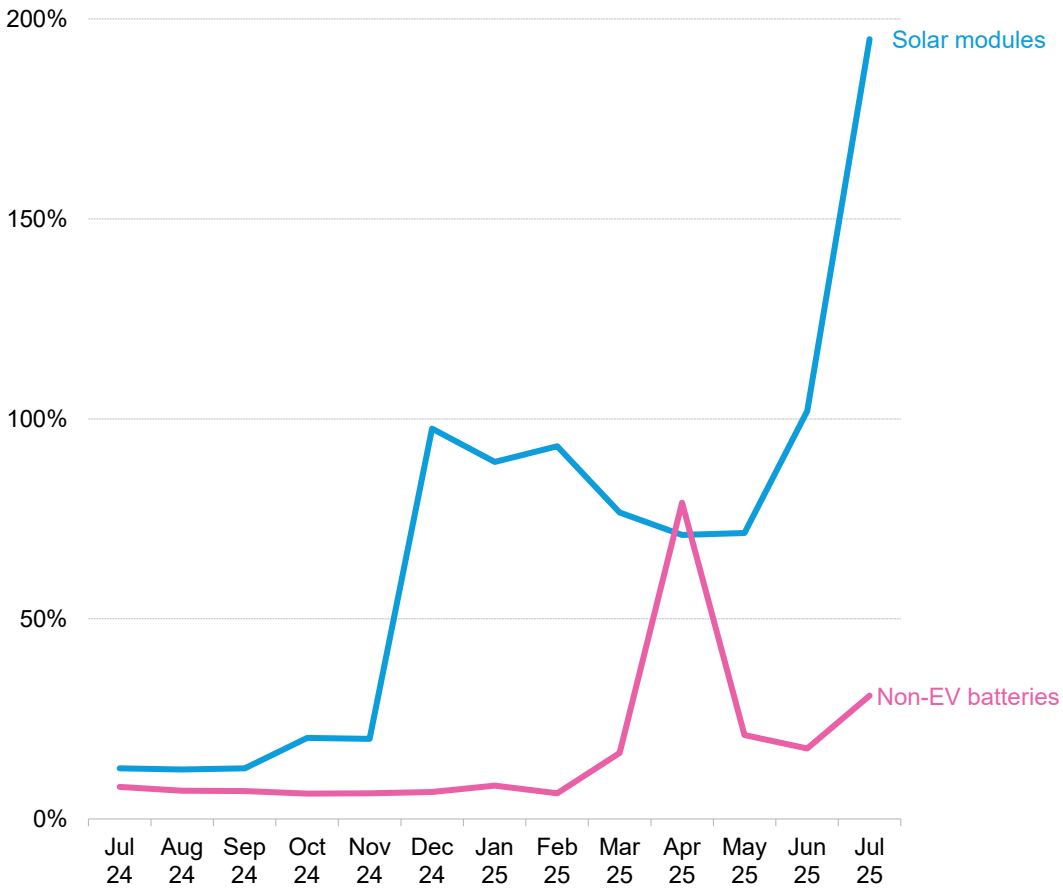


Source: BloombergNEF. Note: Non-China rate for all non-US markets reflect the rate that applies to all markets unless exempted by a free or preferential trade agreement, or subject to additional tariffs. They reflect the most-favored-nation rate under WTO rules. For the US, reflects the maximum tariff applied on non-China markets. Tariffs correct as of September 19, 2025. BEV refers to battery-electric vehicle

- The US, Canada, and the EU typically apply higher tariffs on imports from China, citing the need to protect domestic industries from what they describe as excessive subsidization and unfair trade practices by Chinese firms.
- Even prior to President Trump's tariff measures, the US approach to trade policy frequently produced prohibitively high tariff rates. That's largely due to how they are calculated. Tariffs are designed to fully offset the alleged trade distortion, and the investigative process tends to favor domestic petitioners.
- The EU, by contrast, has taken a more measured stance, imposing lower, targeted tariffs that address distortions while preserving competitive pressure on local manufacturers
- Across emerging market nations in the G-20, higher tariffs on Chinese products are rare with the exception of Mexico and Turkey. However, this could change as the US ratchets pressure on trade partners to adopt stricter measures against China.
- Where restrictions on Chinese products exist, they tend to take the form of local content requirements. These policies mandate domestic sourcing or tie access to subsidies to locally-produced inputs. India is a notable example: most solar projects must use locally-manufactured modules to qualify for government support. Similarly, wind projects are required to source turbine components domestically, even when they do not rely on subsidies.

Tariffs take center stage in US trade policy

Trade-weighted average US import tariff on solar modules and non-EV batteries



Source: Sinoimex, US ITC, BloombergNEF. Note: The trade-weighted average tariff is calculated by multiplying monthly US solar module and non-EV battery imports by their respective import tariffs for each trading partner, summing the results, and dividing by total monthly imports.

- US import tariffs have dominated headlines through much of 2025. President Donald Trump's second administration has been marked by frequent tariff changes, affecting clean-tech products alongside many other goods.
- Solar products and non-EV batteries have faced sharp swings. Over the past nine months, rates have risen under several measures: the 10% blanket "reciprocal tariff" introduced April 5, the higher market-specific reciprocal tariffs implemented August 6 after repeated delays, and a series of country-specific actions targeting China, Canada, Mexico, Brazil and India since the start of the year.
- These new measures add to a long list of tariffs inherited from earlier administrations, dating back to 2012, when the first duties were imposed on Chinese solar products.
- Importing clean-energy equipment to the US has become significantly more expensive. The trade-weighted average tariff shown on the left reflects the average import duty applied by the US, weighted by each trading partner's share of total monthly imports. This provides a more accurate measure of trade costs than a simple average of tariff rates.
- The trade-weighted average tariff on imported solar modules reached 195% in July 2025, up from 13% a year earlier, while battery tariffs rose to 31% from 8%.
- Even higher rates are expected. August will reflect the full impact of market-specific reciprocal tariffs, and further increases could come in November if additional measures on China are approved. The decision, scheduled for November 10, would have the greatest impact on battery imports, as China supplied 40% of the US non-EV battery market in the first half of 2025.

Introduction of clean-tech trade barriers slows outside the US

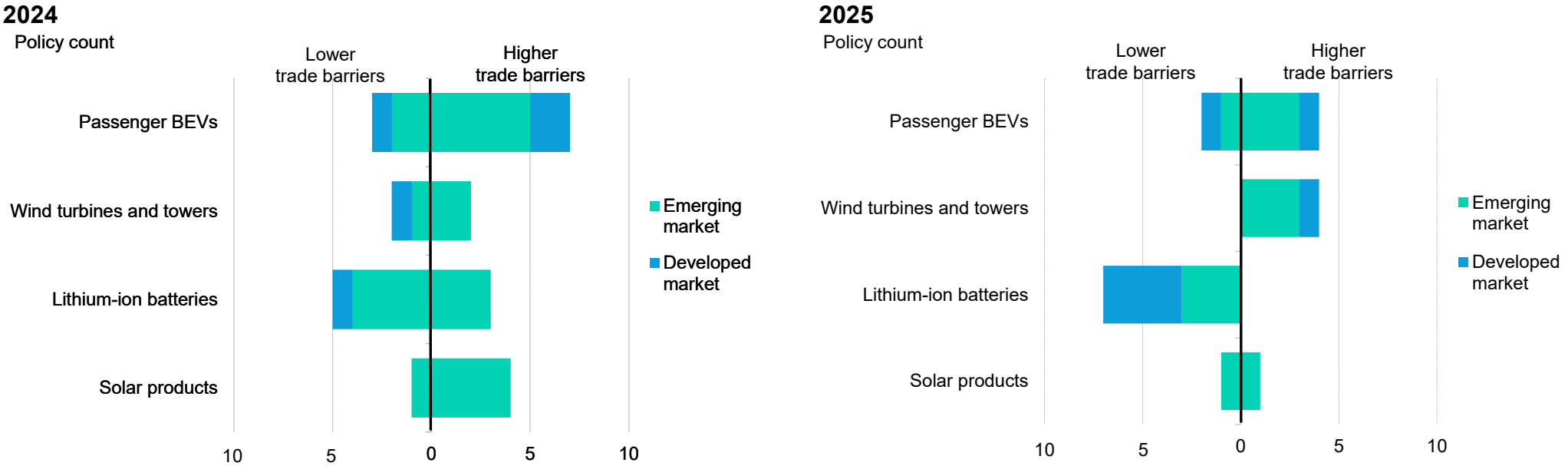
Clean-tech trade policy changes by selected G-20 markets, excluding the US, in 2024 and 2025

- Outside the US, G-20 markets have implemented fewer restrictive trade measures in 2025 than in 2024 – a surprising development. The volatility of President Trump's import tariff policies, which have dominated headlines this year, has created the impression that global protectionism is intensifying. That is not the case yet for clean-tech goods.
- In 2024, G-20 markets (excluding the US, China, Russia, and the African Union) introduced 16 measures raising trade barriers on solar, battery, passenger BEV, and wind products. Passenger BEVs emerged as a key new target.
- Many of these policies specifically focused on Chinese clean-energy products, reflecting tensions between China's export push and other governments' efforts to reduce reliance on foreign-made components.
- So far in 2025, developed economies have been more inclined to lower trade barriers, while emerging markets have introduced fewer restrictive measures.
- The US remains an exception. Its frequent and often reversible tariff changes under the current administration make direct comparison with other G-20 markets difficult. For this reason, the US is excluded from the chart.

Source: BloombergNEF. Note: 2025 data through September 17. The US, China, Russia, and the African Union are excluded. Developed markets include Australia, Canada, and the EU; emerging markets include Argentina, Brazil, India, Mexico, South Africa, and Turkey. Goods covered are solar cells and modules, lithium-ion batteries, wind nacelles, steel wind towers, and passenger BEVs. Trade policy changes assessed include adjustments to tariffs, quotas, surveillance requirements, and rebates. Higher barriers reflect tariff or surveillance increases, or reduced quotas or rebates; lower barriers are the reverse. Local content rules are excluded.

Emerging markets account for most new clean-tech trade barriers

Clean-tech trade policy changes by selected G-20 members, excluding the US



Source: BloombergNEF. Note: 2025 data through September 17. The US is excluded due to the frequency of policy changes. Developed markets include Australia, Canada, and the EU; emerging markets include Argentina, Brazil, India, Mexico, South Africa, and Turkey. Indonesia, Japan, South Korea, Saudi Arabia, and the UK made no policy changes. China, Russia, and the African Union are excluded. BEVs refer to battery-electric vehicles. Assessed trade policies include implemented changes to import tariff rates, reduced-tariff quotas, import surveillance requirements, and tariff rebates. Higher trade barriers are defined as increased tariffs or surveillance requirements, or reduced quotas or rebates; lower trade barriers are the reverse. Non-tariff local content measures, such as India's solar and wind mandates, are excluded.

- Brazil and Turkey accounted for the majority of restrictive trade measures introduced by emerging markets. Together, they were responsible for 11 of 14 policies enacted last year and all six implemented so far in 2025.
- In Brazil, new measures targeted solar, BEVs and – most frequently – wind imports. Multiple tariff increases on wind products this year mean the sector has faced as many restrictive policy changes as passenger BEVs.
- Over the past two years, Turkey has raised trade barriers across clean-tech sectors, with particular focus on solar and passenger BEVs. It is also the only market to introduce new tariffs on batteries. Those measures – paired with generous subsidies – coincide with nearly 37GWh of announced local battery cell capacity.
- In India, EV battery tariffs were adjusted in 2024, slightly reversing earlier reductions. The increase was modest, and rates remain lower than before the tariff cuts were introduced.

Emerging markets consider new measures to stem Chinese imports

Policy outcome unknown

Policy outcome known

Date unknown
Potential clean-tech import tariff hikes

- South Africa's trade commission has proposed higher tariffs on multiple products across solar, wind and battery value chains.
- Plan was part of a four-week public consultation during which South Africa's solar and wind industry associations raised concerns.
- The plan is under review while the responses from the consultation are being evaluated.

Date unknown
Potential ban on some BEV imports

- In December 2023, the Uzbek government proposed banning vehicle imports by individuals intending to resell them.
- The plan would prevent private individuals from transferring ownership of a vehicle after it clears customs.
- In March 2024, Chinese automaker BYD requested that the government curb imports by private individuals intending to resell their passenger vehicles.
- It remains unclear whether the policy is in force or still under review amid widespread backlash from firms and consumers.

July 1, 2026
Higher passenger BEV import tariffs

- Brazil's import tariff rate will rise to 35% in January 2026 from the current 25% rate.
- The tariff hike is due to the scheduled expiry of a tariff-reduction policy.

Date unknown
Potential additional anti-dumping duties on Chinese solar cells and modules

- An investigation into allegedly trade-distortive practices by Chinese solar firms was announced by India in September 2024.
- Additional tariffs could be levied due to this investigation, though dates are unknown.

Date unknown
Potential higher import tariffs across 1,400 products

- Pending approval by Congress, tariffs will be imposed on products imported from trading partners with which Mexico has not signed free-trade agreements.
- Details on specific product tariffs are pending. But divulged details indicate that passenger EV duties would be increased to 50%, from 15%.

July 1, 2026
Higher passenger BEV import tariffs

- Since 2023, passenger BEVs imported by six selected companies have been exempt from Indonesia's 50% tariff. Exemption was conditional on company commitments to set up local factories.
- As set out in 2023, from 2026 government inspections will assess BEVs for import exemptions according to the proportion of local content in each vehicle.

January 1, 2026
Higher wind nacelle import tariffs

- Brazil's import tariff rate will rise to 25% in January 2026, from 20%. The tariff hike was announced May 28, 2025, in Resolution 736.

January 1, 2026
VAT on passenger BEV imports

- In 2026, Kazakhstan will start charging a 16% value-added tax on BEV imports, ending its current tax exemption.
- It's unclear whether import tariffs will also rise to 15% in January from 0% currently. In 2023, the Eurasian Economic Commission – of which Kazakhstan is a member – extended a previous import tariff exemption through 2025.
- There is no sign it will be extended once more.

Source: BloombergNEF. Note: List is not exhaustive. Does not include other surcharges, levies or fees that apply to imported goods.

Import tariffs and the cost of clean energy

Measuring the potential impact on solar and battery deployment

How could higher clean-tech import tariffs impact the cost of reaching COP28 and COP29 goals?

- This section examines how rising import tariffs in selected emerging markets could affect the cost of meeting global clean energy targets.
- At COP28 in 2023, countries committed to triple installed renewable energy generation capacity to 11.2TW by 2030, from a 2022 baseline. That pledge formed part of a broader agreement – known as the UAE Consensus – to bring global efforts more in line with the goals of the Paris Agreement.
- The tripling renewables pledge was based on a report by the International Energy Agency (IEA) in 2021, where solar energy generation was modeled to account for the bulk of installed renewable energy generation capacity by 2030.
- At COP29 in 2024, countries pledged to increase global energy storage capacity sixfold to 1.5 terawatts by 2030. This commitment is a step toward achieving the previous COP's goals. Based on another IEA report, achieving COP28's tripling renewables goal requires a sixfold increase in energy storage from 2023 levels by 2030.
- Growing clean-tech protectionism will likely raise the cost of achieving the COP28 and COP29 goals. The International Renewable Energy Agency – which monitors COP climate targets – warns that US tariffs introduced in 2025 risk undermining momentum in the global energy transition.
- Below are the capacity additions required for these commitments, under BNEF's Net Zero Scenario (NZS). The NZS is BNEF's long-term energy and climate scenario that models the renewable energy generation and energy storage capacity needed to transition to a net-zero carbon economy by 2050. Global capacity additions are divided into eight geographies for this analysis, based on NZS assumptions for deployment rates in each. These capacity additions are used as the basis for calculating the impact of tariff scenarios on investment.
- To assess the potential impact of tariffs, BNEF modeled three tariff scenarios using the methodology summarized in the next slide. The tariff scenario applies to the cost of solar panels and batteries used in energy projects. Other project costs are unaffected. For more, see the Appendix.

Capacity additions required by 2030 to meet COP28 and COP29 goals, by selected technologies and geographies

Gigawatts

Geography	Wind	Solar	Battery
Global capacity additions	1,923	6,234	1,294
Global capacity additions (excluding China)	1,103	3,167	444
Global capacity additions across eight selected geographies	477	1,405	366

Source: BloombergNEF. Note: Wind and solar capacity additions from a 2022 baseline. Battery capacity additions from a 2023 baseline. Wind includes onshore and offshore wind projects. Solar includes utility- and small- scale projects. The selected geographies are Brazil, the EU, India, Indonesia, Mexico, South Africa, sub-Saharan Africa and Turkey.

Scenario analysis scope

Which technologies are exposed the most to import tariff changes?

Wind power generation

Impact of high import tariffs: **Low**

- Wind manufacturing tends to be localized near demand. That has much to do with the high cost of transporting bulky components.
- Local production of wind nacelles, which house the generating components of a wind turbine, exceeds domestic demand in many emerging markets – including India and Brazil.

Solar power generation

Impact of high import tariffs: **Medium**

- Local manufacturing of solar manufacturing has to compete with the availability of low-cost imports. Many countries deploying solar rely heavily on imports, meaning that solar projects are generally exposed to import tariffs.
- But solar modules make up just a small share of total generation project costs – just 17% on average in 2025. That dampens the impact of tariffs.

Battery energy storage

Impact of high import tariffs: **High**

- Battery projects are highly exposed to import tariffs: import reliance is high. Moreover, supply chains heavily rely on China. The market accounted for 83% of global battery cell manufacturing capacity in 2024.
- Moreover, battery racks make nearly half of total stationary storage project costs in 2025. This makes them more sensitive to duties.

Modeling methodology

Capacity additions

- Only utility- and small-scale solar and energy storage projects are considered. Being less exposed to tariffs, wind is not included.
- Capacity additions in BNEF's Net Zero Scenario are used. This long-term outlook, which models a pathway where net-zero emissions are reached by 2050, aligns with the COP28 pledge.
- Data can be found in BNEF's New Energy Outlook 2025.

Geographies assessed

- The model assesses eight geographies: Brazil, the EU, India, Indonesia, Mexico, South Africa, sub-Saharan Africa and Turkey.
- These markets have raised or are considering clean-tech tariffs – or would face significant impacts if they did.
- Grouping sub-Saharan African nations together masks diverse investment environments and levels of clean energy penetration.

Project costs

- Energy project costs are based on global benchmarks from BNEF's most recent levelized cost of electricity (LCOE) update.
- For geography-specific costs not included in our LCOE publication, project costs shared through additional interviews between BNEF and project developers are also considered.
- Data is adjusted annually for technology improvements and cost reductions.

Import tariff scenarios

- Three different scenarios explore the impact on project costs. Scenarios assume a full pass-through of tariffs to equipment costs.
  - **Current tariff scenario**: Keeps today's tariffs on solar modules and batteries.
  - **Higher tariff scenario**: Imposes 50% on solar modules and 25% on batteries.
  - **Extreme tariff scenario**: Imposes 100% on solar modules and 50% on batteries.

100% import duties would boost solar costs by $76.5 billion through 2030

- Under the extreme tariff scenario, the 100% import duty would add $76.5 billion to the cost of new solar capacity additions in the NZS. The EU alone accounts for 61% of this increase, driven by the sharp rise from its current tariff exemption and a substantial modeled buildout of 529GW – about 47% of total solar additions across the assessed geographies.
- As most markets today apply low or no import tariffs, imposing 100% tariffs nearly doubles solar module costs for projects in most countries surveyed. Sub-Saharan Africa sees the sharpest increase to total project cost as low non-equipment costs per megawatt make tariffs more significant. India is least affected because a 100% tariff represents just a 60% jump from its current 40% solar module duty.

Investment needed for NZS solar energy generation capacity additions, selected geographies

Current tariff scenario

Real 2024 $ billion

Geography	Solar module cost	Other project costs	Total project costs	Solar module as a share of total cost
Brazil	4	23	27	14.7%
EU	38	218	255	14.7%
India	13	76	89	14.7%
Indonesia	2	14	16	14.2%
Mexico	4	26	30	14.8%
South Africa	3	20	23	14.7%
Sub-Saharan Africa	4	25	29	14.7%
Turkey	6	34	40	14.7%

Extreme tariff scenario

Geography	Solar module costs	Other project costs	Total project costs	Solar module as a share of total project costs	Impact of tariff on total
Brazil	6	23	29	21.6%	109%
EU	85	218	303	28.0%	118%
India	19	76	95	19.7%	106%
Indonesia	5	14	18	24.9%	113%
Mexico	9	26	34	25.8%	114%
South Africa	6	20	26	23.8%	112%
Sub-Saharan Africa	10	25	35	29.6%	121%
Turkey	12	34	46	25.6%	115%

Source: BloombergNEF. Note: Total project costs are the sum of solar module costs and other project costs. Impact of tariff on total compares total cost under the extreme tariff scenario to the current tariff scenario. NZS refers to BNEF's Net Zero Scenario.

A 50% battery tariff has a larger relative impact on project costs

- A 50% battery import tariff under the extreme tariff scenario would add $60.1 billion to the cost of new storage capacity in the NZS. With similar capacity additions modeled, the gap reflects lower average project costs: $389 per GWh for battery storage versus $646 per GW for solar generation.
- India is the only market projected to spend more on storage than solar under the NZS. This reflects its already high solar tariffs, which limit the added impact of the extreme tariff scenario, and the fact that it is modeled to add 1.5 times more storage capacity (MWh) than solar capacity (MW).

Investment needed for NZS battery energy storage capacity additions, selected geographies

Current tariff scenario

Real 2024 $ billion

Geography	Battery rack cost	Other project costs	Total project costs	Battery rack as a share of total project costs
Brazil	7	10	18	41.5%
EU	56	88	144	38.7%
India	40	63	103	38.5%
Indonesia	7	10	17	41.5%
Mexico	7	10	18	41.5%
South Africa	7	10	18	41.5%
Sub-Saharan Africa	9	13	22	41.5%
Turkey	7	10	16	41.5%

Extreme tariff scenario

Geography	Battery rack cost	Other project costs	Total project costs	Battery rack as a share of total project costs	Impact of tariff on total
Brazil	11	10	21	51.6%	121%
EU	82	88	171	48.3%	119%
India	54	63	117	46.1%	113%
Indonesia	10	10	20	50.1%	117%
Mexico	11	10	22	51.6%	121%
South Africa	11	10	22	51.6%	120%
Sub-Saharan Africa	12	13	25	47.7%	112%
Turkey	10	10	20	51.6%	120%

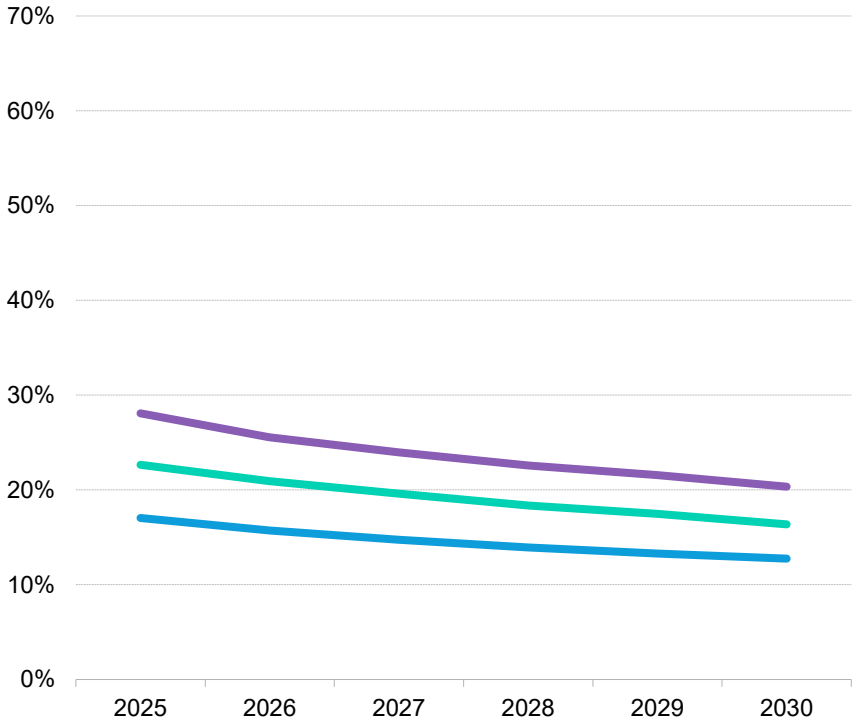
Source: BloombergNEF. Note: Total project costs are the sum of solar module costs and other project costs. Impact of tariff on total compares total cost under the extreme tariff scenario to the current tariff scenario. NZS refers to BNEF's Net Zero Scenario.

Future cost declines dampen the impact of higher tariffs

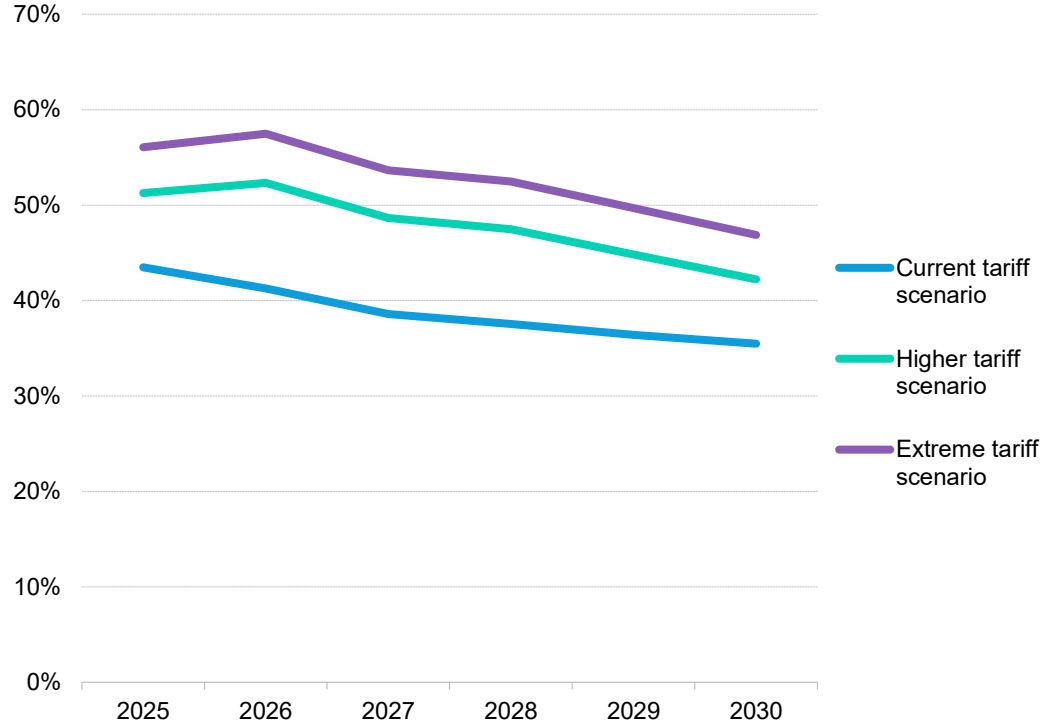
- Battery projects are relatively more exposed to tariffs than solar because battery equipment accounts for a larger share of total battery project costs than solar modules do of solar projects. When costs are averaged across geographies and weighted by planned capacity additions, solar modules account for 30% of total costs under the extreme tariff scenario in 2025. Battery racks – metal frames which hold and organize battery modules – are double that, at 60%.
- Import tariffs raise project costs. But these are somewhat offset by falling solar module and battery-pack prices. By 2030, under the extreme tariff scenario, solar modules account for 20% of costs, down from 28% in 2025. Battery racks show a similar 9-point drop. This trend softens the impact of higher tariffs, as capacity additions for both technologies are set to peak in 2028.

Average clean-tech equipment share of total project costs through 2030, under tariff scenarios

Solar modules as a share of utility-scale solar project costs



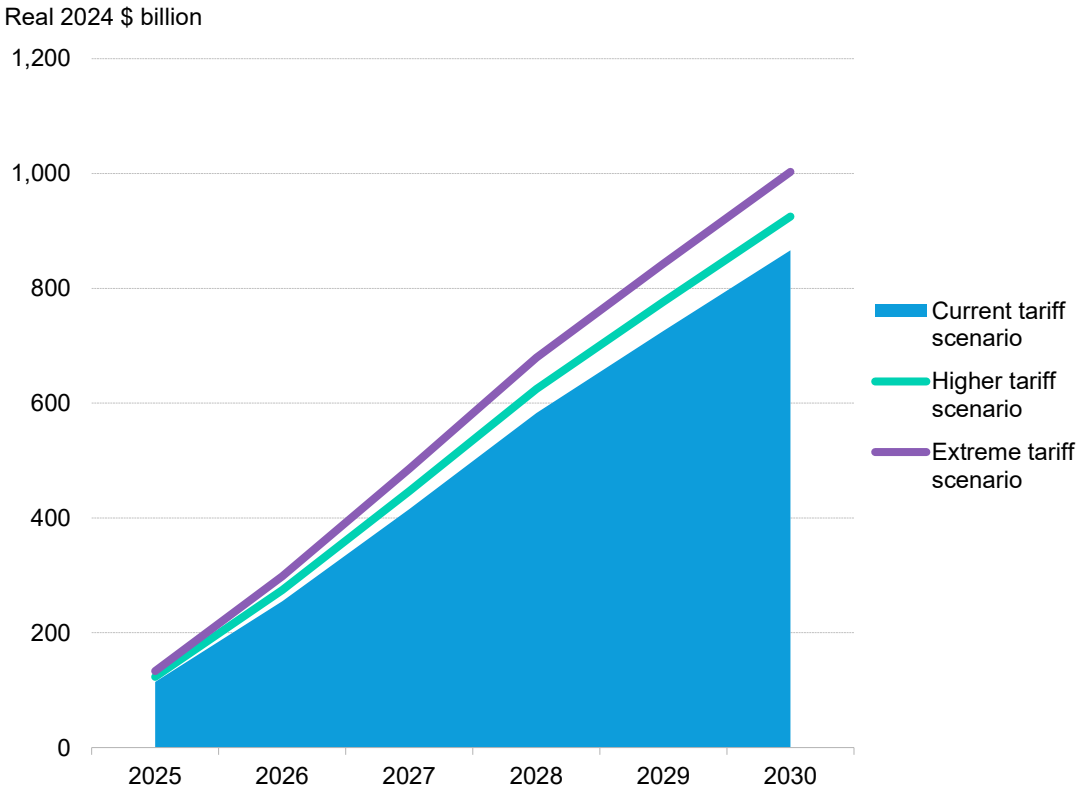
Battery racks as a share of utility-scale energy storage costs



Source: BloombergNEF. Note: Weighted averages are based on capacity additions in each market under the BNEF New Energy Outlook's Net Zero Scenario .

High battery and solar tariffs add at least 16% to the cost of COP28 and COP29 goals

Cumulative cost of capacity additions under the Net Zero Scenario under different tariff scenarios, selected geographies



Source: BloombergNEF. Note: Based on BNEF's Net Zero Scenario capacity additions for solar and energy storage. Costs are derived from BNEF's latest LCOE update and adjusted for technology improvements. Eight geographies are assessed: Brazil, the EU, India, Indonesia, Mexico, South Africa, sub-Saharan Africa, and Turkey. Current scenario applies current tariffs. High and extreme scenarios apply 25-50% tariffs on non-EV batteries and 50-100% tariffs on solar modules, respectively.

- Meeting the COP28 goal of tripling renewables and the associated COP29 goal of a sixfold increase in storage would cost an additional $137 billion under the extreme tariff scenario across the eight geographies assessed. That represents a 16% rise in the cost of capacity additions under the NZS over the next five years.
- Discounting China from COP goals, as the market produces its own clean energy equipment, these assessed geographies account for 44% of global installed solar and 82% battery capacity by 2030.
- Scaled globally, assuming similar effects, the extreme tariff scenario would add about $247 billion in extra costs. This figure does not include China, which is essentially self-reliant when it comes to solar and battery equipment.
- And that only reflects tariffs on clean-tech equipment. Higher duties on other components such as inverters, or on upstream materials like steel, aluminum and copper, would push costs even higher.
- The additional spending may appear modest, but even small cost increases can materially affect project economics, particularly for battery storage. BNEF analysis of onshoring in the US and Europe found that local manufacturing raised costs enough to delay and reduce stationary storage deployment.
- That dynamic is even more relevant in developing economies, where higher financing costs and tighter margins leave less room to absorb price shocks. The same pattern suggests that tariff-driven cost increases, though seemingly limited, could still undermine investment viability and slow decarbonization trajectories.

Appendix

The modeling methodology behind the tariff scenarios

How does BNEF's Net Zero Scenario align with COP28 and COP29 goals?

BNEF's modeling approach evaluates the impact of tariffs on the investment required to meet the clean energy objectives set at COP. That involves applying tariffs assumptions to capacity additions under the Net Zero Scenario (NZS), a long-term energy and climate scenario for the transition to a net-zero carbon economy by 2050. The NZS closely aligns with the renewable energy pledges made at COP28, and the associated energy storage targets of COP29.

COP Goals	BNEF's Net Zero Scenario
To triple global renewable energy generation capacity by 2030 relative to a 2022 baseline, global capacity will need to hit 11.2 terawatts.	Global renewable energy generation capacity reaches nearly 12TW by 2030, or 3.2 times the 2022 baseline.
To grow installed global battery energy storage capacity sixfold by 2030 relative to a 2023 baseline, global capacity will need to hit 1.5 terawatts.	Global battery energy storage capacity reaches 1.7 terawatts by 2030, or 5.8 times the 2023 baseline.

Coverage

Only utility- and small-scale solar and battery energy storage projects are considered in our tariff scenario analysis. Wind is not included given the sector's relatively low reliance on imported equipment. Under BNEF's Net Zero Scenario:

- Solar projects account for 60% of global renewable generation capacity in 2030. The rest of renewable generation capacity is made up of offshore and onshore wind (23%), hydro (12%), nuclear (5%) and geothermal (0.3%) projects.
- Battery projects account for 78% of energy storage capacity in 2030. The rest of energy storage capacity is made up of pumped hydro projects.

Eight geographies are assessed under each tariff scenario: Brazil, the EU, India, Indonesia, Mexico, South Africa, sub-Saharan Africa and Turkey. Under BNEF's Net Zero Scenario:

- These geographies account for 25% of renewable energy generation capacity in 2030.
- These geographies account for 25% of energy storage capacity in 2030.

Only utility- and small-scale solar and battery energy storage projects in these seven geographies are considered. Under BNEF's Net Zero Scenario:

- These geographies' solar deployment account for 14% of renewable energy generation capacity in 2030.
- These geographies' energy storage deployment account for 22% of energy storage capacity in 2030.

What project costs do we use in the scenario analysis?

Capacity additions modeled under the NZS in each market are multiplied by the annual cost of constructing projects to reach an investment value required to meet NZS targets.

Project costs are based on figures shared in interviews between BNEF and project developers incorporated into BNEF's levelized cost of electricity data. Where market-specific data are unavailable, global benchmarks are used. Data are adjusted annually for technology improvements and cost reductions.

Capex cost of solar energy generation projects constructed in 2025

Project type	Market	Cost (Real 2024 $ per megawatt)	Source
Fixed axis solar generation projects	EU	562,858	Levelized cost of electricity
	India	378,887	Levelized cost of electricity
	Indonesia	700,449	Levelized cost of electricity
	South Africa	496,479	Levelized cost of electricity
	Sub-Saharan Africa	493,042	Global benchmark
	Turkey	600,868	Levelized cost of electricity
Tracking axis solar generation projects	Brazil	558,856	Levelized cost of electricity
	Mexico	712,292	Levelized cost of electricity

Source: BloombergNEF. Note: EU based on the average of France, Germany and Italy project cost data.

What project costs do we use in the scenario analysis?

Capacity additions modeled under NZS in each market are multiplied by the annual cost of constructing projects to reach an investment value required to meet NZS targets.

Project costs are based on figures shared in interviews between BNEF and project developers incorporated into BNEF's levelized cost of electricity data. Where market-specific data are unavailable, global benchmarks are used. Data are adjusted annually for technology improvements and cost reductions.

Capex cost of battery energy storage projects constructed in 2025

Project type	Market	Cost (Real 2024 $ per megawatt-hour)	Source
Utility-scale 4-hour battery energy storage projects	Brazil	330,878	Levelized cost of electricity
	EU	324,710	Levelized cost of electricity
	India	333,974	Levelized cost of electricity
	Indonesia	321,877	Global benchmark
	Mexico	321,877	Global benchmark
	South Africa	321,877	Global benchmark
	Sub-Saharan Africa	321,877	Global benchmark
	Turkey	321,877	Global benchmark

Source: BloombergNEF. Note: EU based on Germany project cost data.

What rates are applied in each tariff scenario?

We apply three tariff scenarios to the investment required in each market to meet NZS capacity editions:

- **Current tariff scenario:** Import tariff rates on solar modules and non-EV batteries as of September 17, 2025, are applied. This leaves the investment required to meet NZS capacity editions unaffected.
- **Higher tariff scenario:** A 50% tariff on solar modules and a 25% tariff on non-EV batteries are imposed.
- **Extreme tariff scenario:** A 100% tariff on solar modules and a 50% tariff on non-EV batteries are applied.

Import tariffs are applied retroactively to projects since the start of 2025 and are held constant through 2030.

This analysis focuses on import tariffs and excludes other trade costs such as taxes, surcharges, levies, monitoring requirements or additional import fees.

Low tariff scenario rates

Market	Tariffs on solar modules	Tariffs on non-EV batteries
Brazil	25.0%	0.0%
EU	0.0%	1.3%
India	40.0%	10.0%
Indonesia	5.0%	7.0%
Mexico	0.0%	0.0%
South Africa	10.0%	0.0%
Sub-Saharan Africa	3.9%	16.8%
Turkey	0.0%	0.0%

Source: BloombergNEF. Note: Turkey's low-tariff battery scenario is 0% not the current 32.7% rate, due to tariff exemptions for energy storage projects.

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