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AMERICA'S CARBON ADVANTAGE 2025

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ABOUT

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EXECUTIVE SUMMARY

The United States maintains a strong carbon efficiency advantage. This means that in most sectors across the economy, American firms produce the same or similar goods as their competitors with fewer emissions. Goods manufactured in the U.S. are more than 2X more carbon-efficient than the world average and about 4X more carbon-efficient than those manufactured in China.

The Climate Leadership Council pioneered research in this area with the publication of "America's Carbon Advantage" in 2020. Our latest work uses updated data to re-confirm findings on the U.S. carbon advantage while providing a closer look at the underlying reasons for it: fundamental differences in energy and industrial practices across major economies.

Differences in the carbon efficiency of production around the world demonstrate that—particularly for energy-intensive industries—**where something is made matters**. Which countries dominate production and supply the global market can have a significant impact on global emissions.

KEY FINDINGS OF THIS ANALYSIS INCLUDE:

2x

The U.S. maintains a carbon advantage over major economies. The U.S. is more than 2X more carbon-efficient than the world average.

The U.S. carbon advantage is driven by fundamental differences in energy efficiency, electricity mix, and direct industrial energy use.

The U.S. has improved its carbon efficiency dramatically over the last two decades in comparison to other major economies.

4x

The second largest manufacturer in the world (U.S.) is about 4x more carbon-efficient than largest (China).

Emerging and developing economies are growing rapidly with a continued reliance on high-emitting energy sources.

This advantage will persist in the years and decades ahead, so long as U.S. manufacturers maintain their commitment to innovation and global leadership.

WHY A CARBON ADVANTAGE MATTERS

Policymakers in the U.S. and abroad are exploring trade policies to reward lower carbon production. Based on the evidence in this analysis, a trade system that rewards carbon-efficient manufacturers would position American firms to gain global market share. Recognition of carbon intensity differences can also hold higher-carbon competitors accountable. When more demand is met by innovative producers, global emissions stand to fall.

INTRODUCTION

The global economy is increasingly grappling with a new force in the trading system: border measures that differentiate between products based on environmental impact. Already, the European Union and United Kingdom are at various stages of implementing their Carbon Border Adjustment Mechanisms (CBAMs).[1] Countries as diverse as Australia,[2] Japan,[3] and India[4] are exploring similar approaches. Advanced discussions and a variety of proposals from the U.S. Senate indicate interest here at home. In all, countries that make up more than 60% of the global market are exploring these border measures.

In 2020, the Council's "America's Carbon Advantage" report identified, for the first time, differences in the emissions intensity of manufacturing across economic sectors for the global economy and individual countries.[5] Later analyses confirmed the report's findings: the U.S. is able to produce the same goods as global competitors with significantly fewer emissions per dollar of value.[6] The U.S. enjoys a carbon advantage against the vast majority of trading partners and particularly wide advantages over existing and emerging manufacturing powerhouses like China and India.

Differences in carbon efficiency around the world are both a challenge and an opportunity. The challenge lies in addressing climate change. We will not meaningfully reduce global emissions unless countries, including and especially emerging markets, see clear incentives to decarbonize their economies.

The opportunity is ours to take hold of. A global economy that values lower-carbon production will benefit efficient American firms.

This report updates the 2020 analysis and identifies similar trends: the U.S. maintains a significant carbon advantage against international competitors. It relies on the best publicly available data sets for trade, energy production and use, manufacturing output, and emissions, looking as far back as 1990 and as recently as 2023.

Section 1 provides updated data for differences in the carbon intensity of production across sectors between the U.S. and major economies. Section 2 explores the three most significant contributors to the carbon advantage. Section 3 contextualizes the carbon advantage against historical trends in efficiency and energy use in the U.S. and other major economies. Section 4 compares the U.S. to China, the largest global manufacturer and greenhouse gas emitter. Section 5 explores what carbon intensity and economic trends in emerging and developing countries tell us about the future of decarbonization.

METHODS

The Organization for Economic Cooperation and Development (OECD) periodically releases international trade data; this analysis reflects its 2023 release of input-output data from trade years 2019 and 2020,[7] overlaid with compatible emissions data.[8] The Council commissioned Phylleos to conduct an analysis of the carbon embodied in global trade. They calculated the emissions intensity of 45 highly aggregated economic sectors across 77 individual countries, including a Rest of World category. This analysis focuses on 18 energy, industrial, and manufacturing sectors.

Recognizing that the product of one sector is a necessary input for another, the analysis utilizes the Leontief Inverse Matrix to develop coefficients for the carbon-intensity of production by sector and by country for all supply chain inputs. In the parlance of greenhouse gas emissions scope, this analysis accounts for CO_2e scope 1, scope 2, and upstream scope 3 emissions related to energy use.[9]

To make inter-country comparisons more straightforward, the Council weights embodied emissions associated with economic output from each sector and country relative to the carbon intensity of U.S. output in the sector (U.S. = 1.0).

Historical data for further analysis was sourced from the International Energy Agency (IEA),[10] World Bank,[11] Bureau of Labor Statistics (BLS),[12] and Our World in Data.[13]

Table 1: America's carbon efficiency advantage by industrial sector vs. BRIC, EU, & USMCA Countries

	U.S.	Brazil	Canada	China	EU	India	Mexico	Russia	World
Mining and quarrying, energy producing products	1.0	1.2	2.2	1.9	1.5	1.7	1.0	1.6	1.2
Mining and quarrying, non-energy producing products	1.0	0.9	1.2	3.8	1.3	2.3	1.2	0.7	2.2
Mining support service activities	1.0	1.4	2.9	5.7	3.1	2.0	1.8	7.3	3.4
Wood and products of wood and cork	1.0	1.3	2.1	1.6	0.9	1.3	1.8	3.0	1.4
Paper products and printing	1.0	1.8	4.2	2.2	1.0	3.6	1.0	3.3	1.7
Coke and refined petroleum products	1.0	1.2	1.6	1.5	1.1	1.7	0.9	1.7	1.2
Chemical and chemical products	1.0	1.3	1.5	2.4	0.9	1.6	1.0	5.3	1.8
Pharmaceuticals, medicinal chemical and botanical products	1.0	3.7	3.1	6.6	2.0	6.9	8.5	7.3	3.7
Rubber and plastics products	1.0	1.9	1.2	2.7	1.0	2.7	1.5	4.6	1.9
Other non-metallic mineral products	1.0	2.2	1.2	2.1	1.3	3.8	0.9	3.8	2.0
Basic metals	1.0	2.2	1.3	2.7	1.2	3.5	1.3	5.0	2.3
Fabricated metal products	1.0	2.0	1.2	4.0	1.0	3.9	1.9	5.1	2.4
Computer, electronic and optical equipment	1.0	3.7	2.6	7.1	2.7	17.6	4.4	8.5	5.3
Electrical equipment	1.0	2.2	1.4	3.8	1.2	6.7	1.9	6.2	2.8
Machinery and equipment, nec	1.0	1.8	1.2	3.7	1.0	6.2	1.5	5.7	2.4
Motor vehicles, trailers and semi-trailers	1.0	1.8	1.1	2.6	1.0	5.5	1.4	3.2	1.7
Other transport equipment	1.0	2.0	1.3	5.3	1.3	6.2	2.0	7.1	2.7
Manufacturing nec; repair and installation of machinery and equipment	1.0	1.3	1.3	2.6	0.7	2.9	1.4	3.9	1.6
Economy-Wide	**1.0**	**2.3**	**1.5**	**3.6**	**1.0**	**4.4**	**1.7**	**5.4**	**2.2**

Source: Phylleos and author calculations based on data from the OECD.[14]

U.S. Carbon Advantage (foreign competitors less carbon efficient)

U.S. Carbon Disadvantage (foreign competitors more carbon efficient)

U.S. Carbon Efficiency or Equivalent

1. THE U.S. MAINTAINS A CARBON ADVANTAGE OVER MAJOR ECONOMIES

The U.S. is a global leader in carbon-efficient manufacturing of products across the economy. **Table 1** displays the relative carbon efficiency of aggregated sectors for the largest U.S. partners across major trading blocs: BRIC (Brazil, Russia, India, China), EU (a weighted average for the 27 European Union member states), and USMCA (U.S. Mexico-Canada Agreement) countries.

In **Table 1**, indexed values greater than 1.0 (shown in red) indicate sectors in which the U.S. produces the same value of product with fewer emissions than a competing economy. Put simply, the red values show where the U.S. has a carbon advantage. Indexed values less than 1.0 (shown in blue) mark the cases in which competing economies produce with fewer emissions per value of good than the U.S.—these are the less common instances where the U.S. does not currently have a carbon advantage. Values of 1.0 (formatted in white) highlight a carbon efficiency equivalence between U.S. and foreign production.

The U.S. is more carbon-efficient than most major trading partners at the economy-wide level. Closest to the U.S. in carbon intensity are the EU (roughly equivalent), Canada, and Mexico (50%-70% more carbon-intensive). BRIC countries require far more emissions to create the same dollar of value and are 2-5X more carbon-intensive than the U.S. The U.S. is also more carbon-efficient than the global average, requiring 45% the emissions of the global economy to create the same dollar of value.

Note that the economic sectors used by OECD and listed in **Table 1** are broad. Diverse activities are condensed into single sectors like "chemicals and chemical products" or "machinery and equipment manufacturing." Although this aggregation limits insights into specific products, using highly aggregated sectors allows for better comparisons across countries. The data underpinning this analysis is economic data self-reported by covered countries to the OECD.

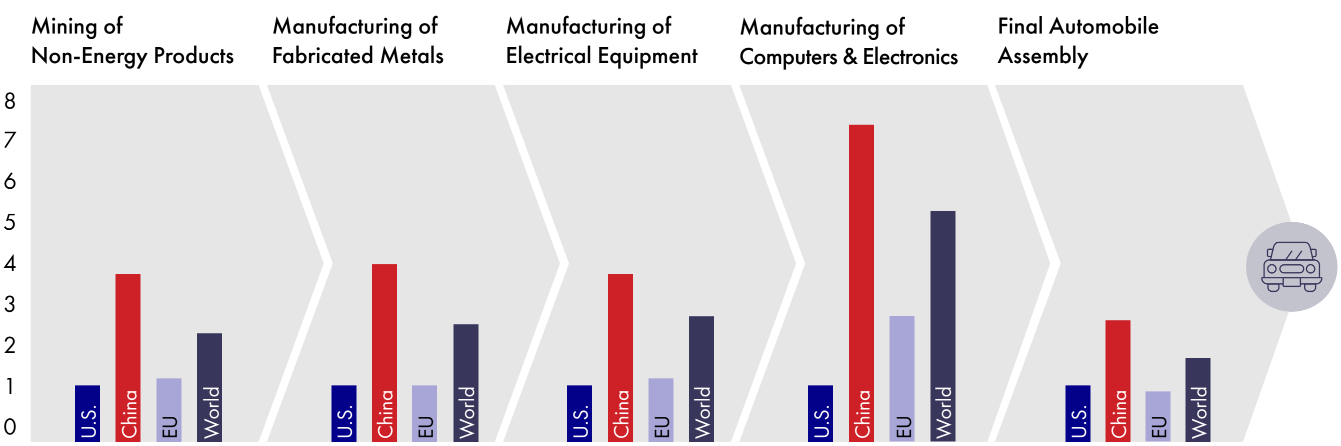
The data in Table 1 accounts for full supply chain emissions, but it's worth noting that differences in the carbon intensity of production often grow across a supply chain. Lower-carbon manufacturing of primary industrial goods allows for lower-carbon intermediate goods and so on. This is perhaps most apparent in the manufacturing of complex goods.

Consider the motor-vehicle supply chain (see **Figure 1**). At the mining stage, U.S. suppliers extract critical mineral inputs for semiconductors more efficiently than competitors. At the manufacturing stage, U.S. firms produce metals like steel and electrical equipment with a smaller emissions footprint. And U.S. firms are more carbon-efficient in the final assembly stage, making cabs, wheels, and bumpers with fewer emissions than competitors abroad. The U.S. carbon advantage through the supply chain allows us to produce vehicles with one-third the emissions of the largest automaker (China) and half the emissions of the world average.

"

The U.S. is also more carbon-efficient than the global average, requiring 45% the emissions of the global economy to create the same dollar of value.

Figure 1. Carbon intensity of motor vehicle production steps, indexed to the U.S., for the three largest vehicle producing economies and the world average



Source: Car manufacturing volumes from the International Organization of Motor Vehicle Manufacturers,[15] carbon intensity from Phylleos.

2. FOUNDATIONS OF THE U.S. CARBON ADVANTAGE

Economy-wide differences in the carbon intensity of production are driven mostly by three key factors: energy efficiency, electricity mix, and direct industrial energy use.[16]

ENERGY EFFICIENCY

Energy efficiency describes the *amount* of energy required to produce the same value of product. U.S. industrial production is highly energy efficient due to a high degree of electrification and low amounts of system-wide heat losses.[17]

ELECTRICITY MIX

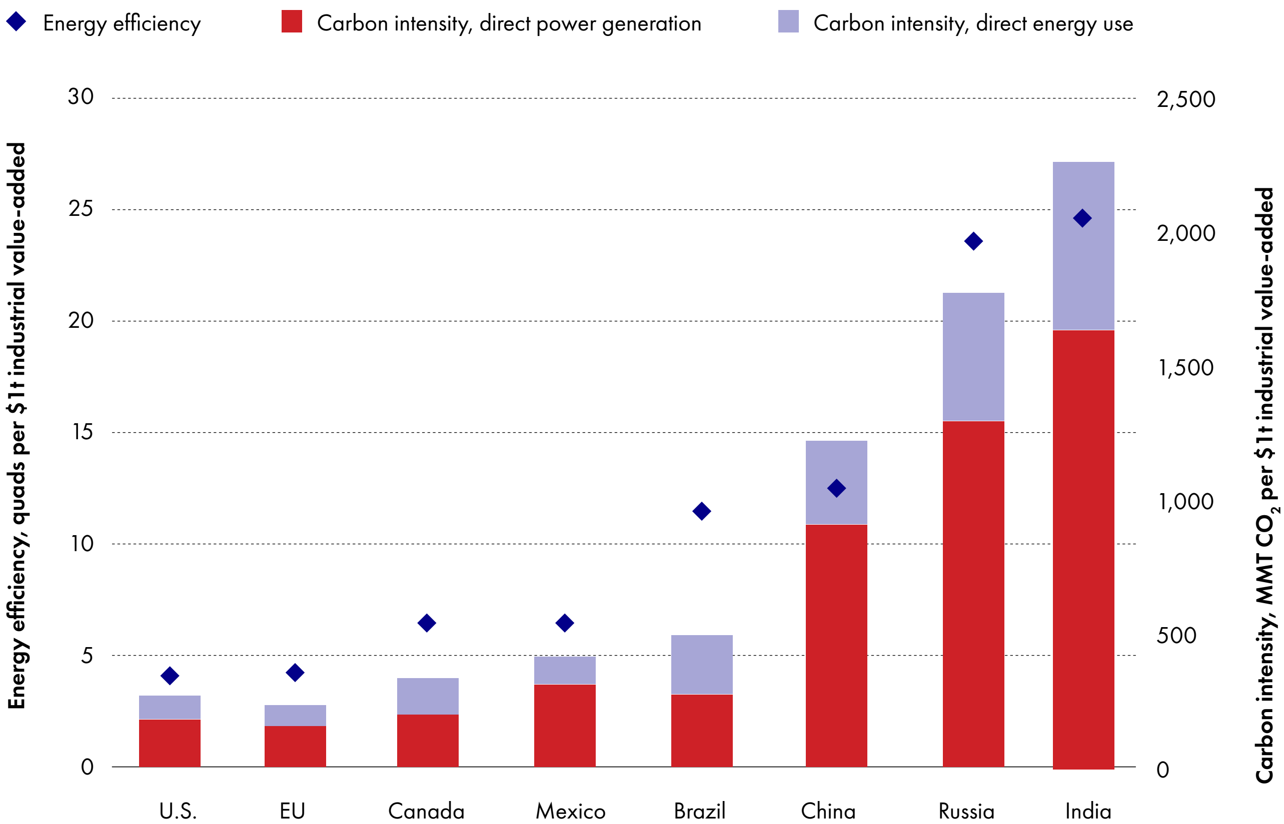
Power generation is responsible for a large share of industrial energy use. The U.S. electricity mix has increased its use of zero-carbon renewable sources like solar and wind, which supplement the zero-carbon power generated through the legacy nuclear and hydropower fleet. The U.S. power sector has also shifted from higher- to lower-emitting energy sources for power generation, including from coal to natural gas as the leading energy source.

DIRECT INDUSTRIAL ENERGY USE

Industrial facilities also generate energy onsite to produce steam, heat, and power or to facilitate chemical processes. U.S. facilities that produce energy onsite have largely shifted to lower-emitting energy sources like natural gas, zero-carbon renewables, or recycled heat.

These three components—energy efficiency, carbon intensity of power generation, and carbon intensity of direct energy use—are illustrated in **Figure 2**. Together, study of these three variables shows that U.S. industry uses less, more carbon-efficient energy to produce the same value of product (see **Figure 2**).

Figure 2. Energy efficiency, carbon intensity of purchased power, and carbon intensity of onsite energy use, U.S. vs. BRIC, EU, & USMCA (2022)



Source: IEA, World Bank, and BLS based on authors calculations.[18]

Industrial value-added describes the economic value that industry contributes by transforming raw materials into finished goods or services. The diamonds indicate how much energy is needed to produce $1 trillion value-added. The red and blue bars represent how much CO_2 *is released in production of $1 trillion value-added from purchased power generation and onsite energy use, respectively.*

Note that energy efficiency is interconnected with the carbon intensity of power generation and direct energy use. When fuel mixture is held constant, a facility that requires less energy to produce the same product value will release fewer emissions than one that requires more energy. Energy-efficient facilities that also use a low-carbon fuel mixture will generate even fewer emissions to produce the same product value. U.S. facilities fall into this category.

Other factors contribute to the U.S. carbon advantage in the production of specific goods. For example, the U.S. tends to use natural gas as a feedstock for ammonia production rather than coal. This feedstock preference allows U.S. firms to produce ammonia, an important input for fertilizers and water purification, with 30% fewer emissions than the global average.[19] And in steel production, American firms pioneered and widely adopted electric arc furnace (EAF) technologies. This process preference has made U.S. steel manufacturers the cleanest in the world.[20]

3. THE U.S. HAS OUTPACED OTHER MAJOR ECONOMIES IN BUILDING ITS CARBON ADVANTAGE

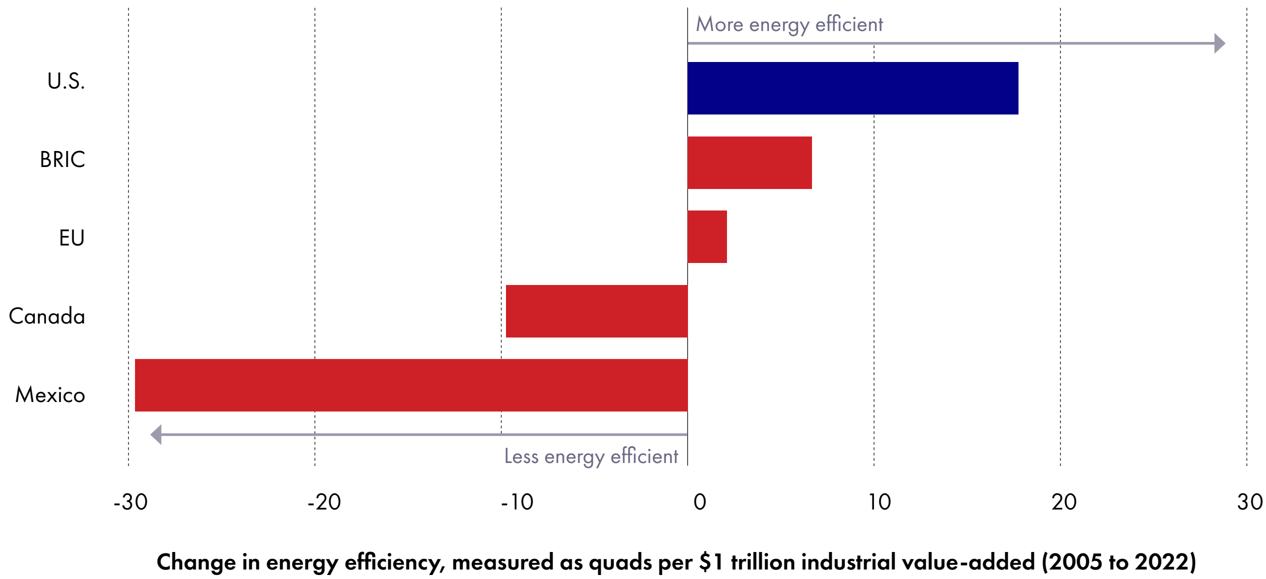
The U.S. carbon advantage shown in Table 1 is a snapshot in time. Historical data allows us to examine how the U.S. has improved its carbon efficiency dramatically over the last two decades in comparison to other major economies.

First, the U.S. has invested in energy efficiency measures to reduce the amount of energy needed to create the same value of product. As shown in **Figure 3**, the U.S. improved the efficiency of energy in industrial production by nearly 20%, a margin that was significantly greater than BRIC (7%), EU (2%), and USMCA competitors (-10% for Canada and -30% for Mexico).

Moreover, the U.S. has transitioned to lower-emitting energy sources. shows that compared to other major economies, the U.S. has lowered the carbon intensity of its power generation.

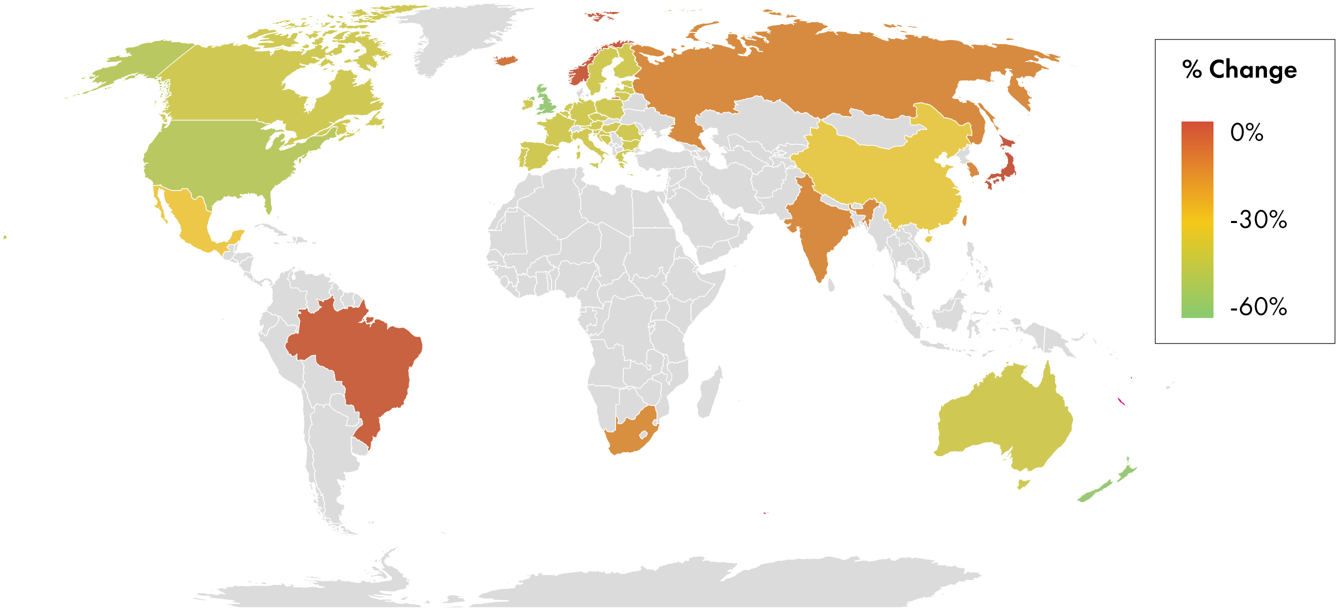
As U.S. firms have shifted to a considerably lower carbon mixture, other economies have moved more modestly, or even in the wrong direction. For example the EU, which has made major strides toward adopting renewables, has seen a much slower shift away from higher-emitting coal and oil use. Other economies like Japan, Brazil, Russia, and India have increased their use of high-emitting resources.

Figure 3. Change in energy efficiency between 2005 and 2022, U.S. vs. EU, BRIC, & USMCA partners



Source: IEA, World Bank, and BLS.[21]

Figure 4: Change in carbon intensity of the power grid, expressed as greenhouse gas emissions per MWh of power generation, between 2005 and 2022.

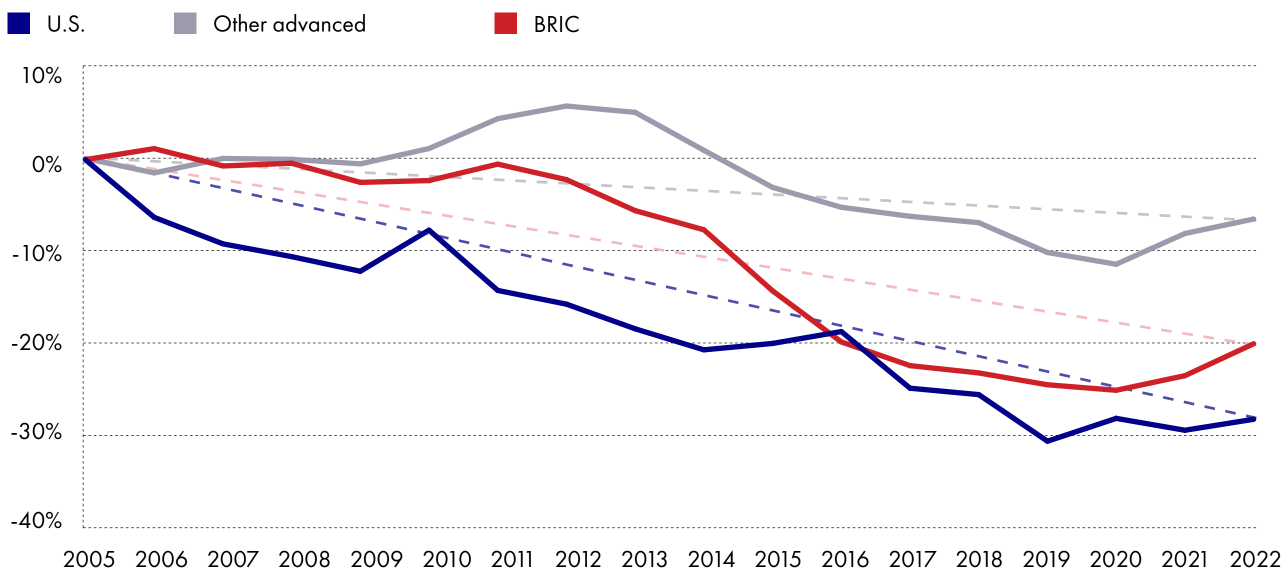


Source: Our World in Data.[22]

The U.S. has become more carbon-efficient over the last two decades because of all three variables – rapid energy efficiency improvements and a shift to lower-emitting energy sources in both the power sector and direct industrial energy use. These three metrics can be combined into a single indicator to track the emissions intensity of the industrial energy and manufacturing sectors over time.

Tracking emissions per dollar over time lets us observe the cumulative impact of American investment in energy efficiency, grid decarbonization, and switching to lower-carbon fuels (**Figure 5**). U.S. industry has reduced the emissions associated with each dollar of production value faster than other advanced and BRIC economies alike.

Figure 5: Change in CO_2 emissions per $ of industry value-add, relative to 2005 levels, for the U.S., other advanced, and BRIC economies



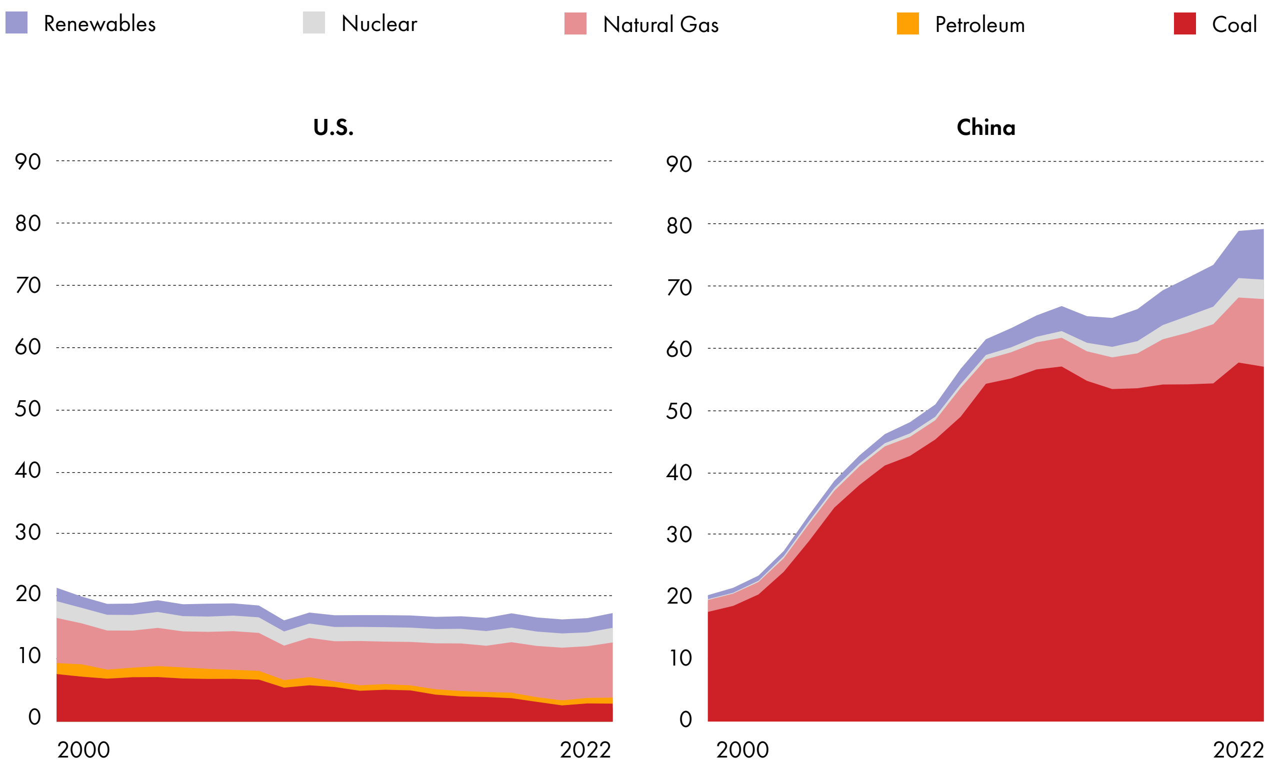
Source: IEA, World Bank, and BLS.[23]

4. THE U.S. COMPARED TO CHINA

China has built up its industrial production over the last twenty years to the size of the next nine largest manufacturing economies combined and now controls over 31% of global manufacturing.[24] The rapid ascendance of Chinese manufacturing has been fueled primarily by coal. This demonstrates the relevance of the carbon advantage literature: the Chinese commitment to growth over environmental performance has created significant competitive pressures on cleaner manufacturing firms while driving up global emissions.

The Chinese industrial sector increased its consumption of fossil fuels by over 300% between 2000 and 2022 (see **Figure 6**). In 2023, China added two-thirds of the world's new coal-fired power plants.[25] Although China has subtly diversified its primary energy mixture, which includes both embedded power and direct industrial energy use, coal still made up 72% of its primary energy mix in 2022. In comparison, coal accounts for 23% of the primary energy used by U.S. industry (see **Figure 6**).

Figure 6: Primary energy inputs to industry in the U.S and China (quadrillion Btu)



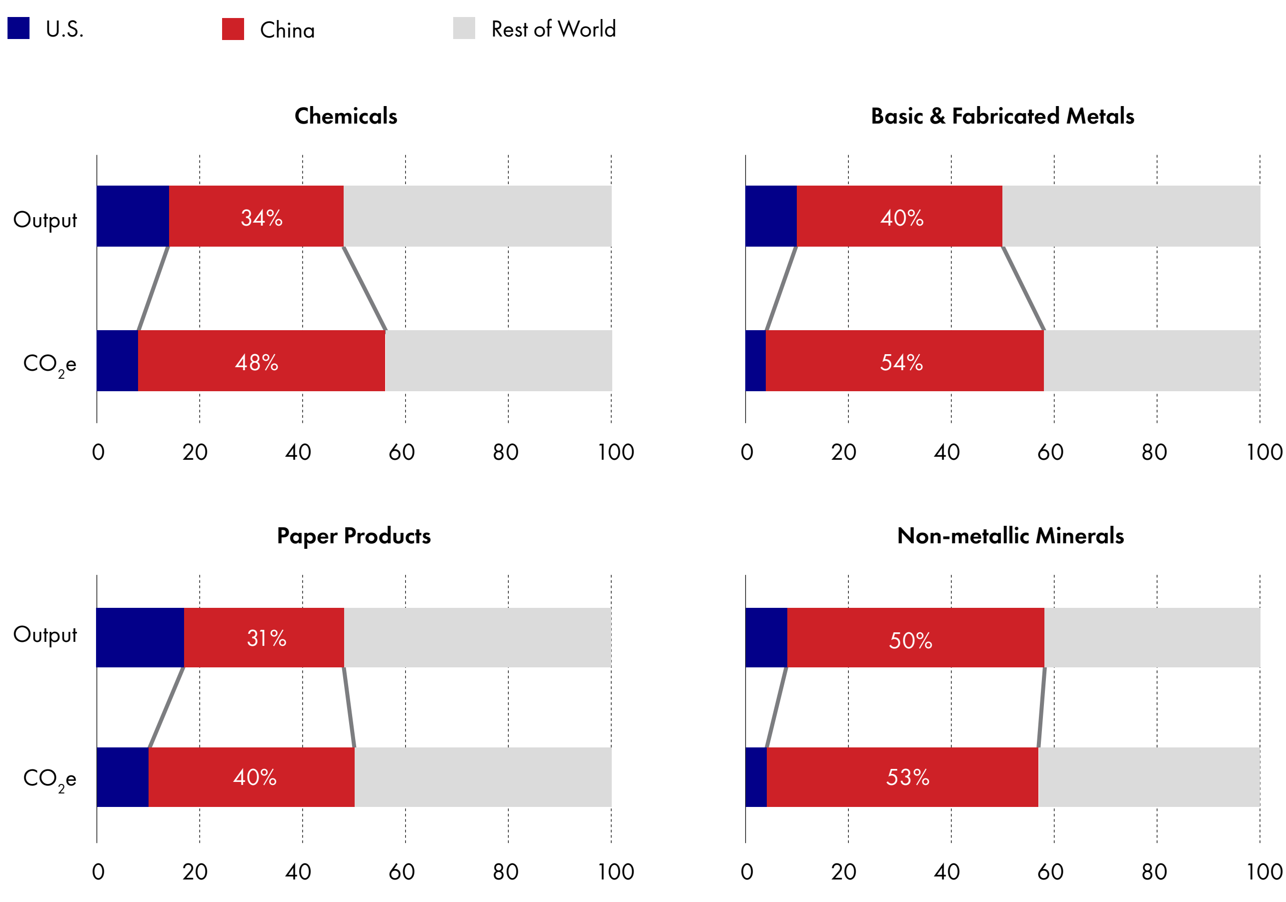
Source: IEA, WorldBank, and BLS.[26]

A consequence of this carbon-intensive energy mix is that China is responsible for a disproportionately large share of global emissions. In other words, China's share of global emissions is even larger than its share of manufacturing output (see **Figure 7**).

For example, in the manufacturing of energy-intensive goods like chemicals, basic and fabricated metals, paper, and non-metallic mineral products like glass and cement, China's emissions share is 3% to 14% larger than its output share. In contrast, the U.S.'s emissions share is roughly half that of its output share in each of these sectors.

Comparing the carbon intensity of manufacturing bases helps us to understand how global emissions will change with shifts in economic activity around the world. As Chinese production expands, the proportion of global goods made through carbon-intensive processes also increases. This shift in global production, in turn, drives up global emissions. Reversing the trend and driving production to more carbon-efficient manufacturing bases—like the U.S.—can lower global emissions by displacing carbon-intensive manufacturing elsewhere.

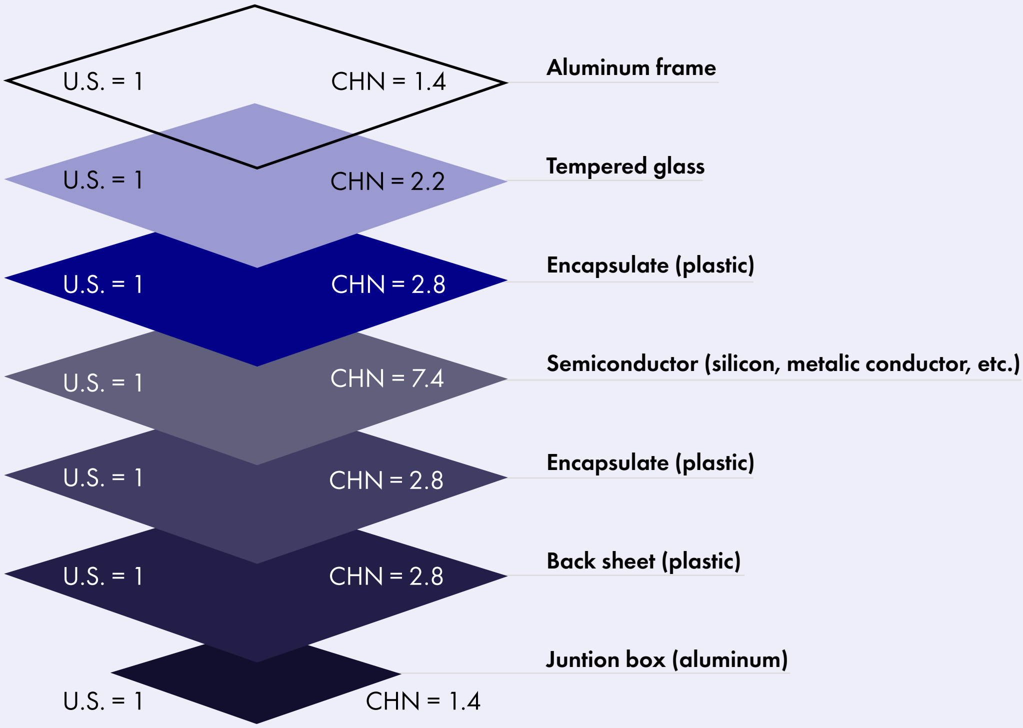
Figure 7: Sector-specific manufacturing output and emissions shares for energy-intensive manufacturing in the U.S., China, and Rest of World



Source: Phylleos.

CASE STUDY: SOLAR PHOTOVOLTAICS (PVS)

Figure 8: Carbon intensity of production for layers of the solar PV cell, U.S. and China (indexed)



Solar panels are complex products that require many material inputs that each have their own distinct supply chains. From the aluminum frame to the internal semiconductor, each layer of a typical solar panel contains many different components. Because the U.S. carbon advantage over China persists across manufacturing sectors, U.S. manufacturing of solar PV cells is 30% more carbon-efficient than Chinese production.[27] More innovative products, like thin film solar, allow some U.S. manufacturers to produce panels with 90% less greenhouse gas emissions than the silicon-based modules made in China.[28] Even so, China holds 80% market share in solar PV production.[29]

Sources: Osilla (image),[30] 8MSolar (background info),[31] Phylleos (carbon intensity values for sectors excl aluminum), JRC (aluminum carbon intensity).[32] Note that values correspond to sectors that include other products.

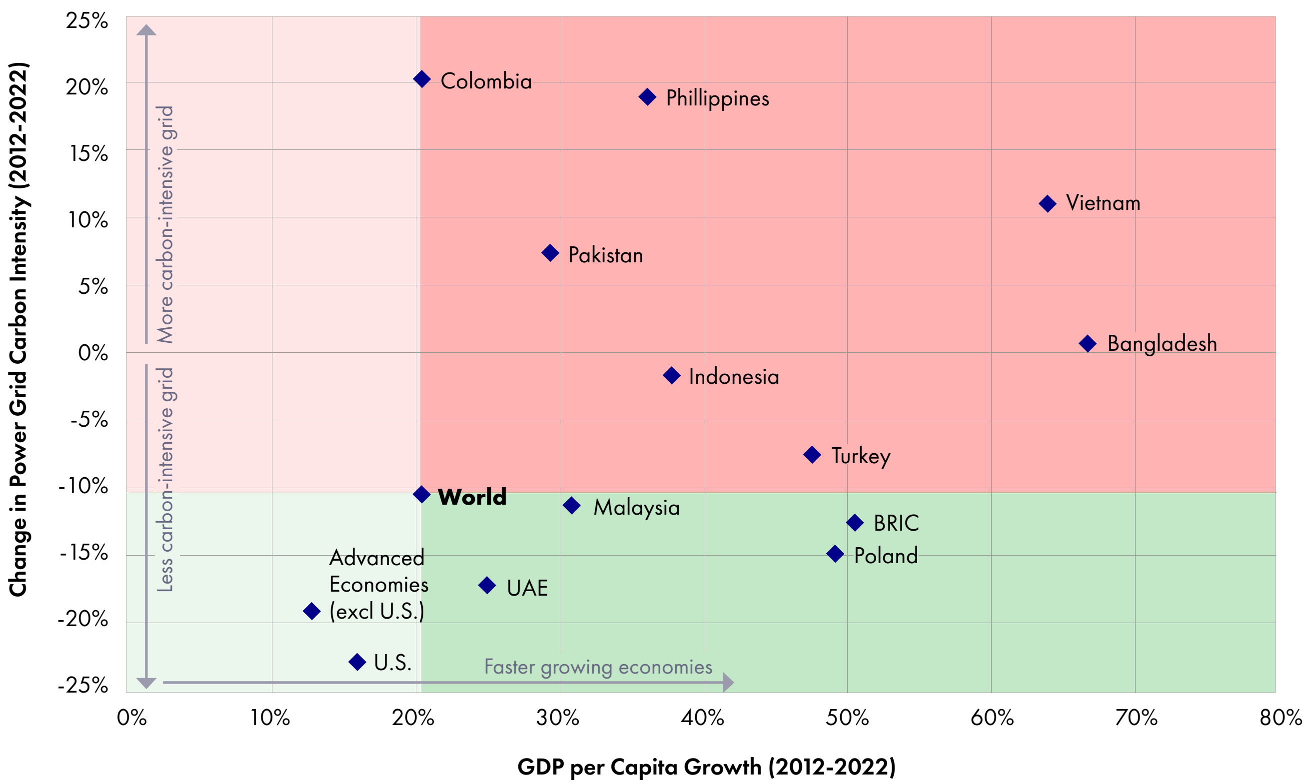
5. EMERGING & DEVELOPING ECONOMIES ARE GROWING THE FASTEST BUT DECARBONIZING THE SLOWEST

The recent history of greenhouse gas emissions growth has been driven by China's manufacturing boom, but future emissions growth will be characterized by trends in the world's fastest-growing emerging and developing economies.

Emerging market emissions are set to double by midcentury due to massive load growth and increased economic activity.[34] Current trends indicate that the markets that are growing the fastest are decarbonizing the slowest. Power grids in non-BRIC emerging markets, for example, are about as carbon-intensive as they were in 2010, even as load increased by over 40% between 2010 and 2022.[35]

The carbon intensity of global electricity production has fallen roughly 10% over the last decade. Of the ten non-BRIC emerging economies growing most rapidly (as measured by gross domestic product per capita), seven rely on power grids that are increasing in carbon intensity or decreasing in carbon intensity more slowly than the world average (see **Figure 9**).

Figure 9: Changes in power grid carbon intensity and GDP per capita (2012-2022) for the fastest growing emerging markets with a GDP greater than $300B in 2022



Quadrants are divided based on the world average for each variable. Economies in the dark red quadrant are growing faster but decarbonizing slower than the world average. Source: Our World in Data.[36]

The seven economies in the dark red quadrant of **Figure 9**—Bangladesh, Colombia, Indonesia, Turkey, Pakistan, the Philippines, and Vietnam—are growing faster but decarbonizing their power grids slower than the world average. These countries are experiencing rapid economic growth and, under a business-as-usual scenario, will make up a projected 14% of global emissions by 2050. That's twice as much as the 7% of global emissions that these seven countries represent today.

Like in China, the primary driver of increased carbon intensity is increased coal-fired power buildout to match massive load growth. In the last ten years, for example, Vietnam has more than tripled the size of its operating coal fleet.[37] Vietnam alone makes up nearly 10% of the pre-construction, planned, and in-construction coal-fired power capacity in non-BRIC emerging markets.[38]

Energy demand will continue to rise due to high population growth, increased industrial activity, urbanization, and improvements to living standards.[39] By 2026, over 30% of new electricity demand worldwide is expected to come from non-BRIC emerging markets.[40] If paired with stagnant or increasing carbon intensity driven by a persistent reliance on coal, energy use in emerging and developing markets will grow through high-carbon production processes.

The world's poorest economies should not be expected to prioritize climate efforts at the expense of building a richer and more secure future. Still, the predictable increase in coal-fired industrial capacity may present long term challenges to American firms making major investments in innovation and decarbonization. It also presents an opportunity for American firms producing the goods and services needed to industrialize and decarbonize these rapidly growing markets.

CONCLUSION

The U.S. carbon efficiency advantage is strong and is the product of American manufacturers' investments in innovation, cleaner energy, and more efficient industrial processes. Differences in the carbon intensity of manufacturing between countries show us that the U.S. produces goods with fewer emissions across the economy. This variation between economies provides both a challenge and an opportunity.

The last two decades were characterized by a rapidly growing Chinese industrial sector that built enormous manufacturing capacity around higher-carbon, less efficient energy and industrial processes. As emerging economies grow into a larger share of global energy demand, the carbon efficiency of their production methods will become increasingly central to global climate progress.

Continued exploration of differences in carbon intensity and the underlying trends in energy and industrial efficiency is vital to illuminate the advantages that American firms have gained over their competitors. Recognition of carbon intensity differences can hold higher-carbon competitors accountable and provide new opportunities for the cleanest firms.

Within a global trading system that will increasingly value lower-carbon production, American firms are uniquely well positioned to claim more market share. This advantage will persist in the years and decades ahead, so long as U.S. manufacturers maintain their commitment to innovation and global leadership, and the U.S. policy environment supports them in this endeavor.

ENDNOTES

1 Daniel Hoenig, "Carbon Import Fees: Active and Proposed Policies," *Climate Leadership Council*, January 2025, https://clcouncil.org/report/carbon-import-fees-guide/.

2 "Australia's Carbon Leakage Review," *Australian Government: Department of Climate Change, Energy, the Environment and Water*, November 2024, https://www.dcceew.gov.au/climate-change/emissions-reduction/review-carbon-leakage.

3 "Establishment of a Working Group on Efficient Collection and Strategic Use of Sustainability-Related Data for Creation of Sustainable Corporate Value," *Japanese Ministry of Economy, Trade, and Industry*, December 12, 2022, https://www.meti.go.jp/english/press/2022/1212_002.html.

4 "Govt mulls options to impose carbon tax on some imports," *The Times of India*, August 10, 2023, https://timesofindia.indiatimes.com/business/india-business/govt-mulls-options-to-impose-carbon-tax-on-some-imports/articleshow/102588226.cms.

5 Greg Bertelsen and Catrina Rorke, "America's Carbon Advantage," *Climate Leadership Council*, September 2020, https://clcouncil.org/reports/americas-carbon-advantage.pdf.

6 "Greenhouse Gas Footprints (GHGFP): Principal Indicators," *Organization for Economic Cooperation and Development (OECD) Data Explorer*, last updated July 15, 2024, https://data-explorer.oecd.org/vis?tm=DF_ICIO_GHG_EXPD_2023&snb=1&fc=Unit%20of%20measure&fs[0]=Unit%20of%20measure%2C0%7CTonnes%20of%20CO2-equivalent%20per%20US%20dollar%23T_CO2E_USD%23&pg=0&df[ds]=dsDisseminateFinalDMZ&df[id]=DSD_ICIO_GHG_MAIN%40DF_ICIO_GHG_MAIN_2023&df[ag]=OECD.STI.PIE&df[vs]=1.0&dq=A....&pd=%2C&to[TIME_PERIOD]=false.

7 Data and analysis from *Phylleos*; economic and trade data retrieved from "Inter-Country Input- Output Tables," *OECD*, 2023, accessed November 2024, https://www.oecd.org/en/data/datasets/inter-country-input-output-tables.html.

8 Emissions from fuel combustion only, expressed in CO_2 equivalency (CO_2e) for seven covered greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen trifluoride (NF_3) as stated in "Air and GHG Emissions," *OECD*, https://www.oecd.org/en/data/indicators/air-and-ghg-emissions.html; emissions data extracted from "Greenhouse Gas Footprints (GHGFP): Emissions embodied in production by scope," OECD Data Explorer, 2023, available at https://data-explorer.oecd.org

9 "The Greenhouse Gas Protocol," *World Resources Institute and World Business Council for Sustainable Development*, https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf.

10 "World Energy Statistics and Balances," *International Energy Agency (IEA)*, last updated July 2024, https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances.

11 "Manufacturing, value-added (current U.S.$)," *World Bank Group*, last accessed in December 2024, https://data.worldbank.org/indicator/NV.IND.MANF.CD.

12 "Consumer Price Index for All Urban Consumers (CPI-U)," *U.S. Bureau of Labor Statistics (BLS)*, data extracted in December 2024, https://data.bls.gov/timeseries/CUUR0000SA0?years_option=all_years.

13 "Carbon intensity of electricity generation," *Our World in Data*, last updated in June 2024, https://ourworldindata.org/grapher/carbon-intensity-electricity; "Electricity Mix," Our World in Data, last updated in January 2024, https://ourworldindata.org/electricity-mix.

14 Economic and trade data retrieved from "Inter-Country Input- Output Tables," *OECD*, emissions data retrieved from "Greenhouse Gas Footprints (GHGFP): Emissions embodied in production by scope," *OECD Data Explorer*.

15 Data from *The International Organization of Motor Vehicle Manufacturers (OICA)*, 2022, accessed at "Car Production by Country, 2024," *World Population Review*, https://worldpopulationreview.com/country-rankings/car-production-by-country.

16 Other contributing factors to the U.S. carbon advantage include lower process emissions, such as innovative U.S. ammonia production, or pathway-specific inputs such as a greater share of electric arc furnace steelmakers that use scrap materials as the primary production input.

17 "2023 Accomplishments for Industrial Efficiency and Decarbonization," *Department of Energy, Industrial Efficiency and Decarbonization Office*, February 2, 2024, https://www.energy.gov/eere/iedo/articles/2023-accomplishments-industrial-efficiency-and-decarbonization; "Use of energy explained: Energy efficiency and conservation," *U.S. Energy Information Administration (EIA)*, January 12, 2024, https://www.eia.gov/energyexplained/use-of-energy/efficiency-and-conservation.php.

18 Authors calculations based on "World Energy Statistics and Balances," *IEA*, "Manufacturing, value-added (current U.S.$)," *World Bank Group*, and "Consumer Price Index for All Urban Consumers (CPI-U)," *BLS*.

19 Catrina Rorke, "The U.S. Carbon Advantage in Chemicals Manufacturing," *Climate Leadership Council*, September 2022, https://clcouncil.org/reports/chemicals_advantage.pdf.

20 "Leveraging a Carbon Advantage: Impacts of a Border Carbon Adjustment and Carbon Fee on the U.S. Steel Industry," *Climate Leadership Council,* May 25, 2021, https://clcouncil.org/report/leveraging-a-carbon-advantage/; Greg Bertelsen and Catrina Rorke, "America's Carbon Advantage," *Climate Leadership Council*, September 2020, https://clcouncil.org/reports/americas-carbon-advantage.pdf.

21 Authors calculations based on "World Energy Statistics and Balances," *IEA*, "Manufacturing, value-added (current U.S.$)," *World Bank Group*, and "Consumer Price Index for All Urban Consumers (CPI-U)," *BLS*.

22 "Carbon intensity of electricity generation," *Our World in Data*, https://ourworldindata.org/grapher/carbon-intensity-electricity.

23 Authors calculations based on "World Energy Statistics and Balances," *IEA*, "Manufacturing, value-added (current U.S.$)," *World Bank Group*, and "Consumer Price Index for All Urban Consumers (CPI-U)," *BLS*.

24 Richard Baldwin, "China is the world's sole manufacturing superpower: A line sketch of the rise," *Centre for Economic Policy Research (CEPR)*, January 17, 2024, https://cepr.org/voxeu/columns/china-worlds-sole-manufacturing-superpower-line-sketch-rise.

25 "Boom and Bust Coal 2024," *Global Energy Monitor,* April 2024, https://globalenergymonitor.org/report/boom-and-bust-coal-2024/.

26 Authors calculations based on "World Energy Statistics and Balances," *IEA*, "Manufacturing, value-added (current U.S.$)," *World Bank Group*, and "Consumer Price Index for All Urban Consumers (CPI-U)," *BLS*.

27 Haoyue Liang and Fenggi You, "Reshoring silicon photovoltaics manufacturing contributes to decarbonization and climate change mitigation," *Nature Communications*, March 8, 2023, https://www.nature.com/articles/s41467-023-36827-z.

28 Shayla Ragimov, "Why We Should Leverage U.S. Solar's Carbon Advantage," *Climate Leadership Council*, April 29, 2022, https://clcouncil.org/blog/why-we-should-leverage-u-s-solars-carbon-advantage/.

29 From "Where are Solar Panels Made?" *Sunsave Energy*, December 4, 2024, https://www.sunsave.energy/solar-panels-advice/solar-energy/where-are-solar-panels-made. Data initially from "Solar PV manufacturing capacity and production by country and region, 2021-2027," IEA, November 23, 2022, https://www.iea.org/data-and-statistics/charts/solar-pv-manufacturing-capacity-and-production-by-country-and-region-2021-2027.

30 "How are Solar Panels Made? Step by Step Process," *Osilla*, https://www.ossila.com/pages/how-are-solar-panels-made.

31 Usman Noor, "What are photovoltaic cells (PV) and how do they work?" *8MSolar*, March 1, 2024, https://8msolar.com/what-are-photovoltaic-cells-pv-and-how-do-they-work/.

32 "JRC Technical Report: Greenhouse gas emission intensities of the steel, fertilisers, aluminium and cement industries in the EU and its main trading partners," *Joint Research Centre*, September 2023, https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/greenhouse-gas-emissions-manufacturing-what-difference-across-countries-2023-09-29_en, pg. 155-161.

33 Ibid.

34 Catrina Rorke, Greg Bertelsen, & Matthew C. Porterfield, "Prioritizing American Interests: A New Strategy for Global Decarbonization," *Climate Leadership Council*, September 2024, https://clcouncil.org/media/2024/12/Prioritizing-American-Interests_Dec2024.pdf.

35 "Carbon intensity of electricity generation," *Our World in Data*; "Electricity Mix," Our World in Data, https://ourworldindata.org/electricity-mix.

36 "Electricity Mix," *Our World in Data*, https://ourworldindata.org/electricity-mix; "GDP per Capita," *Our World in Data*, https://ourworldindata.org/grapher/gdp-per-capita-worldbank.

37 Lucy Hummer, Jeanette Lim, Jelena Babajeva, Claire Pitre, and Xing Zhang, "Just 15 countries account for 98% of new coal-power development," *Carbon Brief*, September 3, 2024, https://www.carbonbrief.org/guest-post-just-15-countries-account-for-98-of-new-coal-power-development/.

38 "Global Coal Plant Tracker," *Global Energy Monitor*, July 2024, https://globalenergymonitor.org/projects/global-coal-plant-tracker/.

39 Rebecca Kurland and Edwin Wachira, "Navigating the Future of Energy: The Growing Power Demand in Emerging Markets," *TCW*, August 2024, https://www.tcw.com/Insights/2024/2024-08-23-Sustainable-Insight?sc_lang=en#:~:text=Low%20income%20and%20emerging%20market,and%20investment%20in%20energy%20infrastructure.

40 "Electricity 2024," *IEA*, January 2024, https://www.iea.org/reports/electricity-2024/executive-summary#:~:text=Emerging%20and%20developing%20economies%20are,structure%20of%20its%20economy%20evolves.

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