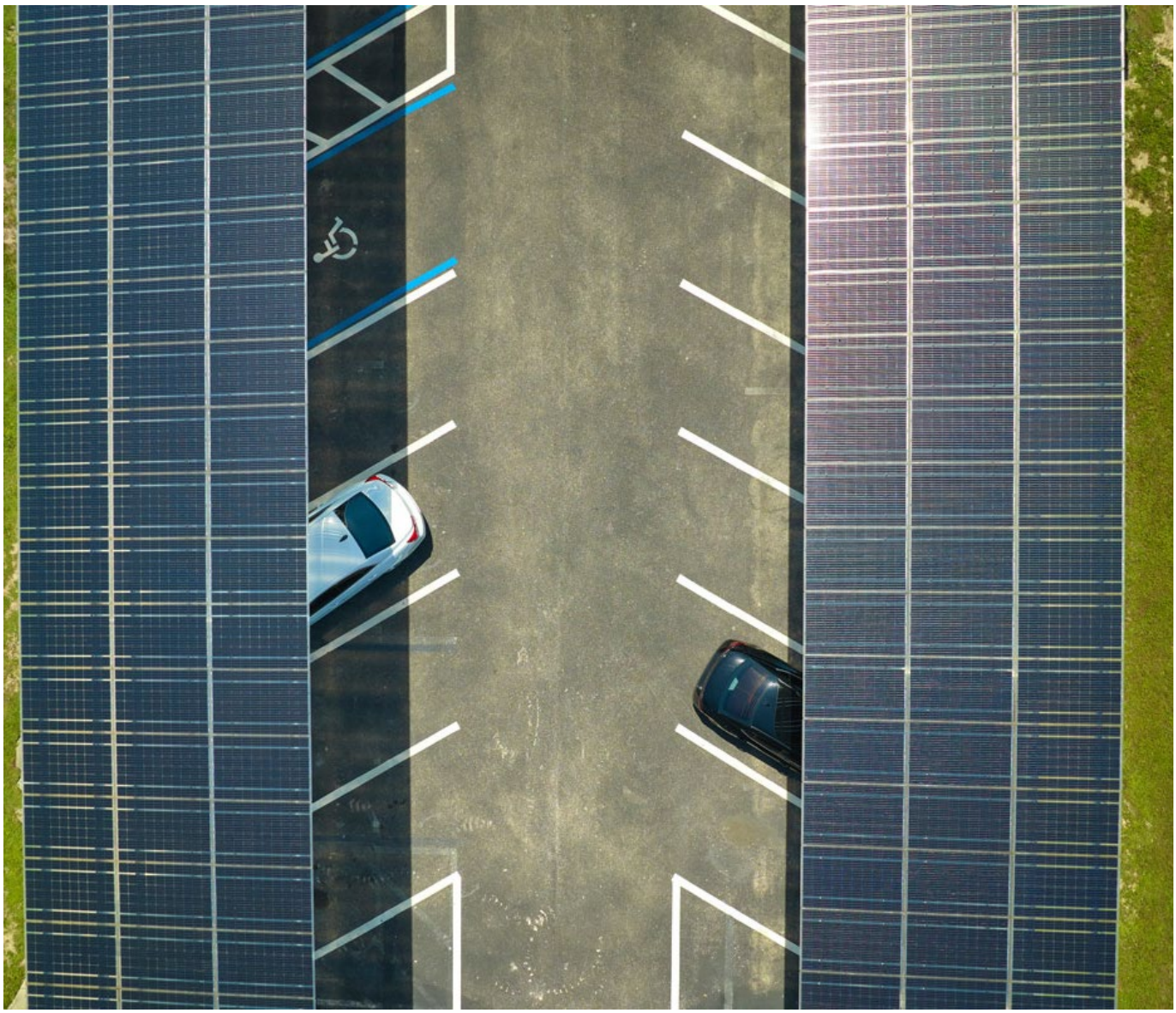

Clean Investment Monitor: Q4 2023 Update

February 29, 2024

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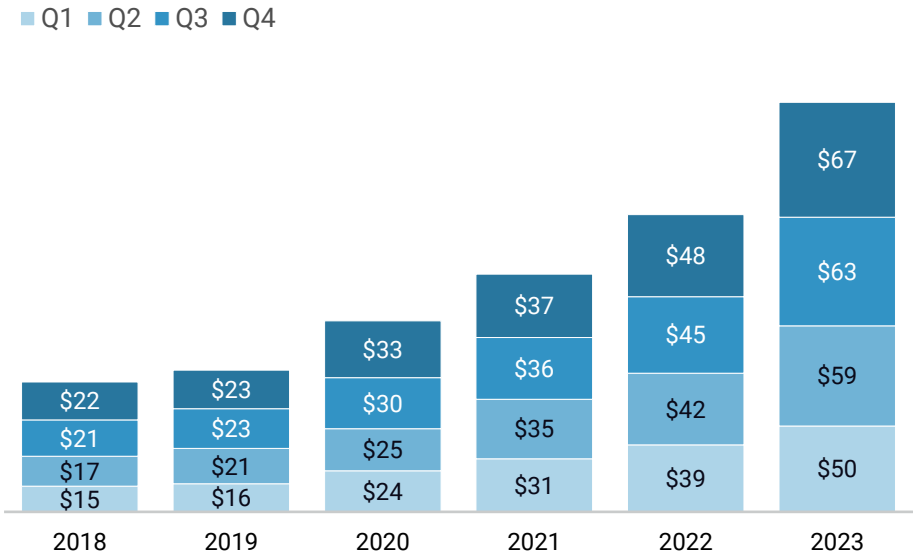
Summary

Clean energy and transportation investment in the US set another record in Q4 of 2023, reaching $67 billion—a 40% increase from the same period in 2022. Clean investment now accounts for 5% of all private investment in structures, equipment, and durable consumer goods in the United States, up from 3.7% at the end of 2022. Looking at the full year of 2023, clean investment came in at $239 billion, up 38% from 2022. Retail investment accounted for nearly half of this total, driven by robust growth in electric vehicle sales (a 52% increase year-on-year). Investment in the deployment of utility-scale solar and storage systems also grew robustly over 2023, up more than 50% year-on-year to $53 billion. But the fastest investment growth last year occurred in the deployment of emerging climate technologies—up ten-fold from $0.9 billion in 2022 to $9.1 billion in 2023—and in the manufacturing of clean technology, up 153% from $19 billion in 2022 to $49 billion in 2023.

In contrast, despite a small bump in Q4 2023, wind investment declined to $9 billion in 2023, a 37% decrease from 2022. Meanwhile, investment in emerging climate technologies (clean hydrogen, sustainable aviation fuels, and carbon capture) surpassed investment in wind for the first time in 2023, both across the year and in Q4. Retail investment in heat pumps is also lagging—down 16% year-on-year, though heat pumps have gained market share in a declining residential construction market.

This report summarizes key trends from our Q4 2023 update to the **Clean Investment Monitor** database, tracking public and private investment in clean technologies in the US. In this report, we also release the first results of our detailed bottom-up model of actual federal government investment in clean energy and transportation. We estimate a total of $34 billion in federal investment—including tax credits, grants, and the fiscal cost of government loans—went to clean energy and transportation projects nationwide in fiscal year 2023 (October 1, 2022 through September 30, 2023). There was $220 billion in total investment in clean energy and transportation projects during the same period. We share a breakdown of that investment by category and state.

FIGURE 1
Clean investment by quarter
Billion 2022 USD



Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor

Investment trends

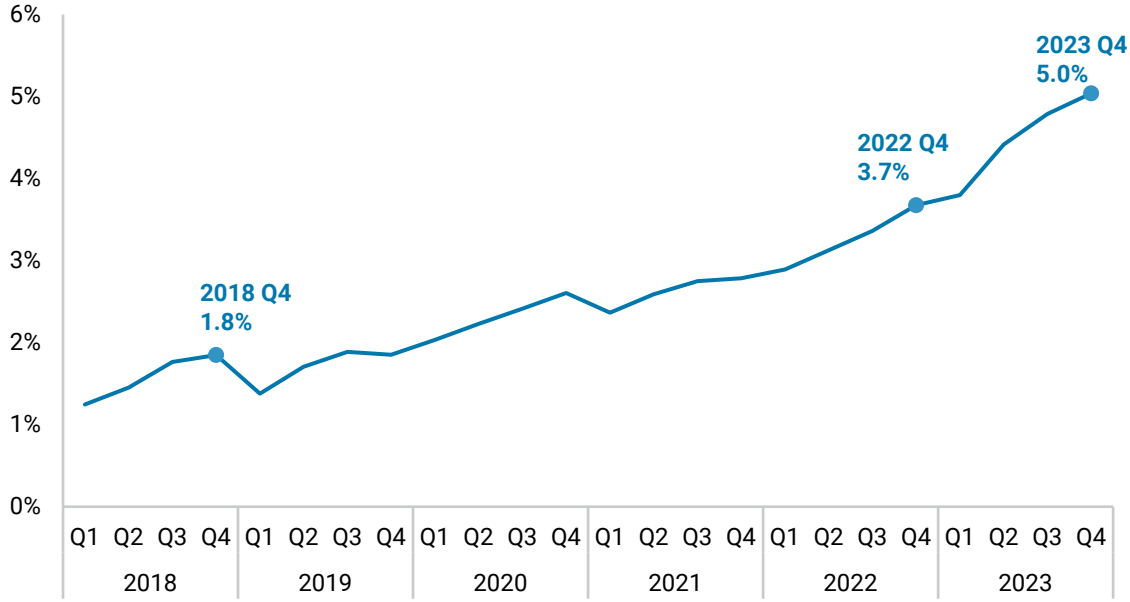
Actual clean energy and transportation investment in the United States reached a record $67 billion in Q4 2023, a 40% increase over Q4 2022 (Figure 1). That brings total clean investment in 2023 to $239 billion, up 38% from the $174 billion invested in 2022. In Q4, clean investment accounted for 5% of total US private investment in structures, equipment, and durable consumer goods nationwide, an increase from 3.7% in Q4 2022 and 1.8% in Q4 2018 (Figure 2). On average, clean investment accounted for 4.5% of total private investment in 2023, up from 3.3% in 2022 and 1.6% in 2018.

We categorize our clean investment tracking into three segments: investment in the manufacture of GHG emission-reducing technology (“manufacturing”); investment in the deployment of that technology, both to produce clean energy or decarbonize industrial production (“energy & industry”); and through the purchase and installation of that technology by individual households and businesses (“retail”). Each dollar figure in this report is actual investment in Q4 2023, or the real dollars spent within the last quarter, and we include headline announced figures to provide context and insight into upcoming actual investment trends.

FIGURE 2

Actual clean investment as a share of total US private investment

Annualized basis, total investment in all private structures, equipment, and durable consumer goods



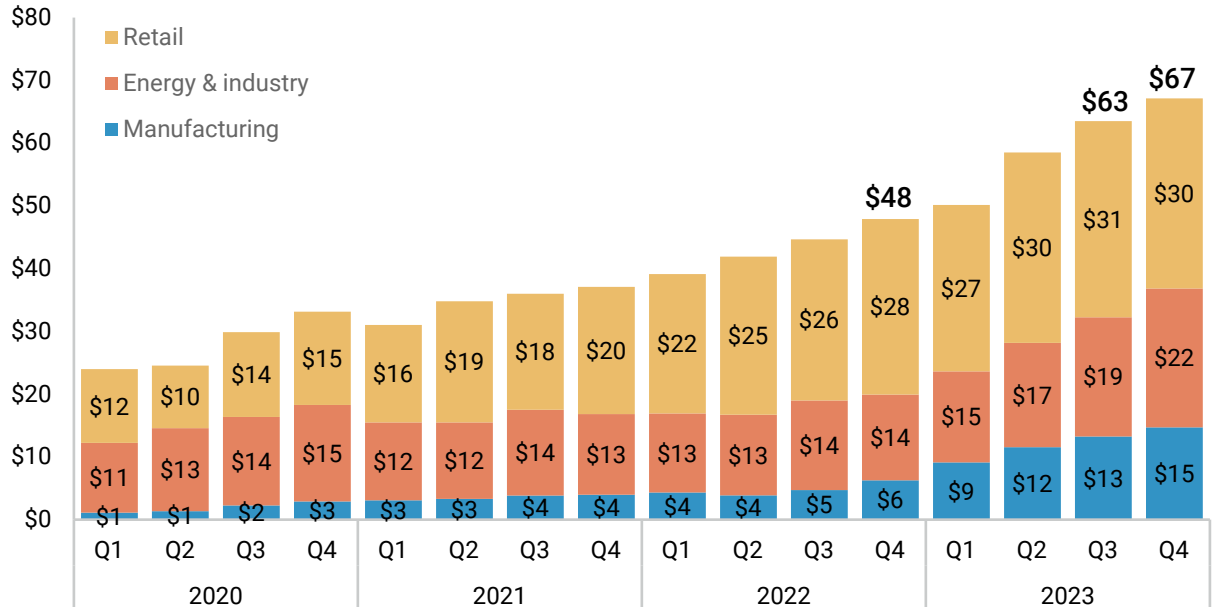
Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor

By segment, retail investment accounted for 45% of total clean investment in Q4 at $30 billion. Actual retail investment declined 3% in Q4 relative to the previous quarter, but was still up 8% relative to Q4 2022. For the full year of 2023, retail investment totaled $118 billion, up 17% relative to 2022. In the energy & industry segment, there was $22 billion in new investment in clean energy production and industrial decarbonization in Q4 2023, up 17% quarter-on-quarter and 62% year-on-year. Full-year 2023 energy & industry investment was $72 billion, up 35% from 2022. Manufacturing continued to be the segment with the most growth in Q4 2023, with $15 billion of new investment, up 11% quarter-on-quarter and 134% year-on-year. For the full year, clean manufacturing attracted $49 billion in new investment in 2023, up 153% from 2022.

FIGURE 3

Actual clean investment by segment

Billion 2022 USD



Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor

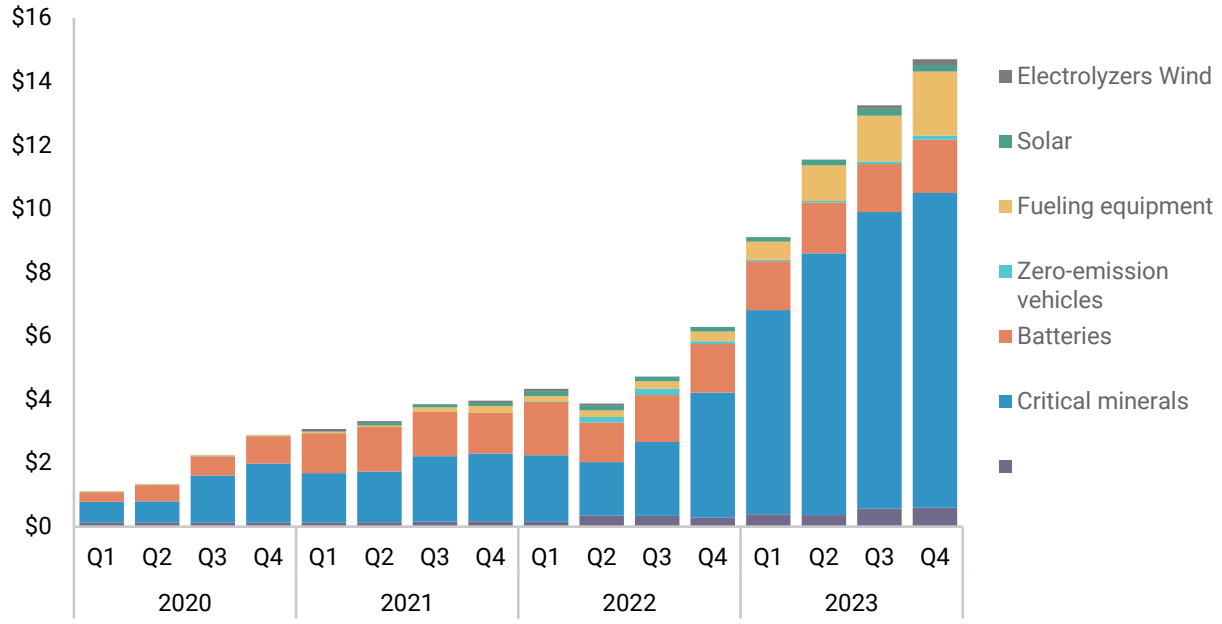
Manufacturing

The electric vehicle (EV) supply chain (critical minerals, batteries, vehicle assembly and charging equipment) continued to dominate clean manufacturing investment in Q4, at $12 billion (84%) of the total $15 billion in actual investment (Figure 4). That brings the 2023 total for investment in the EV supply chain to $42 billion, up 142% from the $18 billion invested in 2022. Solar manufacturing investment reached $2 billion in Q4 2023, up six-fold relative to Q4 2022. Full year 2023 solar manufacturing investment came in at $5.1 billion, up from $0.9 billion in 2022. Electrolyzer manufacturing investment also grew rapidly, but from a lower base—reaching $0.3 billion in total investment in 2023. Wind manufacturing investment declined slightly in Q4, reflecting ongoing issues in the sector, though full year 2023 investment was up 24% year-on-year to $0.7 billion.

FIGURE 4

Manufacturing investment by technology

Billion 2022 USD



Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor

Looking forward, the pipeline of new clean energy and transportation manufacturing investment remains relatively strong. There was $18.3 billion in new investment announcements in Q4, a 6% increase relative to Q3. That brings the 2023 total for new manufacturing investment announcements to $68.6 billion. While down from a peak of $87.7 billion in 2022, it's still up 76% relative to 2021 and 700% relative to 2018.

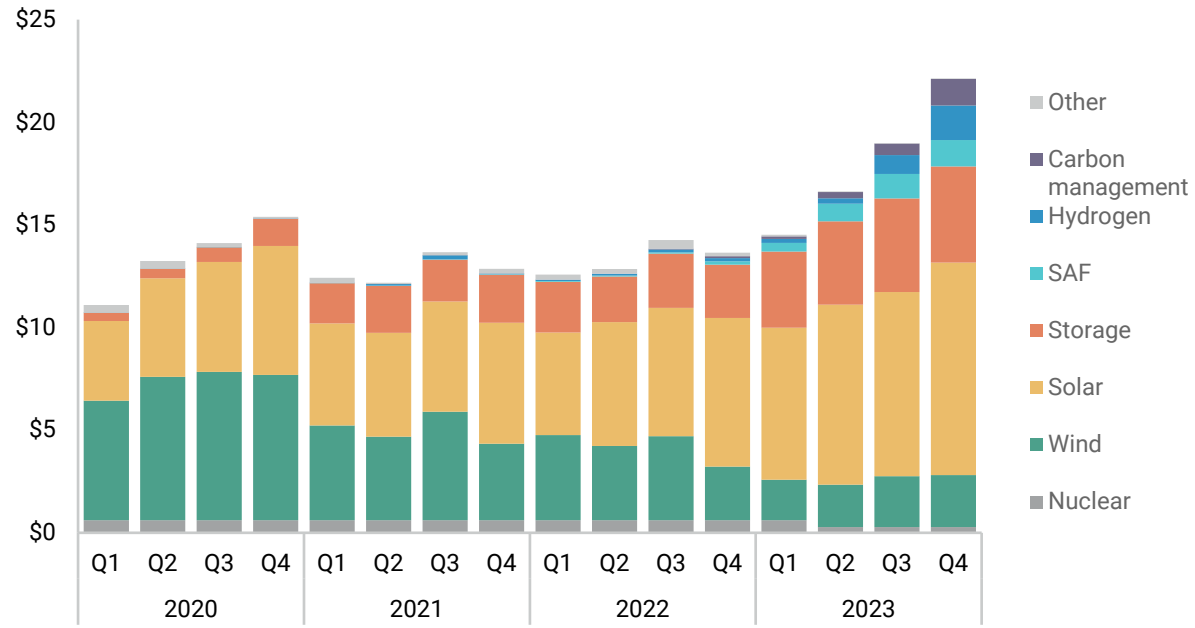
Energy & industry

Of the total $72 billion in new actual investment in clean energy production and industrial decarbonization in 2023, utility-scale solar and storage investment accounted for $53 billion (Figure 5). These technologies saw a record $15 billion invested in Q4 alone—an 11% increase over Q3 2023 and a 53% increase relative to Q4 2022. Full-year 2023 solar and storage investment was also up more than 50% relative to 2022. Wind investment increased slightly quarter-on-quarter to $2.5 billion in Q4, but was down 3% year-on-year. Full-year 2023 wind investment was $9 billion, down 37% from $14.5 billion in 2022.

In the energy & industry segment, the most rapid growth in investment in both Q4 and full-year 2023 occurred in emerging climate technologies (ECT)—clean hydrogen, carbon management, and sustainable aviation fuels. In Q4, there was $4.3 billion in investment in deploying these technologies, a 60% increase relative to Q3 and a ten-fold increase relative to Q4 2022. Full-year ECT investment was $9.1 billion in 2023, up ten-fold over $0.9 billion in 2022. ECT investment

surpassed wind investment for the first time in 2023, both across the year and in Q4, reflecting recent ECT momentum.

FIGURE 5
Energy & industry investment by technology
Billion 2022 USD



Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor

There was $120 billion in new energy and industry investments announced in 2023. That's down 8% from 2022, but up 37% relative to 2021 and 237% relative to 2018. Q4 was particularly weak, with only $9 billion in new announcements, compared to $24 billion in Q4 2022. It's too early to know if this quarterly volatility or the beginning of a broader and more concerning trend, though as we noted in our recent report **Clean Investment in 2023: Assessing Progress in Electricity and Transport,** construction of utility-scale clean electricity generation is lagging projections following the passage of the IRA, likely due to a combination of short-term inflation and supply chain issues, as well as more structural challenges in siting, permitting, and grid interconnection. This is an area where we will be paying particular attention to investment trends in the months ahead.

Retail

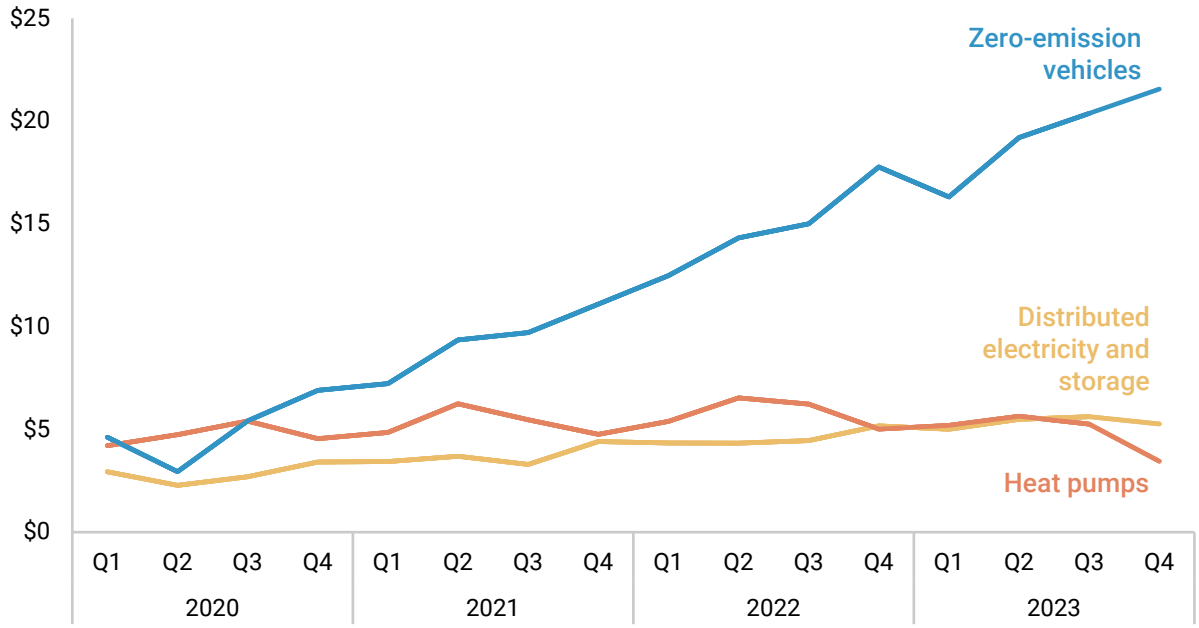
Total 2023 retail purchases of zero-emission vehicles (ZEVs), distributed renewable electricity and storage, and heat pumps came in at $118 billion, up from $101 billion in 2022. ZEV sales drove most of this growth, with $77 billion in investment in 2023, up from $60 billion in 2022 (Figure 6). Total 2023 ZEV sales increased by 52% year-on-year by volume to 1.4 million, but declining ZEV prices meant that total investment only grew by 30%. In the final quarter of the year, ZEV

investment grew 21.3% year-on-year, a bit slower than the 36% year-on-year growth rate in Q3. Investment in distributed renewable electricity and storage systems increased 17% in 2023 to $21.4 billion, though investment declined 6.3% quarter-on-quarter in Q4 of last year. Heat pump investment had the weakest performance across all the technology categories tracked in the Clean Investment Monitor. Q4 heat pump investment was down more than 30%—both quarter-on-quarter and year-on-year—bringing full year 2023 investment to $19.5 billion, a 16% decline from 2022. Earlier in 2023, as continued weakness in residential construction activity negatively impacted the entire heating and cooling equipment industry, heat pump sales initially declined less quickly than gas or oil furnace sales. But by the end of 2023, heat pump sales were declining as, or more, quickly than gas and oil furnaces.

FIGURE 6

Retail investment by technology

Billion 2022 USD



Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor

Federal Investment

Since our launch, the Clean Investment Monitor has been tracking total investment in clean energy and transportation. Starting with this report, we are also tracking and reporting federal government investment in clean energy and transportation, including through tax credits, grants, loans, and loan guarantees. These estimates include investment across the technologies included in the Clean Investment Monitor database.

For tax credits, we assess credit eligibility at the facility/purchase level and quantify the total credit amount based on capital expenditure, production volumes, or other criteria as determined by the specific credit in question. We quantify investment both through relevant tax credits that existed prior to passage of the Inflation Reduction Act (IRA), as well as those extended or created by the IRA.

For grants, loans, and loan guarantees, we identified appropriated funds for programs in the IRA and the Infrastructure Investment and Jobs Act (IIJA) for which the majority of funds are likely to support the manufacture and deployment of technologies included in the CIM database. We estimate outlays based on the most recent Congressional Budget Office projections for the in-scope programs that have begun to outlay, as proxied by the White House's "Investing in America" tracker of announced federal investments. The result is the first detailed, bottom-up estimate of actual federal investment in clean energy and transportation following the passage of the CHIPS and Science Act, the IIJA, and the IRA. A detailed methodology is available **here**. Downloadable data is available at **cleaninvestmentmonitor.org**.

Federal investment by category

For fiscal year 2023 (October 1, 2022 through September 30, 2023), we estimate the federal government invested $33.7 billion in the manufacture and deployment of clean energy and transportation technologies that fall within the Clean Investment Monitor scope of coverage (Table 1). The vast majority of this federal investment ($33.3 of $33.7 billion) was in the form of tax credits. We estimate that $5.5 billion in investment went to manufacturing, primarily resulting from the 45X advanced manufacturing tax credit in the IRA. Within energy & industry ($13.3 billion), most federal investment went to clean electricity generation ($13 billion), both due to Production Tax Credit and Investment Tax Credit provisions that existed prior to the IRA, as well as the extended and enhanced version of these credits. A much smaller amount of investment ($0.3 billion) went to emerging climate technologies like carbon management, sustainable aviation fuels, and clean hydrogen, as all three are at a much earlier stage of market development. Within the retail segment, $8.3 billion of tax credits flowed to households installing distributed clean electricity generation and storage systems or heat pumps. Households and businesses received $6.2 billion for electric vehicle purchases.

TABLE 1

Federal investment on clean energy and transportation in FY 2023

Billion 2022 USD

Segment	Category	Amount
Manufacturing	Advanced Manufacturing Tax Credits	$5.5
Energy & Industry	Clean Electricity Tax Credits	$12.2
	Emerging Climate Technology Tax Credits	$0.3
Retail	Residential Energy & Efficiency Tax Credits	$8.3
	Non-residential Distributed Energy Tax Credits	$0.8
	Zero Emission Vehicle Tax Credits	$6.2
Multiple	Grants, Loans and Loan Guarantees	$0.4
	Total	**$33.7**

FY2023 is October 1, 2022 through September 30, 2023. This includes all federal spending on technologies within the Clean Investment Monitor scope. For loans and loan guarantees, the amounts are only the estimated costs born by taxpayers, not the total value of the loans. Detailed methodology is available **here**.

This analysis focuses on measuring overall federal investment via tax credits in clean energy, rather than isolating spending only associated with the Inflation Reduction Act. Thus, a relevant point of comparison is the Joint Committee on Taxation (JCT)'s estimate of total federal tax expenditures on energy-related tax credits for technologies in the CIM scope. Our topline results are broadly in line with JCT's **estimates from December 2023**—$33.3 billion vs. $32.8 billion in real 2022 USD—though results for certain specific tax credits differ. For example, we estimate a greater share of clean electricity projects take the Investment Tax Credit relative to the Production Tax Credit than assumed by JCT. We also estimate higher spending on electric vehicle tax credits and lower spending on the 48C advanced manufacturing investment credit (though comparable spending on the 45X advanced manufacturing production credit). More detail is available in our **methodology**.

We estimate that total federal investment via grants, loans, and loan guarantees (with the last two assessed just at their estimated cost to taxpayers, i.e. the subsidy cost, and not their headline value) for clean technologies in FY 2023 was $417 million.[1]

[1] To date, there has been $11.3 billion in announced investment and $7.5B in FY 2023, according to the White House's "Investing in America" tracker of announced federal investments. In an effort to consider actual, rather than announced, investment, we focused our analysis on estimated outlays.

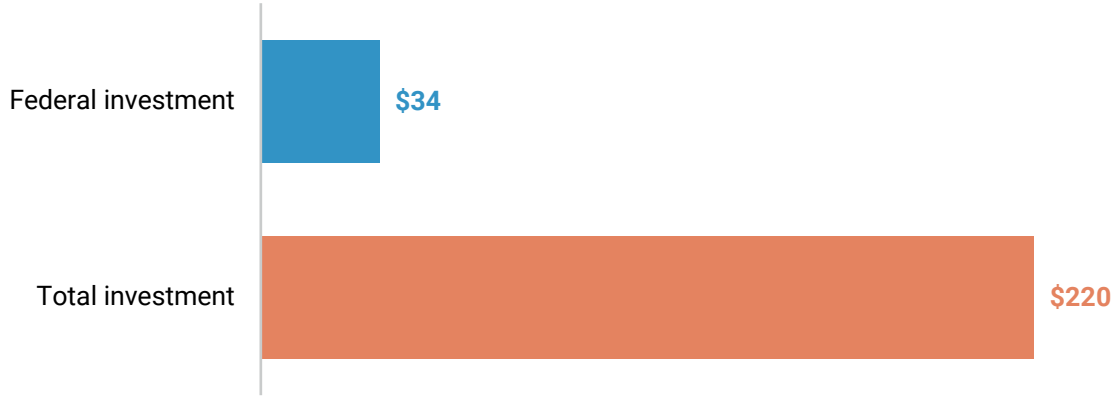
We expect the volume of investment across the categories identified above to shift across time as implementation proceeds. For instance, the share of tax credit investment going towards emerging clean technologies will grow as these projects mature. And, as the Congressional Budget Office projects, the volume of grant and loan outlays will increase as new programs get stood up.

This $34 billion in federal investment represents a relatively small share of total investment tracked in the Clean Investment Monitor in FY 2023 (Figure 7)—with private investment in clean energy technologies somewhere between 5-6 times larger than that of public investment. This suggests that the majority of capital invested in clean energy is coming from private sources, which is incentivized by federal tax credits, grants, loans and loan guarantees.

FIGURE 7

Clean energy and transportation, federal vs. total investment

FY 2023, billion 2022 USD



Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor

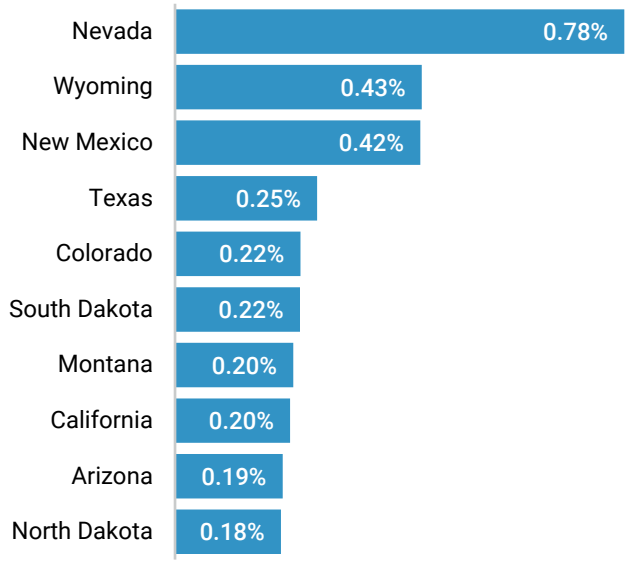
Federal investment by state

In absolute terms, California received the most federal investment in FY 2023, at $7.5 billion, followed by Texas at $6.2 billion, Nevada at $1.8 billion, and Florida at $1.6 billion (Table 2). Relative to the size of the state economy, Nevada was the largest recipient, followed by Wyoming, New Mexico, Texas, and North Dakota (Figure 8). On a per capita basis, the rankings are similar: Nevada at the top with $564 per person in federal clean energy and transportation investment in FY 2023, followed by Wyoming at $369, New Mexico at $259, Texas at $204, and California at $191 (Table 2).

FIGURE 8

Top ten recipients of federal clean energy and transportation investment

Percent of gross state product, FY 2023



Source: Rhodium Group/MIT-CEEPR Clean Investment Monitor

TABLE 2

Federal clean energy and transportation investment by state

FY2023

State	Total Spending (Million 2022 USD)	Per Capita Spending (2022 USD)	Percent of State GDP
Alabama	$382	$75	0.13%
Alaska	$11	$15	0.02%
Arizona	$918	$124	0.19%
Arkansas	$115	$37	0.07%
California	$7,454	$191	0.20%
Colorado	$1,100	$188	0.22%
Connecticut	$201	$56	0.06%
DC	$35	$52	0.02%
Delaware	$66	$65	0.07%
Florida	$1,582	$70	0.10%
Georgia	$1,093	$99	0.14%
Hawaii	$167	$116	0.16%
Idaho	$49	$25	0.04%
Illinois	$801	$64	0.08%
Indiana	$367	$54	0.08%
Iowa	$427	$133	0.17%
Kansas	$219	$74	0.10%
Kentucky	$150	$33	0.06%
Louisiana	$141	$31	0.05%
Maine	$153	$110	0.17%

Maryland	$313	$51	0.06%
Massachusetts	$360	$51	0.05%
Michigan	$632	$63	0.10%
Minnesota	$302	$53	0.07%
Mississippi	$62	$21	0.04%
Missouri	$305	$49	0.07%
Montana	$141	$125	0.20%
Nebraska	$286	$145	0.16%
Nevada	$1,798	$564	0.78%
New Hampshire	$55	$40	0.05%
New Jersey	$529	$57	0.07%
New Mexico	$547	$259	0.42%
New York	$816	$42	0.04%
North Carolina	$589	$55	0.08%
North Dakota	$138	$176	0.18%
Ohio	$1,364	$116	0.16%
Oklahoma	$414	$102	0.16%
Oregon	$314	$74	0.10%
Pennsylvania	$434	$33	0.05%
Rhode Island	$77	$71	0.10%
South Carolina	$341	$64	0.11%
South Dakota	$154	$169	0.22%
Tennessee	$402	$57	0.08%
Texas	$6,176	$204	0.25%
Utah	$134	$39	0.05%
Vermont	$38	$59	0.09%
Virginia	$617	$71	0.09%
Washington	$484	$62	0.06%
West Virginia	$48	$27	0.05%
Wisconsin	$189	$32	0.05%
Wyoming	$215	$369	0.43%

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.

ACKNOWLEDGMENTS

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