

Archetypal Investing into Climate Tech

A post-COP26 roadmap

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Introduction

The 2021 UN Climate Change Conference (COP26) brought forth two outcomes that are particularly relevant for climate tech venture capital (VC) and private capital markets. This note will analyze those outcomes as they pertain to climate tech VC, as well as discuss four archetypal climate tech investment strategies, as laid out by the Glasgow Financial Alliance for Net Zero (GFANZ). GFANZ is a historic alliance of private capital investors committed to accelerating the transition to a net-zero economy, and the Breakthrough Agenda launched at COP26 aims to accelerate investment into clean energy technologies and foster collaboration between the public and private sectors. The latter emphasizes the importance of climate technology to reach the needed emission reductions. While most emissions can be reduced with existing technologies, there remains a technology gap that accounts for an estimated 35% of emissions goals.¹ By investing into startups that can scale technological breakthroughs, VC deployed across the four key climate tech investment archetypes will play a crucial role in closing this gap.

1: "The Time for Climate Action Is Now," Boston Consulting Group, April 8, 2021.

Glasgow Financial Alliance for Net Zero

- Members of GFANZ, a consortium of financial stakeholders representing \$130.0 trillion in assets, are committed to help finance efforts to transform the economy to achieve the objective of the Paris Agreement to limit global temperature increases to 1.5 degrees C from pre-industrial levels.
- These financial commitments can subsidize the estimated \$100 trillion needed for net zero over the next three decades,² which is equivalent to 70% of total investments needed to achieve the COP26 goal of Net Zero by 2050.

Breakthrough Agenda

- Globally, 40+ governments support the COP26 Breakthrough Agenda to accelerate investment into clean energy technologies and stimulate collaboration between the public and private sectors through public-private partnerships.
- Its signatories represent more than 70% of the world's economy and every global region.
- The Agenda focuses on five key areas: power, road transport, steel, hydrogen, and agriculture.

The GFANZ climate tech investor archetypes

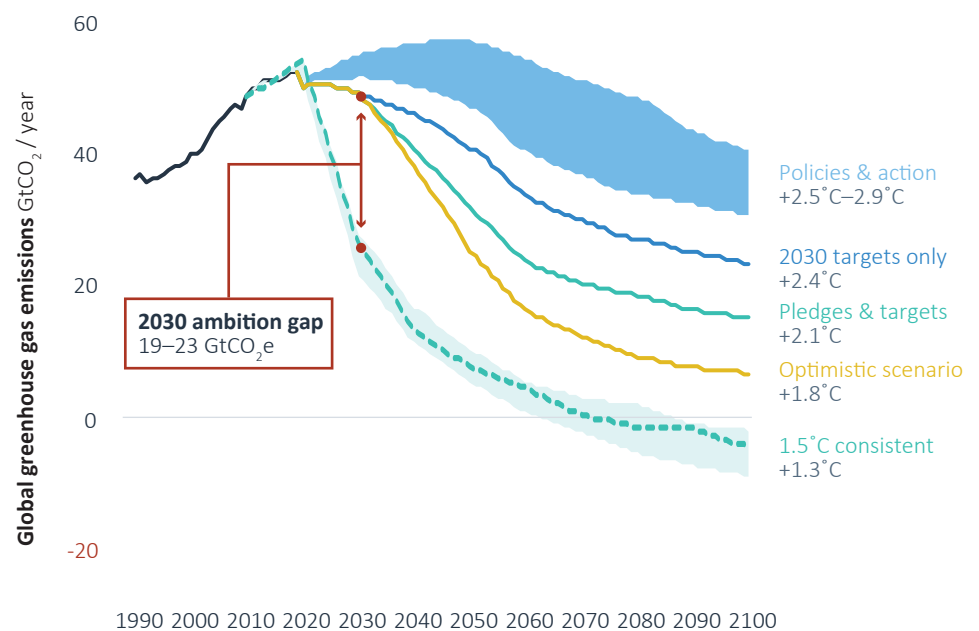
- The four leading areas of climate tech investment will likely include:
 - Grid and PV power in southern world countries
 - Clean industry
 - The built environment
 - Battery and energy storage

2: "We Need To Reach Net Zero Emissions by 2050," Race to Zero, 2021, n.d.

Blended finance

While the first week of COP26 felt cheerful due to an influx of pledges, ambitious announcements, and commitments around preserving forests, private sector finance for clean energy, and phasing out coal, the second week revealed sharp rifts between countries about emission targets and monitoring timeframes. The UN Emissions Gap Report 2021 shows that new national climate pledges, combined with other mitigation measures, put the world on track for a global temperature rise of 2.7 degrees C by the end of the century.³

COP26 pledges fall short of global warming goal



Source: Data used with permission from Climate Action Tracker | Geography: North America
*As of June 30, 2020

The latest analysis from Climate Action Tracker (CAT), the world's foremost climate analysis, is based on countries' short-term goals for the next decade and predicts a rise of 2.4 degrees C, which would far exceed the Paris Agreement's 2 degrees upper limit. Based on commitments made at COP26, CAT further found that emissions are expected to be double than the amount required to follow the Paris Agreement trajectory by 2030. Even though 2 degrees is the high-end threshold of the Paris Agreement, scientists caution that, beyond 1.5 degrees, damage to the Earth's climate will become irreversible, and the world needs to cut emissions by almost 27 billion metric tons per year to remain under 1.5 degrees C.⁴ Current pledges, including those made at COP26, will lead to reductions of only about one fourth of that amount.

Despite the inadequacy of these outcomes, the silver lining was both the private sector's significant pledges in availing trillions of dollars of investment

3: "The Heat Is On," United Nations Environment Programme, 2021, n.d.

4: Ibid.

capital to decarbonize entire industries and policymakers demonstrating a strong willingness to engage public-private partnerships. Given that regulations are as yet unfinished, many investors are still waiting for guidance on vague commitments. A growing number of climate tech VC funds, such as Breakthrough Energy Ventures' Catalyst Fund and the Jeff Bezos Earth Fund, and other major climate funds, such as the \$1 billion Energy Impact Partners (EIP) Energy Impact Fund, are ready to capitalize on this opportunity.

While merging climate policy with financial markets seems to be an impossible goal, several announcements from the recent conference, combined with innovative blended finance mechanisms, promise to ease the process. Currently, most emerging climate technologies cannot compete with greenhouse gas-emitting alternatives and are prone to market failure due to businesses' inability to "secure financing for the initial commercial-scale deployment," according to the World Economic Forum.⁵ As investments into climate tech are often high risk and capital intense, capital structures that blend sources of public and private capital are necessary. That's why blended capital, the combined climate finance from both public and private actors, is necessary. Blended capital reached \$640.0 billion in 2020, according to a report from the Climate Policy Initiative,⁶ with indications that climate financing may exceed \$1 trillion in 2021.⁷

This blended catalytic capital will need to be patient, risk tolerant, and readily available to support climate tech startups throughout high-cost research & development (R&D) phases. Catalytic funding modalities can bridge geographical, institutional, and logistical gaps by, for example, accelerating commercialization and declining cost curves for key climate solutions. In addition, guaranteed offtake frameworks can de-risk projects by guaranteeing customers for the product or service, and targeted project financing can help scale novel technologies.

Top early-stage VC climate tech funds

Fund	Fund size (\$M)*	Fund status	Close date
SOSV Select	\$100.0	Closed	June 14, 2021
New Protein I	\$50.0	Closed	May 14, 2021
Blue Horizon Ventures	\$394.6	Closed	January 20, 2021
Contiguous Venture Capital	N/A	Closed	December 31, 2020
The Actuator Medtech VC	N/A	Closed	December 31, 2020
Stray Dog Capital II	\$27.2	Closed	December 31, 2019
SOSV IV	\$277.0	Closed	December 6, 2017
Artesian China Venture	\$50.0	Closed	December 31, 2017
Clean Energy Seed	\$19.4	Closed	May 24, 2017
SproutX Agtech Seed	\$7.6	Closed	March 17, 2017

Source: PitchBook | Geography: Global
*As of November 25, 2021

5: "How To Finance Industry's Net-Zero Transition," MarshMcLennan, Ilya Khaykin, John T. Colas, and Matthew Aks, January 22, 2021.

6: "Global Landscape of Climate Finance 2021: Preview," Climate Policy Initiative, Baysa Nara, et al, 2021, n.d.

7: "Deploying Catalytic Capital To Bridge Financing Gaps for Climate Action," ImpactAlpha, October 20, 2021.

COP26 climate tech opportunity zones

Glasgow Financial Alliance for Net Zero

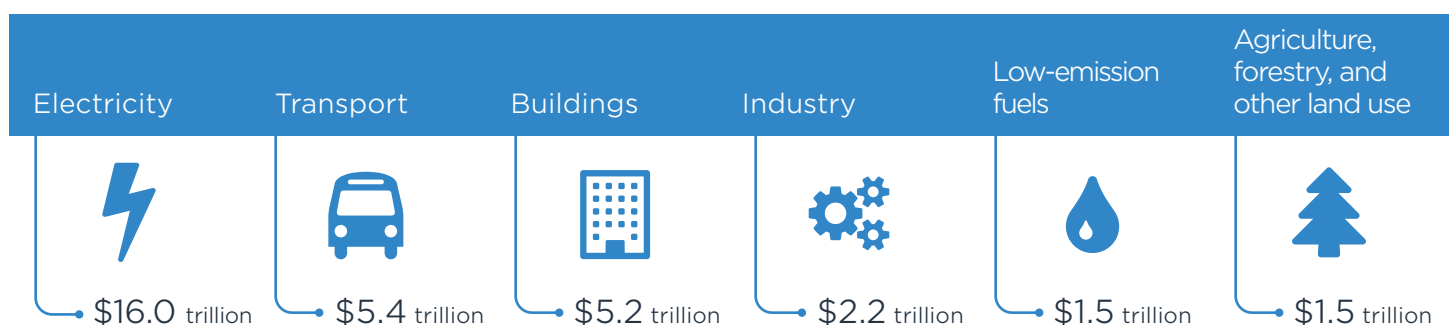
The positive run of public markets and venture capital investments into climate technologies continued as policymakers, the private sector, and “climate celebrities” such as Bill Gates and Jeff Bezos came together in Glasgow at COP26 to commit to new climate initiatives and to pledge trillions of dollars to climate finance. COP26 promised capital, but in comparison with the last five years, annual investment must triple to \$2.6 trillion until 2025—equivalent to approximately \$32 trillion—to meet the summit’s goals. The private sector could provide 70% of that amount to reach net zero,⁸ and already one fifth of major companies by revenue across 15 of the economy’s biggest sectors are set to reduce short-term emissions in line with reaching net zero before 2050.

Unlike previous COP meetings, the private sector became a key enabler in 2021. Climate change mitigation is turning into a mainstream investment strategy that attracted record amounts of capital in 2021. As of the end of November, \$34.2 billion of VC was invested in climate tech in 2021, with \$3.3 billion of that amount invested during the past six weeks. According to the EIP Climate Tech Index, in Q3 2021, public climate technology companies outperformed the Nasdaq by 2.3x in October 2021. By the Index’s measure, these companies are up 220%, compared with 97.6% for the Nasdaq in 2021.⁹

A paradigm shift is taking place, wherein private capital sees climate technology as a promising investment opportunity. GFANZ consists of 450 fund managers, banks, pensions, and other asset owners representing more than \$130 trillion in combined assets that have pledged to mobilize finance at scale to achieve the net-zero emission target by 2050. By stating “We must not let uncertainty defer action any longer,”¹⁰ it echoes the daunting message that climate risk is investment risk.

Financing the transition to net zero by 2050 is expected to require an estimated \$125 trillion of investment, including \$32.0 trillion in the primary six sectors over the next decade.¹¹

Cost of financing the transition to net zero by 2050



8: “We Need To Reach Net Zero Emissions by 2050,” Race to Zero, 2021, n.d.

9: “EIP Climate Tech Index,” Energy Impact Partners, 2021, n.d.

10: “The Glasgow Financial Alliance for Net Zero,” GFANZ, 2021, n.d.

11: “We Need To Reach Net Zero Emissions by 2050,” Race to Zero, 2021, n.d.

Private investors could provide over two thirds of the investment capital needed to reach net zero by 2050

GFANZ includes 450 companies that have achieved 25x growth since April 2021.¹² Existing commitments of this private capital alliance can deliver the estimated \$100 trillion needed to reach net zero over the next three decades.

The Net Zero Financing Roadmap, published by GFANZ and developed jointly with Vivid Economics, identifies key potential sources of private and public investment by sector and region to reach net zero by 2050. It aims to inspire private investment into climate finance by outlining climate investments and opportunities. While the potential for investment areas varies by geography, with \$100.0 billion in clean transport in China, around \$60.0 billion in clean electricity in African countries, and \$30.0 billion in low-emission fuels in the US, tripling overall decarbonization investment between now and 2025 will be necessary to achieve net zero.

GFANZ has the potential to amalgamate the global financial system under several financial sector net-zero initiatives. The importance of mainstreaming private capital into climate finance will not only help the world achieve the net-zero goal but also help corporations realign business models in line with environmental, social, and governance (ESG) aims. Expanding public support through net-zero policies and public investments is key to fully utilize private capital via blended finance mechanisms. Through increased shares of public investment and focusing on projects and technologies that can attract private capital, the ratio could be close to 3:1 between 2021 and 2030—meaning that roughly \$110 billion of public finance could enable nearly \$300 billion of private finance annually.¹³

The Roadmap identifies private investment opportunities across the following key sectors—all of them captured in our [Climate Tech Taxonomy](#):

1. Electricity
2. Built environment
3. Transport
4. Industry
5. Low-emission fuels
6. Agriculture
7. Forestry
8. Land use

12: "The Glasgow Financial Alliance for Net Zero," GFANZ, November 2021.

13: "Private Investors Could Drive Over Two Thirds of the Trillions in Investment Needed To Reach Net Zero," Race to Zero, Climate Champions, November 3, 2021.

Climate tech boost: The Breakthrough Agenda

Investment into emerging climate technologies will be critical to solving the climate change equation, as new technologies are needed to balance the sources and sinks of greenhouse gas (GHG) emissions.¹⁴ According to Bill Gates, a new industrial revolution will be required to avoid a climate disaster, for which around half of the needed technology either doesn't exist yet or is too expensive for widespread use.¹⁵ This is reflected in a BCG analysis that suggests 35% of the technology needed is yet to be invented.¹⁶

Over the past decade, low-carbon economy investments have been improving, and the Green Premium, as described in the sidebar, is approaching zero for several mature technologies such as solar photovoltaic (PV). Other technologies, such as electric vehicles, have the potential to be cost competitive in as little as five years. By 2030, an estimated 70% to 80% of climate technology funding will go toward technologies that are cheaper than conventional alternatives.¹⁷ According to McKinsey, annual investments into five major technology groups exceed \$2 trillion: electrification, agriculture, power grid, hydrogen, and carbon capture.¹⁸ However, further GHG reduction must come from climate technologies that are either yet to be invented, not yet mature enough for use at scale, or still in R&D.

Coined by Bill Gates, the Green Premium describes the added cost of choosing a clean technology over a higher-emission counterpart. Currently, clean solutions are more expensive than high-emission ones, partially because true economic and environmental costs of conventional options aren't accounted for. The Green Premium can assist in measuring progress toward successfully decarbonizing the global economy while simultaneously defining barriers.

COP26 likely boosted the confidence of private capital players to invest in much-needed novel technologies. More than 40 governments, representing over 70% of the global economy, have signed the Breakthrough Agenda aimed at accelerating investment into climate technologies and fostering collaborations between the public and private sector through so-called public-private partnerships. This exploratory approach assumes novel technologies follow a similar cost curve as solar PV technology, which has experienced price drops of more than 90% over the past 10 years.

Ultimately, the Breakthrough Agenda seeks to make climate technologies more affordable, accessible, and cost efficient by 2030. It emphasizes the private sector's central role in successfully decarbonizing the global economy—not in isolation, but in partnership. The agreement requires that governments stimulate large-scale green investments to enable long-term strategic shifts in decision-making and, consequently, to coordinate public investments and mobilize private finance to transform the overall financial market. The Breakthrough Agenda reveals the trajectory for future COPs as an effort to catalyze “an innovative ambition loop between political leadership and the dynamism of the private sector to drive towards a resilient, prosperous zero carbon future.”¹⁹

14: “Innovating to Net Zero: An Executive's Guide to Climate Technologies,” McKinsey Sustainability, Tom Hellstern, et al, October 28, 2021.

15: “Financing the Clean Industrial Revolution,” Breakthrough Energy, Bill Gates, October 29, 2021.

16: “The Time for Climate Action Is Now,” Boston Consulting Group, April 2021.

17: “Private Investors Could Drive Over Two Thirds of the Trillions in Investment Needed To Reach Net Zero,” Race to Zero, Climate Champions, November 3, 2021.

18: “Innovating to Net Zero: An Executive's Guide to Climate Technologies,” McKinsey Sustainability, Tom Hellstern, et al, October 28, 2021.

19: “Glasgow Clean Energy Breakthrough,” Innovators Magazine, Susan Robertson, November 3, 2021.

The five sectors targeted through this plan are collectively responsible for more than 50% of global GHG emissions. They include power, road transport, steel, hydrogen, and agriculture. The Agenda encourages global private investment in order to normalize the use of electric vehicles, decrease the Green Premium of clean energy, scale green hydrogen energy storage, and decarbonize steel production by 2030. This Agenda is expected to help scale these technologies, increase their capacity and efficiency, lower costs, and create a decarbonized economy and green jobs.

GFANZ and Breakthrough Agenda target areas*

	GFANZ	Breakthrough Agenda	Share of climate tech VC
Energy	x	x	14%
Built environment	x		2%
Transport	x	x	57%
Industry	x		6%
Agriculture	x	x	13%
Forestry	x		Included in land use
Land use	x		4%
Steel		x	Included in industry
Hydrogen		x	< 1%
Low-emission fuels	x		Included in industry

Source: PitchBook | Geography: Global
*As of November 25, 2021

Climate tech investment archetypes

Investing in climate tech presents a holistic set of opportunities, wherein the ecosystem can be divided into 17 investment opportunity roadmaps across four investment archetypes and three investment horizons.²⁰ This archetype model is derived from an analysis conducted by Vivid Economics as part of a broader opportunity analysis on behalf of GFANZ and Race to Zero.

Archetype 1: Early technologies

Grid and PV power in southern world countries

Given low technological maturity, below commercial operation, and adoption stages, this archetype includes high-risk investment opportunities with uncertain returns. Novel climate technologies are in need of blended finance mechanisms that can mitigate technology risk through publicly funded R&D and commercialization. Investment opportunities in this archetype include establishing and expanding grid power and solar PV in African countries, as well as improving electricity networks in Central and South America.

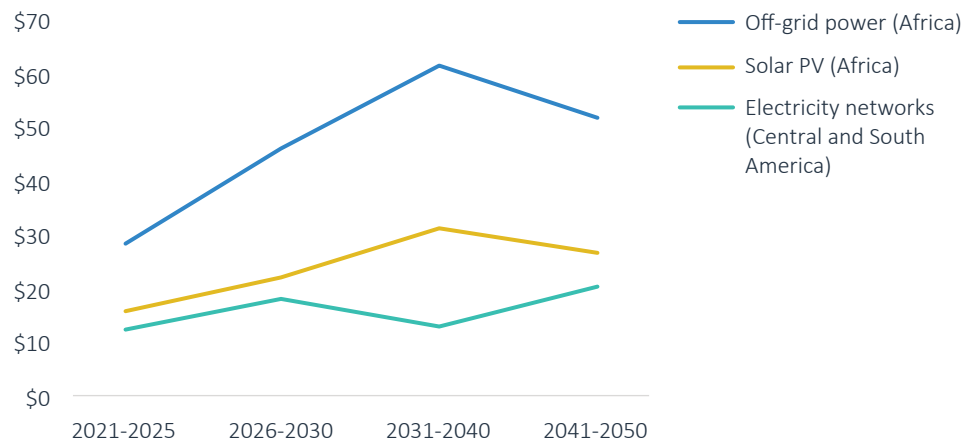
Technologies in this archetype focus on grid integration and smart grid technologies such as advanced controls and software applications. Power grids are widely outdated, inefficient, carbon intensive, and, further, incapable of meeting growing energy demand, which is expected to double by 2050 due to growing electrification.²¹ To modernize grids, renewable energy generation capacity needs to be increased, energy storage capacity needs to be added, and transmission—along with distribution networks—needs to be upgraded. The power sector will likely require the largest share of investment, as scaling renewable capacity is imperative to decarbonizing a multitude of end-use sectors. While annual investment is projected to reach \$1.3 trillion in the next five years and further increase to \$2.2 trillion by the 2030s, private capital could provide one third of direct capital expenditure, often due to ownership of electricity-generating assets. Bottlenecks include outdated permitting processes and contract design, as well as capacity development to advance supportive clean grid infrastructure.²²

20: "We Need To Reach Net Zero Emissions by 2050," Race to Zero, 2021, n.d.

21: "Global Energy Perspective," McKinsey and Co., January 2021.

22: "Private Investors Could Drive Over Two Thirds of the Trillions in Investment Needed To Reach Net Zero," Race to Zero, Climate Champions, November 3, 2021.

Projected annual investment (\$B) into early technologies in southern world countries by region and time period*



Source: GFANZ | Geography: North America
*As of June 30, 2020

Promising technologies to be scaled

- Long-duration storage
- Advanced controls
- Software and communication
- Vehicle-to-grid integration
- Building-to-grid integration
- Next-generation nuclear
- High-efficiency materials

Top early-stage VC energy transition investors since 2015

Investor	Investment count*
EIT InnoEnergy	12
Breakthrough Energy Ventures	11
Capricorn Investment Group	11
Congruent Ventures	9
Climate Capital	8
Prelude Ventures	8

Source: PitchBook | Geography: Global
*As of November 25, 2021

Company highlight: Helion Energy

Led by Silicon Valley titan Sam Altman, Helion Energy's November 2021 \$500.0 million Series E marked a historical clean energy deal and put the company's post-money valuation at \$3.7 billion, with a 2.5x step-up. This breakthrough could be the beginning of a new era—heralding the arrival of abundant clean energy from commercialized fusion technology. After Helion's published results confirmed that it is the first private fusion company to heat a fusion plasma to 100 million degrees C, some of the top Silicon Valley tech investors poured \$500 million—with an additional \$1.7 billion

of commitments—into this nuclear fusion startup. This deal is a milestone for climate tech, as the company's success could deliver practically endless amounts of low-risk clean energy while producing far less operational radioactivity and toxic waste byproducts. With this deal, venture investments into nuclear technology likely represent the largest subcategory in clean energy generation, followed by solar technology.

Archetype 2: Maturing technologies in emerging regions

Clean industry

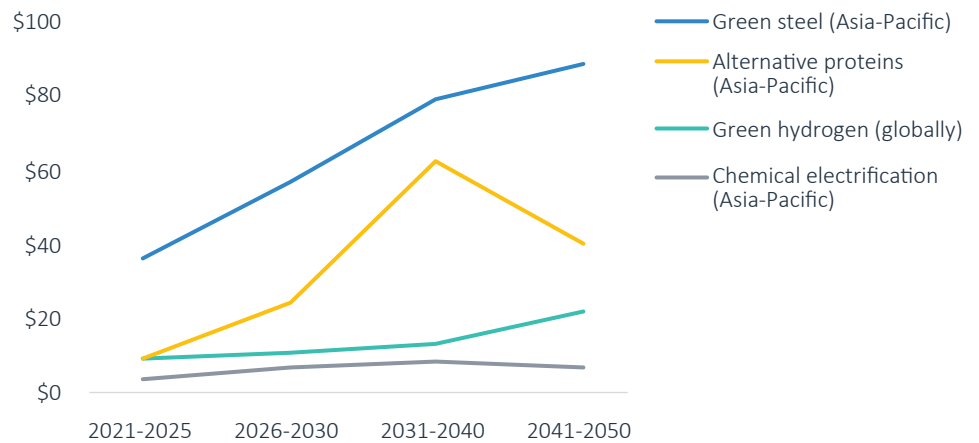
The second archetype encapsulates investment potential for maturing technologies in regions that hold substantial market potential—especially Southeast Asia. Driven largely by activities in emerging economies and rising consumer demand, industrial processes account for roughly 20% of GHG emissions globally, and both are expanding rapidly.²³ While risk constraints due to less mature markets exist, those can be mitigated through public and blended finance mechanisms that co-leverage private finance and potentially improve risk-return profiles.

Investment opportunities in clean industry technology, including green steel and industry electrification, will require annual investments of \$190 billion by 2025 and \$390 billion by 2040. The clean energy industry currently accounts for 6% of 2021 VC deployed into climate tech, or \$1.85 billion in 2021 YTD, making it one of the smaller segments in the taxonomy—though one with growth potential. Around 30% of industry decarbonization investments will likely come from corporations,²⁴ while government co-investments can de-risk the development of novel technologies.

Investment opportunities in this segment focus on economic activities that are difficult to decarbonize, such as industry and manufacturing processes, as well as the methane-intense animal protein sector in emerging markets. Steel is a key industrial emitter and produces between 7% to 9% of global emissions. Investments and technologies for clean alternatives are especially relevant for manufacturing centers such as China and India. Industrial electrification could reduce costs and emissions as prices of renewable electricity and electric equipment drop. Clean hydrogen requires an entire infrastructure of pipes and storage facilities, with promising applications in ammonia production, steel production, and aviation fuel. As with most emerging markets, population, urbanization, and incomes in Southeast Asia continue to expand, thus fueling demand for animal protein, which accounts for 25% to 30% of global methane emissions owing to livestock's digestive processes. Beyond Meat (NASDAQ: BYND) and Impossible Foods are two incumbents in this subcategory, with more than \$10 billion in combined value.

23: "Decarbonization of Industrial Sectors: The Next Frontier," McKinsey & Co., June 2018.
24: "Private Investors Could Drive Over Two Thirds of the Trillions in Investment Needed To Reach Net Zero," Race to Zero, Climate Champions, November 3, 2021.

Projected annual investment (\$B) into maturing technologies in emerging regions by region and time period*



Source: GFANZ | Geography: North America
*As of June 30, 2020

Promising technologies to be scaled

- Green steel
- Alternative protein—both lab-raised and alternative-source protein
- Industrial electrification
- Green hydrogen
- Chemical electrification

Top early-stage VC clean industry and alternative protein investors since 2015

Investor	Investment count*
Stray Dog Capital	18
Unovis Asset Management	17
Blue Horizon Corp.	14
CPT Capital	13
Clear Current Capital	9

Source: PitchBook | Geography: Global
*As of November 25, 2021

Company highlight: Syzygy Plasmonics

Chemical production relies largely on fossil fuel-generated heat and is one of the hardest sectors to abate, as electrification remains challenging. For chemical manufacturers to rely more heavily on electricity generated from renewable sources, fundamental innovations and breakthroughs are required to boost industrial efficiency. Syzygy Plasmonics raised a \$24.0 million Series B in April 2021 led by Horizon Ventures. It further secured around \$12 million in backing through grants from the Department of Energy and the National Science Foundation. The startup seeks to electrify chemical manufacturing and decarbonize many hard-to-abate industries through a reactor that is powered by light rather than heat and operates at lower temperatures than conventional chemical reactor technology. Using light as an energy source eliminates the use of combusted fossil fuels.

Archetype 3: Market creation opportunities

Battery and energy storage

The third archetype consists of investment opportunities in need of additional support to guarantee market development and ensure investment incentives are amply set. These technologies are mostly mature but face underdeveloped markets, thereby leading to limited investment opportunities. Their success will rely upon the establishment of market frameworks and innovations. Investment opportunities are global but reside primarily in the global north and Middle East and consist of electric transportation infrastructure, mature clean energy technology, and electricity storage. As discussed in our [Introduction to Climate Tech](#) report, transport electrification technologies accounted for 48% of 2021 global climate tech VC investment, while mature clean energy generation such as solar and wind accounted for around 6%. Long-duration energy storage will likely draw the largest demand for investments—especially post-2025; while wind energy investments in Europe will likely decline due to the technology's maturity. Long-duration energy storage is a climate tech VC subcategory that has received exponential funding over the past several years, with technology breakthroughs such as Form Energy's sodium-based energy storage technology, which replaces fossil fuel baseload generation with renewable energy.

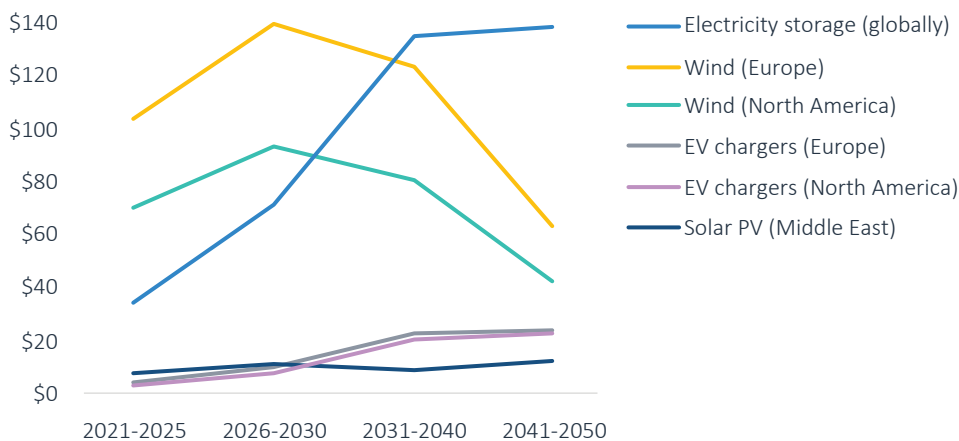
Investment into decarbonized transport, which encompasses our electric transportation and mobility solutions segments, is likely to triple from \$390 billion annually in the early 2020s to \$1.2 trillion by the 2030s—presenting the strongest growth of any end-use sector. By 2040, investments could increase tenfold in comparison with 2020.^{25,26} Consumer loans from commercial financial institutions will support consumer investment into road transport such as electric vehicles, while corporate capital and VC will fund direct capital expenditures on road infrastructure, electric aviation, and electric maritime transport. To accelerate EV charging infrastructure, central policies will be key to reducing uncertainty around EV adoption and costs related to integrating chargers into grid and land planning.

Long-duration storage is one of the main bottlenecks to widespread energy transition. Even with decreasing renewables costs, mainly due to mature wind and solar PV and cheaper lithium-ion batteries, the supply variability of renewables and lack of long-duration storage poses challenges to 100% renewable energy grids. Long-duration storage is needed to supply a network with power for more than two weeks, while lithium-ion batteries can cost-effectively provide backup power for only four hours.

25: "Private Investors Could Drive Over Two Thirds of the Trillions in Investment Needed To Reach Net Zero," *Race to Zero, Climate Champions*, November 3, 2021.

26: "Net Zero Financing Roadmaps," *UN Climate Change Conference UK2020*, November 2021.

Projected annual investment (\$B) into battery and energy storage technologies by region and time period*



Source: GFANZ | Geography: North America
*As of June 30, 2020

Promising technologies

- Battery tech
- Battery control software
- Long-duration energy storage
- Offshore wind grid connectivity

Top early-stage VC EV & grid technology investors since 2015

Investor	Investment count*
EIT InnoEnergy	13
Breakthrough Energy Ventures	12
Climate Capital	12
Kleiner Perkins	9
Prelude Ventures	9

Source: PitchBook | Geography: Global
*As of November 25, 2021

Company highlights: Relectrify and Titan Advanced Energy Solutions

Relectrify addresses one of the most concerning issues in clean energy transition: affordable battery storage. The startup’s cell-level technology targets utility, commercial, and industrial customers. It initially released an energy product produced from recycled Nissan (PINX: NSANY) Leaf EV battery packs. The ReVolve battery energy storage system (BESS) is fully integrated with the company’s cell-level battery management system (BMS), inbuilt inverter, and control system. It is designed for installations in the 120 kilowatt-hours to 2 megawatt-hours range.²⁷ Relectrify has raised \$5.7 million to date and closed a Series A2 in August 2021, led by Energy Innovation Capital.

27: “Relectrify Launches 36 kW/120 kWh Storage System Made of Second-Life EV Batteries,” PV Magazine, David Carroll, February 26, 2021.

Titan Advanced Energy Solutions' battery diagnostics and battery sensing and management technologies aim to improve the safety and efficiency of battery manufacturing, operation, and lifecycle management, including repurposing of lithium-ion batteries. This pioneering company, which develops ultrasound-based battery management solutions, completed a \$33 million Series B in November 2021, led by HG Ventures, the corporate investment arm of Heritage Group. Improving the utility of lithium-ion batteries through electrification and decarbonization by optimizing battery energy storage and repurposing materials will become more important as demonstrated by the recent spike of investments into lithium-ion battery recycling—up more than 1,000% YoY.

Archetype 4: Mature technologies

The built environment

The fourth archetype includes investment and growth opportunities that can be unlocked by addressing nonfinancial barriers to investment and technology used in the built environment, reforestation, and biomethane. Investment opportunities exist across a wide global range, including the Middle East, Central and South America, and Eurasia.

The built environment focuses on retrofits and building efficiency and presents a promising investment opportunity in the Middle East, where technological innovations and breakthroughs are needed. As the building sector accounts for 38% of all energy-related CO₂ emissions,²⁸ the need to make buildings more energy efficient through LED lighting, high-efficiency HVAC, and energy controls will require significant investments. Air conditioning alone will have to undergo a revolution, as current cooling technologies depend upon fluorinated gases, which cause about 2,000 to 4,000 times more warming than each equivalent unit of carbon dioxide and could account for up to 20% of climate pollution by 2050.²⁹ This is especially relevant for emerging economies, as most households in the global south do not yet own air conditioning (AC). Among the 2.8 billion people living in sweltering, low-latitude nations, only 8% have AC.³⁰ Rising temperatures, heat waves, and growing incomes are expected to drive AC adoption from the 1.6 billion units currently in operation to 5.6 billion units by 2050, while electricity demand will likely triple over the same period.³¹ Improved building regulatory and planning environments, as well as reward mechanisms for long-term investment strategies, are urgently needed. Total investments to decarbonize buildings, mainly in retrofits and heating and cooling appliances, could almost quadruple between 2020 and 2040, from \$190 billion to \$710 billion per year.

28: "Building Sector Emissions Hit Record High, but Low-Carbon Pandemic Recovery Can Help Transform Sector - UN Report," UN, December 16, 2020.

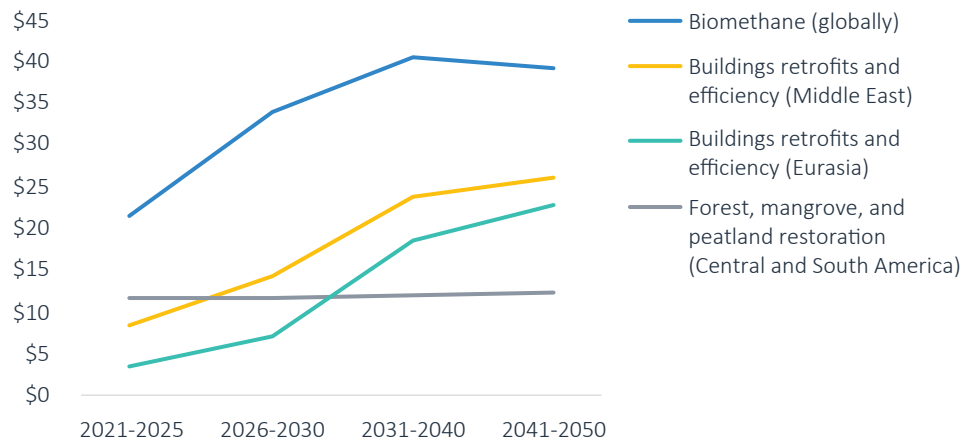
29: "Air Conditioning Technology Is the Great Missed Opportunity in the Fight Against Climate Change," MIT Technology Review, James Temple, September 1, 2020.

30: "Climate-smart Air Conditioning Has the Potential To Keep Saudi Arabia Cool Without Heating the Planet," World Bank Blogs, Helena Naber, Thanavat Junchaya, and Jeff Gibson, June 11, 2019.

31: "The Future of Cooling," IEA, May 2018.

A range of enabling actions is required to create markets for nature restoration and offsets, thus leading to an investment opportunity between \$55 billion and \$60 billion in nature restoration—much of it in Central and South America. Climate tech startups have been innovating reforestation and nature-based solutions—from artificial intelligence (AI) technology to seed banking to mass reforestation—as discussed in our [Q3 Climate Tech update](#).

Projected annual investment (\$B) into mature technologies by region and time period*



Source: GFANZ | Geography: North America
*As of June 30, 2020

Promising technologies

- Efficient building systems—especially heating and cooling
- AI reforestation data analysis
- Bioengineering

Top early-stage VC EV & grid technology investors since 2015

Investor	Investment count*
GGV Capital	5
GV	5
New Enterprise Associates	5
DCVC	4

Source: PitchBook | Geography: North America
*As of November 25, 2020

Company highlight: Viridis Terra

Viridis Terra operates an environmental service platform in the fields of ecosystem restoration and sustainable management to fight global land degradation. The early-stage startup uses advanced biotechnologies to improve the survival and productivity of trees on degraded lands and increase the success rate of forest landscape restoration. Viridis Terra developed two patent-pending technologies. The first enables the growth of high-density forests on highly degraded soils from seeds, and the second is a micro-cutting technology used for seedlings on low-viability soils from the micro-cutting of living woody biomass. Its high-level microbiology technologies address biofertilizer and somatic embryogenesis, thus leading to the optimal selection of high-performing tree varieties while simultaneously ensuring an optimal level of biodiversity. The startup raised a \$2.6 million seed round in a deal led by Bruce McKean in August 2021 and is reportedly seeking \$11.0 million of early-stage venture funding to be completed in early 2022.