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A different high-growth story: The unique challenges of climate tech

Capital-intensive, sustainable businesses offer growth on a scale achieved by technology juggernauts of recent decades. But they face a different set of challenges. Here's how they can overcome them.

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Precisely because sustainability offers such a massive opportunity, it evokes the success achieved by technology companies over the past three decades. Yet while software may have eaten the world, its appetite for capital wasn't voracious. Asset-heavy climate tech solutions—such as green steel, the removal of carbon from the atmosphere, and new ways to produce and store renewable energy—are different. Unlike software or other asset-light businesses, these climate tech ventures require substantial capital at early stages in their life cycle and need more time to break even and scale up. And in contrast to existing solar and wind energy farms, they face greater commercial uncertainty, including the development and adoption decisions of other players across the value chain. Put another way, capital-intense climate tech ventures aren't quite a fit for traditional venture capital (VC) (their businesses offer the promise of extraordinary growth and don't yet have positive cash flow, but need more capital, sooner than VC firms typically provide), aren't quite a match for private equity (PE) (which tends to invest in businesses that are already cash flow positive), and would appear to be too early in their business building to receive significant bank financing. Like other new ventures across sectors and over time, some will surely fail.

Yet encouragingly, several are beginning to access life-giving capital, and some have achieved remarkable, profitable performance. Although the challenges for scaling asset-heavy sustainability solutions businesses are daunting, there are solutions that already *work*, or can work as a matter of engineering and physics. Climate tech also benefits from favorable regulatory tailwinds—themselves a response to urgent climate

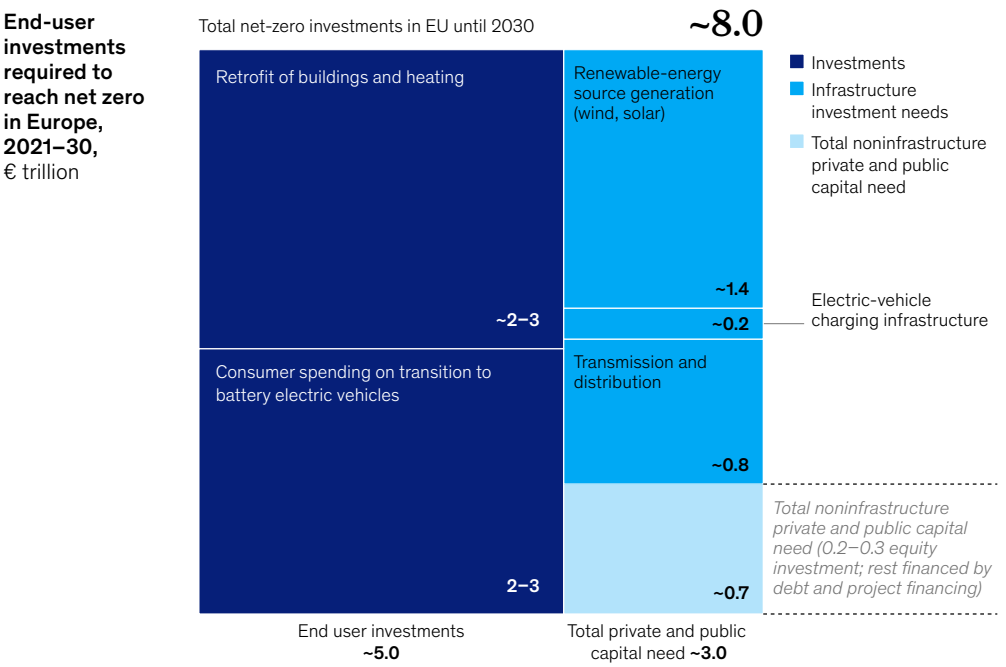
change. Private capital, too, can play a critical role in the green transition (Exhibit 1). In this article, we explore the unique challenges and opportunities of asset-heavy climate tech businesses—and how climate tech can realize its immense potential.

Recognizing the challenge

The first step to overcoming a challenge is to recognize it, in all of its complexity. Make no mistake: the challenges that climate tech businesses face are different—and frankly, harder—than the ones faced by high-tech companies over decades past.[1] That starts with capital intensity. The ticket size of major climate technologies in early-stage VC are five to six times higher than, for example, fintech or quantum computing. In particular, high-demand solutions for sustainable fuels, hydrogen, green power, and circularity have high capital needs well before production (Exhibit 2). Climate tech sectors such as carbon capture, use, and storage (CCUS) and electrification of transport have ticket sizes of more than $25 million at early VC stages.[2]

Exhibit 1

Private capital will play an important role in the green transition.



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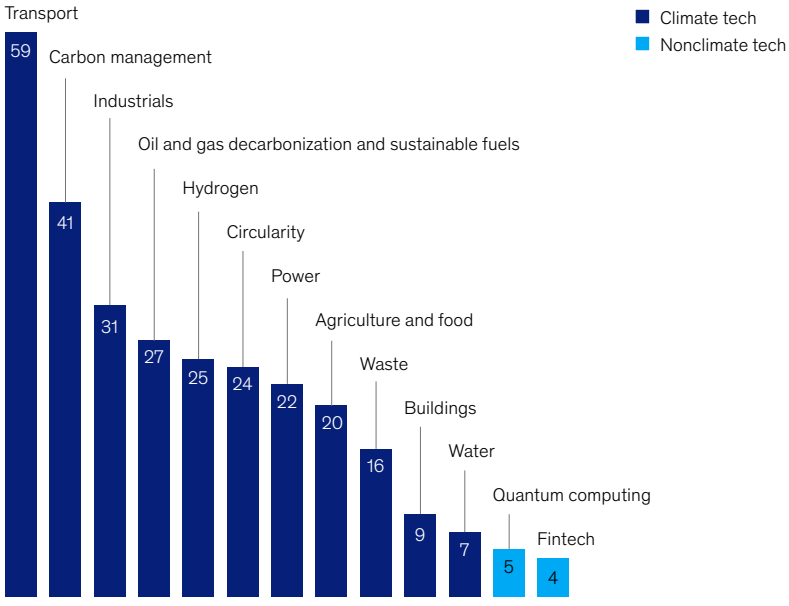
[1] For broader context on the multiple and sometimes competing challenges of the net-zero transition, see "What would it take to scale critical climate technologies," McKinsey, December 1, 2023; "An affordable, reliable, competitive path to net zero," McKinsey, November 30, 2023; and "Solving the net-zero equation: Nine requirements for a more orderly transition," McKinsey, October 27, 2021.

[2] McKinsey analysis based on PitchBook data.

Exhibit 2

Climate tech sectors have significantly larger ticket sizes in later-stage venture capital than other high-growth, high-tech sectors.

Average ticket size in later-stage venture capital, $ million



Source: PitchBook; McKinsey analysis

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It is currently estimated that up to 90 percent of 2050 baseline man-made emissions could be abated with existing climate technologies. Ten percent of abatement potential comes from climate technologies that are already commercially mature; however, approximately 45 percent of required abatements will come from emerging technologies that have not yet been deployed at scale (such as floating wind turbines and e-fuels).[3] For example, sustainable airline fuels represent the only viable way to decarbonize emissions from airlines until at least 2050.[4] While the general process knowledge of producing sustainable fuels has existed for decades, McKinsey analysis shows that production is not expected to be deployed at scale until at least 2025, and it remains to be seen whether a price premium will be sustainable. Traditional project investors—accustomed to debt levels of about 80 percent—can shy away from these longer-term investments, given that projects such as solar and wind power already offer a steady income stream.

Even more critically, some capital-intensive climate technologies lack proven commercial models. Often, the physical product would be similar to or the same as the nondecarbonized product, apart from its net carbon emissions (for example, green steel

[3] "What would it take to scale critical climate change technologies," December 1, 2023.

[4] Laurence Delina and Kristiana Santos, "Soaring sustainably: Promoting the uptake of sustainable aviation fuels during and post-pandemic," *Energy Research & Social Science*, July 2021, Volume 77.

and net-zero chemicals). The investment thesis, therefore, often comes down to relying upon a green premium to generate high returns. But the existence of a *sustainable* green premium *in the future* is not a given. In parallel, construction and operating costs must come down, even at higher price levels, to enable a sustainable commercial model.

Moreover, the break-even point is not immediately in view, which can create tension in financing discussions. Capital-intensive climate businesses usually require significantly more time to scale up physical assets in comparison to asset-light high-tech companies. For example, the average time from Series A to Series D for digital marketplaces is three years; climate technologies based on today's knowledge will take about seven years to achieve scale.[5]

Solving the conundrum

While the challenges are formidable, the promise of capital-intensive climate tech, as a fundamental matter of finance and economics, offers grounds for optimism. Investors naturally seek out attractive risk-adjusted returns, just as businesses ineluctably strive to meet emerging demand. What's more, substantial governmental assistance provides a powerful tailwind. A path forward will require capital-intensive climate tech to derisk the business case, get creative about financing (often by taking advantage of public incentives), and scale up operations more quickly.

Derisk the business case

Capital-intensive solutions are actual solutions—not theoretical ones; most technologies needed for net zero are already mature. There are some technology risks, of course, but making these challenges transparent is actually a positive step toward allaying investor concerns. Businesses can start by explaining that key risks are a matter of engineering, not physics; many net-zero solutions combine technologies where most or even all the individual steps have been proved in other applications. For example, a circular chemical company combined five different steps where all but one were proved at scale—and the new production step was already being demonstrated at one plant. Laying out the solution in clear steps rather than presenting it as a "black box" proved enormously helpful to investors.

Climate tech leaders can also show that new production processes are well-founded and based on engineering certification studies. Often, one or more of the new process steps can be assessed by impartial, respected third-party engineering firms and synthesized into a "bankability study" that addresses, for example, technology maturity, process robustness, cost, and required capital expenditures. These studies are especially effective with project debt financiers in the early-launch phases.

Of course, merely demystifying how solutions would work does not, by itself, equate to derisking; the business needs to bring the solutions to life. But we find that many new businesses can take operational steps quickly. This starts with securing a supply chain:

[5] McKinsey analysis based on Crunchbase data.

new businesses need to line up suppliers of raw materials and other key components early and creatively. We've seen recent examples of companies that establish partnerships with key suppliers to secure a stable future supply chain—and share the risk. For example, one early-stage green-ammonia project developer negotiated a long-term baseload purchase price allocation from a renewable power source; the agreement included guarantees of origin for each project site.

Offtake agreements or similar arrangements are particularly important for derisking and to buttress the commercial model. Negotiations typically go through several steps, culminating in a bankable agreement, which includes timeline, product specifications, warranties, and final-pricing arrangements. Critically for financing, we've seen companies achieve offtake agreements well before a technology was market-tested. For example, a green-materials company started discussing offtakes with leading automotive CEOs early in the business planning phase, well before the first detailed design of the initial plant financing. Management presented latent demand in a transparent way, demonstrating that by 2030, for 30 percent of automotive OEMs, decarbonization would require the use of its specific product—which was less expensive and involved lower technology risk than alternative solutions. In addition, the company clearly laid out demand-and-supply growth on a competitor-by-competitor level, an exercise which highlighted the risk of a shortage between the 2025 to 2035 time period—bolstering the case for long-term contracts. In fact, the company was able to establish win–win offtake agreements well before the design of its first projects and delivery four years thereafter.

Beyond offtake agreements, new businesses can get moving early on a clear strategic plan beyond the typical, longer-term horizon. Consider, for example, the success that some players in the automotive industry scored in driving down the cost for electric vehicles (EVs) by moving from "luxury only" to "below average car cost" for some models. Players in both the battery space and energy sectors, for their part, have entered into joint venture agreements with customers to share equity risk and eliminate most—and even all—demand risk. These arrangements aren't new: in 2012, for example, Intel took an equity ownership in Dutch semiconductor equipment manufacturer ASML to strengthen the company's largest company relationships.[6]

Effective companies across capital-intensive climate tech also secure relationships with equipment providers; suppliers of materials and components; and engineering, procurement, and construction firms as soon as possible. For example, one automotive player is collaborating with Eastern European companies to ensure a supply of low-carbon metal parts. Understandably, investors and partners want to see demonstrable progress on timelines and recoil from delays and cost overruns. Because the stakes are high, even a bit of slippage could result in financial distress given the size of the required plans.

Yet boldness is essential. Winning requires capital-intensive companies to set and meet large, stretch-the-possible aspirations. A true disruptor lays out a clear ambition to build an industry-leading platform with multiple plants, products, and scaling. For example, Ørsted set an ambition in 2010 to shift its portfolio from 85 percent fossil fuels and 15 percent renewable energy to 99 percent power generation from renewable sources by 2025. Its comprehensive

[6] "Intel takes 15% stake in ASML, part of EUV, 450mm development push," *Semiconductor Digest*, July 10, 2012.

plan was to shift from being an integrated energy provider to a world leader in wind energy—and it worked. The company's net income has flipped from negative to positive—ranging from approximately $1 billion to $3 billion from 2016 to 2022, even in the face of recent supply chain strains and rising interest rates—all while decreasing its emissions by about 90 percent.

Get creative with financing

While climate tech now faces steeper challenges than high tech—particularly the amounts of capital needed and the longer horizon to achieve scale—it also enjoys a unique tailwind: the tremendous regulatory push for sustainability. That can be a difference maker in accessing large amounts of capital.

As part of the 2022 US Inflation Reduction Act (IRA), more than $500 billion will be invested in climate technologies (not including significant additional regulatory support for EVs).[7] But IRA initiatives are not the only source of public support: the residential solar company Sunnova Energy International, for example, tapped US government partial loan guarantees of up to $3 billion to back financing for its rooftop solar systems.[8] In the European Union, more than $2 trillion in equity investments, grant money, and policy support has been budgeted through funds dedicated to achieving the European Green Deal.[9] Players such as Solarcentury (acquired by Statkraft), Encavis, and the joint venture of Enbridge and EDF Renewables have allocated significant funds to design, build, and maintain asset-heavy solutions.[10] The European Investment Bank, for its part, supports battery maker Northvolt's gigafactory for lithium-ion battery cells in Skellefteå, Sweden, with backing from the Investment Plan for Europe.[11]

Corporate debt can start as early as the Series A round. New climate tech companies typically access debt through syndicated loans, where commercial and public lenders come together to enable successful debt financing and successful scaling of business. Public institutions are often first movers when lending to climate tech companies. Some commercial institutions are adjusting their lending profile to be more creative, as well. For example, European commercial banks issued conditional commitment letters for €3.3 billion senior debt for an investment in green steel.[12] Nor are banks the only provider of debt financing: growth-lending facilities for venture and scale-up, alternative asset managers, and direct-lender specialists are providing debt financing for the net-zero transition. Given current challenges in equity capital markets, debt will likely remain an important source of capital over the coming one to two years as well as the long term.

In addition to accessing debt at the corporate level, we see companies use project financing as early as the Series B stage to fund projected cash flows. This type of financing—already standard for wind and solar energy generation—helps to protect the parent's balance sheet, even when debt is consolidated on an accounting basis. While renewable energy still constitutes the largest share of transition project financing, project financing for other climate technologies—such as battery production, EV manufacturing

[7] "How a half-trillion dollars is transforming climate technology," *MIT Technology Review*, August 16, 2023.

[8] "US commits to $3 billion loan guarantee for Sunnova to expand solar access," Reuters, April 20, 2023.

[9] EU long-term budget (2021–2027), European Council–Council of the European Union, accessed January 2024.

[10] "Enbridge's joint venture, and EDF Renewables, selected to develop France's largest offshore wind farm," PR Newswire, March 27, 2023.

[11] "European backing for Northvolt's battery gigafactory in Sweden," EU Monitor, May 15, 2019.

[12] "Leading European financial institutions support H2 Green Steel's €3.5 billion debt financing," PR Newswire, October 24, 2022.

plants, and hydrogen plants—has seen growth rates around 15 to 30 percent over the past years and now constitutes about 25 percent of total project financing volume.[13]

Several banks are rapidly ramping up their capabilities to fund climate projects in creative ways. In the case of one leading green-hydrogen production plant, for example, the project financing vehicle was made bankable through a large, indirect governmental shareholding in one of its holding companies and through a 30-year offtake agreement signed by a global hydrogen production company.

Climate tech businesses can also reduce capital costs in a meaningful way through credit guarantees, export credit guarantees, or government guarantees once orders are achieved or within reach. One of the world's largest credit guarantee programs for climate technologies is run by the US Department of Energy (DOE); its Title XVII Innovative Energy Loan Guarantee Program has provided more than $25 billion in loan guarantees for largely renewable-energy facilities.[14] In Europe, where agencies such as EKN, the Swedish export credit agency, help make projects bankable by moving early to assume risk, one green-steel manufacturer received export agency credit guarantees for 10 to 15 percent of its €4.5 billion financing—which helped it, in turn, receive senior loans committed from a consortium led by project financing banks. In another example, the Swedish national debt office provided an 80 percent credit guarantee for a €300 million loan to a European oil refinery to increase the supply of renewable fuels. And at COP28, the UAE announced the launch of Alterra, a $30 billion initiative to help fund climate solutions through which $25 billion will be applied to scale climate investments and $5 billion for risk mitigation. The investment vehicle has already committed $6.5 billion for global investments, including in the Global South.[15]

Scale up faster

There's no getting around it: scaling up capital-intensive plants, production pathways, and other asset-heavy operations takes time. But even marathons can be run quickly—and being fast comes with clear advantages. Suppliers that can provide certified working solutions to their industrial and consumer customers, for example, are more likely to become the industry standard or provide the must-have solution or product that other businesses come to rely upon.

Novel approaches can enable companies to scale capital expenditure–intensive businesses much faster than before. For example, Northvolt was able to significantly cut costs through increased equipment productivity and lower energy requirements and material costs. The automotive industry's drive toward affordable batteries for EVs is a demonstrable example of achieving cost improvements. The price of lithium-ion batteries decreased by more than 85 percent over the past decade, largely through megafactories that employed modular scale. Similar investments in hydrogen production have been forecasted to decrease the price of green hydrogen substantially by 2030, further driving the green transition.[16]

[13] McKinsey analysis based on data from Dealogic, Crunchbase, and PitchBook.

[14] The program provides that the US government will guarantee repayment of 100 percent of the principal and interest on private loans for up to 80 percent of construction costs. Guaranteed loans can have terms up to 30 years. Importantly, the DOE acknowledges the inherent risk and accepts that some loans will fail, meaning that the guaranteed amount will have to be refunded to the guaranteed commercial bank. As of the end of 2022, only 3 percent of loans guaranteed by the DOE have run into repayment issues, and only a fraction of those have defaulted in full. See "Public credit guarantees: Unlocking private investments for climate technologies," Tech for Net Zero Allianz, July 13, 2023.

[15] See "What is Alterra, the UAE's $30 billion green investment fund?," Climate Home News, December 12, 2023; and "Explained: what is Alterra, the $30 billion fund launched at COP28," Energy Connects, December 1, 2023.

[16] See "Global Energy Perspective 2023: Hydrogen outlook," McKinsey, January 10, 2024; "The clean hydrogen opportunity for hydrocarbon-rich countries," McKinsey, November 23, 2022; and Bernd Heid, Christopher Martens, and Anna Orthofer, "How hydrogen combustion engines can contribute to zero emissions," McKinsey, June 25, 2021.

In addition, modular plant design allows nearly identical operating units to be built in parallel as companies rapidly scale up their business.[17] Companies are moving faster by taking an iterative approach, with releases of updated plants, modules, operational instructions, and training that can be refreshed across all facilities at the same time. By focusing on the minimum requirements to prioritize speed to market, rather than designing for every possible customer need, companies can move more rapidly.[18] For example, an industrial gas player minimized costs while maximizing speed to market through a standardized design of its hydrogen equipment and operation of its facilities. Standardizing hydrogen plants envisions them as modules or "trains" that can be easily connected to increase capacity or deployed to customers as individual units. As demand rises, an additional train is added easily. Because the design is standardized across all units, the process does not require significant engineering, design, or other cost outlays. To further ensure operational simplicity, all engineering work is completed in one location.

Capital-intensive projects don't require that one stage be completed before another can start; design and scaling can work in parallel.[19] In fact, optimizing for each step can be the exact wrong approach. Instead, effective climate tech businesses often take a "plant as product" approach and work backward from what is possible. This can mean skipping the pilot and going straight to the smallest commercial scale. As they do so, they engage with partners, especially suppliers, that share the objective of a long-term relationship. Tesla is perhaps the most prominent example of leveraging its engineering, procurement, and construction approach to scale rapidly. But it is hardly unique. Vargas companies such as H2 Green Steel have a similar record of aggressive construction and scaling, and are becoming serial builders of new projects. While not all players can or want to launch multiple plants, it's far more likely that "more and bigger" will be a differentiator. Unlike writing better code, it's hard to be a fast follower in an asset-heavy business.

While the growth potential of climate tech is reminiscent of the spectacular rise of high tech over the past three decades, the key challenges to realizing that growth are vastly different. Getting enough capital, and enough time to build scale, will be particularly hard. But these challenges are solvable. In another decade, some companies *will* be capital-intensive climate tech leaders. Why not yours? Q

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[17] See "Modular construction: From projects to products," McKinsey, June 18, 2019; "How smart platforms can crack the complexity challenge in project industries," McKinsey, October 10, 2019; and Jeff Hart, Niels Phaf, and Koen Vermeltfoort, "Saving time and money on major projects," McKinsey, December 1, 2013.

[18] See Sanjiv Ratan, William Baade, and David Wolfson, "The large hydrogen plant challenge," *Hydrocarbon Engineering*, July 2005.

[19] Mark Bakker and Zak Cutler, "The plant as a product: Hyperscaling green capex," McKinsey, September 7, 2023.

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