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A FINANCIAL GUIDEBOOK FOR U.S. STARTUPS

CROSSING CLIMATE TECH'S VALLEYS OF DEATH AND ACHIEVING SCALE

Authored by: Hugo Mkhize

Background, Acknowledgments, and Disclaimer

As per the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report, in order to achieve our net-zero ambitions, we require a step change in technology innovation[1]. While we have made notable progress in developing climate technologies to mitigate a substantial portion of our emissions, a recent International Energy Agency (IEA) analysis assessed the market readiness of 400 different technologies that will be needed to reach net-zero emissions by 2050 and found that only about half of the technologies are available in the market today[2]. According to PricewaterhouseCoopers (PwC), climate technology or 'Climate Tech' is defined as technologies that are explicitly focused on reducing greenhouse gas emissions, or addressing the impacts of global warming[3]. Climate Tech solutions include software not only hardware, as well as business model innovation and industrial processes which can be different from or overlap with both hardware and software. This is the broad definition that will be used throughout this guidebook.

Both governments and the private sector have critical roles to play in ensuring investment in clean and sustainable energy innovation to scale up these promising solutions. Scaling climate technologies will require funding sources that encourage innovation, large outcomes, risk-taking, rapid iteration, and market disruption. In the early stages, startups and venture capital (VC) investment will be fundamental to finding and growing companies best placed to commercialize breakthrough solutions to the climate crisis' most challenging problems. Over the past 50 years, VC-funded businesses have been a vital source of transformative inventions, from the smartphone to gene sequencing and vaccines. However, while the investments and timelines for the drug development cycle are also risky and lengthy like many climate innovations, the difference is that at least the process for drug discovery has various value-accretive steps that are clear and standardized. On the other hand, funding remains one of the major barriers to replicating this cycle of innovation in the climate technology space.

While founders in other sectors have often cited some of their foremost challenges as the strength of their business model, finding a real problem, or recruiting, although Climate Tech entrepreneurs do also face these challenges, it appears that securing funding is the largest obstacle. In fact, in a recent report by Endeavor Insight

titled "*Scaling Climate Tech: A Global Study of Entrepreneurs and Networks*" interviewed founders cited access to capital as the greatest challenge hindering their progress[4]. Furthermore, climate solutions often require long-term, high-risk capital in both very large and very small investment sizes, sometimes making them unsuited to traditional venture capital. This funding gap is also particularly perceptible at the scaleup or growth stage of a company's development where a startup has matured into an established entity seeking to foster widespread adoption of its products or services.

This body of work is primarily intended for graduate and postdoctoral students, focused on climate solutions, who may be considering commercializing their research but are not sure how to go about it. The guidebook aims to help the reader prepare a financial strategy to shift across the Climate Tech Valleys of Death. According to the Clean Energy Finance Forum, VCs sometimes refer to the "Valleys of Death" for startups, meaning the periods during which companies burn through funding (or have insufficient capital pre-commercialization) as they begin operations but have yet to turn a profit and where risk, challenges, and capital needs shift[5]. This concept is particularly descriptive for Climate Tech because of the large amounts of capital that certain decarbonization technologies require. Despite this intended focus on academic founders, more seasoned entrepreneurs can also derive value from this guidebook as they contemplate sources of funding beyond VC and how some of their peers have navigated the financing of growth in the latter Valleys of Death.

This guidebook sets forward to achieve this aim by demystifying the funding options available to Climate Tech entrepreneurs (formally known as the Climate Tech capital stack). A capital stack is the structure of all capital that is invested into a company. At a high level, this includes cash awards (such as grants and stipends), equity (selling a portion of the company's ownership), debt (borrowing), and milestone-based payments. The guidebook will address: i) what type of capital Climate Tech businesses can raise (and how to tap each source of capital), ii) at what stage in their business evolution (or Valley of Death) should they access each type of funding (distinguishing between hard tech and software), and iii) who to raise the funding from (and why venture capital is not for everyone).

In order to compile the guidebook, I have synthesized pertinent literature from news articles, industry reports, and academic journals. I have also conducted 44 interviews with industry practitioners (VCs and other investors), Climate Tech founders and CEOs, and funding organizations (accelerators, financial institutions, Department of Energy, etc.), subsequently referred to as 'Experts' throughout.

I chose this topic because I fundamentally believe that the responsible use of capitalism and market incentives will be key to standing any chance of mitigating the worst impacts of the climate crisis. In particular, I am of the view that a key enabler of a 'just' energy transition will be the innovation economy. Startups and scaleups are uniquely placed to commercialize disruptive climate solutions

that will benefit those most in need by easing the environmental, economic, and health impacts of the transformation of high-emitting sectors. Given my background as a Finance undergraduate, my Master's in Advanced Studies in Climate Science & Policy, and my time in Investment Banking, I feel that I can add value to the climate community by helping to bridge the gap between Finance and Climate Science. I am particularly passionate about sharing this knowledge with underrepresented founders so that they can meaningfully participate in the impact and investment opportunity of our lifetime. At present, roughly 2% of all VC funding goes to women and about 1% goes to Black founders. I hope that this guidebook can show aspiring Climate Tech founders that there are other sources of funding available to them beyond VC.

I would like to take this opportunity to thank my esteemed Capstone Advisory Committee of Professor David Victor, Chante Harris, and Vanessa Scott for reviewing drafts of this guidebook, the warm introductions, and sending me helpful resources I may have missed. I would also like to give an honorable mention to Professor Corey Gabriel for his unofficial advisership. Lastly, I would like to express my deep gratitude to the Experts who gave their time to answer my questions for this guidebook.

A Financial Guidebook for U.S. Startups Crossing Climate Tech's Valleys of Death and Achieving Scale is intended to be a general guide to key financial and strategic issues involved in starting, growing, and capitalizing a company developing climate technologies generated at a university or a national laboratory. The reader should recognize that each business and technology is unique, so there may be issues important to your company that are not addressed in this general guide. This guidebook is not intended to be specific legal, financial, or business advice and does not reflect the views or opinions of the interviewed Experts, the Capstone Advisory Committee that assisted the author in preparing its contents, Scripps Institution of Oceanography or the University of California, San Diego, and their related entities. The reader is urged to seek the counsel and/or financial advice of an experienced business and licensing attorney or financial advisor before starting a business based on technology licensed from a university.

Executive Summary

Getting Ready to Cross the Four Valleys of Death

The sentiment of the Climate Tech ecosystem is generally positive regarding starting a company in the Climate Tech space at this time. Despite the short-term headwinds from the fallout of regional bank failures, a slowdown in Climate Tech venture capital investment in Q1 2023, interest-rate tightening and a potential recession, more competition for VC capital, human capital challenges etc., the long-term fundamentals are still positive. These positive fundamentals include:

1. Global regulatory policy support and mandates (e.g., Inflation Reduction Act, European Green Deal, etc.)
2. An increase in non-dilutive federal funding grants from the Department of Defense, Department of Energy, Environmental Development Administration, National Science Foundation, etc.
3. The science-backed need for climate technologies to avert the worst impacts of the climate crisis
4. Investor interest and consumer demand
5. Increased public awareness of climate issues
6. Net-zero pledges from corporations

However, significant funding gaps remain for these climate technologies and, as corroborated by Climate Tech entrepreneurs, access to funding remains the key challenge. In order to understand this funding gap, you need to understand the long road to market—punctuated by four significant funding hurdles known as "Valleys of Death." This guidebook is about how to cross those Valleys—from pre-incorporation to early commercialization to scaleup and eventually market leadership—and to know they are coming and get ready early. From the outset, entrepreneurs should be thinking about how to transition from the initial stages of a business' development to a larger-scale organization, a journey that will encompass new kinds of risks and challenges through the stages of company and technology maturity.

Climate Tech Experts emphasize the complexities and unique considerations associated with funding hardware startups, while acknowledging the importance of both hardware and software solutions in addressing climate change's challenges. Founders can best equip themselves to develop a sound financial strategy to make progress along the Climate Tech Valleys of Death by considering the following:

- Why the product development for Climate Tech is different from the successful funding and scaling of software solutions in the past?
- What happened the last time there was a mass effort to scale clean energy technologies?
- What kind of capital is best suited to a startup at each stage of its early development?
- What trade-offs to consider when choosing between different types of capital?
- What they plan to spend the funding on?
- What are investors looking for when assessing whether to give them capital or not?

Developing a Financial Strategy to Shift Across the Valleys of Death

Valley of Death #1: Startup Formation

- Technology Readiness Level (TRL): 1-3
- Commercial Inflection Point (CIP): 1
- Adoption Readiness Level (ARL): Low Readiness
- Business Archetype: Basic Research
- Indicative Funding Need: $2.5k - $500k

Valley of Death #1: Turning basic research into a company and spinning out of a university or laboratory setting. The first Valley of Death is the period of time between the development of a new technology through basic research and the commercialization of that technology (i.e., pre-commercialization). This is a critical period for entrepreneurs, as it is during this time that they must decide to spin out their research and start a business.

Challenges:

- Entrepreneurs at this stage (often postdoctoral students or professors) typically don't have business-building skills or don't realize they have a marketable idea
- Lack of access to facilities and equipment to build the prototype
- Lack of access to a network including pre-seed investors, angel investors, and experienced entrepreneurs

Requirements:

- Sufficient legal know-how to incorporate businesses and negotiate fair intellectual property licensing agreements
- Non-dilutive capital sources willing and able to discover, fund, and support burgeoning scientists and their living expenses
- Facilities such as lab space and equipment to continue developing the first iterations of the product

Sources of capital best suited to overcome the challenges posed by this Valley of Death include:

- Fellowship Programs
- Phase One Grants (and Grant Advances)
- Incubators
- National Labs

This is because these sources of capital typically provide:

- Lower barriers to entry and often access to capital based on a non-developed idea
- A focus on business purpose and potential rather than financial gain
- Access to facilities and equipment
- Stipends to cover living expenses
- Close links to universities and understanding of the spinning-out process

Organizations and programs providing this type of capital include: Activate, Breakthrough Energy Fellows, Small Business Innovation Research, Small Business Technology Transfer, Greentown Labs, Argonne National Laboratory, Cyclotron Road, National Renewable Energy Laboratory, etc.

Valley of Death #2: Product Development

- Technology Readiness Level (TRL): 4-5
- Commercial Inflection Point (CIP): 2
- Adoption Readiness Level (ARL): Low Readiness
- Business Archetype: Spinout
- Indicative Funding Need: $10k - $5m

Valley of Death #2: Turning a company into a business by developing a sought-after product, building a founding team, and establishing industry connections. The second Valley of Death is the period of time between early commercialization and meeting a true customer need (i.e., early-stage, pre-seed, or seed). This is a critical period for entrepreneurs, as it is during this time that they must prove that their technology is viable and that the product addresses a customer pain point.

Challenges:

- Product development cycles take longer for hardware solutions and highly-regulated products
- Climate technologies often need to operate within current market structures and value chains
- Climate Tech startups need the skills to understand the relevant regulators, industry incumbents, existing manufacturing processes, and supply chains at a deep level
- Further skills are needed for site selection, permitting, and pre-development
- There is a particularly long sales cycle when selling to slow-moving incumbents and novel technologies typically require an education period

Requirements:

- A well-written business plan to help entrepreneurs articulate their vision for their company, identify their target market, and develop a strategy for commercializing their technology
- A strong team of skilled, passionate, and resilient professionals who can help the academic founder bring their technology to market
- Capital alongside connections to corporations, regulators, and other resources to speed up the pace of the startup's market discovery and implementation of the go-to-market strategy
- Connection to and understanding of manufacturing partners

Sources of capital best suited to overcome the challenges posed by this Valley of Death are:

- Prizes
- Phase Two Grants (and Grant Advances)
- Accelerators / Ecosystem Builders
- Angel Investors
- Crowdfunding and Investor
- Syndicates
- Early-stage Venture Capital

This is because these sources of capital typically provide:

- Larger check sizes allowing startups to develop a minimum viable product or prototype and hire early employees
- Access to investors, corporations, customers, expertise, and regulators
- Mentorship and training related to business building

Organizations and programs providing this type of capital include: The Keeling Curve Prize, Cleantech Open, gener8tor, Elemental Excelerator, Third Derivative, Venture for Climate Tech, Blueprint, SecondMuse, Early-stage VC funds, ARPA-E SCALEUP, etc.

Valley of Death #3: Market Validation

- Technology Readiness Level (TRL): 6-7
- Commercial Inflection Point (CIP): 3-5
- Adoption Readiness Level (ARL): Medium Readiness
- Business Archetype: Early Commercialization
- Indicative Funding Need: $5m - $100m

Valley of Death #3: Validating that a product is sought-after and that a business model works by developing a pre-pilot, pilot, demonstration project, or first-of-a-kind facility and/or meeting a market need. The third Valley of Death is the period of time between the commercialization of a new technology and the time when the technology has removed sufficient market and technological risks to begin deployment at large scale. This is a critical period for entrepreneurs, as it is during this time that they must prove that their technology can be successfully scaled and replicated to meet its intended market demand.

Challenges:

- Large amounts of capital to build first-of-a-kind or micro-pilot facilities to show that the technology works reliably while managing design and associated risks
- Convincing large corporations to partner on demonstration plants and become the first customer and establish customer adoption
- Overcoming design complexity to prove that the technology works, the product can be built at scale, and limiting construction risk
- Ensuring that adjacent technologies are also ready for deployment
- Cost overruns due to long project development timelines, policy or regulatory bottlenecks, and the need for economies of scale or technology maturity to bring down costs
- Lack of experience and comfort of capital providers around underwriting criteria
- Lack of standards from pilot to proven technology

Requirements:

- Large pools of capital comfortable with taking the risk on a first-of-a-kind plant based on a deep understanding of the underlying technology and a belief in the execution capabilities of the team
- Capital that is patient, risk-tolerant, concessionary, and/or flexible in ways that differ from conventional investment (e.g., philanthropic rather than financial aims)

- Sufficiently de-risking projects without incurring significant dilution by accessing relevant pools of government funding or entering into strategic partnerships
- A high degree of technical, project management, and financing capabilities
- Access to modeling and structuring tools to match with the best financing available
- Establishing a record of best practices and minimizing binary risks (by gaining visibility on customer adoption and cost overruns) so that project finance can be used in the future

Sources of capital best suited to overcome the challenges posed by this Valley of Death include:

- Catalytic Capital / Pilot Funding
- Accelerators for Projects
- Cooperative Agreements (e.g., Office of Clean Energy Demonstrations) and Joint Ventures
- Loan Guarantees and Construction Loans (e.g., New York Green Bank, California Infrastructure and Economic Development Bank) that allow for risk-sharing amongst a number of commercial lenders
- Late-stage Venture Capital (predominantly for low-capital-intensity businesses e.g., software)

This is because these sources of capital typically provide:

- Large check sizes either willing to take on large risks or focused on another motive such as crowding in investment
- Experience structuring large infrastructure investments, including structuring flexibility to match the needs of the individual project
- Relatively patient capital when compared to traditional sources (particularly for catalytic funds)

Examples of organizations and programs providing this type of capital include: Breakthrough Energy Catalyst, PRIME Coalition, Azolla Ventures, Black & Veatch IgniteX Climate Tech Accelerator, Office of Clean Energy Demonstrations, Late-stage VC funds, etc.

Valley of Death #4: Widespread Adoption

- Technology Readiness Level (TRL): 8-9
- Commercial Inflection Point (CIP): 6-8
- Adoption Readiness Level (ARL): High Readiness
- Business Archetype: Scaleup / Project Developer
- Indicative Funding Need: $100m - $1b+

Valley of Death #4: Replicating this working business model and scaling the technology for widespread adoption and full commercialization. The fourth Valley of Death is the period of time between the first few commercial-scale deployments and market leadership. This is a critical period for entrepreneurs, as it is during this time that they must prove that their business model is bankable, self-sustaining, and can be profitable over the long term.

Challenges:

- Lenders want to be sure that projects can be built and operated successfully, that the projects will generate enough cash flow to repay the loan, and that the projects are underpinned by a sound legal framework
- Limited skillset and past experience among lenders and investors to gain the conviction required to quickly deploy capital at this scale
- Gathering sufficient high-quality performance data to showcase the operational track record of the demonstration plants
- Retirement of technology, market, regulatory, and scaling risk

Requirements:

- Mostly debt, project finance, or infrastructure capital requiring evidence of stable cash flows
- Demonstration that the project sponsor has the experience and expertise to successfully complete the project
- Contractually-assured revenues through offtake agreements and demonstration that there is a market for the project's output
- Assurance that the project's risks are manageable

Sources of capital best suited to overcome the challenges posed by this Valley of Death include:

- Revenue-Based Financing
- Infrastructure Finance
- Growth-stage Venture Capital / Private Equity
- Commercial Debt
- Venture Debt
- Project Finance
- Loan Guarantees (e.g., Loan Programs Office)

This is because these sources of capital typically provide:

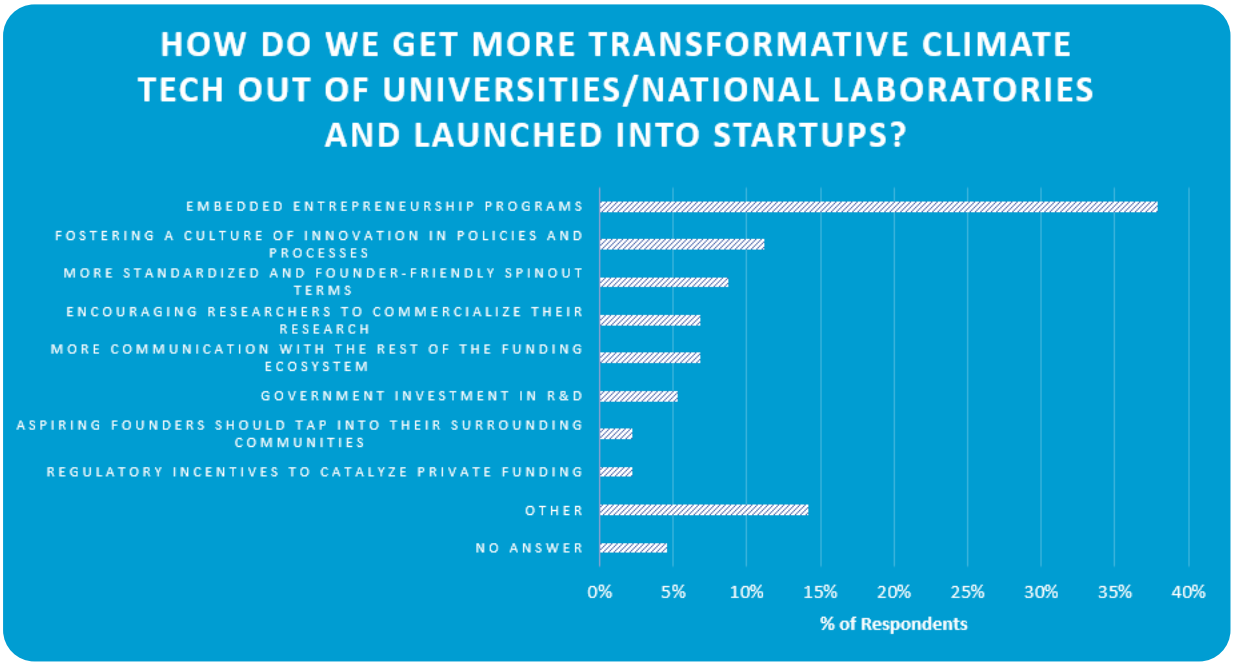
- Large amounts of debt funding based on key operational metrics provided by the company such as revenue, cash flows, and profits
- Relatively cheap, long-term, and non-dilutive capital ensuring entrepreneurs do not need to give up ownership in order to scale
- Large loan guarantees to crowd in commercial debt from typically risk-averse financing institutions

Organizations and programs providing this type of capital include: Enduring Planet, Lighter Capital, Commercial Banks, Generate Capital, Orion Infrastructure Capital, Growth-stage VC funds, Private Equity funds, Investment Banks, Loan Programs Office, etc.

Why Might Funding Outcomes Not Be So Straight forward in the Real World

The Valleys of Death outlined above provide a framework for thinking about the challenges you may encounter along your entrepreneurial journey. However, putting that framework into action requires context and a vision for putting all the pieces together. It is important for Climate Tech founders to be cognizant of the potential for additional challenges beyond those imposed by the Valleys of Death.

Experts emphasized the need for collaboration, mentorship, resource allocation, and cultural shifts within universities and national laboratories to foster a conducive environment for Climate Tech startups to thrive. A lack of embedded entrepreneurship programs, entrepreneurial cultures, lab facilities, and the opaqueness of policies and processes of Technology Transfer Offices (TTOs) result in an issue with the pipeline of Climate Tech companies coming out of these institutions. This adds an additional challenge to the first Valley of Death.



A clear solution to this problem is the creation and expansion of programs designed to help burgeoning scientists develop their business-building skills. These embedded entrepreneurship programs can provide support, resources, and funding to aspiring entrepreneurs, enabling them to translate research into a business and build their initial team.

Furthermore, initiatives like Breakthrough Energy Fellows, Activate, Cyclotron Road, Cradle-to-Commerce, and ARPA-E provide substantial grants to researchers to develop and prototype their technologies. Increased funding for such programs can facilitate the early-stage development of Climate Tech startups.

Furthermore, a number of ecosystem-wide measures need to be taken to ensure that the Climate Tech funding environment becomes more inclusive, equitable, and supportive of underrepresented founders. For example, the VC decision-making process, particularly in the early stages, being underpinned by judgment-based factors such as a belief in the founding team results in underrepresented founders being underfunded. This is exacerbated by a lack of diversity amongst the senior ranks of the capital allocator community. This adds an additional challenge to the second and third Valleys of Death, in particular, when many investment outcomes are relationship-based, paving the way for biases.

For these reasons and others, the funding journeys of Climate Tech startups are often less neatly defined than discussed in this guidebook.

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1 Introduction

> NOW IS THE ONLY TIME TO START A COMPANY IN THE CLIMATE TECH SPACE. WE DON'T HAVE TIME AS A LUXURY. WE DON'T HAVE [TIME FOR] "WELL MAYBE I'LL START A COMPANY TEN YEARS FROM NOW" OR WHAT HAVE YOU. SO I WOULD REALLY REFRAME IT AND SAY WE HAVE TO MAKE NOW A GOOD TIME TO START UP A COMPANY IN THE CLIMATE SPACE. THAT SAID, AS SOMEONE WHO'S BEEN STARTING COMPANIES IN THE CLIMATE SPACE FOR THE BETTER PART OF 20 YEARS AND THROUGH SOME UPS AND SOME DOWNS, IT'S DEFINITELY A MUCH BETTER TIME THAN I'VE EVER SEEN IT BEFORE. SO IT'S THE BEST TIME THAT I'VE EVER SEEN IT, AND I HOPE THAT IT'S THE WORST TIME RELATIVE TO THE TIMES IN THE FUTURE. I HOPE THE TIMES CONTINUE TO GET BETTER."
>
> *CEO of Climate Tech Startup*

Success in building a Climate Tech company depends on many important factors, but chief among them may be your planning around capital injections. Climate Tech is a critical subset of industries that aim to provide sustainable solutions to mitigate the impact of climate change. An analysis by McKinsey & Company suggests that this group of companies could generate more than $12 trillion in annual revenue by 2030[6]. However, despite its importance, the space has dealt with several challenges in this first part of the year. In Q1 2023, the sector experienced a slowdown in venture capital (VC) funding due to less deal activity at the growth stage (see Valley of Death #4). Historically, this VC investment has been crucial in furthering the commercialization of transformational climate technologies and boosting the competitiveness of the United States in terms of technology development[7]. Furthermore, the closure of regional banks such as Silicon Valley Bank, a prominent lender to Climate Tech startups and projects, interest-rate tightening, more competition for VC funding, and a lack of human capital, have also created short-term and more structural headwinds. Nonetheless, the long-term outlook for Climate Tech remains positive, as it is widely recognized that technological innovation across a broad range of low-carbon technologies is required to achieve global climate goals[8].

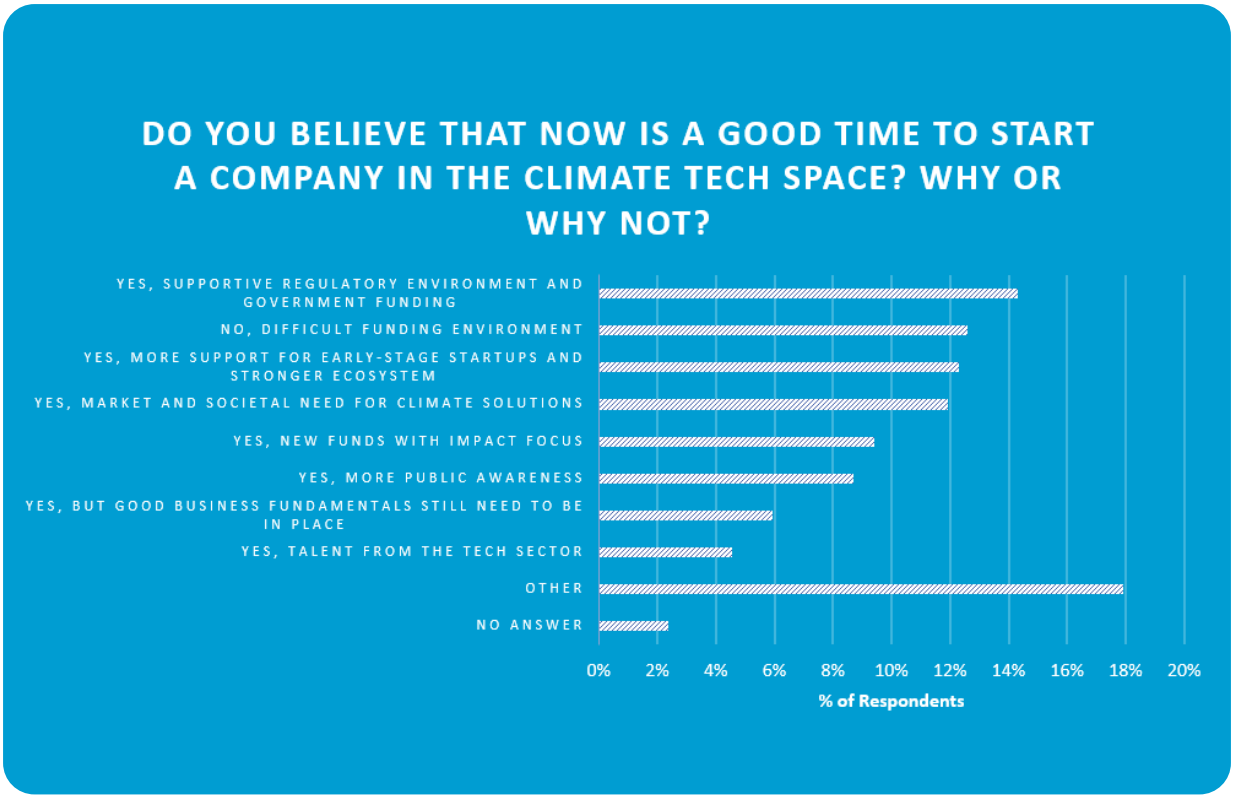


Figure 1: *Survey of Climate Tech Experts; Source: A Financial Guidebook for U.S. Startups Crossing Climate Tech's Valleys of Death and Achieving Scale by Hugo Mkhize; Methodology: Based on 44 interviews between March-June 2023*

What the Experts Say: Key Takeaways

Urgency and Opportunity: The urgency of addressing climate change is emphasized, indicating that there is no time to waste. The Experts believe that now is the best time to start a company in the Climate Tech space due to the pressing need and the potential for significant positive impact.

Favorable Policy Environment: The Experts highlight the favorable policy environment globally, with incentives, tax breaks, and regulatory schemes promoting Climate Tech entrepreneurship. They mention the Inflation Reduction Act and the Bipartisan infrastructure legislation in the United States as examples.

Growing Market and Investor Interest: There is a consensus among the Experts that the Climate Tech market is expanding rapidly. They note the availability of significant capital, including venture funding, impact investment, grants, and other forms of innovative finance. They also mention the increasing interest from corporate partners and the alignment of investment strategies with climate goals.

Improving Talent Landscape: The Experts observe a growing trend of professionals across industries pivoting their careers towards Climate Tech. They mention the availability of diverse talent, including technical experts, HR professionals, marketers, and business development specialists, who are eager to contribute to climate solutions.

Lessons Learned and Infrastructure Development: The Experts point out that the Climate Tech sector has evolved and learned from previous cycles. They mention the availability of debt financing, project finance mechanisms, and the emergence of new funding sources. They also highlight the development of incubators, accelerators, and programs supporting climate founders.

Resilience during Economic Turmoil: Some Experts note that successful companies often emerge during recessions and challenging economic times. They believe that starting a Climate Tech company during such periods can lead to long-term success.

"Yes, I don't think there's been a better time. [For] overarching reasons [such as] the need is the greatest that it's ever been and the opportunity to actually bend the curve is [significant]. [We are] probably two years into a ten-year period where founders can have a real short-term impact on averting some of the worst outcomes. So the opportunity there is big and that's not just [regarding the] impact. These are all the industries and the products of the future and these are trillion-dollar opportunities so as profit-motivated founders, I don't think there's a bigger opportunity to start a business, maybe AI." ***– Expert at Government Funding Organization***

"So there's also a trope or truism around starting companies during times of economic turmoil. If you look at some of the most successful companies in history, they were often started during recessions and survived recessions and then found their way out and so maybe for that reason alone, it's a good thing." ***– Climate Tech Entrepreneur***

"I'm a true believer in the long-run economic transition of climate change so I don't know that there's ever a bad time. But the combination of the opening up of markets over the last 10 years with the scaling of proven technology and the mounting evidence around climate change exposing the need for further innovation has, I think, conditioned the broader capital markets and end-user markets for, further change and the need for new approaches." ***– Expert at Financial Institution***

"I spent ten years in venture starting in the 2005 era when the conditions were just not the same. The innovation was there. There was early-stage equity, but the total market was not present. It was not addressable. And I think all those pieces are visible now. So it's an ideal time and a lot of great companies get started during the recessionary conditions. So this is a good time to strike." ***– Expert at Financial Institution***

What the Experts say

The sentiment of the Climate Tech ecosystem is generally positive regarding starting a company in the Climate Tech space at this time. Here is a summary of their viewpoints:

- **Urgency and Opportunity**
- **Favorable Policy Environment**
- **Growing Market and Investor Interest**
- **Improving Talent Landscape**
- **Lessons Learned and Infrastructure Development**
- **Resilience during Economic Turmoil**

There is a lot of focus on the sizeable investments needed for gigaton-scale climate technologies to achieve the requisite scale by mid-century, however, achieving that kind of scale requires that solutions go through stages of testing and demonstration in the coming years in order to be commercially proven by the 2030s[9]. While many of these solutions are readily available, others involve nascent technologies that are still years, and sometimes even decades, away from broad-based commercial adoption[9] [10]. We cannot afford to wait that long to gain access to tailor-made financing and widespread adoption of these mission-critical climate technologies during this decisive decade[9]. As a result, it is crucial that the Climate Tech funding ecosystem embraces mechanisms that mitigate the risks associated with technology development and establishes innovative frameworks that enable diverse funding sources to secure their position within the capital stack[11]. In this context, Climate Tech founders and entrepreneurs have a pivotal role to play in identifying and scaling the solutions required to mitigate and adapt to the worst impacts of climate change[4]. However, access to capital remains the most significant challenge hindering their progress. In a 2022 report by Endeavor Insight titled "*Scaling Climate Tech: A Global Study of Entrepreneurs and Networks,*" interviewed founders cited access to growth capital as the primary funding challenge (as shown in Figure 2 below)[4]. The funding decision has the ability to dictate the direction of your company and can often be the difference between its success and failure.

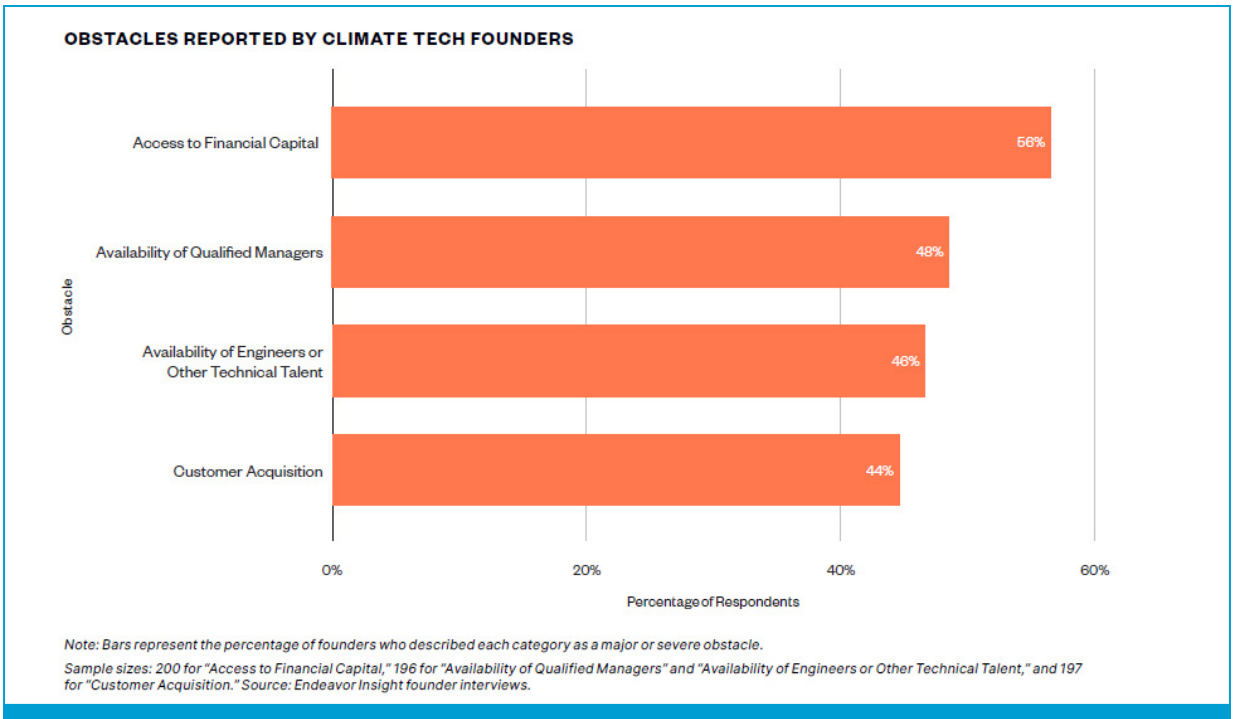


Figure 2: *Obstacles Reported by Climate Tech Founders; Source: Endeavor Insight*

To overcome the challenge of a lack of access to funding, entrepreneurs must have a strong sense of what types of capital are best suited to them at each stage of their startup's journey and how to plan for these capital injections[12] – this is the focus of this guidebook. Innovative hard tech startups often face considerable funding gaps, particularly at the stages where they need to deploy large demonstration projects or where projects do not yet have a sufficient track record to give comfort to project financiers[10]. An example of this is the sustainable aviation fuel (SAF) market which has been relatively slow to gain widespread adoption, despite the underlying technologies being widely understood. This is because low-cost capital providers require time to become comfortable with taking bets on mature technologies applied in a different context. Broadly, founders should prioritize the cost of capital, dilution, complexity, fundraising effort, and value added beyond the funding when evaluating what kind of capital is right for them[13].

In this guidebook, we will explore the funding landscape for Climate Tech businesses and provide guidance on how to identify and secure the right types of capital at each stage of your company's journey. As a Climate Tech entrepreneur, you have an opportunity to make a difference in the world while also building a successful business. By understanding the funding landscape, acknowledging the trade-offs between different types of funding, and identifying the right types of capital for you at each stage, you can increase your chances of success and help accelerate the adoption of critical low-carbon technologies. Furthermore, when you know what investors are looking for, you will know how to tailor your story to strengthen your chances of securing funding.

> "THREE PIECES OF ADVICE: LEARN STORYTELLING, HOW TO PITCH, AND UNDERNEATH THAT YOUR HOOK. YOUR ELEVATOR PITCH IS THE MOST IMPORTANT THING. PEOPLE DECIDE HOW THEY FEEL ABOUT YOU IN THE FIRST 30 SECONDS OF MEETING YOU. LEARN TO PITCH, WORK ON YOUR HOOK. AFTER THAT, THE NEXT MOST IMPORTANT THING IS RESILIENCE OR GRIT. JUST BE PREPARED TO FAIL A WHOLE LOT. IN MY EXPERIENCE, YOU USUALLY HEAR "NO" HUNDREDS OF TIMES BEFORE YOU HEAR "YES." JUST GET MENTALLY READY FOR THAT BECAUSE IT'S DISCOURAGING. AND THEN FINALLY, LEARN THE FUNDRAISING PROCESS. THERE'S A PROCESS THAT THE INVESTMENT BANKS USE. IT'S [ALSO] WHAT SUCCESSFUL VENTURE-BACKED COMPANIES USE. YOU PREPARE YOUR MATERIALS. [THEN] YOU HIT UP ALL YOUR INVESTORS [OR] ALL THE INVESTORS YOU WANT TO REACH OUT TO AT THE SAME TIME AND YOU TRY TO BUILD CRITICAL MASS. AND THEN [WITH] THAT CRITICAL MASS, YOU CAN GET FOMO GOING. THAT CAUSES PEOPLE TO MOVE."
>
> *Founder & CEO of Climate Tech Startup*

Why Some Climate Technologies Are Harder to Scale than Others

The key to understanding investors in the Climate Tech space begins with an understanding of how funding certain types of climate innovations will be different from what is familiar to most early-stage investors: IT and software. The major difference between VC-backed technology ideas and most Climate Tech businesses is the concept of ready scalability. Scale requires de-risking perceived or real business model challenges and de-risking requires trial and error to find market fit (ideally while using as little capital as possible). At its essence, this is what this guidebook is about—the capital dimension to scaling.

Hardware solutions are critical to mitigating climate change, but they require more patient capital and specialized support, which are often in limited supply[4]. Investors are more familiar with software business models, which lowers the barrier for them to get comfortable investing in software-driven solutions to climate change[4]. Moreover, hardware startups often face longer development timelines due to additional product development steps,

such as research and development, prototyping, factory production, and shipping. Another common challenge for hardware companies is regulation, which can hinder the commercialization of climate technologies through burdensome compliance processes, uncertain policies, barriers to market access, lengthy approval procedures, and the lack of financial incentives. These factors have historically made hardware companies less attractive to investors who are used to the fast-paced growth of software companies[4].

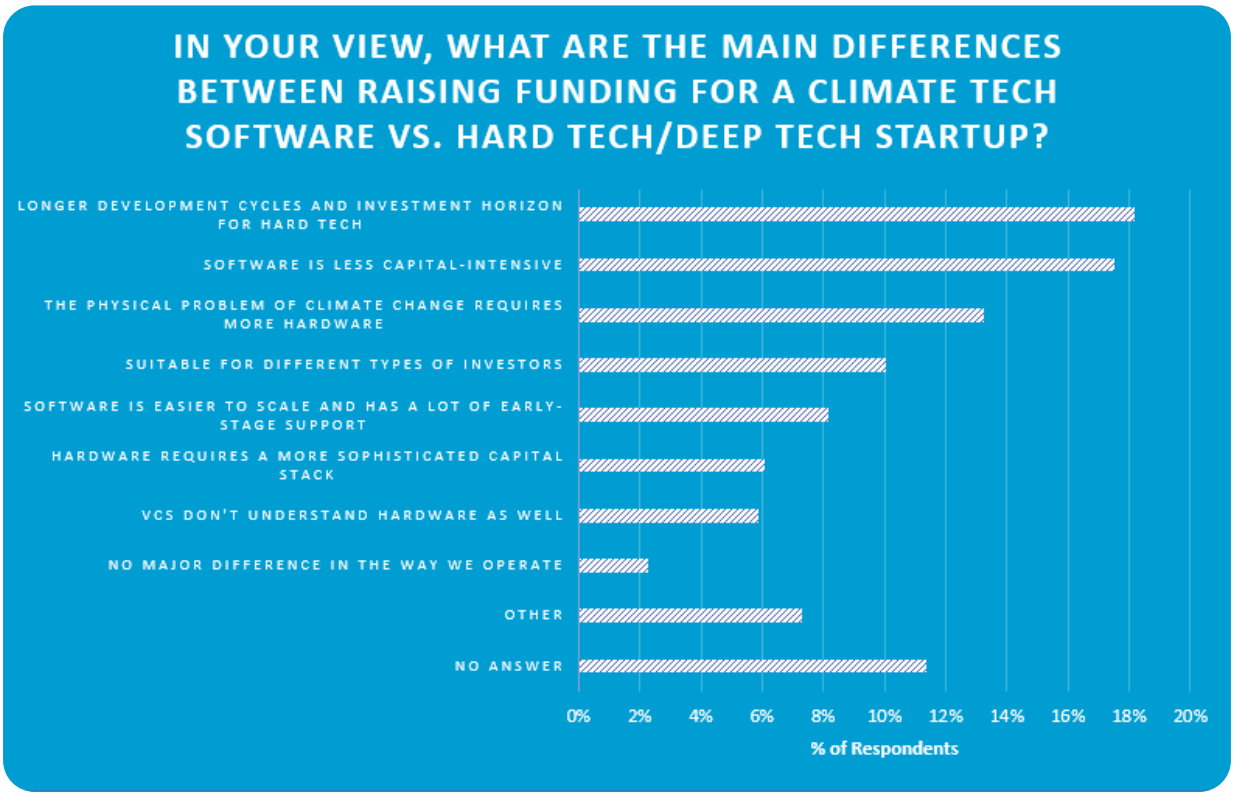


Figure 3: *Survey of Climate Tech Experts; Source: A Financial Guidebook for U.S. Startups Crossing Climate Tech's Valleys of Death and Achieving Scale by Hugo Mkhize; Methodology: Based on 44 interviews between March-June 2023*

What the Experts Say: Key Takeaways

Capital Requirements: Hardware startups generally require more capital compared to software startups. Building physical products, involving designers, manufacturers, and prototypers, takes time and money, making the feedback loops longer. Software startups, on the other hand, require relatively smaller amounts of capital.

Investment Complexity: Venture capitalists often find it challenging to invest in hardware startups due to the need for domain expertise and the wide range of technologies in the energy/Climate Tech space.

Funding Sources and Financing Mix: While software startups can typically rely on venture capital throughout their growth stages, hard tech companies often need to seek funding from other asset classes beyond traditional VC. These alternative sources may include project finance, private equity, mezzanine debt, and government grants. Furthermore, grants are often more accessible for hardware startups, while software startups may face more challenges in securing grant funding.

Time Scale: Hardware startups generally require a longer time to reach milestones and achieve market readiness compared to software startups. The process of designing, prototyping, testing, and manufacturing physical products introduces additional time and resource requirements.

Market Dynamics: Hard tech solutions often compete with existing incumbent systems and face commoditization challenges. Value-based pricing, commonly used in software, may be more difficult in hard tech, where cost competition with established incumbents becomes a significant factor.

Scaleup Capital: As hardware startups scale, the need for working capital and capital expenditures (CapEx) becomes more pronounced. Scaling hardware solutions often involves debt financing, with banks offering more significant financial resources compared to venture capital.

Investor Focus: Some venture capital firms have a specific focus on hard tech startups in the Climate Tech space, leveraging their experience from previous clean tech cycles. These firms are more attuned to the needs and realistic time horizons of such startups, recognizing the differences in capital intensity, margin profiles, and scaling approaches.

"So I think we have to challenge the model a little bit of VC being the sole source of funding. But as we do challenge that model, it creates new opportunities both for startups and other kinds of classes of capital as well." ***– Climate Tech Entrepreneur***

"There are Valleys of Death in the commercialization journey strictly because of the amount of capital required to prove out these concepts. That is just not the case with software. The amount of capital required is so small [in comparison]. So it's a much better fit for [VC]. The VC [model] was designed [for software]. And we're talking about infrastructure-scale investment with a similar risk profile and there just aren't funds that fill that gap and that's why federal dollars are needed to plug that hole." ***– Expert at Government Funding Organization***

"They have different investment needs, different margin profiles, different ways they scale, and that in turn ties to different types of investors that tend to be a good fit for them." ***– Expert at Financial Institution***

"When it comes to software, there are very well understood milestones that you need to achieve before you're able to raise your next round, which is nice." ***- Climate Tech Investor***

"In some ways, there are advantages to building hardware because then you have collateral and you have durable assets that you can finance against, but in other ways, it's harder because you have to build stuff - it costs money." – ***Expert at Climate Tech FinTech***

"We tend to have a bias toward hard tech because of the fact that we're looking for solutions to climate change and computers can't fix that. There needs to be on-the-ground, hard tech solutions that are changing the way that we power the world, [the way] that we move between places and all that... But we do balance that with some investments on the software side [where] there are some key enabling software companies [that] can accelerate that." – ***Climate Tech Investor***

What the Experts Say

Overall, the Experts emphasize the complexities and unique considerations associated with funding hardware startups, while acknowledging the importance of both hardware and software solutions in addressing climate change's challenges. In summary, they touched on:

- **Capital Requirements**
- **Investment Complexity**
- **Funding Sources and Financing Mix**
- **Time Scale**
- **Market Dynamics**
- **Scaleup Capital**
- **Investor Focus**

Silicon Valley has a wealth of experience investing in software companies, allowing the startup ecosystem to quickly scale new ideas and innovations such as social media, digital payments, and telecommunications[12]. Successful software companies are typically characterized by fewer Valleys of Death and follow the well-known J-curve trajectory[12][14]. This path is characterized by companies are generally less capital intensive, have a shorter time horizon to scale, and are less reliant on government incentives or subsidies[7]. In contrast, hardware companies must overcome several stages of product development, from a concept in the lab to one or more demonstration projects designed to prove that the technology can operate viably at or near its intended commercial scale[10]. This requires hard tech companies to put together teams with expertise in technical, commercial, and regulatory spheres to overcome the greater production challenges they face[12].

VCs have historically been unwilling to fund high-risk, capital-intensive Climate Tech ventures[7]. In fact, a widely-cited report from the Massachusetts Institute of Technology (MIT) Energy Initiative found that clean tech may not be well suited to the VC model when compared to software and medical technology[7][15]. While it remains to be seen whether this hypothesis will hold true for the current Climate Tech period of investor interest, there remains scope for other pools of capital that may incorporate longer investment time horizons more suitable for hardware startups[7]. Over many years, it has been established that early-stage VC and government research grants are well suited to help launch new companies, while later-stage growth VCs and private equity can help businesses scale once the technology risk has been retired and their business models are proven[14]. It is more unclear as to what are the appropriate funding sources between these two development stages[14]. Therefore, in order to align your funding strategy to the maturity of your technology or product, it can be useful to consider a more nuanced view of your product development cycle and your position within the Valleys of Death.

The most commonly used scale to measure the maturity of a given technology is the Technology Readiness Level (TRL), as developed by the National Aeronautics and Space Administration (NASA)[14]. The TRL scale has 9 development points from Research (point 1) through to Test & Launch (point 9), however, product launch often only marks the end of the technology development cycle and the beginning of the commercialization journey[14]. There remain funding gaps between the launch of a minimum viable product (MVP) or prototype and achieving mass market adoption. Climate Tech companies with hardware solutions, in particular, will require significant capital, learnings from iterative deployments, and may even undergo fundamental changes in business model after their first deployment[14]. As a result, non-profit investor and growth-stage accelerator Elemental Excelerator, developed a novel Commercial Inflection Point (CIP) scale for Climate Tech companies in 2022 that incorporates major milestones for a startup, from idea to widespread adoption[14]. Figure 4 below depicts this scale in relation to the TRL scale as a startup achieves each milestone along the scale[14].

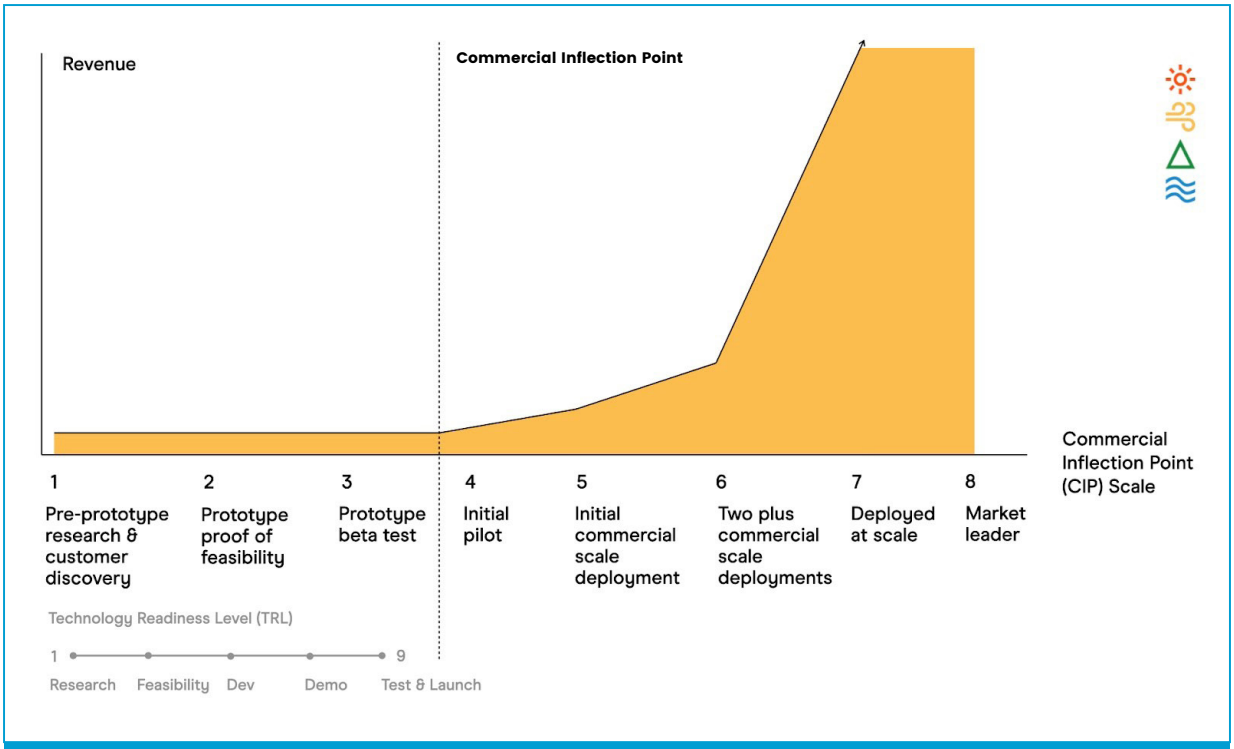


Figure 4: *Commercial Inflection Point (CIP) Scale; Source: Adapted from Elemental Excelerator*

The intention of the CIP scale is to give entrepreneurs and investors common nomenclature for describing a startup's commercialization journey and thus an understanding of the risk profile in order to unlock funding[14]. The CIP scale incorporates both technical and commercial milestones and is most applicable to B2B (business-to-business) and B2G (business-to-government) climate companies[14]. An understanding of this scale and a startup's position on it will go some way to preventing situations where founders incur significant dilution from venture capitalists in order to fund their initial deployments, which can both impact investor returns (through their own dilution in future funding rounds) and disincentivize founders[14].

Another scale, developed by The Office of Technology Transitions (OTT), called the Adoption Readiness Level (ARL) is designed to facilitate the effective movement of technologies through the research, development, demonstration, and deployment (RDD&D) continuum[16]. This framework emphasizes the need for close coordination and partnerships among public sector organizations, private sector entities, and community stakeholders by recognizing that research and development efforts must be aligned with the end-market requirements to ensure successful adoption. For a technology to progress to the deployment stage, it must be thoroughly de-risked, and the economic viability of the ecosystem must be established[16]. Failure in commercialization often arises not from technological shortcomings, but from the lack of consideration for ecosystem

economics or the absence of critical players within the ecosystem.
The ARL framework recognizes the importance of addressing economic and business model requirements for deployment, as well as a technology's societal license-to-operate[16]. It suggests that these considerations should influence the technical problem definition and the development of solutions at every stage of the RDD&D continuum. In addition to the technical risks assessed by the traditional TRL framework, effective technology management requires actively reducing project risks and adoption risks[16]. This relationship between the TRL and ARL frameworks is captured in Figure 5 below. By considering factors beyond technology readiness, such as value proposition, market acceptance, resource maturity, and license to operate, the framework enables stakeholders to identify and address key risks that may hinder the successful deployment and commercialization of a technology[16].

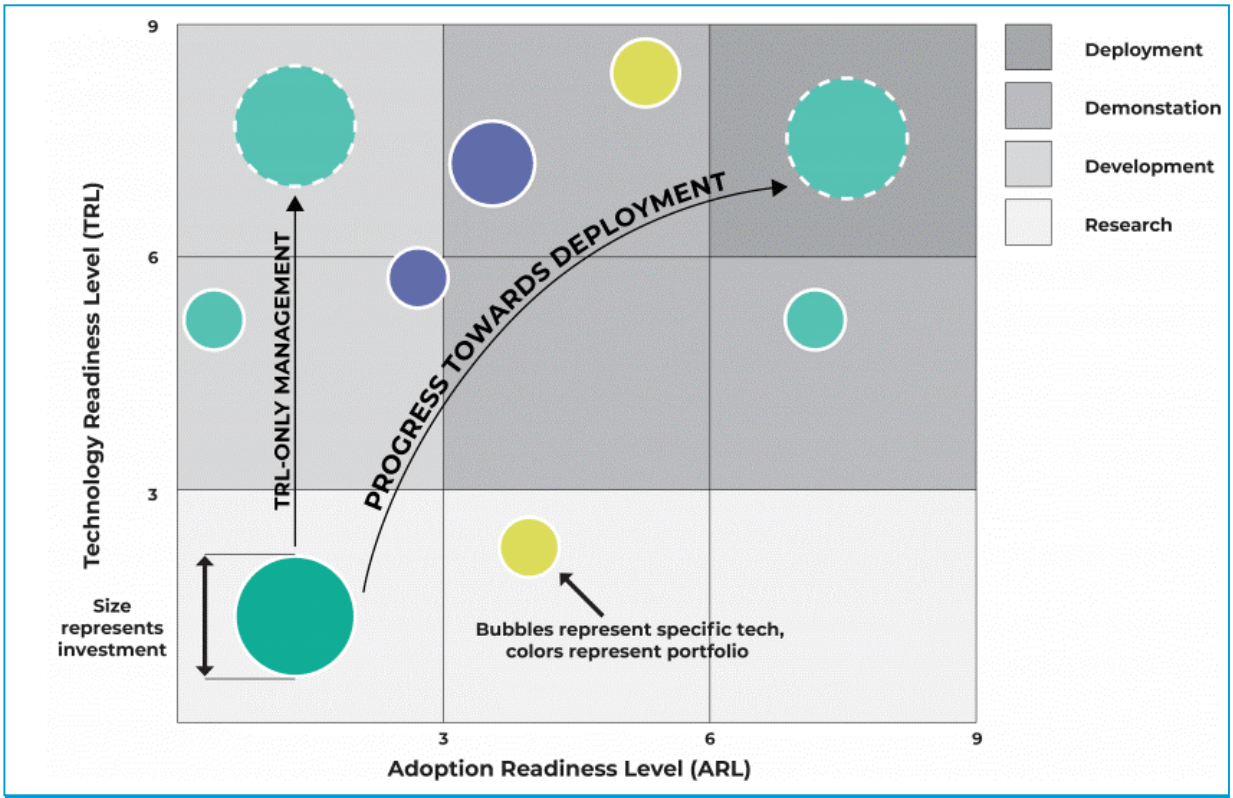


Figure 5: *Commercial Adoption Readiness Assessment Tool (CARAT); Source: The Office of Technology Transitions (OTT), U.S. Department of Energy*

The journey from innovation to widespread adoption involves multiple stages. It begins with proving the concept in a controlled lab or prototype setting, followed by a pilot project that may be larger but still below full scale and not necessarily in the relevant environment[10]. The next step involves incrementally larger demonstration projects to validate the technology's scalability. Only after these stages, a commercial-scale demonstration project is constructed, leading to the first commercial deployment[10]. Project finance providers typically require several instances of successful commercial deployments before considering a solution as "commercially proven." These early deployments include demonstration projects, first-of-a-kind (FOAK) deployments, and subsequent FOAK (2-to-n) projects, with n varying depending on the solution type, indicating when a climate solution reaches widespread adoption[10]. As per a 2022 report by Prime Coalition, this development is outlined in Figure 6 below where n refers to the number of implementations before a technology is bankable, which will vary by type of solution[10].

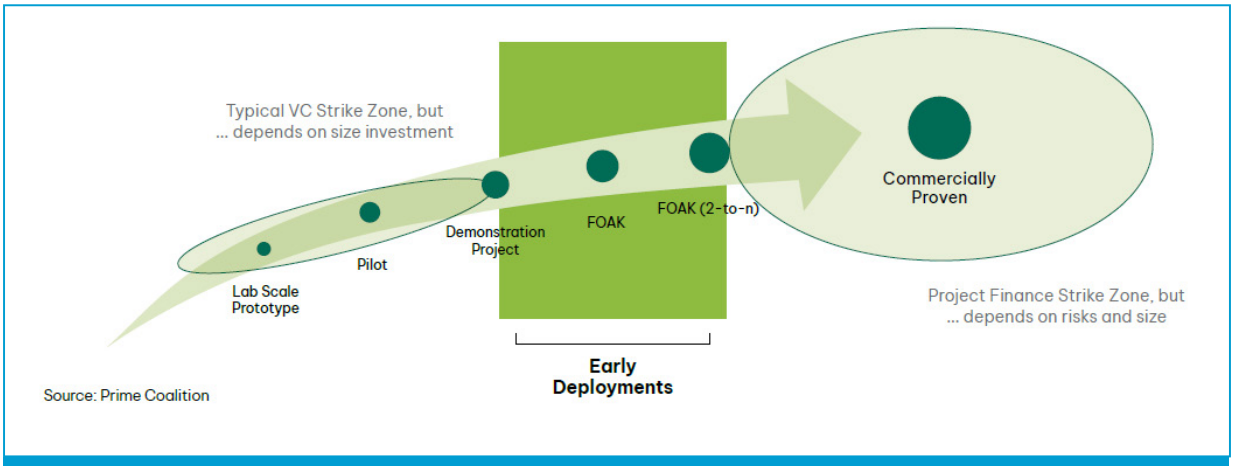


Figure 6: *Sequence from Innovation to Adoption; Source: Prime Coalition*

Despite the challenges faced by hardware businesses, they remain crucial to achieving global climate goals. Hardware solutions are required to address many of the world's most pressing environmental issues. While software solutions can be valuable in reducing emissions and increasing efficiency, hardware solutions are necessary to address issues such as decarbonizing industrial processes, enabling the widespread adoption of renewable energy, and creating carbon-negative materials, for example[10].

Lessons Learned from Clean Tech 1.0 (2006 – 2011)

Building your company with Finance in mind can involve making business model choices that ultimately increase the value of your enterprise. For early-stage hardware startups, the focus is often on overcoming the "first plant" problem, where the first operational facility should produce physical products without incurring losses[17]. When entrepreneurs can innovate around production processes, for example, by leasing or financing existing equipment, this allows them to access credit products instead of relying solely on equity to fund their growth. Similarly, establishing partnerships with larger companies can also be an effective financing strategy, as seen in Tesla's collaboration with Toyota in repurposing one of the Japanese carmakers existing plants to build one of Tesla's early facilities[17]. While potentially more complex, such transactions can create a competitive advantage by reducing competition for startups that can navigate intricate financial arrangements. This was a key part of the learnings from Clean Tech 1.0: intentional decisions aligning product choices with available financing options are key to avoiding pitfalls and maximizing success in Climate Tech[17]. In its own way, this guidebook is part of an effort to codify some of these learnings.

Clean Tech 1.0 refers to the first wave of investor interest in startups focused on sustainability and climate change mitigation during the 2006-2011 period[4]. During that time, clean energy companies are reported to have attracted over $25 billion in venture capital, however, many of these investments proved unsuccessful for a variety of reasons including[4][7]:

- Macroeconomic factors such as the Global Financial Crisis
- Immature technologies that were not ready to scale
- Limited markets for these products
- Cheap natural gas (due to the growth in supply from hydraulic fracturing), making intermittent renewable energy relatively less economical
- Limited investor understanding of the clean tech sector

Furthermore, there were also some highly-publicized failures of VC-backed clean tech companies such as Solyndra and Evergreen Solar[7]. While the United States, Japan, and Germany initially led global production in clean technologies such as solar PV panels through high R&D spend and a drive to create local markets, they were overtaken by China due to its comparative advantages in manufacturing, low cost of capital, and access to global supply chains[8].

This had a detrimental impact on the U.S. clean tech industry.

A retrospective analysis of this period highlights key lessons for the investment community and entrepreneurs alike. During that time, investment losses were mainly due to underestimating technology risks and the long timelines for technology development[18]. Investor focus has since evolved, with some firms leveraging software-driven innovations in the energy sector, while others have specialized in assessing industry-specific risks. Furthermore, new funding structures and

partnerships with institutional investors are addressing the capital intensity challenge faced by Climate Tech companies[18]. These lessons have shaped the approach of today's investor community, not only offering hope for improved returns but more importantly, providing a more robust funding environment better equipped to support aspiring founders in the early stages of their commercialization journey.

Why Is Now Different?

The growth of the Climate Tech investment landscape has shown similar promise to other burgeoning sectors such as FinTech in the early 2010s[2]. Despite a decline in U.S. clean tech VC investment between 2011-2016 by nearly 30%, as reported by Brookings, investor interest has subsequently been on an upward trajectory[7]. In the coming years and beyond, the next step is for Climate Tech startup ecosystem to establish itself as a mainstay among emerging technology sectors and for a sustained increase in late-stage deal activity and exits to be matched by a greater proliferation of mid-stage investments (i.e., Series B and C) in order to validate the markets and business models of earlier-stage companies[2]. The upward recent trajectory of the Climate Tech segment comes as a result of:

- Regulatory tailwinds such as the Inflation Reduction Act (IRA), which will boost demand for Climate Tech products and services via tax credits for consumers and producers of renewable energy manufacturing infrastructure, carbon capture, home insulation, clean household energy, and commercial clean vehicles, among others[4][10]
- Strong investor interest and activism, consumer demand, and market readiness of certain technologies[2][6]
- Increased public awareness of political will as climate change has moved from a niche social interest to the broader public consciousness[2][10]
- Ambitious climate goals and net zero pledges from corporations,
- including the generation of market demand signals (through advance market commitments) as well as the purchase of carbon credits and offsets[10]
- Suppliers within B2B value chains facing ever more stringent greenhouse gas emissions targets[6]
- The growing number of investment firms focused on hardware and the climate transition more broadly, however, these pools of capital remain insufficient[4][10]

It is clear that the Climate Tech ecosystem has evolved significantly since the Clean Tech 1.0 era. Key progress has included technological advancements that have reduced the cost of wind and solar, increased talent and expertise focused on solving climate problems, government commitments and policies, corporate engagement due to regulatory changes and climate risks, internalization of

externalities through carbon taxes and trading, shifting consumer demand for sustainable products, and, the focus of the chapters that follow of this guidebook, the availability of diverse funding options[19]. The convergence of these factors presents a different landscape for Climate Tech, with greater potential for success and impact compared to previous attempts.

As per Endeavor Insight, more experienced founders (i.e., those with five or more years of experience) acknowledged that when they started their businesses, investors did not fully understand or consider Climate Tech as its own standalone investment category, however, in recent years there has been a growing number of Climate Tech-focused VC funds and impact investors emerging[4]. Having said that, there is still some caution from investors when considering relatively niche Climate Tech sectors where founders have found raising funds, especially difficult due to investor unfamiliarity and a reluctance to commit the large ticket sizes required[4]. Investors at the earliest stages will be more willing to back Climate Tech startups if they have the confidence that there are more options for founders as they aim to navigate the Valleys of Death[12]. To overcome these Valleys of Death and mitigate the funding gaps during the stages of early deployment, the Climate Tech funding ecosystem requires increased expertise and capital focused on the following areas[10]:

- Risk-reducing: Government grants and Climate Tech-focused venture investors (both early- and late-stage)
- Risk-neutral: Catalytic capital and first-of-a-kind plant deployment which may be focused on philanthropic aims rather than financial gain
- Risk-mitigating: Debt and project finance structuring and risk management

In conclusion, it is clear that the challenges faced during previous investment cycles can provide insight into how to overcome the challenges imposed by each Valley of Death and thus guide you around what kind of resources your startup needs and ultimately your financial strategy. However, there remains a large need for tailored financial instruments and increased capital availability at different stages of a company's development. Furthermore, there is still significant room for various financial innovations and capital sources that can drive the growth, commercialization, and scaling of Climate Tech solutions.

The remainder of the guidebook is divided into the following chapters:

Chapter 2 – The Climate Tech Valleys of Death: This chapter will outline the key challenges faced by Climate Tech startups along their journey from basic research to large scaleup

Chapter 3 – Developing a Financial Strategy to Shift Your Business Across Each Valley of Death: In this chapter, by being provided with the benefits, considerations, and advice on how to get

the most out of each funding source, you should be able to start identifying which pools of capital are best suited to your startup based on its position in the Valleys of Death from Chapter 2

Chapter 4 – Evidence from the Real World: University Spinouts and Underrepresented Founders: Here, we will explore how universities can produce more Climate Tech spinouts and assess the level of gender and ethnic diversity among the investment community, and what that potentially means for their capital allocation decisions

Chapter 5 - Evidence from the Real World: Case Studies of Climate Tech Startup Funding Journeys Through the Valleys of Death: This chapter will explore which funding options have historically been used most often by a sample of Climate Tech startups and what the entrepreneurs learned from those funding decisions

Chapter 6 – Conclusion: The guidebook will conclude with an overview of the key takeaways for you, the Climate Tech entrepreneur, and look at this guidebook's findings in the context of climate change more broadly

2 The Climate Tech Valleys of Death

"I THINK THAT THE EARLIER-STAGE VALLEYS OF DEATH AFTER INNOVATION-FOCUSED VENTURE EQUITY ARE STILL UNDERCAPITALIZED. SO FIRST COMMERCIAL/FIRST DEPLOYMENT FUNDING IS STILL HARD TO COME BY AND I THINK IT'S GOING TO BE HARDER TO COME BY WITH THE CHALLENGES THAT SMALLER AND REGIONAL BANKS ARE NOW FACING POST SILICON VALLEY BANK. THOSE ARE LENDERS THAT WOULD TYPICALLY HAVE SPENT THE TIME TO CULTIVATE AN UNDERSTANDING OF A YOUNG COMPANY'S NEEDS AND ITS BUSINESS IN ORDER TO MAKE A LOAN THAT WOULD GO TO THE FIRST COMMERCIAL DEVELOPMENT OF THEIR IDEA. SO I THINK WE'RE GOING TO NEED EVER MORE FOCUS ON THAT ASPECT OF THE CAPITAL STACK."

Deputy Director at Development Finance Institution

LET US IMAGINE THAT YOU ARE A FRESHLY-MINTED PHD WHOSE RESEARCH FOCUS IS THE USE OF ELECTROCHEMICAL APPROACHES THAT COULD BE USED TO CONVERT CARBON DIOXIDE AND WATER INTO HYDROCARBONS, USEFUL PLASTICS, AND OTHER HOUSEHOLD PRODUCTS. THROUGH YOUR STUDIES, YOU HAVE GAINED BETTER INSIGHT THAN ALMOST ANYONE ON THE PLANET ABOUT HOW THIS SAME ELECTROCHEMICAL CONVERSION PROCESS COULD BE APPLIED TO A NUMBER OF USE CASES SUCH AS THE PRODUCTION OF RENEWABLE FUELS. YOU THINK YOU MIGHT BE ON TO SOMETHING BUT IN ORDER TO INCREASE YOUR CONVICTION, YOU WOULD LIKE TO CONDUCT SOME EXPERIMENTS TO SHOW THAT YOUR TECHNOLOGY WORKS. UNFORTUNATELY, DOING THAT IS GOING TO REQUIRE A NON-TRIVIAL AMOUNT OF CAPITAL—AND POTENTIALLY AS YOUR IDEA ADVANCES, YOU ARE GOING TO NEED GROWING AMOUNTS OF CAPITAL. YOU REALIZE THAT SHOULD YOU BE SUCCESSFUL; YOU WILL BE FACED WITH THE CONUNDRUM THAT THE PROMISE OF SCALE COMES WITH THE PERILS OF RAISING AND USING THAT CAPITAL EVER MORE EFFECTIVELY. THIS SHIFTING OF NEEDS AS YOU GROW, PARTICULARLY AS IT PERTAINS TO POTENTIAL FUNDING REQUIREMENTS, IS COLLOQUIALLY CALLED THE "VALLEYS OF DEATH."

The main concern of a Climate Tech entrepreneur is to prove that their science or technology works, and rightly so, however, prudent innovators will also consider the key challenges they may face further down the road. In particular, the challenge of funding. This is because precisely as you start to prove that your tech works, the challenges mount and shift because larger scale generally means more variables that could potentially go against you. What was "easy" inside the lab is harder when success depends on things that you, the entrepreneur, don't control. This happens throughout the process of innovation and funding but is concentrated on four key moments. The four Valleys of Death discussed in the chapter and referenced throughout the guidebook are outlined in Figures 7 & 8 below.

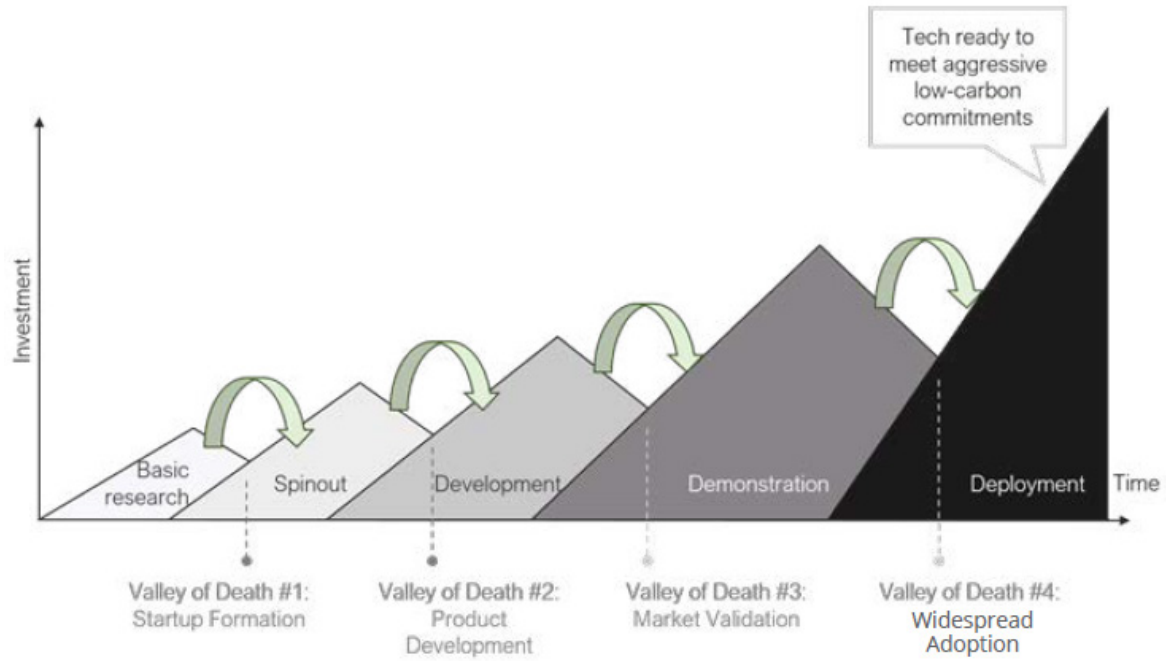
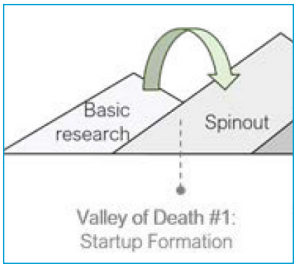


Figure 7: *The Four Valleys of Death; Source: Adapted from Third Derivative*

	Valley of Death #1: Startup Formation	Valley of Death #2: Product Development	Valley of Death #3: Market Validation	Valley of Death #4: Widespread Adoption
Technology Readiness Level (TRL)	1-3	4-5	6-7	8-9
Commercial Inflection Point (CIP)	1	2	3-5	6-8
Adoption Readiness Level (ARL)	Low Readiness	Low Readiness	Medium Readiness	High Readiness
Business Archetype	Basic Research	Spinout	Early Commer-cialization	Scaleup / Project Developer
Indicative Funding Need	$2.5k - $500k	$10k - $5m	$5m - $100m	$100m - $1b+

Figure 8: *Summary of the Four Valleys of Death*

Valley of Death #1: Turning Your Research into a Company ("Startup Formation")



Valley of Death #1: Startup Formation

- Technology Readiness Level (TRL): 1-3
- Commercial Inflection Point (CIP): 1
- Adoption Readiness Level (ARL): Low Readiness
- Business Archetype: Basic Research
- Indicative Funding Need: $2.5k - $500k

Figure 9: *Summary of Valley of Death #1: Startup Formation*

BACK TO OUR EXAMPLE. YOU HAVE DECIDED TO PURSUE YOUR RENEWABLE FUELS IDEA IN SPITE OF THE FUNDING-RELATED SCALING CHALLENGES THAT POTENTIALLY LAY IN WAIT. DURING YOUR STUDIES, YOU WERE FORTUNATE TO MEET YOUR TWO CO-FOUNDERS WHO ARE JUST AS MOTIVATED AS YOU TO SEE THIS POTENTIALLY GAME-CHANGING INNOVATION OF USING ELECTRICITY AND A METAL CATALYST TO SPLIT MOLECULES OF CARBON DIOXIDE COME TO BEAR. YOUR FIRST AND MOST IMMEDIATE CHALLENGE IS THAT NONE OF YOU KNOW WHERE TO START – AS RECENT POSTDOCTORAL GRADUATES, YOU HAVE NEVER BUILT A BUSINESS BEFORE. IN FACT, YOU DO NOT EVEN HAVE A BUSINESS AT THIS STAGE; MERELY AN IDEA BASED ON INTELLECTUAL PROPERTY CURRENTLY OWNED BY YOUR ALMA MATER. FURTHERMORE, YOU DO NOT HAVE ACCESS TO FACILITIES AND EQUIPMENT TO VALIDATE YOUR ELECTROCHEMICAL CONVERSION PROCESS. FINALLY, NO ONE IN YOUR RESPECTIVE NETWORKS CAN INTRODUCE YOU TO POTENTIAL INVESTORS OR EXPERIENCED ENTREPRENEURS WHO HAVE BEEN THROUGH THIS BEFORE.

The first Valley of Death is the period of time between the development of a new technology through basic research and the commercialization of that technology (i.e., pre-commercialization). This is a critical period for entrepreneurs, as it is during this time that they must decide to spin out their research and start a business. This Valley creates a bottleneck that restricts the number of Climate Tech startups emerging from universities and national labs, which is a problem because innovation in this sector is critical to mitigating the worst effects of climate change[12].

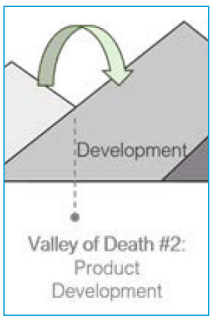
During the crucial first Valley of Death, entrepreneurs face several requirements that are essential for their success[12]. They need sufficient legal expertise to navigate the incorporation process and negotiate fair intellectual property licensing agreements. Additionally, access to non-dilutive capital sources becomes crucial, enabling them to cover their living expenses and avoiding giving up significant ownership in their business before they have even proven their idea's feasibility. Moreover, having access to necessary facilities like lab space and equipment is vital, as it allows entrepreneurs to continue refining and developing the initial iterations of their product[12]. These requirements collectively provide the foundational support necessary for entrepreneurs to traverse the challenging early stages of their venture.

To overcome this Valley of Death, entrepreneurship programs and capital sources are needed to fund and support burgeoning scientists and aspiring entrepreneurs with a passion for commercializing their research[12]. The sources of capital best suited to overcome the challenges posed by this Valley of Death include:

- Fellowship Programs
- Phase One Grants (and Grant Advances)
- Incubators
- National Labs

These sources of capital are best suited to overcome the first Valley because they possess certain characteristics that enable entrepreneurs to navigate this critical phase successfully. Firstly, they offer lower barriers to entry, recognizing the potential of entrepreneurs even at the ideation stage and providing access to capital. Their focus lies on the business purpose and its potential impact rather than solely on financial gain. Furthermore, they provide valuable resources such as access to facilities and equipment, which are essential for product development. Additionally, these capital sources may offer stipends to cover living expenses, alleviating financial burdens during the early stages. Lastly, they maintain close links with universities and possess a deep understanding of the spinning-out process, allowing for effective support and guidance tailored to the needs of entrepreneurs in their journey through the first Valley of Death.

Valley of Death #2: Producing a Product That Meets a Customer Need ("Product Development")



Valley of Death #2: Product Development

- Technology Readiness Level (TRL): 4-5
- Commercial Inflection Point (CIP): 2
- Adoption Readiness Level (ARL): Low Readiness
- Business Archetype: Spinout
- Indicative Funding Need: $10k - $5m

Figure 10: *Summary of Valley of Death #2: Product Development*

AFTER INCORPORATING YOUR BUSINESS, YOU APPLIED FOR AN 18-MONTH FELLOWSHIP PROGRAM AND MANAGED TO GET IN. THE PROGRAM FOCUSES ON LEADERSHIP DEVELOPMENT, MENTAL AND EMOTIONAL WELL-BEING RESOURCES, EXPERT CONNECTIONS, SEED FUNDING, A VIBRANT COMMUNITY, AND PRO-BONO ASSISTANCE. IT AIMS TO BUILD CAPACITY, PROVIDE A STIPEND FOR LIVING EXPENSES, FOSTER A STRONG NETWORK, AND CONNECT PARTICIPANTS WITH EXPERIENCED BUSINESS LEADERS COMMITTED TO ENVIRONMENTAL CHANGE. DURING THE FELLOWSHIP, YOU HEAR ABOUT THE NATIONAL

SCIENCE FOUNDATION'S I-CORPS PROGRAM WHICH YOU DECIDE TO ENROLL IN WITH YOUR CO-FOUNDERS. I-CORPS IS AN INTENSIVE SEVEN-WEEK TRAINING PROGRAM THAT EMPOWERS SCIENTISTS AND ENGINEERS TO TRANSITION THEIR INVENTIONS INTO REAL-WORLD IMPACT BY FOCUSING ON TOPICS SUCH AS MARKET SIZING AND CUSTOMER DISCOVERY. FURTHERMORE, THE NATIONAL LAB ADMINISTERING THE I-CORPS PROGRAM WAS ABLE TO ADVISE YOU ON THE KEY CONTRACTUAL TERMS TO CONSIDER WHEN NEGOTIATING THE INTELLECTUAL PROPERTY LICENSING AGREEMENT WITH YOUR ALMA MATER. HOWEVER, WHILE THE FELLOWSHIP'S STIPEND HAS BEEN HELPFUL TO GET YOU TO FOCUS COMPLETELY ON BUILDING YOUR BUSINESS, IT IS NOWHERE NEAR ENOUGH CAPITAL TO DEVELOP THE PROTOTYPE OF YOUR ELECTROCHEMICAL REACTOR.

The second Valley of Death is the period of time between early commercialization and meeting a true customer need (i.e., early-stage, pre-seed, or seed). This is a critical period for entrepreneurs, as it is during this time that they must prove that their technology is viable and that the product addresses a customer pain point. The second Valley of Death presents several challenges for Climate Tech startups, especially those focused on hardware. Unlike software startups, hardware startups require more time and resources to develop and refine a prototype[12]. This is because hardware offerings must take into account the structure of existing value chains or markets. This often requires an in-depth knowledge of relevant regulators, industry incumbents, existing manufacturing processes, and supply chains[12]. At this stage, startups are still developing both their technologies and business models as they prepare to raise a first round of institutional funding[20]. Furthermore, founding teams continue to try upskill themselves on the requirements for successful deployment of Climate Tech solutions such as site selection, permitting, and pre-development[21].

During the second Valley of Death, entrepreneurs face specific requirements to navigate their startup towards success. A crucial element is a well-written business plan that effectively communicates the company's vision, identifies the target market, and outlines a strategy for commercializing the technology. Additionally, assembling a strong team of skilled, passionate, and resilient professionals becomes vital in assisting the academic founder bringing their technology to market. Access to capital is essential, but equally important are connections to corporations, regulators, and other valuable resources that can accelerate the startup's market discovery and facilitate the implementation of the go-to-market strategy. Climate Tech startups also face long sales cycles, which can be especially challenging for B2B startups aiming to sell to large corporate clients[4].

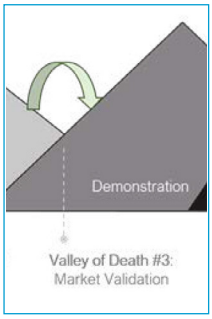
Lastly, establishing connections with reliable manufacturing partners and gaining an understanding of their processes are crucial for ensuring efficient production and scaling of the technology. In order to address these challenges, startups may need to build strategic partnerships with potential customers to build credibility and facilitate knowledge transfer[4].

To bridge the second Valley of Death, startups need programs and capital sources willing and able to provide expertise and support in the areas of customer discovery and go-to-market strategies[12]. In other words, that can help the academic founder validate that their startup is creating a product for which there is an established demand from the potential customer. They may also benefit from access to networks that can connect them with key hires, potential customers, and investors. Startups that can demonstrate customer demand and traction will be best suited to negotiate favorable terms with investors[13]. Ultimately, bridging the second Valley of Death requires patience and commitment to refining the prototype and building strategic partnerships to demonstrate product-market fit[22]. The sources of capital best suited to overcome the challenges posed by this Valley of Death include:

- Prizes
- Phase Two Grants (and Grant Advances)
- Accelerators / Ecosystem Builders
- Angel Investors
- Crowdfunding and Investor Syndicates
- Early-stage Venture Capital

A suitable source of capital to overcome the second Valley of Death offers several key characteristics. Firstly, the provision of larger check sizes that enable startups to develop a minimum viable product or prototype and hire early employees is crucial for scaling the business. Additionally, these sources of capital provide valuable access to investors, corporations, customers, expertise, and regulators, facilitating partnerships, market insights, and regulatory compliance. Moreover, they offer mentorship and training programs focused on business building, equipping entrepreneurs with the necessary skills and guidance to navigate the challenges of scaling their ventures successfully. By combining these elements, a suitable source of capital can effectively support startups in overcoming the obstacles of the second Valley of Death and driving their growth trajectory.

Valley of Death #3: Showing That You Could Meet Customer Needs at the Required Scale ("Market Validation")



Valley of Death #3: Market Validation

- Technology Readiness Level (TRL): 6-7
- Commercial Inflection Point (CIP): 3-5
- Adoption Readiness Level (ARL): Medium Readiness
- Business Archetype: Early Commercialization
- Indicative Funding Need: $5m - $100m

Figure 11: Summary of Valley of Death #3: Market Validation

WITH GOVERNMENT FUNDS FROM NASA, THE NSF, AND THE DOE IN THE FORM OF PHASE ONE AND TWO GRANTS, YOUR FOUNDING TEAM AND FIRST FEW HIRES CREATED A PROTOTYPE ELECTROCHEMICAL REACTOR. THIS REACTOR IS CAPABLE OF PRODUCING CARBON DIOXIDE TRANSFORMATIONS AT A PILOT SCALE WHICH IS SUFFICIENT TO TEST CHEMICAL REACTIONS THAT WILL EVENTUALLY BE USEFUL IN A NUMBER OF INDUSTRIAL PROCESSES, NOT JUST ENERGY. THIS ENCOURAGING PROGRESS CATCHES THE ATTENTION OF A HARD TECH VENTURE CAPITALIST, WHO 18 MONTHS LATER, DECIDES TO LEAD YOUR SEED ROUND OF FUNDING. THESE FUNDS WILL HELP YOU TAKE THE NEXT STEP IN SCALING UP YOUR TECHNOLOGY. HOWEVER, THROUGH YOUR DISCUSSIONS WITH POTENTIAL CUSTOMERS, IT BECOMES CLEAR THAT WHILE THEY ARE INTERESTED IN YOUR SOLUTION'S POTENTIAL CARBON REDUCTION BENEFITS, IT IS CURRENTLY FAR MORE EXPENSIVE THAN THE FOSSIL-BASED FUELS THEY CURRENTLY PURCHASE. AS A RESULT, YOUR BUSINESS ISN'T GENERATING ANY MEANINGFUL REVENUE. FURTHERMORE, WHILE YOU ARE NOW PRODUCING A FEW HUNDRED TONS OF CARBON DIOXIDE PER YEAR, THEIR MINIMUM ORDER SIZES ARE MULTIPLE TIMES LARGER. CONSEQUENTLY, YOU ARE CURRENTLY BURNING THROUGH THE MONEY YOU HAVE RAISED AND NEED TO FIND A WAY TO CREATE A PRODUCT THAT YOUR CUSTOMERS ARE WILLING TO BUY IN LARGER QUANTITIES THROUGH LONG-TERM CONTRACTS SO YOU DON'T HAVE TO RELY AS MUCH ON EXTERNAL FUNDS.

The third Valley of Death is the period of time between the commercialization of a new technology and the time when the technology has removed sufficient market and technological risks to begin deployment at large scale. This is a critical period for entrepreneurs, as it is during this time that they must prove that their technology can be successfully scaled and replicated to meet its intended market demand.

The challenge of the third Valley of Death is to demonstrate the first full-scale commercial product or facility. This is difficult due to incumbents' hesitation to embrace new climate technologies, as well as investors' lack of technical expertise to assess innovative technologies, uncertainty on financial returns, and the threat to existing business operations[12]. Additionally, high design complexity requires a high degree of technical, project management, and financing capabilities[8]. To overcome these challenges, Climate Tech startups may develop a vertically-integrated value chain from the outset, but this option is often not feasible due to the amount of funding and technical expertise required[12]. Along with strategic vision and collaborative partnerships, these attributes enable them to optimize operations, coordinate stakeholders, leverage advanced technologies, and drive sustainable growth in addressing climate challenges.

Large pools of capital comfortable with taking the risk on the first-of-a-kind plant of a given startup, based on their belief and understanding of the underlying technology and the capabilities of the team to execute, are required to overcome this Valley of Death[12]. Climate Tech solutions risk being stuck in a continuous cycle of early-stage deployments and lengthy wait times prior to widespread adoption unless they can overcome the majority of these challenges[22]:

- Proving that the underlying technology works reliably
- Gaining traction with customers and proving products meet their specifications
- Proving the product can be built at scale
- Ensuring that project development timelines and capital expenditures are in line with budgets
- Starting to realize economies of scale and sufficient technology maturity in order to reduce costs of production
- Requisite returns to compensate for the commensurate risk of early projects
- Lack of project finance sophistication (e.g., poorly structured contracts; unrealistic or incomplete financial models)

The sources of capital best suited to overcome the challenges posed by this Valley of Death include:

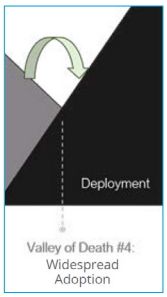
- Catalytic Capital / Pilot Funding
- Accelerators for Projects
- Cooperative Agreements (e.g., Office of Clean Energy Demonstrations) and Joint Ventures

- Loan Guarantees and Construction Loans (e.g., New York Green Bank, California Infrastructure and Economic Development Bank) that allow for risk-sharing amongst a number of commercial lenders
- Late-stage Venture Capital (predominantly for low-capital-intensity businesses e.g., software)

Funding gaps are more likely to occur where the risk-return profile of an investment contains greater uncertainty in its outcome, which is often the case for early deployment projects[22]. VCs can typically tolerate the moderate technology risk at this stage but may not be able to provide sufficient capital; on the other hand, traditional financiers such as banks can write larger checks but can typically not underwrite the technology risk[20]. The government aims to fill this capital gap through the Office of Clean Energy Demonstrations (OCED), but the need for this type of funding often exceeds the supply[22]. OCED aims accelerate the commercial lift-off of Climate Tech demonstration projects by co-investing with the private sector in some of these critical areas. They do this through a cost-sharing structure that effectively acts to de-risk major infrastructure investments. Alternatively, certain Climate Tech startups may aim to secure captive demand for their products before they start to scale in order to reduce this initial investment risk[6].

A suitable source of capital to overcome the third Valley of Death encompasses several important attributes. Firstly, it provides large check sizes and demonstrates a willingness to take on substantial risks or is motivated by factors such as crowding in investment, enabling entrepreneurs to secure the significant funding required for large-scale infrastructure projects. Additionally, it possesses extensive experience in structuring large infrastructure investments, allowing for the flexibility needed to tailor the investment to the specific requirements of each project. Moreover, it offers relatively patient capital, particularly in the case of catalytic funds, which allows entrepreneurs to navigate the longer timeframes and complexities associated with executing large-scale projects. By embodying these characteristics, a suitable source of capital becomes instrumental in supporting entrepreneurs to overcome the challenges of the third Valley of Death and realize their ambitious infrastructure projects.

Valley of Death #4: Turning One Fully-Functioning Plant or Pilot into Many ("Widespread Adoption")



Valley of Death #4: Widespread Adoption

- Technology Readiness Level (TRL): 8-9
- Commercial Inflection Point (CIP): 6-8
- Adoption Readiness Level (ARL): High Readiness
- Business Archetype: Scaleup / Project Developer
- Indicative Funding Need: $100m - $1b+

Figure 12: Summary of Valley of Death #4: Widespread Adoption

THE FUNDING FROM YOUR SEED ROUND ALLOWED YOUR COMPANY TO FURTHER DEVELOP ITS PROPRIETARY CATALYST TECHNOLOGY THAT TRANSFORMS CARBON DIOXIDE INTO CHEMICALS, MATERIALS, AND FUELS THAT ARE CONVENTIONALLY MADE FROM FOSSIL FUELS. YOU HAVE SOME SUBSTANTIAL TRACTION AND STARTED PARTNERING WITH THE AUTOMOTIVE, HOUSEHOLD, AND APPAREL INDUSTRIES, AS WELL AS OTHER BRANDS. IN FACT, YOU HAVE SUFFICIENTLY DE-RISKED YOUR TECHNOLOGY TO THE EXTENT THAT YOU HAVE RECENTLY STARTED TAKING PRE-ORDERS FOR YOUR INDUSTRIAL-SCALE CARBON TRANSFORMATION MODULE. OVER THE COURSE OF A LITTLE OVER A YEAR, YOU RAISED TWO FURTHER VENTURE CAPITAL ROUNDS (SERIES A AND SERIES B) IN RELATIVELY QUICK SUCCESSION. THE FUNDS WERE USED TO SUPPORT THE GROWTH OF YOUR ENGINEERING, MANUFACTURING, AND DEPLOYMENT CAPABILITIES WITHIN THE TEAM SO THAT YOU CAN BUILD MULTIPLE INDUSTRIAL-SCALE DEMONSTRATIONS OF YOUR CARBON TRANSFORMATION TECHNOLOGY. FORTUNATELY, THE FUNDRAISING ENVIRONMENT HAS BEEN NEAR ITS CYCLICAL PEAK SO YOU AND YOUR CO-FOUNDERS HAVE RAISED MORE CAPITAL AND TAKEN ON LESS DILUTION THAN YOU HAD EXPECTED TO BY THIS POINT. FURTHERMORE, AS PART OF THE SERIES B ROUND, A PHILANTHROPIC PROVIDER OF CATALYTIC CAPITAL MADE A STRATEGIC PROGRAM INVESTMENT TO HELP FUND YOUR FIRST-OF-A-KIND INDUSTRIAL-SCALE FACILITY. KEY INDUSTRY VETERANS FROM THE CHEMICALS INDUSTRY ARE NOW A PART OF YOUR SENIOR MANAGEMENT TEAM. THE MAIN ISSUE GOING FORWARD WILL BE SECURING LOW-COST CAPITAL IN LARGE AMOUNTS TO KEEP FUNDING INFRASTRUCTURE PROJECTS THAT WILL ALLOW YOU TO PRODUCE SUFFICIENT QUANTITIES OF YOUR RENEWABLE FUELS AT A LOW ENOUGH COST TO ESTABLISH YOURSELF AS A MARKET LEADER. YOU ARE ALSO WAITING ON THE GOVERNMENT FOR IMPLEMENTATION GUIDANCE FOR A NEW TAX CREDIT THAT COULD MAKE YOUR FUELS COST-COMPETITIVE WITH THEIR FOSSIL-BASED EQUIVALENTS.

The fourth Valley of Death is the period of time between the first few commercial-scale deployments and market leadership. This is a critical period for entrepreneurs, as it is during this time that they must prove that their business model is bankable, self-sustaining, and can be profitable over the long term. This Valley presents a significant challenge, as it requires a large amount of capital and highly-specialized skills and knowledge from investors and lenders to get comfortable underwriting nascent technologies[12]. The types of investors who are able to provide this capital, such as debt or infrastructure investors, require evidence of stable cash flows, contractually-assured revenues through offtake agreements, low volatility in input costs, and minimal technical risk[12]. There is currently a relative dearth of funds investing in growth-stage Climate Tech scaleups, and these growth-stage funds may struggle to build conviction in certain sectors due to the lack of outright success stories in the Climate Tech space to date. Furthermore, unlike enterprise software and other well-understood technology sectors, Climate Tech investors lack a set of key metrics to be able to quickly assess a company's growth potential, making it difficult for investors to assess the appropriate risk-adjusted returns[4].

To overcome this final Valley of Death, vast pools of capital and corporations focused on building, owning, operating, and financing sustainable infrastructure will be required[12]. However, there are several challenges that need to be addressed, such as the lack of underlying infrastructure to support the required value chains and supply channels, the lack of access to large amounts of low-cost financing, early projects not gathering the correct data to favorably showcase their operational track record, and a lack of qualified project developers[9][10]. The sources of capital best suited to overcome the challenges posed by this Valley of Death include:

- Revenue-Based Financing
- Infrastructure Finance
- Growth-stage Venture Capital / Private Equity
- Commercial Debt
- Venture Debt
- Project Finance
- Loan Guarantees (e.g., Loan Programs Office)

One possible response to the lack of underlying infrastructure is for Climate Tech businesses to strive for vertical integration and attempt to build out the value chain for themselves[9]. However, apart from the large capital outlay required, this is often not the most efficient approach. Working with external parties within the value chain validates the company's value proposition, and targeted business models are essential for outlining the most efficient financial strategy for your scaleup[9].

The challenge regarding low-cost financing will require the various sectors within the Climate Tech space to develop financing maturity such that projects can be financed on a standalone basis, separate from the holding company, so that large portfolios of projects can

use off-balance sheet instruments such as project finance[9]. A benefit of this type of financing is that the financial well-being of the project is separated from the business in a way that could prevent its bankruptcy in the situation where a project fails due to some unforeseen circumstances[9]. To de-risk Climate Tech projects to some extent, the project owner needs to find offtakers to agree to purchase the output produced by the facility at an agreed price and quantity. However, often these products are mass-market commodities where the end customer is often unwilling to pay above the market price, requiring subsidization by government to lower production costs in many instances[10].

A suitable source of capital to overcome the fourth Valley of Death encompasses several crucial characteristics. Firstly, it offers large amounts of debt funding based on key operational metrics provided by the company, such as revenue, cash flows, and profits. This allows entrepreneurs to secure substantial financial resources based on their company's performance, enabling them to scale their operations effectively. Secondly, it provides relatively cheap, long-term, and non-dilutive capital, ensuring that entrepreneurs can access funding without relinquishing ownership stakes in their ventures. This preserves their control and incentivizes growth without diluting their equity. Additionally, a suitable source of capital offers large loan guarantees or other risk mitigation measures, which serve to crowd in commercial debt from traditionally risk-averse financing institutions. This further expands the funding options available to entrepreneurs, mitigating the risks associated with scaling their businesses. By combining these attributes, a suitable source of capital plays a crucial role in helping entrepreneurs overcome the challenges of the fourth Valley of Death and propel their ventures towards sustainable success.

Why the Valleys of Death Matter for Your Funding Strategy

After the startup's incorporation, entrepreneurs typically transition from public to private sources of funding[22]. However, as the Climate Tech funding environment matures, public-private partnership will become more commonplace. In response to the changing climate landscape, the Department of Energy (DOE) has shifted its focus from research and development (R&D) to deployment of clean energy technologies[23]. This shift recognizes the need for stronger collaboration with private industry to effectively navigate the various stages of Climate Tech development. By expanding its involvement beyond R&D, the DOE's funding and support aims to address the challenges faced by Climate Tech companies at different stages, including

research, demonstration, and ultimately, widespread deployment[23].

This strategic partnership between public and private sources of funding is crucial because it combines the resources, expertise, and market knowledge of both sectors, maximizing the impact and success of investments in Climate Tech[23]. It enables a comprehensive approach to support the entire value chain of clean energy technologies, ensuring they can overcome obstacles and reach the stage of widespread adoption. This development is outlined in Figure 13 below. Universities, angel investors, and public grant providers are usually comfortable supporting spinouts during the research, development, and early demonstration phases[22]. Other sources of funding and mentorship, such as accelerators and fellowships, become another option for founders, particularly for their access to networks that can support the startup's development. Venture capitalists, on the other hand, often require the technology to be sufficiently de-risked, have increased certainty around market potential, and some evidence of traction[22]. More often than not, however, raising VC rounds to fund large capital projects will prove prohibitively expensive and result in significant dilution for founders. As a result, as a business becomes more sophisticated, it becomes more important to consider the full capital stack, including non-dilutive sources.

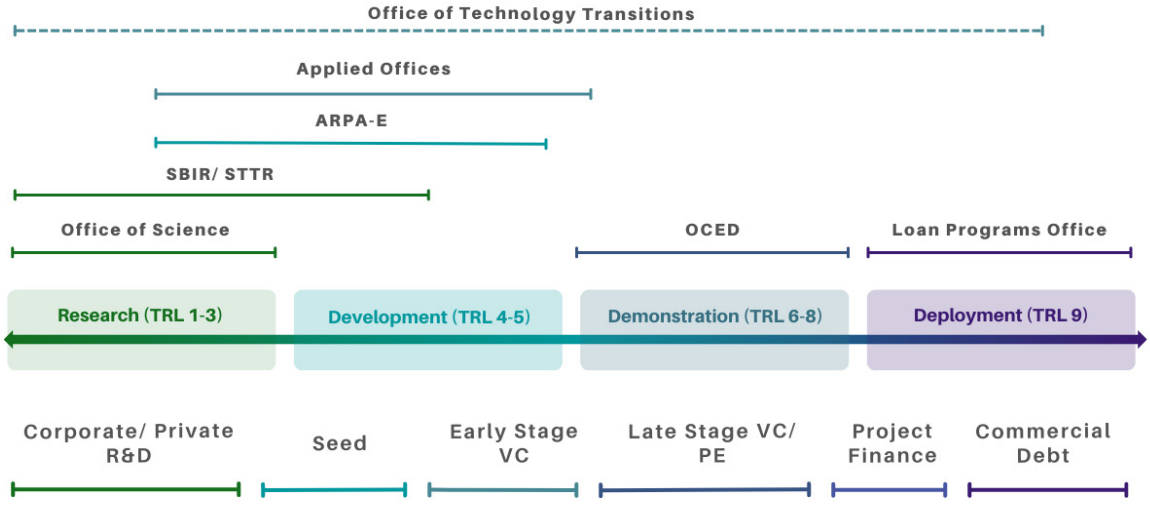


Figure 13: Public-private partnership across RD&D; Source: Climate Tech VC

3 Developing a Financial Strategy to Shift Your Business Across Each Valley of Death

"I THINK THAT FOUNDERS COULD GET SMARTER ABOUT CAPITAL. I THINK THAT FOUNDERS SPEND A LOT OF TIME TALKING TO CUSTOMERS. I THINK THEY SPEND A LOT OF TIME BUILDING PRODUCTS. AND I THINK THEY SPEND VERY LITTLE TIME ACTUALLY UNDERSTANDING WHAT FINANCIAL OPTIONS ARE AVAILABLE TO THEM, HOW TO OPTIMIZE [AMONG THOSE OPTIONS], [AND] HOW TO TAKE ADVANTAGE OF THE RESOURCES THAT ARE OUT THERE. KNOWING HOW TO CAPITALIZE YOUR BUSINESS IS PROBABLY JUST AS IMPORTANT AS ANY OF THOSE OTHER THINGS BECAUSE IT HAS PROFOUND LONG-TERM IMPLICATIONS ON YOUR SUCCESS. AND SO IF YOU DON'T KNOW MONEY, FIND THE FRACTIONAL CFO, HIRE A PROPER BOOKKEEPER, AND AN ACCOUNTING FIRM THAT ACTUALLY KNOWS YOUR BUSINESS. MAKE SURE YOU UNDERSTAND WHAT CAPITAL OPTIONS ARE OUT THERE. GET HELP AND IF YOU CAN'T AFFORD TO HIRE PEOPLE, TALK TO OTHER FOUNDERS WHO ARE IN YOUR SPACE, WHO CAN SHARE THEIR EXPERIENCE RAISING MONEY. IDEALLY, WHO HAVE DONE IT NOT JUST WITH VC [BUT THOSE WHO] UNDERSTAND THE DIVERSE STACK OF PRODUCTS OUT THERE."

Co-founder & CEO of Climate Tech FinTech

Developing a Financial Strategy

In the rapidly evolving landscape of Climate Tech startups, where groundbreaking ideas meet the urgent need for sustainable solutions, navigating the Valleys of Death—as described in the previous chapter—can be an arduous journey. These Valleys are inherently characterized by a scarcity of capital, where innovative ventures face numerous financial challenges that can hinder their progress and even lead to their demise. Recognizing the paramount importance of overcoming these Valleys, this chapter aims to shed light on the different sources of capital relevant to each Valley of Death in order to help you effectively source capital and align these financial resources with your long-term objectives.

At a high level, there are four types of capital available to founders, these are[24]:

1. **Financial awards or 'free' money** (e.g., government grants, prizes, stipends, and research vouchers from fellowship programs, etc.)
2. **Equity** (this is when someone invests in your startup i.e., they give you cash for a share of the ownership)
3. **Debt** (this is borrowing or a loan i.e., a lender gives you cash and you have to pay interest until you pay back the amount borrowed)
4. **Results- or milestone-based finance** (you need to fulfill some obligations and then you get cash in return e.g., a rebate or tax credit for building a solar plant; reimbursement from a government grant for research expenses incurred, etc.)

On top of building a business, the job of an entrepreneur is to understand what type of funding best suits their business and what their cash needs are in the near- and long-term. With this in mind, founders will need to optimize around seven key considerations when thinking about raising capital[24]:

1. **Is the money dilutive?** If you choose equity, you need to make sure that the ownership after the transaction is fair for all parties involved, including yourself
2. **What is the cost of capital?** This may be the interest rate if you choose debt but it could also be the implicit costs of having to report to a government agency if you receive a grant
3. **What is the seniority of the capital?** This basically means, if something goes wrong, who gets paid first?
4. **Are any assets to be used as security?** If you choose debt, what assets (whether it be cash, physical assets, or intellectual property) does the lender get to own if you can't pay your loan back?

5. **How complex is the transaction?** What is the cost of executing or managing the transaction (e.g., do you need to spend some of the proceeds on lawyers or investment banks?)?
6. **How long does the transaction take?** This is the length of time from first speaking to the investor or funding provider to when the money is in your bank account
7. **What value will you receive beyond the financial capital?** Not all capital is made equal. Some investors or programs can help early founders with everything from building a team to giving them executive coaching

Finally, you should have a very clear idea of what you intend to spend the funding on. Frontier R&D may be best funded with grants if you are not facing time pressure and equity if you are; while revenue growth is probably best funded with debt or debt-like instruments because you have more certainty of repayment. Moreover, during your fundraising process, you should be able to articulate the following points to investors, lenders, or government agencies in the context of your company's maturity:

- What your current progress to date is
- What milestones you need to hit to close the next round of funding
- What that funding will enable you to do in the next 18-24 months (or longer), before the next raise

Climate Tech founders should look at each Valley of Death as a milestone where risk and capital shift. As outlined in Figure 14 below, Village Capital has developed a framework called The Viral Pathway which helps entrepreneurs and investors communicate more effectively about the readiness of a company for investment. While this framework was originally designed for software startups, its layout can still be helpful for hard tech startup founders in terms of assessing your readiness for investment, communicating this readiness, and identifying the resources you need to move your business forward[25]. The challenge of a startup is to make as much tangible progress as possible before seeking funding from outside investors in order to command a valuation or commercial terms that reflects this progress and to limit dilution or restrictive covenants following the funding round[26].

Type of funding closed at this level		Level	Narrative	Team	Problem and Vision	Value Prop	Market Validation	Business Model	Product	Market fit	Scale	Growth + Exit
		9	Company growing fast with exit in sight, and is well positioned to provide investors with their desired ROI	Can navigate M&A, IPO	Global leader in stated vision	Cited as the top solution solving this problem.	Clear line-of-sight to exit	2x revenue growth for multiple years	Product recognized as top in industry	Brand value is top in industry	Strong unit economics for multiple customers segments.	Growth with Exit
		8	Company has validated it is scaling successfully to other markets.	Recognized market leadership.	Systems-Level Change evident.	Multiple renewals with low sales effort.	Hard-to-beat partnerships for distribution and growth .	MOM revenue meets industry standard.	Evidence of customer delight in multiple markets .	Brand established.	Growth of customer base accelerates month on month.	Team has turned down acquisition offer.
Close Institutional VC for Reoccuring Revenue		7	Company has validated that it can achieve unit economics that meet or exceed industry in its target market.	C suite as good or better than founding CEO.	Impact is succesfullly measured .	Majority of first sales in target market are inbound.	Sales cycles meet or exceed industry standard.	Business model validated.	Product is built for scale.	Unit economics validated	Unit economics validated across multiple markets.	Team has strong relationships w/multiple acquirers
Close Institutional VC for 1st Sales, Market Expansion		6	Company has validated through sales that its product is exceptional and delights its customers.	Team has proven sales and product dev skills.	Sales validates impact tied to solution .	Sales beyond early adopters	Validation of pathway to market.	Sales begin to map to projections.	Evidence of customer delight - they love it and tell others about it.	Evidence of decreasing CAC with path toward strong unit economics	Addressing regulatory challenges and/or implementing IP strategy	Team has identified specific acquirer(s) or other exit environment
Close Round with Angel and Early VC		5	Company has strong evidence it can make money - and enough of it - to be a profitable business by solving this problem with its solution.	Team has clear sales/ops understanding and strategy.	Evidence of impact tied to solution- by growing the business, company solves the problem.	Customers want to continue using the product.	Promising initial conversations with strategic partners for sales/distribution	Full business model with evidence.	Seamless User Experience	Clear strategy, rooted in evidence, to reach positive unit economics.	Initial evidence of positive unit economics in two markets	Large strategics are taking interest.
Friends and Family, BootStrap	Angel/Seed Funding Starts	4	Company has validated it is solving a problem for a large enough market to build an investable business.	Team has clear understanding of how market operates.	Systems-Level Change clear - clear how this solution would transform the industry..	Validation from large customer base that the solution solves their problem 10x better than others in the market.	Evidence of Investable Market	There is a large market that will pay the target price for this solution.	Target customer can easily use the product.	Evidence that company can capture large market share.	Clear strategy to capture large market share and move to multiple markets.	Market size of $1B+ with meaningful market share.
	Grants for R&D (Hardware)	3	Company has validated that its solution solves the problem significantly better than others in the market.	Team has deep direct engagement w/customers.	The company can solve this problem - it has freedom to operate, the drive, and technical ability.	Evidence of differentiation - solves target customer's problem 10x better than others.	Initial customer traction. For B2C - 100 customers, for B2B - 5 customers.	Initial evidence that customers in target segment will pay target price.	Team has built a fully functional product that solves the problem.	Evidence that potential or pilot customers would refer the product to others.	Initial validation that multiple types of customers find value in the solution.	The solution already solves the problem better than incumbent.
		2	Company has identified a large, solvable problem and a vision of how the company will change the world.	Team has senior members with lived experience of the problem.	Team has identified an important, large, solvable problem.	The team has initial users who confirm solution solves key pain point .	Initial evidence that this is a big problem that affects millions of people.	Initial evidence that solving the problem can make money.	Team has built a working prototype that solves the problem.	Product is painkiller, not vitamin.	Initial validation that multiple markets experience this problem.	Vision for growth has company solving a large piece of the global problem in 10 years.
		1	Company has the right founding team in place to solve this problem.	Strong founding team	The team can articulate its vision at scale - what does the world look like if they succeed?	Team knows their bullseye customer - the specific type of person whose problem they are solving.	Team has a hypothesis about the target market size and how they will address it.	Team has outline of revenue model.	Team has ability to develop minimum prototype.	Team has hypothesis on how they will iterate and adapt to reach market fit.	Team has identified multiple possible markets.	Team understands what an exit is and how they will ultimately provide a return for their investors.
				Team	Problem and Vision	Value Prop	Market Validation	Business Model	Product	Product - Market Fit	Scale	Growth + Exit

Figure 14: *Village Capital Viral Pathway; Source: Village Capital*

The Capital Stack for Valley of Death #1: Turning Your Research into a Company ("Startup Formation")

The sources of capital best suited to overcome the challenges posed by this first Valley of Death are:

- Fellowships
- Grants (and Grant Advances)
- Incubators
- National Labs

This is because they generally provide:

- Lower barriers to entry and often access to capital based on a non-developed idea
- A focus on business purpose and potential rather than financial gain
- Access to facilities and equipment
- Stipends to cover living expenses
- Close links to universities and understanding of the spinning-out process

Fellowships

Description

- Programs designed to support and nurture individuals or teams working in specific fields or areas of interest
- Provide funding, mentorship, training, and networking opportunities to early-stage entrepreneurs or innovators focused on developing solutions for climate change and sustainability challenges
- Typically offer a structured and immersive experience that helps fellows build their skills, develop their ideas, and accelerate the progress of their projects
- The goal of fellowship programs is to empower and enable talented individuals to turn their innovative ideas into impactful ventures that contribute to addressing climate-related issues

Benefits

✓ **Funding:** Fellowship programs provide financial support in the form of stipends, grants, or seed funding. This funding can help cover living expenses, research and development costs, or initial capital requirements for launching a startup

✓ **Mentorship and Guidance:** Entrepreneurs in fellowship programs often receive mentorship from experienced professionals, industry experts, or successful entrepreneurs

✓ **Training and Skill Development:** Fellowship programs typically offer specialized training sessions, workshops, and educational resources to enhance the entrepreneurial skills and knowledge of participants. This includes areas such as business development, marketing, finance, intellectual property, and leadership, equipping entrepreneurs with the tools necessary to succeed

✓ **Networking Opportunities:** Fellowship programs create a community of like-minded individuals, connecting entrepreneurs with peers, industry leaders, investors, and potential partners

✓ **Validation and Credibility:** Being selected as a fellow in a reputable program can enhance an entrepreneur's credibility and validate their ideas or technologies

✓ **Access to Resources and Facilities:** Fellowship programs often provide access to shared resources, such as co-working spaces, laboratories, research facilities, or advanced equipment. This access enables entrepreneurs to develop and refine their prototypes, conduct

experiments, and accelerate their product development process

- ✓ **Exposure and Visibility:** Fellowship programs often provide platforms for entrepreneurs to showcase their work, present their ideas at conferences or events, and gain media exposure. This increased visibility can attract attention from potential investors, customers, and collaborators

Considerations

- ? **Competitive Selection Process:** Fellowship programs often have a competitive application process, so entrepreneurs need to invest time and effort into their submission
- ? **Time Commitment:** This commitment may interfere with other obligations or ventures an entrepreneur is involved in
- ? **Restricted Freedom:** Some fellowship programs may have certain terms and conditions that limit an entrepreneur's freedom in terms of decision-making, equity distribution, or business operations. Entrepreneurs should carefully review the program's terms and understand the extent of their obligations and any potential restrictions
- ? **Relocation or Travel:** Depending on the fellowship program, entrepreneurs may be required to relocate to a specific location or travel frequently for workshops, training, or networking events
- ? **Intellectual Property Considerations:** Some programs may have policies regarding IP ownership, licensing, or sharing of research outcomes

Pro Tips

- ➢ **Focus on the Tech:** *"That's what we really look for and so if you're applying, in your application, make it clear what the fundamental advance here is… I think that sometimes [applicants think] we want to know what your thoughts are about [the] market, but sometimes things get muddled and people [become] focused on a particular market and don't communicate really well what the fundamental technological advance is and that can make it hard for us as readers"* **– Expert at Fellowship Program**
- ➢ **Start Early on Customer Discovery:** *"I think finding a way to do I-Corps and learning about customer discovery and learn how to talk to customers and get feedback from them is probably the first thing that people should be doing"* **– Expert at Fellowship Program**
- ➢ **Reach Out Long Before Applying:** *"I think it can be difficult for people to know just based on reading what's on the website or attending a single Zoom [webinar]. I think it can be very helpful for them to meet people from the community, maybe like a year or two years before they might be interested in doing that. And getting to know some of the staff members so that they can get some feedback"* **– Expert at National Lab**
- ➢ **Learn to Communicate your Value Proposition:** *"Oftentimes, the people who are more successful have done something like an I-Corps program where they've already had some experience in telling their story and formulating [a] value proposition. And so that helps them sell their project in a short period of time when they come to us"* **– Expert at National Lab**

Examples

776 Fellowship
Activate Fellowship
Breakthrough Energy Fellows

Grants

Description

- Cash awards from government and non-profit institutions, usually to promote a specific technology or purpose such as jobs, equity, research, and local industry[27][13]
- Typically require some demonstration of progress within the application[13]
- Small Business Innovation Research (SBIR) grants are targeted at small business or startup R&D projects and administered by several agencies across the federal government[13]
- The SBIR program and the Small Business Technology Transfer (STTR) program are designed to support R&D by early-stage startup companies[26]
- The SBIR program is designed to encourage technological innovation by providing targeted grants to small companies with participation limited to U.S. businesses with fewer than 500 employees[26]
- The STTR program serves similar purposes, while also encouraging cooperative projects involving a small business and a university or other research institution[26]
- For these grants, the first phase of funding can yield up to $150,000 (best suited for Valley of Death #1). If successful, a project can receive up to an additional $1 million in a second phase grant (best suited for Valley of Death #2)[26]

Benefits

✓ **Non-dilutive Capital:** Grants do not require equity or ownership stakes in your business, meaning you don't have to give up ownership or control in exchange for funding[28]

✓ **Generally, No Repayment:** Unlike loans, grants do not need to be paid back. This reduces the financial burden on entrepreneurs and allows them to focus on their projects without the pressure of debt repayment (note that some organizations do issue recoverable grants, which you will need to pay back)[28]

✓ **Support for Climate Solutions:** Grants specifically target businesses that are developing or deploying climate change solutions[28]

✓ **Partnerships and Credibility:** Collaborating with other organizations or local government entities can enhance your credibility and increase your chances of receiving grant funding[28]

- ✓ **Provided by a Number of Organizations:** There are numerous sources of grant capital available if you know where to look (e.g., grants.gov, turbosbir.com)[27]
- ✓ **Value Add Beyond Funding:** You can also receive technical support and go-to-market expertise from the awarding organization[13]

Considerations

- ? **Highly Competitive and Stringent Eligibility Criteria:** Grant funding is often highly competitive, with a limited number of awards available compared to the number of applicants[28]. Eligibility criteria may include factors such as the type of business, the stage of development, the location, and the target audience or sector[28]
- ? **Lengthy Application Process:** Application process can be non-homogenous among different grant providers and is generally quite lengthy[27]. It typically involves extensive paperwork, gathering supporting documents, and developing a detailed proposal. The application requirements and guidelines must be followed closely, which can add to the complexity and time required for submission[28]
- ? **Not Suitable for Urgent Funding Needs:** Even after a successful application, the time to receive the funding may not be immediate(13). Furthermore, for government grants in particular, they often operate on a reimbursement basis, meaning you need to spend the money first and then submit documentation to receive reimbursement
- ? **Onerous Reporting and Compliance Requirements:** Grants usually come with reporting requirements during the term of the grant[13]. These can include providing regular updates on the progress of your project, submitting financial reports, demonstrating how the grant funds are being used, and potential audits[28]

Pro Tips

- ➢ **You May Have to Incorporate Before Applying:** *"[If] you're trying to apply for an SBIR grant. You need to be incorporated to even apply. So you need to have a business number"* **– Expert at Accelerator**
- ➢ **If You Can, Hire an Organization like Climate Finance Solutions to Help with Grant Sourcing and Application Writing[13]:** *"There's so much grant funding out there. I think the difficulty is how do you access and tap into it correctly. This is where it might actually help to have a firm on retainer. [There are] groups now that are starting to specialize in helping startups figure out whether they're going to be eligible for [government funding] and how to put together some of the larger applications"* **– Climate Tech Investor**

- **Grant Providers Can Turn Into Your First Customers:** *"On the grant side, there are certainly businesses, usually the more tech-heavy businesses that we've invested in. Those are businesses where there can be an incentive for the government to advance those technologies in one capacity or another and that's not to say that the government is taking the place of commercial revenue, but that [it's] in addition to that revenue. You can call them government investments in a way because they would kick over into real commercial revenue after the initial grant period was over"* **– Climate Tech Investor**
- **Receiving a Grant Can Help You Access Other Funding:** *"Specifically for climate innovation, when it comes to non-dilutive funding, I often use [that] as a signal to tell me about how good a company is doing or if they're on the right track"* **– Climate Tech Investor**

Examples

ARPA-E
impact stars
Manifest Climate
National Science Foundation
OpenGrants
Wilson Sonsini Clean Energy and Climate Solutions Federal Funding Database

Grant Advances

Description

- If you have been awarded a grant but need cash sooner than what is stipulated in the terms of the grant, there are certain organizations that will give you an advance (usually in the form of a loan), while you wait for the next/first disbursement of the grant[27]
- Instead of the usual timeframe of 6-9 months for state and federal grant funding to be received by startups, advance disbursement expedites the availability of grant liquidity (down to weeks rather than months), thereby accelerating the impact it can have[29]

Benefits

✓ **Improved Cash Flow:** Grant advances provide faster access to funds, allowing entrepreneurs to address pressing financial needs, such as hiring new talent, purchasing equipment, or investing in research and development

✓ **Repaid with Grant Proceeds:** You generally do not need to repay the loan until you have received the proceeds from the grant

✓ **Non-dilutive Capital:** Like grants, advance disbursements do not require equity or ownership stakes in your business

✓ **Generally, No Restrictive Covenants:** Typically, no collateral or personal guarantees are required

Considerations

? **Repayment Obligations:** Grant advances are not free money. Entrepreneurs must understand that they are required to repay the advance according to the terms and conditions outlined in the agreement

? **Restrictions:** Grant advances may come with certain restrictions on how the funds can be used and your ability to borrow additional funds. Entrepreneurs should carefully review the terms and conditions to ensure that the advance aligns with their business goals

? **Cost:** Typical deal terms include a monthly interest rate and an origination fee. You should calculate the estimated total cost before agreeing to a grant advance

Pro Tips

➢ **Best Used for Working Capital:** *"[It's] a working capital tool for winners of state [and] federal grants. Anyone with a state or federal grant can access them… The problem that we're solving for is that the vast majority of grants coming from state or federal institutions are not lump-sum grants. They're either milestone-based or quarterly or biannual or they're reimbursement-based. So they're either paid out in chunks, or they're paid out by reimbursement, and often the team has to invest that cash upfront to buy equipment, to hire people, to build partnerships, whatever. And that's really difficult."* **– Expert at Climate Tech FinTech**

Examples

Enduring Planet

Incubators

Description

- Structured programs that help startups access strategic partners and early investors as well as mentorship and workspace[7][30]
- Their primary role is to nurture and develop startups, enabling them to later apply for accelerator programs[30]
- The length of the incubation period can range from three months to a year[30]
- Startup incubators typically don't seek equity unless they are offering financial support to the startups[30]
- Typically culminate in a demo day where you'll have a chance to showcase your startup to venture capitalists and angel investors[31]

Benefits

✓ **Mentorship and Guidance:** Incubators provide access to experienced mentors who offer guidance and expertise in various aspects of business development[31]

✓ **Networking Opportunities:** Being part of an incubator program allows entrepreneurs to connect and network with other like-minded individuals, including fellow entrepreneurs, industry experts, investors, and potential partners

✓ **Access to Resources:** These resources can include office space, infrastructure, equipment, and technology tools necessary for running and scaling a business

✓ **Validation and Credibility:** Incubators typically have a reputation for selecting promising ventures, and being associated with a reputable incubator can enhance the startup's credibility and validation in the eyes of investors, customers, and potential partners

✓ **Investor Exposure:** This exposure increases the chances of attracting funding and investment opportunities for the startup[31]

✓ **Skill Development:** These programs help entrepreneurs enhance their business acumen, leadership abilities, pitching skills, and overall knowledge required to build and scale a successful startup[31]

✓ **Low-Pressure Environment to Develop Your Startup's Thesis:** Allows you to test whether an idea is worth pursuing as well as helping you build and iterate on your thesis[1][13]

✓ **Long-Term Support:** This can include continued access to mentors, alumni networks, and resources, ensuring that entrepreneurs have ongoing support as they navigate the various stages of their startup journey

Considerations

? **Equity or Financial Obligations:** Some incubators may require startups to provide equity in exchange for participation in the program or access to resources[31]

? **Not All Incubators Are Created Equal:** Programs can vary widely in terms of value-add[1]. You should try and speak to founders who have been through an incubator's program before

? **Lack of Customization:** One program's standardized approach may not fully align with the specific needs and goals of your startup

? **Competition and Cohort Dynamics**: While being part of a cohort of startups creates opportunities for collaboration and networking, it also means that startups may be competing for limited resources and attention within the incubator[31]

? **Geographic Limitations:** Incubators are often located in specific regions or cities, which may limit access for entrepreneurs who are not based in those areas

? **Fixed Timetable:** This limited time frame may not provide sufficient support for startups that require a longer incubation period[31]

Pro Tips

➢ **Be Open to Feedback from Mentors[30]:** *"Even if this means pivoting your startup or making significant changes to your business model, it's important to listen and consider what these experts are telling you. They have the knowledge and experiences that can help ensure your idea becomes a sustainable business"* **– Entrepreneur**

Examples

Greentown Labs
Los Angeles Cleantech Incubator (LACI)

National Laboratories

Description

- There are a growing number of national lab "technology to market" programs or fellowships that help to increase lab participation in local innovation ecosystems[7]. These are known as Lab-Embedded Entrepreneurship Programs (LEEP)
- LEEP aims to facilitate the development of innovative clean energy technologies by providing support to the most promising Climate Tech entrepreneurs
- A two-year funded fellowship, during which early-stage startups work closely with lab scientists at national laboratories in order to address the gap between invention and commercialization[7]
- Provide entrepreneurs with access to technical expertise, business/product feasibility, flexible financing, and commercial validation[7]
- Each participating node utilizes the strengths of their respective national lab and regional innovation ecosystem to connect participants with relevant resources, such as local businesses, funding sources, innovators, and university resources

Benefits

✓ **Access to Cutting-Edge Resources:** Entrepreneurs gain access to state-of-the-art equipment, facilities, and scientific expertise available at the national labs. The largest benefit of these programs is the lab space and network

✓ **Networking and Ecosystem Support:** Founders benefit from a network of connections within the program's ecosystem, including industry experts, investors, fellow entrepreneurs, and potential business partners

- ✓ **Mentorship from Lab Scientists:** Entrepreneurs are paired with experienced lab scientists who provide valuable guidance and mentorship throughout the program
- ✓ **Financial Support and Healthcare Benefits:** This support allows founders to focus on their research and business development efforts while offering financial stability
- ✓ **Entrepreneurship Training:** This training covers various aspects, including business planning, marketing, finance, and intellectual property, enabling entrepreneurs to develop a strong foundation for their ventures
- ✓ **Demo Day and Investor Exposure:** The demo day introduces founders to ecosystem partners and investors who may show interest in supporting their ventures beyond the program

Considerations

- ? **Intellectual Property Rights:** Entrepreneurs need to carefully navigate the intellectual property (IP) landscape and understand the ownership and commercialization rights related to their research and inventions. National labs often have their own IP policies, and entrepreneurs may need to negotiate agreements regarding IP ownership and licensing, which could impact their long-term business prospects
- ? **Competitive Selection Process:** Aspiring founders need to invest time and effort into crafting a compelling application and demonstrating the potential impact and viability of their technology to increase their chances of selection
- ? **Relocation and Geographic Constraints:** Entrepreneurs accepted into the program may need to relocate to the region where the national lab is located
- ? **Limited Funding Scope:** While the programs provide financial support through the fellowship, it is essential to recognize that this funding may not be sufficient to cover all the expenses associated with building and scaling a Climate Tech startup. Entrepreneurs may need to explore additional funding sources or secure follow-on investments to sustain their ventures beyond the program

Pro Tips

- ➢ **Show Your Passion:** *"We're looking for a specific technical area, matched with a passionate science founder that [we] can help"* **– Expert at National Lab**
- ➢ **Show That You're Resourceful:** *"There's no midterm exam that you can study for and ace. No one knows what the rules are. No one's telling you [that you have] to turn this in. And so a lot of it is being resourceful, internally driven"* **– Expert at National Lab**
- ➢ **Articulate How the Lab Can Help You:** *"So I think part of applying for a program is understanding exactly what science question we can help them [with]"* **– Expert at National Lab**

Examples

Chain Reaction Innovations (Argonne National Lab)
Cyclotron Road (Lawrence Berkeley National Lab)
Innovation Crossroads (Oak Ridge National Lab)
West Gate (National Renewable Energy Lab)

The Capital Stack for Valley of Death #2: Producing a Product That Meets a Customer Need ("Product Development")

The sources of capital best suited to overcome the challenges posed by the second Valley of Death are:

- Prizes
- Accelerators
- Angel Investors / Family and Friends
- Crowdfunding / Investor Syndicates
- Early-stage Venture Capital

This is because they generally provide:

- Larger check sizes than the sources in Valley of Death #1, allowing startups to develop a minimum viable product or prototype and hire early employees
- Access to investors, corporations, expertise, and regulators
- Mentorship and training related to business building

Prizes

Description

- These are pitching competitions that provide an avenue for startup funding[30]
- These events offer an opportunity for entrepreneurs to present their business ideas and receive valuable feedback[30]
- While many are purely application-based, some competitions may require the payment of entry fees to join and compete[30]

Benefits

✓ **Funding Opportunities:** Prizes provide a chance to secure funding for startup development without giving up equity

✓ **Validation and Recognition:** Winning a well-known competition can enhance the startup's reputation and attract attention from investors, partners, and customers

✓ **Network Expansion:** These networking opportunities can open doors to valuable partnerships, mentorship, and future investment prospects

✓ **Feedback and Learning:** Competitions often involve pitching to a panel of judges or industry experts who provide feedback on the startup's business model, technology, and overall strategy. Prizes provide an opportunity to test and deliver on product delivery

Considerations

? **Intense Competition:** By definition, pitch competitions can be highly competitive, with numerous startups vying for the same prize

? **Time and Resource Commitment:** Entrepreneurs must allocate resources to prepare a compelling pitch, attend events, and potentially travel to different locations

? **Limited Feedback and Mentorship:** While pitch competitions provide an opportunity to receive feedback, the depth and quality of feedback can vary

Pro Tips

➢ **Apply (Even Just to Get on Their Radar):** *"Just getting into our database is incredibly valuable and what have you got to lose? It's an easy application and the upside is amazing"* **– Expert at Pitch Competition**

Examples

Carbon XPRIZE
Keeling Curve Prize

Accelerators / Ecosystem Builders

Description

- Programs that fund very early-stage businesses (often pre-product or pre-revenue) while also providing mentorship and guidance[1]
- However, accelerators typically show interest in startups once they have gained traction and demonstrated market progress[30]
- The educational aspect of accelerators often involves seminars and workshops[30]
- Typically ends with a demo day and the opportunity to pitch your business to investors[1]

Benefits

✓ **Mentorship and Guidance:** You should receive hands-on, operational advice on how to build your product and team from people with experience in those areas[1]

✓ **Signaling Effect and Credibility:** Participation in prestigious or well-known programs can act as a positive signal for potential investors, customers, and partners[4]

✓ **Networking and Connections to Investors:** Many of these programs aim to connect you with funding sources such as family offices and large institutional investors[7]

✓ **Access to Funding:** Many accelerators provide funding to startups in the form of seed capital

✓ **Education and Resources:** These resources cover various aspects of entrepreneurship, such as business development, marketing, legal matters, and fundraising. Entrepreneurs can acquire new skills and knowledge that are essential for navigating the challenges of building a successful startup

✓ **Cohort and Peer Support:** Accelerator programs bring together a group of like-minded entrepreneurs who are going through similar challenges and experiences. The cohort environment fosters a sense of community, collaboration, and peer support. Startups can learn from each other, share insights, and build relationships that can extend beyond the accelerator program

✓ **Accelerated Growth and Progress:** As the name suggests, accelerators are designed to fast-track a startup's growth. The focused mentorship, resources, and connections provided by accelerators can help entrepreneurs make significant progress in a relatively short period

Considerations

? **Dilution or Entrance Fees:** You often need to pay to enter these programs – usually with an equity stake (in exchange for cash and mentorship) or with cash[1]

? **Varied Experiences:** Programs can vary widely in terms of value-add and the size of the equity stake demanded[1]. Be wary of programs that have a lack of focus on either sector or company stage as this may result in you receiving generic advice not fit for your specific business needs. Few of these programs provide help with access to talent or customers and few are tailored to the needs of hard tech companies such as providing access to lab facilities and technical expertise[4]

? **Intensive and Time-Consuming:** Accelerator programs are often fast-paced and demanding. Entrepreneurs should be prepared to dedicate significant time and effort to the program, which might divert their attention from other important aspects of the business

? **Post-Accelerator Support:** While accelerators provide intensive support during the program, the level of ongoing support after graduation can vary. Entrepreneurs should consider the post-accelerator support and resources available, such as continued access to mentors, investor connections, or follow-on funding opportunities

Pro Tips

➢ **Think About How You Will Build Your Prototype:** *"We're really looking for people that have an idea of a commercial pathway for having a prototype. It's not a requirement, but we find that the ones that do that - at least [for] their prototype - are more successful"* **– Expert at Accelerator**

- **Be Coachable:** *"We want to make sure we can add value to them and also that they're coachable. Because I think sometimes they get so connected to their idea of what their product should be and the uses for it. Sometimes they just need to be more flexible and adaptable"* **– Expert at Accelerator**
- **Make Sure You Can Cover Your Living Expenses for the Program's Duration:** *"Have a strong team and also have a plan in place of how you're going to support yourself or get that support to get you through the process"* **– Expert at Accelerator**
- **Clearly Articulate How the Accelerator Can Help You:** *"That's, in the end, why we say 'No' to a lot of companies because we don't feel we're ready to support them. We don't feel we have the clients or the investors that are interested in collaborating with them so why waste their time in a way. [Our] partners and investors are listed on our website. The rest is obviously the technology has to be outstanding and they have to be a great team to work with. But from a differentiation perspective, what really helps us in the assessment is helping us understand how we can help you. That's what we're here for"* **– Expert at Accelerator**
- **Make Sure You Have the Time for It:** *"If you have a lot of stuff already on your plate and you don't have time for an accelerator, we are not where you want to be because you will get out of this what you put into it. We have a lot of peer-to-peer learning. We have a lot of engagement and [if] people aren't able to make stuff, they're [not] quite [going to] get as much value"* **– Expert at Accelerator**
- **Do a Gap Analysis of Your Startup:** *"One of the things that I would say is, at the earliest stages, you [should] think about what your uncertainties are - whether that's science, engineering, capital, regulatory, etc. [Then] plan your early pre-commercial journey and your program involvement around your perceived needs or your perceived gaps"* **– Expert at Accelerator**
- **Think About Your Company's Role in the Sector:** *"Start thinking about the story - like what the technology will actually do once it's integrated into [the] entire value chain… We're looking for breakthroughs that pay dividends across the sector for decades, not something that creates [a large] market cap for a single company… So I would start to think sectorally"* **– Expert at Accelerator**
- **Understand the Regulatory Environment You're Operating In:** *"I'd be prepared to be conversant on how the fiscal spending from the U.S. government is going to move specifically and have an idea in mind about that coordination, because you're going to get questions about it"* **– Expert at Accelerator**

- **Keep Track of Your Learnings to Date and How You Plan to Address Process Inefficiencies:** *"Beyond that, I would just say [to] store the tech debt really elegantly, so don't make it overly complicated. Sort it like phase one tech debt, phase two tech debt. What are you leaving to other folks in this space? What are you going to borrow from adjacent sectors? That I'd think about, I would organize the technical debt that you have between what's immediately critical for you to get a few more years and become more valid, and then what you'll sort out as you get more mature"* **– Expert at Accelerator**
- **Be Persistent:** *"If you're too early, that's fine, you can reapply. We've had teams apply, not get in, reapply again, not get in, reapply again, not [get in]. And [then] finally get in after six months, nine months, 12 months. We've had teams come spend a week or two with us and really over the course of [the] six-week program realize [that] this isn't working, they go out [and] then they come back in later. We offer a very flexible program specifically for that reason"* **– Expert at Accelerator**
- **Have a Strong Team:** *"We really place a lot of emphasis on the team. We really want to see founders who are passionate about addressing a specific problem that impacts climate in some way. We want founders that are really focused on the problem and not necessarily their solution given the early stages… We look to the founders for their dedication and commitment, their resilience. Why are they uniquely positioned to be the ones addressing the problem they're setting out to solve?"* **– Expert at Accelerator**
- **Start Your Customer Discovery Early:** *"I would say get a head start on customer discovery. Go through an I-Corps program or just start calling customers without a formal structure like an I-Corps around it. That will give you such a head start… Talk to customers and make sure that there's a market for what you're doing and have it help you inform how you're innovating or the way you apply for your patent because oftentimes patents revolve around specific applications of your technology. And so without talking to customers, you might be innovating in a silo and then you might be left wondering where it can go from there… So doing that testing, talking to people in the industry who might have tried this before, and seeing why it hasn't come to life. That will give you a really big edge in the application process, showing that you've done that hard work and research, and also just give you a head start in terms of working on your venture"* **– Expert at Accelerator**

- **Think Deeply About the Problem You're Solving and Your Competitive Advantage:** *"You would be surprised by how often the problem you're trying to solve is not clear. [Founders] think the problem they're trying to solve is climate change, but actually this is not what you want to hear. Usually there is a more specific problem, so being able to understand and articulate the specific problem you're solving, because from that comes your competitive advantage, and often people haven't done a good job at really scanning the landscape of what's out there and how you're going to be different"* **– Expert at Accelerator**
- **Understand Your Potential Climate Impact at Scale:** *"What is the potential of how low the carbon footprint of their product can be versus the competition and so how many emissions are you going to displace at scale? Just basic scale-up assumptions and technology performance assumptions, times market penetration assumptions to demonstrate that you have an impact that will move the needle and we don't have a lot of good answers on this often. Not that you have to know all the answers right now because you're early, but do [a] back-of-the-envelope equation"* **– Expert at Accelerator**

Examples

AirMiners
Blueprint
Carbon to Value Initiative (C2V)
Carbontech Development Initiative (CDI)
Cleantech Open
Climate Tech VC's List of 40+ Accelerators and Incubators
delta v
Elemental Excelerator
gener8tor
SecondMuse
startBlue
Third Derivative
Venture for Climate Tech
Village Capital
Y Combinator

Angel Investors / Family and Friends (F&F)

Description

- High-net-worth-individuals or previous founders within an entrepreneur's network who invest their disposable income into early-stage startups[1][13]
- Angels typically also provide mentorship, access to contacts, and strategic advice[1]
- Usually low on due diligence and thesis or category focused[13]
- Obtaining startup capital from friends and family is a relatively informal form of funding, but it is crucial to handle it with proper legal documentation. While many such transactions are friendly loans, some individuals within your personal network may choose to invest their money in exchange for a small ownership stake in the company[31]

Benefits

✓ **Generally, Take a Long-Term Perspective:** Angels may not apply as much pressure as VCs to grow the business quickly, are less exit-oriented, and generally more focused on the long term than VCs[1][22]

✓ **Can Move Quickly:** They can typically move fast to provide funding as the decision-making chain is shorter[1]

✓ **Mentorship and Guidance:** Companies that receive mentorship from an angel with strong industry connections or who has previously founded a company in a similar industry exhibit a greater likelihood to scale[4]

✓ **Moral Support:** When you receive startup capital from friends and family, they become part of your company's journey and have a stake in its success[31]

Considerations

? **Dilution:** The instrument may vary but you will ultimately be offering the angel investor the opportunity to purchase shares of future equity in your startup[32]

? **High Variability:** Check size and value add can vary a lot between investors. Furthermore, their individual motivations are diverse and challenging to forecast and control compared to the motivations of institutional investors[1][32]

? **Relatively Small Check Sizes:** Difficult for an angel or F&F to provide all the funding if you are raising a large amount of capital[1]

? **Dependent on Relationship Dynamics and Contractual Setup:** Blending business and personal relationships can introduce complexities, especially when money is involved. Improper management of the investment could potentially harm either the investor or your company, despite the initial flexibility provided by the agreement[31]

Pro Tips

➢ **Understand Your Audience When Pitching and Tailor Your Story Accordingly:** *"Just being really clear on the basics. Like what do you do? And why is it special and what are your competitive advantages? And being honest about that. And I'm a big one for being really clear about use cases. How does somebody use this? Tell the story of here's why they need it. What does it take to install? Just the use case from A-Z… And then there are so many times where they kind of skip over how it works and what the real secret sauce is and what the real intellectual property is. And angels aren't going to invest in something they don't understand. And the clearer you can be about how it's valuable and how people use it and who your customers are, [the better]… So just good storytelling"* **– Angel Investor**

Examples

The Decarbon8-US Fund (E8 Angels)
Vectors Angel

Crowdfunding / Investor Syndicates

Description

- Platforms that aggregate smaller investors together so that they can invest larger checks, usually as a single entity through a special purpose vehicle (SPV)[1][13]
- Usually network based, low on due diligence, and thesis or category focused[13]
- Crowdfunding presents a fast and secure method to secure funds for your venture[30]. The distinct advantage lies in the fact that the crowd, comprising individuals supporting your project, generally does not expect a repayment. Rather, their primary interest lies in receiving the product or service that you committed to deliver[30]
- Works well when the product or endeavor can be readily understood and appreciated by the target audience, creating a sense of affinity and connection[33]
- For syndicates, a lead investor (the syndicate founder, or another syndicate member) finds a deal and does diligence on the company. If they decide to invest, they invite other syndicate members to join with additional investment[34]

Benefits

✓ **Strong Gauge of Consumer Interest:** For consumer businesses, the interest in the funding round is typically indicative of the interest in the product[1]

✓ **Potentially Creates Highly Motivated Fan Base for Your Product:** Viral crowdfunding campaigns can generate useful exposure[1][33]

✓ **Mentorship and Guidance with the Right Syndicate Lead:** Similar to angels, investor syndicates are generally filled with people who have a genuine interest in their sector of expertise and thus, they take joy in helping startups grow[34]

Considerations

? **Can Complicate Your Ownership Structure:** Besides potentially adding complexity to your capitalization (or cap) table, you may be required to answer questions from a large number of investors or pitch your business to multiple parties to generate interest[1]

? **Substantial Marketing Campaign Targeting Consumers May Be Required:** Limits on the amount of diligence that individual investors can perform so may not be best suited to B2B or complex businesses[1][33]

? **You Will Generally Need Other Investors Too:** Typically works best when funding has been raised from other sources and a crowdfunding platform or syndicate is used to finish off the round[1][33]. Also some platforms may require you to raise through traditional investors first[31]

? **Cost:** On top of the dilution, large platform fees can reduce your proceeds[31]

Pro Tips

➢ **Start Small to Create Momentum[30]:** *"If you are trying to raise $100k, start with a $10k target. The reason is because getting the first bit of commitment is exponentially harder than the rest of it. No one wants to be the first person to the party. If you surpass $10k (or*

whatever your number is) you can always expand from there. But think specifically about initial momentum, then expansion" **- Entrepreneur**

Examples

[Cap Table Coalition]
[Climate Avengers]
[CREO Syndicate]
[Gaingels]
[Raise Green]
[Seed Checks]

Venture Capital

Description

- Venture Capital is a professionally managed pool of capital that is raised from public and private pension funds, endowments, foundations, banks, insurance companies, corporations, and wealthy families and individuals[26]
- Institutional investors that usually invest in high-growth businesses that have at least built a minimum viable product (MVP) and gained some early traction[1]
- VCs will typically have a portfolio of many startups that they have invested in and look to exit (sell their stake in your business) further down the line for a profit that will generate returns of 5-10 times (or more) of their initial investment[1][26]
- VCs look for businesses that can scale fast, are addressing a large market, have high margins, and improving unit economics as the business grows (e.g., through economies of scale, network effects, and/or 'winner-takes-all' market dynamics)[1]
- Characteristics of this type of funding are high risk, high return, relatively small investment sizes, and shorter time horizons (less than 10 years)[10]
- VCs are able to absorb this higher risk on any individual investment because they invest in a portfolio of companies, providing diversification benefits[10]
- Each VC firm is unique and follows its own investment process. This is also true for each firm's lead investors. Ask for references from entrepreneurs at the VCs other portfolio companies to get a sense of how it is to work with the VC Partner investing in your company[1]
- Investment from a VC can last a long time (roughly 5-10 years) so it is important that you have a strong working relationship with them[1]
- There is an inherent trade-off between the amount of capital raised and the level of control you maintain in the business, as a result, for highly capital-intensive climate companies (e.g., hardware, infrastructure, heavy industry, manufacturing, etc.) it may make sense to explore non-dilutive funding options (e.g., grants, debt, etc.) for capital projects that don't grow the business(27)
- Be clear on your expected milestones and how this current round of funding will get you to the next round of financing when the business is further de-risked[13]
- Figure 15 below highlights the main differences between early-stage VC (more suitable for Valley of Death #2) and late-stage VC (more suitable for Valley of Death #3, specifically, low-capital-intensity businesses e.g., software)[31]
- Growth-stage VC (more suitable

for Valley of Death #4) typically involves larger investment amounts, often exceeding $100 million and is aimed at accelerating growth, scaling operations, and solidifying the company's position in the market

	Round	Summary	Example goals for funding	Average raise range
Early stage	Pre-seed	Founders often bootstrap this stage. This capital provides the foundation on which the company can grow.	• Create minimum viable product (MVP) • Conduct market research • Hire core team • Register IP	$100k - $1m
	Seed	Used to develop an MVP and get it to market. In your pitch, you'll need to demonstrate why your idea has the potential to hit product market fit.	• Carry out research and development • Build out core team • Continue product development • Begin product testing • Develop go-to-market strategy and launch product	$1m - $5m
Late stage	Series A	Companies are usually generating revenue by now, often approaching $1m. This stage is all about scaling the company and building on initial success.	• Refine product development • Increase market share • Develop new products/ services • Acquire more customers • Continue hiring • Expand internationally	$5m - $25m
	Series B	At this stage, your company will have grown to 50+ people, found product market fit, started expanding the offering, and acquired majority market share in your home market.	• Acquire majority share of target market • Increase revenue substantially • Build team to 100+ • Expand internationally	$25m - $50m
	Series C	By now, companies are almost always profitable already and have won a large percentage share of the addressable market. Capital raised at Series C will fund activities that deliver dramatic growth. It's often the last round before IPO.	• Enter new markets • Increase market share through tactical acquisition of another company • Invest in research and development for new products • Fund IPO preparation	$50m - $100m

Figure 15: *Startup Funding Stages; Source: Adapted from SeedLegals*

Benefits

✓ **Increases Growth Potential:** VC goes beyond providing funding for a company's initial launch and survival; it enables the potential for significant scalability. Without engaging in equity fundraising, the growth trajectory of a company can be considerably lower, if not severely limited in its ability to reach its full potential[35]

✓ **Good VCs Add Value:** VCs differentiate themselves through the quality of the operational support and networks they can provide you with[1]

✓ **Learnings from Their Other Portfolio Companies:** Opportunities to learn from the VC's other portfolio companies and past experiences[1]

✓ **Willing to Take Early Bets:** Willing to fund highly innovative ideas, even if your startup has limited internal cash flow or access to debt finance[7]

✓ **VC's Brand and Signaling Effects:** VC's influence, connections, and experience can be the differentiating factor between achieving scale or remaining a small business for an extended period of time[33][35]

✓ **Venture Debt Typically Requires VC Investment:** VC funding can pave the way for accessing more desirable borrowing terms and conditions, making it easier to secure debt that is more advantageous to the company[35]

Considerations

? **High Return Expectations:** VCs expect to generate a significant financial return within a specified time period[22]

? **Potentially Significant Dilution:** VCs need to own a decent size of your company to make their investment worthwhile and the amount of value added after the investment can vary[1]

? **Dependence on VC Funding Going Forward:** Difficult to go back to self-funding (or bootstrapping) your business as the business has to grow large in order to ensure the VCs achieve an adequate return on investment (as a result, you may need to continue raising money to realize this growth)[1]

? **High Pressure:** In fact, the more investors you have (or the larger the amount of money invested in your business by outside investors), the more pressure you will be faced with to explore exit paths such as an Initial Public Offering (IPO) or a sale to another company[3]

? **Company- and Market-Specific:** Not all companies have the upside potential to justify an investment from a VC fund (often cited as at least a $1 billion total addressable market) and many business models are more suited to slower, more sustainable growth[3]

? **Intensive Fundraising Process:** It can take several months (c. 3-6 or longer) to raise funding from a VC, which may divert attention away from your core function of building and growing your business[3]

? **High Focus on Traction:** VCs usually require some demonstration of commercial traction (e.g., evidence of customer sales or commercial contracts)[22]

? **Not Suitable for Large Infrastructure Projects:** While venture capital ticket sizes are increasing, they remain too small for large infrastructure projects characterized by the fourth Valley of Death[9]

Pro Tips

- **Nail the Pitch:** *"Make sure you've practiced your pitch… Investors are seeing a lot of companies so at least being able to communicate succinctly and effectively already puts you in a high percentile. [If] you have a really interesting product [or] technology but it takes you 20 of the 30-minute meeting to really explain what [your] company is doing and this is why it's great, it's hard to be convincing in that way. So I think working on your communication style and just the pitch fundamentally is a big one"* **– Climate Tech Investor**
- **Find Investors with Strong Financial Acumen:** *"Having somebody who really can crunch the numbers and can also go really deep on the different types of energy transition [technologies]. [Who] can help bring the discipline and the investment maturity that you want as an entrepreneur so that you're partnering up with somebody who can really help you"* **– Climate Tech Entrepreneur**
- **Focus on Both Impact and Returns:** *"It's really about communicating. Yes, this is what your business does, your solution. Here's how you're accelerating decarbonization. But how does this business scale? Do you know what it takes to scale ultimately what does an exit look like?"* **– Climate Tech Investor**
- **Think Long Term:** *"We [are] very much about making sure that founders have an appropriate level of equity to feel incentivized but, at the same time, it's grounded in reality. It's all about the next round of financing. Sometimes startups approach us [and] they want us to [give them a] high valuation. They have no idea what it's going to be like the next time that they raise. And I think that's often a red flag. It shows that they're not careful about capital efficiency or about the evolution of the business and they're chasing growth at all costs. We're not about that"* **– Climate Tech Investor**
- **Do Your Research:** *"Have a very good idea of the type of businesses that we invest in so that we're starting off on the right foot and then it's a relevant conversation"* **– Climate Tech Investor**
- **Be Persistent and Stay in Touch:** *"Sometimes just because the first conversation or the first round isn't something that we decide to do, stay in touch, keep us posted, keep the dialogue going because in more than a handful of cases we've passed on deals at the seed or at the pre-seed and seed and then done the [Series] A. It's a very long process for us and we*

like to get to know people over time. So go into it with that outlook where I'm beginning a conversation with this person, I'm beginning a relationship with this person that could be valuable over the course of the next decade, not just over the next couple of weeks" **– Climate Tech Investor**

- **The VC Model Needs Large Addressable Markets:** *"We're VC investors. We're looking for exponential growth and sometimes that's not the right fit for you. Maybe you're not in a market where that makes a lot of sense. I think that the target addressable market needs to be big enough"* **– Climate Tech Investor**
- **Get a Warm Intro:** *"I think a good reference is really the key to get noticed. We get a lot of inbounds, a lot of cold emails. I'm sure there are plenty of good founders and good companies in that [group] but it's just physically impossible to meet with everyone… Getting a reference definitely helps you get noticed. Just to get the foot in the door"* **– Climate Tech Investor**
- **Know Your Stuff and Be Coachable:** *"Make sure you're solving a problem for a qualified buyer and obviously know your stuff. And be coachable… Come with the spirit of collaboration and humility"* **– Climate Tech Investor**
- **You're Also Choosing Them:** *"If you're a founder in Climate Tech, my argument for the types of partners you want to have around the table and the considerations you want to make are: Fundamentally, how helpful is this individual going to be to me? Essentially thinking of them like a partner in [your] business, sitting on the board of your company. What relevant experience are they going to bring to bear to help [you] think through company formation, fundraising, product, technology, strategy, business model, all that kind of stuff. And then also their personality set. Is [this] someone I'm actually going to enjoy working with or is this someone [who] is going to be a pain in my side?"* **– Climate Tech Investor**

Examples

4Ward VC's List of 900+ Climate Tech VCs and Accelerators

Aligned Climate Capital

BlackTech Capital

Blue Bear Capital

Climate Tech VC's List of 180+ Climate Tech VCs

Congruent Ventures

SOSV

Toyota Ventures

The Capital Stack for Valley of Death #3: Showing That You Could Meet Customer Needs at the Required Scale ("Market Validation")

The sources of capital best suited to overcome the challenges posed by the third Valley of Death are:

- Catalytic Capital / Pilot Funding
- Accelerators for Projects
- Cooperative Agreements / Project Equity (e.g., Office of Clean Energy Demonstrations) and Joint Ventures
- Loan Guarantees and Construction Loans (e.g., New York Green Bank, California Infrastructure and Economic Development Bank)
- Late-stage Venture Capital (predominantly for low-capital-intensity businesses e.g., software)

This is because they generally provide:

- Significantly larger check sizes than the sources in Valley of Death #2 and are either willing to take on large risks or focused on another motive such as crowding in investment
- Experience structuring large infrastructure investments, including structuring flexibility to match the needs of the individual project
- Relatively patient when compared to traditional sources (particularly for infrastructure and catalytic funds)

Catalytic Capital / Pilot Funding

Description

- Capital provided by investors whose primary aim is charitable impact, rather than primarily financial returns, and as a result, they are comfortable with levels of risk, investment durations, and/or financial returns that finance-first capital would not be[10][13]
- Typically involves providing early-stage funding to support the development and testing of new ideas, models, or technologies that have the potential for significant social or environmental impact
- Patient and/or flexible capital when compared to traditional sources, with the aim of unlocking additional investment which would not be possible without this first contribution by catalytic sources[10]
- Operate using a number of financial products to meet the requirements of the project or startup including project equity, growth equity, warrants, convertible loans, insurance, and technology warranties[10]
- Catalytic capital is often provided by impact investors, philanthropic organizations, or government agencies

Benefits

✓ **Risk mitigation:** Catalytic capital reduces the risk associated with launching innovative projects. It allows entrepreneurs to experiment and learn from potential failures without bearing the full financial burden, increasing their chances of success in the long run

✓ **Crowding-in Other Investors:** Provide the 'first loss' catalytic capital that sends a strong signal for others to invest through the retirement of key risks[10]

✓ **Long-Term Outlook:** Willing to make a long-term commitment to new technologies by putting patient risk capital to work[7]

✓ **Access to Networks and Expertise:** Catalytic capital often comes with additional support beyond funding. Entrepreneurs may gain access to valuable networks, mentorship, and expertise provided by the investors or organizations offering the capital

Considerations

? **Reporting and Monitoring Requirements:** Catalytic capital providers often require entrepreneurs to report on the progress and impact of their ventures. This can involve regular reporting, impact measurement, and monitoring activities

? **Dependency on Philanthropic Funding:** Catalytic capital is often sourced from philanthropic organizations or impact-focused investors. This type of funding may be limited and subject to market fluctuations

? **Longer Decision-Making Processes:** Securing catalytic capital may involve a more rigorous due diligence and decision-making process compared to traditional funding sources. This can result in longer waiting periods and increased uncertainty for entrepreneurs, potentially delaying their ability to move forward with their ventures

Pro Tips

➢ **Catalytic Capital Looks for Neglected Technologies:** *"Because of our catalytic capital, that's more patient, we look for technologies and founders that are often neglected. And technologies that have a high risk profile or need a lot of de-risking in the very early stages of their technology to be able to then attract typical venture capital... We want to be additional, we want our capital to be the catalyst for closing the round... We want to be able to be that magnet to bring other folks in so they can get comfortable with [the] technology"* **– Climate Tech Investor**

➢ **Articulate What Makes You Different in Simple Terms:** *"So really clearly articulating what makes you different. Is it your knowledge of a certain thing? Is it your chemistry? Is it your process? And then really drilling down into what those things are"* **– Climate Tech Investor**

Examples

Azolla Ventures
Breakthrough Energy Catalyst
Chan Zuckerberg Initiative
Grantham Foundation
LACI Market Access
PRIME Impact Fund
VertueLab

Accelerators for Projects

Description

- An Accelerator for Projects program is a time-limited initiative designed to support startups and entrepreneurs by providing resources such as mentorship, access to industry networks, and funding opportunities
- They offer various types of support, including engineering and design assistance, procurement services, and marketing and sales development
- Participants collaborate with experts to develop, pilot, and market their new technologies with the intention of receiving support at different stages of development, from prototype to demonstration
- Equity investment funding may be available for selected startups
- Post-program engagement and ongoing support are often provided to help participants scale their technology and explore future opportunities

Benefits

✓ **Project-Specific Guidance:** Entrepreneurs receive project-specific guidance from experienced professionals who bring practical expertise and industry knowledge. This support helps in refining project construction plans, developing contingency strategies, and overcoming project-related challenges

✓ **Project Development Support:** Entrepreneurs receive support in project development, including co-development opportunities, access to resources, and assistance in scaling up project implementation

✓ **Testing Opportunities:** Accelerators often offer project testing opportunities, allowing entrepreneurs to test their project solutions in real-world settings. This testing provides valuable insights, feedback, and data for project refinement and improvement

✓ **Financing:** Many accelerators provide project financing options, such as grants or equity investment, to support project implementation. This funding helps cover project expenses, accelerate project timelines, and facilitate successful project deployment

✓ **Project Management Expertise:** Entrepreneurs gain access to project management expertise through mentorship and coaching provided by the accelerator. This guidance assists in effective project planning, resource allocation, risk management, and project execution

✓ **Network and Partnerships:** Accelerator programs offer access to a network of industry professionals, potential partners, clients, and investors who are interested in innovative projects

✓ **Market Insights:** Entrepreneurs benefit from market insights specific to their project, including competitor analysis, market trends, and customer needs

✓ **Post-Program Project Support:** Many accelerators offer post-program support tailored to the specific needs of the project. This support may include ongoing mentorship, access to resources, introductions to investors or clients, and assistance in scaling the project beyond the accelerator program

Considerations

? **Time Commitment:** Accelerator programs often require a significant time commitment from entrepreneurs. The intensive nature of the program may divert attention and resources away from other aspects of the business, requiring careful time management and prioritization

? **Equity Dilution:** In exchange for the benefits provided, some accelerators may require equity stakes in the project or business

? **Limited Program Duration:** Accelerator programs are typically time-limited, often ranging from a few weeks to a few months. This limited duration may not provide sufficient time for some projects to fully develop or implement their ideas

Pro Tips

- **Think About What You Need Help with:** *"For startups, they normally don't have the capability to take their core technology and deploy it as a project finance deal. They need partners to do that. And this is an opportunity to think through, have you thought about insurance? Have you thought [about] the market risk? What's the operational risk? What's the technical risk? The job of an EPC is to serve the technical risk and then in some cases inform the operating risk. But by really understanding what's the technology, what's the company, how long have they demonstrated? Is the expectation [of future plant performance] from physical data or just modeling things"* **– Expert at Accelerator**
- **Make Sure You Have the Organizational Bandwidth:** *"In order to actually design and properly do an integrated demonstration or first-of-a-kind commercial [facility], you actually need quite a bit of capacity. And so a lot of the time, if you haven't hired a VP of Engineering, [or] you don't have a technical staff, you can't actually manage some partners and the folks that you need to engage with to do your design. A subset of that is a lot of companies don't have their basic process and technology documented in a way that would be acceptable to actually be then designed on top of and built. And so a lot of the time it's communicating with them what that looks like and then in many cases explaining why that level of documentation will be helpful downstream and even aligning on what is [the] technology readiness level. All startups think they're further on the technology [than] the industry thinks they are. And so that's a useful conversation in many cases"* **– Expert at Accelerator**

Examples

Black & Veatch IgniteX
Elemental Excelerator Projects

Cooperative Agreements / Project Equity / Joint Ventures

Description

- The newly established Office of Clean Energy Demonstrations (OCED) under the Department of Energy (DOE) has been allocated $20 billion to support demonstration projects in various clean energy sectors[23]
- The primary goal of OCED is to commercialize clean energy technologies and bridge the innovation gap necessary to achieve the nation's climate goals. OCED achieves this by validating these technologies in real-world conditions and instilling confidence that they work as intended[23]
- OCED provides funding in the form of cost-sharing, covering up to 50% of project costs, which serves to reduce the risk associated with significant infrastructure investments
- The ideal projects for OCED support are typically at a Technology Readiness Level (TRL) of 6 or higher, although there may be some flexibility in this criterion
- The funding provided is essentially a grant. It operates under a cooperative agreement, which is a term used by the federal government to define the governing document for the agreement
- This funding is disbursed based on meeting specific milestones, similar to how a project finance structures operate. There are reporting requirements associated with receiving this federal funding, which are not significantly different from the expectations of typical equity or debt providers
- This OCED funding allows private capital (who provide the other 50% of the project costs) to enhance their on-paper Internal Rate of Return (IRR) and create a better alignment between risk and reward for a given project, thus increasing the attractiveness and viability of the project by providing additional financial support without requiring any collateral or repayment obligations
- For smaller projects, or where corporations have larger balance sheets, the private sector may fund demonstration projects on their own or through joint ventures (to share the risk)
- A joint venture (or JV) is a business arrangement where two or more parties come together to collaborate on a specific project or venture, sharing resources, risks, and rewards (note that JV agreements are not necessarily restricted to the third Valley of Death)

OCED Benefits

✓ **Financial Support:** OCED has a substantial budget of $20 billion dedicated to supporting demonstration projects across various clean energy sectors

✓ **De-risking Investments:** By providing a significant portion of the project funding, OCED helps de-risk the investment for entrepreneurs, making it more attractive to other investors and lenders

✓ **Market Adoption Acceleration:** The office collaborates with organizations including tech developers, EPC firms, utilities, and local governments to develop clean energy demonstration projects. By partnering with OCED, entrepreneurs gain access to a network of industry players and potential customers, accelerating market adoption and increasing their chances of success

✓ **Confidence and Validation:** By securing funding and support from OCED, entrepreneurs can gain credibility and confidence in the effectiveness and viability of their technologies

✓ **Private Sector Follow-on Funding:** By demonstrating the viability and potential of their technologies through OCED-funded projects, entrepreneurs increase their chances of securing additional investment from private investors who are more inclined to support proven and validated clean energy solutions

Joint Venture with Corporate Partner Benefits

✓ **Credibility:** Collaborating with the right corporate partner can provide immediate credibility in the target market, enhancing the reputation and trustworthiness of your venture[32]

✓ **Intellectual Property Advantages:** The joint venture can generate valuable intellectual property, which can positively impact your own venture, potentially leading to innovations, competitive advantages, and market differentiation[32]

✓ **Early Revenue from First Customers:** The joint venture may secure the corporate partner as an early customer, providing a reliable revenue stream at the initial stages[32]

✓ **Access to Superior Resources:** Collaborating with a corporate partner grants access to their superior resources, such as research facilities, marketing capabilities, distribution networks, and industry connections[32]

OCED Considerations

? **Competitive Process:** The OCED funding program is likely to attract a large number of applicants seeking financial support for their clean energy projects. Not all applicants will receive funding, and the process may be challenging and time-consuming

? **Strict Reporting and Compliance Requirements:** OCED funding comes with reporting and compliance obligations, as it involves federal

dollars. Entrepreneurs must adhere to these requirements, which may include regular progress reporting, financial audits, and adherence to specific guidelines

- **Milestone-Based Funding:** This requires careful planning, execution, and effective project management to ensure milestones are met on time. Failure to meet milestones could result in delayed or reduced funding, impacting the project's progress
- **Limited Focus on Early-Stage Research:** Entrepreneurs working on earlier-stage research and development may find limited support from OCED. They might need to explore alternative funding sources or collaborate with other DOE programs specifically designed for early-stage research and piloting
- **Matching Funds Requirement:** OCED funding often requires cost-sharing, with the holding company or project developer expected to contribute a percentage of the project costs. While this can help demonstrate commitment and financial stability, it can also be challenging for startups who may struggle to secure the necessary matching funds

Joint Venture with Corporate Partner Considerations

- **Potentially Complex Agreement:** It can be a time-consuming and expensive process to negotiate the complexities of a joint venture, which may not ultimately materialize[32]
- **Intellectual Property Disadvantages:** Intellectual property created through the joint venture may result in the loss of sole ownership and control over valuable intellectual property[32]
- **May Require Additional Funding:** Adequate funding or assets need to be available for the startup to contribute to the joint venture[32]
- **Potentially Narrows Collaboration Opportunities:** Engaging in a joint venture with a specific corporate partner may limit or discourage interactions with other potential corporate partners[32]

Pro Tips

- **Understand the Risks Associated with Your Project and Potential Organization Limitations:** *"There's cost uncertainty around the upfront capital cost for the project and the long-term operating cost of the project. There's a value chain uncertainty around the group of entities that has to come together to deliver the projects - EPC's, project developers, etc. There's permitting uncertainty, especially for first-of-a-kind projects. The time it takes to get a permitting agency comfortable with a project that they've never seen before, that's just upfront non-recurring costs and time delays - all of which threaten the viability of the project. Also, management capabilities as these are large-scale infrastructure projects that take a ton of experience and know-how to deliver on"* **– Expert**

at Government Funding Organization

- **Understand OCED's Mission:** *"[OCED's] mission is to accelerate commercial adoption for these technologies. So applicants should be focused on demonstrating how they will do that. [That] is demonstrating and [having a] knowledge of what the key barriers to adoption are right now and how your project is going to help bring those down and prove them out so that we can accelerate lift off"* **– Expert at Government Funding Organization**
- **OCED Is There to Help You:** *"[OCED has] assembled a pretty phenomenal team made-up of private sector and public sector professionals who have decades and decades of experience delivering large-scale infrastructure projects. So [they] hope to be an advising support function for [their] projects to help [startups] get ahead of some of these risks effectively [in order to] plan and manage them"* **– Expert at Government Funding Organization**

Examples

Office of Clean Energy Demonstrations

Loan Guarantees and Construction Loans

Description

- The Department of Energy's Loan Programs Office (LPO) provides financial support to large-scale energy projects that have progressed past the demonstration stage and aim to achieve commercial-level deployment[23]
- With a budget of $390 billion, the LPO offers direct loans and loan guarantees to bridge the funding gap for innovative climate technologies, allowing them to reach the stage of bankability where private lenders are more willing to commit capital[23]
- The LPO's focus is on supporting the first commercial-scale deployment, subsequent deployments, scale-up efforts, and educating the commercial debt market about clean energy projects[23]
- Direct loans from the LPO provide long-term fixed rates, typically spanning 20-40 years, with interest rates based on U.S. Treasuries plus a margin. This structure resembles a capital markets product similar to bonds, but with the advantage that borrowers don't need to receive the entire loan amount upfront. Instead, the funds can be disbursed over a period of four years, easing the financial burden

- While guarantees are less common, they may be used in cases where there are potential relationship issues with commercial lenders, allowing banks to share the risk with the LPO by offloading a portion of the loan. This arrangement can be advantageous for both the bank and the borrower
- The LPO typically operates in the fourth Valley of Death (c. $100m+), however, there are regional green banks and development finance institutions (DFIs) such as the New York Green Bank and the California Infrastructure and Economic Development Bank that provide smaller loan guarantees (in the $5m – $25m range) or other debt-like products like construction loans (for up to $50m) – these are more suitable for the third Valley of Death
- DFIs play a crucial role by providing loan guarantees for the first commercial loan sought by climate tech innovators who have already proven their product at the lab scale and are ready to move towards manufacturing
- While the banks still need to have their own investment in the project, the guarantee mitigates a significant portion of the risk
- With a guarantee in place, the perceived risk for the bank decreases, leading to potentially lower interest rates and overall reduced financing costs for entrepreneurs

Benefits

✓ **Access to Capital:** These programs provide entrepreneurs with access to significant funding that might otherwise be challenging to obtain from traditional lenders or investors. Loan guarantees, in particular, reduce the perceived risk for lenders, making it easier for entrepreneurs to secure financing

✓ **Lower Cost of Capital:** Loan guarantees and direct loans often come with favorable terms, such as long-term fixed rates or lower interest rates, compared to conventional financing options

✓ **Risk Mitigation:** Loan guarantees provide a safety net by mitigating a portion of the lender's risk. This can make lenders more willing to provide financing, especially for early-stage projects or technologies with inherent risks

✓ **Enhancing Bankability:** Loan guarantees, direct loans, and other debt-like products improve the bankability of projects by providing a stamp of approval and validation from reputable organizations like the LPO, DFIs, and regional green banks. This endorsement can increase credibility and facilitate follow-on funding from private sector investors

✓ **Flexibility and Favorable Repayment Terms:** For example, direct loans from the LPO may have longer-term repayment options, resembling capital market products like bonds. This allows entrepreneurs to manage their cash flow more effectively and repay the loans over an extended period

✓ **Supportive Ecosystem:** These programs often come with additional support, such as technical assistance, guidance, and networking opportunities. Entrepreneurs may benefit from the expertise and resources provided by these organizations to further develop their projects, navigate regulatory requirements, and foster partnerships

Considerations

? **Eligibility Criteria:** Entrepreneurs must meet specific eligibility requirements to qualify for these financing options. This may include demonstrating the viability of their projects, meeting certain technology or scalability milestones, or fulfilling other criteria set by the lending organizations

? **Diligence and Approval Process:** The application and approval process for loan guarantees and direct loans can be lengthy and require extensive due diligence. Entrepreneurs need to be prepared to provide detailed financial, technical, and operational information about their projects

? **Repayment Obligations:** Entrepreneurs who receive direct loans or other debt-like products are responsible for repaying the borrowed funds according to the agreed-upon terms. This includes making regular interest and principal payments, which can be a financial burden, especially during the early stages of a project's commercialization

? **Collateral and Personal Guarantees:** Lenders may require collateral or personal guarantees from entrepreneurs as security for the loan. This means that entrepreneurs may need to pledge assets or provide personal guarantees, putting their own financial standing at risk in case of default

? **Market Perception:** While loan guarantees and other debt-like products can enhance the bankability of projects, there may still be a perception among private investors and other lenders that the need for loan guarantees implies higher risk

? **Reporting and Compliance:** Entrepreneurs who receive financing through loan guarantees or direct loans may be subject to reporting requirements and compliance obligations

Pro Tips

➢ **Understand What Makes Raising Debt Financing Different:** *"A lot of the startups [we see] would be better off having financial literacy about debt and about how to source it, how close it, how to manage it. Or at least have the knowledge that they have to hire somebody who can tell them how to do those things because when you're going out for debt, it looks very different than going out for equity. You don't have a seat on the board, you don't have governance [rights]. And you have first priority rights over the*

cash flows and repayment. And so it's a very different relationship with the company. I think that a lot of borrowers get frustrated with us but part of it is that they don't know what a lender needs and why a lender needs it. So that, I think, is one of my big takeaways" **– Expert at Government Funding Organization**

- **You Need Certain Documentation to Close Your Debt Round:** *"[It is important to understand] what needs to be submitted with the application [and] why it needs to be submitted. You need to have [a] business plan. You need to have a financial model. You need to have [an] operating plan. You need to have [a] construction [plan]. You [need to] have all these things in order to successfully close the debt"* **– Expert at Government Funding Organization**
- **Engage Early:** *"We can talk to people for like two or three years before they're ready to apply, and we keep telling them when you get this piece, come back to us"* **– Expert at Government Funding** ***Organization***
- **They Want to Help You Get Your Loan:** *"You have businesses coming in all shapes and sizes. Some of them are ready to receive a loan and many of them are not. So oftentimes, it's an exercise in technical assistance to develop a business plan, [understand] the local workforce conditions [and] local regulatory conditions that will impact the business. So it can be a series of conversations before it's actually a loanable moment"* **– Expert at Financial Institution**

Examples

Climate Tech Finance (California Infrastructure and Economic Development Bank)

Loan Programs Office

New York Green Bank

The Capital Stack for Valley of Death #4: Turning One Fully-Functioning Plant or Pilot into Many ("Widespread Adoption")

The sources of capital best suited to overcome the challenges posed by the fourth Valley of Death are:

- Revenue-Based Financing
- Infrastructure Finance
- Growth-stage Venture Capital / Private Equity
- Commercial Debt
- Venture Debt
- Project Finance
- Loan Guarantees (e.g., LPO)

This is because they generally provide:

- Large amounts of debt funding based on key operational metrics provided by the startup such as revenue, cash flows, assets and/or profits
- Relatively cheap, long-term, and non-dilutive capital ensuring entrepreneurs do not need to give up ownership in order to scale
- Loan guarantees to crowd in commercial debt from typically risk-averse financing institutions

Revenue-Based Financing (RBF)

Description

- With revenue-based financing, instead of the provider owning a share of your company (i.e., equity), you will be entitled to pay them back (i.e., a loan) with a portion of your revenues[1]
- Normally includes a cap (or upper limit) on the amount of revenue that is paid back to the lender each month (based on their initial investment) and when the revenue sharing should start can be negotiated[1]
- The lender can be paid back with equity if the financing terms include a conversion mechanism[1]

- Typically requires somewhat recurring revenues from diversified revenue streams or customers[33]
- All else being equal, you will get better terms (i.e., lower interest rates and less warrants) if your business is well-capitalized already, so it is best to access RBF when you have already raised other types of funding such as venture capital, or if your business is generating cash[27]
- Do not use this type of funding if you cannot guarantee payment as the terms for default may mean you have to give up substantial ownership in your business[27]

Benefits

✓ **Typically No Dilution and Limited Restrictive Conditions:** Maintaining ownership of your company, while avoiding the risks associated with debt (e.g., such as a claim on your assets or personal guarantees)[1][33]

✓ **Appropriate with Other Sources of Capital:** Compatible with raising VC funding further down the line due to less onerous contractual claims (note that these other sources should not limit your ability to repay the RBF lender, there will be contractual terms prohibiting this)[1]

✓ **Short Application Process:** Relatively fast approval process if you can show that your revenues are recurring and low risk (usually based on a contractual agreement or orderbook)[27]

✓ **Relatively Predictable Repayment:** Repayment is based on a fixed percentage of your revenue, so it will fluctuate with business performance should you experience some volatility in sales, but is generally predictable[27][33]

✓ **Improves Credit History:** As you pay back your loans on time, your ability to raise additional debt usually increases[27]

Considerations

? **Cost:** Typically a higher cost of capital than traditional bank debt[33]

? **Limited Choice:** Relatively few providers of this type of capital[1]

? **Should Be Used to Fund Revenue Growth with High Enough Margins:** Best suited for high-margin businesses (e.g., software)[1]

? **Revenue Track Record Required:** You will typically need to show a track record of at least 6 months of revenue[27]

? **May Require Shareholder Approval:** You may need approval from the angel investors or VCs invested in your company to take on a significant amount of debt[27]

Pro Tips

➢ **RBF Should Be Used to Fund Growth:** *"What's important is that if you're going to take revenue-based financing, [is] that it's applied in the right way and that you are investing it in growth… You shouldn't raise RBF to pay for OpEx, you should raise RBF to pay for growth. Now, on your P&L, it might be OpEx, but in reality it's driving a change in revenue and it's ideally driving a change in*

trajectory. It's not just an incremental step, it's actually changing the growth rate" **– Expert at Climate Tech FinTech**

Examples

Enduring Planet
Lighter Capital

Infrastructure Finance

Description

- At the intersection of traditional infrastructure financing (e.g., Macquarie, Brookfield, Global Infrastructure Partners etc.) and venture capital, these infrastructure finance providers fill a crucial gap in funding by specializing in funding projects related to infrastructure development
- These projects may not yet be attractive to large banks or traditional infrastructure players
- They typically have expertise in assessing the financial viability and environmental impact of infrastructure projects, and they work closely with project developers and stakeholders to secure funding and drive the successful implementation of sustainable infrastructure initiatives
- Their approach is flexible and adaptable, offering various financing options that can resemble project finance, debt, equity, or convertible debt. While project finance is their primary focus, they are open to exploring different structures to meet the specific needs of each opportunity

Benefits

✓ **Infrastructure Expertise:** Infrastructure finance providers understand the unique needs and challenges faced by entrepreneurs in the infrastructure space

✓ **Flexible Financing Options:** They offer a range of financing structures, including project finance, debt, equity, and convertible debt. This flexibility allows entrepreneurs to choose the financing solution that best suits their specific project and growth plans

✓ **Access to Networks and Resources:** They can provide entrepreneurs with access to potential partners, customers, and other stakeholders who can contribute to the success of their projects

✓ **Faster Approval Process:** Compared to traditional infrastructure players or large banks, these providers may have a more streamlined and efficient approval process. This can result in faster access to capital, allowing entrepreneurs to move forward with their projects without significant delays

Considerations

? **Potentially Expensive Capital:** Due to the added risk they take on (i.e., with the construction of a second- or third-of-a-kind commercial-scale project), the capital they provide can be more expensive than traditional project finance structures. There is also an added premium in structuring deals for new types of technologies in terms of time and expertise[9]

? **Stringent Eligibility Criteria:** Infrastructure finance providers may have specific criteria and requirements for funding, including project maturity, scalability, and financial viability

? **Risk Assessment and Due Diligence:** Providers conduct thorough risk assessments and due diligence before committing to funding

? **Financial Terms and Conditions:** Infrastructure finance comes with its own set of terms and conditions, including interest rates, repayment schedules, collateral requirements, and covenants

? **Potential Dilution of Ownership:** In cases where equity investments are involved, entrepreneurs may need to give up a portion of ownership and control in their projects

? **Long-Term Commitments:** Infrastructure projects typically have long gestation periods and require substantial capital investments over extended periods. Entrepreneurs should carefully evaluate their ability to meet long-term financial obligations and consider the impact on their overall business strategy

Pro Tips

➢ **Large Increases in Project Size May Require Additional Diligence:** *"If it's more than a 10x scale up, it's [essentially] a brand new technology"* **– Expert at Infrastructure Finance Provider**

➢ **Reach Out Early:** *"I think even if it's not a fit now, reach out and talk to us. We're more than happy to chat with founders, even in the early stages [to] build those relationships. And I do think that starting to think about optimizing your capital structure is [beneficial], and I think we're learning that now in this environment, you'd rather start thinking about that sooner rather than later"* **– Expert at Infrastructure Finance Provider**

Examples

FullCycle Climate Partners

Generate Capital

Orion Infrastructure Capital

Spring Lane Capital

Commercial Debt

Description

- Debt financing is a common method of raising funds, where borrowers receive a loan that needs to be repaid over a specific period of time, typically with interest[35]
- Subject to market fluctuations, commercial banks typically charge interest rates of around 5% to 15% on the funds they lend, and they often require collateral or a guarantee to secure the loan[30]
- If your business were to fail, you could potentially lose the business itself as well as any assets you put up as collateral so entrepreneurs should aim for a high probability of repayment[30]
- Banks typically require a history of profitability and sizeable revenues (with years of track record)[33]
- It's crucial to be aware of the terms and conditions of the debt, as well as the maturity date, to avoid default and potential consequences for the business

Benefits

✓ **No Dilution:** Maintaining ownership of your company[1]

✓ **Flexibility:** Commercial debt provides flexibility in terms of how the borrowed funds can be used. Entrepreneurs have the freedom to allocate the funds according to their specific needs, whether that's for working capital, expansion, equipment purchase, or other business requirements[35]

✓ **Tax Deductions:** Interest payments on commercial debt are often tax-deductible expenses. This can result in significant cost savings for entrepreneurs, reducing their overall tax liability and increasing their net profits[35]

✓ **Lower Cost of Capital:** Compared to equity financing, commercial debt tends to have a lower cost of capital[35]

✓ **Repayment Improves Credit History:** As you pay back your loans on time, your ability to raise additional debt usually increases[27]

✓ **Relatively Predictable Cost:** Comparatively transparent market among lenders and standardized contractual terms[33]

Considerations

? **Repayment Obligations:** Taking on commercial debt means committing to regular repayments, which can be a financial burden, especially for early-stage businesses with uncertain cash flows[35]

? **Interest Costs:** Commercial debt comes with interest payments, which increase the overall cost of borrowing[35]

? **Collateral and Personal Guarantees:** Debt is difficult to access unless your business has tangible assets to borrow against or predictable cash flows[1]

- **Financial Risk:** Do not use this type of funding if you cannot guarantee payment as the terms for default may mean you have to sell off your company's assets[27]
- **Restrictive Covenants:** Technical default may occur when a borrower breaches one or more of the terms or conditions outlined in the agreement, leading to potential negative consequences[33]
- **Relationship with Lenders:** Building a good relationship with lenders is crucial when relying on commercial debt. Maintaining open communication, meeting obligations, and addressing any issues promptly are essential to preserve the lender's trust and maintain access to future financing opportunities[35]
- **May Deter Future Investors:** Commercial debt can make entrepreneurs less appealing to equity investors, as a portion of the investment would be used to repay the debt rather than fueling company growth[31]
- **May Require Shareholder Approval:** You may need approval from the angel investors or VCs invested in your company to take on a significant amount of debt[27]

Pro Tips

- **Build Your Lending Relationships Early:** *"I think [the] simple [advice] is: just call us. I think what I see is when we work with entrepreneurs, it tends to be relationships that develop over time. We're actually much less interested in when somebody has their pitch book going [around]. We want to get to know them early in a much more natural environment. That's also because [during a pitch] they may be asking for the wrong thing. A lot of the best relationships unfold not in the course of a three-to-six month capital raising process. So that's actually my biggest advice. Call us early. Get to know us and then we can figure out if we're the right partner. And if not, we'll have hopefully given you some good advice along the way"* **– Expert at Financial Institution**

Examples

Federal Reserve's List of 2,000+ Large Commercial Banks

Venture Debt

Description

- This is a bank loan for startups that do not have many assets to borrow against or a track record of revenue and profitability[27]
- The structure can vary markedly between lenders but the loan will generally be paid back in the form of a term loan (fixed maturity date) with interest payments and warrants (options to buy shares in your company at a given price)[27]
- The loan is sized based on your company's last pre-money valuation (based on a loan-to-valuation ratio)[13]
- Similar to VC, the lender is underwriting the likelihood that your startup's valuation will continue to rise and that you will raise more capital in the future to pay off the debt[13]
- It is usually not a matter of one or the other i.e., you can use non-dilutive funding sources such as venture debt in conjunction with dilutive sources of funding such as venture capital[27]
- More and more VC funds are also able to provide venture debt[13]
- As a rule of thumb, you generally want to gear venture capital funding towards 'high risk/high return' projects that have the ability to pay your investors back should the projects succeed such as product development, go-to-market, R&D, growing the team, etc.[27]
- On the other hand, debt funding works well when the projected payoffs from the expenditure are clearer such as hardware purchase orders and building up manufacturing capacity[27]

Benefits

✓ **Lower Cost of Capital Compared to Additional Equity:** Venture debt allows startups to leverage their existing equity and reduce the average cost of capital. Compared to raising additional equity financing, debt financing can be less dilutive and more cost-effective[36]

✓ **Extended Runway:** Venture debt provides additional capital that extends the company's runway, allowing more time to achieve key milestones, develop products, and generate revenue. This extended runway can provide flexibility, bridge working capital shortfalls, and support continued growth without the immediate pressure to raise more equity funding[13][36]

✓ **Complementary Financing:** Venture debt complements equity financing by providing a non-dilutive funding option. It allows startups to access capital while preserving equity ownership and control[1][36]

✓ **Value-added Partnerships:** Some venture debt lenders offer value-added services and connections, providing entrepreneurs with access to their network, expertise, and resources[36]

✓ **Less Restrictive than Commercial Debt:** Generally more favorable terms (except the cost) and less personal claims against your assets than traditional commercial debt[27]

✓ **Limited Applicability:** Venture debt is typically suitable for companies that have already raised significant equity financing from institutional investors. Startups in the early stages or with limited investor backing may find it challenging to access venture debt[36]

✓ **Repayment Improves Credit History:** As you pay back your loans on time, your ability to raise additional debt usually increases[27]

Considerations

? **Increased Financial Obligations:** Venture debt adds an additional financial obligation to the company's balance sheet. The principal amount borrowed, along with interest and fees, needs to be repaid within a specified timeframe[36]

? **Higher Cost of Capital than Traditional Debt:** While venture debt generally offers a lower cost of capital compared to equity financing, it is still more expensive than traditional bank loans[27][36]

? **Risk of Default:** Do not use this type of funding if you cannot guarantee payment as the terms for default may mean you have to give up substantial ownership in your business or sell off your company's assets[27][36]

? **Dilution through Warrants:** Venture debt often includes warrants, which give the lender the right to purchase equity in the company at a predetermined price. This can result in dilution of existing shareholders' ownership if the warrants are exercised[36]

? **Limited Applicability:** Venture debt is typically suitable for companies that have already raised significant equity financing from institutional investors. Startups in the early stages or with limited investor backing may find it challenging to access venture debt[36]

? **Financial Covenants:** Venture debt agreements may include financial covenants that require the company to meet certain financial performance metrics or milestones. Breaching these covenants can have severe consequences, such as triggering default or stricter repayment terms[36]

? **Impact on Future Fundraising:** Taking on venture debt can potentially affect future fundraising efforts. Some investors may be hesitant to invest in a company that has significant debt obligations, as it may impact the company's ability to allocate resources to growth initiatives or increase financial risk[36]

? **May Require Shareholder Approval:** You may need approval from the angel investors or VCs invested in

your company to take on a significant amount of debt[27]

Pro Tips

- **Venture Debt Makes Sense When You're Already Generating a Reasonable Amount of Revenue:** *"Venture debt is a part of a lot of our businesses. After they cross a certain revenue threshold, say 3,4, [or] 5 million dollars in top-line annually, at that point venture debt begins to make a lot more sense. As a company you've already diluted yourself and investors [have] already been diluted through a number of rounds at that point so taking on a little bit of capital that you do have to pay back, but isn't eating out of equity can make a lot of sense depending on the business that you're in"* **– Climate Tech Investor**
- **Venture Debt May Be More Difficult to Obtain for the Foreseeable Future:** *"I think it remains to be seen, while SVB continues to function under its new ownership, how much the availability for venture debt through SVB and its successor entity declines or how those terms shift. The terms used to be extraordinarily favorable and those terms may become much more onerous. Paired with the fact that interest rates are going up so fast"* **– Climate Tech Entrepreneur**

Examples

Hercules Capital
Western Technology Investment
WindSail Capital

Project Finance

Description

- Project finance is used to fund commercially-proven projects (i.e., the installation and/or construction of specific plants or facilities) usually by a standalone subsidiary of the holding company (i.e., a special purpose vehicle or SPV) with the aim of delivering a product or service to one or more customers[10]
- This SPV is funded by a combination of equity from the holding company and non-recourse debt (i.e., a loan for which the holding company is not liable)[10]
- Characteristics of this type of funding typically include low risk, low return, large investment amounts, and long-term horizons for pay back[10]
- Project investors can operate with a 20+ year investment horizon for a single project (i.e., in line with the useful life of the asset)[10]
- Suitable for stable technologies with a track record of numerous deployments in similar conditions, limited uncertainty around construction costs and schedule, established operational performance, and well-known maintenance requirements[10]

- Key factors to consider include proven technology, reliable cash flows, market demand, a secure supply chain, trustworthy counterparties, familiarity with project finance structures, regulatory compliance, and potential government incentives[11]
- Project finance aims to contractually allocate risk to the party best suited to manage that risk (e.g., construction risk to an Engineering, Procurement, and Construction or EPC company, or market risk to a creditworthy offtaker) [10]
- Early-stage companies may find equity investments and government grants more appropriate for financing pure technology risks, while project finance becomes relevant for deployment risks and performance risk. Identifying the best use case for project finance funds and how they can shape your business model is crucial[37]
- As illustrated in a simplified manner in Figure 16 below, in a project finance transaction, the parties involved consist of lenders, such as commercial banks, and equity investors, which encompass various entities like the project sponsors (also known as developers), private equity firms, and institutional investors[11]

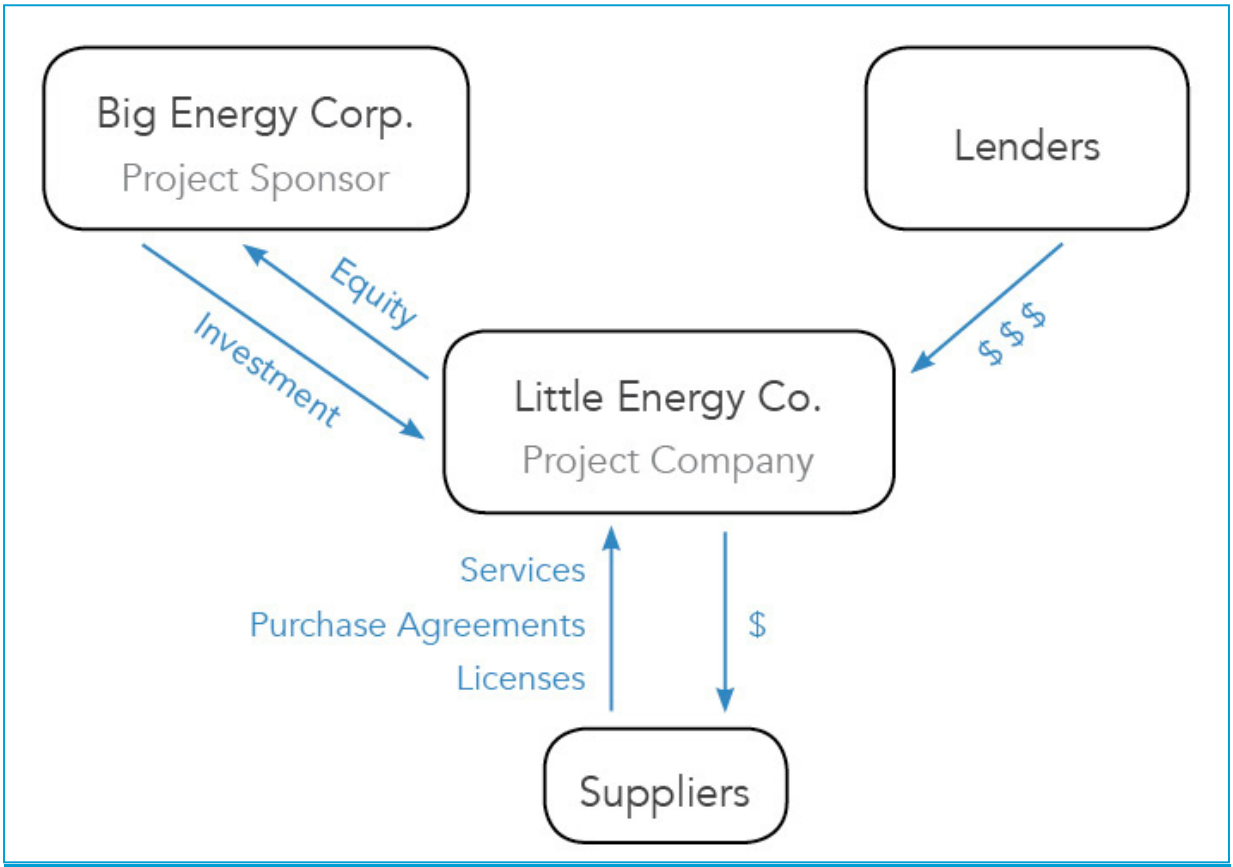


Figure 16: *Simplified Project Finance Structure; Source: Third Way*

Benefits

✓ **Access to Large-Scale Funding:** Project finance allows entrepreneurs to secure significant funding for their large-scale projects. By raising both debt and equity funding through a separate SPV, entrepreneurs can access capital markets typically reserved for more mature borrowers[37]

✓ **Risk Mitigation:** Project finance helps mitigate risks for entrepreneurs. The financing structure of project finance separates the project and its associated cash flows from the creditworthiness of the sponsors or participants. This means that the project's success is primarily based on its projected cash flows, reducing the risk for the entrepreneurs and making it easier to attract investors and lenders[37]

✓ **Long-Term in Nature:** It provides a stable financial foundation, making it easier to plan and manage the project's operations and growth[37]

✓ **Attractive Financing Terms:** Lenders and investors involved in project finance transactions are typically willing to provide longer loan tenures, lower interest rates, and flexible repayment schedules[37]

✓ **Sharing of Project Risks:** In project finance, various stakeholders, including lenders and equity investors, share the risks associated with the project. This helps distribute the risk burden among multiple parties, reducing the potential impact on entrepreneurs. Additionally, the involvement of experienced lenders and equity investors brings valuable expertise and resources to the project, increasing its chances of success[37]

✓ **Improved Creditworthiness:** Successfully executing a project finance transaction can enhance a business' creditworthiness. By demonstrating the ability to manage and finance a large-scale project, entrepreneurs can strengthen their reputation in the market and build a track record that can be leveraged for future projects[37]

✓ **Scalability and Growth Opportunities:** Project finance enables entrepreneurs to undertake ambitious projects that have the potential for significant scalability and growth[37]

Considerations

? **Complexity:** Project finance transactions are often complex and involve significant legal, financial, and technical complexities. Entrepreneurs may need to engage specialized professionals such as lawyers, financial advisors, and engineers. The extensive due diligence process and structuring of the transaction can be time-consuming and resource-intensive[37]

? **Cost:** Significant cost and time effort involved in removing all binary risks from a project, as these types of risks are usually not acceptable to providers of project finance (e.g., permitting, public opposition, interconnection

approvals, lack of a creditworthy offtaker, etc.)[10]

- **High Level of Documentation:** Project finance requires extensive documentation, including legal contracts, financial models, feasibility studies, and technical reports. Entrepreneurs must be prepared to provide detailed information about the project, its risks, and its expected cash flows[37]
- **Strict Eligibility Criteria:** Project finance lenders and investors typically have strict eligibility criteria for the projects they support. Entrepreneurs must demonstrate a solid business case, reliable cash flow projections, and a track record of successful project execution. Underwriting criteria for lenders also includes a proven technology, low-risk equipment suppliers, and demonstrated operational performance (e.g., through a demonstration plant)[2][37][10]
- **Limited Applicability:** Entrepreneurs pursuing projects in emerging or high-risk sectors may find it challenging to attract project finance due to perceived risks or lack of bankability[37]
- **Regulatory and Political Risks:** Projects subject to regulatory changes, policy shifts, or political instability can face additional risks in project finance. Changes in regulations or political climates can impact project economics and jeopardize the anticipated cash flows[37]
- **Milestone-Based Disbursements:** Disbursements of the funding can be based on achieving certain milestones through the development of the project[10]
- **Security Required:** The assets of the project company or SPV are typically pledged as security[10]

Pro Tips

Your ability to access project finance is largely determined by your ability to alleviate the following risks[10]:

- *Technology risk (largely consisting of construction, commissioning, and performance risk i.e., does the technology perform as expected within given time, cost, and customer parameters?)*
  - *After an operational track record has been established through demonstration plants, turnkey EPC contractors will usually be able to assume this risk by providing performance guarantees*
- *Market risk (i.e., is there risk associated with your suppliers and with your customers?)*
  - *Usually mitigated through long-term purchase agreements outlining minimum volumes, quality, and ideally at a fixed or minimum guaranteed price*

- *Regulatory or policy risk (i.e., does your project have the permitting/political will for it to proceed, and is your business model at the mercy of regulatory design, regime changes, or incentives?)*
- *Business scaling risk (i.e., is there a pipeline and demand for similar projects to be built after this one?)*
- *Additional reassurance can be provided to lenders through government loan guarantees, insurance, or warranties*[11][10]
- **Understand How Project Finance Fits into the Capital Stack**[37]**:** *"Use as little equity capital as you need to deploy projects. Use project finance and debt to fund actual projects in your field, and use any corporate equity capital you raise to fund R&D, growth, and overhead of the business"* **– Climate Tech Entrepreneur**
- **Make Sure Your Financing Assumptions Are Robust**[37]**:** *"You really have to make sure you're ready for it before you do it. If we tried to sell this project 6 months ago and it only worked on a razor thin low-interest rate margin, we would have to abandon it now. So you have to work hard to make sure it's flexible for different interest rates"* **– Climate Tech Entrepreneur**
- **Get a Good Sense of the Costs Beforehand**[37]**:** *"Going down the project finance path is not something you should take lightly. There are a lot of costs, both hard and soft, in getting it done. You should do your diligence with your lenders to understand what those costs are going to be. And very importantly, align with your equity investors or other sources of capital"* **– Climate Tech Entrepreneur**
- **Manage the Costs Well Beyond the Transaction**[37]**:** *"[Businesses] need to be careful here because if they build up too much capacity in-house themselves, then they are racking up a lot of fixed costs. What that does is move away the break-even point for these projects, which makes the financing harder"* **– Expert at Climate Tech FinTech**
- **Understand Your Project's Economics without Tax Incentives**[37]**:** *"While the IRA will be an accelerant, do not build your business around any specific incentive program because you will probably go out of business once that incentive money runs out. Even though the IRA is by far the biggest federal injection of cash into the Climate Tech market that we've ever seen, it's probably going to run out faster than you think"* **– Climate Tech Entrepreneur**

Examples

Global Banking & Finance Review's List of 100+ Investment Banks

Additional Pools of Capital

The sources of funding explored in this chapter are not exhaustive. Other pools of capital beyond the scope of this guidebook, but nonetheless worth exploring, include:

- **Capex Facilities / Hardware-as-a-Service (HaaS):** CapEx facilities refer to financing options that help entrepreneurs access capital for acquiring capital expenditure (CapEx) items, such as equipment or hardware. Hardware-as-a-Service (HaaS) is a model where entrepreneurs can lease or rent hardware instead of purchasing it outright
- **Donor-Advised Funds / Philanthropic Funding:** Donor-Advised Funds are charitable giving vehicles that allow individuals or organizations to make contributions to a fund, receive immediate tax benefits, and recommend grants to support charitable causes. Philanthropic funding refers to financial support provided by foundations, organizations, or individuals with the aim of promoting social or environmental causes
- **Family Offices:** Family offices are private wealth management firms that manage investments and financial affairs for wealthy families. They can provide investment opportunities, capital, and expertise to entrepreneurs in various sectors, including Climate Tech
- **Forward Purchase Agreements / Advance Market Commitments:** Forward purchase agreements involve pre-selling products or services to buyers or investors at agreed-upon terms and prices, securing future revenue and enabling access to capital. Advance market commitments are agreements where governments or organizations commit to purchasing or supporting specific products or technologies in advance to provide market incentives and support innovation
- **Government Contract Financing:** Government contract financing refers to financial assistance or loans provided to entrepreneurs who have secured contracts with governmental entities. These programs help entrepreneurs access capital to fulfill government contracts, which can be a significant source of revenue
- **Merchant Cash Advances / Factoring:** Merchant cash advances or factoring involves selling future receivables to a financing company at a discount in exchange for immediate cash. This allows entrepreneurs to access working capital based on their expected future revenue or outstanding invoices
- **R&D Tax Credits:** R&D tax credits are tax incentives provided by governments to encourage research and development activities. Entrepreneurs engaged in eligible R&D projects can claim tax credits, which

provide financial relief and can be used to offset tax liabilities or obtained as cash refunds

- **Sovereign Wealth Funds:** Sovereign Wealth Funds are investment funds owned and managed by governments, typically derived from a country's surplus revenues. These funds invest globally in various sectors, including Climate Tech, with the aim of generating financial returns while supporting national economic objectives
- **Structured Corporate Capital:** Financial instruments, such as convertible debt or preferred equity, that serve as a bridge to help the company reach its next milestone. Importantly, these instruments do not involve making judgments about the company's valuation. Additionally, they can be used to raise capital during periods of market instability
- **Venture Leasing:** Venture leasing refers to leasing arrangements specifically designed for startups and early-stage companies that may not have substantial assets or cash flow. It allows entrepreneurs to lease essential equipment or facilities instead of purchasing them outright, conserving capital and providing flexibility

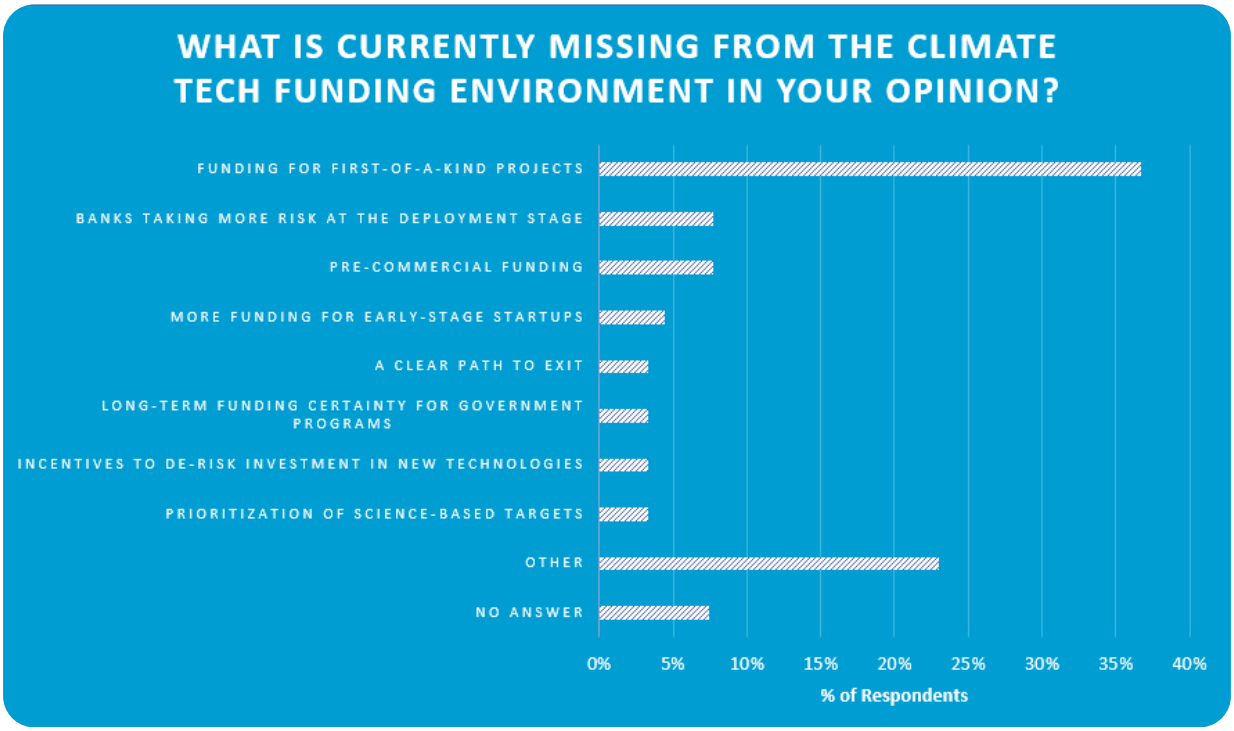


Figure 17: *Survey of Climate Tech Experts; Source: A Financial Guidebook for U.S. Startups Crossing Climate Tech's Valleys of Death and Achieving Scale by Hugo Mkhize; Methodology: Based on 44 interviews between March-June 2023*

What the Experts Say: Key Takeaways

Scaling and Commercialization: Experts emphasize the importance of scaling, growth, and commercialization of Climate Tech solutions. They believe that large-scale projects require significant capital investment beyond what is typically available through VC rounds. Access to financing for first-of-a-kind and commercial-scale projects is crucial, however, this funding is challenging to obtain. Traditional sources of project financing consider these projects too risky, while venture capital may not be suitable due to the high upfront capital costs and technology risks involved. There are a lack of programs and resources to assist in the transition from lab-scale prototypes to manufacturing and large-scale production. Startups need support in scaling their technologies and processes.

Initial Pre-Commercial Funding and Support: There is a need for early-stage funding to help startups with incorporation and smaller expenses that arise during the initial stages of development. Providing small amounts of money during critical periods can help startups bridge gaps and avoid distractions. Funding opportunities are limited for researchers and founders seeking to start a company based on their innovations outside of university or national lab settings. Non-dilutive capital is needed to support development work and bridge the gap between research and venture capital.

Increased Early-Stage Capital: There is a call for an order-of-magnitude increase in early-stage financing across different segments, including SMBs, startups, projects, frontier tech, and deployment. The rapid deployment of existing technologies is crucial in addressing climate change effectively.

Catalytic Capital: Non-dilutive or mezzanine funding that helps early-stage companies make progress and attract subsequent rounds of funding is necessary. This catalytic capital can provide the necessary boost for companies to grow and demonstrate market viability.

Standards and Demand: Setting standards for scientific validity and creating demand for Climate Tech solutions are important factors in unlocking finance. Supporting pilot-stage financing in the range of $5 million to $20 million can be beneficial in bridging the gap between early-stage and project financing.

Engagement of Traditional Financial Institutions: There is a need for traditional banks, infrastructure funds, and institutional investors to engage in Climate Tech funding. Their involvement can provide significant capital to support commercial viability and widespread adoption of Climate Tech solutions.

Government Incentives and Capital Access: Greater awareness and understanding of incentives available through various pieces of legislation and funds are needed to connect existing capital with Climate Tech founders. Facilitating connections between capital providers and entrepreneurs is essential.

"I think there's the opportunity there for the big banks to get involved and understand that all of these technologies are new [and] a lot of these technologies did not exist ten years ago, but you have the big [incumbent] players that are already working with them, that are already partnering with them. This is [to] de-risk these companies, if you will, in the more traditional sense. This is where we really need action in scaling, growth, and commercialization of all these [Climate] Tech [solutions]. It [can] look great on paper, it can look great on a pilot, but you need to stress test it for commercial viability and they cannot get there just with the VC landscape as it is now with, I don't know, $50 million rounds. You need maybe $100 million to actually put a commercial plant in place so it's very difficult to reach the level of scale that we need [to reach] the 2030 milestones or 2050 milestones, [especially] if there are not huge amounts of capital to make that happen." **– Expert at Accelerator**

"I still think this first-of-a-kind capital gap is still very important for first-of-a-kind projects... I do think that the OCED from the DOE is going to be [stepping into that gap]. But even then, they still need private capital to step up. And so hopefully we can find more ways for private capital to step up and ways that provide good risk-adjusted returns." **– Expert at Infrastructure Finance Provider**

"What we really need is for the trillions of dollars of assets under management in the banks, traditional infrastructure funds, and institutional investors to come off the sidelines once we have proven the commercial viability of these projects. That's the critical step to commercialization and lift-off or commercial lift-off. And so a lot of our work will be focused on interfacing with those groups and sharing the learnings from our projects to demonstrate how and where we've brought down adoption risks. And encourage those dollars to come in. All those dollars are on the sideline right now and we've got the at-risk funders ready to fund our projects. We need the projects to be super successful and that's what we can use to bring the next much larger pools of capital into the sector." **– Expert at Government Funding Organization**

What the Experts say

The Climate Tech Experts identified several gaps in the current funding environment. There is a need for diverse funding sources, tailored financial instruments, and increased capital availability at different stages of development, including:

- **Scaling and Commercialization**
- **Initial Pre-Commercial Funding and Support**
- **Increased Early-Stage Capital**
- **Catalytic Capital**
- **Standards and Demand**
- **Engagement of Traditional Financial Institutions**
- **Government Incentives and Capital Access**

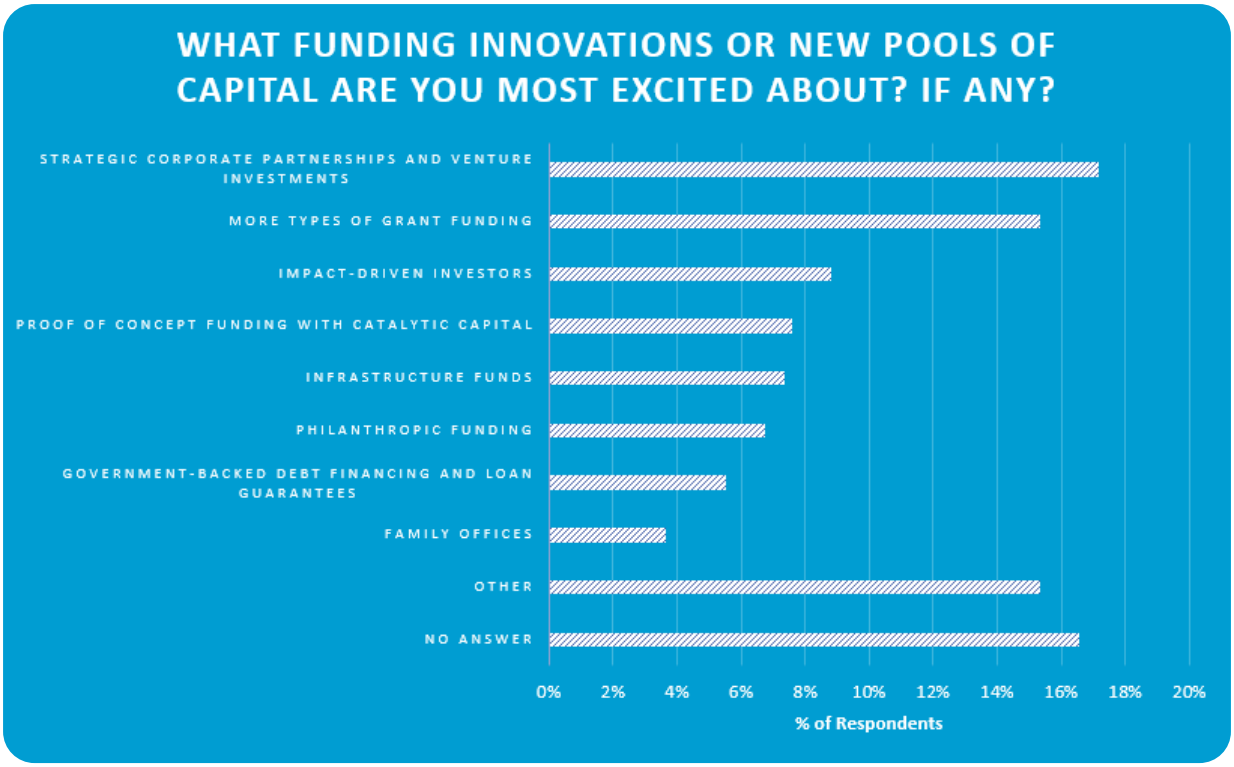


Figure 18: *Survey of Climate Tech Experts; Source: A Financial Guidebook for U.S. Startups Crossing Climate Tech's Valleys of Death and Achieving Scale by Hugo Mkhize; Methodology: Based on 44 interviews between March-June 2023*

What the Experts Say: Key Takeaways

Corporate-Startup Collaborations: Collaborative relationships between corporations and startups, particularly through pilot partnerships, are seen as valuable sources of funding. Experts believe that paid pilots validate and facilitate the scaling of Climate Tech products better than traditional venture investments, making corporate partnerships and corporate venture capital attractive avenues for financial support. The Experts express excitement about non-Climate Tech investors and corporations entering the space. This influx of capital and interest from strategic investors who were previously less involved in Climate Tech is seen as a positive development.

Novel Debt Instruments and Loan Guarantees: Experts are excited about the availability of increasingly innovative debt instruments and loan guarantees. These mechanisms provide securitization behind initial projects, instill confidence in lenders and attract more capital into the Climate Tech sector. Experts acknowledge the increase in capital available through government initiatives like the Inflation Reduction Act (IRA) and the Loan Programs Office (LPO). However, they highlight the need for effective deployment and efficient utilization of these funds to ensure they have a meaningful impact on the Climate Tech sector.

Alternative Funding Models: Enduring Planet's early-stage revenue-based financing model for hardware-and-software-hybrid innovations is seen as a promising alternative to traditional VC. Experts highlight the need to explore alternative funding models, including asset-backed lending, more effective grants, and stacked capital that combines public and private funds to de-risk and support Climate Tech projects.

Fellowship Programs: The Experts find the Breakthrough Energy Fellowship program particularly exciting as it injects substantial funding into the earliest stages of Climate Tech. This funding helps bridge the gap between academia and commercialization, making it more enticing for researchers to pursue entrepreneurship and build teams around their ideas.

Conditional Forgivable Loans: Large philanthropic organizations offering conditional, forgivable loans based on achieving specific outcomes are viewed as an interesting funding model. This approach connects impact-oriented funding with measurable results, allowing philanthropic capital to support Climate Tech projects while aligning with philanthropic objectives.

Climate Adaptation Innovation: Observing and engaging with communities impacted by climate change can lead to innovative solutions. Experts emphasize the importance of recognizing the adaptive measures being taken in such communities as potential sources for startup ideas and fostering engagement between Climate Tech innovators and affected populations.

"I think the most exciting thing of the last couple of years has been the Breakthrough [Energy] Fellowship. We've seen that scale and grow and [they've] put a lot of money into actually getting things moving in the early stage. That I think is critical because the dollars that they put in make it much more viable and enticing for people to come out of academia [and] try to commercialize things and move the needle on it getting towards commercialization and being able to build a team around it that's actually able to raise money and do the things that they have to do." ***– Expert at Accelerator***

"I think one additional exciting opportunity here is there are large philanthropic organizations that are giving essentially loans, but they're conditional, forgivable loans. Essentially, they're saying we're going to invest $10 million in some outcome and if you actually achieve the outcome, then we're going to forgive the loan because then we can point to why it's philanthropic in nature. And if you don't, then you have to pay it back. I think that's a really interesting model because there's lots of money waiting in the wings, looking for impact, and if you can tie it to a specific impact or specific measurable outcome [that] could [work]." ***– Climate Tech Entrepreneur***

"And I think there are interesting solutions around Climate Tech, particularly around climate adaptation and climate mitigation. Necessity is the mother of all invention. How are we observing what is happening in these places and how people are adapting? Because startup ideas could be coming from that too. And how do you engage with that community so that could be another way to get more people engaging with the people that are [most] impacted." ***– Expert at Accelerator***

"I think there is currently a ton of money going into early-stage venture capital [and] angel investing when it comes to climate. A lot of these companies are getting to the stage where they've raised their seed, they've raised their Series A, and now they actually have to deploy. And especially with these hard tech solutions, there's a lack of risk tolerance among venture capital firms or a lack of capital among venture capital firms to help bring large-scale infrastructure projects to life" ***– Expert at Accelerator***

What the Experts say

The sentiment among the Experts is one of optimism, highlighting various financial innovations and capital sources that can drive the growth, commercialization, and scaling of Climate Tech solutions. However, orders of magnitude of the following capital sources are required:

- **Corporate-Startup Collaborations**
- **Novel Debt Instruments and Loan Guarantees**
- **Alternative Funding Models**
- **Fellowship Programs**
- **Conditional Forgivable Loans**
- **Climate Adaptation Innovation**

4 Evidence from the Real World: University Spinouts and Underrepresented Founders

> *"SO I THINK IT'S REALLY [ABOUT] SUPPORT FOR PROFESSORS. HOW TO HELP THE PROFESSORS SEE THEMSELVES AS ENTREPRENEURS SO THAT WHEN THEY ARE THINKING ABOUT WHAT THEY WANT THEIR LAB TO WORK ON, THEY'RE COMING AT IT FROM A PROBLEM-FIRST MENTALITY VERSUS A SOLUTION-FIRST MENTALITY. I THINK THAT THIS IS DEFINITELY NOT SOMETHING THAT IS GENERALLY DISCUSSED IN ACADEMIA, WHICH IS HOW DOES THE ACADEMIC THAT WANTS TO BUILD A [LAB], HOW DO THEY COME UP WITH THE THESIS FOR THEIR LAB? IS IT BECAUSE THEY'RE TRYING TO FIND A UNIQUE NICHE OF RESEARCH? OR IS IT BECAUSE THERE'S A PARTICULAR PROBLEM THAT THEY CARE ABOUT AND THEY WANT TO HEAR WHAT THOSE PROBLEMS ARE SO THAT THEY CAN DESIGN THE SOLUTIONS TO MEET THOSE PROBLEMS? WHAT I JUST DESCRIBED IS NOT STANDARD. BUT I THINK THAT THERE'S AN OPPORTUNITY IF YOU WANT TO ADDRESS CLIMATE CHANGE. THERE IS A REAL OPPORTUNITY TO BE PROBLEM-LED FIRST AND DESIGN YOUR LAB AROUND CREATING SOLUTIONS TO THOSE PROBLEMS."*
>
> *Entrepreneur in Residence at Accelerator*

Ideally, the sources of funding mentioned in Chapter 3 would be available to all aspiring founders in equal measure. However, for a number of non-exhaustive reasons highlighted in this chapter, that may not necessarily be the case. Therefore, in order to prepare a robust financial strategy for shifting across Climate Tech's Valleys of Death, it's important for entrepreneurs to understand why real life may turn out differently than the theory. This chapter aims to address the questions "why doesn't all fundamental research coming out of universities and national labs get turned into companies?" and "what steps need to be taken to include underrepresented founders in the Climate Tech funding environment?" The real value of this guidebook is being aware of potential challenges along your entrepreneurial journey and then designing your financial strategy to overcome those hurdles.

The first part of this chapter addresses university spinouts. Not all startups make it out of the first Valley of Death due to a lack of embedded entrepreneurship programs at their university, limited lab facilities, and the opaqueness of policies and processes of technology transfer offices (TTOs), amongst other factors. The second part covers underrepresented founders. Startups may face additional challenges during the second and third Valleys of Death because raising capital is highly relationship and network driven, resulting in biases and certain segments of society being excluded. While these issues may carry over into the fourth Valley, certain studies argue that by this stage, businesses have reached such a scale that they are predominantly evaluated through objective measures such as financial performance and market position, rather than the characteristics of the founding team, making these late-stage opportunities relatively easier to evaluate[38].

A. Challenges Faced by University Spinouts and Potential Solutions

Challenges

University spinouts in the Climate Tech space face a range of challenges throughout their journey. One of the most significant barriers to success is the need to de-risk the technology to attract outside investment. This requires not only developing the technology but also building a strong entrepreneurial team that can commercialize the innovation[22]. The time commitment of academic advisors can also be a significant challenge as they balance their research with the demands of startup development[22].

Another hurdle that spinouts must overcome is access to the necessary facilities and talent. Startups require technical, managerial, commercial, and entrepreneurial expertise, and the right team can be difficult to assemble. Universities that lack policies and processes to support spinouts can exacerbate these challenges[22].

As a startup progresses, the founder must shift their focus to developing production processes, integrating into established supply chains, and refining their business model. At this stage, risk factors emerge in areas such as technology, production, market, finances, and team[22]. To secure investors and customers, entrepreneurs must prioritize reducing these risks by accessing skilled labor and expertise, absorbing complementary knowledge and insights, testing and validating the commercial viability of their product or service, forming networks and alliances, and securing funding from both public and private sources[22].

Embarking on the journey of building a startup is not without its risks, and academic entrepreneurs must be aware of these risks. A failed spinout may erode the founder's standing as an academic or slow their output of academic publications. However, starting a business can also be a natural career progression for the founder, and if successful, the ownership stake in the startup can lead to significant financial rewards in the long term[22].

The Process for Researchers Once They Have Invented Something They Would Like to Commercialize

Once researchers have decided to commercialize their research, one of the key considerations is the equity split between the founding team, the university, and any additional advisors[22]. This is important because it can affect the incentives for all parties involved and the attractiveness of the startup as an investment proposition. Negotiations around the commercial terms in a university spinout should focus on finding a distribution of equity that is acceptable to all parties based on contributions rather than seniority[22]. It is also important to

agree on non-equity related terms such as license terms and future access to university facilities and expertise. Fairly applying university policies relating to intellectual property (IP) is another crucial factor[22]. While there are four general types of IP (patents, copyrights, trade secrets, and trademarks), for university spinouts, patents are the foundation of the company's intellectual property portfolio[26].

Some of the factors that founders should take into account when deciding how to allocate the initial equity in the spinout include assessing who will or who has played a role in fulfilling the following key functions[26]:

- development of the company's technology
- creation of the business idea and business plan
- leadership in promoting the company
- assumption of risk in launching the company
- investment of time, effort and money in the company

Additionally, in recognition of the academic institution's ownership of the intellectual property or other contributions, the spinout will often issue shares to the university (or its related foundation) in exchange for a license to core intellectual property[26]. In the United States, this initial ownership for the university can typically fall in the region of 3-10% of the company's total issued and outstanding shares[39][26].

In terms of patents, the application process will generally start with the academic institution making one or more applications with the United States Patent and Trademark Office (the "PTO")[26]. It is not uncommon for the applicant to start with as broad a claim as possible in terms of the patentability of the inventions claimed in the application, and then for the PTO to initially reject this broad scope. However, it is in the spinout's interest for the scope to remain broad in order to allow for sufficient flexibility in how the innovation is commercialized further down the line. As a result, this application process can take place over a number of months or years[26].

While the development of an IP strategy is outside the scope of this guidebook, some key questions for an aspiring founder to ask themselves while navigating this process may include[26]:

- Which inventions should I try to patent?
- In which countries should I try to get patent coverage?
- How long will this take?
- How much will it cost?

When structuring and negotiating the terms of the university license, the founder can gain substantially from retaining the services of a licensing attorney who is experienced in working with university spinouts[26]. As outlined in Figure 19 below, many of the key action items relating to incorporation, personnel matters, intellectual property, and company administration may be best navigated with the aid of legal counsel.

Action Item	Responsibility/ resource
Basic Incorporation matters	
Select company name	Founders
Check name for availability	Attorney
File for incorporation in appropriate state	Attorney
Elect Board of directors	Attorney
Adopt Bylaws	Attorney
Adopt conflict of interest policy	Attorney
Adopt financial controls policy	Attorney
Issue founders stock (with vesting suitable to historic and future contributions) in exchange for cash and/or property (including any business plans, IP, websites or other company- specific property created or acquired before incorporation)	Attorney
Appoint officers	Attorney
Stockholder Agreement	Attorney
Personal/ Employee matters	
Clear any prior noncomplete obligation	Founders and Attorney
Satisfy university conflict of interest requirements	Founders
Proprietary Information Agreement (PIA) for each founder	Attorney
Offer letter and PIA for each employee	Officers or Attorney
From 1-9 (immigration form) for each employee	Officers
Consulting Agreement for each consultant/contractor	Officers or Attorney
Stock Incentive plan	Attorney
Stock Incentive Awards for key personal	Attorney
Intellectual Property	
Develop preliminary IP strategy and budget	Officers and Patent Attorney
Secure license from University	Officers or Attorney
Utilize suitable confidentiality agreement	Officers or Attorney
Tax finance /Administration	
Open bank account	Officers
Procure adequate liability, casualty and worker's compensation insurance	Insurance Agent
Obtain Federal employer identification number (EIN) (From 55-4)	Attorney or Officer
File 83 (b) election forms	Attorney or Officer
File 5 election(if applicable) (From 2553)	Attorney or Accountant
Federal, state and local tex filings	Accountant
Payroll and tax administration	Payroll service
Consider medical and other benefit programs	Benefits professional
Qualify to do business in state where business operates	Attorney
Obtain business license from city, town, country, if applicable	Officers or Attorney
Register for government incentives (e.g North Carolina or (Qualified Business Venture tax credit)	Attorney
File annual report in state of incorporate and where business operates	Officers or Attorney
Establish organized, secure system for corporate records (including material contracts and employee files)	Officers or Attorney
BEA fillings if foreign ownership> 10%	Attorney

Figure 19: *Key action items for founders and their service providers over the first few months of starting the business; Source: Hutchinson Law Group*

The Rights of Researchers and Universities

The underlying premise of the Bayh-Dole Act of 1980 is to provide incentives to promote commercialization of federally funded inventions and thus foster improvements to the quality of life and economic growth of the United States through basic research[26]. This public good lens goes some way to explaining why the law has a strong preference for universities owning the inventions from government-funded research. As a result, most spinout transactions are in the form of an award to the spinout of a license to the patented intellectual property that will form the basis of the spinout's business, rather than a sale (or "assignment") of those patents[26]. A university outlining how the licensee (i.e., the spinout) should make use of the IP in an appropriate and constructive manner allows it to demonstrate to the federal government that it is meeting its obligations under Bayh-Dole.

A university often will retain certain rights relating to the IP, such as the right to use the underlying technology for educational and research purposes as well as to publish academic papers about the technology[26]. Under the Bayh-Dole Act, there may also be a requirement that the products covered by the licensed patents be manufactured substantially in the United States. Some of the key terms outlining the rights of the spinout and the university as it pertains to the patents include the patent's scope, any sublicensing restrictions, fees and future expenses, and royalties. Aspiring founders should be aware of the key considerations regarding these terms.

When negotiating a license agreement with the university, the spinout company should aim for the broadest possible rights to the relevant patents[26]. This typically involves seeking a worldwide license that is exclusive to all fields of use, including any related improvements generated by the academic founders. Clearly articulating the company's development and commercialization strategy can help in negotiating appropriate sublicensing terms[26].

The relationship between a technology transfer office (TTO) and a Climate Tech entrepreneur seeking to spin out their technology from a university can be influenced by the alignment or divergence of incentives. In some cases, the TTO's objectives and incentives may closely align with those of the entrepreneur, fostering a collaborative and supportive environment. For instance, if the TTO's primary focus is generating revenue for the university through technology licensing or equity agreements, they are likely to be motivated to facilitate the successful commercialization of the technology. Additionally, some TTOs have specific programs or initiatives in place to

support entrepreneurship and spin-off ventures. In these instances, the TTO's incentives may be closely aligned with the entrepreneur's objectives. Both parties share a common interest in promoting entrepreneurial activities and maximizing the impact of the technology in the market. The TTO's support can range from providing guidance on commercialization strategies to offering access to resources and networks that can benefit the entrepreneur.

There are, however, also situations where the incentives of the entrepreneur and the TTO may diverge. TTOs often manage a portfolio of technologies and must prioritize certain technologies based on factors such as market potential, patentability, or strategic alignment with the university's research priorities. Furthermore, the TTO's risk management responsibilities can impact their incentives. They may need to assess the commercial viability and potential return on investment of technologies. If the entrepreneur's technology is considered high-risk or lacks clear market prospects, the TTO's incentives may be different, leading to a more cautious or conservative approach. The ownership and control of IP rights can also influence the incentives of both parties. If the TTO retains a significant stake in the IP or has restrictions on licensing or commercialization, their objectives may differ from those of the entrepreneur seeking to maximize the technology's potential.

Universities may impose certain restrictions on sublicensing to maintain control over the technology[26]. However, most tech transfer professionals are willing to accommodate the reasonable needs of the spinout company. It is important for the company to communicate its strategy effectively, as it can help in negotiating sublicensing terms that align with the company's goals.

A license fee is a fixed cash payment made at the time of signing the license agreement[26]. It often covers the university's sunk costs for patent filings. The spinout company can negotiate a deferral of the fee, either in part or in whole, until a certain milestone is reached, such as raising a specific amount of capital[26].

The spinout company is generally responsible for future patent expenses[26]. The company may either assume control of prosecuting the patents at its own expense or the university may retain some control over ongoing patent prosecution, with the spinout reimbursing the university for those costs. It is important for the company to ensure that the license agreement grants sufficient rights to prosecute and enforce the licensed patents and to avoid being obligated to cover costs for patents in

non-commercially important countries or for fields of use where exclusive rights are not granted[26].

The spinout company typically agrees to pay a percentage, usually in the single digits, of its revenues from sales of products utilizing the licensed technology[26]. Royalties are generally based on "net sales," which deduct taxes, shipping, returns, and certain discounts from gross revenues. Negotiations may become complex when addressing "royalty stacking" issues, where the company is required to pay royalties under multiple licenses for the same product[26]. The license agreement should include mechanisms to address and potentially reduce royalties when royalty stacking occurs.

All in all, when it comes to the patent application process, it is important for the spinout company to closely monitor the activities of patent counsel, ensuring that the company's IP strategy is being implemented and that costs are approved in advance[26]. Engaging legal expertise familiar with intellectual property and licensing agreements can be invaluable throughout the negotiation process.

It is not uncommon for academic founders to continue to publish, invent, consult and/or collaborate on a wide-ranging basis given their standing in their respective fields as productive inventors and leaders[26]. This thought leadership underlies the value of the academic founder, but may also create conflicts of interest with the spinout (e.g., an academic founder may want to publish material the company considers proprietary). The rights of the academic founder, spinout, and university are usually established through the policies and processes of the given institution's TTO, ideally following an open discussion regarding the scope of the founder's commitment to the common enterprise[22][26]. Aspiring founders should be aware of the key financial points of negotiation and other terms, as described in Figure 20, that may influence how the spinout operates post-incorporation[22].

Financial Terms	Other Terms and Conditions
• Equity split across founding shareholders	• How the IP is transferred into company (license or assign IP, license now and assign at trigger point)
• Equity for different types of contributions e.g., IP, cash, active support/'sweat'	• Rights of the spinout to IP pipelines and improvements
• Equity pools for incoming CEO, employee options, and decisions on how these pools dilute founding shareholders	• How enabled products are to be treated (products enabled by research but not covered by original patents)
• Financial terms on license (royalty-free vs. royalty-bearing; upfront fees; milestone-based payment	• Fields of use and sublicensing terms
• Patent prosecution costs pre- and post-spinout incorporation	• Access to valuable and specialist university facilities and services (e.g., high-performance computing services, lab space, ongoing support)
• Conditions on any cash payments (e.g., deferrals based on ability to pay/ stage of startup)	• Ongoing role of academics and relationship with research in university
	• Board seats and voting

Figure 20: Types of terms that typically have to be negotiated as part of a spinout deal; Source: University of Cambridge.

In summary, factors that can influence the equity distribution between universities and founders in a spinout include the level of support provided by the university, the amount of research that has gone into the spinout, the core value proposition of the spinout, access to cash resources, growth potential, and the type of spinout[22]. Deals will also need to consider the transfer of IP, financial terms, ongoing access to university facilities, and the role of the university in company decisions. Founders should be cautious about cutting ties with their parent university as ongoing access to academic resources can be beneficial, and they should balance giving up equity with the need to pay license fees or royalties to the university[22]. It is important to carefully negotiate these terms to ensure that all parties are fairly compensated for their contributions and to avoid long-term economic losses. The success of achieving these negotiated outcomes can impact the number

of startups making it beyond the first Valley of Death as well as the company's attractiveness for investment further down the line.

Potential Solutions

Universities should consider implementing policies that balance the interests of all parties involved in spinouts, including researchers, founders, and the university itself[22]. This may include developing clear guidelines for IP ownership and licensing, creating transparent equity split structures, and providing access to resources and mentorship to support spinout development. In addition, universities can negotiate the commercial terms of the spinout with academic founders to ensure that access to the IP and know-how is not unreasonably restricted, and that mechanisms are in place for academics to remain involved in the spinout post-incorporation[22].

Another potential solution is to establish partnerships with external stakeholders, such as accelerators, venture capitalists, and industry players, to provide additional resources and expertise to support spinout development[4]. These partnerships can help to bridge the gap between academic research and commercialization, while also providing founders with access to networks that can support their startup's development.

Universities can also consider implementing programs that foster a culture of entrepreneurship and innovation among their students and faculty (i.e., embedded entrepreneurship programs)[4]. This can include offering entrepreneurship courses, hosting innovation challenges, encouraging participation in training programs like I-Corps from the National Science Foundation, and providing mentorship and funding opportunities for early-stage startups. By promoting a culture of innovation and entrepreneurship, universities can help to cultivate a pipeline of talented entrepreneurs and researchers who are well-equipped to commercialize their ideas and bring them to market[22]. Furthermore, universities can help academic founders access capital by creating dedicated investment funds that can co-invest with pre-seed/seed investors[22]. They can also organize events and networking opportunities that allow academic founders to showcase their ideas, receive feedback, and build networks of potential investors. They can also provide support for grant sourcing, patent applications, and patent management prior to incorporation. Finally, universities can provide mentors to academic founders to support them throughout their entrepreneurial journey[22].

Founders should be aware of certain misconceptions when spinning their scientific research out of a university and into a startup. Firstly, that they are not best suited to commercialize the research. This is likely incorrect as, for this stage of the company's journey, one of the people who did the original research will be more invested in a successful outcome than any outsider[39]. Secondly, that the purpose of allocating equity is to recognize past

contributions to developing the scientific breakthrough. In reality, equity is a form of incentivization and its allocation should anticipate future contributions[39]. This might inevitably mean that more junior contributors on the original academic team, who intend to leave the university and pursue the spinout, need to be more highly incentivized than their manager or supervisor. Lastly, that you need to negotiate the licensing agreement immediately and that you need the agreement to start the business. If the agreement feels too burdensome, you should ask yourself if you need it at all[39]. Furthermore, startups often pivot so it might make sense to ensure that any royalties are directly tied to the use of the technology or consider taking an option to license the IP in the future to defer final negotiations[39].

Where possible, academic researchers should try and get in touch with past founders that have recently negotiated spinout agreements with their school's TTO[39]. This can provide useful context for which terms are considered standard and for which terms there is more room for negotiation. In order to obtain as many data points as possible to assist in decision-making and refining your negotiation strategy, you should also consider reaching out to investors, lawyers, and advisors for guidance[39].

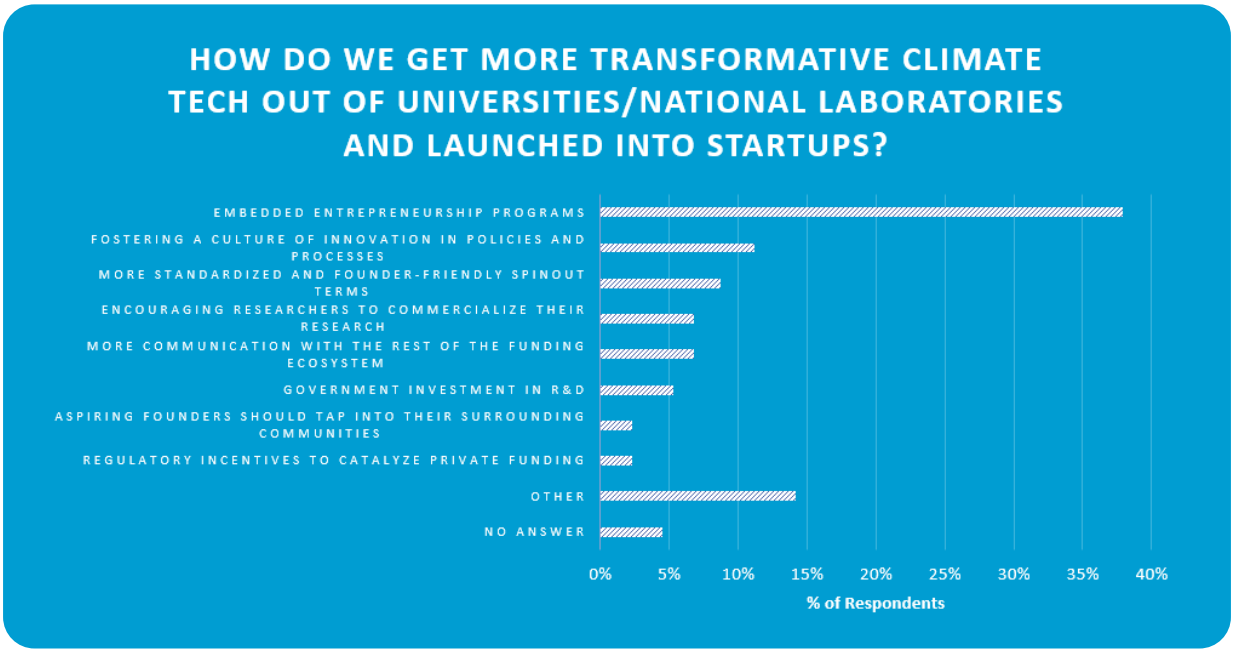


Figure 21: *Survey of Climate Tech Experts; Source: A Financial Guidebook for U.S. Startups Crossing Climate Tech's Valleys of Death and Achieving Scale by Hugo Mkhize; Methodology: Based on 44 interviews between March-June 2023*

What the Experts Say: Key Takeaways

Embedded Entrepreneurship Programs: The Experts were highly in favor of embedded entrepreneurship programs. These programs can provide support, resources, and funding to aspiring entrepreneurs, enabling them to translate research into startups and build initial teams. Furthermore, initiatives like Breakthrough Energy Fellows, Activate, Cyclotron Road, and Cradle-to-Commerce provide substantial grants to researchers to develop and prototype their technologies. Increased funding for such programs can facilitate the early-stage development of Climate Tech startups.

Cultivating an Entrepreneurial Culture: Universities like MIT, Cornell, and Caltech, among others, have successfully established a culture where professors collaborate with venture capitalists to start companies. These universities prioritize and support professors who have innovative ideas and work closely with the venture capital community. Universities need to prioritize and promote entrepreneurship, providing resources, incubators, and entrepreneurial centers to foster a culture where innovation and startups are encouraged.

Improving IP Licensing Processes: Simplifying and streamlining IP licensing agreements can expedite the commercialization of technologies. Establishing standardized and founder-friendly terms, in a similar manner to what Y Combinator did with the SAFE (Simple Agreement for Future Equity), can make it easier for entrepreneurs to secure investments. Universities and national labs need to align their objectives with commercialization and prioritize the dissemination of their science. Striking a balance between protecting intellectual property (and adhering to the objectives of Bayh-Dole) and providing favorable terms for entrepreneurs can lead to more successful partnerships.

Greater Collaboration with the Broader Ecosystem: Creating stronger connections between academia, entrepreneurs, and investors is crucial. National labs and universities should actively facilitate collaborations and matchmaking between researchers and experienced operators who can help commercialize technologies. Establishing test beds and research facilities that provide space, equipment, and resources to entrepreneurs can support the development and validation of Climate Tech innovations. These centers of excellence should actively aim to address problems faced by industry.

Education and Early Exposure: Universities, community colleges, and high schools should enhance curriculum and opportunities for entrepreneurship, offering programs that expose students to climate solutions and provide them with the necessary resources to develop their interest in the space and, further down the line, commercialize their ideas.

"The biggest challenge is someone who is commercializing tech through academia, like a professor who's tenured. They're not going to leave the university - there has to be some path for them to get it into the hands of the grad student who actually wants to commercialize it. And then there needs to be support for them to actually do so. There's a really cool program at Cornell University, which I think MIT has as well for PhDs, where they essentially [have] a Fellowship where they spend one day a week of their five normal working days, so 8 hours a week working on the startup and trying to understand what it would take to commercialize their tech or some tech rather than just working on their research. And I think things like that are cheaper than tactical [programs], especially because we have more PhDs coming out of universities than we have academic positions for them. So helping them translate that to technology I think is huge." ***– Expert at Accelerator***

"There are entities that are doing a good job of this. So Cyclotron Road or Activate [are] really good examples of this where you essentially coach and educate scientists and enable them and give them the tools they need [to build a business]." ***– Climate Tech Entrepreneur***

"I think that universities have a role too. In the experience that I've had, if you talk to tech transfer offices at universities, they say [that] they support getting their science out into the [real] world and then you talk to founders about their experiences of negotiating with that office [and] you hear two very different stories. And so I think universities getting really clear [and] aligning on what their goals are. Would you rather get a slightly less good deal on paper, but actually get that tech out to the world in a way that the entrepreneur actually has a chance to succeed and return some investment? Or would you rather negotiate really harsh terms that maybe hamstring that entrepreneur and make it hard for them to succeed? What ultimately is your goal? Is your ultimate goal money for [the] university or is your ultimate goal getting the university's science out into the world? I think either way, [offering] more founder-friendly terms will help you in the long run on both scores." **– Expert at Fellowship Program**

What the Experts say

The Experts emphasized the need for collaboration, mentorship, resource allocation, and cultural shifts within universities and national laboratories to foster a conducive environment for Climate Tech startups to thrive. This could be achieved through:

- **Embedded Entrepreneurship Programs**
- **Cultivating an Entrepreneurial Culture**
- **Improving IP Licensing Processes**
- **Greater Collaboration with the Broader Ecosystem**
- **Education and Early Exposure**

B. Challenges Faced by Underrepresented Founders and Potential Solutions

> *"WE HAVE TONS OF DATA THAT MORE DIVERSE PORTFOLIOS AND MORE DIVERSE TEAMS AND MORE DIVERSE COHORTS OUTPERFORM MORE HOMOGENEOUS ONES. SO REGARDLESS OF THE MORAL ISSUE, YOU CAN MAKE A DATA-DRIVEN INVESTMENT DECISION THAT SAYS WE SHOULD PROACTIVELY TRY TO SELECT MORE UNDERREPRESENTED FOUNDERS BECAUSE THEY IDENTIFY MARKET OPPORTUNITIES THAT ARE BLIND SPOTS TO MORE HOMOGENEOUS THINKING. BUT YOU'VE JUST GOT TO HAVE THE COURAGE TO DO IT BECAUSE I THINK THERE'S A LOT OF PRESSURE [AROUND] "YOU'RE JUST BEING TOO WOKE" OR WHAT HAVE YOU. WELL, IT'S KIND OF BEING WOKE, BUT IT'S ABOUT MAKING BETTER INVESTMENT DECISIONS AND GENERATING BETTER RETURNS. SO WE THEN ALSO NEED TO TELL THOSE STORIES. WE NEED TO COMBAT THE MYTHOLOGIES THAT ARE PROBABLY BEING WHISPERED BETWEEN VC PARTNERS AND BEHIND CLOSED DOORS AND REALLY EVANGELIZE THE SUCCESS STORIES AND SAY, WE HAD A THESIS THAT WE COULD ACTUALLY DO REALLY WELL AND OUTPERFORM THE MARKET BY INVESTING IN HISTORICALLY UNDERREPRESENTED FOUNDERS."*
>
> *CEO of Climate Tech Startup*

Challenges

Globally and in the United States, female and ethnic minority founders face biases and added difficulties in raising capital[4]. Even during 2021, a record year for venture capital investment, only 2% of VC funding in the United States went to female founders[4]. While Black founders received about 1% of all VC funding, despite making up ~12% of the U.S. adult population[40]. In more challenging markets, as is anticipated over the course of 2023, underrepresented founders may find it increasingly challenging to fundraise in a setting where risk-averse investors fall back on heuristics and pattern matching (e.g., over-indexing on experience and multiple-time founders, traditional academic backgrounds, etc.)[41].

According to an Endeavor Insight study, Climate Tech companies with at least one female founder were less than half as likely to scale than their peers with all-male founding teams[4]. In the same study, minority founders assessed building relevant networks and accessing capital as greater challenges than did their non-minority peers. This disparity may be attributed to the backgrounds of minority founders making it more difficult to connect with investors and mentors without having shared professional and educational experiences upon which to build[4]. Founders can also find it difficult to find mentors with relevant Climate Tech industry experience, so they tend to rely on mentors in the broader tech sector[4].

A 2023 report by Fifth Star Funds put forward that the largest barrier to reversing the racial funding gap is the funding disparity at the so-called 'Friends and Family' (F&F) funding round[42][40]. This is usually the first opportunity for founders to raise external capital, and it is usually sourced from the founder's friends, family, and broader support network[40]. Lack of access to F&F funding prevents many underrepresented founders from building businesses, and ultimately, generational wealth[40][43]. For example, the wealth gap between White and Black American families, when excluding home equity, is 22 times (i.e., White families have 22x more liquid wealth than Black families), with the median Black family having $3,630 in liquid wealth[40]. Given the size of the average F&F round of ~$23,000, this means that the median Black entrepreneur would need to secure the entire liquid wealth of 6 Black families during their F&F round[40]. When founders do not have access to the F&F round, it detrimentally impacts the funding equality in later funding rounds[40]. This wealth disparity results in numerous investment-ready startups never being given the opportunity to scale and thus be targeted by the VC funding ecosystem.

The three primary factors resulting in the systemic underfunding of underrepresented communities can be summarized as discrimination, systemic biases, and the racial wealth gap[44]. Research in social psychology reveals the prevalence of strong, often unconscious biases in human beings. These biases can manifest in decision-making processes, such as investment and hiring decisions, leading to unequal opportunities for underrepresented founders[44]. Studies have shown evidence of these biases in the VC industry. For instance, a study analyzing Q&A sessions between VCs and entrepreneurs found that VCs asked different types of questions to male and female founders, resulting in gender-based biases[44]. Another study revealed that asset allocators were unable to properly evaluate Black-led VC managers, indicating a lack of understanding and familiarity with Black-led teams. These studies suggest that even well-

intentioned individuals can demonstrate unconscious biases, affecting investment decisions[44]. Moreover, in the United States, the economic consequences of racial biases and discriminatory policies, such as redlining and housing disparities, have hindered economic development for Black businesses and families, creating an unequal playing field. As a result, Black households have significantly less wealth than White households, impacting the ability of Black professionals to take risks early in their careers as well as accessing friends and family funding for early-stage companies[44]. These factors are compounded by the lack of easily accessible networks (often crucial in accessing VCs) and limited diversity in the capital allocator community.

The VC Decision-making Process for Early-stage Companies

Venture capital has a critical role to play in ensuring diversity at the onset of the business' journey as companies scale and VC-backed startups remain an important source of employment, innovation, and economic prosperity[43]. Given the early stage of VC investments, a high weighting is placed on the ability of the founder or founding team. A study by Macmillan, Siegel, and Narasimha[45] provides clear evidence supporting this notion that the entrepreneur's quality is the primary factor in determining funding decisions. Regardless of the product, market, or financial criteria, it is overwhelmingly the entrepreneur who determines whether a venture capitalist will invest[45].

The Macmillan, Siegel, and Narasimha study cites that the limited resources and numerous amount of proposals that venture capital firms receive create a significant bottleneck in their operations[45]. This leads to two disadvantages: first, venture capitalists spend valuable time processing and evaluating flawed proposals, diverting their attention from more productive activities; second, some viable proposals are rejected because the entrepreneurs were not alerted to and given the opportunity to address flaws before submission[45]. The study reveals that five out of the ten most commonly rated essential criteria, as shown in Figure 22 below, are related to the entrepreneurs themselves. Venture capitalists generally require entrepreneurs who exhibit sustained effort, demonstrate past leadership, handle risk effectively, possess relevant track records, and can effectively communicate their venture[45]. This finding reinforces the notion that entrepreneur-specific traits are the ultimate determinant of funding decisions in the venture capital community. Furthermore, in a separate study by Gompers et al. (2016), a study of VCs found that even post-investment, investors believe that the team plays a larger role in determining the success or failure of an investment compared to the business itself[38].

	Percent
Capable of sustained intense effort	64%
Thoroughly familiar with market	62%
At least ten times return in 5–10 years	50%
Demonstrated leadership in past	50%
Evaluates and reacts to risk well	48%
Investment can be made liquid	44%
Significant market growth	43%
Track record relevant to venture	37%
Articulates venture well	31%
Proprietary protection	29%

Figure 22: *Ten Criteria Most Frequently Rated Essential; Source: Macmillan, Siegel, and Narasimha, "Criteria Used by Venture Capitalists to Evaluate New Venture Proposals," 1985*

Besides investment selection, another investment activity performed by VCs is investment sourcing (or looking for new investment opportunities). According to the Gompers et al. (2016) study, VCs primarily source investment opportunities through their networks, with over 30% of deals originating from professional networks[38]. Additionally, 20% of deals come through referrals from other investors, 8% through referrals from existing portfolio companies, and nearly 30% are self-generated through proactive efforts. Only 10% of deals come from inbound requests (or 'cold' approaches) from company management[38]. Given that women and other marginalized groups often have limited access to beneficial connections that facilitate warm introductions to venture capitalists, cold approaches become particularly significant for these individuals[46].

The manners in which VCs assess startups (both during investment sourcing and selection activities) lend themselves to potential biases and discrimination. When confronted with a woman or multicultural founder, VCs tend to rigidly adhere to their preconceived notions of "fit" which can lead to homogeneity in portfolio company founder demographics[47]. However, VC firms with greater diversity in their investment teams, whether in terms of gender or race, have a higher percentage of diverse founders in their portfolios[47]. Having said that, less than one-third of VC firms have at least one female partner, while only 2% of investment professionals are Black and 1% are Latinx[47]. In other words, the burden is falling on entrepreneurs to identify firms with partners who are more likely to recognize the potential in their business because they are currently few and far between. Although these results reflect the outcomes of the VC community more broadly, there is little evidence to suggest significant differences in either the Climate Tech space or within the capital allocator community at large.

Diversity in the VC Capital Allocator Community

Research conducted by Lerner et al. (2021) indicates that in 2021, minority-owned groups accounted for only about 1.4% of the total assets under management (AUM) among investment management groups, despite minorities constituting over 40% of the population at that time[48]. This imbalance is potentially problematic for two reasons[48]. Firstly, ownership of financial institutions, especially private capital groups, plays a significant role in generating wealth. Secondly, academic studies have revealed the existence of homophily in private capital markets, whereby investors tend to finance individuals who share similar characteristics to themselves (evidenced in works by Ewens and Townsend, 2020; Gompers et al., 2017)[48]. The racial disparities in the ownership of private capital groups can have significant implications for which entrepreneurs receive funding, creating barriers to crucial avenues of wealth and job creation. Supporting this notion, research by Fairlie et al. (2020) and Cook et al. (2022) demonstrates that Black-owned startups encounter greater challenges in raising external debt and equity capital, hindering their growth prospects[48].

The relative lack of funding for female founders has been attributed to unconscious biases within the investment community, which is predominantly male, also because people tend to be drawn to others who look like them and have shared similar life experiences[4]. As a result of this unequal gender distribution among capital allocators, female founders have also reported that they can be subjected to unfair lines of questioning around their leadership capabilities, particularly in the hard sciences and engineering fields[4]. Beyond gender and ethnicity lines, there is also a lack of diversity in the investor base willing to support university spinouts at the early stages[8].

Why Diversity Matters for Climate

Throughout history, the Black community in the United States has been disproportionately affected by the consequences of climate change[49]. Due to longstanding economic and social disadvantages, this community is consistently at a higher risk of experiencing the full impact of natural disasters, regardless of where they occur. Given this dynamic, the startup ecosystem cannot afford to ignore ideas based on their origin. The unique cultural and social perspectives derived from diverse lived experiences must be integrated into solving climate issues[49].

Currently, the lack of funding and the scarcity of diversity, equity, and inclusion (DEI) data indicate that the venture community as a whole is disregarding a vast amount of untapped potential[49]. Efforts must be made to address systemic barriers that hinder the representation

of women and minorities in Climate Tech. Not only will this encourage a just response to global climate challenges, but research provides compelling evidence that companies with diverse workforces tend to outperform their peers financially[50]. A 2015 McKinsey study (as shown in Figure 23 below) revealed that companies in the highest quartile in terms of gender or racial and ethnic diversity are more likely to exceed the average financial returns within their respective industries. Furthermore, diversity can act as a competitive differentiator, gradually shifting market share in favor of more diverse companies over time[50].

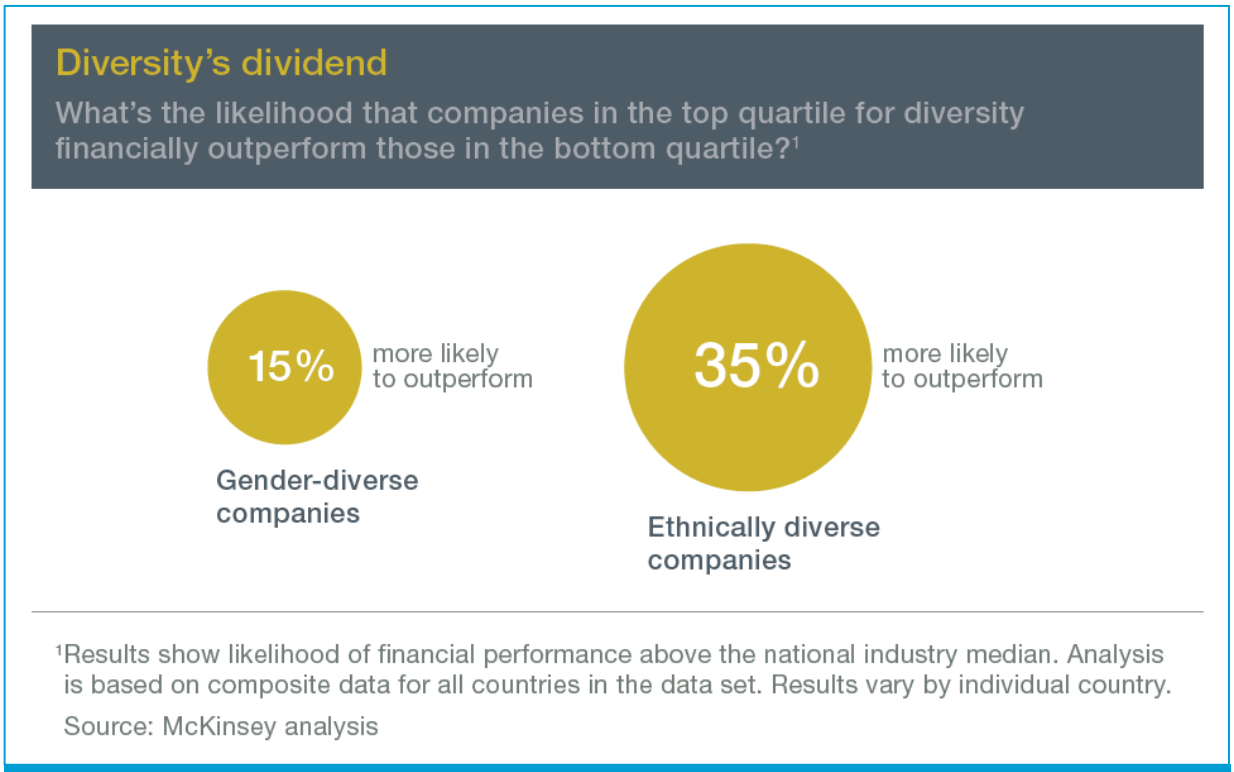


Figure 23: *Diversity's Dividend; Source: McKinsey Analysis*

It's important to note that while correlation does not imply causation (i.e., having greater gender and ethnic diversity in corporate leadership does not automatically guarantee higher profits), but the correlation does indicate that companies that prioritize diverse leadership tend to experience greater success[50]. The McKinsey study hypothesized that this is because more diverse companies have a strategic advantage in attracting top talent, enhancing customer orientation, improving employee satisfaction, and making better decisions. Furthermore, their findings suggest that other forms of diversity, such as age, sexual orientation, and varied experiences (including a global mindset and cultural fluency), are also likely to provide some level of competitive edge for companies that can attract and retain diverse talent[50].

Potential Solutions

Creating a diverse pipeline of Science, Technology, Engineering, and Mathematics (STEM) talent is important in addressing these funding disparities over the long term[42]. Furthermore, environmental justice considerations are intrinsically linked to the equitable distribution of capital within the Climate Tech space. Climate change and underrepresented communities are directly tied[42]. This is because communities dominated by people of color are disproportionately impacted by climate change. As a result, capital allocators and decision-makers should be intentional about funding entrepreneurs that are solving problems in their own communities[42].

Underrepresented founders actively benefit from creating networks with other founders from shared backgrounds[4]. Furthermore, larger networks can also be beneficial when founders are looking to raise capital, in fact, when selecting support programs such as incubators and accelerators, founders should prioritize those that provide introductions to a larger investor base[4]. There is an increasing need to increase representation within the investor community by encouraging women and minorities to pursue careers in venture capital, tech, and entrepreneurship in greater numbers[4]. This will reduce the implicit bias and homogeneity in key decision-making roles within investment firms. In this regard, legislation can also play a role in creating a pipeline of talent within the Climate Tech ecosystem. For example, the CHIPS and Science Act of 2022 will fund the expansion of STEM programs and research at Historically Black Colleges and Universities (HBCUs)[4]. Women and people of color who have experience in founding and operating Climate Tech companies should be encouraged to mentor and act as angel investors to up-and-coming founders from underrepresented groups[4]. Moreover, investors based in established hubs such as Silicon Valley, Los Angeles, and New York should look outside their immediate vicinities to identify scalable Climate Tech companies in other growing markets within the U.S. and beyond[4]. In order to address the funding gap at the Friends & Family funding round, pre-seed-focused programs in conjunction with universities and other institutions should do more to help underrepresented founders navigate the VC funding environment through coaching and training, and ultimately, capital[43]. Lastly, founders can identify venture capitalists that are focused on ensuring that their deal pipeline includes diverse founders by[42][41]:

- Not solely relying on warm introductions – accepting pitch decks directly on their websites
- Having specific events focused on underrepresented founders to educate them about the different pools of capital and how to tap them
- Building relationships with diverse communities, professors, and universities

- Seeking out founder and tech affinity groups focused on underrepresented individuals
- Supporting underrepresented founders with seed-stage, non-dilutive capital
- Providing mentorships, embedded networks, and infrastructure beyond the capital

It is crucial to recognize that excluding women and people of color from investment opportunities not only leaves potential profits on the table but also stifles entrepreneurship for future generations, ultimately acting as a barrier to the scaling of potential climate solutions. As the venture capital industry evolves (both in Climate Tech and more broadly), it needs to address the structures and biases that have perpetuated these inequalities and create an inclusive environment for marginalized founders[51]. Climate Tech investors are uniquely positioned to build strong and diverse portfolios due to the relative newness of the climate field[49].

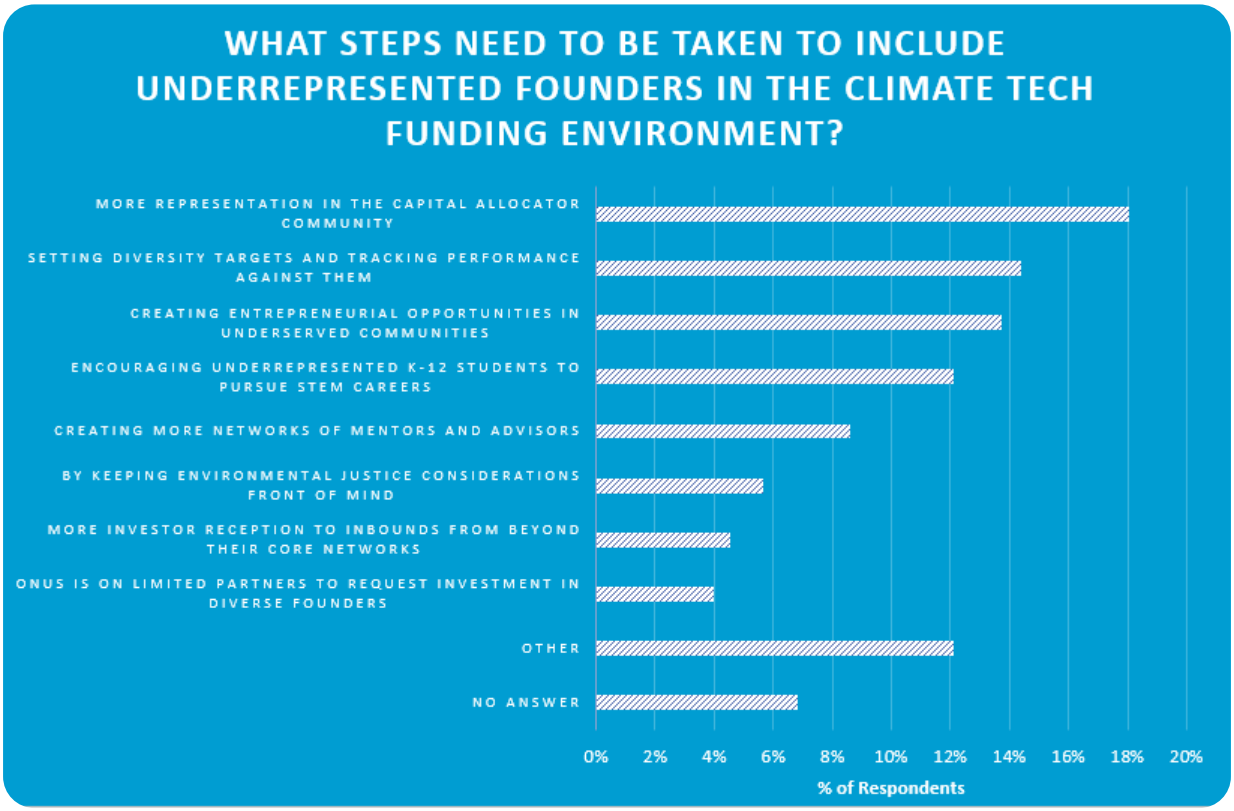


Figure 24: *Survey of Climate Tech Experts; Source: A Financial Guidebook for U.S. Startups Crossing Climate Tech's Valleys of Death and Achieving Scale by Hugo Mkhize; Methodology: Based on 44 interviews between March-June 2023*

What the Experts Say: Key Takeaways

Increased Diversity in Investment Roles: The Experts highlighted that the investment community should promote greater representation of women and people of color in investment roles, as they can better understand and assess the potential of underrepresented founders. This inclusivity in decision-making positions can lead to more equitable allocation of resources. It is crucial to have investors who possess empathy for underrepresented communities and can establish connections with these groups. Elevating new types of investment professionals who understand and relate to these communities is essential.

Data-Driven Investment Decisions: Diverse portfolios and teams have been shown to outperform homogeneous ones. Making proactive efforts to select and invest in underrepresented founders based on data-driven insights and recognizing their ability to identify unique market opportunities is crucial. Investors should acknowledge the existence of biases and implement measures to counter them. Setting thresholds for underrepresented founder representation in portfolios and actively tracking progress helps ensure inclusivity and mitigate bias in selection processes.

Prioritization from Limited Partners (LPs): LPs can play a significant role in championing diversity by signaling to investment funds that they prioritize diversity and inclusivity in their portfolios. The influence of LPs can shape the priorities of General Partners (GPs).

Mentorship and Support Networks: Creating networks of mentors, advisors, and supporters for underrepresented founders is important to provide a safety net and guidance. Access to strong networks is often lacking for individuals from disadvantaged communities. Investors can actively seek out and participate in forums and networks that encompass a wider cross-section of founders from diverse backgrounds. Engaging with universities and programs that have a more diverse pool of founders can contribute to inclusivity. Finally, underrepresented founders who have successfully navigated the funding ecosystem can provide mentorship and support to aspiring underrepresented founders. Sharing insights about investor decisions and board processes can help bridge knowledge gaps.

Expanded Access to Capital: Access to capital for underrepresented founders can be increased by diversifying funding models (i.e., looking beyond just venture investment) and supporting initiatives that provide financial resources. It is essential to provide opportunities for underrepresented investors as well by facilitating access to early-stage funding that allows underrepresented founders to work on their ideas and prove concepts. Pilot programs can help validate technologies and provide opportunities for engagement and networking.

Early Education and Talent Development: Foster interest and engagement in STEM education and entrepreneurship from an early stage, including high school and undergraduate levels. Encouraging integration and representation of minority and underrepresented communities in STEM fields can help create a talent pipeline of Climate Tech founders. Universities should encourage equal representation of technology developers at the university level to ensure a diverse pool of potential founders.

"We have to make sure that we have investors who have both [an] empathy for these communities and an ability to connect [with] these communities. Elevating new types of investment professionals into this area. And there are tremendous efforts underway to try to recognize that. And the first step in all this is just to be aware that the problem [exists]." ***– Investor***

"For sure you need to be able to get more capital to those founders. You also need to get more capital in the hands of underrepresented [investors]. I think [there are] equally terrifying stats on the amount invested versus who also has the capital. So I think that's the obvious first step, which is hard. I think it's diversifying where you are getting talent from." ***– Expert at Accelerator***

"You know this is not unique to the climate space. Venture dollars broadly go overwhelmingly to White men. It's a huge issue. There are some phenomenal leaders in this space who are prioritizing funding for female founders and founders of color. But a lot more needs to be done and ultimately it's on the LPs to signal to their funds that this is something that they want prioritized in their portfolio. Because that's who the GPs listen to." ***– Expert at Government Funding Organization***

"I think from the venture side, we actually see that [despite the] systemic barriers in STEM education, that the highest quality of companies actually come from underrepresented communities, whether that's on the race spectrum or on gender spectrum. My belief is because of [these] systemic barriers, people have to overachieve in order to be [considered]. And if we can go deeper into the pipeline and encourage people in the middle school or high school setting to get involved in STEM education and think about commercialization and the impact they want to have in the world from the early stages, [then] they can frame their educational experience around this kind of thing. We mentor during entrepreneurial education programs, we also invite people from local high schools to experience what it's like to work at a tough tech startup." ***– Expert at Accelerator***

What the Experts say

The Experts provided the following recommendations on how the Climate Tech funding environment can become more inclusive, equitable, and supportive of underrepresented founders:

- **Increased Diversity in Investment Roles**
- **Data-Driven Investment Decisions**
- **Prioritization from Limited Partners (LPs)**
- **Mentorship and Support Networks**
- **Expanded Access to Capital**
- **Early Education and Talent Development**

"Creating mentor and support networks as well for founders that have successfully raised and that have navigated that ecosystem to be able to efficiently gain insights from folks that have figured it out." – ***Expert at Accelerator***

"I think one way to do it is to really focus on who applies to the program. Oftentimes we say, [we're looking for] entrepreneurs. People could have self-selected themselves out, especially women founders. "I'm just a scientist; I'm not an entrepreneur." And all of a sudden that talent has that good idea [but] never applies. So I think it's about how do we really pave the path to say you don't have to have all the boxes checked before you do this. Unlike the VCs, we're not just saying give us your best pitch and your best idea [from] the best team, but more how do we find that potential? In our program, most have PhDs or [are] an engineer with some significant industry experience, so we are a somewhat special flavor of entrepreneurship. But we recognize that we can, at least talk about it very differently and message it differently. We're not just looking for entrepreneurs, we're looking for scientists who have a passion to impact the world in a positive way." – ***Expert at National Lab***

"You need more of them on the venture side. For as much as we need more founders, we also need more venture capitalists, more investors that are women and people of color because they understand the community better to better assess "is this an individual to bet on", particularly in the early stages of [a] startup. It's not so much about the business that you're investing in. You're investing in the team and you're investing in the individuals and if culturally, you don't have a sense of empathy or a sense of understanding, then it's just going to make it that much more difficult." ***– Expert at Accelerator***

5 Evidence from the Real World: Case Studies of Climate Tech Startup Funding Journeys Through the Valleys of Death

> *"UNFORTUNATELY, I THINK THE ADVICE IS [TO] GET AS MUCH AS YOU CAN AS FAST AS YOU CAN. FROM ANYBODY ACTUALLY. HONESTLY, THESE THINGS ARE HARD AND [IT'S A MATTER OF] SURVIVAL. IF YOU DON'T [GET THE FUNDING], YOU CAN'T HAVE AN IMPACT. YOU CAN'T MAKE THOSE NUANCED DECISIONS LATER TO OPTIMIZE, TO DO BETTER. THE IDEAL PATHWAY IS THAT YOU DO A BUNCH OF DE-RISKING WITHOUT RAISING ANY MONEY, OR AT LEAST WITHOUT RAISING ANY DILUTIVE MONEY FIRST, BECAUSE THAT WILL ALWAYS PUT YOU IN A STRONGER POSITION. AND SO THAT STARTS WITH [BOOTSTRAPPING] OR STARTS WITH GRANTS TO DO ENOUGH OF THE DE-RISKING. BUT THE FLIP SIDE OF THAT IS [THAT] THESE ARE FAST-MOVING MARKETS AND ANY TIME DELAYED MAY BE TIME LOST TO COMPETITION OR TIME LOST TO [A] LACK OF AN IMPACT."*
>
> Co-founder & CEO at Climate Tech Startup

As has been discussed throughout this guidebook, understanding how to capitalize a Climate Tech startup is of utmost importance for aspiring founders in the field. Securing adequate funding is crucial not only for the survival and growth of these ventures but also for their ability to make a meaningful impact on the planet. However, experiences of raising capital in the real world are often highly complex and relationship-based. Furthermore, the Valleys of Death and sources of capital available at each stage are often not neatly defined. Nonetheless, the insights in the case studies below, shared by experienced Climate Tech founders and CEOs provide valuable lessons and perspectives that can guide aspiring founders in their pursuit of securing the necessary capital to bring their Climate Tech visions to life and move across the various stage-shifts represented by the Valleys of Death.

Company A (Raised $275 million in funding to date)

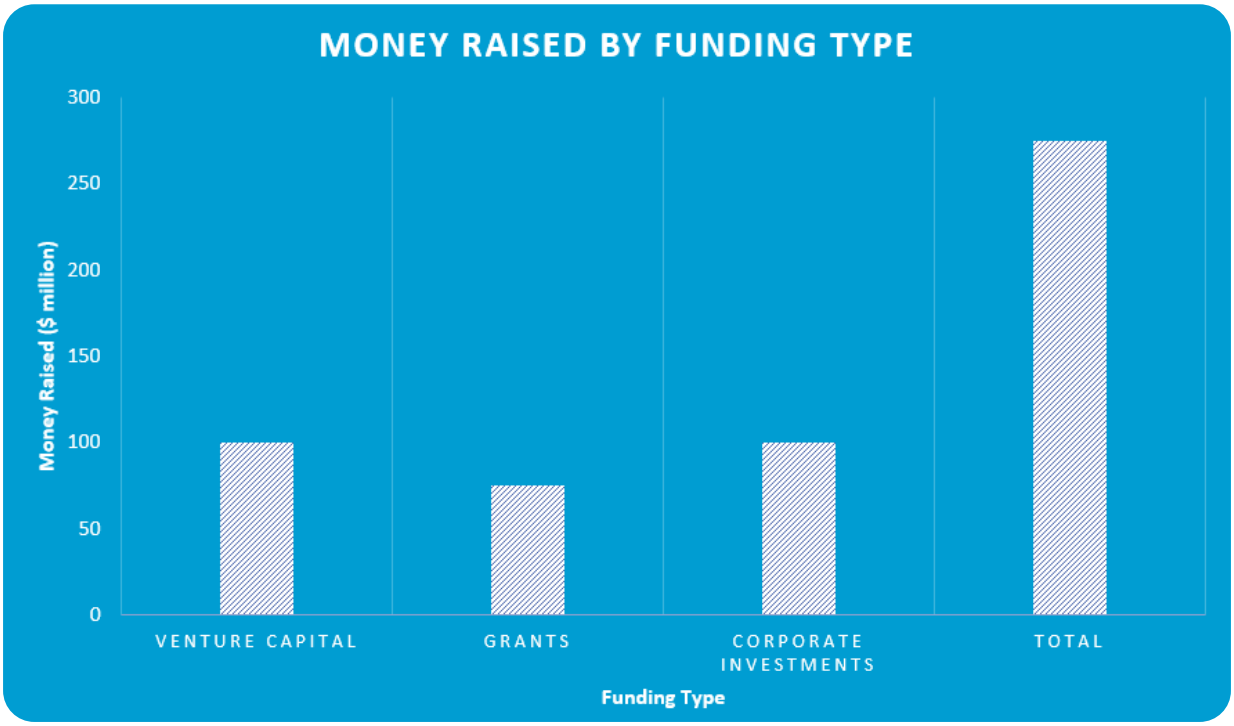


Figure 25: *Company A Money Raised by Funding Type; Source: Crunchbase; Note: Source may not include all sources of capital mentioned in the discussion*

Company A Key Highlights:

Valley of Death #2

- *$30 million* ***Series A*** *in 2005*

Valley of Death #3

- *$35 million* ***venture round*** *in 2010*
- *$10 million* ***venture round*** *in 2013*
- *$50 million* ***corporate round*** *in 2014*
- *$100 million* ***corporate round*** *in 2015*

Valley of Death #3 (Recapitalization)

- *$75 million* ***grant funding*** *in 2022*
- *$25 million* ***Series A*** *in 2023*

On the funding journey...

"What I ended up doing was, because we had the partnership with [a corporate partner], to use that partnership to provide the funding for us to run the company on this project while selling off, partnering off, or shutting down other non-core projects. And so that allowed me for several years, in a non-dilutive way to fund the company. We also took on some venture debt. That helped me spin out one of the businesses into what is now a publicly traded company that again was non-core, but a really cool idea that helped me to transition a couple of other businesses and then we paid back the debt and allowed us to continue our journey of focusing. Over the history, I would say we've done pretty much every kind of financing that you can do. We've done the traditional venture financing, we've done the non-dilutive partnership financing. We've done the venture debt financing. We've done a convertible note and we've done a recap now [with] completely new investors."

On taking investment from strategic partners...

"It always depends on what situation you are in and what you want to accomplish, but everything has a trade-off. If you get non-dilutive funding [from] a strategic partner, for example, you can say, OK, it's not dilutive for the investors, but it may dilute your asset because you're probably having to give away some rights to your assets. So is the asset dilution worth [your investors] not getting diluted? It really depends on the terms, but there is no clear-cut answer. There is no such thing as free money. People always want something."

On venture debt...

"Venture debt can be a really nice tool if you have a path to pay it back because it prevents both asset dilution as well as capitalization table [or] cap table dilution. But you need to have a path to revenue and a path to profitability or another way to pay back the venture debt. So that's typically reserved only for stages where you have a clear path to getting profitable or you have a particular asset that you can sell that you can then use to pay [it back]."

Company B (Raised $7.7 million in funding to date)

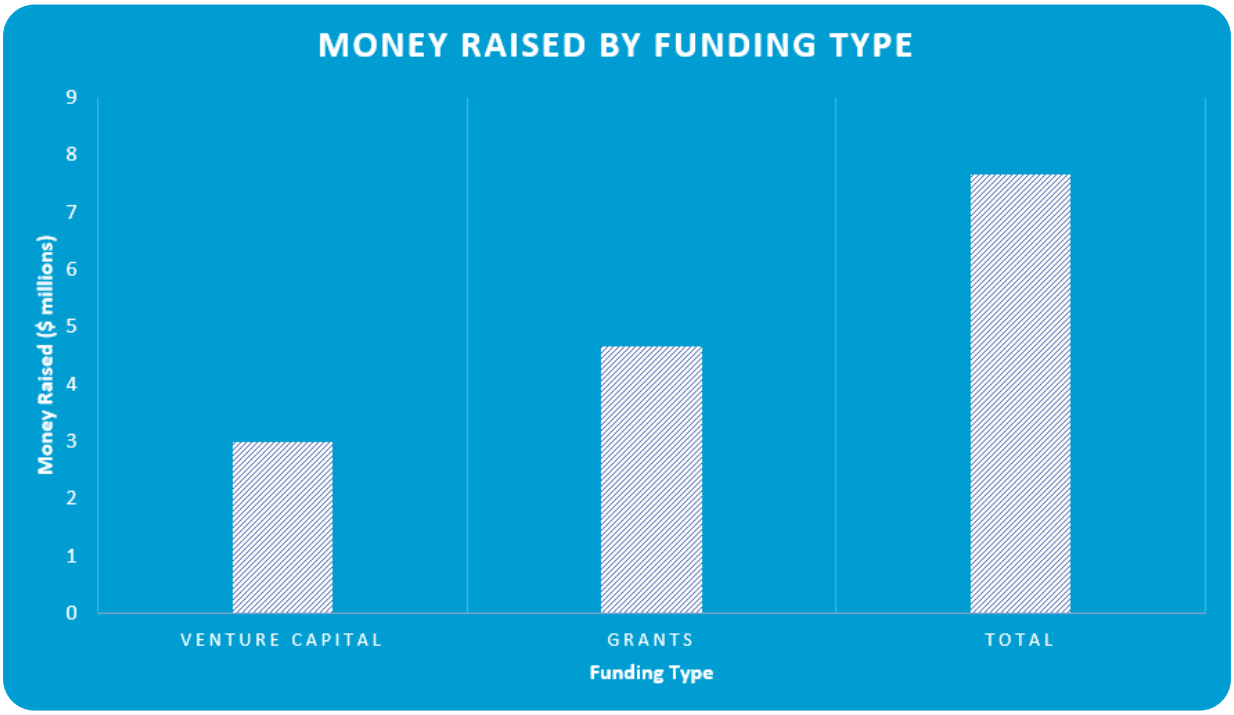


Figure 26: *Company B Money Raised by Funding Type; Source: Crunchbase; Note: Source may not include all sources of capital mentioned in the discussion*

Company B Key Highlights:

Valleys of Death #1 & #2

- *$150 thousand **grant funding** in 2015*
- *$1.25 million **grant funding** in 2016*
- *$1.5 million **grant funding** in 2017*
- *$125 thousand **grant funding** in 2018*
- *$150 thousand **grant funding** in 2019*
- *$400 thousand **grant funding** in 2020*
- *$900 thousand **grant funding** in 2021*
- *$200 thousand **grant funding** in 2022*

Valley of Death #3

- *$3.0 million **seed round** in 2023*

On grant funding...

"The [non-dilutive grant] funding is great. You don't have to give up any seats on your board or give up equity so it's relatively cheap money. Although, there are costs associated with all the reporting obligations [which] can be quite onerous and you've got to make sure that it lines up with where you're trying to go with the company. But more pointedly, it can be quite distracting if it's not aligned with where you're trying to take the company. So before I stepped in, the company had kind of fallen into a bit of a pattern of grant inertia. The team was all scientists and so they were doing what scientists knew how to do which was write grant proposals. With those grant proposals, spend the money and then write more grant proposals and so at some point we decided to raise an equity round of funding."

On venture capital...

"So that was really the reasoning behind doing a small equity round right now. We are a pre-revenue company. We've got large growing grants that are coming in, so we may not have needed it. But I think it was very helpful because it sends a market signal both externally as well as internally that says, we're shifting gears here for a really rapid scale. But then also there's a bit of a feedback loop there, because now that we've raised private funding, we're actually eligible for more grant funding, so there are a number of [organizations] like ARPA-E SCALEUP and stuff like that where they want to see some private funding behind you. So it's coherent with our narrative overall. To be clear though, we raised $3 million and that's a drop in the bucket relative to the probably billions that we're going to invest in really scaling this up. Now we've just done one small round. [Then] we'll do another larger round and then another larger round and then say hopefully get away from, you know, pure equity raises pretty soon."

Company C (Raised $29.3 million in funding to date)

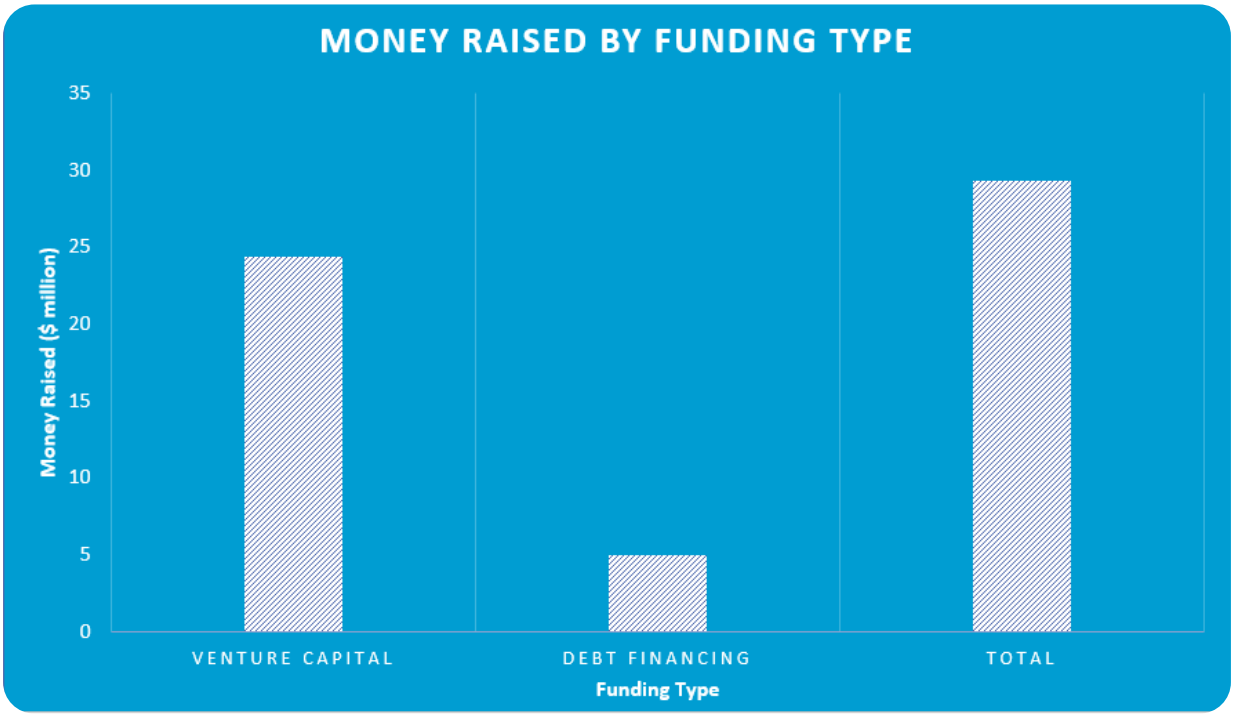


Figure 27: *Company C Money Raised by Funding Type; Source: Crunchbase; Note: Source may not include all sources of capital mentioned in the discussion*

Company C Key Highlights:

Valley of Death #2

- ***Bootstrapping***

Valley of Death #3

- *$5.2 million* ***seed round*** *in 2020*
- *$5.0 million* ***venture debt*** *in 2021*

Valley of Death #4

- *$150 thousand* ***venture round*** *in 2022*
- *$19 million* ***Series A*** *in 2022*

On venture capital...

"If you want to stay a small business, you can continue [to] self-fund and run the business off [of] the revenue that comes in. I think that for us we're raising money because we want to build up our engineering capability in a way that normally we couldn't afford to do off of revenue coming into the business. So it allows us to build an engineering and operations platform, so we're ready to scale our business. Almost all of our money goes into R&D and operations so we raise money because we are confident that our product is needed, it can deliver results. That money will help us get it to the market and multiple markets faster."

On some considerations regarding venture capital...

"There's pressure to deliver things quickly. Or there's [the] time you have to spend reporting and getting ready for board meetings. Those are some of the negatives. I do think one of the biggest negatives is when venture firms start telling you how to operate your business and because of how much engineering is involved in our business and how hard it is, we won't take money from people that plan to tell us how to operate our business. And I think, in general, people overrate how much money someone raises. To me, the terms are more important than the valuation."

On selecting the right investor...

"I think that the most important thing is that you have a good feel of working with these people and they're not going to come in and tell you how to run your business. That's number one."

On waiting for investment...

"I think that people oftentimes wait too long to [move their business forward]. Like I'm going to not do this until I raise money and then when I raise money I'm going to do [it]. Push faster, harder even when you don't have the money - build it yourself. Get it far along. Forget about all the great things you're going to do when you get money and telling that story. Obviously, there are certain things you can't do, but I think that sometimes people could go further without money. Sometimes people just simply wait and sit back. Waiting for a big check to come in and they don't get started building their business, even if they don't have money."

On the benefits of venture debt...

"The debt round allows us to have extra money so we don't have to raise money if we are running low. A debt round gives us more runway to continue to operate our business so we can get better terms when we do decide to actually raise money. And I think that has to be used very carefully. Right now, we've paid off that old one and we have zero on our debt line. Debt is really to be used to extend your runway and should be used carefully."

On some considerations regarding venture debt...

"The interest rate. You [also] have to give away some warrants in your company. And you'd better know how to use it because if you're using it just to stay alive, that's not what it's there for. It's really meant to extend the runway for [a] healthy company. So it can be a little challenging to figure out exactly how and when to use it."

On how they would've done their funding journey differently...

"I would have been more careful about the money we got in the seed round because while $5 million sounds like a lot of money and it is, it's not a lot to scale up a team and have constantly increased costs. So I think that when you raise money, be a little bit more careful upfront. And really being patient and not changing anything once you raise money is something that's important. And really be careful about how you start deploying that capital in people who are fixed costs that are month after month."

Company D (Raised $106 million in funding to date)

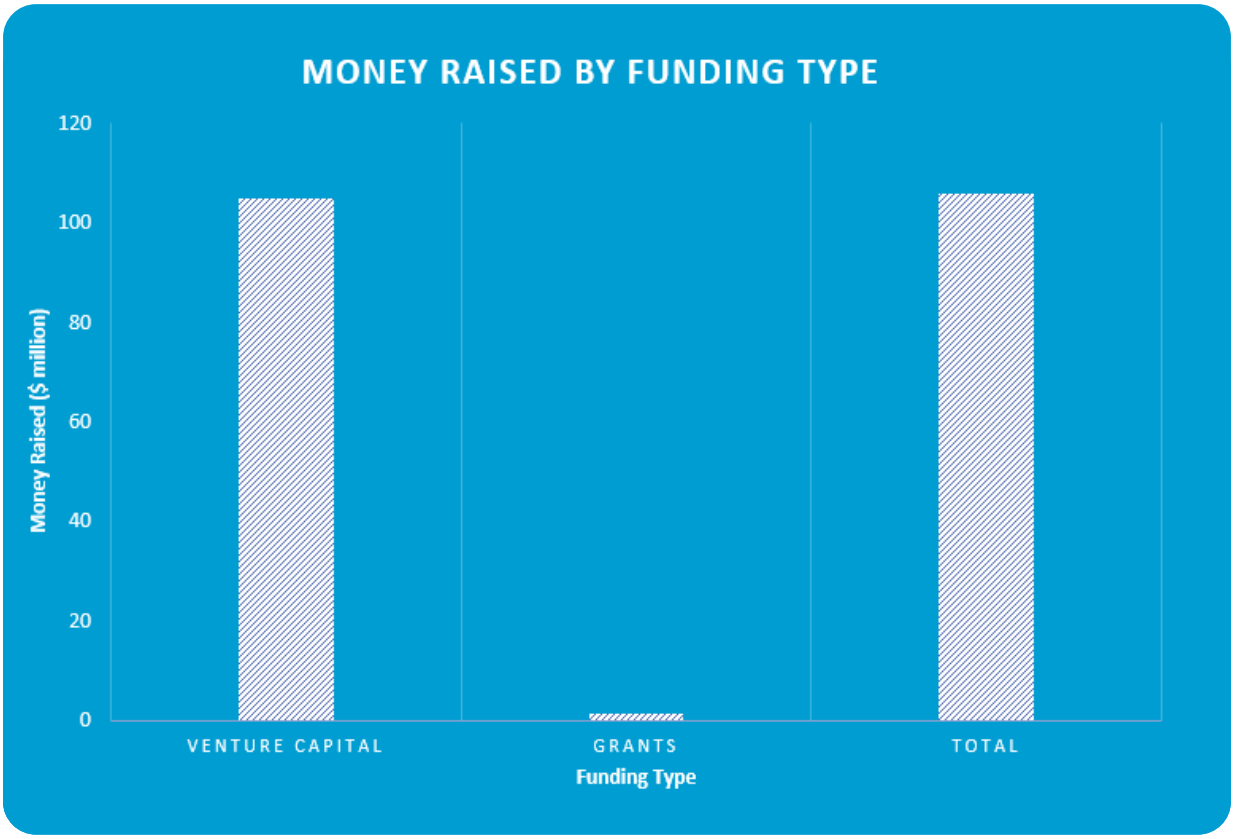


Figure 28: *Company D Money Raised by Funding Type; Source: Crunchbase; Note: Source may not include all sources of capital mentioned in the discussion*

Company D Key Highlights:

Valley of Death #2

- *$220 thousand **grant funding** in 2019*
- *$5.8 million **Series A** in 2019*

Valley of Death #3

- *$23 million **Series B** in 2021*
- *$960 thousand **grant funding** in 2021*

Valley of Death #4

- *$76 million **Series C** in 2022*

On the funding journey...

"So we've gotten, in our history, two grants and we've done four rounds of funding. So seed, Series A, B, and C, and then the two grants are NSF and also ARPA-E."

On venture capital...

"So we went with venture funding because we were not able to get grants. We were pretty much on this path of raise venture capital or die."

On some considerations regarding venture capital...

"Work-life balance. You've got to set aggressive goals. Then you've got to [work hard] to hit those goals because if you don't hit those goals, then they don't give you more money. So the downside was that work-life balance. [Also] dilution sucks, selling off a lot of [the] company... You'd rather own a small chunk of a billion dollar company than a huge chunk of a $100 company. [But] it's different for each founder."

On grant funding...

"Find out when the open period is where you can talk to the program director and call the program director. The earlier you can engage [the better]. Like [during] RFI [stage], when they're asking for info, if you can engage then, that's helpful."

On some considerations regarding grant funding...

"I think that it really constrains what you can do with the money. You can only use the money for what you say you're going to use it for; whereas in venture, if you learn something new and you learn something better, you can adapt. With grants, you can't necessarily do that. The timing [of the] grant process is one of the reasons why we haven't really been trying to lean into the grant stuff because it just goes so slow. You start the process and you don't know if you win for like a year."

On how they would've done their funding journey differently...

"The only thing is in the seed round [and] the Series A, I relied too much on one investor, and when they didn't come in, it was so painful. I wouldn't rely as much on a single investor anymore."

Company E (Raised $12.1 million in funding to date)

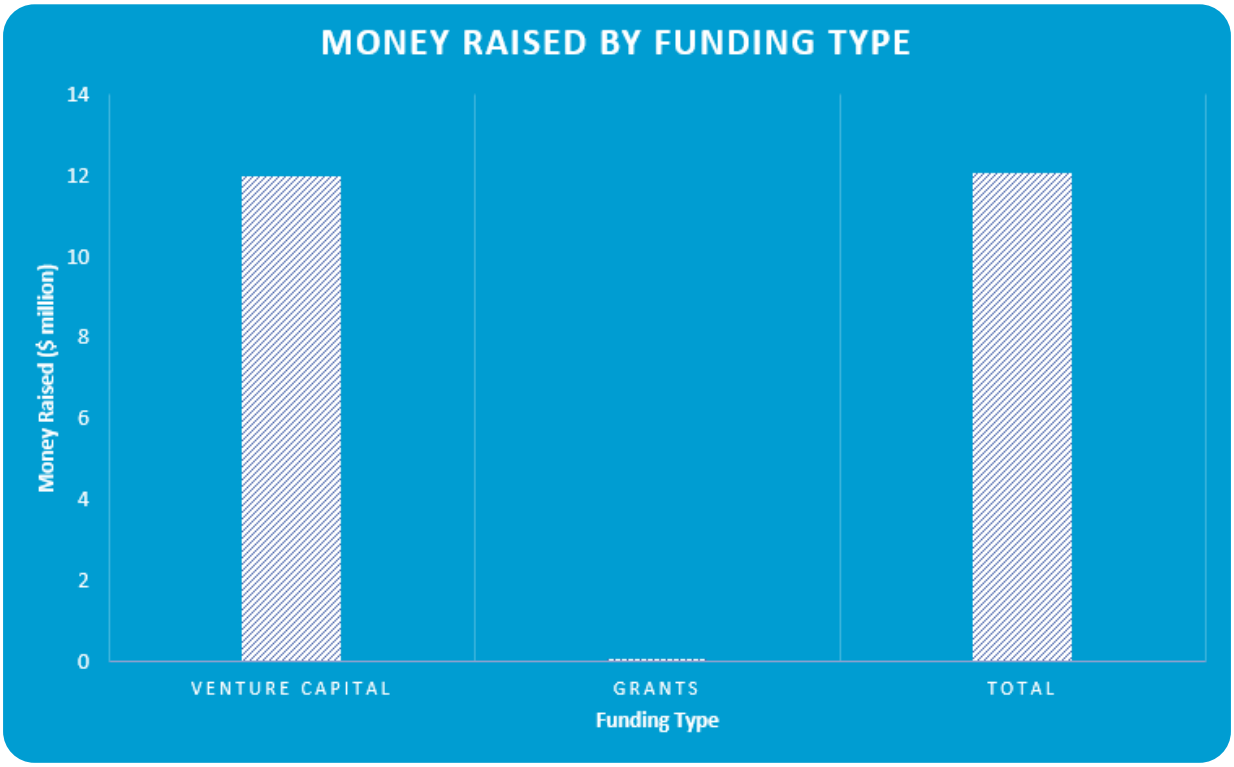


Figure 29: *Company E Money Raised by Funding Type; Source: Crunchbase; Note: Source may not include all sources of capital mentioned in the discussion*

Company E Key Highlights:

Valley of Death #2

- *$75 thousand **grant funding***
- *$12 million **Series A** in 2022*

On selecting the right investor...

"I went out of my way to avoid VCs. I'd like to say I didn't make a single outbound email to [a] VC. It doesn't mean that it was easy, but there's also a sales phenomenon where if someone comes to you, it's easier to sell than if you go to them. So the very first people had a Climate Tech focus and they were seed investors. And then who we approached for our lead was actually a publicly traded European mining company that never had invested as a majority shareholder in an early-stage company. So that was culturally distinct for them."

On grant funding...

"We applied for SBIR but we didn't get it. But we just got a killer patent. So [with] SBIR, you're stuck with whoever reviews your piece. And I got about $75K in New Jersey in grant funding for [the patent]."

On advice for aspiring founders...

"I'd say focus on unit economics. Obsess on unit economics. People are very keen on unit economics. There's one more piece of advice which is focus on solutions that create value for someone."

In conclusion, notwithstanding that each

company undergoes a funding journey that is unique to its circumstances, some of the key themes from these case studies include:

- **Utilize the Whole Capital Stack:** Climate Tech entrepreneurs utilize various funding sources, including traditional venture financing, non-dilutive partnership financing, venture debt financing, convertible notes, and grants. This diversified approach allows them to access different types of capital to support their projects and growth at each stage of their company's journey
- **Form Strategic Partnerships:** Where possible, leveraging strategic partnerships with corporate partners or investors is instrumental in securing funding and support for specific projects or the overall company. These partnerships provide not only financial resources but also expertise, networks, and market access
- **Understand the Trade-offs Between Different Sources of Capital:** The choice between dilutive and non-dilutive funding options depends on the specific situation and trade-offs. Non-dilutive funding, such as grants, can be attractive as it does not require giving up equity, but it may involve other obligations and distractions. Dilutive funding, on the other hand, may provide more growth potential but require giving up ownership in exchange for the ability to pursue the company's vision
- **It Is Best to Access Debt When Your Company Is Already Well Capitalized:** Venture debt has been a useful tool for some climate tech companies to prevent asset and cap table dilution. However, it typically requires a clear path to revenue, profitability, or assets that can be sold to repay the debt. Debt rounds can extend the runway for a healthy company, providing extra time to operate before raising equity funding. Understanding and properly using debt terms are essential for managing the financial obligations associated with this type of funding
- **Investor Selection Is Important:** Selecting the right investors is crucial, considering their experience, network, and alignment with the company's goals. It is important to avoid investors who interfere with operational decisions and instead seek those who provide support and value while allowing the company to maintain autonomy
- **Understand How Soon You Need the Funds:** Timing and speed play a role in fundraising. Waiting too long to raise money may result in missed opportunities or increased competition. While building the business without funding can be advantageous, securing funding can accelerate growth and provide resources to scale
- **Spend the Money Wisely:** Caution with capital deployment is crucial, especially after raising a significant amount of funding. Careful planning and patient decision-making help optimize the use of funds and ensure they are allocated to initiatives that drive growth and value
- **Early-Stage Climate Tech Investors Are Still Active:** Despite challenging economic times, Climate Tech continues to attract interest and funding. Investors focused on early-stage Climate Tech have remained active even when investors in other sectors may have been less active. This demonstrates the ongoing commitment to supporting innovative solutions addressing climate change

6 Conclusion

> *"LOOK, WE'RE EITHER GOING TO SUCCEED IN BUILDING A SUSTAINABLE, PROSPEROUS, AND EQUITABLE FUTURE, IN WHICH CASE THE FORTUNES OF TOMORROW ARE GOING TO BE MADE IN THE CLIMATE TECH INVESTMENTS OF TODAY. OR WE'RE GOING TO FAIL IN DOING THAT, IN WHICH CASE IT DOESN'T REALLY MATTER WHAT INVESTMENTS YOU'VE MADE OR HAVEN'T MADE, BECAUSE WE'RE GOING TO BE UNDERWATER OR ON FIRE."*
>
> *CEO at Climate Tech Startup*

In conclusion, this guidebook is intended to serve as a valuable resource for academic founders and aspiring entrepreneurs in the Climate Tech space. It provides insights into the various types of capital available and when they are most suitable in the journey of building a Climate Tech startup. One of the key takeaways is that funding plays a crucial role in the success or failure of a startup[52]. Sufficient funding is the cornerstone of any startup's growth and can make or break its prospects. Understanding the funding options and designing a financial strategy tailored to overcome the challenges specific to Climate Tech entrepreneurship is of utmost importance. At its core, Finance revolves around aligning the risk and return characteristics of an asset or cash flow with the suitable source of capital[53].

My aim is for the lessons in this guidebook to help you tailor your financial story and capital needs for each financier you encounter in order to put yourself on the path towards having an efficient, scalable capital structure, which is critical for achieving widespread adoption of your climate solution[53].

While the guidebook focuses on the Climate Tech capital stack, it is essential to acknowledge that every startup is unique, as are the investors they encounter. A step-by-step playbook for raising the capital required to scale nascent climate technologies is not feasible due to the individuality of each entrepreneurial journey[54]. However, the true value of this guidebook lies in identifying potential challenges and tailoring your financing choices to overcome them. Venture

capital, although widely sought after, may not always be the most cost-effective way to fund growth[53]. Furthermore, non-dilutive capital sources can provide additional time to achieve milestones and build business value[53]. By understanding the nuances of various funding options, entrepreneurs can navigate the complexities of the Climate Tech ecosystem more effectively. The aim of the guidebook was that it not only caters to academic founders but also offers insights to more seasoned entrepreneurs seeking alternative funding sources and learnings from their peers' experiences.

In summation, the key considerations highlighted in this guidebook for a Climate Tech entrepreneur looking to raise capital are as follows:

- **Technology Readiness Level (TRL):** Understanding the TRL enables Climate Tech entrepreneurs to effectively communicate their technology's maturity, assess risks, set realistic funding expectations, identify strategic partnerships, and develop a comprehensive technology roadmap. This understanding enhances their credibility and increases the likelihood of securing the necessary capital for further development and growth
- **Commercial Inflection Point (CIP):** The CIP scale is a valuable tool for Climate Tech entrepreneurs seeking capital, as it captures the major milestones from ideation to mass market adoption(14). Climate technologies require significant capital, strategic partnerships, and iterative deployments, with insights from initial deployments shaping future trajectory and business strategies[14]. The CIP scale provides a common language for entrepreneurs and investors, facilitating better understanding and collaboration. By visualizing the correlation between revenue and climate impact, the CIP scale helps unlock funding opportunities and accelerates the positive climate impact of Climate Tech startups[14]
- **Adoption Readiness Level (ARL):** The ARL framework assesses the readiness of a technology for adoption by the ecosystem. The framework considers 17 dimensions of adoption risk across four core risk areas: value proposition, market acceptance, resource maturity, and license to operate[16]. By conducting a qualitative risk assessment, the ARL framework provides a readiness score that reflects the technology's preparedness for adoption, going beyond technical readiness to include factors such as market demand, competition, resource availability, and societal acceptance[16]. Understanding the ARL helps entrepreneurs identify and address adoption risks, informing their strategies to attract capital and successfully deploy their climate technology
- **Funding Need:** An in-depth understanding of their funding needs allows Climate Tech entrepreneurs to create a clear financial plan, allocate resources efficiently, determine valuation and equity considerations, align with the right investors, plan

milestones effectively, and mitigate financial risks. This understanding enhances their ability to raise capital successfully and ensures adequate funding to drive the growth and impact of their Climate Tech venture

- **Trade-offs Between Different Sources of Capital:** Understanding the trade-offs between different sources of capital helps Climate Tech entrepreneurs make informed decisions when raising funds. It allows for evaluating dilution, cost of capital, seniority, security, complexity, timing, and the value-add beyond capital. By considering these factors, entrepreneurs can strategically select the right mix of funding sources that align with their financial needs, business objectives, and long-term vision for their Climate Tech venture
- **Use of Proceeds Framed in Terms of Milestones:** For Climate Tech entrepreneurs, understanding how to use raised capital to develop key areas such as Team, Problem and Vision, Value Proposition, Business Model, Product, Market Fit, Scale, and Growth + Exit is essential (see Village Capital Viral Pathway)[25]. This understanding helps entrepreneurs demonstrate their strategic thinking, financial acumen, and ability to allocate resources effectively. It also instills investor confidence by showcasing a clear plan for growth and value creation, aligning the entrepreneur's vision with investor expectations, and increasing the likelihood of successfully raising capital to advance their Climate Tech ventures[25]

The broader context of the guidebook is the urgent need to address the climate problem. We live in an overwhelmingly fossil-fueled civilization, and a complete displacement of this extensive system will have a profound impact on every aspect of our lives[55]. A robust Climate Tech funding environment is essential in the global approach to tackling this age-defining challenge. The guidebook aims to equip entrepreneurs with the knowledge and tools to contribute to the transition to a low-carbon economy. Entrepreneurs in the Climate Tech space should recognize that they are not alone in their journey. A growing Climate Tech ecosystem is ready to support and assist them. The energy transition itself is a decades-long megatrend, driven by planetary need, legislation, consumer sentiment, and investor interest. There is an enormous capital requirement in order to bring the necessity of a low-carbon economy to bear, and entrepreneurs with innovative ideas and strong business plans have the opportunity to best position themselves for this funding.

With the bipartisan Infrastructure Investment and Jobs Act (IIJA), along with the CHIPS and Science Act, the United States is poised for substantial investments in research, science, and innovation addressing climate change[56]. These initiatives, combined with the significant climate spending outlined in the Inflation Reduction Act (IRA), have the potential to lead the country towards a clean energy future and catalyze various technological transitions. The anticipated impact of these endeavors, even without considering the unpredictable factors

of rapid technological advancements and political influences, is a projected reduction of U.S. emissions by approximately 40% compared to 2005 levels[56]. Additionally, it is estimated that these efforts will generate around $3.5 trillion in new cumulative capital investments within the next ten years.

It is important to acknowledge the evolving landscape of public policy and its role in clean energy innovation. In particular, DOE programs such as those from the Office of Clean Energy Demonstrations (OCED) and the Loan Programs Office (LPO) have crucial roles to play. Through this federal funding, policymakers are strategically encouraging technology transitions by addressing the Valleys of Death that hinder the adoption of new technologies[56]. By supporting innovation and providing funding at critical stages of the technology adoption curve, policymakers can accelerate the transition to a clean energy future[54].

The guidebook also attempts to recognize the potential array of challenges faced by academic founders and the need for shifts in corporate governance as startups advance. Converting research ideas into commercial business opportunities requires a different set of skills at each stage as well as a different set of relationships within the funding ecosystem[56]. Founders must be willing to embrace discomfort and evolve as leaders to scale their startups successfully. If you aspire for growth, you must be willing to embrace the challenges that come with it. Be humble and ask questions to understand Climate Tech's nuances and challenges. Should you begin your entrepreneurial journey as more of a technologist, be prepared to delegate tasks and hire subject-matter experts as your business scales. View the new obstacles that characterize each Valley as a sign of progress and expect ongoing challenges.

The Manhattan Project successfully created an atomic bomb within a three-year span, while Project Apollo managed to land two American astronauts on the moon in July 1969, eight years after President Kennedy's announcement of this ambitious goal[55]. However, despite the difficulty and expense of these projects, their impact on the overall economy was limited, their costs were relatively modest, and the daily lives of average citizens were minimally affected[55]. The situation is likely to be quite the opposite when it comes to decarbonizing the U.S. economy. As illustrated in Figure 30 below, and according to the McKinsey Global Institute, the estimated cost of transitioning to a global energy system that reduces carbon emissions is $275 trillion between 2021 and 2050 (with about half of this coming from the United States, Europe, and China)[55]. This figure represents an annual cost of roughly $9.2 trillion or approximately 10% of the global GDP. Consequently, it is clear that if we are to avert the worst impacts of climate change, there will be ample capital available to support such endeavors. With the information provided in this guidebook, I hope you feel better prepared to access it.

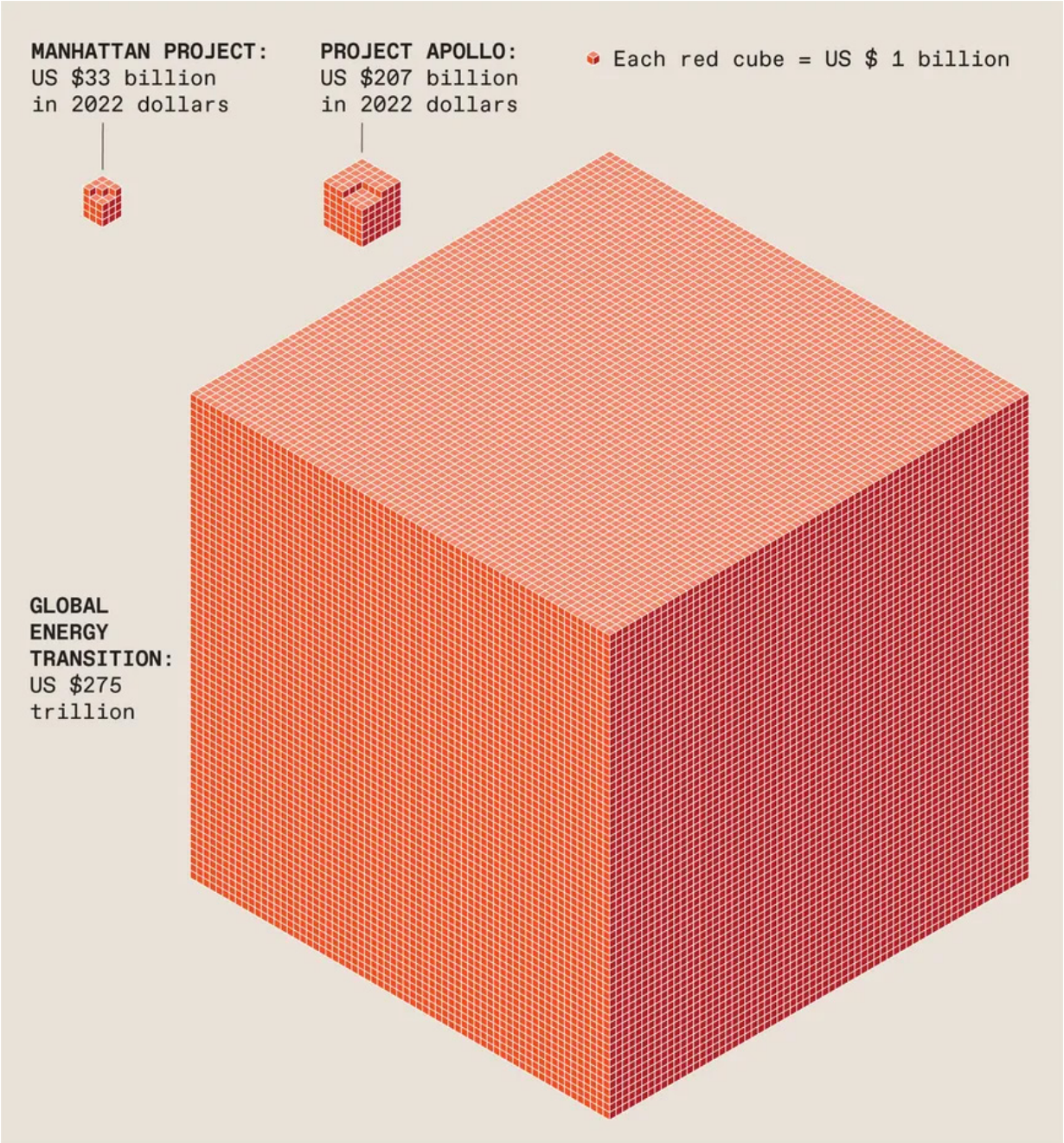


Figure 30; *Source: CTBTO Preparatory Commission; ScienceDirect; McKinsey Global Institute*

The climate crisis requires the collective efforts of entrepreneurs, investors, policymakers, and society at large. It requires aspiring founders to cross the Valleys of Death and drive the development and deployment of climate technologies. By doing so, they can make a significant impact and play a leading role as part of a supportive community dedicated to addressing one of the challenges of our time.

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Glossary

Adoption Readiness Level (ARL): A framework that provides a comprehensive approach to assess the readiness of a technology for adoption

Assets under Management (AUM): The total market value of assets that a financial institution or investment company manages on behalf of its clients

Bankable: Refers to a project or investment that is considered financially viable and attractive to lenders or investors

Binary Risks: Risks that have two possible outcomes, typically characterized as success or failure

Bookkeeper: A person or entity responsible for maintaining financial records and transactions of a company

Bootstrapping: Starting and growing a business with little or no external capital or funding

Business-to-Business (B2B): Refers to commerce or transactions that occur between businesses or organizations rather than between a business and individual consumers

Business-to-Consumer (B2C): Refers to commerce or transactions that occur between a business and individual consumers

Business-to-Government (B2G): Refers to commerce or transactions that occur between a business and government entities

Capital Expenditure (CapEx): Funds used by a company to acquire, upgrade, or maintain physical assets such as property, buildings, or equipment

Capital Injection: The act of providing additional capital or funding to a company or project

Capital Stack: The structure of all capital that is invested into a company

Capital Structure: The mix of debt and equity financing used by a company to fund its operations and investments

Carbon Credit: A tradable permit or certificate representing the right to emit one ton of carbon dioxide or an equivalent greenhouse gas. It is used to incentivize and finance projects that reduce greenhouse gas emissions

Carbon Offset: A reduction in greenhouse gas emissions made to compensate for or offset emissions produced elsewhere

Carbon Tax: A tax imposed on greenhouse gas emissions, typically levied on the carbon content of fossil fuels

Climate Tech: Technologies that are explicitly focused on reducing greenhouse gas emissions, or addressing the impacts of global warming

Collateral: An asset or property pledged by a borrower to secure a loan or other financial obligation

Commercial Inflection Point (CIP): A framework used to indicate a technology's degree of commercial readiness. The CIP scale is designed to capture the major milestones to bring a technology from idea to mass market adoption. The scale is numbered 1 to 8, with 8 being the most commercially mature

Commercial Scale: The level at which a technology, product, or service is produced or delivered on a large, commercially viable scale

Commercialization: The process of bringing a new product, technology, or innovation to the market and making it available to customers

Concessionary: Refers to terms or conditions that are more favorable or concessional than standard market terms

Convertible Loans: Debt instruments that can be converted into equity shares at a later stage, usually upon specific conditions or milestones being met

Convertible Note: A debt instrument that can be converted into equity shares at a later stage, typically during a future financing round

Covenant: A contractual obligation or promise, often related to financial or performance targets, that must be fulfilled by a party

Development Finance Institution (DFI): A financial institution or organization that provides funding and support for projects and initiatives to foster economic development

Debt-like Instrument: Financial instruments that resemble debt in terms of repayment structure or characteristics but may have unique features that differentiate them from traditional debt

Due Diligence: The process of conducting a comprehensive review and investigation of a company, project, or investment opportunity to assess its viability, risks, and potential

Early-stage: Refers to the initial phase of a company's development or a product's lifecycle, typically characterized by the early development of a product or service (e.g., pre-seed, seed, etc.)

Economies of Scale: Cost advantages or efficiencies that a company can achieve as it increases its scale of production or operations

Electrochemical Conversion: The process of converting electrical energy into another form, such as chemical energy, through electrochemical reactions

Embedded Entrepreneurship Program: An entrepreneurship program or initiative that supports and nurtures entrepreneurs within an existing organization or institution

Engineering, Procurement, and Construction (EPC): The process of designing, procuring materials, and constructing a project or infrastructure, often used in the context of large-scale engineering projects

First Loss Catalytic Capital: An initial investment or funding that takes on the highest risk in a project or investment, often with the goal of attracting additional investment from other sources

First-of-a-Kind Facility: A project or facility that represents a novel or innovative approach, often serving as the first commercial-scale demonstration or pilot for future similar initiatives

Follow-on Investment: Additional investment made by existing investors or backers in a company or project, typically after an initial round of funding

Fractional CFO: A part-time or outsourced Chief Financial Officer (CFO) who provides financial management and advisory services to companies

General Partner (GP): In the context of a partnership or investment fund, the general partner is responsible for managing the partnership's operations and making investment decisions

Global Financial Crisis: Refers to the severe financial crisis that emerged in 2007-2009, leading to the collapse of major financial institutions and a global economic downturn

Go-to-Market Strategy: A plan or approach that outlines how a company will introduce and promote its products or services to its target market

Growth Equity: Capital provided to a company that has demonstrated a certain level of growth and aims to expand its operations or enter new markets

Growth-stage: Refers to the phase in a company's lifecycle where it has achieved significant growth and is focused on expanding its operations and market reach

Incorporation: The process of legally establishing a company or organization as a separate legal entity

Initial Public Offering (IPO): The first sale of a company's shares to the public, allowing it to raise capital and become publicly traded on a stock exchange

Institutional Funding: Funding provided by institutional investors, such as pension funds, endowments, insurance companies, or professional investment firms

Intellectual Property (IP): Legal rights associated with intangible creations of the human intellect, such as inventions, designs, trademarks, and copyrights

Internal Rate of Return (IRR): A financial metric used to estimate the profitability of an investment by calculating the rate at which the investment's net present value equals zero

J-curve Trajectory: A graphical representation of an investment's financial performance, showing an initial period of negative or low returns followed by a steep upward curve

K-12: Refers to the education system encompassing primary and secondary education, typically from kindergarten to twelfth grade

Late-stage: Refers to the advanced phase of a company's development or a product's lifecycle, characterized by early commercialization and market validation (e.g., Series A, Series B, Series C, etc.)

Licensing: The process of granting permission or rights to another party to use a company's intellectual property, such as patents, trademarks, or copyrights, in exchange for fees or royalties

Limited Partner (LP): In the context of a partnership or investment fund, a limited partner is an investor who provides capital but has limited liability and involvement in the partnership's operations

Loan-to-Valuation Ratio: A financial metric used to assess the risk associated with a loan by comparing the amount borrowed to the appraised value of the underlying asset

Mezzanine Debt: A form of financing that combines elements of debt and equity, often used to fund expansion or acquisitions, with repayment typically tied to the company's future cash flows

Micro-pilot: A small-scale trial or experimental project conducted to test and evaluate the feasibility or effectiveness of an idea or innovation

Minimum Viable Product (MVP): The most basic version of a product or service that is developed and launched to validate its viability and gather feedback from early users or customers

Network Effects: The phenomenon where the value or utility of a product or service increases as more users or participants join the network or platform

Non-dilutive: Funding or capital that does not require the issuance of additional equity shares or ownership dilution

Non-recourse Debt: Debt that is secured only by the collateral or assets associated with the project or investment, and not by the borrower's other assets or resources

Off-balance Sheet Instrument: Financial obligations or activities that are not recorded on a company's balance sheet but may still have an impact on its financial position or performance

Offtake Agreements: Contracts or agreements between a producer or supplier and a buyer, guaranteeing the purchase or off-take of a specified quantity or share of the producer's products or output

Operating Expenditure (OpEx): The ongoing expenses incurred by a company in its day-to-day operations, such as salaries, rent, utilities, and administrative costs

Patent: A legal right granted to inventors or creators, providing them with exclusive rights to their inventions or creations for a specified period

Personal Guarantees: A commitment made by an individual to take responsibility for fulfilling the financial obligations of a company or project if it is unable to do so

Portfolio Company: A company in which an investor or investment fund holds a stake or has multiple investments

Pre-Money Valuation: The estimated value of a company or project before any external funding or investments are added

Pre-pilot: A preliminary phase or stage before conducting a full-scale pilot project, typically involving smaller-scale testing or validation

Pre-seed: The earliest stage of financing or funding for a startup, often used to develop the initial concept or prototype

Private Equity: Equity investments made in companies that are not publicly traded on a stock exchange, often involving the acquisition or buyout of the company

Product-Market Fit: The alignment or compatibility between a company's product or service and the needs and preferences of its target market

Profit & Loss (P&L): A financial statement that summarizes a company's revenues, costs, and expenses over a specific period, resulting in the calculation of net profit or loss

Project Developer: An entity or organization responsible for initiating, planning, and executing a project, often related to infrastructure development or renewable energy installations

Prototype: An early model or sample of a product or technology that is developed to test and demonstrate its functionality, features, and design

Recapitalization (recap): The process of restructuring a company's capital structure, often involving changes to its debt, equity, or ownership structure

Regional Green Bank: A financial institution or organization that provides funding and support for sustainable or clean energy projects within a specific region or jurisdiction

Request for Information (RFI): A formal process through which grant-making agen cies solicit information or proposals from parties interested in securing the grant funding

Research and Development (R&D): The systematic process of investigating, experimenting, and developing new products, technologies, or knowledge

Research, Development, Demonstrations, and Deployment (RDD&D): The continuum of activities involved in advancing technologies from initial research to practical application and widespread adoption

Royalties: Payments or fees received by a rights holder, such as a patent holder or creator, in exchange for the use or licensing of their intellectual property

Scaleup: The phase in a company's growth where it transitions from the startup phase and aims to rapidly increase its operations, revenue, and market presence

Seed: The initial stage of funding for a startup, typically used to develop the product or concept and validate its market potential

Series A, B, C: Sequential rounds of financing or investment in a startup, typically denoting different stages of growth and funding needs

Small and Medium Businesses (SMBs): Companies or enterprises that fall within a certain size range, often defined based on factors such as revenue, number of employees, or assets

Special Purpose Vehicle (SPV): A legal entity created for a specific and limited purpose, often used to isolate risk or hold assets for a particular project or investment

Spinout: The process of creating a new company or entity by "spinning off" a specific technology, product, or business unit from an existing organization (such as a university or national lab)

Stipend: A fixed or regular payment made to support or provide financial assistance to an individual, often in the context of research, education, or internships

Sublicensing: The act of granting a license or sub-license to another party to use a licensed technology, intellectual property, or product

Tax Credit: A reduction in the amount of tax owed by an individual or business, typically provided as an incentive for specific activities or investments

Tax Deduction: An expense or cost that can be subtracted from a person or company's taxable income, resulting in a reduction of their tax liability

Technology Readiness Level (TRL): A scale or framework used to assess the maturity and readiness of a technology, ranging from concept and basic research (TRL 1) to test & launch (TRL 9)

Technology Transfer Office (TTO): An organizational unit or department within a research institution or university responsible for managing the transfer of technologies, inventions, or intellectual property to the commercial sector

Technology Warranties: Guarantees or assurances provided by a technology provider or vendor regarding the performance, reliability, or functionality of their product or solution

Ticket Size: The amount or size of an individual investment or funding provided by an investor or funding source

Total Addressable Market: The total or maximum market size or revenue opportunity available for a specific product, service, or industry

Underrepresented Founder: An entrepreneur or founder who belongs to a demographic or social group that is traditionally underrepresented in entrepreneurship or business

Underwriting: The process of evaluating and assessing the risks associated with an investment, loan, or insurance policy, and determining the terms and conditions based on the assessment

Unit Economics: The analysis and evaluation of the financial performance and profitability of a product, service, or customer on an individual unit basis

Valley of Death: The periods during which companies burn through funding (or have insufficient capital pre-commercialization) as they begin operations but have yet to turn a profit and where risk, challenges, and capital needs shift

VP: Vice President

Warrants: Financial instruments that give the holder the right, but not the obligation, to buy a specified amount of a company's stock at a predetermined price within a specified period

Working Capital: The funds or capital available to a company for its day-to-day operations, including cash, inventory, and short-term assets minus short-term liabilities

Methodology

The survey portion of this analysis involved interviews with 44 industry practitioners (such as VCs and other investors), Climate Tech founders and CEOs, and funding organizations (accelerators, financial institutions, and the Department of Energy) between March-June 2023. All references to 'Experts' throughout the guidebook refer to the insights gained and synthesized following those interactions. Where the Experts gave more than one response to a given question, the total number of responses (n) was used as a 1/n weighting mechanism for each response. A potential flaw of this methodology is that it does not account for the strength of the experts preferences between given responses. The purpose of the interviews was to gauge the general sentiment of the Climate Tech funding ecosystem.

The typical questionnaire for a funding organization was as follows:

Funding Environment

1. Do you believe that now is a good time to start a company in the Climate Tech space? Why or why not?
2. In your view, what are the main differences between raising funding for a Climate Tech software startup vs. a hard tech/deep tech startup?
3. How do we get more transformative Climate Tech out of universities/national laboratories and launched into startups?
4. What steps need to be taken to include underrepresented founders in the Climate Tech funding environment?
5. What is currently missing from the Climate Tech funding environment in your opinion? What funding innovations or new pools of capital are you most excited about? If any?

[Organization] Offering

1. How does [Organization] help Climate Tech founders access funding?
2. What types of funding do Climate Tech founders approach [Organization] for most often?

a. Why do they choose those types of funding?

3. Are recipients of funding from [Organization] suitable for Venture Capital? Why or why not?
4. What are the most common challenges faced by the founders that you work with?

a. How does [Organization] help them overcome those challenges?

5. What advice or tips would you give to founders thinking of approaching [Organization] for funding?

The typical questionnaire for a Climate Tech entrepreneur was as follows:

Funding Environment

1. Do you believe that now is a good time to start a company in the Climate Tech space? Why or why not?
2. What kind of Climate Tech startups do you believe are suitable for Venture Capital?
3. In your view, what are the main differences between raising funding for a Climate Tech software startup vs. hard tech/deep tech?
4. How do we get more transformative Climate Tech out of universities/national laboratories and launched into startups?
5. What steps need to be taken to include underrepresented founders in the Climate Tech funding environment?
6. What is currently missing from the Climate Tech funding environment in your opinion? What funding innovations or new pools of capital are you most excited about? If any?

[Startup] Funding Journey

1. What types of funding (both dilutive and non-dilutive) has your company raised?

a. Why did you choose that type of funding?

b. What are the main pros/cons of each type of funding?

c. What advice would you give to early-stage Climate Tech founders about each type of funding?

2. If you could re-do your company's funding journey, what would you have done differently, if anything?

The typical questionnaire for a Climate Tech investor was as follows:

Funding Environment

1. Do you believe that now is a good time to start a company in the Climate Tech space? Why or why not?
2. What kind of Climate Tech startups do you believe are best suited to raise capital from [VC Fund]?

a. When would VC funding not make sense for a Climate Tech startup?

3. In your view, what are the main differences between raising funding for a Climate Tech software startup vs. a hard tech/deep tech startup?

4. How do we get more transformative Climate Tech out of universities/national laboratories and launched into startups?
5. What steps need to be taken to include underrepresented founders in the Climate Tech funding environment?

6. What is currently missing from the Climate Tech funding environment in your opinion? What funding innovations or new pools of capital are you most excited about? If any?

[VC Fund] Offering

1. Does [VC Fund] help Climate Tech founders access non-dilutive funding? Why or why not?
2. Why would a founder take funding from [VC Fund] over your competitors?
3. What are the most common challenges faced by your portfolio companies?

a. How does [VC Fund] help them overcome these challenges?

4. What advice or tips would you give to founders thinking of approaching [VC Fund] for funding?

Name	Title	Organization
Adam Wolf	Co-founder & CEO	Eion
Alex Grant	Director of Programs	The Engine
Ben Tarbell	Co-founder and CEO	Ebb Carbon
Bob Marcum	Deputy Director	Loan Programs Office (LPO)
Bryan Guido Hassin	CEO	DexMat
Carly Joos	Partnerships Manager, Northeast	Cleantech Open Accelerator
Cassandra Vickers	Associate	Azolla Ventures
Christian Okoye	Principal, Investment Team	Generate Capital
Dan Adler	Deputy Director for Climate Finance	Climate Tech Finance (California Infrastructure and Economic Development Bank)
Devin Sandon	New Venture Specialist	Venture for Climate Tech
Dick Co	Director, Chain Reaction Innovations (CRI)	Argonne National Lab
Dimitry Gershenson	Co-founder & CEO	Enduring Planet

Name	Title	Organization
Erik Funkhouser	Managing Director	Carbontech Development Initiative (CDI)
Ethan Sohn	Associate, Climate Fund	Toyota Ventures
Frederic Clerc	Director, Carbon to Value Program, Urban Future Lab	C2V Initiative
Greg Horowitt	Director - Innovation Design at Office of Innovation & Commercialization	UC San Diego
Ilya Tabakh	Entrepreneur in Residence	Black & Veatch IgniteX Climate Tech Accelerator
Jack Fritzinger	Founder	climatefounder.org
Jacque Francis	Executive Director	The Keeling Curve Prize (Global Warming Mitigation Project)
Jason Grillo	Partnerships & Operations Director	AirMiners
Jeffrey Carleton	CEO	Runwise
Jenny Larios Berlin	Entrepreneur in Residence & Lecturer	delta v
John Goldstein	Managing Director and Global Head of the Sustainability and Impact Solutions	Goldman Sachs
Juan Estalella	Partnerships Senior Associate	Third Derivative
Karen Jensen	Entrepreneurship Advocate at Rady School of Management and startBlue Program Manager	UC San Diego
Katie Sharp	Senior Fellowship Manager, Activate Berkeley	Activate
Keyona Meeks	General Partner	BlackTech Capital
Melanie Sonsteng	Program Manager	Cyclotron Road
Mike Flanigan	Co-founder & CEO	Seasats

Name	Title	Organization
Mike Rea	Executive Director	The Decarbon8-US Fund (E8)
Nicholas Adeyi	Investor	Congruent Ventures
Oliver Fetzer	CEO	Viridos
Ross Trenary	CFO	LevelTen Energy
Ryan Jones	Senior Program Associate, Climate Tech	SecondMuse
Sean Saunders	Investment Associate USA	Kineo Finance
Steve Meller	President, CEO & Founder	CH4 Global
Susan Tanski	Co-founder & Chief Strategy Officer	Sunstone Credit
Tanatswa Mapondera	Associate	Aligned Climate Capital
Trevor Best	Founder & CEO	Syzygy Plasmonics
Vanessa Scott	Director at the startBlue Accelerator	UC San Diego
Vaughn Blake	Partner	Blue Bear Capital
Westley Dang	Principal, IndieBio	SOSV
William Dean	Portfolio Strategy Team	Office of Clean Energy Demonstrations (OCED)
Zareen Khan	Managing Director	gener8tor Sustainability Accelerator

Appendix

Technology Readiness Level (TRL)

Source: *NASA; TWI (https://www.twi-global.com/technical-knowledge/faqs/technology-readiness-levels)*

Table 1. Technology Readiness Levels

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
System Operations	**TRL 9**	Actual system operated over the full range of expected mission conditions.	The technology is in its final form and operated under the full range of operating mission conditions. Examples include using the actual system with the full range of wastes in hot operations.
System Commissioning	**TRL 8**	Actual system completed and qualified through test and demonstration.	The technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning. Supporting information includes operational procedures that are virtually complete. An Operational Readiness Review (ORR) has been successfully completed prior to the start of hot testing.
	TRL 7	Full-scale, similar (prototypical) system demonstrated in relevant environment	This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment. Examples include testing full-scale prototype in the field with a range of simulants in cold commissioning[1]. Supporting information includes results from the full-scale testing and analysis of the differences between the test environment, and analysis of what the experimental results mean for the eventual operating system/environment. Final design is virtually complete.
Technology Demonstration	**TRL 6**	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment	Engineering-scale models or prototypes are tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing an engineering scale prototypical system with a range of simulants.[1] Supporting information includes results from the engineering scale testing and analysis of the differences between the engineering scale, prototypical system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. TRL 6 begins true engineering development of the technology as an operational system. The major difference between TRL 5 and 6 is the step up from laboratory scale to engineering scale and the determination of scaling factors that will enable design of the operating system. The prototype should be capable of performing all the functions that will be required of the operational system. The operating environment for the testing should closely represent the actual operating environment.
Technology Development	**TRL 5**	Laboratory scale, similar system validation in relevant environment	The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high-fidelity, laboratory scale system in a simulated environment with a range of simulants[1] and actual waste[2]. Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
Technology Development	**TRL 4**	Component and/or system validation in laboratory environment	The basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of ad hoc hardware in a laboratory and testing with a range of simulants and small scale tests on actual waste[2]. Supporting information includes the results of the integrated experiments and estimates of how the experimental components and experimental test results differ from the expected system performance goals. TRL 4-6 represent the bridge from scientific research to engineering. TRL 4 is the first step in determining whether the individual components will work together as a system. The laboratory system will probably be a mix of on hand equipment and a few special purpose components that may require special handling, calibration, or alignment to get them to function.
Research to Prove Feasibility	**TRL 3**	Analytical and experimental critical function and/or characteristic proof of concept	Active research and development (R&D) is initiated. This includes analytical studies and laboratory-scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative tested with simulants.[1] Supporting information includes results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. At TRL 3 the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants. Components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement physical experiments.
Basic Technology Research	**TRL 2**	Technology concept and/or application formulated	Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies. Supporting information includes publications or other references that outline the application being considered and that provide analysis to support the concept. The step up from TRL 1 to TRL 2 moves the ideas from pure to applied research. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate the basic scientific observations made during TRL 1 work.
	TRL 1	Basic principles observed and reported	This is the lowest level of technology readiness. Scientific research begins to be translated into applied R&D. Examples might include paper studies of a technology's basic properties or experimental work that consists mainly of observations of the physical world. Supporting Information includes published research or other references that identify the principles that underlie the technology.

[1] Simulants should match relevant chemical and physical properties.
[2] Testing with as wide a range of actual waste as practicable and consistent with waste availability, safety, ALARA, cost and project risk is highly desirable.

Source: *U.S. Department of Energy, "Technology Readiness Assessment Guide" (https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-04a/@@images/file)*

Commercial Inflection Point (CIP) Scale

Elemental's Commercial Inflection Point (CIP) scale is a framework used to indicate a technology's degree of commercial readiness. The CIP scale is designed to capture the major milestones to bring a technology from idea to mass market adoption. The scale is numbered 1 to 8, with 8 being the most commercially mature.

Commercial Inflection Point (CIP)	Description
1) PRE-PROTOTYPE / RESEARCH	Solution is in the early stages of ideation and development. Commercial applications have been identified and technology solutions are being explored. Founders are setting company values and starting to incorporate Diversity, Equity, and Inclusion (DEI) principles.
2) PROTOTYPE PROOF OF FEASIBILITY	Solution components and processes are being designed and tested in a lab setting. Company is confirming the technology viability of the prototype.
3) PROTOTYPE BETA TEST	Solution prototype is being tested with a small potential customer base before being released to real-world settings. Company is ready to deploy solutions for demonstration in an operational environment, but commercial and operational drivers have yet to be tested in the field. Implications and potential benefits for frontline communities begin to be assessed.
4) INITIAL PILOT *	Solution is deployed in small-scale pilots in a real-world setting. Company is using early technical and commercial results to drive interest for the first commercial deployment and inform further product and market development. Pilots can be paid or unpaid. Company is listening to communities to better understand the unique history and context of the places they want to deploy
5) INITIAL COMMERCIAL-SCALE DEPLOYMENT *	Solution is deployed in a commercial-scale project with a customer or partner for the first time. Deployment can be paid or unpaid. Company is using results to prove viability in real-world settings and generate additional commercial traction.
6) TWO+ COMMERCIAL-SCALE DEPLOYMENTS	Solution is deployed at the commercial scale with at least two paying customers. Company is using technical and financial results to further inform growth plans in terms of team/board composition incorporating DEI principles, product, market, and sales strategy.
7) DEPLOYED AT SCALE	Solution is deployed at a commercial scale with a repeatable business model in a significant number of markets or with a significant number of customers. The business is continuing to expand and grow sales and revenue and is likely gaining market share.
8) MARKET LEADER	Solution is delivering significant value to customers. The sales process is repeatable with predictable revenue in multiple customer segments and/or multiple markets. The solution is gaining market share and the company is broadening its product offerings and support services. An engine to generate new jobs and measurable climate benefits has been created.

* Integrating equity & access early

Source: *Elemental Excelerator, "The Commercial Inflection Point Scale for Climate Tech Startups" (https://elementalexcelerator.com/latest/articles/the-commercial-inflection-point-scale-for-climate-tech-startups/)*

Adoption Readiness Level (ARL)

By conducting a qualitative risk assessment across 17 dimensions of adoption risk, spanning four core risk areas, the Adoption Readiness Level (ARL) framework, as developed by The Office of Technology Transitions (OTT), provides a readiness score that represents the technology's preparedness for adoption by the relevant ecosystem. The four core risk areas addressed by the ARL framework are as follows:

1. **Value Proposition:** This area evaluates whether a new technology can meet the required functionality demanded by the market, at a price point that customers are willing to pay. It encompasses a broadened definition of "product-market fit"
2. **Market Acceptance:** This aspect captures the characteristics of the target market(s) and the risks posed by existing players, including competitors, customers, and other participants in the value chain
3. **Resource Maturity:** It examines the risks associated with the availability of necessary inputs to produce the technology solution. This includes evaluating the maturity of resources required for successful deployment
4. **License to Operate:** This area focuses on identifying non-economic risks at the societal level, including national, state, and local considerations, which could impede the deployment of a technology

Value Proposition:

1. **Delivered Cost:** Risks associated with achieving delivered cost competitiveness when produced at full scale, including amortization of incurred development and capital costs, and accounting for switching costs (if any)

LOW	MEDIUM	HIGH
Technology solution is either: • a) currently more cost effective than the incumbent or competing technology, or • b) close to cost-parity and on a clear cost curve to achieve cost-parity within three years; and fundamental cost components (e.g., cost of critical inputs) are not at risk of significant market swings.	Technology solution is more than three years away from achieving cost- parity with incumbent or competing technology but is on a clear path to be more cost effective; and / or there are some fundamental cost components that are at risk of market swings.	Technology solution is more expensive than the incumbent or competing technology and there is no clear pathway to cost competitiveness without substantial additional R&D advances.

2. **Functional Performance:** Risks associated with the ability of the technology solution to meet or exceed the performance and feature-set of incumbent solutions or create new end-use markets

LOW	MEDIUM	HIGH
Technology solution provides sustained improved performance and / or benefits that justify a premium (if any) in an existing end-use case or value in a new end-use case.	Technology solution provides equivalent functionality to existing products (i.e., same performance on all key parameters), or improved performance does not justify current premium, or performance differential will not be sufficiently sustained (e.g., lack of fundamental competitive advantage or weak IP protection allows incumbent or competitors to reduce differential quickly).	Technology solution provides poorer functionality than existing solutions currently in place.

3. **Ease of Use / Complexity:** Risks associated with operational switching costs; the ability of a new user (individual, company, system integrator) to adopt and operationalize the technology with limited training, few new requirements, or special resources (e.g., tools, workforce, contract structures)

LOW	MEDIUM	HIGH
Technology solution is easy to use / operate and maintain by the typical user / operator (e.g., highly intuitive with little need for additional training or similar to existing systems) and is plug-and-play with current infrastructure / equipment.	Technology solution can be operated and maintained by a typical user / operator after some training and allows for interoperability with existing infrastructure / equipment with minor adjustments.	Technology solution deployment requires extensive operations and maintenance training of personnel and / or there are meaningful integration costs to successfully use / integrate the product.

Market Acceptance:

4. **Demand Maturity / Market Openness:** Risks associated with demand certainty and access to standardized sales & contracting mechanisms (if required), as well with natural (e.g., network effects, first-mover-advantages) and / or structural (e.g., existing monopolies / oligopolies) barriers to entry in the market(s) to which the technology solution can be applied

LOW	MEDIUM	HIGH
There is a clear pathway for the technology solution to be introduced in a target market and gain initial traction; and there is standardized off-take (e.g., long-term agreements, hedge-able commodity market, accessible consumer market).	Technology solution would need to overcome substantial barriers to entry from competing technologies to enter the market but has clear pathway to do so; and there is a developing standardization of off-take.	Technology solution's ability to enter the market is limited due to incumbent advantages and market barriers to entry; or off-take is not easy / standardized and does not meet the needs of technology solution deployment.

5. **Market Size:** Risks associated with the overall size of the market that can be served by the technology, and the level of uncertainty with which it will materialize

LOW	MEDIUM	HIGH
Technology solution is well positioned to compete strongly in a large and existing market or dominate market share in a small and existing market; technology solution can be broadly adopted across geographies.	Technology solution addresses only a moderately sized existing market opportunity, and / or there is moderate uncertainty to whether the market will materialize; technology solution may be limited to select markets because of geographic or other constraints.	Technology solution is limited to small markets, and / or relies on a market that has yet to materialize.

6. **Downstream Value Chain:** Risks associated with the projected path to get the product from a producer to a customer along the value chain (e.g., considering split incentives, technology acceptance, business model changes)

LOW	MEDIUM	HIGH
Path to market is clear; business proposition and technology solution features work within existing incentives / business models, or newly aligns incentives for stakeholders along the value chain.	Path to market requires realigning of value chain; business model and technology acceptance level are not clear for one or more participants in current value chain.	Value chain is non-existent, highly fragmented, and / or technology solution benefits do not accrue to critical decision makers / gate keepers across value chain.

Resource Maturity:

7. **Capital Flow:** Risks associated with the availability of capital needed to move the technology solution from its current state to production at scale, including total investment required, availability of willing investors, availability of associated financial & insurance products, and the speed of capital flow

LOW	MEDIUM	HIGH
Institutional investors confirm return profile in this technology solution is commercially competitive with their broader portfolio. Deal flow / risk profile is sufficient to develop regular equity and debt approval processes at relevant investment institutions and ratings agencies. Major risks are insurable.	There exist one or more "valleys of death" along the required capital stack to full deployment, but hurdles can be overcome, and capital flow and financial and insurance availability is beginning to increase.	Significant additional investment from sources of concessionary / patient / high risk pools of capital (e.g., public sector, philanthropic, and catalytic venture capital) required to achieve deployment.

8. **Project Development, Integration, and Management:** Risks associated with the existence of processes and capabilities to successfully and repeatably execute projects using the technology solution

LOW	MEDIUM	HIGH
Mature processes and capabilities exist (e.g., within engineering, procurement, and construction contractors) to develop, integrate, and manage full projects using the technology solution; demonstrated by a track record of on-budget, on-time projects using the technology solution or comparable projects.	Some processes and capabilities exist to develop, integrate, and manage full projects using the technology solution; but these are as-yet unproven.	Deployment of the technology solution requires building new or significantly improved project development, integration, and management processes and capabilities as compared with the industry status quo; demonstrations and deployments at scale face substantial budget and timeline risks as a result.

9. **Infrastructure:** Risks associated with the physical and digital large-scale systems that need to be in place to support, enable, or facilitate deployment at full scale (e.g., pipelines, transmission lines, roads and bridges, etc.)

LOW	MEDIUM	HIGH
Technology solution can be broadly deployed within existing large-scale physical and digital infrastructure.	Technology solution can be broadly deployed with minimal investment in large-scale infrastructure (i.e., existing infrastructure can be adapted to use with new technology solution) or there exists a clear and economic pathway for investors and developers to build required infrastructure.	Technology solution can be broadly deployed only with additional significant investments in new largescale infrastructure and pathway to required infrastructure remains unclear.

10. **Manufacturing & Supply Chain:** Risks associated with all the entities & processes that will produce the end-product, including integrators, component, and sub-component manufacturers & providers

LOW	MEDIUM	HIGH
Technology solution deployment relies on off-the-shelf or simple adaptation of existing supply base products and existing manufacturing capabilities.	Technology solution deployment requires new components or products that are aligned with existing supply base capabilities but that may require minor upgrades or retooling of manufacturing and other processes.	Technology solution deployment requires creation of new manufacturing processes or supply chain components that are not currently in place, or deployment will overwhelm existing supply chain capacities.

11. **Materials Sourcing:** Risks associated with the availability of critical materials required by the technology (e.g., rare earth and other limited availability materials)

LOW	MEDIUM	HIGH
Technology solution relies on materials that are readily available in a competitive and distributed market and can be procured off the shelf with little to no geopolitical risk.	Technology solution relies on materials that are abundantly available but may face some risks (e.g., rely on new processing methods to make suitable for the application, geographic concentration).	Technology solution relies on materials that are limited in supply relative to the needed demand, may be difficult to obtain, may face geopolitical risks, or are very costly to produce in the needed quantities.

12. **Workforce:** Risks associated with the human capital and capabilities required to design, produce, install, maintain, and operate the technology solution at scale

LOW	MEDIUM	HIGH
Existing workforce has the necessary skills to manufacture and deploy technology solution with little additional training or significant scale-up.	Existing workforce requires additional training to either manufacture or deploy/install technology solution and pipelines exist to provide workforce training, but may need to be scaled.	Workforce is nearly non-existent, significant training is required for initial technology solution introduction and scale-up.

License to Operate:

13. **Regulatory Environment:** Risks associated with local, state, and federal regulations or other requirements / standards that must be met to deploy the technology at scale

LOW	MEDIUM	HIGH
Technology solution can be broadly deployed within existing regulatory framework and standards, and those frameworks and standards are applied in a well-understood and fast-moving process with minimal risk of delays.	Technology solution can be broadly deployed with minor changes to regulations and standards, and / or regulatory hurdles are well-understood but time-consuming and at risk of delays.	Technology solution can be broadly deployed only with major changes to regulations and standards or entirely new regulations and standards; or significant challenges exist to navigate existing regulations and standards.

14. **Policy Environment:** Risks associated with local, state, and federal government policy actions that support or hinder the adoption of the technology at scale

LOW	MEDIUM	HIGH
Technology solution requires little in the way of additional policy intervention to encourage adoption as a preferred solution; policymakers well aligned with any changes needed to encourage adoption.	Technology solution requires moderate policy intervention to achieve broad deployment and is well aligned with current governmental policy positions.	Technology solution requires significant policy intervention to achieve and / or sustain broad deployment; and / or policymakers are not aligned with implementing required intervention to encourage adoption.

15. **Permitting & Siting:** Risks associated with the process to secure approvals to site and build equipment & infrastructure associated with deploying the technology at scale

LOW	MEDIUM	HIGH
Permitting and siting process is easy, well-understood, timely, and repeatable.	Permitting and siting can be time-consuming, but jurisdiction is clear, and complexity is low. Speed can be achieved with repetition.	Permitting and siting is highly complex and time-consuming, with multiple overlapping jurisdictions in play.

16. **Environmental & Safety:** Risks associated with the potential for hazardous side effects or adverse events inherent to the production, transport, or use of the technology solution or end product in the absence of sufficient controls

LOW	MEDIUM	HIGH
Technology solution has minimal inherent environmental or safety risk; results in net zero carbon or negative carbon solution.	Technology solution has potential for environmental degradation and / or safety concerns, but the risks can be managed through current processes and / or anticipated future processes or solutions.	Technology solution has potential to create significant environmental degradation or increases carbon emissions over currently fielded solutions, and / or poses significant safety concerns that are challenging to mitigate.

17. **Community Perception:** Risks associated with the general perception by global and local communities of the technology solution and its risks or impact, whether founded or unfounded

LOW	MEDIUM	HIGH
Technology solution is likely to be positively received by the public with a strong level of support.	Technology solution may create pockets of public resistance but no systemic challenges are anticipated, and local communities are aligned with deployment in key deployment locations.	Technology solution is likely to create controversy that could derail or significantly delay deployment.

Combining the risk dimensions into an ARL score

Totals:

Low 0 **Medium** 0 **High** 0

No. of High Risk Dimensions

No. of Medium Risk Dimensions	0	1	2	3	4	5	6	7	8+
0	9	8	7	5	3	1	1	1	1
1	8	7	6	4	2	1	1	1	1
2	8	7	6	4	2	1	1	1	1
3	7	6	5	3	1	1	1	1	1
4	7	6	5	3	1	1	1	1	1
5	6	5	4	2	1	1	1	1	1
6	5	4	3	1	1	1	1	1	1
7	3	2	1	1	1	1	1	1	1
8+	1	1	1	1	1	1	1	1	1

1-3 = Low Readiness

4-6 = Medium Readiness

7-9 = High Readiness

INSTRUCTIONS:

1. Tally the total number of dimensions assessed to be "High" risk and the total number of dimensions assessed to be "Medium" risk.
2. Use the look-up table to the left to determine the ARL Score.

ADDITIONAL CONSIDERATIONS FOR USERS:

Note that users can modify the look-up table according to their own needs. Because even a few high-risk dimensions that remain unsolved can derail a technology solution from progressing towards commercialization, as a best practice, we recommend an approach that mimics a power law. If there is a critical mass of "High risk" ratings, the technology solution should be binned as "Low ARL."

In choosing to perform this aggregation, the user should balance the value of having a single number that provides an overview of the technology solution's status regarding commercial adoption and the lack of nuance that comes with false precision. The value of the ARL framework lies in its ability to surface an understanding of exactly which dimensions present the key barriers to commercial adoption.

Source: *The Office of Technology Transitions, "Commercial Adoption Readiness Assessment Tool (CARAT)" (https://www.energy.gov/technologytransitions/adoption-readiness-levels-arl-complement-trl)*