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WORLD ECONOMIC FORUM

In collaboration with
the Centre for the Fourth
Industrial Revolution Israel

Pathways to Bioeconomy and Bioconvergence: Perspectives from Serbia and Israel

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Foreword

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The 21st century is defined by rapid technological progress, and the convergence of biological sciences and pioneering innovations. These trends are transforming industries, economies and the ways in which we address global challenges. This revolution – driven by artificial intelligence (AI), biotechnology, advanced computing, and information and communication technologies (ICT) – is already making a tangible impact on healthcare, agriculture, energy and environmental sustainability. Breakthroughs in these fields are tackling pressing issues such as climate change and disease management, demonstrating their capacity to address "real-life disruption".

This white paper, *Pathways to Bioeconomy and Bioconvergence: Perspectives from Serbia and Israel*, offers two unique yet complementary blueprints for developing a resilient and innovation-led bioeconomy. By highlighting the experiences of Serbia and Israel, we aim to provide a **helpful framework that others can draw from** to launch their own initiatives, attract investment or shape national strategies.

Both Serbia and Israel illustrate how different starting points, priorities and policy tools can lead to meaningful outcomes. Serbia is tapping into its strong ICT base while enhancing its biotechnology and AI capabilities to create a strong, sustainable bioeconomy. With the same goal, Israel is taking a focused, interdisciplinary route, positioning bioconvergence as a national strategic priority and harnessing its agile deep-tech industries.

Together, they showcase that global collaboration is a key driver in this transformation. In particular, the Centre for the Fourth Industrial Revolution Serbia and the Centre for the Fourth Industrial Revolution Israel, part of the World Economic Forum's Centre for the Fourth Industrial Revolution network, have joined forces to address global challenges and are harnessing their complementary strengths to advance these fields.

This paper doesn't propose a one-size-fits-all solution. Instead, it offers insights into how these two nations, by aligning education, policy and investment with their unique strengths, build dynamic ecosystems where science and innovation can flourish. Their stories, intertwined through public-private collaboration, strategic foresight and global engagement, are an inspiration and a practical reference for others aiming to unlock the full potential of the bioeconomy.

Preface

The Bioeconomy Initiative at the World Economic Forum aims to accelerate the global transition to a bio-based economy. In collaboration with a global community of public- and private-sector experts, this flagship initiative focuses on three key objectives: raising awareness, increasing commercial adoption and demand, and supporting an equitable and responsible transition to a bio-based economy. The initiative is organized around three complementary working groups, each addressing a core focus area: 1) conveying societal impact, 2) driving bio-enabled value chain transformation and 3) establishing enabling policy frameworks. Harnessing Forum platforms, the initiative drives coordinated action to build a better future through biological technology. Throughout the initiative's history, Serbia and Israel have played leading roles in amplifying impact – showcasing regional successes, identifying new opportunities and advancing key objectives through collaborative action.

Executive summary

Serbia and Israel are pursuing unique, technology-driven pathways to unlock the transformative potential of the bioeconomy.

This white paper explores how Serbia and Israel advance their national bioeconomy strategies through the integration of life sciences and digital technologies – particularly artificial intelligence (AI), and information and communication technology (ICT). While both countries share a commitment to innovation, economic development and sustainability, they have shaped their unique strengths and strategic priorities in different ways.

The Republic of Serbia emphasizes investment in digital infrastructure, biotechnology and AI, exemplified by the BIO4 Campus, which aims to position the country as a biotechnology hub in Eastern Europe. This paper outlines the evolution of Serbia's ICT sector (an ecosystem infused with AI) and highlights its interdisciplinary and collaborative approach, alongside strong support for the start-up community.

The Israeli model presents a somewhat different perspective. The state has identified bioconvergence as a national priority, integrating biology, engineering and computational sciences to drive innovation in healthcare, agriculture and sustainability. The Government of Israel focuses on strategic investments, research excellence and industry collaboration to position the country as a global leader in this field.

Key insights from this comparative study include:

- **Investment in research and development (R&D) and digital infrastructure**: catalysing bioeconomy growth
- **Cross-sector collaboration**: among academia, industry and government to cultivate innovation
- **Regulatory frameworks**: supporting responsible and scalable biotechnology innovation
- **Human capital development**: a fundamental driver of long-term competitiveness

Together, these case studies offer a practical reference for other countries seeking to unlock the potential of the bioeconomy. By learning from each other's successes and deepening bilateral cooperation, Serbia and Israel are not only advancing their national goals but also contributing to global scientific and economic progress.

Introduction

As exponential technologies evolve, global cooperation ensures they benefit society through responsible, ethical and transformative implementation.

The World Economic Forum's Centre for the Fourth Industrial Revolution network spans 21 national and thematic centres, each working to accelerate the responsible adoption of exponential technologies. These centres share a common mission: to advance transformative innovations in areas such as bioconvergence, artificial intelligence (AI) and digital health while generating positive impact across sectors. By harnessing this global network, the Centre for the Fourth Industrial Revolution centres collaboration and knowledge exchange, ensuring that emerging technologies are deployed in ways that benefit society while upholding ethical standards.

The role of the Centre for the Fourth Industrial Revolution Serbia in advancing bioeconomy

The Government of the Republic of Serbia and the World Economic Forum jointly established the Centre for the Fourth Industrial Revolution Serbia in 2022. It began operating under Serbia's Office for Information Technology and e-Government, with a strong emphasis on biotechnology and AI applications in healthcare. As such, the Centre for the Fourth Industrial Revolution Serbia is actively contributing to bioeconomy growth through initiatives focused on digitalizing health and genetic data, as well as the use of this data in research. By developing legislation and building infrastructure for the secure storage and responsible use of this data, the centre is paving the way for transformative advancements, including personalized medicine and data-driven bio-solutions.[1]

The centre's leadership in the **Bioeconomy Initiative** (which was launched at the Biotech Future Forum 2023 in partnership with the World Economic Forum) represents a key milestone. As co-leader of this global effort, Serbia plays a central role in shaping policy dialogue and developing frameworks that support the adoption of bioeconomy solutions. The centre leads the policy group within the initiative, working to create an environment that drives innovation while promoting ethical and sustainable practices.[2] Beyond its policy leadership, the Centre for the Fourth Industrial Revolution Serbia catalyses international collaboration through the **Biotech Future Forum**, using the platform to highlight the bioeconomy's potential to drive economic growth, sustainability and technological advancement. Now a national initiative, the Biotech Future Forum emphasizes Serbia's commitment to this field, convening leaders from government, industry and academia.[3] In parallel, the centre actively supports start-ups in the biotechnology and AI sectors by connecting them with the World Economic Forum's global network,[4] enhancing visibility, enabling collaboration and helping to integrate Serbian innovators into the international ecosystem.

The Centre for the Fourth Industrial Revolution Serbia's story is one of vision, action and tangible impact. By building infrastructure, shaping policies and empowering innovators, the centre is not only preparing Serbia for the future of bioeconomy but actively defining that future.

The role of the Centre for the Fourth Industrial Revolution Israel in advancing bioconvergence

Established in 2019 through government resolution, the Centre for the Fourth Industrial Revolution Israel (part of the World Economic Forum's global Centre for the Fourth Industrial Revolution network) was created to position Israel at the forefront of responsible technological innovation. Operating under the Israel Innovation Authority and supported through robust public- and private-sector engagement, the centre serves as a national and international platform for shaping future policies, cultivating cross-sector collaboration and accelerating ecosystem growth through the development and scaling of groundbreaking technological solutions.

The Centre for the Fourth Industrial Revolution Israel leads strategic initiatives that tackle global challenges and drive economic development. Its **Alternative Protein Initiative** positioned Israel as a global food technology leader, as highlighted in an international report published by the centre outlining this strategy to advance alternative proteins.[5] **The Israel National Drone Initiative** (INDI) pioneers next-generation air mobility through a regulatory sandbox and cross-border collaboration (including a joint webinar with the Centre for the Fourth Industrial Revolution India).[6] To connect local

innovation with global networks, the Centre for the Fourth Industrial Revolution Israel launched the **C4IR Israel Innovators Community** – a hub for Israeli chief executive officers who participate in the World Economic Forum's Innovators Communities to exchange insights, learn from peers and contribute to both national initiatives and the World Economic Forum's global innovation efforts.

As part of its **Bioconvergence Initiative**, the Centre for the Fourth Industrial Revolution Israel works closely with the head of Israel's National Bioconvergence Program and the Centre for the Fourth Industrial Revolution Serbia to address critical biotechnology challenges and create lasting global impact. As a partner of the World Economic Forum's Bioeconomy Initiative, the centre contributes to global knowledge-sharing through reports, working groups and participation in major events, including the Annual Meeting in Davos.

The Centre for the Fourth Industrial Revolution Israel recognizes that sustainable technological progress depends on robust global partnerships. By integrating cutting-edge initiatives with dynamic public-private collaboration, the centre not only tackles current challenges but also lays the groundwork for shared global growth.

Centre for the Fourth Industrial Revolution: Serbia and Israel partnership

In recent years, the Centre for the Fourth Industrial Revolution Serbia and the Centre for the Fourth Industrial Revolution Israel have not only maintained strong working relationships but have also deepened their partnership through formal collaboration agreements and joint initiatives. Their active leadership within the World Economic Forum's Bioeconomy Initiative has positioned them as strategic partners shaping global innovation agendas. They have co-developed mutual strategies and shared policy approaches, and supported one another in navigating technological and regulatory challenges. This partnership continues to serve as a model for cross-sector collaboration that seamlessly blends innovation, governance and impact.

1 Serbia's vision for a bioeconomy

Serbia is making significant strides in biotechnology and sustainable development by harnessing strong digital foundations and bioeconomic regional leadership.

The Government of the Republic of Serbia acknowledges that the Fourth Industrial Revolution is reshaping the world and transforming nearly every aspect of human life. Serbia identifies digitalization, research excellence and strategic policy-making as the core pillars of building a sustainable, bio-based economy. To advance its bioeconomy, Serbia has prioritized AI, biotechnology and its information and communication technology (ICT) infrastructure, and formulated a strategic vision for creating an innovative digital ecosystem. The country aims to strengthen its position in the international market and become a leader in digital transformation in the region.

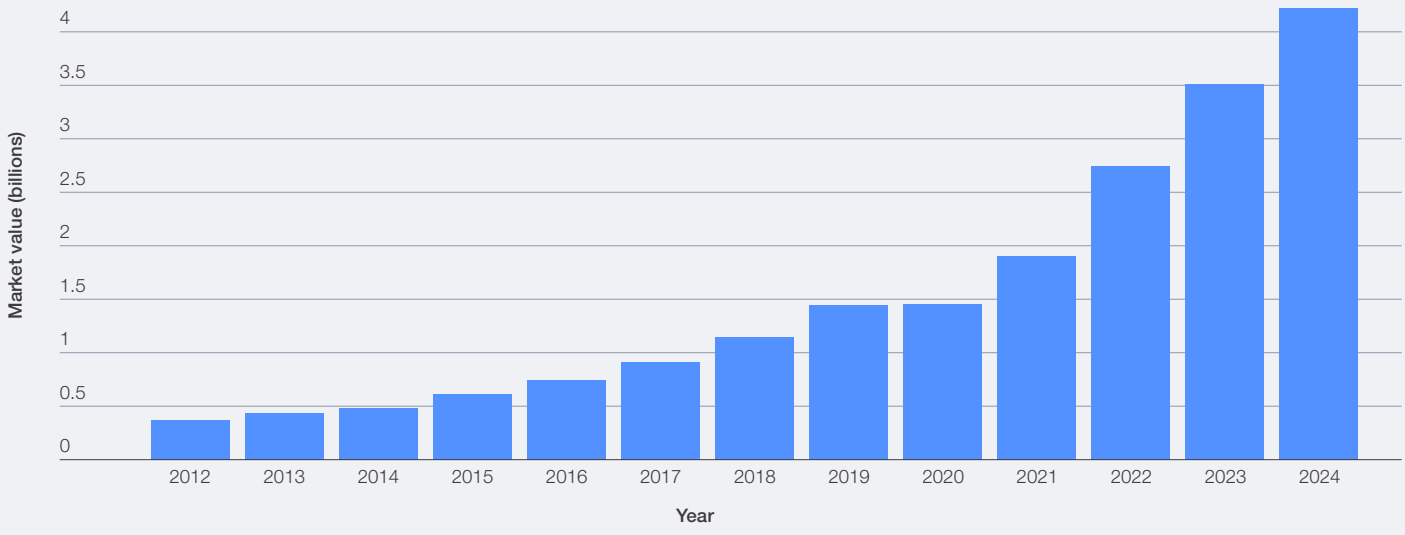
In recent years, Serbia has taken significant steps towards building a knowledge-based economy by enhancing its framework for innovation and technology development. These efforts have improved Serbia's international innovation ranking and accelerated the growth of its start-up ecosystem.

According to the *Global Innovation Index 2024*, Serbia ranks 52nd among 133 countries in innovation.[7] Additionally, the European Innovation Scoreboard 2024 places Serbia second out of 39 countries in innovation performance growth, with an increase of 4.4 percentage points compared to the previous year.[8]

Over the past decade, Serbia has harnessed its rapidly advancing ICT infrastructure to accelerate innovation across multiple sectors. The ICT sector is one of the main pillars of Serbia's economic development and, in 2024, ICT service exports reached €4.2 billion (10 times more than in the prior decade). This growth has been primarily enabled by Serbia's digitalization strategy, which actively integrates advanced technologies into the bioeconomy, positioning it as a key driver of sustainable economic growth.[9]

By aligning ICT, biotechnology and AI, Serbia is transforming its economy and emerging as a key contributor to the global biotechnology and bioeconomy landscape.[10] Through the development of an innovative and digital ecosystem, Serbia is demonstrating that even smaller nations can become influential players that shape the future of these strategic industries.

FIGURE 1 **ICT export value in Serbia 2012-2024**



Source: National Bank of Serbia. (n.d.). *Balance of payments*.

BOX 1 | **BIO4 Campus**

The BIO4 Campus, which is set to be operational in 2027, lies at the heart of Serbia's bioeconomy vision. This $600 million initiative will span 20 hectares (ha), include over 300 laboratories, research and development (R&D) centres and life science companies, and employ over 1,000 doctors and over 4,000 students from seven faculties and nine scientific institutions. As such, it will position Serbia as a new bioeconomy hub in Europe.[11]

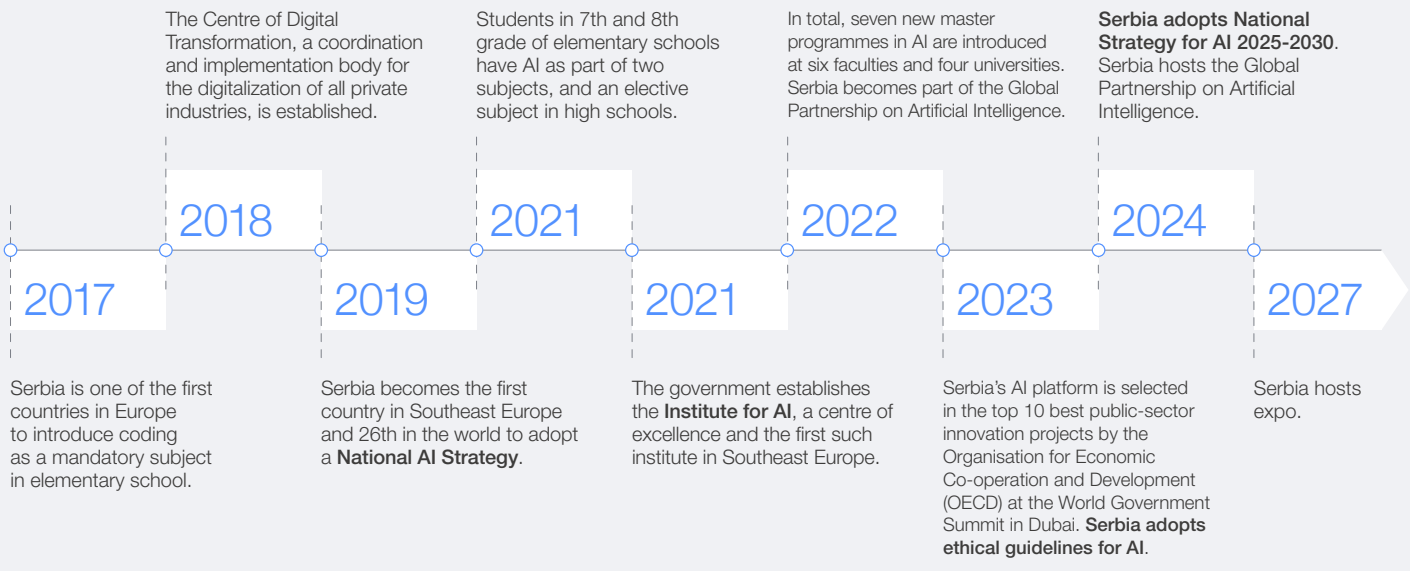
↓ **Image credit:** BIO4 Campus, Serbia

1.1 From AI and ICT to bioeconomy

AI as a catalyst for innovation

FIGURE 2 | **Overview of AI initiatives in Serbia 2017-2027**

Serbian government: Leading the way



Serbia identified AI as a strategic priority with the adoption of its **first National AI Strategy** in 2019, becoming the first country in Southeast Europe to do so.[12] Additionally, Serbia introduced AI education into school curriculums, ensuring that future generations acquire the digital skills necessary for long-term national growth.[13]

The Serbian AI ecosystem includes corporate, start-up and public sectors:

- The **corporate sector** engages in international collaborations.
- The **start-up sector** has seen rapid growth, with over 150 AI-driven start-ups located in science and technology parks in Belgrade, Novi Sad, Niš and Čačak serving as innovation hubs.[14]
- The government is investing €70 million to expand these parks, supporting innovation, entrepreneurship and technological advancement.[15]
- In 2023 alone, business entity growth reached 18% and 3,000 new start-up jobs were projected.[16]

The Innovation Fund has financed **565 innovative projects** and supported the creation of four venture capital funds. Between 2018 and 2023, Serbia recorded over $700 million in exit value across its start-ups.[17] As of 2024, Serbia is home to approximately **800 start-ups**, with more than 300 founded in the last two years. The *Startup Scanner 2024* shows over 6,000 employees (nearly double the number from 2022), while the Startup Genome estimates that the ecosystem is worth almost $1 billion, with a 6% annual growth rate.[18]

FIGURE 3 **Serbian AI start-ups**

Of the 600 start-ups in Serbia, more than 25% use AI as their core technology, and around one-third use data science.

Energy

Typhoon HIL
Power Path
KAGERA
TRAKEN
RENWAI
PODUHVAT
SmartCat

Recycling

SOMA
SOLAGRO
wool a pack

Computer vision, sensors

OTTOMETRIC
BITGEAR
Sigmoid
MACHINES CAN SEE
protech

> Serbia has embedded AI into primary and secondary school curriculums, and over 130 students are enrolled in AI-focused multidisciplinary postgraduate programmes.

Serbia has positioned itself as a cost-efficient and business-friendly destination by offering tax incentives, regulatory sandboxes for AI experimentation and a streamlined visa process for international talent. According to Oxford Insights, Serbia ranks highest in Southeast Europe on the *Government AI Readiness Index* and benefits from customs-free access to a market of almost 3 billion people through free trade agreements (FTAs) with China, the United Arab Emirates, Egypt, South Korea and others.[19]

Public-sector AI initiatives focus on applications in healthcare, smart cities, natural language processing, real-time data-driven decision-making and deep computer vision.[20] Serbia has also embedded AI into primary and secondary school curriculums, and over 130 students are enrolled in AI-focused multidisciplinary postgraduate programmes.[21] The digital transformation is further reinforced by investment in infrastructure, including the **National Data Center** and the **Institute for Artificial Intelligence Research and Development of Serbia (IVI)**.[22]

CASE STUDY 1

Mammography Project

The Mammography Project, funded by the Ministry of Health and led by the IVI and the Institute for Radiology and Oncology of Serbia (IORS), uses AI to enhance breast cancer detection. The IVI developed an AI model, which:

- Analyses mammograms
- Predicts malignancy likelihood
- Assigns a breast imaging reporting and data system (BI-RADS) score to assist physicians

Initially trained on public datasets, the model was fine-tuned with IORS data and expert feedback. It can function as a standalone web application or be integrated into a national healthcare system.

The ICT sector represents 50% of EU productivity growth.

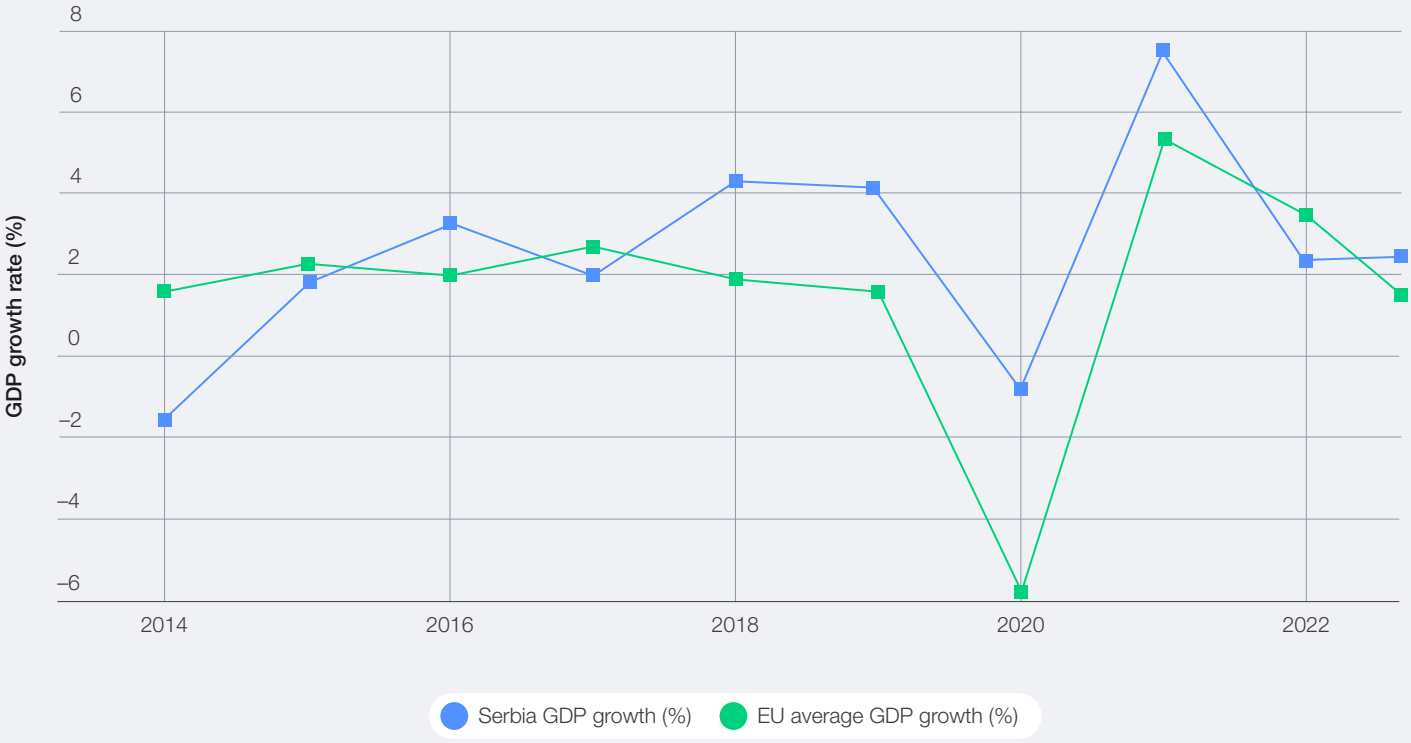
The power of ICT in economic growth

The ICT sector is massively important for the European economy. It represents 4.8% of the European economy, 25% of business R&D spending and 50% of EU productivity growth.[23]

The Serbian Government has aligned with this vision by investing in digital infrastructure, supporting ICT education and workforce development, and establishing institutions such as the Office for Information Technology and e-Government and the IVI.[24] As a result, ICT exports hit **€4.2 billion in 2024** (an increase of over 20%) and are on track to exceed **€4.5 billion in 2025**. The sector recorded a €3.23 billion surplus, employs over 109,500 professionals[25] and contributes 10% of Serbia's overall gross domestic product (GDP).[26] Additionally, the average monthly ICT salary reached €2,511 in 2024 – more than double the national average salary of €1,187.[27]

From 2018 onwards, Serbia's GDP growth has consistently outpaced the EU average. According to a study, Serbia's GDP has grown 2.5 times faster than the EU average since 2018. This accelerated growth positions Serbia among the top-performing European economies in recent years.[28]

FIGURE 4 **GDP growth rate in Serbia and the EU 2014-2022**



Source: Trading Economics. (n.d.). *GDP Annual Growth Rate Europe*; Statistical Office of the Republic of Serbia. (2024). *Economic trends in the Republic of Serbia, 2024*.

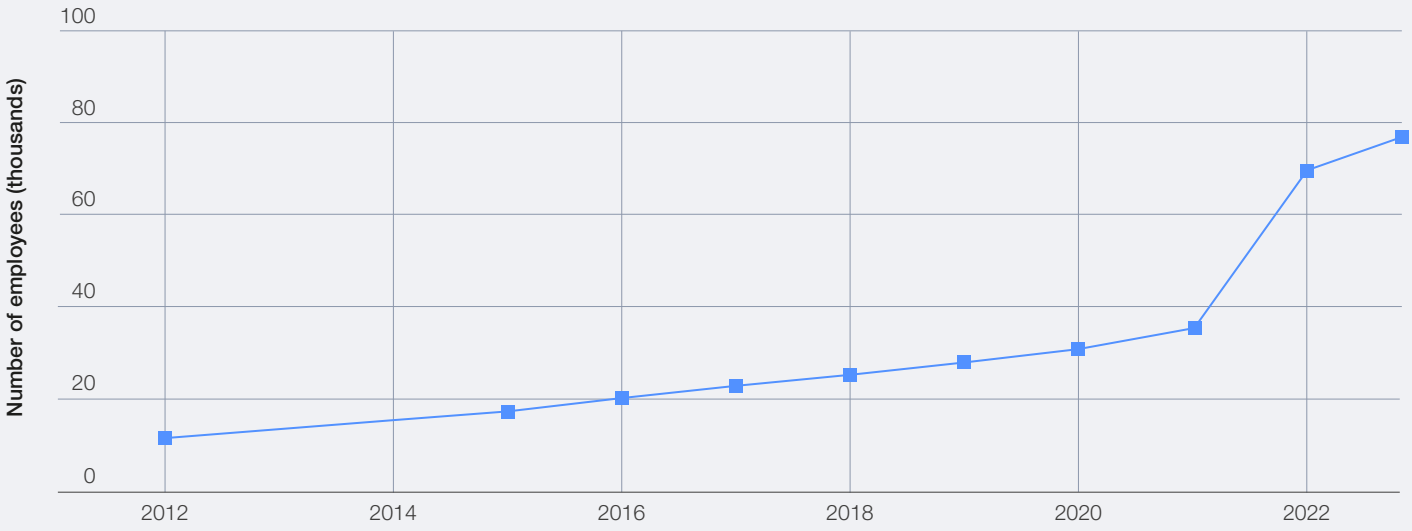
ICT and bioeconomy: a synergistic future

> **Thanks to recent state policies, the Republic of Serbia has been recognized as a regional leader in the fields of science, technological innovation and digital transformation. Investments in key infrastructure, such as national data centres, supercomputers and modern e-Government systems, are further positioning us in the highly demanding and dynamic market of participants in the Fourth Industrial Revolution. With additional investments in key digital infrastructure of national importance expected in the coming years, we are not only improving public services but also laying the foundation for future development in areas such as healthcare, natural sciences and the bioeconomy. These investments enable Serbia to continue supporting researchers, entrepreneurs and scientists, thereby significantly contributing to the improvement of the quality of life for all our citizens and setting standards for innovative scientific and technological solutions in the region, and in the broader scientific community.**
>
> Mihailo Jovanović, Director, Office for Information Technology and e-Government

The connection between ICT and biotechnology, particularly AI and bioinformatics, offers Serbia a unique opportunity to lead in precision medicine, sustainable resource management and health-focused biotechnology. The **Office for IT and eGovernment** plays a key role in this ecosystem by developing national ICT infrastructure, maintaining strategic data registries (including for genetic and biomedical data) and supporting the integration of digital technologies into public administration and scientific research.

Serbia's ICT market continues to attract leading global firms, such as Microsoft, Rivian, SAP, Schneider Electric, Stellantis, Bosch, Huawei, Oracle, Continental, Cisco Systems and Asseco. These companies have established R&D centres in Serbia or outsourced development to Serbian ICT companies. With 35 higher education institutions offering ICT programmes and over 1,500 ICT graduates annually, Serbia has a strong foundation for innovation.[29]

FIGURE 5 **Number of employees in the ICT sector 2012-2022**



Source: Trading Economics. (n.d.). *GDP Annual Growth Rate Europe*.

The BIO4 Campus further strengthens this vision. It has already signed memoranda of understanding (MoU) with global leaders like Roche, Pfizer, Takeda, Swiss Rockets, AstraZeneca, Novartis, Merck Sharp & Dohme (MSD), Merck, Medtronic, BGI and others. With its multidisciplinary approach, the BIO4 Campus aims to position Serbia as a European hub for biotechnology, bioinformatics, biodiversity and the broader bioeconomy. It integrates research, education and innovation, enabling advancements in personalized medicine and data-driven bio-solutions.[30]

CASE STUDY 2

Collaboration with Takeda

1. In 2023, the Government of the Republic of Serbia and **Takeda** signed an MoU under the umbrella of the BIO4 Campus initiative. The agreement outlined collaboration on the project, which harnesses AI for the early diagnosis of rare diseases in Serbia (with Fabry disease selected as a pilot case).[31] The goal is to reduce diagnostic complexity and shorten the time to accurate diagnosis using advanced AI tools.[32]
2. Under the European Health Data Space Regulation **(EHDS) initiative**, Serbia collaborated with the **European Institute of Innovation and Technology** and **Takeda** to organize the EHDS Morning Health Talk in Belgrade. The workshop served as a platform to explore Serbia's alignment with EHDS standards and the future implementation of health data exchanges with the European Union.[33] A white paper outlining a roadmap for health data governance, secondary use of data and digital literacy in Serbia will also be published.

CASE STUDY 3

Collaboration with Roche

1. The Non-Small Cell Lung Cancer (NSCLC) Project: Led by the Institute of Molecular Genetics and Genetic Engineering (IMGGE) in partnership with Roche and seven public clinical institutions, this project investigates the impact of NSCLC on patient outcomes. The project includes a retrospective analysis of genetic associations and secure data handling through pseudonymization, and aims to build national capacity in next-generation sequencing via public-private partnerships.[34]
2. Open Data Institute (ODI) workshop: The Centre for the Fourth Industrial Revolution Serbia organized a workshop on the data-sharing ecosystem for health in Belgrade in collaboration with ODI, with the support of Roche Serbia. The workshop focused on the value of health and genetic data, with examples from Finland, Denmark and Singapore, and explored how Serbia can adopt similar models.[35]
   - Prompted by their roundtable with the Centre for the Fourth Industrial Revolution Serbia, ODI conducted research and published a report in December 2023. This work defines strategic objectives and next steps.[36]
3. Revolutionizing Innovative Strategies for Emerging Leaders in Healthcare (RISE) Academy: This initiative is designed to equip young physicians with skills essential for 21st-century healthcare. The curriculum integrates scientific training, leadership development and digital health management, offering a comprehensive foundation for emerging medical leaders.[37]

1.2 BIO4 Campus: a future hub of Serbia's bioeconomy

Steve Jobs once predicted that the greatest innovations of the 21st century would emerge where biology meets technology.[38] According to McKinsey & Company, this biological revolution could generate $2-4 trillion in economic impact annually over the next two decades.[39]

Serbia is embracing this vision through the development of the BIO4 Campus – a multidisciplinary centre for biomedicine, bioinformatics, biotechnology and biodiversity. Backed by strong foundations in science, technology, engineering and mathematics (STEM), life sciences, global partnerships, high biodiversity and a vibrant innovation system, Serbia is investing in a future where science fuels economic growth.[40]

Located on a 20 ha site in Belgrade, the BIO4 Campus will bring together seven faculties of the University of Belgrade and nine scientific institutes. It will prompt an expansion of the Science and Technology Park and help to establish R&D centres for global and local biotechnology companies. The campus is designed as a collaborative space for academia, industry and start-ups, equipped with advanced labs and business infrastructure, a modern vivarium and a central gathering space called the "Minglarium". Additional facilities will include a congress centre, an interactive science museum and leisure spaces.[41]

Construction is set to begin in the third quarter (Q3) of 2025, with completion anticipated by the middle of 2027. However, BIO4 is already active, with ongoing biomedical and AI projects, international interest from top biotechnology companies and involvement from Serbia's scientific diaspora. BIO4 Campus will be the first project of its kind in Southeast Europe and a recognizable name on the global R&D map. It will enable evidence-based healthcare, establish national genetic bio-banks and drive advances in synthetic biology. BIO4 is more than a research centre – it is a catalyst for economic growth, scientific development and improved quality of life.[42]

> **We believe that the BIO4 Campus is the frontrunner of the future economic growth of Serbia, and we get to see its huge impact even now, at the very beginning. As a powerful platform for collaboration, it is accelerating the development of the national biotech ecosystem and integrating Serbia into the European and global landscape of science and innovation.**
>
> Smiljana Krivokuća, Director, BIO4 Campus

1.3 Building the ecosystem for a bioeconomy in Serbia

Serbia is actively building a robust bioeconomy ecosystem through investments in advanced infrastructure, forward-thinking strategies, regulatory frameworks and international collaborations. Below is an overview exemplifying key components of this interdisciplinary ecosystem.

BOX 2 **Pillars of the bioeconomy ecosystem in Serbia**

Infrastructure

- National Data Center
- National AI Platform
- Innovation District in Kragujevac
- Genetic and Biomedical Data Registry

Policy and data governance

- Law on Health Documentation and Records
- Bylaw on the secondary use of health and genetic data
- Artificial Intelligence Development Strategy (2025-2030)

Partnerships

- Biotech Future Forum
- Global Partnership on Artificial Intelligence (GPAI)
- Expo 2027

Education

- Masters 4.0 Bioinformatics
- Workshops with Regeneron
- BIO4 go-to-market strategy workshops

> Serbia is building a robust bioeconomy ecosystem through advanced national infrastructure, forward-thinking strategies and international collaboration.

Infrastructure

1. **National Data Center** in Kragujevac: Managed by the Office for Information Technology and e-Government, the centre is Serbia's most advanced data facility and a key driver of ICT and innovation. Opened in December 2023, it spans 4 ha, encompasses two buildings and complies with **Tier 4 reliability standards** (99.995% uptime). It supports state institutions, local governments, private companies, scientific parks and start-ups. Major global players like **IBM and Huawei** are already collaborating with the centre.[43]

2. **National Platform for Artificial Intelligence**: The Government of Serbia has established this national supercomputing infrastructure, which supports the development and application of AI technologies across the public sector, scientific research and industry (including start-ups).[44]

3. **Innovation District in Kragujevac (opening in 2026)**: Spanning 85 km², the district will include zones dedicated to bioinformatics, bioengineering, smart cities, AI, ICT and cybersecurity. It will host research laboratories, co-working spaces, training centres and conference facilities, becoming a hub for innovation and cross-sector collaboration.[45]

4. **Genetic and Biomedical Data Registry**: This centralized registry will securely store all human genetic data generated in Serbia, link it to health data and enable secondary use of anonymized and pseudonymized genetic and health data for research. Access will be granted with ethical oversight, ensuring alignment with the General Data Protection Regulation (GDPR) and Serbia's Data Protection Law.[46]

Policy and data governance

1. **Law on Health Documentation and Records**: This legislation governs the creation, management and integration of medical data within the National Integrated Health Information System. It defines data requirements for local health information systems and establishes centralized registries, including the centralized Electronic Health Record and the Genetic and Biomedical Data Registry.[47]

2. **Bylaw on the secondary use of health and genetic data**: This regulation sets protocols for responsible reuse of sensitive data, supporting innovation while ensuring data security and patient privacy.[48]

> Belgrade is set to become a hub for education, culture and innovation, with plans to convene representatives from various countries in the Serbian capital for the Specialised Expo.

3. **Artificial Intelligence Development Strategy (2025-2030)**: Building on the foundational AI Strategy (2019), the new strategy[49] focuses on:
   - Establishing a comprehensive legal and ethical framework
   - Enhancing AI education and public awareness
   - Supporting AI R&D and innovation
   - Promoting adoption in key sectors (e.g. healthcare, agriculture)
   - Expanding infrastructure and data management systems

Partnerships

1. **Biotech Future Forum**: Since its launch in 2022, the conference has gathered over 3,000 participants from all over the globe. This annual event in Belgrade has become a national initiative and a global hub for showcasing advancements in biotechnology and AI. The Government of the Republic of Serbia, the World Economic Forum, the United Nations Development Programme (UNDP) and BIO4 Campus are responsible for the organization of the forum. The conference promotes collaboration among global leaders, scientists, entrepreneurs and policy-makers, providing a unique opportunity to explore emerging trends, exchange ideas and develop solutions in these fields. The 2025 edition, scheduled for 27-29 October, will feature an exclusive scientific programme implemented in collaboration with Nature Journals.[50]
2. **Global Partnership for AI (GPAI)**: Serbia hosted the GPAI Summit in December 2024 in collaboration with key government bodies and international organizations. The event emphasized responsible AI development and societal benefits, culminating in the adoption of the Belgrade Declaration. Over 500 global experts participated, including 70 speakers across 25 sessions.[51]
3. **Expo 2027**: Belgrade is set to become the global hub for education, culture and innovation in 2027, with plans to convene representatives from various countries in the Serbian capital for the Specialised Expo. The Specialised Expo 2027 in Belgrade, themed “Play for Humanity”, will unite the world with inspiration, innovation and joint solutions to global challenges.[52]

Education

1. **Masters 4.0 Bioinformatics**: This initiative is led and implemented by the Centre for the Fourth Industrial Revolution Serbia in collaboration with the Ministry of Education. Its goal is to modernize university curriculums by adding needed bioinformatics programmes and providing necessary knowledge and skills to future bioinformatics experts in Serbia. The ministry awarded funds to three consortia, enabling them to introduce their programmes at the University of Belgrade and the University of Kragujevac. Besides the faculties, these consortia encompassed research institutes and representatives from the industry.[53]
2. **BIO4 Campus Go-to-Market Strategy Workshop**: Organized and implemented by BIO4 Campus in April 2025, this workshop focused on different go-to-market strategies for products and technologies commercialized through scientific innovations. The goal was to drive revenue growth and strengthen the presence of Serbian scientists in the market.[54]
3. **Workshop with Regeneron**: The Centre for the Fourth Industrial Revolution Serbia and Regeneron will organize a dynamic half-day event to inspire and engage top PhD students from three Serbian universities. Regeneron will have a dedicated session tailored to the needs and interests of students and respective faculties. These sessions will be followed by a hands-on segment led by Serbian experts, with remarkable contributions from the Regeneron Genetics Center.[55]

1.4 Serbia's participation in international bioeconomy networks

In 2023, the **Centre for the Fourth Industrial Revolution Serbia** joined the **Global Alliance for Genomics and Health (GA4GH)** to adopt international standards for genetic and health data, and became part of the **Genome of Europe consortium** alongside IMGGE. The consortium submitted a Digital Europe project, which sequenced 100,000 European genomes in an effort to establish a reference genome for Europe.[56] Serbia also initiated a three-year process towards full membership in the **European Molecular Biology Laboratory (EMBL)**, supporting scientific collaboration and infrastructure sharing.[57] Additionally, Serbia became the 33rd member of the **AI Governance Alliance** under the **World Economic Forum**, accelerating AI development with a focus on sustainability, resilience and security.[58]

Serbia has been participating in **EU research and innovation programmes** since 2007, steadily advancing its national research and innovation policies, and strengthening its participation in EU initiatives. Since 2014, Serbia's performance in these programmes has quadrupled, making it the most successful country from the Western Balkans in the EU's research and innovation programmes.[59] In December 2021, Serbia became a fully associated member of Horizon Europe, the EU's key funding programme for research and innovation. Demonstrating its research excellence, Serbia achieved an 11.53% success rate in Horizon 2020 projects, securing over €102.6 million in funding.[60]

1.5 Challenges and final thoughts

Serbia is navigating a few bumps in the road as it works to advance its biotechnology and bioeconomy sectors. While some solid policies are in place, there's a real need to align them more efficiently with international standards and regulatory bodies. Simplifying the approval processes could help attract foreign investment and spark innovation. For long-term growth in biotechnology, it's critical to have both private and public financing. This means that finding new funding sources – like venture capital grants and strategic partnerships – is key to maintaining research and commercialization. Additionally, to really compete on the global stage, Serbia needs to develop top-notch research facilities, boost its biomanufacturing capabilities and ensure easy access to innovative technologies. Building a strong bioeconomy ecosystem will also rely on promoting collaboration among research centres, industries and policy-makers. This collaboration should focus on sharing knowledge, launching incubation projects and encouraging cooperation across various sectors to drive progress.

The bioeconomy of Serbia is at a crucial point, supported by deeply interconnected institutions, a responding research ecosystem and positive feedback trends in biotechnology. The innovation-based strategy represented by the BIO4 Campus (and the country more generally) signals a clear desire to harness cutting-edge science as part of a forward-thinking economic strategy. Identifying solutions to systemic issues, encouraging innovation and improving Serbia's competitiveness in the international landscape will all be crucial to addressing these problems and maintaining investments in the long term. The initiatives presented in this paper will support this small country in overcoming challenges. Measurable impact is already leading to remarkable growth. The bioeconomy sector holds great promise, and a careful balance that enhances regulatory clarity, boosts financial sustainability and facilitates knowledge transfer will be key to realizing that potential.

2 Spotlight on bioconvergence in Israel

Israel positions bioconvergence as a national growth strategy, harnessing deep-tech capabilities to address global cross-sector challenges.

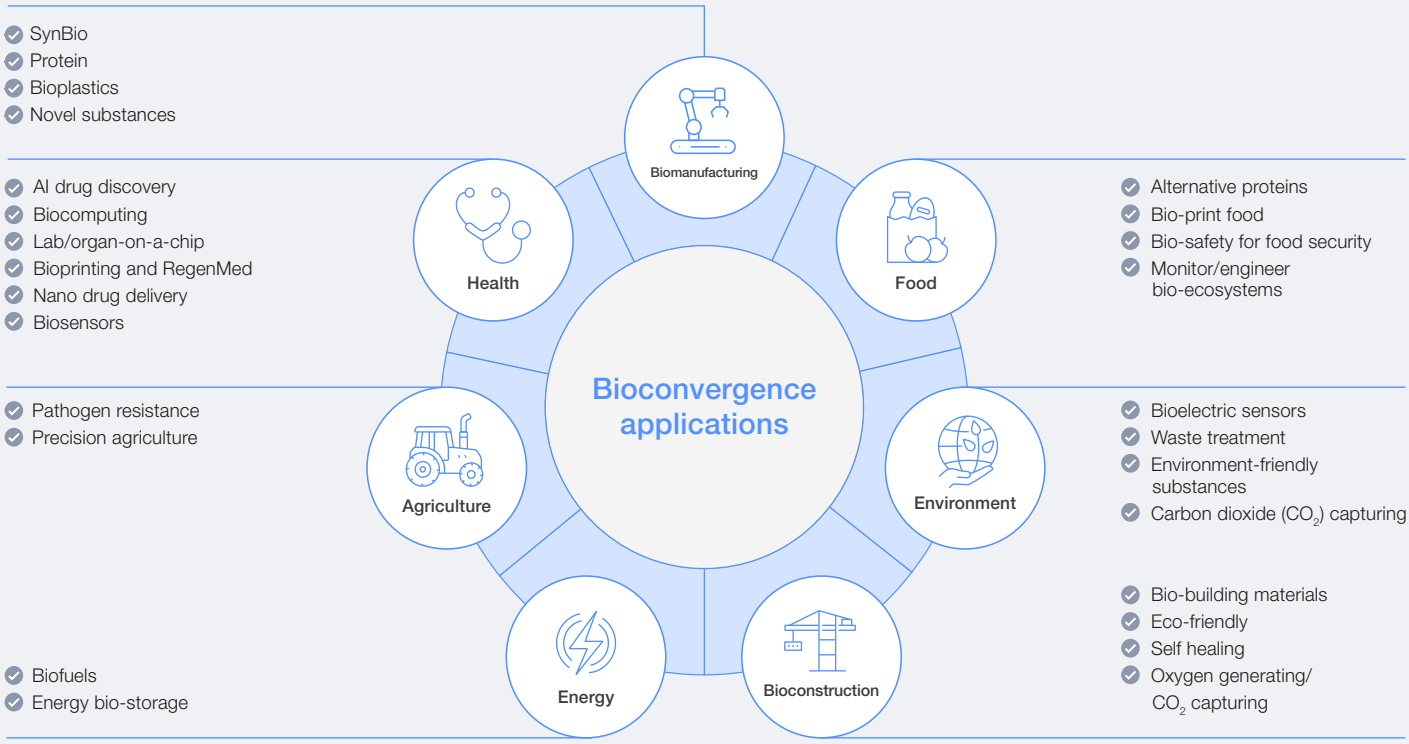
2.1 Bioconvergence acceleration

Breakthroughs in life sciences, combined with rapid advances in engineering, miniaturization, computation and AI, are fuelling a new wave of interdisciplinary innovation known as the bioconvergence revolution.[61] According to McKinsey & Company,[62] up to 60% of the physical inputs into the global economy could be biologically produced within the next two decades – generating an estimated $4 trillion in annual direct economic impact.

In 2018, the Israel Innovation Authority, Israel's independent public innovation agency, officially identified the term bioconvergence to describe the integration of biological sciences with engineering, computational technologies and software.[63] Recognized as a strategic priority, bioconvergence is now considered a cornerstone of Israel's technological and economic growth.

Crucially, the impact of bioconvergence extends well beyond healthcare. As highlighted in Figure 6, its applications span agriculture, food, energy, environment and other areas,[64] showcasing its role in addressing complex global challenges through the fusion of disciplines and the creation of scalable, cross-sector solutions.

FIGURE 6 **Bioconvergence applications**



Source: Israel Innovation Authority. (2025). *Internal presentation*.

2.2 A global hub for disruptive technologies

Israel has established itself as a global hub for technological innovation, driven by a unique combination of world-class research, entrepreneurial culture and strategic government support. This ecosystem cultivates groundbreaking advancements in deep-tech sectors, including bioconvergence, alternative proteins and digital health.

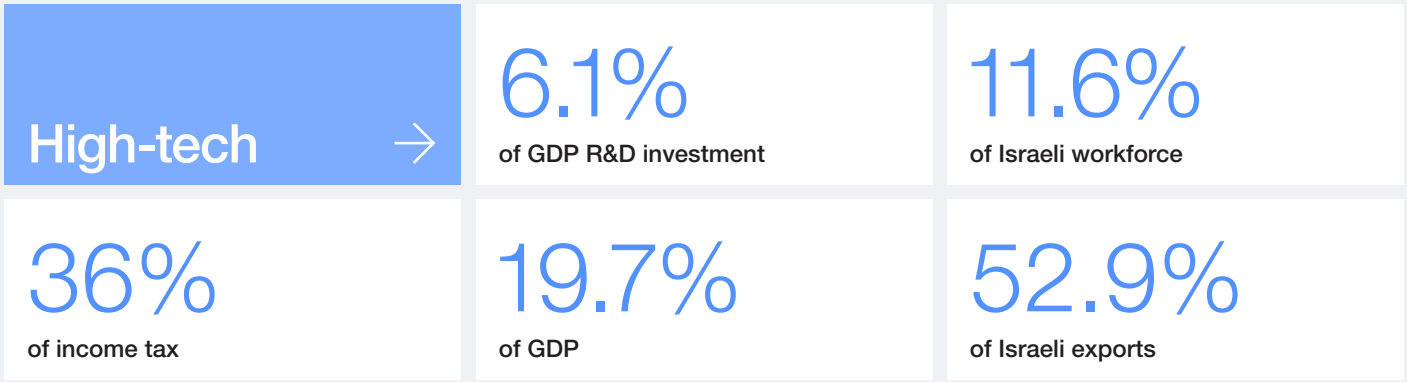
> **Disruption doesn't happen by chance – it is the result of deliberate choices. In Israel, we've made a national commitment to lead where we already have relative advantage and can bring added value to the global market. Bioconvergence is not just a scientific evolution – it's our strategic bet on the future. By merging biology, engineering, AI and other technological disciplines, we are redefining innovation and building technologies that will shape global industries for decades to come.**
>
> Dror Bin, Chief Executive Officer, Israel Innovation Authority

The country invests more in R&D as a percentage of GDP than any other Organisation for Economic Co-operation and Development (OECD) nation (6.3% of GDP).[65] (Figure 7)

FIGURE 7 **Gross domestic expenditures as a percentage of GDP**

Source: Organisation for Economic Co-operation and Development (OECD). (n.d.). *Gross domestic spending on R&D*; Main Science and Technology Indicators (MSTI). (n.d.). *Internal database*.

FIGURE 8 | **High-tech: the main pillar of the Israeli economy**



Source: Israel Innovation Authority. (2024). *2024 Annual Report: The State of High-Tech*.

Israeli academia: fertile ground for talent and innovation

Israel's success in bioconvergence is driven by exceptional synergy between its academic institutions and high-tech industry. Leading universities – five of which rank among the top 50 globally for producing start-up founders[66] – generate a constant stream of talent and breakthrough research. Robust research activities further support the vibrant academic-to-market pipeline. Approximately 500 new PhDs in bio-related fields graduate each year.[67] Meanwhile, the Israel Central Bureau of Statistics (CBS) data for 2023 shows that 58.3% of post-doctoral research was conducted in the natural sciences – with 29.4% in biological sciences, 20.7% in physical sciences and 8.2% in mathematics, statistics and computer science.[68] These figures underscore the country's strong research foundation, which fuels translational innovations in biotechnology. Through comprehensive technology transfer frameworks and close collaborations between academia and industry, Israel not only cultivates groundbreaking discoveries but also rapidly transforms them into market-ready solutions. This action solidifies its global leadership in bioconvergence and other disruptive technologies.

2.3 Policy-driven innovation and strategic investments

> **Technology-based economic engines may form 'bottom-up', nurtured by natural assets – but when multiple parameters are involved, this might require government assistance in a 'top-down' manner. Israel owns many assets in biology, engineering and computation but it is the National Bioconvergence Program that accelerates their synergistic combination, fills the gaps between them and facilitates the growth of a sustainable full-fledge economic engine.**
>
> Shai Melcer, Head, National Bioconvergence Program, Israel Innovation Authority

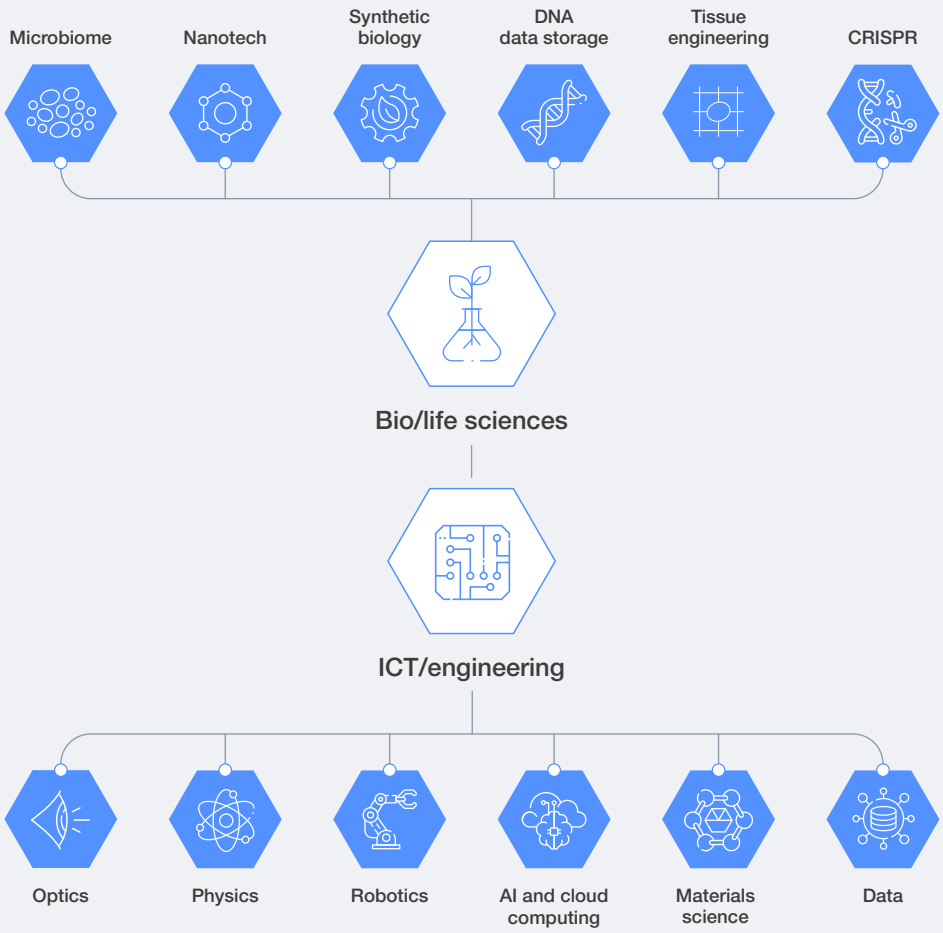
To position Israel as a global leader in bioconvergence, the government launched the National Bioconvergence Program, led by the Israel Innovation Authority. Designed by leaders from academia, healthcare, industry and venture capital, the programme was approved in 2022 with an initial NIS 435 million (Israeli shekels) budget, which equates to approximately $133 million. The programme executed by the National Infrastructure Forum for Research and Development (TELEM), focuses on research excellence, R&D infrastructure, human capital, facilitative regulation and multidisciplinary innovation. Priority fields include bioengineering devices, synthetic biology, "theranostics", bioprinting and environmental microbiomes. With additional phases and private-sector matching, total investment is expected to reach NIS 2 billion (approximately $610 million) over 10 years. These strides will support both academic and industrial leadership in bioconvergence.

FIGURE 9 | **The National Bioconvergence Program**

162 companies

$58 million
2024 programme investments

$164 million
total since 2022



Source: Israel Innovation Authority. (2025). *Internal database*.

Implementation

Now in its third year, the programme's initiatives are advancing. TELEM partners promote their objectives by funding innovative bioconvergence research proposals, multidisciplinary bioconvergence infrastructure, training programmes for 1,000 biologists and engineers, and a call for proposals for bioconvergence technologies with complex regulatory paths. The achieved milestones contribute to Israel's dynamic innovation landscape.

FIGURE 10 | **Bioconvergence public investments**

Human capital

In total,12 Israel Innovation Authority programmes (NIS 5.6 million) and additional national R&D initiatives (NIS 3.5 million)

Facilitative regulation

Consultation pilot programmes with Ministry of Health assisting clinical design and trials of (currently three) complex bioconvergence health technologies

Core facilities

Alagene, YD Labs – fermentation process development, from proof of concept to scale up (NIS 26 million); Israel centre for biochips/devices design, prototyping and small-scale manufacturing (NIS 75 million)

Multidisciplinary R&D

Direct investment in BC companies by the Israel Innovation Authority (NIS 308 million) and in academic research groups by the Ministry of Science and Technology (NIS 40 million)

R&D consortia

Bio-chip (NIS 40 million);organospheres (NIS 17 million); liquid BX (NIS 52 million); bioplast bio-based/degradeable polymers (NIS 25 million); Black Soldier Fly (NIS 25 million) – circular economy

Multiomix

Multiomix infrastructure (NIS 15 million) and high-cost research equipment (NIS 47 million), both funded by the Israel Council for Higher Education

Source: Israel Advanced Technology Industries. (2025). *IATI Israel's Life Science & Health-Tech Annual Industry Report 2024-25*.

Elevating research excellence

Investing in cutting-edge research infrastructure is critical to advancing bioconvergence and breakthrough innovations. The programme has elevated research excellence through substantial investments, including in the establishment of the Multiomix infrastructure (NIS 15 million) and procurement of high-cost research equipment (NIS 47 million), funded by the Israel Council for Higher Education (VATAT). Additionally, targeted R&D consortia are cultivating specialized innovations.

- Bio-chip (NIS 40 million): cutting-edge biological chips driving novel applications
- "Organospheres" (NIS 17 million): methods for cultivating and characterizing organoids, driving new drug discovery and personalized medicine
- LiquidBX (NIS 52 million): early disease detection through the integration of sensors and AI in liquid biopsy methods
- Bioplast (NIS 25 million): development and implementation of biodegradable polymers and plastic materials
- Black Soldier Fly (NIS 25 million): circular economy initiatives incorporating AI tools and genetic editing of black soldier flies

> To date, the authority has supported the training of 1,000 biologists and engineers through specialized programmes in bioconvergence.

Building diverse human capital

Emerging fields like bioconvergence face significant human capital challenges. To address these, the Israel Innovation Authority established the Human Capital Fund, which supports targeted training programmes aimed at expanding the talent pool, accelerating start-up creation and reinforcing Israel's global leadership in the sector.

To date, the authority has supported the training of 1,000 biologists and engineers through specialized programmes, including 12 initiatives funded with NIS 5.6 million, alongside other national talent development efforts totalling NIS 3.5 million. The following two programmes demonstrate the tangible impact of these efforts.

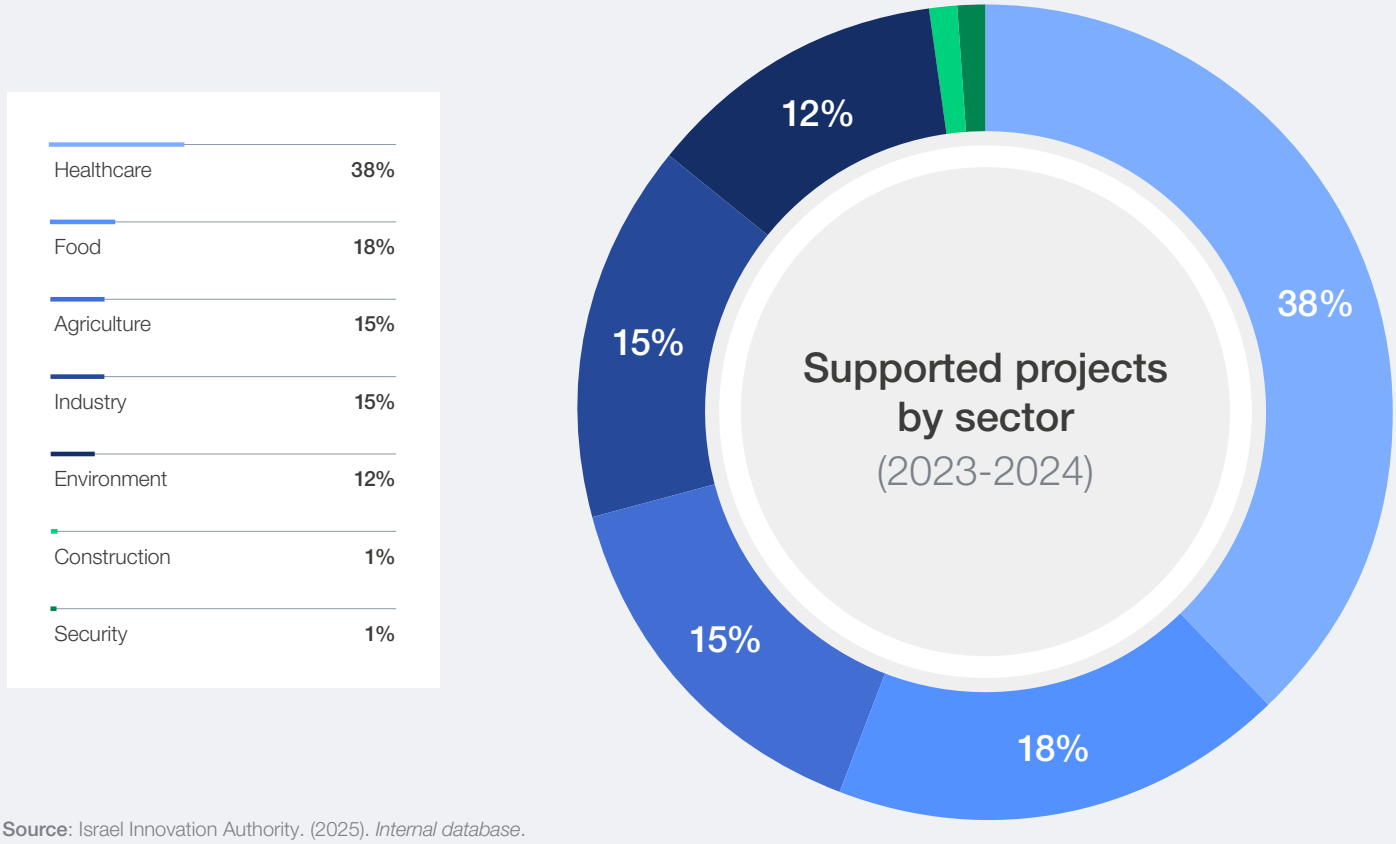
- **SpearHealth**, part of the 8400 Health Network, is a unique training programme for senior technology and business professionals transitioning into the healthcare sector. It offers a structured path combining in-depth industry knowledge, hands-on experience and direct access to the ecosystem. Since its launch, **130 participants** have graduated – **50%** of whom have moved into executive or entrepreneurial roles – resulting in **30 new ventures**.

- AlphaWave by BrainstormIL focuses on nurturing multidisciplinary talent in bioconvergence and cultivating collaboration between academia, industry and entrepreneurship. The programme trained **80 participants** (over **50% women**) out of **400 applicants**, with **40%** of alumni now working in the industry. It also contributed to two Innovation Authority-funded initiatives. Notably, one of these is working towards company formation.

Supporting multidisciplinary R&D

Multidisciplinary R&D is central to Israel's bioconvergence strategy. The Israel Innovation Authority invested NIS 308 million (approximately $94 million) in bioconvergence companies, while the Ministry of Science and Technology granted NIS 40 million (approximately $12 million) in academic research. These investments support innovations such as smart implants, cybernetic tissues, non-invasive brain sensors and environmental sensing. In both 2023 and 2024, NIS 20 million (around $6 million) was allocated for bioconvergence research. A new national call for proposals in "theranostics" for 2025 was also issued. As shown in Figure 11, healthcare leads in supported projects (38%), followed by food (18%), agriculture (15%) and environment (12%). This cross-sector investment approach reinforces Israel's commitment to translating cutting-edge research into real-world solutions.

FIGURE 11 **Supported projects by sector 2023-2024**



Source: Israel Innovation Authority. (2025). *Internal database*.

> Israel's bioconvergence ecosystem has undergone remarkable growth, evolving into a dynamic hub of interdisciplinary innovation.

Enhancing multidisciplinary R&D infrastructure

Government leadership is instrumental in promoting emerging fields in the fast-paced innovation landscape. The Israel Innovation Authority has been taking decisive action, laying the groundwork for bioconvergence. Through targeted investments in multidisciplinary R&D infrastructures, the government cultivates collaborative hubs that support industry. These facilities, equipped with cutting-edge tools and expert support, drive cross-sector partnerships, accelerate breakthrough discoveries and ensure these discoveries translate into real-world applications. They demonstrate how strategic public intervention can drive technological and economic impact. The following examples illustrate how this approach is being implemented across key infrastructure projects:

- **YDLabs**: Established in 2022, YDLabs operates Israel's first fermentation pilot for food technology and agricultural technology. Its multidisciplinary team supports scale-up to 1,000 litres, optimizing production processes for sustainable, high-yield biomanufacturing.
- **Alagene**: This synthetic biology platform uses the "design, build, test, learn" (DBTL) model to engineer fungi, bacteria and yeast. It offers R&D services and expert consultation in product development, regulation and intellectual property (IP), advancing biotechnology applications in health, food, energy and agriculture.
- **Bio-chips**: Currently in development, BioChip infrastructure will support R&D for bio-devices in health, agriculture and the environment. Once established, it will be equipped with chip fabrication technology, bioprinters, wet labs and prototyping tools to enable the development of smart implants, microfluidics, sensors and other technologies.

Progressive enabling regulation

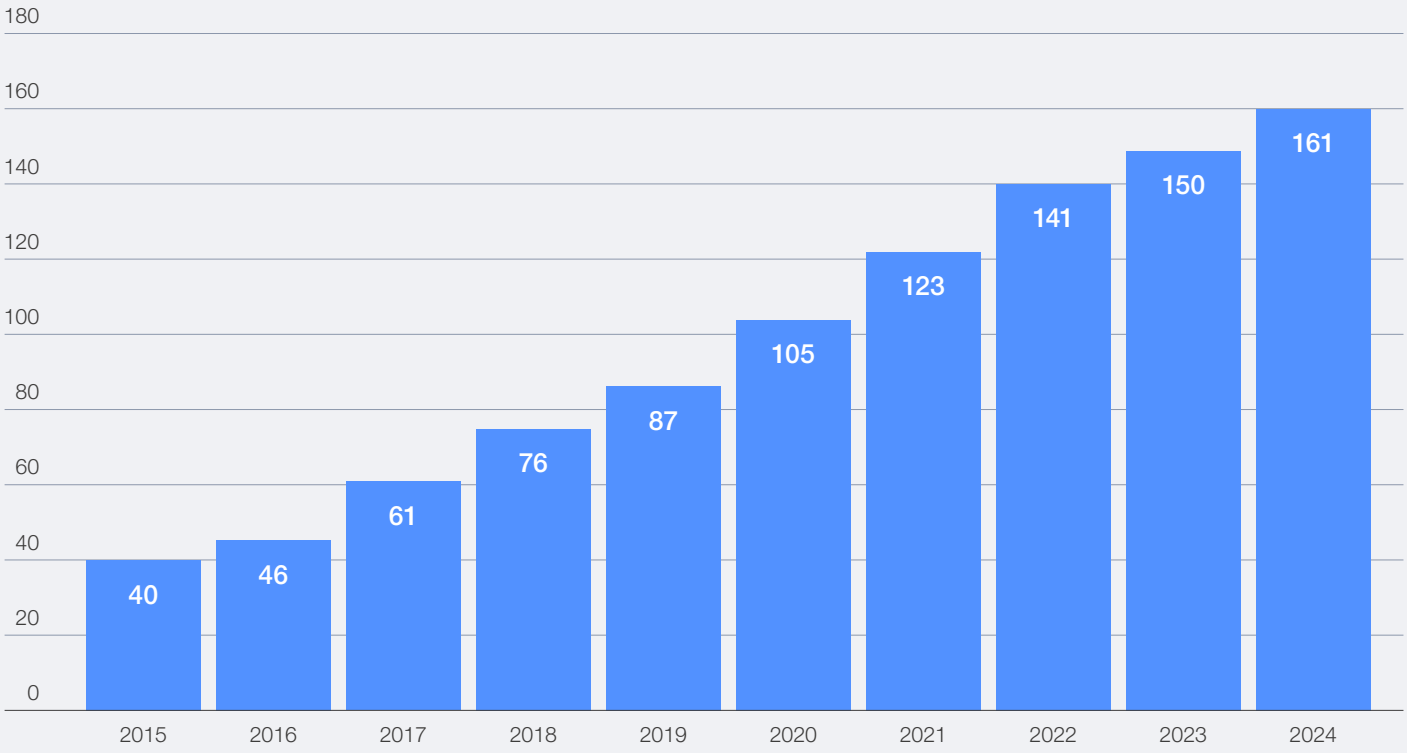
The Disruptive Innovation Program provides technology companies with a regulatory sandbox to develop and validate bioconvergence technologies, easing market entry through early regulatory support. By enabling facilitative regulation and consultation pilots with the Ministry of Health, the programme accelerates clinical development and helps companies overcome global regulatory barriers.

- **SpotitEarly** combines the scent detection abilities of trained dogs with AI and machine learning (ML) for breath-based diagnostics. This approach faces regulatory challenges, as no similar canine-based cancer tests exist in the US, complicating Food and Drug Administration (FDA) approval. To support this, Israel's Ministry of Health is developing clinical validation guidelines and quality standards for the biological components while addressing the AI aspects of SpotitEarly's LUCID platform to ensure safety and transparency.
- **Precise Bio** fabricates tissues from human cells and natural materials to address the shortage of donor tissue and unmet therapeutic needs. Its initial focus is on ophthalmology. The platform integrates cell biology, biomaterials, engineering and clinical aspects to create transplantable tissues. Precise products are regulated as "combination products" or biologics license applications (BLAs). Since this project is the "first in the world" to transplant a 3D bio-printed cornea, the regulatory aspect has been a significant challenge. Close collaboration with the Israel Ministry of Health over the last year and a half has facilitated a clear path towards the clinic.

2.4 Israel's bioconvergence sector: a thriving entrepreneurial ecosystem

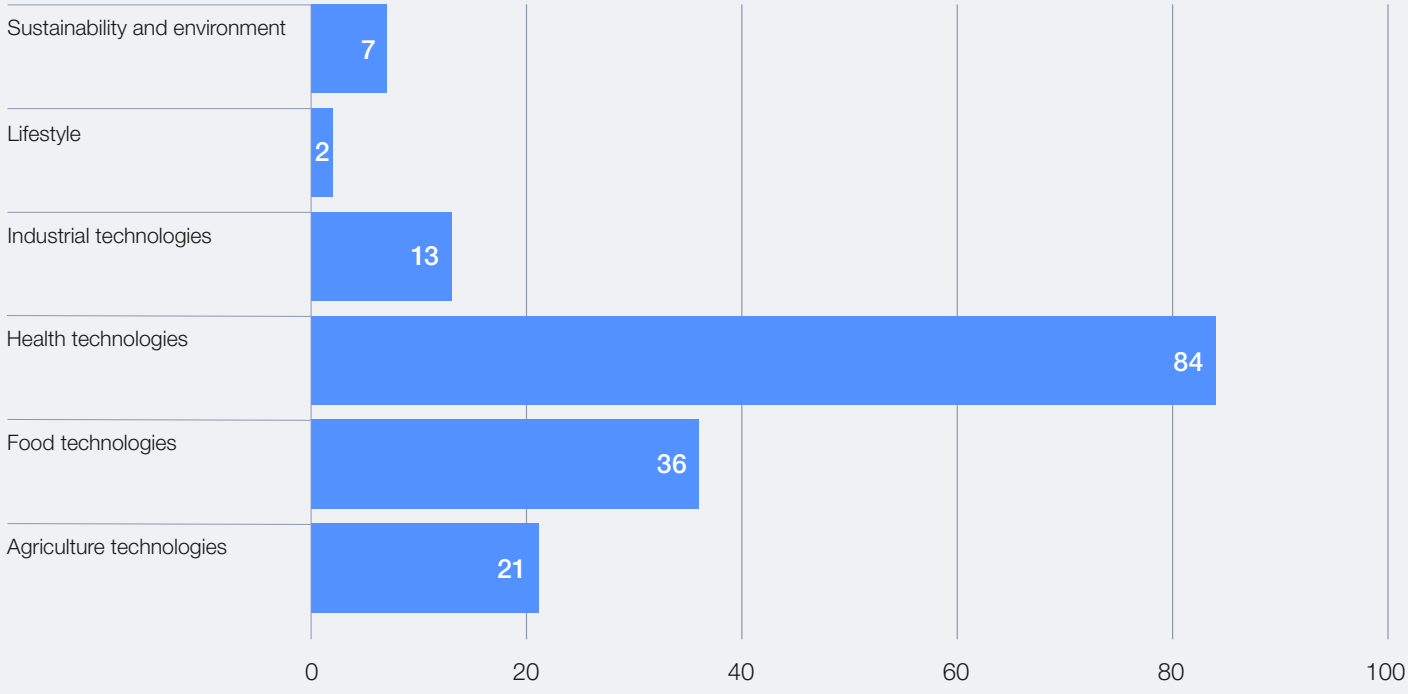
Over the past decade, Israel's bioconvergence ecosystem has undergone remarkable growth, evolving into a dynamic hub of interdisciplinary innovation. Since 2015, the number of companies operating in the field has increased fivefold – from approximately 30 to over 160 today (Figure 12). This expansion reflects a strategic national focus on integrating biology with engineering, data science and advanced technologies. As shown in Figure 13, health technologies represent the largest share at 51.5%, followed by food technologies (22.1%) and agriculture technologies (12.9%). Smaller shares are seen in the industrial (8.0%), sustainability and environment (4.3%), and lifestyle (1.2%) sectors. This distribution reflects the field's broad applicability as well as its potential to address diverse global needs through a multidisciplinary approach.

FIGURE 12 | **Number of bioconvergence companies in Israel 2015-2024**



Source: Israel Innovation Authority. (2025). *Internal database*.

FIGURE 13 | **Distribution of companies by sector**



Source: Israel Innovation Authority. (2025). *Internal database*.

> Israel's bioconvergence ecosystem has evolved into a dynamic hub of interdisciplinary innovation, reflecting a national strategic focus.

1. Enzymit

(Biomanufacturing/cell-free production)

Enzymit integrates AI-driven enzyme design with cell-free production. Enzymit's proprietary platform combines computational protein engineering, high-throughput screening and advanced biochemistry to develop novel enzymatic processes for specialty chemicals. By applying this multidisciplinary approach, Enzymit creates highly efficient, scalable and sustainable production routes for molecules in pharmaceuticals, cosmetics and nutrition. Enzymit's technology exemplifies the fusion of life sciences, computational modelling and industrial chemistry, enabling cost-effective biomanufacturing that overcomes traditional fermentation limitations and expands the possibilities of synthetic biology.

Enzymit is part of the World Economic Forum's Tech Pioneers Community and the C4IR Israel Innovators Community.

2. ImmunAI

(Health/personalized medicine)

ImmunAI aims to revolutionize drug discovery and development through an AI model of the immune system. It takes over 10 years to bring a drug to market, with a less than 10% success rate. ImmunAI's products optimize decisions around drug development and clinical trials, improving statistics and patient outcomes. ImmunAI's platform uses a multidisciplinary approach, integrating cutting-edge single-cell technologies, functional genomics, big data and ML to support therapeutic discovery and development. ImmuneAI partners with leading pharmaceutical and biotechnology companies, academia and hospitals to optimize their preclinical and clinical decision-making.

ImmuneAI is part of the Global Innovators Community of the World Economic Forum and the C4IR Israel Innovators Community.

3. Biotic

(Environment/circular economy)

Biotic develops biodegradable, bio-based polymers using marine-derived feedstocks like macroalgae. The technology integrates biotechnology, materials science and environmental engineering. By harnessing biological processes, Biotic creates sustainable alternatives to conventional plastics, addressing plastic pollution while ensuring performance and scalability. The solution is applicable across various industries, including packaging, agriculture and medical devices, illustrating how cross-disciplinary collaboration can lead to effective sustainability advancements in response to pressing environmental challenges.

4. BugEra

(Agricultural technology/feed/circular economy)

The black soldier fly efficiently decomposes organic waste, converting it into oil and protein. BugEra, a US/Israeli start-up, harnesses black soldier flies and biotechnology to develop innovative strains for sustainable solutions across various industries. The company focuses on the waste-to-biofuel, sustainable feed and biomanufacturing sectors, driving a circular economy model. BugEra advances renewable bio-based energy, eco-friendly feed alternatives and biomanufacturing processes. It promotes a sustainable, circular bioeconomy as part of its efforts to address significant global environmental challenges.

5. Starstone

(Bioconstruction)

Starstone is transforming construction by creating a sustainable, bio-based alternative to cement through biomineralization. As part of this process, bacteria grown on agricultural feedstock react with calcium and high-purity carbon dioxide (CO_2) to form a calcium carbonate ($CaCO_3$) binder, merging biology, chemistry and engineering. Traditional cement production contributes 8% of global CO_2 emissions, and rising construction demands strain resources. Starstone's technology reduces emissions and facilitates sustainable future infrastructure construction, addressing environmental challenges and ensuring sustainable development for generations.

6. Aleph Farms

(Food technology/alternative protein/cultured meat)

Aleph Farms is pioneering cellular agriculture – a new way to make a wide range of animal products directly from animal cell cultivation, with a fraction of the resources, no climate impact (net zero) and no reliance on local arable land or climate. Aleph uses AI to accelerate bioprocess optimization, lower costs and increase the scalability of animal cell production, opening new opportunities for the bioeconomy. Its first product is a cultivated beef cut meeting flexitarians' need for healthy, sustainable and ethical proteins.

Aleph Farm is part of the Global Innovators Community of the World Economic Forum and the C4IR Israel Innovators Community.

7. AION Labs

(Health/AI-driven drug discovery and development)

Applied computational biology is a key driver of health innovation in Israel. It harnesses advanced computational tools to analyse complex biological data (including genomic sequences and protein structures), accelerates drug discovery and enhances production efficiency. AION Labs exemplifies this through a first-of-its-kind venture studio built by an alliance of global pharmacology leaders, technology giants and top-tier investors. AION Labs is developing and integrating AI technologies that have the potential to revolutionize drug discovery and development, with the ultimate goal of improving human health. The unique partnership includes AstraZeneca, Merck Group, Pfizer, Teva, the Israel Biotech Fund, Amiti Ventures and Amazon Web Services (AWS), powered by the BioMed X Institute and supported by the Israel Innovation Authority.

AION Labs, launched in 2021, uses a venture studio model to connect global pharmacology leaders with AI and biotechnology innovations. By enabling cross-sector partnerships, data sharing and expert mentorship, it reduces risk and accelerates start-up success. To date, it has launched nine start-ups, which have raised over $27 million – generating private investment with a fourfold return on the funding received from the Israel Innovation Authority.

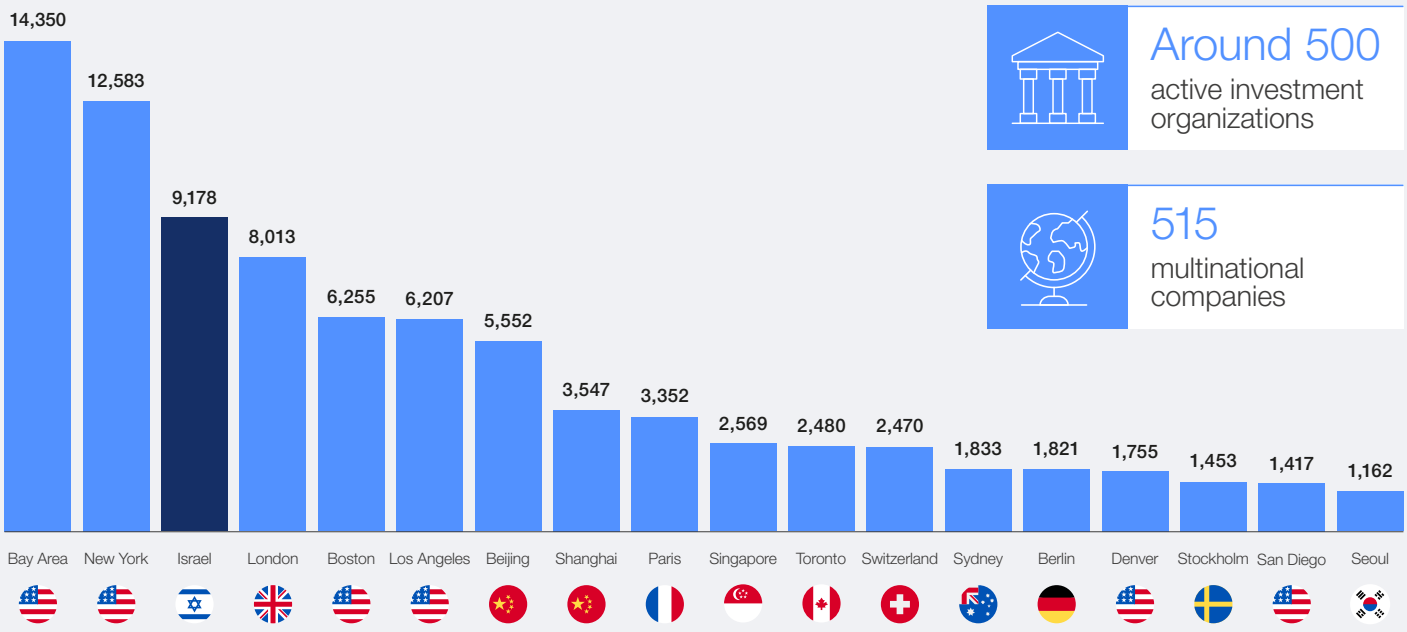
2.5 Global partnerships and cross-border collaboration

> **Global collaboration is essential to unlock full potential and ensure that scientific and technological progress translates into real-world impact. Through shared knowledge, partnerships and trust, we can build a more resilient and connected future.**
>
> Shani Dayan, Project and Partnership Manager,
> Centre for the Fourth Industrial Revolution Israel, Israel Innovation Authority

Israel's innovation ecosystem ranks third globally in active technology companies, hosting over 500 active investment organizations and 515 multinational corporations (Figure 14), and fuelling extensive international collaboration. This global engagement is evident in high-impact initiatives such as:

- **Merck Israel** plays a key role in the OrganoSpheres Consortium, which unites industry and academia to develop 3D cellular systems for pharmaceutical R&D. The consortium focuses on optimizing 3D cellular systems for tumour models, translating these into clinical research and drug discovery. It aims to create cellular systems that mimic vascular structures and immune responses, using innovative methods to characterize cultures and AI applications, and predict cellular behaviour.
- **IBM's Israel Research Lab** participates in various bioconvergence projects, collaborating with the Massachusetts Institute of Technology (MIT), the Hebrew University and the Technion. Through the AI Alliance's Drug Discovery Working Group, it partners with global IBM labs and partners like the Cleveland Clinic Foundation and Boehringer Ingelheim. Biomedical foundation model (BFM) technologies make use of multimodal data – including single-cell ribonucleic acid (RNA) sequencing and over one billion drug-like molecules – to expand the search for novel molecules while refining candidate selection based on molecular structure and dynamics.

FIGURE 14 | **Number of active technology companies that raised capital in prominent hubs**



Source: Israel Innovation Authority; CrunchBase; Israel Venture Capital (ICV) Research Center data.

Israel's leadership in bioconvergence is built on strategic investment, academic excellence and a vibrant start-up ecosystem.

Beyond its collaborations with industry leaders like Merck and IBM, Israel also plays a significant role in shaping global regulatory standards. For instance, the Ministry of Health has partnered with many countries both bilaterally and multilaterally to facilitate ongoing dialogue on pertinent issues and policies, collaborate on essential projects and technologies, and promote harmonization of best regulatory practices. This includes collaborations with organizations leading global healthcare policies, such as the World Health Organization (WHO) and the OECD, in regulatory forums such as the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH) and the International Medical Device Regulators Forum (IMDRF). This engagement also occurs in international collaborative projects such as Project Orbis (for oncology products).

Future strategic approaches

Israel's leadership in bioconvergence is built on strategic investment, academic excellence and a vibrant start-up ecosystem – but continued progress depends on addressing several key national challenges.

As bioconvergence spans diverse sectors (such as health, food technology, agriculture and sustainability), tailored integration strategies are required to meet varying regulatory, technical and market needs. The interdisciplinary nature of the field also necessitates a shared professional language to integrate expertise in biology, engineering and computation.

Israel's small size presents a unique infrastructure challenge. Unlike larger countries that can support massive physical R&D platforms, Israel must focus on shared national infrastructures and efficient resource allocation to remain globally competitive. At the same time, navigating regulatory complexity is essential – frameworks must evolve to support the fast pace of innovation while ensuring safety and public trust.

To unlock the full potential of bioconvergence, Israel must continue to cultivate cross-sector collaboration, align its regulatory environment and attract diverse funding sources. The following steps can be applied to achieve this:

- **Establish mechanisms for serial venture creation**: Transitioning from organic, entrepreneur-driven venture creation to a proactive "venture-studio" approach will systematically generate bioconvergence start-ups. International collaborations will be prioritized to enhance these mechanisms.

- **Expand multinational corporation (MNC) activity in Israel**: Encouraging MNCs to participate in venture creation platforms – such as studios and incubators – and to establish bioconvergence R&D units targeting various applications and markets will bolster the ecosystem.

These objectives aim to directly enhance the private sector by stimulating early-stage R&D and supporting growth efforts. This strategy mirrors the successful trajectory of Israel's high-tech sector and represents a natural progression towards establishing a robust bioconvergence ecosystem.

Conclusion

This paper explores the bioeconomy and bioconvergence through the lens of Serbia and Israel, **providing a roadmap for other countries looking to harness ICT, AI, engineering and life sciences to fuel economic growth**. The key takeaway is that, despite differing starting points, both nations have focused on building strong bioeconomy foundations, and their unique paths offer valuable lessons for other regions. These examples show that **countries can adapt and implement similar strategies** by building on their own strengths, resources and institutional frameworks. They demonstrate that there is no one-size-fits-all model, but rather a set of adaptable principles that can guide national bioeconomy development.

Serbia thoughtfully integrates ICT infrastructure with its bioeconomy vision. The BIO4 Campus, for instance, symbolizes Serbia's dedication to attracting investment and spurring innovation within a bright ecosystem. By putting a focus on education, creating a business-friendly atmosphere and making substantial investments in AI and digital infrastructure, Serbia is laying a solid foundation for lasting success in the bioeconomy. What's more, the nation's focus on data governance and public-private partnerships illustrates its proactive stance in tackling the complexities of this field.

With the same goal, **Israel** has adopted a more concentrated and diversified model by emphasizing bioconvergence as a strategic national priority. The country's substantial investments in multidisciplinary research and human capital development distinguish it as a global leader. Israel's approach demonstrates how a clear national strategy, supported by significant government funding, can rapidly accelerate growth in bioeconomy sectors. Collaboration between academia, industry and government is central to Israel's success. This highlights how aligning these sectors can unlock vast potential.

Although Serbia and Israel have taken different approaches, shaped by their distinct economic contexts and starting points, this diversity strengthens their shared message. Their experiences demonstrate that, regardless of a country's size or economic power, strategic vision and targeted investments in ICT and life sciences can drive meaningful bioeconomic development. Serbia and Israel both showcase how tailored national strategies supported by smart policies and cross-sector collaboration can unlock the potential of the bioeconomy. **This paper serves as a roadmap for countries at various stages of development, demonstrating how both small and large nations can harness ICT and life sciences to boost their bioeconomy**. It draws on the experiences and strategies of Serbia and Israel, harnessing these stories to provide a roadmap for a sustainable, innovation-driven, bio-based future.

Policy directions

Both Serbia and Israel exemplify a valuable lesson: when governments make smart investments, they can significantly boost their bioeconomy and bioconvergence efforts. Even though they approach it differently, both countries emphasize three key areas that can drive progress: 1) making sure there's equitable access to infrastructure in order to promote excellence, 2) creating flexible policies that support research and innovation, and 3) transforming education systems to develop future-oriented professionals.

A few key policy directions come to light from the comparative analysis of Serbia and Israel:

- Investments: Ongoing investment in both fundamental and applied research is essential, especially in AI and data science. This should reach various bioeconomy sectors, focusing on areas that can generate major economic impact and societal benefits.

- Interdisciplinary collaboration: Strong collaborations between academia, industry and government are critical for successful bioeconomy and bioconvergence initiatives. It's crucial to address barriers like bureaucratic red tape and funding constraints to support this cooperation.

- Human capital development: Encouraging a skilled workforce capable of navigating multiple disciplines is essential. Education programmes should mirror the interdisciplinary nature of bioeconomy and bioconvergence, balancing theoretical knowledge with practical skills.

- Data governance and ethics: Establishing clear, strong frameworks for data governance is necessary to ensure the ethical and responsible use of sensitive health and genetic data. Regulations should prioritize data privacy, security and interoperability while supporting data use for research and innovation.

- Regulatory harmonization: Simplifying regulations and the approval process for innovative technologies and businesses will catalyse participation in the bioeconomy ecosystem.

Looking ahead

As the fields of bioeconomy and bioconvergence rapidly evolve, Israel and Serbia are uniquely positioned to lead with complementary strengths. This paper highlights not only their progress to date but also the global and local challenges they continue to face – ranging from infrastructure limitations and interdisciplinary communication to regulatory harmonization and early-stage venture creation.

Deepening the partnership between the Centre for the Fourth Industrial Revolution Serbia and the Centre for the Fourth Industrial Revolution Israel will be essential to unlocking new opportunities. By harnessing their shared experiences, national strategies and active roles within the World Economic Forum's bioeconomy community, both centres can amplify their impact through co-developed frameworks, mutual policy learning and expanded innovation ecosystems. Global stakeholders across academia, industry and policy are invited to engage, collaborate and co-create scalable solutions.

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