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## Segment overview

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Climate tech taxonomy

As a nascent and somewhat nebulous industry, it can be challenging to draw a hard line between what is and is not climate tech, and we can expect a long-lasting debate to coin the terminology, especially between climate and clean tech. While there is no right or wrong answer, PitchBook’s climate tech taxonomy includes any new business model and technology which has a core focus to mitigate the impacts and drivers of global greenhouse gas emissions. We organize the climate tech vertical into nine segments, each with up to six categories.

- **Electric transportation**
  - 48%

- **Food systems**
  - 13%

- **Energy transition: Clean grid technology**
  - 9%

- **Energy transition: Clean energy generation**
  - 6%

- **Mobility solutions**
  - 9%

- **Clean industry tech**
  - 6%

- **Land use**
  - 4%

- **Built environment**
  - 2%

- **Carbon tech**
  - 2%
Climate tech VC ecosystem market map

Click to view interactive market map on the PitchBook Platform.

Market map is a representative overview of venture-backed or growth-stage providers in each segment. Companies listed have received venture capital or other notable private investments.

Electric transportation
- Aviation
- Road consumer
- Road industry
- Maritime
- EV infrastructure
- EV battery tech

Energy transition - clean energy generation
- Solar
- Nuclear
- Waste
- Wind
- Ocean and hydro
- Thermal

Mobility solutions
- Shared mobility
- Autonomous
- Smart infrastructure
- Green hydrogen
- Micromobility

Carbon tech
- Carbon fintech
- Carbon capture & storage
- Carbon sequestration
- Carbon accounting
- Carbon utilization
- Analytics
Energy transition: Clean energy generation

Energy transition

Energy transition is one of the major industries that needs to be reconstructed to reach net zero by 2050 as energy consumption is responsible for more than two thirds of global greenhouse gas emissions. 8 We divide energy transition into two smaller segments—clean energy generation and clean grid technology—to provide the most precise data possible and gain better financial insights between the two categories.

Definition

To reduce the climate impact of the energy sector, it is essential to find reliable and affordable ways to generate clean energy from renewable, zero emission, non-polluting sources. Even though mature clean energy technologies are affordable, efficient, and increasingly competitive, fossil-fuel-based electricity and heat energy generation is still responsible for about one-third of global greenhouse gases emissions every year. 9 The main technologies to generate clean energy are solar and wind, while other technologies, especially around generating energy from waste, are emerging. Clean energy generation accounts for around 6% of total climate tech investment in 2021 YTD, the equivalent to $1.9 billion across 103 deals. The top deals are made across solar and nuclear energy, while wind and waste-to-energy deals are gaining more traction.

Disruptive technology: Advanced solar analytics

Solar energy is a major source of clean energy generation and one of the most mature technologies within the segment. Many solar hardware startups have begun to phase out of the VC ecosystem as they are mature enough for traditional investors to provide financing. In a new wave, numerous startups are exploring innovative technologies to further advance solar panels’ efficiency and applicability. Several startups focus on automated processes for solar panel installation through 3D modeling, solar design, software, and advanced sensor technology. In particular, advanced analytics will become increasingly important as the clean electricity grid expands. As solar plants generate vast amounts of real-time data, artificial intelligence (AI) can advance predicting capacity levels and improve the accuracy of solar forecasting by 30%. 10

Categories

Solar

Solar energy is one of the two major sources of clean energy generation, and the technology has reached relative maturity. The solar market is predicted to quadruple in the US over the next decade. 11 Emerging technologies in this segment include improved solar panel technologies (for example, solar panel robotics), automated solar panel installation, and solar financing. Startups are also working to utilize AI to increase performance in solar power systems.

Wind

Wind energy is the second major source of clean energy generation and has reached relative maturity in the market. Wind energy refers the process of creating electricity using the wind or air flows that occur naturally in the earth’s atmosphere. Emerging technologies in the space include offshore floating wind concepts, smart rotors that can adjust themselves to non-homogeneous wind flow.

9: Ibid.
ENERGY TRANSITION: CLEAN ENERGY GENERATION

Nuclear

Even though it is the second largest source of low-carbon electricity today, providing 10% of global electricity supply, nuclear is seen as controversial and often gets left out of the “clean energy” conversation due to safety issues and unresolved questions about permanent nuclear waste storage. Nuclear energy can provide a safe and clean alternative through either fission or fusion energy. Fission technology is the splitting of a heavy, unstable nucleus into two lighter nuclei, while fusion technology is the process where two nuclei fuse to produce energy. Emerging technologies in the segment are small modular and microreactors, while fast neutron reactors that operate through closed nuclear fuel cycles are seeing a comeback as they can increase efficiency of nuclear energy while decreasing radioactive waste.

Waste-to-energy

Waste-to-energy (WtE), or energy-from-waste, is the process of generating energy in the form of electricity and/or heat from the primary treatment of waste. Waste-to-energy technologies include thermal processes such as mass-burn incineration and gasification along with nonthermal processes such as anaerobic digestion or landfill-gas recovery.

Ocean and hydro

Ocean energy is power produced by the surge of ocean waters during the rise and fall of tides, while hydro energy uses the power of moving water to generate electricity. Emerging technologies in ocean energy include wave energy converters to generate power from surface waves, tidal energy converters to generate power from the movement of tidal currents, and ocean thermal energy converters to generate power from thermal differences between warm surface seawater and cold deep seawater. Ocean energy has the potential to power offshore activities and remote islands or coastal regions.

Geo-thermal energy

Thermal energy refers to the energy derived from heat flows in various settings. Traditionally, geothermal technology has used the heat from the earth’s crust to generate electricity. Now, geothermal plants must be situated in locations where hot water is trapped under the surface to pump the hot water to the surface to collect heat. Emerging technologies in the segment use advanced mapping to find geothermal activity and carbon dioxide (CO₂). For example, Plume Geothermal uses a novel technology that simultaneously collects heat and stores CO₂ underground.

VC activity

VC activity into clean energy generation continued to grow in 2021. Startups in clean energy generation raised $1.9 billion in VC investment across 103 deals through Q3 2021, an increase of 58.8% YTD in comparison to 2020 total investments. As in previous years, solar and wind companies received most VC investment. VC investments into early- and late-stage clean energy generation startups increased in 2021 compared with 2020 from $134.0 million to $189.4 million and $1.0 billion to $1.7 billion, respectively. Consistent over the years, more than half of the deals—54 deals—took place in solar, accounting for 52.4% of the funding in this category ($1.0 billion). Nuclear energy raised 35.2% of 2021 YTD funding, followed by waste and wind with 3.9% and 1.5%, respectively.

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ENERGY TRANSITION: CLEAN ENERGY GENERATION

Figure 1. CLEAN ENERGY GENERATION VC DEAL ACTIVITY BY CATEGORY

Figure 2. CLEAN ENERGY GENERATION VC DEAL ACTIVITY

Figure 3.

Key clean energy generation startups

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>SUBSEGMENT</th>
<th>YEAR FOUNDED</th>
<th>TOTAL RAISED ($M)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAE Technologies</td>
<td>Nuclear</td>
<td>1998</td>
<td>$1,094.8</td>
</tr>
<tr>
<td>Aurora Solar</td>
<td>Solar</td>
<td>2013</td>
<td>$323.7</td>
</tr>
<tr>
<td>Solaria</td>
<td>Solar</td>
<td>2000</td>
<td>$303.7</td>
</tr>
<tr>
<td>Sunseap</td>
<td>Solar</td>
<td>2011</td>
<td>$285.5</td>
</tr>
<tr>
<td>NuScale</td>
<td>Nuclear</td>
<td>2007</td>
<td>$245.2</td>
</tr>
</tbody>
</table>

Source: PitchBook | Geography: Global | *As of September 30, 2021
Energy transition: Clean grid technology

Definition

Clean grid technology is the second component of energy transition. Grid technology is essential to reaching a clean energy grid, which relies on transmission lines and smart grid technologies. To successfully develop utility-scale solar power projects, for example, access to high-voltage transmission lines is key to move power from the project site to the consumer. Smart grid technologies include devices and controlling systems that deliver and utilize digital information to optimize the delivery efficiency, reliability, and security of renewable power. Hardware such as long-duration energy storage and battery technology are also key components of this segment.

Key growth drivers

- Supportive political frameworks
- Demand driven
- Improved technologies for energy transmission and storage

Disruptive technologies

Efficient, long-duration energy storage is a significant bottleneck in clean grid technology, yet it is necessary for the year-long supply of renewable energy and the replacement of mid-range and fossil fuel power plants. Sodium-based energy storage systems that substitute fossil baseload generation with renewable energy could present a cost-effective multi-day energy storage technology. Grid management and analytics have become essential for clean energy grids, particularly energy storage. We have seen the highest growth in VC deals in energy storage, reflecting the challenges inherent to providing the grid with consistent energy amid variabilities in energy generation. Two major deals in the segment include a $200.0 million Series D raised by Form Energy, a developer of sodium-based energy storage. The deal was led by ArcelorMittal and Breakthrough Energy Ventures and valued the company at $1.1 billion. SVOLT, a developer and manufacturer of electric batteries, raised a $1.6 billion Series B, attaining a valuation of $5.0 billion. (For more information on Form Energy, see our Q3 2021 Climate Tech VC Update)

Categories

Energy storage

Low-carbon grids need long-duration storage, and startups are developing several technologies to meet the demand for growing renewable energy storage—especially from wind and solar. These include pumped hydro, stacked blocks, liquid air, underground compressed air, and flow batteries.

Grid management

Smart grid management systems are essential for modernized and low-carbon grids to provide solutions that address the increasingly complex distribution environment of renewable electricity. Startups in this category work on technologies including devices and controlling systems that deliver and utilize digital information to optimize the efficiency, reliability, and security of renewable power. VC investment has almost tripled since 2018, from $209.0 million to $606.0 million.
ENERGY TRANSITION: CLEAN GRID TECHNOLOGY

Analytics

Startups in this category develop software solutions to optimize and accelerate the performance of low-carbon grids, including cloud-based intelligence and analytics platforms, energy consultancy services, data modeling, and ultra-high-density smart grid technology. VC employed in this category has increased by 266.3% since 2018 and is expected to gain further traction through applications such as AI and Big Data management.

Battery technology

The expansion of electricity generated from renewable resources in the supply matrix has driven the clean energy transition. Unlike fuels, this type of energy expires, and temporal balancing has become a significant challenge. Based on the Sustainable Development Scenario (SDS) of the International Energy Agency (IEA), nearly 10,000 GWh battery storage will be required across the grid annually by 2040—the current capacity is limited to 200 GWh. This is a major technology gap, and considerable progress is needed to store large quantities of electricity at a competitive price. Technologies in this category focus specifically on battery technologies designed to improve the operational reliability, economics, and efficiency of electric power systems, as opposed to battery packs for automotive applications.

Clean hydrogen

Clean hydrogen technology intends to eliminate harmful emissions produced by carbon-based technologies; however, around 76% of hydrogen is currently produced from natural gas, and the remainder of 23% almost entirely from coal. Hydrogen generated from water (electrolysis) makes up 2% of global hydrogen production while hydrogen from renewable energy sources is currently being deployed on a small scale, mainly in European countries. Through further advancing clean hydrogen technologies, various clean energy challenges can be addressed by decarbonizing sectors such long-haul transport, chemicals, and iron and steel. Clean hydrogen can also strengthen energy security and increase flexibility in clean power systems. The Q3 2021 Climate Tech VC Update analyzes the novel technology of turquoise hydrogen as an emerging opportunity.

VC activity

VC activity into clean grid technology has skyrocketed in 2021 to $2.8 billion in VC investment across 148 deals YTD, an increase of 50.7% investment value in comparison to 2020. As in previous years, grid management technology has received consistent funding, while the energy storage subsegment has seen the highest increase in proportion of VC invested in the space, from 18.2% to 40.2% of total VC invested in grid technology from 2020 to 2021, respectively. Total deal values for angel & seed, early-stage, and late-stage clean grid technology startups have increased in 2021 from $70.3 million to $75.6 million, $375.0 million to $520.7 million, and $1.4 billion to $2.2 billion, respectively.

ENERGY TRANSITION: CLEAN GRID TECHNOLOGY

Figure 4. GRID TECH VC DEAL ACTIVITY BY CATEGORY

Figure 5. GRID TECH VC DEAL ACTIVITY

Figure 6. Key grid technology startups

Source: PitchBook | Geography: Global | *As of September 30, 2021
Electric transportation

Definition

Transportation has been a fast-growing and major contributor to global carbon emissions, with an increase of 79% since 1990. Accounting for 16.2% of global carbon emissions, electrifying transportation has been a favored tool to tackle climate change. Electric transportation technology has received around 50% of total climate tech VC funding through Q3 2021. The segment includes software and hardware solutions for electric road vehicles, electric aviation solutions, and electric maritime vessels, along with the supporting infrastructure such as charging stations and battery technology. In 2020, more than 2 million electric vehicles populated US roads, while more than 50 electric vehicle models are available today. Around 140 models are expected by 2024, and the market is expected to grow as electric vehicle infrastructure expands.

Key growth drivers

- Ongoing OEM investment
- Improving technology and affordability
- Favorable regulations and scale

Disruptive technologies

Electric mobility adoption is growing fast, with 18.7 million electric vehicles expected on the road by 2030, making it necessary to drastically expand the electric vehicle charging infrastructure through technological innovation and multiple charging scenarios. Statistically, the average car is parked for around 95% of the time, which makes cars a promising resource for decentralized energy storage without added operating costs. Vehicle to grid charging (V2G) is a novel technology that allows for a bidirectional exchange between the vehicle and the grid. Through this two-way exchange, energy stored in electric vehicles can be pulled back into the grid when the demand peaks and stress loads on the grid are high. This helps optimize grids by leveraging millions of electric vehicles as decentralized energy storage. Several startups have pushed through the R&D phase in this area—such as Fermata Energy, Nuvve, and Connect California—and the technology is ready to scale.

Categories

Electric aviation

Prior to the COVID-19 pandemic, air travel accounted for 2.5% of global carbon emissions, a number that could triple by 2050. To reduce carbon emissions in this sector, the nascent electric aviation space provides a novel alternative. VC activity in this category grew to 5.4% of total investment in 2021 YTD—accounting for $801.3 million.

Road consumer (Passenger travel)

Road travel—consumer and commercial—accounts for about 75% of total transportation emissions, while passenger travel is responsible for about 60% of all road transport emissions. The number of electric vehicles in the US is expected to more than triple between 2016 and 2020—from 300,000

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16: “Electric Transportation,” Edison Electric Institute, n.d.
17: Ibid.
18: “95% of a Car’s Lifetime is Spent Parked,” Milita Technology, November 20, 2017.
ELECTRIC TRANSPORTATION

Electric transportation is responsible for around 40% of road transportation emissions, which is why fleet and truck electrification becomes more important as corporations pledge to go carbon neutral by 2050 or earlier. Road industry refers to electric trucking, electric hauling, electric buses, and electric fleet solutions, with relatively stable investments of $338.5 and $338.3 million in 2020 and 2021 YTD, respectively.

Electric maritime vessels

The carbon footprint produced by the international shipping industry amounts to about 940 million tons of CO2 per year, which accounted for approximately 2.5% of global GHG emissions in 2020. Alternatives are electric vessels powered by lithium-ion batteries with capacities of up to 50,000 kWh. These are novel technologies, and investors have been supportive over the past two years with a total of around $75 million in VC across five deals.

Electric vehicle infrastructure

Electric infrastructure will be necessary to support the growth of electric road transport. This category includes electric vehicle charging stations and software infrastructure to support the increasing demand for battery charging. The growing market share of electric vehicles is expected to further drive the expansion of the electric vehicle charging infrastructure market. Other growth drivers include increased investments from car manufacturers into charging infrastructure and related technologies such as radio frequency identification and near-field communication (NFC), which allow for self-operated charging stations.

Electric vehicle battery tech

After electric vehicle infrastructure, electric vehicle battery tech is the second largest category in the electric transportation space. Demand for lithium-ion batteries is expected to grow 1,700% by 2030 in response to the electrification of the grid and transportation system. Innovative startups in this category focus on technologies to advance cell components through novel electrolyte formulations, electrode architectures, or chemical composition to improve performance. Investments employed in this category have grown exponentially since 2018, from $1.1 billion to $6.1 billion in 2021 YTD.

VC activity

VC activity into electric transportation continued to dominate in 2021, with startups raising almost 50% of all VC invested in climate tech: $14.9 billion across 111 deals through Q3—44.6% more investment value YTD than in 2020. Following the trend of previous years, consumer road vehicles received the most funding, while the electric aviation space almost doubled from $415.5 million in 2020 to $801.3 million in 2021. Battery tech put up the strongest numbers, increasing VC funding by 485%, from $1.0 billion to $6.1 billion. Total deal values of angel & seed startups decreased from $67.4 million in 2020 to $62.5 million in 2021 YTD. Both, early- and late-stage VC have already exceeded 2020 investments by 132.7% and 32.7%, respectively.

23: Ibid.
24: “This is the Drawing Age of the Battery,” Bloomberg, Nathaniel Bullard, December 17, 2020.
Figure 7. ELECTRIC TRANSPORTATION VC DEAL ACTIVITY BY CATEGORY

Figure 8. ELECTRIC TRANSPORTATION VC DEAL ACTIVITY

Figure 9. Key electric transportation startups

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>SUBSEGMENT</th>
<th>YEAR FOUNDED</th>
<th>TOTAL RAISED ($M)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rivian</td>
<td>Road consumer</td>
<td>2009</td>
<td>$8,951.3</td>
</tr>
<tr>
<td>Northvolt</td>
<td>EV battery tech</td>
<td>2016</td>
<td>$4,410.1</td>
</tr>
<tr>
<td>Weltmeister</td>
<td>Road consumer</td>
<td>2012</td>
<td>$3,915.5</td>
</tr>
<tr>
<td>SVOLT</td>
<td>EV battery tech</td>
<td>2018</td>
<td>$2,268.9</td>
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<tr>
<td>Enovate Motors</td>
<td>Road consumer</td>
<td>2015</td>
<td>$1,409.9</td>
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</tbody>
</table>
**Mobility solutions**

**Definition**

While revenue streams from transportation are set to grow significantly, they will also diversify toward mobility solutions such as on-demand mobility, analytics, and data services, adding a 30% revenue potential—up to $1.5 trillion.\(^{25}\)

Technologies that decarbonize transport through efficiency and decentralized ownership, such as transit infrastructure, multi-modal usage, shared mobility, clean hydrogen, and electric micro mobility solutions, will transition the car into a shared good, and shared-mobility solutions are expected to grow by more than 20% through 2030.\(^{26}\)

**Key growth drivers**

- Growing urbanization
- Traffic congestion driving inefficiency
- Growing shared mobility infrastructure

**Disruptive technologies**

As a result of the increasing number of internet of things (IoT) sensors on vehicles, data volumes from bus schedules, speed, passenger numbers, environmental conditions, and traffic congestion are increasing as well. This data can help maximize capacity and accessibility as well as provide opportunities for other analytics. Solutions to these data challenges include machine learning (ML), which has grown tremendously across most sectors, and quantum computing. The latter is well suited for data problems that are too complex for conventional computers to solve, such as route planning in public transport. As demand-responsive services gain traction to decarbonize mobility, traditional binary computing is unlikely to meet the demand for real-time optimized scheduling for a growing number of first-mile and last-mile pickups and drop-offs. Quantum computing offers a way to generate data outside of a binary model and has the potential to solve complex data queries such as point-to-point journeys across an entire city.\(^{27}\) Quantum computers are already operated by large software providers, and we expect transport operators will be able to leverage quantum computing to optimize route planning within the next few years.

**Categories**

**Shared mobility**

Shared mobility includes ridesharing, often via a mobile app or software for personal use. Especially in urban areas, shared mobility has achieved widespread adoption as it solves the cost and convenience issues around individual car ownership. A recent OECD study estimates that a reasonable utilization of shared mobility services can decrease 6.3% of urban passenger transport emissions by the end of 2050 across 247 cities.\(^{28}\) However, shared mobility services, such as ridehailing providers, must invest in fleet electrification and incentivize customers to take pooled rides. While shared mobility services accounted for only 9.6% of investment value in 2020, that share has risen to 23.4% in 2021 YTD.

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As the private markets continue to grow in complexity and competition, it’s essential for investors to understand the industries, sectors and companies driving the asset class.

Our Emerging Tech Research provides detailed analysis of nascent tech sectors so you can better navigate the changing markets you operate in—and pursue new opportunities with confidence.

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Emerging Tech Research

Independent, objective and timely market intel

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