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A study of CleanTech Innovations in the Israeli Entrepreneurial Ecosystem

Israel

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Executive Summary:

This report presents a study on the innovation and entrepreneurial ecosystem in Israel, with the focus on the CleanTech industries, which include technologies that facilitate environmental and developmental sustainabilities, such as renewable energy and water technologies. The ecosystem was evaluated through analysis of the five main stakeholders (government, corporate, entrepreneur, capital, and university), both in general and with additional emphasis on the CleanTech fields. Analysis was based on both literatures and interviews with local stakeholders in the ecosystem. The common problems faced by the Israeli CleanTech entrepreneurs are discussed and recommendations for different stakeholders to address these issues are proposed in the end.

Introduction:

Economy of Israel

Prior to the 1970s, Israel's economic output mainly depended on traditional industries including chemicals, rubbers, and textiles. With the development of the defense force, related Hi-Tech industries, such as hardware, telecommunications, and medical devices, started emerging, attracting big multinational corporates like Intel, Microsoft, IBM, etc. to locate their research and development centers in Israel. By 2006, Hi-Tech output accounted for 70% of the industrial product of the country (Israel Ministry of Foreign Affairs).

Israel is also known to spend the highest percentage of its GDP on R&D in the OECD world, at 4.9% as compared to 2.7% by the US. 90% of this budget is spent on Hi-Tech industries. In addition, major bi-national or multi-national funding also contributes to the R&D budget in Israel. For example, the Israel-US Binational Industrial Research and Development (BIRD) foundation supports applied research. In addition to with the US, Israel has also

established major foundations Germany, France, and Britain to support basic research in the country (Israel Ministry of Foreign Affairs).

Culture of innovation

Often referred to as 'the Startup Nation', Israel is known to have an active culture of innovations. As widely pointed out, one major trait of the Israeli character is the tendency to challenge authority, which reflects an emphasis on critical thinking. As discussed in the book 'Start-up Nation: the Story of Israel's Economic Miracle' by Dan Senor and Sual Singer, even in the army, the hierarchy is not always obvious, and young soldiers can bring up challenging ideas to senior officers (Senor and Singer, 2011). In addition, because of the mandatory military service immediately after high school, Israelis are more likely to have faced situations that require on-the-spot solutions while being under pressure and with limited resources, which encourages them to think outside of the box. Senor and Singer pointed out that the mandatory military service system also strengthens long-term connections between people from different professions due to the mandatory reserve service that can last for decades, whereby facilitating collaborations between industries and generation of new ideas and innovations.

Need and development of CleanTech

Despite rarely seen on the headlines, clean and sustainable technologies are urgent needs for Israel. Two of the main areas of CleanTech that are vital to the livelihood of the Israeli state are water technologies and renewable energy.

Located in the Middle East, Israel cannot rely heavily on rainfall for water resources. The main freshwater source were the Sea of Galilea in the North and underground aquifers. However, these sources are limited in both quantities and the locations they can naturally serve. To sustain population growth of the country, it is important to increase the supply and accessibility of freshwater. There have been multiple large-scale water infrastructure projects in Israel, among which the National Carrier is one of the most famous. The National Carrier is a gigantic pipeline that was built half a century ago to supply fresh water from the North to the Negev desert in the South, where people started to settle and farm. Israel is also an innovator

in waste water treatment, inventing the technique of using natural aquifer as a filter to treat water. Today, 80% of the sewage water is recycled in the Dan region, which houses nearly half of Israel's population. The waste water, after being treated in Shafdan, a treatment plant south of Tel Aviv, is so clean that it is transported to the Negev for irrigation use. Due to the climate change, drought, and pollution in the Jordan river, the natural fresh water has become less reliable, which prompted the blooming of the desalination industry in Israel. With several big desalination facilities along the coast, 70% of the drinking water in Israel now comes from desalination. In addition, Israel has a big agriculture industry, exporting many vegetables, which further adds on to its water need (Siegel, 2015).

Renewable energy is a major component of sustainable technologies. In Israel, the need for renewable energy is significant not only because of the inherent limitations of fossil fuels, but also because of the country's political relationship with its neighbors in the Middle East, which makes energy independence an urgent need for Israel (Yossi Rosenwaks, 2018). Currently, out of the 53 billion kWh of electricity consumption in Israel, only around 5% comes from renewable energy (WorldData). The government had set a target for 10% of the electricity to be generated from renewable sources by 2020 (Export.gov, 2018). Despite the abundant sunlight, the largest solar-thermal power project, still under construction, is said to have a capacity of 300MGW, as compared to some larger solar PV plants in the world that have five times of the capacity. Moreover, the continuous population growth in the region also adds on to the future demand of energy. Therefore, there is still a great need for renewable energy technologies, especially in the long term.

Methodology

Materials and information for this report mainly comes from two sources, the Internet and interviews with stakeholders in Israel. Resources from the Internet include academic studies published online, governmental and company websites, online database, as well as relevant articles. A total of 10 stakeholder interviews were conducted either in person or through phone calls, usually with durations between 30 and 60 minutes. The stakeholders were

selected because of their involvement in either the entrepreneurial ecosystem or the CleanTech industry in Israel. Most of the 5 types of the stakeholders in the ecosystem were represented in the interviewees, with the exception of government. However, the governmental website of the Israeli Innovation Authority contains thorough and useful information, which provided perspectives from the government's involvement in the ecosystem. The interviewees, their association, along with the purpose of each interview are tabulated below.

Table 1. Interviewee Information

Name	Association	Purpose of Interview
Shilony, Amit	Former employee at Hutchinson Kinrot, a venture capital company; long involvement in water treatment	To understand the funding situation from the private sectors for early-stage CleanTech startups, and the general CleanTech landscape in Israel.
Bleich, Sivan	Manager at WaTech, Mekorot, the innovation department of the Israeli national water company	To better understand the role that corporates play in the development of CleanTech startups.
Koretz, Binyamin	Consultant at BrightSource Energy, an Israeli solar energy company; long involvement in the solar-thermal energy in Israel	As an introduction to the renewably energy situation in Israel, to help evaluate the challenges of starting a business in this field.
Semiat, Raphael	Professor Emeritus, Chemical Engineering, Technion; extensive research on water technologies; Co-founder of MemTech, a membrane startup for water treatment	To learn about the academic research on water technologies, as well as to hear from an entrepreneur's perspective on starting a company in CleanTech
Tal, Alon	Professor, Social Science, Tel Aviv University (TAU); environmental activist	To learn about the pressing environmental issues in Israel, the attitude from the society, and thus the demand for CleanTech technologies, as well as their social impacts.
Rosenwaks, Yossi	Professor, Dean of the School of Engineering, Director of the Renewable Energy Center, Tel Aviv University	To understand the academic research on renewable energy in university campuses, and their likelihood of resulting in startups, as well as efforts from academia to promote CleanTech research.

Calfon, Oren	VP at Ramot, the technology transfer company of Tel Aviv University	To understand, through the technology transfer process, the university's efforts at helping technologies become commercial, which is a critical part of entrepreneurship.
Cohen, Nimrod	Managing partner at TAU Venture, the venture capital company at Tel Aviv University	To gather information about the early-stage growth of startups, specially how universities act as hubs for innovators, and what universities have done to promote entrepreneurial efforts.
Kandel, Daniela	Director at Start-Up Nation Central	To obtain a comprehensive perspective of the innovation and entrepreneurial ecosystem through Start-Up Nation Central's role as the interface between entrepreneurs and investors or collaborators.
Abramowitz, Yosef	President and CEO of Energiya Global Capital; co-founder of Arava Power, the first commercial solar PV field in Israel	To gain a better understanding of the current situation of solar energy in Israel, and to learn about the experience of starting a CleanTech company in the country despite resistance.

Key Findings

Analysis on the Stakeholders in the Ecosystem:

1. Universities

Israeli universities are known for their active innovative and entrepreneurial cultures. For example, TAU has been ranked as one of the most innovative universities in the world outside of the US. In addition to establishing its own technology transfer company and partnering with equity partners, the university has recently established TauVenture, a venture capital that provides supports for entrepreneurial efforts by offering seed money and connecting them with services ranging from accountants, lawyers, and designers, as well as investors or high-level management in relevant big companies. TauVenture also offers co-working spaces for these early-state entrepreneurs (Nomrid Cohen, 2018). Ramot, the technology transfer company, helps researchers and faculty patent their technologies for future commercial use. Although Ramot does not serve just entrepreneurs, its existence makes the researchers aware of the practicality and applicability of their research, promoting more relevant innovations from the

university (Oren Calfon, 2018). Such programs are to promote general entrepreneurial efforts at the university, but programs that focus on CleanTech or non-IT startups are still lacking (Raphael Semiat).

CleanTech research in university campuses are diverse in terms of their types, scales and contents. Some research focus on basic science, while others have more practical purposes, both of which are essential for the advancement of technologies but have different levels of suitability in the entrepreneurial ecosystem. Among the water technology research in the Technion, some research labs, such as Prof. Raphael Semiat's group, formulate their topics around problems faced by water engineers in reality and conduct experiments on pilot-scale instrument. On the other hand, some researchers work on developing new technologies radically different from current practices, so their tests are performed on much smaller scales. The former type of research appears readier to result in companies, because the solutions they provide can be more easily adopted without the existing industry having to make big changes in their industry, which is usually costly in the CleanTech industry. The startup company that came out of Prof. Semiat's group is such an example, which will be discussed in later sections.

Israeli universities and research centers effectively improve I-Cap in the ecosystem, as they bring researchers together and facilitate innovations. The entrepreneurial programs in the universities also help transform the I-Cap into E-Cap.

2. Government

One of the major governmental organizations involved in the nation's entrepreneurial and innovation ecosystem is the Israel Innovation Authority. It consists of several divisions that provide supports for technological innovations of different kinds and at various stages. The Startup division, targeting entrepreneurial efforts at earlier stages, offers programs such as Tnufa, which helps innovators in terms of proof of concept and R&D, and the incubator, which helps local entrepreneurs to start building their companies. The Startup division also offers additional programs that encourage foreign innovators to start companies in Israel, as well as educational programs about entrepreneurship for middle school and high school students. The

Innovation Authority includes a Growth division that promotes innovations in more mature startups or established companies. This division is in charge of R&D funding in all industry.

The Innovation Authority provides supports for the CleanTech industries through additional programs: the renewable energy center, the greenhouse gas emission reduction program, and financial support for investment in alternative fuels for transportation. The renewable energy program provides financial support from 50% to 85% of the R&D cost for projects from research to testing stages. The greenhouse gas reduction program, on the other hand, gives grants to cover installation cost of implementation of Israeli technologies of emission control and energy efficiency improvement. This indirectly helps the growth of the CleanTech industry by increasing demands in the relevant fields.

In addition, Israel also partners with European and North American countries to establish binational foundations to promote technological innovations, such as BIRD (US), GIP (Germany), etc., as well as joint innovation projects with many countries in Europe and Asia. Details of these funds will be discussed in the Capital section.

The governmental programs in general improves E-Cap in the ecosystem, as they encourage the carry-over of innovation to entrepreneurial efforts. In the meantime, the funding for CleanTech industries also promotes I-Cap because it provides incentives for more research on innovations in the related fields.

3. Corporate

Some big corporates can play an important part in the ecosystem through the establishment of innovation centers that collaborate with innovators. In Hi-Tech, many multi-national big companies have established research and development centers in Israel since long ago, and have contributed significantly to the innovations in corresponding fields. Such phenomenon is present but less prominent in the CleanTech fields. An example is the WaTech department in the Israeli national water supplier, Mekorot. WaTech was established in 2004 to find novel solutions in water technologies by collaborating with innovators such as startups, research institutes, incubators. Connections are established through an ‘open call’ process, in which Mekorot states the issues that need to be addressed and call for solutions. After the

solutions are admitted, the innovators may receive some funding from Mekorot, or get help on applying for governmental and international fundings (Sivan Bleich, 2018). Although such collaborations do not often result in mergers or large investment from Mekorot itself, they provide several benefits to the startups. First, the startups have the incredible opportunities to test their technologies on existing Mekorot infrastructure, as it is usually not practical for startups to build large testing sites themselves. Second, the innovators become more familiar with the actual challenges facing the industry, which may therefore improve the relevance of their solutions. Third, having the name of a famous corporate on the technology increases the chance of it being adopted by other companies. On the corporate side, such collaborations expose the employees to new technologies, and also save the corporates from developing the solutions themselves, which could increase the chance of new and cleaner solutions to be used in the industry, promoting the CleanTech market in general.

I-Cap and E-Cap could both benefit from such programs by corporates, as the corporates collaborations can span from research institute to startups, whereby promoting innovations and entrepreneurial efforts alike.

4. Capital

In addition to the funds provided by the Innovation Authority and international funding programs, private capital is a major funding source, especially for later-stage startups (Amit Shilony, 2018). In 2016, Israeli companies raised $4.43 billion in total, among which around 70% was backed by venture capital. The later rounds have in general accounted for the biggest fraction of the capitals over the past few quarters. Among the early stage investments, round A and B have taken up more funding compared to seed and round C. in terms of capital raised by sectors, IT and enterprise software continued to be the biggest contributor, while the internet industry was significant up to 2016 but has since seen a decline. Life science industries, such as pharmaceuticals, have also been increasingly attracting funding. Capitals invested in CleanTech industries, however, have always been insignificant compared to the IT sectors, accounting for no more than 5% of the total capital investments. Among all the investments, Israeli VC funds accounted for around 15% of the capitals in first investments, and mostly in the form of follow-

on investment, with around 90% of the investment into mid and late stage companies. Foreign investments have historically been a bigger source of capitals for Israeli Hi-Tech companies (IVC and ZAG-S&W, 2017).

While there are abundant VC activities in Israel, investments in CleanTech industries have not been as available. Due to the popularity of cyber, communication, and software industries, VCs tend to prefer funding these Hi-Tech companies, because they require less upfront capitals and have shorter return period. The CleanTech industry, on the other hand, is a less favorable candidate due to the uncertainties in evaluating the technology as they generally require significant scale-up from research scale (Amit Shilony, 2018), large capital investment, reluctancy of big corporates to make changes in infrastructure, and the long return period. For example, TauVenture, the VC company at TAU, has explicitly stated that they prefer to not fund 'hard-tech' startups. However, as the needs for CleanTech start emerging, there has started to be VCs and incubators specializing in CleanTech startups and technologies. For example, Capital Nature is an investment firm that focuses on innovations, including academic research and startups, in fields related to renewable energy. Their portfolio includes startups that address the energy problem in various angles, from PV production technologies to energy storage, as well as smart energy management (Capital Nature). Hutchinson Kinrot is also a leading seed investor in CleanTech, mainly in water technologies. Hutchinson Kinrot usually provides early-stage startups with seed funds of $0.5-1 million to help them get started, with the funding sources a combination of private and governmental sectors (Amit Shilony, 2018).

The capital is an essential part of the ecosystem, sustaining the E-cap through monetary support, but is also a screening process for the startups. The evaluations performed by the investors is a good indicator of how viable a potential startup is, so the capital also indirectly improves the quality of the companies in the entrepreneurial ecosystem.

5. Entrepreneurs

According to a study conducted by the IVC Research Center and REVERSEXIT about Israeli startups, more than 10,000 Hi-Tech companies were founded between 1999 and 2014, showing activity of the entrepreneurial ecosystem in the country. Among these companies,

however, only half were still active at the time of the study. Most of the active companies were yet to become 'successful', which was defined as having an annual revenue of more than $100 million or over 100 employees (IVC and REVERSEXIT, 2015). In terms of demography of entrepreneurs, out of more than 4000 founders of startups since 2014, only around 10% are women, whose startups tend to be in the fields of education and knowledge technologies (CALCALIST, 2017). Based on the in-region interviews and surveys of startup profiles, the majority of entrepreneurs have had at least some work experience prior to founding companies.

In the CleanTech industries, founders of the companies tend to be older and more experienced, and often already established in relevant fields. For example, professors can easily access innovations their research, and can also connect with industries easily because full professors in Israeli institutes are allowed, and even encouraged, to consult with companies outside of the universities (Raphael Semiat, 2018, and Oren Calfon, 2018). Similarly, people with significant experience in the field have better understandings of the landscape of the industry and are thus more likely to be able to find the niches, not to mention the connections accumulated over the years. In addition, co-founders from international background are not uncommon, as they bring in foreign investment. The CleanTech industry requires more investment and connections, but young entrepreneurs tend to have less of these resources available due to lack of experiences.

Common Challenges of CleanTech Innovations and Entrepreneurs

Sustainability is seen as a commercial trend by companies, mostly for their public images (Ami Shilony, 2018). In addition, Israel is not a leader in sustainability, as it has strong competing priorities, such as national security and development, scale of the country's economics, as well as the desire to take the path of the least resistance (Alon Tal, 2018). Discrepancy between research supply and industry demand can also be a significant problem for CleanTech startups (Oren Calfon, 2018). Because sustainable technologies tend to be relatively specific, it is difficult to tweak the technology to fit into a different need once it is

developed. Therefore, a mismatch of the supply and demand can be a serious and even detrimental problem.

CleanTech startups also face additional technical challenges compared to those in other Hi-Tech fields because of the difficulties of scaling up (Amit Shilony, 2018). Because of the complexity of the hardware requirement of many of these technologies, unexpected problems tend to emerge during the translation of a proof-of-concept prototype to the actual implementation, whereby increasing the risk of investing in these technologies. At the same time, the market, including utility companies and powerplants, is conservative, making them even less motivated to adopt cleaner technologies.

Reluctance of corporates to invest significantly on cleaner technologies is yet another challenge to the entrepreneurs in the CleanTech industries. For example, BrightSource Energy, one of the leaders in the solar-thermo industry, no longer invest on research after optimization studies on their first project. Even WaTech, from the largest water company in the country with thousands of employees, only consists of seven people. The lack of interest in new technologies from big corporates leads to a lack of the market for sustainable technologies, which in turn discourages the research and development of these technologies.

Financial challenges have also become obvious, especially at later stage of investment (Amit Shilony, 2018). Since many investors, even including TauVenture, prefer short-term return and less initial investment, CleanTech companies have disadvantages compared to other Hi-Tech industries.

Recommendations

As discussed in the previous section, CleanTech startups in Israel face more obstacles as compared to other Hi-Tech companies, despite the importance of the sustainability industries. However, there are some measures that the stakeholders in the local ecosystem can take to promote the CleanTech culture and entrepreneurial efforts.

Because of the large scale of the projects in the CleanTech industry, government plays an important role in the implementation of new technologies. To promote development of

innovations, the government, specifically the Innovation Authority, need to establish funding or programs specific for CleanTech, which provide relatively long-term support for CleanTech startups. Nonetheless, because many existing energy and resource companies are affiliated with the government, the government needs to prioritize long-term development and take a stronger position in advocating for cleaner technologies (Yossi Abramowitz, 2018). In addition, the government can promote the CleanTech industry through regulations on environmental standards. Regulation has been found to be the most effective incentive for corporate to adopt cleaner technologies (Alon Tal, 2018), so the demands of more environment-friendly technologies will increase in the market.

Entrepreneurs in the CleanTech industry could promote themselves through entering the global market, even at early stage. Due to the size limitation of the local market in Israel and the relatively conservative utility industries, entrepreneurs need to be mindful of the difficulties of surviving solely on domestic market. With the technological advantages and the country's reputation of innovation, Israeli companies have a good start to enter the international market, which is beneficial for the companies in a long term (Daniale Kendal, 2018). In addition, staying international from the beginning allows the companies to ensure that their technologies can comply with the stricter regulations adopted by other countries, therefore increasing the competitiveness of the companies. At the same time, the entrepreneurs could work with environmental activists to increase the public awareness about environmental issues, and educate the public about the need for CleanTech, which can also improve the demands for such technologies in the market. Apart from entering the CleanTech industies from the infrastructure level, entrepreneurs can in fact contribute to the fields in a variety of ways. For example, the startup Ecoppia specializes in solar panel cleaning, and a few companies, including Kedma Solar, develop solutions for more efficient energy uses (Yossi Abramowitz, 2018). With the overall CleanTech industries expanding over time, entrepreneurs can find niches to grow in these fields, without always requiring a formidable amount of upfront funding.

While the primary purpose of universities is not educating entrepreneurs, universities could still take some measures to promote the transfer of their existing academic research to

commercial innovations. One important step is to facilitate dialogues between the industry and the researchers. If researchers have more opportunities to communicate with experts in relevant industries, their innovations could have better match with the need of the market. Such communication would not only increase the likelihood of adoption of lab innovations, but could also potentially bring more research funding to the CleanTech research in the universities. However, it is also essential to allow researchers to maintain independence of their research, and to provide resources for basic science research at the same time.

Although some large corporates already collaborate with innovators, such as in the case of Mekorot, this kind of collaborations need to be more common. Although CleanTech innovations tend to face challenges scaling up, therefore requiring large-scale testing sites, yet early startups usually have limited access to such infrastructure. On the other hand, large corporates, such as utility companies, control the infrastructure but in general do not invest much in research and development. Therefore, collaborations where startups can test their technologies on infrastructures of large corporates, or even work with the corporates to improve the applicability of the technologies, can be beneficial to both sides, while promoting more CleanTech entrepreneurial efforts in the ecosystem.

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