GLOBAL DEEP TECH ECOSYSTEMS

CATALYZING INNOVATION FOR SUSTAINABLE DEVELOPMENT

Acknowledgements

Global Deep Tech Ecosystems: Catalyzing Innovation for Sustainable Development is a product of the UNDP Global Centre for Technology, Innovation and Sustainable Development, based in Singapore. The report is authored by Weijing Ye, with guidance from Joe Hooper and research support from Sofie Andal and Yong Zhin Ng.

We extend special thanks to the stakeholders and interest groups involved in different deep tech sectors worldwide, whose experiences and insights have greatly enriched this report. Our gratitude goes to Clovis Freire (UNCTAD), Songjia Wen (Research Institute of Tsinghua University in Shenzhen), Hiroshi Ishikawa, (Ministry of Economy, Trade and Industry, Government of Japan), Angelo Romasanta (ESADE-Ramon Llull University), Alejandrina Vendrell (Loci Labs), Jack So (A*STAR), Magnus Melander (DeepTech Alliance), Agata Zborowska and Riam Kansar (Conception X), Houda Gouzzi and Yesmine Mansar (Open Startup), Luuk Eliens (Singapore Deep-Tech Alliance), David Toh (NTUitive), Benjamin Tee and Donghai Wang (National University of Singapore), Salih Ötegen, Ahmet Kerim Nalbant, and Özkan Can (Teknopark Istanbul), Jamie Soon (NextUp), Xinyi Tow and Janaye Cheong (Hello Tomorrow Asia Pacific), Kate Hach (Intel Ignite), and the UNDP Global Centre team (Calum Handforth, Kevin Schmidt, Carla Gomez Briones, Khairunnisa Yahya, Gary Chew, and Francesca Puricelli).

We thank Li Wen Ng for her design and layout expertise. We also appreciate the administrative support provided by Hurshid Kalandarov and Regina Lio.

Suggested citation:
Global Deep Tech Ecosystems: Catalyzing Innovation for Sustainable Development (Singapore: UNDP Global Centre for Technology, Innovation and Sustainable Development, 2025)

UNDP is the leading United Nations organization fighting to end the injustice of poverty, inequality, and climate change. Working with our broad network of experts and partners in 170 countries, we help nations to build integrated, lasting solutions for people and planet.

Learn more at undp.org or follow at @UNDP.

TABLE OF CONTENTS

Executive Summary

Photo: Freepik

I. Executive Summary

Deep tech innovations, rooted in scientific advancements and engineering breakthroughs, have the potential to address complex global challenges—from climate change and food security to healthcare and clean energy. Deep tech presents new opportunities for countries looking to advance progress on the Sustainable Development Goals (SDGs), accelerate industrial development, and spur economic diversification.

Recognizing its potential, countries worldwide are increasingly investing in deep tech ecosystems, integrating national strategies, funding mechanisms, and regulatory frameworks to foster innovation, partnerships, and commercialization. However, the development of deep tech remains uneven, with many countries facing challenges in building the necessary research infrastructure, talent pipelines, and investment network. This publication provides a global overview of deep tech ecosystems, examining key initiatives, policy approaches, and ecosystem-building efforts across different countries and regions.

This report draws on academic research, industry literature, and in-depth interviews with stakeholders—including policymakers, scientists, entrepreneurs, investors, and ecosystem builders—to address knowledge gaps on how different economies, particularly low-and middle-income countries, are shaping their deep tech ecosystems. Rather than providing a comprehensive overview of all initiatives, this publication highlights best practices, collaborative models, and key lessons that can serve as inspiration for policy development and ecosystem building. This effort aligns with UNDP's mission to strengthen the innovation and technological capabilities of low-and middle-income countries, ensuring that deep tech serves as a catalyst for sustainable and inclusive development, rather than widening technological divides.

Despite the growing momentum in deep tech, several challenges remain. A key issue is the lack of a universally accepted definition of deep tech. For example, technologies like AI are categorized as deep tech in some studies, while in others, only advanced forms such as explainable AI (see Table 1) are considered within this domain. Such inconsistencies complicate cross-country comparisons and a cohesive global narrative. Additionally, the availability of relevant data remains limited, particularly in emerging markets where deep tech ecosystems are still developing. The lack of standardized global and regional statistics on deep tech further hinders efforts to measure progress, benchmark performance, and identify trends at international and regional levels.

Deep tech is rapidly evolving, with advancements continuously reshaping industries and economies, offering both opportunities and challenges for countries. Harnessing the potential of deep tech for sustainable development often requires governments to take a whole-of-ecosystem approach and tailor policies and investment efforts to their unique socio-economic contexts. There is no one-size-fits-all model—each country's strategy will need to align with national priorities, leverage existing strengths, and address local constraints while fostering partnerships and knowledge exchange. As deep tech continues to advance, visionary leadership, strategic investments, and international cooperation will be critical in shaping its role as a driver of sustainable and inclusive growth.

What is Deep Tech?

Photo: Canva

II. What is Deep Tech?

For the purposes of this publication, deep tech refers to advanced and often disruptive technologies rooted in scientific discoveries, engineering innovations, or significant research breakthroughs in fields like physics, chemistry, biology, and computer science. Unlike more conventional technology, which typically focuses on business model innovation, user-oriented applications, or incremental improvements, deep tech aims to solve complex challenges and unlock opportunities with the potential to significantly impact industries, economies, and societies. Many of today's common technologies—such as the Global Positioning System (GPS), mRNA vaccines, lithium-ion batteries, or Wi-Fi—were once considered deep tech. This progression highlights deep tech's ever-evolving nature: what is revolutionary today can become mainstream tomorrow as these technologies mature, scale, and achieve widespread adoption.

Key Characteristics of Deep Tech

Early-stage development: Deep tech innovations are often positioned at lower Technology Readiness Levels (TRLs)[1]; technology readiness is a systematic metric to assess the maturity of a technology. TRLs range from 1 to 9, with 1 indicating basic principles observed and 9 signifying full deployment in operational settings. At early stages (usually TRLs 3 to 5), technologies remain in the experimental or prototype phase, requiring further development, validation, and testing to prove their practical utility and readiness for commercialization.

High research and development (R&D) investment: Deep tech relies on substantial and long-term investment in R&D, as these innovations require continuous experimentation and refinement to validate their feasibility and effectiveness. Deep tech ventures often navigate significant technical and scientific uncertainties before their technology can be commercialized. This high level of R&D commitment is crucial for pushing the boundaries of what is technologically possible, ensuring these solutions achieve the reliability, scalability, and impact necessary to address complex global challenges.

Need for patient capital: Deep tech innovations depend on patient capital—investments from stakeholders who are prepared to embrace long-term horizons and delayed returns. This type of funding supports the extended development cycles characteristic of deep tech, which often involve high upfront costs, lengthy R&D phases, and significant technical uncertainties. While early-stage deep tech investments carry risks, investors are drawn by the potential for long-term value

[1] For a detailed description of each TRL stage, refer to NASA's official guide: https://www.nasa.gov/directorates/somd/space-communications-navigation-program/technology-readiness-levels/

creation, including breakthrough innovations, sustainable impact, competitive advantages, and high-growth market opportunities.

Intellectual property (IP) driven: IP protection ensures that new technologies can be commercialized while maintaining a competitive edge. Patents, trade secrets, and proprietary knowledge provide legal protections, preventing unauthorized use and enabling companies to attract investments. A well-defined IP strategy not only encourages continued research but also strengthens collaboration between public entities, startups, investors, research institutes, and industry players, creating a pathway for deep tech solutions to reach the market.

Sectoral impact: Deep tech contributes to advancements across various sectors, including healthcare, manufacturing, energy, and transportation, amongst many others. By tackling complex, large-scale challenges, these technologies have the potential to drive innovation, enhance efficiency, and support the development of new industries. Their ability to optimize existing systems and introduce novel solutions can lead to significant shifts in industrial operations, shaping the future of economic and social progress. (see Table 1)

Ecosystem collaboration: The development and commercialization of deep tech thrives on the collective efforts of a diverse ecosystem of stakeholders, including governments, universities, research institutions, startups, corporates, and investors. This collaborative network provides the resources, expertise, and infrastructure needed to nurture and scale deep tech innovations. By fostering knowledge exchange, aligning incentives, and leveraging complementary strengths, ecosystem collaboration accelerates innovation and ensures that new technologies can reach their full potential.

Table 1: Selected Deep Tech Use Cases and Their Alignment with the SDGs

	Technologies	Definition	Use Case and Benefits	SDGs
Novel AI	**Explainable AI (XAI)**	It refers to AI systems designed to provide clear, interpretable, and transparent decision-making processes. Unlike traditional AI models that function as "black boxes," XAI enables users to understand how an AI system arrives at a specific decision.	XAI can play a role in high-risk domains such as healthcare or legal systems where hidden biases or errors create issues for trust, accountability, and pose a barrier to regulatory compliance. Explainable AI can resolve these issues in medical diagnosis systems, credit scoring models and self-driving vehicles so that scientists can understand what goes into a decision.	• SDG 9 (Industry, Innovation, and Infrastructure): Supports responsible AI adoption by making AI decisions more interpretable and ethical. • SDG 16 (Peace, Justice, and Strong Institutions): Enhances transparency in AI-driven decision-making, promoting fairness and reducing bias in applications like law enforcement and governance.
Novel AI	**Multimodal AI**	It refers to AI systems that can process and integrate multiple types of data, such as text, images, audio, and video, to improve understanding and decision-making.	It can improve human-computer interaction, autonomous systems, and decision-making processes by leveraging multiple sources of information. For example, in autonomous vehicles, multimodal AI models can integrate visual, radar, and LiDAR inputs to enhance real-time navigation and safety.	• SDG 9 (Industry, Innovation, and Infrastructure): Enhances AI-driven automation and intelligent systems across industries, improving efficiency and innovation. • SDG 3 (Good Health and Well-being): Advances medical diagnostics and personalized healthcare through the integration of diverse data sources.
Biotechnology	**Lab-Grown Organs and Tissues (Tissue Engineering)**	Tissue engineering involves the development of biological substitutes that restore, maintain, or improve tissue function. It combines bioengineering, stem cell research, and 3D bioprinting to create artificial tissues and organs that replicate natural biological structures.	When applied in regenerative medicine, tissue engineering enables the development of artificial skin for burn patients and bioengineered corneas to support vision recovery. These innovations can offer complementary solutions to traditional organ transplantation by addressing organ shortages and reducing reliance on human donors.	• SDG 3 (Good Health and Well-being): Reduces organ transplant waiting times, increases accessibility to life-saving treatments, and enhances medical innovation. • SDG 9 (Industry, Innovation, and Infrastructure): Advances biotechnology manufacturing processes, fostering new industries in regenerative medicine and healthcare.

Table 1: Selected Deep Tech Use Cases and Their Alignment with the SDGs (continued)

	Technologies	Definition	Use Case and Benefits	SDGs
Biotechnology	**CRISPR-based Gene Editing**	CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) is a gene-editing technology that enables precise modifications of an organism's DNA by acting as molecular scissors. This technology allows scientists to insert, delete, or modify genes with high accuracy and efficiency. It is widely used in genetic research, therapeutic development, and agricultural biotechnology, paving the way for disease-resistant crops and personalized medicine.	CRISPR-based gene editing has been used to develop gene therapies for inherited genetic disorders such as sickle cell anemia—a condition that affects red blood cell shape and function—and cystic fibrosis, which causes severe damage to the lungs and digestive system. It is also applied in agriculture to enhance crop resilience against pests, reduce reliance on chemical pesticides, and improve food security in vulnerable regions.	• SDG 3 (Good Health and Well-being): Enables breakthrough treatments for previously untreatable genetic conditions, improving healthcare outcomes. • SDG 2 (Zero Hunger): Supports sustainable agriculture by creating crops with improved yields and resistance to environmental stressors.
New Materials	**Biomimetic Materials**	They are engineered materials that imitate natural structures, functions, and biological processes found in nature. These materials are inspired by biological systems such as plant leaves, animal skins, and seashells, enabling the development of high-performance, sustainable, and adaptive materials. By leveraging principles from biology, biomimetic materials enhance efficiency, durability, and environmental adaptability in various industries.	Biomimetic materials have been applied across various industries. In construction, they are used to develop self-healing concrete and lightweight yet durable structures, helping to reduce maintenance needs and extend the lifespan of infrastructure. In textiles, materials inspired by lotus leaves and shark skin enable the creation of water-repellent, breathable, and self-cleaning fabrics—enhancing both performance wear and medical applications.	• SDG 9 (Industry, Innovation, and Infrastructure): Drives innovation in materials science, enabling high-performance, adaptive materials in construction, healthcare, and manufacturing. • SDG 11 (Sustainable Cities and Communities): Promotes sustainable urban development through biomimetic construction materials and eco-friendly infrastructure. • SDG 12 (Responsible Consumption and Production): Encourages biodegradable, recyclable, and energy-efficient materials, reducing waste and environmental harm.

Table 1: Selected Deep Tech Use Cases and Their Alignment with the SDGs (continued)

	Technologies	Definition	Use Case and Benefits	SDGs
New Materials	**Superabsorbent Hydrogels**	They are highly absorbent polymer networks capable of retaining and holding large amounts of water relative to their mass. These hydrogels are designed to absorb liquids quickly and efficiently while maintaining structural integrity.	Superabsorbent hydrogels can improve soil moisture retention, reduce water consumption, and enhance crop resilience in drought-prone areas, promoting sustainable farming. Moreover, they can be used in wound dressings, drug delivery systems, and tissue engineering, providing moist healing environments and controlled medication release.	• SDG 6 (Clean Water and Sanitation): Supports water conservation and purification through hydrogel-based water retention and filtration technologies. • SDG 2 (Zero Hunger): Enhances agricultural productivity by improving soil water retention, reducing irrigation needs, and increasing crop yields in water-scarce regions. • SDG 3 (Good Health and Well-being): Advances biomedical and hygiene applications, contributing to improved patient care and sanitation.
Advanced Computing Technologies	**Quantum Computing**	Quantum computing leverages the principles of quantum mechanics, such as superposition, entanglement, and quantum interference, to perform complex computations exponentially faster than classical computers.	Quantum computing can significantly enhance cybersecurity by advancing cryptographic techniques, making data encryption more secure. It can also simulate molecular interactions at a quantum level, enabling breakthroughs in pharmaceutical research and material innovation.	• SDG 9 (Industry, Innovation, and Infrastructure): Drives advancements in computing power, enabling innovation in multiple industries. • SDG 3 (Good Health and Well-being): Supports drug discovery and medical research, accelerating the development of new treatments and personalized medicine.
	Neuromorphic Computing	Neuromorphic computing is an approach that models the structure and function of the human brain and nervous system. It involves designing hardware and software systems that use artificial neurons and synapses to process information in a way that mimics biological neural networks—enabling more efficient, adaptive, and brain-like computation.	Neuromorphic computing is designed for tasks that benefit from brain-like processing, such as handling unstructured data, recognizing complex patterns, and enabling adaptive learning. Its architecture allows systems to respond dynamically to changing environments, making it suitable for applications in robotics, autonomous vehicles, and smart image processing—where the ability to adapt to unpredictable stimuli and make rapid decisions is pivotal.	• SDG 9 (Industry, Innovation, and Infrastructure): Drives innovation in low-power AI computing, making AI applications more accessible and sustainable. • SDG 11 (Sustainable Cities and Communities): Enhances smart city infrastructure by enabling intelligent, energy-efficient systems.

Why Deep Tech Matters for **Sustainable Development**

Photo: UNDP Ocean Innovation Challenge/AquaInSilico

III. Why Deep Tech Matters for Sustainable Development

Global efforts to achieve the SDGs are off track, with only 17% of targets met or progressing as of 2024[2]. Deep tech has the potential to accelerate progress by offering solutions where traditional approaches often fall short. Research shows that 97% of deep tech innovations contribute to one or more SDGs[3]. For example, cellulose-based superabsorbent hydrogels (SAHs)[4], derived from sustainable sources, help address water scarcity in arid regions by absorbing moisture from humid air and storing up to 1,000 times their dry weight in water. This makes them a viable solution for resource-constrained environments.[5]

For low- and middle-income countries, deep tech presents an opportunity to bypass traditional growth constraints in infrastructure, industrialization, and service delivery, supporting progress in key sectors. (see Box 1) By fostering technology-driven industrial growth, deep tech can contribute to more resilient and diversified economies. Importantly, low- and middle-income nations are not only recipients of deep tech innovation—they are active contributors in shaping its trajectory; some are among the first movers in designing national deep tech policies and initiatives to harness its potential for economic development and sustainability. (see Box 2)

Despite its potential, several barriers continue to limit the widespread adoption and scalability of deep tech. Many countries face funding gaps, particularly for high-risk, long-term R&D projects. Limited access to technical expertise further constrains the ability to develop and deploy deep tech solutions. Regulatory uncertainties, including slow adaptation of policies to new technologies, create additional barriers for commercialization. Ecosystem fragmentation, where research, industry, and capital remain disconnected, limits opportunities for scaling deep tech innovations. Without dedicated efforts to bridge these gaps, deep tech's impact will remain concentrated in a few economies, exacerbating global disparities.

---

[2] UNDESA. 2024. *The Sustainable Development Goals Report 2024.* https://unstats.un.org/sdgs/report/2024/
[3] This finding is based on a survey of 1,277 companies conducted in 2018-2019. More information, see Hello Tomorrow & BCG. 2021. *Deep Tech and the Great Wave of Innovation:* https://www.bcg.com/publications/2021/deep-tech-innovation
[4] Chang, Chunyu, Bo Duan, Jie Cai, and Lina Zhang. 2010. *Superabsorbent Hydrogels Based on Cellulose for Smart Swelling and Controllable Delivery.* https://www.sciencedirect.com/science/article/abs/pii/S0014305709001864
[5] Matthews, Mary, Weijing Ye, and Khristine Gudczinki. 2024. *Deep Tech Series Vol. 4: Thirst for Innovations - Deep Tech for Global Water Challenges.* https://www.undp.org/policy-centre/singapore/blog/deep-tech-series-vol-4-global-water-challenges

Realizing deep tech's potential for sustainable development requires removing systemic barriers and fostering a globally inclusive ecosystem. A whole-of-ecosystem approach—bringing together governments, industry, academia, and investors—is essential to ensuring equitable access to funding, expertise, and market opportunities. This calls for stronger international collaboration, policy alignment, and investment in local capacity-building to enable deep tech solutions to scale effectively. By creating an environment where deep tech can be developed, deployed, and commercialized more equitably, countries can harness its potential to drive sustainable and long-term economic progress.

Box 1: Two case studies on the potential of deep tech to address global development challenges

Case Study 1: Advancements in Solid-State Battery Technology and Their Impact on Sustainable Energy

The "Tracking SDG7: The Energy Progress Report 2023" underscores the urgent need for advancements to achieve SDG 7—universal access to sustainable and modern energy by 2030. Despite renewable energy accounting for 19.1% of total consumption in 2020, its deployment must accelerate, especially in heat production and transport. The transport sector, heavily reliant on oil, constitutes nearly 91% of its energy use and over a third of CO2 emissions from end-use sectors. Transitioning to battery-electric and hybrid vehicles could reduce CO2 emissions by over 60 billion tons by 2050.

Lithium-ion batteries are widely used in consumer electronics and electric vehicles due to their relatively low cost, high efficiency, and well-established manufacturing infrastructure. However, they also come with certain limitations, including safety concerns related to flammability and constraints in energy density that can pose challenges for larger-scale applications.

As a potential alternative, solid-state batteries are emerging as a new solution. By using solid electrolytes—such as ceramics, sulfur, or selenium—these batteries can significantly reduce the risk of fire and thermal runaway. In addition, their cobalt- and nickel-free composition may contribute to a more sustainable and less resource-intensive production process. While still in development and not yet widely commercialized, solid-state batteries hold the potential to complement or eventually enhance existing energy storage systems in the future.

Key Improvements in Solid-State Batteries:

- **Higher Energy Density:** Offering up to 500 Wh/kg, solid-state batteries provide up to five times the energy of current lithium-ion batteries.
- **Better Safety:** Non-flammable and functional even when damaged, they require less cooling.
- **Quicker Charging:** Can reach a full charge in approximately 10 to 15 minutes.
- **Reduced Weight:** Their design can reduce weight by 30-40%, improving efficiency.

Solid-state batteries are emerging as a potential next step in energy storage that could significantly influence the future of transportation. With electric vehicles (EVs) projected to account for 18% of global car sales in 2023, innovations in battery technology are helping to accelerate the shift toward electric mobility, including electric cars and e-buses. While still emerging, solid-state batteries—known for their safety improvements and potential for higher energy density—are expected to be integrated into commercially available vehicles as early as 2027.

Public transportation systems are also beginning to explore the integration of solid-state batteries, offering opportunities to enhance the sustainability and resilience of urban mobility. This shift is particularly relevant for low- and middle-income countries, where transportation-related emissions are rising and the adoption of EVs has been slower due to high upfront costs and limited infrastructure. However, growing evidence suggests that the long-term economic, operational, and environmental benefits of electric mobility can outweigh initial investments, supporting a more sustainable and inclusive transition.

Case Study 2: Addressing Global Water Challenges with Deep Tech

Water is an essential resource, fundamental to human and ecological survival. As of 2023, approximately 2 billion people, primarily in Sub-Saharan Africa, lack access to safe drinking water. Despite Earth's abundant oceans, only about 0.5% of water is usable as freshwater. The repercussions of water scarcity extend beyond human health, impacting biodiversity and global ecosystems. In 2019, inadequate access to safe water, sanitation, and hygiene (WASH) services led to 1.4 million deaths and accounted for 74 million disability-adjusted life years (DALYs) globally. Over 80% of global wastewater still flows untreated into water bodies, exacerbating pollution and further straining water quality. Agriculture, a primary source of income and food security for 80% of the world's poor, consumed about 72% of global freshwater withdrawals in 2023, predominantly in low-income countries.

Some Deep Tech Solutions for Water Challenges:

Hydropanels: Hydropanels use solar energy to extract clean drinking water from the air, even in arid conditions with humidity as low as 5%. These panels use nanostructured composite materials that combine solid and liquid desiccants' properties. Operating without electricity, hydropanels are deployed in over 50 countries, supplying essential water to schools in Mexico, refugee communities in Lebanon and Jordan, and hurricane-stricken areas in Puerto Rico.

Zwitterionic Membrane Technology: Designed to tackle industrial wastewater contaminants, zwitterionic polymers effectively repel grease, oils, and proteins, preventing membrane degradation. This innovation enables the treatment of highly contaminated wastewater from industries such as dairies and pharmaceuticals, enhancing water purification and sustainability.

Superabsorbent Hydrogel (SAH): Biodegradable hydrogels, developed from sustainable sources such as soy-based materials, can absorb thousands of times their weight in water, acting as miniature reservoirs in soil. By retaining moisture for longer periods, these hydrogels reduce irrigation needs, enhance crop resilience in arid regions, and support food security efforts in water-scarce communities.

For more details and additional case studies on how deep tech is being applied to advance sustainable development, visit our ongoing Deep Tech Blog Series: https://www.undp.org/policy-centre/singapore/deep-tech-blog-series

Deep Tech **Ecosystems**

Photo: Limitless Visions/Adobe Stock

IV. Deep Tech Ecosystems

A well-functioning deep tech ecosystem requires more than novel ideas—it can only thrive on a network of stakeholders to create an enabling environment and address challenges. This ecosystem forms the foundation that integrates multiple layers of support to foster innovation and growth. Government entities act as strategic enablers by implementing supportive policies, providing financial incentives where feasible, and developing infrastructure to catalyze progress. Universities and research institutions drive advanced R&D, facilitate commercialization, and nurture talent pipelines. Venture capitalists and business angels supply patient capital and provide strategic expertise, while dedicated incubators and accelerators deliver mentorship, workspace, and early-stage investment tailored to deep tech ventures.

Beyond these core actors, corporations, international organizations, non-governmental organizations (NGOs), and media also contribute to ecosystem development. Corporations play a key role in supporting deep tech ventures by facilitating commercial pilots, co-development opportunities, and strategic partnerships that accelerate market access. International organizations contribute by advocating for cross-border collaboration and promoting inclusive policies to ensure the equitable adoption of emerging technologies. NGOs amplify these efforts by driving advocacy, capacity building, and fostering partnerships. Meanwhile, the media acts as a connector, raising public awareness, shaping perceptions, and educating audiences about the potential of deep tech solutions.

Figure 1: The deep tech ecosystem: key stakeholders and their roles (developed by the author)

Universities and Research Institutions:
- Conduct advanced R&D and fundamental research
- Offer tech transfer services and commercialization support
- Provide grant, access to specialized equipment and laboratories
- Facilitate the conversion of students into deep tech startup founders...

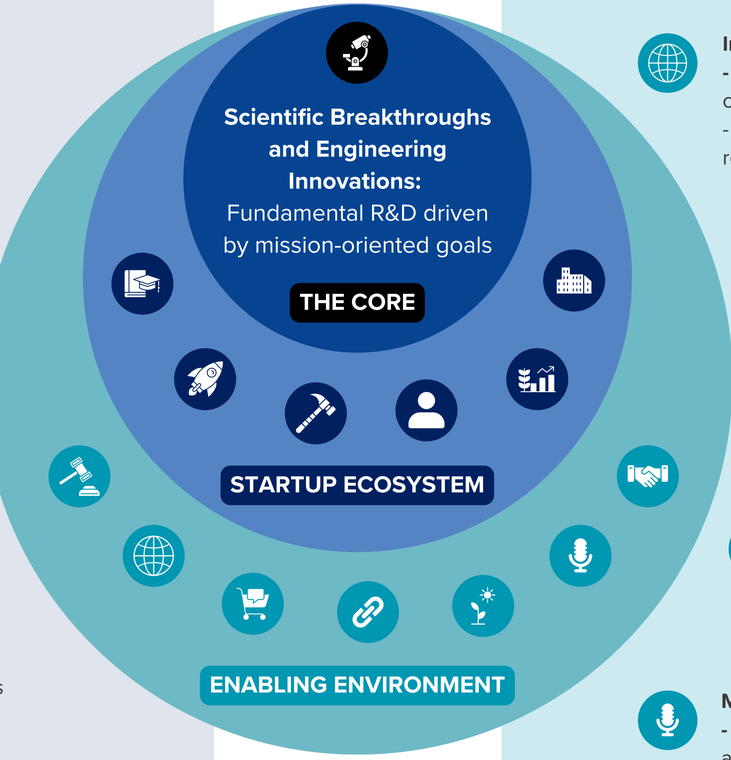
Dedicated Incubators and Accelerators for Deep Tech:
- Provide tailored mentorship, workspace, lab-like facilities, and early-stage investment
- Support for business model development and market entry strategies...

Deep Tech Venture Builders and Startup Studios:
- Offer investment and mentorship
- Provide access to networks and business expertise
- Develop go-to-market strategies for startups
- Help with follow-on funding and exit strategies
- Assist in scaling operations and international expansion...

Entrepreneurs:
- Translate cutting-edge research into investable and commercial solutions
- Identify market opportunities and assemble and lead teams to build and scale deep tech startups...

Venture Capitalists (VCs) and Business Angels:
- Provide seed, early-stage, and growth capital
- Facilitate connections and networking opportunities
- Offer strategic guidance and governance support...

Established Corporates:
- Offer corporate venture capital (CVC)
- Provide resources, infrastructure, and mentorship
- Enable commercial pilot and customer and market access
- Facilitate partnerships for co-development through open innovation initiatives...



Government and Public Institutes:
- Create favorable policy and regulatory environments
- Provide grants, tax exemptions, and R&D incentives
- Develop infrastructure to support deep tech initiatives
- Adopt new technology through procurement processes to foster market entry and scale...

International Organizations:
- Advocate for global standards and policies, facilitate cross-border collaborations
- Promote sustainable development and social responsibility within the deep tech sector...

Customers and End-users:
- Act as early adopters of new technologies
- Provide validation and feedback that helps refine and improve products
- Drive market demand and influence the direction of deep tech innovation...

Industry Associations:
- Provide networking opportunities, organize events, and offer industry insights

Natural Resources:
- Serve as a source of inspiration for biomimicry and other nature-inspired innovations
- Provide a rich base for research in biotechnology and related fields...

Media:
- Conduct public awareness campaigns, storytelling, and advocacy
- Influence public perception and acceptance of deep tech innovations...

NGOs and NPOs:
- Engage in advocacy, capacity building, and facilitating partnerships...

Global Deep Tech Ecosystems
Landscape and Key Trends

Photo: Canva

V. Global Deep Tech Ecosystems: Landscape and Key Trends

Deep tech ecosystems around the world are shaped by their varied socio-economic contexts, development priorities, technological capabilities, and policy landscapes. Some countries have established national deep tech ecosystems with supportive policies, strong talent pipelines, and dynamic innovation networks, while others are still in the nascent stages. This section explores the distinctive strengths, best practices, shared challenges, and collaborative potential observed across global deep tech ecosystems.

The analysis considers several themes within its regional examination. The *Technological Readiness and Innovation Landscape* theme assesses regional disparities in R&D infrastructure, talent availability, and market maturity—factors that influence the adoption and commercialization of deep tech. The second theme, *Public-Academia-Private Landscape*, examines the roles of (i) public institutions, which contribute through government support, policy frameworks, and infrastructure development; (ii) academic and research institutions, which drive scientific research, talent development, and technology transfer; and (iii) the private sector, which focuses on industry dynamics, investments, and commercialization.

Collectively, examining these themes through a regional lens enables a nuanced understanding of the global deep tech landscape, offering insights into structural strengths and opportunities for cross-learning and collaboration among different deep tech ecosystems.

Asia and the Pacific

The Asia-Pacific region comprises diverse and dynamic innovation landscapes, marked by varying levels of development and opportunities. High-income countries in the region benefit from well-established research institutions, advanced infrastructure, and strong innovation networks; while low- and middle-income economies are increasingly engaging in deep tech development, driven by growing ambitions and capacity-building efforts. This diversity can foster collaboration, knowledge exchange, and the cross-pollination of ideas across the region, creating opportunities for shared innovation and development.

Technological Readiness and Innovation Landscape

The Asia-Pacific region demonstrates heterogeneity in its readiness to adopt and benefit from frontier technologies[6], as highlighted by the UNCTAD Technology and Innovation Report 2023[7]. High-income countries such as Singapore, Japan, and Australia have developed advanced infrastructure, strong R&D capabilities, and high levels of industrial capacity. Other economies in the region, including India, Vietnam, and Thailand, are expanding their technological capabilities through targeted policies and investments. For example, Vietnam and Thailand have embraced policies to attract investment in high-tech manufacturing. However, these countries often face challenges related to gaps in digital infrastructure, uneven access to technology, and skills shortages.

According to the Global Innovation Index (GII) 2024[8], several economies in the region excel in infrastructure, knowledge creation, and business sophistication. Singapore and South Korea, for instance, have strong innovation capabilities, patent generation, and advanced manufacturing. Similarly, upper-middle-income countries like China have built a well-functioning innovation ecosystem, demonstrating strengths in research output, high-tech exports, and manufacturing capabilities. Meanwhile, Thailand and Malaysia continue to advance their innovation capabilities, driven by government-led initiatives to attract investment in deep tech sectors and foster public-private collaboration.

Lower-middle-income economies such as India and Vietnam continue to develop their deep tech ecosystems, supported by an expanding startup ecosystem and increasing venture capital investments. Vietnam, for example, has exhibited strengths in manufacturing and has made progress in adopting digital and high-tech solutions. However, lower-income nations, particularly those classified as Least Developed Countries (LDCs) and Small Island Developing States (SIDS), face structural barriers that hinder their participation in the global deep tech ecosystem. These challenges include limited R&D investment, inadequate infrastructure, and skills shortages, as well as vulnerability to climate change, geographic isolation, and constraints in accessing global markets and financing mechanisms.

[6] Frontier technologies, as defined in the UNCTAD Frontier Technology Readiness 2023 report, include a broad range of cutting-edge innovations such as gene editing, robotics, nanotechnology, and green hydrogen, among others. These technologies often serve as enablers for deep tech but may not always align fully with the narrower scope of deep tech, which typically refers to innovation rooted in profound scientific and engineering advancements.
Currently, there are no globally standardized metrics or statistics to assess deep tech readiness specifically. However, the Frontier Technology Readiness Index provides a useful proxy for understanding the readiness of countries to develop, adopt, and scale these transformative technologies. By using this index as a reference, this report aims to offer valuable insights into the strengths and gaps within national ecosystems as they relate to deep tech innovation.

[7] UNCTAD. 2023. *Technology and Innovation Report 2023.* https://digitallibrary.un.org/record/4007851?v=pdf

[8] WIPO. 2024. *Global Innovation Index 2024 Unlocking the Promise of Social G Entrepreneurship.* https://www.wipo.int/web-publications/global-innovation-index-2024/assets/67729/2000%20Global%20Innovation%20Index%202024_WEB3lite.pdf

Public-Academia-Private Landscape

Many countries in the Asia-Pacific region have demonstrated strong governmental support for deep tech sectors, often integrating it into broader national economic strategies. In China, deep tech is central to the nation's innovation-driven development agenda, as outlined in the 14th Five-Year Plan[9] and the Law on the Progress of Science and Technology[10]. An initiative led by the Ministry of Industry and Information Technology, in collaboration with six other ministries, highlights "future industries"[11] such as quantum computing, 6G networks, space tech, and advanced materials. These sectors are identified as critical to fostering the "new quality productive forces"[12], underscoring China's focus on deep tech as a driver of economic and industrial transformation.

Similarly, Thailand's Deep-Tech Regionalisation program[13] focuses on decentralizing tech growth by building regional innovation hubs that specialize in biotechnology, medtech, and other key sectors. India's Draft National Deep Tech Startup Policy (NDTSP)[14] aims to support deep tech startups, thereby solidifying India's financial stability and stimulating the transition towards a knowledge-centric economy. (see Box 2) In Singapore, the government has taken a lead in alternative proteins by becoming the first country to approve lab-grown meat for sale, demonstrating the country's enabling regulatory environment and support for the development and commercialization of new technologies[15].

The academic landscape is increasingly integral to the region's deep tech ecosystem, combining specialization in research fields with supportive mechanisms to bridge the gap between innovation and commercialization. For example, Japan hosts several research institutions focusing on quantum research, including the National Institutes for Quantum Science and Technology (QST), University of Tokyo, and the Okinawa Institute of Science and Technology (OIST), underpinned by the country's National Quantum Strategy[16]. Programs like Japan's Deep Tech Startups Support Fund[17] further promote international collaboration by enabling joint R&D activities between Japanese startups and foreign partners.

---

[9] National Development and Reform Commission (NDRC). 2021. *Public Announcement on the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035.* https://www.ndrc.gov.cn/xxgk/zcfb/ghwb/202103/P020210323538797779059.pdf

[10] Ministry of Science and Technology of the People's Republic of China. 2021. *Science and Technology Progress Law of the People's Republic of China (2021 Revision).* https://www.most.gov.cn/xxgk/xinxifenlei/fdzdgknr/fgzc/flfg/202201/t20220118_179043.html

[11] National Development and Reform Commission (NDRC). 2024. *Public Announcement on Supporting Technological Innovation and High-Quality Development Policies.* https://www.ndrc.gov.cn/wsdwhfz/202404/t20240428_1366248.html

[12] Xinhua News. 2024. *China Unleashes New Quality Productive Forces in Push for Reform, Innovation.* https://english.www.gov.cn/news/202406/25/content_WS667a2943c6d0868f4e8e8835.html

[13] Suchit Leesa-nguansuk. 2020, *NIA focuses on regional deep-tech startup plan.* https://www.bangkokpost.com/business/general/2031107/nia-focuses-on-regional-deep-tech-startup-plan

[14] Office of the Principle Scientific Adviser to the Government of India. 2024. *National Deep Tech Startup Policy (NDTSP).* https://www.psa.gov.in/deep-tech-policy

[15] Singapore Food Agency. 2023. *Safety of Alternative Protein.* https://www.sfa.gov.sg/food-information/risk-at-a-glance/safety-of-alternative-protein

[16] Japan Cabinet Office. 2024. *Quantum Technology and Innovation Strategy Outline.* https://www8.cao.go.jp/cstp/english/quantum/index.html

[17] New Energy and Industrial Technology Development Organization (NEDO). 2024. *Overview of NEDO's Activities.* https://www.nedo.go.jp/english/activities/activities_ZZJP_100262.html

Research institutions and universities like Universiti Malaya (UM) are fostering innovation through initiatives like the UM Deep Tech Accelerator Programme[18], a structured program designed to transition lab-based proof-of-concept (PoC) research into market-ready prototypes. Macquarie University's DeepTech Incubator[19] in Australia supports biotech innovation by equipping startups with certified lab spaces and specialized tools to overcome early-stage development hurdles, commonly known as the "valley of death." Moreover, initiatives like the HKU DeepTech 100 from the University of Hong Kong[20] spotlight deep tech startups with high potential and provide mentorship, networking opportunities, and funding support.

The private sector is a dynamic force propelling deep tech innovation, characterized by substantial investments, strategic partnerships, and the establishment of specialized funds. The region has seen a sustained rise in deal activity, even amid global market corrections. In 2022, deep tech accounted for 71% of tech deal value in China, with significant activity in biotechnology, semiconductors, and new materials. Meanwhile, Southeast Asia continues to attract growing investment interest, particularly in emerging areas like advanced manufacturing, medtech, and agritech[21]. In Thailand, a collaboration between a local corporate innovation firm and a foreign investment platform has led to the establishment of a $50 million venture capital fund that aims to invest in early-stage deep tech startups across Asia[22]. In India, initiatives like the Bharat Innovation Fund provide specialized funding that focuses on IP-driven deep-tech solutions[23]. (See Investment and Funding Section)

Africa

Africa's deep tech ecosystem is rapidly evolving, with countries of diverse contexts harnessing innovation through various approaches. Despite challenges such as infrastructure deficits, talent shortages, and limited funding, Africa's deep tech landscape is gaining momentum, particularly in key sectors like climate tech, agritech, and medtech. The region's youth demographic, growing entrepreneurial ecosystems, and expanding digital infrastructure provide a foundation for innovation. Additionally, the increasing emphasis on cross-border collaboration strengthens opportunities for deep tech solutions tailored to address local challenges and drive sustainable growth.

[18] Universiti Malaya. 2024. *About UMDT.* https://umcie.um.edu.my/um-deep-tech
[19] Macquarie University.2024. *Deeptech Incubator.* https://www.mq.edu.au/partner/access-business-opportunities/innovation-entrepreneurship-and-it/incubator/deeptech-incubator
[20] University of Hong Kong. 2024. *DeepTech 100.* https://tec.hku.hk/deeptech100/
[21] GPCA. 2023. *2023 Emerging Tech Trends in Asia.* https://www.globalprivatecapital.org/app/uploads/2023/02/GPCA_2023-Emerging-Tech-Trends-in-Asia_vF.pdf
[22] Tnglobal. 2023. *Thailand's RISE and Israel's OurCrowd launch $50M deep tech fund.* https://technode.global/2023/11/15/thailands-rise-and-israels-ourcrowd-launch-50m-deep-tech-fund/
[23] Bharat Innovation Fund. 2024. *About.* https://bharat.fund/innovation/bif.html#page1

Technological Readiness and Innovation Landscape

Africa faces challenges in technological preparedness, as highlighted in the UNCTAD Technology and Innovation Report 2023[24]. Many countries have limited capacity to adopt and scale frontier technologies like AI and biotechnology due to insufficient infrastructure, low R&D investment, connectivity gaps, and limited digital literacy, particularly in low-income economies. Despite these challenges, some countries are making significant progress. South Africa, for example, has made advancements in technology adoption through public-private partnerships and a growing emphasis on technological sectors like AI and renewable energy. Similarly, Kenya has prioritized sectors such as fintech and agritech, supported by a thriving entrepreneurial ecosystem.

The Global Innovation Index 2024[25] also highlights the diversity of Africa's innovation performance. For example, South Africa demonstrates strengths in areas such as knowledge creation, market sophistication, and ICT services exports. Kenya and Nigeria have developed vibrant startup ecosystems with a strong focus on mobile and digital solutions. Rwanda has established initiatives such as the Kigali Innovation City to promote technology-focused collaboration and entrepreneurship, while Ghana has implemented targeted programs and partnerships to support startups and strengthen its innovation capacity. However, disparities remain, with some low-income nations facing significant challenges in infrastructure, funding, and digital connectivity, limiting their ability to scale innovation initiatives.

Public-Academia-Private Landscape

Governments across Africa are increasingly supporting digital transformation while recognizing the need for greater emphasis on R&D and deep-tech-specific policies. Deep tech is gradually being integrated into national development agendas as a strategic driver of economic growth and innovation. For instance, the African Union's Agenda 2063[26] highlights the importance of leveraging science, technology, and innovation to propel continental transformation. At the national level, some initiatives are beginning to address deep tech explicitly. In 2024, Uganda's Science, Technology, and Innovation Secretariat organized the Uganda Deep Tech Summit[27] in collaboration with partners, bringing together stakeholders to catalyze the commercialization of emerging technologies. The summit aimed to develop a structured framework to foster innovation and attract investment in the country's nascent deep tech ecosystem.

Africa's deep tech ecosystem relies heavily on universities and research institutions, which serve as key drivers of research and spin-offs. More than 100 universities across the continent host active research labs focused on deep tech innovation, with South Africa, Egypt, and Kenya leading in

---

[24] UNCTAD. 2023. *Technology and innovation report 2023 : opening green windows : technological opportunities for a low-carbon world.* https://digitallibrary.un.org/record/4007851?v=pdf

[25] WIPO. 2024. *Global Innovation Index 2024 Unlocking the Promise of Social G Entrepreneurship.* https://www.wipo.int/web-publications/global-innovation-index-2024/assets/67729/2000%20Global%20Innovation%20Index%202024_WEB3lite.pdf

[26] African Union. 2024. *Agenda 2063: The Africa We Want.* https://au.int/en/agenda2063/overview

[27] Brain. 2024. *Captures and Highlights from #UgandaDeeptechSummit2024 Day 1.* https://www.linkedin.com/posts/brain-ost_ugandadeeptechsummit2024-uganda-openstartup-activity-7247181074869456896-i-aZ?utm_source=share&utm_medium=member_desktop

research output and spin-off creation in 2023[28]. South Africa alone accounts for 47% of identified spin-offs, reflecting the strength of its research infrastructure and intellectual property frameworks. Many universities have established Technology Transfer Offices (TTOs) to streamline the commercialization of research outputs and foster stronger academia-industry linkages.

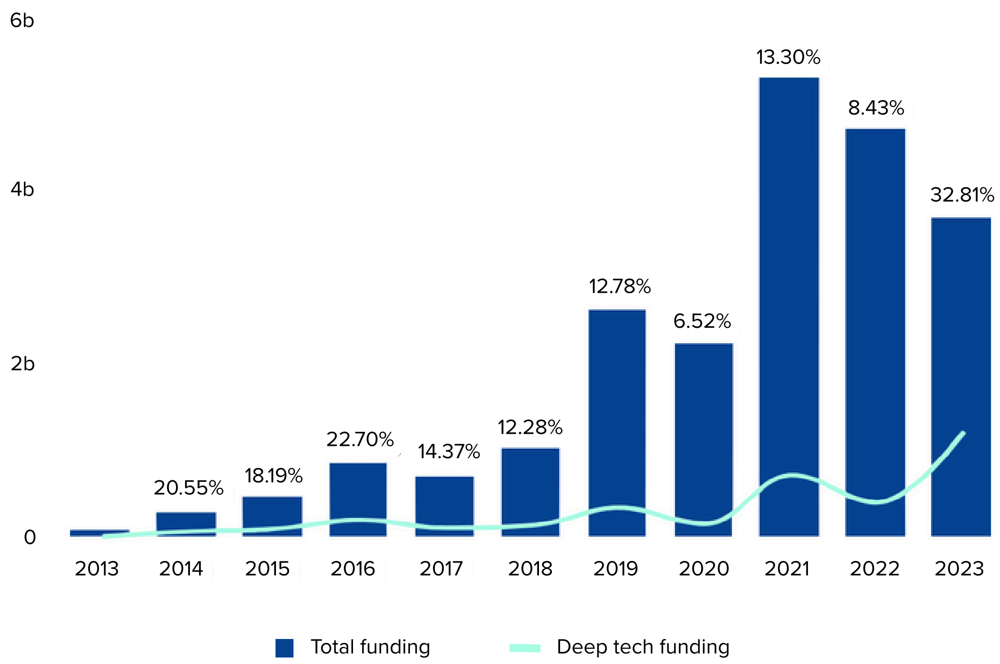
In Morocco, Mohammed VI Polytechnic University (UM6P) has developed a model for university-driven innovation by focusing on advanced research in fields like agrobioscience and medtech. The University hosted the UM6P Deep Tech Summit in 2024[29], which brought together academics, researchers, investors, and industry experts to explore the intersection of deep tech and sustainable development in Africa. Further advancing its innovation agenda, UM6P Ventures[30], the university's venture arm, has designed dedicated initiatives that integrate cash and in-kind investments, IP assessment, and business analysis services to support entrepreneurs and researchers.

The private sector also contributes to Africa's deep tech ecosystem by providing financial resources, industry expertise, and partnerships that help scale innovation. Over the past decade, African deep tech startups have raised more than $3 billion across 360 deals, with the majority of funding directed toward early-stage ventures[31]. Countries like Nigeria, Kenya, and South Africa have emerged as hubs for venture capital inflows. Equity financing dominates, accounting for 67% of the funds raised in 2023, while grants and venture debt contribute smaller shares. Early-stage incubators and accelerators also bridge initial funding gaps and provide mentorship, yet the availability of later-stage capital remains limited.

NGOs also play a key role in nurturing deep tech innovation and entrepreneurship across the continent. Organizations like Open Startup provide tailored support to startups, offering resources such as grants, networking opportunities, research collaborations, and capacity-building initiatives. Pan-African programs like BRAIN (Bridging Research and Innovation), supported by global partners, have further strengthened the deep tech ecosystem. By connecting scientists and entrepreneurs to global resources and fostering research-to-market pipelines, these initiatives are laying the foundation for a well-connected deep tech ecosystem in Africa.

[28] Brain. 2024. *Mapping the African Deeptech Landscape.* https://drive.google.com/file/d/1s2YSbtlhXFWCRNhR3zNFTD7mwJJ80M0z/view
[29] DTS. 2024. *Deeptech Summit 2024.* https://deeptech.um6p.ma/events/summit-2024
[30] UM6P Ventures. 2024. *UM6P Ventures' Deep Tech Offer.* https://um6pventures.com/wp-content/uploads/2022/07/UV_Deep-Tech-Offer.pdf
[31] OpenStartup. 2023. *Mapping the African Deeptech Landscape.* https://drive.google.com/file/d/1s2YSbtlhXFWCRNhR3zNFTD7mwJJ80M0z/view

Figure 2: Share of funding into deep tech in Africa[32]



Europe

Europe has a well-established deep tech ecosystem, underpinned by supportive policies, advanced infrastructure, solid research foundations, and a commitment to integrating sustainability with technological progress. The deep tech ecosystem in Europe benefits from collaborations between public and private sectors, significant investments in research and development, and enabling regulatory frameworks that accelerate the deployment of technologies such as AI, quantum computing, climate tech, and advanced materials. Initiatives like the European Union's Horizon Europe and the European Innovation Council (EIC) offer relevant funding and strategic guidance, empowering innovators across the region.

Technological Readiness and Innovation Landscape

Europe is recognized for its technological readiness and advanced innovation ecosystem, driven by significant investments in R&D, high digital adoption rates, and conducive policy frameworks. According to the UNCTAD Technology and Innovation Report 2023[33], Europe shows significant advancement in the adoption and development of frontier technologies. Countries like Germany, France, and Sweden demonstrate strong technological readiness, with advanced digital

[32] OpenStartup. 2023. *Mapping the African Deeptech Landscape.* https://drive.google.com/file/d/1s2YSbtlhXFWCRNhR3zNFTD7mwJJ80M0z/view
[33] UNCTAD. 2023. *Technology and Innovation Report 2023.* https://digitallibrary.un.org/record/4007851?v=pdf

infrastructure, high levels of R&D investment, and relevant industrial capabilities. Meanwhile, other countries in the region, including Poland and Hungary, have strengthened their innovation systems by leveraging dedicated EU funding and digital transformation initiatives. Despite this progress, some gaps remain in certain areas, particularly in bridging the digital divide between rural and urban areas and scaling innovations across smaller economies.

The Global Innovation Index 2024[34] highlights Europe's innovation capabilities, with countries demonstrating strengths in different areas. Switzerland excels in knowledge creation and advanced manufacturing, while Sweden's innovation performance is supported by its focus on sustainability and green technologies. The Netherlands is recognized for its logistical and digital connectivity, creating a conducive environment for startups and scale-ups. Other countries in Europe, such as Estonia and Slovenia, have shown strong innovation outputs. Estonia, for example, has become a hub for digital innovation through government-led initiatives. Slovenia has focused on developing advanced manufacturing capabilities and fostering regional innovation networks.

Public-Academia-Private Landscape

Governments and public bodies across Europe demonstrate a multifaceted approach to nurturing the deep tech ecosystem, leveraging funding mechanisms, strategic initiatives, and cross-border collaboration frameworks. At the core of these efforts lies the European Union's Horizon Europe program, which allocates €95.5 billion for research and innovation from 2021 to 2027, focusing on advanced technologies such as AI, space tech, semiconductors, and green energy solutions. This program is complemented by the European Innovation Council (EIC), which has already disbursed over €1.2 billion in direct equity investments through its EIC Fund in 2023, attracting an additional €3.5 billion in private investment[35].

National governments have also introduced targeted initiatives to strengthen deep tech capabilities. Germany has allocated €30 billion for technology-oriented startups, supported by organizations like SPRIND, the German Federal Agency for Disruptive Innovation, which fosters technological advancements in the country. France's Bpifrance has committed €2.3 billion to deep tech startups (see Box 2), participating in over 160 funding rounds since 2016, while the UK's Advanced Research and Invention Agency (ARIA) aims to invest £800 million in groundbreaking research projects[36]. Regional collaborations further underscore Europe's commitment to deep tech. The European Tech Champions Initiative (ETCI)[37], a €3.85 billion fund-of-funds program, addresses the scale-up funding gap by targeting late-stage capital mobilization for high-tech companies.

---

[34] WIPO. 2024. *Global Innovation Index 2024 Unlocking the Promise of Social Entrepreneurship.* https://www.wipo.int/web-publications/global-innovation-index-2024/assets/67729/2000%20Global%20Innovation%20Index%202024_WEB3lite.pdf
[35] EIC. 2024. *The European Innovation Council Impact Report 2023: a €70 billion deep-tech portfolio.* https://eic.ec.europa.eu/news/european-innovation-council-impact-report-2023-eu70-billion-deep-tech-portfolio-2024-03-18_en
[36] Dealroom. 2023. *The European Deep Tech Report 2023.* https://dealroom.co/uploaded/2023/09/The-European-Deep-Tech-Report-2023.pdf
[37] EIC. 2023. *European Tech Champions Initiative.* https://www.eib.org/en/events/european-tech-champions-initiative

Europe's academic institutions contribute significantly to the deep tech ecosystem through research, innovation, and the commercialization of new technologies. Institutions such as the University of Oxford, ETH Zurich, and the Technical University of Munich (TUM) drive advancements in research fields like quantum computing, material science, and space tech. Their efforts in patent development, spin-offs, and industry collaborations help translate research into real-world applications, strengthening the deep tech ecosystem. For example, ETH Zurich has contributed to advancements in CO_2 capture technologies[38], while the University of Cambridge has made strides in advanced cybersecurity solutions[39]. The spin-offs from universities also benefit from the support of the technology transfer offices, which facilitate the commercialization of academic research by connecting academia with industry.

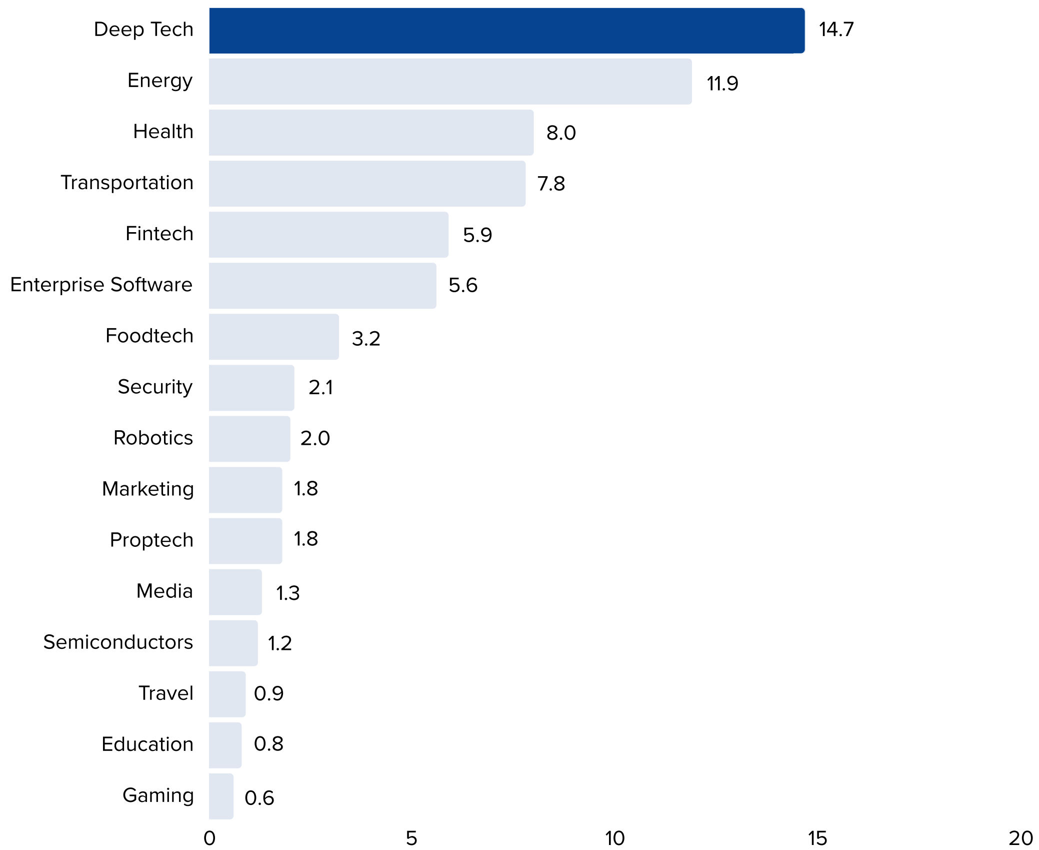
To support the transition from research to entrepreneurship, targeted programs like Conception X[40] in the UK empower PhD students to become deep tech founders, launching research-driven startups with a focus on long-term impact. (see Box 5) Meanwhile, the EIT Deep Tech Talent Initiative[41], launched under the European Institute of Innovation and Technology (EIT), aims to train one million deep tech professionals by 2025. This initiative equips individuals with specialized skills in areas such as AI and life sciences, addressing the growing demand for a highly skilled workforce. Recognizing the need for diversity in innovation, several initiatives within the academic ecosystem also focus on closing gender disparities in deep tech. Programs such as Women in Deep Tech and efforts within the EIT Deep Tech Talent Initiative provide mentorship, networking opportunities, and targeted funding to empower women in deep tech[42].

Deep tech represents a significant portion of the region's venture capital landscape, increasing from 10% of all European tech funding in 2010 to 44% in 2023. In the same period, Europe's share of global deep tech funding nearly doubled, rising from 10% in 2019 to 19% in 2023[43]. European deep tech firms benefit from a landscape of venture capital and corporate investment. Specialized funds target early-stage deep tech, while entities like the EIC provide additional support. The EIC Fund has co-invested over €1.2 billion in equity alongside venture capitalists, leveraging an additional €3.5 of private investment for every euro disbursed. This synergy between public and private funding mechanisms amplifies resources for startups. Moreover, programs like the European Tech Champions Initiative (ETCI)[44], an initial €3.75 billion fund-of-funds, address the late-stage funding gap by mobilizing resources for high-tech companies scaling beyond €50 million in investments.

[38] World Economic Forum. 2023. *How academia contributes to the world's net zero ambitions.* https://www.weforum.org/stories/2023/01/how-academia-contributes-to-the-world-s-net-zero-ambitions/
[39] University of Cambridge. 2025. *Building business partnerships.* https://www.cam.ac.uk/business-partnerships-computing
[40] Conception X. 2023. *Conception X.* https://www.conceptionx.org/
[41] EIT Tech Talent. 2025. https://www.eitdeeptechtalent.eu/
[42] EIT Tech Talent. 2024. *Women Founders in European Deep Tech Startups Main Findings Report.* https://supernovas.eitcommunity.eu/wp-content/uploads/2024/11/Executive_Summary_Supernovas_Digital_FV.pdf
[43] Dealroom. 2023. *The European Deep Tech Report 2023.* https://dealroom.co/uploaded/2023/09/The-European-Deep-Tech-Report-2023.pdf
[44] European Investment Bank (EIB). 2024. *European Tech Champions Initiative.* https://westernbalkans-infohub.eu/initiatives/european-tech-champions-initiative/

Furthermore, many large corporations have established corporate venture capital (CVC) arms to invest in deep tech startups, fostering partnerships that accelerate the development of transformative technologies. Moreover, initiatives like the DeepTech Alliance[45], a collaboration among European entrepreneurship hubs associated with universities and research institutions, connect deep tech entrepreneurs with international corporations and investors, fostering strategic and commercial partnerships. Despite these advancements, challenges remain in securing growth-stage capital and ensuring diversity within the ecosystem. For early and late-stage venture capital, women-founded startups receive just 11% of the total investment[46], highlighting the need for inclusive practices and targeted interventions to create a more equitable and thriving innovation landscape.

Figure 3: European VC funding by industry 2023 ($ bn)[47]



[45] DeepTech Alliance. 2025. https://www.deeptechalliance.org/

[46] EIT Tech Talent. 2024. *Only 15% of the seed funding goes to women-led deep tech start-ups, reveals new study.* https://www.eit.europa.eu/news-events/news/only-15-seed-funding-goes-women-led-deep-tech-start-ups-reveals-new-study#:.

[47] Dealroom. 2023. *The European Deep Tech Report 2023.* https://dealroom.co/uploaded/2023/09/The-European-Deep-Tech-Report-2023.pdf

Latin America and the Caribbean

The Latin America and the Caribbean (LAC) region shows a burgeoning yet uneven landscape for deep tech innovation, marked by dynamic entrepreneurial ecosystems and growing digital transformation efforts. High-income economies like Chile and Uruguay and upper-middle-income nations such as Brazil, Argentina, and Mexico[48] have demonstrated early success in fostering technological advancements, particularly in areas like agritech, biotech, and cleantech—sectors which align with regional priorities, including sustainable agriculture, healthcare innovation, and renewable energy. However, the region faces several barriers, including fragmented policies, insufficient funding for advanced research, and weak integration of public and private sector initiatives.

Technological Readiness and Innovation Landscape

According to the UNCTAD Technology and Innovation Report 2023[49], most LAC countries are classified as either "emerging" or "lagging" in their readiness for frontier technologies. Brazil, Mexico, and Chile are making significant strides towards technological adoption, implementing policies that support innovation in agritech, renewable energy, and advanced materials. Brazil has made notable progress in biotechnology and agricultural technologies, supported by initiatives like the Brazilian Agricultural Research Corporation (EMBRAPA) which has helped advance precision farming and bio-based fertilizers. Similarly, Chile has developed expertise in advanced mining technologies, particularly in extracting and processing critical minerals. However, low-income economies, particularly in the Caribbean, struggle with limited digital infrastructure, insufficient R&D investment, and gaps in technological skills.

While high-income and upper-middle-income countries have established strengths in knowledge creation and research infrastructure, many LAC nations lag in innovation output and technological adoption, as noted in the Global Innovation Index 2024[50]. The region's average R&D expenditure remains at just 0.6% of GDP—significantly below the global average of 1.7%—underscoring the need for greater public and private sector investment in innovation. A trend in the region is the rise of innovation clusters and accelerator programs aimed at fostering deep tech. Mexico, for example, is home to several technology parks, such as Monterrey's Technology and Innovation Park, which supports startups in advanced AI, robotics, and smart manufacturing. Argentina is making strides in nanotechnology and advanced materials, supported by collaborative efforts between academic institutions and industry.

---

[48] Although Mexico is geographically located in North America, this report includes its analysis within the Latin America and the Caribbean (LAC) section. This classification is based on Mexico's economic structure, technological landscape, and regional policy frameworks, which align more closely with LAC economies in the context of deep tech innovation, government support mechanisms, and investment patterns.
[49] UNCTAD. 2023. *Technology and innovation report 2023: opening green windows: technological opportunities for a low-carbon world.* https://digitallibrary.un.org/record/4007851?v=pdf
[50] WIPO. 2024. *Global Innovation Index 2024 Unlocking the Promise of Social Entrepreneurship.* https://www.wipo.int/web-publications/global-innovation-index-2024/assets/67729/2000%20Global%20Innovation%20Index%202024_WEB3lite.pdf

Public-Academia-Private Landscape

Governments across LAC are gradually embracing the potential of deep tech, integrating it into national and regional development agendas. Public institutions and international organizations like the Inter-American Development Bank (IDB) contribute to fostering a conducive environment for deep tech innovation. The IDB's innovation and venture capital arm, IDB Lab[51], underscores the importance of leveraging deep tech to address social and environmental challenges, highlighting its capacity to drive inclusive growth and resilience.

National initiatives further demonstrate this commitment. In October 2024, an expert commission in Chile presented the report "Recommendations and Challenges for Strengthening the Quantum Ecosystem in Chile," outlining a strategic roadmap to advance the country's quantum technology sector with applications in mining, renewable energy, and cybersecurity[52]. Additionally, Chile's National Green Hydrogen Strategy aims to accelerate research and development in clean energy technologies at universities and research centers[53]. Similarly, Brazil's 2024-2028 Artificial Intelligence Plan (PBIA) commits approximately BRL 23 billion (USD 4.1 billion) to enhance AI infrastructure, supercomputing capabilities, develop Portuguese language models, and provide professional training in AI[54].

Academic institutions in LAC are key drivers of deep tech development, combining strong research foundations with initiatives that connect academia and industry. Institutions like the University of São Paulo (USP) in Brazil and the Pontificia Universidad Católica de Chile (PUC) have made contributions to the region's innovation capacity. USP, for instance, hosts advanced research programs in bioinformatics and agricultural technologies, while PUC is involved in quantum research and has partnerships with international stakeholders to advance Chile's quantum ecosystem. Additionally, initiatives like QuantumHispano[55], based in Mexico City, are fostering a regional community focused on leveraging quantum computing for global impact.

Universities in LAC are increasingly prioritizing technology transfer and commercialization to foster deep tech innovation. In Chile, the government agency Corporación de Fomento de la Producción (Corfo), in collaboration with academic institutions, has established regional tech transfer hubs to support the commercialization of research outputs[56]. Similarly, Tecnológico de Monterrey in Mexico has launched technology parks and bootcamps specializing in advanced manufacturing and medical devices, creating a bridge between academia and industry. In Argentina, the

---

[51] IDB. 2025. *About.* https://bidlab.org/en

[52] Minciencia. 2025. *Quantum Technologies Advisory Commission.* https://minciencia.gob.cl/areas/comision-asesora-tecnologias-cuanticas/

[53] Ministerio de Energía, Gobierno de Chile. 2020. *Estrategia Nacional Hidrógeno Verde.* https://energia.gob.cl/sites/default/files/estrategia_nacional_de_hidrogeno_verde_-_chile.pdf

[54] Global Trade Alert. 2024. *Brazil: Government adopts the new Brazilian Artificial Intelligence Plan (PBIA).* https://www.globaltradealert.org/intervention/138729/state-aid-unspecified/brazil-government-adopts-Athe-new-brazilian-artificial-intelligence-plan-pbia

[55] QuantumHispano. https://quantumhispano.org/

[56] Choupay, E. 2019. *Public policy to promote technology transfer in Chile – Licensing, technology transfer offices and technology transfer hubs: Case study contribution to the OECD TIP Knowledge Transfer and Policies project.* https://stip.oecd.org/assets/TKKT/CaseStudies/5.pdf

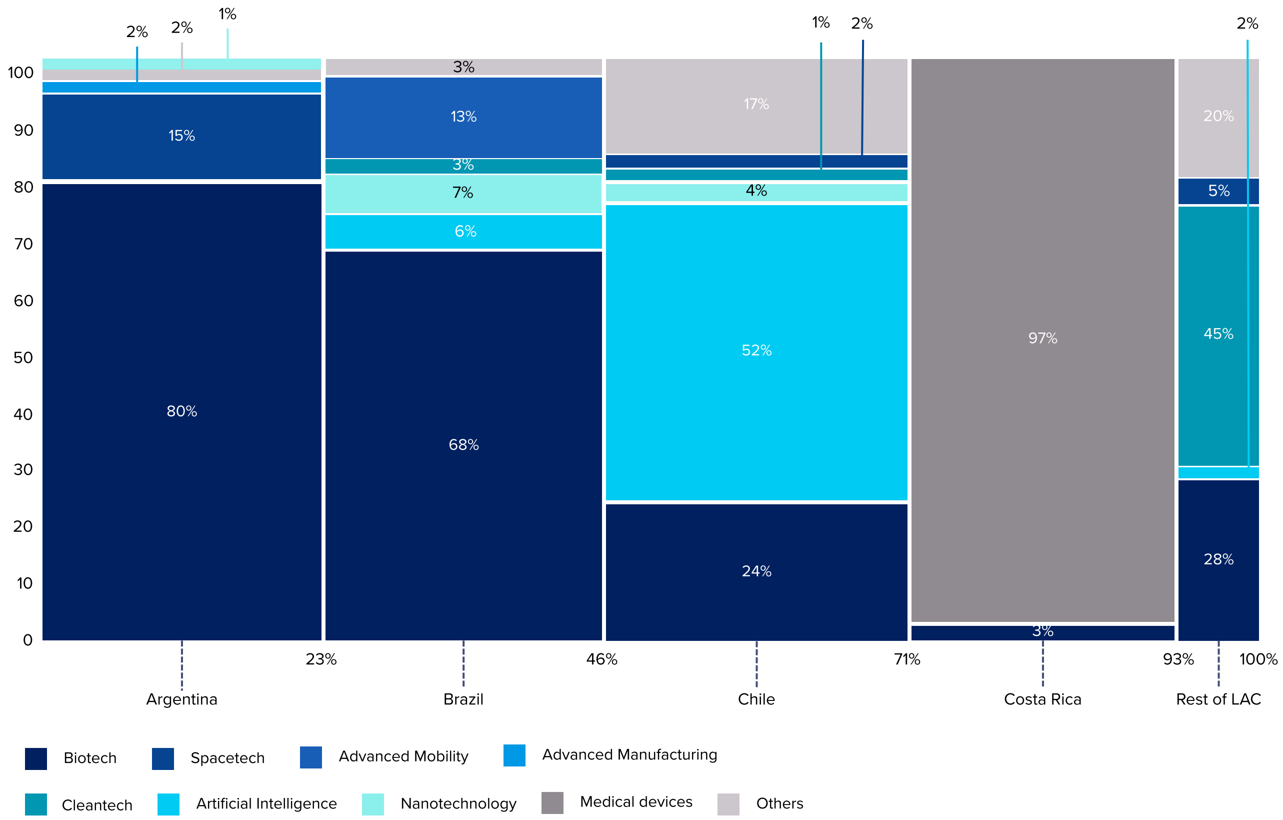
Argentine Nanotechnology Foundation (FAN) promotes advanced research in nanotechnology, fostering collaboration between academia and industry to bridge scientific discovery and commercialization. In addition, the Instituto Balseiro supports entrepreneurship and commercialization through its annual deep tech startup competition[57].

The region is home to approximately 340 deep tech startups that have collectively raised $2.2 billion in venture capital, contributing to an ecosystem valued at $8 billion in 2023. Venture capital investments in deep tech startups have shown a steady upward trajectory, growing from $96 million in 2020 to $172 million in 2022[58]. The investment landscape includes both regional and international players, with 15 dedicated deep tech VC funds as of 2023—primarily based in Argentina, Brazil, Chile, and Uruguay. Deep tech entrepreneurship in LAC is also mainly concentrated in Argentina, Brazil, and Chile, which together account for 80% of the region's startups. Costa Rica has emerged as a relevant player, contributing 22% of the ecosystem's total value.

Sectorally, biotechnology dominates the landscape, representing 42% of the ecosystem's value[59]. (see Figure 4) This prominence is attributed to the region's well-established agricultural base and a strong talent pool in life sciences. As a result, the region has become a hub for biotech innovation. While the private sector is gaining momentum, challenges remain. Many startups are not fully investor-ready, often limited by incremental innovations, underdeveloped commercialization strategies, and weak IP protection. Additionally, limited venture capital availability and weak commercialization pathways continue to hinder startups from scaling their innovations.

[57] IB50K. 2025. *About.* https://ib50k.ib.edu.ar/
[58] Inter-American Development Bank (IDB). 2023. *Deep Tech: The New Wave.* https://publications.iadb.org/en/deep-tech-new-wave
[59] Ibid

Figure 4: Share of each deep tech's vertical value across countries[60]



Middle East

The deep tech ecosystem in the Middle East is shaped by government-backed initiatives and increasing focus on research-driven technologies. The region faces significant geographical and environmental challenges, such as water scarcity, food security, and reliance on non-renewable energy sources. These factors are driving innovation and investment in critical sectors such as water management, agricultural technology, and renewable energy, which align with long-term strategic priorities and sustainability goals.

Technological Readiness and Innovation Landscape

The Middle East is making progress in technological readiness, with several countries expanding their technological capabilities. According to the UNCTAD Frontier Technology Index[61], high-income countries including Israel, the UAE, and Saudi Arabia have advanced infrastructure, well-funded R&D ecosystems, and supportive innovation policies. However, challenges remain in low-

[60] Inter-American Development Bank (IDB). 2023. *Deep Tech: The New Wave*. https://publications.iadb.org/en/deep-tech-new-wave

[61] UNCTAD. 2023. *Technology and innovation report 2023: opening green windows: technological opportunities for a low-carbon world*. https://digitallibrary.un.org/record/4007851?v=pdf

income economies, where insufficient digital infrastructure, limited access to high-performance computing, and weak linkages between academia and industry hinder the growth of advanced technologies. Countries like Jordan and Lebanon have growing tech ecosystems but face barriers such as brain drain, limited venture capital availability, and regulatory constraints. The region's digital divide is further exacerbated by geopolitical instability, which restricts cross-border collaboration and investment in emerging technologies.

According to the Global Innovation Index (GII) 2024[62], the Middle East presents a diverse innovation landscape, with disparities in research output, funding availability, and commercialization capabilities. Israel, the UAE, and Saudi Arabia have demonstrated strong innovation performance, particularly in patent activity, knowledge creation, and high-tech exports. The UAE is recognized for its digital innovation efforts, particularly in ICT adoption, government digital services, and AI integration. However, innovation performance remains uneven across the region. Low- and middle-income countries in the region have growing tech ecosystems but continue to face structural challenges such as limited R&D expenditure, insufficient funding mechanisms, and weak technology transfer frameworks.

Public-Academia-Private Landscape

Governments across the Middle East are increasingly prioritizing deep tech as a strategic pillar for economic diversification, industrial competitiveness, and sustainable development. Saudi Arabia's Vision 2030 strategy[63] places science and innovation at the core of its transformation agenda, focusing on novel AI, quantum computing, biotechnology, and clean energy technologies. As part of this vision, Saudi Arabia has established the National Technology Development Program (NTDP)[64], a national initiative designed to systematically strengthen the country's high-tech ecosystem and accelerate sustainable development. Additionally, the country launched a deep tech venture studio[65], backed by the Saudi Ministry of Investment and the Research, Development, and Innovation Authority, with an initial capital of $300 million. This initiative aims to support deep tech startups, drive commercialization, and foster cross-border innovation between the Middle East and Southeast Asia.

The UAE has also prioritized deep tech development, with novel AI, space tech, and biotechnology playing a central role in its innovation strategy. The UAE Artificial Intelligence Strategy 2031[66] aims to integrate advanced AI solutions across key sectors, enhancing its application in healthcare,

---

[62] WIPO. 2024. Global Innovation Index 2024 Unlocking the Promise of Social Entrepreneurship. https://www.wipo.int/web-publications/global-innovation-index-2024/assets/67729/2000%20Global%20Innovation%20Index%202024_WEB3lite.pdf
[63] PIF 2024. Leadership Vision. https://www.pif.gov.sa/en/private-sector-hub/leadership-vision/?gad_source=1&gclid=CjwKCAiAneK8BhAVEiwAoy2HYQRa1nFtlvb110-w9WxmQvcWMB7_a_jElarR3gU1zMdxNn9LCL_-LxoCsKsQAvD_BwE
[64] NTDP. 2024. *Who we are.* https://ntdp.gov.sa/who-we-are
[65] Arab News. 2025. *Startup Wrap – Saudi VCs pour capital into ventures through strategic investments.* https://www.blab.com.sa/news/startup-wrap---saudi-vcs-pour-capital-into-ventures-through-strategic-investments
[66] UAE National Program for Artificial Intelligence. 2017. *UAE National Strategy for Artificial Intelligence 20231.* https://ai.gov.ae/wp-content/uploads/2021/07/UAE-National-Strategy-for-Artificial-Intelligence-2031.pdf

energy, and transportation. Complementing this, the UAE National Advanced Sciences Agenda 2031[67] aligns deep tech initiatives with sustainability objectives, emphasizing advancements in clean energy and biotechnology. Additionally, the UAE has made investments in space exploration, including the Emirates Lunar Mission and Mars Science City[68], both of which contribute to progress in robotics, autonomous systems, and aerospace technologies.

The academic landscape in the Middle East plays an increasingly important role in shaping the region's deep tech ecosystem. In Saudi Arabia, the King Abdullah University of Science and Technology (KAUST) has emerged as a hub for deep tech research with dedicated programs like Destination Deep Tech[69], driving innovation in clean energy, biotechnology, and advanced materials. The UAE has made strides in integrating academic research with industry-driven innovation. The Mohammed Bin Zayed University of Artificial Intelligence (MBZUAI), the first university globally dedicated solely to AI, focuses on machine learning, computer vision, and natural language processing. The Khalifa University Space Technology and Innovation Center (KUSTIC), in collaboration with international space agencies, is advancing space science, robotics, and aerospace engineering to support the UAE's growing space exploration ambitions. Additionally, the UAE Space Agency, in collaboration with universities, supports research in planetary sciences, space robotics, and satellite technology, further solidifying the region's growing deep tech expertise[70].

The private sector also contributes significantly to advancing deep tech across the Middle East, with a surge in VC investments, the expansion of technology parks, and the establishment of specialized incubators and accelerators. VC-backed deep tech startups in the region have seen rapid expansion, supported by both domestic and international investors. In Saudi Arabia, initiatives like the fund-of-funds have mobilized capital to support high-tech ventures. The UAE has also seen growing deep tech investment, with the Dubai Future District Fund[71] focusing on startups specializing in advanced AI, robotics, and smart mobility, while Mubadala Ventures, a sovereign investment company, continues to channel funding into climate tech, biotech and semiconductor technologies. Meanwhile, Bahrain is fostering tech entrepreneurship through initiatives like Startup Bahrain[72], which provides early-stage support for emerging deep tech startups and facilitates collaboration between government agencies, investors, and private enterprises.

---

[67] UAE National Program for Artificial Intelligence. 2023. *National Advanced Sciences Agenda 2031.* https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/industry-science-and-technology/national-advanced-sciences-agenda-2031
[68] UAE National Program for Artificial Intelligence. 2024. *Space missions.* https://u.ae/en/about-the-uae/science-and-technology/key-sectors-in-science-and-technology/space-science-and-technology/space-missions
[69] Kaust. 2025. *Destination Deep Tech*. https://destinationdeeptech.kaust.edu.sa/
[70] UAE Space Agency. 2017. *UAE Space Agency Signs MoUs with Eight Leading UAE Universities.* https://space.gov.ae/en/media-center/news/7/1/2017/uae-space-agency-signs-mous-with-eight-leading-uae-universities
[71] Dubai Future District Fund. 2025. *We Invest into Funds and Co-invest Alongside Them to Support Promising Ventures.* https://dfdf.vc/about-us/investment-thesis/
[72] Bahrain EDB. 2025. *Scaling Your Business: StartUp in the GCC and Bahrain*. https://www.bahrainedb.com/business-opportunities/startup-bahrain

The region has also seen the rise of deep tech-focused technology parks and incubators aimed at accelerating the commercialization of cutting-edge research. In Qatar, the Qatar Science & Technology Park (QSTP)[73] serves as an enabler of innovation by hosting R&D centers for global technology firms and fostering startups in AI, precision medicine, and sustainable energy. Saudi Arabia's King Abdulaziz City for Science and Technology (KACST)[74] contributes to the R&D in quantum computing, biotechnology, and aerospace engineering. In the UAE, Abu Dhabi's Hub71 acts as a deep tech innovation hub, offering equity-free subsidies, housing, and office space to ease financial barriers for early-stage startups. These initiatives underscore the private sector's growing role in shaping the Middle East's deep tech ecosystem.

North America

North America's[75] deep tech ecosystem is driven by government-backed initiatives, strong research institutions, and a mature private investment landscape. The United States and Canada host a dynamic deep tech landscape, with notable advancements in AI, quantum computing, space tech, biotechnology, and advanced manufacturing. A key strength of the region is its dynamic startup ecosystem, which benefits from strong intellectual property protections, a risk-tolerant investment culture, and well-established commercialization pathways. Public and private sector collaboration has enabled a steady flow of innovation from universities and research labs into high-growth startups, supported by venture capital firms, corporate R&D partnerships, and technology incubators.

Technological Readiness and Innovation Landscape

North America demonstrates a high level of technological readiness, underpinned by advanced digital infrastructure, strong R&D capabilities, and a robust intellectual property framework. The United States ranks among the highest globally in technological readiness, driven by strong industrial capacity, a highly skilled workforce, and strong research institutions[76]. The country maintains a significant edge in high-tech exports, venture capital funding, and R&D investments. Canada also ranks among the leading countries in frontier technology adoption, with significant strengths in AI, quantum computing, and life sciences. According to UNCTAD's Technology and Innovation Report, both the United States and Canada benefit from a well-educated workforce, strong public sector investment in R&D, and a growing network of innovation hubs.

[73] Qatar Science and Technology Park. 2025. *Technology Gateway to the Middle East & Beyond.* https://qstp.org.qa/
[74] Gov.SA. 2025. *King Abdulaziz City for Science and Technology.* https://my.gov.sa/en/agencies/17537
[75] Although Mexico is geographically located in North America, this report includes its analysis within the Latin America and the Caribbean (LAC) section. This classification is based on Mexico's economic structure, technological landscape, and regional policy frameworks, which align more closely with LAC economies in the context of deep tech innovation, government support mechanisms, and investment patterns.
[76] UNCTAD. 2023. *Technology and innovation report 2023: opening green windows: technological opportunities for a low-carbon world*. https://digitallibrary.un.org/record/4007851?v=pdf

According to WIPO's Global Innovation Index 2024[77], North America remains one of the most innovation-intensive regions, with the United States consistently ranking among the world's top economies for innovation output. Canada also demonstrates high performance in knowledge-intensive employment, public R&D funding, and innovation clusters. These clusters foster collaboration between academia, industry, and government, driving the commercialization of deep tech. Sustaining North America's competitiveness in innovation will require continued investment in workforce development, infrastructure resilience, and equitable access to technological advancements.

Public-Academia-Private Landscape

The governments of the United States and Canada support deep tech advancement through strategic policies, funding mechanisms, and targeted national initiatives. In the United States, major legislative efforts have been introduced to enhance technological competitiveness. The CHIPS and Science Act (2022) allocated $280 billion to expand domestic semiconductor manufacturing, advance AI research, and develop quantum computing capabilities. The act also includes provisions for workforce development and the establishment of regional technology hubs to strengthen local innovation ecosystems. Additionally, the National Quantum Initiative Act provides long-term federal funding to advance quantum research, ensuring sustained progress in this field[78]. The United States Innovation and Competition Act (2022)[79] further strengthens scientific and technological innovation by increasing funding for R&D, improving tech transfer mechanisms, and fostering collaboration between universities and industry partners in sectors such as synthetic biology, robotics, and climate technology.

In Canada, deep tech innovation is driven by a combination of government-led initiatives and public-private partnerships. The Pan-Canadian AI Strategy[80] has strengthened the country's role in AI research by supporting talent development and commercialization. The National Quantum Strategy[81] seeks to enhance the country's capabilities in quantum computing and quantum-safe cybersecurity, backed by federal investment. The Innovation Superclusters Initiative[82] fosters collaboration between industry and academia in sectors such as advanced manufacturing, clean energy, and protein industries. Additionally, the Strategic Innovation Fund[83] provides financial support for high-growth innovative companies, promoting the development of key industries.

[77] WIPO. 2024. *Global Innovation Index 2024 Unlocking the Promise of Social Entrepreneurship.* https://www.wipo.int/web-publications/global-innovation-index-2024/assets/67729/2000%20Global%20Innovation%20Index%202024_WEB3lite.pdf
[78] Quantum.gov. 2025. *National Quantum Initiative.* https://www.quantum.gov/
[79] Congress.gov. 2022. *H.R.4521 - United States Innovation and Competition Act of 2021.* https://www.congress.gov/bill/117th-congress/house-bill/4521
[80] Government of Canada. 2024. *Pan-Canadian Artificial Intelligence Strategy*. https://ised-isde.canada.ca/site/ai-strategy/en
[81] Government of Canada. 2024. *Canada's National Quantum Strategy.* https://ised-isde.canada.ca/site/national-quantum-strategy/en/canadas-national-quantum-strategy
[82] Government of Canada. 2016. *Innovation Superclusters Program Guide.* https://www.clustercollaboration.eu/sites/default/files/international_cooperation/sprclstr-prgrm-gd-v2-en.pdf
[83] Government of Canada. 2025. *Strategic Innovation Fund.* https://ised-isde.canada.ca/site/strategic-innovation-fund/en

Academic institutions in the United States play a significant role in advancing deep tech research, benefiting from government funding, industry collaborations, and technology transfer programs. Universities across the country engage actively in fields such as AI, robotics, and biotechnology, collaborating closely with industry partners to accelerate innovation and commercialization. Additionally, university-affiliated incubators and innovation centers provide essential infrastructure and resources to facilitate technology transfer and market entry. Several federal agencies—including the National Science Foundation (NSF) and the Department of Energy (DOE)—provide research grants and funding for advanced technology development, including in areas such as semiconductors, quantum computing, and clean energy solutions.

In Canada, universities also play a relevant role in advancing deep tech through interdisciplinary research, strong industry collaborations, and dedicated innovation hubs. The Quantum Valley ecosystem in Waterloo, which includes the Perimeter Institute for Theoretical Physics and the Institute for Quantum Computing (IQC), has strengthened Canada's capabilities in quantum research and commercialization. These institutions work closely with private-sector partners and government agencies to accelerate research in quantum cryptography, quantum sensing, and scalable quantum computing applications. Canada is also actively advancing AI research and machine learning applications, with a strong emphasis on responsible innovation and commercialization.

North America continues to be an important destination for deep tech investment, with the United States accounting for 49% of all global deep tech venture capital funding in 2023[84]. Cities like Silicon Valley, Boston, and Austin attract significant venture capital, supporting AI, life science, new materials, and semiconductor startups. In Canada, the BDC Deep Tech Venture Fund is the country's largest dedicated deep tech fund, aimed at supporting high-risk, long-term innovation[85]. Other Canadian specialized investment firms focus on high-growth technologies, particularly AI and quantum computing, contributing to the country's expanding innovation landscape.

Major tech corporations in the region are actively involved in deep tech, frequently partnering with academic institutions and startups. North America hosts a network of specialized incubators and technology parks that support early-stage research and commercialization. Several cities serve as hubs for innovation, hosting accelerators and programs that provide structured mentorship, funding, and commercialization support. Additionally, non-profit organizations and industry partnerships contribute to strengthening the region's deep tech ecosystem by advancing research and fostering entrepreneurship.

[84] BCG. 2024. *State and trends of deep tech investment in 2023*. https://web-assets.bcg.com/9b/83/f79faa654ee2aeeb70eddd3e8adc/bcg-report-deep-tech-investment-trends.pdf
[85] BDC. 2025. *Deep Tech Venture Fund*. https://www.bdc.ca/en/bdc-capital/venture-capital/funds/deep-tech-venture-fund

Key Enablers for a Thriving **Deep Tech Ecosystem**

Photo: DC Studio/Adobe Stock

VI. Key Enablers for a Thriving Deep Tech Ecosystem

The global deep tech landscape is shaped by a complex interplay of economic conditions, technological capabilities, and policy environments, as explored in the previous section. While each region navigates distinct challenges and opportunities, the ability of deep tech ecosystems to thrive and deliver solutions hinges on a set of foundational enablers that transcend geographical boundaries.

This section examines the pillars that underpin deep tech ecosystems, focusing on the structural elements required to support the entire innovation lifecycle—from fundamental research to commercialization and large-scale deployment. These interconnected elements create an environment where deep tech ventures can grow and deliver long-term economic and societal benefits:

- **Policy and Regulation** provide the institutional framework that governs deep tech development, influencing incentives, risk mitigation, and regulatory pathways.
- **Research and Talent** serve as the backbone of deep tech, supplying the knowledge, expertise, and skills necessary to drive technological breakthroughs.
- **Investment and Funding** address the financial barriers associated with deep tech, which often requires patient capital and long development cycles.
- **Entrepreneurship and Venture Building** facilitate the transition from research to real-world applications, ensuring that deep tech solutions reach commercialization.
- **Collaborations** between governments, academia, industry, and investors are crucial in accelerating innovation, de-risking investment, and promoting technology diffusion.

By analyzing these key enablers through a whole-of-ecosystem lens, this section provides insights into best practices, lessons learned, and collaborative models that can strengthen deep tech ecosystems globally. It offers considerations for policymakers, investors, and ecosystem builders seeking to cultivate a resilient, inclusive, and high-impact deep tech landscape that advances development goals.

Policy and Regulation: Establishing an Enabling Environment

Well-designed policy and regulatory frameworks are fundamental to building a thriving deep tech ecosystem. Governments play a central role in shaping deep tech ecosystems by establishing clear national strategies, mobilizing funding, developing infrastructure, and fostering an environment that enables innovation and commercialization. However, deep tech differs from other technology sectors due to its long R&D cycles, high capital requirements, and high levels of technical uncertainty. As a result, adaptive and forward-looking policies are needed to address both immediate challenges and long-term growth objectives.

For many low- and middle-income countries, deep tech is increasingly seen as an opportunity to leapfrog development models by focusing on sectors that align with national priorities and address pressing societal needs—such as agriculture, clean energy, healthcare, and digital infrastructure. However, unlocking this potential requires more than scientific breakthroughs. It requires coordinated policy efforts to bridge the gap between research and commercialization, de-risk private sector investment, and create pathways for collaboration.

National Strategies for Deep Tech

Deep tech cannot develop in isolation; it is often integrated into national development planning to maximize its impact. Many countries are already prioritizing industrialization, digital transformation, climate resilience, and inclusive economic growth—deep tech can directly support these objectives. A well-defined national deep tech strategy should be anchored in existing economic frameworks, identifying how advanced technologies can accelerate progress in areas such as agriculture, clean energy, and healthcare. This ensures that deep tech investments are not just about technological advancement but also about supporting broader national objectives and addressing pressing development challenges.

Given resource constraints in some low- and middle-income economies, governments should make strategic choices about where to focus their deep tech investments. Rather than spreading efforts too thinly across multiple areas, national strategies should **identify and prioritize sectors** where deep tech can have the most immediate and scalable impact. This sectoral prioritization involves assessing existing industrial strengths, market demand, and comparative advantages to determine high-impact sectors for deep tech innovation.

For instance, countries with strong agriculture-driven economies may benefit from advanced agritech innovations, such as AI-powered climate forecasting, precision farming, and bioengineered crops. Those with growing energy demand may prioritize advanced battery storage, green hydrogen, or next-generation solar technologies. Investing in biotechnology and healthcare solutions can help address public health gaps, particularly in regions facing limited healthcare infrastructure or a high disease burden. By concentrating efforts on high-priority sectors, governments can ensure that policy interventions, funding mechanisms, and institutional support are effectively targeted—avoiding fragmentation and maximizing impact.

Beyond setting priorities, governments should also invest in **institutional capacity** to effectively support deep tech development. Establishing dedicated innovation agencies, strengthening technology transfer mechanisms, and fostering cross-sector collaboration can help bridge the gap between scientific research and commercialization. Public institutions also play a crucial role in creating an enabling environment by ensuring that policies are well-coordinated, responsive, and adaptable to the evolving needs of deep tech ecosystems.

Box 2: National Deep Tech Policy and Plans

India

The *National Deep Tech Startup Policy (NDTSP)* of India, which is awaiting approval at the time of this report, is designed as a comprehensive framework to nurture the deep tech startup ecosystem by addressing specific challenges and enhancing the overall environment for innovation. The executive summary of the NDTSP outlines its vision structured around four key pillars:

1. Securing India's Economic Future: The policy aims to solidify India's position in the global economy through advancements in deep tech.
2. Progressing Towards a Knowledge-Driven Economy: It emphasizes fostering an economy based on knowledge and innovation.
3. Bolstering National Capability and Sovereignty: Through the Atmanirbhar Bharat initiative, the policy seeks to enhance self-reliance and national capability.
4. Encouraging Ethical Innovation: The policy prioritizes the development of technologies and solutions that are ethical and beneficial to society.

The NDTSP identifies the need to support research, development, and innovation ecosystems, proposing an increase in gross expenditure on R&D. It aims to foster technology commercialization through partnerships between academic institutions, research labs, and industry, and to incentivize faculty members to engage in entrepreneurial activities. The policy also intends to create an Open Science and Data Sharing platform to facilitate collaboration. Further, the NDTSP highlights the importance of strengthening India's Intellectual Property Rights (IPR) regime, proposing measures such as a unified IP framework tailored for deep tech startups and enhanced global IP protections.

In terms of funding, the policy recognizes the unique financial needs of deep tech ventures, suggesting mechanisms to ease access to long-term capital, like the creation of a fund-of-funds dedicated to deep tech investments and the use of Technology Impact Bonds. To reduce startups' initial capital expenditures, the policy proposes providing access to shared infrastructure and resources. Regulations, standards, and certifications will be strategically developed to support emerging technologies, ensuring safety and compliance. Lastly, the NDTSP aims to build a robust human resource base by expanding skill enhancement grants, promoting diversity, and incentivizing investments in deep tech startups led by underrepresented groups.

This whole-of-ecosystem approach intends to create a synergized ecosystem that is conducive to the growth and sustainability of deep tech startups in India, enabling them to contribute significantly to the nation's economic and technological prowess.

Source:
Office of the Principal Scientific Adviser (PSA), Government of India. 2025. *National Deep Tech Startup Policy (NDTSP).*
https://www.psa.gov.in/deep-tech-policy

Thailand

Thailand is advancing its national agenda to become a leader in deep tech and innovation. The National Innovation Agency (NIA) has outlined a comprehensive strategy aimed at elevating Thailand's global innovation standing. This strategy includes fostering innovation-based enterprise capabilities, building human capacity in innovation, enhancing innovation infrastructure and accessibility, and transforming innovation systems to address global challenges. By 2025, the NIA aspires to have around 100 companies registered as deep tech companies, focusing on making Bangkok and Chiang Mai the primary tech cities of Thailand.

Additionally, the NIA's "*Deep-Tech Regionalisation*" program is designed to boost economic growth and create future job opportunities by supporting deep tech startups in regional areas. This initiative aims to cultivate 100 startups with intellectual property rights by 2023, drawing support from large corporations, conglomerates, and foreign venture capitalists. The program will work alongside universities and science parks nationwide.

Parallel to these efforts, the Thai government is developing a National Artificial Intelligence Action Plan to enhance the country's technological competitiveness. This plan focuses on nurturing AI talent, creating at least 13,500 skilled individuals annually, and establishing a central platform for AI services. The plan categorizes AI workforce skills into high, medium, and basic levels, aiming to improve national economic growth and the quality of life for Thais through increased employment and job creation in digital skills and AI from 2023 to 2027.

Sources:
The Nation. 2022. *NIA unveils ambitious plan to make Thailand among most innovative countries*.
https://www.nationthailand.com/in-focus/40016222
Bangkok Post. 2020. *NIA focuses on regional deep-tech startup plan*.
https://www.bangkokpost.com/business/general/2031107/nia-focuses-on-regional-deep-tech-startup-plan
OpenGov Asia. 2022. *Thailand to Develop AI Action Plan to Drive National Growth.*
https://opengovasia.com/2022/12/17/thailand-to-develop-ai-action-plan-to-drive-national-growth/

France

The *Deeptech Plan,* launched in 2019, is a comprehensive initiative aimed at establishing France as a major player in disruptive innovation on a global scale. With a budget of 3 billion euros by 2025, the plan is orchestrated by Bpifrance and supports the entire lifecycle of innovation—from laboratory to market, emphasizing the creation, growth, and support of deep tech startups.

Key objectives of the Deeptech Plan include:

- Creation of Startups: Stimulating the formation of 500 deep tech startups annually.
- Supporting Growth: Aiming to develop industrial leaders of tomorrow and establishing 50 new industrial sites each year by 2023, with an ambition to create 10 unicorns by 2025.
- Boosting Innovation Ecosystems: Encouraging innovation across different territories and sectors, enhancing the capacity of universities and other innovation actors to engage deeply with the opportunities presented by the plan.

Significant investments and initiatives under this plan have led to substantial growth in the number of deep tech startups. For example, Bpifrance has been involved directly or indirectly in 70% of the fundraisings within the sector since the plan's inception. Moreover, initiatives like the PhD competition and the Deep Tech Tour have been successful in mobilizing the academic and entrepreneurial communities, contributing to a vibrant ecosystem that supports innovation across various fields including healthcare and green technologies.

The plan also integrates with France 2030, providing a focused boost to industrial deep tech ventures, and aims to create a more robust infrastructure for emerging technologies and startups. This strategic alignment seeks to solidify France's future economic stability and drive its transformation into a knowledge-driven economy.

Sources:
Les Deeptech. 2025. *Créer et développer sa startup deeptech*. https://www.lesdeeptech.fr/
Bpifrance. 2023. *Les Deeptech*. https://evenements.bpifrance.fr/big-2023/en/content/les-deeptech

Policy Instruments to Support Deep Tech Growth

Developing a thriving deep tech ecosystem requires policy instruments that address funding gaps, de-risk early-stage investment, and facilitate the commercialization of cutting-edge technologies. Given the high capital intensity and long development cycles inherent to deep tech, governments can play a catalytic role in creating the right incentives for investment and innovation. A well-structured approach to public funding, government procurement, and IP protection can help bridge market failures and ensure that deep tech ventures receive the support they need to grow and scale.

R&D tax credits and sector-specific grants have proven to be effective tools for fostering deep tech growth. For example, Türkiye's Technology Development Zones (TDZs)[86], established under the Technology Development Zones Law, provide financial incentives such as tax exemptions, R&D grants, and infrastructure support to deep tech startups and research-driven enterprises. These zones serve as dedicated innovation hubs, fostering university-industry collaboration and accelerating the commercialization of advanced technologies in areas such as biotechnology and material science. Similarly, **phased co-investment models** have emerged as effective tools for supporting deep tech startups. The UK's British Patient Capital Fund[87], for instance, co-invests alongside private venture capital firms, ensuring that deep tech startups receive funding without relying solely on government grants. This model reduces investment risk while crowding in private sector capital, making it an effective strategy for scaling deep tech innovations.

While high-income economies often deploy large-scale investment funds and established venture capital networks, low- and middle-income countries face persistent challenges in mobilizing financing for deep tech ventures. Limited fiscal resources, higher investment risks, and competing national priorities make it difficult to replicate high-cost funding mechanisms seen in high-income economies. Instead, low- and middle-income countries could adopt adaptable, resource-efficient strategies that maximize impact while minimizing financial risk. One effective approach can be leveraging public-private partnerships (PPPs) to attract private capital while ensuring that deep tech aligns with national development priorities. Governments can create blended finance structures, where public funds de-risk early-stage investments, encouraging private investors to participate in deep tech sectors. (See the section of Investment and Funding)

Public sector procurement can serve as a driver of deep tech innovation, particularly in low- and middle-income countries where the private market for advanced technologies may still be nascent. In contrast to conventional approaches, which prioritize cost-effectiveness and proven solutions, public procurement for deep tech can benefit from being more adaptive and innovation-focused. By acting as an early adopter, governments can create a reliable initial market for deep tech startups, validating their innovations and reducing market entry risks. This not only stimulates

---

[86] ÖZBEKCPA. 2025. *Technology Development Zones (TDZs) Turkey*. https://ozbekcpa.com/technology-development-zones-in-turkey

[87] British Patient Capital. 2025. https://www.britishpatientcapital.co.uk/

commercialization but also ensures that deep tech solutions directly contribute to national development goals, such as agriculture modernization, clean energy access, and healthcare innovation.

Box 3: Public Procurement as a Catalyst for Deep Tech Innovation

Public procurement policies focused on engaging with deep tech solutions can play a leading role in promoting innovation, stimulating economic growth, and enhancing marketplace competitiveness. By acting as early adopters of new technologies, governments can provide market validation to startups, helping them to scale innovations from the developmental stage to commercial readiness.

European Union – EU-wide Public Procurement for Deep Tech:
The EU encourages member states to use public procurement to drive innovation by including deep tech solutions in public contracts. This policy not only improves the quality and efficiency of public services but also supports the development of new markets for innovative products. The EU's directive on public procurement promotes the inclusion of innovation partnerships within procurement contracts, allowing public authorities to call for tenders to solve specific problems without pre-empting the solution, thereby fostering innovation.

Canada – Build in Canada Innovation Program (BCIP):
The BCIP helps companies bridge the pre-commercialization gap by procuring and testing late-stage innovative goods and services within the federal government before they are taken to market. This program helps new technologies find their first real customer in the government, which can validate and potentially scale up the technology for broader commercial deployment.

Finland – Innovative Public Procurement:
Finland has implemented policies that foster innovation through public procurement, specifically targeting sectors such as clean technologies. The Finnish government supports pilot projects and partnerships with startups to integrate innovative solutions into public infrastructure, demonstrating a commitment to fostering a dynamic innovation ecosystem.

Sources:
European Commission. 2023. *Flagship 2: Enabling Deep Tech Innovation through Experimentation Spaces and Public Procurement.* https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda/new-european-innovation-agenda-roadmap/flagship-2-enabling-deep-tech-innovation-through-experimentation-spaces-and-public-procurement_en
Innovation, Science and Economic Development Canada. 2025. *Innovative Solutions Canada.* https://ised-isde.canada.ca/site/innovative-solutions-canada/en
Ministry of Economic Affairs and Employment of Finland. 2025. *Innovative Public Procurement.* https://tem.fi/en/innovative-public-procurement

While several high-income economies have leveraged innovation procurement programs to accelerate deep tech development (see Box 3), low-income countries often face challenges such as limited public budgets, weaker regulatory environments, and lower levels of technological readiness. To make government procurement a viable driver of deep tech growth, these policies can be adapted to fit local economic and institutional contexts. Introducing pilot procurement frameworks—in which startups engage in small-scale government projects prior to full deployment—allows for greater flexibility while mitigating financial and technical risks. Public-private partnerships can further strengthen procurement-driven deep tech adoption, particularly in economies where fiscal constraints limit large-scale public investment. Additionally, low- and middle-income countries can also co-finance deep tech procurement through partnerships with stakeholders such as private investors. Blended finance mechanisms—where governments provide partial funding while private investors co-finance procurement contracts—help reduce risk and attract external expertise and investment.

Governments play a central role in **balancing IP protection and knowledge diffusion** to encourage innovation. An overly restrictive IP regime can stifle collaboration and slow technological adoption, while weak protection can discourage investment and lead to IP theft. Governments in low- and middle-income economies can adopt a flexible approach by offering tiered patenting fees, fast-track procedures for high-impact technologies, and incentives for companies that commercialize university research. For example, the SG IP Fast Track program[88], launched by Singapore's Intellectual Property Office (IPOS) in May 2020, is designed to accelerate patent applications across all technology sectors. Initially focused on patents, the program expanded in September 2020 to include trademarks and registered designs, providing a comprehensive IP acceleration service. Rebranded as SG IP FAST, this initiative helps innovators and enterprises build and manage their IP portfolios more effectively, facilitating quicker commercialization of their creations.

Technology transfer is another key area where governments can play a pivotal role in driving deep tech commercialization. Research institutions and universities are often the birthplace of deep tech innovations, but without clear pathways for transferring these technologies to industry, many breakthroughs fail to translate into market-ready solutions. Governments can strengthen technology transfer mechanisms by incentivizing industry-academia collaboration, implementing technology transfer programs, establishing dedicated technology licensing offices, and ensuring that publicly funded research is strategically aligned with national development priorities.

[88] Intellectual Property Office of Singapore. 2025. *Acceleration Programmes.* https://www.ipos.gov.sg/about-ip/patents/how-to-register/acceleration-programmes

Testbeds and Regulatory Sandboxes

As deep tech continues to push the boundaries of scientific discovery and technological advancement, governments should ensure that regulatory frameworks evolve alongside these innovations. Traditional regulatory models, which were designed for established industries, often struggle to accommodate the disruptive, cross-sectoral nature of deep tech. Without a proactive and adaptive regulatory environment, startups face delays in commercialization, investors encounter heightened risks, and breakthrough technologies struggle to gain market entry. To address these challenges, governments can leverage testbeds, regulatory sandboxes, and adaptive policies to support deep tech innovation while effectively managing risks.

Testbeds provide controlled, real-world environments where deep tech solutions can be developed, tested, and refined before full-scale deployment. They allow innovators to validate their technologies in collaboration with policymakers, industry partners, research institutions, and investors, accelerating the path from research to commercialization while reducing the risks associated with scaling complex innovations. Testbeds are designed for technical experimentation and validation, helping innovators fine-tune performance, assess feasibility, and address operational challenges before products or solutions enter the market. They often focus on infrastructure-heavy sectors such as renewable energy and advanced manufacturing, where real-world testing is essential for ensuring functionality, safety, and scalability.

Governments can be instrumental in establishing and managing testbeds, ensuring that they are aligned with national development priorities, industry needs, and regulatory frameworks. Beyond providing physical infrastructure and financial support, governments can facilitate cross-sector collaboration, create policy incentives for industry participation, and integrate testbed findings into broader innovation strategies. In low- and middle-income countries, where deep tech startups often struggle with limited funding and market access, well-designed testbeds can bridge gaps by providing access to resources, regulatory clarity, and commercialization pathways.

In addition to supporting technology validation, testbeds can also serve as policy laboratories, enabling governments to develop, refine, and test regulations for emerging technologies in a controlled setting. Many deep tech sectors, such as quantum computing, synthetic biology, AI-driven automation, and advanced materials, evolve faster than regulatory frameworks can adapt. Without proactive policy experimentation, outdated regulations may slow innovation or create uncertainty for investors. By closely monitoring testbed results, governments can gain early insights into the risks, opportunities, and societal implications of emerging technologies, ensuring that policy frameworks remain agile, evidence-based, and conducive to sustainable growth.

Regulatory sandboxes, on the other hand, provide a controlled regulatory environment where deep tech startups can trial and validate their innovations under modified or relaxed regulatory conditions before they are subjected to the full spectrum of compliance requirements. Unlike testbeds, which focus on technical development and operational feasibility, sandboxes are designed to test regulatory frameworks, allowing policymakers to assess how emerging technologies interact with existing policies and regulations. These temporary regulatory waivers help governments identify potential policy gaps, risk factors, and necessary adjustments to ensure that regulations keep pace with innovation. Sandboxes are particularly important for technologies in highly regulated sectors such as fintech, privacy-enhancing technologies (PET), and digital health, where rigid compliance requirements can otherwise hinder early-stage experimentation.

Box 4: Regulatory Sandboxes

A regulatory sandbox is a framework set up by regulatory bodies that allows startups and other innovators to conduct live experiments in a controlled environment under a regulator's supervision. The primary aim is to test new products, services, or business models without immediately incurring all the normal regulatory consequences. This setup is especially beneficial in industries that are heavily regulated, such as finance, healthcare, and telecommunications. A regulatory sandbox helps identify potential regulatory issues and minimizes risk due to its limited scale testing. Sandboxes may lead to changes to existing regulations or policies, new regulations, regulatory approval or licensing of the innovation or product, or a cease-and-desist if the test fails.

In 2023, the Brazilian National Data Protection Authority (ANPD) announced a regulatory sandbox pilot program on AI and personal data protection, in collaboration with the Development Bank of Latin America and the Caribbean (CAF). This sandbox serves as a controlled testing environment for collaborative experimentation between regulators, technology companies, academics, and civil society organizations. Its goal is to test AI innovations within a secure regulatory framework, fostering innovation, promoting algorithmic transparency, and ensuring compliance with Brazil's Data Protection Law (LGPD). The pilot program, expected to last 18 to 24 months, is currently evaluating 71 contributions from diverse stakeholders to shape its structure, with 66 from Brazil and 5 from abroad.

Singapore's Infocomm Media Development Authority (IMDA) launched a Privacy-Enhancing Technology (PET) sandbox in 2022, demonstrating the government's commitment to data protection while cementing its position as a regional technology hub. PETs refer to tools and processes that enable the sharing of useful insights extracted from data without disclosing the actual data. PETs could help address a company's data security concerns when sharing information and allow more opportunities for businesses to collaborate and develop useful AI applications. While nascent, PETs occupy a sweet spot by allowing the extraction and sharing of insights while ensuring the security and confidentiality of personal data. The sandbox was thus launched with the intent of encouraging more widespread adoption of these useful technologies to foster trust in the digital ecosystem.

Sources:
Autoridade Nacional de Proteção de Dados (ANPD). 2023. *Consulta à Sociedade: Sandbox Regulatório de Inteligência Artificial e Proteção de Dados no Brasil.* https://www.gov.br/anpd/pt-br/documentos-e-publicacoes/anpd-sandbox-regulatorio-consulta-bilingue.pdf
Infocomm Media Development Authority (IMDA). 2024. *Privacy Enhancing Technology Sandboxes.* https://www.imda.gov.sg/how-we-can-help/data-innovation/privacy-enhancing-technology-sandboxes

Research and Talent: Strengthening Knowledge and Skills

Deep tech ventures demand a highly skilled workforce with advanced technical expertise in fields such as aerospace, advanced computing technologies, and bioscience, making the role of research institutions, universities, and industry collaborations essential for success. For many low- and middle-income countries, building a strong research and talent ecosystem for deep tech presents several challenges. Limited public funding for R&D, weak university-industry linkages, and intense global competition for top talent often constrain deep tech growth. Without sustained investment in higher education, research infrastructure, and knowledge transfer mechanisms, many promising innovations may fail to transition from the laboratory to commercial applications. Additionally, the migration of skilled professionals to economies with higher income levels further exacerbates talent shortages, limiting the ability of low-income nations to establish globally competitive deep tech industries.

Strengthening Knowledge Institutions and Deep Tech R&D

Governments around the world have launched deep tech R&D initiatives that focus on key sectors such as climate tech, quantum computing, and advanced materials. To maximize impact, policymakers could prioritize applied research that addresses development challenges. A proven strategy is the establishment of mission-driven research programs that concentrate on high-impact domains. These programs not only lead to valuable IP but also create clear commercialization pathways, driving economic growth and industrial development. One example is India's National Quantum Mission[89], which seeks to strengthen the country's capabilities in quantum computing, communication, sensing, and materials. As part of this initiative, four Thematic Hubs (T-Hubs) have been established at relevant institutions, including the Indian Institute of Science (IISc) Bengaluru and Indian Institutes of Technology (IITs). These hubs serve as centers for research and innovation, fostering collaboration among academia, industry, and government to accelerate advancements in quantum technology and its applications.

Governments can also set up national research centers that serve as platforms for interdisciplinary research, collaboration, and innovation. An example is the Brazilian Center for Research in Energy and Materials (CNPEM), a non-profit institution funded by the Brazilian Ministry of Science, Technology, and Innovations (MCTI)[90]. CNPEM hosts four national laboratories specializing in key areas of deep tech research. The Brazilian Synchrotron Light Laboratory (LNLS) advances materials science, while the Brazilian Biosciences National Laboratory (LNBio) drives biotechnology and pharmaceutical innovation. The Brazilian Nanotechnology National Laboratory (LNNano) focuses on nanoscience, and the Brazilian Biorenewables National Laboratory (LNBR) develops sustainable bioenergy solutions. Such centers not only drive scientific advancements but also provide critical infrastructure for public-private partnerships and technology transfer to industry.

[89] Choucair. 2024. *India's National Quantum Mission Launches Four Thematic Hubs to Encourage Development in Quantum Technology and Innovation*. https://thequantuminsider.com/2024/10/02/indias-national-quantum-mission-launches-four-thematic-hubs-to-encourage-development-in-quantum-technology-and-innovation/
[90] LNBR. 2025. *Overview*. https://lnbr.cnpem.br/overview/

Universities and research centers are key drivers of deep tech research, producing scientific discoveries that lay the foundation for technological breakthroughs and push the frontiers of innovation. Many groundbreaking advances—such as those in new materials, synthetic biology, and photonics—were first developed in academic institutions before being commercialized. Beyond conducting fundamental research, universities increasingly serve as hubs for applied R&D, where academic teams collaborate with industry to solve real-world challenges. Joint research programs, university-affiliated innovation hubs, and interdisciplinary research clusters enable scientists and engineers to work on mission-driven projects that support strategic national priorities. Many universities have also developed sector-specific research centers and labs to concentrate expertise and resources in high-impact fields.

Universities also contribute to training the next generation of deep tech scientists, engineers, and entrepreneurs. Given the highly specialized nature of deep tech, higher education institutions can facilitate programs that provide students and researchers with both theoretical knowledge and hands-on experience in fields such as synthetic biology, photonics, robotics, and engineering innovations. Moreover, to address the global competition for talent, some universities have introduced talent retention initiatives, including industry-academia collaborations, competitive funding programs, and clear career pathways for scientists and engineers. Providing research fellowships, funded PhD programs, and industry-sponsored scholarships can help retain high-potential talent and ensure that deep tech expertise remains within the country's innovation ecosystem.

Another relevant aspect is promoting industry engagement in deep tech education. Universities can establish joint training programs, co-develop curricula with industry partners, and provide students with access to advanced research facilities. Moreover, universities are increasingly supporting deep tech entrepreneurship, helping scientists and engineers translate research into viable commercial ventures. Most deep tech innovations require long development cycles and specialized infrastructure, making universities ideal launchpads for deep tech ventures. Many successful ventures originate from university spinouts, where researchers commercialize their innovations through university-backed technology transfer offices and dedicated venture building programs.

An example of this approach is the NUS Graduate Research Innovation Programme (GRIP) at the National University of Singapore (NUS)[91], which provides scientists, engineers, and researchers with training, mentorship, and funding to build deep tech startups. The program supports early-stage deep tech entrepreneurs in commercializing university-based research, helping them navigate business development, IP strategy, and investor engagement. By offering a structured pathway from research to commercialization, GRIP serves as a model for how universities can actively cultivate deep tech entrepreneurship, ensuring that scientific advancements lead to industry transformation and economic impact.

[91] National University of Singapore (NUS). 2024. *Graduate Research Innovation Programme (GRIP)*. https://nus.edu.sg/grip/

Box 5: Converting PhD Students into Deep Tech Startup Founders

Transforming PhD students into deep tech startup founders is an innovative approach that leverages their specialized knowledge and research expertise to build high-impact ventures. By transitioning from academia to entrepreneurship, these students can convert their cutting-edge research into scalable, market-ready solutions. Programs that foster this transition aim to bridge the gap between research and commercialization by providing tailored support, entrepreneurial training, and access to vital resources. The goal is to equip PhD students not only with scientific expertise but also with the business acumen necessary to launch and grow deep tech startups.

India – PhD-DRIVE

Similarly, BITS Pilani, a university in India, has introduced an innovative PhD program designed to bridge the gap between academic research and entrepreneurial venture creation in the deep tech sector. Known as PhD-DRIVE (Deep-tech Research, Innovation, Value generation & Entrepreneurship), this initiative aims to foster the development of deep tech startups that address societal and business challenges.

The PhD-DRIVE program is tailored for PhD students with a clear focus on creating startups based on their innovative research. It uniquely combines rigorous academic research with practical entrepreneurial training, providing a structured pathway for students to transition into founders. The program includes comprehensive courses in entrepreneurship, opportunities for incubation, and direct links to funding, which are essential for building and scaling a startup.

Central to the program's strategy is its integration within the vibrant ecosystem of BITS Pilani, which includes strong alumni networks and collaborations with industry and government. This ecosystem not only supports the students with resources and mentorship but also enhances their opportunities to secure further investment and partnerships necessary for their growth. Moreover, the PhD-DRIVE program is ambitious in its scope and aims to incubate 100 startups by 2030, demonstrating BITS Pilani's commitment to fostering innovation that can make a substantial impact on both the local and global stage.

Source:
Birla Institute of Technology and Science (BITS) Pilani. 2025. *PhD-DRIVE: Information for prospective candidates.*
https://web.bits-pilani.ac.in/PhDDrive/info-phd-drive.aspx

UK – Conception X

Conception X is a UK-based venture program that supports the development of deep tech entrepreneurship within academia. The initiative adopts a sector-agnostic approach, encouraging innovation across a broad spectrum of deep tech fields, including advanced AI, quantum computing, robotics, and renewable energy. Targeted at STEM PhD students, the program aims to bridge academic research and commercialization by equipping participants with the skills and resources needed to explore startup ventures with long-term potential.

The program, which runs virtually over nine months, allows PhD students to maintain their academic pursuits while also gaining entrepreneurial skills. Conception X provides one-to-one business and technology coaching, deep tech entrepreneurial training, and access to a network of experts from industry, investment, and academia. Additionally, it facilitates eligibility for innovation grants, awards, and venture capital funding, which are crucial for the early-stage growth of any startup.

One of the standout features of Conception X is its commitment to taking no equity from the startups, enabling founders to retain full control over their ventures while receiving support and mentorship. The effectiveness of Conception X is reflected in its statistics: as of 2024, over 400 students and 360 PhD teams from more than 50 universities have participated, collectively raising over £71 million. This reflects the program's ability to bridge the gap between deep tech research and the commercial market, creating a nurturing environment for the transition from academic projects to viable, scalable ventures.

Source:
Conception X. 2025. *We turn today's PhD research into tomorrow's deeptech startups.* https://www.conceptionx.org/

Investment and Funding: Mobilizing Capital for Growth

Deep tech investment has experienced significant growth over the past decade, reflecting increased interest in cutting-edge innovations. Research highlights that deep tech's share of global venture capital funding has doubled in the past ten years, accounting for approximately 20% of total investments in 2023[92]. In 2023, the United States attracted nearly half of all global deep tech investment, while Europe accounted for 20%. In Africa, deep tech startups secured one-third of all startup funding on the continent in 2023[93], underscoring the sector's increasing importance in driving technological development and economic growth.

Despite growing investor interest, deep tech startups continue to face funding barriers. Studies indicate that deep tech startups often require 35% more time and 48% more capital than traditional startups to achieve comparable revenue levels of $5 million or more[94]. Insights from stakeholder interviews and findings from the regional snapshot section highlight limited investment access as a persistent barrier. Unlike other startups that may achieve rapid scaling with relatively low capital, deep tech ventures demand substantial upfront investment in R&D, prototyping, testing, and regulatory approvals before reaching market viability. These long development cycles mean that deep tech startups often take years to commercialize, requiring investors who are willing to adopt a patient and long-term approach.

A challenge is the high level of risk and uncertainty associated with deep tech investments. Many deep tech innovations are scientifically complex, unproven at scale, and require significant technical validation before they can be deployed in real-world applications. This high-risk profile—combined with long return timelines—makes deep tech less attractive to traditional VC firms that typically seek faster exits and lower-risk investments. The disconnection between scientific advancements and investor expectations makes deep tech less attractive to traditional VC firms, which typically seek faster exits and lower-risk investments.

Another challenge is the structural gap in funding mechanisms. While VC remains the dominant funding source, many deep tech startups struggle to secure early-stage financing, particularly for capital-intensive projects like space tech and advanced computing. Non-dilutive funding sources, such as government grants, can play a key role in supporting early innovation, but accessing these funds is often complex and highly competitive, as some stakeholders highlighted in the interviews. The grant application process can involve administrative burdens, rigid milestone-based

---

[92] BCG. 2023. *An Investor's Guide to Deep Tech.* https://www.bcg.com/publications/2023/deep-tech-investing
[93] OpenStartup. 2023. *Mapping the African Deeptech Landscape.* https://drive.google.com/file/d/1s2YSbtlhXFWCRNhR3zNFTD7mwJJ80M0z/view
[94] Dealroom. 2023. *The European Deep Tech Report 2023.* https://dealroom.co/uploaded/2023/09/The-European-Deep-Tech-Report-2023.pdf

disbursements, and strict reporting requirements, which can divert valuable resources away from core research and innovation. Additionally, the uncertainty of grant approvals adds further risk and delays to startup progress.

These challenges can be more complex in countries where deep tech investment faces systemic barriers to accessing private capital. While mature ecosystems often benefit from established VC networks, corporate investors, and angel funding to support high-risk innovation, many emerging markets are still in the early stages of developing dedicated investment channels for deep tech startups. This gap is exacerbated by limited local investor expertise in deep tech sectors, higher perceived investment risks, and insufficient capital allocation to high-tech ventures. As a result, early-stage deep tech startups in these economies often struggle to secure financing, forcing them to rely on government funding, international grants, or foreign investments, which may not always be sustainable or aligned with local priorities.

A well-functioning deep tech investment ecosystem requires a diverse mix of funding sources that align with the capital-intensive and long commercialization cycles of deep tech ventures. While public sector funding plays a crucial role in the early stages, ensuring a continuous capital flow through a combination of private investment, strategic partnerships, and alternative financing mechanisms is essential for long-term growth. VC remains a key source, but deep tech's high-risk profile and longer return timelines often require specialized investors with patient capital. This has led to the rise of corporate venture capital (CVC) and industry-driven funds, where corporations invest in startups aligned with their strategic priorities, providing not just capital but also sector expertise and market access. However, reliance on CVC funding can sometimes limit deep tech startups' flexibility, as investments may come with conditions tied to corporate interests.

In response to these constraints, hybrid funding models are becoming more relevant. Joint development agreements (JDAs) and strategic co-investments can enable deep tech startups to access funding while collaborating on technology validation and commercialization with established players. Similarly, revenue-based financing and licensing models offer alternatives that allow startups to generate cash flow without diluting equity. These approaches, alongside the expansion of mission-driven funds and sovereign wealth investments, can help bridge the deep tech financing gap by offering tailored solutions that accommodate the sector's unique investment needs. As the funding landscape evolves, creating structured pathways that connect early-stage grants with scalable private investments will be important to foster deep tech innovation at a global level.

Entrepreneurship and Venture Building: Scaling Deep Tech Innovations

Deep tech entrepreneurship requires more than just funding—it also depends on structured venture-building mechanisms that bridge the gap between scientific discovery and commercialization. Venture builders—including incubators, accelerators, venture studios, and corporate innovation programs—can be instrumental in de-risking early-stage ventures by providing entrepreneurs with technical expertise, business development support, and market access. These structures help deep tech startups refine technologies, secure pilot opportunities, and develop commercialization strategies that align with industry needs.

Universities and research institutions support deep tech entrepreneurship by establishing dedicated venture-building services, spinout programs, and translational research initiatives. These efforts provide researchers with mentorship, funding, and business development expertise to navigate the commercialization process effectively. For example, King Abdullah University of Science and Technology (KAUST) in Saudi Arabia has launched the Destination Deep Tech program, which connects high-potential deep tech startups with KAUST's research ecosystem, industry partners, and investors. The initiative provides startups with tailored acceleration services, funding opportunities, and access to specialized R&D facilities, fostering their transition from research labs to market-ready enterprises[95]. Furthermore, by embedding entrepreneurial training into graduate and postdoctoral programs, universities can support scientists and engineers in applying their research to real-world challenges, thus fostering the creation of deep tech startups. (see Box 5)

Beyond research institutions, large corporations also contribute to deep tech entrepreneurship by validating new technologies and facilitating commercialization. With access to capital, infrastructure, and industry networks, corporations can help scale deep tech ventures, bridging the gap between innovation and market adoption. However, their involvement can be shaped by competing priorities, including shareholder expectations, financial performance targets, and strategic alignment. Many companies have established corporate venture arms, deep tech accelerators, and innovation labs to incubate disruptive technologies, co-develop solutions with startups, and integrate new technologies into their business models. Corporate-backed deep tech entrepreneurship can be particularly valuable in highly regulated or capital-intensive sectors, such as pharmaceuticals, energy, and semiconductors, where startups may struggle to navigate regulatory approvals, industrial scaling, and supply chain integration. By partnering with deep tech startups through venture-building programs, strategic investments, and pilot collaborations, corporations can help de-risk early-stage innovations while gaining access to emerging breakthroughs that align with their long-term R&D strategies.

[95] KAUST. 2025. *Destination Deep Tech*. https://destinationdeeptech.kaust.edu.sa/

Other venture builders—including accelerators, incubators, and venture studios—also serve as important catalysts for deep tech entrepreneurship. They often co-develop startups from inception, providing not only funding but also hands-on support in areas such as IP strategy, regulatory compliance, and industrial prototyping. These institutions also connect startups with corporate partners, government grants, and global investors, creating a collaborative ecosystem that supports innovations with high societal impact. Successful deep tech venture builders emphasize cross-disciplinary collaboration, bringing together experts in science, engineering, business development, and investment to accelerate the journey from laboratory discovery to market-ready products.

Singapore, for example, has developed a dynamic venture-building ecosystem that supports deep tech startups through strong public-private collaboration, well-structured accelerators, and dedicated funding mechanisms. As discussed in UNDP's Deep Tech Blog Series[96], the country's approach integrates corporate venture programs, government-backed initiatives, and translational research platforms to support the scale-up of early-stage deep tech ventures. Similarly, regional networks such as the Deep Tech Alliance, a European network of incubators and accelerators, operate across multiple countries to connect deep tech entrepreneurs with investors, industry partners, and researchers, fostering cross-border collaboration and market expansion.

Venture-building models that rely on patient capital and long-term R&D investment may not align with the financial realities of resource-constrained ecosystems. Instead, hybrid models that leverage public funding, impact investment, and private sector engagement have proven to be more viable alternatives. As highlighted in the section of regional snapshots, several low- and middle-income countries are exploring blended finance initiatives, innovation challenge funds, and government-backed co-investment programs to mitigate investment risks in deep tech. Additionally, fostering localized deep tech ecosystems—such as sector-specific innovation hubs focused on agritech, medtech, or climate tech—can provide startups with targeted support, including access to shared R&D facilities, regulatory guidance, and capacity-building programs.

[96] Ye, W & So, J. 2024. *Deep Tech Series Vol. 5: Science is Not Fiction - Insights from Singapore's Deep Tech Venture Building*. https://www.undp.org/policy-centre/singapore/blog/deep-tech-series-vol-5-science-not-fiction-insights-singapores-deep-tech-venture-building

Collaboration Models: Fostering Synergies Across Stakeholders

Effective collaboration is essential for a thriving deep tech ecosystem, where the complexity of scientific advancements and interdisciplinary innovation requires strong cross-sector and cross-border partnerships. These collaborations can operate at multiple levels—ecosystem-to-ecosystem partnerships facilitate knowledge exchange across borders, corporate-startup engagements leverage agility and scale to drive commercialization, and academic-industry collaborations ensure that scientific research translates into real-world applications. Together, these partnership models create a dynamic innovation environment where deep tech can mature, scale, and generate impact.

Ecosystem-to-Ecosystem Collaboration

Deep tech innovations flourish in well-connected ecosystems, where institutions, countries, and regions leverage their strengths to drive progress collectively. For low- and middle-income countries, independently building a mature deep tech ecosystem can be time- and resource-intensive. A more effective strategy is to collaborate with established ecosystems, gaining access to expertise, infrastructure, and investment networks. These partnerships accelerate local innovation by facilitating knowledge exchange, joint research, and technology transfer while connecting emerging ecosystems to global talent and investors.

Rather than reinventing the wheel, ecosystem-to-ecosystem collaborations offer a scalable pathway for growth, enabling emerging hubs to learn from proven models and established regulatory frameworks. Beyond individual ecosystem development, these partnerships contribute to the global deep tech landscape by addressing shared challenges such as capital access, regulatory barriers, and talent shortages. Mechanisms like research collaborations, joint funding initiatives, startup exchange programs, and cross-border accelerators help de-risk investments, fast-track commercialization, and scale high-impact technologies worldwide.

Development-Oriented Testbeds for Deep Tech Collaboration

Testbeds provide real-world environments for deep tech startups to develop, test, and refine their innovations, bridging the gap between R&D and market deployment. By enabling startups to trial their technologies under controlled but practical conditions, testbeds help de-risk early-stage innovations, generate evidence for scalability, and facilitate regulatory adaptation. For emerging deep tech ecosystems, testbeds provide an experimental setting that allows stakeholders—including governments, corporates, investors, research institutions, and end users—to co-develop, validate, and scale high-impact technologies.

Many countries face pressing challenges in agriculture, clean energy, water management, and public health, where existing solutions remain inadequate or inaccessible. By establishing themselves as testbed hubs, countries can invite deep tech innovators to pilot solutions tailored to local socio-economic and environmental conditions. This approach accelerates technology transfer, attracts investment, and generates localized data, ensuring that innovations are not only tested but also adapted to the realities of emerging markets, increasing their long-term viability and impact.

Several countries have already embraced testbed-driven collaboration through innovation zones, living labs, and public-private initiatives to attract global startups and investors. As highlighted in the section of regional snapshots, some nations have partnered with international climate tech startups to test renewable energy solutions in off-grid rural areas, while others have collaborated with biotech firms to pilot affordable diagnostics and medical devices in underserved communities. These partnerships create a win-win scenario—deep tech startups gain real-world validation and market access, while host countries leverage cutting-edge innovations to address development challenges more effectively. Recognizing the transformative potential of testbeds, UNDP Global Centre for Technology, Innovation and Sustainable Development in Singapore is developing a People-Centric Testbed Handbook to help countries design, implement, and scale testbed initiatives that are inclusive, development-focused, and aligned with national priorities.

Cross-Sector Collaboration: Bridging Industries for Deep Tech Innovation

Cross-sector collaboration can be a driver of deep tech innovation, bringing together expertise, technologies, and resources from diverse industries to tackle complex challenges that no single sector can address alone. These partnerships allow for the integration of advanced technologies, such as quantum computing, biotechnology, and nanotechnology, into new applications that can significantly impact fields like healthcare, energy, and manufacturing. By bridging the gap between different industries, cross-sector collaborations facilitate the development of novel solutions, leveraging the complementary strengths of each partner to push the boundaries of what is technologically possible.

Cross-sector collaborations can be especially effective in deep tech, as they bring together expertise from multiple disciplines to tackle complex scientific and engineering challenges. For example, the intersection of quantum computing and biotechnology can open new frontiers in drug discovery and personalized medicine. Quantum computing's ability to process large volumes of complex data at high speeds can accelerate the modeling of molecular structures, enabling researchers to design and test new drugs more efficiently than traditional methods. Similarly, the integration of advanced AI and materials science can transform next-generation energy storage solutions. AI-driven simulations accelerate the discovery of advanced battery materials with higher energy density and longer lifespans, optimizing performance for electric vehicles and renewable energy grids. (see Table 1)

By pooling resources and aligning strategic goals, cross-sector collaborations can not only enhance technological breakthroughs but also reduce risks, accelerate commercialization, and expand the scalability of deep tech solutions. These partnerships can foster a deeper understanding of how emerging technologies can be applied across industries, creating innovations that deliver tangible development impacts. However, cross-sector collaborations also face several challenges. Differences in organizational priorities, regulatory frameworks, and risk tolerance can create barriers to effective cooperation. Misalignment in incentives between industry, academia, and government stakeholders may slow down decision-making and hinder progress. Additionally, IP rights and data-sharing concerns can further complicate partnerships. Ensuring clear governance structures, fostering trust among partners, and developing flexible collaboration models will be essential in overcoming these barriers and maximizing the benefits of cross-sector innovation.

Corporate-Startup Collaboration

As highlighted in previous sections, corporate-startup collaboration can be an enabler within the deep tech ecosystem, allowing large corporations and nimble startups to leverage each other's strengths to drive innovation and scale technologies. These collaborations can take several forms. One approach involves joint R&D and co-development agreements, where corporations partner with startups to develop and refine deep tech solutions, sharing research facilities and technical expertise.

Additionally, corporations can engage in pilot programs and procurement contracts, acting as early adopters and testbeds for deep tech solutions, allowing startups to validate their technologies through real-world applications. Finally, manufacturing and supply chain integration offers deep tech startups access to large-scale production capabilities, specialized manufacturing expertise, and global distribution networks—critical for startups that often lack the industrial-scale capabilities needed to bring their solutions to market.

These collaboration models can be relevant in low- and middle-income countries, where many global technology firms have established R&D centers, innovation hubs, and local business operations. These companies can leverage their presence in emerging markets to support deep tech startups working on solutions tailored to local challenges, such as climate adaptation, smart agriculture, renewable energy, and digital health. By partnering with local startups, multinational firms not only gain access to untapped talent and innovation but also contribute to ecosystem growth, skills development, and technology diffusion.

While corporate-startup collaboration offers many advantages, several challenges can limit its effectiveness. Differences in organizational culture and operational speed can create friction, as large corporations often have structured processes and lengthy approval cycles, whereas startups operate with agility and rapid innovation. Additionally, power imbalances may put startups at a disadvantage when negotiating IP rights, revenue-sharing models, or strategic direction, potentially leading to a loss of control over their innovations. Overcoming these challenges requires clear agreements, transparent communication, and structured collaboration frameworks to ensure that both corporations and startups derive mutual benefits while advancing deep tech innovation.

Collaboration between Academia and Industry

As emphasized throughout this report, deep tech innovation relies on strong linkages between research institutions and industry players. While universities and research institutions generate scientific and engineering discoveries, translating these innovations into real-world solutions requires close engagement with industry. Beyond traditional research partnerships, more integrated models—such as industrial PhD programs, co-designed curricula, and joint talent development initiatives—are emerging as effective ways to align academic research with industry needs. These initiatives not only equip researchers with industry-relevant skills but also ensure that companies can tap into cutting-edge academic knowledge, fostering a pipeline of talent capable of driving deep tech innovation.

As highlighted in in-depth interviews with stakeholders, a key mechanism for strengthening academia-industry collaboration is the co-development of educational programs tailored to industry demands. Universities are increasingly partnering with industrial players to design specialized deep tech curricula, ensuring that graduates are equipped with the skills required for emerging fields such as quantum computing, synthetic biology, and advanced manufacturing. These programs, often co-taught by industry professionals, provide students with hands-on exposure to real-world challenges, bridging the disconnect between academic theory and industrial practice. In addition, companies can benefit by helping to shape future talent pools, reducing skill gaps, and accelerating workforce readiness in deep tech sectors.

Beyond talent development, industry-integrated research initiatives are fostering deeper collaboration between academic institutions and corporations. Industrial PhD programs, where doctoral candidates split their time between university research and corporate R&D, allow for the direct application of academic discoveries to industry challenges. Similarly, joint research centers and corporate labs embedded within universities create environments where researchers and industry experts collaborate closely on high-impact projects. These partnerships ensure that deep tech research remains both scientifically ambitious and commercially viable, reducing the barriers to technology adoption.

Despite the promise of academia-industry collaboration, several challenges persist. Differences in research priorities and timelines often create misalignment, as academic institutions may focus on long-term, exploratory research, whereas industry partners may prioritize market-driven solutions with shorter development cycles. IP ownership is another common issue, with universities seeking to retain rights to their discoveries while corporations aim for exclusive access to innovations. Additionally, slow decision-making processes in some academic institutions can pose barriers to efficient collaboration, making it difficult to keep pace with industry needs.

To maximize the impact of academia-industry partnerships, clear collaboration frameworks, well-defined IP agreements, and effective communication channels are essential. Universities can enhance engagement with industry by establishing dedicated innovation hubs, industry liaison offices, and structured internship programs that integrate students and researchers into corporate R&D initiatives. By fostering a culture of open innovation and strategic alignment, academia and industry can work together to drive the development and commercialization of deep tech solutions that address global challenges.

Open Science for Collaboration

Open science can transform how deep tech innovation is developed, shared, and commercialized by promoting transparency, accessibility, and collaboration across disciplines and sectors. Unlike traditional, proprietary research models where knowledge is confined within institutional or corporate silos, open science encourages the free exchange of data, methodologies, and findings. This approach can accelerate discovery, reduce duplication of efforts, and enable a wider range of stakeholders, including policymakers, startups, universities, and corporations, to contribute to and benefit from scientific advancements. This is particularly critical in deep tech fields such as space tech, quantum computing, and synthetic biology, where interdisciplinary collaboration and access to shared knowledge can accelerate innovation cycles.

One of the key enablers of open science is the rise of open-access research platforms and collaborative repositories. Initiatives such as the European Open Science Cloud (EOSC)[97] and the U.S. National Institutes of Health (NIH) Open Data initiative[98] provide researchers with access to vast datasets, high-performance computing resources, and shared infrastructure. These platforms allow scientists to build upon existing research, accelerating breakthroughs in fields like drug discovery, climate modeling, and advanced materials. Additionally, open-source software and hardware lower the barriers for deep tech startups and researchers to develop and refine innovative solutions. UNESCO's Recommendation on Open Science[99] provides an international framework to guide policy and practice in the field.

However, the transition to open science is not without challenges. Concerns over IP rights, data security, and misuse of research findings remain significant barriers. While some researchers and institutions worry about losing competitive advantages, companies may be hesitant to engage in open science due to commercial sensitivities. Additionally, disparities in infrastructure and digital access can limit the participation of researchers from under-resourced institutions. To address these challenges, structured open innovation models, public-private partnerships, and clear guidelines on data governance and attribution are necessary. When implemented effectively, open science can act as a catalyst for global deep tech collaboration, fostering innovation that is inclusive, scalable, and impactful.

---

[97] European Commission. 2024. *European Open Science Cloud (EOSC).* https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/open-science/european-open-science-cloud-eosc_en
[98] National Institutes of Health (NIH). 2025. *NIH Data Sharing Policies.* https://sharing.nih.gov/
[99] UNESCO. 2023. *UNESCO Recommendation on Open Science*. https://www.unesco.org/en/open-science/about?hub=686

Looking to the Future

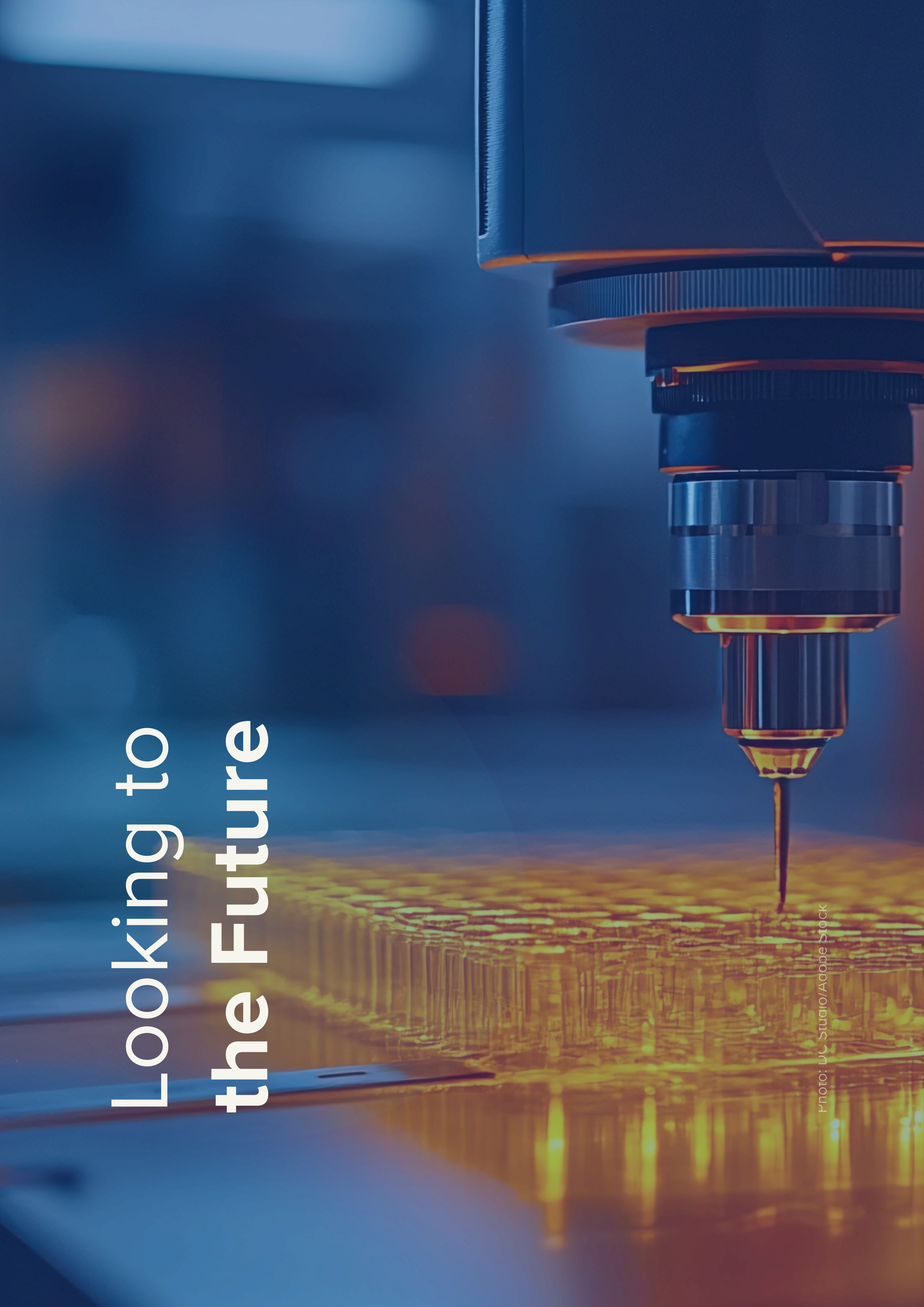


Photo: DC Studio/Adobe Stock

VII. Looking to the Future

Deep tech is increasingly recognized as a catalyst for sustainable and inclusive development across the globe. Looking ahead, many countries are expected to further invest in deep tech ecosystems to tackle complex socio-economic and environmental challenges. Insights from diverse regional experiences underscore the value of a collaborative, whole-of-ecosystem approach—one that harnesses the complementary strengths of governments, the private sector, research institutions, and international partners.

Fostering resilient deep tech ecosystems requires a holistic approach—one that brings together enabling policies, targeted funding instruments, adaptive regulatory frameworks, and supportive infrastructure to create conditions conducive to sustained innovation. To fully harness the potential of deep tech, policymakers should prioritize foundational elements such as digital infrastructure, human capital development, and enabling regulatory frameworks. Strategic investments in these areas can strengthen national resilience, attract international collaboration, and support sustained innovation and economic growth.

International collaboration and cross-border partnerships are expected to play an increasingly important role in facilitating knowledge exchange, enabling technology transfer, and supporting inclusive growth across economies. By tapping into existing global innovation networks and promoting ecosystem-to-ecosystem partnerships, countries can strengthen their innovation capacity and accelerate technological progress while avoiding unnecessary duplication of efforts and resources.

Looking ahead, effective deep tech governance will depend on the adoption of flexible and adaptive regulatory approaches that can evolve alongside technological advancements and societal shifts. Policymakers will need to strike a careful balance between managing risks and enabling innovation. Tools such as regulatory sandboxes, adaptive regulatory frameworks, and inclusive policymaking processes can support this balance—helping to ensure that emerging technologies align with societal values and ethical standards.

Ultimately, the vision of thriving deep tech ecosystems is not only about technological advancement but also about ensuring equitable access, fostering inclusivity, and promoting sustainability. As countries navigate this complex and rapidly evolving landscape, shared learning and collective action will be essential. By cultivating collaborative ecosystems that are diverse, adaptable, and globally connected, the international community can harness the potential of deep tech to drive sustainable and inclusive development for future generations.

Glossary

Photo: ultramansk/Adobe Stock

VIII. Glossary

A

Advanced Materials – Innovative materials engineered with enhanced properties such as higher strength, lighter weight, and greater conductivity, enabling breakthroughs in sectors like energy storage, healthcare, and manufacturing.

Artificial Intelligence (AI) – The simulation of human intelligence in machines, enabling them to perform tasks such as learning, reasoning, and problem-solving. Includes subfields like explainable AI (XAI) and multimodal AI.

B

Biotechnology – The use of living organisms, biological systems, or derivatives to develop new technologies, particularly in medicine, agriculture, and environmental sustainability.

Biomimetic Materials – Materials designed to replicate the structures and functions found in nature, such as self-healing concrete and water-repellent fabrics.

Blended Finance – A strategic approach that combines public, private, and philanthropic capital to fund projects with high social impact, often used to support deep tech ventures.

C

CleanTech – Technologies that improve environmental sustainability by enhancing energy efficiency, reducing emissions, or promoting renewable resources.

Computational Biology – The application of data science and algorithms to biological research, used for drug discovery, genomics, and personalized medicine.

Corporate Venture Capital (CVC) – Investments made by large corporations in startups, particularly in emerging technologies, to gain strategic advantages.

D

Deep Tech – Technologies rooted in advanced scientific discoveries and engineering breakthroughs, often requiring long R&D cycles and significant investment before commercialization.

Digital Twins – Virtual models of physical objects, systems, or processes that allow for real-time monitoring, simulation, and optimization.

E

Edge Computing – A distributed computing model that processes data closer to its source (e.g., sensors, IoT devices) rather than relying solely on centralized cloud infrastructure.

Explainable AI (XAI) – AI models designed to provide transparent and interpretable decision-making processes, improving accountability and regulatory compliance.

Entrepreneurial University – A university that actively promotes innovation, research commercialization, and startup creation through technology transfer programs and incubators.

F

FinTech (Financial Technology) – The application of technology to financial services, including digital payments, blockchain, and AI-driven financial analysis.

Funding Gap – The difficulty deep tech startups face in securing sufficient capital due to long development cycles, high R&D costs, and market uncertainties.

G

Gene Editing – Techniques like CRISPR that allow precise modifications to an organism's DNA, used in medicine, agriculture, and biotechnology.

Government Procurement for Innovation – A policy tool where governments act as early adopters of emerging technologies, helping deep tech startups scale by providing initial demand.

H

Hydropanels – Renewable water technology that extracts clean drinking water from the air using solar energy, useful in arid and remote areas.

I

Intellectual Property (IP) – Legal protections for inventions, including patents, copyrights, and trademarks, crucial for safeguarding deep tech innovations.

Innovation Clusters – Geographic hubs where businesses, universities, and investors collaborate to accelerate technological development and commercialization.

L

Lab-on-a-Chip – Miniaturized devices that integrate multiple laboratory functions onto a single chip, enabling rapid medical diagnostics and research applications.

M

Machine Learning – A subset of AI where computer algorithms improve automatically through experience and data analysis, widely used in automation and predictive analytics.

Metamaterials – Engineered materials with properties not found in nature, often used for advanced optics, telecommunications, and medical imaging.

Multimodal AI – AI systems capable of processing and integrating multiple types of data (text, image, audio) to improve decision-making and automation.

N

Nanotechnology – The manipulation of matter at an atomic or molecular scale, enabling innovations in medicine, materials science, and energy storage.

Neuromorphic Computing – A computing approach that mimics the neural structure and function of the human brain, enhancing efficiency in AI applications.

P

Patient Capital – Long-term investments made in high-risk, high-impact technologies, essential for deep tech startups that require extended R&D cycles.

Photonic Computing – Computing systems that use light (photons) instead of electrical signals to process information, offering ultra-fast and energy-efficient computation.

Public-Private Partnership (PPP) – A collaborative investment model where governments and private sector entities co-develop projects, including technology innovation and infrastructure development.

Q

Quantum Computing – A form of computing that leverages quantum mechanics to perform complex calculations exponentially faster than classical computers.

Quantum Sensors – Devices that use quantum phenomena to achieve high-precision measurements in fields like navigation, medical imaging, and defense.

R

Renewable Energy Technologies – Innovations that harness renewable resources such as solar, wind, and bioenergy to produce sustainable power.

Regulatory Sandbox – A controlled policy environment where startups can test new technologies under relaxed regulatory conditions before full compliance is required.

Research-to-Market Pipeline – The structured process of transitioning innovations from scientific discovery to commercial application.

S

Semiconductors – Materials with electrical conductivity between that of conductors and insulators, forming the foundation of modern electronics, computing, and telecommunications.

Smart Manufacturing – The integration of AI, IoT, and robotics in production systems to enhance efficiency and reduce waste.

Superabsorbent Hydrogels – Highly absorbent polymers that retain large amounts of water, used in agriculture, medical applications, and hygiene products.

Superconductors – Materials that conduct electricity with zero resistance when cooled below a critical temperature, enabling energy-efficient power grids and advanced medical imaging.

T

Technology Readiness Levels (TRLs) – A scale used to assess the maturity of a technology, ranging from basic research (TRL 1) to full-scale deployment (TRL 9).

Testbeds – Controlled environments for testing and refining deep tech solutions before large-scale deployment, used in smart cities, renewable energy, and digital infrastructure.

Tech Transfer Office (TTO) – University or institutional offices that facilitate the commercialization of research discoveries and patents.

V

Venture Building – The process of systematically developing deep tech startups through structured programs, including incubators, accelerators, and corporate venture arms.

Venture Debt – A form of non-dilutive financing that allows startups to raise capital without giving up equity, often used alongside venture capital.

Z

Zwitterionic Membrane Technology – A type of membrane designed for industrial wastewater treatment, capable of repelling contaminants such as oils and proteins.