The Clean Investment Monitor: Tracking Decarbonization Technology in the United States

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Executive Summary

Clean energy is quickly becoming one of the largest industries in the U.S. Across the economy, public and private investment in decarbonization is growing—accelerating manufacturing and the adoption of the technologies needed for clean electricity and transportation, building electrification, low-emission industrial production, and carbon management. However, there is currently no comprehensive tracking of actual investments in clean technology and infrastructure in the U.S., making it difficult to assess on-the-ground progress in the country's transition to a cleaner economy. In order to fill this gap, Rhodium Group and MIT's Center for Energy and Environmental Policy Research (CEEPR) have created the Clean Investment Monitor, which provides real-time, methodologically consistent tracking of all public and private investments in the manufacture and deployment of the full spectrum of greenhouse gas emission-reducing technologies in the U.S.

In our inaugural report, we find that in the past year, there was $213 billion in new clean investment across the economy—a 37% increase from the previous year and a 165% increase from five years ago. At this level, clean investment nationwide is larger than the annual GDP of 18 of the 50 U.S. states. The most rapid investment growth has been in clean technology manufacturing—with annual investment growing 125% year-on-year to $39 billion—and particularly within electric vehicle and solar manufacturing. Investment in clean energy production and industrial decarbonization rose 15% year-on-year to $61 billion. And household and business retail investment in purchasing and installing clean technologies like heat pumps and zero-emission vehicles (ZEVs) rose 32% year-on-year to $113 billion.

The Clean Investment Monitor catalogs public and private investments in a wide range of emission-reducing technologies and their input components. To create a historical baseline against which to assess recent clean investment developments in the U.S., the CIM includes all investments in our covered technologies since 2018. This results in a database with roughly 20,000 individual facilities, 3 million ZEV registrations, 20 million heat pump sales, and 4.5 million distributed electricity generation or storage installations. Detailed data is available at **cleaninvestmentmonitor.org**, including breakdowns of all investment trends highlighted in this report at the state level.

Introduction

In 2021 and 2022, the United States passed three major pieces of legislation that fund public investment and provide incentives for expanded private investment in the manufacture and deployment of greenhouse gas (GHG) emission-reducing technology in the United States: the Inflation Reduction Act (IRA), the Infrastructure Investment and Jobs Act (IIJA), and the CHIPS and Science Act. **Rhodium Group projects** that these investments will accelerate the pace of net GHG emission reductions in the U.S. to 29-42% below 2005 levels by 2030. Other analysts **have reached similar conclusions**. If recently passed federal legislation is complemented with federal regulatory action and new policy at the subnational level, Rhodium projects U.S. net GHG emissions will decline to 45-51% below 2005 levels by 2030, putting the U.S. 2030 commitment under the Paris Agreement within reach. In addition to reducing GHG emissions, this suite of legislation also seeks to incentivize the growth of new industries in the U.S., reduce economic vulnerability to disruptions in global clean energy supply chains, support economic diversification in regions of the country in which investment and employment in traditional industries is in decline, and encourage investment in communities that have been disproportionately impacted by pollution and energy development in the past.

The current data gap

Unfortunately, there has been a shortage of timely, robust, and methodologically consistent data to track actual investments in clean technology and infrastructure in the United States. Government data from the Bureau of Economic Analysis, the Census Bureau, and other sources are too aggregate to understand what's happening in the most important areas of GHG-reducing investment in the economy—clean energy, clean vehicles, building electrification, industrial decarbonization, and carbon management. Company announcements of intent to build new (or expand existing) facilities only capture a subset of clean investment activity and give little information about whether and how announcements translate into actual investments over time. Finally, information on the balance between public and private funding in new clean investment is currently limited. Data is available on the grants, loans, or loan guarantees from the IRA, IIJA, and CHIPS and Science Act, but this finance accounts for a minority of the expected public funding for GHG-reducing technology in the U.S. Tax credits will play a more significant role, data on which is limited by IRS confidentiality requirements and only published years after the credits are claimed by taxpayers.

Introducing the Clean Investment Monitor

To help fill this data gap, Rhodium Group and MIT's Center for Energy and Environmental Policy Research (CEEPR) have launched the Clean Investment Monitor (CIM). The CIM provides a comprehensive, real-time, methodologically consistent, and publicly available source of information on investment in the

manufacture and deployment of technologies that reduce GHG emissions in the U.S. This inaugural report introduces the CIM database and highlights key trends in clean investment in the U.S. at a national level, both before and after the adoption of the IIJA, IRA, and CHIPS and Science Act. Detailed data is available online at **www.cleaninvestmentmonitor.org**, as well as through Rhodium Group and Breakthrough Energy's **ClimateDeck** platform, including breakdowns of all investment trends highlighted in this report at the state level.

Rhodium and MIT will update the CIM database on a quarterly basis and publish regular reports on how investment trends are evolving. In the months ahead, Rhodium and MIT will publish two more detailed analyses: one on the estimates of the public investments associated with the IRA, IIJA, and CHIPS and Science Act—yielding an assessment of the public and private breakdown of investment—and a second report providing an initial assessment of how the current pace of investment compares to projections when the three laws were passed.

Methodology

The CIM seeks to catalog, in a methodologically consistent manner, investment in the manufacture and deployment of GHG emission-reducing technologies across the U.S. There is a wide range of technologies that have the potential to reduce GHG emissions, and each of those technologies has a wide range of input components. For analytical tractability and comparability of investment data over time, V1 of the CIM includes those technologies that are eligible for tax incentives under the IRA. Most of these technology categories are also eligible for grants, loans, or loan guarantees funded through the IRA, the IIJA, or the CHIPS and Science Act. Table A1 in the Appendix includes a detailed list of the technologies currently included in the CIM with the corresponding provision of the U.S. tax code under which they receive incentives.

To create a historical baseline against which to assess recent clean investment developments in the U.S., the CIM includes all investments in our covered technologies since 2018. This results in a database with roughly 20,000 individual facilities, 3 million zero-emission vehicle (ZEV) registrations, 20 million heat pump sales, and 4.5 million distributed electricity generation or storage installations as of Q2 2023. All investment figures are in 2022 U.S. dollars.

How we categorize investment

When the Bureau of Economic Analysis (BEA) reports **overall investment trends for the U.S. economy**, they capture both investment in structures and equipment (like factories) as well as the purchase of durable consumer goods (like automobiles). We have taken a similar approach with the CIM for comparability to BEA aggregate investment data. We break out clean investment into three "segments": investment in the manufacture of GHG emission-reducing technology

("Manufacturing"), and investment in the deployment of that technology, both to produce clean energy or decarbonize industrial production ("Energy and Industry") and through the purchase and installation of that technology by individual households and businesses ("Retail").

For the Manufacturing and Energy and Industry segments, we track investment at the individual project level through a combination of third-party data sources, company announcements, financial filings, and news reports. Projects are monitored from initial announcement through construction to operation. We only include projects as "announced" in our database when a specific location and timeline for the project has been specified and, in the case of larger projects, Front-end Engineering Design (FEED) work has begun. When project investment amounts are reported by the company, we use those in the CIM; otherwise, we estimate investment amounts using reported project-specific technology and capacity/production information and an investment cost model calibrated with recent data from comparable projects. Total investment costs are spread over the life of the reported construction period. When construction timelines are not available, they are estimated based on average construction times for similar projects.

For the Retail segment, we rely on third-party state-level data. For ZEVs, we combine state-level vehicle registration data by make and model from S&P Global with MSRP data from FuelEconomy.gov, Edmonds.com, and other sources. For heat pumps, we downscale national sales data from the Air-Conditioning, Heating and Refrigeration Institute (AHRI) and the federal Energy Star program to the state level using the Energy Information Administration's (EIA) Residential Energy Consumption Survey. We estimate investment cost using data from the EIA. In the case of distributed renewable electricity generation and storage, we use state-level installation data from the EIA and installation cost data from the National Renewable Energy Laboratory (NREL). For Retail, we treat all investment as occurring in the quarter in which the registration, sale, or installation is reported.

More information on our methodology is available **here**.

National Clean Investment Trends

The CIM currently has data through June 30, 2023. To assess annual investment trends in this report, we compare the July 1, 2022 through June 30, 2023 period (which we label as 2022/2023) to the same twelve-month period in previous years (which we label as 2018/2019, 2019/2020, 2020/2021, and 2021/2022).

In 2022/2023, we identified $213 billion in actual clean investment occurring across the U.S. (Figure 1). $213 billion is an increase of 37% from the previous year (2021/2022), and a 165% increase over the annual total five years ago. The most rapid investment growth this year has been in clean technology manufacturing, with annual investment growing 125% year-on-year to $39 billion. Investment in

clean energy production and industrial decarbonization rose 15% year-on-year to $61 billion. Retail investment in the purchase and installation of GHG emission-reducing technology rose 32% to $113 billion.

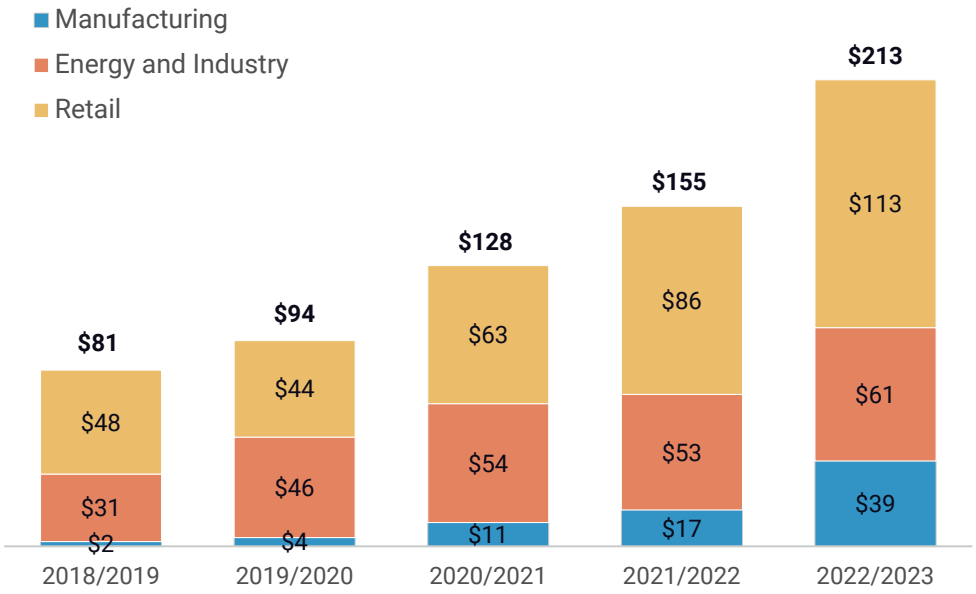
> “Last year, clean investment in the U.S. rose 37% from the year before and 165% over the annual level five years ago.

Clean energy is becoming one of the largest industries in the U.S. economy. The GHG emission-reducing investments in our database for 2022/2023 accounted for 4.1% of total private investment in structures, equipment, and durable consumer goods nationwide.[1] That's an increase from 1.7% in 2018/2019. At $213 billion, clean investment nationwide is larger than the annual GDP of 18 of the 50 states in the U.S.

FIGURE 1

Annual clean investment in the U.S.

Billion 2022 USD, July 1-June 30



Manufacturing

Investment in new or expanded factories to manufacture renewable energy technologies, batteries, electric vehicles, electrolyzers, and other GHG-reducing technologies is the fastest-growing segment in our database. After years of

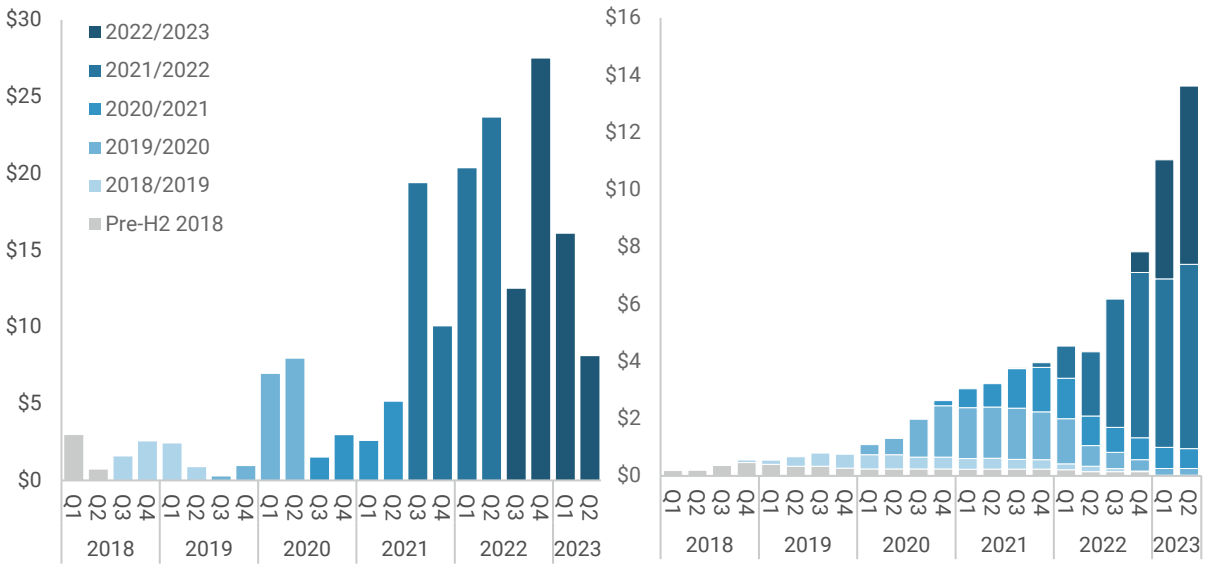
[1] Data on economy-wide private investment in structures, equipment and durable consumer goods comes from the Bureau of Economic Analysis.

relatively modest activity, company investment announcements jumped in Q3-2021 (Figure 2). Over the following year, companies announced $73 billion in clean manufacturing investment, and another $64 billion in 2022/2023. That's more than a five-fold increase from the $12 billion annual average during the preceding three years. There is meaningful lead time between project announcement and the commencement of construction, but we estimate that $37 billion of the $137 billion in announced manufacturing investment over the past two years has already occurred. On a quarterly basis, actual clean manufacturing investment reached $13.6 billion in Q2-2023, five times more than the average quarter during 2020/2021 ($2.7 billion) and 26 times that of 2018/2019 ($0.5 billion).

FIGURE 2

Announced (left) and actual (right) manufacturing investment by announcement year

Billion 2022 USD



In absolute terms, the majority of announced and actual investment in the manufacture of GHG-reducing technology in the U.S. has been in the electric vehicle supply chain (Figure 3). Over the past two years, companies have announced $7 billion in investment in critical mineral production, $96 billion in battery manufacturing (the majority of which is for electric vehicles), $24 billion in ZEV assembly (battery electric vehicles, plug-in hybrids and fuel cell vehicles), and nearly $1 billion in the manufacture of EV charging equipment. As those announcements have turned into construction activity, actual investment in EV-related manufacturing in the U.S. has grown to $36 billion over the past year, more than doubling the 2021/2022 level of $15 billion in 2021/2022 and 23 times the 2018/2019 level of $1.5 billion.

> Annual EV-related manufacturing investment has grown from $1.5 billion to $36 billion over the past five years.

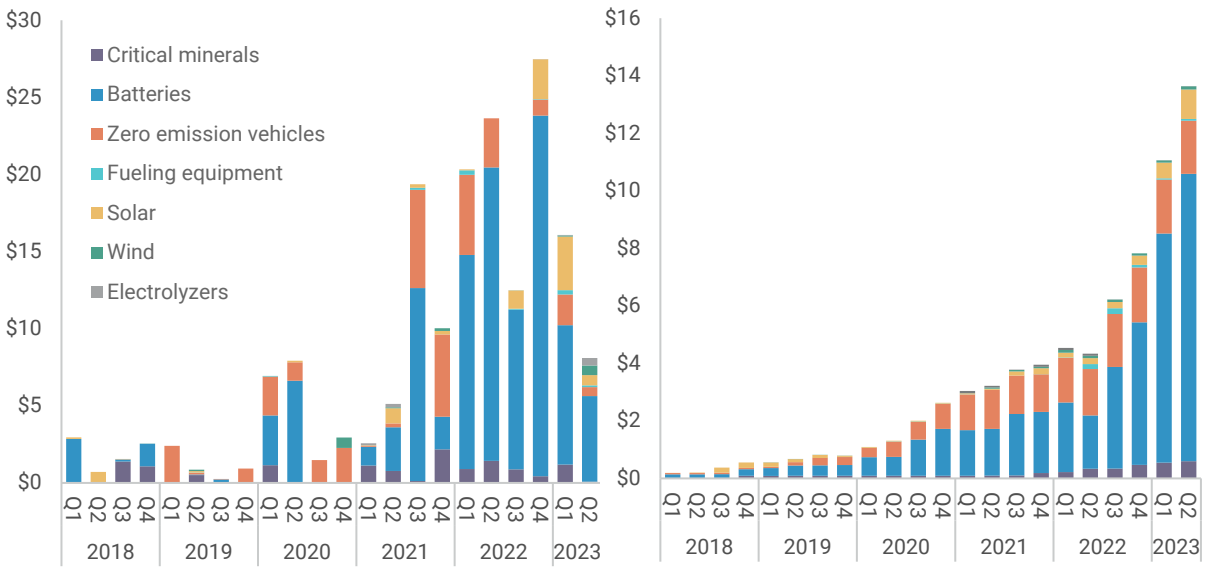
There has also been meaningful growth in investment in solar manufacturing. Between Q3-2021 and Q2-2023, companies announced $8.4 billion in new or expanded solar ingot, wafer, cell, module, and inverter manufacturing capacity. There was another several billion in new solar manufacturing investment announcements in July and August, which will be included in our next quarterly report. Actual investment in solar manufacturing reached $2 billion in 2022/2023, up from $0.7 billion the year before and $0.6 billion in 2018/2019.

Investment in new or expanded wind manufacturing facilities has been more muted. A number of existing factories that idled over the past few years have restarted, however. There is potential for meaningful growth in offshore wind-related manufacturing investment in the years ahead tied to state procurement programs in New England and the Mid-Atlantic. As many of these announcements are still conditional on the outcome of those programs, they have not been included as official announcements in our database.

FIGURE 3

Announced (left) and actual (right) manufacturing investment by technology

Billion 2022 USD



Energy and Industry

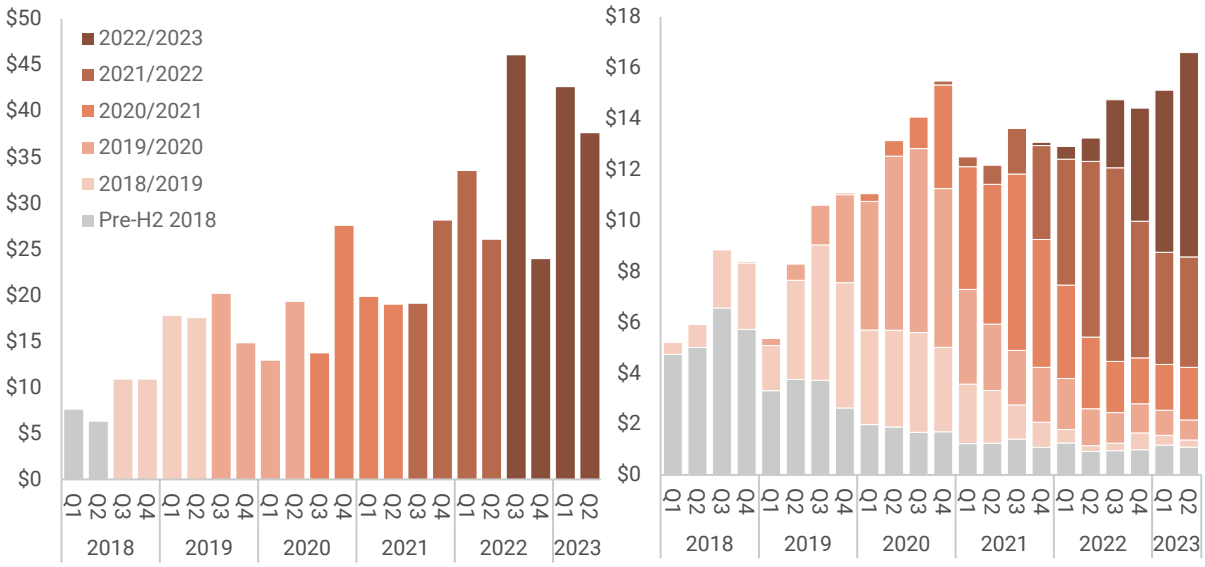
Over the past year, companies have announced $150 billion worth of new investment in clean energy production or the capture of carbon dioxide emissions in industry. That's an increase of 41% from the $107 billion announced the year

before, which itself was a 33% year-on-year increase (Figure 4). Only $63 billion of the $257 billion in investment announced over the past two years has occurred—$20 billion in 2021/2022 and $43 billion in 2022/2023—given the relatively long project lead times for big energy-producing projects. Coming on top of $18 billion from previous year announcements, total Energy and Industry investment in 2022/2023 was $61 billion. This is a 15% increase year-on-year, and a doubling in annual investment relative to five years ago.

FIGURE 4

Announced (left) and actual (right) Energy and Industry investment by announcement year

Billion 2022 USD



The majority of Energy and Industry investment activity has been in the complementary technologies of solar PV and grid-connected storage (Figure 5). Companies announced $58 billion worth of new solar projects and $40 billion in new storage projects last year. This was a 72% and 157% year-on-year increase, respectively. While most of the newly announced projects have not yet translated into steel in the ground, actual utility-scale solar and storage investment still grew significantly last year. Storage investment increased 51% from $9.1 billion in 2021/2022 to $14 billion in 2022/2023, while solar investment increased 34% from $22 billion to $30 billion during the same time.

In contrast, wind investment declined last year for the second twelve-month period in a row. Companies invested $23 billion in wind projects in 2020/2021, $17 billion in 2021/2022, and $11 billion in 2022/2023. Announced investment also fell by more than half, from $27 billion in 2020/2021 to $12 billion last year. Current transmission siting and permitting constraints impact wind more than solar and storage, the effects of which are evident in the recent slow-down in wind

investment activity. Another factor may be the phase-down of the value of pre-IRA tax credits, which were approaching zero before the new law was enacted.

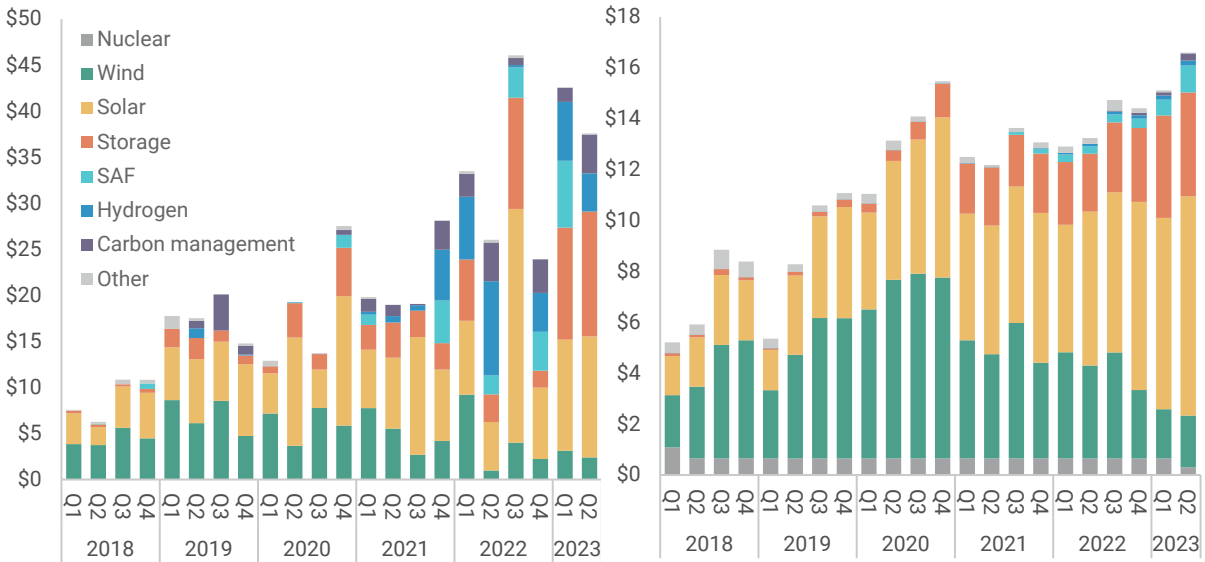
> “There was $80 billion in new investment in clean hydrogen, carbon management, and sustainable aviation fuels announced over the past two years, a more than five-fold increase over the preceding two years.

While these more mature clean energy technologies account for the overwhelming majority of investment in our Energy and Industry category, investment in emerging climate technologies (ECTs) like clean hydrogen, carbon management (point source capture and direct air capture), and sustainable aviation fuels is set to grow quickly. Over the past two years, there has been $80 billion in announced investment in these three technologies ($38 billion, $20 billion, and $21 billion respectively). That’s an increase from just $7.5 billion ($1.6 billion, $3.3 billion, and $2.6 billion) during the preceding two years. There was only $3.5 billion in actual investment in these technologies in 2022/2023, and only $1.1 billion in 2021/2022, but that number is poised to rise considerably over the next few years given the fast-growing announced investment figures.

FIGURE 5

Announced (left) and actual (right) Energy and Industry investment by technology

Billion 2022 USD



Retail

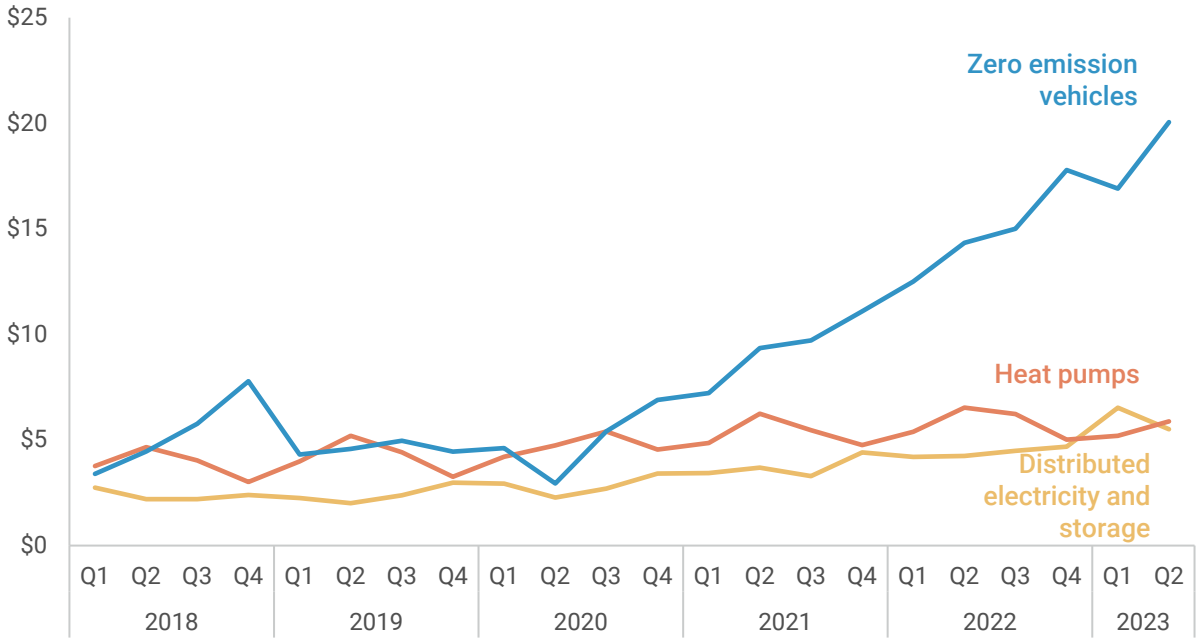
American businesses and households invested $113 billion last year in the purchase and installation of ZEVs, heat pumps, and distributed renewable energy

generation, fuel cells, and storage systems. That's a 32% increase over 2021/2022 levels and a 138% increase relative to the annual rate five years ago. Within our Retail category, the fastest growth has been in the purchase of ZEVs. We estimate that American businesses and households invested $70 billion in ZEVs over the past year, up 46% from the year prior ($48 billion) and 211% relative to the annual rate five years ago ($22 billion) (Figure 6).

FIGURE 6

Retail investment by technology

Billion 2022 USD



> "American businesses and households invested $21 billion in distributed clean electricity generation and storage over the past year, a 31% year-on-year increase.

Purchase and installations of residential and commercial rooftop solar systems, other distributed renewables, fuel cells and battery storage has increased robustly as well. We estimate American businesses and households invested $21 billion in distributed clean electricity generation and storage last year, up 31% ($16 billion) from 2021/2022, and 139% relative to the annual rate five years ago ($9 billion).

Investment in the installation of space and water heat pumps is growing, but much more slowly than either ZEVs or distributed electricity generation and storage.

Over the past five years, annual investment has increased by 38%, from $16 billion in 2018/2019 to $22 billion over the past year, but heat pump investment only grew 1% year-on-year in 2022/2023.

Learn More

This report provides an overview of the national investment trends in the Clean Investment Monitor database. More detailed information on state-level trends is freely available online at **www.cleaninvestmentmonitor.org** or through the **ClimateDeck** platform managed by Rhodium Group and Breakthrough Energy. We welcome the use of the Clean Investment Monitor database by others for further research and analysis. To receive bulk data access, please email **datarequest@cleaninvestmentmonitor.org**.

We will update the CIM database on a quarterly basis and publish a summary report of developments that quarter at **www.cleaninvestmentmonitor.org**. In the coming months, we will also publish two larger analyses. The first will break down overall investment data in the CIM into public and private sources, with attribution for public funding sources to specific provisions of the IRA, IIJA, and CHIPS and Science Act. The second report will compare full-year 2022 and 2023 investment data to what was projected to occur under the IRA, IIJA, and CHIPS and Science Act when they were adopted. This will provide real-time information on whether these three pieces of legislation are driving emission-reducing investment in the economy as intended.

Appendix

Table A1 below provides a detailed breakdown of the technologies currently included in the CIM database, along with the corresponding section of the tax code under which they receive incentives.

TABLE A1
Technologies included in the Clean Investment Monitor

Segment	Technology	Subcategories	Tax Code
Manufacturing	Solar	Modules, Cells, Wafers, Polysilicon, Torque Tubes, Structural Fasteners, Polymeric Backsheets, Inverters	45X, 48C
	Wind	Blades, Nacelles, Towers, Offshore Foundations, Related Vessels, Distributed Wind Inverters	45X, 48C

	Critical Minerals	All Eligible for 45X Credits	45X, 48C
	Batteries	Electrode Active Materials, Cells, Modules	45X, 48C
	Zero Emission Vehicles	BEVs, PHEVs and FCVs	48C
	Electrolyzers	PEM, Alkaline or SOE	48C
	Fueling	EV Charger Equipment	48C
Energy and Industry	Solar	Solar PV, Concentrating Solar Power	45, 48, 45Y, 48E
	Wind	Onshore Wind, Offshore Wind	45, 48, 45Y, 48E
	Geothermal	Geothermal	45, 48, 45Y, 48E
	Nuclear	Retention of existing and construction of new nuclear	45U, 45Y, 48E
	Storage	Batteries, Pumped Storage, Long-Duration Storage	48, 48E
	Other Electricity	Landfill Gas, Hydroelectric, Biomass	45, 48, 45Y, 48E
	Hydrogen	PEM, Alkaline, SOEC, AEM, Oil w/ CCUS, NG w/ CCUS,	45V
	Carbon Management	CCUS, Direct Air Capture	45Q, 48C
	Sustainable Aviation Fuels	HEFA, AtJ, PtJ, Bio-FT, Methane Pyrolysis	40B, 45Z
Retail	Zero Emission Vehicles	Battery Electric Vehicles, Plug-in Hybrid Electric Vehicles, Fuel Cell Vehicles	30B, 45W
	Heat Pumps	Ducted ASHP, Ductless ASHP, Geothermal Heat Pumps, ASHP Water Heaters	25C
	Distributed Electricity and Storage	Distributed Solar, Wind, Hydro, Fuel Cells and Storage	25D, 45, 48, 45Y, 48E

ABOUT THE CLEAN INVESTMENT MONITOR

The Clean Investment Monitor (CIM) is a joint project of Rhodium Group and MIT's Center for Energy and Environmental Policy Research. The CIM tracks public and private investments in manufacturing and deployment of climate technologies in the United States. Through this data and analysis, the CIM provides insights into investment trends, the effects of federal and state policies, and on-the-ground progress in the U.S. towards net-zero greenhouse gas emissions.

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Website: **www.cleaninvestmentmonitor.org**

Rhodium Group

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