REPORT SEPTEMBER 2025

THE US INFLATION REDUCTION ACT

IMPACTS ON CLEANTECH, TRADE AND INVESTMENT

MAX GRUENIG

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SUMMARY

In this report, we look at the impacts of the 2022 US Inflation Reduction Act's (IRA) climate-related provisions on cleantech trade and investment as well as knock-on effects on the global energy transition. Our assessment focuses on the timespan between the IRA coming into force in Q4 2022 and the latest available data at the time of writing, up to the end of Q2 2025.

On 4 July 2025, President Trump signed the One Big Beautiful Bill Act which will phase out key energy support measures of the IRA. The impact of this revision will not yet be visible in the current data, which precedes the expiration of EV tax credits at the end of September 2025 and of consumer tax credits such as for rooftop solar or heat pumps at the end of 2025. Tech-neutral tax credits for clean electricity will require projects to be placed in service by the end of 2027 to still qualify for benefits. In addition, projects now must comply with newly added foreign entity of concern requirements, adding complexity and uncertainty to new investments. Still, many projects are already under way as we enter a new chapter for cleantech in the US.

US trade partners voiced concerns about the knock-on impacts of the IRA, especially its domestic content preference and in particular, requirements for EVs. Such concern was most pronounced in the EU and South Korea but also in emerging economies. We want to shed light on the actual impacts of the IRA on international trade and investment flows to interrogate whether those concerns were valid. Even with significant parts of the IRA being repealed in the near future, an analysis of its impacts on trade and investment is still helpful for better understanding the potential ramifications of industrial policy pursued in other jurisdictions, such as in the EU, the UK or China. This understanding will be useful for a fact-based discussion of cross-border impacts caused by so-called unilateral trade measures, both in climate and trade policy contexts.

While other nations may be very interested in the IRA's impacts on trade, the US is much less trade-exposed than the global average and, thus, more focused on the domestic impacts. Demand for **solar PV** has increased significantly, representing 82% of all new utility-scale power generation capacity added in 2024, continuing a massive expansion since 2021. The first 4 months of 2025 show some shift, with solar PV representing 78% of new utility-scale power, albeit at significantly higher total installed capacity compared to the first 4

months of 2024. Utility-scale solar PV is not only the most successful renewable energy technology but also on a steep upward trend.

A second cleantech growth market is **battery storage** which is expected to grow by over 19 GW new installed capacity, an 81% growth in the additions compared to 2024. A third and less dramatic success story is the rise of battery-electric passenger vehicles (EVs) which are on a continuous, albeit slowing, growth trajectory.

Without tax credits to support further cleantech roll-out, soft costs need to be reduced to create a level playing field for cleantech to compete in the open market. This, then, can also generate new opportunities for cleantech exporters abroad as well as foreign investors in the US.

Trends in imports following introduction of the IRA

Solar PV imports increased markedly in 2022 and even more so in 2023. Growth was very high in 2023, resulting in over $18bn of imports, though in 2024 imports reduced to $16bn, albeit representing higher volumes, owing to lower prices. In Q1 2025, imports decreased both in terms of value and volume, compared to Q1 2024. The decrease in imports is possibly due to the growing domestic manufacturing capacity for solar PV panels, which reached 57 GW at the end of August 2025, and is sufficient to cover all domestic demand for modules. Asian countries dominate the solar PV imports with six countries contributing 90% of imports: Vietnam, Malaysia, Thailand, South Korea, Cambodia and India. There is no indication that the US is exporting significant amounts of solar PV.

Battery imports into the US started growing already in 2021, when they surpassed $14bn for the first time, and have since more than doubled to over $33bn in 2024, holding steady in Q1 2025. China remains the key source for batteries, with 54% of imports in Q1 2025, followed at some distance by South Korea (12%) and Japan (11%). In total, 80% of imports came from Asia, with European countries playing only a marginal role. Germany and Mexico are losing relative market share and Germany's exports are even shrinking in absolute terms. The US has increasingly exported batteries since 2022, primarily and increasingly to Mexico (36% in Q1 2025), Canada (25%) and Australia (8%).

EV imports were marginal until 2021, when they surged to $5bn. They continued to grow in 2022 (over $10bn) and 2023 (over $18bn) and reached almost $23bn in 2024, though there was a year-over-year slowing of demand in Q1+2 2025. From 2020 until Q2 2025, 93% of imports came from just five countries: Mexico has become the number one import source (30%), followed by Germany (29%) and South Korea (19%), then Japan (9%) and Belgium (6%).

We expect that two main cleantech trade sectors – solar PV and batteries – will remain strong even after losing their IRA benefits. EVs face an uncertain future.

Developments in domestic and foreign investment in cleantech

The IRA did not result in a major re-allocation of capital on a global scale; foreign direct investment flows into and out of the US remain within their usual scopes. However, among the most striking impacts of the IRA is a massive rise in both domestic and foreign investment in the US cleantech sectors. Domestic investments doubled from $2.5bn to over $5.5bn, while foreign investment has shown an exponential growth from $4.5bn at the time of introduction of the IRA in Q4 2022 to $13.5bn in the second quarter of 2024.

Investments in batteries are the leading cleantech manufacturing investments by far with 68% of money received, followed by zero emissions vehicles (13%) and solar (10%). Other sectors (critical minerals, wind, electrolyzers and fuelling equipment) attracted considerably less investment. Batteries are also the sector with the highest share of foreign investment (82%), followed by wind (75%) and solar (57%). In absolute terms, South Korea is by far the number one investor in US cleantech ($30.7bn), followed by Japan ($13bn) and China ($5.3bn), mirroring the relevance of the battery and solar sectors. European countries invested significantly less in the timespan Q4 2022 to Q2 2024: Germany is in 6th place with $1.2bn, Switzerland 8th with $0.44bn, Norway 9th with $0.36bn. European countries risk losing the race for the US cleantech market.

Global impacts of the IRA

Given the size of the US cleantech market, policies driving it can lead to several **global effects**:

1. Given limited access to the US market, Chinese cleantech overcapacity such as solar panels is more readily available to emerging markets, which can decarbonize faster and at lower cost. Without import restrictions, given the high demand and willingness to pay in the US, the American market could absorb a large share of the Chinese PV production.
2. China's dominant position in batteries and critical minerals has been unaffected, so far, and new supply options such as in Chile or Angola are still to fully mature. Development returns of the IRA have been limited.
3. The IRA has neither resulted in massive trade tensions, nor been able to produce a geopolitical dividend and rally support for the US globally.

While the IRA did little to shift the power balance in the global cleantech markets, in particular in competition with China, it provided a lifeline and a guarantee for US manufacturers to stay in the race with time to catch up and develop new technologies. **The IRA was a policy for the energy transition, not for an energy revolution. It was also an attempt to bring back manufacturing to the US. Early successes include the sub-fields of solar, battery and EV cleantech manufacturing.**

Post-IRA cleantech trade outlook

With US electricity demand expected to grow, driven in no small part by the expansion of data centres and in particular artificial intelligence (AI), bringing new generating capacity online will be essential in the coming years. As nuclear has very long lead times and gas turbines currently feature wait lists of 3–7 years, in the absence of a wind renaissance, only solar PV combined with battery storage provides a ready remedy. Even with the expiration of key provisions of the IRA, cleantech might be able to keep playing a key role in investment and trade.

The last chapter for IRA cleantech trade impacts depends on:

> Whether investors trust they can install solar PV and onshore wind projects before the cut-off date for tax benefits, at the end of 2027.

> Whether the US Treasury will provide actionable guidance on how to manage newly added foreign entity of concern requirements to provide sufficient investment certainty to developers.

> Whether demand for EVs can weather the removal of tax credits and reach a critical mass.

> Whether soft costs for solar PV can come down to outweigh the loss of tax credits after 2027.

Despite facing significant fiscal and regulatory headwinds, cleantech in the US is expected to grow, albeit unequally. The sheer size of the US cleantech market means that it remains an attractive prospect both for exports and foreign direct investment. The new policy environment will require adjustments by cleantech exporters and investors and might lead to a restructuring of market shares.

ABOUT THIS REPORT

In August 2022, US President Joe Biden signed into law the Inflation Reduction Act (IRA) as a milestone legislation to drive the decarbonization of the US economy while bolstering domestic manufacturing.

Trade partners across the globe, in both the Global North and South, have expressed concern about the impacts of the new US climate law on their economies, their ability to decarbonize and the balances of the global economy at large.

In 2023, we published an initial stocktake of key impacts on cleantech trade and investment, looking mostly at the EU.[1] Now, after the three-year anniversary of the IRA, we want to expand our analysis of the impacts on trade, investment and development, in both the Global North and the Global South.

With the signing into force of the One Big Beautiful Bill Act of 2025, key provisions of the IRA will phase out or become more restrictive, given newly added foreign entity of concern requirements.

In this report, we set out to:

1. Assess the impacts of the IRA on investment flows for cleantech manufacturing in the US.
2. Analyse impacts on imports and exports for key cleantech goods and sectors, looking at the US, Germany, and select emerging economies such as India & China.
3. Understand the potential longer-term impacts for key trade partners.
4. Explore what these impacts could mean for global decarbonization, development prospects and geopolitics.

Given data limitations, this study is exploratory in nature and does not aim for final conclusions.

[1] E3G, 2023, **One year Inflation Reduction Act**

This report reflects the information available at the three-year mark of the IRA, with many datasets ending in Q1 or Q2 2025 at the latest. Many of the data points in this report stem from official sources yet may still undergo adjustments as is customary with very recent statistical data. Meanwhile, some data is sourced from unofficial compilations and may not stand to the same standards as official statistical data.

This report does not seek to paint a complete picture of the economic or other impacts of the IRA. Our focus is first and foremost on the external dimension, that is, impacts on international trade with and foreign direct investment into the US.

We will start out with a look at the key aspects of the IRA in as far as these are relevant for cleantech, followed by the updates coming with the passage of the One Big Beautiful Bill Act in July 2025. We then assess the impacts of the IRA on cleantech trade with the US for key product categories:

> solar PV

> wind power

> batteries

> electric vehicles (EVs).

As a next step, we review the impacts on cleantech investment in the US with a particular emphasis on foreign direct investment.

Finally, we derive some cautious conclusions after these first three years of the IRA and an outlook into the next chapter for cleantech.

THE US INFLATION REDUCTION ACT OF 2022

The 274-page Inflation Reduction Act celebrated its third birthday on 16 August 2025. While the law is known in policy circles, most Americans are not familiar with it and even fewer people are aware of its three main components:

> reducing costs on prescription drugs

> adjusting corporate taxation

> supporting climate and energy action.

Our report focuses narrowly on the third part, which consists of a range of instruments covering different sectors and addressing several actors over a timeframe of about 10 years, with some deviations for specific programs.

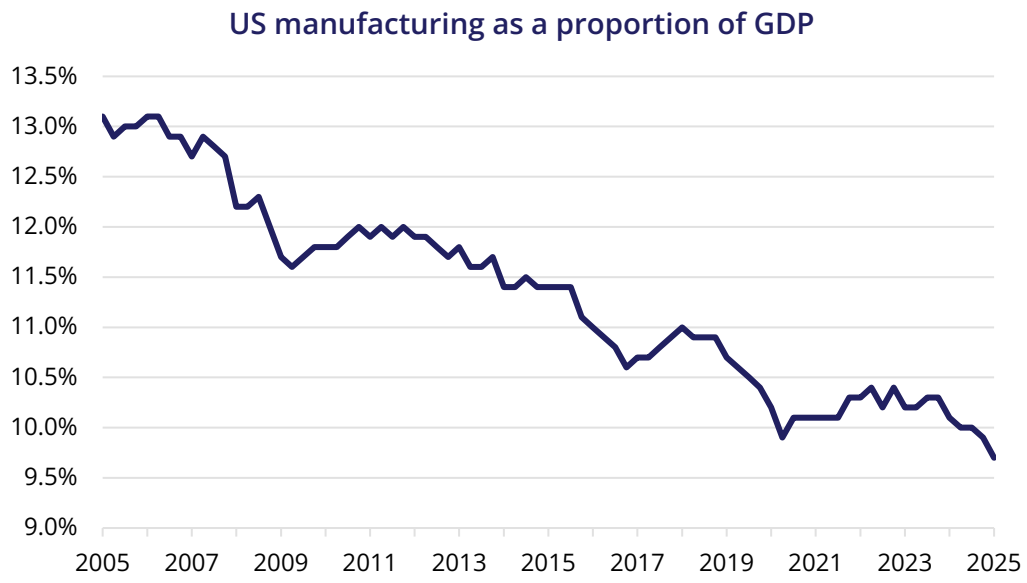
The goal of the IRA was not only to reduce greenhouse gas emissions, but to increase the share of manufacturing and related jobs in the US. It is helpful to consider manufacturing as a share of Gross Domestic Product (GDP) in this context: it has reduced from 13% in 2005 to around 10–11% since 2020 (Figure 1).

The bulk of funding arising from the IRA – about 60–70% – was expected to go to electricity generation, storage and efficiency.[2] Other sectors with significant expected spending were mobility – in particular electric vehicles (EVs) – clean manufacturing, and clean hydrogen generation.[3]

Most of the climate and energy spending were expected to come in the form of investment and production tax credits for clean electricity generation and storage, as well as for manufacturing. Tax credits were offered for businesses, individuals and nonprofit entities, allowing them to benefit from a direct pay option, even if they don't have a tax burden. In addition, tax credits can be traded over the counter and on private marketplaces.

[2] McKinsey & Company, October 2022, **The Inflation Reduction Act: Here's what's in it**

[3] Jenkins, J.D., Mayfield, E.N., Farbes, J., Jones, R., Patankar, N., Xu, Q., Schivley, G., updated September 2022, **Preliminary Report: The Climate and Energy Impacts of the Inflation Reduction Act of 2022** (PDF), REPEAT Project, DOI: 10.5281/zenodo.7106218



Source: US Bureau of Economic Analysis, **Value Added by Industry: Manufacturing as a Percentage of GDP** [VAPGDPMA], retrieved from FRED, Federal Reserve Bank of St. Louis, 26 June 2025.

Figure 1: Manufacturing as share of GDP is on a long-term decline in the US

Other instruments included grants and loans, which have a set budget. By contrast, tax credits were not capped and thus depended largely on offtake by taxpayers: they may be very high in a high uptake scenario and can veer towards zero in the opposite situation.

Given this high level of uncertainty, any attempts to predict the total funding to be derived from the IRA run afoul. The initial estimate from the Congressional Budget Office put the climate part at $369bn,[4] though even the authors of this number must have recognized that the final spending aggregate over tax credits, grants and loans was hard to pinpoint. Too much depends on trends in national and global economic growth, inflation, interest rates and technological progress. Additionally, as has transpired, the longer-term impact the IRA is subject to the political climate. Key provisions of the bill, in particular regarding tax credits, are being curtailed – as set out in the next section.

[4] Congressional Budget Office, 2022, **Estimated budgetary effects of Public Law 117-169, to provide for reconciliation pursuant to Title II of S. Con. Res. 14**

Revisions to the IRA energy provisions

As part of the One Big Beautiful Bill Act, signed into law by US President Trump on 4 July 2025, key IRA provisions will be revised.[5]

1. Expiration of tax credits for EVs at the end of September 2025.
2. Expiration of tax credits for rooftop solar and other consumer energy tax credits at the end of 2025.
3. Clean electricity tax credits will require projects to be in service before the end of 2027 to still qualify.
4. Battery storage tax credits continue under the 2022 timeframe.
5. Other technologies are exposed to a range of revisions, affecting qualification terms, timeframes and level of the tax credits.

Most notably, the revision also introduces strict foreign entity of concern requirements that serve to both prevent entities owned or controlled by foreign entities of concern (such as China, Iran, North Korea or Russia) from benefitting from IRA tax credits and set limits on material content sourced from such entities. Details for the implementation are yet to be published by the Treasury. These constraints might hinder the use of products and intermediary goods of Chinese origin.

Given these challenges, we will train our eyes on statistical information covering primarily the time from the 4th quarter of 2022 to the 2nd quarter of 2025, beginning with trade data and then looking at investment in cleantech, including foreign direct investment.

We will close with an analysis of what these findings imply for the future of cleantech trade and investment in and with the United States and explore what these findings could mean for global decarbonization, development prospects and geopolitics.

[5] US Congress, 2025, **H.R.1 - One Big Beautiful Bill Act**

IMPACT ON CLEANTECH TRADE

The US is not highly exposed to international trade, by global standards. Trade as a share of GDP was 25% in 2024, compared to 57% for the world and 92% for the European Union.[6]

However, trade exposure can be higher for specific sectors, especially for sectors where a sudden change in demand might be triggered by a change in the tax regime as is the case with the IRA. We will look more closely at primary cleantech sectors: solar, wind, batteries and electric vehicles. Cleantech as such is an umbrella term that emerged in the mid-1990s and covers all technology that serves to reduce pollution.[7]

Cleantech demand in the US

Demand for some forms of cleantech such as solar, batteries and EVs has increased significantly since the introduction of the IRA in August 2022. The picture is not uniform though, with wind energy expansion in particular slowing.

Additions of solar energy have grown in recent years, with a significant leap in new solar from 2022 onwards (Table 1). Utility-scale solar dominated the overall added capacity in 2024 with over 30 GW (almost 82% of all added capacity),[8] a significant increase over 2023 when utility solar's record added 18.4 GW capacity made up 49% of new capacity.[9] The first four months of 2025 saw 9.5 GW of new solar added (78%), up from 8.1 GW in the first four months of 2024 (72%). Anticipated higher tariffs on panels from Southeast Asia created a downward pressure on imports from key Asian countries.[10] On the other hand, rising electricity demand[11] and the looming phase-out of the IRA tax credits, created an upward momentum.

[6] World Bank, 2025, **Trade (% of GDP) - United States, European Union, World**

[7] Shakeel, S. R., 2021, **Cleantech: prospects and challenges**, *Journal of Innovation Management*, *9*(2), VIII-XVII.

[8] FERC, April 2025, **Energy infrastructure update for December 2024 (revised data on April 22, 2025)**

[9] FERC, May 2024, **Energy infrastructure update for December 2023**

[10] Solar World, 2025, **It's official: High tariffs initiated on solar cells and panels from Southeast Asia**

[11] EIA, 2025, **After more than a decade of little change, US electricity consumption is rising again**

Table 1: New installed capacity for utility-scale solar PV and wind power (in GW)

	2020	2021	2022	2023	2024	Jan–Apr 2024	Jan–Apr 2025
All	35.7	29.2	29.8	37.2	37.8	11.2	12.2
Utility-scale solar	7.9	5.5	12.2	18.4	30.8	8.1	9.5
Wind	16.4	10.8	10.2	6.4	3.1	1.8	2.2

Source: FERC energy infrastructure updates, available from **https://www.ferc.gov/staff-reports-and-papers**

New wind is on a downward trend since 2020. In 2024, wind contributed 8% (3.1 GW) of all added capacity in the US,[12] compared to 17% (6.4 GW) in 2023.[13] The first third of 2025 halt that trend with wind representing 18% of new added capacity (2.2 GW), compared to 16% in the first third of 2024 (1.8 GW). This can be read as developers trying to complete more wind projects earlier to hedge against a possible reversal on IRA tax credits and against growing tariff threats.

Similar to utility-scale solar, small-scale solar is also growing, with 4.4 GW added capacity in 2020, 5.5 GW added in 2021, 6.7 GW in 2022, 8 GW added in 2023, 5.5 GW in 2024 and an expected added 7.2 GW in 2025.[14] Reasons for the up and down in installed small-scale solar can be found in price fluctuations, and uncertainty about future pricing. For 2024, year-on-year, pricing for residential solar systems increased by 2%, while commercial systems decreased by 7% and utility-scale systems decreased by 4%, leading to an uneven trend. Tariffs play an important role for module prices, while soft costs such as labour and sales play a bigger role for small-scale residential systems.[15] With significant changes coming in both the tariff and tax landscape, estimates for future demand carry a high level of uncertainty.

Another strong growth segment is utility battery storage, with 4.3 GW newly added in 2022, 7 GW added in 2023, to 10.7 GW added in 2024 and expected 19.4 GW added by the end of 2025.[16] Total utility-scale battery storage reached

[12] FERC, April 2025, **Energy infrastructure update for December 2024 (revised data on April 22, 2025)**

[13] FERC, May 2024, **Energy infrastructure update for December 2023**

[14] US Energy Information Administration, 2025, **Short Term Energy Outlook Data Browser**

[15] Solar Energy Industries Association, March 2025, **Solar Market Insight Report 2024 Year in Review**

[16] US Energy Information Administration, 2025, **Short Term Energy Outlook Data Browser**

26 GW in 2024.[17] Prior to the IRA, there was very limited domestic manufacturing capacity. As of August 2025, battery pack manufacturing capacity has reached 68 GWh per year, while battery cell manufacturing capacity is close to 21 GWh, implying that a significant number of cells will still need to be imported.[18]

We will see that despite a growing demand, solar PV imports have not increased in lockstep, reflecting the trend for building domestic manufacturing capacity in the US, and that for the ailing wind sector imports are on a downward trend.

Sales of full electric vehicles (EVs), including battery-electric and fuel cell vehicles, went from 258,000 in 2020, to 491,000 in 2021, to 812,000 in 2022, to 1.2 million in 2023, to 1.3 million in 2024 and 607,000 in Q1&Q2 2025 – compared to 598,000 in Q1&Q2 2024. The steady increase picked up speed in Q1 2025 out of consumer concern about the impending loss of EV tax credits. Sales slowed in Q2 2025 and decreased by over 6% compared to the previous year, reflecting uncertainty about the EV tax credit. [19] [20] [21] [22] [23]

Hybrids, plug-in hybrids and EVs made up 22% of all new car sales in Q1 2025, up from 18.0% in Q1 2024 and 18.8% in the last quarter of 2023.[24] [25] In Q1 2025, the share of hybrid vehicles was 12%, followed by battery-electric vehicles (8%) and plug-in hybrid vehicles (2%). Pure battery-electric vehicles have not yet been able to exceed 10% of new car sales at any moment, despite IRA incentives.[26]

It is expected that EV sales will peak in Q3 2025 before falling sharply with the expiration of the tax credit at the end of September 2025.

[17] US Energy Information Administration, 2025, **US battery capacity increased 66% in 2024**

[18] Solar Energy Industries Association, August 2025, **Solar Storage Supply Chain Dashboard**

[19] Cox Automotive, 2024, **Kelley Blue Book Electric vehicle sales report Q3 2024** (PDF)

[20] Cox Automotive, 2021, **Kelley Blue Book Electrified light-vehicle sales report Q4 2021** (PDF)

[21] Cox Automotive, 2023, **Kelley Blue Book Electric vehicle sales report Q4 2022** (PDF)

[22] Cox Automotive, 2025, **Kelley Blue Book Electric vehicle sales report Q1 2025** (PDF)

[23] Co Automotive, 2025, **Kelley Blue Book Electric vehicle sales report Q2 20225** (PDF)

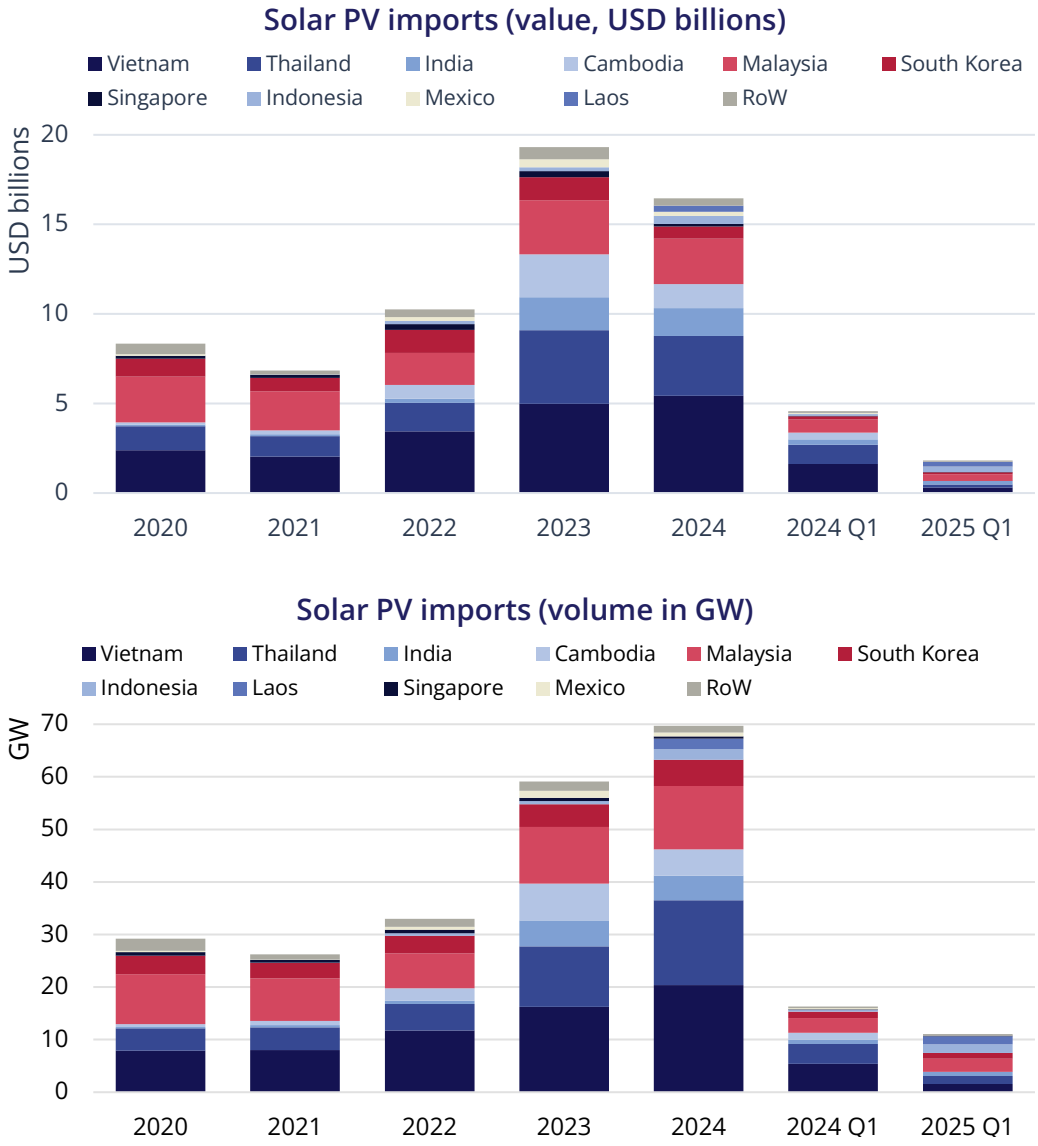
[24] US Energy Information Administration, 2024, **US share of electric and hybrid vehicle sales decreased in the first quarter of 2024**

[25] US Energy Information Administration, 2025, **Hybrid vehicle sales continue to rise as electric and plug-in vehicle shares remain flat**

[26] ibid.

Solar PV imports

Against the backdrop of very fast growth in solar PV manufacturing capacity in the US, imports have increased significantly since 2021, peaking in 2023 before starting to fall in 2024 and 2025 in terms of both value and volume (Figure 2).



Source: USITC DataWeb, **https://dataweb.usitc.gov**; HTS codes 8541.42.00 (Photovoltaic cells not assembled in modules or made up into panels), 8541.43.00 (Photovoltaic cells assembled in modules or made up into panels), and former codes in use before 2022: 8541.40.6015 (solar cells, crystalline silicon photovoltaic cells, assembled into modules or panels), 8541.40.6025 (solar cells, crystalline silicon photovoltaic cells, others), 8541.40.6035 (solar cells, assembled into modules or made up into panels, others) and 8541.40.6045 (solar cells, others)

Figure 2: Solar PV imports saw a steep increase in 2023, in both value and volume. Imports from several countries increased markedly over time, resulting in Malaysia and South Korea's share of the market decreasing.

Solar PV imports increased markedly in 2023, reaching more than $18bn or over 55 GW. Imported volumes increased even more in 2024, with almost 70 GW imported at a value of $16.5bn. We observe a clear drop in both value and volume in the first quarter of 2025, presumably linked to the increased tariff rates and growing domestic manufacturing capacity in the US: US domestic solar PV module manufacturing capacity reached 57.5 GW per annum by August 2025, with another 15 GW under construction. US module manufacturing capacity was only around 7 GW in 2020, growing to 14.5 GW in 2023 and 42 GW in 2024.[27] [28] [29] Other aspects of the solar PV value chain rely more on imports with 25 GW per annum capacity for polysilicon and 2 GW for cells, none for ingots and wafers, as of August 2025.[30] This illustrates how the US may rely less on module imports in the future, while still depending on imports of precursor inputs. The current volume of module manufacturing capacity is expected to suffice to cover all US solar demand.

Asian countries dominate solar PV imports by far (see Figure 2). Six countries – Vietnam, Malaysia, Thailand, South Korea, Cambodia and India – made up 90% of solar import quantities from 2020 to Q1 2025. A shift in supply chains is visible, with Vietnam, Thailand, India and Cambodia gaining prominence, while China, Malaysia and South Korea are losing relative shares. China's dominance had disappeared already before the start of the time series. However, a share of imports from Asian countries is either Chinese trans-shipments or manufactured in Chinese-owned facilities. Turkey is the only European country with any relevance in solar imports, showing the limited role of European countries in the solar supply chain.

The changes in the import rankings over time show how dynamic the solar PV market is and that it is possible to gain – or lose – ground quickly. This points to possible opportunities for new market entrants but also goes to show that price is a crucial driver for purchasing decisions with little regard to alliances and politics.

The imports are highly diversified with no country exerting a dominant influence. However, the strong regional clustering in Southeast Asia brings a certain risk

[27] Solar Energy Industries Association, February 2025, **United States surpasses 50 GW of solar module manufacturing capacity**

[28] Solar Energy Industries Association, March 2025, **Solar Market Insight Report 2024 Year in Review**

[29] Solar Energy Industries Association, August 2025, **Solar & Storage Supply Chain Dashboard**

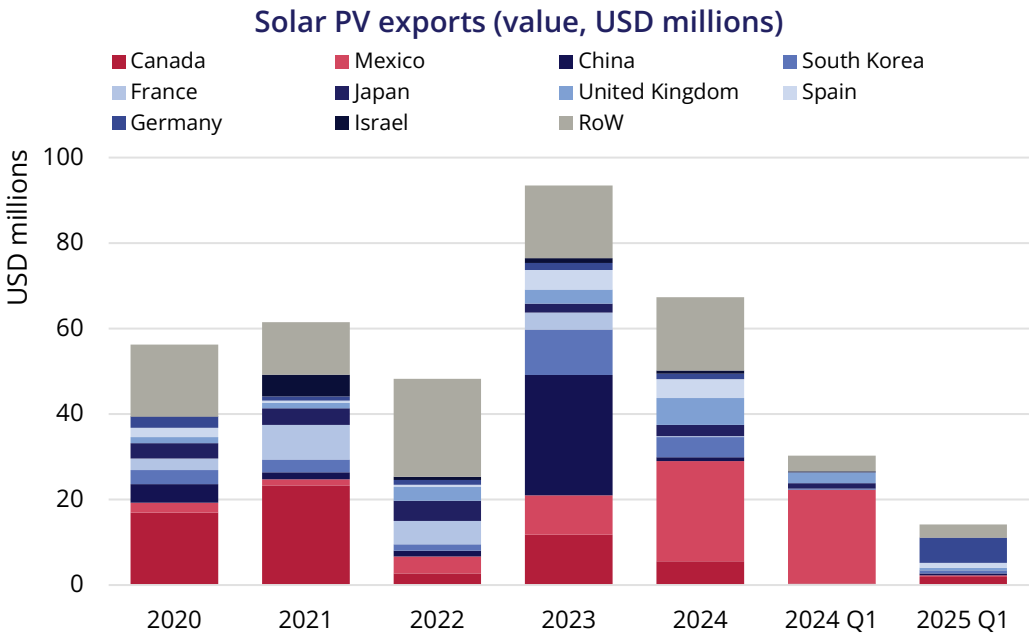
[30] Solar Energy Industries Association, updated August 2025, **SEIA Solar and Storage Supply Chain Dashboard**

exposure should supply chains be affected. Building up alternative supply chains outside Southeast Asia could provide significant benefits in terms of resilience and price development.

The most recent solar PV tariffs of up to 3,521% are not yet reflected in these numbers,[31] and neither is the growing domestic manufacturing capacity in the US. Both these trends are expected to reflect in future statistics with possibly much lower import volumes and values.

Solar exports

The US is not a very active exporter of solar PV modules or cells (Figure 3). Total exports in 2023 amounted to less than $100mn and 2024 saw exports of below $50mn, a slight easing of exports compared to 2023. Exports are considerably smaller than imports, by a factor of 150, and there is no indication that the US is increasing solar PV exports, despite the increase in solar manufacturing capacity.



Source: USITC DataWeb, **https://dataweb.usitc.gov**; HTS codes 8541406020 (solar cells assembled into modules or panels), 8541406030 (solar cells, not assembled into modules or made up into panels) 854142 (photovoltaic cells not assembled in modules or made up into panels) 8541420000 (solar cells, not assembled into modules or made up into panels) 854143 (photovoltaic cells assembled in modules or made up into panels), and 8541430000 (solar cells assembled into modules or panels),

Figure 3: US solar PV exports remain negligible despite the IRA

[31] BBC, 2025, **US sets tariffs of up to 3,521% on South East Asia solar panels**

30% of the exports went to USMCA partners Canada and Mexico, the rest being shipped to a wide range of countries, including 11% to China (see Figure 3).

In summary, we find that the US is increasing its solar PV import volumes while developing its domestic manufacturing capacity which is meant to serve domestic demand in the future. The US is not showing any signs of becoming a relevant exporter of solar PV panels or cells.

Wind power imports

Wind power equipment imports showed a declining trend (Figure 4). They amounted to over $4.6bn in 2020, declining steadily to below $2.3bn in 2023, followed by a rebound to about $3.2bn in 2024. 2025 is set to be closer to 2023 values again. Given the slow build-out of onshore and offshore wind energy in the US, it is hardly surprising that wind power equipment imports are showing little growth. The rebound in 2024 could be partially triggered by stockpiling to pre-empt tariffs.

Five countries made up 68% of imports over the time from January 2020 to May 2025: Mexico (19%), India and China (13% each), Spain (12%) and Germany (11%). Canada and Denmark contributed 6% each, followed by Brazil (5%), France (3%) and Vietnam (2%). The top 10 exporters to the US delivered 90% of wind power equipment.

This shows that being physically close and connected via a trade agreement such as the USMCA in the case of Mexico and Canada can be helpful for wind power sales. On the other hand, countries such as India, Spain or China don't fall into this category, proving that price and technology can be important drivers as well. Chinese imports are decreasing over time, in both relative and absolute terms.

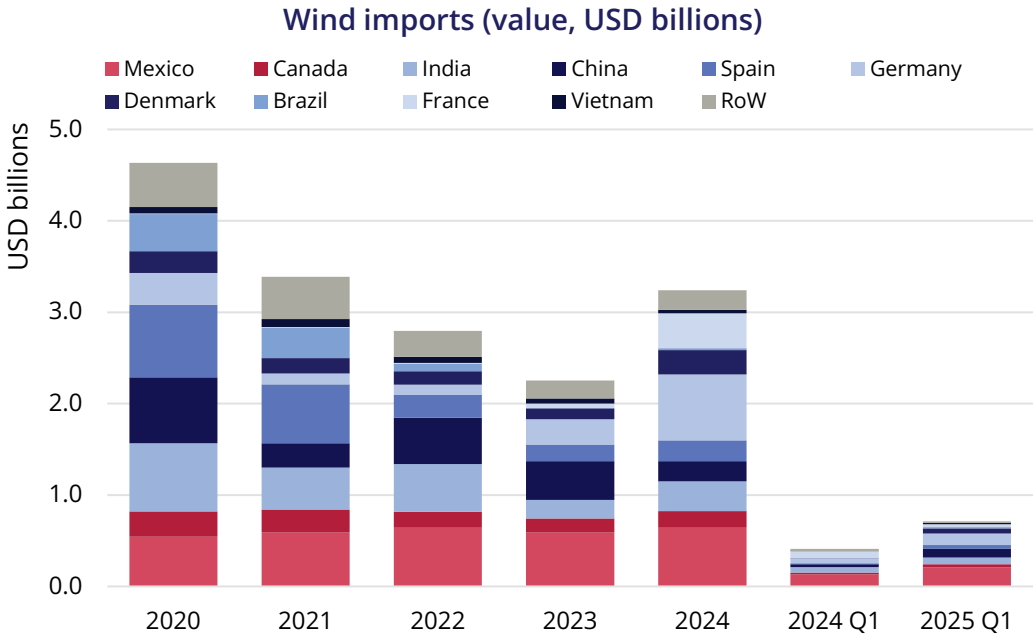
While we don't have comparable data to translate the wind equipment imports into GW, International Energy Agency (IEA) data shows that for 2023, only relatively modest volumes of wind power equipment were traded.[32] There is also only a marginal price advantage for Chinese wind manufacturing with 14% higher production cost in the wind sector in the US compared to China.[33] The US is able to manufacture over 90% of nacelles, around 80% of towers but only around 10%

[32] International Energy Agency, 2024, **Energy Technology Perspectives 2024**

[33] ibid.

of blades domestically, showing that – similar to the solar sector – the depth of the supply chain matters.[34]

The high concentration in a few countries carries only moderate geographic risk,[35] given that the market is overall quite small compared to other cleantech sectors and that proximity to the US is a much bigger driver for wind power, given the volume and weight of the equipment, favouring USMCA partners Mexico and Canada. This trend is likely to further increase over time given the general trend to larger and taller wind turbines, both on- and offshore.



Source: USITC DataWeb, **https://dataweb.usitc.gov**; HTS codes 8412909081 (wind turbine blades and hubs), 85023100 (wind-powered electric generating sets), 8503009570 (parts of wind-powered generating sets classified in subheading 8502.31), 8501640121 (ac generators (alternators), output exceeding 750 kva but not exceeding 10,000 kva for wind-powered generating sets classified within 8502.31.00), 8501640021 (ac generators (alternators), output exceeding 750 kva but not exceeding 10,000 kva for wind-powered generating sets classified within 8502.31.00), 8503009560 (machinery parts suitable for use solely or principally with the machines of heading 8501 or 8502, nesoi), 8503009580 (machinery parts suitable for use solely or principally with the machines of heading 8501 or 8502, nesoi), 8502310000 (wind-powered electric generating sets, nesoi), 7308200020 (towers and lattice masts of iron or steel, tubular, whether or not tapered, and sectional components thereof) and 8503009546 (generator parts for ac generators (alternators) classified within hts number 8501.64.0021).

Figure 4: Wind power equipment imports decreased, though imports from USMCA partners Mexico and Canada remained consistent.

[34] Lawrence Berkeley National Laboratory, 2024, **Land-based Wind Market Report: 2024 Edition**

[35] We don't cover the full supply chain risk. For more information, International Energy Agency, 2024, **Energy Technology Perspectives 2024**

Overall, the picture is of a trend of declining imports with no clear outcome. Another key difference from the solar sector is that OECD-countries hold strong positions among wind exports to the US.

Wind exports

We could not register relevant wind power equipment exports in the HTS codes under investigation. We conclude that the US is not exporting wind power equipment, neither before nor after the IRA took effect.

Battery imports

Batteries are primarily used for electric vehicles and as battery energy storage system (BESS) for grid stabilization. By far the largest share of battery demand came from the automotive sector in 2023.[36] With the end of EV tax credits and the continuation of support for grid storage batteries, this could shift in the coming years. Already, media report a shift in focus for manufacturers changing from EV batteries to grid storage.[37] [38]

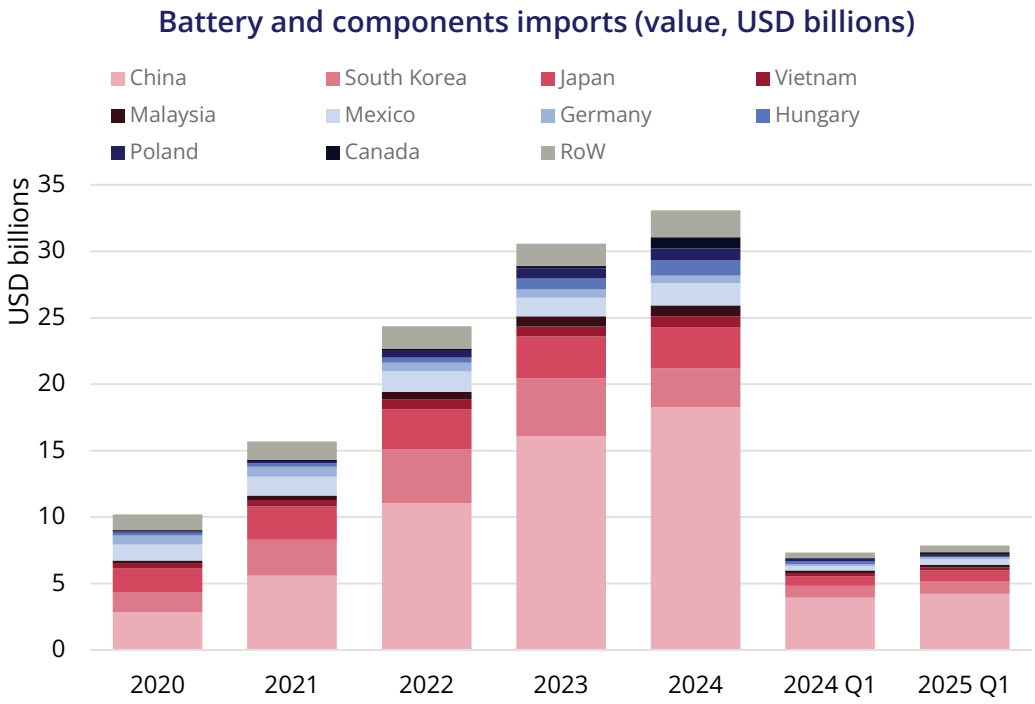
Imports of batteries, battery cells and parts thereof[39] have increased sharply since 2021 and are continuing their growth pattern in 2024 and seem to hold steady in Q1 2025 (Figure 5). Despite the many incentives for domestic manufacturing of batteries, cells and parts, coupled with explicit measures to curb imports from entities of concern such as China, imports from China have seen a steady rise. The other relevant sources of battery imports are South Korea and Japan. The growth trend preceded the introduction of the IRA: imports grew by more than 50% in 2021. This shows that the IRA is supporting existing trends, not creating trends. This growth in imports is even more remarkable, given the rapid expansion of domestic manufacturing capacity for cells and packs.

[36] Grand View Research, 2025, **US Battery Market Analysis**

[37] Detroit Free Press, August 2025, **GM shifts EV battery focus to energy storage for AI firms**

[38] Wall Street Journal, July 2025, **Battery Makers in Slumping EV Business Find Lifeline Elsewhere**

[39] Our analysis does not differentiate anode and cathode materials or precursors.



Source: USITC DataWeb, **https://dataweb.usitc.gov**; HTS codes 8507 (electric storage batteries, including separators therefore; parts thereof) and 8506 (primary cells and primary batteries; parts thereof)

Figure 5: Imports of batteries, battery cells and parts thereof increased already pre-IRA and come primarily from Asia.

Given the dominant position of Asian countries, foremost China, in battery manufacturing, combined with a growing demand for electricity storage in batteries, it is likely that this trend will continue in the near term, despite the push for domestic manufacturing of batteries in the US. Given the expected expansion of US domestic manufacturing capacity[40] and ever-stronger sourcing requirements in the IRA tax benefits, we expect a shift away from imports, especially from imports from China.

From 2020 until the end of Q1 2025, 48% of battery imports came from China, 13% from South Korea and 12% from Japan, a total of 73% from just three countries. Other relevant sources are Mexico (6%), Vietnam (3%), Germany (3%), Hungary (2%), Malaysia (2%), Poland (2%) and Canada (1%).

[40] US battery manufacturing increased from 232 GWh in 2021 to 302 GWh in 2024, according to Argonne National Laboratory, March 2024, **Quantification of Commercially Planned Battery Component Supply in North America through 2035** (PDF)

The regional clustering in Asia has increased over the time series; over 80% of imports originated from Asia in Q1 2025. However, the total supply chain risk could be even higher, given the deep reliance on Chinese critical minerals for the global battery industry.[41]

China's dominance among battery imports is also increasing over the time series. In Q1 2025, China's share was 54%, followed by 12% from South Korea and 11% from Japan, 5% from Mexico, 3% each from Vietnam and Canada, and 2% each from Germany, Malaysia and Poland. The market share for both Mexico and Germany decreased compared to their average over the time series. Germany's battery exports to the US peaked in 2021 and 2024 exports reached just 75% of its 2021 value, indicating a structural issue with the German battery industry.

Despite the rise of India in other import sectors, the battery sector is not yet at a stage where the subcontinent shows presence, ranking 23rd among the countries exporting batteries to the US.

Judging from the data, the US does not yet have an alternative to importing batteries or battery technology from China. With more domestic battery manufacturing technology coming online in the near future, the dependence on Chinese battery technology could decrease. This might lead to more Chinese batteries being available for other markets, which could drive down the price for storage technology in emerging and developing economies, accelerating the global energy transition. On the other hand, a closing of the lucrative US battery market for imports could result in developing local battery supply chains in emerging economies becoming less viable, especially in aligned countries where the energy transition could benefit from such an impulse. This could negatively affect development and decarbonization in low- and middle-income countries in Latin America, Africa or Asia.

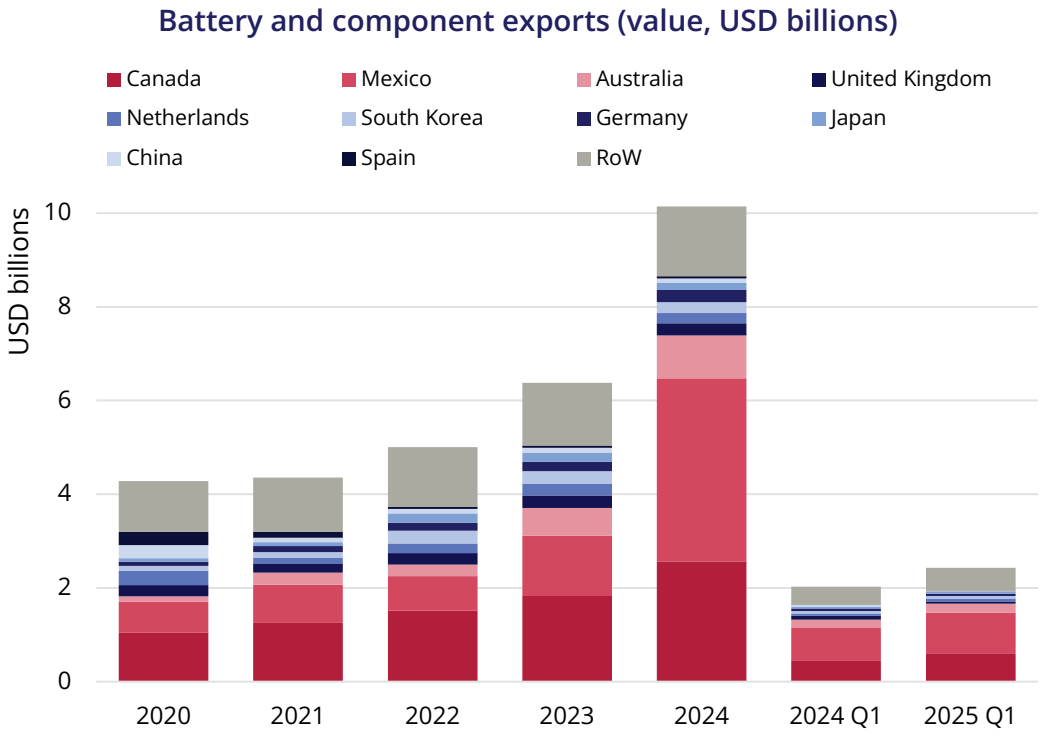
Battery exports

While still considerably smaller than the imports, battery exports have been growing since 2022, in particular to Canada, Mexico and Australia (Figure 6). If we consider the entire time series 2020 to Q1 2025, then 27% of exports went to Canada, 25% to Mexico, 7% to Australia, 4% each to the UK and the Netherlands, and 3% each to South Korea and Germany. If we look only at data for Q1 2025,

[41] US Department of Energy, no date, **What are critical materials and critical minerals?**

Mexico represents 36% of exports, followed by 25% to Canada and 8% to Australia, showing a distinctive change in the export portfolio.

With global demand for battery storage expected to increase significantly over the coming decades, we expect trade in battery technology to increase as well. The emergence of a competitive domestic battery industry in the US could become a global choice alternative to Chinese technology, alongside South Korean and Japanese options, especially in critical infrastructure and other security-critical applications. A large share of US battery exports go to neighbouring Mexico and Canada, from where they might end up being re-imported in turn.

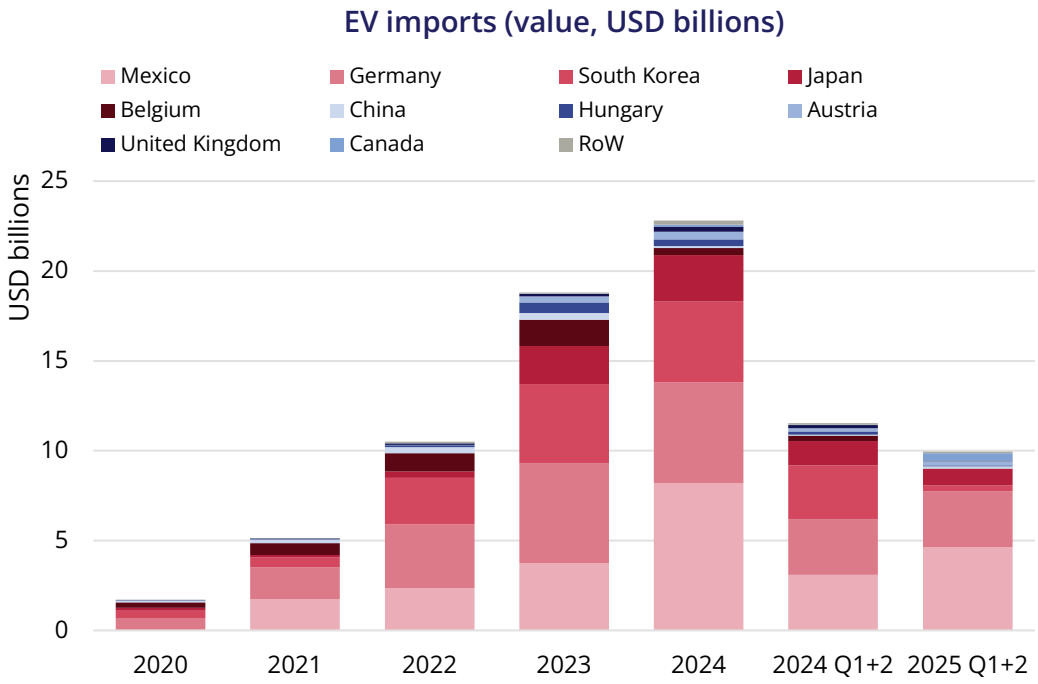


Source: USITC DataWeb **https://dataweb.usitc.gov** HTS codes 8507 (electric storage batteries, including separators therefore; parts thereof) and 8506 (primary cells and primary batteries; parts thereof)

Figure 6: Growing battery exports after 2022, mostly to Canada, Mexico and Australia.

EV imports (passenger vehicles)

Passenger EV imports show a dramatic growth, despite the many challenges about qualifying for the IRA tax credits and increased scrutiny against Chinese-made components. Imports grew from less than $1.7bn in 2020 to almost $23bn in 2024 (Figure 7).



Source: USITC DataWeb, **https://dataweb.usitc.gov**; HTS codes 8501.32.45 (DC motors not elsewhere specified or included, of an output exceeding 14.92 kW but not exceeding 75 kW, used as primary source of mechanical power for electric vehicles) and 8703.80.00 (Motor vehicles to transport persons, w/electric motor for propulsion)

Figure 7: Steep rise of EV imports since 2019 with noticeable easing in 2025. Five countries dominate: Mexico, Germany, South Korea, Japan, Belgium.

Five countries provide 93% of EV imports, making this sector a highly concentrated one among the cleantech domains. For the entire timeline from 2020 to the end of Q2 2025, 30% of imports came from Mexico, followed by 29% from Germany, 19% from South Korea, 9% from Japan and 6% from Belgium.

The composition of imports has changed considerably over the timeframe. In 2025, four countries represented 91% of imports: 46% came from Mexico, 31% from Germany, 9% from Japan and 4% from Canada. The trend towards concentration seems particularly pronounced for Mexico, which can benefit from

being member of the USMCA and being able to qualify for IRA EV tax credits which require manufacturing in North America.

But the data show that both countries with and without trade agreements with the US can export high numbers of EVs to the US as well as countries in North America and elsewhere. Trade agreements existed with Mexico and Canada, and a critical minerals agreement existed with Japan. However, no trade agreements existed with Germany, Belgium and South Korea.[42] A series of new trade agreements with Japan and the EU will take effect soon. The compound effect of these agreements and the expiration of IRA EV tax credits on 30 September 2025 is yet to be seen.

There are concerns[43] in the US that the fast rise of Mexican EVs may be partly Chinese re-imports, but these are so far unsubstantiated.[44] Rather, the share of Chinese EVs imported into the US has been low from the start and remains low throughout, driven by tariffs and non-tariff barriers rather than tax incentives. So far, only one Chinese manufacturer assembles EVs in the US: Polestar in South Carolina.

Here too, India is not yet visible. Imports of EVs and EV technology from India are marginal with no clear trend or development.

Germany is the European country with the most success in exporting EVs to the US, in addition to EV sales of German brands made in the US, which includes both Volkswagen and Mercedes. BMW is producing hybrid models in the US and was aiming to manufacture EVs in the US in the future.[45] That might change, given the possible erosion of EV sales in the US.

Countries with a minor presence in the sector include Austria, China, Hungary and the UK. China's share is 2% of imports over the entire timeframe from 2020 to 2025. But when looking at 2025 data alone, the share dropped to 1% or a mere $113m. This may be the result of tariffs or of a re-shoring of supply chains.

[42] Office of the United States Trade Representative, 2025, **Free Trade Agreements**

[43] The Christian Science Monitor, June 2024, **Chinese EVs may be coming to the US – through Mexico**

[44] CSIS, February 2024, **Green industrial policy: A holistic approach**

[45] BMW Group, October 2022, **BMW Group announces $1.7 billion (USD) investment to build electric vehicles in the US and signs agreement with envision AESC for the supply of battery cells to Plant Spartanburg**

Passenger EV tax credits have become increasingly hard to secure. Only 11 manufacturers qualified in 2025, including 3 South Korean and 2 Japanese brands (for models made in North America, not for imports), but no European brands at all.[46] Imports may qualify for commercial EV tax credits if they are subject to a lease agreement, as the US Treasury treats all leased EVs as commercial. There is no requirement to make commercial EVs in North America, in addition to other simplifications regarding batteries and battery components. The termination of EV tax credits at the end of September 2025 may have profound impacts on domestic demand and imports.

EV exports

Similar to the wind sector, the US does not have significant EV exports. This could change in the future: with many EV factories being built in the US, manufacturers could veer towards exporting their product if domestic demand reduces. Given that 2025 demand was still driven by the availability of IRA EV tax credits, the removal of these credits in September could impact EV demand in the US in the very near term.

Manufacturers might also shift their portfolio away from EVs towards hybrid and plug-in hybrid electric vehicles. In particular, hybrid vehicles seem to be increasing their market share in the US.[47]

[46] US Department of Energy, August 2025, **Federal Tax Credits for New Plug-in Electric and Fuel Cell Electric Vehicles Purchased from January 1, 2023, through September 30, 2025**

[47] US Energy Information Agency, May 2025, **Hybrid vehicle sales continue to rise as electric and plug-in vehicle shares remain flat**

IMPACT ON CLEANTECH INVESTMENT

Looking at investments in the cleantech sector in the US, we need to differentiate between announced and actual investments, before looking in more detail at the role of foreign direct investment in the development of the cleantech sector in the US.

As we will see, some cleantech sectors show significant differences between announced and actual investments, most notably in batteries, wind and solar.

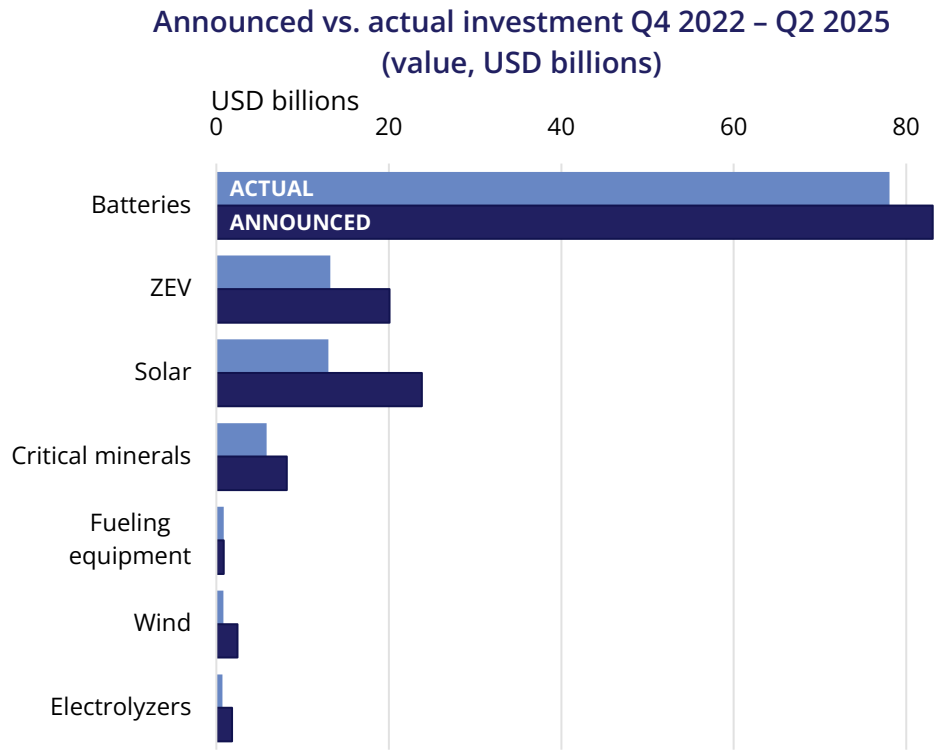
We find that while both domestic and foreign investments in cleantech increased significantly, the foreign finance flows are the main driving force behind the massive growth in clean manufacturing capacity.

Announcements vs actual investments

We collected data from the Clean Investment Monitor database which includes data up to the end of Q2 2025 (Figure 8).[48]

Just like in any business or policy field, there is a visible difference between announced and actual investments, with the latter being smaller than the former. There are, however, clear differences from sector to sector. Solar, EVs and batteries are the sectors with the most marked absolute difference between the stated intent and the actual deployment of capital (being $10.8bn for solar, $6.9bn for EVs and $5bn for batteries), while wind manufacturing and electrolyzers stand out as the sectors with the most relative “melt” (67% and 61% respectively). On the other hand, announcements for investments in fuelling equipment for hydrogen were surpassed by the actual investments, with 103% implemented. Overall, 80% of announced investments in cleantech manufacturing were implemented over the timeframe, from the third quarter of 2022 to the second quarter of 2025.

[48] Rhodium Group and MIT CEEPR, August 2025, **Clean Investment Monitor Database** (accessed on August 11, 2025)



ZEV = zero-emissions vehicles

Source: Rhodium Group and MIT CEEPR, August 2025, **Clean Investment Monitor Database** (accessed on August 11, 2025)

Figure 8: The difference in actual vs. announced investment is greatest for solar in absolute terms, while relative melt is greatest in the smaller wind and electrolyzer sectors.

Reasons for a gap between announced and actual investments are manifold, including the setting of the federal interest rate, inflation, permitting, business and consumer confidence, and – most recently – changes in the policy framework. They also include changes in the expected future demand for products. The stalling or slowing of consumer interest in some cleantech has implications up the value chain: slower uptake of EVs means less fast growth for battery demand, which can encourage investors to delay or scrap battery plant plans, unless demand for grid storage is conceived as an equivalent alternative.

The fact that certain sectors show more melt than others also reflects their respective exposure to depressing forces: sectors with higher capital investments and longer payback times are most affected by a combined rise in input and capital costs.

These numbers reveal key messages regarding the uptake or success of IRA manufacturing incentives:

> Wind is facing serious headwinds. Announced investments are not being realised, reflecting a weak market in decline.

> Electrolyzers and the hydrogen market in general face a high level of uncertainty with limited investor appetite.

> For both solar and EVs, announced investments are only partially realised, reflecting uncertainty about the future market size.

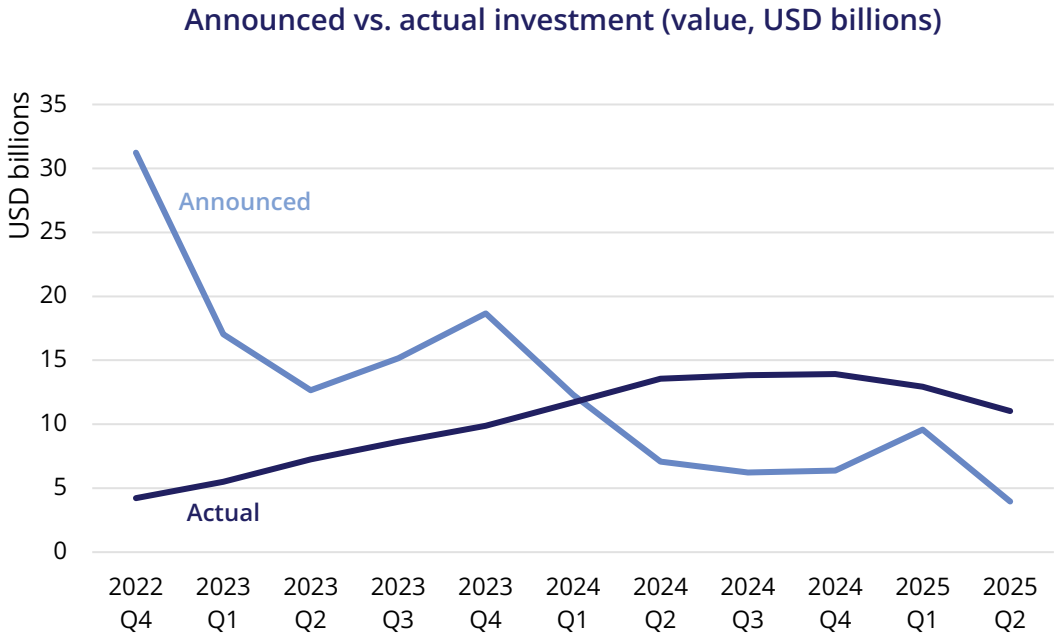
> Batteries are the clear frontrunner, not only with the highest investment, but also with the highest level of investor confidence, possibly since there are alternative use cases.

Cleantech investment in the US has grown from $75bn in 2018 to $173bn in 2022. In 2023, clean investment amounted to $230bn, followed by $273bn in 2024. Investment in the first quarter of 2025 was $67bn, the highest first quarter on record. Retail investments dominate by far and are the key driver for growth, the majority being purchases of EVs. Investments in energy and industry sectors, in contrast, have levelled off since Q4 2023. Investments in manufacturing plateaued in 2024 and have started to decline in 2025.[49] This signifies that a drop in EV purchasing could entail a decrease in total US cleantech investment.

There is a clear trend from announcements to actual investments over time (Figure 9). The decline in new announced investments can be read in two ways. First, it shows that investors have moved from making announcements to putting steel in the ground, a positive development. Second, given the time delay between new announcements and later build, the decline in announcements could signal a drying up of new cleantech investment in the coming years. If so, this could hamper the further development of cleantech manufacturing and cleantech roll-out in the US.

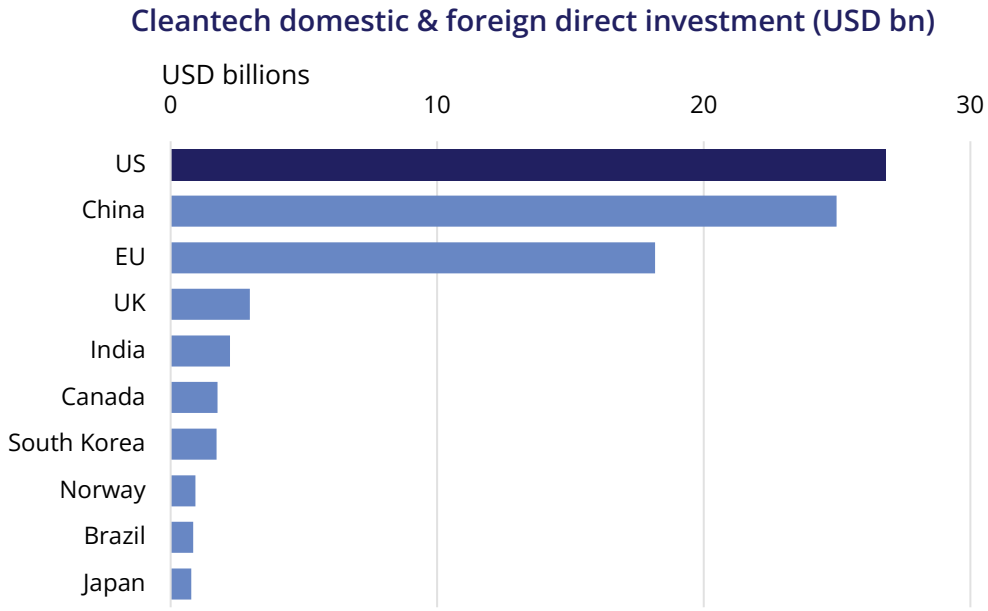
The US are a global leader for cleantech manufacturing investment, as shown in Figure 10. Only China came close to the US for the timeframe Q3 2024 to Q4 2024. We want to understand better how much of this investment is domestic vs. foreign.

[49] Rhodium Group and MIT CEEPR, August 2025, **Clean Investment Monitor Database** (accessed on 11 August, 2025)



Source: **https://www.cleaninvestmentmonitor.org/** (accessed August 12, 2025)

Figure 9: Shift from announced to actual cleantech investment Q4 2022 – Q2 2025



Source: **Rhodium Group Climate Deck**, July 2025

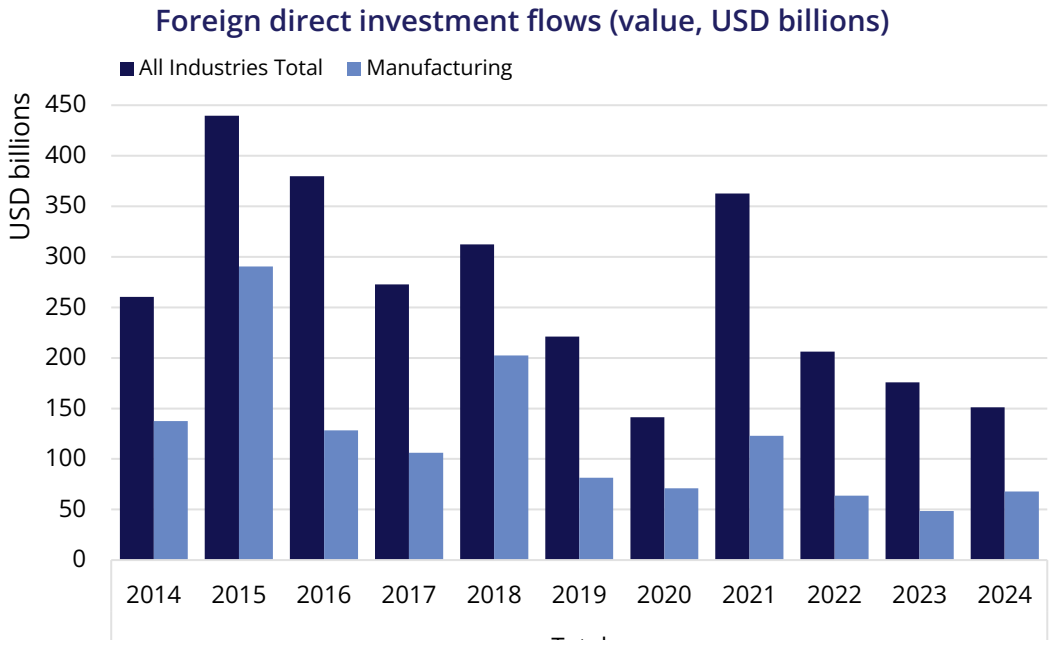
Figure 10: Cleantech manufacturing investment for the second half of 2024 – the US is the global leader.

Foreign direct investment

Foreign direct investment (FDI) flows into the US between 2014 and 2024 follow a saw-tooth pattern, ranging between $141bn in 2020 and almost $440bn in 2015 (Figure 11). FDI inflows amounted to $206bn in 2022, $176bn in 2023, and $151bn in 2024.

Looking at manufacturing investment only, foreign investment was $64bn in 2022, followed by $49bn in 2023 and $68bn in 2024. We cannot observe a general trend shift linked to the IRA introduction. This suggests that the IRA did not result in a major re-allocation of capital on a global scale.

Since there is only limited data on cleantech FDI, we rely on limited information aggregated via the Clean Investment Monitor by Rhodium Group and MIT CEEPR.[50] This data is no longer in the public domain. We use data retrieved on August 8, 2024. Among the most striking impacts of the IRA is a massive rise in foreign investment in the US cleantech sectors (Figure 12).

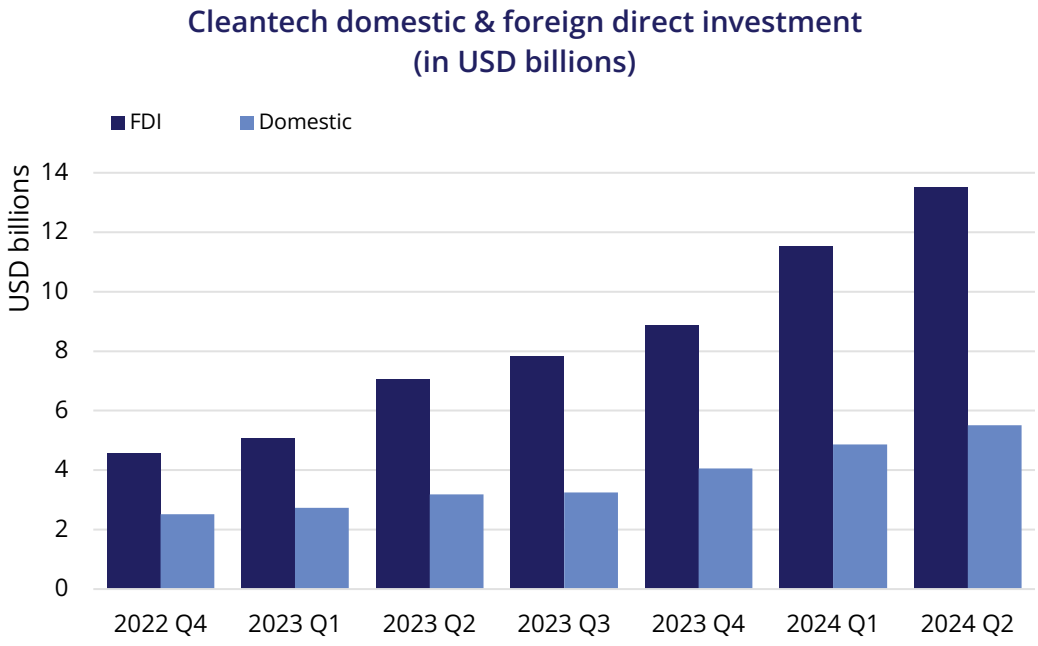


Source: Bureau of Economic Analysis, **Data on new foreign direct investment in the United States**

Figure 11: Overall and manufacturing FDI flows into the US were not affected by the introduction of the IRA.

[50] Rhodium Group and MIT CEEPR, August 2024, **Clean Investment Monitor Database** (accessed on August 8, 2024)

Both domestic and foreign investment in cleantech manufacturing increased steadily and significantly since the introduction of the IRA. Foreign investment, however, far outpaced the growth in domestic investment, the former growing from $4.5bn to almost $13.5bn and the latter from $2.5bn to $5.5bn. In aggregate, foreign companies invested over $58bn in cleantech manufacturing or 69% compared to domestic investments of $26bn or 31%.



Source: Rhodium Group and MIT CEEPR, August 2024, **Clean Investment Monitor Database** (accessed on August 8, 2024)

Figure 12: Foreign-owned vs. domestic-owned cleantech investments since the IRA.

Looking more closely at the different cleantech sectors, the picture becomes more nuanced, as shown in Table 2.

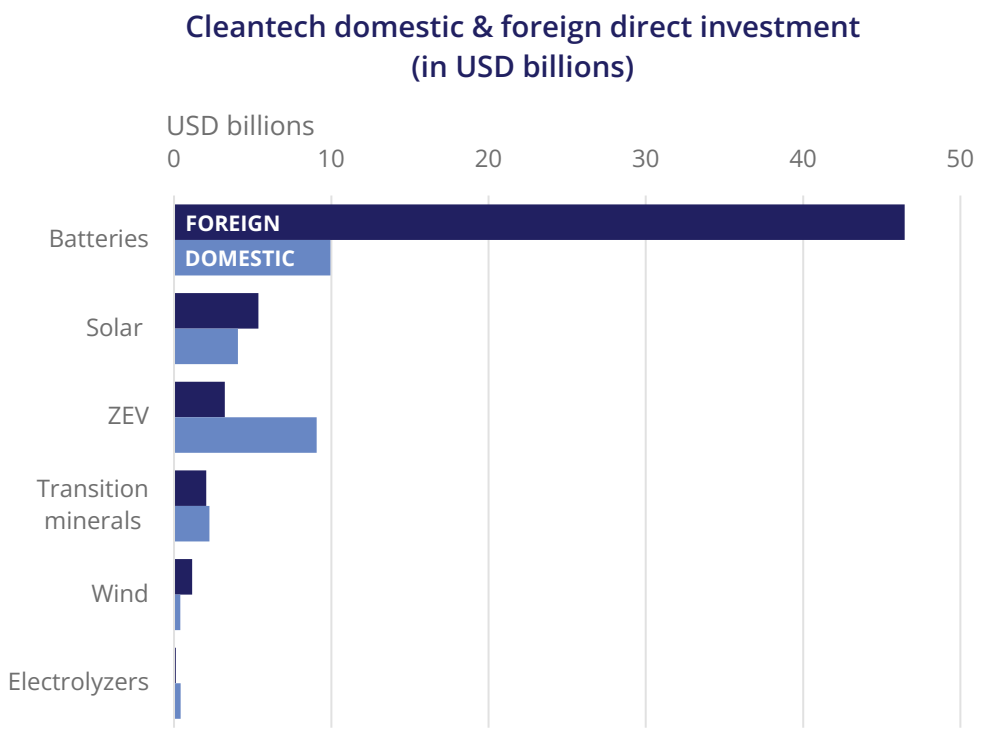
Given the order of magnitude of the sectors, foreign investments in batteries and solar are by far the most significant. However, compared to total US FDI flows, these numbers are still relatively modest. For comparison: In 2024 alone, total FDI inflow was over $150bn (Figure 11).

From Q4 2022 to Q2 2024, the batteries sector dominated the cleantech investment space with a share of 68%: two out of three dollars invested in cleantech went into battery manufacturing.

Table 2: Total domestic and foreign cleantech investment Q4 2022 – Q2 2024

Q4 2022 to Q2 2024	Domestic investment	Foreign investment	Share of foreign investment
Batteries	$9.9bn	$46.6bn	82%
Solar	$4.1bn	$5.4bn	57%
Zero-emissions vehicles	$9.0bn	$3.2bn	26%
Transition minerals	$2.2bn	$2.0bn	48%
Wind	$0.4bn	$1.2bn	75%
Electrolyzers	$0.4bn	$0.1bn	21%
Total	**$26.0bn**	**$58.5bn**	**69%**

Source: **Clean Investment Monitor**, Rhodium Group and MIT CEEPR (legacy data from August 2024)



Source: **Clean Investment Monitor**, Rhodium Group and MIT CEEPR (legacy data from August 2024)

Figure 13: Investment in batteries dominated overall cleantech investment over the period Q4 2022 – Q2 2024

The origins of these foreign investments closely mirror the countries that have a significant presence in the battery and solar imports statistics and centre on Asian countries primarily. The overview in Table 3 shows that South Korea is by far the leading cleantech manufacturing investor in the US. While this analysis builds on incomplete data and can only provide insights into the time until Q2 2024, there is a high likelihood that first movers will remain relevant beyond the timeframe under assessment.

Table 3: Leading foreign investors by sector (Q4 2022 to Q2 2024)

Cleantech	#1	#2	#3	#4
Batteries	South Korea $27bn	Japan $12bn	China $3bn	Australia $1bn
Solar	South Korea $1.9bn	Canada $1.8bn	China $1bn	Switzerland $0.4bn
Zero-emissions vehicles	South Korea $1.4bn	Japan $0.9bn	Germany $0.4bn	Vietnam $0.2bn
Transition minerals	China $0.9bn	Canada $0.7bn	Australia $0.5bn	France $0.02bn
Wind	Norway $0.34bn	Denmark $0.27bn	Germany $0.26bn	South Korea $0.2bn
Electrolyzers	Belgium $0.04bn	Norway $0.01bn	—	—

Source: **Clean Investment Monitor**, Rhodium Group and MIT CEEPR (legacy data from August 2024)

Table 4 provides a more in-depth look at the total volumes of confirmed investments between Q4 2022 and Q2 2024. It reveals a massive imbalance between leading investors such as South Korea, Japan and China, to a lesser degree also still Canada, Australia and Germany, and the many countries with very limited cleantech investments such as the UK, Spain or France, to name just a few European countries with smaller cleantech investments not listed in the top 10. While this is by any means just a very early look into investment patterns, nevertheless it allows us to draw initial conclusions as to which countries seem to be pursuing an active strategy to overcome trade challenges by re-shoring manufacturing into the US market in order to secure current market shares or expand these in key cleantech industries.

Table 4: Foreign cleantech investment (in bn USD) by sector from top 10 sources of foreign investment into the US (Q4 2022 – Q2 2024)

	Batteries	Solar	Zero-emissions vehicles	Wind	Minerals	Electrolyzers	**Total**
South Korea	27.2	1.9	1.4	0.2			**30.7**
Japan	12.1		0.9				**13.0**
China	3.3	1	0.1		0.9		**5.3**
Canada	0.4	1.8	0.02	0.16	0.67		**3.1**
Australia	0.9				0.46		**1.4**
Germany	0.37	0.13	0.4	0.26	0.001		**1.2**
Vietnam	0.72		0.18				**0.90**
Switzerland		0.44					**0.44**
Norway	0.005			0.34		0.01	**0.36**
Turkey	0.28						**0.28**
Total (all countries)	**46.1**	**5.4**	**3.0**	**1.3**	**2.0**	**0.1**	**57.9**

Source: **Clean Investment Monitor**, Rhodium Group and MIT CEEPR (legacy data from August 2024)

IMPACTS ON GLOBAL DECARBONIZATION, DEVELOPMENT PROSPECTS AND GEOPOLITICS

The fact that the US is increasing domestic manufacturing capacity for cleantech, especially for batteries, solar and EVs, has potential global impacts, given the sheer size of the US market and the important role it plays in global geopolitics.

Given that the US domestic contribution to global greenhouse gas emissions was below 11% in 2023 and has been decreasing from its peak of 31% in the 1880s,[51] even major domestic reductions will be insufficient in themselves to achieve the goals of the Paris Agreement and keep global temperature increase below 2 °C and ideally below 1.5 °C. At the same time, the US are a key engine of the global economy, with almost 15% of global value added in their economy, more than the EU's share of 14.4% but less than China's 19% (based on GDP at purchasing power parity).[52] Economic rivalries transcend into geopolitical ones and, thus, any change in economic power has also impacts on geopolitics.

Furthermore, the US faces a high level of uncertainty regarding its future decarbonization trajectory. Long-term trends such as power sector decarbonization are expected to continue, albeit at a slower rate, and certain IRA provisions will remain in place or phase out over time. However, the end of EV tax credits and offshore wind funding and permitting, as well as the December 2027 deadline for wind and solar projects, place a question mark on the future growth of cleantech in the US. Therefore, it is increasingly difficult to assess the implications of the remainders of the IRA for global decarbonization, development prospects and geopolitics.

Our findings only provide a glimpse into the trade and investment impacts related to the IRA in its first three years. With a massive policy shift taking effect in the US, any attempts at extrapolating trends become moot. We will, therefore, be cautious with our geopolitical analysis.

[51] Our World in Data, 2024, **Share of global greenhouse gas emissions**, based on Jones et al., 2024, **National contributions to climate change due to historical emissions of carbon dioxide, methane and nitrous oxide**

[52] International Monetary Fund, 2025, **GDP based on PPP, share of world**

Impacts on global decarbonization

With a growing domestic US manufacturing base for solar PV, total global manufacturing capacity is increasing, resulting in increased availability and lower pricing globally, leading in turn to faster uptake and deployment of solar PV around the world. This trend is – all else equal – supporting global decarbonization efforts. According to the IEA's announced policies scenario, global manufacturing capacity for solar PV modules is expected to grow from 1,155 GW in 2023 to up to 1,695 GW in 2035 with a good part of the increase coming from North America, in addition to India, reducing China's overall market share.[53] Even with the end of IRA tax credits for rooftop solar in December 2025 and the expiration of credits for commercial projects in 2027, there are two key drivers that all but guarantee a continuation of solar in the US:

1. Solar manufacturing facilities cannot easily switch to other production and risk becoming sunk costs if the investment cannot be productive.
2. Solar PV, especially utility-scale, is expected to be competitive in many markets without any subsidies.

This does not imply that the US will become a significant solar PV exporter. On the other hand, the US market is expected to become less dependent on solar PV imports, including less dependent on precursor products.

For batteries, IRA tax credits will continue, and grid storage is expected to become a leading market. The US is already exporting some battery technology and, with continued support, it is possible that exports continue to grow, providing more supply to the global battery market.

The US has claimed in the past that the build-out of a domestic cleantech manufacturing base in the US would drive down costs for cleantech globally and would enable low- and middle-income countries to decarbonize at a lower cost thanks to the lower unit costs for cleantech linked to economies of scale and innovation.

So far, we cannot see any evidence that US cleantech development has lowered costs globally or has accelerated the global energy transition. Most notably, there are no significant exports of US cleantech in any sector surveyed in this report. Given the huge difference in scale between the manufacturing capacity

[53] International Energy Agency, 2024, **Energy Technology Perspectives 2024**

of Chinese PV or EV plants compared to anything evolving in the US, a major role of US cleantech manufacturing in the global energy transition is not likely.

By limiting cleantech imports into the US, the IRA reduces sales volumes of cleantech trade partners which might lead in some instances to a destabilization of the entire cleantech industry, if exports to the US were a significant share of the business model. The only cases where this could be argued to some degree is for EVs from Korea and Germany. However, both countries have been able to adapt to the circumstances by e.g. relocating manufacturing to the US, at least initially.

With the onset of trade restrictions and new tariffs on a range of key imports, including EVs as a result of the trade reset initiated by the new US administration, the economics of exports to the US have significantly eroded. Adding this to the uncertain future for some manufacturing investments made in conjunction with the IRA, negative impacts on cleantech businesses globally are possible. What's more: the loss of trust in the US market might take years to rebuild.

As an unintended consequence, the closing of the US market for Chinese PVs and other products linked to Foreign Entities of Concern such as China, leads to an abundance of low-cost PV panels available for low- and middle-income countries such as Pakistan[54] or sub-Saharan Africa.[55] It is challenging to directly attribute and quantify this unintended effect to the IRA. If we explore the counterfactual and imagine the US having no trade barriers to Chinese PV, imports would be in the order of current added PV capacity, i.e., 35 GW, which is more than the total Pakistani PV added capacity in 2024, but a small number compared to the 600 GW installed globally in 2024 and the 540 GW Chinese PV module manufacturing capacity.[56] [57]

As such, the impact of the US market on global decarbonization efforts is most likely neutral or at most marginal. This may be of little consolation to individual businesses or to people losing their employment in the up and down of the US decarbonization but might mitigate some concern as to the global decarbonization impacts.

[54] World Economic Forum, 2024, **Pakistan is experiencing a solar power boom. Here's what we can learn from it**

[55] The Telegraph, 2024, **Why Africa is on the brink of solar power revolution**

[56] Solar Power Europe, 2025, **Global Market Outlook for Solar Power 2025-2029**

[57] International Energy Agency, 2024, **Energy Technology Perspectives 2024**

Impacts on global development prospects

There are many reasons to assume that co-benefits for global development deriving from the IRA would be welcomed by people living in low- and middle-income countries:

> With a number of countries struggling to provide reliable energy access and economic development opportunities to their citizens, there is a clear need to improve energy access and economic growth in low-income countries.

> According to the World Bank, Sub-Saharan Africa had 16% of the world population in 2024, but 67% of people living in extreme poverty. Overall, 3.5 billion people – or 44% of the global population – live on less than $6.85 per day, almost the same number as in 1990.[58]

> 1.18 billion people live in energy poverty, that is, they show no statistical evidence of electricity usage. Over 657 million people are energy-poor in Sub-Saharan Africa alone.[59]

> As economic development is still correlated with higher greenhouse gas emissions under business-as-usual, providing lower cost access to renewable energy can allow over 1 billion people to exit energy poverty without increasing greenhouse gas emissions.

> Sub-Saharan Africa is a key geography for remedying economic and energy poverty, despite being a region rich in natural resources and holding about 30% of global critical minerals, resources at the centre of geopolitical competition.[60]

The IRA did not include provisions to support low-carbon energy access and economic development in low-income countries. There was the implication that the increase in volumes would lead to economies of scale and, thus, lower costs for cleantech globally. So far, there has been no evidence to substantiate this hope and with main the IRA provisions winding down, there is very little prospect for this second-order effect to materialise. It appears that cleantech policy and

[58] World Bank, 2024, **Poverty, Prosperity, and Planet Report 2024: Pathways Out of the Polycrisis**

[59] Brian Min, Zachary P. O'Keeffe, Babatunde Abidoye, Kwawu Mensan Gaba, Trevor Monroe, Benjamin P. Stewart, Kim Baugh, Bruno Sánchez-Andrade Nuño, 2024, **Lost in the Dark: A Survey of Energy Poverty from Space**

[60] Wenjie Chen, Athene Laws, and Nico Valckx, 2024, **Harnessing Sub-Saharan Africa's Critical Mineral Wealth**

economics in China have a significantly larger impact on global low-carbon energy access.[61]

Linked to the idea of the IRA becoming a driver for global decarbonization was also an implied opportunity for low- and middle-income countries to not only buy lower-cost cleantech, but that some part of the supply chain and manufacturing ecosystem could eventually be located in such countries, especially if these are allies and could qualify for friend- and nearshoring. This idea is especially prominent in conversations around the supply of transition minerals, key ingredients for cleantech and global decarbonization.

While this is meant partly to counter the Chinese investment offer and while there is a clear argument for securing supply chains for transition minerals, no such development impacts have yet materialized. Even though there are several projects in countries such as Angola, especially the Lobito Corridor,[62] and Chile,[63] these have not yet led to significant or measurable development impacts in the countries in question.

Geopolitics

While the IRA is primarily a domestic policy aimed at increasing manufacturing in the US with the goal of reducing greenhouse gas emissions, some of its provisions show an interest in geopolitics.

Initial tensions related to the IRA with close allies such as the EU – especially car-exporting Germany – or South Korea have been mostly defused through diplomacy and outreach. Testament to this fact is that until now, only China has filed an official complaint about the IRA at the World Trade Organization.

One striking example is the special treatment for EV batteries and minerals they contain coming from so-called foreign entities of concern, which covers, among others, China. While this undeniably has an impact on the prospect for Chinese exports in these fields, the US market remains just one among many and overall, there is still some space for Chinese cleantech exports into the US market. Interestingly, the policy line was further accentuated for solar and wind projects

[61] EMBER, 2025, **The first evidence of a take-off in solar in Africa**

[62] Atlantic Council, 2024, **What to know about the Lobito Corridor—and how it may change how minerals move**

[63] Baker Institute, 2024, **Chile's New Lithium Strategy: A Market Boost or Miss**?

with the passage of the One Big Beautiful Bill, providing geopolitical continuity. The tension between the United States and China permeates all domains of economic activity and affects countries interacting with the two global powers.

The question is how the IRA may shift geopolitical positioning in key third countries, including transition mineral rich countries such as Indonesia, where Chinese companies control over 75% of nickel refining capacity.[64] Since the IRA never provided incentives for investments outside the US, not even for opening new transition mineral supplies, it also had no leverage to drive countries' geopolitical positioning.

With the competition between the US and China emerging as one of the dominant geopolitical tensions in the first half of the twenty-first century,[65] and with both countries vying for dominance in research and development, the ability to manufacture and deploy cleantech such as that supported by the IRA – primarily solar PV, batteries, wind power and clean hydrogen – becomes a key enabler to solidify one's geopolitical position and to instill confidence among allies that siding with the US will open doors to development, peace and prosperity.

The challenge is the uneven weight of China and the US in the cleantech world, with China's production capacity vastly outgunning that of the US (Table 5). Even with the substantial help of the IRA, such as increasing US solar module capacity to 57 GW in 2025,[66] the US will not be able to match China in terms of production volume any time soon. What the IRA provided, however, was a guarantee to stay in the race, buying American manufacturers time to catch up or develop new technologies. While this may sound like a small feat, it can prove to be a crucial advantage in the long run as experience shows that technologies have a very hard time being re-established once abandoned, especially when multiple geographies vie to attract them in a time of global industrial policy renaissance.[67]

[64] C4ADS, 2025, **Refining Power**

[65] S&P Global, 2024, **Top Geopolitical Risks of 2025**

[66] Solar Energy Industry Association, August 2025, **Solar and Storage Supply Chain Dashboard**

[67] International Monetary Fund, 2024, **Industrial Policy is Back But the Bar to Get it Right Is High**

Table 5: Manufacturing capacity for cleantech in the US and China (2023)

	EV battery[68]	Solar PV modules[69]	Wind nacelles[70]	Electrolyzers[71]
US	147 GWh	8.8 GW	7.3 GW	0.33 GW
China	1789 GWh	540 GW	88 GW	1.8 GW

Source: International Energy Agency 2024

That was at least the case until the One Big Beautiful Bill came to be. Now, with tax credits for cleantech eroding, the US seems to bet almost exclusively on data technology and AI to secure geopolitical dominance over China.[72] [73] [74]

[68] International Energy Agency, 2023, **Regional EV lithium-ion battery manufacturing capacity by manufacturer headquarters**

[69] International Energy Agency, 2024, **Energy Technology Perspectives 2024**

[70] Ibid.

[71] Ibid.

[72] Ian Bremmer, 2025, **The Politics, and Geopolitics, of Artificial Intelligence**

[73] Hal Brands, 2025, **How the US Could Lose the AI Arms Race to China**

[74] Atlantic Council, 2025, **Reading between the lines of the dueling US and Chinese AI action plans**

CONCLUSION AND OUTLOOK

The total volume of cleantech imports into the US increased since the IRA was introduced:

> EV imports are the fastest growth segment, climbing from around $5bn in 2021 to almost $23bn in 2024.

> Solar imports soared from below $7bn in 2021 to over $18bn in 2023.

> Battery imports grew from just under $15bn in 2021 to over $33bn in 2024.

> Wind imports, however, decreased from a high of over $4.5bn in 2020 to around $3.2bn in 2024.

Despite the many obstacles for EV imports and the fact that they can't benefit easily from the IRA provisions (except for commercial vehicles, including all leased cars), EV imports show a strong growth among cleantech imports into the US. This benefits traditional car exporters such as Germany, South Korea and Japan, but also increasingly Mexico. China was and is not a relevant source for EV imports into the US. However, China is still a key source for batteries, despite shrinking volumes.

As a result of geographic proximity combined with the USMCA trade benefits, both Mexico and Canada have significant trade in cleantech with the US, in the wind sector, batteries, and at least in Mexico's case, EVs. This situation is subject to change, not only because of changes in cleantech demand in the US, in particular for wind power, but also because of general trade frictions. These include the ongoing section 232 investigation into wind turbines,[75] and tariffs of up to 25% for Mexico and 35% for Canada on non-USMCA exports to the US.[76] A review of USMCA is foreseen for 2026, at which point the agreement can be extended for another 16 years.[77]

India is a small but rising star for solar and wind imports into the US up to now, possibly developing an alternative supply option for these technologies in the future. Currently, however, India faces a high tariff rate for most exports to the

[75] Bureau of Industry and Security, 2025, **Section 232 Investigations**

[76] White House, 2025, **Fact Sheet: President Donald J. Trump Adjusts Tariffs on Canada and Mexico to Minimize Disruption to the Automotive Industry**

[77] US Congressional Review Service, 2024, **U.S.-Mexico-Canada (USMCA) Trade Agreement**

US. The initial "reciprocal tariff rate" was set at 25% in July and was doubled to 50% as a secondary sanction for India's continued importing of Russian oil.[78] [79]

Until now, the US are not a key cleantech exporter and the only sector where these are noteworthy is batteries going to Mexico and Canada.

Domestic cleantech manufacturing has grown in the years since the IRA took effect, supplanting some imports, and powered by substantial foreign direct investment (FDI) in batteries, followed by smaller investments in solar and zero emissions vehicles. FDI in batteries dominated all cleantech FDI and was also the cleantech sector with the most domestic investment, followed by zero emissions vehicles.

FDI in US cleantech is more than double the amount of domestic cleantech investment and has tripled since the IRA was introduced. Cleantech FDI is still at a relatively moderate level of investment that is unlikely to cause major disruptions in the US or in the countries of origin. Total FDI in the US was not affected. Total FDI in the US increased by $332.1bn in 2024, driven primarily by investments from Europe, totalling $204.7bn.[80] Renewable energy-related FDI is estimated around $65bn for the five years from 2010 to 2014, followed by $90bn for 2015–2019 and over $140bn for 2020–2024, showing the rapid increase of clean energy FDI (5-year aggregated values), albeit starting from low levels.[81]

In summary, the IRA was much more a policy for the energy transition than for an energy revolution. As for its global impacts on decarbonization, development and geopolitics, early signs point to a mostly neutral impact. Given the short lifespan of the IRA and the many other changing factors, it is challenging to come to a final verdict on the global impact.

While we acknowledge that the available data does not lend itself to a final assessment, we nevertheless want to try a brief outlook into the future for cleantech in the US, given the changes in the funding regime imminently taking place.

[78] White House, 2025, **Executive Order: Further Modifying the Reciprocal Tariff Rates**

[79] White House, 2025, **Fact Sheet: President Donald J. Trump Addresses Threats to the United States by the Government of the Russian Federation**

[80] Bureau of Economic Analysis, 2025, **Direct Investment by Country and Industry, 2024**

[81] SELECTUSA, 2024, **Capitalizing on Clean Energy: Foreign Direct Investment Trends Post-Inflation Reduction Act**

The future for cleantech investment and trade in and with the United States

It is highly likely that cleantech roll-out will slow down, given the ending of several tax credits (for EVs in September 2025, consumer tax credits at the end of 2025, and clean power tax credits at the end of 2027) and the introduction of new foreign entity of concern requirements.

For the next two years at least, existing projects will come online and new capacity in the US power system will be overwhelmingly renewable. Utility solar generating capacity is expected to grow over 22% or 33 GW in 2026, while natural gas is set to grow by only 1.8 GW and coal to shrink by 3.4 GW. [82]

At the same time, electricity demand is growing in the US (expected 2.3% in 2025 and 3% in 2026)[83] and only solar and batteries offer readily available added capacity with wait times for gas turbines ranging 3–7 years and limited options in terms of retired conventional power plants available for reconnection.

Wind, especially offshore, will stagnate in the coming years even if the economics could work out without tax credits, given the impossibility to get projects permitted or even permitted projects built.

The electrification of road transport and homes will most likely slow down considerably with impacts for manufacturers' strategies and portfolios, even though some states move forward, such as New York which banned new gas in most residential new buildings from 2026 on.[84] The attractiveness of clean options will now depend on the relative cost of gasoline and natural gas, possibly supported by local and state subsidies, but not federal tax credits.

As for hydrogen and the linked electrolyzers, the relaxation of the clean requirements passed within the One Big Beautiful Bill will allow their continuation at a low level. On the other hand, many investors and projects have faltered and moved on given the long wait, implying that hydrogen won't be able to make up for lost time and rather grow as a niche product. Projections see

[82] US Energy Information Administration, September 2025, **Short Term Energy Outlook**

[83] ibid.

[84] New York Assembly, 2025, **The ALL-ELECTRIC BUILDINGS LAW: What it means for you**

most hydrogen continue to come from fossil sources, with some carbon capture and storage, but negligible amounts from electrolysis.[85]

The bottom line is that, without regulation or a clear price signal, incentives alone won't suffice for a full-scale energy transformation in the US.

Given the rapid expansion of data centres and the growth in power demand, electricity tariffs will go up (an estimated 4.5% in 2025 and 4% in 2026), [86] increasing pressure on consumers and businesses to reduce consumption or start generating their own power through installing solar PV with batteries. Costs for installing solar PV in the US are significantly higher than in other markets, such as Australia,[87] mostly due to inefficient regulation and permitting. Reducing these so-called soft costs could far outweigh the loss in tax credits and bring the US back on the track towards decarbonization.

[85] US Energy Information Administration, 2025, **Annual Energy Outlook 2025, Table 19**

[86] US Energy Information Administration, September 2025, **Short Term Energy Outlook**

[87] Saul Griffith, July 2025, **Make Electricity Cheap Again**