From Lab to Leader

Unlocking Europe's €8 Trillion Deep Tech Opportunity

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Executive Summary

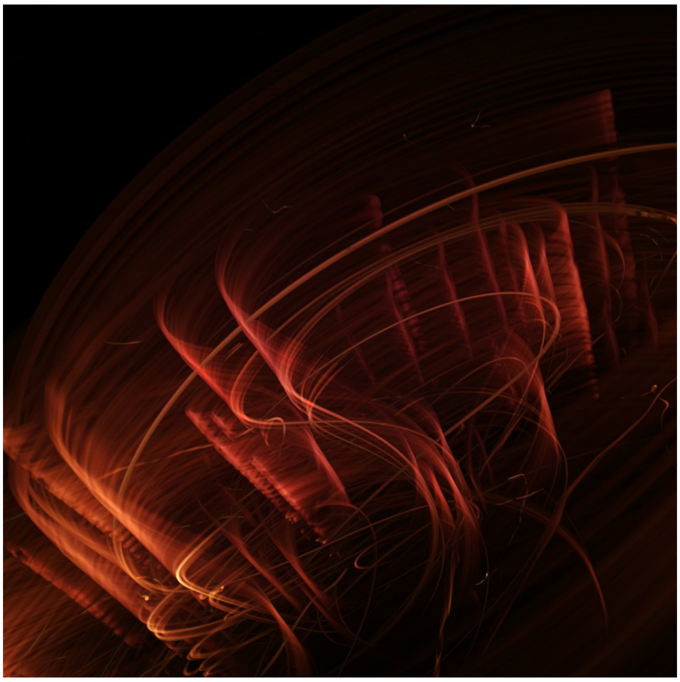
Deep tech offers a vital opportunity for European industries to tackle global challenges, drive new growth, and establish Europe as a leading economic powerhouse on the world stage. By 2030, the total value pools associated with deep tech sectors worldwide could reach €8 trillion, equivalent to almost half the projected GDP of the 27 EU countries. Since 2014, the share of global venture capital and private equity funding going to deep tech companies has increased from 10 percent to 20 percent.

Europe currently lags behind the US in deep tech investment and commercialization. Between 2018 and 2023, US deep tech companies received €215 billion in funding, compared to only €58 billion for European firms. Fewer than 10 percent of the world's 427 deep tech unicorns are based in Europe.

Europe's relatively small share of deep tech investment stands at odds with its leading position in science, research, and development. European countries hold seven out of the top 10 places in the World Intellectual Property Organization's Global Innovation Index, and the region hosts nine of the top 20 global research institutions.

Europe's large corporations have a key role to play in translating deep tech innovations into transformative businesses. Compared to small companies, large organizations generate shareholder returns up to 10 times larger per patent issued.

European companies must develop clear strategies for engaging with deep tech, and the first big decision is determining where they should play by **mapping industry-specific opportunities.** BCG's analysis of global deep tech research , investment, and commercialization activity has identified nine key applications where technological evolution, market demand, and European research, industrialization, and commercialization capabilities combine to create significant opportunities for companies in the region. Those applications include sensor fusion platforms, cognitive (humanoid) robots, solid-state EV batteries, hyperpersonalized medicine and care, AI in cybersecurity, nuclear fusion, next-generation rockets, advanced soil management, and high-tech aerial drones.



The second key decision for European corporates is how best to deploy their capabilities. Here, companies can act as **deep tech shapers**, influencing early strategic decisions for research and product development, or **deep tech amplifiers**, helping to scale innovations through their vast resources, broad market access, and operational expertise.

As the challenges of the 21st century intensify, Europe's commitment to deep tech will determine its ability to compete on the global stage and secure a prosperous future for its industries and citizens.

How Deep Tech is Changing the World

The biggest challenges require the most ambitious solutions. That's driving a wave of investment in pursuit of high-risk, high- reward breakthroughs. Deep tech has the potential to create trillions in new value for European industries. It offers companies a unique opportunity to secure lasting technological leadership and gain a competitive edge in tomorrow's most important markets.

Technological leaps have always driven human progress. The world as we know it today was shaped by the transformation of scientific and technical know-how into products and services that addressed challenges and created opportunities for economic progress. And, as we enter the middle of the 21st century, the world faces plenty of significant challenges: climate change and the ongoing destruction of biodiversity; demographic shifts creating worker shortages while pushing up the cost of health and social care; and looming shortages of critical raw materials, to name just three.

Yet, there are plenty of technological opportunities as well. Recent years have seen an explosion in scientific and technical advances in multiple fields. Deep (or emerging) technologies are already creating entirely new industries and changing the way existing sectors operate.

You don't have to look far to find evidence of that mechanism at work. Advances in semiconductor technology underpin the continuing exponential growth in computing power that has enabled the development of large-scale artificial intelligence (AI) systems. Faster, cheaper genome sequencing and new gene-editing techniques are unlocking novel medical treatments. High-performance laser systems have ignited progress in the quest to produce clean, sustainable energy from nuclear fusion.

Each of these advances was the result of years or decades of hard work, punctuated by breakthroughs and setbacks in almost equal measure. Turning the next generation of big scientific ideas into world-changing innovations will be equally demanding.

While the gap between deep tech and regular tech development has narrowed in recent years, the work involved in developing, scaling, and deploying such deep tech innovations still presents distinct challenges. **Deep tech** development requires the following:

1. Stamina—with long time-to-market due to technological and regulatory challenges. On average, deep tech startups take 35 percent longer than regular startups to grow their revenues from $1 million to $5 million, and 39 percent longer to grow from $5 million to $10 million.

2. Financial strength—with high CAPEX requirements for R&D, or the construction of first-of-a-kind plants. By the time they reach $5 million in revenue, deep tech startups have consumed 48 percent more funding than their regular-tech counterparts.

3. Agility—with significant uncertainty about the technical and commercial viability of radical new approaches. Deep tech startups are half as likely as regular-tech startups to survive beyond the seed funding stage. Successful deep tech players need the scientific and technological firepower to solve tough problems. And when promising avenues turn into dead ends, organizational flexibility is required to adapt quickly to keep development on track.

Deep Pockets

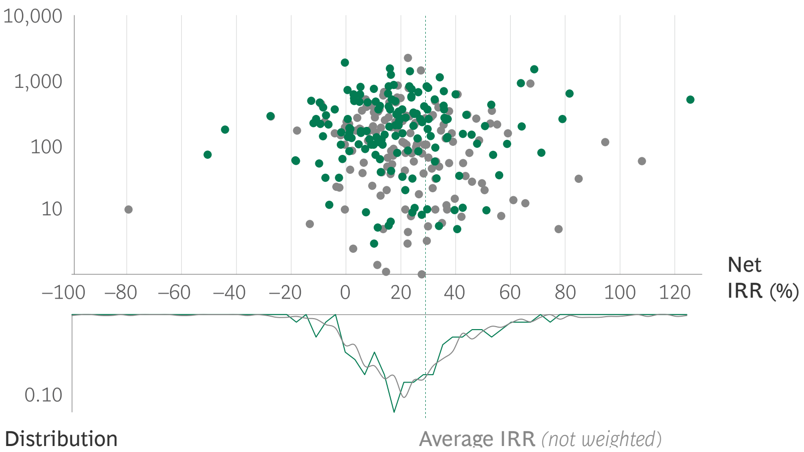
Despite these challenges, deep tech has become a significant, and increasingly popular, investment class. Successful deep tech startups tend to generate big returns for investors, and the overall IRR of deep tech–focused investments matches or exceeds that of traditional venture capital funds (see Exhibit 1).[1]

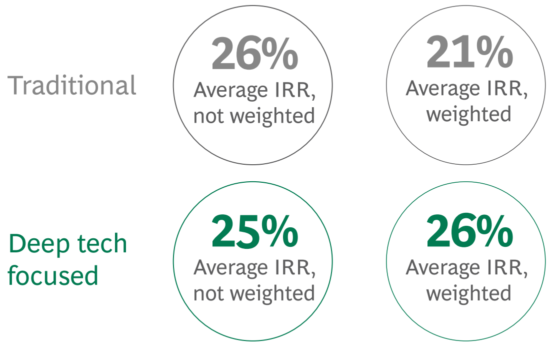
Consequently, the sector is attracting a growing fraction of global technology investment. Since 2014, the share of global venture capital and private equity funding going to deep tech companies has increased from 10 percent to 20 percent. In absolute terms, annual global deep tech investment excluding China increased more than fivefold over the same period.

[1] BCG, An Investor's Guide to Deep Tech, November '23, Exhibit 2.

Source: Dealroom; Preqin; expert interviews; BCG

Exhibit 1: Traditional and Deep tech-focused funds deliver similar internal rates of return

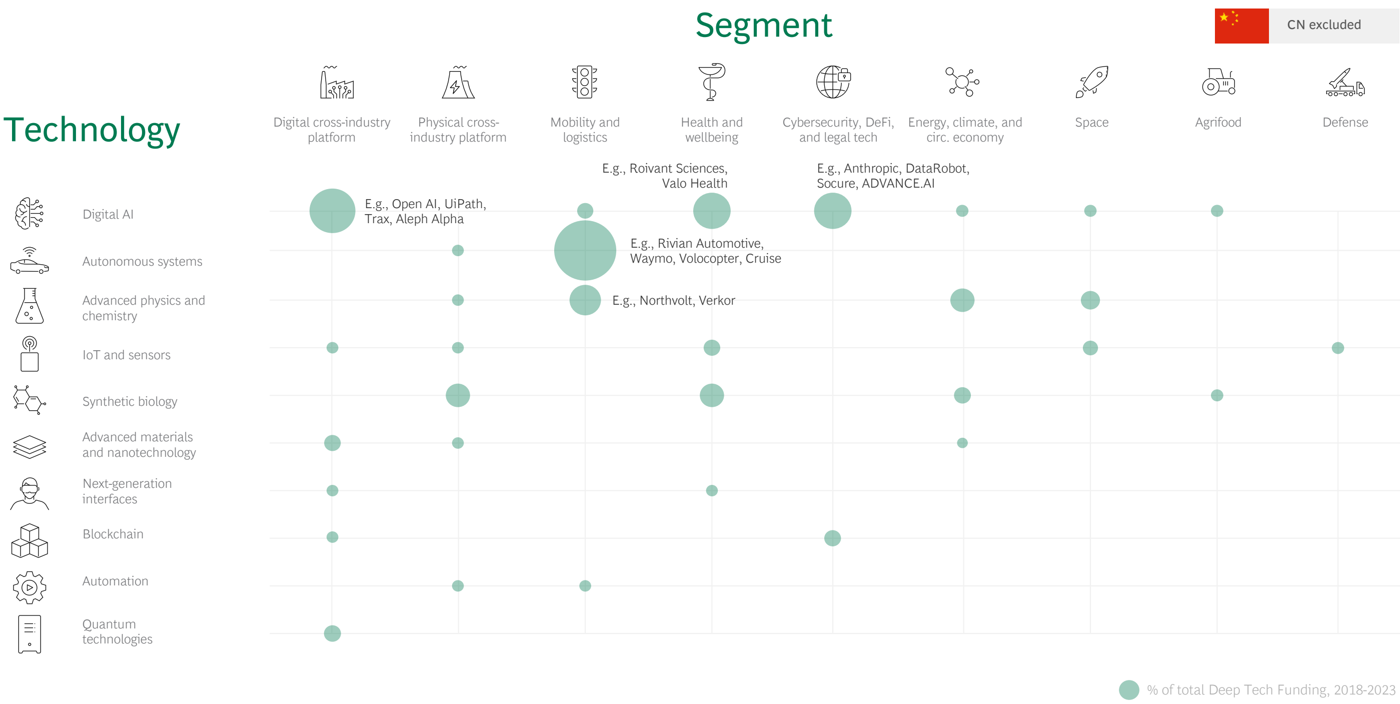




Sources: Preqin; BCG analysis.
Note: VC = venture capital. N = 911 for traditional funds, and n = 164 for deep tech-focused funds. Only 150 randomized data points are shown on the scatter plot.

Multibillion Euro investments in AI have been the most attention-grabbing example of this trend in recent months, but investors are putting their capital to work on a broad range of core technology areas, including advanced materials, autonomous systems, advanced physics and chemistry, the Internet of Things (IoT), sensors, synthetic biology, next-generation interfaces, blockchain, and quantum technologies. Each of these technologies has existing or potential applications in multiple industry sectors. That has created a landscape littered with investment opportunities. Ongoing activity is spread across this landscape, with notable hot spots in a handful of areas, including digital platforms with cross-industry applications, autonomous mobility technologies, and advanced cybersecurity technologies (see Exhibit 2). Since 2010, the flood of investment in deep tech–focused companies has created a total of 427 unicorns: companies with an implied market valuation of more than $1 billion .

Exhibit 2: Deep tech has become mainstream in investment categories, with funds pouring into a range of technologies and application areas



Chance to tap into growing markets

BCG analysis suggests that, by 2030, the global value pool (the sum of new revenues and avoided costs) associated with the top ten deep tech sectors will be around €8 trillion (see Exhibit 3). That's equivalent to almost half the projected GDP of the 27 EU countries—from products and services that barely exist today.

Such a dramatic shift in global value pools has profound implications for today's corporates. Some of that €8 trillion flowing to deep tech will come at the expense of existing commercial offerings, as new technologies replace legacy approaches. Some will represent entirely new value, generated by products and services that could not exist without fundamental advances in technology.

Exhibit 3: Ten key deep tech technologies with substantial market potential for corporates offer a chance to tap into growing markets and shape tech USPs

Technology cluster	Applications	Potential global value pool '30 (€)
Artificial intelligence	AI drug development, GenAI, enterprise workflow	1T-1.5T
Autonomous systems	Autonomous driving, drones, robots, nanosatellites	< 0.3 T
Advanced physics and chemistry	Batteries, energy production, and rocket propulsion systems	0.5 – 1 T
IoT and sensors	Next-gen telco, sound/video/motion sensors, microscopes	0.5T–1T
Synthetic biology	Bioreactors, new protein/cell designs, gene sequencing	< 0.3T
Advanced materials and nanotechnology	Semiconductors, metal alloys, construction/bio/nano-materials	1T–1.5T
Next-generation interfaces	AR/VR headsets, optical waveguides, haptics, digital twins	0.3T–0.5T
Blockchain	Only platforms, use cases like NFTs excluded	0.3T–0.5T
Automation	Industrial robots, additive manu-facturing, automation software	1T–1.5T
Quantum technologies	Quantum computing, quan-tum communication, quantum sensing	< 0.3T

Deep tech expected to **dictate market develop-ment** along core verticals globally

Identified technology cluster in scope for this report alone account for **value pool of around €8B in 2030**

By **investing in deep tech now**, corporates can:
- Secure a **piece of growing deep** tech pie
- **Increase share on value pool** with industry-specific tech USP

Europe: Still in the Shallows?

"When it comes to deep tech, bureaucracy is the main obstacle in Europe. We need to do more and become more flexible to keep up the pace, especially compared to the USA."

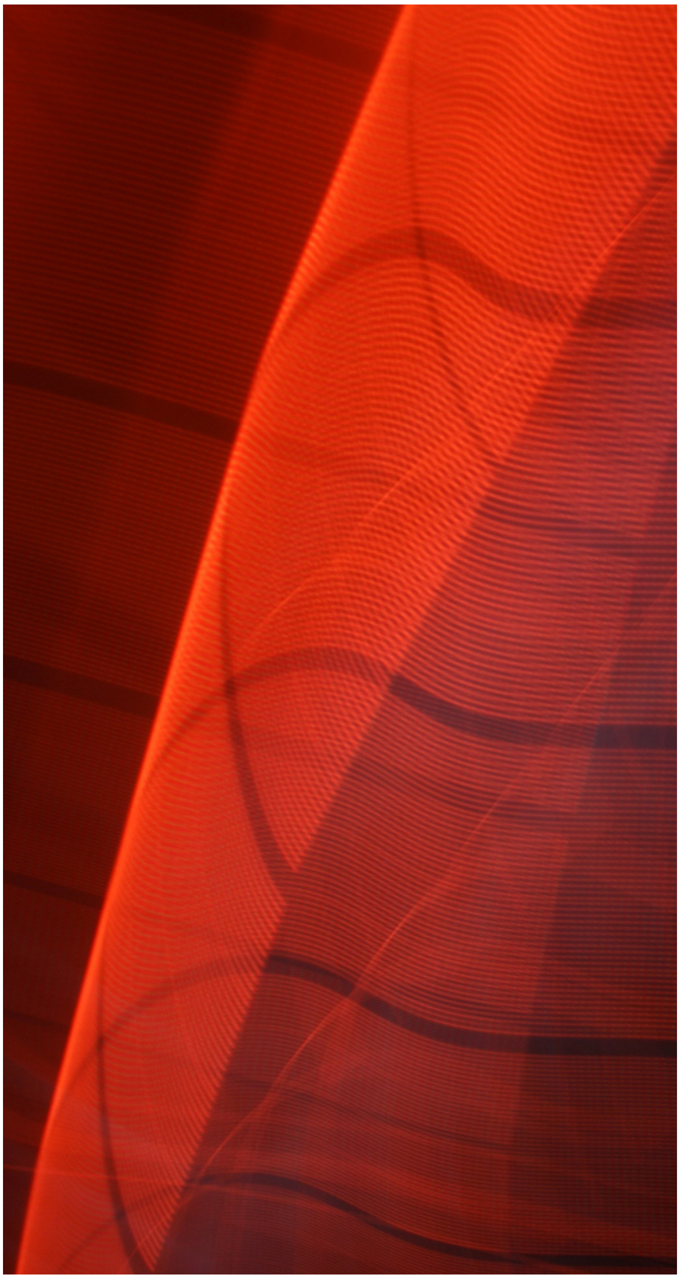
SPRIND Innovation Manager

In the race to capture the value promised by deep technology, the US currently holds a commanding lead. Between 2018 and 2023, American deep tech companies secured €215 billion in funding from venture capitalists and private equity, for example. That's almost four times the €58 billion that flowed to European players over the same period. More than half of today's deep tech unicorns are US companies, while only 42 are based in Europe—less than 10 percent of the total.

Access to patient, risk-tolerant investors is one challenge for European startups, but compared to their counterparts elsewhere in the world, Europe's deep tech pioneers also face several other key structural and cultural challenges. They include the following:

1. Difficulty achieving technology transfer from academia and R&D organizations to industry. Europe's industrial players have historically been cautious to engage with startups or to take an entrepreneurial approach to developing new technologies and markets
2. Market entry challenges due to structural and attitudinal barriers to industrial partnerships and collaboration
3. Limited access to growth-oriented funding, especially from venture-backed investors for Series B/C rounds
4. A complex and slow-moving regulatory environment

These challenges give rise to the so-called European paradox in innovation. Europe's academic and research institutions produce a high volume of high-quality research, measured by the number of patents generated and the frequency that those patents are cited in subsequent work. Yet, it is companies in the US, especially technology startups, that achieve the most success in translating that work into commercial innovations.[2]



[2] https://www.sciencedirect.com/science/article/pii/S0048733324000878

How Europe's corporates could change the Deep Tech Game

"Deep Tech and innovations have been in our DNA since the start. We distinguish between projects we handle ourselves and those where we engage in ecosystems and with startups."

CTO, Siemens Healthineers

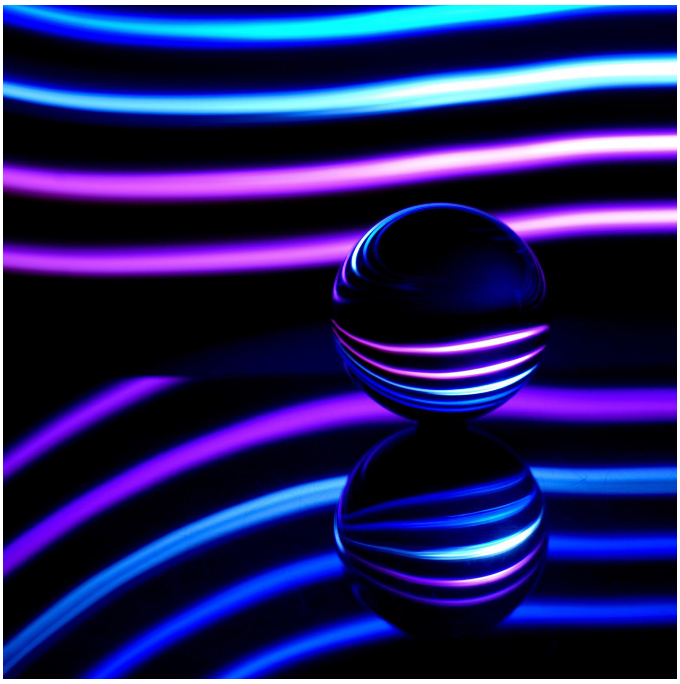
Europe's corporate players have a critical role to play in ensuring the region secures a larger share of global deep tech value pools. In part, that's because European companies will naturally want to benefit from the significant growth potential offered by deep tech, as well as the long-term competitive advantage that technological leadership may confer.

It's also because larger companies are the ideal entities to take valuable technologies from lab to market. They can provide essential market insight and access, along with the expertise and financial resources needed to commercialize deep tech innovations. And large companies have the financial and brand power to scale new innovations quickly, accelerating payback times and increasing the value derived from R&D investments.

Finally, Europe is rich in the raw materials that drive deep tech development: scientific and technological ingenuity. European countries hold seven out of the ten top spots in the World Intellectual Property Organization's Global Innovation Index. In a list of countries ranked by annual patent applications per capita, European nations hold 25 of the top 40 spots. Germany, Finland, Austria, and France are in the top ten.

If corporations tap into these resources more effectively, the effect could be transformative. Researchers at the US National Bureau of Economic Research have found that the size of the organization involved in an innovation has a dramatic effect on its value. Large corporates extract up to 10 times more value from individual patents than their smaller counterparts.[3] For corporates, winning in deep tech will require more than just money. Europe's companies will also need to strengthen their deep tech muscles with a focus on the following:

1. Building deep tech ecosystems and fostering collaborative relationships within them
2. Deciding where to play in their industry's deep tech landscape
3. Leveraging their own technical and organizational expertise to bring new technologies to market



[3] National Bureau of Economic Research researched the patent output of 2,786 firms in 1980–2015 and found that large corporates can extract considerably more value from patents compared to smaller firms—calculated by abnormal market returns within a three-day window in response to a patent issuance

A Team Sport: Building Europe's Deep Tech Ecosystems

"Many companies would benefit from a more systematic approach towards Deep Tech — both in terms of where to focus and consequently pursue an engagement, but also in terms of how to create value from it."

Managing Director TUM Venture Labs

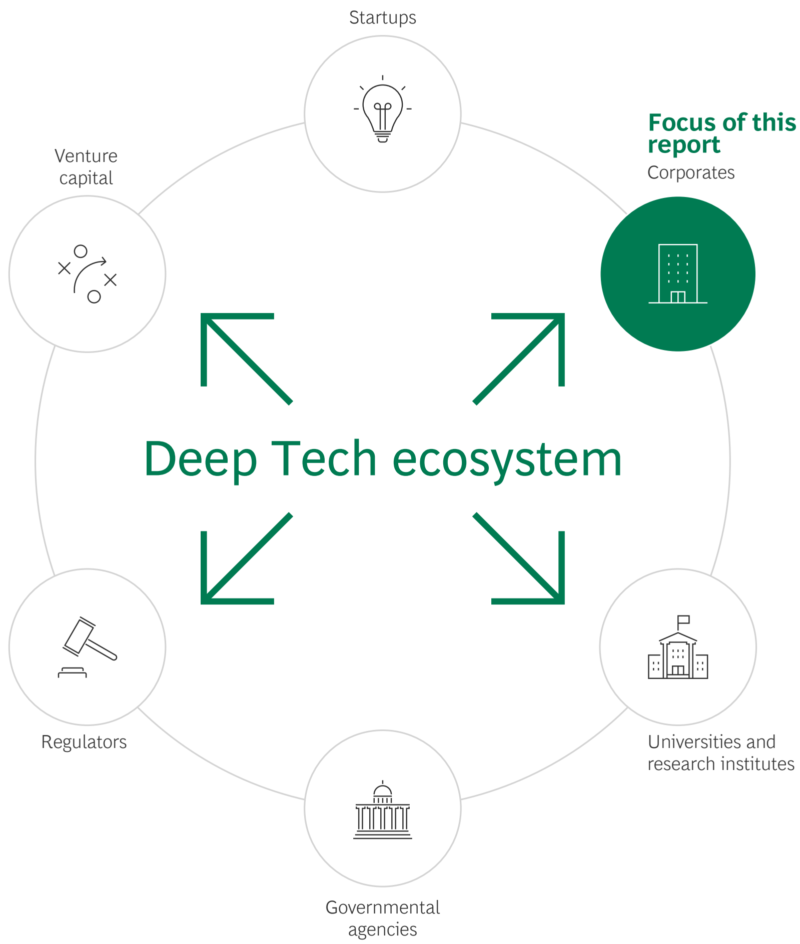
Corporates have a key role to play in deep tech development, but they won't be working alone. Even more than previous waves of technological progress, progress in deep tech depends on developing effective ecosystems. Deep tech ecosystems are networks of research organizations, funding sources, regulators, startups, and established companies that can work together to take new ideas from concept to application on a large scale.

With the world's most successful innovation ecosystems, the US offers a template for best practice that Europe should follow. The country has systematically created space for innovation across its economy. Regulators have permitted the development of regional test centers for autonomous vehicles; for example, offering a "sandbox" environment where developers evaluate and improve their technologies in real-world environments. Transferring intellectual property from research institutions to corporate entities is fast and easy. Incentives for innovation in critical missions are managed via targeted funding pools, talent programs, and public procurement processes—the so-called ARPA vehicles (Advanced Research Projects Agencies). These ensure an early connection between scientists and companies with a focus on effective routes to the commercialization of promising approaches.

US-based corporates, meanwhile, have actively developed their own, deep tech innovation ecosystems for decades. These ecosystems combine in-house research capabilities, relationships with leading academic institutions, significant investments in deep tech companies, and the strategic acquisition of startups with relevant IP.

Replicating approaches like these in Europe is eminently feasible. The region already has all the components it needs to assemble deep tech innovation machines to rival anything in the world (see Exhibit 4). Together, Europe's private and public sectors contain world-class players in each of these categories. For example, three of the world's top ten universities for computer science and engineering, are European. The region hosts nine of the top 20 global research institutions.

Exhibit 4: Europe has all the components it needs to build world-beating deep tech development ecosystems



Case Example

UnternehmerTUM and TUM Venture Labs: Creating Deep Tech Ecosystems in Europe

TUM Venture Labs are a pioneering joint initiative by the Technical University of Munich (TUM), the top-ranked technical university in the EU and UnternehmerTUM, Europe's largest and – according to Financial Times – leading Startup-hub. TUM Venture Labs aim at fostering innovation and entrepreneurship, particularly in deep tech and high-tech sectors.

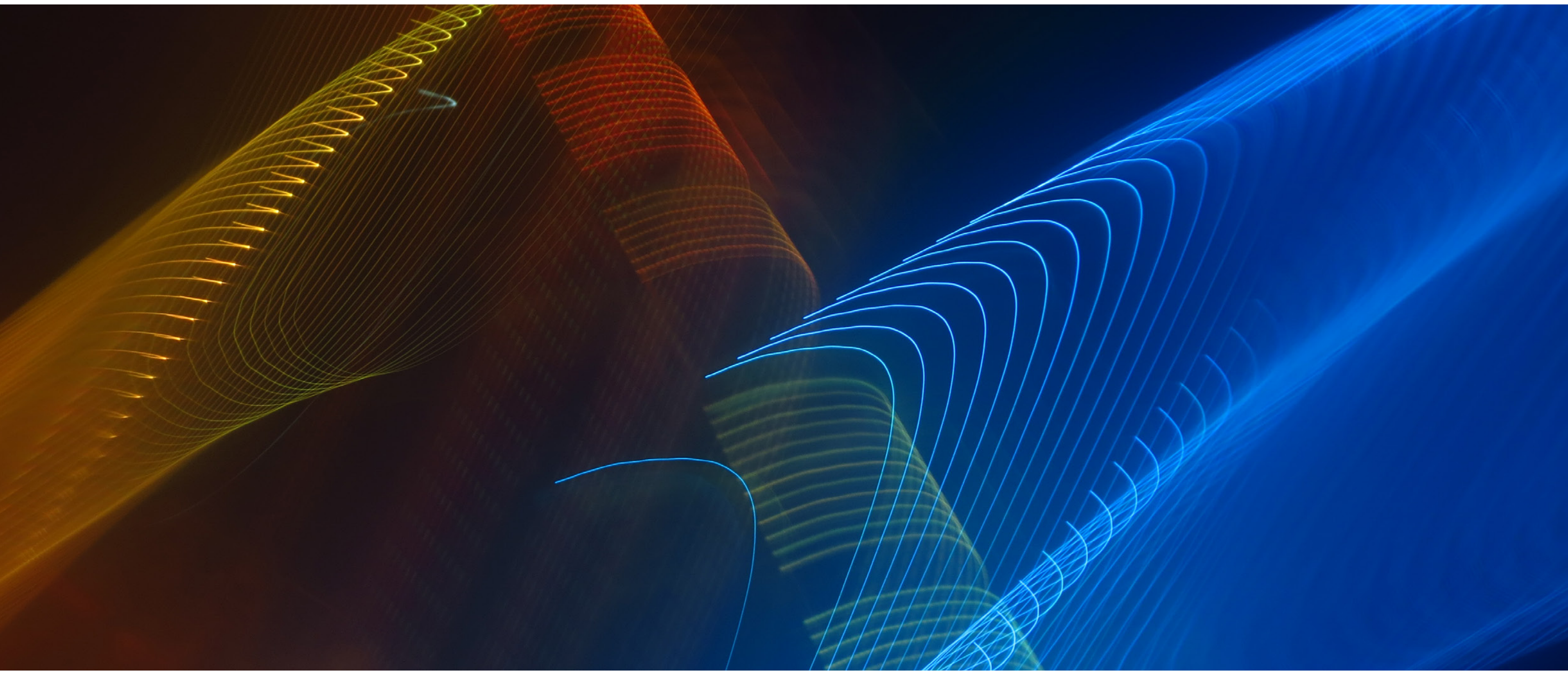
These labs provide an integrated ecosystem that brings together academic research, industry expertise, and entrepreneurial support to accelerate the development of groundbreaking technologies.

Each TUM Venture Lab focuses on a specific field, such as robotics, quantum technologies, AI, and life sciences, offering tailored support for startups and research projects in those areas. The labs offer a range of resources including access to state-of-the-art facilities, mentorship from industry experts and academics, funding opportunities, and networking with potential investors and industry partners. By providing this comprehensive support, TUM Venture Labs help bridge the gap between research and market-ready innovations, driving forward the commercialization of advanced technologies and ensuring that new ventures have the best possible start. This initiative is a strategic effort to position the TUM and UnternehmerTUM Ecosystem at the forefront of technological innovation, helping to translate cutting-edge research into impactful products and companies that can compete on a global scale.

Building Your Organization's Deep Tech Strategy

"The problem often lies in the culture of large companies. The person responsible for M&A does not align with the one responsible for CVC. Here, a unified goal and understanding need to be established."

Professor at a German university



For corporate leaders, two key sets of decisions will decide the trajectory of their organization's engagement with deep tech:

1. First, they must determine **where to play**, by developing a comprehensive picture of the deep tech landscape in their own industry and its implications for their own business and that of competitors, suppliers, and other stakeholders.

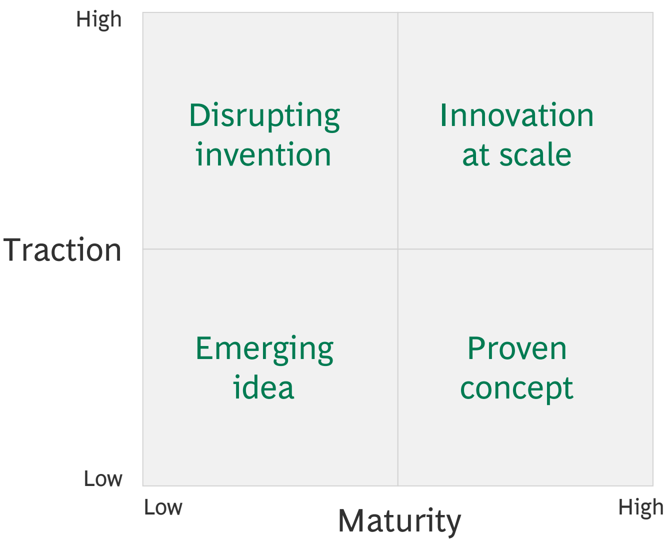
2. Second, they must determine **how to win**, by mapping out the role they want to play within that landscape and identifying the resources, capabilities, and partnerships they will need.

Where to Play: Understanding the Deep Tech Landscape

In most industries, work is underway on a wide range of applicable deep technologies. Some of these innovations are at a mature stage of development, while others are little more than small-scale proofs of concept. Enterprises need to stay on top of this constantly evolving landscape to understand where and when to engage their resources.

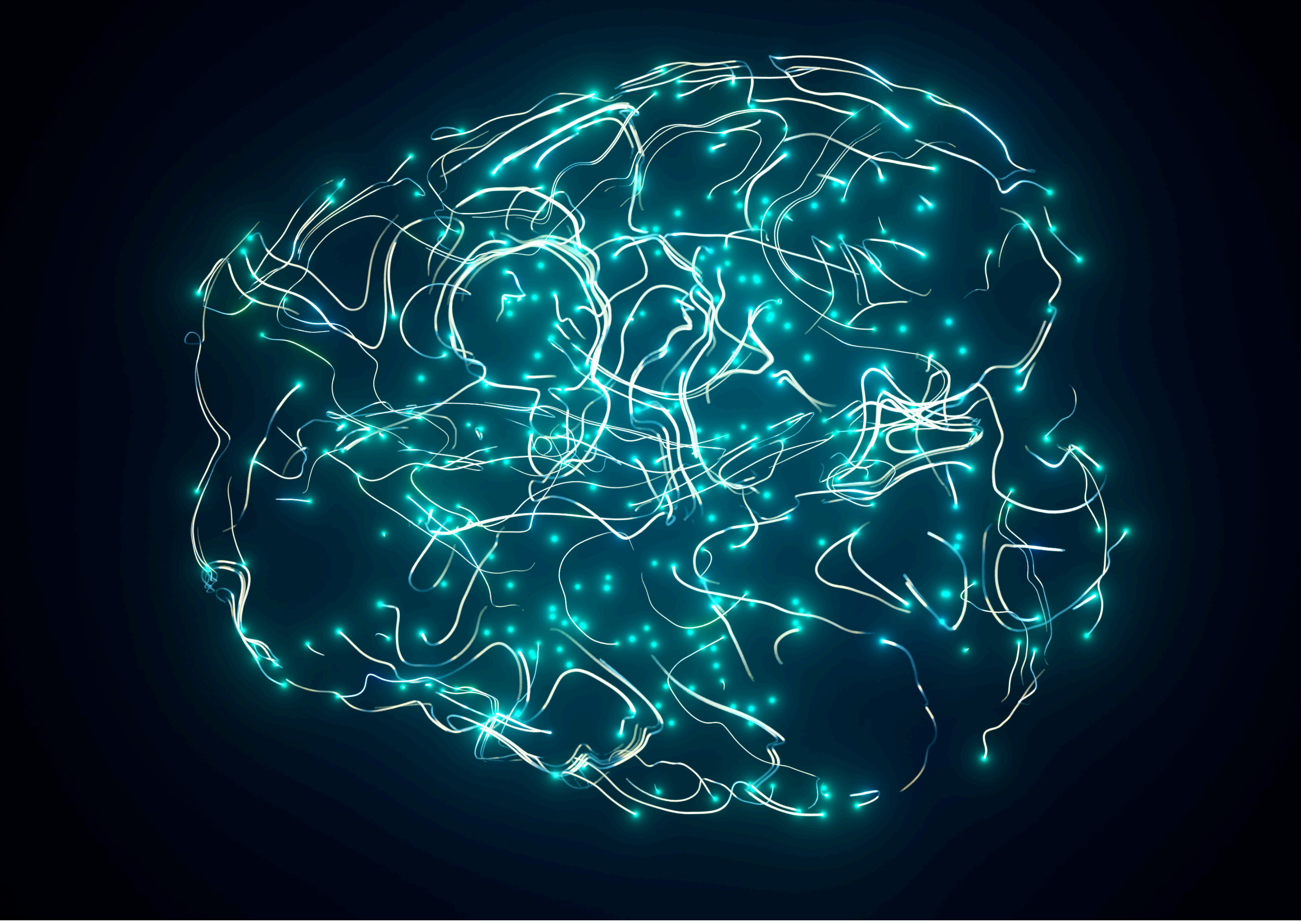
To help companies navigate the labyrinth of deep tech opportunities, BCG has developed an intuitive framework, shown in Exhibit 5. This approach maps deep tech across two dimensions: maturity, a measure of the technology's readiness for commercial use, and traction, a measure of the global level of attention associated with the technology.

Exhibit 5: A novel framework helps companies analyze the deep tech opportunities in their sectors



Explanation

- Framework categorizes DT applications per verticals based on two axes: "Traction" (level of attention) and "maturity" (development/ readiness for market implementation)
- High-traction, high maturity: Applications are well-developed and widely recognized, high attention and close to/already in commercialization, e.g., large language models (LLMs)
- High-traction, low maturity: Applications get significant attention but are still in the early stages of development and market readiness, e.g., green hydrogen
- Low-traction, high maturity: Applications are mature and reliable but currently receive less attention and interest from the market, e.g., blockchain
- Low-traction, low maturity: Applications are in nascent stages and not yet attracting significant attention, representing potential future opportunities for growth and development



Innovation at scale: Technologies in the high traction, high maturity quadrant are well-developed and widely recognized. The key opportunity for corporates here often lies in finding ways to integrate these technologies into their products, processes, and business models. AI systems based on large language models (LLMs) fall into this category in 2024.

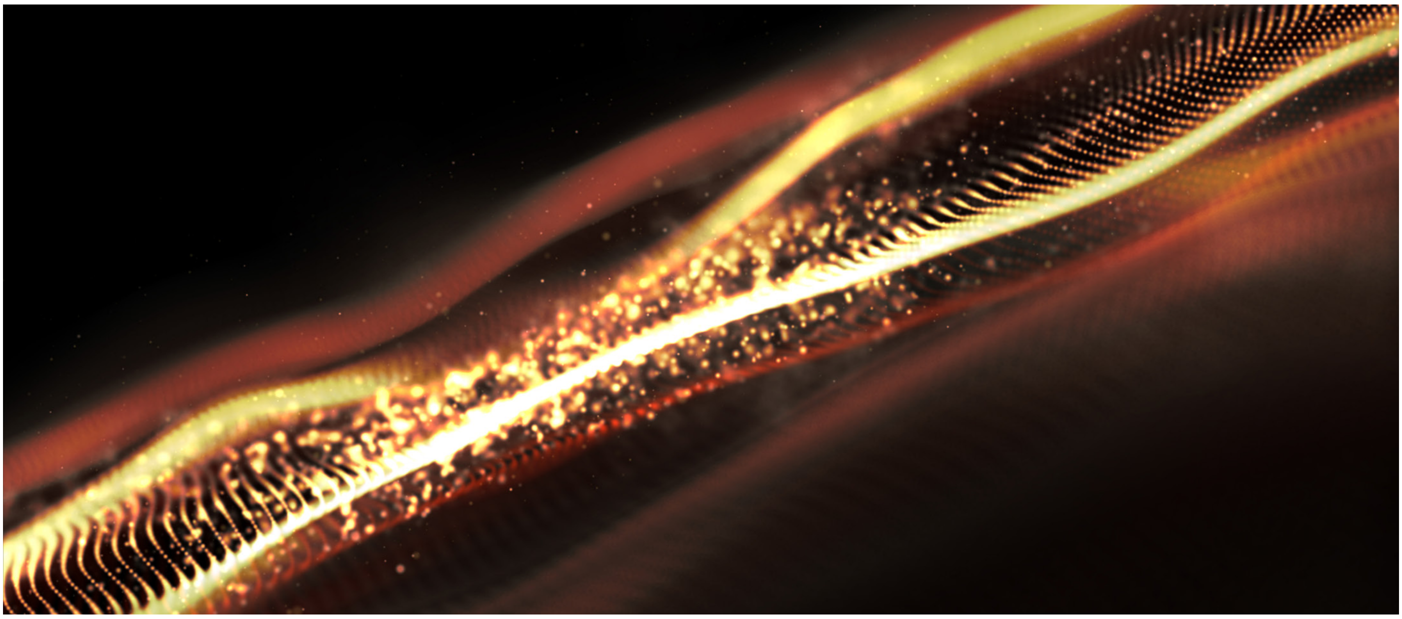
Proven concept: Technologies in the low traction, high maturity quadrant may be powerful ideas still searching for their large-scale "killer applications." Companies should ask themselves whether such an application exists within their business. Blockchain, a robust, versatile, and well-established concept, with few large-scale applications outside cryptocurrencies, is one such technology.

Emerging idea: Technologies that have achieved neither significant traction nor high maturity are the riskiest deep tech category. Many of these concepts may fail for technical reasons, or they may develop into effective inventions that never find a large market. For corporates, investing in this corner of the deep tech landscape is a high-risk, high-reward strategy. They may need to tolerate many failures, but success could generate significant value or competitive advantage through technological differentiation. Quantum computing is an archetypical emerging technology today. Although it holds the promise of solving complex problems far beyond the reach of classical computers, its practical applications are still limited, and significant technical challenges remain.

Disrupting invention: Technologies in the high traction, low maturity quadrant are likely to be of particular interest to many corporates. These technologies have already received significant attention and investment, suggesting widespread confidence in their viability and value potential. Yet there are still significant opportunities for businesses to contribute, by guiding the direction of development work, identifying and developing end-use applications, or building manufacturing infrastructure. Green hydrogen is one such potentially disruptive technology, offering a route to the decarbonization of energy-intensive industries such as heavy transportation or steelmaking.

Nine Industry-Shaping Deep Tech Applications

BCG's analysis of global deep tech research, investment, and commercialization activity has identified nine key hotspots for European corporates: intersections where the needs of specific industries combine with the potential of deep tech innovation to create significant opportunities for companies in the region. .



To help corporates prioritize "where to play," this analysis combines qualitative and quantitative research to identify the most promising deep tech opportunities for specific verticals. The objective is to a nswer a key question: What could be the next major breakthrough from a vertical perspective? Therefore, we talked to:

- Sector experts to uncover the primary challenges within their industries,
- Tech experts to identify deep tech innovations with the potential to address these challenges, and
- Ecosystem members to understand the essential resources needed to scale industry-specific applications.

Each of these nine applications is well-aligned with a high-priority challenge or opportunity in the European economy, enhancing their potential value to European companies by tapping into a strong local market.

The nine deep tech applications highlighted in this analysis are all disruptive innovations with the potential to impact major sectors of the European economy, including agriculture, energy, healthcare, computing, defense, and space science.

1 **Sensor fusion platforms** which leverage data integration from multiple sources to enable unseen of productivity and control

2 **Cognitive (humanoid) robots**, which bridge the gap between humans and machines to unlock new levels of automation

3 **Solid-state batteries**, which will enable the development of electric vehicles that are safer, lighter, more durable, and have a longer range

4 **Hyperpersonalized medicine and care**, using advances in AI to accelerate drug development and tailor treatment delivery of healthcare interventions, leading to better outcomes

5 **AI in cybersecurity**, with systems that can detect and neutralize cyberattacks in real time, proactively identify and mitigate system vulnerabilities, and continuously evolve to counter increasingly sophisticated threats

6 **Nuclear fusion**, providing a pathway to the large-scale production of carbon-free energy to power homes, industrial processes, and the production of green hydrogen

7 **Next-generation rockets**, which could transform the economics of delivering payloads into orbit with lower production and operating costs, and improved reliability, fuel efficiency, and reusability

8 **Advanced soil management**, using sophisticated sensors, advanced analytics, and AI to increase agricultural production, while reducing consumption of water, land, pesticides, and artificial fertilizers

9 **High-tech aerial drones**, which will transform defense operations with longer range, greater autonomy, and better integration with other intelligence, planning, and control systems

Exhibit 6: Top 9 applications in details

Digital cross-industry platforms

Sensor fusion

Enhancing automation and simulation across industries by integrating data from multiple sensors

Technologies	European market size by 2030	Current pace of adoption	Market maturity by 2030
AI Next-gen interfaces IoT and sensors	€1.0B–2.0B	↗	

Why is this application disruptive?

- Transforms processing | Harness data from various sources to generate contextual insights driving innovation/efficiency across industries
- Enables adv. automation | Enhance capability of autonomous systems, improving ability to interact with and adapt to complex environments
- Enables precise simulations | Facilitate highly accurate and realistic simula- tions for training, research, and predictive modeling

Which next steps are needed?

- Refine data integration | Develop algorithms that seamlessly combine and interpret diverse sensory data for more accurate/actionable insights
- Improve processing | Leverage advancements (e.g., quantum computing) to enhance capabilities for handling complex data in real time
- Advance synthetic data creation | Invest in tech for generating synthetic data to enhance model training, simulation accuracy, and data diversity

Exemplary European front-runner: ramblr.ai

Fast | Moderate | Slow | High to low

Physical platforms

Cognitive (humanoid) robots

Optimizing (industrial) automation across various sectors with cognitive (humanoid) robotics

Technologies	European market size by 2030	Current pace of adoption	Market maturity by 2030
AI Automation Autonomous systems	€0.5B–1.0B	↗	

Why is this application disruptive?

- Redefines interactions | Enable more natural and intuitive engagement across sectors, bridging gap between humans and machines
- Innovates automation strategies | Offer a flexible and adaptable approach to automation by recognizing diverse inputs (language, vision, etc.)
- Advances AI/robotics | Pursue multimodal robots to push boundaries of AI and mech. engineering, leading to innovations with wide-reaching impacts

Which next steps are needed?

- Advance AI/ML | Develop cognitive and adaptive abilities of multimodal robots to improve understanding of complex interactions and environments
- Improve robot-human collaboration | Develop tech for smoother, more collaborative, and safer interactions, especially in sensitive environments
- Reduce costs | Lower production and maintenance costs to make cognitive (humanoid) robots accessible to a broader range of clients

Exemplary European front-runner: NEURA

Fast | Moderate | Slow | High to low

Mobility and logistics

Solid-state (EV) batteries

Enhancing battery energy density with advanced (sodium-ion) solid-state technology

Technologies	European market size by 2030	Current pace of adoption	Market maturity by 2030
Advanced physics and chemistry	€0.5-3.0B	→	

Why is this application disruptive?

- Extends battery life and range | Offer higher energy density, enabling EVs to achieve longer driving ranges and enhanced battery longevity
- Improves safety | Reduce risk of fires and improve safety significantly by eliminating flammable liquid electrolyte in batteries
- Revolutionizes EV design | Allow for lighter, more flexible designs with compactness and battery efficiency—new possibilities for innovation

Which next steps are needed?

- Scale up production | Develop manufacturing processes to produce solid-state batteries at scale, reducing costs/making them economically viable
- Enhance material innovation | Continue research into solid electrolytes to improve performance and reliability under various conditions
- Integrate into EVs | Collaborate with automakers to design EVs leveraging benefits of solid-state batteries, optimizing energy efficiency and performance

Exemplary European front-runner: northvolt

↑ Fast → Moderate ↓ Slow — High to low

Health and wellness

Hyperpersonalized medicine and care

Transforming healthcare with tech (e.g., AI) to personalize care and develop drugs faster

Technologies	European market size by 2030	Current pace of adoption	Market maturity by 2030
AI Synthetic biology IoT and sensors	€10.0-20.0B	↑	

Why is this application disruptive?

- Tailors treatments | Leverage detailed patient data, including genetics, lifestyle, and environment, to create highly specific treatment plans
- Accelerates drug development | Enable faster and more personalized drug development by predicting responses to treatments
- Enhances patient monitoring | Allow for real-time adjustments in care with continuous data collection and analysis, ensuring optimal treatment

Which next steps are needed?

- Improve data integration | Develop systems that seamlessly aggregate/analyze diverse data (genomic, clinical, etc.) to refine treatment strategies
- Advance AI-driven diagnostics | Enhance AI capabilities to provide accurate and early diagnostics, crucial for personalized treatment
- Expand clinical trials | Design clinical trials that focus on validating hyper-personalized treatment protocols across diverse patient populations

Exemplary European front-runner: AlphaFold

↑ Fast → Moderate ↓ Slow — High to low

Cybersecurity, DeFi, and legal tech

AI cybersecurity

Enhancing defense capabilities with AI security platforms

Technologies	European market size by 2030	Current pace of adoption	Market maturity by 2030
Artificial intelligence	€10.0B–20.0B	↑	

Why is this application disruptive?

- Reinforces cybersecurity | Enhance real-time threat detection and response, offering faster, more accurate protection
- Automates threat mitigation | Enable proactive measures by automatically identifying vulnerabilities/executing countermeasures
- Adapts to evolving threats | Ensure robust protection against increasingly sophisticated cyberattacks through evolution

Which next steps are needed?

- Improve threat intelligence | Enhance ability to aggregate and analyze intelligence from multiple sources for comprehensive security coverage
- Advance real-time processing | Boost processing capabilities to ensure instant detection and response to threats, minimizing potential damage
- Prepare for quantum threats | Develop quantum-resistant algorithms protecting against immense computational power of future computers

Exemplary European front-runner: Helsing

↑ Fast → Moderate ↓ Slow — High to low

Energy, climate, and circular economy

Fusion power

Introducing a new era of clean energy with commercially viable fusion power

Technologies	European market size by 2030	Current pace of adoption	Market maturity by 2030
Adv. physics and chemistry Advanced materials and nanotechn.	€1.0-5.0B	↑	

Why is this application disruptive?

- Generates sustainable electricity | Provide clean electricity, reducing reliance on fossil fuels and decreasing greenhouse gas emissions
- Powers industrial processes | Offer reliable energy source for high-demand industrial processes, reducing carbon emissions
- Facilitates hydrogen production | Power large-scale production of green hydrogen, a key component of the energy transition

Which next steps are needed?

- Advance reactor tech | Improve reactors, e.g., in sustaining plasma confinement and reducing required energy input
- Materials development | Develop materials that can withstand the extreme conditions inside fusion reactors
- Regulatory/infrastructure | Establish frameworks and infrastructure to support deployment/integration into existing energy grid

Exemplary European front-runner: Proxima Fusion

↑ Fast → Moderate ↓ Slow — High to low

Space

Next-gen rockets

Democratizing space access through cost-efficient and precise next-gen rocket technology

Technologies	European market size by 2030	Current pace of adoption	Market maturity by 2030
Advanced physics and chemistry	€2.0B–4.0B	↑	

Why is this application disruptive?

- Democratizes space access | Reduce mission costs, making space accessible to wider range of industries
- Accelerates connectivity | Enable the deployment of satellites that provide global coverage for internet, communications, etc.
- Drives innovation in space tech | Foster the development of new technologies and services by making launches more affordable

Which next steps are needed?

- Enhance efficiency | Improve fuel efficiency and payload capacity of launch vehicles to further reduce cost per kilogram
- Expand reusable tech | Increase use of reusable rocket components to lower costs and significantly reduce environmental impact
- Develop responsive launch systems | Build rapid and flexible launch systems, ensuring timely access to space

Exemplary European front-runner

isar aerospace

RFA Rocket Factory

Fast Moderate Slow High to low

Agriculture

Advanced soil management

Improving soil health using advanced tech such as AI, sensors, biotech, and data analytics

Technologies	European market size by 2030	Current pace of adoption	Market maturity by 2030
AI Synthetic biology	€2.0-5.0B	↗	

Why is this application disruptive?

- Enhances soil fertility | Improve soil health by balancing nutrients, organic matter, biostimulants, leading to sustainable long-term productivity
- Reduces footprint | Minimize land, water, and pesticide use, making farming more sustainable and environmentally friendly
- Boosts resilience | Strengthen soil structure and water retention, making crops more resilient to climate change and extreme weather condition

Which next steps are needed?

- Advance IoT and sensor tech | Improve precision tools to monitor and optimize growing conditions/crop yields
- Enhance biological solutions | Invest in biofertilizers, biostimulants, and soil microbiome tech to naturally boost soil fertility and crop yields
- Expand data analytics | Integrate advanced analytics to refine soil mgmt. strategies, ensuring optimal nutrient management/sustainable farming

Exemplary European front-runner

Humify

Fast Moderate Slow High to low

Defense

High-tech aerial drones

Reducing human involvement through advanced tech deployment and high-tech aerial drones

Technologies	European market size by 2030	Current pace of adoption	Market maturity by 2030
IoT and sensors	€2.0B–5.0B	↗	

Why is this application disruptive?

- Redefines aerial capabilities | Expand precision, autonomy, and decision-making of defense operations by leveraging AI, edge computing, and sensors
- Operates in challenging env. | Empower operations in complex environments by extending reach of missions to previously inaccessible areas
- Delivers superior data insights | Provide high-resolution, multispectral data for defense operations, offering actionable insights in complex situations

Which next steps are needed?

- Advance swarm intelligence | Develop algorithms for drone swarms to enhance coordination, efficiency, and autonomy in complex defense missions
- Boost energy efficiency | Improve battery technology to extend the endurance and payload capacity of drones, ensuring sustained operations
- Integrate with airspace systems | Ensure seamless integration into existing air traffic management for safe, coordinated operations

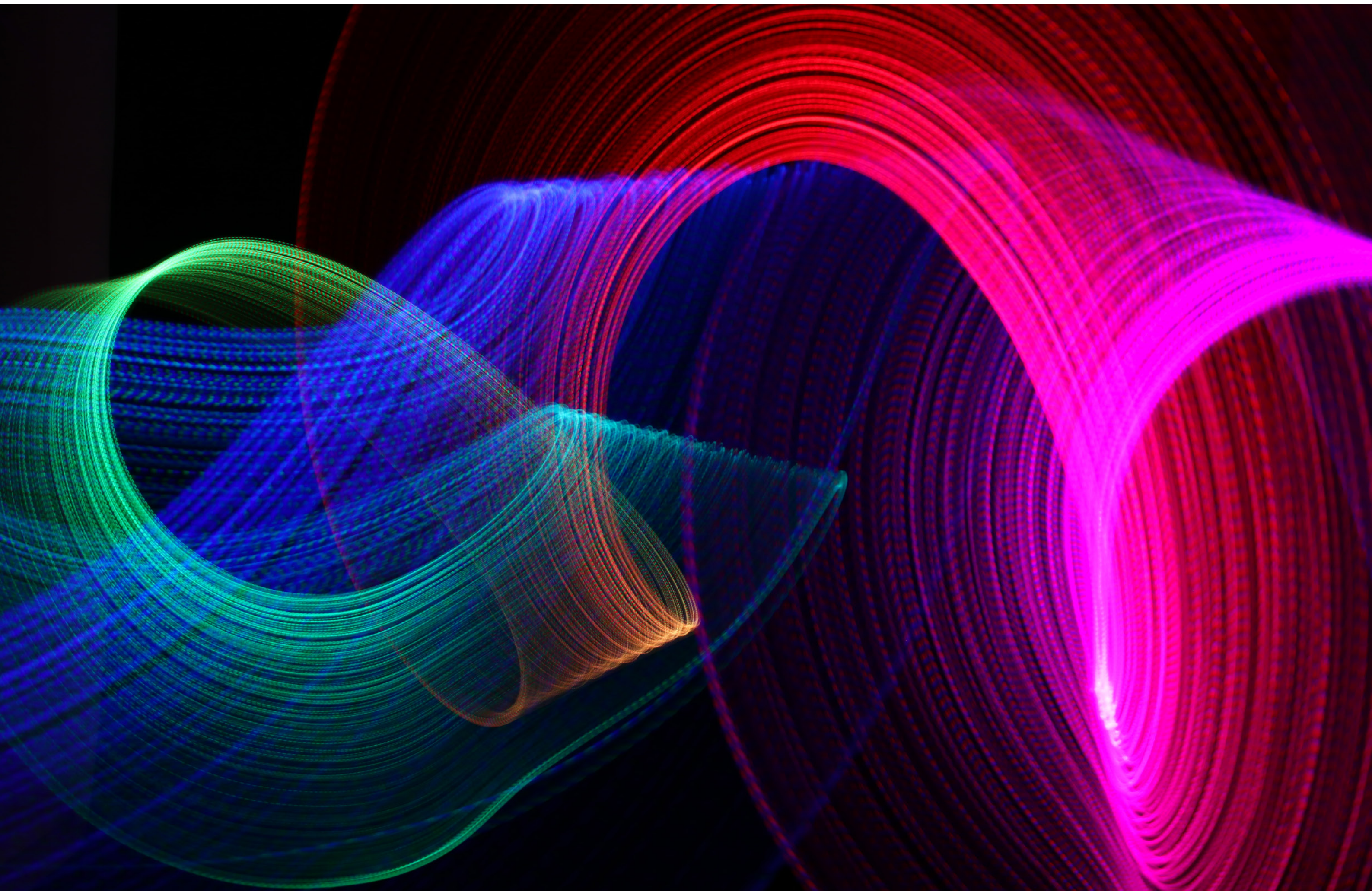
Exemplary European front-runner

QUANTUM SYSTEMS

Fast Moderate Slow High to low

How to Win: Engaging with Deep Tech

Once a corporation has narrowed the areas of deep tech in which it needs to participate, it must decide how to engage. The foundation of any organization's strategy is a choice between two basic approaches.



1 Deep tech **shapers** engage early in the evolution of a technology, aiming to achieve breakthroughs through intensive investment in R&D.

2 Deep tech **amplifiers** excel at scaling, offering the financial firepower and market access to transform promising technologies into innovative products, services, and businesses.

The Deep Tech Shaper

Organizations that become deep tech shapers are already technology leader in their sectors, with substantial in-house R&D capabilities. They have a long-term vision about the evolution of those sectors and are willing to tolerate lengthy and uncertain innovation processes to achieve that vision.
Shapers should influence early strategic decisions about the scope and focus of R&D activity. They can do that by applying their own resources, including both capital and expertise, to early-stage R&D and by supporting startups and other companies in various ways, often providing workspace and people alongside direct financial investments

Deep tech shapers also play a decisive role in creating and directing ecosystems to support basic and applied research. They can identify the most promising early use cases for new technology or define the key industrial challenges that the technology should address. They can connect researchers to suppliers or development partners with specific domain knowledge or industry expertise.

Case Study: Extreme Ultraviolet Lithography

Dutch semiconductor equipment maker ASML partnered with laser specialist Trumpf, precision optics company Zeiss, and around 1,200 other organizations to develop a revolutionary approach to microchip production. The collaboration, two decades in the making, aimed to create photolithography systems using far shorter light wave- lengths than previous generations of equipment. That allows chipmakers to etch smaller features onto their devices, a key requirement for the latest generation of high-performance semiconductors.

The development of extreme ultraviolet chipmaking equipment required multiple deep tech innovations, with Trumpf driving the creation of high-powered ultraviolet lasers, Zeiss creating the sophisticated optical components needed to focus and project the light onto silicon wafers, and ASML integrating the new technology into advanced lithography machines.

Extreme ultraviolet (EUV) lithography has enabled significant advances in semiconductor manufacturing, allowing the production of smaller, faster, and more energy-efficient microchips. The development of the technology has enhanced the competitive and technological leadership of European companies in the global semiconductor market.

The ASML example showcases the impressive commercial success that can be achieved through this venture. While the journey may be long and costly, the rewards of a shaping strategy like this are ultimately invaluable.

The Deep Tech Amplifier

Organizations that become deep tech amplifiers are masters of growth. They are skilled at building large businesses with strong sales and marketing capabilities, alongside the operational resources to assemble new supply chains and develop manufacturing, logistics, and support networks. Like shapers, amplifiers are patient, willing to invest time and resources to build new markets or transform existing businesses.

Amplifiers should influence the commercial evolution of deep technologies, often by acting as the first customer or user of a new technology. This strategy, known as “venture clienting,” is an alternative to more traditional corporate venture capital (CVC) approaches that offers a faster and more cost-effective way to gain access to new technologies. Becoming “client number one” also gives corporates input on important go-to-market decisions, including the regions, market segments, and product types selected at launch. Amplifiers should go on to expand new technology applications beyond their first markets; for example, by identifying the product features and certification standards required for success in other regions or market segments.

Deep tech amplifiers should also play a central role in the physical scaling of new technologies, applying their expertise in manufacturing to build the production systems that allow deep tech to meet volume and cost objectives. They might do that by integrating new technologies into their existing products and manufacturing processes or by supporting the development of separate facilities.

Case Study: Amazon and Kiva Systems

In 2012, e-commerce giant Amazon acquired Kiva systems, a robotics company specializing in automated warehouse solutions, for $775 million. Amazon integrated Kiva’s robotic technology into its fulfillment centers, automating the process of fetching items from shelves for packing and shipping. The automation program was rolled out across Amazon’s global warehouse network, with existing warehouses retrofitted for the technology and new ones designed specifically for the robots. The continual expansion of the robotic fleet helped bring down the cost of the technology, while Amazon’s experience informed development of the robots’ capabilities and enabled warehouse automation to be integrated into the company’s broader logistics and supply chain systems.

Today, Amazon’s fulfillment centers are significantly faster, more efficient and more flexible thanks to the integration of robotics. The time, effort, and cost required to locate and pick items has been reduced, order accuracy has increased, and space utilization has improved. Those changes helped Amazon scale its operation without increasing its costs. The company’s approach to warehouse automation has set new global standards, influencing others to adopt similar approaches.

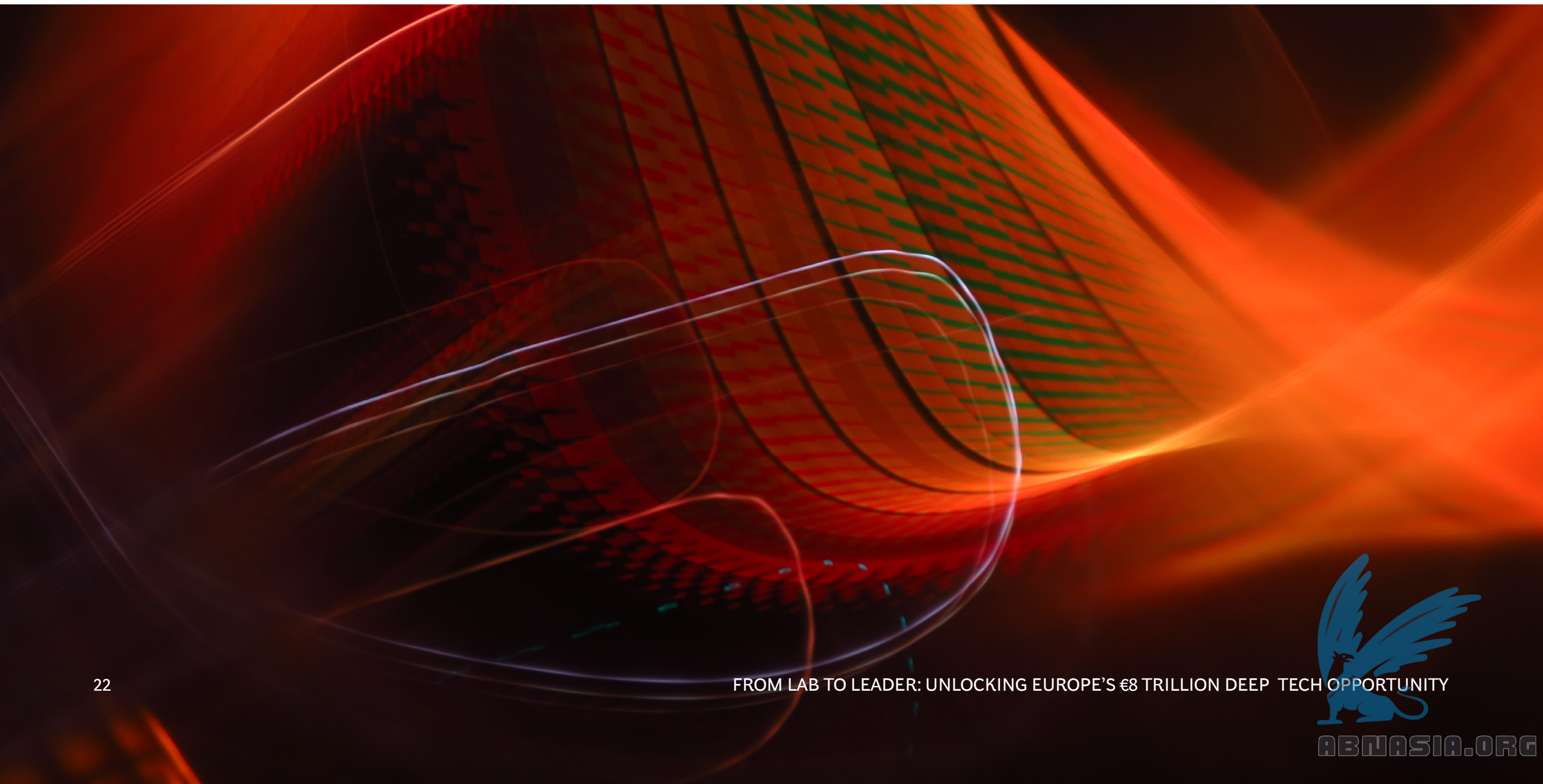
Europe's Path to Deep Tech Leadership

Europe's path to leadership in deep tech hinges on its ability to leverage its existing strengths in research and innovation while overcoming the structural and cultural hurdles that stand between scientific advances and transformative businesses. Building effective deep technology ecosystems will be a triple win, benefiting the region's startups, corporations, and national economies. With a systematic approach, deciding where to play and how to win, European corporates can focus its resources on high-impact areas, maximizing the chances of success.

The continent's corporate giants have a pivotal role to play in this process, not only by providing the necessary capital and expertise but also by fostering collaborative ecosystems that can accelerate the journey from lab to market. Actively cultivating these ecosystems allows Europe to bring innovations to market more effectively and helps overcome commercialization challenges.

By strategically deciding where to engage and how to maximize their impact, European companies can position themselves at the forefront of the next technological revolution, ensuring they capture a significant share of the immense value deep tech promises to generate in the coming decades.

As the challenges of the 21st century intensify, Europe's commitment to deep tech will determine its ability to compete on the global stage and secure a prosperous future for its industries and citizens.



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