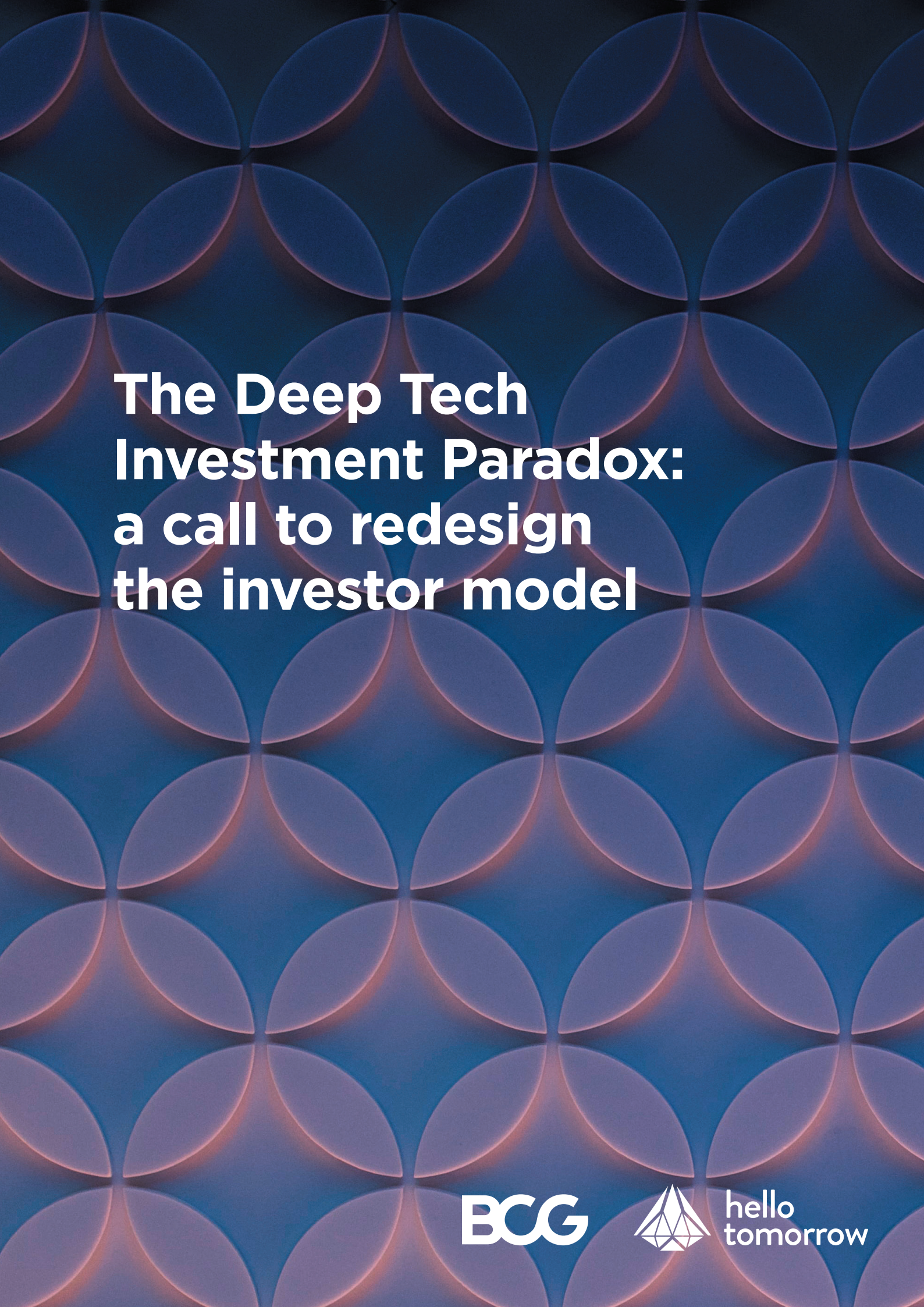
The Deep Tech Investment Paradox: a call to redesign the investor model



The Deep Tech Investment Paradox: a call to redesign the investor model

This paper is the third of a series of reports on deep tech. It focuses on the investment dynamics of deep tech.

In this third report, we outline the different friction sources along the investment chain as well as the opportunities of investing in deep tech. We conclude with a proposal on how to improve and rethink the investor model and create new investor archetypes.

We will address the "why invest now" question and the strategic imperatives that investors must understand in order to seize the full potential of deep tech.

Contents

Executive Summary

Despite investment growing to more than $60 billion in 2020 and its massive disruption potential as the Fourth Wave of Innovation, deep tech is hindered by the current investment model:

- Difficulty in shifting from laboratory (grant/subsidy-based) to venture funding
- Insufficient and unequally-spread VC funding, mostly directed to Synthetic Biology, Artificial Intelligence and Advanced Materials, and dominated by US ventures
- Paradoxically, investment "dry powder" is reaching record levels at $1.9 trillion across PE, VC and Growth money and is at risk of the depressed returns of bonds and safe investments, pushing investors towards higher risk-adjusted investments

Both the deep tech-based battle against climate change and Sustainable Development Goal (SDG)-supporting progress are being impeded due to frictions along the investment chain, fueled by mindset paradoxes and investment model biases:

- VC funds are structurally unfit (lifetime, size, incentives) to invest in deep tech, relying on the traditional blueprints of ICT (high market risk, low technology risk) and Pharma / biotech (high technology risk, low market risk) and they often lack the expertise needed to understand advanced science, engineering risks and to support ventures
- Part of the VC landscape has lost its original "venture" mindset and has ended up relying instead on the power of distributed investments
- Deep tech remains outside the risk profile and deal flow of most PE funds, despite the high risk of disruption to their portfolio companies by these new technologies
- LPs remain risk-averse towards deep tech, preferring to invest in "big names" and the largest funds
- While at the pointbreak of the innovation wave, most corporates are not as well-equipped as ICT / PharmaCos to be deep tech-savvy and digest external innovation
- Government & Institutions power research in universities but lack (as a state-mission) support for deep tech ventures, to move them from grant to venture funding and scaling.

Despite frictions, four paradoxes arise and raise hopes that we can rethink the investor model

- Deep tech offers an opportunity to rediscover that early venturing mindset, just when VC has shifted away from its pioneering roots, relying on the power of distributed returns
- While investors categorize deep tech as risky, the reality is that not being exposed to deep tech investment is riskier, as it is poised to disrupt incumbents and PE portfolios
- Barriers to raise deep tech funds are increasing, consolidating capital towards the largest funds, whereas barriers to innovation and deep tech venture building are falling along with the recombination of scientific breakthroughs
- Investment dry powder has never been so high; bond returns are expected to be depressed while deep tech offers the next wave of investment returns

To solve these paradoxes, it is a prerequisite to reframe and articulate the narrative for deep tech investment, and share it widely across ventures, direct investors and their LPs:

- Deep tech market and technology risks are high, but, once the early science risks have been eliminated in the laboratory, they can be mitigated by shifting to a problem-market orientation, acceleration of DBTL cycles, design to value and cost and defensible IP
- While deep tech ventures require higher early dilutive equity compared to digital, it remains controlled on average over time, as revenues from the first commercialized product enable ventures to switch to non-dilutive instruments
- Deep tech investment activity is already growing with billions invested, unicorn valuations, corporate M&A, and is maturing, with sovereign wealth funds investing directly, most traditional funders see the swells but misdiagnose the coming wave deep tech represents

The deep tech investor model is emerging along three design principles:

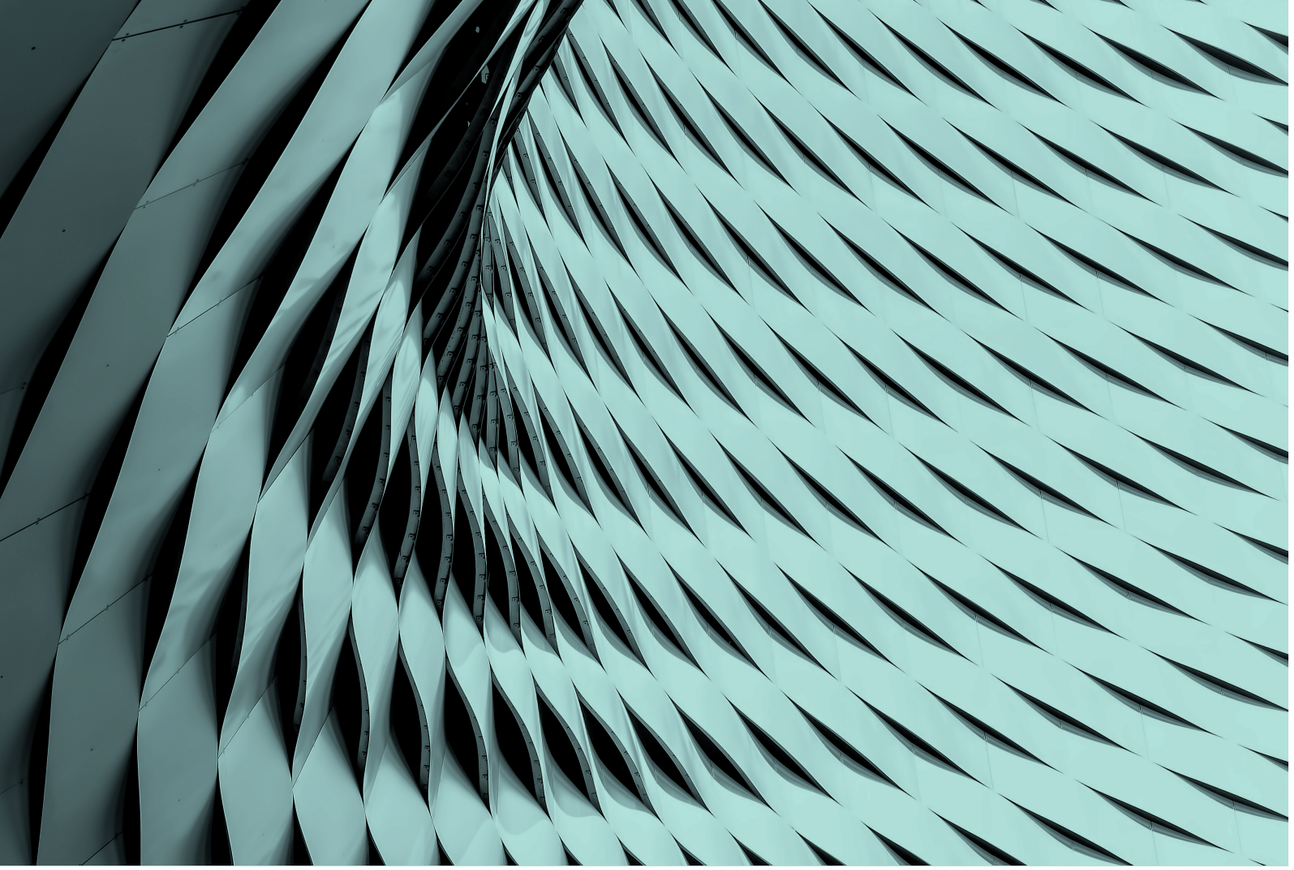
- *Adopt a new approach:* growing in-house knowledge and building a large ecosystem to support ventures, acquiring a problem-market orientation mindset favoring risk mitigation over risk minimization, and rethinking the portfolio strategy thus reshaping the distribution of returns
- *Embrace new investment models* with adapted financing tools, larger funds with possibly longer timelines, and new investment structures to support it.
- *Emphasize the profound SDG and societal impact* deep tech ventures aspire to have at a time when SDG and climate concerns are becoming ever more central and become mission driven for the coming existential challenges ahead for humankind.

These principles shape investor archetypes in an ecosystem that is shifting from few players and assumptions trapped in a static equilibrium, to players engaged in the evolution of both the boundaries and rules of the game in a dynamically adaptive equilibrium:

- Deep tech VCs are better suited to support ventures across investment stages, empowered by approximate 10-15-year lifetimes, $150-300 million fund size, multi-disciplinary teams, a research engine and a wide network
- Deep tech adaptive capital offers a wider array of financing tools to ventures and a new value proposition to LPs willing to diversify their risk profile and maximize deep tech impact
- Deep tech venture building capital (e.g., studios, accelerators) broadens investment opportunities for the creation and acceleration of deep tech ventures and moves them through key moments of truth, growing deep tech deal flow and signaling new opportunity niches
- Deep tech PE funds have a higher value proposition on growth of ventures or diversified project financing, and can benefit from vertical integration; Sovereign Wealth Funds can enrich their portfolio as trusted investors in deep tech and contribute to societal transformation
- Deep tech-savvy corporates act as go-to-market accelerators to catalyze their industry's ecosystems while validating deep tech business models through a venture client model
- Governments and institutions provide strategic stimuli, impacting on R&D funding, seeding provocative grand challenges, establishing deep tech hubs and clusters to build the future knowledge workforce needed to scale the market, provide blended finance, emerging talent production and matching, and signaling drumbeat investors

Deep tech investing presents a unique opportunity for investors as well as a moral imperative

- Deep tech addresses massive untapped markets (e.g., quantum, nature co-design)
- The deep tech "tax" is lower than ever (e.g., lower tech costs, descaling infrastructure)
- Now is the time to seize a first-investor advantage, to avoid missing the exponential wave
- We estimate that deep tech investments could exceed $200 billion by 2025 if this new investor model (and ecosystem) is mobilized into action
- Investors have a critical part to play in supporting in parallel all the breakthrough solutions that alone can meet the world and society's most intractable problems



1. Introduction: the great wave of deep tech innovation is coming, but the current investment model is broken

While digital transformation is accelerating across world economies, catalyzed by the Covid pandemic and led by the GAFAMs, BATXs (tech giants including Google, Apple, Facebook, Amazon, Microsoft, Baidu, Alibaba, Tencent, Xiaomi) as well as data-savvy startups, a deeper revolution is on the way. What we call deep tech ventures are at the forefront of this wave of technological innovation. One of the largest constellations of satellites in orbit is launched by a startup (Planet Labs); another startup is working on building supersonic airplanes (Boom Supersonic); others lead the synthetic biology revolution (Ginkgo Bioworks, Zymergen); more of them are revolutionizing food by cultivating cell-based meat (e.g., Memphis Meat) or through precision fermentation (e.g., Impossible Foods), just to mention a few. Some even have ambitions to unlock the power of atoms: Commonwealth Fusion Systems and Seaborg Technologies are planning to build the next small-size nuclear (fusion and fission respectively) reactors by 2025, D-wave is developing quantum computers and Sila Nanotechnologies uses nanoparticles to improve Lithium-ion battery capacity.

While there is no such thing as a "deep" technology, successful deep tech ventures all share a unique approach and differentiate themselves with **four main attributes**[1] (see our report Deep Tech: The Great Wave of Innovation)

- Successful deep tech ventures are problem-oriented. Very often they work on solving large and fundamental problems: 97% of deep tech ventures contribute to at least one of the UN's Sustainable Development Goals.
- They look at using the best existing or emerging technologies to solve the problem at hand. As a result, they play at the convergence of technologies: 96% of deep tech ventures use at least two technologies and 66% use more than one advanced technology. They generate defensive IP: 70% of deep tech ventures own patents in their technologies.
- They are shifting the innovation equation from bits alone (digital) to "bits and atoms" (physical). They build on the ongoing digital transformation, the power of data and computation, to develop mostly physical products, rather than software. About 83% of deep tech ventures are building a physical product.
- They are at the center of a deep interconnected ecosystem: because of the complexity of the task at hand and the deep scientific background needed, it is impossible for two people in a garage to come up with a meaningful deep tech innovation. Some 1,500 universities and research labs are involved in deep tech, and deep tech ventures received some 1,500 grants from governments in 2018 alone.

Deep tech has the potential to impact the world as fundamentally as the Internet did and is leading the fourth wave of innovation. The first wave gave birth to the first two industrial revolutions especially through chemical inventions such as the Haber Bosch process for ammonia or the Bessemer process for steel production. The second wave post-WWII, the information revolution, was driven mainly by corporate labs such as IBM, Xerox Parc, with high-caliber multi-disciplinary teams strongly involved in the scientific community, doing basic research, among which came the revolution of semiconductors. The third wave, the digital revolution, saw the decline of corporate research, and the emergence of small disruptive firms, backed by venture capital, defining a Silicon Valley model, focusing on Internet-based ICT/digital giving birth to Apple, Google, Alibaba, and in biotechnology to Genentech. US governmental agencies like DARPA, NSF and NIH were no strangers to the last two waves. While the innovation engine is seizing and crystallizing over ICT and biotech, the fourth wave is now building with deep tech and nature co-design.

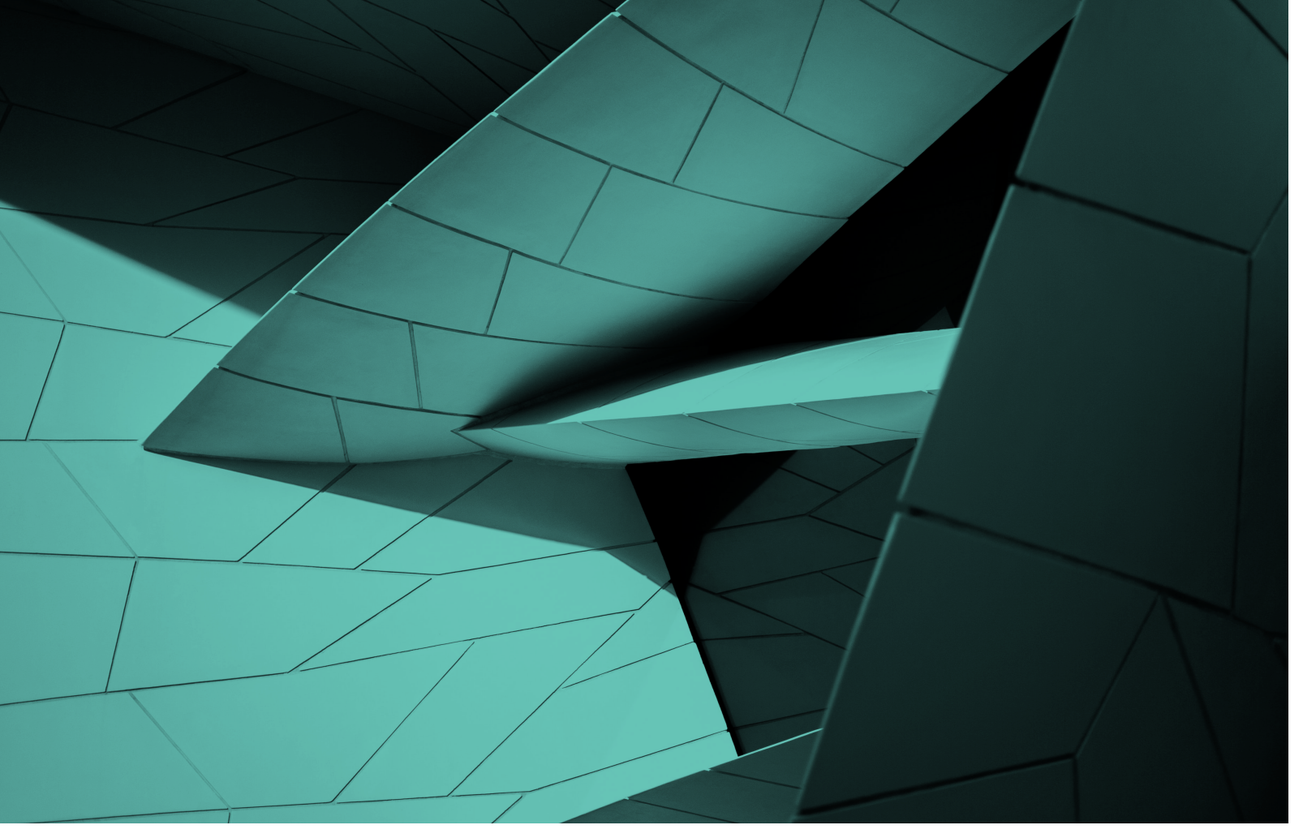
1. Note: deep tech is still a nascent terminology, there are still multiple definitions for deep tech and no single consensus

Imagine it is the early 1980s and the PC and biotech revolutions are starting to get traction… At that time VCs provided the steppingstones to activate the disruption. Venture capital pioneers from the 1960s-1980s invested in science and technology companies: Georges Doriot (Digital Equipment Corporation - DEC) and Arthur Rock (Arthur Rock & Co) funded the rise of minicomputers and microelectronics. Kleiner Perkins, then KPCB, participated in the emergence of semiconductors and microprocessors (Sun Microsystems) and was deeply involved in the rise of the biotech industry with the creation of Genentech. These pioneers were the founders of the venture capital industry and created its forward-looking mindset.

However, most VCs have found it difficult to explore new horizons beyond biotech and ICT/digital since then, and some of them have further constrained their investment strategy opting instead for the power of distributed returns. They started to depend on the rearview mirror for their investment strategy rather than looking through the windshield at what lies ahead.

While deep tech ventures face both high market and technological risks (mainly engineering and science risks)**, these risks are often misunderstood.** Deep tech ventures are often only seen as requiring bottomless equity funding compared to today's scalable Software-as-a-Service (SaaS) and digital ventures, paired with uncontrollable development timelines. However, these risks can be methodically and systematically mitigated leading to controlled development timelines and funding in the long run. In addition to the approach embraced by deep tech ventures, **a new investment model should be established** that is a better fit with the unique characteristics of the field.

Investors need to grow deep tech know-how to advise and understand the landscape, adopt a problem-focused and DBTL-based approach to de-risk investment portfolios and offer appropriate support (funding and timeline) to their ventures. This new breed of deep tech investors should bridge the capital gap and help bring deep tech ventures more easily through the funnel, while exploring different exit options including M&A by deep-pocketed and ideally "deep tech-savvy" corporates. In parallel, 20% of the 2050 target for reducing greenhouse gas emissions (to bring global warming to a 2°C target –not even 1.5°C) cannot be achieved with conventional solutions. After a decade of frenzied VC activities in digital, venture capital needs to confront head-on the deep tech opportunity standing in front of it, much needed for our battle against climate change and for a sustainable future.

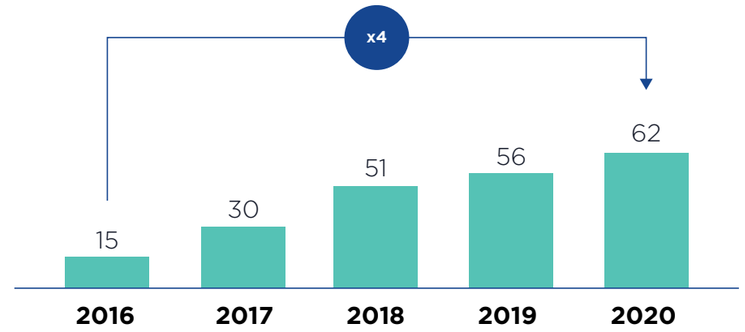


2. Despite growing funding, deep tech suffers from a capital gap with insufficient and imbalanced investment

Deep tech investment is on the rise: disclosed funding amounts increased from about $15 billion in 2016 to more than $60 billion in 2020 (Exhibit 1). Similarly, when looking at private investments, transaction amounts rose from $13 million to $44 million on average, fueled by the acceleration of synthetic biology (Exhibit 2), and transactions involving corporates among investors rose from $5 billion in 2016 to $18 billion in 2020 (Exhibit 3).

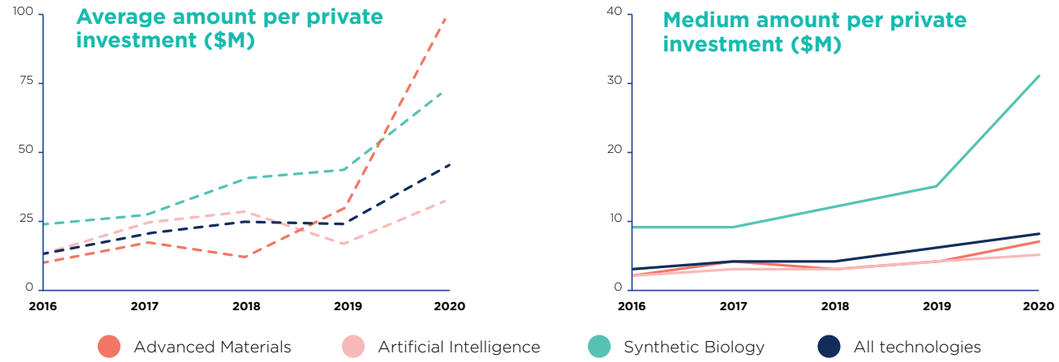
Exhibit 1: deep tech investments quadrupled between 2016 and 2020

Deep tech total investments in start-ups and scale-ups ($B)



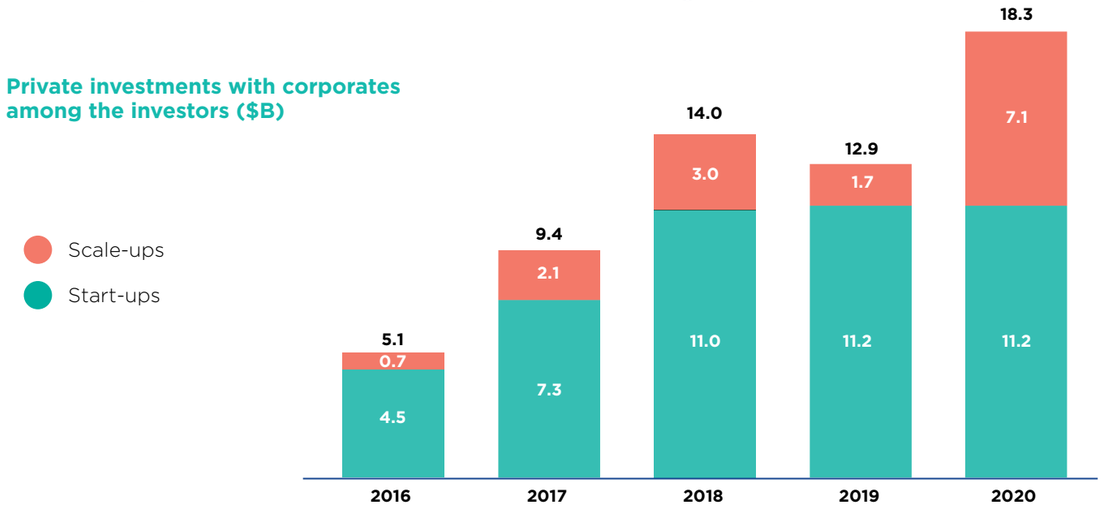
Note: investments include private investments, minority stakes, initial public offerings, and M&A; ~25-30% of undisclosed transactions
Source: Capital IQ, Crunchbase, Quid, BCG Center for Growth and Innovation Analytics, BCG and Hello Tomorrow analysis

Exhibit 2: average transaction amounts of deep tech private investments are rising



Note: ~25-30% of undisclosed transactions
Sources: Capital IQ; Crunchbase; Quid; BCG Center for Growth & Innovation Analytics; BCG and Hello Tomorrow Analysis

Exhibit 3: private investments in deep tech involving corporates are on the rise

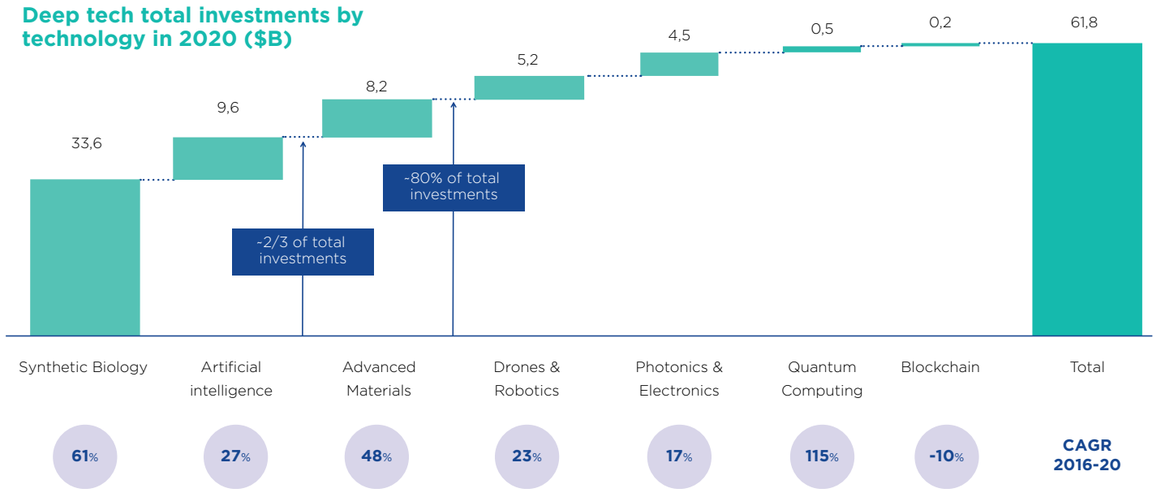


Note: ~25% of undisclosed transactions
Sources: Capital IQ; Crunchbase; Quid; BCG Center for Growth & Innovation Analytics; BCG and Hello Tomorrow analysis.

Nevertheless, deep tech ventures experience issues moving from grant funding to equity. As shown by Different Funds, almost 50% of grant-funded deep tech ventures require several rounds of grants before failing or succeeding at attracting VC funding. This is confirmed in our latest BCG and Hello Tomorrow survey, 41% of deep tech ventures state that "there is more security with grant funding than with equity funding" (Exhibit 7).

In addition to this funding gap, deep tech investment is unevenly distributed across sectors. Following the previous innovation focus on biotech and ICT / Digital, deep tech ventures in Artificial Intelligence and Synthetic Biology collected two-thirds of deep tech investment in 2020 (Exhibit 4), thus leaving only one-third to the remaining heterogeneous and vast population of deep tech startups. Synthetic Biology itself has been the fastest growing technology segment with a CAGR 2016-20 of 61% (after Quantum Computing).

Exhibit 4: deep tech investment is unequally spread with around 80% accounting for Synthetic Biology, Artificial Intelligence and Advanced Materials



Note: investments include private investments, minority stakes, initial public offerings, and M&A; transactions mapped on several technologies were split equally between these technologies; ~25-30% of transactions remain undisclosed
Source: Capital IQ, Crunchbase, Quid, BCG Center for Growth & Innovation Analytics, BCG and Hello Tomorrow analysis

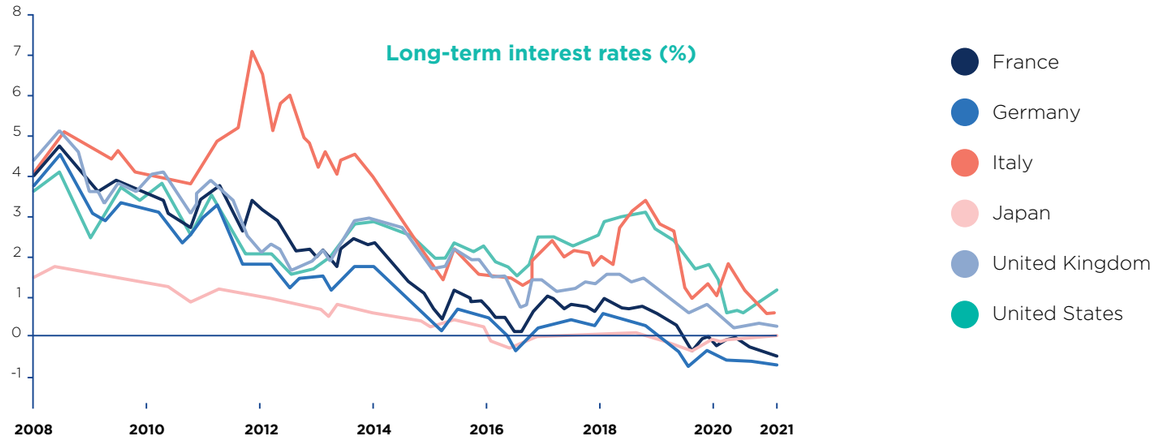
Deep tech investment is also uneven at the regional level where the US comprises almost 75% of total investments. However, when looking at private investments only, Europe and China have grown faster than the US with respective CAGRs 2016-20 of 49%, 34% and 28%.

But it's not because there is a dearth of available capital. Paradoxically, investment "dry powder" is at record levels (totaling $1.9 trillion[2] in December 2020, of which $1.1 trillion is in Private Equity and $331 billion Venture Capital and $250 billion is Growth Capital). These record sums are driven by PE & VC funds raising capital from LPs more easily than ever before.

This dry powder is at risk of depressed returns. Low (or even negative) interest rates are driving investors away from bonds and safe placements (Exhibit 5), towards higher risk-adjusted return pockets (equity and stocks). As a matter of fact, the number of active PE investors grew by CAGR 11% over the past 10 years[2] and the S&P 500 annual return over 2009-2019 reached 13.6% according to Berkshire Hathaway (including earnings from dividends paid by stocks). The most recent symptom of large pools of available capital is the boom in SPACs (Exhibit 6).

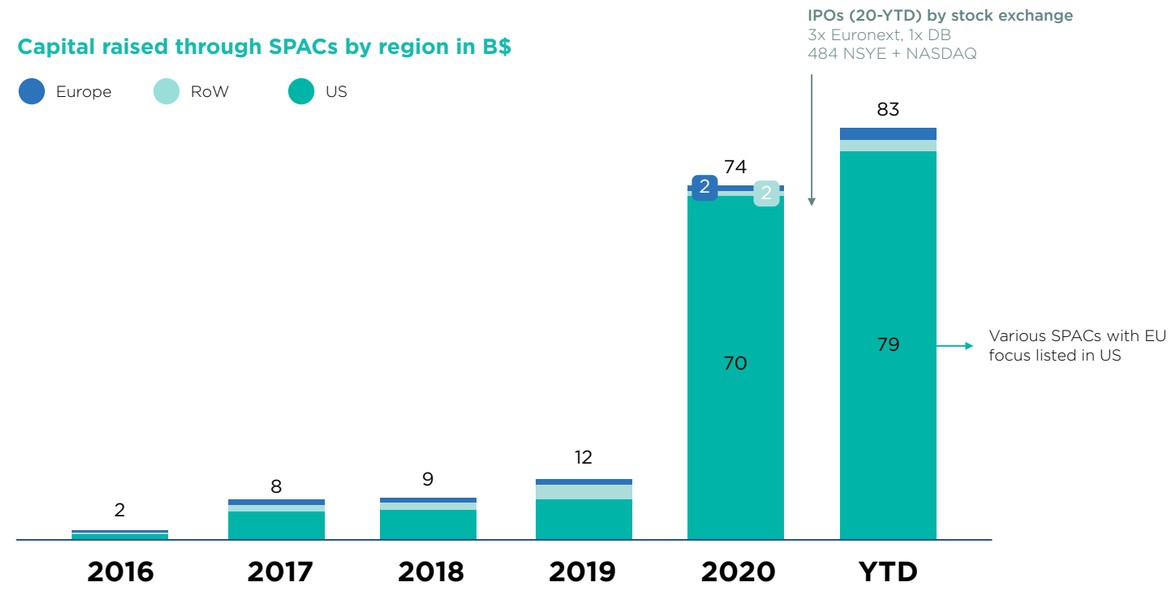
2. Preqin

Exhibit 5: long-term interest rates decreased to record-low levels



Source: OECD

Exhibit 6: capital raised through SPACs boomed in 2020, mainly driven by the US



Note: YTD, year to date is March 23rd, 2021
Source: S&P Capital IQ, BCG analysis

While part of this dry powder is actively reserved for follow-up rounds, investors have not yet been able to fully match this excess of available capital with the funding needed by deep tech. Lux Capital managing partner, Peter Hebert analyzes the capital market situation as follows: "near-zero interest rates have moved trillions of dollars to equities on the risk curve looking for better performance, and venture as an asset class has been among the greatest beneficiaries. But unless deep tech ventures have charismatic founders like Elon Musk able to promote a business that could be several years out from today, a significant share of them first fail because they ran out of money and less because of market risks. Hopefully, this has been improving over the past years thanks to deep tech ventures proving their successes to investors". Failure to consider a significant capital reallocation not only risks capital missing the rewards of the next wave of innovation: it also risks slowing down the progress of humankind and our race against time to combat climate change.

3. Frictions appear along every link of the deep tech investment chain, while uncovering four paradoxes

Obstacles exist at every point in the investment chain, involving all players in the investment ecosystem: Venture Capital and Private Equity funds, Limited Partners (LPs), Corporates, Governments and Institutions.

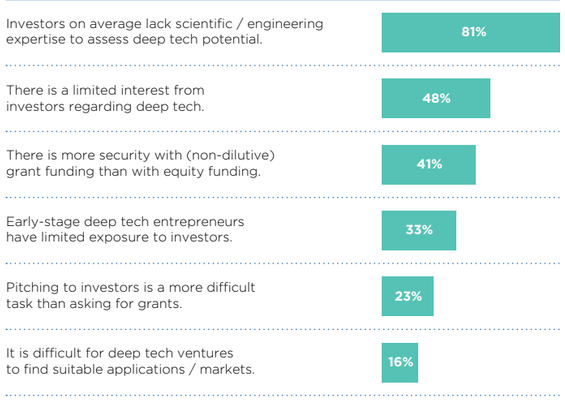
a) Venture Capital funds

There are obvious reasons why frictions exist among standard, generalist funds but deep tech funds have their own issues too. **Generalist funds** which have not yet invested in deep tech can be reluctant to do so for several reasons:

- Most Venture Capital (VC) General Partners (GPs) are used to the structure of large and "safer" funds, comforted by fixed management fees (of one or two percent) based on total Assets Under Management (AUM). The larger the fund, the bigger the fees for GPs, with associated economies of scale. Moving away from their traditional investments could limit their ability to attract capital from Limited Partners.
- Unfortunately, most of these funds categorize deep tech as high-risk and uninvestable. If a fund's cycle, at ten years, is shorter than the runway from laboratory to exit, some deep tech ventures can look uncommercial. According to our latest survey, 48% of deep tech ventures agree that "there is limited interest from investors regarding deep tech" (Exhibit 7).
- Their mindset crystallized along the two archetypes of the previous innovation wave: biotech (high technology risk, low market risk) and ICT (low technology risk, high market risk)
- Deep tech teams inevitably comprise academic scientists and too few funds have suitably qualified experts in-house or a network of advisors, who can both understand the science and communicate well with the team. According to our latest survey, 81% of deep tech ventures confirm that "investors on average lack scientific/engineering expertise to assess deep tech potential" (Exhibit 7). Those issues are especially important in the early stages when there is no or limited commercial traction to compensate. Because the commercial dynamics of deep tech are not the same as, for example, digital plays, VCs struggle to see the true value of a venture's IP, technological (i.e., scientific and engineering) risks and opportunities. Investors have issues scoping deep tech. Both nascent and complex, deep tech **lacks an articulated narrative** and, as a result, suffers from a void of understanding or inaccurate reputation.

Exhibit 7: 81% of deep tech ventures indicate that "investors on average lack scientific / engineering expertise to assess deep tech potential"

Which of the following statements about fundraising do you agree with as a deep tech entrepreneur ? (% of deep tech ventures)



Source: BCG and Hello Tomorrow survey across 116 ventures and investors, March 2021

"Deep tech specialized" funds have emerged over the past years as deep tech became more in vogue. However, they are on average relatively small: over 2010-2020, deep tech VC funds raised on average $96 million compared to $106 million for non-deep tech funds, when including growth funds, the gap widens with $105 million on average for deep tech funds versus $148 million for non-deep tech funds. They lack the size to provide relevant financial support and their partnership ecosystem may be limited. The deep tech investment landscape would benefit from more partners who are capable of both understanding and funding high-potential projects.

Since traditional references do not apply (e.g., clinical trials gates in biotech, customer base / revenue model / burn-rates in SaaS) or have not yet been properly defined by funds, ventures may miss milestones and KPI targets because time-to-market expectations and business models are different, often based on physical products and B2B channels. This lack of framework also limits investors in correctly assessing the deep tech ventures valuations.

But the issue isn't just that the investment blueprint needs to change: it's also a matter of finding a different mindset.

Historically, first business angels and then VCs were investment entrepreneurs focusing on breakthrough science, joining efforts to mitigate its risks and build innovative businesses. Influenced by digital / SaaS success stories making the headlines, the VC industry has seen a progressive mindset change.

Short fund lifetime may force managers to invest too quickly and exit too early in order to meet LP expectations, sometimes before an investee's full potential is realized. Since the 2000s, the much lower initial capital needed for new digital ventures made it much cheaper, and faster, to test their potential. An exponential digital wave flooded deal flows. Funds were left with limited time to dig into the value proposition of each venture. Some turned from "active-seeker" mode to passive "deal-receiver" mode, as funds with successful deal reputations often attracted deal-flow automatically. Trusted and copy-pasted models of the digital era (e.g., "the Amazon of", "the Deliveroo of", "the Instagram of") became shortcuts to assess the potential of a venture.

Consequently, two opposing VC views started to prevail. Some, like Founders Fund (c.60 ventures in-portfolio for a c.$5 billion fund size), stood for selective investments in promising companies. Others, like 500Startups (c.2,500 ventures for c.$600 million), turned to the **power of distributed returns** by betting on large numbers of promising pitches and teams, hoping that at least one in ten succeeds to compensate for the nine that don't.

While performing well in SaaS / digital as a risk minimization approach (see chapter 5 on the principles for a new investor model), the "spraygun"

investment strategy doesn't work for deep tech, where time and expert analysis are required to complete proper due diligence and select the best ventures based on evidence, science, technology, market potential and team composition. In addition, the standard mindset of maximizing quick returns raises risks of constraining the venture towards short-term potential thereby missing out on high return opportunities that lie in the long term.

The second order risk of spread-betting and hoping that unicorns will compensate for losses, is to fall into the "too big to fail" spiral. As demonstrated by cases such as Theranos or WeWork, the stakes are so high that investors may be blind to endemic weaknesses (especially uncontrolled cash burn-rates or technology challenges) or adopt lax governance.

b) Private Equity funds

On the Private Equity (PE) side, deep tech often remains outside their investment profile, perceived as early-stage only and incompatible with their skillset.

At the risk of sounding like a prophet of doom, history tells us to take heed. PE funds need to invest in deep tech to anticipate the inevitable disruption in-play and to diversify their portfolio risk, by either divesting condemned assets or investing in deep tech ventures. The option to simply "buy" this as a service on the market has two major disadvantages: first, the capabilities needed to understand and apply deep tech are far from plentiful, and second, such an approach would fail to capitalize on important knowledge by combining it with the internal investment process.

PE funds would do well to remember the stress caused by digital. Many of them saw their assets threatened by digital attackers who exploited their hidden weaknesses, by reinventing customer journeys, improving performance with data analytics, and leveraging asset-light business models. The dominating question was: "is my asset an Uber or a taxi company? Will it be able to seize the benefits of digital?" Funds need to ask similar questions about deep tech and its power to rewrite the rules. An additional factor underscoring the de-risking potential of deep tech is the breadth of its impact – most deep tech ventures solve large and fundamental issues which have applications across multiple industries, therefore increasing its de-risking potential. Synthetic biology is revolutionizing the food we eat with cultivated meat, the clothes we wear with bio-produced silk, our petrochemical industry with engineered microorganisms to produce biofuels, and even our medicine with mRNA vaccines. Advanced materials and nanotechnologies are reinventing manufacturing processes from consumer products to industrial goods. Quantum technology will accelerate drug and protein discoveries to treat and heal people, unlock complex network optimization problems such as those in mobility. What companies are ready for it?

Ultimately, **there is only one thing riskier than investing in deep tech and that is, not being exposed to deep tech investment**.

c) Limited Partners

Similarly, LPs are still reluctant to invest in deep tech funds due to a perceived mismatch with their expected risk/reward profile. They are often neither sufficiently qualified to understand the science behind deep tech nor, as a result, exposed to it. In some cases, their network includes risk-averse intermediaries such as banks that will dissuade LPs from deep tech investment, or just don't have the right narrative to convince them.

LPs tend to invest in the largest and best-known funds and are conservative in their choices. According to Mountain Ventures, only 20% of LPs surveyed invested in a fund they had known for less than a year. The bias is backed by the fact that the largest funds have proven to be safer: the spread between top-quartile and median net IRRs has steadily risen over the past decade[3], explaining why less well-known funds have been chronically undersubscribed. There is also a strong network component where LPs tend to invest and reinvest in investment managers whom they are close to and they trust.

The dominance of the biggest players is reinforced as LPs first look at a fund's track record and founders' names, instead of its approach: according to Mountain Ventures, 60% of LPs say that track record is the number one criterion. Harvard Business School (HBS) has analyzed the impact of this on venture capital as a whole: 5% of venture capital firms raised half of the total capital between 2014 and 2018.

This trend is reinforced by the growing buyout fund size: the average buyout fund size[4] rose from $700 million in 2015 to $1.6 billion in 2019. These top funds are gatekeepers and market makers, relegating deep tech to smaller funds, less addressed by LPs. A vicious circle occurs when deep tech funds raise capital but lack critical scale for follow-ons, therefore failing to build a critical positive track record. A second vicious circle emerges as the largest LPs will not take a significant share in a fund (typically not more than 10%) due to regulation or risk management, therefore blocking deep tech funds growth, which then have to rely on numerous smaller investors.

Nevertheless, not all LPs have the same approach towards deep tech investment:

- Pension Funds, and more specially closed ones, are committed to paying benefits every month. With such responsibilities, they need to focus on selected assets classes (a few hundred million minimum ticket), with a majority of low-risk liquid assets, and few higher-risk less-liquid assets (2-5 years), often with a thematic investing angle (e.g., energy, autonomous vehicles)
- Sovereign Wealth Funds, if not responsible for pensions, balance state strategic priorities (e.g., innovation funding, ESG, strategic industries), long-term capital support and liquidity (e.g., stock trading, private equity)
- Family Offices would be good candidates for patient capital (10-20 years) as long as they are guaranteed exit opportunities. Family Offices, especially in Europe, first think in terms of future generations and legacy, instead of a 10 + 2-year timeline. However, each family office has a different investment philosophy, not always matching deep tech.

d) Corporates

At the end of the investment chain sit corporates, whose importance in the investment ecosystem has grown over the last five years. Post-WWII, the corporate labs of IBM, Bell or even Dupont, played a crucial role in driving innovation and funding it. But, today few corporates have the necessary internal R&D capabilities and agility to apply the deep tech approach**.** According to our latest survey, 47% of deep tech ventures recognize that "corporates lack agility to work with deep tech ventures". There are exceptions: for example IBM, Honeywell or Atos on quantum computers and hardware, Microsoft on data storage and computing leveraging DNA and holographic technologies, Bayer launching Joyn Bio, a joint venture with Ginkgo Bioworks aiming at replacing fertilizers with genetically engineered microbes. Others compensate by targeted acquisitions (e.g., Amazon's acquisition of Zoox in 2020, Hyundai's acquisition of Boston Dynamics for $920 million in 2020) or investments (e.g., BASF in Zapata Computing in 2019, Tyson Foods in Memphis Meats in 2018, Danone in Nature's Fynd in 2019, Volkswagen in Quantumscape in 2018, Siemens in Lanzatech in 2014). These examples show how companies can gain a leapfrog advantage by investing in market-proven ventures.

Such strategies can work but only under specific conditions. First, corporate venture capital (CVC) arms need to be equipped to perform deep tech due diligence and support ventures as a VC investor (not just provide funding). Next, cooperation can fail if corporates do not have the appropriate talent and structure to work with them and leverage their technologies. Successful integration can be difficult to achieve, due to cultural differences. Incumbents need to overcome the R&D "Not Invented Here" syndrome, which isolates and rejects disruptive acquisitions that challenge the status quo. Corporate R&D activities are often focused on incremental development rather than major disruption. Incumbents are at the breakpoint of the disruption wave. And finally, by waiting until a venture is market-proven, corporates often pay a hefty valuation premium.

e) Governments and Institutions

Often underestimated as players in the funding landscape, Governments and Institutions form the backbone of deep tech investment (but not only deep tech). As conceptualized by Bill Janeway in his book *Doing Capitalism in the Innovation Econo*my, innovation sits in the middle of a three-player game between markets, speculators and the state. But the state plays a specific two-sided role which should not be forgotten: it facilitates innovation and it must cope with the consequences of innovation. More specifically on the facilitation side, it is public capital that disburses grants to early-stage ventures, making government and institutions the highest risk-takers. Leading-edge research at the early stage is fraught with uncertainty, and off-putting to traditional VCs looking for a more advantageous and efficient risk/reward profile. Bill Janeway summarizes it as follows: "efficiency is the enemy of innovation".

That is not where it ends: public bodies often subsidize specific industry segments to provide benign market conditions, reducing price and cost; they provide university laboratories and other assets to help researchers; they act both as regulators and political facilitators for infrastructure and project finance, bringing together stakeholders such as banks, companies, municipalities, associations and private investors.

On the one hand, governments can ignite deep tech ventures through grants and subsidies. On the other hand, it can be hard to quit the grants and subsidies world and deal with the VC world: more than 50% of grant-funded deep tech ventures require several grant rounds before they reach a success proof point and are ready to apply for VC funding. Governments and Institutions, too, lack

3. From 3.8 pts for vintage 2006 funds to 11 for vintage 2016 according to Preqin
4. Preqin

an efficient network and vital bridges between the academic world and the investment world, both in terms of visibility and mutual understanding. This means grant-funding alone can be a dead end. The Engine, a venture fund spun of the Massachusetts Institute of Technology observed that most US grant funding plans fail because governments do not have the same to privileged access to entrepreneurs as VCs and involve them with commercial opportunities.

Although a number of initiatives have been launched (the European Innovation Fund; the Intellectual Property Financing Scheme in Singapore, France's Quantum National Plan, the $1 billion National Quantum Initiative Act in the US), most governments have not yet developed a broader policy framework for deep tech. Such policies might include tax incentives, prefential loan conditions and guarantees, investment in tech hubs, and IP licensing, for example.

As Steve Blank describes in the *Secret History of Silicon Valley*, many breakthrough technologies that have been the foundations of successful ventures – radar, Internet, nuclear technology, GPS – were launched in order to serve the state- (and world-) missions of beating the Germans during WWII and later the Soviets and Koreans during the Cold War. The US government harnessed its universities and their brightest minds to win the war; in the UK, Alan Turing developed the first computer to break German codes. Today, deep tech is a unique opportunity for governments to address the UN's Sustainable Development Goals, especially the climate change challenge.

While all these numerous frictions clearly penalize deep tech investment, **four core paradoxes surface** from analyzing the inadequacy of the current investor model for deep tech: a mindset paradox, a risk paradox, a barrier paradox and a funding paradox (Exhibit 8). Hidden within each paradox is a way forward that helps us rethink the deep tech investor model:

- Deep tech ideally matches the very origins of the venture capital mindset focusing on science and breakthrough problem-solving with long-term vision (risk mitigation approach) **just when** VCs have progressively shifted away from their roots mainly relying on the power of distributed returns and well-established, narrow paths of ICT and biotech (risk minimization approach)
- Investors perceive deep tech as risky with both technology and market risks colliding with long-term and high investments **and yet** it is riskier not to be exposed to deep tech investment at all. Rather deep tech threatens to disrupt incumbents and PE portfolios, destroying value
- The barriers to raise deep tech funds are increasing, consolidating most capital towards the largest traditional funds and few deep tech funds which grow their unfair advantage **whereas** the barriers to innovation and deep tech venture building are falling (e.g., DBTL cycle times decreasing, cost of prototyping and testing are falling)
- The investment dry powder has never been so high with depressed returns from cautious investments in safe havens and bonds shifting to higher risk-adjusted investments, **while** deep tech ventures lack funding and are the next wave of investment returns, with valuations not yet sky-rocketing.

These paradoxes have persisted due to misunderstandings and a lack of knowledge of how deep tech ventures succeed and how to fund them. It is time to set the record straight.

Exhibit 8: four paradoxes emerge from the current deep tech investment model

Mindset paradox

How to adopt a deep tech investment orientation

VC investors have a heritage that is aligned with deep tech, because of their longstanding interest in advanced science and breakthrough technology

VCs have drifted away from that heritage, to an ICT or biotech model of distributed returns: less aligned with deep tech and its mindset

Risk paradox

How to mitigate the risks in deep tech and seize its opportunities

Investors associate deep tech with high risk because of a lack of experience in assessing its risk and reward accurately

Investors and incumbents are at greatest risk if they ignore deep tech, miss the opportunity and thus become vulnerable to disruption

Barrier paradox

How to establish channels for funding deep tech

Barriers to fundraising are expanding, with large legacy funds positioned as the default option, drawing capital away from new deep tech funds

Barriers to innovation are falling, which will enable more deep tech ventures and thus more investment opportunities

Funding paradox

How to prioritize investment in deep tech

"Dry powder" has never been so high ($1.9T) and safe investment returns are declining, leading investors to accept higher risk

Deep tech is increasingly recognized as the future of innovation, but has not yet been fully accepted as such by investors

Source: BCG and Hello Tomorrow analysis

4. Create and spread an articulated narrative for deep tech investment

Deep tech was born in laboratories reserved for privileged researchers operating within a small community of experts. This breed of deep tech pioneer is very different from Silicon Valley's entrepreneur kings. Deep tech entrepreneurs are often scientists passionate about their technology but sometimes less able to build a supporting narrative. Among the many testimonies from surveyed deep tech ventures, it was acknowledged that "the biggest challenge we faced was being able to tell a story about what the tech means".

First, deep tech faces a vocabulary problem, grounded in technicality. A pitch is very different from a thesis presentation and needs to excite even an uneducated audience. Pitching genetically-modified nitrogen-fixing microorganisms may sound abstruse, if not like wizardry, to investors. It becomes even less engaging if it misses the end-applications or the commercial opportunity and terminology.

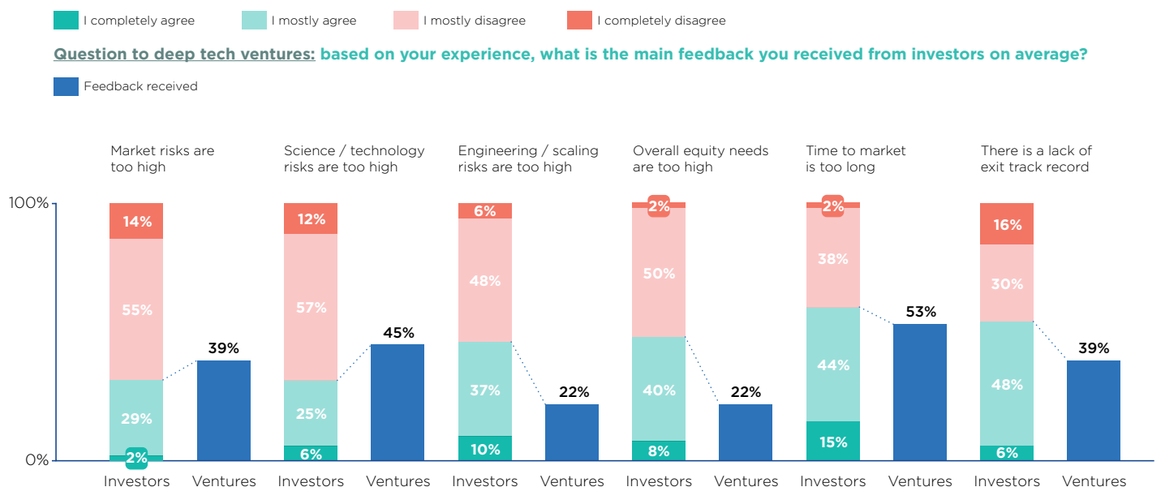
Second, investors may need to read between the lines of deep tech pitches, either beyond the technology presentation or dig into the unsaid. Indeed, scientists and engineers are usually very conservative about data proofs and evidence: they may keep additional opportunities which are only 90% backed by evidence and experiment to themselves. Investors need to adjust their evaluation strategies accordingly.

Third, deep tech stories should cascade over the three investment levels: ventures, direct investors (e.g., VCs), and LPs. The narrative is nurtured at the venture level. Founders build a story to VCs highlighting the targeted problem and how their technologies enable a breakthrough solution to it. VCs also build their pitch to LPs, bringing together an investment thesis around the problems they are willing to invest in, how they will assess the potential of ventures, through which mechanisms money could be invested (see chapter 5). LPs are the source of all funding to be unlocked for deep tech ventures. LPs should also educate their peers to activate funding and grow the deep tech network.

Our latest BCG and Hello Tomorrow survey of deep tech investors and deep tech ventures highlights an asymmetry of perceptions between deep tech investors and all investors on average (based on the average investor feedback received by deep tech ventures) (Exhibit 9).

- Market and science risks are overrated by investors on average, while deep tech investors disagree that "market risks are too high" at 69% (deep tech ventures typically offer a 10x better solution) and that "science / technology risks are too high" also at 69% (deep tech investors typically invest once the science risk has been left behind in the lab).
- Interestingly, deep tech investors are 47% concerned by too high engineering risks and 48% by equity amount risks. Indeed, and as articulated below, investors should care about how to mitigate these risks. Average investors are only 22% likely to anticipate these risks to be too high, disregarded compared to market and science risks.
- Deep tech investors still confirm that "time to market is too long" (59%) and that "there is a lack of exit track record" (54%), despite accelerating development cycle times and a growing investment track record detailed hereafter

Exhibit 9: different risk perception between deep tech investors and the feedback deep tech ventures receive from investors on average



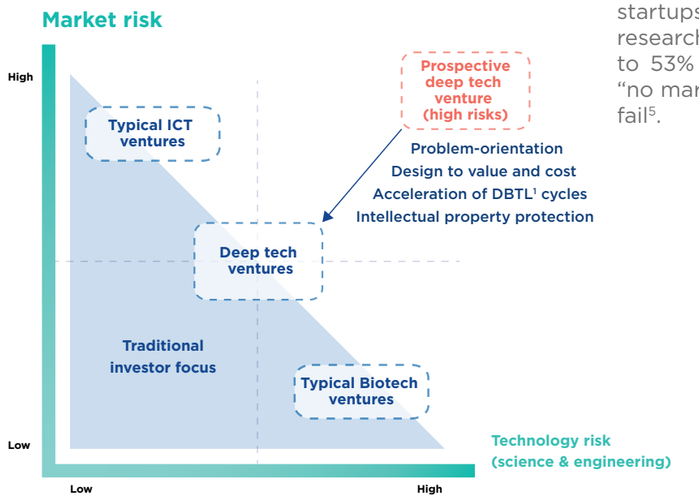
Source: BCG and Hello Tomorrow survey across 116 ventures and investors, March 2021

Most investors know very little about deep tech and what they do know can be fraught with biases or clichés, putting them off. According to Prime Movers Lab founder, Dakin Sloss, "There are three big myths about [...] deep tech: that it takes longer, that it's more capital intensive, and that it's higher risk". On top of the problem solved and the technologies leveraged in solutions, the narrative to investors should clarify the de-risking approach of deep tech, reassure on the control of its equity needs and emphasize the existing track record showing that deep tech investment is dynamic and that exit opportunities are real.

a) Deep tech market and technology risks are high, but they can be mitigated

Deep tech lives at the intersection of science and engineering: it usually involves several advanced technologies and has a physical product as its outcome. It's not an app. Successful deep tech ventures are not sitting in labs creating a hammer looking for nails, but rather focusing on the world's most intractable problems in domains such as hunger, climate change, pollution, sustainable energy. Investors may well feel that, given the complexity of the problems many deep tech ventures address, and the immaturity of their emerging technologies, they are inherently risk-laden, but these fears are overstated (Exhibit 10). Yes, "deep tech is hard" as confirmed in *Sifted* by David Grimm, Investment Director for the UCL Technology Fund. In deep tech, market and technology risks are often integrated, but so are the ways to mitigate them.

Exhibit 10: market and technology risks of deep tech investment can be mitigated



1. Design Build Test Learn; Source: BCG and Hello Tomorrow analysis

I. Problem-oriented mindset and problem/market-fit

Successful venture-backed, deep tech teams must address a real problem – a need, a market. This focus on the problem acts like a compass to guide the entrepreneur through the valley of death, ensuring that there is market-fit at every stage of development. To borrow from Seth Bannon, founding partner at Fifty Years, every deep tech outcome should pass the "Mr Burns Test" – to "build a product that Mr Burns (the prototypic self-absorbed, egoistic, greedy capitalist) would buy not because it's sustainable but because it's the best/cheapest/most convenient." Similarly, the example of climate change is too broad to be treated as a problem; successful ventures drill down to specific problem roots with enough clients willing to pay for it, thus identifying the closest problem/market-fit to tackle. As highlighted by Russell Tham, Joint Head, Enterprise Development Group & Strategic Development at Temasek, investors need to prioritize ventures with a "strong focus on the go-to-market stakes and the business model, not just the technology alone".

One key differentiator of deep tech ventures is their ability to propose a ten-times-better product, not just a 10% improvement. It is a strong de-risking lever for many ventures once the problem is well-scoped, but scoping it requires a major effort. A 2020 HBS survey estimates that problem orientation and market research are a top contributory factor to high valuation ventures: "38% of low valuation startups completed at least six months of customer research before launching their products, compared to 53% of high valuation counterparts." Similarly, "no market need" is the main reason why start-ups fail[5].

5. according to CB Insights (2019)

II. Design-Build-Test-Learn (DBTL)

Despite the high risks, one deep tech entrepreneur stated that he and his colleagues were "not risk tolerant but rather risk averse". They navigate through uncertainty in a methodical way. Although deep tech investors fund breakthrough scientific discoveries, they are unlikely to take science risks which are mainly mitigated during the laboratory discovery phase, funded by governments and philanthropists, and are IP-protected. CEO and Managing Partner at The Engine, Katie Rae clarifies further that "the frontier between science and engineering risks is blurry especially in the early stages, so that deep tech (Tough Tech in the words of The Engine) investors have to believe that they are substantially only taking engineering risks and not pure scientific risks. Whenever science risks inadvertently resurface, there are still opportunities for another grant funding".

Then, the DBTL frames and accelerates the mitigation of the engineering and scaling risks. The DBTL approach in a deep tech context is the adaptation of Lean startup methodology to deep tech, and brings together multi-disciplinary teams from science, engineering and design to maximize problem solving and de-risking.

Having targeted a problem, the team uses DBTL cycles to iterate and experiment fast. More importantly, deep tech teams prioritize in the cycle the most critical risks to secure MVP delivery. As the DBTL cycle rejects sub-optimal pilots, activity and capital is directed constantly at mitigating the most significant risks upfront, building an all-in-one "full-stack" solution, as Eclipse VC describes it.

On the one hand, DBTL cycles lead to continuous learning and design adaptation to improve the technology, de-risk the solutions, and accelerate time-to-market (and therefore earlier revenues) thanks to falling technology barriers and costs. On the other hand, they will improve the product to fit customer needs.

- Biofoundries like Ginkgo Bioworks or Doulix reduce the time to synthetic biology DBTL cycles from months to weeks
- Commonwealth Fusion Systems focused on the fastest and least expensive part to improve reactors, i.e. the magnets instead of the plasma physics, and shortened the DBTL cycle from a one-year average to one month.
- It is not only learning from failure that helped SpaceX but also failing early: the first SpaceX launch failed in 2006. As a result of lessons learned, SpaceX realized its first successful launch in 2008, only six years after the startup's founding.

III. Design to value and cost

Market and engineering risks are further mitigated when manufacturing beyond the prototype is approached with a design to value and cost strategy. It frontloads the cost analysis into the design phase, while making sure that the value (better and possibly cheaper product) is delivered, rather than addressing them later. Practically, this means mapping the projected cost curve decrease to the specific applications or situations of the problem where the highest value can be delivered. This way deep tech ventures can minimize the market adoption risk. SILA nanotechnologies, for example, was able to develop new battery technology using globally available components for piloting and bulk synthesis reactors that scale efficiently. Adoption risk needs to be further anticipated when dealing with corporate clients who could be slower to move and adopt a new solution.

"Early win" applications can be identified upfront, reaching first commercial revenues faster, proving the value and financing the cost reduction. Successful deep tech ventures improve the trajectory (shrinking the time) to profitability if design to value and cost is embedded in the first commercial pilot.

IV. Deep tech IP

Because the barriers to entry for deep tech are set much higher than for digital ventures (while barriers to run DBTL cycles are falling), they offer a high measure of protection from competition risk, limiting the costs to outcompete rivals. Besides patent protection, scientific complexity and engineering difficulty together offer the investor insurance against a proliferation of me-too lookalikes that can steal the market. Closing the door behind patented deep tech and technology advantage is relatively easy.

b) Deep tech equity needs can be controlled

Some investors will argue that even if the market and technology risks are mitigated, deep tech still requires high initial investment. This is generally true: compared to SaaS, for example, deep tech has higher capital needs at the early stages. However, it is also true that the lifetime capital needs of a deep tech investment may be no higher than its counterparts in other fields.

On the one hand, SaaS ventures typically have low early-stage equity needs but for some of them it can blitzscale due to high cash burn rate as they go to market, acquire and retain customers below

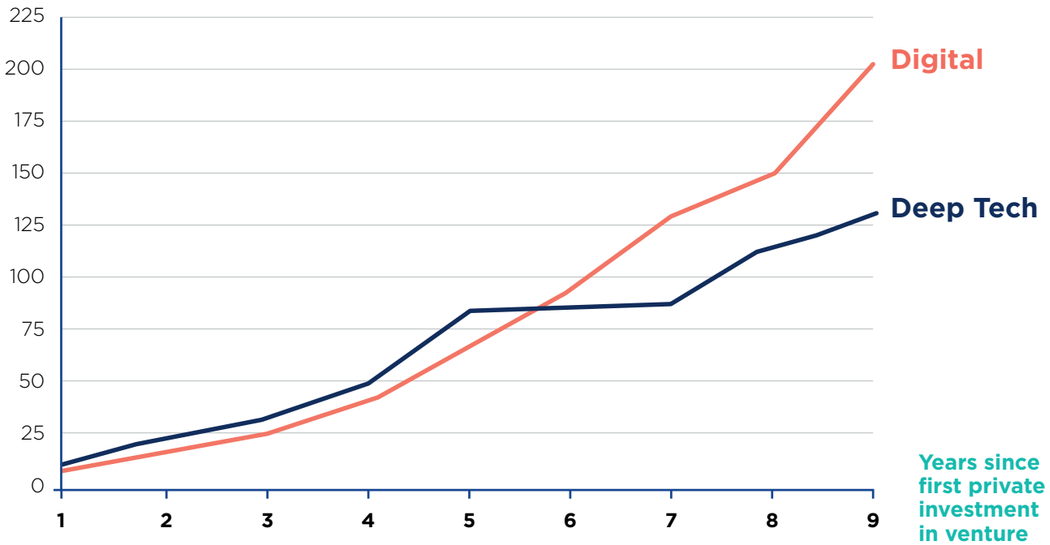
the cost of delivering services to them (e.g., Uber, WeWork, Palantir). On the other hand, successful deep tech ventures require higher early-stage equity funding but once their deep tech product has been effectively de-risked and designed to value and cost, equity needs on average are controlled over time (Exhibit 11). As confirmed by several ventures interviewed, "once running, the need for outside capital will decrease". Also, revenues from the first commercialized product enable a shift to project financing (see section 5. b) i. Adapt financing tools to future needs).

In addition, deep tech ventures evolve in such a complex and constrained environment that there is possibility of wasting capital. It forces them to build a de-risking plan which will prioritize most critical risks and minimize spending while finding the closest pools of revenues.

Prime Movers Lab shared its experience in deep tech investment (Exhibit 12): it would be more advantageous to raise more in one seed round (c.$5-$8 million) than two smaller seed rounds (c.$2-$3 million). The investment sweet spot for deep tech is earlier, but also higher: with equivalent dilution, this approach combines the opportunities of dealing with fewer investors, condensing raising effort to free up time for execution and getting all resources for de-risking to Series A. By receiving relatively high funding early, the venture can meet upfront research and infrastructure costs, and accelerate its development. Earlier and higher funding is a (necessary but not sufficient) condition to set the venture for faster success and revenues from the first commercialized product, unlocking non-dilutive project financing.

Exhibit 11 - private investments in deep tech are higher than digital in the first years but remain controlled on average

Average cumulated private investments per year for a venture ($M)



Ventures per year with disclosed transactions

28725	10217	8217	5871	4040	2715	1712	1106	712
2346	674	656	473	331	238	136	103	66

Note: the number of ventures per year does not represent a funnel analysis as ventures do not raise every year; Sources: Capital IQ, Preqin, Crunchbase, BCG and Hello Tomorrow analysis

Exhibit 12: deep tech investment experience recommends larger seed rounds

	Seed 1 + Seed 2 strategy (two rounds of $2-3mm each)	Larger Seed Strategy (one round of $5-8mm)
Dilution	15-25% each round, but adds up to 30-40% altogether	Expect 30-40% upfront dilution
Cap Table	More distributed, more names of funds, more voices + differing incentives	1-2 larger names, Strategic angels
Structure	Often series of SAFEs/notes	Typically priced round
Time	Add another 4-6 months to raise Seed 2: huge distraction when focus is needed on execution	More planning work / modeling required upfront; but then entrepreneur can focus heads down on execution
Series A	VC flag: founders couldn't reach milestones as planned with original round (i.e. 'didn't do what they said they would')	Sets up well for Series A

Note: SAFE stands for Simple Agreement for Future Equity
Source: Prime Movers Lab

c) Deep tech investment track record is growing but it's just the beginning

Lastly deep tech suffers from a lack of information and communication. Obviously, we are just at the beginning of the fourth wave of innovation and its track record is only now starting to build. As Exhibits 13, 14 and 15 show, while all eyes have been focused on the next Uber or Deliveroo, hundreds of millions of dollars in smart money has been pouring into deep tech, and quietly creating unicorns, successful corporate and IPO / SPAC exits. According to the VC Fifty Years, for example, they have increased the equity value of their portfolio by at least $3 billion, with at least eight companies enjoying valuations over $100 million. It's not that there are no success stories in deep tech: it's that the stories are not being told.

While between 2015 and 2019, the aggregated IPO exit value[6] decreased from $466 billion to $308 billion, M&A is an important exit option for deep tech: for corporate market leaders, acquisition opportunities in deep tech are strategic priorities to avoid suffering the same shocks that digital inflicted. According to the Hardware Club, 47% of hardware ventures anticipate an acquisition as an exit versus only 17% that anticipate an IPO.

Beyond dynamic deep tech funding and corporate M&A, deep tech investment is gaining credibility and becoming more mature (Exhibit 14): Sovereign Wealth Funds and Pension Funds trust deep tech by investing directly in ventures or in venture capital firms (Rhode Island public pension fund broke with precedent and invested directly $20 million in DCVC in 2020), M&A is starting between deep tech ventures themselves and VCs demonstrate successful exits. MIG is the most recent exit with meaningful returns, distributing €600 million in dividends to LPs after selling 5% out of its 6% of BioNTech shares (with the share price gaining 650% since IPO).

6. Preqin

Exhibit 13: deep tech investment track record gathers billions in funding and unicorn valuations

Company	Estimated total private investments ($M, as of April 9th 2021)	Unicorn	Estimated valuation ($B)	Valuation year	Sector
IMPOSSIBLE	1500	✓	10	2021 (pending SPAC)	Plant-based protein meat
indigo	1200	✓	3,5	2020	Agtech microbiology
LILIUM	1200	✓	3,3	2021	Electric aviation
chargepoint	885	✓	2,4	2020	Electric charging stations
SILA NANOTECHNOLOGIES	875	✓	3,3	2021	Energy storage materials
zymergen	875	✓	3	2021	Biomanufacturing
GINKGO BIOWORKS THE ORGANISM COMPANY	800	✓	17,5	2021	Biofoundry
QuantumScape	800	✓	3,3	2020	Energy storage
Desktop Metal	712	✓	2,5	2020	3D metal printing
GRAPHCORE	710	✓	2,8	2020	AI chipmaker
Carbon	662	✓	2,4	2019	Carbon 3D printing
JUST	650	✓	1-2	2021	Cellular agriculture
Beam THERAPEUTICS	482	✓	4-5	2021	Genetic medecine
PsiQuantum	445				Quantum computing
IONQ	434	✓	2	2021	Quantum computing
spire	380	✓	1,6	2021	Satellite
planet.	350	✓	1-2	2019	Satellite
Spiber	340	✓	1	2021	Bioproduced silk
LanzaTech	280	✓	1	2019	Bioproduced chemicals
Commonwealth Fusion Systems	199				Fusion energy
MEMPHIS MEATS	180				Cellular agriculture
D-Wave	160		0,2	2020	Quantum computing

Note: selected examples, not exhaustive
Source: Crunchbase, Capital IQ, press search, BCG and Hello Tomorrow analysis

Exhibit 14: illustration of investment journey of deep tech ventures with selected examples

Deep Tech VCs investments

Data Collective · Prime Movers Lab · SOSV · The Engine · Flagship Pioneering · Future Ventures · Breakthrough Energy Ventures · 50Y · Lux · elaia · C4 Ventures · Ahren

Sovereign wealth funds and pension funds investing directly

Temasek → Just · Commonwealth Fusion Systems · Pivot Bio · Generalfusion · Memphis Meats

Generation → Deepmap

Saudi Aramco → Desktop Metal

Alaska Permanent Fund → indigo

CPP Investments → chargepoint

Deep tech acquisitions by corporates (transaction amount / year)

J&J	Auris	$3.4B 2020	Michelin / Faurecia	Symbio	2019
Hyundai	Boston Dynamics	$921M 2020	BASF	Sculpteo	2019
Amazon	Zoox	$1.2B 2020	John Deere	Blue River Technology	$305M 2017
Facebook	CTRL-Labs	$0.5-1B 2019	Veolia	Kurion	$350M 2016

M&A dynamics among ventures themselves

Zymergen	enEvolv	2020	Planet.	Terra Bella	2018
				Boundless	2017
Rigetti	Q Branch	2019	Auris	Hansen	2016

IPOs

Biomanufacturing	Zymergen	$3B 2021
Genetic medecine	Beam Therapeutics	$0,8B 2020
DNA sequencing	10x Genomics	$3,7B 2019
mRNA biotech	BioNTech	$3,4B 2019
mRNA biotech	Moderna	$7,5B 2018
Synthetic DNA	Twist Bioscience	$0,4B 2018
DNA editing	CRISPR Therapeutics	$0,6B 2016

SPACs

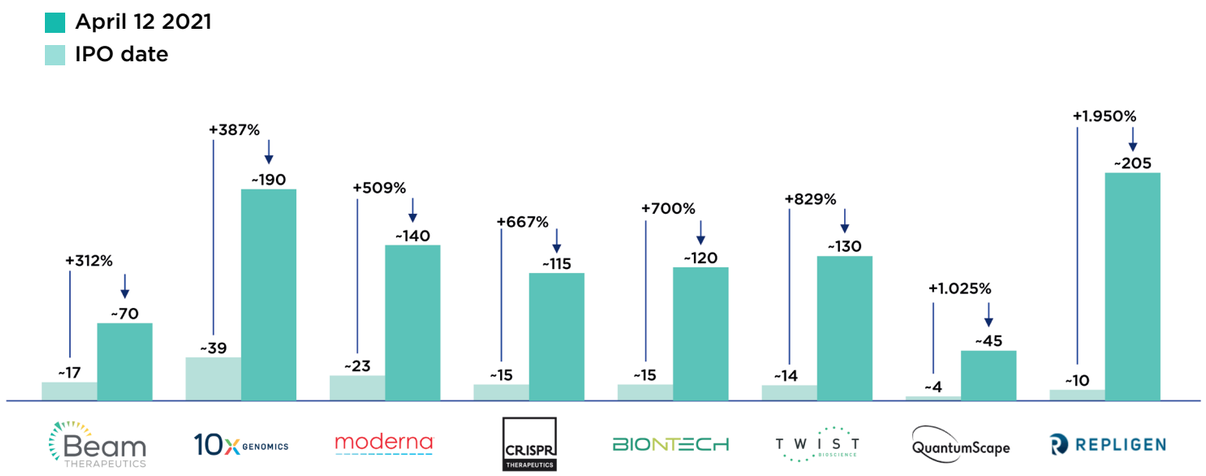
Biofoundry	Ginkgo Bioworks	$17,5B 2021
Plant-based protein meat	Impossible	$10B e 2021 e
Electric aviation	Joby Aviation	$6,6B 2021
Electric aviation	Lilium	$3,3B 2021
Quantum computing	IonQ	$2B 2021
Satellite	Spire	$1,6B 2021
Protein sequencing	QuantumSi	$1,6B 2021
Protein sequencing	Nautilus Biotechnology	$0,9B 2021
Energy storage	QuantumScape	$3,3B 2020
3D metal printing	Desktop Metal	$2,5B 2020
Electric charging stations	chargepoint	$2,4B 2020

VCs already performed successful exits

Future Ventures	D-Wave, Zoox, Planet.	Data Collective	Blue River Technology, Agenovir, Desktop Metal
Lux	Zoox, CTRL-Labs, Kurion, Aeva, Desktop Metal, Auris	Khosla Ventures	Blue River Technology, Amyris

Note: selected examples, not exhaustive; the exit activity of deep tech ventures accelerated over the course of the research
Source: Crunchbase, Capital IQ, press search, BCG and Hello Tomorrow analysis

Exhibit 15: deep tech ventures also made it to the IPO with share price performances from x3 to x20 + since IPO date

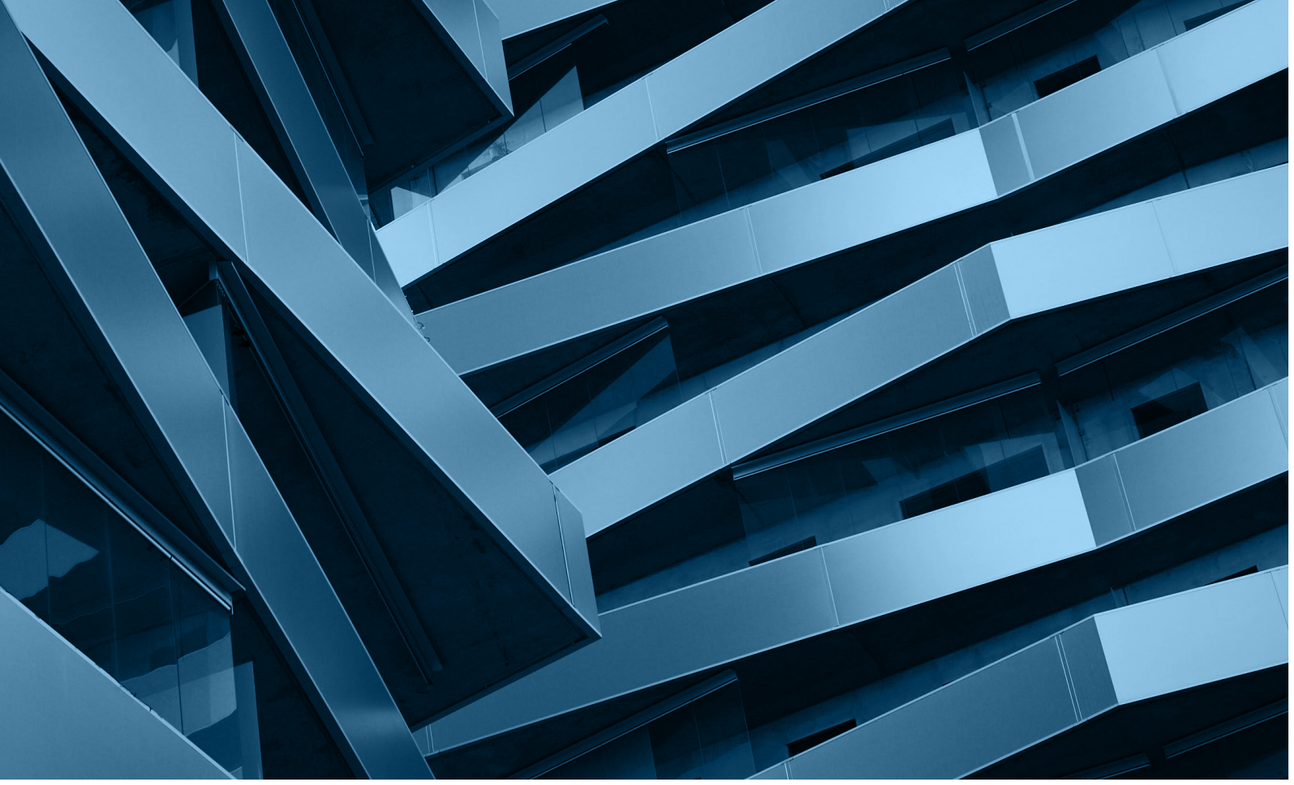


Note: selected examples, not exhaustive
Source: Crunchbase, press search, BCG and Hello Tomorrow analysis

A different tale from the valley, from Peter Platzer, CEO of Spire Global

NASA or SpaceX do not hold the monopoly for putting satellite constellations in orbit. Spire was founded in 2012 with the ambition to build the largest constellation of multifunction satellites. They started raising from small VCs and angels, balanced with venture debt, but there were pitfalls along the way. As for many deep tech ventures, many were the investors telling them "if someone else leads, I invest", so that substantial funding was available but with no lead, and Spire did face some difficult years. Moreover, leading space experts challenged that their satellites could overcome the laws of physics. By 2017-18 Spire proved them wrong, with established annual recurring revenues reaching $38 million (unaudited) in 2020, and growing, at 63% gross margin, following the same $1 million to $100 million revenue path of top SaaS companies. Their latest achievement has been their SPAC merger valued at $1.6B in March 2021.

But even better, is this story told in the words of its CEO, Peter Platzer *(The Three Little Pigs* fable takes on a new flavor once told by a deep tech founder). "Once upon a time, three little pigs were each building their house. The first pig quickly builds a simple house made of straw, like a SaaS MVP, minimizing risk. Everybody loves it and wants to invest in it, while they laugh at the third pig taking more time to build a brick house, like a deep tech product, focusing on mitigating its risk. As the first pig becomes well-known, more wolves lurk around his house ready to blow it away, and fencing costs increase desperately. In the meantime, the third piggy finished his house and has been able to monetize it with a massive rent, as it could not be blown away."



5. The deep tech investment model requires a new approach and new principles

In order to remove the frictions that are holding back deep tech investment, and seize the full potential of deep tech returns, a whole new investment approach is required. One deep tech investor surveyed stated that deep tech investment "is not for the faint-hearted and best practices are still emerging". As observed by SOSV partner Benjamin Joffe, "deep tech also faces a financing risk if the investment ecosystem is not ripe for it and to support ventures throughout their funding journey". Beyond creating and spreading an articulated narrative about deep tech, investors should adopt **three major principles** to make the shift happen:

a) Adopt a new approach leveraging deep tech knowledge and its ecosystem, anchoring problem-orientation and reshaping the distribution of returns
b) Embrace new investment models including adapted financing tools, possibly longer timelines, and new investment structures
c) Emphasize and capitalize on the profound impact deep tech ventures can have on society at a time when SDG and climate concerns are becoming ever more central

a) Adopt a new approach

I. Grow in-house deep tech knowledge and build an ecosystem

As with any successful relationship between investor and investee, deep tech ventures benefit from shared expertise, active support, contacts and experience. Investee teams need help in making the right decisions early to avoid wasting precious time. Speaking the same technical language helps build trust and cooperation between the venture and the fund, and this may mean funds will need to grow in-house expertise by including both post-doctoral scientists, engineers, former operators as well as an active network to draw on for on-demand needs. According to our latest survey, of investors that have invested in deep tech, 79% leverage external expertise, 42% have hired PhDs and 37% have hired people with MSc or engineer profiles to assess deep tech potential.

- Ahren Innovation Capital team includes cutting-edge experts such as two Chemistry Nobel Prize-winners, the IRIS eye recognition inventor and Illumina founder (global gene sequencing platform)
- Fifty Years fund works on the activation of the PhD community in deep tech with several initiatives: PHDVC (a campaign to onboard PhDs into venture capital), Translation Podcast (a podcast series on scientists' discoveries in labs) and Fifty 50 (a community of top 50 North American researchers interested in entrepreneurship)
- Commonwealth Fusion Systems' (CFS) investors include hardware and energy veterans from the Clean Tech era like Khosla Ventures
- As an LP, Temasek is building the team with the technical skills and competences to assess and support deep tech ventures and VCs
- Almost half of Breakthrough Energy Ventures staff, another CFS investor, has a PhD background

Founder and CEO of C4 Ventures and Chairman of Business France, Pascal Cagni clearly highlights this issue: "Due to the rapid cycles of innovations and the increasing complexity of deep technologies, there is a sizeable 'knowledge gap' between innovators and investors. This represents a major bottleneck in terms of accessing funding for the majority of Europe's deep tech companies. To bridge the gap, investors need to boost their in-house knowledge and develop strong ties with the right research and innovation ecosystems.

"In summary, investors should not look into deep tech if they do not understand the science behind it or are unwilling to invest in the necessary scientific knowledge. Only then will funds help frame the venture strategy. One investor surveyed clarified that "deep tech investment is about tech, not investment".

Deep tech investor expertise also lies in the active support and clear understanding of the stakes and opportunities of its ventures. It takes shape in the customization of development / progress milestones to emerging technologies and problem/market-fit. They are very different from well-benchmarked SaaS ventures or well-defined biotech phase gates in clinical trials. Investors mastering bespoke deep tech milestones or even developing a new framework adapted to deep tech (or specific deep tech sectors) are one step ahead. This active role is crucial in making many deep tech ventures successful.

Ultimately, a whole deep tech ecosystem is mandatory to foster innovation: corporates help ventures to scale, institutions improve regulation, universities provide technology expertise and transfer, etc. More specifically, the ecosystem building creates additional opportunities as it connects several industries and technologies, across value chains. As an example, Polyera's corporate ecosystem was complex (Polyera produced semiconductor materials for flexible smartphones or tablets). It involved specialty chemistry manufacturers, specialty glass manufacturers, display panel manufacturers, electronics integrators, and consumer product companies. Investors play an important role in making these connections, sourcing ventures and expertise, thus creating more value for everyone, aka growing the deep tech pie. The ecosystem symbiosis is especially critical between investors and research institutes, as shown by Blue Bear Ventures (BBV). BBV is an early-stage investment institution that spun out of UC Berkeley, to support founders from leading research universities, addressing some of the world's most pressing challenges in health and climate. They back cutting-edge innovations including CRISPR technology, an antiviral for COVID-19, cell therapy, battery technology or air quality sensors.

II. Become problem-oriented

In order to align fund and venture goals, funds need to change their approach to become problem-focused and help ventures in that approach too. "Think forward 500 years: what is the inevitable endpoint that no one will debate?" asked Steve Jurvetson, VC investor in SpaceX, Tesla, or Memphis Meats. The underlying principle of the inevitable is to assess risks upfront instead of nurturing investor dreams in the equity story. Listen to IndieBio Founder and Venture Advisor, Arvind Gupta: "I invest in problems, not in solutions". It can be a blocker for ventures as a founder testified: "it has taken us a long time because we are attacking a problem that no one wanted to think about."

Being problem-oriented also means being focused. Deep tech addresses highly complex problems and cannot have several irons in the fire to navigate successfully through uncertainty. As Arvind Gupta says, “if you have a problem, you have a company. If you have two problems, you’re dead”.

Since its launch in 2000, Flagship Pioneering has applied hypothesis-driven innovation processes based on existing technologies to imagine products or reimagine value chains, thus originating and fostering more than 100 scientific ventures, resulting in over $34 billion in aggregate value. Its founder Noubar Afeyan also co-founded Moderna, now hitting the headlines. Benchmark, one of the most successful VC firms in history, investing in eBay and Twitter, defined problem-oriented approaches as “seeing the present clearly”, not investing in trends.

Problem-orientation for ventures should be triggered by having a purpose. It is a fundamental frame within which ventures can define their mindset, their objective and shoot at a north star. The first welcome sessions for new ventures at IndieBio are about thinking and defining their purpose. Deep tech investors should play a coaching role in the ecosystem to help founders structure and polish their narratives for fundraising, making their venture accessible to many with well-identified problems to solve and their solutions.

Being problem-oriented also aligns the ecosystem to a clear goal, bringing together all stakeholders able to solve the problem. It is especially important in deep tech where markets are not always mature, and underlying ecosystems not well connected.

At its origin, Benchmark was a field-based fund, which means spending more time out in the field in laboratories, in entrepreneurs’ garages, seeking out quality investments, not waiting for the deal flow to come to them. They did not try to predict the future (which involves too much complexity); deep tech ventures address by nature complex adaptive systems which are too difficult to predict. It is not by chance that Benchmark and Lux Capital have ties with the Santa Fe Institute whose work on complex adaptive systems is widely recognized. “Seeing the present clearly” refers to a deep understanding of existing and emerging technologies and inevitable endpoints, and their impacts across markets and value chains.

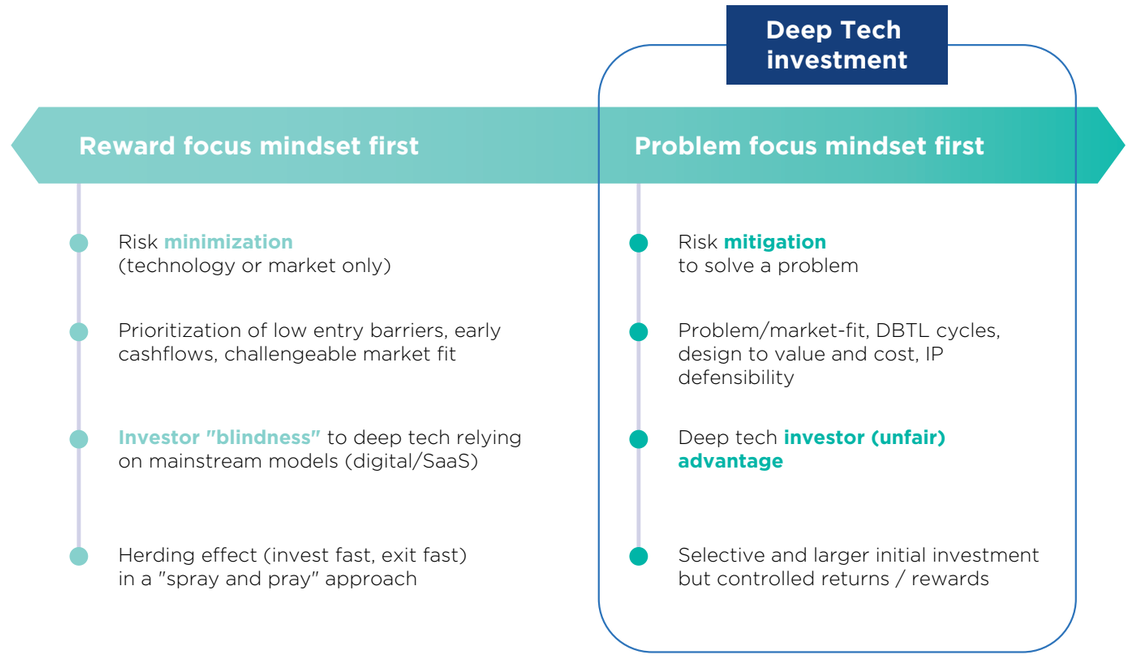
As noted by Silicon Valley’s iconic figure Tim O’Reilly, “there are two economies, often confused: the operating economy, in which companies make and sell products and services, and the betting economy, in which wealthy people bet on which companies will win and which will lose in the beauty contest that stock markets have become”. A parallel distinction can be made about the investor mindset. Paradoxically, to reap the benefits of deep tech, one must not invest first in a reward-first mindset. Reward just becomes the consequence. One bias of being reward-focused in the first place is inverting risk minimization with risk mitigation (Exhibit 16). Risk minimization encourages the mainstream reflexes (e.g., focus on low entry barriers) which drove the boom of SaaS and digital ventures for example. Problem-first mindset fits with deep tech with a risk mitigation perspective. Although investors balance risk management between mitigation and minimization, deep tech investors have an unfair advantage to invest and de-risk what other investors do not see as an opportunity. Unlike machine-learning algorithms, investors should not apply data derived from SaaS investment to analyze deep tech: the recipe does not work. As Bill Janeway says, frontier innovation investment should be led by contrarian investors (e.g., Warren Buffet) not followers.

III. Rethink the portfolio strategy and the value of distributed returns

The added-value of a VC should be to outperform and not reproduce the standard landscape of returns, naturally power law-distributed. In deep tech, successful investors are the ones to uncover the most promising teams and ventures before others, but are also problem-focused de-riskers, who understand what is inevitable and where the risks lie. Through an active and problem-oriented thought-process, the investment return profile can be reshaped to include a higher share of successful ventures.

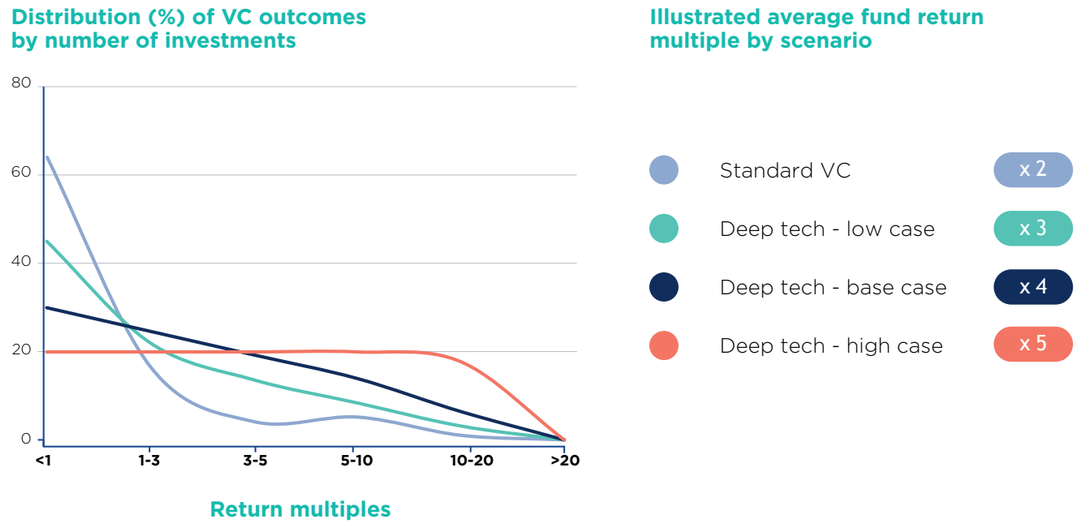
A different distribution of returns would have a positive impact on the profitability of funds. It can be illustrated with three deep tech distribution profiles (low / base / high) (Exhibit 17). The low case is a first derivative from the standard VC distribution, whereas the high case is an ideal situation in which full implementation of deep tech investor model principles such as problem focus, active support, DBTL and new funding schemes is applied. Leveraging Collaborative data, we built an example of a standard VC distribution curve with an average x2 return multiple on investments. Taking this case as a starting point, deep tech investment profiles illustrate a x3 multiple for the low case, x4 for the base case and x5 for the high case. For every $100 invested in deep tech, compared to more traditional VC areas, the additional return would be an estimated $200 in the base case illustration.

Exhibit 16: deep tech shapes investment towards risk mitigation, leveraging an unfair advantage



Source: BCG and Hello Tomorrow analysis

Exhibit 17: illustration of return profiles with flattened distribution curves increasing from x2 to x3-5 average return



Note: each curve sums to 100%; Source: Collaborative data, Different Funds, BCG and Hello Tomorrow analysis

b) Embrace new investment models

In order to deliver a flattened curve of returns and best support deep tech ventures, the investment model needs reimagining in terms of: financing tools, fund lifetime, and investment structure.

I. Adapt financing tools to future needs

On top of traditional dilutive equity and grants, deep tech investors can explore a wider set of asset classes to adapt to ventures' needs, such as non-dilutive financing, long-term horizon of returns aligned with the venture's performance (revenues or profits). Our latest survey (Exhibit 18) highlights that a majority of deep tech ventures would "very likely" and "most likely" use different financing tools on top of traditional equity (78%): revenue-based financing (60%), client advance payments (59%), and convertible equity / debt (58%).

First, as described earlier, **debt or venture debt** (provided by non-banking lenders) can be activated once a venture has generated its first sustainable revenues. It is a cheaper non-dilutive solution than traditional equity. Total venture debt is growing faster than the broader VC market, reaching $28 billion in 2019[7].

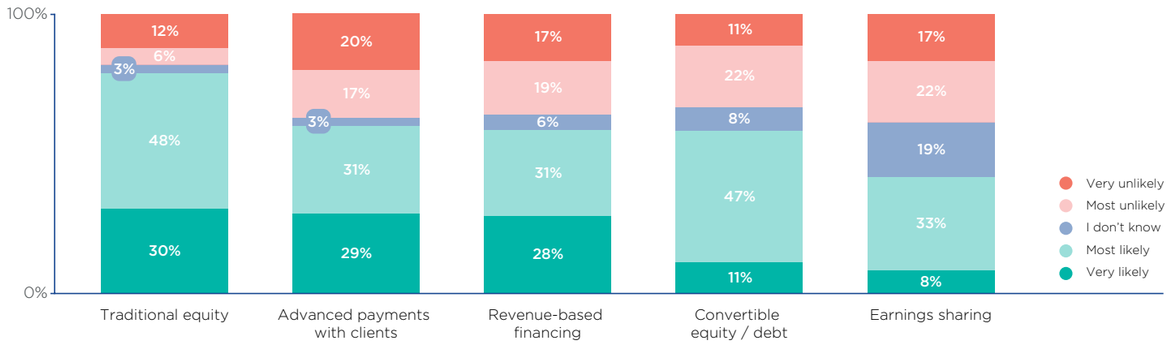
Ventures can explore **revenue-based / royalty financing** for a specific product or project. The same way movie producers finance the filming phase, investors could pay for development of a product and get paid back on a share of its revenues (capped or not). Investors can focus their investment strategy on the venture's most promising projects while the venture is de-risked by only paying back once it has revenues from them, categorized in the cost base. An example of this non-dilutive financing for SaaS ventures is Pipe. A Pipe-equivalent for deep tech would be highly valued. Ventures could bypass equity funding issues, without asking for debt or a loan. It also provides a safety net for investors securing returns when revenues come sooner than a potentially too distant realization for them. What are the odds of having an exit before your portfolio company makes any revenues? Deep tech platform businesses (e.g., Ginkgo Bioworks) could see the incentive alignment in providing revenue-based financing to the deep tech ventures using their platform: by financing the revenues of their ecosystem ventures, they secure their future revenues, plus returns on the financing.

Earnings sharing also provides non-dilutive financing with returns activated only once the venture makes profits. For example, Earnest Capital proposes shared earnings agreements according to which investors receive a percentage of "shared earnings" (including founder salaries, dividends and retained earnings). It acts like preferred dividends without the condition of giving away equity and typically returning later than first revenues.

For climate fighting ventures with commercial revenues, **carbon credits** can be an option to attract capital from companies penalized by their carbon emissions, while the European CO_2 pricing hit a record-high €34 per ton in January 2021. It aligns a venture's financing with its carbon footprint impact in a non-dilutive way.

Exhibit 18: beyond traditional equity, other financing tools are also envisaged by deep tech ventures

What would be the main financing tools you would most likely use after reaching your first commercial revenues from a final product ? (% of ventures)



Note: only deep tech ventures with no commercial revenues yet in 2020
Source: BCG and Hello Tomorrow survey across 116 ventures and investors, March 2021

7. Pitchbook

Another non-dilutive financing solution involves **advance payments** from customers for a specific contract or exclusivity to help ventures accelerate development. For example, Moderna received an upfront payment of $240 million from AstraZeneca for a 5-year, exclusive partnership in 2013.

From the investor's perspective, **convertible debt** can be used to balance risk management: if the venture's success grows, the lender can swap to higher equity risks but also higher potential returns. It suits investors looking for risk optionality. Similarly **convertible equity** balances risk the opposite way.

II. Invest for longer

Although not true of all deep tech ventures, many may require longer investment timelines to leave time for R&D to be de-risked and the first product to be launched. This does not imply that all deep tech ventures require much longer investment horizons but more that new funds would fit better if they were flexible on individual investments' times-to-exit. Investment timeline becomes less of an issue if the returns are shown and reassure LPs to stay longer.

Some deep tech funds have already set up longer lifetimes: Future Ventures is 15-years; The Engine is 12-years extendable up to 18-years; Ahren Innovation Capital is up to 15-years. Breakthrough Energy Ventures is a 20-year fund and it has the advantage of being founded by Bill Gates and supported by many of the world's billionaires. A relevant longer lifetime for a deep tech fund could be 15 years, broken down into: 2-5 years of de-risking research and business, 2-5 years of business growth and scale before divesting (in line with average PE holding period), 2-5 years buffer of investment screening. Extensions of 2-3 years could be included to leave space to capture more opportunities and value. According to our latest survey to investors, the ideal mechanisms to support long term investment vary: 44% would prefer an evergreen fund, 37% would opt for a 15-20-year fund and 35% for successive 10-year funds.

In addition to providing long-term support to deep tech ventures, longer fund lifetime has two advantages for funds. On the one hand it avoids rushing into ill-considered investments and it enables a better selection of top-performing assets. On the other hand, it leaves more time to capture more value from growing ventures rather than exiting early due to fund close. This approach is crystallized in the Ahren Innovation Capital philosophy of "patient active" capital which has invested in Graphcore (semiconductors for machine learning), Nu Quantum (quantum hardware) and Mogrify (cell transformation).

Family Offices and Sovereign Wealth Funds are perhaps best placed to invest over long-term horizons and align solutions with the world's most fundamental challenges. Some specific principles could apply to funds planning for longer timelines in a deep-tech context

- Set up periodic reviews of fund budgets and fees vs. fixed percentage of AUM, as pioneered by Draper and Gaither & Anderson
- Set up mechanisms for LPs to enter or exit (see secondary markets, hereafter). Trades would be based on regular assessment of the net asset value of closed-end vintages.

III. Adopt new investment structures

In order to catch up on non-deep tech fund sizes (on average $105 million for deep tech funds versus $146 million), deep tech funds would benefit from larger sizes both to better fund ventures early and develop more investment vehicles in the growth stages.

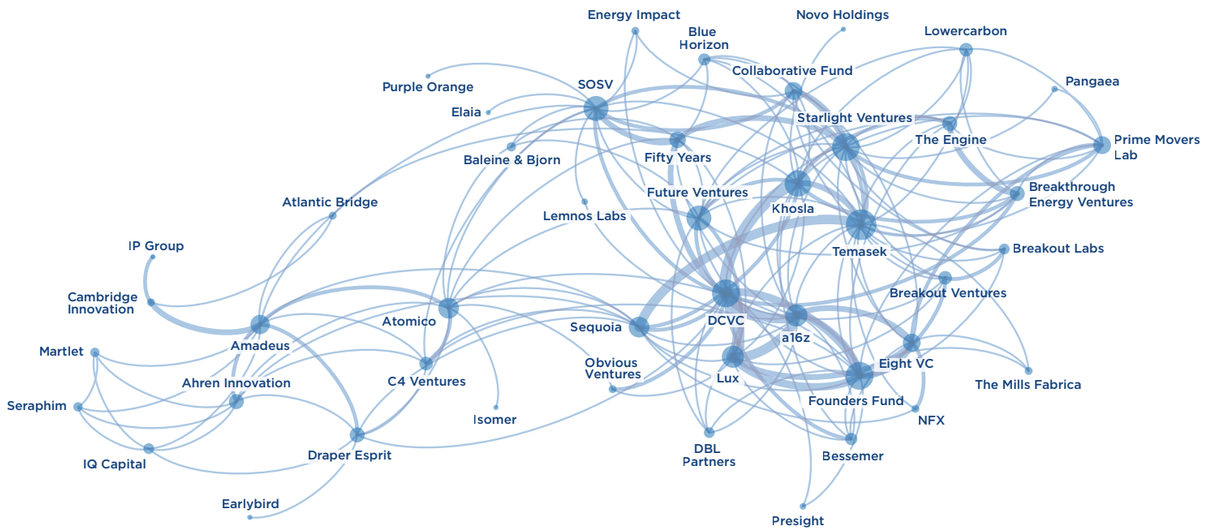
Feedback from deep tech ventures suggests that some would indeed be willing to have a mixed shareholding structure: mix of VCs for expertise, corporates providing a platform to scale, government and institutions for strategic support. This is different from the traditional investment scheme where PE & VC tend to remain separate from most corporates and governments. The interconnected nature of deep tech ventures and their ecosystem is a logical reason for this mixed shareholding structure.

Deep tech co-investments are already happening with leading funds such as a16z, DCVC, Founders Fund, Khosla, Prime Movers Lab or Lux Capital all involved in them. Co-investments validate the investment thesis, but leading deep tech funds still behave independently, far from the typical herding effect. The graph network below (Exhibit 19) illustrates this interconnection with the co-shareholding relationships between top deep tech funds in deep tech ventures.

Traditionally, funds raise consecutive closed-end funds, to grow progressively in size, build track record, and possibly repurchase portfolio companies from the first funds. New investment vehicles could also be looked at to broaden the pallet of funding and exit sources and find a balance in the deep tech investment model:

- **Rolling funds** such as AngelList allow their managers to share deal flows with fund investors on a quarterly subscription basis, structured as a series of limited partnerships where LPs can modify or cancel their subscription. The minimum quarterly subscription can be as low

Exhibit 19: deep tech investors operate in a tight network of co-investors



Note: selected list of deep tech investors, not exhaustive; the width of the links shows the number of deep tech co-investments between two investors and the size of the nodes shows the number of deep tech co-investments for a given investor
Source: S&P CapitalIQ, BCG and Hello Tomorrow analysis

as $1,000 per quarter for some funds. More typically, this minimum quarterly subscription ranges from $6,250 to $25,000 per quarter. The advantage is to raise capital more progressively and have a broader set of available investors if they are publicly marketable on online platforms.

- **Publicly-quoted funds** such as IP Group or Draper Esprit provide an even wider access to capital with lower entry cost. They also offer the fastest way to raise capital with, for example, Draper Esprit taking just three days (plus one month of upfront preparation for market assessment) to raise £110 million in 2020, instead of the more normal fund process of one to two years. Augmentum VC, which went public in March 2018, sees it as an opportunity to keep companies as long as needed in their portfolio. Publicly-quoted funds also catalyze IPO exits by exposing their companies to public markets early. The side-effect is that the fund market capitalization is subject to market speculation and volatility. This can be counterbalanced by portfolio mix and successful track record.
- **VC-as-a-service** could fill a white space in the deep tech investment chain and act as a catalyzer to compensate for the lack of knowledge and understanding of deep tech in the investment market as a whole. Venture-capital-as-a-Service (VCaaS) can provide ventures with more flexible check sizes and offer LPs a broader deal flow than that only accessible by their funds.
- **Special Purpose Acquisition Companies (SPACs),** raise money through a SPAC IPO to merge with a private company and thereby provide for funding and immediate listing. This investment vehicle has been a growing trend especially for clean tech, SDG companies and other high growth sectors. SPACs offer a secure listing opportunity (mostly in the US) as shown by Desktop Metal's announcement regarding Trine at a $2.5 billion valuation (December 2020), or NavSight taking Spire Global public valuing the company at $1.6 billion (March 2021). SPACs also boomed during the pandemic crisis thanks to increased available capital pools, the fact that SPAC transactions are basically M&A deals in essence, and attractive valuation levels. However, it is still unclear whether SPACs will be sustainable, as an alternative to traditional IPOs, or an epiphenomenon, depending on the investors' ability to understand their benefits and limitations[8].
- **Secondary funds or trading platforms** offer the possibility for LPs to trade their interests in a fund. The secondary market is emerging as some LPs are looking for liquidity tools or asset rebalancing, and others are seeking stakes in de-risked / known portfolios at a discounted value. 500Startups founder Dave McClure launched PracticalVC, a VC secondary fund claiming to "skip the J-Curve" and cut by half the typical 10-15-year VC holding period. Platforms like Palico, emerged over the past years as an attempt to liquefy secondary trades like digital marketplaces.
- **Opportunity funds** (or follow-on funds) would step in as side funds of a VC to double down and provide longer term funding to top-performing portfolio companies. It supports the portfolio strategy with diversified LP risk exposure and protects selected pro-rata agreements. Silicon Valley-inspired hybrid funds, like €60 million Barcelonian fund aldeA Ventures, balance their strategy between tickets in specialized deep tech micro-funds and series A direct co-investments. It builds a bridge between seed and later stages, while keeping a preferred access to pre-selected deep tech ventures.
- **Non-profit companies,** such as Time for the Planet, are an early sign of responsible and purpose-driven investments available to all (e.g., citizens, companies, associations, banks, etc.). Anyone can become a shareholder by purchasing a share of the company, whose value cannot be traded on public markets. Instead of distributing dividends to investors, the company invests in innovations and creates corporations pursuing goals in accordance with the investment company's purpose. All profits are reinvested in either the investment company's or its "subsidiary" companies' development.

In an ecosystem play, sharing carry will dynamize collaboration with stakeholders commonly incentivized towards the success of the fund. With this mindset, Kindred Capital deploys equitable venture: 20% of the carry is distributed to portfolio founders to incentivize them to the success of the fund, activating their network for quality deal flow or joining forces with ventures to succeed. Collective Equity Ownership offers founders to cash-out part of their equity and pool them. First exits pay back cash partners and follow-on benefits are distributed between founders and cash partners; founders become incentivized towards the success of other ventures.

c) Emphasize the profound and societal impact of deep tech

Fifty Years pledges to "back founders using technology to solve the world's biggest problems." At its core, deep tech lives by this mission statement, making "problem-orientation" live. Along with LPs' and society's SDG concerns, deep tech investment follows the same longer trajectory as Impact investment. Some deep tech investors can be identified as Climate Tech funds: these include Breakthrough Energy Ventures, OGCI Climate Investments, LowerCarbon Capital or Generation Investment Management.

Instead of chasing unicorns, investors would do better to chase quality impact ventures. These single-horned magical creatures are often positioned in a densely competitive landscape, meaning that the core strategy is to battle and eat competitors for breakfast – usually a capital-intensive strategy. One just needs to look at the Uber/Lyft/Didi case that has raged long and hard, burning cash for all the combatants.

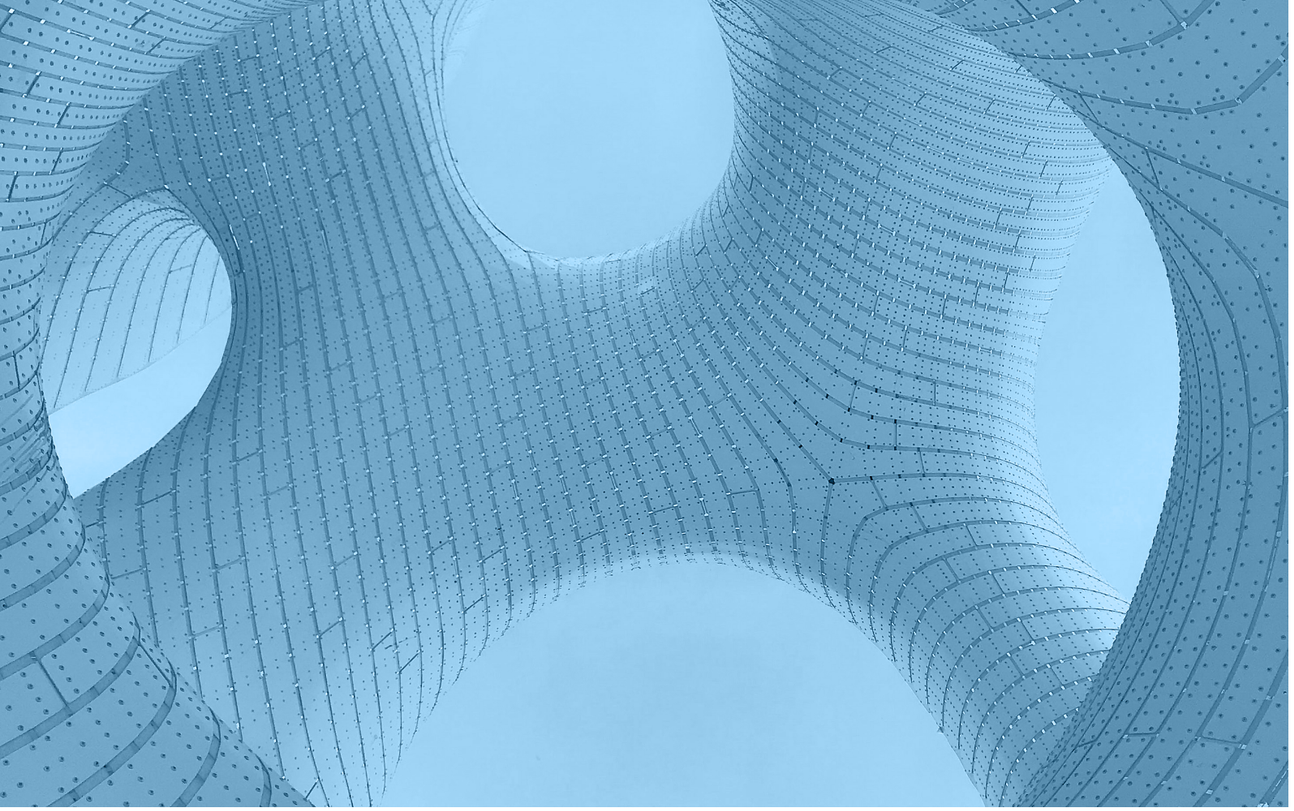
A parallel to Fifty Years can be set with Mayfield's concept of Conscious Capital based on five pillars: conscious leadership, philanthropy and diversity, rise of the individual, powering human and planetary evolution, and rehumanizing social media. The objective is to make meaningful investments for humankind and not just profits, but paradoxically by doing so, higher profits tend to accrue.

A deep tech investor should not lower its ambition. The key for a sustainable model is to start looking at the potential for future development of deep tech ventures and to translate their SDG outcomes into interesting investment opportunities via higher exit multiples (which would more than compensate for high entry prices). The lesson from Conscious Capital is to start pricing in SDG contributions into valuations – the underlying rationale being that these companies will thrive precisely because they make substantive contributions toward meeting SDGs. Such an approach could help better align the interests of shareholders and society.

The global call to climate action and more broadly SDG concerns are starting to shake up PE and LPs with dedicated initiatives: 370+ investors from Climate Action 100+ "ensure the world's largest corporate greenhouse gas emitters take necessary action on climate change", Vanguard began offering funds that invest solely in companies screened for specific social, human rights, and environmental criteria. As SDGs are prioritized to meet LP requirements, deep tech ventures addressing these issues are an obvious answer for funds seeking a sustainable home.

Finally, in the deep tech context, SDG and impact investing does not throw out profit; rather it integrates profit into a broader ambition. Profits for ventures means profits for investors. It paves the way for successful deep tech ventures solving problems in the sustainability field, supported by new consumer habits and regulatory incentives.

8. https://www.linkedin.com/pulse/pulling-back-curtain-spacs-dr-jens-kengelbach/



6. New investment archetypes required in an ecosystem of dynamized players

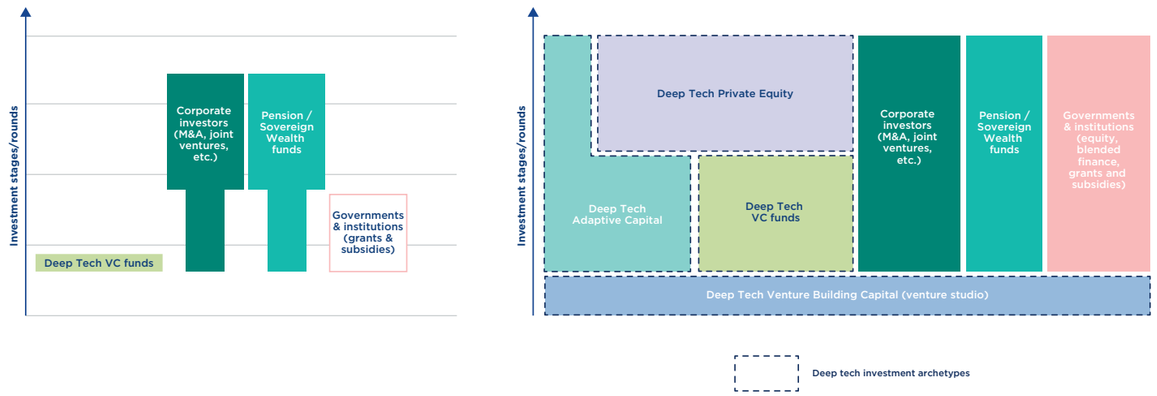
As education of investors in deep tech propagates and the new investor model is implemented, we can begin to delineate a new investment ecosystem in which LPs, VC and PE funds, corporates and governments and institutions each play a mutually supportive role. Today's investment chain is broken, both because of the frictions we discussed in Chapter 3, but also because there is a gap in the investing landscape. It can be bridged by four main archetypes (Exhibit 20): deep tech VC funds, deep tech adaptive capital, deep tech venture building capital, and deep tech PE funds.

a) Deep Tech Venture Capital funds

The ideal deep tech fund will have a deep bench of scientists and engineers, an appropriate alignment with a problem-oriented approach, and a larger pool of capital to deploy. Specifically, the ideal deep tech fund (Exhibit 21) will look like this:

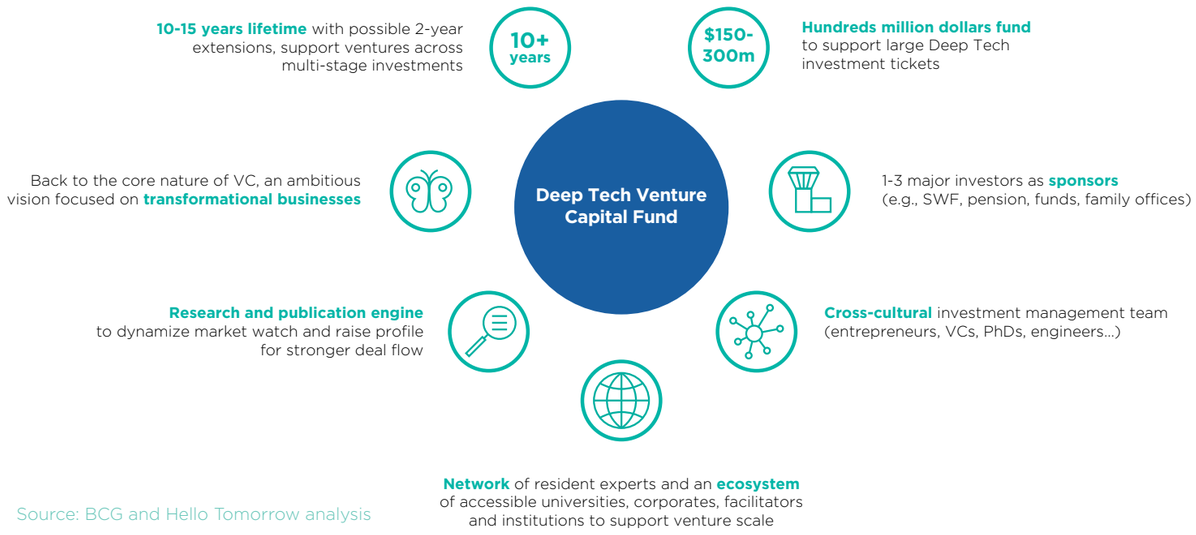
- An ambitious vision focused on impact (including SDGs) and transformational rather than incremental businesses, relying on conscious capital principles
- A long-term lifetime of minimum 10 years or more with two-year extensions, ideally 15 years
- A fund size of hundreds of millions of dollars backed by deep tech savvy LPs, "deep pocketed" and long-term sponsors such as Sovereign Wealth Funds, Family Offices, Pension Funds or strategic corporate investors looking to augment their innovation approach. It may be open to new investment vehicles such as public funding with lowered entry tickets to facilitate more capital raises (e.g., publicly-traded funds, rolling funds) or to facilitate an exit (e.g., SPAC)
- A multi-disciplinary fund team (entrepreneurs, scientists, consultants, engineers) all aligned with the problem-oriented approach, acknowledging that appropriate compensation, working environment and research environment will be offered to attract rare talent.
- An active and well-connected network of niche deep tech experts, and an ecosystem of universities, facilitators, corporates and institutions both to keep an up-to-date and informed view of the deep tech field and provide relevant support to ventures and due diligence
- A research and publication engine to trigger technology knowledge sharing and consolidation, dynamize market watch and raise fund profile for stronger deal flow. It might include data science and analytics use cases with product/market-fit recommendations, as Tribe Capital does.

Exhibit 20: four deep tech investment archetypes as stronger participants in the deep tech investment funnel



Note: simplified representation as investment relationships between stakeholders are more complex and intertwined (e.g., corporates or pension funds can be limited partners of funds)
Source: BCG and Hello Tomorrow analysis

Exhibit 21: what does a successful deep tech VC fund look like?



Source: BCG and Hello Tomorrow analysis

This deep tech VC fund archetype **fits seed phases and bridges the gap with growth phases** (and PE world) as it has the funding capacity to provide trusted support for its ventures. Such a fund would be a pivotal element in bridging the gap in the investment chain.

Successful deep tech investors will demonstrate a unique approach to venture support beyond elementary funding and team selection. They need a framework to navigate through the deep tech universe. As discussed in Deep Tech: *The Great Wave of Innovation*, deep tech ventures can be staged into four moments: what is probable (Copernicus moment), possible (Newton moment), real (Armstrong moment), and profitable (Asimov moment). Deep tech investors can extrapolate the questions that arise from these moments to their ventures:

- How to be problem-oriented and derive the best strategy to address the ultimate goal?
- How to bring emerging technologies together and identify key assumptions to be tested first to reduce risk upfront?
- How to move quickly to a working prototype?
- How to always keep the economics in mind by following a design to value and cost approach?

This customized framework sets the stage to define progress milestones and KPIs and calibrate valuation assessments and follow-on strategies. This detailed and adapted approach would reassure LPs on hands-on management and de-risking steps. In a context where a deep tech venture has mitigated market risks with problem-orientation and secured adoption through problem market-fit and design to value and cost, the de-risking milestones are focused on the engineering side which are more easily measurable than market risks. Deep tech VC teams should play an active support role to ventures leveraging this framework, helping them remain problem focused and encouraging them through the DBTL cycles.

In addition, during the deal process, the investment team can build **terms and conditions** taking into consideration the specificities of the deep tech venture target. General Partners should build an **investment pitch** to LPs about problems chased by the fund, translating this into the investment thesis, in line with problem-orientation (and not invest in deep tech for the sake of deep tech).

imec xpand

imec.xpand exemplifies the symbiotic relationship with its ecosystem. imec.xpand is a circa €120 million VC fund partnering and colocalized with the technology and research hub of imec (including some 4,500 researchers in nanoelectronics and digital solutions). imec.xpand is not the corporate venture arm of imec, but leverages imec as a catalyzer with R&D facilities and tech expertise to advise and support ventures, including imec spin-outs. Downstream, imec.xpand is well connected to the semiconductor industry both as partners or clients for ventures, but also as potential co-investors or exits. It is stage agnostic as long as imec can add value to the venture. At seed rounds, it invests tickets of €2-€3 million and puts together stronger syndicates in order to sufficiently back ventures and get them to a meaningfully de-risked inflexion point. imec.xpand identifies the most promising ventures, prioritized according to the most critical tech risks in their mitigation plan. It syndicates its ecosystem of partners in follow-ons to carry the ventures on.

Some larger funds are garnering attention in the deep tech space by adopting some if not all of these features already:

Flagship Pioneering

Flagship Pioneering is a circa $4.4 billion fund founded by Noubar Afeyan, focusing on "breakthroughs in human health and sustainability". To date "$1.9 billion has been deployed toward the founding and growth" of more than 30 current portfolio ventures, especially in life sciences companies, complemented by more than $10 billion from other institutions. Among its most prominent successes are Moderna, Indigo Agriculture, Incredible Foods. Compared to the total $1.9 billion deployed, Flagship's stake in Moderna alone was worth $5.6 billion in February 2021 according to Bloomberg. Flagship has formalized an approach based on four funnel steps (Explorations, ProtoCos, NewCos, and GrowthCos), which are animated through its venture studio, Flagship Labs. The four moments of truth of deep tech ventures mirror these four steps, showing the way to a methodical and systematic approach for investors to venture de-risking and problem-orientation.

Breakthrough Energy VENTURES

Breakthrough Energy Ventures is a 20-year-horizon and circa $2 billion fund backed by Bill Gates and notable LPs (e.g., Xavier Niel, Jeff Bezos, Jack Ma, Masayoshi Son, Richard Branson, Michael Bloomberg, Vinod Khosla). Its portfolio comprises deep tech ventures aimed at fighting climate change or sustainability goals.

SOSV

SOSV is a global venture capital firm with about $900 million AUM that operates startup accelerator investment programs, such as hardware-oriented HAX and life-science-driven IndieBio. SOSV invests in over 100 new companies each year, many of which target human and planetary health, and provides lab space, in-house experts and a network of mentors and over 2,000 alumni.

LUX

Lux Capital is a $2.5 billion fund making "long-term bets on contrarians and outsiders". To quote them further, "Lux Capital invests in emerging science and technology ventures at the outermost edges of what is possible. We partner with iconoclastic inventors challenging the status quo and the laws of nature to bring their futuristic ideas to life."

DCVC | Data Collective

DCVC is a more than $2 billion fund which backs entrepreneurs using Deep Tech to pragmatically and cost-effectively tackle trillion-dollar problems, helping to multiply the benefits of capitalism for everyone while reducing its associated costs. DCVC has more than 48 exits, including four multi-billion dollar public companies where it was part of the seed or first institutional round (Elastic, AbCellera, Zymergen and Recursion Pharmaceuticals). DCVC's portfolio companies use their Deep Tech advantage to address our climate crisis, create new breakthroughs in human life sciences and transform industries. Some notable examples include Pivot Bio (replacing harmful synthetic fertilizer with naturally occurring soil microbes), Opus 12 (transforming CO_2 emissions into cost-competitive chemicals and fuels), Planet (operating the largest fleet of earth observation satellites), Capella Space (building SAR satellites for Earth observation even through smoke and clouds), Atomwise (AI for small molecule drug discovery), Caption Health (AI-guided ultrasound software) and Gro Intelligence (an AI-powered insights platform addressing the food, agriculture and climate economies), among others.

Prime Movers Lab

Prime Movers Lab is a billion dollar deep tech fund. Prime Movers Lab invests in breakthrough scientific startups founded by *Prime Movers*, the inventors who transform billions of lives. They have already invested in 28 ventures at the convergence of technologies and fundamental problems: Covaxx develops a vaccine for the Covid pandemic, Upward Farms cultivates aquaponic farms for sustainable agriculture, Boom builds the next supersonic airliner, Space Perspective lays the ground for space travel, CFS builds a fusion energy reactor, Carbon Capture removes CO_2 from our atmosphere. In order to get the most out of deep tech, they also invested in the Idealab venture studio.

LowerCarbon Capital is an impact investment fund launched by Lowercase Capital founder, Chris Sacca. It "backs kickass companies that make real money slashing CO2 emissions, sucking carbon out of the sky, and buying us time to unf**k the planet". The fund has backed around 40 ventures mainly in deep tech such as Commonwealth Fusion Systems (fusion reactors), Lilac (ion exchange technology for lithium extraction), Solugen (enzyme-based specialty chemicals production) or Mosa Meat (non-GMO lab-grown meat), but also non-profit research such as the planet-cooling research and policy initiative, SilverLining, or carbon removal studies, CarbonPlan.

The Engine is a firm with approximatively $500 million in assets under management that was spun out of the Massachusetts Institute of Technology in 2017, providing long-term capital support to "Tough Tech" companies - currently 31 in portfolio between its two funds. The Engine has an ambition to bring breakthrough technologies from the lab to commercialization across a broad spectrum: advanced materials, advanced manufacturing, artificial intelligence, energy, food and agriculture, life sciences, robotics, space, quantum and next generation computing, and semiconductors. Beyond the Fund, it also offers infrastructure services including access to specialized labs and equipment.

IndieVC's story should be regarded as a word of caution for many GPs. Although not specifically focused on deep tech, this brand from O'Reilly AlphaTech Ventures had implemented many of the principles proposed in this report. They provided an active support from the investor side flattening the distribution curve, lowering the mortality rate down to 12%. They partnered to offer a diversified capital stack of debt, equity and more. IndieVC sponsored community-based pilots to activate the ecosystem. According to its co-founder, it was his decision to end this activity as it did not align with their LPs' orientations. The learnings from Indie show the consequences of a lack of proper narrative to LPs to ensure the alignment. One should not forget this lesson when raising a deep tech fund.

b) Deep Tech Adaptive Capital

Two illustrations make the case for new ways of financing ventures.

Since its launch in 2014, Closed Loop Partners have invested in 45 portfolio companies with the objective of building circular economies to address the climate emergency. They aligned on this mission with their LPs: large retailers (e.g., Amazon, PepsiCo), large financial institutions, family offices and foundations. LPs pick and choose four asset classes according to their risk profile: VC, credit, Growth and PE. Their strategy is long-term and adapted to venture financing needs, inspired by Unilever approach to sustainability, breaking the compromise between impact[9] and profitability - their ventures are already profitable. They look at investing with an ecosystem perspective and collaborate not only with corporates but also with municipalities, and have their own innovation lab.

On the other side of the Atlantic, in 2020, Marie Ekeland announced "2050" a "Tech for Good" French evergreen fund. The structure is 100% held by a non-profit trust fund (*fonds de pérennité*), able to remain as long as needed as a shareholder of its ventures. The objective would be to raise a first fund of €100-€150 million (first from Family Offices) and have up to €1 billion AUM by 2025. 10% of AUM and 50% of the carry will be reinvested in strategic commons (e.g., shared knowledge, shared research, shared infrastructure) which would benefit the whole ecosystem, including their portfolio. At each portfolio value assessment (e.g., twice a year), LPs would be able to enter (with a 5-year investment lock-in period) and exit, trading their shares on a private secondary market platform.

Inspired by 2050 and Closed Loop Partners, deep tech "adaptive capital" would offer a different value proposition to long-term LP investors willing to maximize the impact of deep tech investment above financial returns. It would blend VC and Growth activities, taking the role of a multistage investor (focusing on seed/series A for entries and ad-hoc later stage opportunities) and would explore other assets like venture debt, convertibles, or revenue-based financing. According to our latest survey, 41% of investors expect their LPs to be interested in adaptive capital while 30% see it as unlikely (29% do not know). Like Sequoia, these funds would only select a few deep tech deals per year since they would have no timeline constraints.

Such funds would also need to be equipped with the skillset to take ventures across multiple stages as they need different kinds of investor expertise at different stages: seed derisking, growth, international expansion, acquisitions. Adaptive capital, together with the lack of standardized milestones, challenges the classical approach of financing rounds (seed, series A, B, C ...) as each venture requires a specific operational and financing roadmap. Ventures should ask for and receive what they need, how they need it and when they need it.

9. They track impact of asset classes with tons diverted from landfill, GHG reduction and job creation

c) Deep Tech Venture Building Capital

Deep tech venture building capital focuses on the **foundation and acceleration of ventures**, earlier than investors and with very active support. The studio or accelerator provides a de-risking enabler as part of the operations and development in a problem-focused approach. A start-up studio is a natural consequence of a strong problem-orientation and the reluctance of many scientists to become entrepreneurs: it is a way to **create the deal flow** and also a lever to deliver value fast or fail fast. This can typically deliver 30% higher success rates and 50% faster progress from zero to series A according to the Global Startup Studio Network. It provides a methodical way of working with rapid and low-cost learning. Although there is no rule that guarantees whether scientists or PhDs will be great founders, such a structure can improve their odds. Deep tech venture studios could also be an additional arm within a deep tech VC fund, an adaptive capital fund or even a corporate. The examples of Flagship and SOSV show the potential power of studios and accelerators.

d) Deep Tech Private Equity funds and institutional investors

Even if deep tech VC funds move up the funding ladder closer to the Private Equity space, ventures would still need Private Equity funds. They would be their larger cousins but with different missions. PE funds would participate in the growth phases of deep tech ventures and in project finance needs with even greater firepower.

PE funds could seize the opportunity for a vertical integration strategy or diversified project financing. Today's deep tech venture deals are the deep tech assets of their future portfolio or M&A targets for their portfolio companies. Deep tech ventures can also be supported by PE project financing at a later stage after de-risking their technology and market: revenues from the first commercialized product will enable the venture to shift from equity-based financing to debt or project-based financing, where PE can provide greater firepower at lower risks.

Very few PE funds have started to enter the deep tech space. Reynir Indahl, Managing Partner at Summa Equity, has highlighted the importance of the investor mindset in deep tech private equity; the importance of focusing on problems especially sustainability challenges first, and the need to leverage the appropriate technology expertise in due diligence as happens in research institutes. Summa Equity also confirms the opportunity to move up the funnel in deep tech growth phases. Deep tech PE funds should follow the approach of Private Equity funds like General Atlantic which provide operational support with operational partners to their portfolio companies. Private Equity funds turning to deep tech may be structurally fit for efficient support by merging their core business capabilities with additional understanding of science and technology.

As with deep tech adaptive capital funds, Family Offices and Sovereign Wealth Funds should intensify their presence with more deep tech-colored portfolios. By investing directly in deep tech ventures, they would reassure other investors to join and provide the longer timescales of support that some ventures would need to succeed. Temasek is leading the way with focused thematic investment. Deep tech investing supports the long-term orientation of such funds and can have huge societal, climate and market impact if backed by such investors.

e) Deep Tech-Savvy Corporates

The first action that corporates should take is to **rethink their innovation model by synchronizing it with their deep tech investment**. Just as it took time for Pharma and ICT companies, corporates will need to restructure their organizations, skills and culture to be ready for this wave of innovation. Corporates must become deep tech-savvy in order to be aware of the changes around them, understand them and decide when to partner, acquire, fit with, or incorporate external innovation from deep tech ventures. Most importantly, they need to embrace problem orientation together with re-imagination, and scan the deep tech landscape for fundamental and not incremental answers to big problems, often combining different technologies. Or, alternatively, they need to understand their core strengths, and how these can be best combined with those of deep tech ventures.

Companies, too, need to strategically rethink and redefine their build-or-buy strategy and their place in the deep tech ecosystem. Strategic deep tech investments are also key for corporates to keep competition under control as disruptors arise or to acquire strategic knowledge and capabilities, as

the recent investments by Volkswagen in Quantumscape and by Mercedes in Sila Nanotechnologies show.

As strategic investors, corporates could join as LPs of deep tech VC funds if they lack exposure to the innovation ecosystem or their CVC is not well-equipped for deep tech. One example is Sofinnova Partners which raised funds from Total, Michelin, Avril, and Cristal Union. They could also amplify their corporate VC arms (such as the $800 million TRI-AD fund for Toyota's mobility strategy or Bayer Leaps for Bayer's Health and Agriculture investments like CRISPR or JoynBio in a joint venture with Ginkgo Bioworks), while transforming themselves in parallel with capabilities to work with deep tech ventures and serve their strategy. In any case, all the arguments made in this paper for VC funds apply to CVC aiming to operate in deep tech.

Corporates can also leverage deep tech investment to foster climate innovation and **strengthen their SDG and climate change policies with a deep tech approach**. While targeting fundamental issues, corporates can repurpose their R&D capabilities, and with that ensure their survival. All industries face the challenge of reinvention. The aircraft industry, for example, is in the midst of climate change challenges: Airbus has set itself a deadline of 2035 to put a carbon-free commercial aircraft into service, leveraging new technology breakthroughs such as "green" liquid hydrogen combustion reactors.

Designed as an engine of the deep tech investment chain, corporates are **acceleration platforms for ventures' go-to-market**. This will only be possible with an understanding of this role and a step change in companies' strategy and ambition towards deep tech, driven by C-level commitment cascading across the organization. One example of a bold corporate ambition is Toshiba's target of $3 billion revenues in quantum cryptography by 2030, while relying on partnerships such as Quantum Xchange. Deep tech ventures can leapfrog the understanding of customer expectations by working closely with corporates which consolidate all this knowledge, just as Bolt Threads worked with fashion brands to appropriately define the textile needs of end-customers. In our latest survey, 56% of deep tech ventures emphasize that "corporates bring a unique expertise of the industry and its pain points.

Corporates can diversify their deep tech investment strategy into a venture client model, aka be the first big client of a venture. The objective is to buy a sample of the startup's solution as a "minimum viable purchase" for validation in a real pilot project conducted by the business unit. By mid-2019, BMW's Startup Garage had applied this model, with >1500 startups evaluated since the launch of the program in 2015. It is a good way of attracting top start-ups and assuring high integration rates quickly and at low fixed costs. Early venture clients not only gain strategic insights into new technologies, but they also benefit from customization, pricing, and time-to-market advantages.

The next step is to convert corporate-venture partnerships into stronger cooperation, by **leveraging corporate assets to help venture scale fast**. In April 2019, Sumitomo Chemical and Zymergen signed a multi-year partnership to bring new specialty materials to the market. Zymergen will leverage Sumitomo's access to key markets as well as industry insight to ensure that materials meet requirements to drive the next generation of electronics products. In December 2020, Sanofi partnered with in-silico drug discovery venture Aqemia, to accelerate the development of two of its Covid treatment candidates. It can involve a broader ecosystem like Lanzatech (biologically converting carbon emissions into ethanol) partnering with Total (polymerizing ethanol into polyethylene) and L'Oréal (producing polyethylene-based packaging).

f) Governments and Institutions

Governments play a pivotal role, as they should provide the necessary funding for the fundamental research that is too risky or far out for commercial relevance and also act as **supervisors of active R&D funding and create incentives to stimulate a continuous drumbeat of investment.** There are two main ways for governments to invest: either as an active facilitator of the ecosystem with a dedicated portfolio of incentives (e.g., norms and regulations, approval of new investment vehicles, labels, private/public partnershwips in line with the venture client model) or be fully hands-on in an Apollo-like program backed by massive government funding. The state-mission and strategic investments could target national security, economic growth or a meta-cause / purpose (e.g., climate change), if not the three simultaneously. Kennedy's Moonshot program inspired the global Earthshot prize rewarding best initiatives to achieve five simple goals by 2030. Successful investment at government level is based on long-term state vision and policy, just as China decided to be the global leader in batteries for electric vehicles. In March 2021, in the midst of the coronavirus vaccine campaign, President Macron acknowledged[10] "We didn't shoot for the stars" contrasting Europe's response to the pandemic with that of the US. "We were wrong to lack ambition, to lack the madness." His takeaway was two-fold: first, Europe should "rediscover the appetite for risk and investment" for future scientific and technologic ambitions, and second, Europe "needs to simplify its responses" which are "too slow, too complex".

10. EU's vaccine failure is because it didn't 'shoot for the stars,' Macron says
    Emmanuel Macron - Conseil européen du 25 mars 2021

To answer these concerns, governments and institutions must upgrade their procedures and align their mindsets to deep tech in grant awards by reducing bureaucracy and reporting, defining new KPIs adapted to deep tech. They should follow the DARPA model of high freedom and stage-gating based on adapted KPIs. Governments should also invest in the development of new academic curricula which would provide a pipeline of deep tech talents powering the whole ecosystem. Just as programmers, software engineers and data scientists were the gold miners of our data era, so the scientists and engineers working on emerging technologies will be the most scarce and valuable resources in the upcoming wave.

As deep tech is by definition **enabled by a deep interconnected ecosystem**, it is worth envisaging more concentrated (physical or virtual) hubs and clusters of researchers, investors and corporates to foster innovation and relationships between these stakeholders; what The Engine refers to as *innovation-dense areas*, with a critical mass of entrepreneurs and talent. We would do well to remember Frederick Terman's involvement in Stanford's successful ecosystem in the 1940s and 1950s which resonates with deep tech: Terman made Stanford a focal point for defense budget funding on scientific research; he created an ecosystem of partners making Stanford attractive for students, defense companies, engineers and investors; and he shifted laboratories towards a customer-driven mindset and entrepreneurial culture by listening to military customers and understanding their problems, rather than technologies pushed by researchers to the market. Governments and institutions have a role in sharing an educated and articulated narrative of deep tech in this ecosystem towards LPs, investment firms and ventures.

Beyond hubs or clusters, it is fundamental to **facilitate technology transfer in university spin-offs and the conversion from laboratory research to venture IP**. As MonteCarlo Capital puts it, the basic option of transforming a laboratory PhD into a successful entrepreneur is more easily said than done. Universities could partner with venture firms to source and match entrepreneurs with PhDs, either as with the Entrepreneur First program or as with entrepreneurship courses for students willing to launch a business. Universities should have structured a standard process (forms, terms & conditions, partners, lawyers) to smooth and speed up license approvals or patents and equity fundraising.

Governments and institutions could offer instruments such as **blended finance levers**, where private investors can lower their risk exposure with state co-investments or even have mechanisms covering part of their losses. The public agenda can be long-term and thus fit deep tech investment. As the General Director of Research and Innovation of the European Commission, Jean-Eric Paquet, recently stated, their latest 2020 pilot confirmed the need for mixed grants and equity for venture success and scale-up. Institutions are the most immediate entry point that may lead to equity financing for deep tech, where traditional VCs do not have the capacity to assess science potential. Institutional equity if deployed properly can be a guarantee for future investors. It can take the form of **direct investor or LP**, providing a guarantee as a trusted stakeholder for other investors. In an ecosystem play, governments should team up with deep tech VCs to coordinate efforts on most promising ventures and better balance funding needs between grants, government equity and private equity, without an excess of non-dilutive funding. This leverages the strengths of deep tech VCs to identify ventures and those of governments to bring strategic national funding in state-mission priorities. As Mariana Mazzucato has proposed, a better way for states to collect the fruits from their public funding on research would be to stand as shareholders of some of their promising deep tech ventures. Institutions can benefit from tech transfer opportunities like Stanford University exclusively licensing the search engine technology to Google in exchange for company stocks, however they should not ask for excessive ownership, since this might scare away other investors. Looking at the breadth of impact of deep tech, government investment (including project finance initiatives) is also a way to remain close to these strategic assets.

Incentives could be provided through several means, such as the public purchase of deep tech products, financial instruments complementing grants and subsidies (such as zero rate deep tech loans as in the case of In-Q-Tel, the not-for-profit VC fund of the Central Intelligence Agency), models inspired from impact-linked finance (e.g., carbon credit incentives to influence behaviors) or investments via Sovereign Wealth funds (leveraging the emergence of new investment models to play an increasingly active role as shown by Temasek). However, governments should ensure they keep these incentives at a fair level, in order to avoid market distortion and prevent destructive economic consequences.

Let's not forget that states can also be customers of deep tech ventures. Recommendations for corporates for "deep tech" procurement could also apply to governments and institutions.

7. Now is the time for investors to seize the deep tech investing advantage

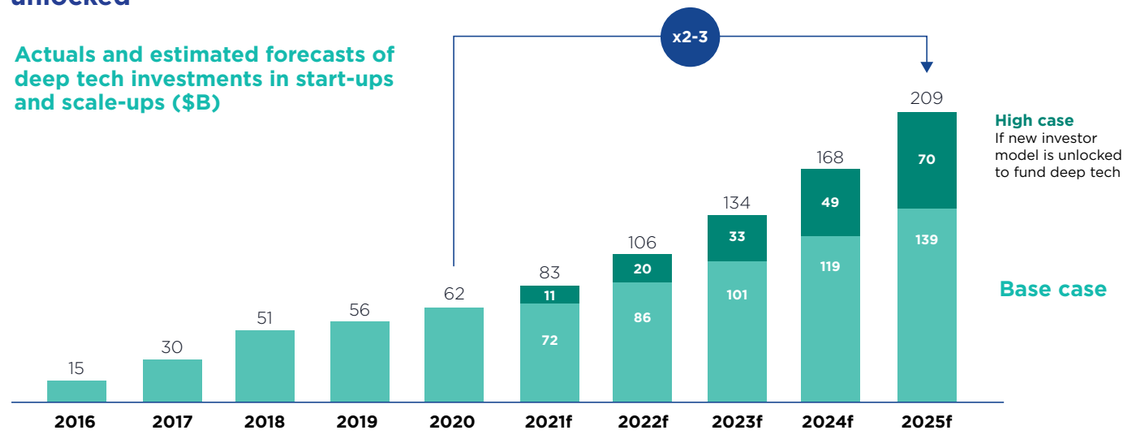
While most investors have yet to see the light with deep tech, the wake-up alarms are getting louder.

The **size of the prize is massive**. In spite of needing high investment, deep tech can unlock even higher returns by creating new markets (e.g., $50 billion quantum computing market by 2030) or attacking established markets (e.g., $30 trillion market disrupted by Nature Co-Design). The disruptive potential of deep tech both offers a carrot in the form of new market opportunities and a stick in the consequent destruction of some existing market verticals.

The **deep tech 'tax'**[11] **is lower than ever**. Firstly, research and development costs (e.g., gene sequencing, prototyping, simulation) are falling exponentially, as is the cost to reach out to consumers (e.g., the Shopify platform). Secondly, for infrastructure-related ventures, "descaling" opportunities rely on new economics with faster time-to-market because of smaller plant setup, progressive capital deployment, customized on-time production and optimized maintenance efficiency. The vast ecosystem of stakeholders involved in traditional large infrastructure projects (such as energy production) usually complicates building and maintenance activities. Building smaller, distributed plants, "descaling", is illustrated by ventures like Seaborg Technologies with floating

11. Additional costs specific to deep tech

Exhibit 22: deep tech investments to triple by 2025 if the new investor model is unlocked



Note: investments include private investments, minority stakes, initial public offerings and M&A
Source: Capital IQ; Crunchbase; Quid; BCG Center for Growth and Innovation Analytics; BCG and Hello Tomorrow analysis

fusion power plants and barges or Desktop Metal on local additive manufacturing systems.

There is a **first-investor (unfair) advantage** in deep tech, but investors willing to "buy" their early-bird tickets need to hurry. Innovation waves occur at exponential speed, as evidenced by the onrush of digital. Development time is reducing fast: the ETA for the quantum computer continues to shrink, DeepMind's AlphaFold2 solved the 50-year-old 3D protein folding challenge far earlier than most expected. Knowledgeable early investors will reap the benefits of understanding deep tech's potential before others and will be protected by entry barriers such as higher initial funding, technology IP and continuous improvement by learning.

Deep tech investment offers a sweet spot and mid-hanging fruit: deep tech **valuations are still "affordable"** compared to the potential upside (more in Europe than in the US where valuations are picking up and deal flow is stretching). Overall deep tech has not yet climbed the hype curve of the unicorn-heavy digital space.

The opportunity is huge and we are awaiting investors to play their part. We estimate that current trends, all things being equal, would make deep tech investments grow to circa $140 billion. By setting up the new investment model and ecosystem described in this paper, we estimate that investments could surpass $200 billion by 2025 (Exhibit 22). Such a scenario would be facilitated by:

- An increased funnel with smoother technology transfer from universities (or venture studio-created) and enlightened funding earlier in the life of deep tech ventures
- More and robust investment vehicles, adaptive capital and a more dynamic investor landscape (and increasing exit opportunities attracting investors)
- A higher share of ventures graduating towards larger-size funding rounds thanks to the active support of investors and the ecosystem

We are reaching an epochal shift, and are, at the same time, also at a crossroads for humankind: while we walk on the edge of the climate cliff, deep tech can propel our societies to a new dimension of unthinkable but tangible 'bits and atom' solutions, fostering the shift of our industrial and economic tissue from the "exploitative" to the "generative" paradigm. But the cards are still to be dealt: everything is still to be built and no-one quite knows the scale and shape of the disruption wave about to impact almost every area of the economy. It is a moral imperative to remove the frictions in the investment funnel and debunk the misperceptions to unlock the real power of deep tech.

The current climate crisis and the coronavirus emergency have shown that it is necessary, and in some instances also possible. Unprecedented investments have been unlocked to protect people both financially and in terms of their health, improve infrastructure and behaviors, as well as accelerate innovation and cooperation. There is no doubt that deep tech will play a major role in developing the solutions to meet the ambitious objectives of humankind to eradicate Covid-19 (or future pandemics) and of NetZero (if not negative) gas emissions to limit the damages of climate change. These joint crises of our time present a major opportunity for deep tech to benefit from this momentum and initiate a global change in its investment ecosystem.

There can be no doubt that deep tech funding will come. The real question is what will be the scale of this funding and the speed at which it will grow. Many PhD scientists viewed 2020 as beset with uncertainties and are still reluctant to leave their laboratories and launch their venture. A call to action and a greater awakening of investors are required to seize the opportunity of deep tech innovation and make it happen. The size of the prize is too huge not to be taken more seriously in the months and years to come. In 1932, Winston Churchill wrote a set of predictions in his essay *Fifty Years Hence* where he envisaged nuclear energy use, satellite communication, synthetic food, biology, or even gene editing. Without naming deep tech, Churchill imagined a future that is here now or very close. It is now our turn to imagine a new future and make it happen. While Alan Kay taught us that "the best way to predict the future is to invent it", we would dare to say that "the best way to predict the future is to invest in it".

Context of the report

This report is the third of a series of Hello Tomorrow and BCG reports on deep tech. The objective is to provide an overview of the current investment dynamics in deep tech, while highlighting which opportunities could be unlocked and how. The report relies on multiple inputs and sources: press, market reports on venture capital, private equity and investment in deep tech, interviews of deep tech founders, deep tech investors and experts, a Hello Tomorrow and BCG survey to deep tech ventures and investors. Over the course of the study, deep tech investment gained momentum and the content continuously got enriched. In fact, the deep tech investment ecosystem is emerging and moving fast, so that the content of this report is only the start of the discussion this important topic. Also because, as of today, deep tech still encompasses a wide range of very different technology fields for which the recommendations will need over time to be declined, to reflect the specific needs and characteristics of the field.

Elements of methodology for deep tech investment estimates

'Deep tech' is not yet a standard criteria in transaction data providers. The investment estimates of this report are based on a pre-selection of ventures founded after 2005 and who own patents in specific technology fields (including Artificial Intelligence, Synthetic Biology, Advanced Materials, Photonics and Electronics, Drones and Robotics, Quantum Computing…) or whose key team members (e.g. founders, CEO, CTO, VP of Research…) are patent inventors in these specific technology fields. This pre-selection is manually curated and enriched by BCG and Hello Tomorrow market research and analysis.

Capital IQ and Crunchbase are the data sources of investment events; their analysis is performed in Quid. The investment events are equity-based: private investments, minority stakes, public offerings and mergers & acquisitions. These events represent the investment period of a venture until it goes public (including Initial Public Offerings and transactions with Specialty Purpose Acquisition Companies). Grants are excluded from the estimates to avoid inconsistencies across data sources..

About the Authors

Massimo Portincaso is chairman of Hello Tomorrow and a former managing director and partner in the Berlin office of Boston Consulting Group. You may contact him by email at massimo.portincaso@hello-tomorrow.org

Antoine Gourévitch is a managing director and senior partner in BCG's Paris office. You may contact him by email at gourevitch.antoine@bcg.com.

Arnaud de la Tour is the cofounder and CEO of Hello Tomorrow. You may contact him by email at arnaud.delatour@hello-tomorrow.org

Arnaud Legris is a consultant in BCG's Paris office. You may contact him by email at legris.arnaud@bcg.com

Thomas Salzgeber is the Startup & Investor Ecosystem Manager of Hello Tomorrow. You may contact him by email at thomas.salzgeber@hello-tomorrow.org

Tawfik Hammoud is a managing director and senior partner in BCG's Toronto office. He is global leader of the firm's Principal Investors & Private Equity practice and member of the firm's Executive Committee. You may contact him by email at hammoud.tawfik@bcg.com.

Acknowledgments

The Authors are grateful to Mickey McManus, Jérôme Moreau, Michael Brigl, Helene Scheer, Nicolas Eid, Laura Bogaert, Silvia Gelonch, Thibaut Willeman, Anne-Douce Coulin Kuhlmey, Yannick Vesters, Juha Toivanen, Jean-Francois Bobier, Marco Duso, Flora Muniz-Lovas, André Pietri, Pierre Samec, Jens Kengelbach, Thomas Endter and from Hello Tomorrow, Christophe Tallec, Nicolas Goeldel, Sarah Pedroza, for the development of the content and the analyses. They thank Wendi Backler, Usman Chaudhry and the BCG Center for Innovation Analytics for the help in developing and analyzing the data. They are grateful to Liz Bolshaw (Kite Insights) for the writing support, and Bettina Boon Falleur and Martin Saive (CartoonBase) for design and production support. And are thankful to Emmanuelle Martiano Rolland (Aqemia), Erich Greiner (Cedrus Therapeutics), Gary Ong (Celadyne Technologies), Bob Mumgaard (Commonwealth Fusion Systems), Robert Marino and Guillaume Berteloot (Deeptech Founders), Azeem Azhar (Exponential View), Thomas Wolf (Plasmion), Mathias Bohge (R3 Communications), Jonas Stampe (Seaborg Technologies), Gene Berdichevsky (Sila Nanotechnologies), Khalid Alam (Stemloop), Anne-Lise Bance (2050), Herman Hauser (Amadeus Capital Partners), David Michael (Anzu Partners), Patrick Scaglia, Deepak Gupta, Alic Chen and Irfan Vissandjee (Blue Bear Ventures), Neal Bhadkamkar (Bold Capital Partners), Samuel Dominique (Brains Venture), Hemai Parthasarathy (Breakout Labs), Ann Mettler, Philippe Offenberg and Allegra Kowalewski-Ferreira (Breakthrough Energy Ventures), Frank Naylor (British Telecommunication Pension Scheme), Pascal Cagni, Michel Sassano, Philippe Dewost, and Philippe Gillet (C4 Ventures), Archimede Mulas (Collective Equity Ownership), Jesko Frommeyer (Canada Pension Plan Investment Board), Kelly Chen (DCVC), Seth Bannon (Fifty Years), Xavier Lazarus and Louisa Mesnard (Elaia), Faÿçal Hafied (French Treasury), Cyril Vančura (imec.xpand), Gayathri Radhakrishnan and Karthee Madasamy (Kauffman Fellows), Anne Wade (Leaders Quest), Mario Branciforti (Lunar Ventures), Peter Hebert (Lux Capital), Stephan Beyer (nFrontier), Tim O'Reilly (O'Reilly Media), Bryce Roberts (OATV), Brian Pallas (Opportunity Network), Marianne Hyltoft (PreSeed Ventures), Dakin Sloss and Kenny Lauer (Prime Movers Lab), Jean-Gabriel Boinot-Tramoni (Quantonation), Stefano Gurciullo (Redstone VC), Jamie Arbib (RethinkX), Mike Dybbs (Samsara Capital), Jean-Michel Deligny (Silverpeak), Johannes Rabini (Sobera Capital), Michael Krel (Sofinnova Partners), Reynir Indhal and Sebastian Sunde (Summa Equity), Benjamin Joffe, Jun Axup and Ned Desmond (SOSV), Peter Platzer (Spire Global), Russell Tham (Temasek), Paul Reynolds (Thamesis Limited), Katie Rae and Tyson White (The Engine), Nicolas Colin (The Family), Denis Galha Garcia (Time for the Planet), Amos Benaroch (VisVires Capital), Bill Janeway (Warburg Pincus), Matt Stack (XLP Capital) for their input and insights. They warmly thank all survey respondents from Kauffman Fellows and Hello Tomorrow network.

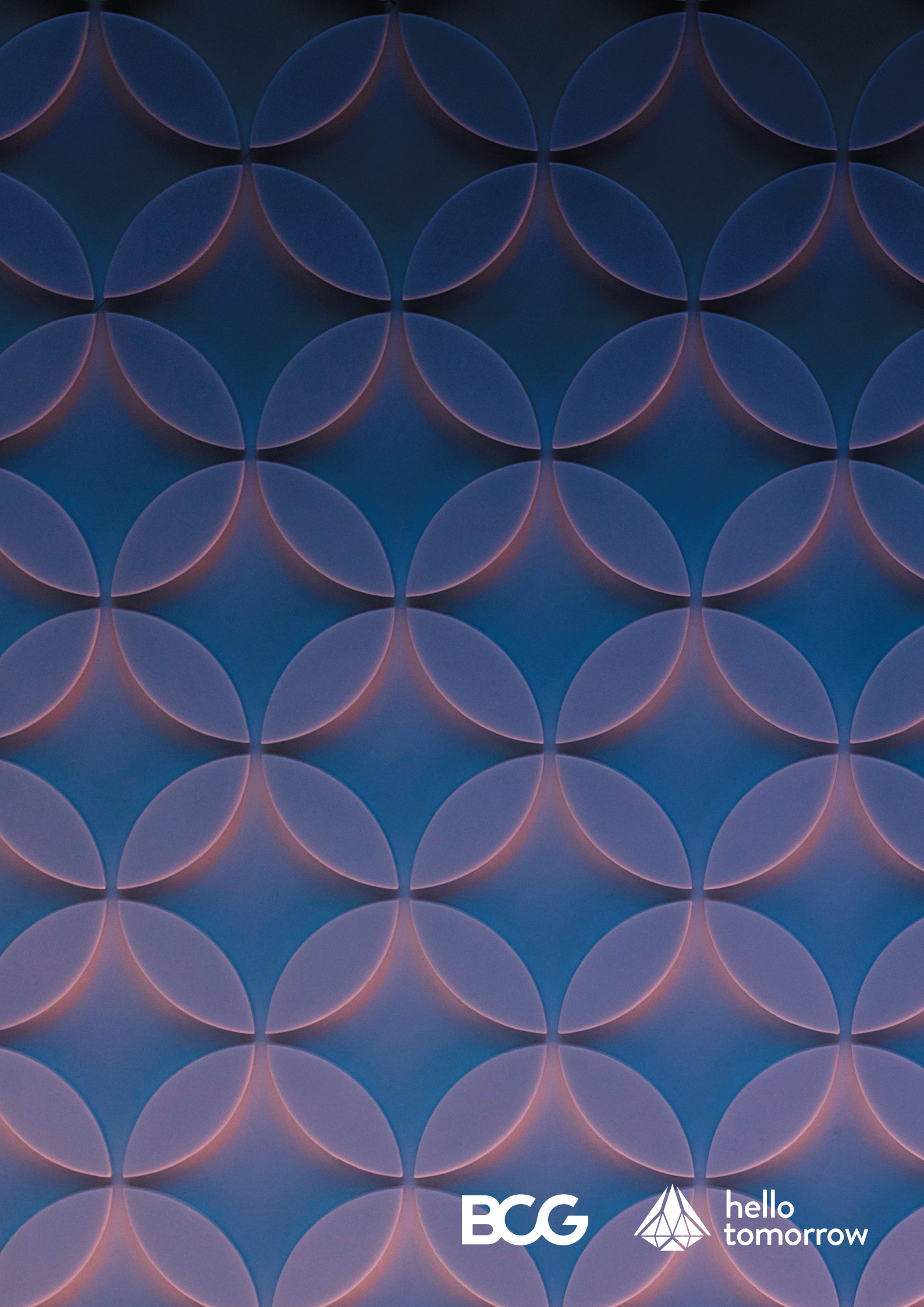
For Further Contact

If you would like to discuss this report, please contact one of the authors.

Arnaud de la Tour
Cofounder and CEO Hello Tomorrow
arnaud.delatour@hello-tomorrow.org

Massimo Portincaso
Chairman of Hello Tomorrow
massimo.portincaso@hello-tomorrow.org

For information or permission to reprint, please contact BCG at permissions@bcg.com or Hello Tomorrow at contact@hello-tomorrow.org.
To find the latest BCG content and register to receive e-alerts on this topic or others, please visit bcg.com.
Follow Boston Consulting Group on Facebook and Twitter.
To find the latest Hello Tomorrow content and register to receive newsletters on this topic or others, please visit hello-tomorrow.org.
Follow Hello Tomorrow on Facebook, LinkedIn, Instagram, and Twitter.


BCG
hello
tomorrow