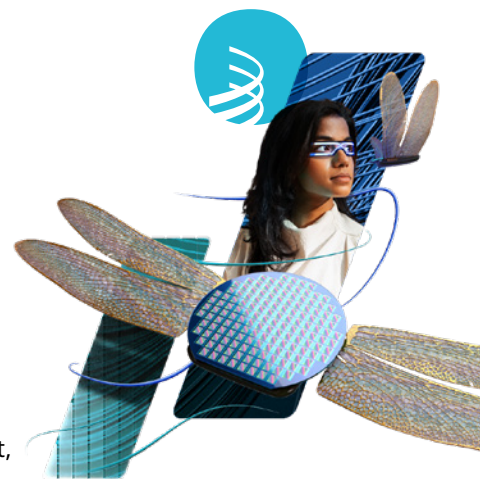


Nurturing a global hub for deep-science startups – Singapore

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1. Introduction

For over two decades, Singapore has consistently invested about 1 percent of its GDP in research, innovation and enterprise (RIE) plan. This has built a strong base of research talent, attracted multinational corporations (MNCs) to establish research and development (R&D) and economic activities, enhanced local enterprises' competitiveness, and advanced national strategic priorities (National Research Foundation Singapore, 2026a).

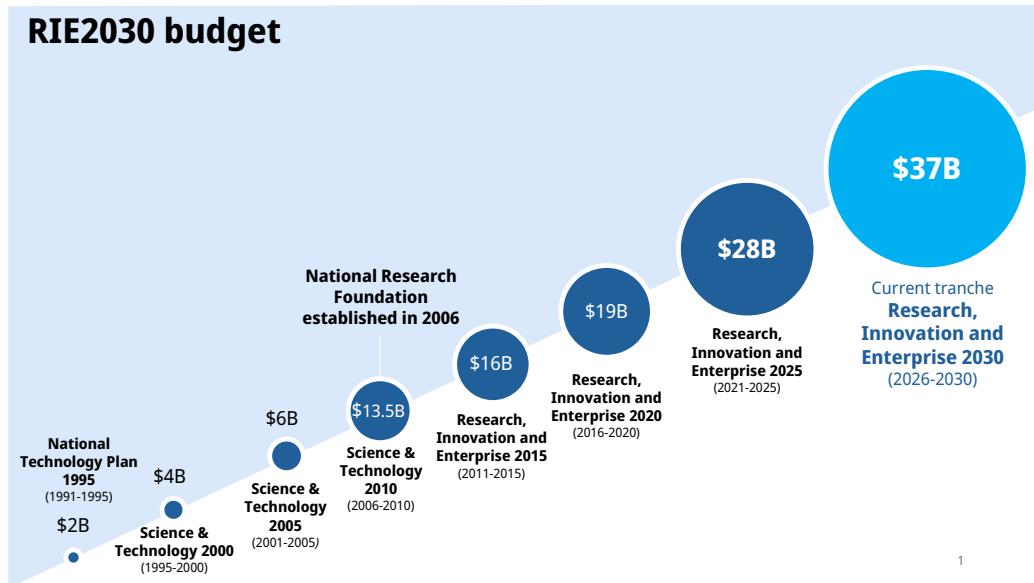
Singapore's RIE journey began in 1991 (see Figure 1), with the launch of the first National Technology Plan. Earlier investments into science and technology focused on building research capabilities to anchor key MNC operations in Singapore, primarily within the manufacturing sector. In 2001, Singapore made a deliberate decision to develop biomedical sciences as an additional engine of growth, and significant long-term investments were made into this sector (National Research Foundation Singapore, 2026a; National Archives Singapore (2001)).

At the same time, there was a concerted effort to increase the research intensity of Singapore's institutions. This was driven by key initiatives such as the establishment of the Agency for Science, Technology and Research (A*STAR) in 2001, the corporatization of the National University of Singapore (NUS) and Nanyang Technological University (NTU) in 2006, the establishment of Research Centres of Excellence (RCEs), and the Campus for Research Excellence and Technological Enterprise (CREATE). CREATE houses research centers set up by top universities in Singapore, while the RCEs were designed to build peaks of excellence in long-term, investigator-led fundamental research (National Research Foundation Singapore, 2026a; 2026d).

Having built strong basic research capabilities, Singapore's next phase focused on harnessing research outcomes to drive economic and societal impact. This was signaled by the shift from a five-year "Science and Technology" plan to a "RIE" plan in 2010. This has remained a major focus in subsequent five-year plans, including the RIE2030 plan, which will launch two RIE Flagships and two RIE Grand Challenges to drive economic outcomes and advance national strategic priorities (National Research Foundation Singapore, 2026b; 2025).

The cumulative effect of these long-term efforts has resulted in a vibrant innovation and enterprise (I&E) ecosystem in Singapore today, that includes MNCs establishing R&D headquarters and corporate laboratories to collaborate with Singapore's universities and research institutes, an increasing base of technology-based small and medium-sized enterprises (SMEs), and a growing start-up landscape supported by venture capital firms (VCs) and venture builders (VBs). The latter is the focus of this paper.

Figure 1 Singapore's RIE journey, 1991–2030



2. The next phase of growth for Singapore's start-up ecosystem: deep-tech entrepreneurship

Singapore's start-up ecosystem is home to over 4,500 technology start-ups, 500 VCs and over 220 incubators, VBs and accelerators. A coordinated suite of government schemes under the Startup SG umbrella also provides Singapore-based start-ups with comprehensive assistance across financing, technology commercialization, capability development, access to talent, and internationalization (Startup SG, n.d.; National Research Foundation Singapore and partner agencies, 2026).

Through collaboration between private and public ecosystem players, Singapore has become a globally recognized start-up hub, ranking fourth in the 2025 Global Startup Ecosystem Index (StartupBlink, 2025). This has enabled Singapore-based start-ups to attract significant VC investment (StartupBlink, 2025).

While the start-up ecosystem is making steady progress, Singapore is now turning its focus to a small but high-potential subset: deep-tech start-ups. These ventures are grounded in advances from R&D and characterized by higher technological complexity, longer development timelines, more complex regulatory and market-entry pathways, and greater capital intensity (SGInnovate, 2019). These higher entry barriers can make such companies more defensible against global competition and capable of disrupting existing sectors (SGInnovate, 2019).

Singapore believes that deep-tech start-ups are key to unlocking future economic growth opportunities. It also recognizes that they require more specialized and sustained policy interventions and is adopting a more targeted approach to grow deep-tech clusters in selected areas where it can have a comparative advantage.

3. Key enablers of Singapore's deep-tech start-up ecosystem

Universities and research institutes

Universities and research institutes provide a pipeline of commercial intellectual property (IP), which forms the basis of the core differentiating technology in deep-tech start-ups. Through Singapore's investments into R&D, its universities and research institutes have established peaks of research excellence in emerging technology areas. Technology transfer offices (TTOs) identify promising research discoveries and support researchers in their commercialization. Translation grants such as the Central Gap Fund also enable technologies to be further developed to address technical risk, so that they become more attractive for private investment and industry adoption (National Research Foundation Singapore, 2026c).

The Central Gap Fund (CGF) supports the commercialization of publicly-funded research to a stage where they become attractive to companies and private investors (National Research Foundation Singapore, 2026c). One example is Amperesand, a spin-off based on NTU's solid-state transformer technology for medium-voltage critical power conversion solutions. With support from the CGF and investment from venture builder Xora Innovation and other early-stage VC funds, the technology matured for commercial deployment. This enabled Amperesand to secure over USD 90 million in financing within two years of incorporation and undertake subsequent industry pilot trials with PSA International and hyperscale data-center customers, demonstrating the commercial viability of its infrastructure solutions (National Research Foundation Singapore and partner agencies, 2026).

I&E and business talent

Creating successful deep-tech start-ups requires a broad range of I&E and business talent archetypes. The earliest stages of development require academic entrepreneurs who are motivated and able to translate research discoveries into investible deep-tech ventures. Recognizing that most researchers may not naturally possess the necessary business acumen or experience, Singapore has put in place structured deep-tech entrepreneurship programs such as the National Graduate Research Innovation Programme (NGRIP) and A*StartCentral Essentials Bootcamp, which equip researchers with entrepreneurial skills and aim to collectively nurture more than 160 deep-tech start-ups between 2024 and 2030 (National Research Foundation Singapore and partner agencies, 2026).

As start-ups gain traction, additional talent archetypes become critical, including professionals who can scale technologies, drive revenue and market expansion, and build organizational capabilities to support expansion. To meet this need, the Economic Development Board's (EDB) Global Founder Programme attracts experienced founders to Singapore to strengthen the local start-up ecosystem. Since 2023, the program has attracted more than 50 serial founders who have facilitated the launch of over 30 new ventures, many in high-growth sectors such as AI, health care and sustainability. To date, these ventures have raised over USD 450 million in venture capital (Economic Development Board Singapore, 2025).

The National Graduate Research Innovation Programme (NGRIP), which integrates the National University of Singapore's Graduate Research Innovation Programme and the Nanyang Technological University (NTU) Lean Launchpad, is a structured deep-tech entrepreneurship program for researchers and postgraduates. Participants receive training in customer discovery and venture creation, are matched with experienced entrepreneurs and industry mentors, and have opportunities to pitch to venture capital networks. Through NTU Lean Launchpad, Zero-Error Systems, a NTU spin-off developing radiation-resilient electronics, refined its commercial strategy by identifying applications beyond its initial focus. It has since attracted venture funding, supporting its transition from research to global commercial deployment in satellite operations (National Research Foundation Singapore and partner agencies, 2026).

Specialized infrastructure

Access to state-of-the-art equipment and prototyping facilities enables early-stage deep-tech start-ups, which have limited capital, to de-risk and productize technologies. When embedded within translation platforms that provide compliance-ready environments and catalyze public-private partnerships, these facilities can lower adoption risks for industry and accelerate commercialization.

Singapore has established several sector-specific translation platforms that provide shared infrastructure alongside specialized expertise to support productization and regulatory navigation. These include the Diagnostics Development Hub (medical diagnostics and digital health), the Experimental Drug Development Centre (drug discovery and development), Medtech Catapult (medical devices and life science tools), the National Additive Manufacturing Innovation Cluster (additive manufacturing), the National Semiconductor Translation and Innovation Centre (semiconductors), and the Advanced Remanufacturing and Technology Centre (advanced manufacturing and remanufacturing) (National Research Foundation Singapore, 2026e).

The Diagnostics Development Hub (DxD Hub), a national platform hosted by A*STAR, addresses the productization gap in *in vitro* diagnostics, point-of-care tests and digital diagnostics, by translating IP into clinically validated, market-ready devices. Its ISO 13485-certified capabilities include product-market fit assessment, design and development for manufacturing, pilot manufacturing, regulatory strategy, and a CAP-accredited clinical lab. DxD Hub has supported over 70 medtech companies, catalyzed more than Singapore dollars (SGD) 1 billion in follow-on investment, and enabled products serving over 18 million patients globally. A notable example is UNITED™, a tissue-based clinical-grade cancer profiling test co-developed by Lucence and DxD Hub. Through DxD Hub's support in assay development, clinical validation and access to public health care partners, UNITED™ progressed from a research-stage assay to a clinically deployable diagnostic used to guide treatment decisions for cancer patients (National Research Foundation Singapore and partner agencies, 2026).

Deep-tech VCs and VBs

Deep-tech start-ups have a different risk profile from general technology start-ups, as they have higher technical risk and longer gestation periods. Consequently, they require specialized investors, including deep-tech VCs and VBs, that can provide patient capital alongside deep domain expertise and hands-on support. Early investor involvement integrates technical evaluation and commercial rigor into the commercialization process, helping founders navigate regulatory pathways, strengthen strategies and address scale-up challenges (Andrén, 2018).

Recognizing the importance of smart, patient capital, Singapore's economic agencies actively partner experienced deep-tech VCs and VBs, including through the strategic use of government equity to crowd in private investment via co-investment and fund-of-funds approaches. Universities and A*STAR also engage such investors through structured venture creation programs and university venture funds, such as A*STAR's Venture Atelier Programme and the NUS Venture Capital Programme (Startup SG, n.d.; National Research Foundation Singapore and partner agencies, 2026).

The Startup SG Equity (SSGE) scheme catalyzes private sector investment into Singapore-based deep-tech start-ups. Through co-investments into start-ups and investments into selected venture funds, the Government's appointed fund managers, SG Growth Capital and SGInnovate, partner deep-tech VCs and leverage their domain knowledge and global networks to help start-ups develop and scale innovations. Across RIE2020 and RIE2025, SSGE has supported over 260 start-ups, with more than S\$500 million in government investment catalyzing over SGD 2.6 billion in private sector capital, while anchoring 16 foreign deep-tech VCs (Startup SG, n.d.; National Research Foundation Singapore and partner agencies, 2026). A notable example is VFlowTech, an energy storage spin-off from Nanyang Technological University that specializes in vanadium redox flow battery systems. The Government's equity investment through SG Growth Capital

helped crowd in strategic private investors, enabling VFlowTech to raise over USD 33 million in funding. This strategic investment gave VFlowTech opportunities to work with investors such as MOL PLUS, PSA Ventures and Inci Holding to explore deployment opportunities and new business opportunities within their respective operating segments and countries.

Large corporates

These can provide industry-defined problem statements that anchor start-up solutions to real-world use cases, increasing the potential for market adoption, or serve as the first reference customers. In deep tech, where development cycles are long and technical risks high, a successful pilot or proof-of-concept with a large corporate can significantly boost investor confidence, with subsequent commercial contracts providing strong market validation.

The Singapore Economic Development Board's Corporate Venture Launchpad (CVL) supports start-ups through two pathways. Under venture creation, CVL works with large corporates to build and launch corporate-backed start-ups that combine start-up agility with the parent company's domain expertise, technical capabilities and go-to-market networks. Under start-up partnerships, existing start-ups gain access to real corporate demand by co-developing and piloting solutions with established companies, thereby accelerating commercial growth. One example is the partnership between global agribusiness Golden Agri-Resources (GAR) and Arkadiah, a Singapore-based climate and nature-tech start-up using AI, satellite imagery and LiDAR to build digital twins of forest landscapes for high-integrity carbon measurement and monitoring. The collaboration in Indonesia enabled large-scale deployment on GAR's landholdings, validating Arkadiah's models against complex tropical forestry data and strengthening its credibility in carbon markets (Economic Development Board Singapore, n.d.; National Research Foundation Singapore and partner agencies, 2026).

Overseas networks

Successful innovation ecosystems need to be well connected with global innovation hubs to enable bidirectional flows of ideas, talent and capital. Such overseas networks are particularly critical for deep-tech start-ups in Singapore, given its small domestic market. Consequently, international networks that provide access to customers and investors, as well as co-innovation and test-bedding opportunities, are critical for the success of Singapore's deep-tech start-ups (Enterprise Singapore, n.d.; OECD, 2004)

The Global Innovation Alliance (GIA), led by Enterprise Singapore, supports start-ups' internationalization by facilitating innovation and overseas market access across more than 50 countries. Through strategic partnerships with government bodies, corporates and innovation leaders, GIA has supported over 700 start-ups and tech SMEs, helping them enter new markets, forge partnerships and collaborate on R&D with overseas partners. An example is Quantified Energy (QE), a National University of Singapore spin-off specializing in advanced photovoltaic health analytics and electroluminescence inspection. Through GIA-supported partnerships, QE co-developed field-deployable evaluation systems for distributed solar assets in China and expanded into India in early 2026 through GIA-enabled pilot projects that demonstrated measurable improvements in solar farm inspection efficiency, strengthening its commercial credibility across diverse international markets (Enterprise Singapore, n.d.; National Research Foundation Singapore and partner agencies, 2026).

4. Challenges for Singapore deep-tech ecosystem

Through efforts to strengthen the key enablers for its deep-tech ecosystem, Singapore has built a conducive environment that supports innovators who wish to build and scale deep-tech companies. Nevertheless, several challenges remain that the Government is working closely with ecosystem stakeholders to address.

Need to strengthen entrepreneurial culture among researchers

Deep-tech entrepreneurship requires researchers to engage in research commercialization, venture creation and industry collaboration. Despite sustained efforts to promote academic entrepreneurship, Singapore's pool of academic entrepreneurs remains relatively small. This reflects structural disincentives within traditional academic career pathways, where success is often measured primarily by high-impact publications and research grant acquisition rather than translational or commercial outcomes. Consequently, relatively few technical founders are willing to leave stable research positions to build companies. The limited presence of such role models also makes it harder to inspire the next generation of researchers to view entrepreneurship as a viable career pathway.

How Singapore is addressing this challenge

The national deep-tech entrepreneurship programs outlined in Section 3 aim to grow the pipeline of academic entrepreneurs. In parallel, universities have introduced measures to better recognize and support academic entrepreneurs. For instance, NUS has launched the Innovation and Venture Creation Awards in 2024, which recognize entrepreneurial achievements at different academic career stages and provide dedicated funding and mentorship for research translation. Universities have also updated academic promotion criteria to recognize entrepreneurial and translational outcomes, alongside traditional scholarly achievements. Together, such efforts aim to nurture a stronger entrepreneurial culture and signal institutional commitment to academic entrepreneurship.

Need to build a stronger pipeline of commercially viable public IP

Singapore's investments into fundamental research and early-stage translational R&D have generated a strong base of public IP. However, a persistent challenge lies in bridging the gap between technology readiness and commercial readiness, as additional development is often required to address technical and market risks. While translation grants support technology maturation, even high technology-readiness-level assets may remain unattractive to investors if factors such as product-market fit, scalable manufacturing, cost competitiveness, and regulatory pathways were not adequately considered.

How Singapore is addressing this challenge

Technology transfer offices play a critical role in strengthening the pipeline of commercially viable IP, by guiding researchers in technology development in relation to product-market fit, regulatory pathways and potential business models. Thus, Singapore is strengthening the capabilities of institutional TTOs to better perform these roles and facilitate inter-institutional TTO collaborations to collectively drive stronger commercialization outcomes.

In parallel, universities and research institutions have deepened partnerships with VCs and VBs, enabling earlier market validation and injecting commercial guidance and mentorship into supporting the development of public IPs toward market adoption.

Need to strengthen growth-stage financing and exit pathways

A self-sustaining deep-tech start-up ecosystem depends not only on early-stage venture building to create the pipeline of start-ups, but critically on access to growth-stage financing and exit opportunities to enable capital and talent recycling. While the early-stage financing ecosystem is generally robust, start-ups face challenges at the growth-stage because of a limited availability of late-stage financing. At the same time, domestic exit pathways, including acquisitions, public listings and other liquidity events, remain relatively limited for Singapore-

anchored deep-tech start-ups. These constraints are further compounded by global capital dynamics, where later-stage financing is increasingly concentrated in jurisdictions with strong industrial policies. Taken together, limitations in growth-stage financing and exit options may hamper the growth of Singapore's deep-tech ecosystem to achieve long-term self-sustainability.

How Singapore is addressing this challenge

To strengthen the deep-tech start-up ecosystem, Singapore has implemented targeted policies designed to catalyze growth-stage financing and improve market liquidity, particularly for technology-intensive ventures.

To address gaps in growth-stage capital, the Government announced in 2026 that it would inject a further SGD 1 billion into the SSGE scheme to expand its mandate and allow government equity to participate in growth-stage rounds of deep-tech start-ups, with the objective of crowding in growth-stage private capital that provides relevant networks and expertise to help start-ups progress toward eventual exits (Ministry of Finance Singapore, 2026)

In parallel, Singapore has taken steps to enhance the Singapore Exchange (SGX) and improve market liquidity. These include the Equity Market Development Programme, where an additional SGD 1.5 billion has been committed to fund managers mandated to invest in Singapore-listed equities, as well as the launch of the NASDAQ-SGX dual-listing bridge, which enables companies to list on both exchanges using a single set of documents (Monetary Authority of Singapore, 2025; 2026). Together, these measures are intended to improve SGX's attractiveness as a listing venue for high-growth technology companies (Money Authority of Singapore, 2025; 2026).

5. Conclusion: key lessons

Singapore has made significant progress in building its innovation ecosystem. However, deep-tech entrepreneurship is a long-term endeavor, and while Singapore has started to see early signs of success, continued collaboration with ecosystem stakeholders is required to build a self-sustaining deep-tech innovation ecosystem. Drawing on Singapore's experience, three key lessons stand out:

Lesson 1: Deep-tech commercialization requires sustained, long-term commitment

Deep-tech entrepreneurship requires sustained investment over long development timeframes, as commercial outcomes typically only emerge after a long gestation period. Beyond time, it also demands the systematic and concurrent build-up of critical enablers, including specialized talent, productization and venture-building capabilities, access to patient capital, and a supportive entrepreneurial culture.

Multi-year national strategies for RIE provide policy continuity and certainty to ecosystem stakeholders that the Singapore Government will invest consistently in building basic research strengths, while doubling down on value creation in economic and national strategic priority areas. This has enabled Singapore to build up a suite of critical enablers systematically over time, and to create a conducive ecosystem for high-quality deep-tech start-ups. Importantly, sustained government commitment also gives global VCs the confidence to invest patient capital into deep-tech ventures in Singapore.

Lesson 2: Connecting the dots from lab to market is critical

Having an end-to-end strategy is critical because the deep-tech commercialization journey is complex, characterized by multiple "valleys of death," and requires specialized support. For national strategic sectors, Singapore has been developing and refining a comprehensive strategy that addresses needs along the entire value chain, starting from laboratory research, through translation and early market validation, to industry-ready deployment and scaling. This involves developing targeted interventions that address the needs of specific stages of development, ensuring there is adequate support in bringing technologies to the next value inflection point. Crucially, as technologies advance along the value chain, expectations of

commercial milestones will correspondingly increase. Clear transition mechanisms between stakeholders are also essential to ensure that technologies successfully cross each valley of death, and that public funding used to de-risk early-stage technologies can catalyze private sector involvement and investment, with investors and industry playing an increasingly greater role as commercialization progresses.

Lesson 3: Deep tech is a team sport

Deep-tech commercialization is inherently complex and requires collaboration across stakeholders, including universities and research institutes, VCs and VBs, corporates, public agencies, and international partners.

Recognizing that the capabilities of different parties are required to bring deep-tech innovations to market, Singapore's approach involves bringing together key ecosystem stakeholders or working with global partners, as illustrated by three broad policy mechanisms.

First, in priority areas, major national programs such as the national RIE Flagships and Grand Challenges are used to align key stakeholders to work on shared problem statements that lead to impact. Second, Singapore promotes public-private partnerships through sector-specific translational platforms, industry consortia and corporate laboratories, which combine public research capabilities with private sector market insights and commercial expertise to accelerate development and adoption. Third, recognizing the constraints of having a small domestic market, international collaborations connect local stakeholders with global partners, enabling access to overseas markets, regulatory pathways and major demand drivers. Together, these mechanisms enable earlier and more effective engagement across the commercialization lifecycle and position Singapore-anchored deep-tech start-ups to compete globally.

As Singapore continues to position itself as a global hub for deep-tech start-ups, it will build on these key lessons, while adapting strategies to meet evolving technological, economic and geopolitical conditions.

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WIPO Reference No. GII2026/EN/EXTCONT

DOI: 10.34667/tind.59195

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