



2018-19

Innovation in Israel overview

Introduction - Innovation Authority Management

This report presents the Innovation Authority's analysis of the challenges and opportunities facing the innovation system in Israel. We have endeavored to create a professional and interesting document that will serve as a focal point for decision makers, for the industry, and for those, both in Israel and abroad, who are interested in Israeli innovation. Accordingly, the report encompasses key topics relating to current innovation policy in Israel and surveys the central technological and economic trends in the high-tech industry, both locally and around the world.

As part of this report, we are proud to present the Innovation Authority's accomplishments during 2018. The Authority, now entering its third year of operation (following the transition from the Chief Scientist's Office), is in the midst of heightened activity. This activity is directed at implementing the five-year program that includes detailed objectives and goals, the highlights of which are presented in this report.

The State of Israel is facing significant challenges in the field of innovation during a period in which artificial intelligence is establishing itself as the central technological platform of our generation. In recent years, many countries rich in resources, have realized the power of innovation as key to economic growth and are investing huge sums in innovation and in research. These challenges will occupy center-stage in the Innovation Authority's activity in the coming years.

Extensive government cooperation is required in order to ensure the State of Israel's leading position in the global innovation competition, and to increase the economic and social impact of innovation activity in Israel. In 2018, the Innovation Authority strengthened its collaboration with a range of government departments responsible for central sectors of the Israeli economy, and we intend to continue striving towards this goal in the years to come.

We wish to thank the Authority's Strategy and Economy Division for preparing and editing this report. We would also like to thank all the Authority employees and the members of the Authority Council for their devoted and productive work during 2018 and to congratulate the entire Authority on the many achievements that typified this past year. We invite our partners in government and industry to continue acting together with us in 2019 in order to advance Israeli innovation and to expand its influence on the Israeli economy.

Sincerely,

Dr. Ami Appelbaum
Chairman, Innovation Authority
Authority
And Chief Scientist in the Ministry
of Economy and Industry

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State of Innovation in Israel 2018
Israel Innovation Authority

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Israeli Innovation Breaks the Boundaries

Israeli Innovation Breaks the
Boundaries Introduction



INTRODUCTION

Israeli innovation has attained great heights in recent decades. Israel is a global center with a vibrant innovation culture based on interdisciplinary capabilities, a spirit of entrepreneurship and strong technical skills. Recent years have witnessed a flourishing of Israeli hi-tech that is expressed by widespread activity of multinational corporations, innovative startup companies, and Israeli growth companies.

The “High Tech in Israel 2018” Chapter of this report will describe yet another year of impressive achievements for Israeli innovation. This has been attained despite the challenging period in which the world order has destabilized, following world trade wars and tax reforms instituted by the Trump government. It is especially worth noting the breakthrough of sectors such as Fintech and artificial intelligence (IA) alongside the maturing of growth companies in the “traditional” fields of internet, cyber, medical devices etc.

However, if Israel wants to make the transition from a startup nation to a smart-up nation, the Israeli innovation ecosystem must break through the boundaries within which it presently operates.

Israeli innovation is defined by several dimensions. Technologically, the majority of the innovation activity is focused in the ICT sector. From a geographical perspective, the dominant mass of activity is still concentrated in central Israel, with only relatively low activity even in major cities like Haifa, Jerusalem, and Beersheba. From a demographic perspective, approximately half of all high-tech employees are up to 45-year-old non-Haredi Jewish men.¹ Moreover, technological innovation has yet to breach the bounds of the high-tech industry. As a result, the overwhelming majority of Israeli citizens do not feel that they live in a “technological” country in areas that affect their daily lives such as transportation, commerce, finance, and access to public services. The upshot is that the huge economic and social potential inherent in Israeli innovation remains largely unfulfilled.

Our perception is that innovation is a key engine for economic growth and wellbeing. As such, all citizens, sectors, regions and spheres all life in Israel should benefit from it. A central theme in our State of Innovation in Israel report for 2017 was increasing the number of employees in innovation-based firms. In the current report, we present a vision of the Israeli innovation breaking boundaries in several additional dimensions.

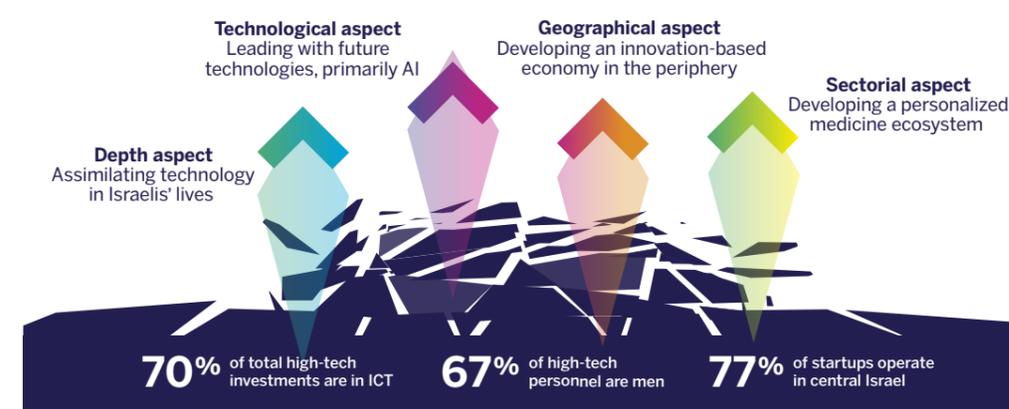
In the “Technology Power Race” Chapter, we will discuss the challenge of the technological dimension – the competition on leadership in the technologies of the future. This is especially relevant when set against the background of intensifying global competition in emerging technologies, primarily in artificial intelligence.

In the “Personalized Medicine” Chapter, we will present the challenge in the sectorial dimension – how to breach the bounds of ICT and develop a leading personalized medicine ecosystem in Israel. Israeli industry enjoys significant advantages in areas of unique medical data: It is based on the health funds’ computerized medical files, on genomic databases, on sophisticated basic science, and on the proven capability of the Israeli ecosystem in ICT, all of which place Israeli industry at an excellent starting point.

In the “Innovation-Driven Economy in the Periphery” Chapter, we will present the challenge of the geographical dimension – breaching the borders of innovation activity that is currently located primarily in central Israel and bringing it to the rest of the country. We will propose a practical strategy based on bolstering high-tech in the metropolises, improving utilization of the human capital potential in the periphery and strengthening the regional advantages via technological innovation.

Finally, in the “From a High Tech Industry to a Smart Economy” Chapter, we will present the “depth” dimension of the challenge – how to cause Israeli technological developments to become an integral part of daily life in Israeli society. We will propose possible directions for closing the gap between Israel and the leading Western nations that increased the level of their populations’ accessibility to advanced technologies in all areas of daily life.

Israeli Innovation Must Break New Ground



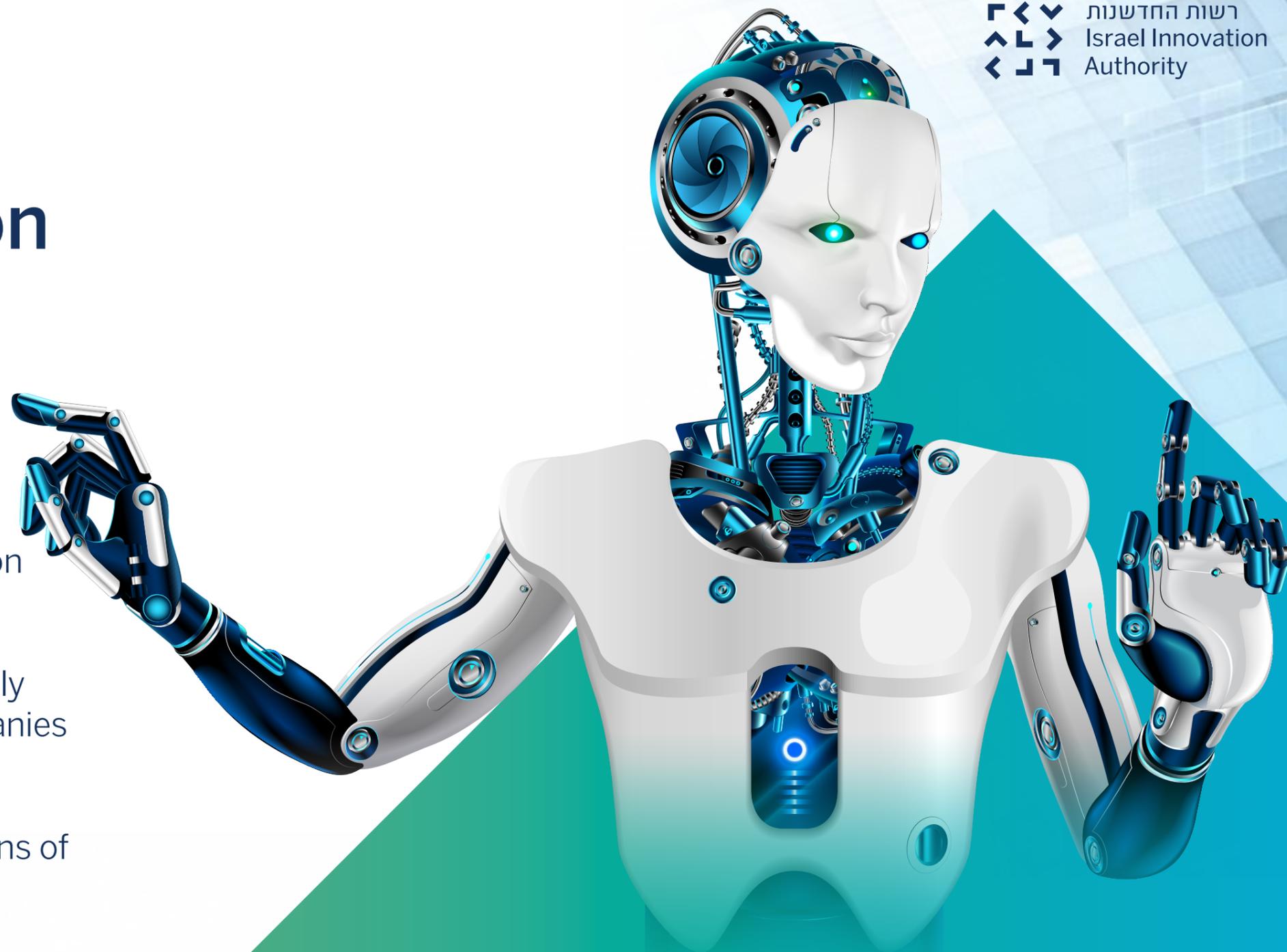
Breaking through the boundaries of Israeli innovation is a multi-layered national mission. In order to become a leader in the technologies of the future, Israel needs to invest in research infrastructures, in human capital in academia, and in industrial R&D. Development of an innovation-driven economy in the periphery requires determined action, both on local and national levels; coordination between all government health and innovation bodies is needed in order to develop a personally-tailored healthcare ecosystem; support from regulators in different sectors is necessary to implement Israeli technological developments in the local economy.

The Innovation Authority is therefore cooperating with a range of government departments in order to promote these goals. In so doing, we have asked our government partners to contribute to this report and present their proposed solutions and detailed suggestions for contending with the relevant challenges and objectives.

The report features short vision-focused articles written for us by the Ministry of Health, the Ministry of Education, the Council for Higher Education's Planning and Budgeting Committee (PBC), the Ministry of Transport, the Ministry of Energy, the Ministry for environmental protection, the Ministry of Economy and Industry, the Ministry of Agriculture and the Ministry of Finance together with the Ministry of Justice.

In summary, in this report we seek to promote the transformation of Israel from a startup nation to a smart nation, a move that will benefit the Israeli economy and enhance the welfare of its citizens. Global technological, economic, and social trends are today converging to create a window of opportunity, one the Innovation Authority will strive determinedly to seize for the benefit of the State of Israel.

¹ CBS data – Labor Force Survey, 2017



➤ The Innovation Authority

Soaring achievements

The Innovation Authority's vision is to establish Israel as a world leader in innovation and entrepreneurship that frequently grows innovation-driven companies that provide extensive, highly productive employment for all population groups and all regions of the country



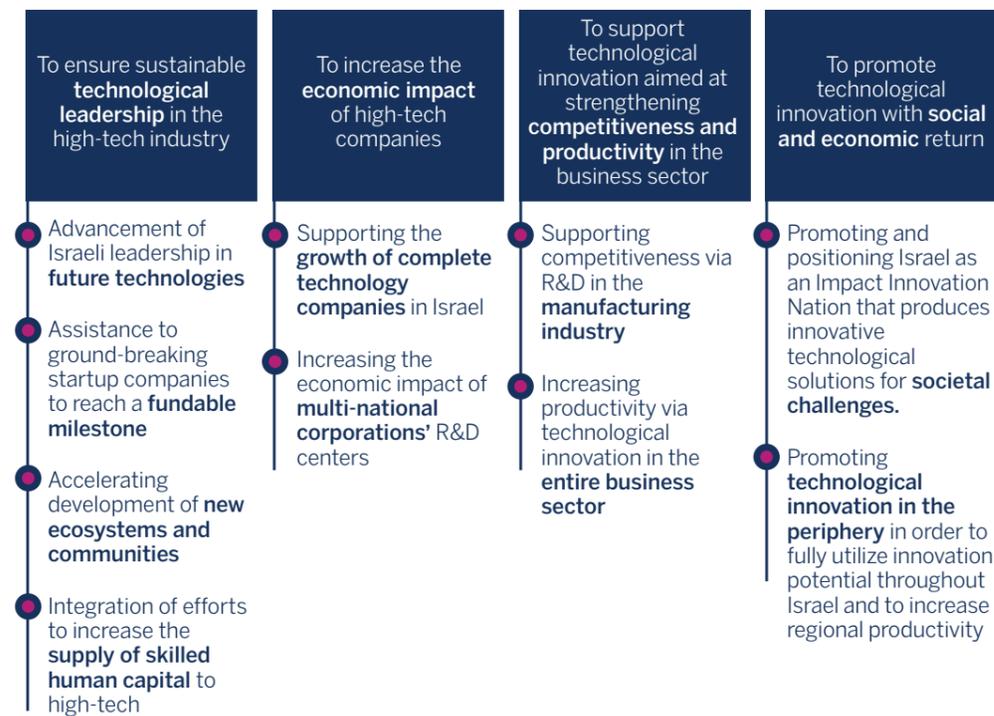
The Innovation Authority Soaring achievements

The Innovation Authority's Activity in Numbers – 2018



2018 was a productive year for the Innovation Authority, marking the outset of the implementation of the Authority's five-year strategic program, which was granted approval by the Authority's Council over the course of the year. The Council is comprised of representatives of the Ministry of Economy and Industry, the Ministry of Finance, and of the industry and the public, under the leadership of Dr. Ami Appelbaum, Chief Scientist for the Ministry of Economy and Industry and Chairman of the Board of the Innovation Authority. The program is centered on ten primary strategic goals:

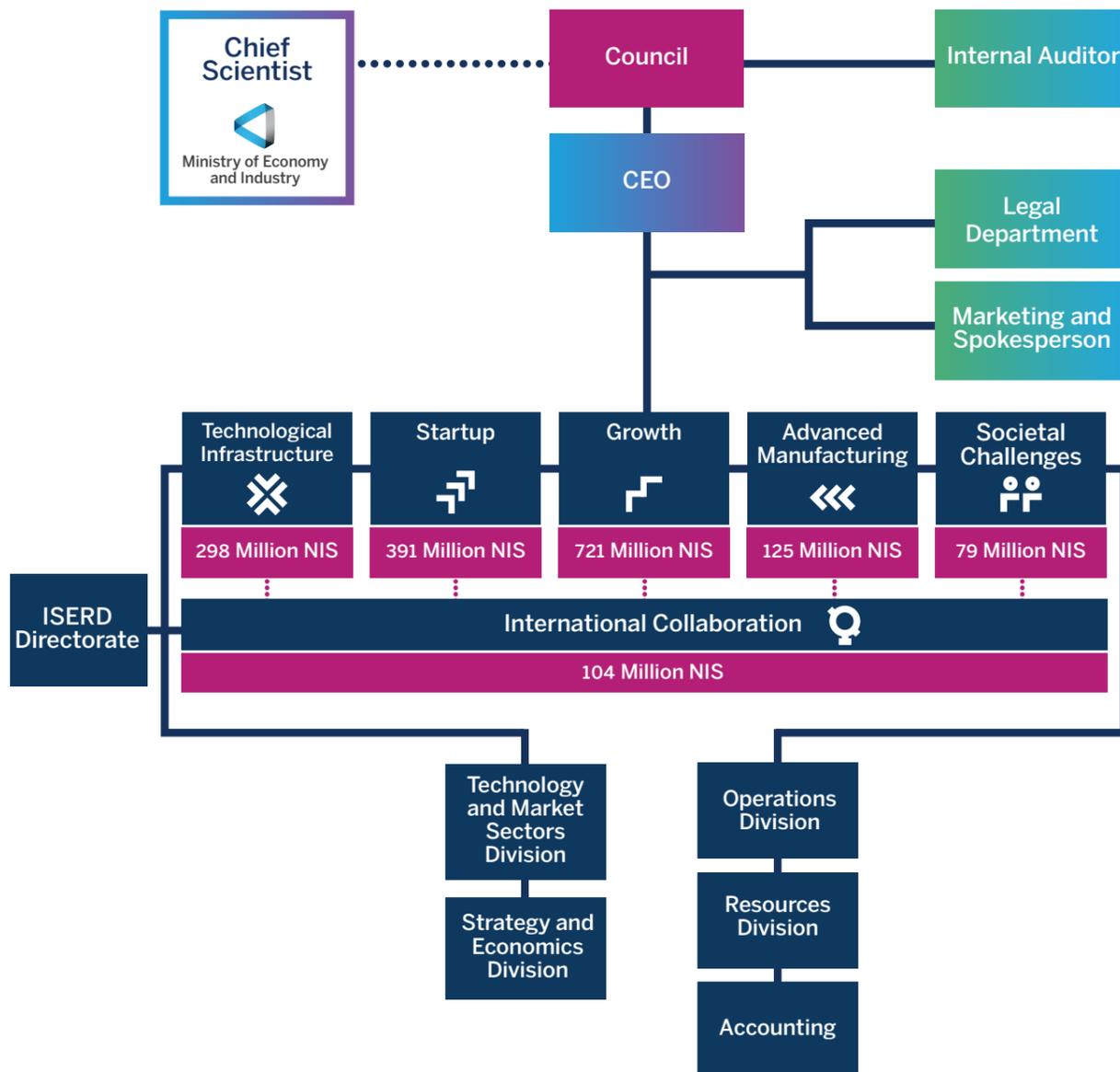
Strategic Objectives 2018-2022



In this chapter, we will present the salient features of the Innovation Authority's activity in 2018, and will then present the issues that are slated to be the focal point of the Authority's activity in 2019. The implementation of the Authority's policy on the ground is primarily assigned to its innovation divisions – mission and client-oriented divisions, each offering a unique toolbox for the various challenges posed in the technological innovation cycles. A variety of Authority division activities performed over the past year will be reviewed in the context of each of their sectors. A key trait shared by all divisions over the past year is increased collaboration with all branches of government. The synergy of the various government entities' knowledge, experience, and regulatory authorities with the Authority's

expertise in supporting technological innovation lies at the core of a range of collaborative incentive programs launched this year. This synergy bolsters the government's ability to propel the Israeli economy forward. In this chapter, in addition to reviewing activities in the various divisions, we will present a critical issue that extends beyond the confines of the Authority: the Innovation Authority's new outlook on serving its clients – entrepreneurs, companies, and researchers – that is currently being formulated.

Structure of Innovation Authority and Innovation Divisions Budgets in 2018



Technological Infrastructure Division

The Technological Infrastructure Division is responsible for Research and Development infrastructures, development of applicable knowledge, transfer of knowledge from academia to industry, and the development of generic technologies.

Division programs include: MAGNET Consortiums, Programs for knowledge transfer (KAMIN, NOFAR, MAGNETON), Research Institutes

In 2018:

- Total support approx **300 million NIS** was provided for **290 projects**
- **160 million NIS** invested in MAGNET consortiums (joint academic-industrial generic-technological R&D)
- Approx. **200 research groups** were supported in applied research and industrial collaborations
- Support of approx. **20 million NIS** for **17 international collaboration projects** for transfer of knowledge to Israeli companies

The primary incentive program operated by the division of technological infrastructure is MAGNET consortiums (Generic Technologies R&D Consortiums), a program designed to foster the development of generic technologies by groups of companies from the industry and researchers from academia (see margin text). The program has undergone several changes over the past year in an effort to adapt it to shorter development times and to fierce global competition over leadership in future technologies. The time period offered for the support of the program is now only three years (previously, most consortiums were given support for five years); incentive has been added to integrate global players into the consortium who are at the forefront of technological development; and an additional tool has been launched for the continued funding of select technologies emerging from the consortium. Several new consortiums were granted approval in 2018: an IoT consortium in the field of food products, a space communications consortium, a generic processor consortium for electronic components, and a consortium for quantum sensing.

In 2018, the technological infrastructure division also eased threshold conditions and operating procedures in the NOFAR and KAMIN incentive programs, aimed at directing and transferring knowledge from academia to industry to support applied research in academia, and the MAGNETON program that supports collaborations between an Israeli company and an academic research group. The objective of these changes is to focus the programs on effective and applied collaborations with the industry. The KAMIN program, for example, is currently offering unique conditions, a pilot program in the field of drug development, offering three years of support in order to bridge gaps in the translational research stage.

Over the course of 2018, the division also advanced a variety of international collaborations in an effort to accelerate the development of future industry technologies in Israel. The division launched a collaboration with particle accelerator CERN to transfer knowledge to companies in Israel, it began to support the commercialization of academic knowledge in the field of quantum technologies through the European collaboration program Quanterra, and it contributed to project funding for Israeli companies collaborating with German companies and research institutes in the field of nanotechnology.

Lastly, in 2018, the division was marked by widespread activity in the field of advanced manufacturing, which is taking center stage in the Innovation Authority's strategy. In addition to the consortium established in the food industry, the division of technology infrastructure, in collaboration with the division of advanced manufacturing, is currently working on a strategic plan to increase the efficacy of applied research institutes that serve the manufacturing industry. In this past year, several changes were implemented to support these institutes in order to ensure their technological excellence and to increase the incentive for them to collaborate with industrial companies. At the same time, the two divisions are working together with the Ministry of Economy to establish new applied institutes in the fields of food technology and advanced manufacturing – both of which will operate in Northern Israel. The advanced manufacturing institute will be based on a partnership between the business sector and academia, and will work to improve productivity and competitiveness in the manufacturing industry by integrating advanced methods and technologies, with an emphasis on industries characterized by a medium or low rate of innovation. The establishment of the food institute is currently at the stage of identifying industry needs.



The Innovation Authority – In practice: A quantum leap in brain therapy in the BSMT consortium

The Israeli consortium BSMT (Brain Stimulation and Monitoring Toolbox), funded over the course of the past five years by the Innovation Authority with a NIS 67 million grant, was established in order to develop technological and scientific infrastructure combined with neurological stimulation and monitoring to enable personalized and improved treatment of neurological and psychiatric disorders. The infrastructure is designed to serve as the basis for a new generation of products that could elevate consortium member companies – InSightec, EIMindA, Alpha Omega, and Bransway – to the global forefront in the field. The involvement of clinical research groups from universities and hospitals in the consortium has allowed member companies to conduct groundbreaking clinical trials in the consortium period with human subjects.

The consortium has had several groundbreaking achievements, some of which have led to technological maturity and clinical execution. HaGuide, for example, software developed in the consortium by Alpha Omega and researchers from the Hebrew University and Hadassah Medical Center, is used in DBS procedures (Deep Brain Stimulation) performed on patients suffering from Parkinson's disease or other disorders. The software enables the automatic analysis of raw material recorded from the brain, and is used for the automatic and precise navigation of an electrode implanted into a particular nucleus in the brain that controls mobility. The system has been tested on over one hundred Parkinson's patients undergoing DBS procedures. Due to its promising results, it was granted regulatory approval by the FDA and the CE.

Another technological and commercial achievement, the product of close collaboration between several consortium members, is a digital platform, for functional brain imaging for psychiatric patients. The product is based on BNA technology (Brain Network Analytics) by EIMindA, which utilizes big data and machine learning tools for the analysis of brain signals. The unprecedented technology provides access to 'brain software' on the composition, the connectivity, and the synchronization of functional brain networks. A new lab was established at the Mental Health Center in Be'er Ya'akov-Ness Ziona on the basis of this platform, offering cognitive testing of psychiatric patients. These tests provide a groundbreaking integration of digital medicine in processes for diagnosing and treating psychiatric patients – a quantum leap in the quality of psychiatric medicine in Israel. The integration of the platform in therapy is slated to advance personalized medicine and to offer support for doctors' treatment modalities.

Startup Division

The Startup Division provides a range of tools that support technological enterprises in their initial stages and assists them in product development, raising initial capital and advancing to sales. The Division is also active in strengthening the Israeli technological entrepreneurial ecosystem, especially in emerging fields.

Division programs include: Tnufa, Incubators Incentive Program, Early Stage Companies, Innovation Labs

In 2018:

- **213 startup companies** received total support of approx. **400 million NIS**
- The average grant awarded to startup companies was **1.9 million NIS**
- **19 technology incubators** operated throughout the country, 12 of which supported life science companies
- **73 entrepreneurs** received support as part of the Tnufa Program
- **5 innovation labs** began operating in the fields of advanced manufacturing, transportation, construction, food-tech and advanced materials

Over the course of 2018, the startup division launched several new incentive programs and expanded its support of existing programs. Firstly, the innovation labs incentive program – connecting entrepreneurs seeking unique technological infrastructure with experts in order to prove feasibility, and connecting corporations seeking collaborations with startup companies that operate with an open innovation model – commenced operations in 2018 following its launch in 2017. The five labs selected through competitive procedures in the fields of advanced manufacturing, smart transportation, construction and infrastructure, food tech, and advanced materials, began to adopt innovative initiatives over the course of the year. Furthermore, in 2019, a new cyber security and fintech innovation lab will be established in Be'er Sheva in collaboration with the National Cyber Security Authority and the Ministry of Finance, which will leverage national assets to promote startups in the field.

The lab in Be'er Sheva will join other programs launched in 2018 aimed at fostering technological entrepreneurship in the periphery and in large cities outside of central Israel. Over the course of 2018, a competitive procedure was announced for the establishment of a food tech incubator in the sub-district of Tzfat, whose results will be released in 2019, and a program for fostering entrepreneurship in the periphery was approved in association with regional anchors. For additional information on the Authority's policy for encouraging technological entrepreneurship in the periphery and for further details about these programs, see the chapter in this report titled Innovation-Driven Economy in the Periphery.

At the same time, this year saw the expansion of one of the the division's key programs– the early stage companies incentive program designed for startups seeking to develop and advance an innovative technological initiative and to penetrate the market by raising investment capital from the private sector. Threshold requirements for program application submissions have been eased, the annual budget restriction for applicants has been increased to NIS 10 million, the potential timespan for supporting applicants has been extended, and companies included in the program are now able to simultaneously apply to other Authority program for support in other projects. At the same time, the distinction between the startup division, which supports entrepreneurs and early-stage startups, and the growth division for growth-stage companies, has been clarified, so that companies with revenue over \$1 million or that have raised over \$10 million are directed exclusively to the growth division.

The Innovation Authority – In Practice: An automation system for sports broadcasts that has penetrated the American market

The Pixellot startup established in 2013 has developed an innovative system that allows the production and broadcasting of a variety of sports events with almost no human intervention. The company started out in The Time incubator, a franchisee of the incubators incentive program in the startup division, and was later provided additional grants through the R&D fund incentive program in the growth division.

The market segment the company is targeting is millions of sporting events that are not currently being recorded due to high production costs, such as games played in colleges, high schools, little leagues and teenage leagues worldwide. The system it developed includes cameras, tracking capabilities, content manipulation through the cloud, broadcasting to different devices, and exclusively automatic live-streaming, allowing spectators to perform simple move manipulation – all at a low production cost. Since its establishment, the company has already sold roughly 2,500 systems producing 20 thousand broadcasting hours a month. In 2018, it raised \$30 million, which will allow it to accelerate its future market penetration.

Growth Division

The Growth Division encourages startup companies reach the stage of sustainable growth and provides growth companies and mature companies with tools to develop technological engines

Division programs include: R&D Fund, Generic R&D, Pilots Fund

In 2018:

- **177 companies** received total grants of approx. **430 million NIS** from the R&D Fund. The average grant was **2.1 million NIS**
- **22 large companies** received total support of **85 million NIS** in the Generic R&D Program
- **60 companies** received **70 million NIS** to conduct pilots for innovative technologies at a range of trial sites in Israel with the cooperation of different government ministries.
- **30 million NIS** were invested in the establishment of multinational corporations' R&D centers in the fields of medical devices digital healthcare

Over the course of 2018, a new incentive program for supporting technological pilots conducted in Israel commenced operations in the growth division (it is formally named "incentive program for innovation with government entities"). The program is designed to encourage innovative companies to advance from the R&D stage to the scale-up and commercialization stage in order to progress to a growth track. The program operates in collaboration with a range of government entities, which enables greater support of

companies and ensures that pilots can operate in accordance with regulation requirements or under a targeted regulatory draft as needed. In the program's first year, dozens of applications were submitted for the support of pilots at a variety of sites in the fields of digital healthcare, environmental protection, energy, smart transportation, cyber security, agriculture, and government-owned companies, and the program is expected to expand in the coming years to include more fields and collaborations with additional government entities. The program has strategic significance for the Innovation Authority because it encourages companies to grow as full companies in Israel, and it bridges between the high-tech industry and other sectors of the Israeli economy. For further detail, see the chapter in this report titled From the High-Tech Industry to a Smart Technology Economy.

Another new program that commenced operations in 2018 in the growth division is the incentive program to encourage the establishment of multinational companies' R&D centers in the fields of biotechnology and health. In a competitive procedure, three leading multinational companies were selected to participate in the program – Change Healthcare, which operates in the field of digital healthcare, and Medtronic and GE Health, which operate in the field of medical devices. Through this program, these companies are slated to establish significant local anchors of activity, knowledge and expertise, and to create new intellectual property in Israel.

In 2018, the division also worked to expand the generic R&D incentive program for large companies. The program, which works with large, mature companies, supports long-term R&D of groundbreaking technologies that companies will be able to leverage in the future for a range of products. In order to expand the circle of large companies investing in groundbreaking technological developments in Israel, in this past year, the division encouraged companies at advanced growth stages to join the program. The total sum invested in the program grew from NIS 60 million in 2017 to NIS 85 million in 2018.

The Innovation Authority – In practice: AI in the Meuhedet Health Fund (HMO) and at Soroka University Medical Center

The National Digital Health Plan is striving to make Israel a key player in the field of digital healthcare – both as an engine of growth for the Israeli economy, and as a means to improve health services in Israel. The program, established by a team comprised of professionals from different government ministries, will see an investment of hundreds of millions of shekels over the course of five years. Of this sum, NIS 132 million will be invested in targeted programs that will be operated by the Innovation Authority in order to develop the digital healthcare industry while strengthening its connection to health organizations in Israel.

To this end, in 2018, the Authority launched a program for supporting pilots in the field of digital healthcare that are either performed in Israeli healthcare organizations, or that are based on capabilities or the data at their disposal. The program garnered a great deal of attention both from the industry and from healthcare organizations seeking to assimilate technological innovation. Over the course of the year, 52 applications for pilot support were submitted in 22 healthcare organizations. The Authority approved the backing of 24 pilots that will be conducted in 15 different healthcare organizations, with a total investment valued at roughly ILD 74 million, about half of which is government funded.

The Digital Robotics pilot, which stands out among the pilots approved, has developed a computerized system based on AI – the first of its kind – aimed at cutting healthcare costs and improving service. The system, which is designed to be used by medical teams, includes a personalized recommendation engine for patients based on a broad clinical picture. In the context of the pilot program, the system will first be implemented in two healthcare organizations: Meuhedet Health Fund, where it will be positioned at clinic entrances and at an emergency care center, and will be accessible for use at home by app; and at the Soroka Medical Center's emergency room for Kupat Holim Klalit in Be'er Sheva.

Societal Challenges Division

The Societal Challenges Division focuses on two fields: the development of skilled human capital for high-tech and the encouragement of technological entrepreneurship and R&D directed at solving societal challenges.

Division programs include:

Human Capital: Coding Bootcamps, Back to Tech, Early Stage Companies – Ultra-Orthodox and Minorities

R&D for Societal Challenges: Public Sector Innovation, Grand Challenges, EzerTech

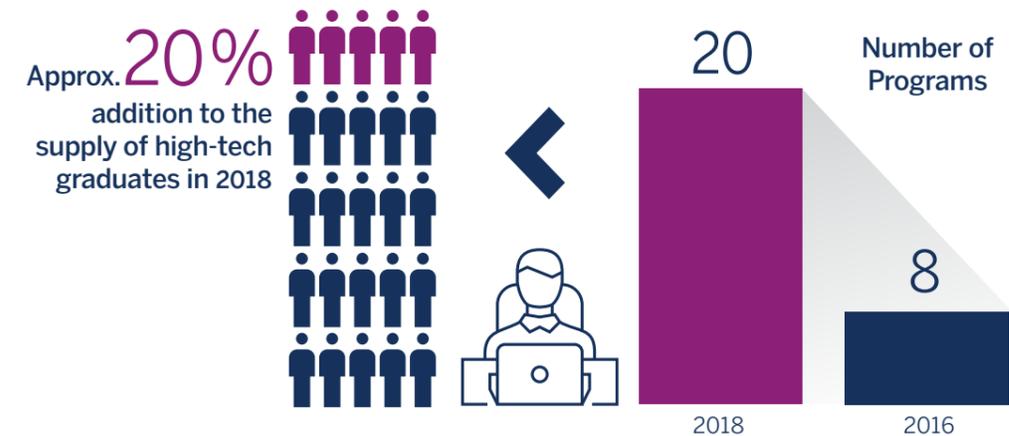
In 2018:

- **7 training programs**, that were chosen as part of the Coding Bootcamp Incentive Program to train approx. 250 graduates, received more than **10 million NIS** in their first year of operation
- **A pilot model of a new program – “Back to Tech”** – was launched and assisted approx. 100 Israelis living abroad to connect to high-tech employment opportunities in Israel
- **17 startup companies** led by Ultra-Orthodox and Arab entrepreneurs received total support of approx. 30 million NIS as part of a special sub-program
- **57 innovative projects** received total support of **35 million NIS** as part of the **Public Sector Challenges Program** operated jointly by the Innovation Authority and the Digital Israel Project
- **16 innovative projects** received total support of **10 million NIS** as part of the **Assistive Technology** for the Disabled R&D Incentive Program (Ezertech)

Development of skilled human capital for high-tech

The societal challenges division is working to expand the supply of human capital skilled in high-tech professions by removing obstacles and developing suitable infrastructure. Among other activities, it is advancing the integration of underrepresented populations in the industry. A key channel the division is promoting to make these objectives a reality is elite extra-academic training – coding bootcamps – designed to train or retrain highly skilled individuals (such as graduates with degrees in the sciences) for development positions in high-tech. Over the course of 2018, the division began to operate coding bootcamps to support this type of training. The program's compensation model is contingent on the successful integration of bootcamp graduates in the industry in high-paying development positions, and incentivizes the integration of women and underrepresented populations in high-tech. In 2018, at the end of a business development process and a competitive procedure, seven high-quality extra-academic training settings for development professions in high-tech, which opened by the end of the year, were selected. The program launch and the comprehensive industry consultation that had preceded it for the previous two years began to propel a conceptual shift in the high-tech industry, and spurred momentum in the elite extra-academic coding training market.

Increase in Elite Extra-Academic Coding Training market Alongside the Development and Launching of Coding Bootcamps Program



Additional channels of division operations in 2018 for boosting the supply of human capital in high-tech include obstacle removal for integrating foreign experts in industry, connecting returning residents in tech professions with high-tech companies, and fostering technological entrepreneurship among underrepresented populations in the industry. In order to enable Israeli high-tech companies to hire foreign experts with unique knowledge, the Population and Immigration Authority, the Foreign Trade Administration at the Ministry of Economy and Industry, the Ministry of Labor, Social Affairs and Social Services, the Ministry of Foreign Affairs, and the National Economic Council at the Prime Minister's Office in collaboration with the Innovation Authority, created a new category of work visas for foreign experts designed solely for high-tech experts. This channel offers many benefits, including electronic access, a fast work visa approval process, and work visas for partners. The pilot program "returning to high-tech" was launched to reintegrate Israelis living overseas with knowledge and experience in high-tech into Israel's high-tech industry by connecting them with employers and with relevant employment opportunities. Lastly, the incentive program for ultra-orthodox and minorities operated by the societal challenges division with the startup division was updated with the objective of increasing the number and the quality of the backed initiatives. This action followed an in-depth analysis of program outcomes conducted by the Authority's Strategy Division. In the context of the updated program, comprehensive marketing was performed in an effort to reach relevant target audiences. As a result, the number of initiatives supported through the program grew by 20% in 2018 in comparison to 2017.

The division also gathers data and analyzes obstacles in the ecosystem, and participated in the publishing of the report on human capital in high-tech led by Start-Up Nation Central, which gave a situation report on the current shortage and possible future solutions.

Encouraging R&D to meet social and public challenges

In 2018, the division assembled all of the incentive programs in these fields under one strategic umbrella of impact investments. The programs were updated accordingly, and comprehensive marketing activities were performed together with an array of partners from across the ecosystem in order to expand the target audience, to increase the scope and quality of the initiatives requesting backing, and to focus the entrepreneurs in the field on significant challenges outlined in calls for proposals. The Digital Innovation for Public Sector Challenges Program, working in collaboration with the National Digital Israel Initiative in the Ministry of Social Equality, and the assistive technology for the disabled incentive program (Ezertech) that operates in collaboration with the Funds Division of the National Insurance Institute were operated through focused calls for proposals. The method for evaluating submitted projects was also improved. At the same time, the GCI – Grand Challenges Israel incentive program, which operates in collaboration with the Ministry of Foreign Affairs and has been inactive since 2015, was updated and relaunched in 2018.



The Innovation Authority – In practice: Operation of smartphones and tablets with head movements

The Sesame Enable startup, established in 2013, has developed an exclusive app that allows people with mobility disabilities to operate smartphones and tablets using head movements alone, using the device's front-facing camera. The company was awarded a substantial grant by the Innovation Authority through the Ezertech incentive program, in collaboration with the National Insurance Institute, to encourage the development of assistive technologies for people with disabilities. At the same time, the company won a \$1 million prize in the international Powerful Answers Award Contest conducted by communications giant Verizon, as well as other prizes.

Solutions offered by the company are already in wide use throughout the US, where the company receives government subsidies. Their technology serves an audience with a wide range of mobility disabilities such as spinal cord injuries, neuromuscular diseases, MS, and cerebral palsy. Recently, the municipality of New York chose the company's product as a preferred solution for children with disabilities in the city's public education system, and negotiations are taking place with other US municipalities and states to expand this activity.

Advanced Manufacturing Division

The Advanced Manufacturing Division strives to strengthen the manufacturing industry and enhance its competitiveness in Israel and the global arena by encouraging R&D processes and technological innovation.

Division programs include: R&D Preparatory Incentive Program, MOFET (R&D in the Manufacturing Industry)

In 2018:

- **246 R&D projects** received total funding of 125 million NIS, half of which was invested in the periphery
- The average grant in the MOFET Program was **660,000 NIS**
- About **half of the manufacturing companies** that submitted a request for assistance as part of the MOFET Program made their initial approach to the Authority **this year**
- **23 companies** progressed from the R&D Preparatory Incentive Program to the MOFET Program and advance their level of technological innovation

The primary program operating in the advanced manufacturing division is the MOFET – R&D in the manufacturing industry incentive program. The objective of the program is to encourage manufacturing-driven industrial factories to advance and assimilate technological innovation processes by running R&D programs aimed at developing innovative products, improving existing products, or developing and improving manufacturing processes. In 2018, the division conducted intensive groundwork to make the program accessible to industrial companies, particularly in the periphery. The division's team made dozens of visits to companies and participated in professional conventions in the periphery. Roughly half of the industrial companies that submitted an application for support through the program in 2018 were first-time applicants. At the same time, over half the companies backed in the division operate in northern and southern Israel.

The MOFET program is complemented by the R&D preparatory incentive program, aimed at helping industrial companies that have never conducted R&D, or that need guidance in this field, join the track of innovation. Over the course of the year, 23 companies that had successfully completed the R&D preparatory program advanced to the MOFET program. This is a reflection of the great strides these companies have made, made possible through backing by the Innovation Authority.

An additional channel of division activity in 2018 for fostering R&D in the manufacturing industry was targeted calls for proposals for submissions for various industries. Calls for proposals were sent to textile companies, plastics and polymer companies, electricity and metal companies, and suppliers for the Merkava and AFV (Armored Fighting Vehicle) projects. Another exclusive call for proposals was circulated, in collaboration with the Ministry of Health, for Efsharibari, the National Program for Active and Healthy Living. The appeal was designed to encourage R&D targeted at improving the nutritional value of food, improving people's nutrition security and promoting public health.

Lastly, this year, the division held a first-ever 'speed dating' event at Kinneret College in northern Israel, between startups developing solutions in the field of manufacturing, and industrial companies. Following the success of the event, which included 160 attendees and many connections were made, a second similar conference is planned for early 2019 in the south.

In addition to its activity targeting manufacturing companies, the division is also developing support tools for innovative companies seeking to advance to the manufacturing stage. In late 2018, the division launched a support for examining feasibility for small-scale manufacturing incentive program, in collaboration with the Israel Investment Center at the Ministry of Economy. The objective of the program is to bridge the 'valley of death' between R&D stages for small-scale manufacturing, and to create a continuum of government support of technological development – from the research stage, until the establishment of an industrial factory in Israel.

The Innovation Authority – In practice: The Golan Heights Winery's innovative wine water

The R&D preparatory program is an exclusive program operating in the advanced manufacturing division, designed to help manufacturing-driven companies lacking experience in R&D and in leading innovation processes, or that need focus and direction in their R&D processes. The preparatory program offers companies support in establishing new ideas for products or processes, in examining technological feasibility, and in developing solutions for manufacturing failures, under the guidance of technology consultants.

A prominent company backed by the preparatory program is the Golan Heights Winery, which ventured to develop a completely new product: Wine Water. The backed project led to the construction of a concept based on innovative technology: extracting grape waste reduced in the wine manufacturing process and diluting it with water, so that the nutrients in grape peels and the unique aroma and smell of wine are absorbed by the water. The product made its world debut in July 2018 at the Fancy Food Show in New York and gained unprecedented success, with hundreds of distributors from across the globe seeking marketing rights for the product. It is already being sold by leading chains in the US.

International Collaboration

The International Collaboration Division acts to create a competitive advantage for Israeli companies and entities by coordinating international collaboration in innovative R&D

Division Programs include: bilateral collaborations in innovation with dozens of countries, facilitating access to the EU Horizon 2020 Program for industry and academia in Israel.

In 2018:

- **7 new agreements** for R&D collaboration were signed with various countries, bringing the total of active agreements to approx. 70
- **90 Israeli companies** received grants to conduct joint R&D projects with companies from other countries. The average grant awarded to these companies was approx. **500,000 NIS**
- **92 Israeli companies** received total financing of approx. **40 million Euros** as part of the prestigious European SME Instrument European R&D Program
- **9 Israeli companies** received approx. **11 million Euros** as part of the European Ecsel R&D Program

A key channel for the International Collaboration Division activity is advancing and enacting bilateral agreements for technological collaborations. In 2018, seven new bilateral agreements were signed between Israel and other countries: Britain, Thailand, Argentina, and four US states, and the India-Israel Industrial R&D and Technological Innovation Fund commenced operations. These agreements create a supportive setting that enables Israeli tech companies to collaborate with companies from these countries. Moreover, in these new agreements and through existing agreements, this year, the Division established a series of points of agreement that pave the way for Israeli companies to conduct pilots overseas in the fields of healthcare, agriculture, energy, and water.

Another vital channel for Division activity through ISERD (the Israel-Europe R&D Directorate) is making European R&D programs, primarily Horizon 2020, accessible to industry and academia in Israel.¹ In 2018, the directorate operated to increase participation of Israeli companies in various programs offered by Horizon 2020. This activity was reflected in the extraordinary involvement of Israeli industry in the flagship SME Instrument program offering funding for excellent innovative companies (92 Israeli companies received funding valued at €40 million), and the Ecsel program that funds projects in the field electronic components and systems (9 companies were granted roughly €11 million). These results were achieved through a concentrated effort of the ISERD Directorate for increasing the number of applicants and for improved application quality. This activity, among others, is offered by the new program aimed at bolstering the participation of Israeli corporations in the European framework program. The program backs expenses for overseas travel, participation in conferences for seeking partnerships, and an approved grant writing advisor. The total participation of Israeli industry in the European framework program since its inception is currently valued at over €200 million, with 2017-2018 demonstrating increased participation.

¹ The directorate operates under an inter-administrational steering committee whose members include the Innovation Authority, the Ministry of Science and Technology, the Planning and Budgeting Committee of the Council for Higher Education, the Ministry of Finance, and the Ministry of Foreign Affairs.



The Innovation Authority – In practice: Remote monitoring of cardiovascular diseases funded by Horizon 2020

Vectorious Medical Technologies was conceived in 2011 in the RAD BioMed technological incubator backed by the Innovation Authority. The company offered a groundbreaking solution for remote, continuous, precise, and safe monitoring of patients suffering from cardiovascular disease – one of the leading causes of death worldwide.

The inimitable technology enables the implantation of a microcomputer for battery-free communication. Thus far, the company has raised over \$10 million, including a \$2.25 million grant from the European R&D program Horizon 2020 and the Innovation Authority. The exclusive grant has helped the company recruit additional investors and accelerate development and clinical trials.

The company is currently conducting trials on human subjects in Germany, England, Italy and Israel, on its way to receiving the necessary regulatory approvals and to market the product. The company projects that the development will reach the European market within roughly six months.

Another accomplishment spurred by ISERD through its participation in the Horizon 2020 program, in collaboration with the Authority's division of growth, is making funding tools included in the InnovFin initiative (EU Finance for Innovators) of the EIF (European Investment Fund) for Israeli companies and entrepreneurs. The EIF issued a guarantee for Bank Leumi for a credit portfolio valued at \$200 million allocated to loans for SMEs (small and medium-sized enterprises) in the fields of innovation. At the same time, the fund served as an anchor investor in an Israeli venture capital fund targeting investments in early-stage startups. It has invested about \$20 million and has signed an agreement for matching funds with angels or superangels in Israel valued at a total of \$15 million.

A central aspect where the Authority operated to establish and implement new service in 2018 is shorter response times through the cycle of support in the initiative or in the company. This endeavor began as a pilot in 2017 in the startup division, and in 2018, it was assimilated throughout the entire Authority. The results were evident on the ground: 90% of entrepreneurs and startup companies that submitted an application for funding in the startup division were granted the committee's decision within nine weeks, and 83% of companies in other divisions responded within 12 weeks.

Another aspect that the Authority examined in 2018 regarding its work processes against clients is reporting requirements applied to companies that have received funding from the Authority. In late 2018, the Authority's Council approved easing royalties reporting requirements for companies owing royalties of up to \$5,000 per half-year – from submitting two royalties reports a year, to the submission requirement of only one report.

At the same time, the Authority took several steps to improve the technological examination process of R&D support applications submitted to it, which is performed by 180 professional, experienced evaluators, managed by the technology and market sectors division in the Authority. Firstly, computerized knowledge tools were developed that are used in the professional examination and the entire Authority. One key tool is the scouting system, which is linked to a wide range of commercial information sources and to the Innovation Authority's main database, enabling the location of companies and projects in any technological field. Another key tool is the knowledge building center, which serves to collect and distribute technological, business, and administrative information critical to the procedure of technological examination.

Secondly, in 2018, the Division assimilated a new recruiting model for professional testers, to enable the recruiting and ongoing refreshing of professional testers in accordance with the changing needs of technological and business trends in the markets. Furthermore, over the course of the past year, the Division has assimilated an innovative methodology for examining R&D projects of startups, including several key aspects in the Lean Startup approach. Market validity is tested, as is understanding the unmet need and the required response (for example, using the Minimum Viable Product method) and there is increasing openness in the testing phase for changes (Pivot) that the company performs on its products according to an evolving understanding of the target market.

Working for the industry – Improving interfaces with Authority clients

The Innovation Authority sees its clients as an important innovation resource for Israel, and is constantly working to make the incentive programs and the work processes accessible for them. To this end, the Authority is currently establishing a comprehensive service outlook whose principles will be based on mapping and locating the needs of the Authority's clients, and will treat all stakeholders in the ecosystem in which the Authority operates: entrepreneurs, companies in Industry, investors, academic researchers, governmental entities and others. The guiding values for this outlook would be professionalism, availability, and simplicity.





Changes in intellectual property standards imposed on companies that the Authority has invested in

For many years, the Innovation Authority has been advancing a policy of support for R&D activity that would lead to the creation of quality intellectual property in Israel. Registration of intellectual property is an important component in the financial success of both the entrepreneur and the economy. One of several reasons why its registration in Israel has a great deal of economic significance is because it serves as an anchor for local economic activity, including employment and tax revenue. This logic lies at the core of the conditions that the Innovation Authority sets for companies it invests in, in terms of registration of intellectual property, its future use, and its transfer to companies operating in other countries.

Nonetheless, in the era of accelerated digitization, globalization, and rapid technological changes, the process of technological development takes many forms, including the concept of intellectual property and the ways it is used. The Innovation Authority is aware of these trends, and consequently, is updating some of the conditions it had set regarding the registration and use of intellectual property developed with its backing. To this end, over the course of 2018, the Authority's Council approved two significant changes in its policy on intellectual property.

Firstly, in order to enable support of R&D programs that include open-source software development – a widespread phenomenon that reflects current business models in the field of software – council approval was granted to back projects that include open-source coding to be used by the general public, as long as delivering the source code for public use is expected to create economic and business value for the backed company.

Secondly, new rules have been determined for the sharing of technological knowledge by Israeli companies that received a grant by the Innovation Authority with affiliated companies outside Israel, by authorizing the non-exclusive use of knowledge. These rules reflect the understanding that many R&D processes in Israel are currently being conducted with affiliated countries worldwide. This phenomenon increases the more that Israeli high-tech companies are growing and becoming global, and the more that multinational companies are putting down roots in the Israeli ecosystem. The new rules enable companies supported by the Authority to conduct global development processes without needing to transfer intellectual property ownership to an affiliated company in another country. With Amendment 73 of the ECIL (Encouragement of Capital Investments Law), they are establishing an infrastructure to expand the economic activity of multinational companies that hold development centers in Israel.

2019 – Looking ahead

In conclusion, 2018 was marked by a great deal of activity in the Innovation Authority – new programs were launched, existing programs were updated in order to improve their response to the industry, new bridges were built with world countries, and collaborations were reinforced within the government for the advancement of innovation in Israel. In 2019, which has just begun, the Authority will continue its implementation of the strategic plan it approved this year, with several issues derived from the plan which are discussed at length in this report expected to be at the heart of Authority activity.

The first issue is advancing technological innovation in the periphery. In this report, in the chapter Innovation-Driven Economy in the Periphery, we review the challenges that lie at the core of technological innovation activity in metropolitan Tel Aviv area, and we propose an action plan that will be implemented over the course of 2019. The second issue is the development of skilled human capital for the high-tech industry. In 2019, in addition to the programs that were launched in 2018, greater emphasis will be placed on the integration of skilled human capital from the periphery in industry, and on the development of targeted human capital for AI. AI and other future technologies are a third issue that will play a key role in Innovation activity in 2019, with an emphasis on advancing a national strategy on AI (for further details, see the chapter The Race for Technological Power) with extensive government cooperation. A fourth issue is the development of additional innovation systems alongside Israel's ICT ecosystem. In this field, the Authority will highlight the development of a biopharma ecosystem while leveraging global trends in the field of personalized medicine, as detailed in the Personalized Medicine chapter of this report. A fifth issue is advancing collaborations between the manufacturing industry and high-tech companies and applied research facilities.





High Tech in Israel 2018

Growth in the Context of a New World Order

The global tech industry is gearing up for a new world order that has an impact on Israel's high-tech industry as well. What changed in the global economy in 2018, and what were the industrial trends during these past years in terms of funding, technology, and human capital?



High Tech in Israel 2018

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The global tech industry is gearing up for a new world order that has an impact on Israel's high-tech industry as well. What changed in the global economy of 2018, and what have this past years' industrial trends been in terms of funding, technology, and human capital?

Tech industries today are more global than ever before. Capital, people, services and products are traversing borders at a dizzying rate, and tech giants have no less of an impact on citizens than national governments do. The Israeli high-tech sector, which operates within a small and open market, is particularly global by nature: most of its industry competitors and clients are scattered across the globe, it is highly involved with multinational companies and foreign investors, and it performs most of its transactions in foreign currency. This reality creates economies of scale, but it also makes it particularly vulnerable to changes in the global economy.

Recent years have been marked by global economic and technological trends that have worked in the Israeli high-tech sector's favor: The global growth rate has increased, new tech markets have opened, and vast capital has continued to fuel innovative companies with accelerated growth. Accordingly, as of the publication date of this report, the performance of Israel's high-tech sector in 2018 has been outstanding.¹

However, dramatic developments in the global economy in 2018 are reshuffling the deck – namely, the US' retreat from the globalization trend, and the tightened regulations on the tech companies' activities in developed countries. The global tech industry is laying the groundwork for a new world order which has yet to stabilize and its future impact on the Israeli high-tech sector remains unclear.

In this chapter, we will analyze key developments in the global and local high-tech sector over the course of the past year. In the first section, we will describe changes in the global economy in 2018 that are slated to be gamechangers for the Israeli high-tech sector, and we will review their ramifications. We will then examine key trends in the Israeli sector over the past year in terms of economy, funding, technology, and human capital.

¹ On the publication date of this report, final data on 2018 is not yet available. Therefore, data cited in the chapter indicates trends in the first three quarters of the year. Some of the diagrams provide an assessment of 2018 as a whole, based on the first three quarters of the year and on previous years

Digital borders in a global world

The rules of the game are changing

In the past two decades, the rapid penetration of digital technologies has been gradually creating a parallel borderless world. In this world, fast communication between people situated on opposite sides of the globe is now taken for granted. Consumers can benefit from products and services offered by countries that have no physical presence in their country, and development teams of different countries can work together and concurrently on innovative digital products.

Lately, however, governments worldwide have been reminding the global high-tech sector that it still operates on a country-by-country basis. Countries have begun to clash with tech companies and with one another over their share of the digital world's taxation pie. This trend is upending the balance in the global tech industry. While it could potentially lead to improved equilibrium in the future, it is giving rise in the meantime to a great deal of uncertainty.

In 2016, the OECD released BEPS guidelines to address the floating profits of data-rich companies to tax shelters around the world, and encouraged the registration of intellectual property in the same country where it is being developed. By releasing these guidelines, the OECD aspired for tax harmonization that would guarantee the taxation of real economic activity in the location where value is created. Indeed, over the course of 2017, many countries, including Israel, began setting the groundwork for adopting these guidelines, and worked on updating their tax environment in order to appear more attractive to tech companies.

In 2018, however, Trump's Tax Cuts and Jobs Act reform significantly transformed the existing structure. The reform includes far-reaching changes to the US taxation system that are designed, among other objectives, to draw economic activity of multinational US companies, including tech companies, back to the US. The most notable measures enacted with these companies involve a dramatic corporate tax cut and the issuing of GILTI and BEAT taxes.²

These are slated to boost the tax liabilities of international companies that have reciprocal ties with the US such as companies operating in the US, companies owned by US residents, and companies that own US-affiliated companies.

The impact of these changes on Israeli high-tech companies is expected to be significant, because these companies are global in nature and have close ties with the US. The Israeli government recognizes the need to update its tax environment in order to remain attractive for both startups and large companies, and the government is examining ways to relieve their tax burden anticipated from this reform (see margin text).

² BEAT (Base Erosion and Anti-Abuse Tax) is a tax primarily applied to certain intercompany transactions issued to related foreign parties charged as an expense and deductible in the US, and to additional payments that are not included in the acquisition cost in the American company's records. GILTI (Global Intangible Low-Taxed Income) is a 10% tax on supernormal profits of CFCs (Controlled Foreign Corporations) where companies can receive a credit on up to 80% of foreign income



The Trump reform

On December 22nd 2017, a historical tax reform was passed – the US Tax Cuts and Jobs Act of 2017. The primary objective of the reform is to encourage job creation and to spur investments in the US using the carrot and stick approach.

The carrot – in an effort to encourage new company launches and the relocation of operations to the US, federal corporate tax in the US was significantly reduced from a progressive tax rate of 15-35% to a single flat rate of 21%. It is important to note that in the US, state and local taxes must be added to the federal tax rate. As a result, the inclusive effective tax rate (federal, state and local) currently stands at an average of 27%. In comparison, Israel's corporate tax rate (currently 23%) is still lower than the US corporate tax rate; however, the gap between the countries' tax rates has narrowed, as has Israel's competitive edge.

The stick – laws regarding the US taxation of CFCs (Controlled Foreign Corporations) have been toughened. For US taxation purposes, a CFC is a non-US company (Israeli, for example), with over 50% of its value or voting power controlled by or affiliated with US persons. The laws were toughened in two primary tracks: first, the reform expanded the breadth of situations in which an Israeli company would be considered a CFC; second, the tax ramifications imposed on US stockholders would be more severe if the company is defined as a CFC for US tax purposes.

As a result, since the legislation of the tax reform, some US funds have expressed concern over investing in non-US companies (including Israeli companies). In rare instances, funds even stipulate their investment in Israeli companies on corporate inversion (establishing a US parent company of which the Israeli company would be a subsidiary). The classification of the Israeli company as a CFC would not impact the company itself; rather, it would impact the American stockholders. As such, the Israeli company is indifferent to whether or not investors are American, and would favor an investor making the better offer.

The establishment of an American parent company could provide relief to US stockholders, but it could also cause the company itself significant tax leakage because it would subjugate the company and the group to the US tax network. Exiting this network at a later date could prove impossible.

Understanding the issue and its ramifications, the Israeli Tax Authority recently unleashed its Green Track, which simplifies the corporate inversion process while offering a tax exemption in Israel. The objective of the track is to allow entrepreneurs and early-stage startups to incorporate as an Israeli company, while offering flexibility to establish an American parent company in the future, if so required by business demands such as attracting investors and foreign capital. In certain instances, there may still be a preference for the structure of an American parent company from the date the group is established, and not through retroactive corporate inversion. This would depend on a company's business plan for raising capital from US and non-US funds, on the anticipation that an entrepreneur would relocate to the US, on profit and loss forecasts of the upcoming years, and on other data.

The extent of the impact that the US tax reform will have on Israeli companies is still uncertain. Following the reform, there is no generic solution or structure that suits all situations, and each startup needs to make these decisions on a case-by-case basis. Nonetheless, the more Israel is able to offer regulatory and taxation solutions that benefit companies and that allow them to be competitive in Israel, the smaller the impact of the US tax reform will ultimately be.

Written by Itai Ran, Partner, US tax desk; Yael Hadad, Partner, US tax desk, Kost Forer Gabbay & Kasierer of Ernst & Young

While tech companies across the globe are examining where to position themselves in order to benefit from optimal taxation conditions, another earthquake was caused this year by the OECD³ when it announced that economic value from digital activity is not only determined by the location of a company's core activity (such as R&D), it is also determined by the location where digital information is created, meaning the location where users are situated. Tech companies around the world are slated to be affected by this approach: companies operating in one country while providing digital services to users located in another country, as well as companies that gather digital information by use of a product or a service in order to generate revenue.⁴

The OECD has yet to establish clear guidelines for the implementation of this approach, but the European Commission has been quick to adopt it. As a temporary solution, it has proposed the imposition of a direct tax on revenue generated from digital activity where users or clients play a key role in creating value (DST – Digital Service Tax).⁵ Those hit hardest by this tax would be large multinational companies – primarily US companies.

Since this proposal, if adopted, would apply to all EU member states, the tech giants' contention over a piece of the tech giants' tax pie is increasingly shifting from an argument between tech giants and European countries, to an argument between the US and European countries. Thus far, in the spirit of the EU proposal, England has already announced that it would levy a 2% DST on revenue generated from the digital activity of British users, and Hungary and Italy have announced that they would impose similar taxes as well.

The Israeli Tax Authority has also adopted the OECD's approach to taxing revenue based on local digital users. The authority's circular on "the taxation of foreign corporate activity via the internet"⁶ (published in 2016) states the transformations evolving in the digital economic environment, and details incidences wherein services that multinational companies provide to users via the internet will be subject to taxation in Israel.

Alongside these developments on taxation, the trade war between the US and China that began in 2018 is an expression of government reaction to tech globalization, adding to a sense of unease in the global tech industry. In the context of US claims against Chinese practices on global trade, particularly on intellectual property and technology, over the course of 2018, the US imposed tariffs on a total of \$250 billion dollars on goods imported from China, including tech products.⁷ China, of course, retaliated by imposing tariffs on US products, with Chinese investments in the US dropping by roughly 90% in the first half of 2018 in comparison to the first half of 2017, reaching its lowest rate of investment in the past seven years.⁸

The upheaval in trade relations between these two tech superpowers could potentially upend the tech world as a whole. While many are expressing concerns, it could also create business opportunities for smaller countries like Israel, whose impact on the global order is minimal. Indeed, in light of the close ties that the Israeli industry has with the US market, and in light of the strengthening of ties between Israeli and Chinese innovation systems, Israel is following these developments closely as well.

³ OECD. (2018). Tax Challenges Arising from Digitalization

⁴ Ibid

⁵ According to the European Commission, revenue subject to DST includes revenue generated from online advertising, revenue generated from digital mediation, and revenue generated from the sale of users' digital information. The tax would be imposed on companies with an annual revenue of over €750 million with annual taxable revenue of over €50 million (Source: European Parliamentary Research Service, 2018)

⁶ Israeli Tax Authority, 2016

⁷ BBC. (2018, September 18). US-China trade row: What has happened so far?

⁸ Hanemann, T. (2018, June 19). Arrested Development: Chinese FDI in the US in 1H 2018. Rhodium Group

Israeli high-tech in 2017-2018 – Decline in early stages and a boost in growth stages

The developments described are projected to make their mark on the global tech industry and on Israel's high-tech sector in the near future. As of late 2018, however, players in the network of Israeli innovation who might be impacted by these developments – especially multinational companies, early-stage startups, and growing startups – are still on the fence and contemplating their next move. In the meantime, the Israeli ecosystem is continuing to flourish, and the trend of maturation and stabilization that we have been reporting on in recent years is continuing to intensify.

This account can be seen in the 2017 high-tech index and in interim data on 2018, as will be illustrated in this chapter. The high-tech index (see diagram 1), a synthetic index created by the Strategy and Economy Division of the Innovation Authority, is comprised of two sub-indices that depict the position of two distinct groups – startup companies, and mature companies.⁹ The index points to excellent performance in the two groups for 2017, but in the startup group, performance is lower than its peak in 2015.

Diagram 1: High-tech index, 2004-2017

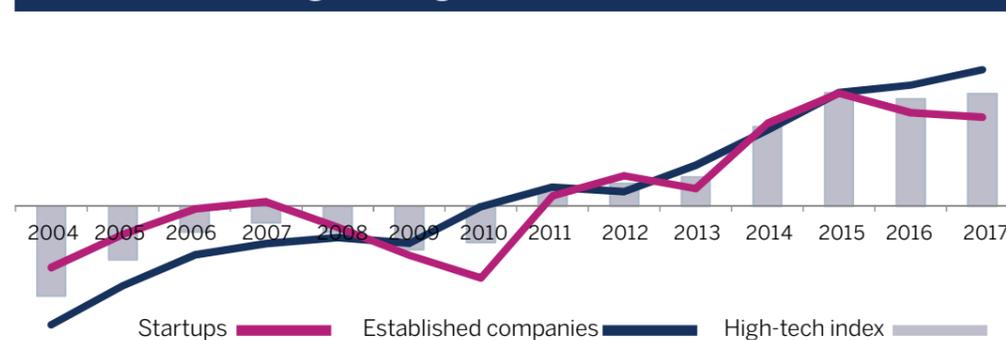


Diagram by the Innovation Authority (see appendix for complete details on the index indicators and values ,PP 100).

In the established companies' group, the growth trend in 2017 is attributed to macroeconomic indicators: high-tech exports, high-tech output, and the number of people employed in high-tech. In particular, the total volume of high-tech exports grew by 8%. It is important to note that software¹⁰ is the main driving force behind the growth in all these indices.

Against the backdrop of the high-tech sector's 2018 performance forecast lie this year's shakeups in Teva. According to interim data, drug exports plummeted by 21% in the first half of 2018 in comparison to the same period in 2017.^{11,12,13} At the same time, in the first half of 2018, exports of R&D and software saw an uptick of 22% in comparison to the same period in 2017, and the export of electronic components grew by 55%. As a result, 2018 is projected to end with a positive trend despite the Teva crisis.¹⁴

⁹ For comprehensive methodology of the high-tech index for 2017: Israel Innovation Authority website

¹⁰ Branch 62 in the Central Bureau of Statistics' 2011 classification of economic activities – coding and consulting on computers and other services, including the activity of startups, mature companies, and multinational software companies' R&D centers

¹¹ Manufacturing Exports by Technological Intensity, September 2018, Central Bureau of Statistics

¹² The Israel Export Institute. (2018). Developments and Trends in Israeli Exports, first half of 2018 summary report

¹³ It is important to note that manufacturing high-tech exports are marked by high centralization. Activities of Teva, Intel and other companies lead to acute changes in scope

¹⁴ This is also indicated in industrial manufacturing indices by the Israel Central Bureau of Statistics

In the startup companies' group, consistent growth in the volume of investments has continued through 2018 as well, with the total capital raised reaching \$6.4 billion compared to \$5.3 billion last year.¹⁵ Most of the increase in capital raised in the past few years is attributed to growth companies (see diagram 2). Furthermore, 75% of the total growth in the volume of capital raised in Israel in 2012-2017 was from funding rounds valued at over \$20 million. This data reflects the Israeli ecosystem's trend of maturation, which we have been reporting on in recent years. In contrast, there is an evident decline in early stages. After a few years during which over 1,000 new startups were launched every year, 770 startups were launched in 2017, with preliminary data pointing to a further decline in 2018. Likewise, there is a downturn in the number of exits and in their total monetary value in comparison to the 2015 peak.

Diagram 2: Volume of capital raised by stage in the company's life cycle (\$M)

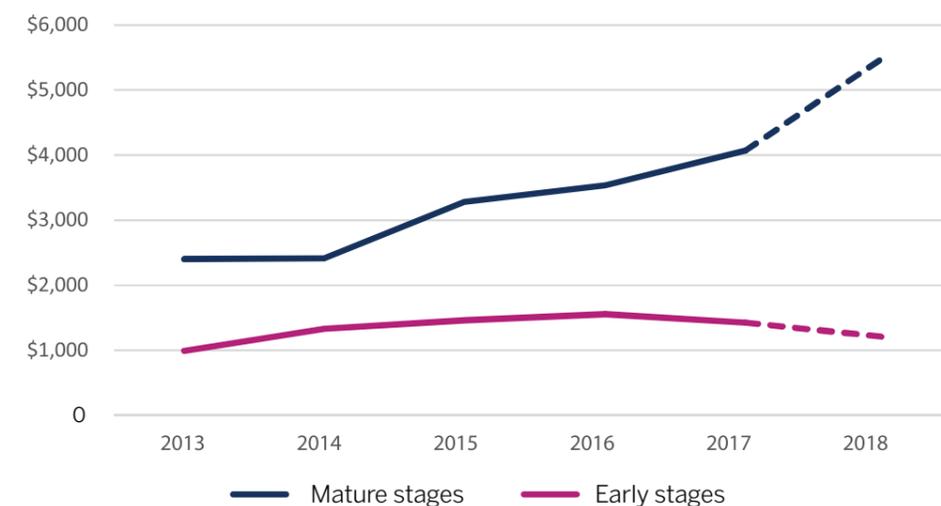


Diagram by the Innovation Authority based on IVC data.¹⁶

The overall picture in the startups group reflects global funding trends that are not sparing Israel. At the outset of the decade, economies across the globe were beginning to recover from the economic crisis of 2008. Investors were seeking high returns in an environment with low interest rates, and there was an accelerated flow of capital towards young startups around the world. In this climate, many entrepreneurs who were just starting out were able to raise funds with ease. In recent years, however, this has begun to change. Today, venture capital funds around the world prefer to gamble on a smaller number of promising startups and to 'fuel' them over a longer stretch of time with generous funding in the hope of eventually profiting from a huge exit, even if the wait is long. This is evidenced in the fact that the number of first rounds of startups in the US plummeted by over 40% in 2014-2018,¹⁷ while the volume of capital invested in startups is steadily increasing – especially in growth stages. Furthermore, the number of huge rounds – raising over \$100 million – has seen a significant spike in recent years.¹⁸

¹⁵ IVC and ZAG-S&W

¹⁶ According to final data on 2013-2017 and a forecast for 2018 based on final data for q1-q3, and on q4 data from 2016-2017

¹⁷ Pitchbook. (2018, October 8). The 3Q 2018 PitchBook-NVCA Venture Monitor. Pitchbook and a forecast of q4 of 2018

¹⁸ Ibid

This climate has been fertile ground for the flourishing of unicorns – startups valued at over \$1 billion that have not yet issued IPOs (Initial Public Offerings). Fifteen companies established by Israeli entrepreneurs are members of this club. In 2017, many people in the tech world viewed huge investments in unicorns with suspicion. Valuations seemed inflated, and it appeared as if investors would not be able to make profitable exits. Nonetheless, developments in 2018 did not corroborate these concerns. The number of exits by unicorns grew – especially IPOs that offered investors impressive returns.¹⁹ As of 2018, some believe that the preference of venture capital funds to invest larger sums of money in a smaller number of companies and to facilitate their growth is a new balance, and not merely a passing trend.

Israel's high-tech sector is closely influenced by global trends; as such, the global processes described are closely correlated with processes occurring in the Israeli ecosystem. Diagram 3 illustrates the changes in the rate of startup launches in Israel correlate with changes in the availability of capital for early stages around the world. In other words, the drop in the rate of new startup launches in Israel reflects the global shift in investors' preferences.

Diagram 3: New startups in Israel and first-round funding in the US, 2008-2018

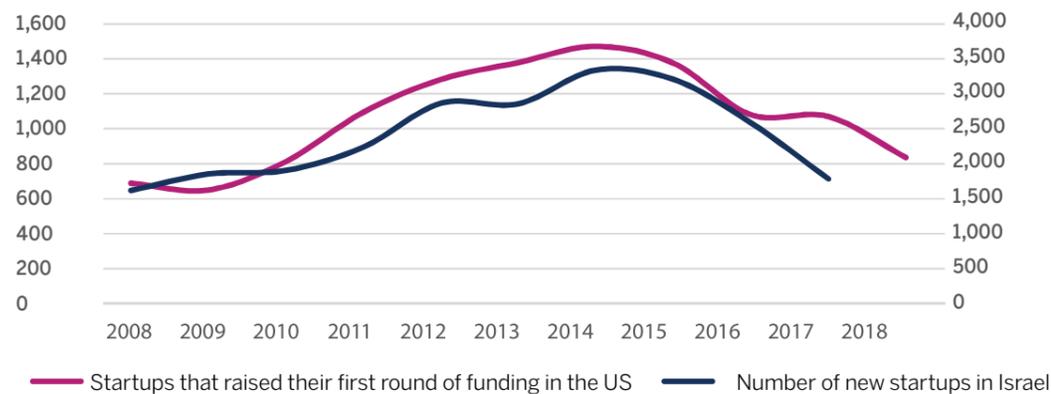


Diagram by the Innovation Authority based on IVC and Pitchfork data

In recent years, investors have begun to invest larger sums of money in Israeli high-tech for longer stretches of time and in a smaller number of startups. Accordingly, the number of capital raising rounds in Israel has been steadily declining, especially in early stages, while the size of the median round has been increasing. For example, the median raising of capital in round B was approximately \$10 million in 2015 in contrast to \$20 million in the second half of 2018.²⁰

These trends mean that investors in Israel and across the globe are 'choosing winners' at a very early stage, and that the funding environment for early-stage startups is becoming highly competitive. In contrast, promising startup companies are able to raise private equity at an enormous scope and to grow rapidly without adhering to stringent conditions that public equity would need to satisfy.

¹⁹ Glasner, J. (2018). Global unicorn exits hit multi-year high in 2018. As a rule, this past year has been marked by an uptick in stock value after two relatively slow years – a trend that has led to IPOs by companies that have already demonstrated significant growth and have surpassed early stages

²⁰ Start-Up Nation Central. (2018). Israeli High-Tech H1 2018 Report

Shortage in human resources A change on the horizon

In light of the funding trends described, in recent years, many Israeli companies have been on the path to rapid growth, fueled by large equity. Under these circumstances, they are required to recruit skilled personnel at an accelerated rate, and they are competing for these resources with other players in the ecosystem, especially multinational companies that are continuing to expand their operations in Israel.

Indeed, the tremendous demand for skilled developers and engineers is still being felt in the industry. According to a study conducted by Start-Up Nation Central in collaboration with the Innovation Authority and Zviran, there were an estimated 15,000 positions available in the industry in 2018. Likewise, the rate of terminated employees in the sector has been steadily declining in recent years, while the rate of voluntary departures is increasing – a trend pointing to a high demand for human resources.²¹

The Israeli government is coordinating efforts to expand the supply of personnel skilled in all high-tech fields by increasing the number of students pursuing high-tech related disciplines in universities, by establishing a variety of extra-academic paths into the industry, by opening channels to recruit skilled personnel from overseas, and by encouraging the study of math and science in schools. In the context of these efforts, heavy emphasis is being placed on integrating women and underrepresented populations in high-tech (Arabs and Haredis in particular), with a recognition of the notable unfulfilled potential in these groups.

Government efforts to expand the supply of skilled human resources



²¹ Startup Nation Central (2018). Human Capital Report 2018

The results of the government endeavor can already be seen on the ground. On the academic front, the number of students studying engineering and computer science comprised 26% of the student body pursuing bachelor's degrees in 2017-2018, demonstrating a significant spike in this field.²² Of this group, there has been a significant increase in the number of Arabs, who make up about 10% of the student body.²³ In the extra-academic sector, this year saw a marked increase in elite training for high-tech professions due to - among other reasons - the Authority launching coding boot camps.²⁴ Furthermore, with the objective of increasing resources by attracting overseas talent, the government created a Green Track for foreign high-tech professionals. The track expedites the visa applications process, in addition to ongoing efforts to help returning residents reintegrate into the Israeli ecosystem. At the same time, this year, the Ministry of Education reported that within three years, the number of students pursuing five points level in math doubled – a change that will begin to make its mark on the high-tech sector in a few years.

A field that has seen markedly higher demand for skilled human capital, especially recently, is data science. The rapid growth in the field of AI in the high-tech sector, as well as accelerated digitization in other fields such as the health industry, are creating an increasing need for skilled professionals. The worldwide demand for data scientists grew by 650% in 2012-2017,²⁵ and it pays particularly well. In Israel, the average salary for a data scientist with five years of experience is NIS 27-32 thousand a month, the highest among many other development positions with a similar level of experience.²⁶

Data scientists are required to possess an unusual set of traits: on the one hand, they need advanced capabilities in statistics and coding, and a familiarity with machine learning; on the other hand, they must be able to effectively and coherently communicate conclusions that arise from the sea of data, to provide solutions for business-related problems, and to play an active role in designing technological solutions. The demand for this unique amalgamation of traits along with the widespread requisite of a master's degree or a doctorate (40% of positions stipulate this level of education) translate into a high requirement-bar creating a challenge to meet the growing demand at the necessary pace. Some believe that as the field continues to mature, especially as the rate of automation of data processing accelerates, threshold requirements for positions will drop.

Since the profession is still relatively new, there are still no targeted training programs for data scientists. Thus far, positions have been filled by people with an academic education in computer science, mathematics, statistics, and economics. Israel's higher education system, however, has recognized the need for targeted training, and is quick to respond. Several universities such as the Technion, Ben-Gurion University, the Hebrew University, Bar-Ilan University, and the University of Haifa are now offering data science programs sponsored by the Planning and Budgeting Committee. At the same time, intensive boot camp-style career reorientation programs in data science are being designed for scientists from a variety of disciplines in exact sciences. The Innovation Authority recognizes the shortage of data scientists as well, and in the coding boot camps it opened in 2018, three out of seven supported programs provide training in data science or machine learning.

22 The Council for Higher Education. (2018). Data collected before the beginning of the 2018-2019 academic year

23 Harpaz, Y. & Krill, Z. (2017). Springboard to High-Tech

24 See chapter 1 – Updates on Authority Activities

25 LinkedIn. (2017, December 7). LinkedIn's Emerging Jobs Report

26 Ethosia data

Emerging tech trends

The growing demand for data scientists is a reflection of profound changes in the world of technology. On the one hand, 'classic' ICTs (Information and Communications Technology) are reaching saturation point; on the other hand, groundbreaking technologies such as AI and blockchain are maturing and evolving rapidly, and are expected to tighten their grip in the coming years. At the same time, accelerated digitization of all aspects of human activity is paving the way for the emergence of new high-tech fields such as digital health, smart transportation, precision agriculture, and Industry 4.0.

These trends are evident in the funding of global innovation. According to a report by Startup Genome, there has been a decline in investments in early stages and in the scope of exits for digital media, ad tech and gaming. In contrast, AI, blockchain, robotics, and Industry 4.0 are growing rapidly.²⁷ Similar patterns can be found in Israel. Diagram 4 demonstrates that AI, digital health and transportation are leading in growth rate in terms of quantity of companies and the capital invested in them in 2015 and in 2018,²⁸ along with the more established fintech and cyber, which are continuing to show rapid growth. In contrast, the field of communications is showing significant decline.

Chiefly, the diagram points to the rapid growth of AI as the groundbreaking information technology of our generation – a trend we will discuss at length later in this report.²⁹ It also points to the enormous potential of the Israeli industry in innovation applications of advanced information technologies. Transportation, for example, combines digital vision, big data, sensory systems, and communications. Over the years, Israel's high-tech sector has excelled at leading implementation technologies; as such, its ability to produce innovative companies that are prominent in the field of transportation such as Mobileye and Innoviz is not surprising. Digital health is also based on a variety of advanced technological applications, and the national digital health plan launched this year is projected to propel it even further with a range of funding, infrastructural, and regulatory tools.³⁰

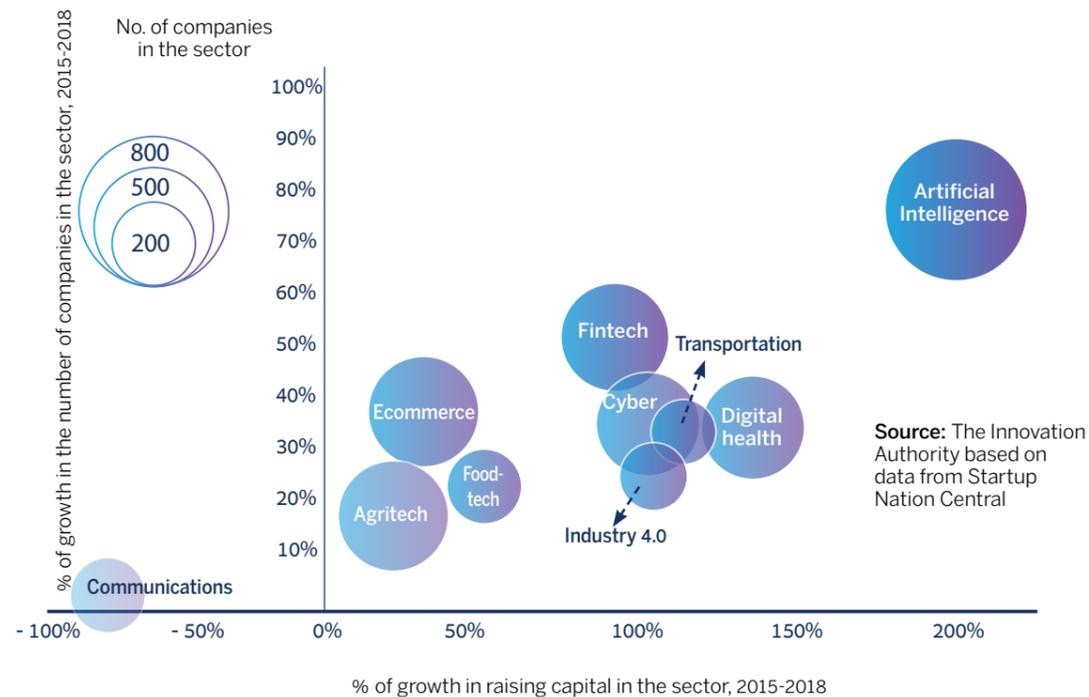
27 Startup Genome. (2018). Global Startup Ecosystem Report 2018

28 Data on 2018 refers to the first three quarters

29 See chapter titled The Technology Power Race

30 See chapter titled From a Startup Nation to a Smart Technological Marketplace

Technological changes in the Israeli high-tech industry



Blockchain – What does the future hold?

Distributed ledger technology (blockchain) has many potential uses; some are still far from commercial readiness, while others have already produced active marketplaces. Crypto tokens belong to the latter category, and can be divided into several types: tokens that can be used as payment, security tokens, and tokens for products and services. The field is currently known for its high volatility, but many people predict that once the technology matures and the hype dies down, the use of cryptocurrency will become a tangible reality.

In 2017, there appeared to be a new funding model for startups that was not contingent on traditional investors – decentralized funding by ICOs (Initial Coin Offerings). Some claimed that this funding method would replace venture capital as a funding source for blockchain companies; yet 2018 ended with mixed results. The plummeting value of various cryptocurrencies over the course of the year and the rapid collapse of many startups that had raised tens and hundreds of millions of dollars in ICOs in 2017 gave the field a dubious reputation, and public trading in cryptocurrency was halted. At the same time, the decentralized investment model was increasingly being based on venture capital funds and on other accredited investors, and less so on the general public.^{31,32}

In the meantime, regulators across the globe have been contemplating the legal status of these tokens and the necessary regulation, such as taxation concerns, the prohibition of money laundering, and the protection of investors. Regulatory clarity will allow the field to fulfill its economic potential and will keep speculators who tarnish its reputation at bay. In 2018, the Israel Tax Authority clarified its position on the taxation of cryptocurrency, and the Israel Securities Authority established a committee to examine the regulation of ICOs.

31 PWC & Crypto Valley. (June 2018). Initial Coin Offerings – A Strategic Perspective
32 Orcutt, M. (2018, July 3rd). Despite shadiness and crackdowns, the ICO boom is bigger than ever

From the startup nation to the blockchain state?

Gigi Levy Weiss

Over the last few years, we have seen the evolution of the global blockchain ecosystem, which has started to move from cryptocurrency excitement and skyrocketing funding rounds to the development of scalable blockchain powered products by strong, proven teams. In that regard, the Israeli blockchain ecosystem is a microcosm of the global industry and the changes reshaping the future of blockchain and decentralization. In the coming few years we expect Israel to produce some of the most meaningful blockchain startups globally.

Real Projects Coming to Life

We are noticing a promising change in the Israeli blockchain industry. In 2017, focus was primarily on fundraising - fueled by the cryptocurrency 'goldrush' and the ability to raise capital at unprecedented levels for seed companies. But in 2018, we are seeing real projects coming alive. Groundbreaking concepts in areas such as collective intelligence and governance (DAO Stack) or data privacy in blockchain applications (Enigma), that started as mere theoretical whitepapers, are now delivering real platforms. Fintech and Insurtech Blockchain companies such as Colu, a token based payment platform are already in production with consumers using them in real life. It probably won't be until 2020 that we see many of these ideas gain market traction, but this year marks a cornerstone for when the possibilities of blockchain technology started becoming a reality.

Quality of teams

A major shift in the recent 18 months is seen in the quality of the teams pursuing Blockchain ventures. If 2 years ago most teams were visionaries who in many cases lacked operational experience, recent founding teams include some of Israel's top entrepreneurs. This is a major shift which is clearly visible in the quality of the ventures being funded, the additional talent these companies attract as well as the quality of the investors supporting these projects.

A real product focus

After the hype of the crypto-goldrush subsided, attention shifted from glorifying enormous fund raises to discussing projects that can truly create meaningful products. Projects are no longer designated mainly for raising money; instead, they are focused on real products that can gain traction in the market. This was a critical step in the evolution of the industry, as in the blockchain space - just like in any other startup field - projects that will not find their product-market fit will not be successful.

The need for a positive regulatory framework

While the Bank of Israel and the Finance Ministry deliberate on the potential for a state-approved cryptocurrency, the conversation is opening room for national optimism. The Tax Authority and stock exchange have released statements to begin establishing regulation for the issuance, exchange, and use of cryptocurrencies. This is a huge opportunity - current regulatory restrictions in many jurisdictions - including the United States - are slowing down innovation. Should Israel be able to craft a favorable regulatory environment allowing the industry to move fast - while protecting consumers of course - this could serve to accelerate the pace of innovation and help position Israel even better in becoming a leader in Blockchain technologies.

This brief glance at the current state of the Israeli blockchain ecosystem is far from a comprehensive overview, yet the trend is clear. In the global arena, Israel is maintaining its dominance as it spearheads theoretical, practical and legal innovation to advance the industry. Recent visits of the top global blockchain investors in Israel are the best indication that the industry is maturing and that meaningful companies are being created. It is now safe to say that also in this new frontier, Israel is being positioned as the 'Blockchain Startup Nation'.

Gigi Levy Weiss, managing partner NFX
The writer may hold financial interests in some of the companies mentioned in the article

Corporate innovation in a world of disruption

The technological changes described – the widespread growth of AI and the rapid process of digitization in all segments of the economy, medicine, agriculture, energy, transportation and more – are blurring the distinction between high-tech and low-tech. In such a reality, corporations operating in all fields must prepare for swift changes in technology and business. Companies that are resistant to change will quickly discover that innovative and fast startups have become noteworthy competitors.

Large corporations around the world understand that they must take swift action in order to be part of the sphere of innovation and not miss out on emerging technologies. This phenomenon can be seen in a variety of ways. First, many corporations are investing in technological innovation within the company itself, as is the practice in large tech companies and in an increasing number of companies in traditional industries. Second, corporations in all fields are acquiring tech companies, a trend we reported on extensively in our 2017 innovation report. Third, corporations from all industries are joining the trend of open innovation and are collaborating with startups in a variety of models.

In the context of these trends, in recent years, corporate venture capital funds have become a more critical player – both in Israel and worldwide. In 2013-2017, the volume of corporate venture capital investments tripled, and they now make up approximately 20% of the total volume of venture capital investments worldwide.³³ As for corporate investments, the demand for health, AI, and automotive technologies, the same technologies that we pointed to as being at the heart of startup activities in Israel and around the world, has become particularly prominent.

Corporate venture capital funds are especially prevalent in Israel. There are currently roughly forty funds of this type operating in Israel,³⁴ including four out of five of the most active funds in the world. In 2017, their investments in Israel amounted to over \$1 billion. Corporations amount to about a third³⁵ of all venture capital investments in Israel, compared with 20% worldwide. This may be due to the massive presence of R&D centers of multinational companies in Israel.

Corporate venture capital funds are a key player in Israel's ecosystem



Collaborations with startup companies are critical to the assimilation of innovation in large corporations, but they do not guarantee success in their own right. A key challenge facing large corporations is how to integrate innovative ideas – either internal or external – and reach markets in an institutionalized, procedure-rich organizational culture. In a special interview for this report, Steve Blank, the world-renowned innovation expert credited with launching the Lean Startup Movement, shared his insight on the right ways for large corporations to invest in innovation in the 21st century.

³³ CB Insights. (2018). The 2017 Global CVC Report

³⁴ Startup Nation Central Finder

³⁵ IVC Research Center. (October 2018). Israel Tech Funding Report, Q3 2018

Innovation in large corporations A special interview with Steve Blank

What is the biggest impediment to innovation in large corporations?

“What holds back innovation inside a large company is not a lack of technology, but the lack of process, procedures and budgets that will allow innovation to exist. Usually, large corporations work by finance, procurement and human resources procedures. These procedures are necessary to get scale and they work well in a large company's normal business model. The problem is that when corporations try to be innovative at speed, all these procedures strangle innovation in its crib. The very processes that make money in a large company, are the antithesis of what you need for innovation”.

How can it be overcome?

“Corporations need to build an innovation pipeline as a parallel organization, which will operate on completely different rules and regulations, and have greater operational freedom. It should be built as an end-to-end process: From incubation stage of innovative ideas to market scale-up”.

How does the innovation pipeline integrate with the corporation's business activity?

“If the innovation pipeline is not hardwired into the existing corporation and does not tap into engineering, design, manufacturing and support - innovative ideas will end up as demos and will not be a part of the existing product-line of the company. Usually, innovators themselves are great at creating the first prototype, but they are the last people on earth you want to run an organization at scale. Therefore, the corporation needs a small group whose job is to integrate the innovative ideas into the product line. People should go back and forth between the innovation and execution groups, so that there are diverse sources of good ideas and innovators learn how to execute. In addition, the corporation should make sure financial resources for delivery of innovative ideas are always in place, and actually allocate 5-10 percent of its annual budget for this purpose.

Of course, all this applies to corporations that have time and resources for internal innovation processes. Other large corporations have the advantage of acquiring start-ups.”

What is the right way of integrating start-ups into corporations?

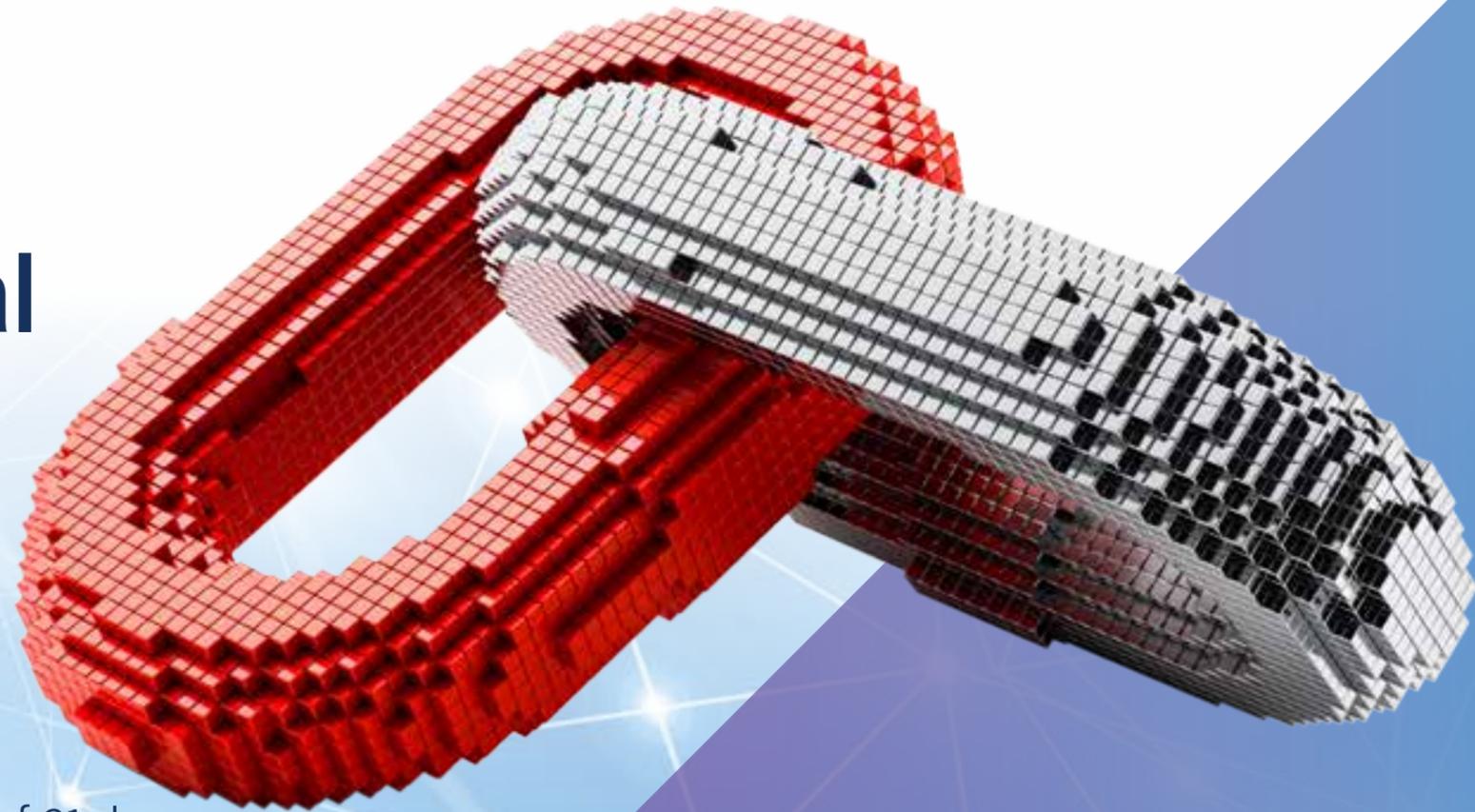
“There are four types of acquisitions. The first – you target only the IP (Intellectual Property). In this case there is no need to integrate the innovators into the corporation. The second - you acquire the team that is working on a viable high fidelity product but has not achieved a product market; leave it in place and give them resources as needed. The third – you acquire a start-up that has product/market fit but has not scaled yet. Again - leave them alone but give them the resources they explicitly need for scale, such as access to the existing sales channel. The last – the startup has product/market fit and their cash flow is positive. You can start thinking about fully integrating them, but be careful not to break the new shiny toy.

It is important that large corporations understand how fragile the process of start-up acquisition is: The most valuable thing that you actually acquire is not the technology but the culture that made it possible”.



The Race for Technological Leadership

The Advent of the Smart Machine Era



AI is slated to be at the heart of 21st century technological developments. Will Israel, which was among the world leaders in previous waves of technology, successfully find its way to lead with this technology as well?



The Race for Technological Leadership

The Advent of the Smart Machine Era

AI (Artificial Intelligence) is slated to be at the heart of the 21st century's technological developments. After several decades referred to as the AI winter, the present decade began with a long-awaited breakthrough in the field. The combination of powerful processors and a multitude of users with access to massive amounts of data, have created a critical mass that has launched us into the commencement of a new wave of technology. This new surge in the digital revolution is based on earlier waves: computability, connectivity, and mobility. Consequently, AI is also expected to become a GPT (General Purpose Technology) that will serve as the foundation for many future advanced tech applications that will revolutionize every aspect of our lives: Autonomous vehicles, personalized medicine, precision agriculture, mobile robots, computers that speak and understand natural language, and many other developments we cannot yet envision, will all be based on AI capabilities.

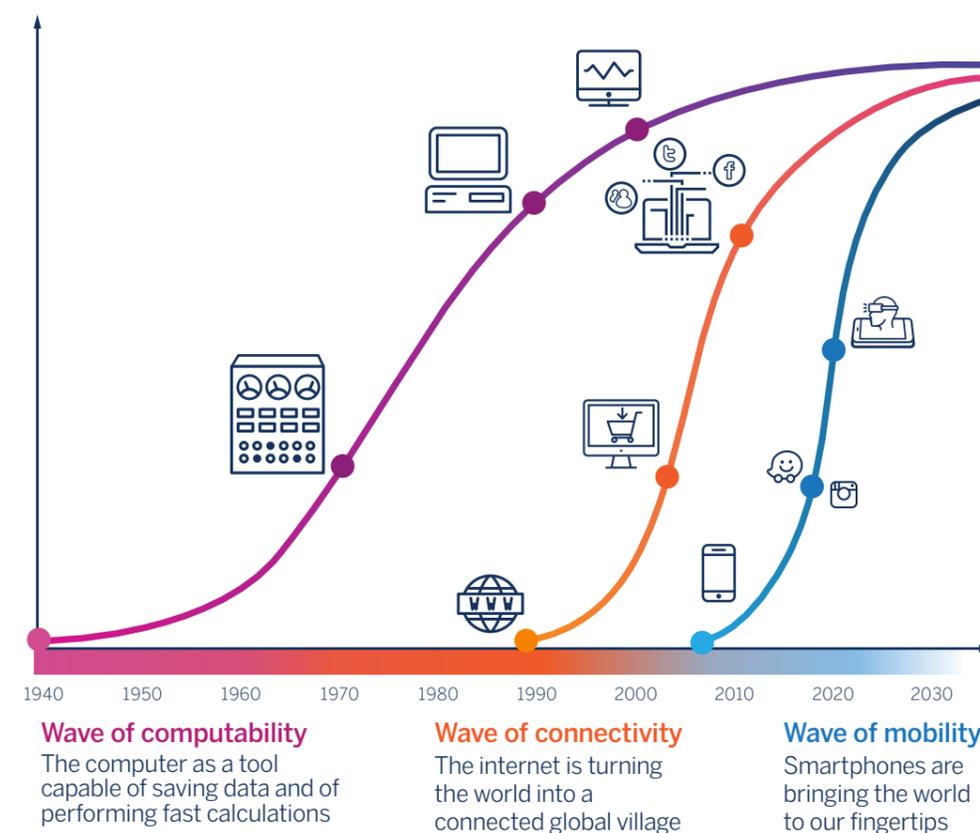
Accordingly, AI-based innovation is expected to be key for economic growth in companies, in sectors, and in countries that will be at the forefront of this technology. It is not surprising, therefore, that many countries have already announced their national AI strategy and are developing research infrastructure, human capital, and a supportive regulatory framework. Will Israel, which was among the world leaders in previous waves of technology, successfully find its way to lead with this technology as well?

Technological waves in the digital revolution

The digital revolution, which has gradually enabled the representation of nearly everything in the world as universally accessible digital data, is the most important revolution of the late 20th century, and most likely of the 21st century as well. But this transformation is not one-dimensional; it is built on the foundation of waves of a variety of core enabling technologies. An astute analysis of these waves allows us to understand when a wave of technology is dwindling down – meaning its rate of innovation is decreasing – and when another wave is emerging and its rate of innovation is skyrocketing. Economic growth in relevant sectors is

closely tied to technological waves; it carries, therefore, considerable weight in innovation policies. In this chapter, we will propose a classification of the digital revolution into three waves: the wave of computability based on the computer, the connectivity wave based on the internet, and the mobility wave based on the smartphone. Of course, as in all models, here too, the attempt to simplify reality by dividing it into distinct parts can be controversial; yet we believe that this classification helps explain the significance of the present era as a crossroads in Israel's innovation policy.

Waves of technology in the digital revolution thus far:
Wave of mobility, wave of connectivity, and wave of computability



The common and most important thread in all of these waves is that they are GPTs. GPTs are technological platforms that serve as a basis for a range of tech products and services. As such, the wave of computability was the foundation for the development of supported hardware and of a great deal of software that boosted work productivity worldwide, from the operating system – which in itself serves as a platform enabling many other developments – to software designed for the end user, such as the word processor or the electronic spreadsheet. The wave of connectivity, which included browsers, search engines, and social media, helped users navigate the internet's endless sea of data and connected people from all four corners of the earth. The wave of mobility – which was powered by key technologies such as GPS and cloud computing – paved the way for all of the apps designed for the mobile devices that we take everywhere we go, allowing the creation of the immense amount of data currently at our disposal. Successive waves were built on

the foundations of preceding waves. The result is that most people on earth, especially in industrial countries, are in motion (mobility) with a computing device (computability) connected to most people around the world and have access to a great deal of human knowledge (connectivity).

Nonetheless, the rate of innovation in these waves is slowing down, and it is likely that significant breakthroughs in these fields will become less frequent. The growth of computing and connectivity capabilities are reaching a saturation point, mostly due to the needs of end users, whose appetite for increasing capabilities at a higher price is diminishing. Innovation in mobility and its primary platform, the smartphone, has also been dwindling in recent years. Today, two thirds of the world's population owns a mobile phone. In countries such as the US, Britain and Israel, the number of cellular subscribers is now higher than the number of residents, with 122, 120, and 127 subscribers per 100 residents respectively. While there is still room for the penetration of smart devices into developing countries, this wave appears to be approaching saturation.

The link between these waves has produced yet another consequence. Any of us who carries a mobile device connected to the internet is creating a large amount of data; collectively, we are creating a vast amount of data: 2.5 quintillion bytes of data every day (2.5×10^{18}), and this volume of data is increasing rapidly. Big data created from these processes is compounded with the exponential growth of computing capabilities, and together have revived a technology that we had already eulogized as irrelevant: machine learning. Machine learning is the basis for the upcoming wave in the technological revolution – AI.

AI is taking center stage

The term AI was first coined in a seminar in Dartmouth College in 1956. It describes the capability of machines to simulate human intelligent behavior.¹ After years of speculating that neural networks, a very rudimentary version of the human brain, would be unable to advance AI, there was a breakthrough. At the outset of this decade, researchers were running old applicable algorithms on powerful processors that did not previously exist, and discovered that the combination of computability capability and a large amount of data that had now become accessible, suddenly produced impressive results. For the first time, machine learning algorithms (especially those based on a method called backpropagation) successfully completed 'intelligent' tasks like identifying objects in an image, and quickly outperformed all other methods. Enthusiasm grew with the wide coverage of accomplishments, such as the AlphaGo software's 2016 victory against the best Go player in the world – a game where even the most powerful computer in the world had been unable to methodically pass each stage of the tree search that the game entails.

These developments marked the commencement of the AI revolution that has been sweeping the world. No other technology seems to be equally terrifying and exciting to humankind. While other technological revolutions have helped us surmount limitations in fields that require physical strength, speed, and long-distance communication, AI touches upon the fundamental quality that has allowed the human species to rule the planet – intelligence.

¹ Alan Turing, a pioneer in computability theory, is likely to have been the first scientist to have posed the question "Can machines think?" in his classic paper from 1950. However, he immediately followed this question with the claim that according to its most common interpretation, the question is meaningless. He then replaced the question and asked if a computer can behave in such a way that an observer would be unable to ascertain whether it is a human or a machine

Accomplishments in this field in recent years have created the sense that the day when machines become smarter than us is closer than we may have once thought. At the same time, there have been extensive debates on whether or not this development is a positive one.

Proponents of the 'optimistic side' of the debate view AI as a technology that will overcome the limitations of humankind and will spur unprecedented prosperity. They believe that all living systems – agriculture, health, transportation, manufacturing and commerce – will be conducted automatically by smart machines that will meet all of our needs. Smart machines will know how to study us and will adapt specific products or services that we may need. All 'tedious' work will be performed by machines, leaving humans to complete the tasks that require creativity, empathy, and human contact.

Proponents of the 'pessimistic side' of the debate, including prominent personalities such as Elon Musk and Stephen Hawking, caution that AI could lead to the destruction of the human race. They feel that imbuing a network of machines with an almost unlimited capacity for computing and storing data with learning capabilities, will make computers far smarter than humans. Our imagination can be carried away to horror plots – from countries using smart computers to take over the world, to machines subjugating the entire 'inferior' human race. Less apocalyptic scenarios envision that smart computers will replace us in a wide range of professions, leading to widespread unemployment. They also caution against an almost absolute eradication of our privacy: As more aspects of our lives are being linked to smart machines, huge companies or the governments that control them will know all about our actions, or even our thoughts.

Alongside these imagined scenarios – whether optimistic or pessimistic – many others, led by AI researchers, feel that the excitement may be premature. They point to the huge challenges the field is still facing, to the Sisyphean progress, and primarily, to most people's confusion regarding AI capabilities. One such researcher is Rodney Brooks, one of the most experienced and prominent researchers in the field. In an article in 2017, he explains why most short-term predictions about AI are missing the mark.² He cites the capability of a deep learning algorithm to identify children playing frisbee in a photo – by all means, an impressive feat, considering the fact that the computer had 'learned' to identify these objects on its own. But if you were to ask that same software a few simple questions about the described scene, such as: How do you throw a frisbee? From what age can children play frisbee? Or, why do children play frisbee in the first place? you would not be given an answer that would be considered intelligent. In other words, the software can label the objects in the image, but it does not have any 'human' understanding of the described image.

What conclusion can be reached regarding the effect of AI on our lives? As is the case with other GPTs, the law that best describes future developments is Amara's law, which states that we tend to overestimate the effect of a technology in the short run, and underestimate the effect in the long run. Public discourse is focused on the danger that AI will pose to many professions in the next few years, but is struggling to envision how, in a few decades, AI will completely transform our lives.

In the spirit of Amara's law, we believe that the tech world is indeed at the outset of a new wave of innovation that will forge a link between several technological trends such as big data, machine learning, and IoT (Internet of Things), and will lead to the emergence of smarter machines. If the earlier waves of technology in the digital revolution connected people to one another, the upcoming wave will connect machines to one another, and will allow them greater decision-making capability and increasing autonomy.

² Brooks, R. (2017, October 6). The Seven Deadly Sins of AI Predictions. MIT Technology Review

These developments will amount to the creation of tremendous economic value, and the tip of its iceberg is already within sight. Any business process that undergoes automation and becomes even slightly smarter is slated to bolster the firm's profitability. For example, a better understanding of the customer based on identifying their purchasing patterns, or the patterns of similar consumers, increases sales efficiency of better-suited products. The use of algorithms for identifying an image used in combination with images from satellites or drones, helps predict agricultural output and helps identify crop diseases and pests; computer vision capabilities enable better diagnostics of medical tests that previously necessitated a lab. These and other processes, that have already been implemented by thousands of companies worldwide, are expected to place these companies in a leading competitive position. In 2016, this realization led to CEO of IBM Ginny Rometty's announcement that within five years, AI will impact all business decisions.³

In the throes of global competition

AI becoming the next enabling technology is a probable scenario. Countries and companies that lead this wave of innovation will then get the lion's share of the ensuing profits, while those who lag behind will be forced to make do with the leftovers. In recent years, we have been seeing an increasing number of countries develop a national AI strategy. As of late 2018, 17 countries have already announced such a strategy,⁴ with some investing billions of dollars. This is a clear indication that the race for technological dominance in the field is in full force.

But why are governments throwing their hat in the ring of technological competition, when this competition is ultimately being driven by the business sector? For the most part, preliminary stages in waves of technology coincide with heavy, long-term investments in infrastructure that facilitate the development of core technologies. This infrastructure is too costly and its use is too broad for individual companies (excluding giant tech companies). As a result, any country that wants to take part in the race for global technological leadership hopes to be among the first to invest in this infrastructure. As outlined in this chapter, huge investments in infrastructure were typical to earlier waves of technology.

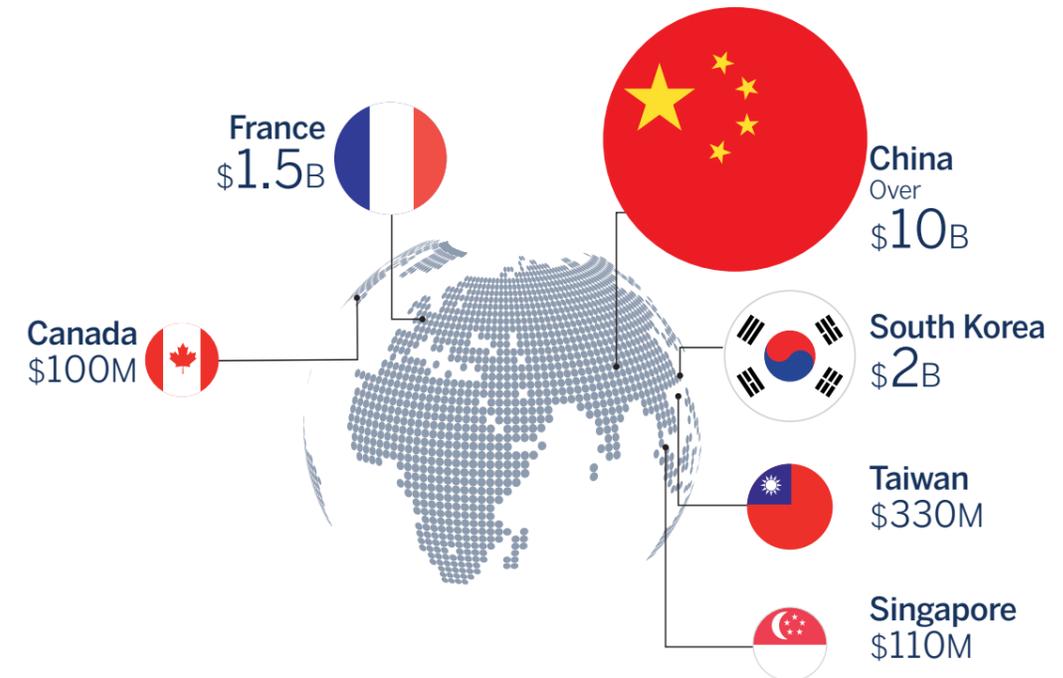
Another reason for governments to be key players in the race for global AI dominance pertains to two main obstacles that are currently hindering development in the field: regulation and human capital.

Regulation, under government scrutiny, is a fundamental condition for the advancement of the field. We are accustomed to humans making decisions about our lives. Consequently, the transition to accepting decisions made by algorithms, particularly in critical domains, calls for appropriate regulation. In AI, decisions are made by non-human entities. As a result, there is a shift in the concept of culpability, along with entire legal frameworks. A clear example of this phenomenon is autonomous car crashes. Autonomous vehicles are expected to reduce the incidence of traffic accidents by over 90%, but we still find it difficult to tolerate fatal accidents caused by algorithms. This means that regulators must address the question of culpability, and are up against a difficult dilemma: To protect the public, should there be a stringent threshold that requires the production of a retrospective account of the algorithm's decision making process, or would it be better to lower the bar of culpability in order to promote the adoption and development of AI-based innovation with all its benefits?

³ Recode. (2016, June 8). Full video: IBM CEO Ginni Rometty at Code 2016

⁴ Dutton, T. (2018). An Overview of National AI Strategies

Global competition over leadership in AI is increasing, and governments are making massive investments



Another issue associated with regulation is privacy. Machine learning yields results when applied to a massive amount of pertinent data. In most commercial applications that implement these processes, we, the users, 'manufacture' this data. In the era of connectivity and mobility, this data can convey a clear representation of our actions, our interests, and even our thoughts. An important milestone regarding this issue occurred in May 2018, when the EU implemented the GDPR (General Data Protection Regulation). Accordingly, every government should establish regulatory restrictions for this data collection.

Another concern that governments must address is the workforce and the private equity needed in order to flourish in the age of smart machines. The workforce is expected to make a full transformation; the increasing demand for AI is slated to deem traditional human skills superfluous, creating high demand for new expertise. Expertise in STEM (Science, Technology, Engineering and Mathematics) will become increasingly important, in addition to soft skills such as problem solving, creativity, and emotional intelligence. These skills will provide a significant advantage to the people who possess them.⁵ While it is difficult to predict future changes with a high degree of precision, there is no doubt that in the future, workers will need to possess stronger capabilities in technological literacy and will need to be prepared for frequent changes.

Education systems in developed countries currently place an emphasis on STEM studies – especially on the study of coding. In Europe, for example, 15 EU countries already include coding in school curriculums.⁶ The idea behind this policy is that coding skills should be instilled from a young age in order to reinforce the core logical and algorithmic thinking that will be required in many future professions. Coding is already transforming from a skillset limited to tech professions into a language that will become more pervasive throughout the entire workforce.

The Ministry of Education is leading a national plan to advance STEM studies in Israel. For details see page 58

⁵ Deloitte. (2016). Talent for survival – Essential skills for humans working in the machine age

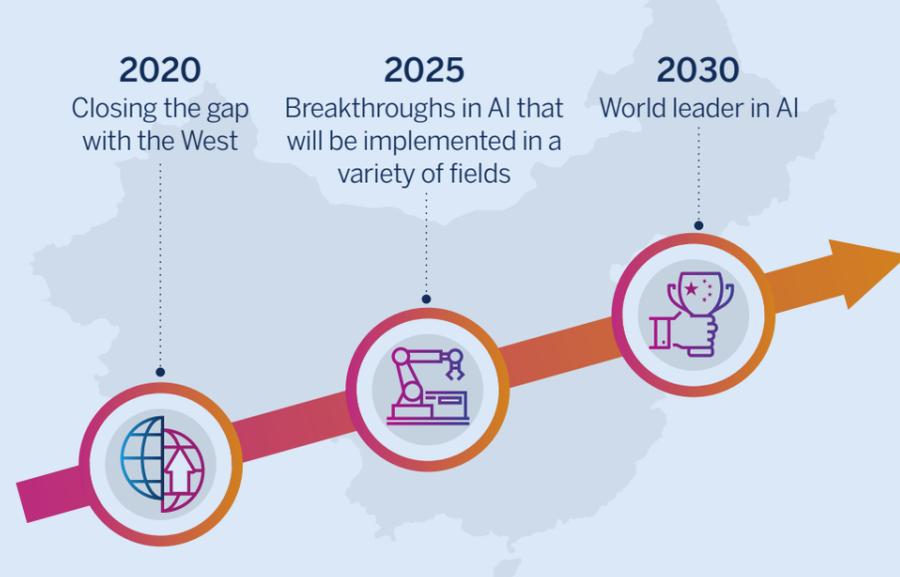
⁶ Euroactiv. (2015, October 16). Coding at school: How do EU countries compare?

AI in China

China is a clear example of a country that is resolutely striving to dominate in the era of AI. Recognizing that “the rapid development of AI will revolutionize humankind and the world”, the Chinese government has launched a program aimed at “seizing the strategic opportunities created by developments in AI, to give China a competitive edge in the development of AI”.

A component of this strategic program is the government's investment of tens of billions of dollars in the development of these technologies and their implementation in Chinese companies, in order to meet the goals the government has set: By 2020, China will bridge its gap with the West; by 2025, China will lead important breakthroughs in the field, and will implement them in critical infrastructure, manufacturing, agriculture, and other fields; and by 2030, China will be the global leader in AI.⁷

The Chinese vision for being a world leader in AI



The chances of this vision becoming a reality are high, because China has several structural advantages over other countries in this race. It has a vast number of researchers and engineers in the field, in contrast with a tremendous shortage of skilled professionals in other countries. Furthermore, this skilled human capital has access to a massive amount of data derived both from the country's high population and from its less stringent regulation of collecting data from private citizens. In a field that is based on the integration of algorithms and data, this translates into a huge advantage. China is already dominating with 48% of all global equity investments in AI startups, in contrast with just over 10% in 2016 – a trend that is expected to continue.⁸ Huge companies such as Baidu and Tencent are already leaders in this revolution with their extensive implementation of AI technologies.

China's explicit objective is to harness AI-based technologies in an effort to continue the strong economic growth of the last few decades, which has slightly abated in the past decade. This reflects a shift in Beijing's mindset. It hopes to turn China into a technological superpower, and to leave its image of a low-cost manufacturing hub behind. Correspondingly, China does not want to continue to keep up with the technological progress of the West; rather, it wants to be quick to implement new technologies and to overtake developed countries.

⁷ FLIA. (2017, July 30). China's New Generation of Artificial Intelligence Development Plan

⁸ MIT Technology Review, vol. 120 | NO.6 November/December 2017

An AI Strategy for Israel

Israel was a leader in the earlier technological waves of the digital revolution. Technologies and capabilities in communication fields developed by Israel's security apparatus in combination with academic excellence in coding fields put Israel in a strong position to take advantage of internet developments. Many leading Israeli companies that emerged in the 90s such as Check Point, Amdocs, Nice and Mellanox, positioned Israel as a superpower in communications, security, data storage, and semiconductors. An additional component of excellence was added to Israel's ecosystem – entrepreneurial culture. Thousands of startups established in Israel in the past two decades based on internet and smartphone platforms have made Israel fertile ground for innovative companies that respond promptly to developments in tech markets.

Past successes could indicate that the Israeli ecosystem of innovation will certainly lead the AI wave of innovation, even without special intervention by policy makers. We believe that taking this passive stance runs the risk of Israeli technology losing its lead.

Firstly, history dictates that often, countries have been technological leaders for relatively short periods of time. Japan is a clear example of this phenomenon. Japan was a technological superpower in the 70s and 80s and dominated the field of electronics, but it missed the wave of connectivity in the 90s and did not join the forefront of computing.

Secondly, it is important to remember that the Israeli ecosystem's competitive edge was established, among other factors, due to correct policies that recognized and responded to technological developments and challenges in real time. Israel was one of the first countries to recognize the potential in encouraging innovation-based industry. The Office of the Chief Scientist – the entity that preceded the Innovation Authority – had already begun to bolster R&D in industry in the 70s, many years before the world had discovered the potential of innovation-based growth. In the 90s, the government focused on advancing Israeli potential through groundbreaking programs such as Entrepreneurship, Technology Incubators, and the MAGNET program. In these past decades, the Office of the Chief Scientist was one of the only government bodies in the world tasked with supporting technological innovation. However, the global scene of innovation policy changed beyond recognition in the past two decades. Today, nearly all developed countries, and a dominant group of developed countries, are heavily invested in technological innovation.

In particular, we must acknowledge the fact that we are already falling behind in the race for AI-based technological dominance. The heavy investments in AI infrastructure planned by governments that are cited in this chapter should be a warning signal for all of us. If appropriate resources are not allocated, and if we do not develop suitable tools to advance Israeli leadership in AI-based technologies, we risk lagging behind. Accordingly, we are calling for the consolidation of all sectors – government, academia, and industry – to establish a vision and a strategy on AI for the Israeli economy.

For readers proficient in Israel's history of innovation policy, especially the policy of the Office of the Chief Scientist (the entity that preceded the Innovation Authority), this approach will look like a turning point. The Office of the Chief Scientist's policy was technologically neutral, investing in R&D projects based on project quality alone, without prioritizing different technological fields. We should emphasize that the Innovation Authority's policy is still in place, in its implementation of policy tools aimed at bolstering technological innovations that are 'close to the market,' meaning developments that are driven by economic competitiveness. In contrast, the extensive investment in technological

The PBC-CHE (Planning and Budgeting Committee – Council for Higher Education) is allocating roughly NIS 1.5 billion to establish and revamp research infrastructure in academia, with an emphasis on data science, quantum science, and personalized medicine. For details see page 59

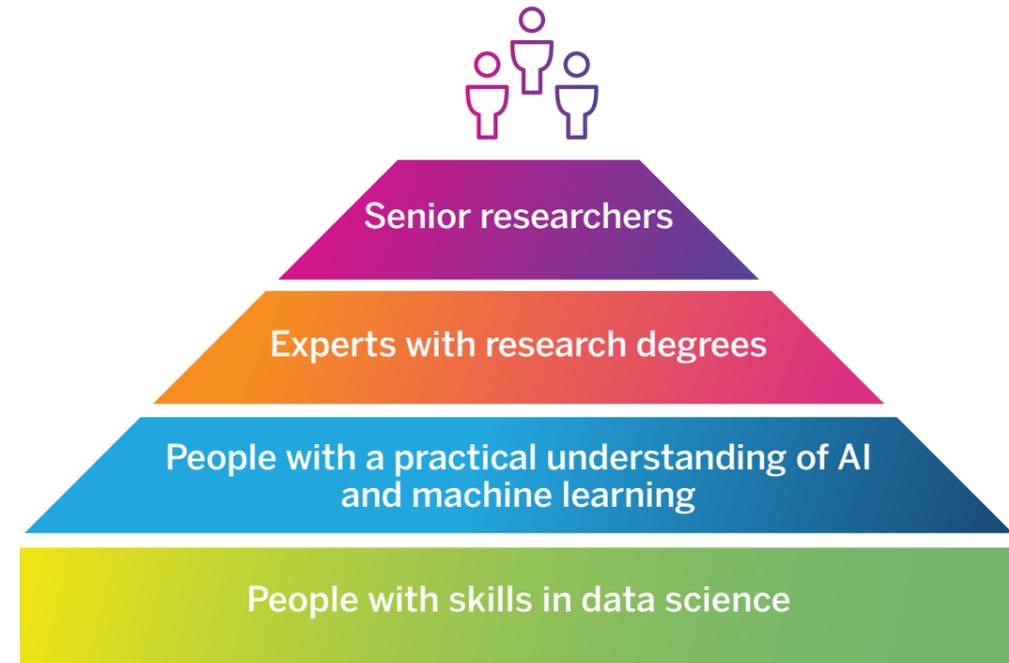
infrastructure and generic developments associated with new waves of technology such as AI is 'far from the market.' At this stage, market forces are not operating at an optimal level, necessitating targeted government intervention. It is important to establish an active strategy for the development of targeted infrastructure that will allow the industry to develop AI-based products and services that meet market demand.

This strategy should respond to several key challenges. The first challenge is to reinforce research infrastructure in AI fields in academia, and to turn Israeli research universities into AI excellence centers. Currently, the most advanced AI algorithms are developed by academia, and serve as the basis for groundbreaking applications in the industry.

The second challenge is the nurturing of all the human capital required in the field. The top of the pyramid represents senior researchers who specialize in algorithms. These researchers are needed both in academia, for advancing research and cultivating the future generation of professionals, and in industry. Tech giants offer them huge salaries. In the US, for example, the phenomenon is already posing a threat for research institutions. As a result, it is important to increase the supply of these researchers and to offer them attractive incentives. Next in line is AI professionals with research degrees. The demand for these professionals who possess a broad scientific foundation is already high, and they serve as a channel for knowledge transfer between academia and industry. In addition to these professionals, there is high demand for a workforce with an understanding in AI and machine learning for positions in application development, and for a workforce trained in data science⁹ - a phenomenon we described at length in the chapter titled High-Tech in Israel, 2018. It is important to note that data science, which serves as a critical foundation for AI, is also classified to several segments. While academia is a key training channel for tech application positions at the base of the pyramid, additional evolving channels under the auspices of industry entities and extra-academic institutions are slated to play a critical role in expanding the supply of human capital in the field.

The third challenge is the development of R&D infrastructure that would serve both academia and industry – particularly computing power and data infrastructure. Two prominent data sources are the government and giant tech companies.¹⁰ Consequently, it is important to ensure that government data is made accessible to researchers, entrepreneurs and companies, without losing sight of privacy and transparency concerns. It is also important to create appropriate incentives to encourage open innovation for multinational tech companies that operate R&D centers in Israel and that manage private big databases. A field in which the government has already begun operating for the creation of advanced data infrastructure is healthcare, as we will describe at length in the following chapter.

The human capital pyramid required for leadership in the field of AI



Another important challenge is the penetration of AI technology in all branches of the economy. The vast economic value of AI does not end with the potential it offers to leading future high-tech industries, but also, or even primarily, in the increased productivity and improved wellbeing that it can offer in all aspects of life. As we previously stated, it is critical to encourage the implementation of technology with applicable regulation and with the training of human capital that would be equipped to take on imminent workforce challenges.

Despite the substantial threat posed by the growing global competition, we believe that Israel has an excellent chance of being a technological leader in the era of AI. Israel's system of innovation is mature and sophisticated: Israeli academia is at the forefront of global knowledge in computability, its security apparatus creates advanced technologies and skilled human capital, Israeli entrepreneurs stand out in their daring and their innovation, and the Israeli high-tech industry is flourishing and evolving. While a small country like Israel cannot compete with huge investments in China, in Google or in Amazon, over the years, Israeli companies have managed to be technological leaders in exclusive fields, and have been able to compete with resource-rich organizations. These are all important assets that will help Israel get on board with the next wave of technology – the wave of AI – if we succeed in paving the way for the industry.

9 The Samuel Neaman Institute. (August 2018). Artificial Intelligence, Data Science and Smart Robotics

10 Ibid

The Ministry of Education - Promoting Excellence in Science



Today's high-school students are tomorrow's high-tech, science, and research professionals. Their ability to excel in math, science and English has a critical impact on the country. In the upcoming decades, Israel will experience both economic and social stagnation without this high-achieving human capital. Excellence also has a positive impact on a student's future status: According to research conducted by the Taub Center, there is a direct link between students' success in five-points math and earning capacity and employment opportunities.

2006-2012 showed a steady, worrying decline in the number of students who took five-point math level exams. The same period was marked with stagnation in the number of students studying physics, chemistry, and computer science. In effect, the number of graduates in the Israeli education system did not meet expectations for graduates majoring in scientific subjects, nor was it providing them with sufficient opportunities. In addition to the drop in the number of students who took exams, disparities were widening between Israel's peripheral and central regions, and between boys and girls. This decline gave a sense of missed opportunity due to a disparity between the high number of positions available in the marketplace, and the abundance of high-quality students who were not given the opportunity to study STEM subjects (Science, Technology, Engineering and Mathematics).

Ministry officials, under the minister's leadership and in collaboration with the 5x2 initiative, decided to change this situation and to turn the crisis into an opportunity: they launched the National Program for the Promotion of Math and Science in Israel. The program aspires to position Israel as a leader in math and science, to bolster math education in general and five-point math level particular, to make STEM subjects accessible to all students in Israel, to improve students' attitude towards these subjects, and to fulfill students' potential in the periphery and among various population groups.

The MoE's declared objectives for the program are:

- 19,700 students studying five-point¹¹ math by 2021.
- 17% of 12th grade students will take five-point math by 2025 (versus 9.1% in 2012 and 14.3% in 2017).
- 850 schools will offer five-point math by 2025 (versus 566 schools in 2012 and 751 schools in 2017).
- 14,200 students will study five-point in physics, and 13,000 students will study five-point in chemistry by 2022.

The MoE is executing a comprehensive action plan in order to fully enact the program. To address the shortage of teachers skilled in the relevant disciplines, the Ministry is working to recruit university graduate teachers by offering scholarships and stipends, and is launching programs to expand certification for existing teachers to enable them to teach STEM subjects. In order to increase the study of STEM subjects, the Ministry is supporting and encouraging math and science students from a young age, especially in middle school. It is developing advanced math instruction programs focused on personalized teaching, and is increasing the university admissions bonus for students who completed five-point math in high school (to 35 points). In order to narrow disparities between the periphery and the center, the Ministry is broadening the conditions for opening classes in locations that do not offer a five-point track in STEM subjects, and is currently establishing a comprehensive national program to this end. Lastly, the MoE is working on streamlining the linkage between the education system, the higher education system and the job market by strengthening ties with high-tech companies and building collaborative programs to bolster students' motivation to study STEM subjects.

¹¹ The level of study of 5 points is the highest level of learning in high schools in Israel

Digital campus and big data research: The future of Israeli academia – The Planning and Budgeting Committee – the Council for Higher Education



We are living in an era of accelerated technological transformation. Digitization of all aspects of life is creating a tremendous volume of accessible information; knowledge is created and transmitted in ever-changing methods. These trends have an impact on academia across the globe. Leading academic institutions worldwide are putting this information revolution to use by transforming both academic training and scientific research. The PBC (Planning and Budgeting Committee), a subcommittee of the CHE (Council for Higher Education), is working to leverage these trends for a quantum leap in Israeli academia by launching the New Campus, and by initiating a program to revamp research infrastructure in Israel, with an emphasis on big data infrastructure.

1. The vision of the New Campus – Progressing towards digital and active learning

Campuses for higher education are the focal point where knowledge is created by way of research, and is shared with students by way of instruction. The internet revolution offers easy access and transmission of information. This necessitates an upgrade in academia of research and instruction to meet the needs of the new era. To this end, the New Campus aspires to create a fresh and current learning experience: digital, active, and in tune with the industry.

Firstly, Israel will join the global revolution of digital courses. Working together with the edX initiative created by Harvard University and MIT, Israeli academic institutions will be able to offer digital courses through the international edX platform and through a designated Israel platform. PBC-CHE and the Headquarters for the National Digital Israel Initiative, Ministry of Social Equality, are also funding this enterprise to create digital courses that correspond with the stringent norms of edX.

Secondly, the academic institution will become a space where students can set groundbreaking entrepreneurial ideas into motion. To this end, as of 2019, entrepreneurship and innovation centers will be established on campuses where students will receive training in entrepreneurship, and will work together with lecturers, researchers, and professional mentors to promote projects of social and economic consequence. Entrepreneurship centers will transform campuses into an ecosystem that is adapted to innovation, encourages creativity, removes obstacles, and mediates between academia and industry.

2. Israel at the forefront of global knowledge - a multiannual program to establish and update research infrastructure

Research infrastructure is a decisive component in the ability of Israel's scientific community to stand at the forefront of global research. As such, PBC-CHE's current multiannual program is allocating roughly NIS 1.5 billion to establish and update the research infrastructure of higher education institutions.

Hundreds of millions of shekels will be allocated for scholarships to purchase advanced research equipment and to fund the use of this equipment in all fields. Moreover, a number of flagship research fields of national and global import have been designated – such as personalized medicine, quantum technology and science, data science, and humanities. Research infrastructure in these fields would be markedly promoted at a total value of about NIS 600 million.

Flagship programs for quantum technology and science and data science are designed to bring about a significant breakthrough in Israel's capabilities and global standing in the research and instruction fields, and to contribute to the vitality of Israel's security and economy. Data science is unique in that it touches upon almost all content fields of academia. These programs will advance innovation not only in exact sciences, but in social sciences and humanities as well. The link between humanities and technological advances is also evident in the flagship program for the promotion of humanities. Among other objectives, the program would promote academic studies that combine humanities with science and engineering.



Personalized Medicine

The Turning Point of the Israeli Biopharma Industry?

Radical transformation in the global biopharma industry may bring about an awaited leap forward of the Israeli biopharma industry. How do we realize Israel's competitive advantage in an age of personalized medicine?

Personalized Medicine The Turning Point of the Israeli Biopharma Industry?

Introduction: The future of medicine starts in Israel

Dr. Kira Radinsky

Israeli tradition has been known for its deep belief in Tikkun Olam – improving the world and building a model society. Israel has long shown its dedication to social justice through its healthcare systems, providing care for any and all while digitalizing data at an accelerating rate. This data has been accumulating for 20 years and serves today as a groundbreaking change in the way healthcare can be provided to Israelis.

The AI preventive care revolution:

For the first time in history, a medical system can study its patients statistically for long periods of time and provide insights originating from big data to better predict diseases. The prevention of illness is playing an ever-larger part in the Israeli medical ecosystem, as startups and homegrown initiatives of the health organizations are building digitalized solutions to intervene and protect people from chronic disease as early as their birth. Clalit¹ has been developing tools to monitor diseases and predict acute myeloid leukaemia risk, while Maccabi² presented an AI system that is able to predict the presence of colon cancer from a simple blood test.

The AI personalized treatment:

The wealth of data is opening the possibilities for true personalized medicine. Maccabi has been building tools to personalize drug treatment for hypertensive patients. Based on the large data accumulated they are able to present real-time recommendations to the medical provider suggesting which drugs will best affect the specific patients at hand. Numerous solutions and companies have also focused on genetic-based personalized treatment. Armed with comprehensive genomic databases, Israeli companies like FDNA, leverage AI to detect physiological patterns that reveal disease-causing genetic variations. These can change the game for personalized treatment and preventive medicine just by looking at the patient's face.

Medical Breakthroughs based on Big Data:

The data accumulated by this eco-system provides medical insights that can serve not only Israeli citizens, but also provide real breakthrough in medical discoveries. Several studies have now been initiated to create algorithms to identify drugs that have association and causation with negative and adverse symptoms.

Decision Support Systems:

With the growing shortage of doctors and medical staff in the world, the wealth of anonymized patient data accumulated in the Israel ecosystem serves as a basis for developing automated diagnosis tools that represent the future of medicine. One such

1 National health service providers

2 Ibid

example is the automated radiologist solution Developed by Israeli companies such as ZebraMed and Aldoc, which provide a support tool for medical providers via data and diagnostics. Revolutions come from need, and the medical system is in need. The growing, aging population with diminished access to medicine limits our chances for a fair society, where each person has the same right to live. Israel has all the resources to lead this change in the world and to bring Tikkun Olam.

Dr. Kira Radinsky, Director of Data Science, eBay and Israel's Chief Scientist

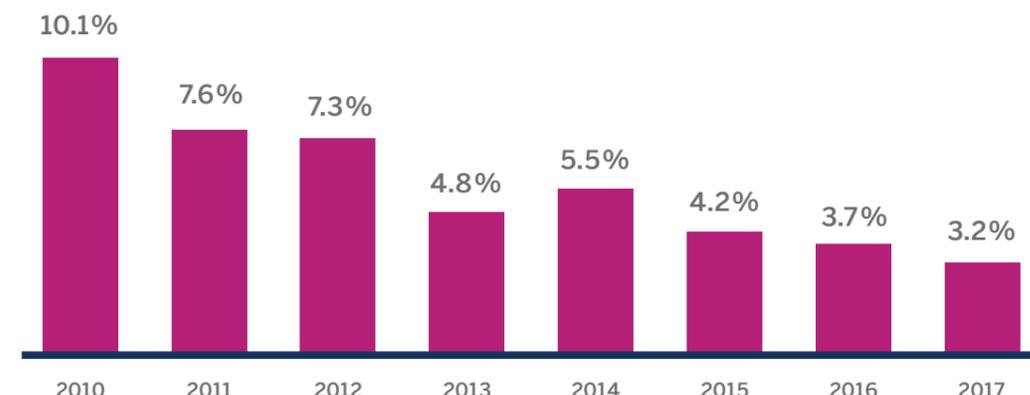
The medical automation and information revolution described in the introduction is giving rise to dramatic changes in all branches of medicine such as the global biopharma industry, which is hungry for innovative technologies. Personalized medicine, in particular, is becoming increasingly pervasive. Innovation in genetics and biology is being integrated with developments in big data and AI (Artificial Intelligence), revolutionizing the entire drug development process. This trend is blurring the boundaries between 'classical' biopharma and IT (Information Technology).

Israel's many years of excellence in biomedical science have yet to translate into the creation of a mature local biopharma industry. The trend outlined above creates an opportunity for the Israeli biomedical science with its lead in IT to develop a global technology center for personalized medicine. In this chapter, we will describe personalized medicine's effect on the global biopharma industry, and we will present the Innovation Authority's vision to harness it as an engine of growth for Israel's biopharma ecosystem.

The global biopharma industry is undergoing a profound transformation

In recent years, the traditional business model for drug development, which has dramatically improved the health of humankind over the past century and laid the groundwork for global biopharma giants, has reached a crossroads. There has been a decline in the number of late-stage R&D pipeline developments in large cap biopharma companies, with a parallel increase in development costs. This is evidenced in steadily declining returns over the past decade on R&D investments in the global biopharma industry from 10% in 2010 to roughly 3% in 2017.³

Diagram 1: Expected returns on investments in large cap pharmaceutical companies' R&D, 2010-2017 (in percentages)



Source:
Deloitte, 2018

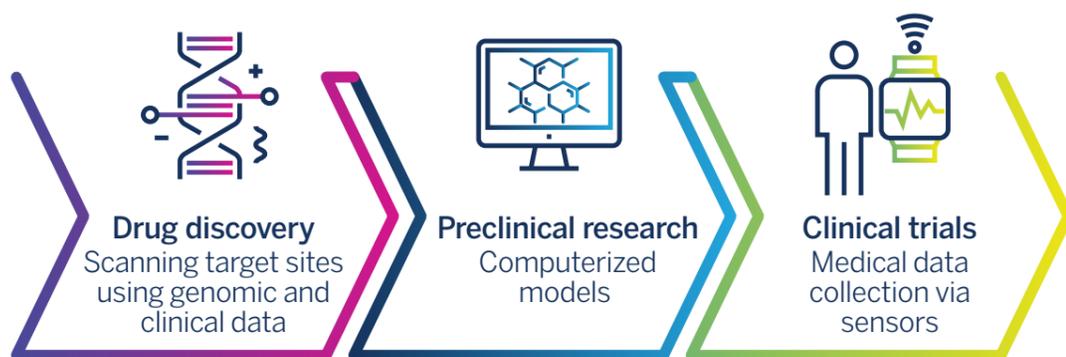
3 Deloitte. (2018). A new future for R&D? Measuring the return from pharmaceutical innovation 2017

First, the drug discovery phase is expected to change significantly. Medical big data analysis derived from a range of sources, and especially the linking of medical records (EMR/EHR), genomic information, and functional protein-centric data (OMICS data), will allow researchers and companies to identify target sites (for example, a problematic protein in the cell) in order to discover new drugs with more ease and speed. At the same time, revolutionary CRISPR technology, which enables genome editing and repair, has the potential of becoming a new, powerful tool for identifying target sites for new drugs by providing an innovative method to identify genes and proteins that cause or prevent disease (see margin text).⁴

Second, new drugs will be developed and manufactured with more precision, which would ensure optimal safety and efficacy. Computerized models of biological processes, in particular, will be able to create information that could help in passing through the preclinical phase of drug development, in designing and conducting better clinical studies, and possibly in replacing some of the clinical data required for drug approval. Innovative drug manufacturing technologies, such as 3D-printing of drug components, could also help control new drugs' toxicity in a manner that would facilitate their entire development and market-entry processes.

Third, advanced information technology will transform the clinical trial phases. Clinical development currently takes an average of 7.5 years and costs hundreds of millions to billions of dollars. Advanced information technology will significantly streamline this process. It will allow the selection of the most suitable trial participants using genomic and clinical data derived from a variety of sources (big data), allowing the monitoring of trial participants, using several types of sensors that transfer electronic data on a range of physiological measures. Biopharma companies will be able to examine the effect of drugs after they are on the market and thus reduce the expense of the clinical trial phase.⁵

Advanced digitization will transform the entire drug development process



The technological changes outlined would generate significant regulatory changes. The ability to develop a drug suitable for a particular population, to ensure its safety, and to prove its efficacy with precision, is paving the way for faster, smarter, and cost-effective approval processes. Regulatory bodies across the globe are bracing for this trend, and are becoming open to new models for testing drugs that correspond with the new era of personalized medicine. For example, the FDA, the most authoritative regulatory body in the field of biopharma, has launched a program for the fast-track approval of cancer therapies, and will enable the harnessing of new technologies for data collection in clinical trials, such as physiological data collected from wearables.⁶

⁴ Scott, A. (2018, March 7). How CRISPR is transforming drug discovery
⁵ The FDA-directed paradigm shift for drug approval has made information gathering on the action of new drugs in the 'real world' – not in the context of controlled clinical trials – critical
⁶ The Economist. (2018, March 24). FDA Wants to help unproductive drug makers



Faulty gene? CRISPR will repair it

CRISPR, genome editing technology, allows the cutting of a bit of mutated DNA and replacing it with a healthy strand. It is at the forefront of the vision of personalized medicine. In recent years, Israeli academia has been gaining expertise in this technology. Will excellence in fundamental research translate into future success for companies?

In this era, the high-tech industry is producing innovative developments at an accelerated pace. Public discourse is mainly concentrated on autonomous vehicles, AI, and advanced robotics. Under the radar, however, a tremendous revolution is materializing in healthcare – the revolution of genome editing, which is sourced in biological research. The technology of genome editing is employed to alter and repair genes in order to cure diseases. The hopes of many are riding on this technology, because it offers direct access to the source of the defect to alter the genetic material – the DNA – in order to repair it. Genome editing technology corresponds well with personalized medicine, where doctors tailor therapies to patients' individual genetic makeup in order to maximize efficacy and to reduce the risk of side effects.

Genome editing technology: The CRISPR system
Genome editing technology is based on the use of the CRISPR system, which allows the cutting away of a bit of mutated DNA and replacing it with a healthy DNA strand. The system is based on a mechanism discovered in bacteria, which protects them from attack by viruses by cutting the viruses' DNA. In 2012, the journal Science published a groundbreaking article written by two researchers, Prof. Jennifer Doudna and Prof. Emmanuelle Charpentier, that illustrated the manner in which the CRISPR system can be engineered to edit any sequence of DNA. One year later, in the same journal, researcher Prof. Feng Zhang demonstrated how the system can be employed to edit DNA in human cells. While the technology is still young, the CRISPR system is now considered to be one of the most important and promising technologies in the pharmaceutical industry. It is already being employed in clinical trials of patients in the US, Europe and China. Further developments in genome editing technology could potentially lead to effective, precise, and safe cures for many diseases.

In recent years, Israeli academia has been attracting young scientists who specialize in genome editing from leading universities such as Stanford, Berkeley and MIT, to continue the development of this technology in Israeli laboratories.

For example, the laboratory for gene repair at Bar-Ilan University headed by Dr. Ayal Hendel, in collaboration with pediatrician Prof. Raz Somech's research group from the Sheba Medical Center at Tel Hashomer, is working on the development of genome editing technology for bubble boy disease. Bubble boy disease (SCID – Severe Combined Immunodeficiency) is a general name for a group of genetic disorders marked by disturbed creation and function of immune cells. Children suffering from this disease can only live in sterile conditions; if left untreated, they do not survive past their first year. The most common treatment available today is a bone marrow transplant, but it is hard to find a matching donor, and a transplant from a donor who is not a full match could prove dangerous. The employment of genome editing to directly repair the faulty gene in the patient's own cells could offer an alternative to bone marrow transplants. This method is the laboratory's focal point of research.

This research is currently being complemented by the work of a handful of startups, but it is also the basis for the emergence of additional companies. This trend is providing Israel with a tremendous opportunity to be included in the global race for the advancement of genome editing technology as a tool for gene therapy and for the advancement of personalized medicine as a whole.

Written by Dr. Ayal Hendel, senior lecturer and principal investigator at the gene therapy laboratory in the Institute for Nanotechnology and the Faculty of Life Sciences at Bar-Ilan University

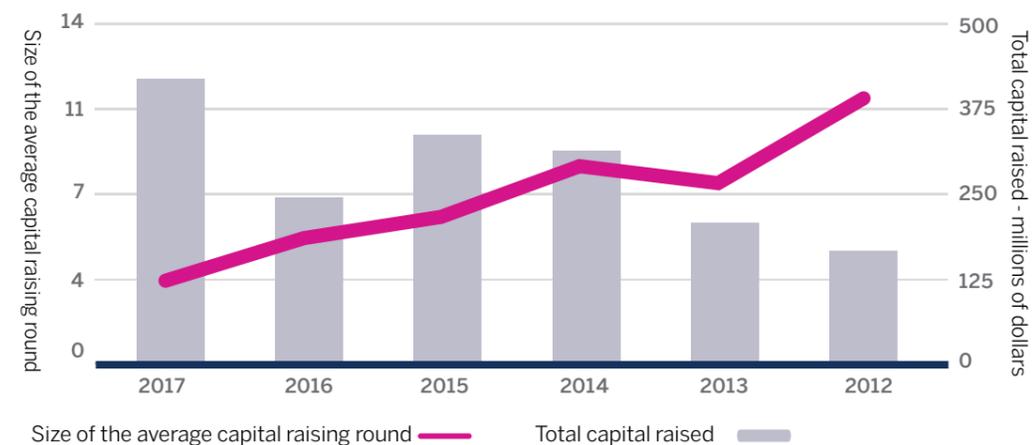
Israel can be a leader in the era of personalized medicine

These technological changes are expected to be a turning point for the global biopharma industry; they are also creating an opportunity for a long-anticipated Israeli breakthrough, thus spurring a new multi-disciplinary ecosystem in the local biopharma industry.

Over the years, Israel's biopharma industry has not been meeting its extraordinary scientific potential: Most drugs discovered in Israel have been developed overseas by foreign companies,⁷ and the Israeli economy has lost lucrative business and high-quality jobs. Kite Pharma's huge exit in 2017, valued at roughly \$12 billion, is a clear example of this phenomenon. Its products are based on scientific developments at the Weizmann Institute, and the company was founded by a former Israeli; however, its operations are located solely in the US. While a number of innovative Israeli biopharma companies that launched operations in the past couple of decades have reached advanced development phases, most have yet to achieve considerable sales.

Nonetheless, recent changes in the local industry are pointing to a positive momentum. Israel's biopharma industry is currently comprised of roughly 200 companies,⁸ with about 15 new ones being added to the list every year.⁹ Investments in the field have seen a significant increase in recent years, and the average funding round has grown threefold (see diagram 2). In 2012-2017, investments by Israeli venture capital funds in the industry grew by 400 percent. Among other reasons, this increase reflects the new funds that have joined the field, and the establishment of additional investment bodies, such as the FutuRx incubator funded by the Innovation Authority.

Diagram 2: Capital raised in the Israeli pharma industry in 2012-2017 (in millions of dollars)



Source: IVC

The era of personalized medicine could potentially present a breakthrough for Israel's biopharma industry, based on a number of assets that give it a unique competitive edge. One such key asset is Israel's longstanding scientific excellence. Developments that emerged from Israeli academia are responsible for eight innovative drugs that were sold for a total of roughly \$40 billion:¹⁰ Israel's scientific community excels in cancer research,

⁷ Teva's Copaxone is the exception

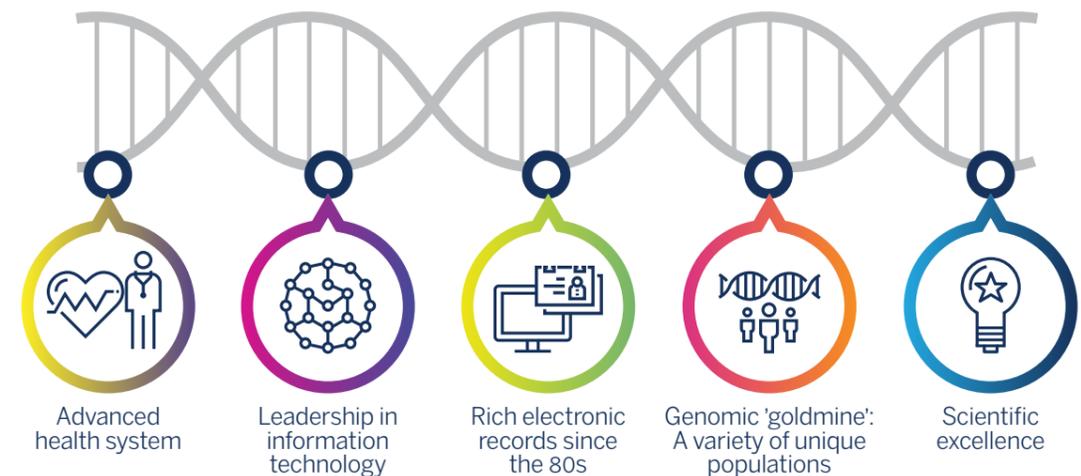
⁸ IVC data

⁹ IVC data – the average in 2012-2017.

¹⁰ As of 2014

immunology, and the research of degenerative diseases – fields that are currently a focal point for the development of personalized medical therapies. Added to these are Israel's unique genomic and medical data sources. Israel is comprised of a variety of singular population groups located within a small geographical territory. This makes it a 'genomic goldmine,' and EHR (Electronic Health Records), which have been in use in Israel since as early as the 80s, cover the overwhelming majority of the population. Israel's lead in information technology is allowing the leveraging of medical and genomic data, and its advanced healthcare system is providing a platform for productive collaborations.

Israel's competitive edge in the era of personalized medicine



This competitive edge is significant throughout the entire drug development process, and is especially crucial in the drug discovery and clinical development phases. To capitalize on this advantage, it is important to reinforce the connection between relevant fields of research, to make the required information and research infrastructure accessible, and to encourage investment in groundbreaking technologies – biological, computational, and integrated. At the same time, the importance of 'traditional' technological and business skills that are still critical for the biopharma industry should not be underestimated. Consequently, while bolstering the outlined advantage, it is important to examine the factors that are currently impeding the success of Israeli biopharma companies, and to remove the pertinent obstacles.

Drug discovery

In personalized medicine, drug discovery makes use of scans of huge genomic and clinical data sets in order to identify new target sites that are specific for certain population groups. Thus, at this stage, the integration of Israel's genomic and clinical data with computational capabilities carries great potential.

In the Israeli industry, there are already several companies using this drug discovery method. Ayala Pharmaceuticals developed a personalized treatment for a specific group of cancer patients carrying a genetic mutation, based on a diagnostic marker that is identified through clinical and genomic data. Another example is ImmPACT-Bio, which

For the Ministry of Health's full vision on the leveraging of information technology for Israeli health services, see page 71

the Israel Innovation Authority supported through FutuRx incubator. It develops a CAR-T technology - a treatment in which a patient's T cells are changed so they will attack cancer cells. The treatment will be personalized to each patient based on bioinformatics tools and databases of patients' samples. A third example is CytoReason that aims to discover drugs using machine learning models applied to biological data of the immune system. These industry operations are joined by academic multidisciplinary research centers, such as the Israel National Center for Personalized Medicine at the Weizmann Institute that incorporates bioinformatics in drug discovery.

Recently, this activity in academia and industry received backing via a number of government measures. One such measure is the establishment of the Mosaic Project. The initiative, established in collaboration with the Innovation Authority, the Ministry of Health, PBC-CHE, and the Ministry for Social Equality, has led to the establishment of new genomic and clinical data infrastructure, to benefit both academic research and the development of products and services in the industry.

At the same time, the Innovation Authority, with joint funding by the National Digital Israel Initiative in the Ministry of Social Equality, is presently establishing a users' association for digital health, which will serve as a network of medical data infrastructure to be shared with the industry. The stated objectives of the association, which will include startups, mid-to-large cap companies, as well as multinational companies, are to share new and existing medical data, to make the data accessible, and to establish regulatory infrastructure and information security. The program will work in collaboration with Israeli entities - both academic and clinical - as well as international entities. Both the Mosaic Project and the users' program are slated to be a quantum leap in the field of medical data in Israel, to further advance existing relevant companies and to aid in the establishment of new companies.

In addition, since many breakthroughs in drug discovery are emerging from academia, it is important to ensure that processes for knowledge transfer from academia to industry occur correctly. Over the course of the past year, the Innovation Authority closely consulted with industry and academia in an effort to map obstacles in the growth of the biopharma industry, and learned that the translational research phase, meaning the process of advancing from scientific discovery to launching of commercial drug development, is lacking. In particular, the process is lacking the early involvement of a business-industrial body specializing in the filtering of academic projects, in designing appropriate trials, and in laboratory-industrial development. The Innovation Authority, in collaboration with all relevant entities, is currently formulating a draft to revamp the process of translational research in Israel. Among other steps, the Authority will improve the testing and filtration mechanisms of technologies that emerge from basic research at their applicable research phases, and will attract international translational research experts to Israel, to encourage the flow of knowledge to local industry in the field.

Clinical trials

The aforementioned global trends in the field of clinical trials enable Israel to leverage its competitive edge for the success of its drug development companies, for the establishment of an entire ecosystem that supports clinical trials in Israel, and for making Israel a global focal point for clinical trials.

Currently, for Israeli biopharma companies, the transition from preclinical and early clinical development phases to the phase of proving drug efficacy in patients is commonly referred to as the valley of death. Due to funding difficulties that companies face, along with a shortage of experienced regulatory process managers, the clinical data created often

does not satisfy the regulator. However, changing trends in the design and performance of clinical trials across the globe provide an opportunity for improved accomplishments for Israeli startup companies at this phase. A calculated selection of the trial population based on clinical and genomic data, along with regulatory openness for faster approval of personalized therapies, especially for cancer, will enable companies to pass each phase with far fewer patients, and will enable a larger portion of the clinical trials to be conducted in Israel. This means that Israeli biopharma companies that are able to harness these evolving trends could reach the market with fewer costs at a faster pace.

The aforementioned steps for making genomic and clinical data accessible to the industry are thus slated to help biopharma companies in clinical trial phases as well - especially when selecting the trial population. In addition, the Innovation Authority will increase its support in early clinical phases of effective, smart trials that are in line with the global trend.¹¹The Innovation Authority will also create incentives to attract global experts in the management of regulatory processes to the Israeli ecosystem.

At the same time, global demand for advanced information technology that supports clinical trial phases, and the need to test personalized therapies on specific populations, could lead to the emergence of an entire ecosystem that supports clinical trials in Israel. Israeli biopharma companies would also benefit from this trend, because it would lead to the formation of a local body of knowledge on conducting clinical trials. There are already several companies in the Israeli industry that have recognized the need for advanced technological solutions to test the effects of drugs, and are throwing their hat in the ring. Pilltracker, for example, has developed an electronic device that enables the precise monitoring of clinical trial participants to ensure drug compliance, while updating participants on dose changes and receiving ongoing feedback from them. Data2Life is riding the global wave of analyzing the effect of drugs after market penetration (real-world data). The company aggregates data from patients through several channels: social media, medical monitoring devices, medical records, clinical trial data, and other sources. It uses this data to gain insight on the efficacy and side effects of drugs via machine learning and natural language processing.

Israel could also become a hub for conducting the actual clinical trials. High-quality research hospitals, advanced medical care, experience in conducting trials, and the small geographical area of the country make it relatively easy to recruit patients. As such, Israel is already attractive to global biopharma companies. For example, in 2017, companies submitted over 1,500 requests to conduct clinical trials in Israeli hospitals.¹² The penetration of personalized medicine and digitization trends in clinical trials could bolster Israel's standing in the field. First, the variety of unique population groups in Israel makes it very attractive for conducting trials on personalized therapies based on genetic mutations. Second, being a leader in information technology that supports clinical trials will allow Israel's ecosystem to provide innovative services to biopharma companies that will perform clinical trials in Israel.

In conclusion, the Innovation Authority sees personalized medicine as a potential turning point for the Israeli biopharma industry. Sweeping changes in the biopharma industry worldwide are creating an opportunity for breaking down barriers between the world of classical biopharma and the ICT industry, and for the emergence of new players and experts. We should harness the global technological trends and develop a multidisciplinary ecosystem that would be propelled by groundbreaking research, will make optimal use of existing genomic and clinical data in Israel, will leverage advanced information technology, and will ensure that the future of the global biopharma industry will begin in Israel.

¹¹ Consultation with the industry showed that government support of companies in early clinical phases is more critical and more effective than it is at more advanced phases

¹² Summary of 2017 and a comparison to 2014-2016, May 15 2018, The Ministry of Health, approvals by the Committee for Communications with Commercial Companies

Case study: How a database on Parkinson's patients in Israel has become an attraction of global investment

The Israeli population has great appeal for the world of medical research. Mass immigration to Israel has translated into a multitude of unique genetic backgrounds and ways of life. These populations enable the research community to identify causes of diseases. As such, they serve as a source for drug development, for new therapeutic interventions, for technological development to characterize diseases in early, preclinical stages, and for understanding processes in disease development, leading to drug development for health maintenance.

Building on this uniqueness, the largest clinical-biological-genetic database of Ashkenazi Parkinson's patients in the world was established in Israel, at the Tel Aviv Sourasky Medical Center – Ichilov Hospital. The database was created thirteen years ago, and was reported by many widely distributed scientific publications. Within a few short years since its inception, research based on database revealed that a third of Ashkenazi Parkinson's patients carry a genetic mutation that contributes to the eruption of the disease. They also discovered that mutations of two genes, GBA and LRRK2, are prevalent among roughly 8.3% of the Ashkenazi population, and are associated with a significantly higher risk for developing Parkinson's disease.

The creation of the database and the scientific publications reporting on it spurred international collaborations, and attracted investments by key players in the research of Parkinson's disease. For example, the Michael J. Fox Foundation, which is based in the US and invests over \$100 million a year in advocating research for the prevention of Parkinson's, began to support the expansion of the database by investing millions of dollars, and by collaborating with Columbia University and Mount Sinai Beth Israel Hospital in New York.

One promising research angle in battling degenerative brain diseases is a study being conducted on patients' disease-free relatives (carriers of the mutated genes), who are at high risk for developing the disease, and a study on healthy carriers of the genetic mutation who become sick during the course of the study. The database built at the Tel Aviv Sourasky Medical Center – Ichilov Hospital creates exclusive knowledge about these two population groups. At the conclusion of ten years of research at the center, the US company Biogene discovered that the knowledge accumulated on the progression of Parkinson's disease in Jewish Ashkenazi patients could also apply to the ten million Parkinson's patients around the world, and to the tens of millions of people at risk of developing the disease. This knowledge could lead to the development of innovative therapies to prevent the disease.

Biogene initiated a collaboration with the hospital, and is investing tens of millions of shekels to advance and upgrade the clinical-biological database, while preserving Israeli researchers' academic rights and sharing the fruits of research. This type of partnership serves as a basis for extending collaborations to additional fronts, such as technological development for characterizing the progression of Parkinson's by use of miniature technology for monitoring movement at home, new imaging methods for diagnosing Parkinson's disease with MRI or PET scans, technology for quantifying cognitive function and sleep characteristics, and identifying genetic traits that protect at-risk populations from developing Parkinson's disease. Moreover, first and second phase studies and new drugs for preventing Parkinson's disease being developed by Biogene are currently being tested in Israel in groundbreaking clinical trials.

Investments by multinational companies, such as the outlined collaboration with Biogene, would not have taken place if not for the identification of the inherent potential of studying the Ashkenazi population to crack the code of Parkinson's disease. Similar potential lies in the research of additional degenerative nerve diseases, which are prevalent among other ethnic populations in Israel.

Written by Prof. Nir Giladi, director of the Neurology Division at the Tel Aviv Medical Center (Ichilov), responsible for the cathedral named after Shiratzki for neurology, Tel Aviv University; and Prof. Avi Or, director of the genetics center and director of the genome research laboratory, the Tel Aviv Medical Center (Ichilov), and a full professor from the pediatrics department and the department for molecular genetics and biochemistry, Tel Aviv University

A digital quantum leap in the healthcare system The Ministry of Health's vision



In recent years, the Ministry of Health has been advancing national digital health infrastructure that positions Israel at the forefront of the race for a data-centric world of medicine. The objective of the initiative is to enable the Israeli healthcare system to successfully address the challenges of the 21st century, such as the aging of the population, the pervasiveness of chronic illness, a spike in the number of insured people, unhealthy lifestyles, all while leveraging the Israeli system's comparative advantages.

In an effort to advance optimal health for Israel's entire population, the Ministry of Health has outlined a targeted vision for digital health: a quantum leap in the healthcare system that will allow it to become sustainable, advanced, innovative, and constantly improving; it will leverage information and communication technologies at its disposal, for the improved health of the entire Israeli population. The individual patient lies at the center of this medical activity, and plays an important role in the progress of their health and treatment. Medical decisions are made with the support of data derived from a variety of accessible sources, and through implementing the outcomes of R&D, which are also based on health data.

The realization of this vision requires a transformation in five aspects:

- The patient at the center – as a key engine for the overall changes.
- Personalized medicine – therapies adapted for individual human traits and needs.
- Promotion of health – proactive, predictive, and preventative medicine.
- Sustainable health – effective and economically viable processes in the healthcare system.
- Accessible health – digital services.

Israel prides itself on a quality digital healthcare system and on its technological and enterprising spirit. After a two-decade investment in medical digital documentation, Israel is at the forefront of existing digital medical data, and is growing hundreds of startups in the health field. Nonetheless, realizing the vision and making optimal use of the tremendous technological opportunity would require comprehensive infrastructure changes, including the advancement of processive and regulatory infrastructure in the system.

Led by the Ministry of Health and the Headquarters for the National Digital Israel Initiative through the Ministry of Social Equality, and in collaboration with the Prime Minister's Office, the treasury, the Innovation Authority, the Planning and Budgeting Committee, and the Ministry of Economy, in March 2018, the Israeli government set its sights on advancing digital health as a national engine of growth. The decision is centered on removing regulatory and infrastructure obstacles hindering collaboration between health data-centric sectors, and on the Mosaic Project, whose objective is the establishment of a genomic clinical data-base that would enable R&D of products that advance personalized medicine.

A digital health program, which was launched as a result of this decision, has already begun to operate on several fronts: The national big data infrastructure for R&D in the field of healthcare; telemedicine infrastructure, Halev infrastructure (the patient at the center) aimed at synchronizing interorganizational processes in the healthcare system (such as making an appointment for a medical procedure which is currently the patient's responsibility) and a new version of medical information exchange between medical professionals within the healthcare system (Eitan, the next generation of the Ofek system).

With a view to the future, and with suitable processive and regulatory infrastructure, the Ministry is anticipating health services to be based on an integration of capabilities from all these infrastructures. For example, telemedicine infrastructure that would link devices in possession of patients or their primary medical professionals, to health data in the Eitan system based on IoT (Internet of Things) capabilities.

Furthermore, R&D and big data development products will be implemented in processes for supplying the health services, whether in the patient's home, in community facilities, or in hospitals. According to forecasts, by 2030, big data and advanced data analysis tools will be implemented in the therapeutic environment, and will supply products that are learning and improving. Therapeutic decisions will be made with the backing of these tools, and will reflect accumulated knowledge in the fields of medical treatment and preventative medicine. The integration of the systems of healthcare, welfare and education, and broadening treatment processes to include the needs and capabilities of patients and their families, will complete the picture of the future, and will make Israel a global leader in healthcare.

From a High-Tech Industry to a Smart Economy



Weak competitive intensity and regulation that do not foster innovation have thus far slowed the adoption of new technologies in the Israeli economy. Israel must now brace itself for inevitable 'Creative Destruction' processes that will coincide with global automation trends





From a High-Tech Industry to a Smart Economy



In recent decades, Israel has established itself as a global hub of innovation that excels in tech development and produces groundbreaking companies. We often cite the extraordinary accomplishments of yet another Israeli company that has developed a new, revolutionary product; nevertheless there seems to be a significant discrepancy between the advanced high-tech industry and day-to-day life in Israel. Most people in Israel do not feel that they are living in a 'technological' country when they are on their way to work, when dealing with bureaucracy, or when shopping at chain stores. This is more than just a feeling – substantial sectors in Israel, such as transportation, commerce, construction, education, and public services, are still lagging behind other Western countries. A Londoner, for example, might take advanced services for granted, such as taking an Uber, a contactless or cellphone payment at a coffee shop, broadband browsing, efficient online communications with public entities, and fast, efficient construction.

Comparative data indicates that Israel excels at creating innovation - meaning technology development – but is falling behind developed countries in the consumption of innovation – meaning technology assimilation. For example, in the Global Competitiveness Index published by the WEF (World Economic Forum), Israel has consistently been a leader in a number of parameters that reflect the strength of its innovation ecosystem, such as its heavy investment in R&D and quality scientific research. On the other hand, in other parameters included in the index that characterize innovative economies, such as digital infrastructure and the technological capabilities of its population, Israel is coming up short in comparison to other developed countries (see diagram 1).

A prominent sector where there is a substantial discrepancy between technological developments and the penetration of innovative technologies in people's day-to-day lives is transportation. Despite impressive Israeli developments – including apps like Waze, Moovit, and other groundbreaking products like Mobileye – transportation solutions made available to the Israeli population are very limited.

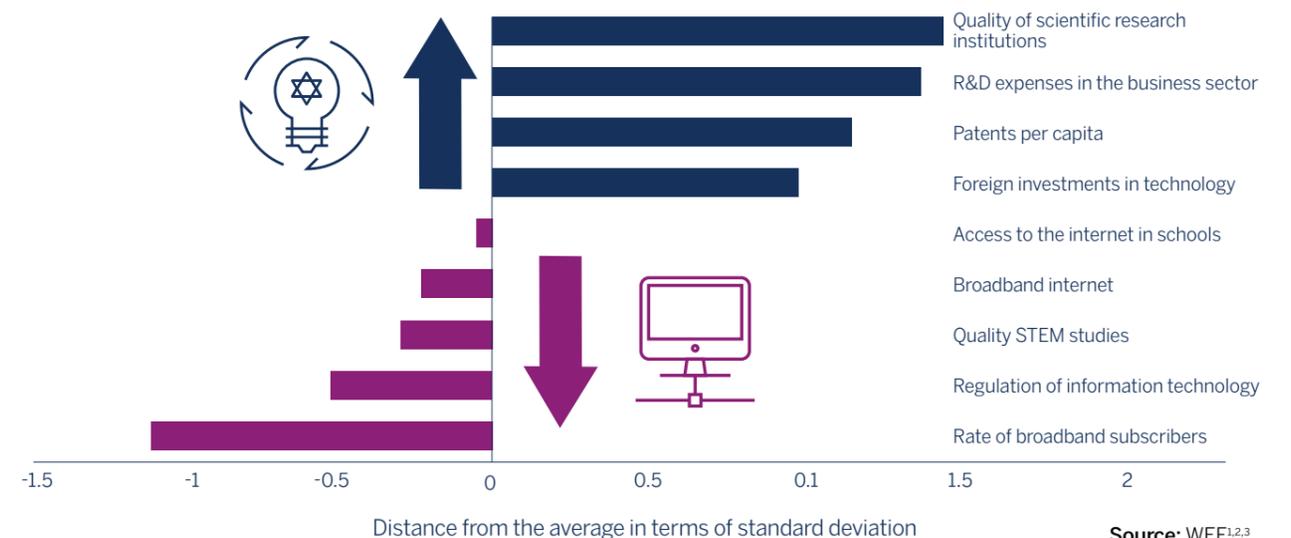
We believe that increasing the penetration of advanced technologies into day-to-day life in Israel is critical for economic prosperity and for improved quality of life. If Israeli innovation doesn't break through the confines of the high-tech industry, this innovation will only be accessible to small, distinct segments of the population. In our previous annual report, we pointed to the need to increase the number of employees in innovation-driven companies – so that more employees would benefit from high productivity, high pay, and challenging

work. In this chapter, we will discuss the need to expand Israeli innovation even further, to function as an engine to improve the lives of its population as a whole. To this end, Israel must progress from a startup nation to a smartup nation – a smart and technological economy that excels both in developing innovative technologies and in implementing them in all aspects of life.

The importance of this change becomes even clearer in light of the fast-paced technological changes taking place in all fields of human activity: technological innovation spurs new products and industries, but at the same time, makes existing industries obsolete. The Israeli economy is not immune to these processes, as evidenced in difficulties that several business sectors are currently facing. Consequently, the Israeli government must lay the necessary groundwork to harness new technologies to improve the quality of life in Israel and to enhance the prosperity of its business sector.

In this chapter, we will discuss the origins of the discrepancy between Israel's capabilities in technological development and its ability to adopt and assimilate these developments in the local economy, and we will present viable paths to bridge this gap. In particular, we will describe the Innovation Authority's policy to increase the link between Israel's high-tech industry and its other business sectors, and we will discuss the importance of supportive regulation both for the development of innovative technologies and for their assimilation into the economy. In the final section of the chapter, we will present the vision of several government ministries on that ways that innovation would upgrade their respective fields.

Israel's relative standing among developed countries in select innovation indices, 2017-2018



Source: WEF^{1,2,3}

1 Israel's standard score among a group of 29 countries that meet the definition of "developed economies" according to the Monetary Fund OECD membership. All parameters are updated to reflect 2017-2018 data, except for the regulation of information technologies, which is updated to reflect 2016 data
2 World Economic Forum. (2018)
3 World Economic Forum. (2017)

Technology adoption in the Israeli economy

Why isn't Israel's economy technology-driven as a whole, despite its flourishing high-tech industry? In this chapter, we will hone in on two possible causes: the nature of competition in the business sector, and Israel's regulatory environment.

In recent years, weak competition that characterizes many branches of Israel's business sector has been at the heart of public discourse regarding the cost of living, but it has had another consequence: it impedes investment in innovation. Weak sectorial competition, especially with leading actors across the globe, reduces the incentive to bolster productivity through investing in innovation and technology, and hinders consumer access to advanced, inexpensive services and products.⁴

For all intents and purposes, Israel is a small 'island economy' far from global supply chains. This results in relatively low exposure of many local companies to global competition with innovative companies, because the feasibility of launching operations in Israel – whether via imports or via local presence – is low.

The small size of Israel's economy and its geographic isolation also affect the intensity of competition in sectors that from the outset have very low exposure to imports, such as construction, infrastructure, banking, communications, and trade in certain products. In these sectors, which generally offer low profit margins relative to international shipping costs, a short shelf life, natural monopolies, and singular local regulation, manufacturing and consumption take place in close geographic proximity. In economic jargon, these sectors are called non-tradable sectors. In large geographic markets, such as the US and the EU, it is economically feasible for many actors to operate in these sectors. In contrast, in Israel, a small, isolated economy, the economic incentive for new competitors to enter these sectors is weak; as a result, competition is limited.

Another component that impacts the adoption of innovation is the regulatory environment. As we will detail in the following discussion, regulation plays a key role in either encouraging or hindering the assimilation of technological innovation in the local economy. Regulation can block competitors dependent on innovative technology from entering a certain market, or it can make it difficult for existing competitors to provide services and products using innovative technologies. In the financial sector, for example, regulatory restrictions, stemming from financial regulators' desire to ensure the stability of the financial system and protect consumers, mean that Israelis do not benefit from innovative financial services as people in other countries might. Regulation can also impact the level of technological innovation in services that a variety of public entities provide, such as legal services, transportation services, and vital utilities like water, electricity and others.

However, an analysis of current technological trends indicates that we are at the crux of processes that are slated to rock existing markets, and which will not spare the Israeli economy. Firstly, the rapid digitization and automation of products and services is diminishing the importance of geographical distance, and is transforming Israel from a distant island economy to yet another location in the global village that is exposed to fierce competition. Any product or service that can be digitized, such as books, newspapers, or even certain financial services, is becoming available for sale and consumption from any location.

Secondly, tangible consumer products are undergoing and will continue to undergo a radical transformation in the business models for their supply – from the streamlining of logistic systems, to delivery by drones or autonomous vehicles, to the home manufacturing of products by use of 3D printing. Just over the course of this past year, we have seen long-established retailers in Israel cave to competition posed by online, international businesses offering inexpensive products and low shipping costs.

Thirdly, the penetration of innovative technologies in highly regulated, 'local' fields, such as transportation and finance, is changing the rules of their usage. In particular, innovative, fast-moving startups are quickly becoming potential contenders for banks, credit card companies, and public transportation providers worldwide. Ultimately, it will become impossible, and undesirable, to halt their penetration to local operations in Israel.

Lastly, problems in public and vital service sectors in Israel are growing, and the pressure to solve these problems is increasing. Israelis, who are more exposed to standards provided in developed countries than in the past, are now demanding trains that arrive on time, orderly mail delivery, reduced traffic congestion, and other basic vital services.

These trends will expose companies across all business sectors in Israel to global competition, and will increase pressure on regulators to adapt the rules to a new era. We believe that a response focused on fortifying defenses will lose efficacy over time, and will not serve the interests of the Israeli public. To the contrary – Israeli companies should be offered assistance in facing global innovation-driven competition, and regulation should be adapted to new technologies and to global regulatory trends.

In recent years, the Israeli government has been working to bridge the gaps in digitization that have been accumulating for decades – but this is not enough. Other developed countries are already gearing up to derive maximum benefit from technologies of the future, particularly from AI. Last year, many countries presented national programs aimed at harnessing developments in the field of AI in order to bolster productivity and improve wellbeing, while addressing the implications of these technologies in the workplace. Israel is facing a significant challenge on its way to becoming a smart technology economy: the gap must be bridged quickly in order to secure Israel's future standing among the advanced economies of the world. The duality that has existed thus far between the innovative high-tech sector and the rest of the economy, which has been slow to adopt new technologies, is not sustainable.

⁴ It is important to note that in certain sectors, fierce competitiveness could also have a negative impact on innovation incentives, because companies' profit margins are very low.

An interministerial team led by the Finance and Justice Ministries recommended the establishment of a regulatory sandbox for the field of Fintech. See page 83

How can we effect change?

A first and necessary step in this direction is to reinforce the link between Israeli high-tech companies and other sectors in the economy. Currently, Israeli high-tech companies primarily deal with global markets, and have few local customers. As a result, the extraordinary potential of Israeli innovative developments in improving products and services offered to the local population remains unfulfilled. Encouraging collaborations between Israeli high-tech companies and Israeli organizations in the business and public sectors would benefit both sides: local organizations would be exposed to innovative technologies and would assimilate such technologies, while high-tech companies would work on upgrading their products 'close to home', thus improving their starting point in the global competitive market.

The Innovation Authority has taken on this task, and is already acting to fulfill this vision. The Authority's new track for supporting pilots is encouraging Israeli high-tech companies to test or demonstrate their products at a range of sites in Israel (see margin text). The Authority is working in collaboration with several government ministries that have an interest in fostering the assimilation of innovation in their respective fields. These ministries are contributing funding and regulatory approvals for the demonstration of innovative technology as needed. At the same time, the Authority is providing support for the development of technologies aimed at addressing challenges in Israel's public sector, in collaboration with the National Digital Israel Initiative by the Ministry of Social Equality.

The direct effect of government regulation on innovation is becoming increasingly significant with the increasing pace of technological changes; as a result, it is necessary to take further action in the field of regulation. This challenge – balancing public protection and guaranteeing market fairness with advancing innovation – is also becoming increasingly complex. Innovative technologies are generating new human and business activity and are completely transforming market dynamics. Regulators must promptly create, change, enforce and communicate rules to the public.

The present rate of regulator activity is a central limitation in the traditional regulatory climate. Policy cycles take from 5-20 years, whereas a startup can develop into a global company in a matter of months.⁵ Other fundamental regulatory restrictions include regulatory barriers that do not communicate with one another (unlike technologies that operate across sectors), and a tendency to rely upon input such as technical specifications that only apply to a particular technology, instead of striving for performance and results.

Several developed countries are currently testing with innovation-supporting regulation, and are creating new paradigms in an effort to overcome these restrictions. In the US, for example, the NHTSA (National Highway Traffic Safety Administration) is attempting to create regulation for testing autonomous vehicles that updates periodically in accordance with technological developments. In 2016, it published rules that permitted the testing of autonomous vehicles on public roads. In 2017, these rules were already updated in response to new gathered data and newly developed technologies,⁶ and are expected to be updated again in the future. In Israel, the Ministry of Transport recently began working on the regulation of autonomous vehicle testing and on the regulation of additional smart transportation technologies.

The Ministry of Transport is working to adapt Israel's regulatory framework to promote the development and assimilation of advanced transportation systems. See page 82

⁵ Turley, M., Eggers, W. and Kishani, P. (2018, June 19). The future of regulation – Principles for regulating emerging technologies

⁶ Crowell & Moring. (2017, September 17). DOT and NHTSA Release New "2.0" Guidance for Automated Vehicles. Lexology

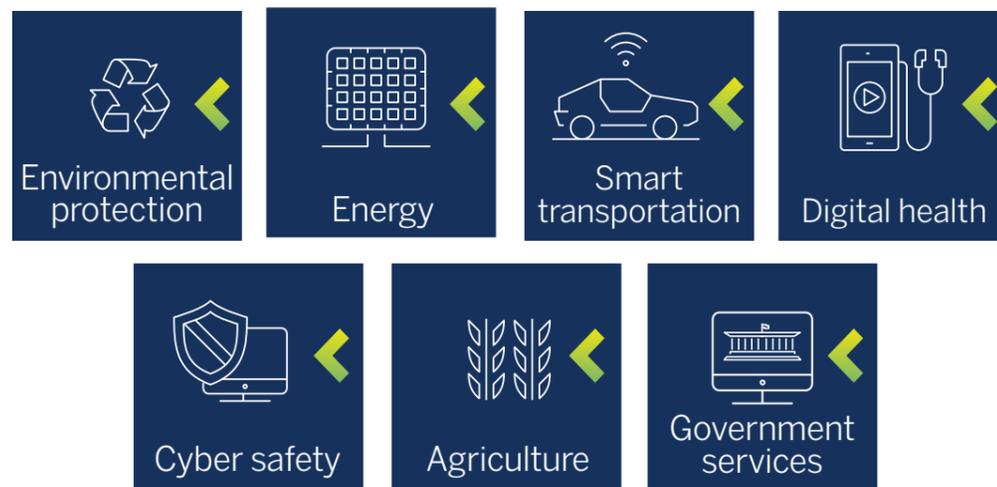
Supporting pilots by tech companies in Israel

Over the course of 2018, the Innovation Authority launched a track to provide funding and regulatory support to technology pilots conducted primarily at Israeli sites. A pilot is a prototype, a trial model for testing feasibility, proving value, or introducing changes and improvements to existing technology, in a work environment that simulates the target market. For example, a company that has developed a prototype for a product in the field of digital healthcare would need to test its product in a therapeutic-clinical environment, such as a hospital. The pilot stage is usually followed by a serial manufacturing exit or commercial market penetration.

The Innovation Authority has begun supporting pilots in order to realize a key strategic objective: increasing the economic value that the high-tech industry yields for Israel, while helping young companies mature into complete companies in Israel. The pilot stage is a critical milestone in the path to product commercialization and market penetration. Often, a variety of obstacles hinder pilot performance – primarily funding and regulatory obstacles, and limited access to pilot sites. These obstacles are particularly notable in highly regulated fields such as transportation, infrastructure, healthcare, energy, and environment. Removing these obstacles is imperative in order to help startups advance to growth stages.

The track operates in collaboration with over ten government entities. As such, it reflects the inherent benefit of conducting pilots in Israel: high-tech companies are granted a boost for growth, and the local economy is exposed to innovative technologies for improved performance. Collaboration with a variety of regulators extends companies' access to an array of pilot sites, and allows them to demonstrate innovative technologies while adhering to regulation requirements.

Test-run country: The Innovation Authority supports pilots of technology companies in Israel in a variety of fields



particular, and for Israel's business sector to maintain this edge over other countries in general".⁷ The Israeli government recognizes the magnitude of this issue and has begun to reduce the bureaucratic and regulatory burden, but it is critical to establish firm policy to keep up with other countries.⁸

The Innovation Authority has also begun advancing regulation that fosters innovation. In the context of an emerging collaboration with the WEF (World Economic Forum), Israel is slated to join the C4IR network (Center for the Fourth Industrial Revolution) aimed at establishing and sharing best practices in the field of innovation regulation, with an Israeli Innovation Authority center working with local regulators to establish and adopt regulatory rules for future technologies.

The Ministry of Environmental Protection is allowing pilots in the field of environmental innovation to operate with controlled leniency of regulatory requirements for pollutant emissions. See page 85

Another widespread paradigm is the development of trial and error mechanisms for industry, called a regulatory sandbox. A regulatory sandbox is a controlled environment that allows entrepreneurs and companies to test products, services or business models, without adhering to all existing regulatory requirements. They often operate in collaboration with government, private companies, and academic institutions. Many countries currently operate such regulatory sandboxes, especially in the field of financial regulation. In Israel, the Ministry of Finance and the Ministry of Justice are examining the development of a similar trial and error environment for the fintech sector (see margin text).

The Ministry of Energy has established a strategy aimed at making Israel's energy economy clean. See page 84

Regulation can also directly encourage innovation by setting standards that incentivize the business sector or citizens to adopt innovative technologies. This is a commonly held practice in the energy and environmental sectors, where many countries set targets for reducing emissions on the one hand, while setting targets for the penetration of renewable energy on the other. In Israel, the Ministry of Energy is currently taking this approach to increase the penetration of renewable energy and the use of less polluting vehicles, such as electric vehicles.

At the same time, the indirect effects of the regulation of innovation are no less remarkable. In Israel, inadequacy in ease of doing business is frequently cited as one of the most notable obstacles for growth in the country today. According to the World Bank Ease of Doing Business index, Israel was ranked 54th in 2017, after an accumulative drop of 21 places in the past five years. The Israel Business Environment Improvement Committee appointed by the Ministry of Finance Accountant General identified a series of problems in government activity that increase the bureaucratic burden placed on the business sector, such as inconsistency and lack of government coordination for improving the business environment, and inadequate mechanisms for creating routine dialogue with the business sector. The Committee stated that "Rapid adaptation to change, innovative thinking, and the adoption of progress, are critical for a business to maintain its competitive edge in

⁷ The Ministry of Finance Accountant General. (June 2018)
⁸ A five-year plan has been implemented by the Prime Minister's Office to reduce the overall regulatory burden in an effort to streamline regulation and to cut the cost of government bureaucracy by 25%. The Israel Business Environment Improvement Committee has also recommended the establishment of a senior general management committee headed by the Accountant General that will integrate operations to improve the business environment, and will advance a uniform applicable policy from an economic and business standpoint. Another central recommendation is to advance the establishment of a government portal and a personal digital space for businesses

Futuristic transportation in Israel | The Ministry of Transportation



A safe and efficient transportation system is critical for a flourishing economy, and has a direct effect on the lives, the wellbeing, and the livelihood of all the country's citizens. The vision of the MoT (Ministry of Transport), which is tasked with transportation planning in Israel, is to make Israel a world leader in the field of innovative transportation, by using the country's rich technological resources and human capital. In an effort to make this vision a reality, the Ministry is aspiring to promote smart transportation, to expand public transit, to lessen traffic congestion, to lower incidences of road accidents, and to reduce pollution caused by transportation. To a large extent, meeting these goals hinges on the development and implementation of technological innovation in the field of transportation.

Over the past few years, the revolution spurred by the penetration of advanced ICT (Information and Communications Technology) into the vehicle and transportation field has provided an opportunity for Israel to be a leader in this domain. Recent years have seen the growth of a prominent ecosystem in vehicle and transportation technologies in Israel. However, an active government policy is critical if breakthrough technologies are to improve local transportation. The implementation of innovative transportation technologies requires supportive regulation, uniform international standardization, monetary incentives, and the allocation of physical infrastructure.

In order to create suitable conditions for Israeli and foreign companies to work on Israel's transportation system, the MoT is tackling the issue on several fronts. Firstly, the Ministry established an organizational support infrastructure for the implementation of innovative transportation technologies in Israel. In early 2018, a senior manager of technologies and innovation in the transportation administration was appointed to follow technological developments in infrastructure and advanced autonomous vehicle systems, and to assist in their implementation in Israel.

Secondly, the Ministry is working to adapt Israel's regulatory system to allow its knowledge-rich industry to develop and assimilate advanced systems in Israel. Committees of experts have been established, procedure manuals have been drafted, and regulations have been updated in order to facilitate progress from R&D to advanced stages, and from closed facilities vehicle testing to public roads. Thus far, test vehicles with installed autonomous driving systems, alternative navigation systems, advanced sensors, advanced cameras, as well as other features, have already received approval for use on public roads.

Furthermore, in early 2019, the MoT's Planning and Infrastructure Administration will be launching two initiatives to promote the testing of advanced technologies in Israel. The Testing Center will examine developments by innovative companies in a natural, yet sterile environment, and will be managed and operated by the Ayalon Highway company. The center will be aided by a regulatory mechanism that allows the Transportation Supervisor to approve exceptions from regulations for testing purposes. The initiative is designed for mature innovative products that are ready to be tested in a normal environment, but do not meet transportation regulations.

However, local regulatory support is not enough – the development and assimilation of advanced transportation technologies requires uniform, standardized international regulation. The MoT and the Alternative Fuels and Smart Transportation Administration are promoting a platform for engaging in dialogue with regulatory bodies from EU states, the US, Asian countries, manufacturer representatives, and other entities in the automotive industry, worldwide. At the same time, MoT representatives have begun to take part in deliberations by the UN's primary standardization committee held in Geneva.

Thirdly, the MoT is providing financing incentives for the development and assimilation of innovative technologies in the transportation field while offering pertinent regulatory support: In 2018, the MoT and the Innovation Authority launched a multiannual budgeted program to provide financial and regulatory support for the demonstration of transportation and infrastructure systems at their advanced development stages (pilots). Particular emphasis is placed on improving safety, reducing traffic congestion, and encouraging the use of public transportation. In an effort to advance the technological capabilities of the MoT's infrastructure companies, the Ministry's Planning and Infrastructure Administration will also fund the testing and implementation of their innovative technologies.

Israel is opening its doors to FinTech The Ministry of Finance and the Ministry of Justice



The fintech sector – companies that leverage new technology, either fully or partially, to supply or produce financial products and services – has seen significant growth in the past decade, and Israel's fintech industry is considered a world leader in the field. According to Bank of Israel data, the 600 fintech companies currently operating in Israel are transforming the global finance industry.

Fintech has the potential to transform Israel's finance industry, as well – by fostering innovation in the financial sector, by adapting financial services to clients and improving usability, by streamlining the financial system, and by bolstering competition in Israel's financial sector. However, only a handful of Israeli fintech companies offer extensive services to the Israeli consumer, unlike other fields, where the Israeli consumer benefits from technological innovations and is viewed as being quick to adopt them.

The challenges facing fintech companies in Israel stem from the fact that they operate within a complex, heavily regulated environment. This reality is not exclusive to Israel – many financial systems around the world face complex regulations; they are aimed at ensuring the stability of financial bodies from market failures and risks that are unique to the financial world, for the benefit of the public. In the absence of a suitable framework, fintech companies face an array of regulatory challenges which pose an obstacle to their launching, their business development, and to their ability to offer products and services in the Israeli market. Consequently, the Israeli market is not meeting the fintech industry's potential both as a significant growth engine within the high-tech industry, and as a tool for upgrading Israel's financial system.

The Israeli government would like to expand the activity of fintech companies in Israel, and allow the Israeli consumer to enjoy a wide range of advanced financial products and services. Accordingly, the government has established an intergovernmental team comprised of all financial regulators under the auspices of the Ministry of Finance and the Ministry of Justice. The team will be recommending a regulatory sandbox: a testing environment that facilitates learning through trial and error, in order to address the regulatory challenges that both fintech companies and regulators face. This testing environment will include an adaptive regulatory outline tailored to the companies' activities and features, while taking Israel's normative framework, consumer welfare, and market characteristics into account. Furthermore, a targeted direction draft will be established to provide regulatory solutions to the unique difficulties encountered by companies that want to operate in Israel but do not need licensure, according to current regulation.

The team's guidelines will be laid out in legislation that will provide regulators with the authority necessary for the implementation of the program in order to facilitate the safe assimilation of financial technologies in Israel to benefit consumers and the Israeli economy as a whole.

A clean energy sector by 2030 | the Ministry of Energy



The Ministry of Energy, in charge of Israel's natural resources and energy sectors, is pushing hard for a clean Israeli energy sector by 2030. To this end, the Ministry drafted a strategy focused on generating electricity from natural gas and renewable energy, on increasing energy efficiency, and on promoting a total transition to electric transportation. In July 2018, the Ministry led a government decision to shut down the coal-fired power stations in Hadera, and in 2019, roughly 2,000 electric vehicle charging stations will be dispersed across the country at a cost of NIS 30 million.

In 2018, roughly 30% of Israel's electricity generation was coal based, while only 3% was based on renewable energy. In transportation, electric vehicles have been scarce. Following the signing of the global agreement at the Paris Climate Conference in 2015, Israel set long-term goals to reduce greenhouse gas emissions in an effort to take part in the global action against climate change. The Ministry of Energy plan is aimed at fulfilling Israel's role in the agreement and at promoting an efficient, green economy. The plan is based on several strategic goals:

- The penetration of renewables, mostly variable renewables,⁹ amounting to at least 17% of Israel's total electricity generation.
- An increase in local and decentralized electricity generation at higher energy efficiency, with an emphasis on generation of renewable energy and cogeneration.¹⁰
- The development of a smart, electrical grid comprised of reliable local grids with local control of generation and consumption of electricity.
- The encouragement of a massive penetration of electric vehicles that rely on managed charging and discharging, and as of 2030, the prohibition of sales of new private vehicles that are not powered by electricity.

The way to meeting these goals is full of challenges. Firstly, it is imperative to develop energy storage capabilities, both to stabilize the grid and for energy security purposes, and for energy security purposes. Secondly, managing a reliable, highly distributed electrical grid is difficult. Lastly, Israel's high population density hinders its ability to establish new energy infrastructure. The development and implementation of novel technologies in the field of energy are critical in order to overcome these obstacles and fulfill the vision of a clean energy sector. Fundamental technological developments required to meet these challenges include fuel cells, the use of hydrogen as an energy source, and increasing the efficiency of solar energy production and energy storage for both mobile and stationary applications.

The Office of the Chief Scientist at the Ministry of Energy – the technological arm that serves as a knowledge center for the entire energy sector – is tasked with promoting, developing, and using advanced energy technologies to make this vision a reality. The OCS advances systemic technological issues such as fuel alternatives for transportation, electric vehicles, a smart electrical grid, renewable energy, and nuclear energy, among others. The OCS also funds and supervises R&D operations in the field of energy both in academia and in industry through public proposals in different research stages, from inception to implementation. It supports academic research in the amount of 20 million NIS annually; it offers overseas grants to post-doctoral researchers to study energy disciplines that are lacking in the Israeli academia; it supports pre-seed startups (prototypes and proof of concept), pilot and demonstration projects to encourage an innovative energy and fuel industry in Israel.

⁹ Unstable energy sources that depend on environmental conditions – sun, wind, etc

¹⁰ Cogeneration – electricity generation technology that makes use of residual heat, leading to better fuel efficiency

Innovative environmental technologies in Israel The Ministry of Environmental Protection

In Western countries and in Israel, pollution is said to pose the greatest risk to public health. The Ministry for Environmental Protection is tasked with the monitoring, regulation, supervision, enforcement, and the reduction of pollution and its risks. The Ministry also provides support tools and incentives to encourage improved energy efficiency and to reduce pollution from the four primary sources of pollution: industry, energy generation, transportation, and open burning.

Another key issue facing the Ministry is waste treatment and the implementation of a new national treatment strategy for this purpose. Currently, roughly 80% of Israel's waste is buried, and the remainder is recycled. Waste burial creates a variety of environmental hazards: air and odor pollution, greenhouse gas emissions, groundwater and soil pollution, the utilization of land that is a limited resource, public health risks, and an ineffective use of resources. The OCS is aspiring to reduce waste burial and to recycle waste for the production of valuable raw materials. Other challenges it is addressing include decreasing risks from hazardous materials, reducing emissions, and conserving water and natural resources.

In order to face these environmental challenges, the Ministry of Environmental Protection is fostering the development of innovative initiatives for environmental technologies (cleantech) aimed at reducing environmental risks and minimizing the use of natural resources in a variety of energy generation and product manufacturing processes. The main markets for these technologies include primarily the various energy field derivatives (energy efficiency, creating renewable energy, storage and distribution), as well as water resource management. In addition to the energy and water sectors, other environmental technology sectors include smart and sustainable transportation, waste resource management, and advanced industrial manufacturing that streamlines raw materials usage.

In Israel, there are a few hundred companies that operate in a variety of environmental technology fields, however the implementation of innovative, technological, environmental solutions requires government backing on several fronts:

- **Assistance in establishing pilot environmental technology facilities** – A facility or a process on a larger scale than lab testing designed to examine the real-life feasibility of the implementation of the innovative technology on an industrial scale.
- **Funding** – The stage of demonstrating the environmental technology on an industrial scale is costly; banks, institutional entities and venture capital funds should be encouraged to fund it.
- **Regulation** – An innovative technology that has not yet been field tested cannot guarantee to meet the required environmental performance and emissions regulations. Field testing necessitates the drafting of regulatory policy that takes into account the risk of temporary and controlled deviation from performances and values attributed to an optimal available technique. To this end, the OCS has a new treatment policy in the licensing of pilot facilities for environmental innovation designed to remove regulatory obstacles under the auspices of the Ministry. Regulatory support includes assistance with bureaucratic procedures for facility licensure under the framework of the Ministry's regulation authorities, and the possibility for controlled relief of pollutant emission values over the course of the pilot period.

The problems facing cleantech markets are not unique to Israel. On the one hand, we are witnessing the consistent growth of environmental technology markets around the world, and this growth is projected to continue; on the other hand, in order to realize the environmental and economic potential of environmental technologies, governments worldwide must join forces and support these initiatives.

A new program launched by the Ministry of Environmental Protection and the Innovation Authority will create conditions that will allow innovative environmental technologies to mature and to be implemented on an industrial and global scale. The program offers monetary and regulatory support of environmental technology initiatives at the beta stage, the stage for testing commercial feasibility. Over fifty projects from a wide range of environmental fields have been submitted for the first support round, with a total budget equaling roughly NIS 150 million.



An Innovation Driven Economy in the Periphery

A National Priority

Innovation activity in Israel is concentrated predominantly in the Tel Aviv metropolitan area and does not exhaust the resources of innovation in the periphery. The Innovation Authority is leading a national strategy to promote an innovation-driven economy in the periphery, which will benefit both the regional economy and the entire national innovation system



An Innovation-Driven Economy in the Periphery A National Priority

Is the State of Israel worthy of its description as “the startup nation”? The initial answer is surely “yes” – Israel is a world leader in terms of the number and quality of its startups. However, another question arises: is Israel the startup nation or is it just the Tel Aviv metropolitan area that can justifiably claim this description, and not the country as a whole?

This chapter seeks to examine this question – not only with regard to startup companies, but also in regard to the entire Israeli innovation system. It will propose a practical agenda with a dual goal: optimal use of the innovation resources that exist beyond the Tel Aviv metropolis for the benefit of the Israeli innovation system, and innovation-inclined economic growth throughout the country. We believe in a plan of action that will benefit both the Israeli innovation system and the areas in the geographical periphery. However, this requires implementable solutions that consider the market forces acting on national innovation systems, that are adapted for each individual region. For example, an attempt to duplicate Rothschild Boulevard’s high-tech activity in the Galilee or the Negev may fail, or worse, come at the expense of successful practical solutions better suited to these areas.

Geographical Specialization in Israel and its Ramifications

When examining the geographical distribution of the various economic sectors in Israel, we must distinguish between results that are the consequence of economic forces at work in Israel and wishful thinking. The premise we must accept is that high-tech companies tend to concentrate in certain geographical areas, frequently in urban metropolises. The most prominent example of this is San Francisco although other centers such as London, Beijing and Berlin have followed suit in recent years. This phenomenon has many advantages, both for the companies themselves and for the regional economy. The companies inspire each other with technological knowledge, exchange skilled human capital, and attract investors. The trend has grown over the past decade, for reasons that include increasing technological complexity necessitating greater collaboration, and because of the increasing attraction of workers to vibrant urban areas.¹ In practice, today, more than 50% of venture capital investment in the world is concentrated in only ten urban metropolises.²

1 Katz, B. and Wagner, J. (2014). The Rise of Innovation Districts: A New Geography of Innovation in America
2 Florida, R. (Oct 3, 2017). Venture Capital Remains Highly Concentrated in Just Few Cities. Citylab

The other side of the coin is that the area in which they are concentrated benefits from accelerated growth and high-quality employment. As these regions develop, they become a powerful magnet, attracting most of the “talent”, investors and entrepreneurs. While they serve as an economic growth engines, attracting innovation resources may harm the potential growth and quality employment in other areas. This dynamic can also have negative ramifications for the national economy by potentially increasing disparities and leading to an under-utilization of skilled workers who, for various reasons, are unable to work in these centers.

A similar “centralization” trend in high-tech also exists in Israel: more than 60% of all high-tech jobs in Israel are located in the Tel Aviv and central regions, and as Diagram no. 1 illustrates, approximately 77% of the companies operate in this area. Diagram No. 2 reveals that this trend has even intensified in recent years with the growth in high-tech employment in Tel Aviv constituting approximately 70% of the total increase in this sector in Israel.³

Diagram 1: Startups in Israel by Region - 2018

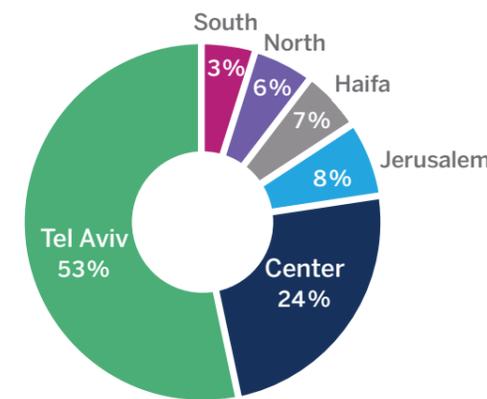
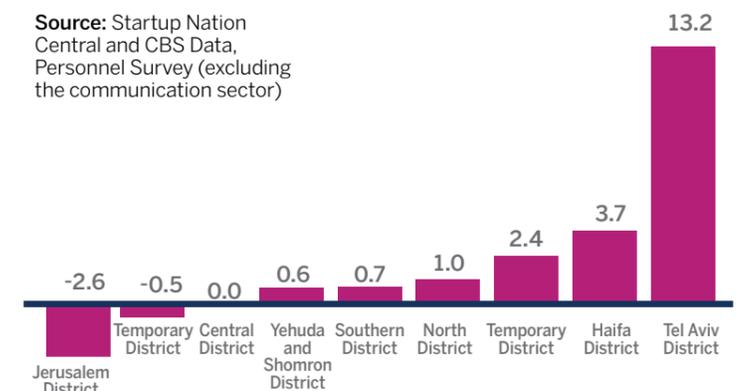


Diagram 2: Salaried High-Tech Employees Growth Between 2015-2017 (Thousands)



Source: Startup Nation Central and CBS Data, Personnel Survey (excluding the communication sector)

As mentioned above, this trend is not surprising. Access to skilled human capital is decisive for high-tech companies and they therefore tend to locate themselves at the center of innovation activity. Other considerations, such as the high cost of office space in city centers are of only secondary importance for them, because of the relatively small office space required per employee. This is in contrast to other sectors such as manufacturing and agriculture that generally require large space, occasionally even far from population centers.

It is not surprising therefore that approximately half the jobs in mass manufacturing industries and about 80% of all farmed agricultural land is located in the north and south of Israel.⁴ The high availability and low cost of land in these areas lead to specialization in mass manufacturing, agriculture and food, and as will be presented below, we believe that these advantages should be leveraged and strengthened by connecting them to Israel’s advanced innovation system.

Although the geographical distribution described here is based on economic logic and relative regional advantages, it creates several economic and social challenges for the Israeli economy. The first of these challenges is a significant productivity disparity between the country’s periphery and center that is reflected in salaries which are approximately

3 CBS Data, Labor Force Survey, High-tech sectors excluding communications sector

4 CBS Data, Annual Yearbook 2017, Table 20.12, excluding high-tech, and the Ministry of Agriculture & Rural Development, Agricultural and Rural Planning Policy Paper (2015)

35% lower than the average in central Israel.^{5,6} 32% of this disparity can be explained by the difference between the different sectors i.e., by the fact that the high-tech sectors, which are concentrated in the center of the country, are characterized by high productivity compared to the average in developed countries, whereas the mass manufacturing and agriculture sectors, concentrated in the periphery, are typified by lower productivity.

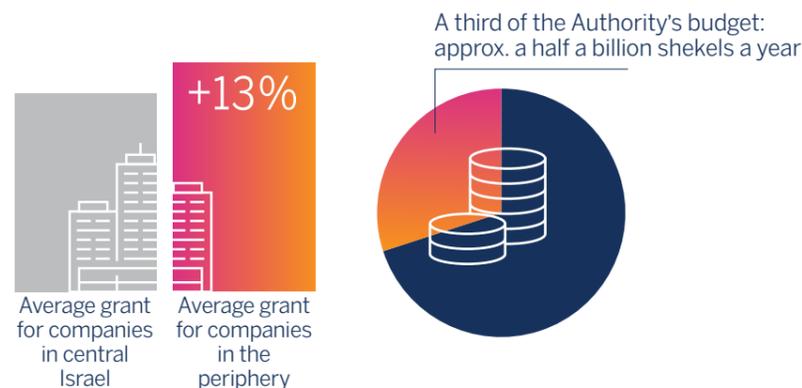
A further challenge arises in light of the shortage of skilled high-tech workers. As we mentioned in the "High-Tech in Israel 2018" chapter, there are an estimated 15,000 unfilled jobs in the high-tech industry. Due to the concentration of high-tech in the center of the country, skilled workers living in the periphery have lower access to high-tech employment. Consequently, the Israeli high-tech industry fails to fully utilize the human capital potential in the periphery.⁷



A Strategy for an Innovation-driven Economy in the Periphery

The challenges described above lie at the foundation of a strategy formulated by the Innovation Authority that is aimed at promoting an innovation-inclined economy in the periphery areas and serve as a clear guiding light for the Authority: a successful policy is beneficial, both for the local economy in the periphery, and the innovation system as a whole.

The Innovation Authority Consistently Invests in Technological Innovation in the Periphery



This policy was not created in a vacuum. For years, the Chief Scientist's Bureau in the Ministry of Economy, from which the Innovation Authority was born, endeavored in a number of ways, to promote technological innovation in the periphery. Firstly, companies from all sectors located in the periphery⁸ received increased grants. Secondly, as part of the Technological Incubators Program, incubators operated, and still operate today, in a range of peripheral areas. Furthermore, large high-tech companies that established development centers in the periphery received special benefits. Approximately a third of the Authority's

⁵ National Insurance Institute Data. Only a small part of this disparity is offset by lower living costs in the periphery – according to National Economic Council analysis, expenses in the periphery are lower by approx. 300-1000 shekels per month than expenses in central Israel

⁶ The National Economic Council in the Prime Minister's Office, 2018. Towards 2040 – A Metropolitan View of Economic Development

⁷ It should be pointed out that this estimation relies on the assumption that there are people living in the periphery with high-tech skills who fail to find quality employment in the field – an assumption that still requires empirical confirmation. An indication to this appears later in this chapter

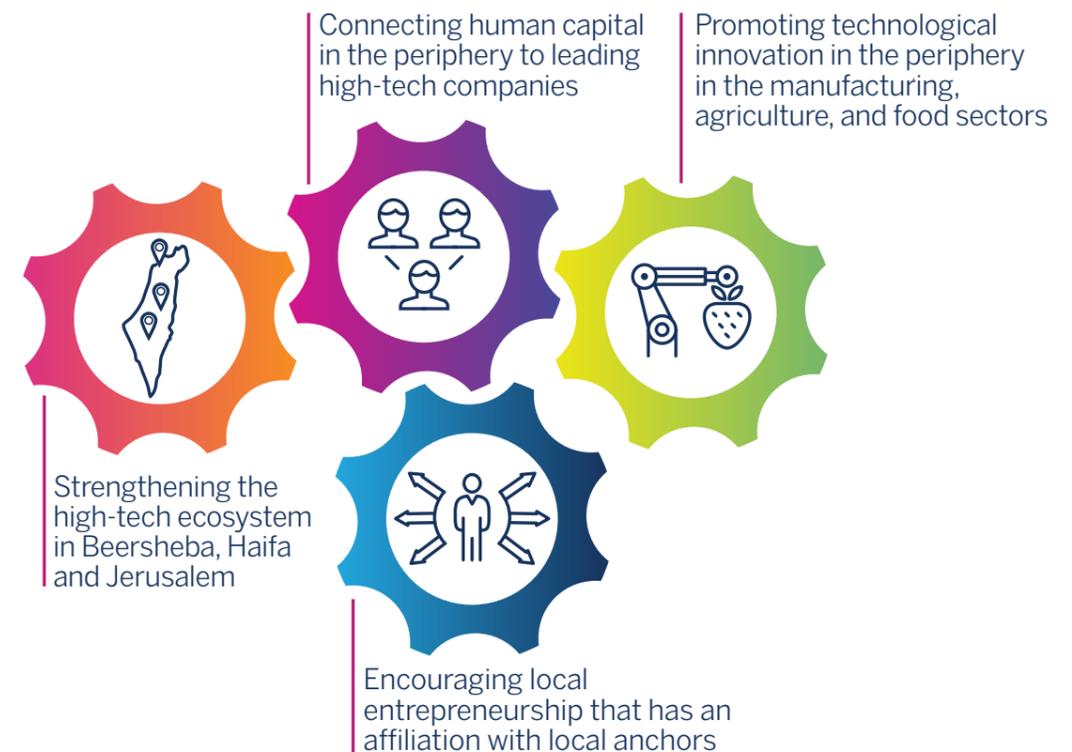
⁸ In 'A' Development Areas as defined by the Ministry of Economy, the Gaza periphery area, and Jerusalem

annual grants budget was allocated in recent years to R&D activity in the periphery – a total of about half a billion shekels (\$140 million) a year.

The need to formulate an updated and comprehensive strategy for innovation in the periphery arose from the very outset of the Innovation Authority's operation. The Knesset, with the legislation that founded the Authority, placed explicit emphasis on promoting technological innovation in the periphery as one of the Authority's central policy objectives.⁹ Accordingly, throughout 2018, we conducted an in-depth examination of policy alternatives for promoting technological innovation in the periphery regions, while considering prior experience in Israel, in other countries, and a current situation report. In addition, we conducted a comprehensive field study among a range of relevant local entities: local authorities, innovation centers, higher education institutions, entrepreneurs and companies.

The study clearly revealed that a national policy for promoting an innovation-inclined economy in periphery areas must be based primarily on regional competitive advantages. In other words, effort should be made to strengthen the local center of gravity of economic activity in the periphery – specifically, mass manufacturing, agriculture and food processing – by encouraging technological innovation and entrepreneurship. The study also found that quality high-tech employment should be made more available to periphery residents – both in order to increase wages and productivity in the periphery, and as a solution for the shortage of human capital in the high-tech industry. Accordingly, the Innovation Authority's strategy to promote technological innovation in the periphery is based on four central objectives:

The Innovation Authority's strategy for promoting technological innovation in the periphery is based on four central goals:



⁹ The Encouragement of Industrial Research and Development Law, 5744-1984, Clause 1

1. Promoting Technological Innovation in the Manufacturing Industry and in the Agriculture and Food Sectors in the Periphery

The manufacturing industry in Israel in general has suffered from under-investment in technological innovation for many years. Among the variety of causes for this were a lack of financing solutions, only loose affiliations with technology and research players, a shortage of technicians, difficulty in allocating managerial resources, and the lack of a sufficient knowledge infrastructure for implementing innovative technologies.¹⁰

On the other hand, the agriculture and food processing sector in Israel has always been typified by development and adoption of advanced technologies.¹¹ However the challenges facing it today, particularly lower than average productivity compared to other developed countries, expected population growth, and the need for more efficient water use – require increased investment in innovation and its implementation in agricultural production. In its survey of agricultural policy in Israel, the OECD points out that extensive investment in research and development and the transfer of knowledge between R&D bodies and farmers will ensure a future increase in the productivity of this sector.¹²

Entrepreneurship Incubators in the Periphery, Food-Tech in the North

As part of its strategy for promoting an innovation-inclined economy in the periphery, starting in 2019 the Authority will launch a new program aimed at encouraging local technological entrepreneurship in the periphery while maintaining an affiliation with local anchors such as academic institutions and centers of industry, food and agriculture – an entrepreneurship incubators program in the periphery.

The incubators will be established and operated during the year by franchises chosen in a competitive process. The franchise will locate and select suitable local initiatives, provide them with technological and business support and connect them to regional anchors – investors, partners and potential clients. If necessary, work space will be provided for the entrepreneurs and the startups they establish, in addition to supplementary financing.

The Innovation Authority will participate in funding the incubator's ongoing operations and will grant incentives to encourage entrepreneurship, the commercialization of applied research, and the R&D activity of startup companies founded as part of the incubator. The incentives will be granted as part of the Authority's range of incentive programs, including the Tnufa Program, the Early Stage Companies Program, and KAMIN and NOFAR Programs for applied research. In 2018, the Authority began establishment of a food-tech incubator in the Tzefat District, as part of the existing Technological Incubator Program. The incubator aims to develop a regional innovation ecosystem in the field of food technology by connecting investors, strategic partners, startup companies, and regional anchors.

10 Ministry of Economy and Industry (2018). National Strategic Plan for Advanced Manufacturing in Industry

11 For example, according to the OECD, Israel is the world leader in recycling wastewater for agricultural use and sustainable agricultural production in arid areas. Source: Review of Agricultural Policy: Israel (2010), OECD

12 Ibid

Peripheral areas in all countries are characterized by low accessibility to skilled personnel, financing and knowledge networks. This hinders the capability of companies operating in these regions to implement innovation,¹³ thereby magnifying the obstacles to investment in innovation in the manufacturing, agriculture and food processing sectors in Israel. Removing obstacles to technological innovation in these sectors is the key to promoting an innovation-inclined economy in the periphery.

The Innovation Authority is already providing approximately 120 million shekels (approximately \$34 million) a year for support of technological innovation in the manufacturing industry. In order to focus efforts on companies located in the periphery, the Authority will primarily strive to increase their participation in the various incentive programs. In particular, the Authority will operate the Preparatory R&D Program – aimed at aiding companies without prior experience in technological innovation processes and companies in need of focusing and direction in their R&D activity – at a number of focal points throughout the periphery. The Authority will also cooperate with the clusters of local authorities that are forming in the Negev and the Galilee to market and provide access to incentive programs for manufacturing companies in the periphery.

The Authority will simultaneously endeavor to encourage technological collaboration between industrial, agricultural, and food processing companies and hi-tech companies, technology entrepreneurs and applied research institutions. The Authority will actively promote the appropriate incentive programs and assist in creating connections between the different entities.

2. Encouraging Local Entrepreneurship in the Periphery with a Link to Regional Anchors

Most of the technological entrepreneurship in Israel is concentrated in the center of the country: the overwhelming majority of venture capital funds in Israel are located in the center, and 77% of all startup companies are located in the Tel Aviv and central regions (see Diagram 1).

The low presence of technological entrepreneurship in periphery areas severely reduces the possibilities for local entrepreneurs in these areas. The development of technology entrepreneurship communities in the periphery will assist local entrepreneurs to realize their potential, will strengthen the connection of local industrial, agricultural and food companies to technological innovation, will contribute to the development of high-quality local employment, and will improve the overall quality of life.

Furthermore, studies show a positive correlation between direct exposure of children to technological innovation activity in one's home area and the probability of engaging in innovation as adults.¹⁴ Increasing exposure to technological innovation among children and youth in the periphery will therefore help them realize their high-tech entrepreneurial and employment potential in the future. Naturally, at the same time, teenagers in the periphery should be encouraged to acquire sciences, engineering and mathematics skills at their high school and university – a goal towards which several government departments are working on.¹⁵

13 Ibid.

14 Lost Einsteins – Innovation and Opportunity in America, Chetty, R. (2017)

15 Especially the Planning and Budgeting Committee (PBC), the Ministry of Education, and the Ministry for the Development of the Periphery, the Negev and the Galilee

The Ministry of Agriculture is striving to turn Israel into an agritech superpower. For details see page 98

The Ministry of Economy is leading together with the Innovation Authority a national strategic plan for advanced manufacturing. For details see page 99

The Innovation Authority will therefore encourage local entrepreneurship in the periphery, with special emphasis on an affiliation with regional anchors such as academic institutions and centers of industry, agriculture, and food, via support of local “entrepreneurship incubators” (See box). These incubators will promote the establishment of local startup companies by local entrepreneurs while connecting them to the needs of local industrial, agricultural, and food companies and to regional applied research centers. The incubators will thus contribute towards the development of a local innovation ecosystem.

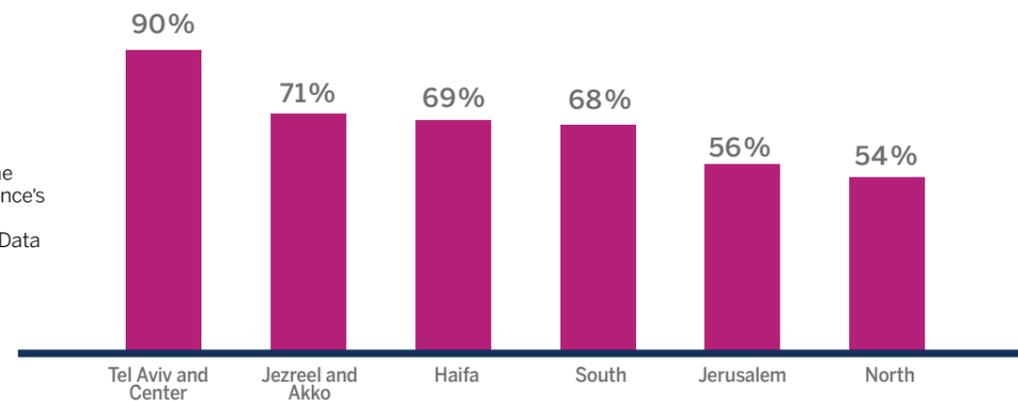
3. Creating Connections Between Human Capital in the Periphery and the Leading High-Tech Companies

In recent years, the high-tech industry in Israel has suffered from a shortage of engineers and programmers that is threatening to cause a slump in its growth. Alongside government efforts to increase the supply of human capital to high-tech, the Israeli industry must vary the sources of human capital to which it turns. Previous innovation reports dealt extensively with the potential human capital sources among women, Arabs, Haredim and older workers. The human capital for high-tech among the residents of the periphery is yet another group the potential of which remains unfulfilled, in this case due to the concentration of high-tech in the center of the country.

Many of those possessing high-tech academic education are interested in living in the Galilee or the Negev for proximity to family, for quality of life or other reasons. Data gathered in the Chief Economist’s Bureau at the Ministry of Finance reveals that more than half the students of science and engineering studies returned after graduation to live as adults in the area in which they grew up (See Diagram 3). Furthermore, approximately only a quarter of science and engineering graduates who grew up in the Israeli peripheral areas move to live in the center as adults.¹⁶ It should be pointed out that the tendency to remain in the same area throughout their lives is especially strong among the Arab population.

Diagram 3: The Tendency of Science and Engineering Graduates to Live as Adults in the Area in which they Grew Up

(The rate of those living in these areas in 2013 out of those who lived there at age 17)



Source: Chief Economist in the Ministry of Finance's Adaptation of Administrative Data

¹⁶ Both universities and academic colleges

Program for Encouraging the Establishment and Expansion of Hi-Tech Companies' Activity in the Periphery

The program provides high-tech companies with incentives to establish centers of technological excellence in the periphery, with a dual objective: leveraging human capital in the periphery for manpower needs in the high-tech industry, and creating a highly productive manpower pool.

In order to attain this goal, incentives will be given to companies interested in establishing a presence in the periphery in order to work on innovative and advanced R&D projects, relying on local human capital. The program's conditions include generous benefits to companies to initiate R&D activity in the periphery, providing that the majority of R&D activity be performed by local workers with adherence to a high innovation level.

In order to moderate the risk involved in initiating R&D activity in a geographically distant area and a “thin” market, the companies participating in the program will receive support for a guaranteed period of three years. The support will begin at 70% of the approved budget and will gradually decrease to 50% by the third year, up to a limit of 10 million shekels (approximately \$2.7 million) a year. Furthermore, the companies will receive up to 3 million shekels (approximately \$0.8 million) for necessary preparatory activity, such as purchase of R&D equipment and personnel training. The support will be provided on condition that 60% of the employees working on the supported R&D project will be periphery residents, and will also depend on the quality level of the project.

After 3 years support, the companies can apply for additional support as part of the framework of the Ministry of Economy and Industry's employment programs (the Israel Investments Center).

Due to the concentration of high-tech activity in central Israel, science and engineering graduates living in the periphery may have difficulty finding employment to suits their skills. Although there are some focal points of high-tech activity in the north and the south, the labor market in these areas is a “thin” market. A thin market is characterized by a small number of “buyers and sellers” – in this case employers and workers – and by an equally low number of employment transactions. This fact leads to employers having difficulty in finding suitable employees and difficulty for workers in finding suitable work or professional advancement. In other words, the upshot is unrealized potential of human capital for the industry and a compromise regarding employment on the part of the workers.

Great importance is placed therefore on the development and enhancement of the high-tech labor market in the peripheral areas. In order to achieve this objective, the Authority will provide incentives to innovative high-tech companies interested in increasing their scope of search for potential employees to open branches in the periphery, while supporting necessary training and adjustments via a specially designated program (See box below).¹⁷ Because experience teaches us that excellence and innovation are key to the growth of sustainable activity in the periphery, the program will emphasize the establishment of local anchors of technological excellence, based on local “talents”, with the intention that these will grow and become prominent and independent centers of the companies’ activities.

4. Strengthening the High-Tech Ecosystem in the Large Cities: Haifa, Jerusalem and Beersheba

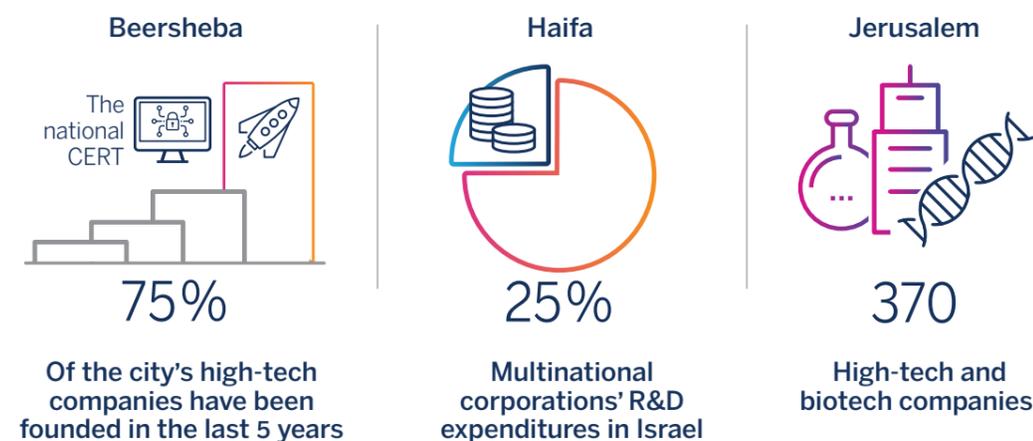
Haifa, Jerusalem and Beersheba already have in place the essential foundations for a high-tech ecosystem, yet their full potential has not been realized: Research universities with strengths in exact sciences and engineering (the Technion, Ben-Gurion University and the Hebrew University), university and research hospitals (Rambam, Hadassah and Soroka), technological entrepreneurship, and R&D centers of large multinational corporations. Haifa is especially characterized by a high level of multi-national R&D centers that are responsible for approximately one quarter of total multinational corporations’ R&D expenditure in Israel.¹⁸ Leading high-tech companies such as Mobileye and OrCam have established themselves in Jerusalem and dozens of startups are already operating in Beersheba where the national Cyber Directorate (a civilian cyber and cyber security center) has been founded.

These cities, already functioning as regional employment centers also have a critical mass of government and municipal activity supplying a supportive environment for high-tech activity, such as allocation of suitable facilities, municipal innovation, investment in education and mass transportation. Furthermore, most of the country’s regions are located within a 50-kilometer radius of these cities,¹⁹ they are connected or will soon be connected by high-speed rail to Tel Aviv,²⁰ and they already constitute regional employment centers.²¹

Nevertheless, none of the above cities have a complete high-tech ecosystem. In order to realize the potential of Haifa, Jerusalem and Beersheba as high-tech employment centers for the peripheral areas, the Innovation Authority will strive towards establishing a high-tech ecosystem in these three cities. To this end, the Authority will promote technological entrepreneurship, will bolster cooperation between players from academia, IDF technology units and industry, and will develop crucial R&D infrastructures for Israeli industry as a whole in these cities while collaborating with the three city municipalities. This will naturally be alongside the ongoing support of existing R&D projects in these cities.

Already in 2018 a new program for encouraging technological entrepreneurship in Haifa was approved by the Authority’s council. Its goal is to promote technological innovation and to increase the number of high-tech companies in Haifa with an emphasis on the “Lower City” borough. The program will include the establishment of hubs and accelerators and the activation of programs to encourage entrepreneurship, and to connect between the different players in the municipal ecosystem. The program will be run by a body selected in a competitive procedure and will receive funding of 25 million shekels (approximately \$6.9 million) from the Innovation Authority for an operating period of 4 years. During 2019, an innovation laboratory in the field of Fin-Sec (Cyber-Financial Technology) will be opened in Beersheba in cooperation with the National Cyber Security Authority and the Ministry of Finance; it will aim to leverage Beersheba’s cyber assets, such as the existing Cyber Directorate for ecosystem development. At the same time, the Authority will conduct an in-depth examination of the cyber assets and the obstacles to the development of a complete ecosystem in Jerusalem and Beersheba, on the basis of which it will formulate broad plans of action.

Potential exists in Haifa, Beersheba and Jerusalem for development of a complete high-tech ecosystem



¹⁷ Based on a sample of people born between 1975-1985. This may be an undervaluation because of possible unreported residential address changes
¹⁸ Amendment to Benefit Track No. 15 – Assistance for R&D centers of large corporations in the periphery

¹⁹ CBS Data, R&D survey, 2015
²⁰ (Except for the 'Galilee Finger' the Golan, and the Southern Negev)
²¹ Already today, the three cities serve as a regional employment center: 350,000 salaried employees work in the Jerusalem area, 240,000 in the Haifa District, 200,000 in the Beersheba District (2017)

TOMORROW'S AGRICULTURE BEGINS IN ISRAEL | THE MINISTRY OF AGRICULTURE



One of the Ministry of Agriculture's central objectives is to continue supplying close to 100% of the Israeli fruit and vegetable consumption in the year 2030. To succeed in this endeavor, the agriculture sector must be at the forefront of technological innovation. The Ministry's vision is therefore to transform Israel into an Agri-tech power that upholds a strong synergy between agricultural crops and the frontline of technological development.

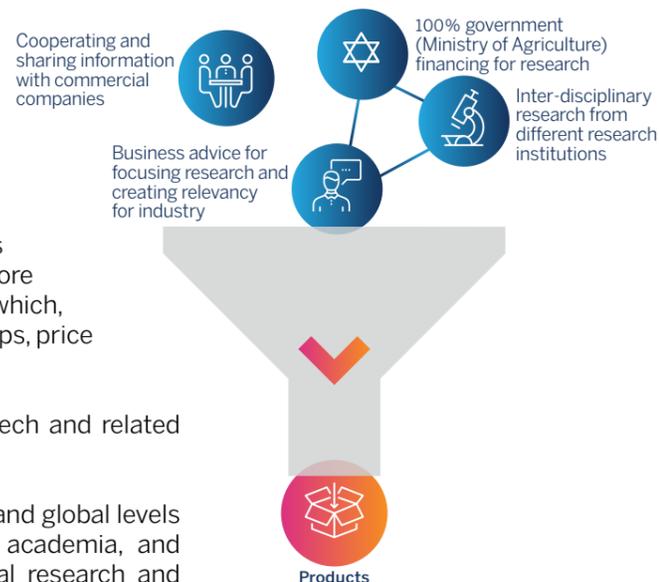
Worldwide agriculture is currently undergoing rapid technological and economic changes. From a technological point of view, there is a transition to precision-agriculture which combines innovative sensors and robotics that will identify parameters such as surface conditions, fruit maturity, seed location etc. This technological development is expected to lower the risk in growing processes, thereby facilitating increased healthy agricultural produce. At the same time, biotechnology developments will enable an increase in crop yield and reduction in the use of pesticides.

With the help of advanced digitalization the agriculture sector is adapting itself to compete in a perfect market: The consumers' insistence on a transparent agricultural value chain and the thirst for full information on food quality, will expedite processes of adaptation to consumers' personal preferences and transparency in the agriculture sector itself.

In order for Israel to be part of these trends and meet the challenges of agriculture in the future, the Ministry of Agriculture is leading a comprehensive strategic program. Its central objective is to increase investment in technological developments, to streamline the agricultural value chain, and to raise the level of Israeli agriculture's global competitiveness in agricultural technologies and products.

The Ministry of Agriculture is striving to achieve these goals in a number of ways:

- Establishment of a support mechanism for new crops that facilitates financial aid, assistance and partnership in developing crop innovations.
- Agricultural knowledge centers that leverage Israeli research capabilities into agricultural technologies that are directed at industry and export, and that supply innovative solutions for efficient and advanced agricultural production.
- Establishment of a 10 million-shekel (approximately \$2.7 million) investment fund with the aim of encouraging implementation of new technologies in agriculture and supporting farmers, in accordance with various parameters.
- Establishment of digital trading floors that facilitate direct contact between growers and buyers. The trading floors enable a more efficient management of agriculture output which, in turn, allow for trade of varied qualities of crops, price transparency, and encourages competition.
- Increasing the scope of investment in Agri-tech and related innovation.
- Assistance in expanding cooperation at local and global levels between entrepreneurs, investors, farmers, academia, and anyone involved in the worlds of agricultural research and innovation.



NATIONAL STRATEGIC PLAN FOR ADVANCED MANUFACTURING IN INDUSTRY | THE MINISTRY OF ECONOMY AND INDUSTRY

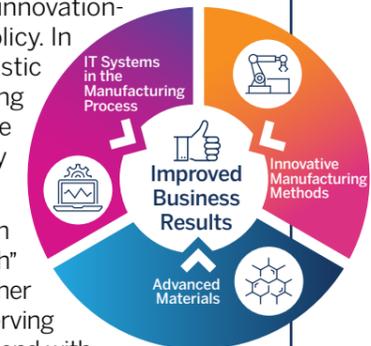


Advancing the Israeli economy and specifically, transforming it into a smart and innovation-inclined economy is a central aspect of the Ministry of Economy and Industry's policy. In conjunction with the Innovation Authority, the Ministry recently formulated a holistic plan of action that aims to support the implementation of advanced manufacturing technologies in the manufacturing sector by building a national supportive infrastructure and providing designated assistance tools to factories, thereby strengthening the manufacturing sector and enhancing its competitiveness.

In recent decades, Israeli industry has undergone a gradual process of polarization between the steadfast strength of the high-tech sectors and the decline of "old-tech" industries, due to - among other factors - accelerated globalization processes. As in other developed countries, here too these processes have lowered the importance of preserving the manufacturing stage in the product's value chain and have created the need to contend with competition from developing countries that are characterized by low labor costs and loose regulation.

"Advanced Manufacturing Technology" which is integrated with "The Fourth Industrial Revolution" - Industry 4.0 - are the precursors of the significant changes in the balance between two types of competitiveness: the one based on personnel expenditure and the one based on value, efficiency and technological advantage. "Advanced Manufacturing" is a relatively new term relating to improved productivity and business performance through implementation of new manufacturing systems using advanced raw materials and IT integration in the manufacturing process.

These technological developments, together with the opening of additional markets to international competition, provide Israel with a unique opportunity to significantly and sustainably strengthen local manufacturing via technological upgrading of the existing factories and the opening of new technologically powerful companies. Furthermore, Israel has the opportunity to position itself as a center for technology and startup companies that supply advanced manufacturing solutions in a range of fields including big data, machine learning, cyber defense, and additive manufacturing. Realizing these opportunities is expected to have an extremely positive impact on the economy, to increase GDP, lead to improved competitiveness and productivity, and expand the high-quality employment options in Israel.



The programs that have been formulated and initiated are detailed below:

- Infrastructure reinforcement and improved access to knowledge that supports implementation of advanced manufacturing – an innovation-supportive environment with suitable infrastructure will assist in the implementation of advanced manufacturing and the development of Israel's industrial sector. This includes the development of R&D capabilities in selected technologies, the creation of a platform that enables knowledge-access to industrial developments, to ecosystem support, while developing and strengthening communication and collaboration between all the field's players. Establishing the national institute for advanced manufacturing will support the effort to increase the sector's productivity and competitiveness.
- Continuous support for the technological implementation process at the factory level – the implementation of innovative technologies, digitalization, and transition to a smart factory is a complex process; continuous support is crucial for small and medium-sized factories to succeed.
- Capital investment and financing avenues – industrial factories, especially small and medium-sized ones, face difficulties when trying to raise suitable financing via traditional banking channels. Without incentives, capital support, and access to creative financing avenues, the factories embarking on a process of technological upgrading will face obstacles.
- Developing skilled human capital for the manufacturing industry – a central condition for implementing advanced manufacturing in the industry is the high availability of technologically skilled and talented personnel. Only a flexible system capable of adapting to market needs at the factory level, rapidly and efficiently training its workforce, will succeed.

Re-modelling the image of the manufacturing industry as a market growth engine – traditional industry is perceived as old-fashioned and devoid of promising employment prospects. The desired image is an "advanced manufacturing industry" with a high level of technology and enticing employment prospects.

Results of the Indicators that make up the High-Tech Index

The Startup Companies Sub-Index:

- Net New Companies:** The sub-index is the net change in the number of Israeli companies operating in the high-tech industry. In other words, the number of Israeli high-tech companies that were opened minus the number of Israeli high-tech companies that were closed.
- Number and Value of Companies' Capital Recruitments:** The total sum raised and the number of transactions in which Israeli high-tech companies recruited capital from all investors – venture capital funds, angels and other investors.
- Number and Value of Exits:** The number and monetary value of the exits in which Israeli high-tech companies participated. An exit is defined both as an Initial Offering (IPO) and as a merger or acquisition (M&A).
- Funds' Recruitments:** The total yearly sum recruited by Israeli venture capital funds, the figure is an indicator of the future investments expected in Israel by the same funds.

Year Indicator	Actual Value			Normalized Value		
	2015	2016	2017	2015	2016	2017
Value of Exits (in billions of dollars)	8.85	5.47	7.78	0.76	-0.4	0.39
Number of Exits	134	120	126	1.86	0.92	1.32
Value of Companies' Capital Recruitment (in millions of dollars)	4307	4834	5278	3.63	4.45	5.15
Number of Company Recruitments	706	673	623	1.9	1.56	1.04
Funds' Recruitments (in millions of dollars)	1503	1926.5	1558	1.91	2.99	2.05
Net New Companies	715	549	452	2.52	0.88	-0.07

The Mature Companies Sub-Index:

- Added Value:** Defined as the difference between the gross output and total input. The sub-index was calculated as the sum of the added value in both high-tech industry and services (the computer and software sector and the R&D services sector that includes the startup companies).
- High-Tech Export:** The total exports of industry and services in the high-tech sectors, including the startup companies' exports.
- Salaried High-Tech Employees:** The number of salaried employees in the high-tech industry, excluding those in the communications services sector.
- The Blue-Tech Index:** The TA Global Blue-Tech Index that includes all the shares from the technology and biomed sectors. The index is calculated as an average of the daily closing indices for each year.
- The Number and Value of Secondary Offerings:** The number and monetary value of the public offerings performed by the Israeli high-tech companies whose shares are listed for trade (secondary offerings). These variables describe the continued growth in value of Israeli public companies.
- The Number and Value of High-Tech Acquisitions:** The number and monetary value of merger and acquisition transactions completed by the Israeli high-tech companies, where the acquired company is not necessarily Israeli or technological.

Year Indicator	Actual Value			Normalized Value		
	2015	2016	2017	2015	2016	2017
Added Value (in millions of shekels, current prices)	117,471	119,444	126,488	2,300	2,450	2,980
Salaried High-Tech Employees	258	270	277	2.82	3.74	4.21
High-Tech Exports (in millions of dollars)	40135	41492	44817	1.82	2.05	2.62
Blue-Tech Index – Yearly Average	351.6	334.92	368.57	0.69	0.42	0.97
Number of Secondary Offerings	34	19	22	2.08	0.39	0.73
Value of Secondary Offerings (in millions of dollars)	2432	639	878	0.99	-0.51	-0.31
Number of High-Tech Acquisitions	75	71	62	2.65	2.14	0.99
Value of High-Tech Acquisitions (in millions of dollars)	7493	8328	921	0.97	1.22	-0.93

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