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Energy Transition Investment Trends 2023

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26 January, 2023

BloombergNEF

Executive summary

This report is BloombergNEF’s annual accounting of global investment in the low-carbon energy transition. It includes a wide scope of sectors, covering renewables, energy storage, electrified vehicles and heating, hydrogen, nuclear, sustainable materials and carbon capture. It also covers VC/PE and public markets investment in climate-tech companies. For the first time this year, we also track power grid investment, and supply chain & manufacturing investment for clean energy technologies.

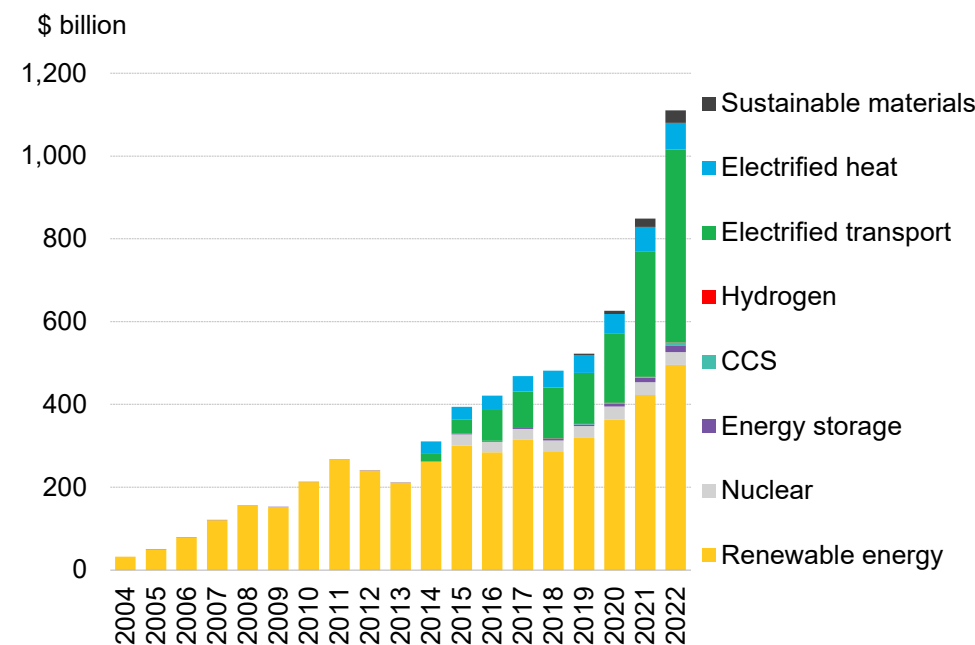
- In 2022, global energy transition investment totaled \$1.1 trillion, up 31% on the prior year and the first time the figure has been measured in trillions. This figure includes investment in projects, such as renewables, storage, charging infrastructure, hydrogen production, nuclear, recycling and CCS – as well as end-user purchases of low-carbon energy tech, such as small-scale solar, heat pumps and zero-emission vehicles.
- While renewable energy remained the largest sector at \$495 billion (up 17% year-on-year), electrified transport is growing much faster and hit \$466 billion (up 54%).
- China is by far the largest contributor, accounting for just under half of global energy transition investment. The US is a distant second.
- Energy transition investment is on the brink of overtaking fossil fuel investment for the first time. Both are estimated at \$1.1 trillion in 2022. But transition investment needs to average more than 3x this level, for the rest of this decade, to get on track for BNEF’s Net Zero Scenario.
- Climate-tech companies raised a total of \$119 billion from global public equity markets and private investors in 2022 – down 29% from the year before during a challenging year in the markets.
- Investment in clean energy manufacturing facilities grew to \$79 billion in 2022. No significant acceleration is needed to get on track for net zero.

\$1.11 trillion Global energy transition investment in 2022

31% 2021-2022 increase in energy transition investment

3x Increase in investment levels needed to get on track for net zero

Global energy transition investment by sector



Source: BloombergNEF. Note: start-years differ by sector but all sectors are present from 2019 onward; see Appendix for more detail. Nuclear figures start in 2015.

Authors

Energy transition investment trends

Albert Cheung

Miko Tan

Climate-tech corporate finance

Mark Daly

Sarra Raza

Supply chain & manufacturing investment

Antoine Vagneur-Jones

Leo Wang

Yali Jiang

Evelina Stoikou

Youru Tan

Sectoral and thematic contributions

Allen Tom Abraham (electrified transport)

Meredith Annex (renewable energy)

Julia Attwood (sustainable materials)

Corey Cantor (electrified transport)

Brenna Casey (carbon capture & storage)

Ryan Fisher (electrified transport)

Chris Gadomski (nuclear)

Kyle Harrison (sustainable finance)

Luxi Hong (oil & gas)

Matthias Kimmel (net zero)

Claudio Lubis (net zero and fossil fuels)

Pietro Radoia (secondary markets)

Sanjeet Sanghera (grids)

Nikolas Soulopoulos (electrified transport)

Yayoi Sekine (energy storage)

Martin Tengler (hydrogen)

Lewis Williams (electrified heat)

Understanding this report

Energy transition investment

The first two sections of this report cover ‘energy transition investment’, our term for money spent to deploy clean technologies such as clean energy, electric vehicles, heat pumps, hydrogen and carbon capture.

In a word, these sections focus on funding for **deployment**, across both the supply and end-use of energy.

With data going back as far as 2004, we track each of these sectors as much as possible from a bottom-up perspective, giving the most robust estimate available of investment in the deployment of net-zero aligned technologies.

In 2022, global energy transition investment totaled \$1.1 trillion.

An additional \$274 billion was invested into power grids.

Where to find the data

The underlying data for energy transition investment can be found here:

<https://www.bnef.com/interactive-datasets/2d5d59acd9000005>

Climate-tech corporate finance

The third and fourth sections of this report cover the raising of capital by ‘climate-tech’ companies, either via public equity markets or venture capital / private equity.

In a word, these sections focus on funding for **innovation and scale-up**.

The scope includes technologies and business models to decarbonize the energy, transport, buildings & infrastructure, industry and agriculture sectors, or help better understand our planet and environment, assist in tracking greenhouse gas emissions, and mobilize financial (and consumer) markets toward greener investments.

Comprehensive data in this section only begin in 2021, though we do have corporate finance data for renewable energy and storage going back to 2004 (in the separate Renewable Energy Investment Tracker).

In 2022, global climate-tech corporate finance totaled \$119 billion.

Where to find the data

Our *Investment Radar* provides the latest update on climate-tech investment trends.

Supply chain & manufacturing investment

The fifth section of this report covers investment into the construction of **manufacturing facilities** for clean energy technologies. These sums are critically important to ensure that supply of needed components and systems for the energy transition keeps up with the pace of deployment.

In 2022, manufacturing investment totaled \$79 billion.

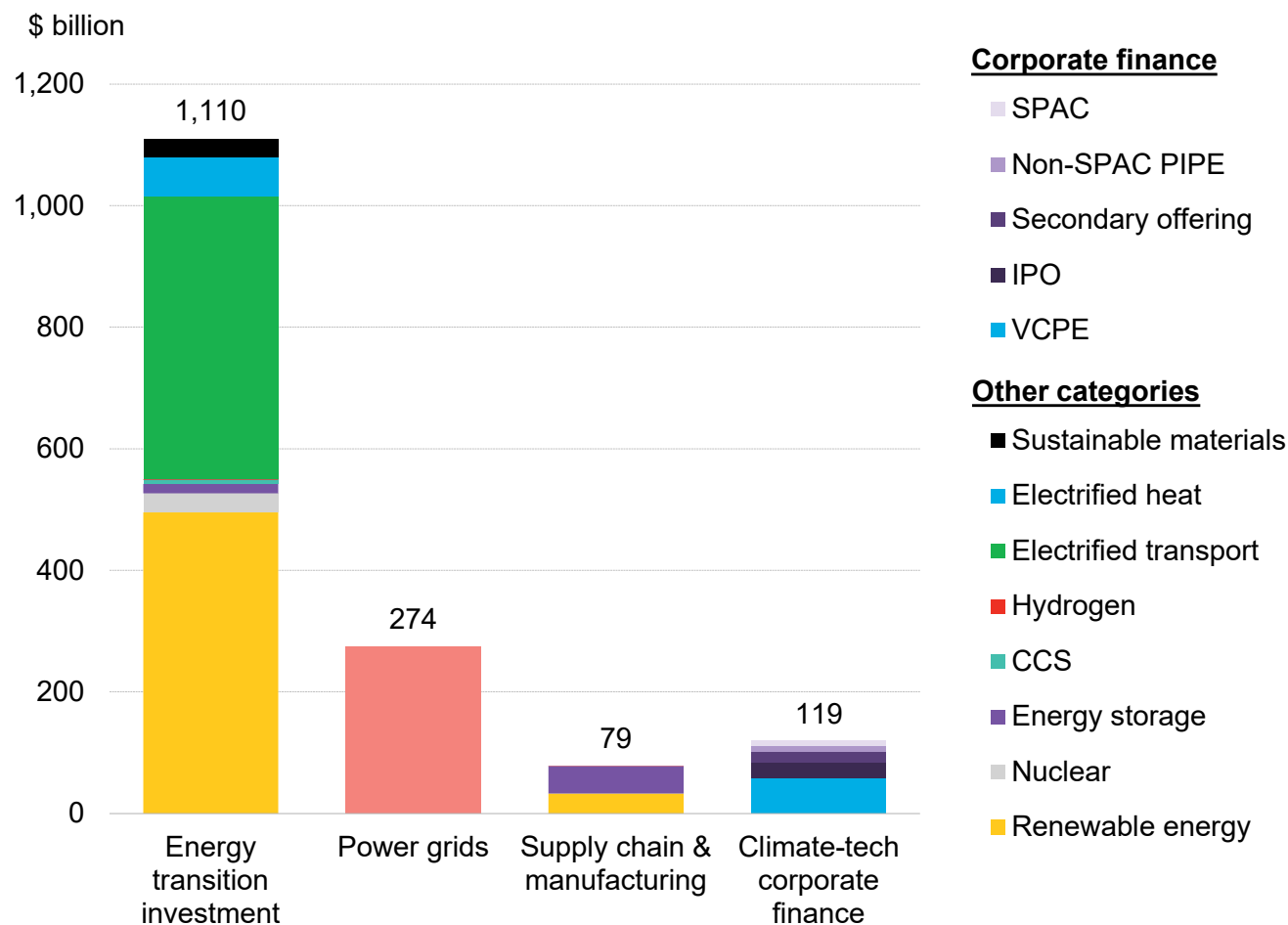
Thematic highlights

The last section of this report covers notable narratives from the world of climate and energy transition finance over the last year, such as:

- Public market performance of clean energy equities
- The rise of sustainable debt and ESG-themed ETFs
- Investment in clean energy from oil & gas companies
- Secondary transactions of renewable energy plants

Overall, BNEF tracked \$1.6 trillion in investment flows relating to the low-carbon transition in 2022

Total 2022 investments across categories covered in this report



- This report tracks a variety of flavors of investment in the low-carbon transition.
- Global *energy transition investment*, our measure of money spent to deploy low-carbon energy technologies, hit \$1.1 trillion in 2022 – the first time this figure has exceeded \$1 trillion.
- BNEF also tracked \$274 billion in *power grid investment*, which we have kept as a standalone category. Power grid investment is a key enabler for the net-zero transition.
- For the first time, we have included *investment in supply chain / manufacturing facilities* as a new category. We tracked \$79 billion in clean energy factory investment in 2022.
- Finally, climate-tech companies raised \$119 billion in *equity financing* from public markets and private investors in 2022.
- There may be some limited double-counting between the corporate finance total and the other three columns, as companies can in principle raise equity and then use those proceeds to fund technology deployment, grid expansion or factory construction. In practice this overlap is probably small.
- The total across these categories stands at \$1.6 trillion in investment flows in 2022. Each category is discussed in the following chapters.

Source: BloombergNEF



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Energy transition investment: overview

Top-level findings

Energy transition investment: preface

For interactive data,
click [here](#).

This section presents our top-level findings on global investment in the low-carbon energy transition.

Brief definition and methodology

The figures in this section represent capital spent on deployment of low-carbon technology. This largely excludes capital invested in companies (see next section for that), and money spent on research, development and manufacturing (with an exception for CCS, where we include some of these sums).

For large infrastructure projects such as renewables, stationary energy storage, hydrogen production, EV charging, CCS, nuclear and sustainable materials, our figures are built based on bottom-up intelligence on individual projects and financial commitments. In general, we account for money that has been committed to a specific project, whether through a final investment decision, a government grant allocation, or a project proceeding to construction and commissioning. We don't include money that hasn't been explicitly committed to a known project (such as unallocated government grant funding), or projects that have not yet reached final investment decision. We apply cost estimates where project values are not disclosed.

For consumer- or end-user-led technologies, such as small-scale solar, heat pumps, and electric and fuel cell vehicles, we estimate the total amount invested (spent) based on our own benchmarks of the total costs of these products, including any relevant installation costs.

More information on our methodology for each sector is available at the end of this report.

Coverage

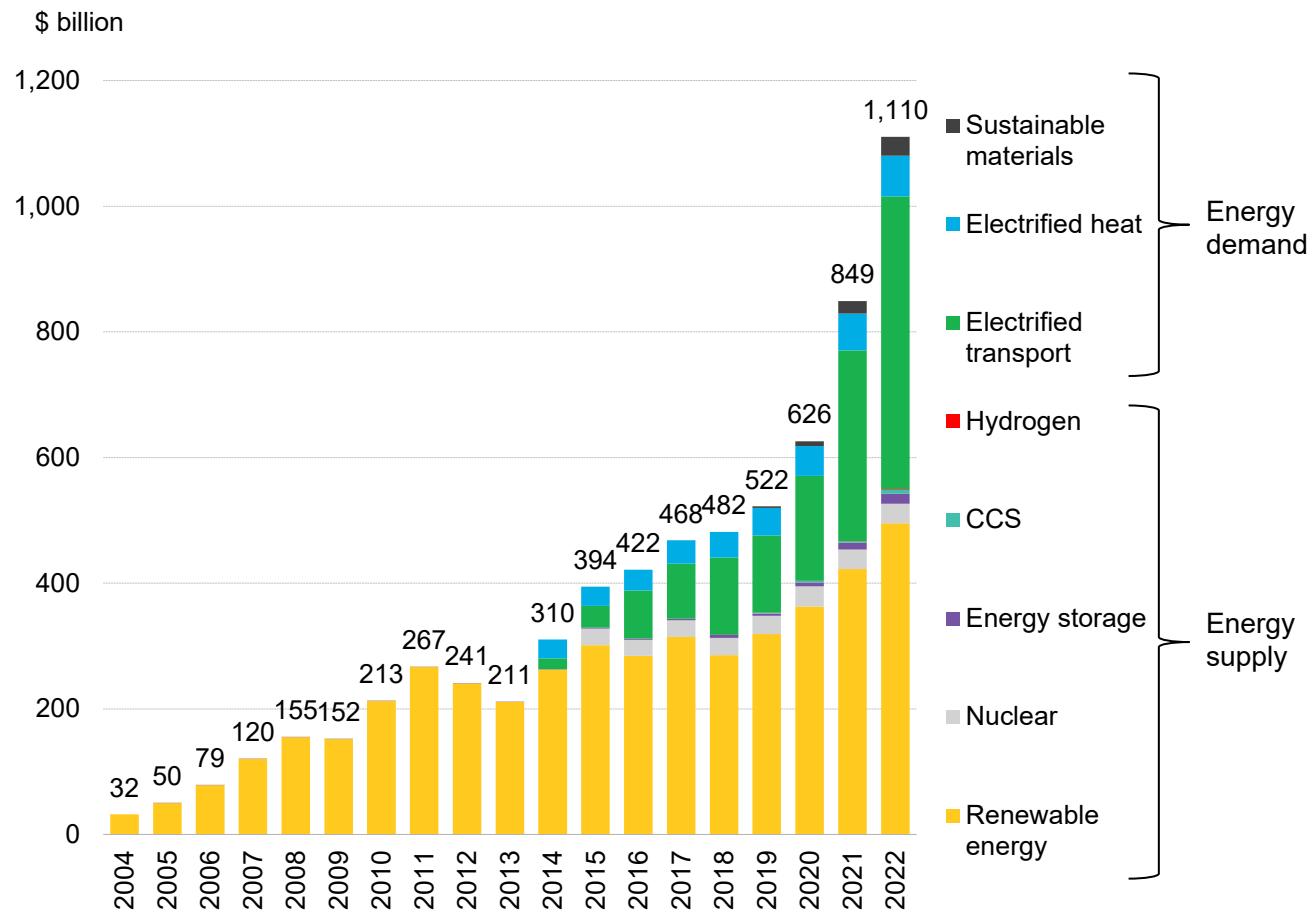
The sectors covered are:

- **Renewable energy:** wind (on- and offshore), solar (large- and small-scale), biofuels, biomass & waste, marine, geothermal and small hydro
- **Energy storage:** stationary storage projects (large- and small-scale), excluding pumped hydro, compressed air and hydrogen. The majority are battery projects.
- **Nuclear power:** reactors under construction and major refurbishments
- **Hydrogen:** hydrogen electrolyzer projects, thermochemical hydrogen production, pipelines and underground storage
- **Carbon capture and storage (CCS):** large- and small-scale commercial CCS projects, dedicated transport and storage
- **Electrified transport:** sales of electric cars, commercial vehicles and buses, as well as home and public charging investments. We also include hydrogen fuel cell vehicles and refuelling stations in this category.
- **Electrified heat:** residential heat pump investments
- **Sustainable materials:** circular economy (recycling) and bioplastics

These sectors encompass a broad range of low-carbon technologies and are a good representation of global energy transition investment. Energy efficiency is not covered, and grid investment is treated separately. The totals here can therefore be thought of as a conservative estimate of global energy transition investment.

Energy transition investment surged past \$1 trillion in 2022

Global investment in energy transition by sector

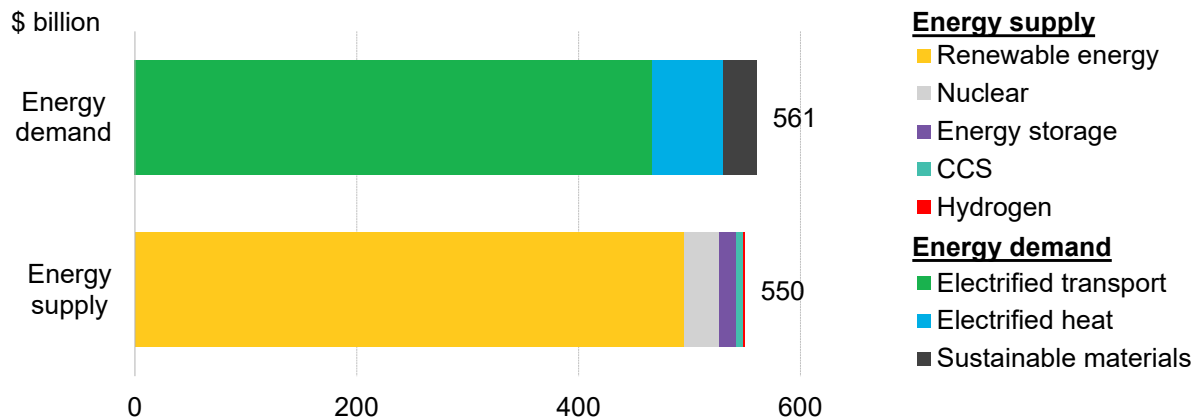


Source: BloombergNEF. Note: start-years differ by sector but all sectors are present from 2019 onwards; see Appendix for more detail. Nuclear figures start in 2015.

- Annual global investment in energy transition technologies has exceeded \$1 trillion for the first time, hitting a new record level of \$1.11 trillion in 2022 and recording a 31% yearly gain.
- Renewable energy, which includes wind, solar, biofuels and other renewables, narrowly retained its position as the largest sector and achieved a new record of \$495 billion in new project investments.
- Electrified transport, which tracks spending on electric vehicles (EVs) and charging infrastructure, is now a very close second. The sector grew to \$466 billion (up 54%) as the EV market continued to accelerate globally.
- With the exception of nuclear power, which has been flat in recent years, all other sectors also saw record levels of investment:
 - Electrified heat saw \$64 billion in funding
 - Sustainable materials grew to \$30 billion
 - Energy storage surged to \$15.7 billion
 - Carbon capture and storage hit \$6.4 billion
 - Hydrogen was the smallest sector at just \$1.1 billion but grew the fastest, more than tripling investment year-on-year.
- Growing policy support and the increasing competitiveness of clean energy technologies continues to underpin a rapid acceleration in the energy transition. While supply chain disruption and inflation have posed challenges, they do not appear to have put a meaningful dent in the speed of the transition.

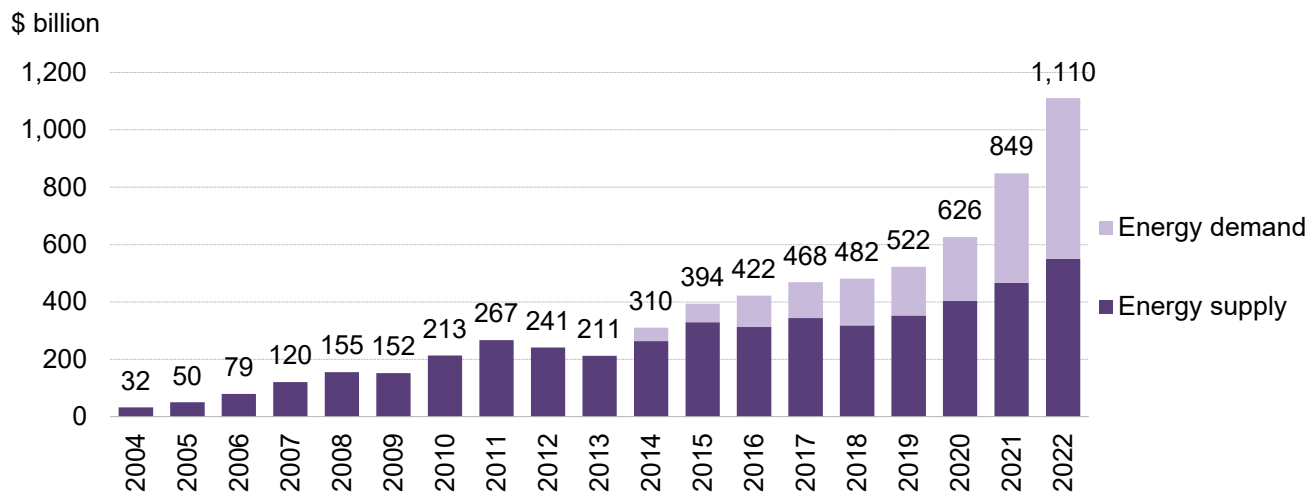
Demand-side investment outweighs the supply-side

Investment comparison: supply-side versus demand-side in 2022



- Demand-side investment in energy transition technologies now outweighs the supply side.
- In our ‘energy demand’ category, we include electrification of heat and transport, as well as the sustainable materials sector (circular economy and bioplastics). These technologies attracted \$561 billion in investment in 2022, with electrified transport being by far the largest contributor.
- Our ‘energy supply’ category includes all clean energy production technologies, as well as storage, hydrogen and carbon capture. These sectors collectively received \$550 billion in new project investments in 2022.
- The ‘supply’ category also includes some small-scale technologies, like rooftop solar and behind-the-meter battery storage, which are typically funded by end-users and would further boost the ‘energy demand’ total if they were considered demand-side investments.

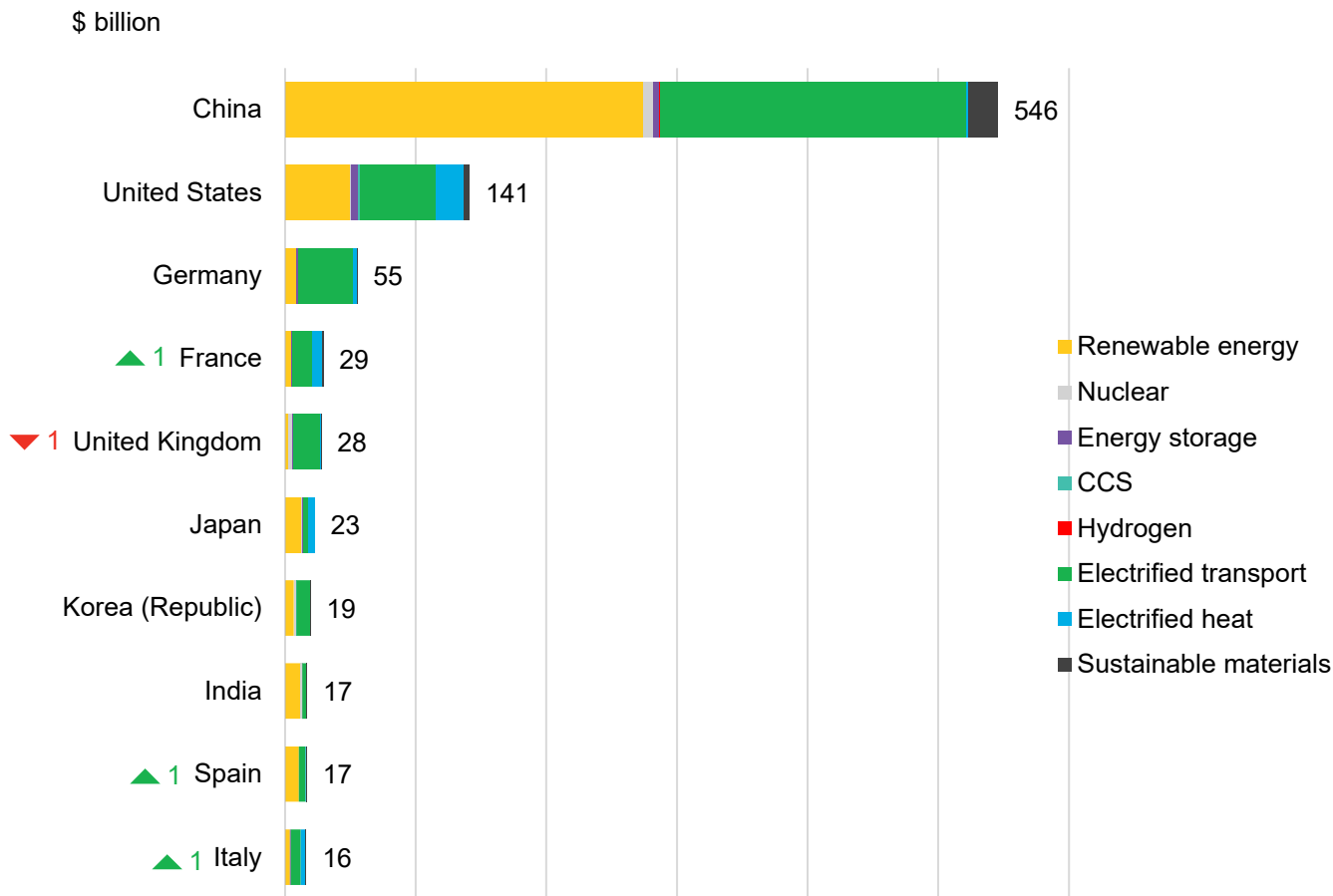
Global energy transition investment by supply / demand split



Source: BloombergNEF. Note: for this chart, we define ‘energy demand’ as the categories where energy users are likely to have committed the capital, or where the technology is mainly energy-consuming (not producing).

China extended its lead over other countries, the UK dropped a place

Top 10 countries for energy transition investment, 2022



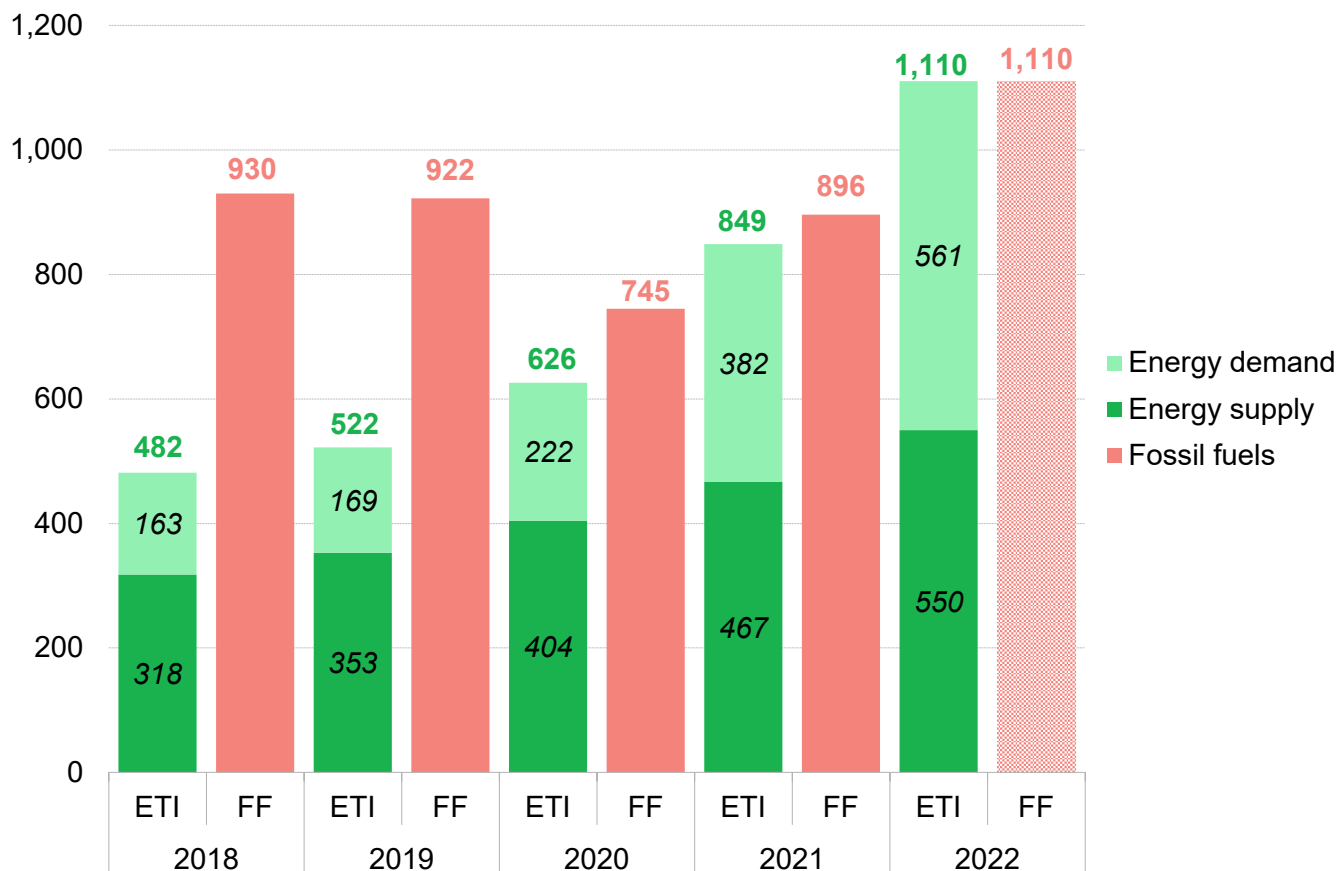
- China’s energy transition spending hit \$546 billion in 2021 – just shy of half the world’s total. Its lead over the US and other countries has grown as its renewable energy and electric vehicles sectors have ramped up. The country’s investments in steel recycling (captured under sustainable materials) also contribute meaningfully to the total.
- The US remains the second-largest funding destination for energy transition technologies, with a total of \$141 billion in 2022 – up 11% from 2021. New climate legislation in the US is expected to drive a rapid acceleration in the coming years.
- However, the EU (not shown in chart) would be in second place ahead of the US if treated as a single bloc, posting \$180 billion in new investment in 2022.
- Germany has retained its third position, largely thanks to a growing EV market that made up for a slowdown in renewables.
- Investment in France ticked up slightly in 2022, but the UK’s figures fell by about 20% thanks to a drop in offshore wind deals, dropping it to fifth in the table.
- Japan, South Korea and India each retained their places in the top 10, while Spain and Italy gained a place each.

Source: BloombergNEF

Global energy transition investment has matched fossil fuels for the first time

Investment comparison: energy transition versus fossil fuels

\$ billions



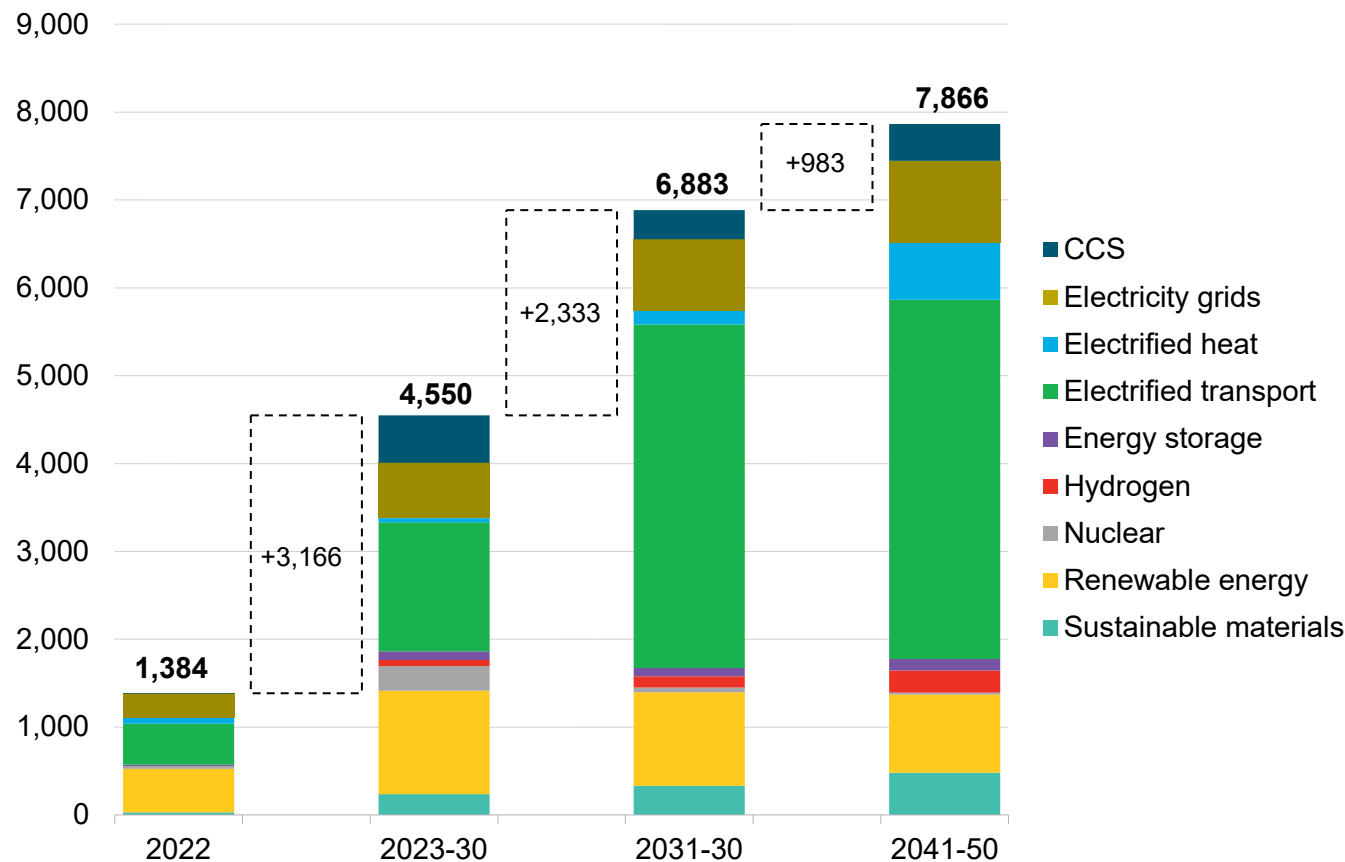
Source: BloombergNEF, IEA. Note: ETI stands for Energy transition investment. FF stands for Fossil fuels. 2018-21 FF values were derived from the IEA World Energy Investment 2022 report. 2022 fossil fuel investments are BNEF estimates, and include upstream, midstream, downstream sectors and unabated fossil power generation.

- For the first time, energy transition investment has caught up with fossil fuels investment in 2022. This came despite an uptick in spending for the latter as many regions focused their attentions on shoring up energy security.
- In 2022, energy transition investment summed to \$1.1 trillion, growing by \$261 billion from the previous year. Fossil fuels spend was at the same level, based on our estimates (with IEA data as an input), and up \$214 billion against 2021 levels.
- The energy transition and fossil figures were arrived at independently. Future revisions of both estimates may affect this fine balance.
- The growth in fossil fuel investments in 2022 occurred against the backdrop of high commodity prices, with many oil and gas majors earning record profits. Increased climate awareness has however made these companies more focused on share buybacks and diversifying to lower-carbon assets.
- The shift in investment towards clean energy is a historic change that is unlikely to be reversed, as low-carbon industries continue to grow. However, it should be noted that clean energy *supply* investments on their own are not yet a match for fossil fuels.

Investment must triple for the rest of the 2020s to get on track for net zero

Comparison: 2022 energy transition and grid investment versus required annual investment in 2023-30, 2031-40, and 2041-50 in NEO 2022 Net Zero Scenario

\$ billion (2022)



Source: BloombergNEF. Note: future values are from the New Energy Outlook 2022, except electrified transport, which is from the Electric Vehicle Outlook 2021 Net-Zero Scenario. The Net-Zero Scenario target global net zero by 2050 in line with 1.77 degrees Celsius of warming. Investment includes electricity grids.

- To get on track for global net zero, according to our New Energy Outlook, energy transition and grid investment need to average \$4.55 trillion between 2023 and 2030. This is more than three times the total spent in 2022.
- Across 2023-30, electrified transport, renewable energy and grids form the largest energy transition investment opportunities, accounting for 72% of the share combined at \$1.47 trillion, \$1.18 trillion and \$630 billion per year, respectively. Increased co-operation between the public and private sectors will be needed to mobilize capital towards these sectors in the near term.
- In the 2030s, annual investment ticks up to \$6.88 trillion. The investment opportunity to electrify mobility demand expands to \$3.91 trillion per year, while spending in renewable energy and electricity grids combined accounts for 26% of the overall share at \$1.88 trillion per year.
- By the 2040s, annual energy transition investment requirements will total \$7.87 trillion, almost six times the 2022 levels. Electrified transport forms the lion's share, followed by grids and renewable energy.

Climate-tech corporate finance: overview

Venture capital, private equity and public
markets investment for the climate
transition

Climate-tech corporate finance: preface

What is this section?

As asset investment in the energy transition grows, companies providing low-carbon products and services must raise capital to scale up and meet demand. This section of the report tracks all forms of equity financing for climate-tech companies. It analyzes which sectors and markets have raised the most equity funding in 2022, and what kinds of capital each sector is raising.

This year, this section also tracks funding at a subsector level, showing with greater resolution which technologies and business models are attracting the most interest from equity investors. The data in this section does not include mergers and acquisitions or debt funding.

Definition of sectors

BNEF defines “climate tech” as technologies and business models that act to decarbonize six sectors: **energy, transport, industry, agriculture, buildings and climate and carbon**. The climate and carbon sector includes products and services that track or model the climate or the emissions footprint of businesses, companies that operate in carbon offsetting, and companies operating in carbon removal, transport and storage.

Methodology

The data for this section has come from a variety of sources: the Bloomberg Terminal, Bloomberg proprietary datasets, PitchBook and public news announcements. In this analysis, we only use disclosed deal values, and do not make estimates for undisclosed deals.

This year, rather than tagging each deal as relevant to only one sector, deals are now tagged to multiple sectors and subsectors if a single application for an application-neutral technology cannot be determined. Energy storage companies are the most common example of this as they have both power-system and transport applications. Funding is evenly distributed between tagged sectors.

Examples of technologies in the different sectors

Mega-sector	Examples
Transport	Lithium-ion batteries, electric-vehicle charging and manufacturing, ride hailing, micromobility, low-carbon aviation and shipping
Energy	Clean-energy equipment manufacturers, renewable-power developers, hydrogen, biofuels, grid technology
Agriculture	Precision agriculture, indoor farming, alternative proteins
Industry	Mining of energy-transition metals, low-carbon chemicals, metals and cement
Buildings	Insulation, energy-efficiency systems, heat pumps, waste-heat reuse, district heating and cooling
Climate and carbon	Carbon removal, carbon transport and storage, carbon offsetting, climate-monitoring technology

What types of financing are covered in this section of the report?

Private financing

Funds raised by privately-owned, earlier-stage companies, in exchange for company equity. This portion of funding is referred to as venture capital and private equity (VC/PE) funding throughout the report. BNEF does not distinguish between venture capital and private equity investments. This data also includes convertible debt funding. The investors can be government, accelerators, incubators, private individuals, sovereign-wealth funds, VC/PE firms, corporates or banks.

Public financing

Funds raised by publicly-quoted or over-the-counter pure-play companies on the capital markets. This may be through IPOs, SPACs or follow-on offerings like secondary offerings or PIPE.

- **Initial public offering (IPO):** The first sale of stock by a private company to the public. IPOs are often issued by smaller, younger companies seeking the capital to expand, but can also be done by large privately-owned companies looking to become publicly traded.
- **SPAC reverse mergers:** A publicly-traded blank check company (special purpose acquisition company, SPAC) raises investment funds in the form of blind pool money through an initial public offering (IPO). The purpose is to complete an acquisition of an existing private company, sometimes in a specified target industry. When a target has been identified, the target raises equity through a PIPE (see below) before reverse merging with the SPAC and acquiring the cash in trust.

- **Secondary offering:** A secondary offering is the sale of new or closely-held shares by a company that has already made an initial public offering.
- **PIPE (private investment in public entity):** A private investment firm's, fund's or other qualified investor's purchase of stock in a public company at a discount to the current market value per share for the purpose of raising capital. PIPE can also be raised by private companies that are about to go public.

Overlap with other sections of this report

This section tracks equity financing raised by companies in the climate-tech space. In principle, these funds could then be invested by those companies into energy transition project deployment, such as renewable projects or EV charging networks. If that were the case, then those funds would also show up in the 'energy transition investment' section of this report.

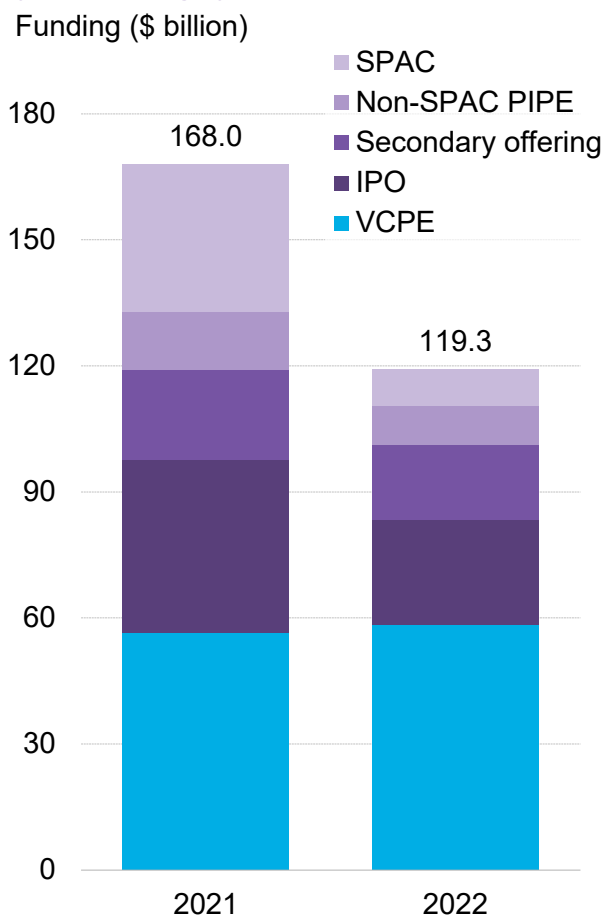
Similarly, if these companies invested their fundraising proceeds into factories or supply chain expansion, those figures might show up in the 'supply chain & manufacturing investment' section of this report (depending on the sector coverage).

Therefore, there is some possibility of double-counting and these figures should not necessarily be thought of as 'additive' to other sections of this report.

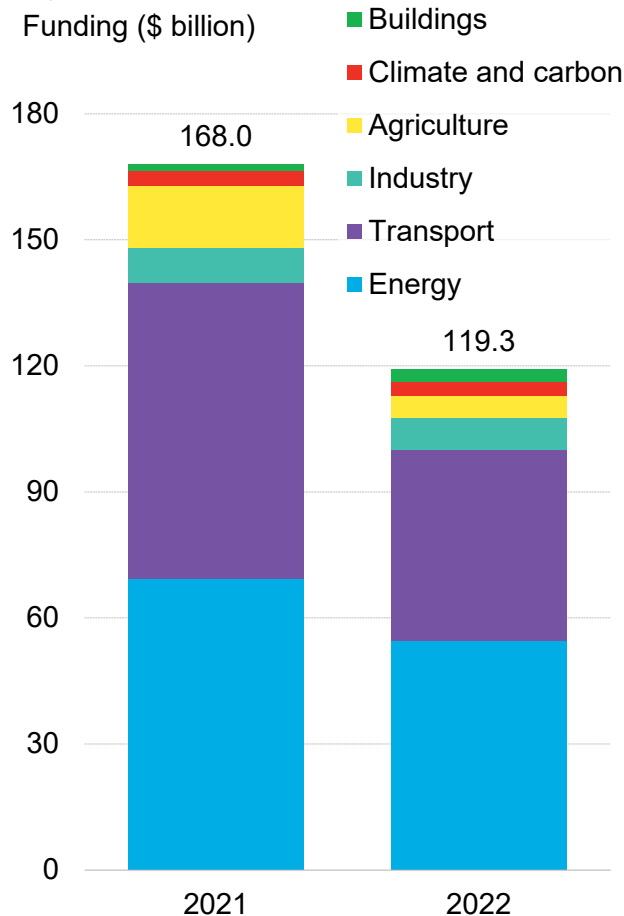
Summary: climate-tech corporate finance down 29% as public offerings decline

Climate-tech corporate finance by financing type and sector

By financing type



By sector



Climate-tech companies raised \$119 billion in 2022, a 29% decline on the year before.

With a challenging backdrop in the public markets throughout 2022, it was the steep decline across all types of public equity financing that drove the drop in headline numbers (left chart).

Funding raised through reverse mergers with special purpose acquisition companies (SPACs) declined 75%, the biggest drop in any kind of financing.

VC/PE investment was the only type of funding tracked by BNEF that did not decline, with a small increase of 3%, as appetite for private opportunities in climate tech held strong.

The energy and transport sectors attracted more than 80% of total climate-tech funding for the second year running, but had the biggest dollar value declines. Agriculture had the biggest percentage decrease in funding at 65%, while low-carbon buildings – the least funded sector – was the only sector to see an increase in overall funding.

Companies located in Mainland China attracted the most funding of any market due to its strength in clean-energy-equipment and electric-vehicle manufacturing. The US ranked second in total but first in VC/PE funding.

Source: BloombergNEF, PitchBook. Note: SPAC stands for 'special purpose acquisition company'. PIPE stands for 'private investment in public equity'.

Supply chain & manufacturing investment

Investments in factories producing wind, solar, battery and hydrogen equipment

Supply chain and manufacturing investment: preface

This section presents our findings on global investment in the manufacturing facilities underpinning the low-carbon energy transition.

The figures in this section represent the capital spent on building the factories that manufacture low-carbon technologies. This only tracks spending on the factories themselves, and therefore excludes the operational expenses required to *produce* clean energy equipment.

Our approach

For each sector, we show historical spending over 2018-22 and compare this to future spending required to meet global clean technology demand under two scenarios modeled by BNEF's New Energy Outlook (NEO): the Economic Transition Scenario and Net-Zero Scenario. The forward-looking estimates are for spending over 2023-30.

For historical capacity additions, we rely on our proprietary, sector-specific datasets tracking factory additions. To arrive at our investment figures, we use top-down factory capex estimates rather than bottom-up intelligence per facility. Region or country-specific benchmarks (eg in \$/MW/year) are used for historical spending, whereas a weighted global benchmark is applied for future investments (thereby avoiding taking a view on *where* factories will be brought online). These benchmarks are held constant over the measured periods.

We use the year in which a factory was commissioned as a proxy for that in which the related investment was made. Actual lead times vary by region and whether a project is brown or greenfield. Historical capacity is of the nameplate variety, based on company announcement (and not derisked). As such, actual operational capacity is likely to be slightly lower than our investment numbers imply.

We do not account for retirements or retrofits, and assume that future capacity tracks global demand under either NEO scenario. For some years, no new factories of a certain type are required.

Sector coverage

The data captures investment required for factories that manufacture the following components and systems:

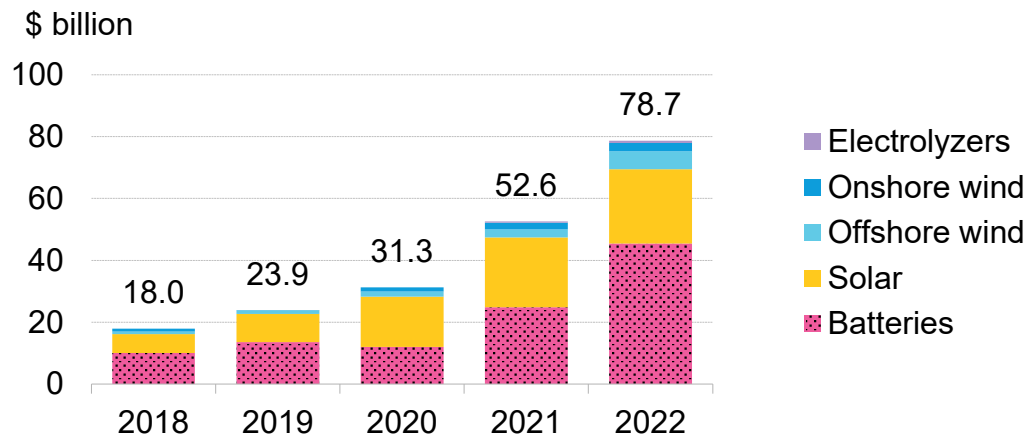
- **Lithium-ion batteries:** separators, electrolytes, anodes, cathodes and battery cells. These serve both the electric-vehicle and stationary energy storage markets
- **Solar:** polysilicon, ingots and wafers (taken together, as the two are typically produced in the same facility), modules and cells
- **Wind:** nacelles and blades
- **Hydrogen:** electrolyzers, which produce hydrogen from electricity

These sectors encompass the bulk of low-carbon factory investment other than for electric vehicles, which are often produced in existing vehicle factories. They are therefore a good representation of global energy transition investment. There are, however, areas that we have not yet included – such as various segments of the wind supply chain.

The totals here can therefore be thought of as a conservative estimate of global investment in energy transition supply chains.

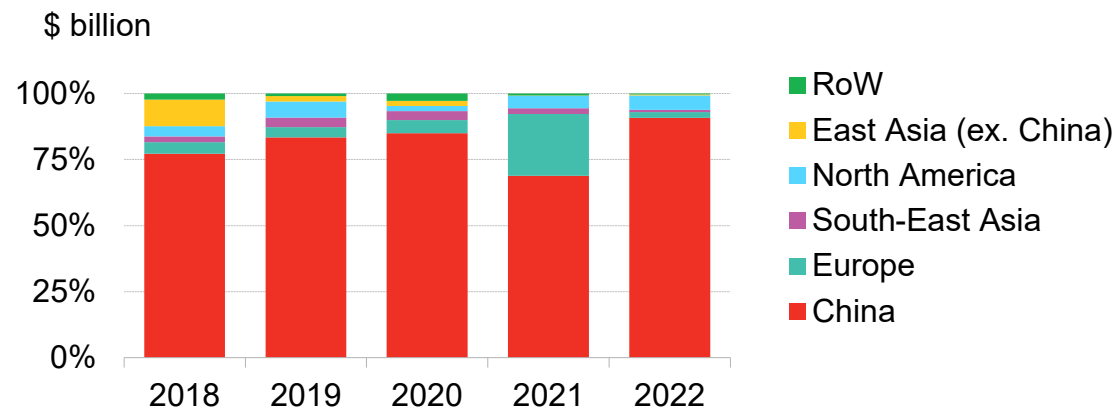
Batteries and China dominate new factory spending as global additions surge

Clean energy factory investment by technology, 2018-22



Source: BloombergNEF. Note: Sectors include upstream inputs and components, such as polysilicon for PV and anodes for batteries. No electrolyzer investment recorded before 2022. Solar investment for 2022 may have missed new capacity late in the year.

Clean energy factory investment by geography, 2018-22

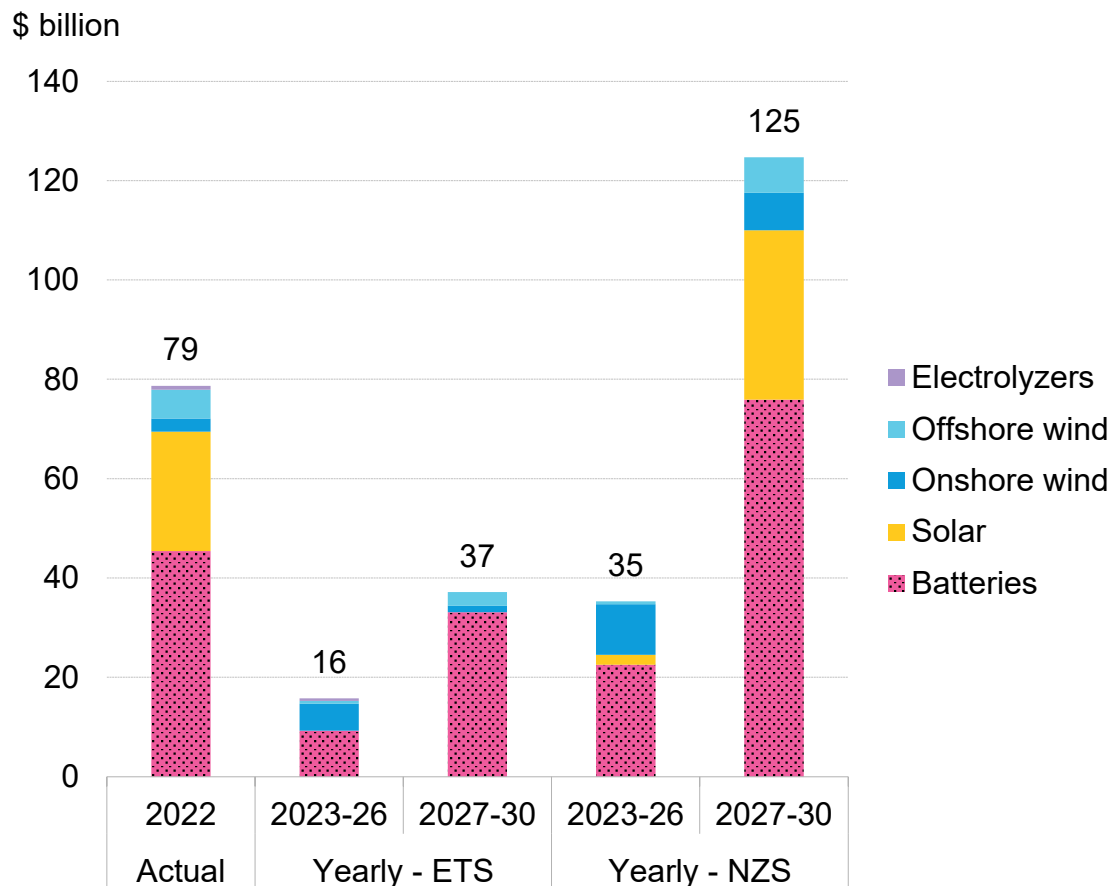


Source: BloombergNEF. Note: Does not include wind.

- Investment in clean-technology factories is rising fast, hitting \$78.7 billion in 2022. This figure represents a four-fold increase since 2018 and a jump of 44% year-on-year.
- Battery-related factory spending is growing at pace and now attracts more investment than other clean-tech sectors at \$45.4 billion in 2022. Facilities to produce lithium-ion battery components accounted for about 58% of facilities opened in 2022.
- Solar continues to attract significant manufacturing investment at \$23.9 billion in 2022, while wind is showing robust growth with investment up by a third year-on-year.
- Despite the considerable attention given to supply-chain diversification in recent years, the regional picture has barely budged. China accounted for 91% of investments in 2022, up from an average of 79% over 2018-21.
- Some other regions saw a strong expansion in factory investment in 2022. Spending in North America, driven by the US, grew by 40%, although spending in Europe was down from a bumper year of battery investments in 2021.
- Growth in North America could be boosted by the Inflation Reduction Act, which provides incentives for manufacturing in the US and North America. Similar efforts are afoot in other geographies such as India and Europe, though talk of an EU “Net-Zero Industry Act” is still in its earliest stages.

Net-zero requires thrice the factory investment of a least-cost transition

Clean energy factory investment by scenario, 2023-30



Source: BloombergNEF. Note: ETS = Economic Transition Scenario. NZS = Net Zero Scenario. Accounts for operational factories, but not closures nor retrofits of existing fleet. Sectors include upstream components, such as polysilicon for PV and anodes for batteries. Electrolyzer historical average taken over 2021-22.

- New factories will be required to meet clean energy demand under BNEF’s New Energy Outlook. But the picture varies according to whether the transition is modelled at lowest cost – the Economic Transition Scenario (ETS) – or must solve for net-zero by 2050 – the Net-Zero Scenario (NZS).
- Achieving net-zero by 2050 requires a good deal of factory investment. By 2027-30, yearly NZS factory spending totals three times that of the ETS. Yet in the short-term, existing manufacturing capacity is sufficient to meet the bulk of demand for solar and, surprisingly, electrolyzers.
- Yearly factory spending will eventually have to step up to meet clean power demand, but existing facilities mean there is not an immediate need for the investment volumes seen in 2022. Under the more ambitious NZS, annual investment needs would only rival last year’s levels toward the latter half of this decade. Meanwhile, enough solar and electrolyzer production capacity has been built to obviate the need for new factories under the ETS.
- Future factory investment will likely overshoot these scenarios. They do not, for instance, account for the duplication of supply chains – an inevitability as policies prioritize resilience and job creation. The world’s battery cell factory pipeline is already far higher than our projected demand.

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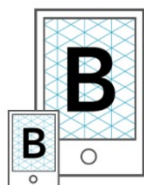
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