International Energy Agency

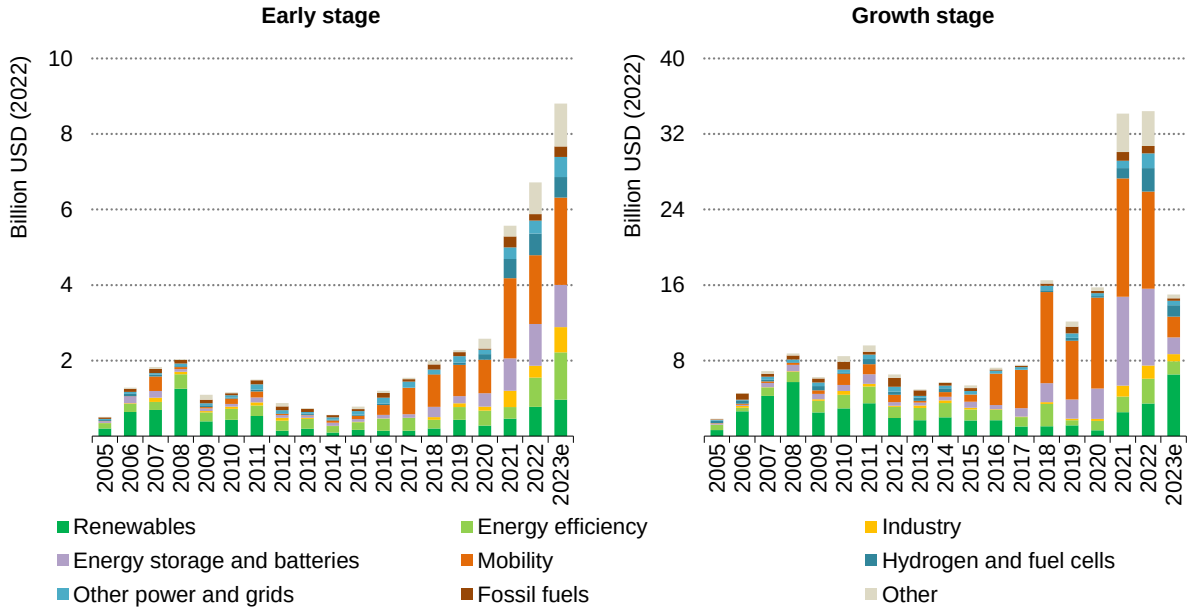
World Energy Investment 2023

Supplementary charts: energy venture capital trends

15 June 2023

Early-stage equity funding for energy start-ups is booming

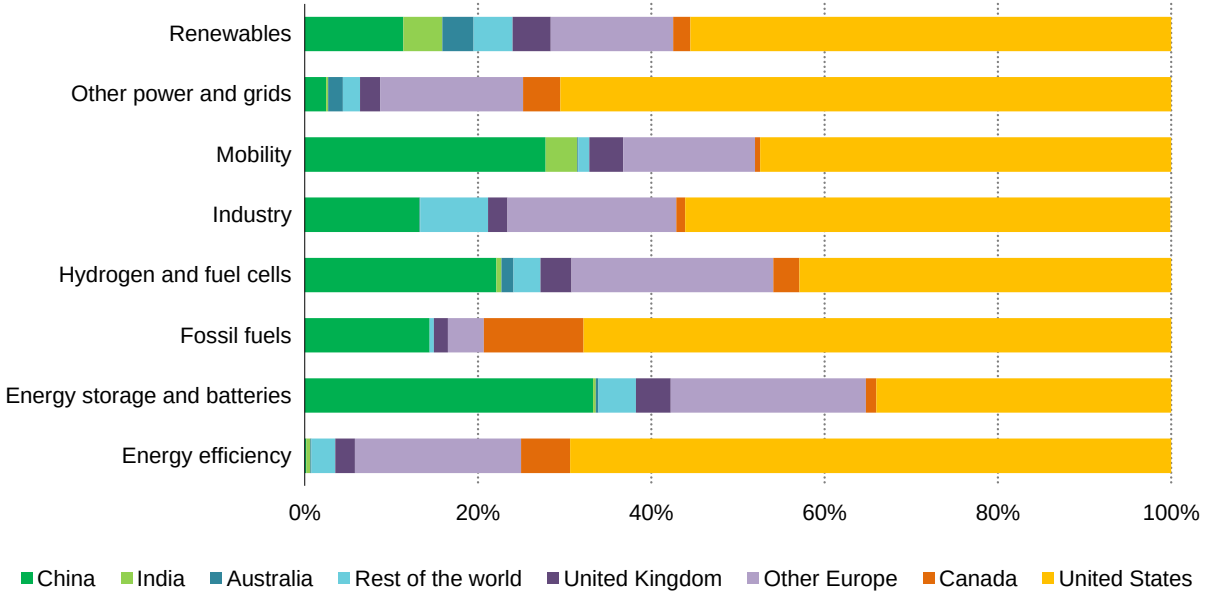
VC investment in energy start-ups, by technology area, for early-stage and growth-stage deals, 2005-2023e



Investment is led by clean mobility and renewables, but prevailing macroeconomic conditions have dented the amount of capital available and 2023 could be leaner for later-stage deals

Most VC funding for energy has flowed to US-based start-ups

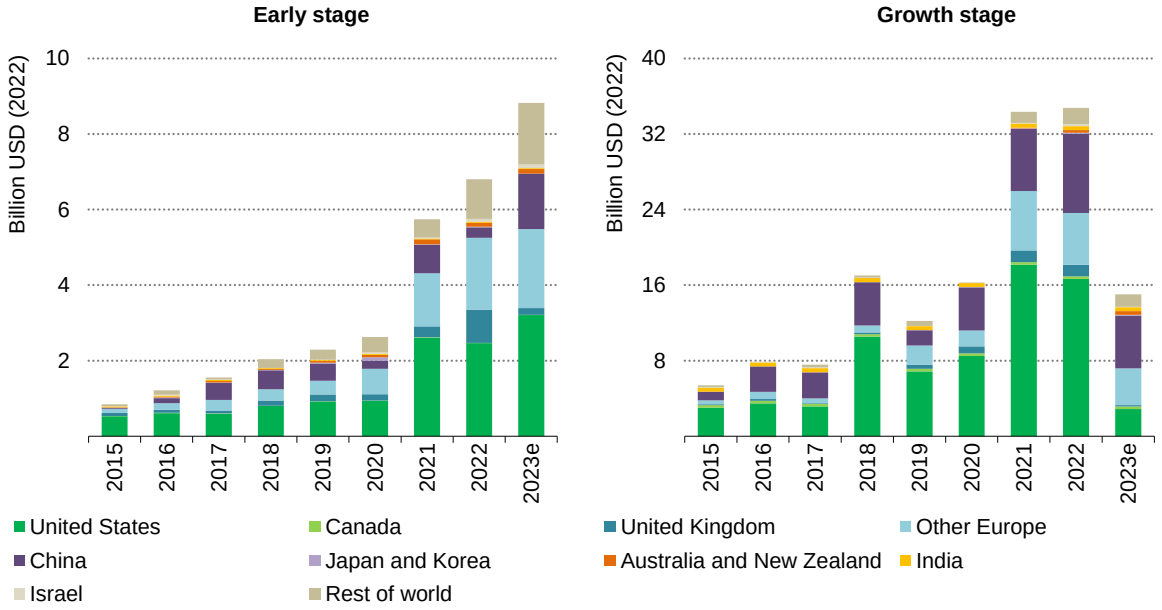
Early- and growth-stage equity investment in energy start-ups by region and technology area, 2020-2022



Europe has a strong presence in hydrogen and China active in mobility and batteries, but other emerging market and developing economies account for just 5%

European start-ups attract a higher share of early- than growth-stage

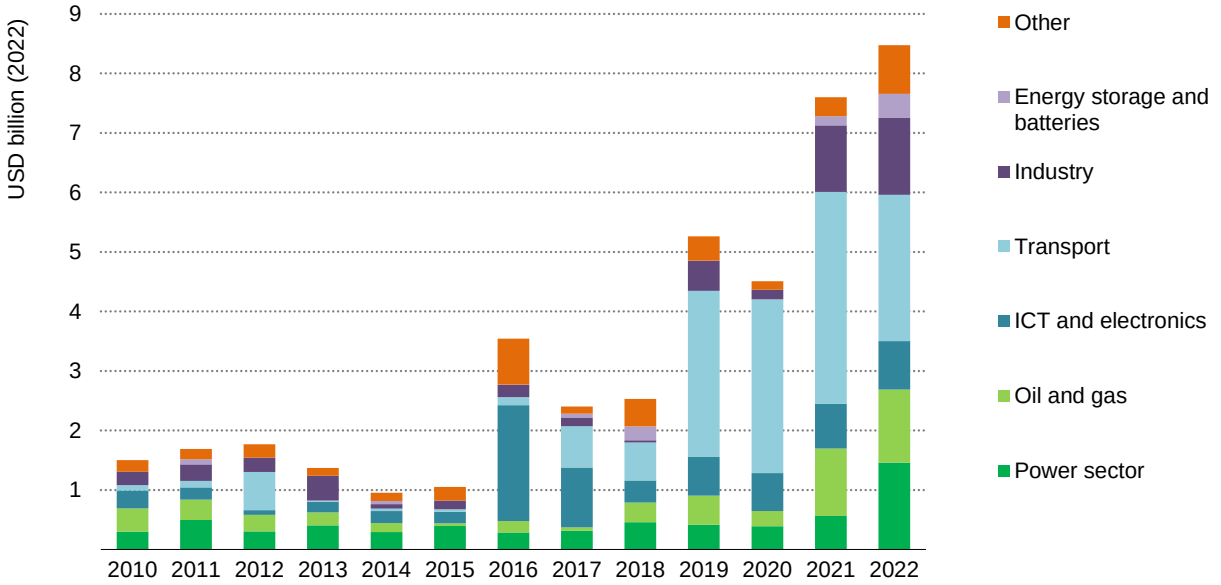
VC investment in energy start-ups, by location of start-up, for early-stage and growth-stage deals, 2015-2023e



The big rise in investment in 2021 to 2023 was spread across the main regions, led by the United States, then Europe and China. Other regions represent much lower shares, a result that has not changed significantly since 2015.

Corporate VC investment in clean energy start-ups remains high

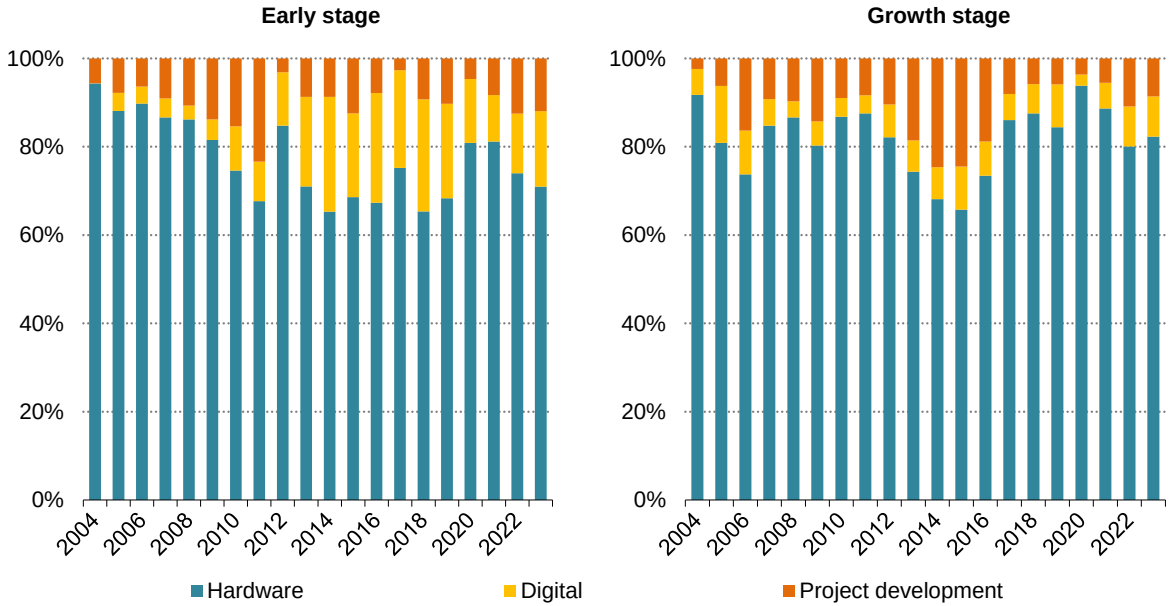
Corporate VC investment in energy start-ups, by sector of corporate investor, 2010-2022



The contribution in 2022 from electricity, oil and gas, and heavy industry companies rose

Most of the boom in energy is for start-ups working on hardware

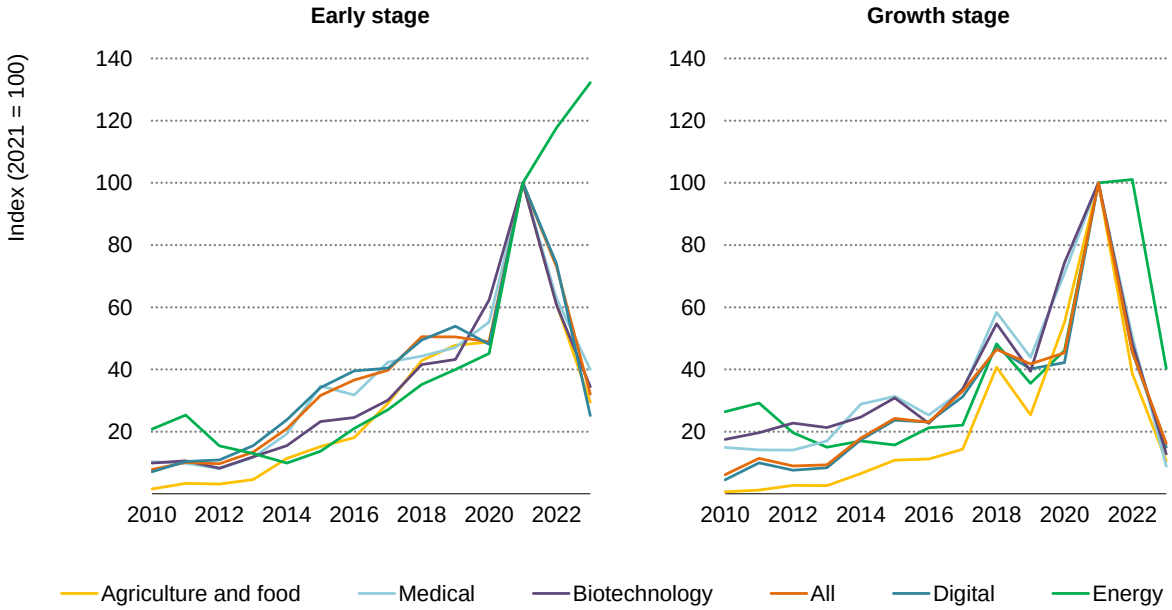
Share of early and growth-stage VC investment in energy start-ups, by type of start-up, 2004-2023



More than 25% went to less risky digital technology and project developers in 2022, more than in 2020-2021
2023, likely reflecting lower willingness among VC funds to make large, long-term bets

Energy has outperformed other VC segments since 2021

Growth in global VC investment by sector of start-ups, 2010-2023



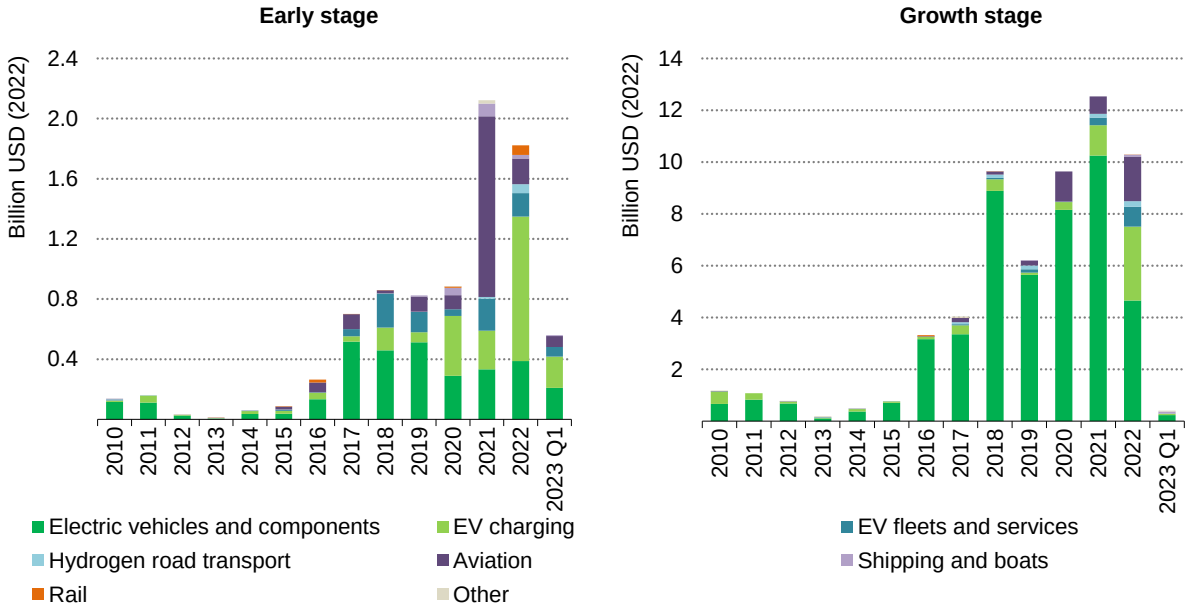
Early-stage equity funding for energy start-ups in particular has experienced impressive growth while VC investment has fallen in general

Trends by category

Mobility

Early-stage deals for mobility have shifted from vehicles to charging

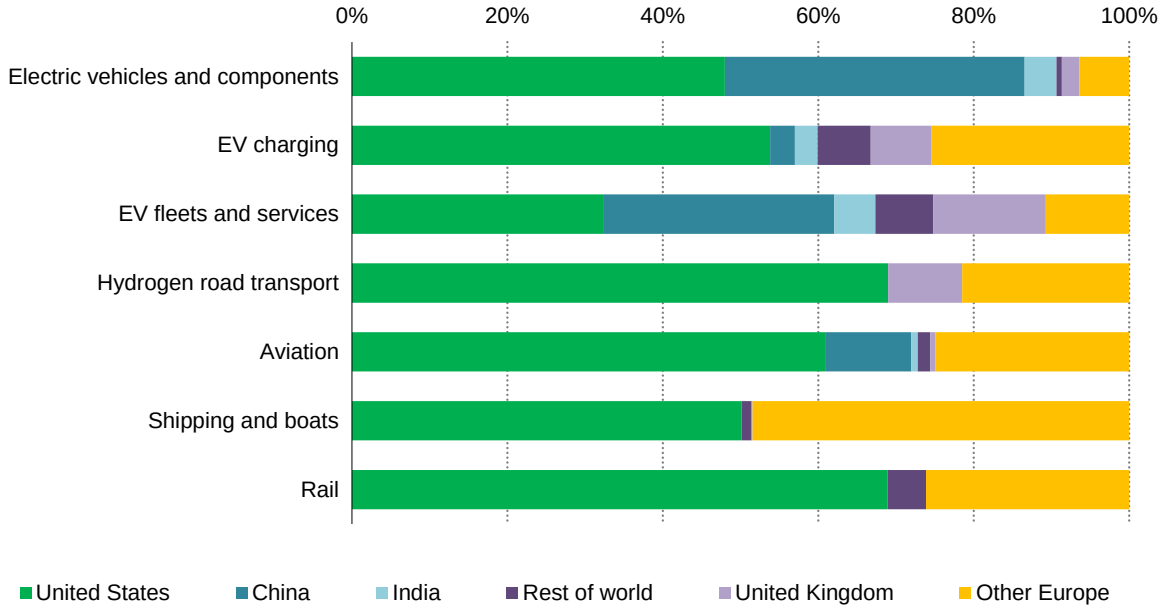
VC investment in energy start-ups in the Mobility category, for early-stage and growth-stage deals, 2010-2023



Early-stage funding for charging, fleets and aviation is starting to translate into finance for scale-up

Chinese EV start-ups are well-funded, while US leads mobility VC

Early- and growth-stage equity investment in energy start-ups in the Mobility category by region, 2018-2022

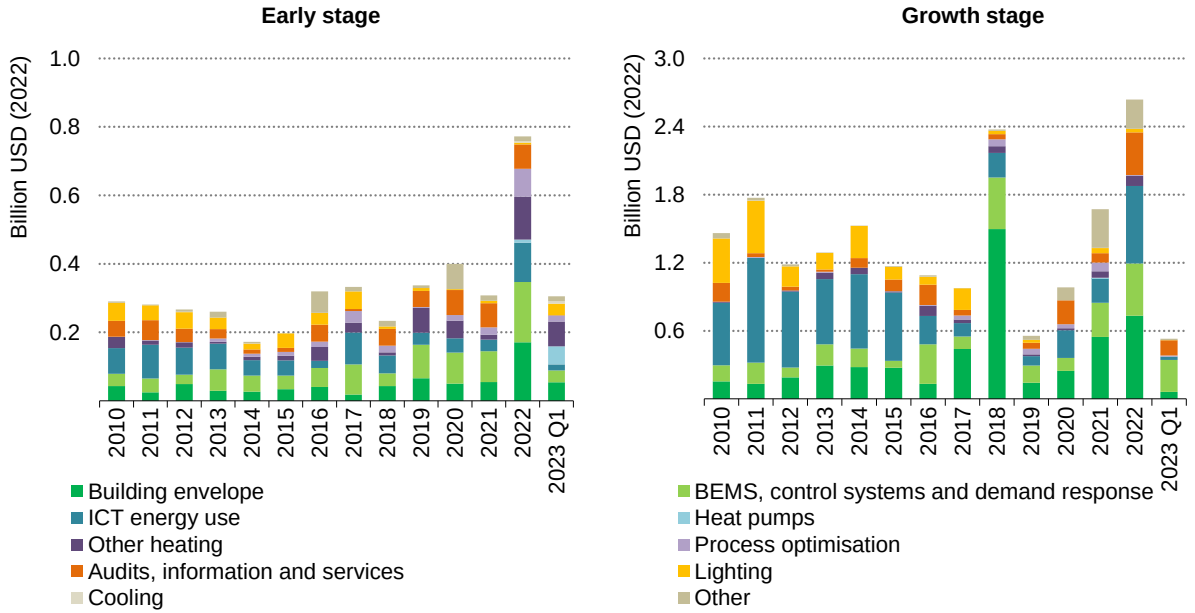


Europe has strong shares of funding for non-road and hydrogen-based mobility

Energy efficiency

VC funding for energy spiked in 2022 across nearly all categories

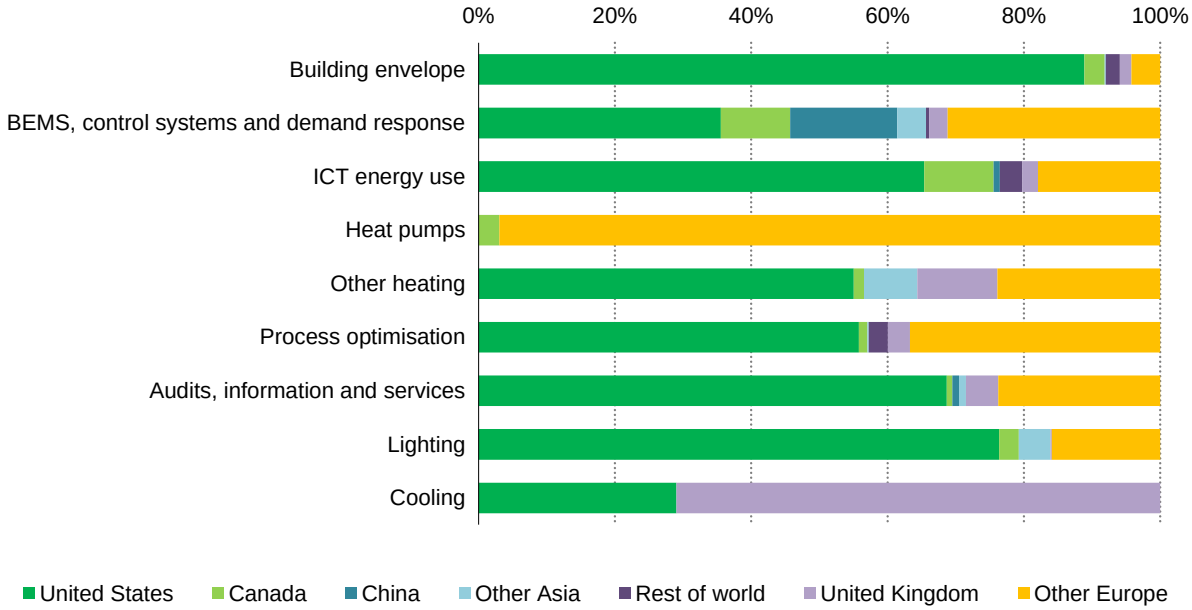
VC investment in energy start-ups in the Energy efficiency category, for early-stage and growth-stage deals, 2010-2023



Energy efficiency has been a strong performer in the past, with most activity in digital-related products and processes. In 2022, there was more funding for heating, and heat start-ups entered the market.

North American and European start-ups dominate energy efficiency

Early- and growth-stage equity investment in energy start-ups in the Energy efficiency category by region, 2018-2022

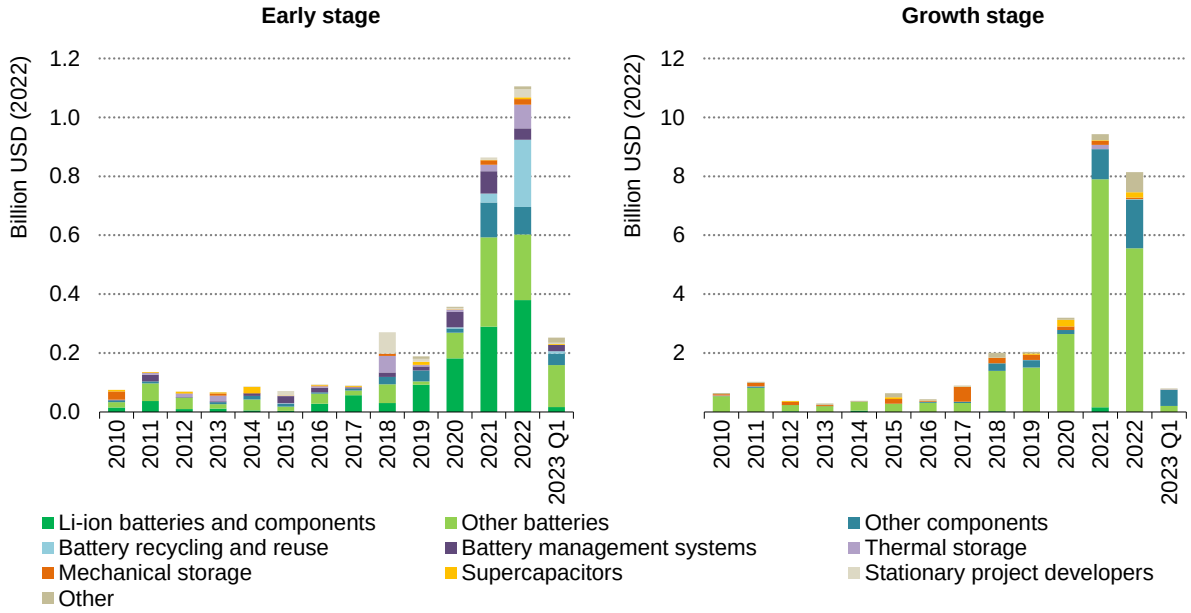


Digital and connected solutions for building energy management show the most regional diversity. Recent investment in heat pumps has been largely in Europe.

Energy storage and batteries

Li-ion leads growth-stage VC, but other storage options are emerging

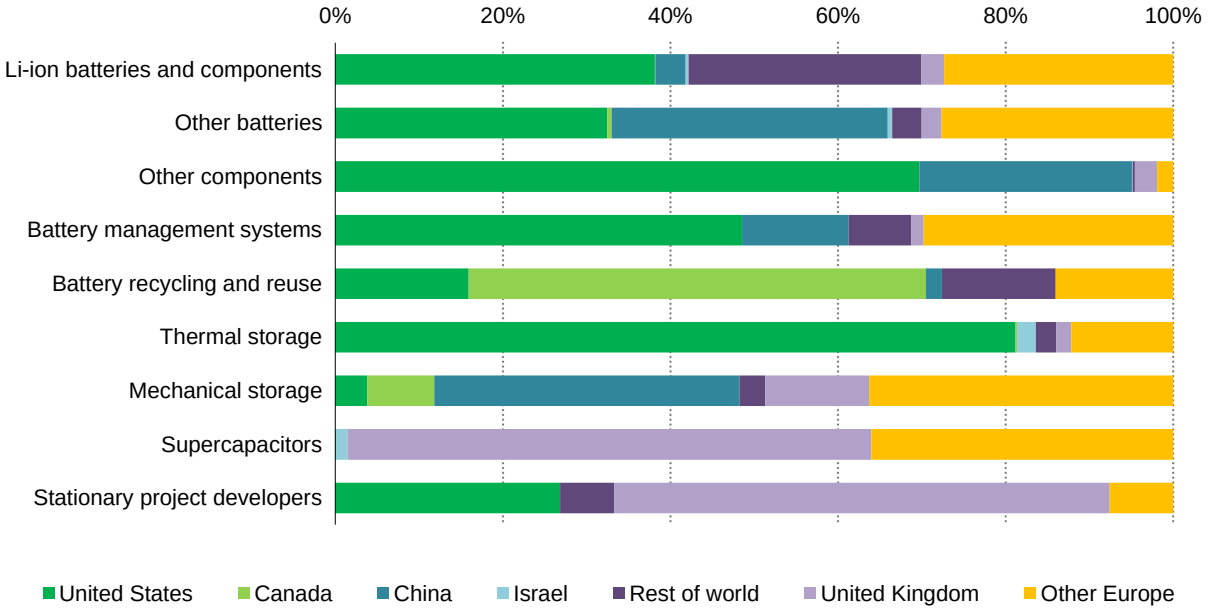
VC investment in energy start-ups in the Energy storage category, for early-stage and growth-stage deals, 2010-2023



In 2022, both early-stage and growth-stage funding for the dominant battery technology, lithium ion, dipped. Energy storage funding nonetheless reached a new high, as other battery types and battery recycling surged ahead.

Energy storage VC is regionally diverse

Early- and growth-stage equity investment in energy start-ups in the Energy storage category by region, 2018-2022

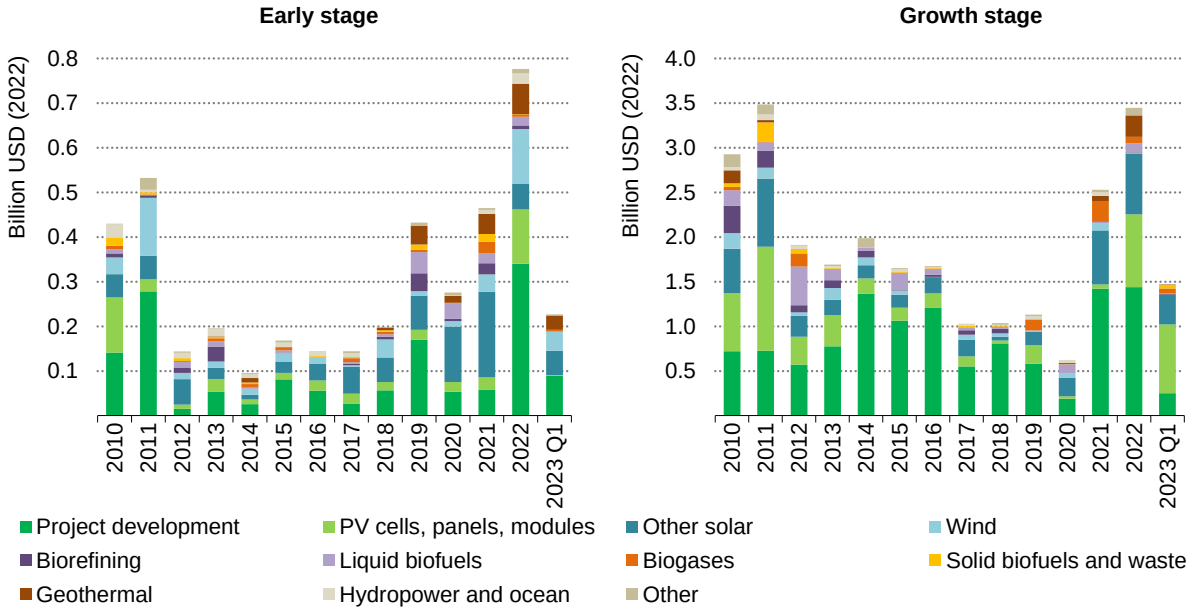


Funding for lithium ion start-ups has been evenly split between China, Europe and the United States. While US start-ups have attracted most funding for other battery types, data indicate a European focus on non-battery storage

Renewables

In 2022, VC funding for renewables returned to 2011 levels

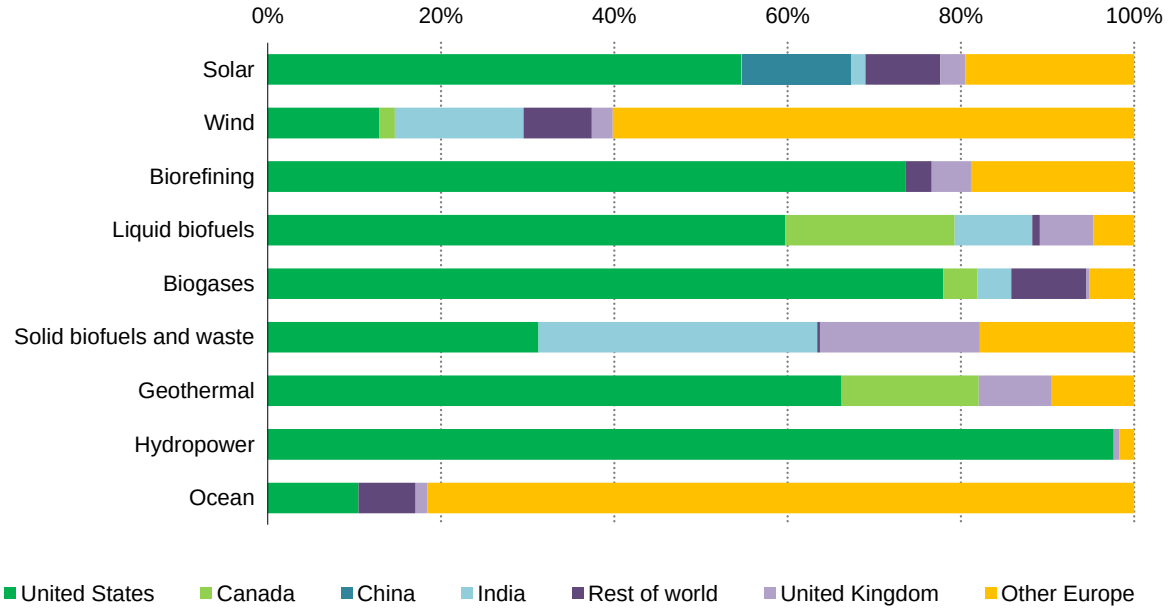
VC investment in energy start-ups in the Renewables category, for early-stage and growth-stage deals, 2010-2023



Project developers continue to raise a large share of the VC investment for renewables, though early-stage funding has shifted in part from solar start-ups to wind, bioenergy and geothermal

Europe and India have produced innovators in bioenergy and wind

Early- and growth-stage equity investment in energy start-ups in the Renewables category by region, 2018-2022

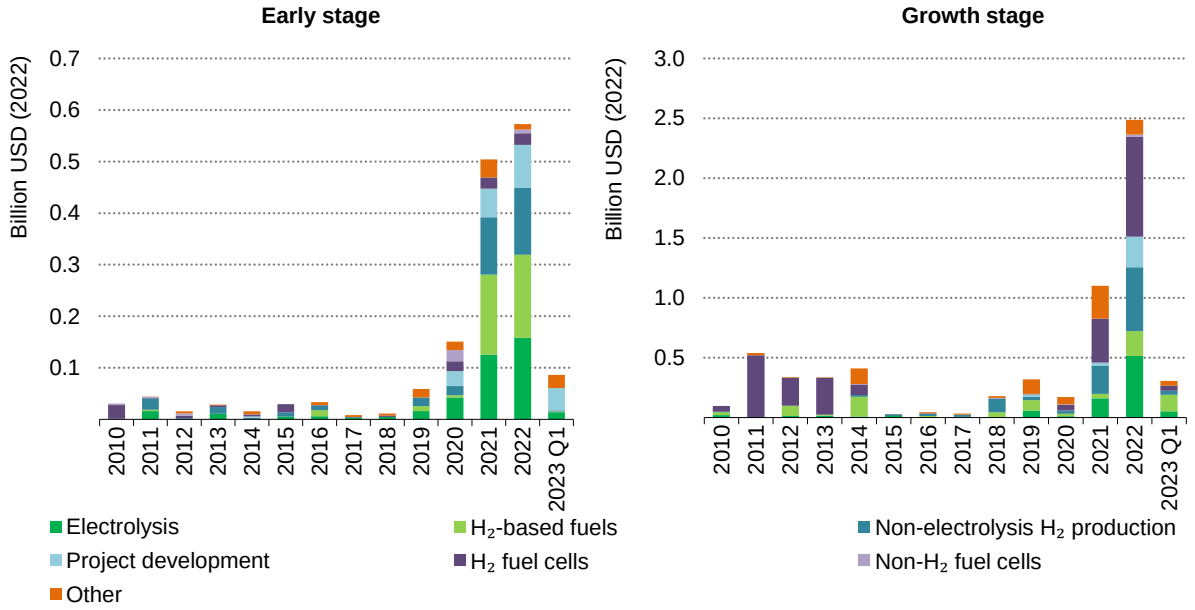


While manufacturing of solar PV has become concentrated outside North America, US entrepreneurs developing new designs continue to attract VC financing. The region is also home to the recent uptick in funding for geothermal.

Hydrogen and fuel cells

Investors have responded to the rise of policy support for hydrogen

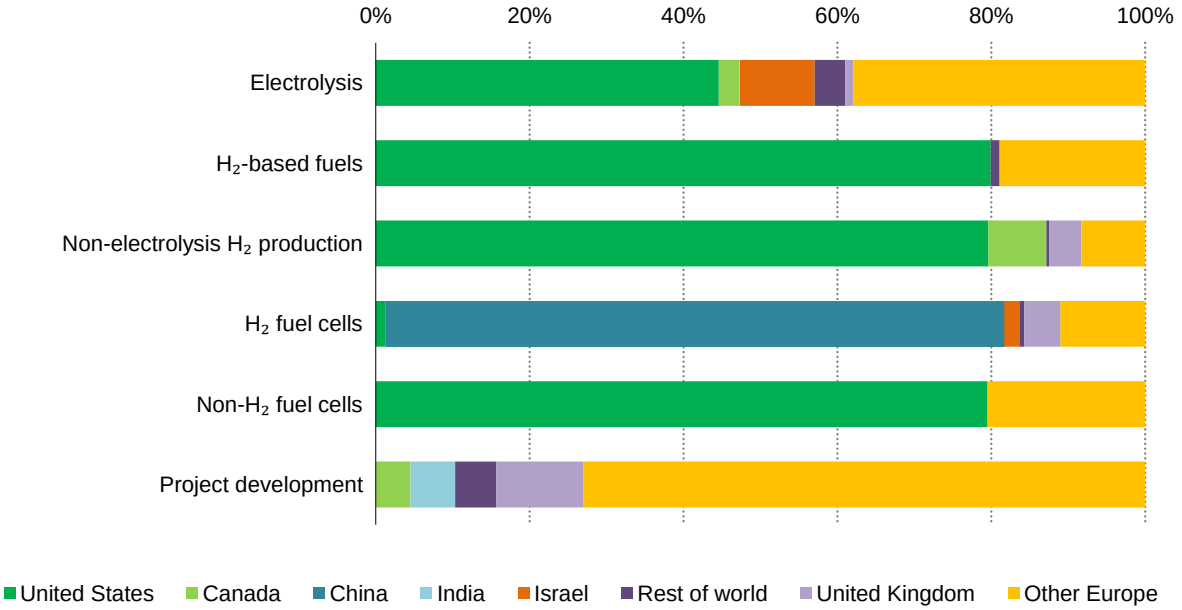
VC investment in energy start-ups in the Hydrogen and fuel cells category, for early-stage and growth-stage deals, 2010-2023



Investors see growing opportunities in early-stage businesses across hydrogen supply segments, but this is yet to translate into growth-stage funding, which has been led by fuel cells over the past decade

No region shows dominance in VC funding across H_2 and fuel cells

Early- and growth-stage equity investment in energy start-ups in the Hydrogen and fuel cells category by region, 2018-2022

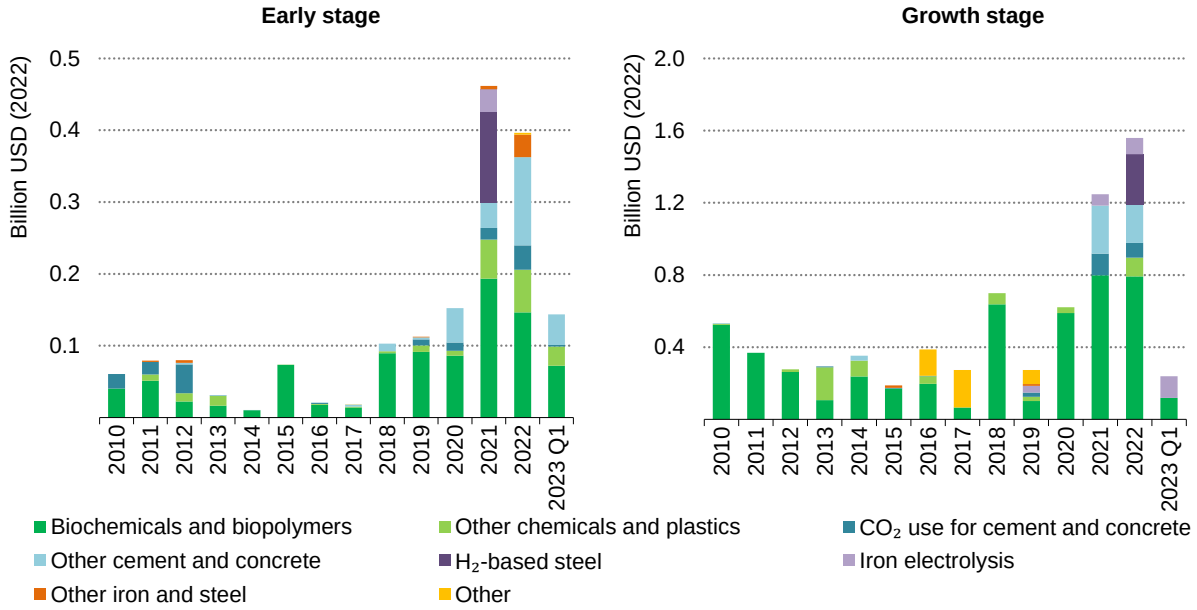


VC investors keen to profit from the scale up of hydrogen-related technologies are looking for excellence around the world, with only hydrogen-based fuels showing significant regional concentration

Industry

VC activity in heavy industry has been boosted by cement and steel

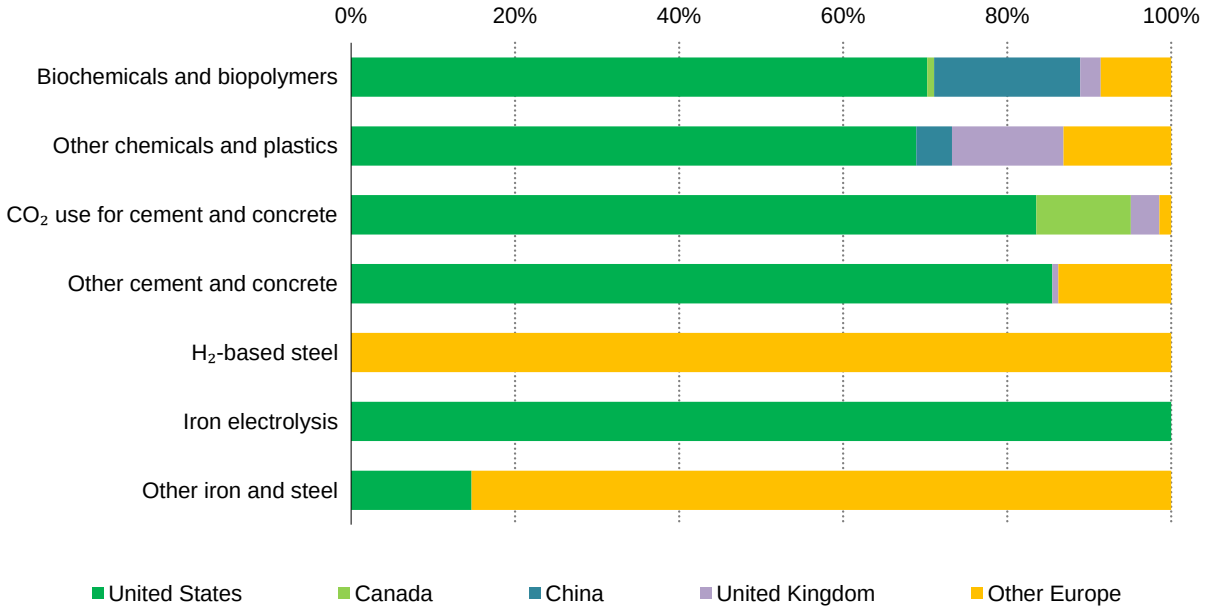
VC investment in energy start-ups in the Industry category, for early-stage and growth-stage deals, 2010-2023



The spike in energy-related VC activity in 2021 and 2022 extends beyond traditional energy areas and indicates that net zero pledges are creating value for start-ups aiming to shift industrial activity away from CO_2-intensive processes

Industrial decarbonisation funding is mostly going to the US and EU

Early- and growth-stage equity investment in energy start-ups in the Industry category by region, 2018-2022

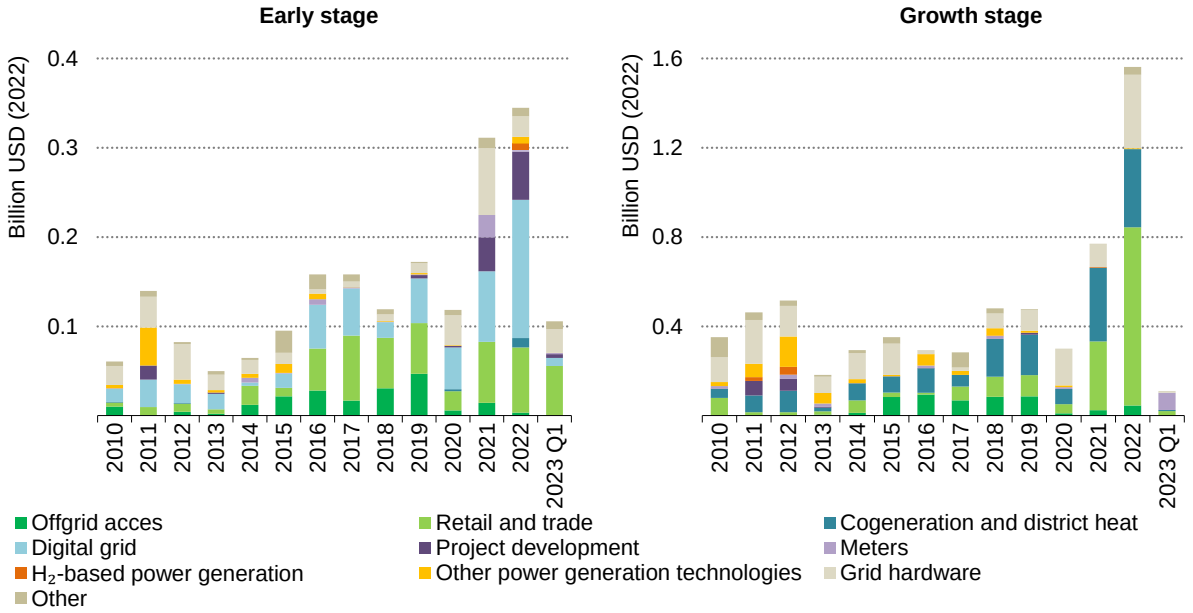


European and US start-ups are seeking different technology paths to transition the steel sector away from fossil fuels

Other power and grids

Early-stage grid-related investments have mostly been for digital

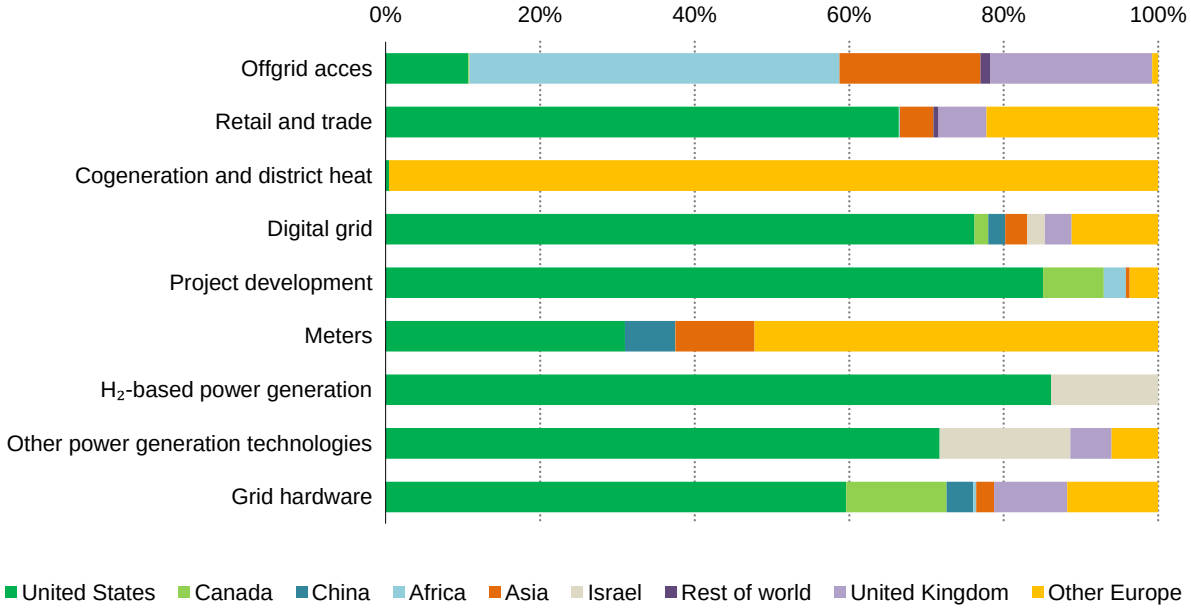
VC investment in energy start-ups in the Other power and grids category, for early-stage and growth-stage deals, 2010-2023



Both early- and growth-stage funding for grids has risen sharply. The newer entrants are led by digital businesses, such as optimisation services, while scale-up deals are for more traditional areas of district heating and metering

African and Asian start-ups are the leaders in offgrid energy access

Early- and growth-stage equity investment in energy start-ups in the Other power and grids category by region, 2018-2022

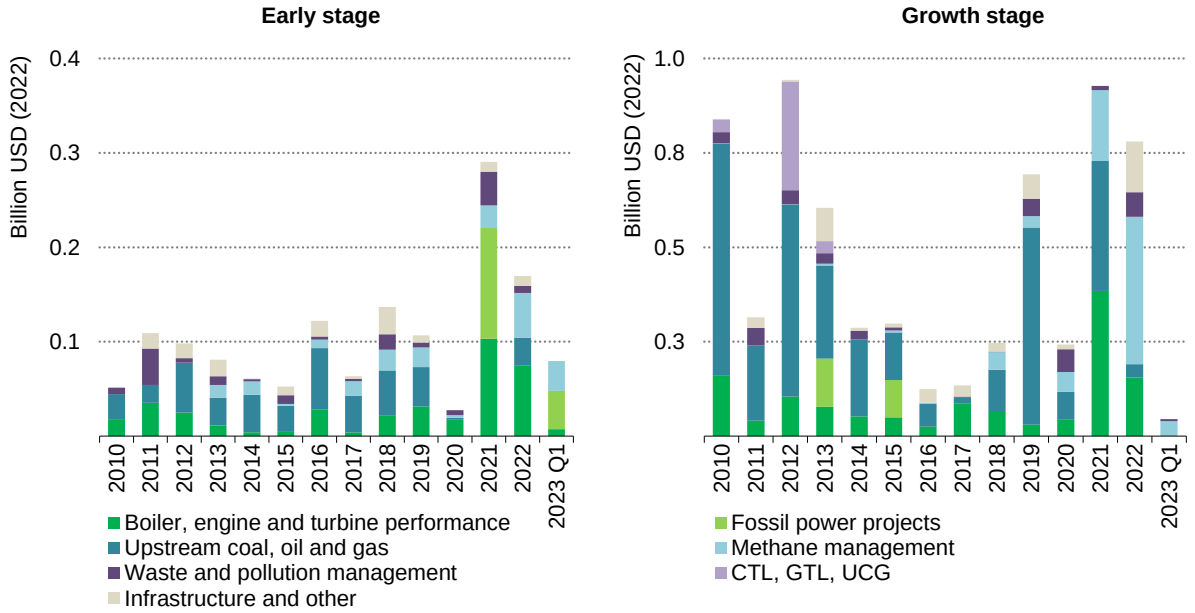


District heat remains a Europe-dominated area, while Israeli start-ups have attracted attention for power generation technologies

Fossil fuels

Fossil fuel-related VC deals shift to methane and pollution control

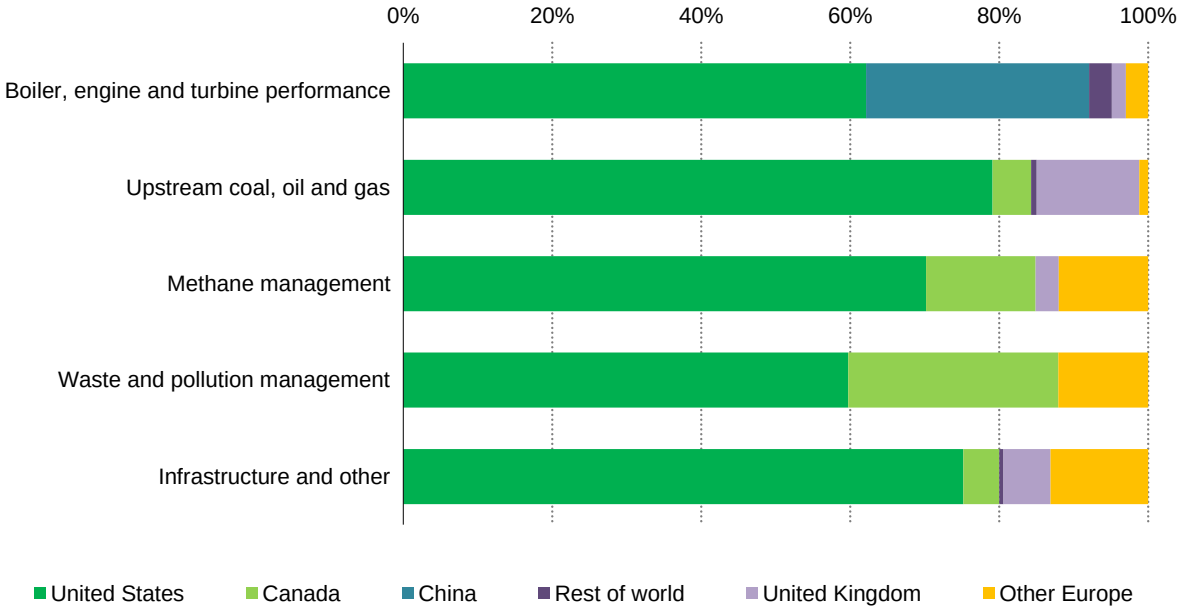
VC investment in energy start-ups in the Fossil fuels category, for early-stage and growth-stage deals, 2010-2023



VC funding for start-ups aiming to improve the economics of fossil fuel production is back at 2010-2012 levels, but with more emphasis on dealing with scope 1 and 2 emissions

Fossil fuel VC activity has largely been North American

Early- and growth-stage equity investment in energy start-ups in the Fossil fuels category by region, 2018-2022

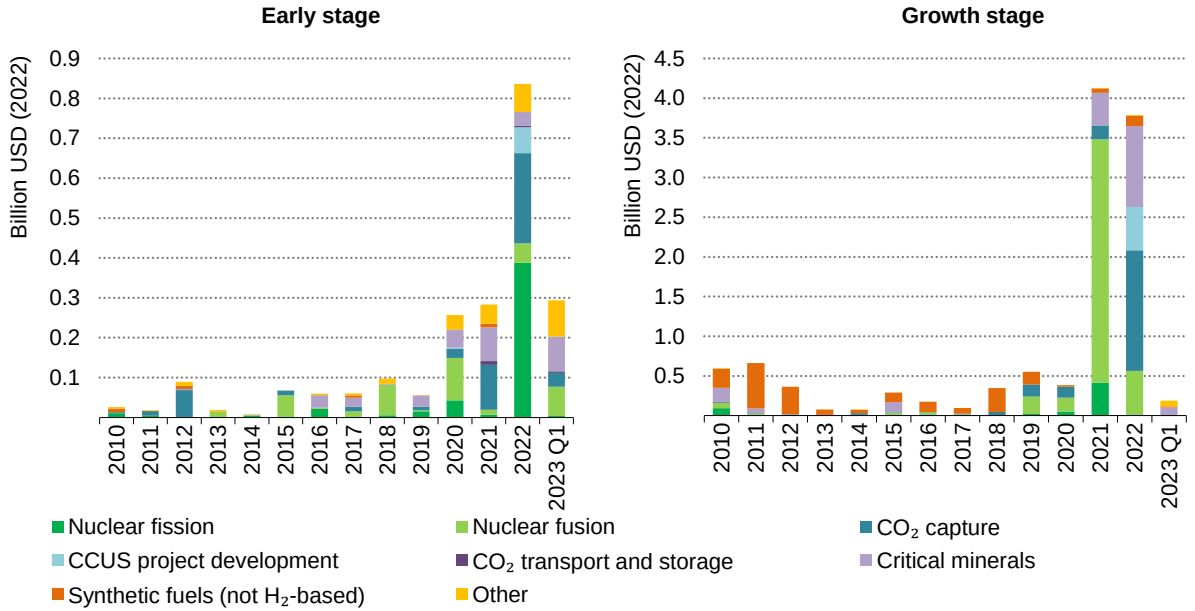


Outside North America, Chinese start-ups have attracted funding for better combustion technologies and European start-ups have been most active in infrastructure, such as natural gas distribution

Other

There was a big jump in investment in nuclear start-ups in 2021-2022

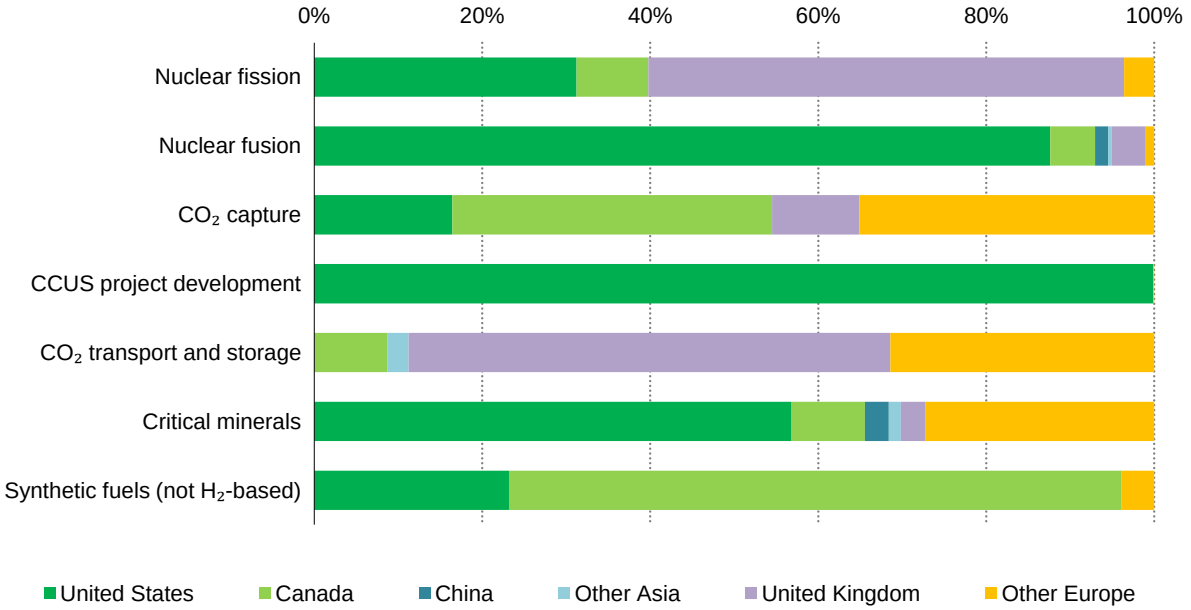
VC investment in energy start-ups in the Other category, for early-stage and growth-stage deals, 2010-2023



VC investors see value in both nuclear fission (especially small modular reactors) and fusion start-ups, with more money going to fusion. There have also been a major increases in CCUS and critical minerals funding

The United Kingdom is a potential hub for nuclear fission innovation

Early- and growth-stage equity investment in energy start-ups in the Other category by region, 2018-2022



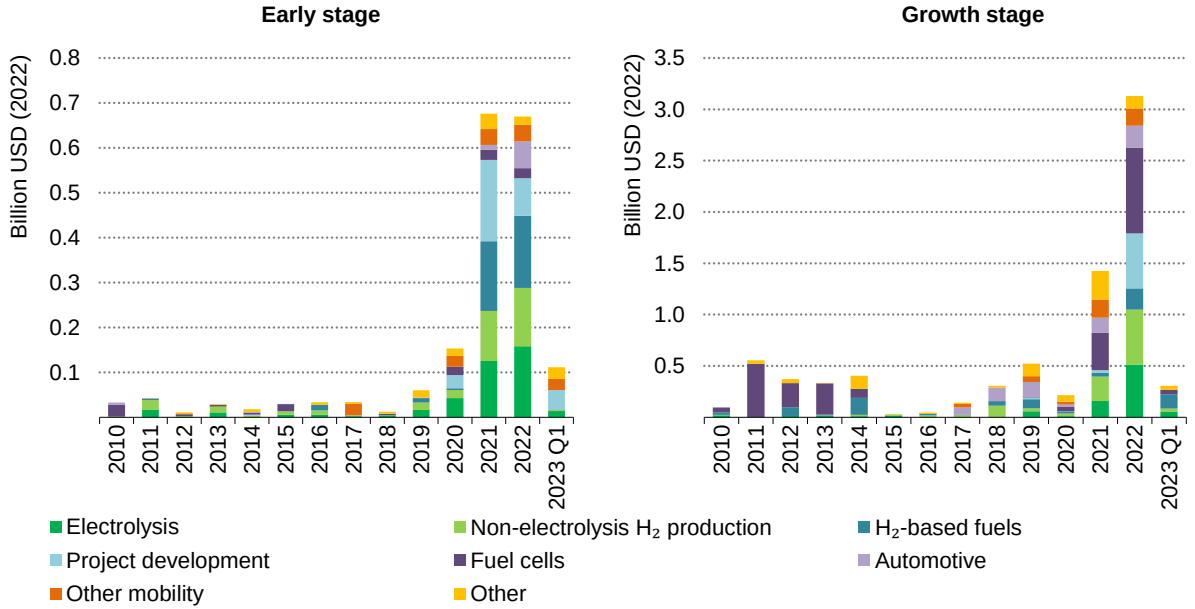
UK start-ups are also present in several CCUS areas, though US companies have attracted most of the investment into CO_2 capture, transport and storage

Trends for cross-cutting categories

Hydrogen

Most VC funding for hydrogen is for supply-side technologies

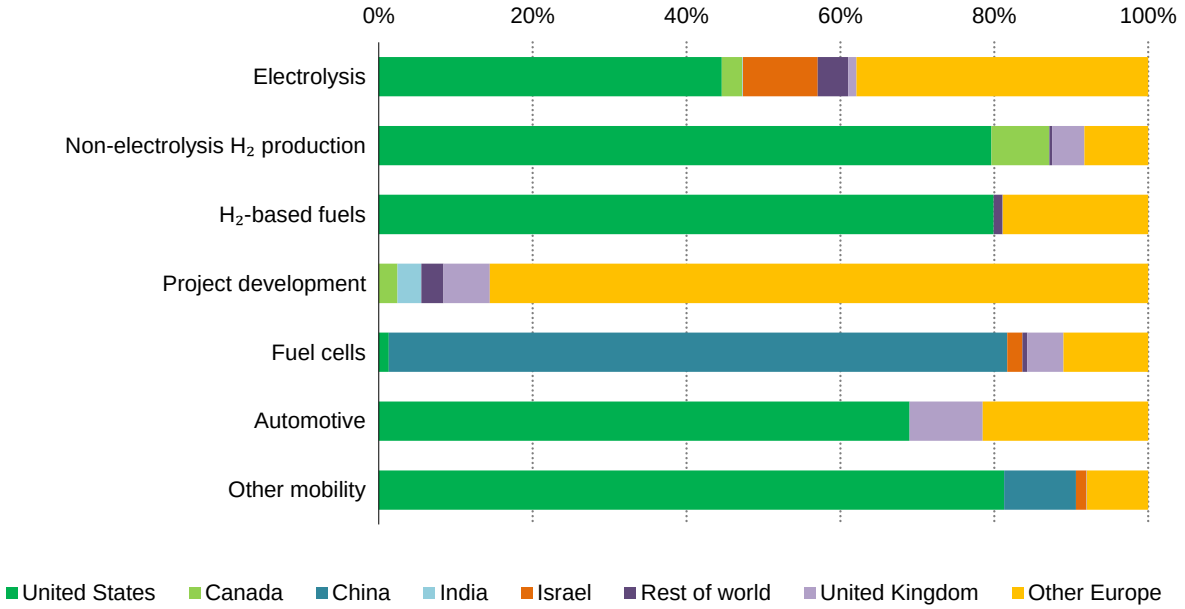
VC investment in energy start-ups in Hydrogen-related areas, for early-stage and growth-stage deals, 2010-2023



Hydrogen start-ups were absent from the boom in clean energy VC in 2010-2012, but have now become a major area of expected returns. Early-stage bets are split between novel approaches to making and converting hydrogen.

Chinese start-ups have raised most money for fuel cell development

Early- and growth-stage equity investment in energy start-ups in hydrogen-related areas by region, 2018-2022

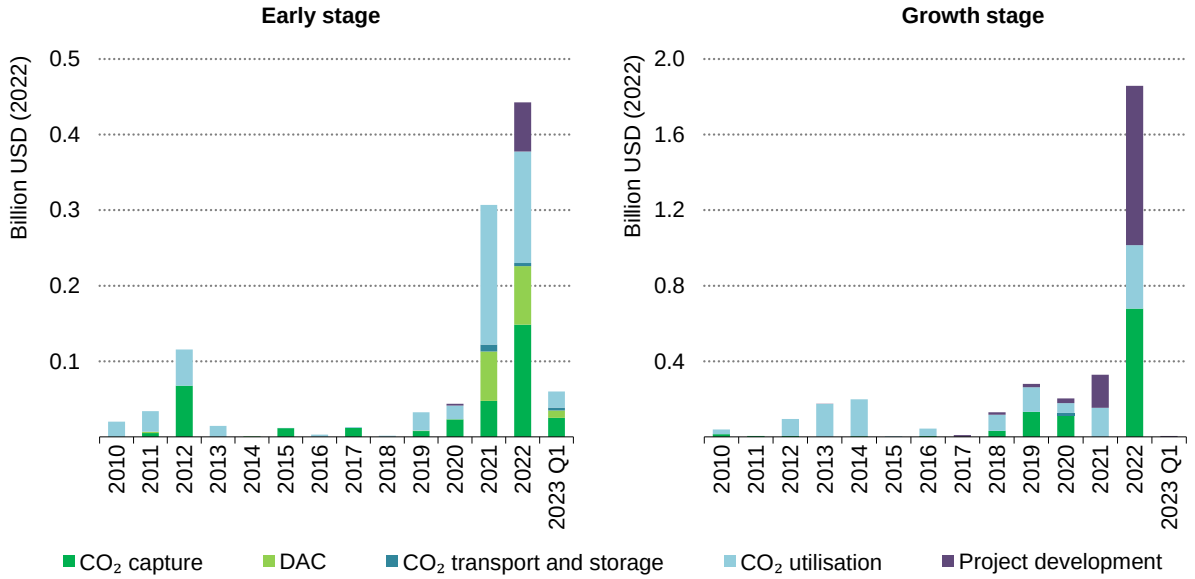


So far, hydrogen-related project developers have mostly been founded in Europe, but this may change as the outlook for project finance has improved under recent US policies

Carbon capture, utilisation and storage (CCUS)

A surge of investment in CCUS project developers is a sign of trust

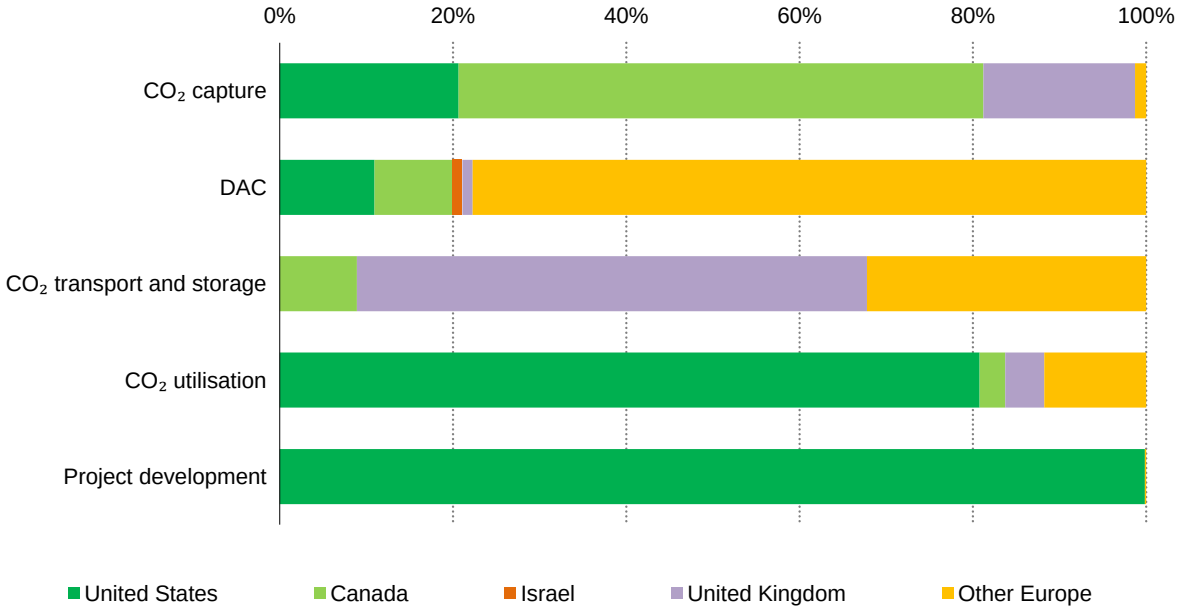
VC investment in energy start-ups in CCUS-related areas, for early-stage and growth-stage deals, 2010-2023



More early-stage funding has been directed to technologies for CO_2 utilisation – in fuels, cement or chemicals – which can target niche consumer products, compared with policy-dependent CO_2 capture and storage

VC investment for CCUS is going mainly to North American start-ups

Early- and growth-stage equity investment in energy start-ups in CCUS-related areas by region, 2018-2022

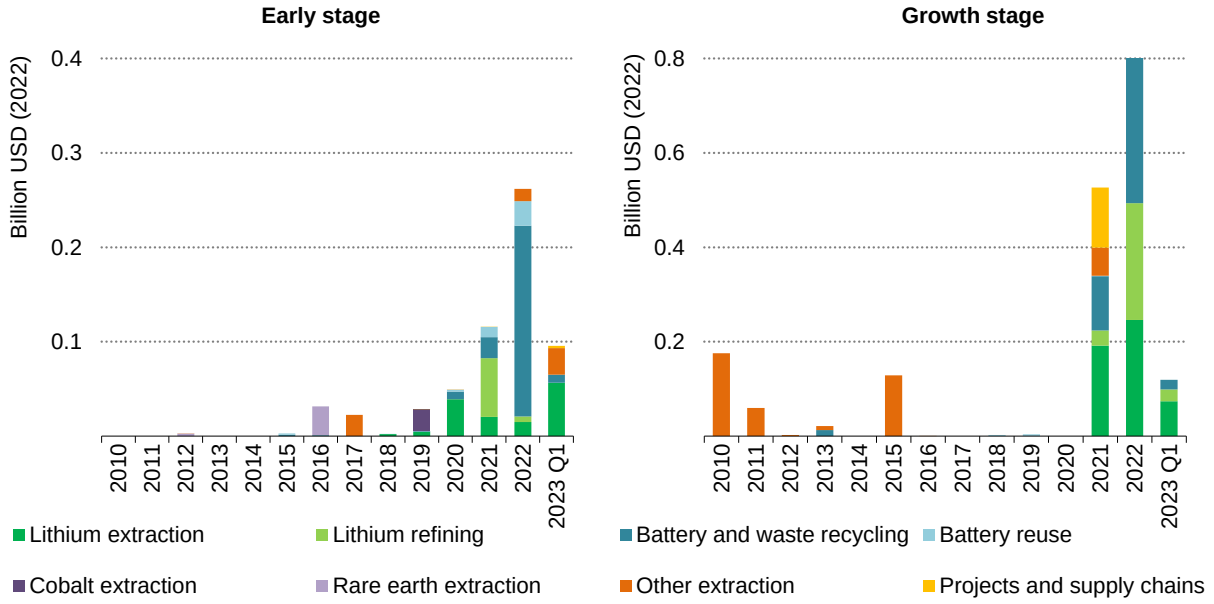


Direct air capture and CO_2 infrastructure are exceptions, with European start-ups attracting most money

Critical minerals

Concerns about minerals supplies are spurring new energy VC areas

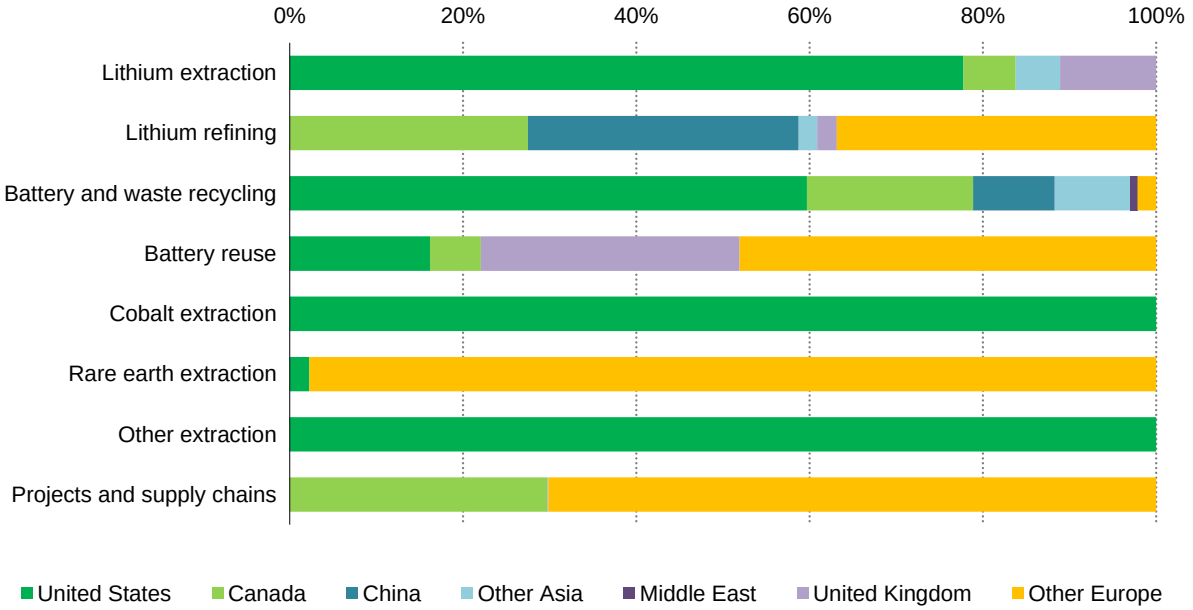
VC investment in energy start-ups in critical mineral-related areas, for early-stage and growth-stage deals, 2010-2023



Early-stage funding has translated very rapidly into scale-up funds for promising start-ups, especially in lithium supply and battery recycling

Most VC for critical minerals is in regions that have also funded R&D

Early- and growth-stage equity investment in energy start-ups in critical mineral-related areas by region, 2018-2022

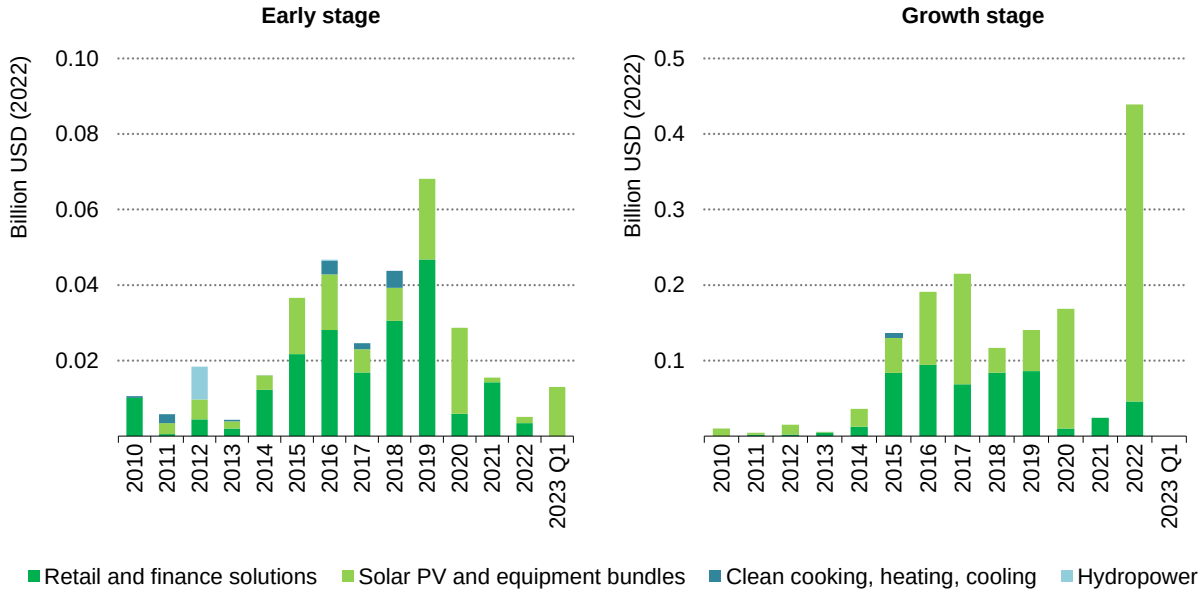


The United States and Canada are home to the start-ups attracting most funds for battery minerals and recycling, but various countries are active, especially in regions looking to de-risk international supply chains

Energy access

A concerning dip in early-stage funds for energy access

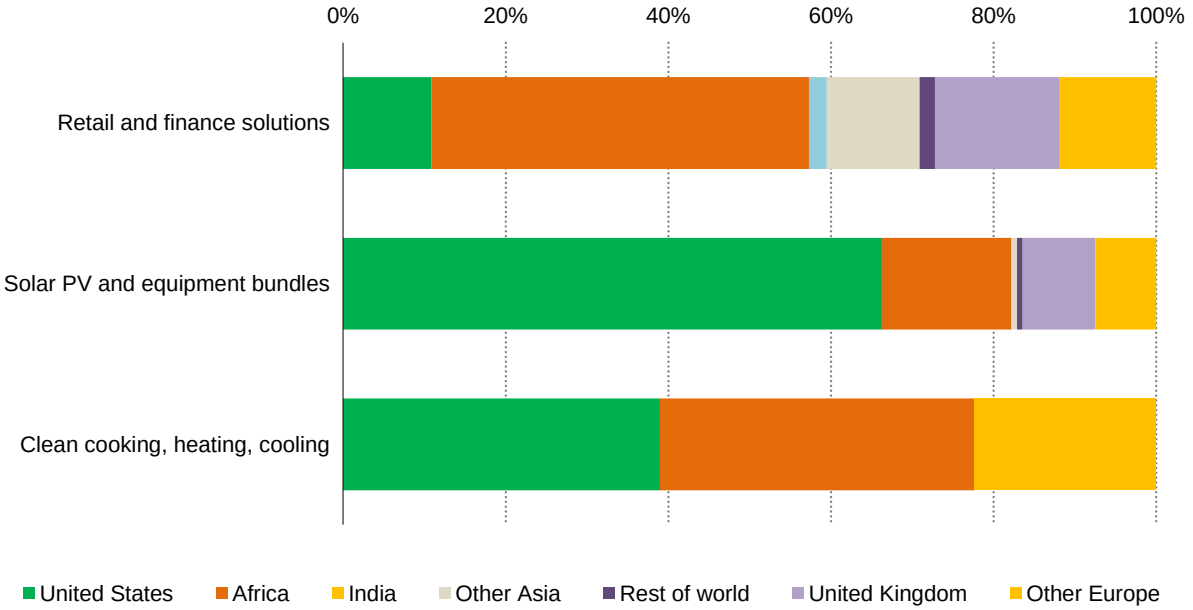
VC investment in energy start-ups in energy access-related areas, for early-stage and growth-stage deals, 2010-2023



Funding for start-ups working on products and services for energy access in emerging market and developing economies has not followed the rapidly rising trend in other energy technology areas

African start-ups are successful in digital and hardware for access

Early- and growth-stage equity investment in energy start-ups in Critical mineral-related areas by region, 2015-2022



VC fundraising by African and Asian start-ups indicates the importance of exposure to local challenges as a spur to innovation

Classification breakdown

Energy efficiency

- Agriculture
- Audit tools and information for consumers ‡
- Building design tools ‡
- Building Energy Management System hardware
- Buildings construction and renovation
- Compressors
- Control systems and demand response ‡
- Cooking appliance
- Electronics, ICT and data centres
- Heating and cooling
  - Cold chain, electrical oscillations, electric resistance, heat pump, heat transfer, ice and water-based cooling, induction, installation and retail *, magnetic cooling cycle, maintenance and performance, passive heating and cooling, radiant ceiling, solar cooling, vapour
- Industrial tools and machines
- Lighting
  - Passive, streetlighting, control systems and demand response ‡
- Motor
- Process optimisation ‡
- Project management and services *

Other power and grids

- Cogeneration
  - Project development and operation *
- Cybersecurity ‡
- DC mini and microgrids
- District heat
  - Operation optimisation ‡, Project development and operation *
- Grid hardware
  - Cables, data and communication, HVAC line performance, HVDC, maintenance and performance, superconduction, transformers, inverters, converters, switches
- Grid optimisation ‡
- Meter hardware
- Offgrid electricity access
  - Finance solutions *, Retail solutions ‡
- Onsite power quality and management
- Power generation
  - Beta radiation harvesting, energy harvesting from electronics, H2 boilers and turbines, mechanical energy harvesting, NH3 turbine, pressure energy harvesting, salinity, waste heat to power
- Project development and operation *
- Retail ‡
- Trade ‡
  - Blockchain ‡, local energy exchange ‡
- VPP and DERMS ‡
- Wireless power

Energy storage and batteries

- Battery charging
- Battery components
  - Lead acid, Li-ion [Casing, Cobalt-free, Graphene, Graphene monoxide anode, Iron cathode, Lithium-silicon anode, LVO anode, Manganese-rich, Niobium, Silicon, Silicon-graphene, Silicon-carbon anode], Li-metal, Li-S [Silicon], Metal-air, Na-ion, Redox flow [Vanadium]; Sodium; Solid state
- Battery maker
  - Al-ion, alkali sulfur liquid, alkaline carbon, carbon foam, iron, lead acid, Li-ion [Active carbon, LFP, nickel, niobium, polymer, silicon, solid state], liquid metal, Li-S, Li metal [solid state], metal-air [Aluminium air], metal-H, Mg-ion, molten silicon, Na-ion [sodium metal halide, solid state], Ni-H2, nickel metal, other flow [Iron, HBr, HMg, salt water], other solid state, organic materials, polymer battery, PbC, radioisotopic, redox flow [CO2, organic, sulphur, vanadium, zinc-bromine, zinc-iron], salt water, zinc [AgZn, MgZn, MnZn, NiZn, zinc-air]
- Battery management system ‡
- Battery metal and mineral supply chains *
- Battery recycling
- Battery reuse
- Battery testing
- Cold storage
- Heat storage
- Manufacturing technologies
- Mechanical storage
  - CAES, flywheel, gravity (non-hydro), LAES, pressurised CO2, pressurised oil or other fluid, pressurised water, pumped hydro
- Stationary project development and services *
- Supercapacitor

Fossil fuels

- Aviation
  - Liquid hydrocarbon engine, turbine
- Boiler and furnace performance
  - Modelling and optimisation ‡
- CNG engines and vehicles
  - Fleets and rental ‡
- Coal mining and processing
  - Project development and operation *, Modelling and optimisation ‡
- CTL
- GTL
- Fossil fuel power generation
  - Project development and operation *
- Internal combustion engine performance
- Methane management
  - Project development and operation *, Data, modelling and attribution ‡, Methane use for onsite energy, Detection, Flares, Methane use for energy and other products
- Natural gas engine
- Natural gas storage and distribution
  - Project development and operation *
- Oil & gas upstream and refining
  - Project development and operation *, Modelling and optimisation ‡
- Oil products retail and systems
- Performance transport fuels
- Pipeline
  - Project development and operation *
- Turbine
- UCG and underground microbial CTG
- Waste and emissions management
  - Modelling and optimisation ‡

Industry

- Chemicals and plastics
  - Biocatalysis, Biochemicals and biopolymers [Bulk, speciality, compostable], CO2 utilisation, Non-bio non-CO2 non-petroleum, Operation optimisation ‡, Recycling
- Cement and concrete
  - Additive construction, aggregate, alternative to limestone, ambient CO2 capture, binder, calcination, CO2 utilisation, electrochemical, gypsum, polymer alternative, recycling, supply chain tools ‡, waste-to-clinker, wood and bio substitutes
- Industrial heat
  - H2-based heat, High temp electrification
- Iron and steel
  - Biocoke and carbon, EAF, electrolysis, laser furnace, operation optimisation ‡, recycling, steel production, H2-based steel [Project development and operation *]
- Aluminium

Hydrogen and fuel cells

- Electrolysers, components and installation
- H2-based fuels
  - CO2 utilisation, Fe/FeO, MeOH production, NH3 production, synfuel synthesis, synthetic CH4, waste and emissions
- H2 fuel cells components and installation
- H2 project development and services *
- H2 storage and infrastructure
  - Cryo-compression, gaseous storage, gaseous tanker, liquid borohydride storage, liquid storage, LOHC, pipeline, purification,
- Non-electrolysis H2 production
  - Algae, bacteria, biogas, biomass electrolysis, CH4, CH4 decomposition, CH4 photocatalytic, CH4 plasma, gasification, in situ oil and gas, microwave catalytic CH4 reforming, natural hydrogen deposits, NH3 cracking, photocatalytic water splitting, photoelectrochemical, plasma electrolysis, separation, SMR, sour gas cleaning,
- Non-H2 fuel cells, components and installation
  - Biogas fuel cell, CH4 fuel cell, enzymatic fuel cell, ethanol fuel cell, formic acid fuel cell, hydrocarbons fuel cell, LPG fuel cell, MeOH fuel cell, Mg fuel cell for electricity storage, microbial fuel cell, NH3 fuel cell,
- Other hydrogen end-use technology
  - Waste treatment

Other

- Access to clean cooking, heating and cooling (not biomass)
  - Cold chain, retail and finance *
- Bio-based CDR
- CCUS
  - CO2 capture [BECCS, biogas, buildings, cement, DAC, natural gas processing, ocean-based DAC, oxy-combustion, power, road vehicle, ships], CO2 storage [EOR, geological, mineralisation, ocean], project development and operation *
- Critical minerals
  - Cobalt extraction, copper extraction, exploration and extraction, lithium extraction, lithium refining, magnesium extraction, minerals from waste, modelling and optimisation ‡, non battery metal and mineral supply chains, project development and operation *, rare earths, refining, seabed, silicon
- Emissions tracing ‡
- Nuclear
  - Fusion, Project management and services, Fission [Components, SMR, thorium, waste management, uranium supply projects *]
- Synthetic fuels (not H2-based)
  - 3D printed plastic waste, biocatalytic syngas conversion, CO2 utilisation, FT, gasification, hydrothermal liquefaction, methanol-to-gasoline, olefins-to-liquids, partial oxidation reforming, project development and operation *, pyrolysis
- Waste heat recovery

Mobility

- Aviation
  - Design, autonomy and optimisation ‡, electric [Balloons and airships, components; CTOL; eVTOL, hybrid CTOL, hybrid STOL, hybrid VTOL, solar; STOL, UAV]; energy efficient fuselage or wing, H2 airship, H2 FC plane, H2 turbine plane, H2 turbine space propulsion, motor for SAF
- Biofuel distribution, refuelling and engines
  - Project development and operation *
- Electric motor for mobility
- Electric road transport
  - Electric 2/3-wheeler maker, electric bus maker, electric car maker, electric commercial vehicle maker, electric mobility digital and software products ‡, electric mobility fleets and rental ‡ [2- and 3-wheelers (excl. pedelec) ‡, buses ‡, cars ‡, retail solutions ‡, trucks ‡], electric truck and heavy duty vehicle maker, EV charging and infrastructure [Battery swapping, charging station manufacturer, dynamic charging, electric charging digital and software products ‡, EV charging project development and operation *, faster charging, home or onsite charging, induction, onboard PV, V2G], EV finance ‡, EV project development and operation *, EV retrofits, hybrid car maker, other micromobility, vehicle component and manufacturing
- H2 vehicles and drivetrains
  - ICE, FCEV, FCEV drivetrain
- Other road transport components
- Rail
  - Electric train maker, fuel economy, hyperloop, levitation
- Shipping and boats
  - Electric boat, electric boat components, fuel economy, H2 FC boat, operation optimisation ‡, sails, solar

Renewables

- Biogases
  - Algae, biomethane, design and optimisation software ‡, digestion, fermentation, heat and/or power generation, landfill, microbial electrolysis, project development and operation *, storage, distribution and retail, thermal, underground digestion
- Biorefining
  - Project development and operation *, acid hydrolysis, aqueous catalysis, biocatalysis, deoxygenation, digestion, direct liquefaction, enzymatic hydrolysis, fermentation, gasification, ionic liquid, mechanical dewatering, microbubbles, microwave, organosolv, pyrolysis, steam reforming, thermal cellulose decomposition, thermal solvolytic, torrefaction
- Bioresources
  - CO2 utilisation, Project development and operation *
- Geothermal
  - GSHP, closed loop, EGS, exploration, gravity pump, ground source convection, hot dry rock, power generation, project development and operation *, SHR
- Hydropower
  - Access, components, dams and canals, operation optimisation ‡, project development and operation *, river, water-powered devices
- Liquid biofuels
  - Project development and operation *, Retail and tracing ‡
- Ocean
  - Project development and operation *
- Operation optimisation ‡
- Project development and operation *
- Solar
  - Components, CSP, floating, installation, manufacturing technologies, O&M, Operation optimisation ‡, Project development and operation *, PV cells panels modules [3D, bifacial, BIPV, CPV, DSC, flexible, integrated PV and CSP, luminescent solar concentrator, MJSC, Mono, multi, poly-crystalline, nanotubes and nanowires, organic, perovskite, photonic, quantum dot, SiC, solar road, thin film], PV integrated with access to commercial energy services, PV battery lights etc bundle for access, recycling, solar cooling, solar heating [Building, cooking, industrial], space-based solar, tracking
- Solid biofuels and waste
  - Boiler, clean cooking and appliances, fuel preparation, gasification, pollutant management, power generation and cogeneration, project development and operation *
- Wind
  - Airborne, bladeless, blades, components, DAWT, EHD, floating, funnel, hybrid wind solar, installation, micro and mini, O&M, operation optimisation ‡, project development and operation *, recycling, tower

All charts are from IEA analysis based on Cleantech Group i3 database and supplemented by insights from Crunchbase. Analysis is based on the 8 617 deals that have a disclosed deal value among the 10 771 relevant deals since 2010 in the dataset.

In all categories, “Other” includes unclassified start-ups.

BEMS = building energy management systems

CCUS = carbon capture, utilisation and storage

CTL = coal-to-liquids

EV = electric vehicle

GTL = gas-to-liquids

ICT = information and communication technology

PV = photovoltaic

UCG = underground coal gasification