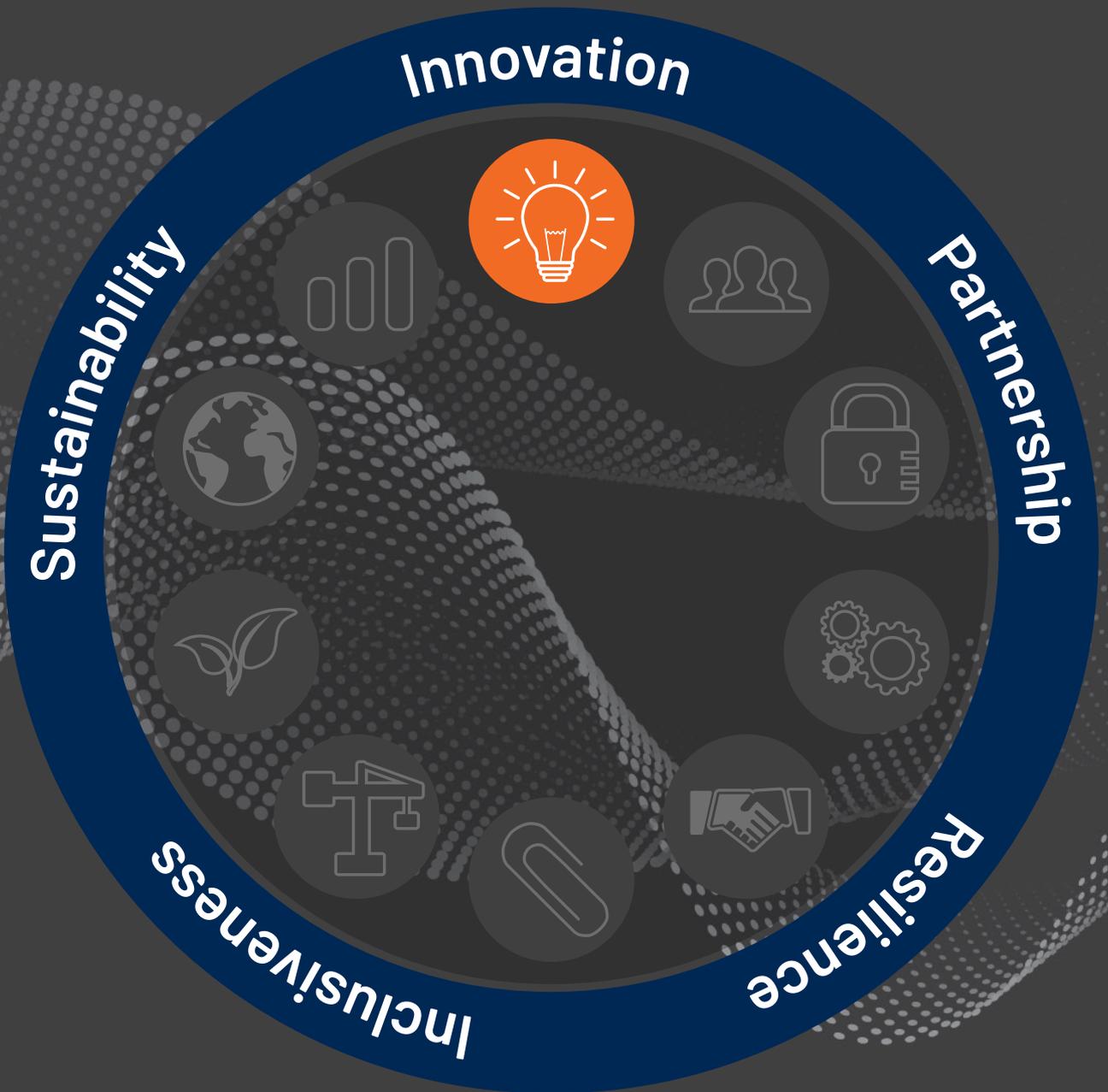


Frame the Future Innovation



The Innovation Landscape

Innovation is the transformation of knowledge into new products, processes, methods, business models, and organizational solutions that create economic and societal value. It improves productivity and is the fundamental growth engine of today's economies. Innovation is responsible for a minimum of 50 percent of growth in OECD member countries.¹ A report issued by the U.S. Department of Commerce in 2010 suggested that innovation accounted for three-quarters of U.S. growth since WWII.² Similarly, an analysis of how income per worker evolved across 98 countries highlights the importance of innovation. According to the study, innovation accounts for around 90 percent of growth in Korea, Taiwan, and Hong Kong during their fast-growth periods.³ In the same way, company-level data across countries, including emerging nations, shows that companies that innovate are more productive, more profitable, grow more and create better jobs.⁴

There are plenty of reasons for countries worldwide to bet on innovation, from emerging to advanced economies. Emerging nations are benchmarking innovation frameworks and playing catch-up.⁵ Innovation policies are now an essential part of government toolkits worldwide.⁶ As a result, the innovation geography is changing, with the emergence of players such as China, Israel, and South Korea. In 1960, the United States was responsible for more than two-thirds of the global investment in research and development. It now responds for about 25 percent of that total, with funding amounting to \$2 trillion in 2020.⁷ The GFCC Competitiveness Decoder™⁸ reveals five clusters of countries when we consider innovation metrics



— Japan and the United States are ahead of the pack as "I.P. powerhouses," and the "challengers" include South Korea and China, the fastest mover coupling scale and speed.

Advanced nations are on the move too. The European Union is currently implementing a series of flagship projects,⁹ as reviewed in the GFCC *Leveraging Extreme Innovation* report,¹⁰

1 OECD. (2015). *The Innovation Imperative Contributing to Productivity, Growth and Well-Being*. Paris: OECD.

2 <https://www.nber.org/books-and-chapters/nber-macroeconomics-annual-1997-volume-12/neoclassical-revival-growth-economics-has-it-gone-too-far>.

3 <https://www.nber.org/system/files/chapters/c11037/c11037.pdf>.

4 IPEA books.

5 <https://revistapesquisa.fapesp.br/en/lessons-from-innovators/>.

6 <http://www2.itif.org/2019-national-innovation-policies.pdf>.

7 <https://www.rdworldonline.com/global-rd-investments-unabated-in-spending-growth/#:~:text=For percent202020 percent2C percent20those percent20changes percent20are,those percent20same percent20organizations percent20in percent202019.>

8 <http://decoder.thegfcc.org>.

9 <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/fet-flagships>.

10 <https://www.thegfcc.org/universities-innovation>.

and is adopting the notion of mission-oriented innovation to guide a new and massive initiative.¹¹ Japan has included innovation as a component of its new Science, Technology, and Innovation (STI) basic plan¹² and expanded funding to include moonshot projects via the Japan Science and Technology Agency. The United States is boosting funding for R&D. President Joe Biden announced the intention to take public investment in basic research and science to a level close to 2 percent.¹³ This decision was informed and propelled by initiatives such as the Council on Competitiveness National Commission on Innovation and Competitiveness Frontiers.¹⁴

The emergence of new global research and innovation players has contributed to building knowledge creation capacity across geographies. The number of researchers around the globe grew 21 percent since 2007¹⁵ and, although they still are primarily concentrated in advanced economies, there is a trend towards a more globally distributed pattern. Advanced research infrastructures such as Sirius, FAST, and SKA — all reviewed in the GFCC *Leveraging Extreme Innovation* report¹⁶ — can now be found in emerging nations. Nevertheless, accumulating research capabilities and assets, in general, does not translate automatically into innovation prowess. Emerging countries have systemic, economy-wide gaps that limit research efficiency,¹⁷ and they need to tackle those to overcome the innovation paradox.¹⁸ In other words, nations — and companies, too — need to master the secret sauce of innovation. That is easier said than done.

The Forces Shaping the Innovation Game

Innovation is a contact sport and flourishes in diversity when different stakeholders (businesses, research organizations, entrepreneurs, investors, government agencies, civil society) and people from various backgrounds and origins interact and work together. The environment needed for innovation resembles more of a rain forest than a monoculture.¹⁹ A lot has

been researched, said, and written about it, with concepts like the triple,²⁰ quadruple,²¹ and quintuple²² helix being introduced in recent decades. Interactions are at the core of all such models. The role of connectors in innovation ecosystems can hardly be overemphasized, together with the need for institutions that allow for the seamless cross-sector circulation of resources and the usage of contemporary innovation toolkits. The GFCC *Optimizing Innovation Alliances Report*²³ provides a good account of those. But having these elements in place still is a challenge for most nations.

New efforts to boost innovation — in advanced and emerging economies — meet a scenario in which the innovation game itself is changing in at least five different ways. First, innovation activities increasingly happen outside the traditional organizational boundaries (of corporations, universities, and research organizations) and involve startups, individual innovators, citizen scientists, teams, and people who operate autonomously and are self-organized in networks and digital platforms. Second, innovation is becoming more science than art, with the emergence of the new structured frameworks, from the lean startup approach²⁴ to the new ISO 56002²⁵ standard. Third, technology growth has reached an unprecedented speed, enabling the constant introduction of new business models into the market and reducing the lifespan of companies. Fourth, speed and experimentation became a central part of all innovation approaches — agile methods gained prominence over traditional project management. Fifth, technology enhances innovators' capabilities via virtual collaboration platforms, advanced computing and simulation, A.I. applications for generative design, data analytics, and digital tools powering massive social experiments, trend discovery, and learning.

This new scenario brings massive new opportunities and challenges for incumbent players, requiring businesses to adopt new approaches. It is not a surprise, though, that innovation is gaining more attention from corporations²⁶ worldwide. The corporate investment in R&D from the 2,050

11 https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/missions-horizon-europe_en.

12 <https://blog.thegfcc.org/what-the-japan-science-and-technology-agency-jst-envisions-for-the-future-of-the-sti-basic-plan-499393622404>.

13 <https://www.whitehouse.gov/briefing-room/speeches-remarks/2021/03/25/remarks-by-president-biden-in-press-conference/>.

14 <https://www.compete.org/programs/nc>.

15 <https://unesdoc.unesco.org/ark:/48223/pf0000235406>.

16 <https://www.thegfcc.org/universities-innovation>.

17 https://www.researchgate.net/publication/233816281_An_international_comparison_of_RD_efficiency_of_multiple_innovative_outputs_Role_of_the_national_innovation_system.

18 <https://openknowledge.worldbank.org/bitstream/handle/10986/28341/9781464811609.pdf>.

19 Wang, V; Horowitz, G. (2012). *The Rainforest: The Secret to Building the Next Silicon Valley*. Los Altos Hills: Regenwald.

20 Etzkowitz, Henry and Leydesdorff, Loet, *The Triple Helix — University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development* (January 1, 1995). *EASST Review*, Vol. 14, No. 1, pp. 14-19, 1995.

21 Monteiro, Sara, Carayannis, Elias G. (Eds.). *The Quadruple Innovation Helix Nexus: A Smart Growth Model, Quantitative Empirical Validation and Operationalization for OECD Countries*. Palgrave McMillan: 2017.

22 Carayannis, Elias; Barth, Thorsten; Campbell, David. *The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. Journal of Innovation and Entrepreneurship — A Systems View Across Time and Space*. Springer, August 2012.

23 <https://www.thegfcc.org/universities-innovation>.

24 <http://theleanstartup.com/#principles>.

25 <https://www.iso.org/standard/68221.html>.

26 <https://www.bcg.com/en-br/publications/2021/most-innovative-companies-overview>.



largest corporations grew from €538 billion in 2013 to €904 billion in 2020.²⁷ Similarly, corporate venture capital (CVC) has been gaining momentum since the early 2000s, and CVC deals reached record funding in 2020.²⁸ This happens in a moment when the whole startup scene worldwide continues to expand, ecosystems mature, and the global "startup economy"²⁹ grows in importance. In tandem with that, venture capital funding in 2020 has topped \$300 billion,³⁰ reaching the highest point in history, despite the COVID-19 pandemic.

The pandemic accelerated the use of digital technologies and the adoption of digital business models. It also catalyzed a boom in entrepreneurship and excitement in the startup scene in 2020.³¹ This fact seems to combine two components. First, the rise of the entrepreneurs, a long-term trend associated with a generational shift in mindsets: 54 percent of millennials aspire to be entrepreneurs.³² Second, the need for survival. More people are creating new businesses because

they lost their jobs and need to generate income. While the first aspect underscores many opportunities, the second sheds light on critical issues faced by societies.

Global Challenges Can Be an Opportunity to Create Value

The pandemic has highlighted unbalances in our societies and, in some ways, called attention to a series of global challenges: climate change, terrorism, poverty, hunger, the loss of biodiversity, ocean acidification, the lack of access to energy, water, sanitation, housing, education, etc. These are significant problem areas and, in turn, can constitute massive opportunities for innovators. The numbers are astonishing: 2.4 billion³³ people face water scarcity on the planet, almost 800 million do not have access to electric power.³⁴ Around 40 percent of the population in emerging nations live in slums. The world will need to substantially expand food production³⁵ in the coming decades and, simultaneously, adopt a variety of measures to transition to a more sustainable food future.³⁶ To compound the situation, addressing some of the challenges outlined here would put additional pressure on natural resources and further accelerate emissions – for instance, the buildings and construction sector is responsible for almost 40 percent of energy and process-related CO₂ emissions globally.³⁷ There are several connections among global challenges and cleaner, greener, zero-emissions technologies, which are needed across the board to fight climate change. How can technology help in the fight against climate change? How can entrepreneurs help? How can innovation help?

Sustainable energy provides a good illustration of how the combination of technological progress (primarily and especially), innovation in business models, entrepreneurship, and regulation can drive change and help humanity to address some critical challenges. New investments in clean energy have reached \$301.7 billion U.S. dollars in 2019.³⁸ The price of electric power from solar utility-scale projects dropped by a factor of five since 2010,³⁹ with wind⁴⁰ power and Lithium-ion battery⁴¹ prices following a similar path. Advancements in technology are

27 <https://iri.jrc.ec.europa.eu/scoreboard/2020-eu-industrial-rd-investment-scoreboard>.

28 <https://www.cbinsights.com/research/report/corporate-venture-capital-trends-2020/>.

29 <https://startupgenome.com/article/state-of-the-global-startup-economy>.

30 <https://news.crunchbase.com/news/global-2020-funding-and-exit/>.

31 <https://www.forbes.com/sites/forbestechcouncil/2021/04/09/pandemic-fuels-global-growth-of-entrepreneurship-and-startup-frenzy/?sh=166d9fc87308>.

32 <https://www.forbes.com/sites/bernhardschroeder/2020/02/18/a-majority-of-gen-z-aspires-to-be-entrepreneurs-and-maybe-delay-or-skip-college-why-that-might-be-a-good-idea/?sh=32431df65a45>.

33 <https://worldwater.io/>.

34 <https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity>.

35 http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf.

36 <https://www.wri.org/insights/how-sustainably-feed-10-billion-people-2050-21-charts>.

37 <https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2019>.

38 <https://www.statista.com/statistics/186807/worldwide-investment-in-sustainable-energy-since-2004/>.

39 <https://rameznaam.com/2020/05/14/solars-future-is-insanely-cheap-2020/>.

40 <https://www.irena.org/costs/Power-Generation-Costs/Wind-Power#:~:text=The%20cost%20of%20electricity%20from,higher%20hub%20heights%20that%20mean>.

41 <https://news.mit.edu/2021/lithium-ion-battery-costs-0323>.

accompanied by the proliferation of startups that provide innovative solutions to enable distributed and self-generated power systems, like those in the virtual power generation domain.⁴² Beyond that, there are signs⁴³ that the buzz around clean tech is not just a fad, and global investors are increasingly stating their preferences towards sustainable assets — more than three-quarters of big global investors say they plan to stop buying into conventional funds in favor of Environmental, Social, and Governance (ESG) products.⁴⁴ At the same time, it is estimated that the transition to a low-carbon economy can create 24 million new jobs worldwide by 2030.⁴⁵ Despite all these developments, many things are still unclear, and not a single path should be taken for granted.

As GFCC Chairman Charles O. Holliday, Jr. commented⁴⁶ during the 2019 Global Innovation Summit: "We know that energy transition will happen, but we don't know precisely what that transition will be, and how quickly it will take place." Limiting global warming to 1.5°C would require massive shifts taking place now, and the use of new energy sources quickly gaining momentum. But how can we accelerate innovation in energy? Can a similar dynamic be produced in other domains that require action to build a sustainable and inclusive future? How can we create value while addressing global challenges and promoting sustainable development? What is the role of innovation in building the future society?

The COVID-19 pandemic has also stressed the need for resilience in all organizations, the economy in general, society, and individuals, with three drivers being worth mentioning. First, the frequency of epidemics⁴⁷ and other disruptive happenings, such as extreme climate events,⁴⁸ is increasing and requires new innovative types of approaches, early warning, mitigation, and quick-recovery solutions. Second, new risks are emerging, with cyber being chief among those — the pandemic itself⁴⁹ and the move to digital platforms provide good illustrations on the matter. Third, technology growth and the acceleration of business and economic transformations — the rise and death of industries, the reduction of the lifespan of companies, the need to constantly upgrade and upskill the workforce and local economies — creates the need for more resilient business models, workforce, and organizational setups.

Innovation is needed to create new value, to drive productivity and growth, to make companies and nations more competitive, to address global challenges, to create new business opportunities, and to prepare organizations and societies to face risks and rebound from extreme events. Innovation is changing, and it is challenging to keep pace with it, understand its secret sauce, and replicate models. This undoubtedly calls for strategy.

Innovation is a complex and multi-layered game, and not all opportunities are accessible to all players. Organizations, cities, and countries need to factor in their capabilities and resources when designing innovation strategies. From a national policy perspective, nations can seek two goals: 1) to accelerate the adoption of new technologies and business models, raising productivity levels economy-wide; or 2) to build a competitive edge via the development of new advanced technologies, shaping future markets and the economy. The balance between the two varies from country to country, and the latter option is hardly available to all countries. Nations — and cities to a certain extent — also need to think through their innovation toolkits, deploying contemporary tools and combining bottom-up and top-down approaches. But the innovation economy itself presents serious gaps and limitations.

Still today, innovation is mostly an elite and male-dominated game. Most of the world's population is not included in the innovation economy. Even in the United States, the most advanced economy on the globe, two-thirds of the population do not participate in the innovation economy.⁵⁰ Bringing that contingent of people into the innovation economy would generate massive opportunities for value creation. The gender gap is particularly critical when we think about innovation and, with fluctuations, consistent across nations in various stages of innovation value-chains. Worldwide, around 30 percent of the researchers in science are women,⁵¹ and the figures about female participation are starker when we think about the business sector. According to Startup Genome, only 14.1 percent of founders around the globe are female,⁵² and a mere 2.3 percent of venture capital

42 <https://tracxn.com/d/trending-themes/Startups-in-Virtual-Power-Plant>.

43 <https://fortune.com/2021/02/16/clean-tech-trends-investing-venture-capital-green-investment-trends-climate-change-electric-vehicles-hydrogen-agriculture/>.

44 <https://www.lexology.com/library/detail.aspx?g=54640853-42f9-49b2-87d7-4d99abefb4d6>.

45 <https://www.un.org/sustainabledevelopment/blog/2019/04/green-economy-could-create-24-million-new-jobs/#:~:text=As%20the%20world%20moves%20to,production%20of%20electricity%20from%20coal>.

46 <https://www.youtube.com/watch?v=wUqAgkLk18&t=5s>.

47 https://ipbes.net/sites/default/files/2020-12/IPBES%20Workshop%20on%20Biodiversity%20and%20Pandemics%20Report_0.pdf.

48 <https://www.sciencedaily.com/releases/2018/03/180321130859.htm>.

49 <https://www2.deloitte.com/ch/en/pages/risk/articles/impact-covid-cybersecurity.html>.

50 <https://www.forbes.com/sites/deborahwince-smith/2021/01/15/4-ways-the-biden-harris-administration-can-boost-us-innovation-tenfold-in-the-first-100-days/?sh=79df0fb2474>.

51 <http://uis.unesco.org/sites/default/files/documents/fs55-women-in-science-2019-en.pdf>.

52 <https://startupgenome.com/article/state-of-the-global-startup-economy>.



funding in 2020 — a year of record investment volumes — went to female-only startups, indicates Crunchbase⁵³ data. Only 12.4 percent of the decision-makers in U.S. V.C. firms are female,⁵⁴ a percentage that is even lower in Central and Eastern Europe, where only 7 percent of V.C. partners are female.⁵⁵

Bringing people of all genders, ethnicities, and geographies into the innovation economy is a major challenge. The agenda to do that encompasses a broad set of factors, from skills development to the provision of infrastructures — topics that will be explored throughout the Frame the Future series. Despite the challenges and the complexity of the matter, there should be no doubt that, in making innovation inclusive, we would generate opportunities for prosperity and growth. For instance, simply (but not simple) by addressing gender equality in the economy at large, we could add more than \$12 trillion to the global economy.⁵⁶ Imagine what could be achieved if other gaps were addressed and value creation opportunities amplified through the lens of innovation.

Frame the Future Lenses

- **Partnership:** Innovation requires the engagement of different stakeholders — from the micro (to make innovation projects happen) to the macro (to drive change in policy and innovation frameworks) levels — and partnership has to be at the core of all innovation agendas.
- **Sustainability:** Innovation is necessary to create sustainable solutions (technologies, products, processes, and models) and a focus on sustainable innovation has the potential to unleash value creation, and create new jobs, products, businesses, and even industries.
- **Resilience:** Innovation is needed to develop new organizational models, processes, toolkits to enable businesses, economies, and societies to be better prepared for future disruptions and extreme events. At the same time, a focus on resilience can generate demand for innovation.
- **Inclusiveness:** Most of the world's population are not active contributors to the innovation economy today; including all genders, ethnicities, demographics, and geographies in the innovation economy can boost innovation by expanding capacity, circulating new ideas and creating unparalleled growth opportunities for societies and the global economy.

⁵³ <https://news.crunchbase.com/news/global-vc-funding-to-female-founders/>.

⁵⁴ <https://www.axios.com/women-venture-capital-gender-equality-3811e58d-6d89-48ea-bd13-6dc3e03a8911.html>.

⁵⁵ <https://ceereport2021.experiorvc.unconventional.vc/18/>.

⁵⁶ <https://www.mckinsey.com/featured-insights/employment-and-growth/how-advancing-womens-equality-can-add-12-trillion-to-global-growth>.

Trends

- Global investment in science, technology, and innovation continues to grow.
- S&T and innovation assets are more distributed around the globe than ever before.
- Digitalization was boosted by the pandemic and is a key topic for economies.
- Innovation is gaining renewed attention in the policy arena and the corporate world.⁵⁷
- Innovation is becoming more systematized – increasingly, it is more science than art.
- Technology growth has become a central policy and business-strategy topic.
- Key technology areas such as A.I.⁵⁸ grow by double-digits every year.
- Technology drives innovation in business models and leads to shorter corporate lifespans.
- Advancements in technology open opportunities to boost innovation – e.g. simulation.
- There is a renewed interest in (advanced, technology-intensive) manufacturing worldwide.
- Venture Capital funding has reached record levels and continues to grow.
- Companies today tend to continue as private entities longer⁵⁹ than in the past.
- Open innovation is gaining speed, and CVC investment grows more than V.C. on average.
- Clean technologies are on the rise, attracting investments and corporate attention.⁶⁰
- Governments are pouring money into clean and carbon-neutral technologies.
- Innovation is behind new models to drive sustainability, like the circular economy.
- Sustainable production and consumption are being supported by new policy frameworks.⁶¹
- Entrepreneurship is on the rise, and startup ecosystems continue to grow and mature.
- There is a growing interest in mission-oriented innovation.
- Governments use missions to tackle societal challenges and develop frontier technologies.
- Women's participation in innovation is growing, but a significant gender gap persists.
- Countries continue their quests to build high-performing innovation systems.

57 <https://www.bcg.com/en-br/publications/2021/most-innovative-companies-overview>.

58 <https://www.idc.com/getdoc.jsp?containerId=prUS47482321>.

59 <https://www.forbes.com/sites/forbesfinancecouncil/2020/02/26/why-more-businesses-are-choosing-to-stay-private/?sh=f7bdf6640059>.

60 <https://fortune.com/2021/02/16/clean-tech-trends-investing-venture-capital-green-investment-trends-climate-change-electric-vehicles-hydrogen-agriculture/>.

61 https://ec.europa.eu/environment/strategy/circular-economy-action-plan_en.

Challenges

- Silo-thinking, regulations, and institutional frameworks limit innovation potential.
- There is a global gap in the understanding of innovation dynamics and processes.
- Emerging nations continue to lag behind in innovation and use old-fashioned toolkits.
- Startup ecosystems worldwide need world-class venturing expertise to mature.
- Venture capital is highly concentrated.
- Venture capital funding does not support big bets; moonshot-like projects.
- Governments evolve slower than tech and business, and lack innovation expertise.
- There is a need for long-term capital to support high-risk projects.
- Clean tech is advancing, but needs to be further accelerated to fight climate change.
- Innovation is key for sustainable development, but business cases are missing.
- Organizations, economies, and societies need to innovate to be more resilient.
- Countries do not include the majority of their citizens in the innovation economy.

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